General Plan of Operations

Greens Creek Mine
Admiralty Island, Alaska

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ACRONYMS

ADEC – Alaska Department of Environmental Conservation

ADFG – Alaska Department of Fish and Game

ADNR – Alaska Department of Natural Resources

ANILCA – Alaska National Interest Lands Conservation Act of 1980

APDES – Alaska Pollution Discharge Elimination System

AWQS – Alaska Water Quality Standards

BOD – Biological Oxygen Demand

DA – Direct Area

EIS – Environmental Impact Statement

EPA – Environmental Protection Agency

FCS – Flow Control Structure

gpm – gallon per minute

GPO – General Plan of Operations

HDPE – High Density Polyethylene

HGCMC – Hecla Greens Creek Mining Company

IMP – Integrated Monitoring Plan

LHD – load-haul-dump

LOM – life of mine

mgd – million gallons per day

mg/L – milligrams per liter

Monument – Admiralty Island National Monument

NEPA – National Environmental Policy Act

NEP – North Extension Project

NOI – Notice of Intent

OPMP – Office of Project Management and PermittingRC – reverse circulation

ROD – Record of Decision

RQD – rock quality description

SAG – semi autogenous grinding

SCADA – Supervisory Control and Data Acquisition

TDF – tailings disposal facility

TSS – Total Suspended Solids

µg/L – microgram per liter

USFWS – U.S. Fish & Wildlife Service

WTP – water treatment plant

1. INTRODUCTION

The Greens Creek Mine (Mine) is an existing polymetallic underground mine located about 18 miles southwest of Juneau, Alaska, on the northwest side of Admiralty Island (**Figure 1-1, General Location Map**). Hecla Mining Company holds a 100% interest in the Mine through its subsidiaries Hecla Greens Creek Mining Company (HGCMC), Hecla Juneau Mining Company and Hecla Alaska LLC. For the purposes of this updated General Plan of Operations (GPO), the acronym HGCMC will be used, as this entity is the operator of the Mine.

Major facilities at the Mine include the mill and mine portal facilities, tailings disposal facility, waste rock storage facilities, roads, and Hawk Inlet facility. The locations of existing facilities are shown on **Figure 1-2, Greens Creek Mine Facility Locations**.

The U.S. Forest Service, Tongass National Forest, is responsible for the administration and management of federal lands on Admiralty Island, including Admiralty Island National Monument (Monument) where portions of the Mine facilities are located. Section 503(i)(1) of the Alaska National Interest Lands Conservation Act of 1980 (ANILCA) provides that holders of valid mining claims under subsection (f)(2)(B) be entitled to carry out mining activities within the Monument, consistent with the purposes for which the Monument was established.

This updated GPO describes the history of the Mine, the location and purpose of Mine facilities, an overview of Mine operations, and how the environment and resources in the area of the Mine are protected through compliance with federal, state and local requirements. The GPO, as previously approved by the Forest Service, is a working agreement between HGCMC and the Forest Service for the operation and reclamation/closure of the Mine. When future Forest Service approvals are granted for operation or reclamation activities at the Mine, HGCMC will revise and update the GPO. An example of such an update would be if the Forest Service approves HGCMC's 2020 request for extension of the existing tailings disposal facility (TDF), under the name "North Extension Project" (NEP).

HGCMC prepares an "Annual Work Plan" for review and approval by the Forest Service and the Alaska Department of Natural Resources (ADNR) Office of Project Management and Permitting (OPMP). The Annual Work Plan defines activities for the upcoming year and is assembled to be consistent with the GPO. The Forest Service must approve any significant changes to the existing GPO, as provided by 36 CFR 228.5(c).

Figure 1-1, General Location Map

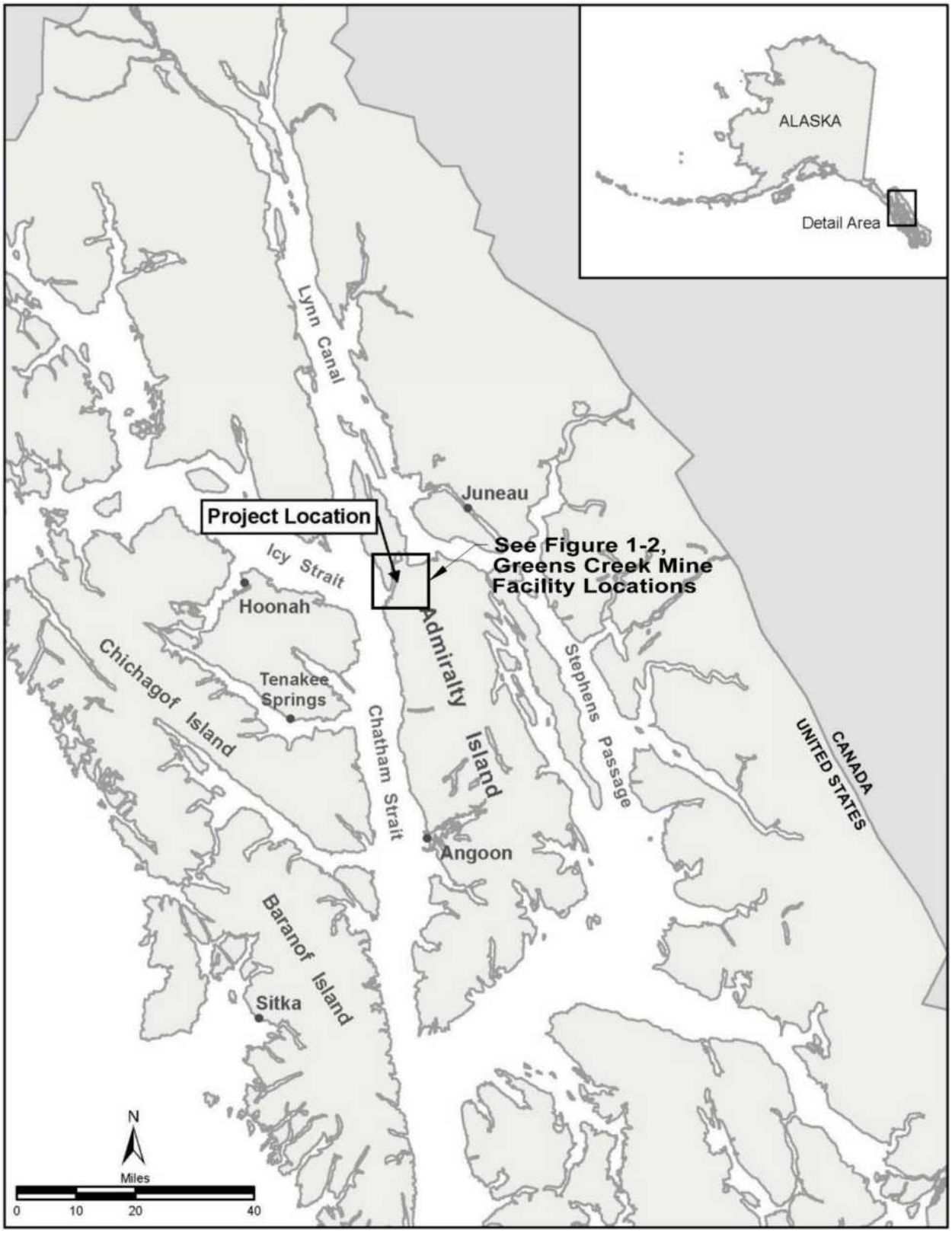
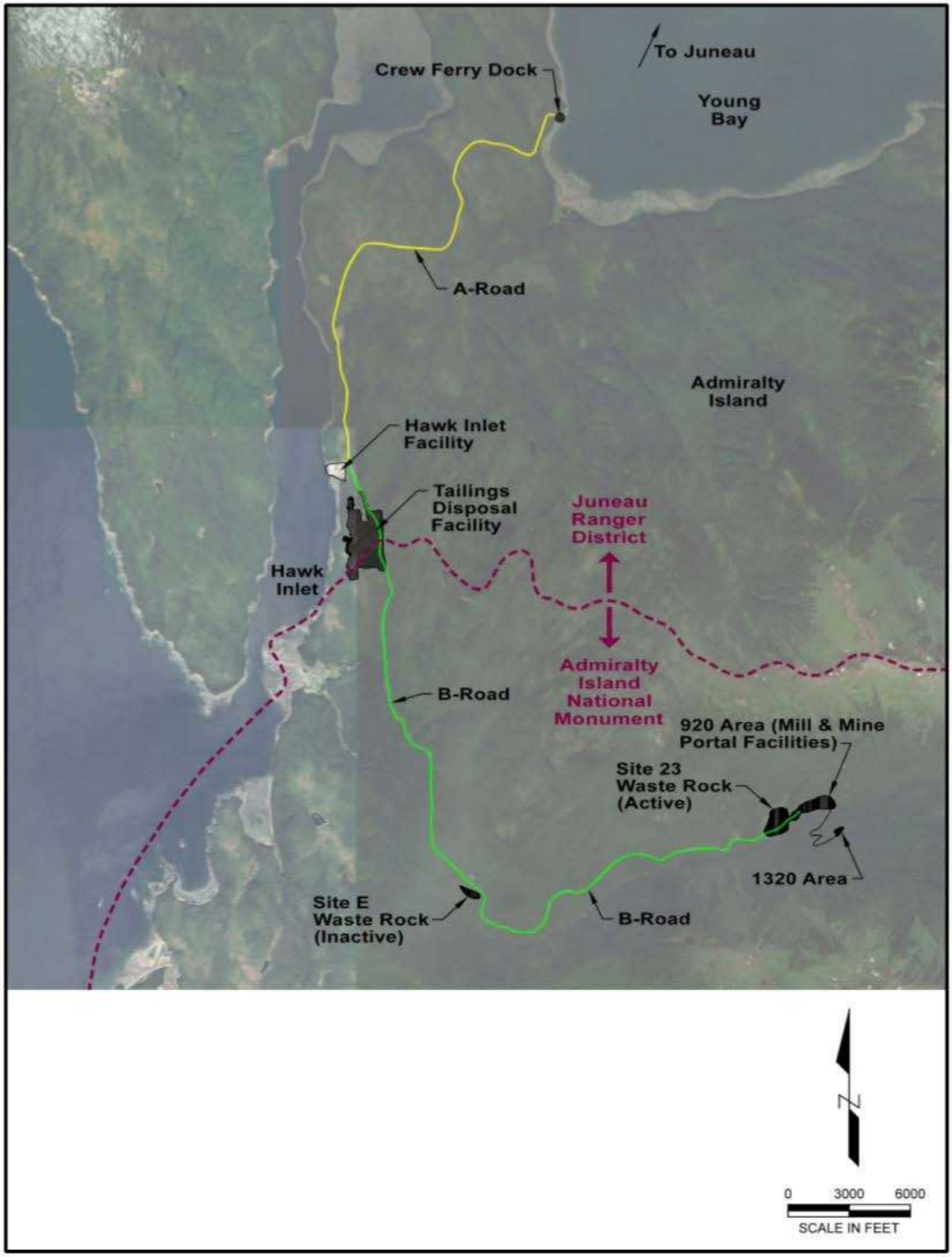


Figure 1-2, Greens Creek Mine Facility Locations



1.1 History of Greens Creek Mine Operations

The summary of the Greens Creek Mine history is presented in **Table 1-1, History of Greens Creek Mine Operations**.

Table 1-1, History of Greens Creek Mine Operations

Timeframe	Entity Involved	Activity
1973	Pan Sound Joint Venture	Reconnaissance mineral exploration begins in southeast Alaska, including on Admiralty Island. Joint venture includes Noranda Exploration, Marietta Resources International, Exalas Resources Corporation, and Texas Gas Exploration. **Noranda Exploration is operator of the joint venture**.
1975 - 1977	Pan Sound Joint Venture	Mineralization is recognized near Greens Creek and mineral claims staked. Surface exploration drilling commences. Exploration and geological efforts determine potential significant mineral resource at the Greens Creek site.
1978	Greens Creek Joint Venture	Pan Sound Joint Venture is dissolved and replaced by Greens Creek Joint Venture. Companies in new joint venture are Marietta Resources International, Exalas Resources Corp, Texas Gas Exploration, Noranda Exploration, and Bristol Bay Resources, Inc. **Noranda Exploration is operator of the new joint venture**.
1978 - 1979	Noranda Exploration	Exploration adit is developed to allow underground drilling and sampling of mineralized areas. Extensive underground drilling begins to define the Greens Creek ore body. Engineering work determines mining/milling methods and the presence of an economical operation. Numerous environmental baseline studies are completed. Noranda Exploration submits a plan of operation to Forest Service for the development and operation of the Greens Creek Mine.
1979	Forest Service	A Notice of Intent (NOI) to prepare an EIS for the proposed Greens Creek Mine is published in the *Federal Register*. Work begins on an EIS for the proposed mine.
1980	Forest Service	Public and agency scoping occurs to determine issues involving the proposed mine. Noranda Exploration mineral claims at the Greens Creek project site are validated.
1982	Forest Service	A Draft EIS on the proposed Greens Creek Mine is prepared and released. Public and agency comments on Draft EIS are received.
1982	Anaconda Minerals Company	Acquires Marietta Resource's interest in the Greens Creek Joint Venture.
1983	Forest Service	Final EIS is released in January 1983.
1983	Noranda Exploration	Based on consequences and conclusions in Final EIS, a General Plan of Operation is prepared for the Greens Creek Mine and filed with Forest Service.
1984	Forest Service	General Plan of Operations for Greens Creek Mine is approved.
1985	Amselco Minerals Inc.	Acquires Anaconda Minerals Company's interest in the Greens Creek Joint Venture.
1986	Amselco Minerals Inc.	Acquires Noranda Exploration's interest in the Greens Creek Joint Venture. **Amselco Minerals Inc. assumes position as project operator**. Initiates construction of the mine. Also begins review of existing information and development of detailed mining plan and other design studies, including review of tailings handling plans.
1987	Amselco Minerals Inc.	Submits annual work plan for final project construction, which includes a change of tailings handling from conventional slurry deposition to filtered (dry-stack) placement. Seeks a revision of the General Plan of Operation.
1987-1988	Forest Service	Determines requested plan changes from Ameselco Minerals Inc. requires NEPA review. An EA is prepared and released. Requested operational changes approved.
1988	Kennecott Greens Creek Mining Company	Acquires control of project. **Kennecott Greens Creek Mining Company becomes project operator**.

Timeframe	Entity Involved	Activity
1989	Kennecott Greens Creek Mining Company	Ore production begins at the Greens Creek Mine.
1990	Kennecott Greens Creek Mining Company	Based on continued successful ongoing exploration, seeks revision to the General Plan of Operations for additional waste rock disposal capacity.
1991 - 1992	Forest Service	Determines requested plan changes from Kennecott Greens Creek Mining Company requires NEPA review. An EA is prepared and released. Requested operational changes approved.
1993 - 1996	Kennecott Greens Creek Mining Company	Greens Creek Mine operations suspended due to low metal prices
1996	U.S. Congress	The Greens Creek Land Exchange Act is passed, which grants Kennecott Mining Company the title to subsurface of 7,500 acres adjacent to existing claims
2001	Kennecott Greens Creek Mining Company	Based on positive results of continued underground exploration work, submits modifications to the General Plan of Operations for the extension of the existing tailings disposal facility (TDF).
2001 – 2003	Forest Service	Determines requested plan changes from Kennecott Greens Creek Mining Company requires NEPA review and completion of an EIS. Public and agency scoping occurs to determine issues involving the extension of the existing TDF. A series of alternatives are considered. A Draft EIS on the TDF extension is prepared and released. After receipt and review of comments on the Draft EIS, a Final EIS is prepared and released. Forest Service Record of Decision (ROD) is issued that approves the TDF extension.
2008	Hecla Greens Creek Mining Company	Acquires control of project. **Hecla Greens Creek Mining Company becomes project operator**.
2009	Hecla Greens Creek Mining Company	Requests revision to the General Plan of Operation to allow co-disposal of waste rock stockpiled at Site E with tailings at the existing TDF.
2009	Forest Service	Reviews HGCMC request for co-disposal of waste rock and tailings and determines requested modification does not represent a substantial change to the 2003 Final EIS and ROD and approves the request.
2010	Hecla Greens Creek Mining Company	Based on positive results of continued underground exploration work, reduction in capacity of TDF for geotechnical conditions (unsuitable foundation conditions in areas approved in 2003 Forest Service ROD, and elevated production rates, HGCMC submits a request to modify the General Plan of Operations to allow for an extension of the existing TDF to allow 30-50 years of additional storage capacity.
2010 -2013	Forest Service	Determines requested plan changes from HGCMC requires NEPA review and completion of an EIS. Public and agency scoping occurs to determine issues involving the extension of the existing TDF. A series of alternatives are considered. A Draft EIS on the TDF extension is prepared and released in 2012. After receipt and review of comments on the Draft EIS, a Final EIS is prepared and released. Forest Service Record of Decision (ROD) is issued that approves only an approximate 10-year extension of the existing TDF. ROD requests HGCMC re-examine future TDF capacity needs based on Monument values and concerns over potential impacts to anadromous fisheries in Tributary Creek.
2018	Forest Service	Approval was granted to HGCMC for the removal of the limitation on the co-disposal ratio.
2020	Hecla Greens Creek Mining Company	Requests Forest Service approve a revision to the General Plan of Operation for another extension to the existing TDF based on need for additional tailings disposal capacity for expected future mine production.

1.2 Mineral Tenure, and Surface Rights

The land comprising the Mine consists of both public and privately-owned land. The Mine area includes 440 unpatented lode mining claims, 58 unpatented mill site claims, 17 patented lode claims, one patented mill site and other private (fee) lands, notably the Hawk Inlet Facility. There are approximately 8,072 acres of unpatented claims and 328 acres of patented claims. HGCMC's total land package encompasses 16,140 acres.

The patented lode claims, containing approximately 327 acres, are located in Sections 4, 8, 9 and 10, Township 44 South, Range 66 East, Copper River Meridian, Juneau Recording District, Alaska. The 0.62-acre mill site claim is located in Section 1, Township 43 South, Range 65 East.

The unpatented lode and mill site mining claims are situated in Sections 1-3, 10-15, and 22-27, Township 43 South, Range 65 East, and Sections 7, 17-20 and 29-33, Township 43 South, Range 66 East, Copper River Meridian. The unpatented lode and mill site claims encompass approximately 8,072 acres.

HGCMC also holds title to mineral rights on 7,301 acres of federal land acquired through a land exchange under the Greens Creek Land Exchange Act of 1995 (Public Law 104-123). This land exchange allows for restricted surface usage rights by HGCMC. Additional leased parcels from the Forest Service occur on both Monument and non-Monument lands. HGCMC also uses other public lands pursuant to special use permits issued by the Forest Service and leases issued by the State of Alaska. **Figure 1-3, Land Holdings Layout for the Project Area**, shows the various land holdings in the Mine area.

1.3 Native Alaska Interests

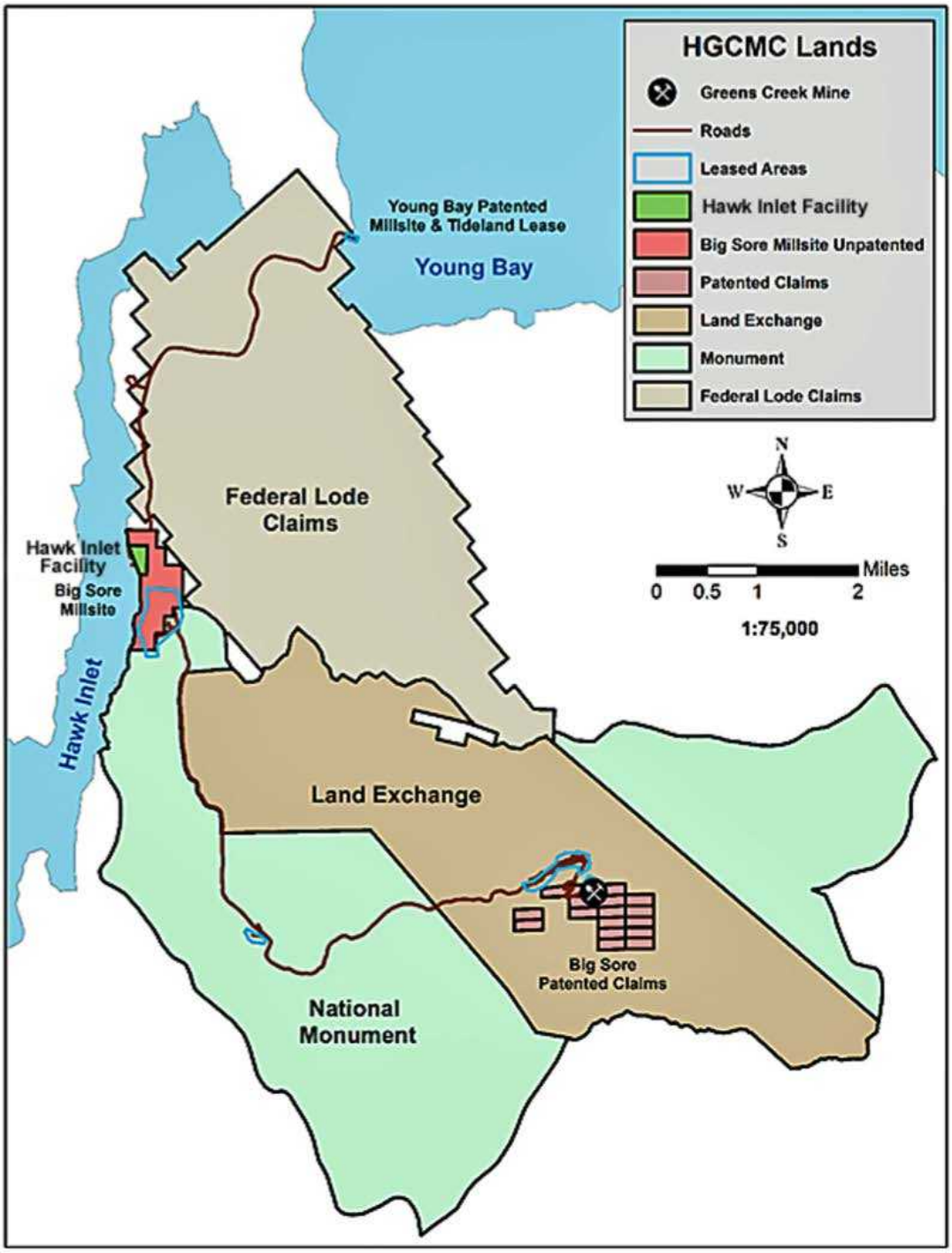
HGCMC complies with Alaska and federal employment laws, which identify Native Alaskans as a protected minority classification.

HGCMC has no Native Alaska agreements and there are no outstanding Native Alaskan claims in the Mine area.

1.4 Permits and Environmental Compliance

The Mine is currently regulated by numerous permits and approvals issued by various federal, Alaska and local agencies covering activities at and around the Mine (**Table 3-1, Greens Creek Mine - Major Permits and Approvals**). The operation of the Mine and associated facilities are authorized in part under a series of leases and other land use authorizations that are carried out in accordance with Forest Service-approved permits and approvals. HGCMC has obtained and maintains applicable permits and approvals for Mine operations to ensure that mining activities are conducted within the regulatory framework required by federal, state, and local regulations.

Figure 1-3, Land Holdings Layout for the Project Area



HGCMC has developed and maintains an extensive environmental monitoring system to verify that the Mine operates within permit limitations to minimize and/or eliminate environmental impacts during operations and later as part of reclamation and closure. Monitoring activities include surface water, groundwater, process water, and drinking water monitoring; geochemical characterization of tailings, waste rock, and construction rock; geotechnical monitoring of Site 23 waste rock storage facility and tailings disposal facility, including Ponds 7 and 10; and biological monitoring of activities during

operations and closure. HGCMC also maintains a reclamation and closure plan to address interim, concurrent, final reclamation and post-mining land use.

GPO appendices that describe HGCMC's management, monitoring, sampling programs, and best management practices (BMP) and are listed below:

- Appendix 1 - Integrated Monitoring Plan (IMP)
- Appendix 2 - APDES Marine Water and Sediment Sampling Programs
- Appendix 3 - Tailings Disposal Facility Management Plan
- Appendix 4 - Fish and Wildlife Monitoring
- Appendix 5 - Best Management Practices
- Appendix 6 - Spill Prevention, Control, and Countermeasure Plan
- Appendix 7 - Integrated Waste Management and Disposal Plan
- Appendix 8 - Road Operation and Maintenance
- Appendix 9 - U.S. Coast Guard and Operations Plan and Facility Response Plan
- Appendix 10 - Pond 7/10 Operations and Maintenance Program
- Appendix 11 - Waste Rock Management Plan
- Appendix 12 - Air Quality Plan
- Appendix 13 - Fire Plan
- Appendix 14 - Reclamation and Closure Plan
- Appendix 15 - Conceptual Suspension of Operations Plan

1.5 Land Use

1.5.1 Land Use Authorizations

The Forest Service is responsible for the issuance of leases, special use permits, timber sales, and other authorizations for HGCMC activities identified in this GPO and any subsequent HGCMC Plans of Operations, which must meet National Environmental Policy Act (NEPA) requirements and be approved by the Forest Service prior to implementation.

The following authorizations are required:

1. Annual Work Plans - These plans set forth work to be conducted by HGCMC during the upcoming year and include more detail than this GPO. The Annual Work Plans cover overall project activity, mitigation, monitoring, development of storage/disposal areas for tailings and waste rock, and exploration activities. These plans are approved by the Forest Service and are reviewed and approved by the State as needed.
2. Special Use Permits – The Forest Service has issued a special use permit to authorize construction and maintenance of the Mine's A and B roads for the life of mine (LOM).
3. Leases - Leases are required for the milling and mining-related use of lands that are not authorized on such lands under other provisions. Such leases shall provide for refund of any lease fees during the period of adjudication if the claims are determined to be valid.
4. Mineral Materials Contracts - Minerals materials contracts are required to authorize use of quarry material for construction and maintenance purposes.
5. Timber Disposal Sales - Timber disposal sales contracts or permits are required preceding operations for any additional clearing. Timber removal is usually authorized after plans for various other facilities are approved.

1.5.2 General Conditions

During Mine operations, Forest Service representatives will be notified prior to undertaking any significant surface disturbance not described in the existing GPO. The Forest officers will inspect the site periodically to assure compliance with the operating plan.

In accordance with 36 CFR 228.8, "all operations shall be conducted so as, where feasible, to minimize adverse environmental impact on National Forest surface resources". All requirements for environmental protection contained in 36 CFR 228.8 will apply.

In addition, HGCMC will meet applicable requirements of 36 CFR 228, 252.10, and 252.11 pertaining to maintenance during operations, public safety, removal of structures and equipment, and fire prevention and control.

Use and storage of explosives will be conducted in accordance with applicable state and federal laws.

If, during the initial survey or during any subsequent ground altering activities, any cultural or paleontological resources are encountered, work in that area will stop, and the Forest Service will be notified immediately. As soon as practicable a determination as to the significance of the remains will be made by the Forest Service archaeologist. Mitigating measures will be enacted to ensure the protection of these resources and may include relocation of the drill site, or excavation of the remains.

Approval of the use of water from National Forest lands by the Forest Service during drill operations does not in any manner constitute certification of water rights.

Discharge of any petroleum products into any aquatic upland ecosystem is prohibited. Any accidental spills of petroleum products in saltwater shall be reported to the US Coast Guard. Petroleum product spills in areas other than saltwater shall be reported to the Alaska Department of Environmental Conservation (ADEC). Petroleum product spills will be reported in accordance with federal and state laws. A contingency plan for clean-up of any petroleum product spills includes materials and methods of spill clean-up as approved by the U.S. Coast Guard and ADEC (**See Appendix 6, Spill Prevention, Control, and Countermeasure Plan; and Appendix 9, U.S. Coast Guard and Operations Plan and Facility Response Plan)**.

Hunting and fishing by HGCMC employees or contractors are prohibited at the mine site during their work rotations. Employees or contractors may access Admiralty Island by their own means to hunt and fish during their time off.

The harassment of wildlife by low flying aircraft is prohibited.

The baiting or feeding of any wildlife species is prohibited.

2. GREENS CREEK MINE OPERATIONS

1.6 Mine Layout

The major infrastructure areas supporting operations at the Mine include the mill and underground mine area, Site 23 waste rock storage facility, Hawk Inlet Facility, the TDF, Young Bay dock, approximately 13 miles of connecting roadways, a power intertie connecting the Mine to the Juneau area power grid, and various pipelines and outfalls for wastewater and stormwater (See Appendix 05, BMP Plan).

The 920 area, shown on **Figure 2-1, Mill and Mine Site Area**, is located adjacent to the main portal approximately eight road miles from the Hawk Inlet Facility. Located at the 920 area are the mill, backfill batch plant, powerhouse, water treatment plants, surface maintenance shop, main warehouse, administrative offices, and fuel storage tanks. There is also a road to the 1350 exhaust portal.

The 860 area, also shown on **Figure 2-1, Mill and Mine Site Area**, is immediately adjacent to the 920 area, and has additional office buildings, assay laboratory, and core-logging facilities. Site 23, shown on **Figure 2-2, Site 23 Waste Rock Storage Facility**, which is approximately 0.2 miles from the 920 area, is the active waste rock storage facility and includes a helipad and shotcrete batch plant.

The TDF, shown on **Figure 2-3, Tailings Disposal Facility**, is the permanent disposal site for tailings not placed as underground backfill. Ponds 7 and 10, a truck wheel wash, and a water treatment plant (WTP) are located at the TDF Area.

The Hawk Inlet Facility, shown on **Figure 2-4, Hawk Inlet Facility**, includes core storage; concentrate storage; a deep-water port that accommodates cargo ships, freight barges and fuel barges; warehouse; sanitary sewer and potable water treatment; fuel storage; and camp housing.

The Young Bay facility (not shown) consists of a boat dock for the crew transport ferry, parking for buses, and a generator for powering lighting.

Figure 2-1, Mill and Mine Site Area

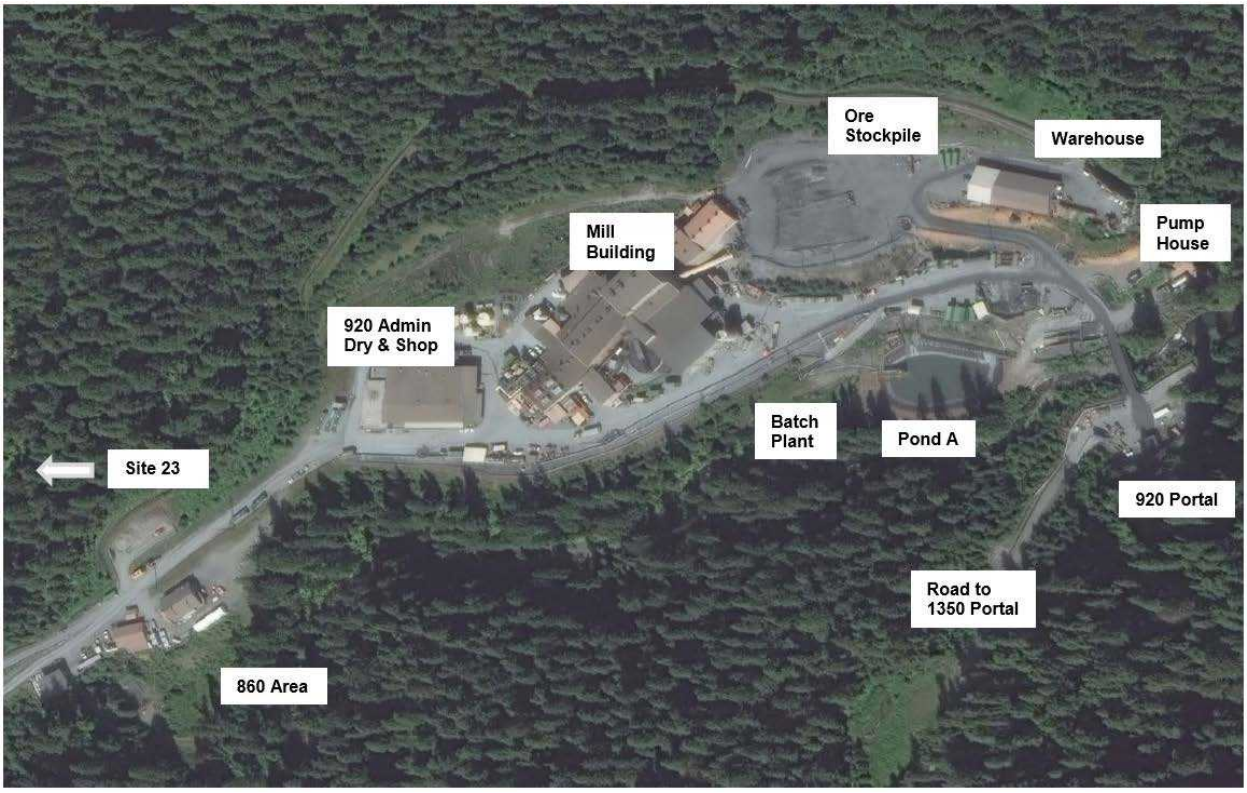


Figure 2-2, Site 23 Waste Rock Storage Facility

Figure 2-3, Tailings Disposal Facility

Figure 2-4, Hawk Inlet Facility

1.7 Exploration

Initial and ongoing site exploration activities have included surface reconnaissance, geological and structural mapping, geochemical sampling, ground and down-hole geophysical surveys, and surface and underground drilling.

From 1975 through 2018, 8,041 drill holes (3,846,373 feet) were completed at the Mine site. Of these drill holes, 418 (510,499 feet) were surface drilled 5,147 (2,832,264 feet) were underground drilled for exploration purposes, and 2,476 (503,609 feet) were drilled for further definition of the ore resources.

Bedrock drilling is completed using core methods. Surface drill holes collaring into unconsolidated sediments utilize reverse circulation (RC) methods until bedrock is encountered (typically less than 100 feet), then completed using core methods.

As part of the drilling programs, downhole surveys are completed using standard industry techniques. Drill core is logged for recovery, rock quality description (RQD), lithology, alteration, mineralization, structure and fabric.

1.8 Underground Mining

The Mine is primarily accessed via the 920-level portal, shown on Figure 2-1, Mill and Mine Site Area. This portal also serves as the primary air intake. A second portal adjacent to the 920 Portal serves as a secondary escapeway and an additional air intake. A third portal located at the 1350 elevation serves as the primary ventilation exhaust and an additional escapeway. There is also a ventilation raise to the 1350 portal area which serves as an additional exhaust.

The working areas are accessed via ramp. Most ramps are connected with cross-cuts at various locations, therefore most working areas have multiple options for equipment access in the event a particular ramp is blocked for rehab or utility work. Two of the ramp systems have a single route for mobile equipment access. These ramps feature laddered escapeway raises to enable airflow and a secondary means of egress.

Mine production and development are undertaken with modern mechanized trackless equipment. Ore and waste are hauled to the surface using trucks. Backfill is achieved using a combination of three methods: paste pumped from the underground paste plant, cemented tailings trucked and jammed and into the heading, and development waste placed into the area to be backfilled. In addition to the conventional trackless mining equipment, the Greens Creek fleet contains LHD (load-haul-dump) units capable of tele-remote operation. This equipment enables production activities to continue during the shift change and post-blasting periods when no personnel are allowed underground.

The current production rate is approximately 2,300 t/d of which approximately 2,000 t/d is produced by cut-and-fill with the remaining 300 t/d from longhole stoping.

Greens Creek is considered to be a dry mine with groundwater inflows typically less than 50 gpm. Water is collected in centralized sumps where solids are allowed to settle. The water is then pumped out of the mine to the 920 water treatment facilities and the solids are disposed of underground.

Maintenance facilities for the mine's mobile equipment are located both underground and on surface. Major underground equipment includes a variety of trucks, graders, drills, load haul dump machines, compressors, pumps, sprayers, telehandlers, and transmixers.

1.9 Mine Support Area and Mill Site

The mine support area (located near the 920 Portal) consists of equipment, maintenance and repair facilities, mine backfill plant, ore concentrator, power plant, fuel storage tanks, locker and shower rooms, ore and waste rock storage, a warehouse, office space, maintenance/electrical shop, and a truck scale.

An extensive sediment control program is used for the mine support area. Pond-A in conjunction with a system of collection ditches, paving, sediment traps, and storm drains collect surface runoff from disturbed surface areas. A sediment basin installed upstream of Pond-A receives water pumped from underground workings and some surface runoff. The sediment basin, paving, and sediment traps were designed to reduce sediment loading in Pond A. Water from Pond-A is routed to Pond 7 at the TDF via a pipeline. From Pond 7, water is treated at the TDF WTP before being discharged into Hawk Inlet in compliance with HGCMC's Alaska Pollution Discharge Elimination System (APDES) permit.

Non-contact runoff upgradient of the mine support area is intercepted and diverted around the area with a berm and trench diversion system.

1.9.1 Milling

The HGCMC mill produces flotation concentrates and tailings. The flotation process concentrates valuable minerals (lead, zinc, silver and gold) using a series of steps: size reduction, mineral concentration, and moisture reduction of the concentrate and tailings. Size reduction involves reducing ore from the Mine in a semi-autogenous grinding (SAG) mill prior to feeding the ore into the flotation cells.

The ore slurry is routed in pipes to flotation cells or tanks, where valuable minerals are separated from waste rock materials in a froth flotation process. The valuable minerals adhere to air bubbles that rise to the surface of the tank and are removed. To facilitate an efficient process, air and various reagents are added to the tanks. This allows the bubbling or frothing action to float different ore minerals selectively, so that metal concentrates can be produced.

Lead, bulk, zinc concentrates, and final tailings are pumped to separate thickeners tanks where ore concentrates and tailings, are thickened. From these thickeners, the ore concentrates and tailings are individually routed to filter presses to reduce the moisture content of these materials to approximately 10-15% by weight. The resulting products are known as “filter cakes”, and they are dropped into appropriate bins below the filter presses. These filter cakes are the final concentrate products and tailings from the milling operation. From here the ore concentrates are hauled to the Hawk Inlet Facility for off-site shipment, while the tailings are hauled to the TDF or used for paste backfill.

Reagents and consumables used during the milling process are listed in **Table 2-1, Reagents and Consumables**.

Table 2-1, Reagents and Consumables

Item	Usage
Mill Consumables	
4.5” SAG mill balls	Primary grinding
2” ball mill balls	Secondary grinding
1/2" regrind balls (12% Cr)	Lead and zinc re-grinding
Plant Reagents	
Carbon Dioxide	pH modifier, (Lead roughing/cleaning)
Zinc sulfate monohydrate	Zinc depressant, (Lead roughing/cleaning)
Sodium isopropyl xanthate	Collector, all circuits
Aerophine 3413 promoter	Collector/promoter, Lead roughing and cleaning
Copper sulfate pentahydrate	Activator, zinc and bulk circuits
MIBC	Frother (all circuits)
Line (unslaked)	pH modifier (zinc circuit, treatment plants)
Flocculants and Coagulants	
Z Flocc 2525	Non-ionic flocculant (thickeners)
Ferric chloride (42%)	Coagulant – water treatment plants
Goldenwest 774	Anionic flocculant – treatment plants

1.9.2 Concentrate and Supplies

Lead, zinc and bulk concentrates are transported to the marine terminal at the Hawk Inlet Facility on a daily basis, seven days a week, and are placed in a covered storage facility, from which they are loaded onto ships via an enclosed conveyor belt system.

Flatbed trucks are used to transfer supplies from the Hawk Inlet Facility to the mine support area. Shipping containers are used for material containment and shipping. Forklifts are used to load and unload supplies and containers. Storage areas and warehouses are located both at the Hawk Inlet Facility and the mine support area.

1.9.3 Mine and Mill Wastewater Transport

Three single-walled high-density polyethylene (HDPE) pipelines carry mine and mill wastewater from the mine support area (including water generated from storm events) to Pond 7 at the TDF. They include an 8-inch, 10-inch, and 18-inch pipeline. The 8-inch is dedicated to stormwater; the 10-inch is dedicated to treated water from the water treatment plants in the mill; and the 18-inch is a backup pipeline for the other two. An 18-inch diesel pump is used as needed to move additional water down the 18-inch pipeline as well. The 8 and 10-inch pipelines can be routed into the 18-inch pipeline as needed. The pipelines are located within the B-Road corridor, adjacent to the drainage ditch. Segments of the pipelines are buried to provide protection from physical damage.

The pipelines are pressure tested every three years to verify that they do not leak. In addition, water operators monitor the pipeline daily when driving the B-Road. Flow rates are monitored in the mine’s SCADA system.

HGCMC monitors the quality of mill effluent to determine overall water quality. Monitoring is routinely performed, typically monthly.

1.10 Tailings Disposal Facility

The mill generates approximately 1,800 dry tons of filter-pressed tailings per day, or approximately 650,000 tons annually. The TDF has undergone multiple staged, incremental expansions as the Mine life has been extended over time. About 50% of the tailings are mixed with cement and hauled back into the underground mine for disposal in mined-out areas as backfill. The remaining 50% of the tailings are transported from the mill on the B Road using covered 45-ton haul trucks to the TDF the tailings are end dumped from the trucks, spread by a bulldozer, and compacted in lifts in a manner to minimize surface infiltration and promote runoff.

Geomembrane liners, cutoff walls, and above- and below-liner drainage systems are used to control and contain potential seepage from the tailings. Surface water is managed via lined ditches and culverts.

The following items are monitored at the TDF:

1. Surface and ground water quality;
2. Water levels with wells and piezometers;
3. Geochemical properties of the tailings;
4. Geotechnical stability; and,
5. Aquatic biology in adjacent drainages and creeks.

Appendix 3, Tailings Disposal Facility Management Plan, provides information on the management objective, operations, and monitoring and inspection requirements for the TDF.

The Alaska Department of Environmental Conservation (ADEC) has established receiving water quality standards pertinent to discharge of wastewater from the WTP into Hawk Inlet. Under the APDES permit, up to 4.60 million gallons per day (mgd), or 3,200 gpm, are permitted with a 3.7 mgd 30-day average requirement. Water released into Hawk Inlet must meet the standards set by ADEC at the mixing zone, which is an area around the diffuser that measures 165 feet by 80 feet. **Table 2-2, Effluent Limitations and Monitoring Requirements**, outlines water quality criteria as set in the Mine's APDES permit.

Table 2-2, Effluent Limitations and Monitoring Requirements

Parameter	Units	Effluent Limits		Monitoring Requirements	
		Daily Maximum	Monthly Average	Minimum Frequency	Sample Type
Flow	mgd	4.6	3.7	continuous	recording
Cadmium [a]	µg/L	100	50	weekly	24-hour composite
Copper [a]	µg/L	99	39	weekly	24-hour composite
Lead [a]	µg/L	327	123	weekly	24-hour composite
Mercury [b]	µg/L	1.9	1.0	weekly	24-hour composite
Zinc [a]	µg/L	1,000	500	weekly	24-hour composite
TSS	mg/L	30	20	weekly	24-hour composite
pH	s.u.	See Permit Part 1.2.4		continuous	recording
Cyanide [c]	µg/L	19	9.2	weekly [d]	24-hour composite
Temperature	°C	-	-	weekly	grab
BOD_5	mg/L	-	-	monthly	grab
Fecal coliform bacteria	#/100 mL	-	-	monthly	grab

Notes:
a. Metals shall be measured as total recoverable.
b. Mercury shall be measured as total.
c. Cyanide shall be measured as weak acid dissociable (WAD).
d. Weekly sampling may be reduced to monthly after four months (16 weeks) if all samples have levels of WAD cyanide below the detection level of 5 µg/L. Otherwise, 16 consecutive weeks of WAD cyanide concentrations below 5 µg/L is necessary to reduce monitoring frequency to monthly. Before monitoring frequency may be reduced, the permittee must receive written DEC approval.

1.11 Waste Rock Disposal Facilities

HGCMC has an approved waste rock storage area (Site 23), that is located near the mine support area. HGCMC expects that the storage capacity for Site 23 will be exhausted in early 2022, so the company is evaluating several options to extend the life of this facility. However, once the full capacity of Site 23 is reached, waste rock will be hauled to the TDF and/or possibly more waste rock will be used as underground backfill if space is available.

Other inactive waste rock storage areas at the Mine included Site D (downslope from Site 23) and Site E (located at mile marker 4.6 on the B-road).

Site E is currently undergoing a multi-year removal effort, with waste rock from this site being removed and hauled for disposal at the TDF. As waste rock is removed capacity will develop for the storage of peat and other overburden materials at the site, should additional storage capacity be needed, and as approved by the Forest Service. **Appendix 11, Waste Rock Management Plan**, describes management objectives for the waste rock sites.

1.12 Reclamation Material Storage Stockpiles

Reclamation material has been stockpiled at various locations along the B Road. This material will be used in final reclamation activities.

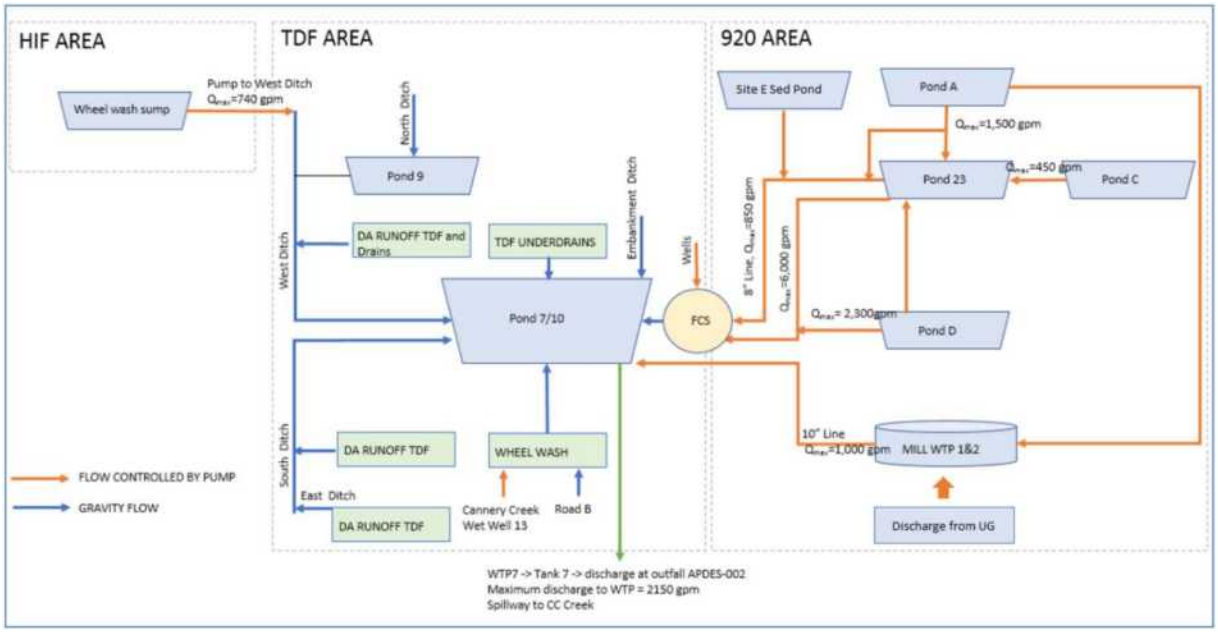
1.13 Water Management

HGCMC manages both "non-contact" and "contact" water. Non-contact water is runoff that is routed around Mine facilities. Contact water includes, but is not limited to, water withdrawn from Greens Creek, and Cannery Creek; water from mine dewatering; runoff from waste rock facilities, the TDF and port facility; and groundwater from underdrain systems.

HGCMC diverts non-contact water around Mine facilities in upgradient ditches to the numerous freshwater courses adjacent to the Mine facilities. Contact water is collected and treated in complaince APDES permit requirements before discharge to the environment.

Figure 2-5, Greens Creek Mine Water Management Flowchart, displays the current Mine water management system. All contact water reports to the Ponds 7/10 system, from which it is passed through the WTP before being discharged into Hawk Inlet in compliance with HGCMC's APDES permit.

Figure 2-5, Greens Creek Mine Water Management Flowchart



1.14 Marine Terminal (Hawk Inlet Facility)

Offloading and storage of supplies, along with ship loading of concentrates, are completed at the Mine's Hawk Inlet Facility. Mine supplies and ore concentrate are stored in designated facilities at Hawk Inlet.

Containerized supplies are transported from suppliers to the Hawk Inlet Facility by barge, unloaded by a forklift, and hauled to either storage areas at the Hawk Inlet Facility or to the mine support area at the 920 area. Fuel is received in bulk by barge, and is pumped to an onshore storage tank. Supplies, such as lime and cement, are received in bulk in specialized containers, which are transported for storage and use at the mill. Aggregates are delivered to Hawk Inlet Facility by barge and are stockpiled at various locations throughout the Mine site.

A conveyor is used to safely move ore concentrates from a covered storage building at the Hawk Inlet marine facility directly into the holds of the ocean-going concentrate ships. The conveyor is contained in a telescoping boom structure to avoid concentrate spillage into Hawk Inlet.

HGCMC maintains an employee and contractor housing complex at the Hawk Inlet Facility. This complex is capable of comfortably housing up to approximately 200 people. There are no permanent residents (or family members) at the site; the housing facility accommodates some workers on a rotating basis.

1.15 Young Bay Dock

The Young Bay dock is primarily a pedestrian dock. Only small quantities of supplies which may be carried by hand are transported on the personnel boat. As addressed in Section 2.9, Marine Terminal (Hawk Inlet Facility), major supplies and equipment are landed at the Hawk Inlet Facility.

1.16 Roads

Two roads link the Young Bay and the Hawk Inlet Facility with the 920 area. The A-road is a five-mile long road for personnel transport from the Young Bay dock to the Hawk Inlet Facility. The B-road is an 8.5-mile road used for transport of personnel, supplies, and ore concentrates between Hawk Inlet and the 920 area, as well as transport of tailings from the mill to the TDF

HGCMC maintains a strict travel/transportation policy for these single-lane roads. Turnouts are maintained to allow safe traffic flow, and all employees and contractors who use the road must maintain radio contact during transit. **Appendix 8, Road Operation and Maintenance,** provides information on road operations and maintenance activities at the Mine.

The roads are occasionally traveled on foot by hunters who access Admiralty Island via private boat.

1.17 Power and Electrical

The Mine's electrical power needs are met by a combination of two sources. The primary source is from power purchased from the Alaska Electric Light & Power Company, which maintains an undersea cable from Douglas Island (near the city of Juneau) and an onshore 13-mile-long 69 kV aerial powerline from Youngs Bay to the Mine site facilities. This electric power is generated at hydroelectric dams and is available to the Mine except when water reservoir levels fall below predetermined limits.

The secondary source of electricity for the Mine is from on-site diesel-powered generation. This system includes two separate powerhouses that contain nine generating units. The on-site generators include a combination of reciprocating internal combustion engines and turbine generators.

1.18 Communications

Mine communications are handled over fiberoptic cables, leased from GCI Communication Corp, utilizing voice-over-internet protocol technology.

Vehicle safety and emergency reporting and communication are accomplished using a Mine-wide radio system with dedicated channels for the mill, mine, and road operations. Vehicle safety on the surface and underground is enhanced with a proximity detection and collision avoidance system.

In the event of a fiber optic failure, a backup microwave system is in place to ensure site safety. Emergency satellite phones are also available at both the Hawk Inlet and 920 offices.

1.19 Non-Hazardous and Hazardous Wastes

HGCMC manages non-hazardous wastes at the Mine, including sludge generated in the water treatment processes (both process water and sewage). Sediments removed from settling ponds, ditches and basins are placed into the TDF. HGCMC maintains a waste management permit issued by the ADEC that

allows for the placement of non-hazardous waste materials in the TDF. Hazardous wastes are collected and shipped to approved off-site facilities. **Appendix 7, Integrated Waste Management and Disposal Plan**, describes the procedures for deposition of solid wastes and hazardous materials generated at the Mine.

1.20 Fuel Storage and Handling

Fuel arrives at the Hawk Inlet Facility by ocean barges that serve Southeast Alaska and is pumped directly into a 200,000-gallon storage tank within secondary containment. The fuel is then delivered by bulk fuel tanker trailers to the 920-area fuel storage area, which consists of three fully contained tanks yielding a storage capacity of approximately 156,000 gallons.

When electricity is supplied by the local utility intertie, fuel is typically delivered at one to two-month intervals. When the Mine is required to operate the diesel generators to supply power to the site approximately 150,000 gallons is delivered weekly.

All fuel is stored above ground, away from major stream courses and water bodies, in diked or double lined steel tanks. In the event of a ruptured tank, the contents of the tanks can be contained by dikes constructed in compliance with Federal oil pollution prevention regulations (40 CFR 112).

Gasoline is stored at the Hawk Inlet Facility or at the 920 area. Lubricating oils are stored in 55-gallon drums or in reusable 300-gallon flow totes in warehouses at both sites.

HGCMC maintains a Spill Prevention, Control and Countermeasure (SPCC) plan, as required by the U.S. Environmental Protection Agency (EPA). This SPCC plan lists equipment on hand at the facility and includes instructions for HGCMC personnel in the event of a spill or clean-up operation (**See Appendix 6, Spill Prevention, Control, and Countermeasure Plan)**.

1.21 Fire Protection

The Mine's fire protection system was designed and is maintained to meet applicable fire codes and the requirements of HGCMC's insurance underwriter. In general, the Hawk Inlet Facility and the 920 site have underground water distribution networks, with fire hydrants at the required distance from buildings and other structures. The design criteria for water service call for a 4-hour rate of 500 gpm for fire, and a pressure range of 37 pounds per square inch (psi). A diesel booster pump is used as needed to increase the pressure in the system.

The U.S. Coast Guard requires the Mine maintain an "Operations Manual" for the Hawk Inlet marine facility. This document includes a description of fire safety equipment and procedures for use (**See Appendix 9, US Coast Guard Operations Plan and Facility Response Plan**).

For the time period April 1 through October 31, the Forest Service requires the Mine to maintain a fire plan **(See Appendix 13, Fire Plan**).

3. PERMITS AND APPROVALS

HGCMC maintains federal, state, and local permits for the Mine. See **Table 3-1, Greens Creek Mine - Major Permits and Approvals**.

Table 3-1, Greens Creek Mine - Major Permits and Approvals

Authority	Permits and Approvals	Topic
Federal Government		
Environmental Protection Agency (EPA)/ US Coast Guard (USCG)	Facility Response Plan	Spill
Nuclear Regulatory Commission (NRC)	Radioactive Material License	Other
US Army Corps of Engineers (USACOE)	Clean Water Act (CWA) Section 404 Permit and/or Section 404 Nationwide Permit	Water
US Department of Justice (USDOJ)/ Alcohol, Tobacco, Firearms and Explosives (ATF)	ATF Explosive Permit	Other
US Forest Service (USFS)	General Plan of Operations (GPO)/Plan or Operations (POO) and Decision Notice Special Use Permit	Land Land/Comm
State of Alaska		
Alaska Department of Environmental Conservation (ADEC)	APDES/NPDES Permit 404 Permit (CWA) Health Permit Waste Management Permit Title V Air Quality Permit Owner Request Limit (ORL) Air Quality Operating Permit	Water Water Facilities Waste Air Air
Alaska Department of Natural Resources (ADNR)	Certificate of Approval to Operate a Dam Certificate of Approval to Modify a Dam Right of Way Permit Tideland Permit Water Use Permit Water Authorizations for Diverting and Intercepting Water	Facilities Facilities Land Land Water Water
Alaska Department of Game & Fish (ADGF)	Fish Habitat Permit Certificate of Approval to Modify a Dam Right of Way Permit Tideland Permit Water Use Permit and Authorizations	Wildlife Facilities Land Land Water
Alaska Department of Revenue (ADOR)	Mining License	Land
Local		
City and Borough of Juneau (CBJ)	Allowable Use Permit	Land

4. RECLAMATION AND CLOSURE

HGCMC maintains a reclamation and closure plan to address interim, concurrent, final reclamation and post-mining land use of the Mine (**See Appendix 14, Reclamation and Closure Plan)**.

The reclamation and closure plan, along with a reclamation and closure cost estimate, is required by the Forest Service under 36 CFR 228.1 et. seq. The reclamation and closure plan and associated cost estimate are also required by to the ADNR and ADEC in accordance with AS 27.19.010 et. seq., 11 AAC 97.100 et. seq., AS 46.03.010 et. seq., and 18 AAC 60.25 et seq.

The reclamation and closure plan include performance goals applicable to interim, concurrent, and final reclamation, as well as addressing post-closure monitoring requirements. This plan sets scheduling and other standards for reclamation and for final closure planning requirements, and it explains how detailed, regularly updated reclamation task planning will be used for purposes of calculating a reclamation bond. Reclamation practices will utilize best practicable established and accepted technologies and methodologies suitable for the southeast Alaska environment.

HGCMC will reclaim exploration, development, mining and process-related disturbances at the Mine in a manner compatible with the final land use selected and applicable regulations. The final land use will likely be limited primarily to Monument-related activities, and therefore returning the surface to a near-natural condition will satisfy post-mining land use needs.

Private lands will retain their status after mining and were developed for non-Monument uses prior to creation of the Admiralty Island National Monument. After closure, HGCMC will consult with the landowners, as well as any agencies having regulatory authority over reclamation of such lands, to determine the final disposition of structures and facilities.

At some point following mine closure and reclamation, HGCMC anticipates that the collection and conventional treatment of surface stormwater (contact water) will be phased out as source areas are reclaimed, the engineered cover is constructed on the TDF, vegetation established, and water quality monitoring demonstrates the applicable Alaska water quality standards (AWQS) are met. Long-term water treatment may be required for some components of the contact water through active water treatment. The existing WTP has adequate capacity to efficiently treat potential post-closure sources, such as from the TDF.

5. MONITORING PLANS

HGCMC conducts compliance monitoring to verify that the Mine operates within permit limitations to eliminate or minimize environmental impacts during operations and post closure. The objective of the Integrated Monitoring Plan (IMP) is to provide mine operations and state and federal regulators with a clear and concise plan that lists monitoring and sampling criteria for surface and ground water quality, geochemical characterization of materials, geotechnical stability of structures, and aquatic biological resources present at the site. The relevant historical and procedural information important to the development and implementation of this monitoring plan for sample collection/analysis, data analysis, and reporting are contained in the IMP (**See Appendix 1, Integrated Monitoring Plan (IMP)**).

In general, monitoring will be similar during operations and closure, with monitoring decreasing as reclamation activities are completed and performance goals are met. Long-term, post-closure, active water treatment may be required for some components of the contact water.

1.22 Fisheries Mitigation and Monitoring

To offset long term, unavoidable production losses to the anadromous fisheries of the area, HGCMC maintains fisheries and wildlife mitigation and monitoring programs (**See Appendix 4, Fish and Wildlife Monitoring).**

The fisheries mitigation involved the replacement of potential lost habitat through (1) a modification of the waterfall barrier at road marker 5.0 on the "B" Road, and (2) creation of at least five jump pools to allow adult migrating salmon to pass the barrier. This action made available approximately three miles of habitat which contain at least one acre of usable habitat not previously utilized by anadromous fish for spawning or rearing.

For initial Mine construction and development, HGCMC designed and implemented a spawning gravel monitoring program to verify the predicted effects of sediment additions, the efficient operation of the settling pond system, and the recovery period for any short term unavoidable fine sediment additions to Zinc Creek and Greens Creek during the construction phase. Results from current research on fine sediment accumulation in spawning gravel beds is conclusive as to the exact degree of impact on anadromous salmonid production. The project design has addressed these impacts in a number of ways including construction timing, settling ponds, and road run-off systems.

In 1991, a review of all spawning-related data indicated no impact to spawning gravel and the program was scaled back to monitoring once per year. In 1994, the spawning gravel program was concluded. The monitoring program provided the information required by the Forest Service and identified that a 25% increase in sediment would be the level at which some action would be taken. All sites, except for one site well downstream of the mine (Site 205), were below the 25% level. At the down stream site, there were local natural streambank disturbances that resulted in the increased levels of sediment.

1.23 Wildlife Monitoring

A monitoring plan for bald eagles and brown bears was developed and approved by the Forest Service and ADFG. Monitoring of these species was conducted for the first four years of Mine operation.

Bald eagle nest sites are monitored to ensure compliance with the Bald Eagle Protection Act. Nests sighted in Hawk Inlet and Young Bay were checked in 2019 to determine nesting activity. Eagle nest surveys were conducted by the U.S. Fish and Wildlife Service (USFWS), with assistance from HGCMC.

Between 1990 and 1993, a brown bear monitoring study occurred to ensure compliance with ANILCA, and to document and to determine the Mine effects on the brown bear population, and to provide basic information that can be used during Mine operations to identify sources of possible impacts and subsequent mitigation measures. Bear monitoring was conducted by the Alaska Department of Fish and Game (ADFG), with assistance from the HGCMC. In 1993, the ADG&F concluded that the brown bear management program was successful in maintaining bear populations over the study period (**See Appendix 4, Fish and Wildlife Monitoring)**.

1.24 Freshwater Quality Monitoring - Surface Water

Water quality monitoring plans are reviewed by EPA, ADEC, Forest Service, and other interested agencies annually through the Annual Work Plan. Effectiveness of specific monitoring plans, including sites to be monitored, parameters to be measured, and sample frequency, are reviewed and evaluated as part of the agencies' annual review process.

Monthly flow monitoring is conducted in upper Greens Creek, the mine service area sedimentation pond discharge (**See Appendix 1, Integrated Monitoring Plan (IMP)**), and continuous monitoring at the tailings pond marine discharge (**See Appendix 2, APDES Marine Water and Sediment Sampling Programs and APDES Quality Assurance Project Plan**). Monitoring during reclamation will be necessary only on Greens Creek, Zinc Creek, and Tributary Creek, if no other water quality problems have been detected.

1.25 Groundwater Quality Monitoring – (IMP)

Three ground water quality monitoring wells are monitored outside the TDF and one is located at Site 23. The TDF monitoring wells are located downgradient to detect potential seepage from the TDF. The ground water monitoring well located at Site 23 is up-gradient of the facility and is used as a background site. The ground water monitoring wells are monitored on four times annually.

1.26 Freshwater Aquatic Biota Monitoring – (IMP)

Heavy metal tissue burden analysis is measured annually for fish species in freshwater.

Freshwater monitoring requirements include:

1. Monitoring for the life of the Mine;
2. Compliance with the ADEC Waste Management Permit; and,
3. Adherence to monitoring schedules included in the Integrated Monitoring Plan.

1.27 Marine Water Quality Monitoring - (APDES)

A marine water quality monitoring plan is required as part of the Mine's APDES permit. The monitoring plan includes three marine water quality monitoring locations (mid-channel off the port facility, Chatham Strait off Hawk Point, and proximal to the permitted APDES mixing zone). These sites are sampled quarterly for parameters set forth in the APDES permit.

1.28 Marine Aquatic Biota Monitoring - (APDES)

Representative samples of indicator species (mussels and polychaetas) are taken annually near the Hawk Inlet marine facilities, near the Greens Creek delta, outside of Hawk Inlet, and within the ADPES permit Hawk Inlet diffuser mixing zone. Samples are analyzed for metals.

A QA/QC Plan for Hawk Inlet monitoring is covered in the Quality Assurance Plan (QAPP) required under the APDES Permit. Monitoring results are included in the Annual Report, which includes a statistical evaluation of data showing averages, variations, and changes over time including a comparison of the past year's data to annual averages from the pre-production period and the production period.

1.29 Air Quality

In accordance with 18 AAC 50.326(a), HGCMC monitors emission units for visible emissions under Permit No. AQ0302TVP03. Environmental Protection Agency (EPA) annual Method 9 observations are conducted to test for visible emissions. Source tests for CO and NOx emissions are conducted every 5 years, as required. Emissions factors generated from source testing are used to calculate monthly emissions of CO and NOx. Electrical load is monitored to ensure sources are running within the limits set out in the permit. Sulfur dioxide production is limited by the use of ultra-low sulfur diesel fuel. Hours of operation and fuel consumption are also monitored on a monthly basis.

Hawk Inlet power generation is covered by an owner requested limit (ORL) AQ0853ORL03 under 18 AAC 50.225(b). This ORL limits the stationary source's potential to emit (PTE). The PTE is limited by the amount of fuel that is allowed to be consumed for any consecutive 12-month period to 300,000 gallons.

Fugitive dust monitoring is a requirement of the Waste Management Permit. Fugitive dust is monitored through multiple methods including atmospheric deposition container monitoring, real-time monitoring, and visual monitoring. These monitoring programs are discussed in **Appendix 1, Integrated Monitoring Program (IMP)**.

General Plan of Operations
Appendix 01
Integrated Monitoring Plan

May 2020

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Attachment

Attachment A - Quality Assurance Project Plan (QAPP) of the General Plan of Operations Appendix 1 Integrated Monitoring Plan

Acronyms

AAC	Alaska Administrative Code
ABA	Acid Base Accounting
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish & Game
ADNR	Alaska Department of Natural Resources
ADC	Atmospheric Depositional Container
AP	Acid Generation Potential
ARD	Acid Rock Drainage
AWQS	Alaska Water Quality Standards
BMP	Best Management Practices
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
EPT	Aquatic insects (Ephemeroptera, Plecoptera, and Trichoptera)
FB	Field Blank
FL	Fork Length (tip of snout to the end of middle caudal fin rays)
Forest Service	U.S. Department of Agriculture Forest Service
FWMP	Fresh Water Monitoring Plan
GPO	General Plan of Operations
HGCMC	Hecla Greens Creek Mining Company
HDPE	High Density Polyethylene
ICP	Inductively Coupled Plasma Analysis
IDL	Instrument Detection Limit
IMP	Integrated Monitoring Plan
LCS	Laboratory Control Sample
MD	Method Blank
MDL	Method Detection Limit
MLE	Maximum Likelihood Estimate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MW	Monitoring Well
NEPA	National Environmental Policy Act
NP	Acid Neutralization Potential
NNP	Net Neutralization Potential
QAPP	Quality Assurance Project Plan
TDF	Tailings Disposal Facility
TDR	Time Domain Reflectometry
RTM	Real Time Monitoring
SOW	Statement of Work
UGM	Undifferentiated Glacial and Marine
USEPA	U.S. Environmental Protection Agency

Units of Measure

mm	millimeter
cm	centimeter
m	meter
km	kilometer
m^2	meter squared
m^3	meter cubed
mg	miligram
µg	microgram
mL	milliliter
L	liter
gpm	gallons per minute

1. INTRODUCTION

Hecla Greens Creek Mining Company (HGCMC) prepared this Integrated Monitoring Plan (IMP) to meet the operational needs of the site while addressing the goals and objectives of the federal and state regulatory agencies. This Plan was developed to meet the requirements of the Alaska Department of Environmental Conservation (ADEC) in accordance with AS 46.03.010 et. seq. and 18 AAC 60.015 et. seq. and 18 AAC 80.005 et. seq. and the U.S. Forest Service (Forest Service) implementation of 40 CFR § 1505.3 to ensure monitoring requirements identified in the National Environmental Policy Act (NEPA) documents that relate to HGCMC are met.

The Greens Creek Mine is owned and operated by HGCMC, a wholly-owned subsidiary of Hecla Mining Company, Inc. The Greens Creek Mine is located near Hawk Inlet on northern Admiralty Island, in the Tongass National Forest, approximately 18 miles southwest of Juneau, Alaska (Figure 1-1). The mine site is situated partly within the Admiralty Island National Monument, and completely within the municipal boundaries of the City and Borough of Juneau. The mine site is comprised of federal and patented mining claims. The Greens Creek mine facilities are located within the Greens Creek, Zinc Creek, Tributary Creek, and Cannery Creek watersheds.

The Forest Service has issued special use permits/leases for various aspects of the operations. In addition, HGCMC holds 17 patented mining claims (7,300 acres), 645 unpatented mining claims (12,200 acres) in the area, and 17 acres in Hawk Inlet under a warranty deed with Bristol Resources, Inc.

The Greens Creek Mine has been in operation since 1989, with only a short temporary cessation of operations due to low metal prices from April 1993 until July 1996. HGCMC produces three concentrates containing four payable metals (silver, zinc, lead, and gold) for shipping to smelters around the world.

1.1. Purpose

It is the goal of HGCMC to operate the mine and milling processes in a manner that will ensure the protection of the environment. This monitoring plan will assist HGCMC in the establishment and refinement of operating procedures to ensure the long-term protection of land, wildlife, and water resources. Periodic updates of the monitoring plan will coincide with regulatory changes, five-year environmental audit reviews, process modifications, or anomalies noted as a result of monitoring and sampling.

This IMP and the associated *Quality Assurance Project Plan (QAPP) of the General Plan of Operations Appendix 1 Integrated Monitoring Plan* (Appendix 1.A), are an intricate part of the environmental and operational management system for the Greens Creek Mine. The overall operation and each process component have specific management plans, which share common elements with this monitoring plan.

Figure 1. Greeens Creek Project Location

To minimize duplication of information and rationale for specific monitoring and sampling requirements, the reviewer needs to reference the following site analytical reports and management plans:

- *Greens Creek Mine Reclamation and Closure Plan, GPO Appendix 14, April 2019*
- *Greens Creek Mine Tailings Disposal Facility Management Plan, GPO Appendix 3, April 2019*
- *Greens Creek Mine Waste Rock Management Plan, GPO Appendix 11, April 2019*
- *Greens Creek Mine Standard Operating Procedure, Construction Rock Environmental Characterization, March 2010*
- *Greens Creek Mine 2010 Site Water Balance, February 2010*
- *Greens Creek Mine Site 23/D Hydrogeology and Geochemistry Analysis, March 2004*

1.2. General Information

Location: (Mine Portal) Latitude 58° 04'58" North, Longitude 134° 37'57" West
Name of Facility: Hecla Greens Creek Mining Company – Greens Creek Mine
Type of Facility: Underground Silver, Lead, Zinc, and Gold Mine and Milling Operation

Corporate Information:
Business Name: Hecla Greens Creek Mining Company
PO Box 32199
Juneau, Alaska 99803
Telephone: (907) 789-8100
General Manager: Brian Erickson

Hecla Greens Creek Mining Company is a wholly-owned subsidiary of:
Hecla Mining Company
6500 N. Mineral Drive, Suite 200
Coeur d'Alene, Idaho 83815

Designated Contact Person for Regulatory Issues:
Name: Christopher Wallace
Title: Permitting and Environmental Compliance Coordinator
Telephone: (907) 790-8473

1.3. Objectives

Compliance monitoring is undertaken to verify that the project operates within permit limitations thereby minimizing the impact on the environment during operations and post-closure. The objective of this document is to provide HGCMC and state/federal regulators with a clear and concise plan that lists monitoring and sampling criteria for surface water and groundwater quality, geochemical characterization of materials, geotechnical stability of structures, and aquatic biological resources present at the site. The relevant procedural information for sample collection, sample analysis, data analysis, and reporting are contained in Appendix 1.A.

1.4. Summary of Monitoring

This IMP presents the elements of HGCMC's monitoring and sampling program that have been initiated for operations. The monitoring and sampling areas cover critical aspects of the project's infrastructure, including Hawk Inlet facilities, Tailings Disposal Facility (TDF), waste rock sites, inactive rock quarries, and mill site. This document will be updated as needed, based on regulatory changes, periodic reviews,

process modifications, and the results of monitoring which indicate that further attention may be warranted.

Table 1-1 presents a summary of the water quality monitoring, biological monitoring, geochemical characterization, and geotechnical monitoring activities performed during the period of active mining operations. More detailed information on monitoring at each facility and component is provided in subsequent sections. Compliance monitoring of wastewater and stormwater discharges, air emissions and other resources, such as Hawk Inlet monitoring, are addressed under specific permits and not included in this document.

Table 1. Summary of Monitoring Activities

Facility	Component	Method	Media	Parameters	Frequency
Project Area	Water Quality Compliance	Fresh Water Monitoring Program	Surface Water	Suite P or Q	Monthly
			Ground Water	Suite Q	Quarterly
	Aquatic Community Health	Biological Monitoring	Fish, macro-invertebrates, periphyton	Metals, abundance, diversity	Annually
	Const. Rock Characterization	ABA, ICP *	Rock	NNP, metals	As needed
Tailings Disposal Facility	Internal Water Quality Monitoring	Water sampling	Ground Water	Suite C1 or C2	Quarterly
			Pore Water	Suite L1	Annually
	Tailings Characterization	ABA, ICP	Tailings	NNP, metals	Annually
	Stability	Visual inspection	TDF surface	Checklist	Monthly
		Compaction	Tailings	% moisture, density	Quarterly
		Wells, piezometers	GW, pore water	Water level, pressure	Monthly
	Fugitive Dust	ADC *	Dust	mass, Pb, Zn	Bi-weekly
Site 23	Internal Water Quality Monitoring	Water sampling	Ground Water, Drains	Suite C1 or C2	Quarterly, Some sites Annually
	Waste Rock Characterization	ABA, ICP	Waste Rock	NNP, metals	Quarterly
	Stability	Visual inspection	Site 23 surface	Checklist	Monthly
		Survey	hubs, inclinometers	movement	Semi-Annually
		Wells, piezometers	GW, pore water	Water level, pressure	Monthly
Inactive Waste Rock Sites & Quarries	Internal Water Quality Monitoring	Water sampling	Surface Water	Suite C1	Annually or Semi-Annually
	Material Characterization	ABA, ICP	Rock	NNP, metals	Once every five years
	Stability	Visual inspection	Area	cracks, sloughs	Quarterly
Dam Systems	Geotechnical Stability	Visual inspection	Embankments, spillway	ADNR-Dam Safety Checklist	Monthly
		Survey	Monuments	movement	Quarterly or Semi-Annually

* ABA – Acid-Base Accounting
ICP – Inductively Coupled Plasma
ADC – Atmospheric Deposition Container

2. FRESH WATER MONITORING PROGRAM

2.1. Project Background

Monitoring and sampling surface and groundwater resources is an integral part of the environmental protection measures at the project.

The Hecla Greens Creek Mining Company (HGCMC) Fresh Water Monitoring Program (FWMP), in conjunction with the Quality Assurance Project Plan (QAPP) (Appendix 1.A), documents the methods and procedures for sample collection, laboratory analysis, data management, and information utilization necessary to ensure that monitoring requirements are fulfilled. Both surface water and groundwater monitoring are included. The FWMP and QAPP are to be reviewed and updated as needed to ensure the best use of resources, appropriate quality of data, and use of the results in management decisions.

Before 1995, freshwater monitoring at the Greens Creek Mine was conducted under two documents; the Greens Creek Fresh Water Monitoring Operations Manual 1988; and the draft General Plan of Operations (GPO), Appendix 1 (June 1992). These documents were revised and combined into the 1995 Fresh Water Monitoring Program. The purpose of the 1995 revision was to update the information goals for monitoring, and the standard procedures for sample collection, laboratory analysis, data handling, data analysis, and information utilization. Information goals are specific quantitative and qualitative statements describing the information expectations of the monitoring program. Information utilization is defined as how the information derived from data analysis is reported and applied to management decisions.

The 2000 revision of the FWMP was a result of a Greens Creek sponsored interagency regulatory review of the Greens Creek Mine. The Project Team consisted of representatives from the Greens Creek Mine and several State and Federal regulatory agencies, including the State of Alaska Department of Natural Resources (ADNR), Environmental Protection Agency (EPA), United States Forest Service (Forest Service), United States Fish and Wildlife Service (USFWS), State of Alaska Department of Fish and Game (ADFG), State Attorney General Office (AGO) and State of Alaska Department of Environmental Conservation (ADEC). The purpose of the review was to allow the State and Federal agencies having jurisdiction over the mine to ascertain overall compliance with existing authorizations and environmental laws and to implement corrective action, if needed; amend existing authorizations or plans, if necessary; and process any new authorizations required to provide for confidence in regulatory compliance and environmental effectiveness of the Greens Creek programs. The revision incorporated changes requested and approved by the participating regulatory agencies and Greens Creek Mine.

This 2019 revision was undertaken in conjunction with the renewal of the Waste Management Permit. An environmental audit of Greens Creek Mine was required as part of the permit's renewal. HDR Engineering, Inc. conducted the audit and submitted a final report in January 2019. Recommendations from the audit have been incorporated into the IMP and QAPP.

2.2. Actions for Compliance Monitoring Directives

Conduct annual reviews of information goals, analytical data, statistical analyses, and sampling frequencies to ensure that information utilization needs are met.

Apply the information derived from data analysis and interpretation to management decisions.

2.3. Data Quality Objectives (DQOs)

DQOs are quantitative and qualitative objectives for the quality of the data used. DQOs define the quality of services requested from the laboratory and are used in the quality assurance (QA) review by comparing the quality control (QC) data against the DQOs to qualify the data as entirely usable, estimated, or rejected as unusable. Refer to the QAPP (Appendix 1.A) for additional detail on the DQOs.

2.3.1. Qualitative DQOs

Qualitative DQOs are established for representativeness and comparability.

Representativeness is a determination of how well the sample represents environmental conditions. It is addressed by monitoring site selection and sample collection and handling protocols. Requirements for blank analyses and QA reviews of blank data verify that samples have not been contaminated in the sampling or analytical processes.

Comparability is a determination of how well data from different sources compare to each other. It is addressed by ensuring appropriate method detection limits are achieved, and QC measures and QA data reviews are performed to verify that the data are of known and acceptable quality.

2.3.2. Quantitative DQOs

Quantitative DQOs are established for method detection limits (MDLs), minimum levels (MLs), precision, accuracy, and completeness.

MLs are established for each analyte at 90% of the Alaska Water Quality Standards (AWQS) with one exception: the ML for chromium will be the same as for chromium VI. Waters monitored under this plan are protected for all uses, and the most protective standard is applicable (18 AAC 70.020(1)). Of concern for these waters is protection for the growth and propagation of freshwater fish, shellfish, other aquatic life, and wildlife (18 AAC 70.020(1)(c)).

For those analytes having a hardness dependent AWQS, the hardness value used to calculate the standard for determining the ML was based on the 25th percentile of the measured hardness at surface water and groundwater sampling sites over the previous five years. Surface water and groundwater hardness values were summarized independently for the 25th percentile determination. Table 3 in the QAPP (Appendix 1.A) shows the MLs for each analyte evaluated by this plan.

MDLs are calculated based on the ML using certain information developed by EPA (EPA 821-B-95-002, April 1995). For the purposes of this plan, the MDL=ML÷3.18, rounded up to the same number of significant digits as the AWQS for that analyte. Table 3 of the QAPP (Appendix 1.A) shows the MDLs for each analyte evaluated by this plan.

Precision is a measure of the ability to replicate analysis and is expressed as the relative percent difference (RPD). The RPD criterion for water samples is ±20% and is only applicable when the analyte concentration is more than five times the instrument detection limit (IDL), and if the native amount is not greater than four times the spiked amount.

Accuracy is a measure of how close the analytical result is to the actual concentration of the analyte and is expressed as percent recovery (%R). The Matrix Spike/Matrix Spike Duplicate (MS/MSD) criteria are 75-125 %R for all metals. The criteria are only applicable for MS/MSD analyses if the native amount is not greater than four times the spiked amount. The accuracy limits for the Laboratory Control Sample (LCS) are method dependent, e.g. 90-110 %R for Inductively Coupled Plasma Analysis (ICP).

Completeness is a measure of how many planned analyses for all analytes resulted in usable data, defined as all data that is not rejected and is expressed in percent (%). The completeness criterion is 95% for a water year, which is October 1st through September 30th.

2.4. Monitoring Sites

HGCMC has designated freshwater monitoring sites including those utilized in the FWMP. Once a site is established it is never changed and remains a site even if it becomes inactive. If a site is obliterated by construction or moved, the original site number becomes inactive, and the new monitoring location is given a unique site number.

Monitoring can be discontinued, and a site becomes inactive for a variety of reasons. These include if the site is destroyed due to construction or natural phenomenon, was stopped at some time in the past prior to the 2014 FWMP revision or deemed no longer necessary by the regulatory agencies and HGCMC.

2.4.1. Description and Location of Fresh Water Monitoring Sites

Table 2-1 lists all surface, and groundwater monitoring sites in the current FWMP contains a brief location

description and coordinates. Figure 2-1 depicts the approximate locations of compliance monitoring sites. These sites are considered "active." They have been determined to meet the analytical and informational needs necessary for comparison and interpretation of previous data to those of the current conditions at the site. Other sites that were previously required for monitoring are called "inactive" and are not discussed here. Details of the inactive sites can be found in previous FWMPs and annual reports.

One new surface water monitoring site has been added to replace a site that was abandoned due to natural phenomena. Greens Creek upstream of the mining activities meandered and carved a new channel segment that bypasses the Upper Greens Creek Site 48. A new site was established at the confluence of Greens Creek with the new channel and is designated Site 63. This is documented in an Alaska Department of Fish and Game memorandum dated September 7, 2018.

Table 2. Active Monitoring Site Locations

Site #	Site Name	Location	Latitude	Longitude
6	Middle Greens Creek	The site is on Greens Creek downstream of the mine and mill. It is about 15 m upstream of the confluence of Bruin Creek.	58°04'47.424" N	134°38'25.849" W
9	Tributary Creek	The site is on Tributary Creek, about 800 m downstream of the TDF, and about 500 m upstream of the confluence with Zinc Creek.	58°06'22.040" N	134°44'44.100" W
13	Upper East Mine Drainage	Small drainage to the East from the 1350 adit. The site is below a former waste rock storage area.	58°04'47.685" N	134°37'39.951" W
27	MW-2S	The site is an 2.4 m deep well completed in the peat/sand unit. It is in muskeg about 60 m south of the TDF.	58°06'48.546" N	134°44'38.365" W
29	MW-3S	The site is a 4.6 m deep well completed in the peat/sand unit. It is in muskeg about 50 m west of the TDF.	58°06'59.860" N	134°44'51.821" W
32	MW-5S	This site is a shallow well completed in the peat/sand unit. It is in the Muskeg about 50 m west of the TDF.	58°06'57.732" N	134°44'51.225' W
46	Lower Bruin Creek	The site is on Bruin Creek downstream of waste rock areas 23 and D. It is about 20 m upstream of Greens Creek.	58°04'46.450" N	134°38'32.580" W
49	Upper Bruin Creek	The site is on Bruin Creek upstream of waste rock area 23.	58°05'04.070" N	134°38'30.410" W
54	Greens Creek below D-Pond	The site is on Greens Creek downstream of waste rock areas 23 and D. It is about 20 m upstream of the confluence of Gallagher Creek.	58°04'41.681" N	134°38'46.529" W
57	MW-23-00-3	The site is a 20.7 m deep well completed in gravel and clay. It is upgradient of waste rock area 23.	58°04'59.933" N	134°38'39.881" W
60	Lower Althea Drainage	The site is on a small drainage about 150 m downstream of Pond 7.	58°04'41.770" N	134°45'08.432" W
61	Greens Creek Floodplain	The site is a surface water site ~ 40 m west of D Pond in the floodplain.	58°04'43.480" N	134°38'52.910" W
62	Greens Creek Lower than 54	The site is on Greens Creek downstream of waste rock areas 23 and D. It is about 250 m downstream of Site 54.	58°04'38.650" N	134°39'06.000" W
48	Upper Greens Creek	The site is on Greens Creek upstream of all mining activities. It is about 250 m upstream from the Greens Creek bridge at the 920 portal.	58°04'57.720" N	134°37'42.240" W
609	Lower Further Drainage	This site is on small drainage about 200 m downstream of the TDF.	58°07'05.707" N	134°45'06.332" W
711	Greens Creek above Site E	This site is on Greens Creek about 50 m upstream of Site E.	58°04'08.425" N	134°43'27.181" W
712	Greens Creek below Site E	This site is on Green Creek about 200 m downstream of Site E.	58°04'13.858" N	134°43'42.438" W
37	Cannery Creek Upper	Located on Cannery Creek about 50 m upstream of the B-Road		

Site #	Site Name	Location	Latitude	Longitude
1923	Cannery Creek Lower	Located on Cannery Creek downstream of the B-Road		
TBD	TDF Well			
TBD	TDF Well			
TBD	TDF Well			

2.4.2. Monitoring Sites

Figure 2. Fresh Water Monitoring Site Location Map

2.5. Monitoring

2.5.1. Site Selection

A primary criterion for selecting a monitoring site is that it must meet the DQO for representativeness. A monitoring site must be in the appropriate location so that collected data is representative of the facility or condition (i.e., natural background) it is intended to monitor. This is determined based upon an annual review, analysis, and interpretation of collected data.

The current FWMP sites listed in Table 2-1 have been demonstrated to be representative for monitoring potential water quality impacts from the mine operations, while also maintaining an efficient monitoring program. The addition and activation of any new sites would be associated with either a facility expansion and the need to establish proper up-gradient and down-gradient compliance points or in response to a statistically significant change in water quality at an existing site and the need to better characterize the nature and extent of the change. Changes to FWMP monitoring sites must be approved by the regulatory agencies.

2.5.2. Frequency Selection

Monitoring frequency is determined based upon results of previous data analysis, planned future uses of data, and changes in mine operations. The frequency will be sufficient to detect any seasonal trends. For new monitoring sites, quarterly or monthly sampling will be sustained until sufficient samples are taken to conduct statistical trend analyses. Exceptions can be made based on site accessibility and hazards, such as brown bear activity. Unexpected events may also affect monitoring frequency.

2.5.3. Analytical Parameters for Fresh Water Monitoring

The suite of analytical parameters for samples collected at a given site in a given sample period is based upon an annual review of the information goals. The suite of analytical parameters is selected to meet those informational needs based on results from previous analysis.

Surface water sample analytical Suite P (Table 2-2: Suite P (Surface Water)) contains the shortest list of critical analytes developed over the course of the mine life. The listed parameters generally characterize constituents of concern at surface water monitoring sites.

A more comprehensive analytical profile is used for groundwater analysis and periodically used for surface water, typically during months of low flows. Suite Q (Table 2-3) analytical profile contains additional dissolved metals associated with the Greens Creek orebody or waste rock that are important indicators for groundwater and surface water quality during periods of low flow.

Table 2. Suite P (Surface Water)

Analytical Parameters	
Conductivity	pH
Temperature	Sulfate
Total Alkalinity	Hardness
Dissolved Metals	
Arsenic	Lead
Cadmium	Mercury
Copper	Zinc

Table 3. Suite Q (Ground and Surface Water)

Analytical Parameters	
Conductivity	pH
Temperature	Sulfate
Total Alkalinity	Hardness
Dissolved Metals	
Arsenic	Mercury
Barium	Nickel
Cadmium	Selenium
Copper	Silver
Chromium	Zinc
Lead	

2.5.4. Fresh Water Quality Monitoring Schedule

The frequency of sampling surface and groundwater sites has been developed over the life of the operation with numerous adjustments as the program has continuously been re-evaluated and refined. Table 2-4: Fresh Water Monitoring Schedule provides a general overview of annual surface and groundwater sampling.

Table 4. FWMP Monitoring Plan

Site	Site Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
006FMS	Middle Greens Creek	Q		P		P		P		P		P	
009FMS	Tributary Creek-Lower	Q		Q		Q		Q		Q		Q	
013FMS	Mine Adit Discharge East					Q		Q		Q		Q	
027FMG	Monitoring Well 2S					Q		Q		Q		Q	
029FMG	Monitoring Well 3S					Q		Q		Q		Q	
032FMG	Monitoring Well 5S					Q		Q		Q		Q	
046FMS	Lower Bruin Creek	Q				P				P		Q	
048FMS	Upper Greens Creek	Q		P		P		P		P		P	
049FMS	Control Site Upper Bruin Creek	Q				P				P		Q	
054FMS	Greens Creek below D-Pond	Q		P		P		P		P		P	
057FMG	Monitoring Well -23-00-03	Q				Q				Q		Q	
060FMS	Althea Creek - Lower					Q		Q		Q		Q	
061FMS	Greens Creek Floodplain	Q		P		P		P		P		P	
062FMS	Greens Creek Lower Than 54	Q		P		P		P		P		P	
609FMS	Further Creek Lower					Q		Q		Q		Q	
711FMS	Greens Creek Above Site E					Q				P			
712FMS	Greens Creek Below Site E					Q				P			
37FMS	Cannery Creek Upper	Q		P		P		P		P		Q	
1923FMS	Cannery Creek Lower	Q		P		P		P		P		Q	
TBD	TDF Well					Q		Q		Q		Q	
TBD	TDF Well					Q		Q		Q		Q	

Site	Site Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TBD	TDF Well					Q		Q		Q		Q	

KEY:
P= Suite P
Q= Suite Q

2.6. Sample Collection

Following the current monitoring schedule in Section 2.4.4, water samples are collected using protocols designed to minimize bias from systematic and/or erratic contamination introduced during sample collection. Procedures for the collection of surface water and groundwater samples are provided in the QAPP (Appendix 1.A).

2.7. Sample Documentation, Packaging, and Shipping

All FWMP samples are collected by HGCMC personnel, packaged, and transported off Admiralty Island for laboratory analyses. Information on the protocols for documentation, packaging, and shipping of samples is provided in the QAPP (Appendix 1.A).

2.8. Sample Analyses

Independent laboratories will be used for water sample analyses. A written statement of work (SOW) defining contractual requirements, DQOs, and data deliverables for the FWMP will be prepared and sent to any laboratory selected to conduct water quality analyses. Laboratories will also be periodically audited.

2.8.1. Scope of Work for Analyses

A written SOW shall be provided to the selected laboratory(s) giving direction on the analytical work to be furnished, which includes the following.

- The anticipated number of samples, including QC samples, the analytes to be monitored, and the DQOs that must be met will be stated.
- The laboratory shall notify HGCMC immediately if any sample is lost due to a lab accident. This prompt notification allows HGCMC the option of re-sampling to replace the sample or taking additional samples to confirm the unusual result.
- Water quality sample analyses shall be performed within holding times and using the approved methods listed in 40 CFR § 136, Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act.
- The laboratory shall be responsible for biological sample preparation. This includes the final cleaning of benthic macroinvertebrate samples of the debris before analysis and rinsing periphyton samples with DI water before analysis.
- The laboratory shall provide their latest comprehensive MDL study, done in accordance with 40 CFR § 136 Appendix B, to the third party conducting the QA review and will provide updates as they are done.
- Field Blank (FB) samples shall be analyzed for the same suite of analytes as the sample collected at the site where the FB was collected.
- For every sample group, a method blank (MB) shall be analyzed for each analyte scheduled for analysis in that sample group.
- For every sample group, a laboratory control standard shall be analyzed that is traceable to

different source standards than the ones used for calibrations. The LCS will have a concentration for each required metal at its MDL level or, for those analytes whose MDL is outside the range of the calibration curve, at a concentration appropriate to the curve. Duplicate analysis of this LCS will also be performed.

- For every sample group matrix, spike/matrix spike duplicate (MS/MSD) analyses shall be performed for all the metals scheduled for that group. The laboratory will select the site on which MS/MSD analyses are performed and rotate it monthly to ensure all sites are included. In the laboratory the sample from the selected site will be split into thirds and two of them spiked accordingly. At least one fraction will be spiked, and the laboratory will select that fraction. The spiking level should result in concentrations at or above the AWQS for each metal.
- The laboratory shall keep the complete set of raw data for the samples including sample preparation logs and instrument calibration information in easily accessible files for a period of at least 6 months.

- The laboratory shall notify HGCMC immediately upon any change in certification status, personnel, equipment, or any other aspect of laboratory operations that may adversely impact the integrity of the samples or the attainment of DQOs for the analytical results.

2.8.2. Scope of Work for Data Deliverables

The written SOW provided to the selected laboratory(s) shall give direction on the data deliverables to be continuously been in a report to HGCMC, on laboratory letterhead, within 45 days of sample receipt, with the following information:

- Document the date samples were received by the laboratory, whether the shipping container was received with the seal intact, and if all samples listed on the sample inventory sheet were present.
- Document whether inductively coupled plasma (ICP) was used and if raw data were generated before inter-element and background corrections were applied.
- Document any problems, QC criteria exceedances, holding time exceedances, and observations affecting sample integrity and provide a detailed description.
- Provide a statement of authenticity and certification of the data with the date the report was generated and dated signature of the lab manager.
- Document the results of all sample analyses, including blind duplicates submitted at HGCMC's discretion, with HGCMC sample numbers and their corresponding laboratory number(s), date received, analyses performed (analyte and dissolved, total, or total recoverable fraction), analytical result, IDL, MDL, ML, and unit of measurement for each analyte.
- Document the results of the MB and FB analyses for each analyte.
- Document the results of the LCS analyses including the calculated %R for each analyte, and the RPD of the LCS results for each analyte.
- Document the results of the MS/MSD analyses including the calculated %R for each analyte, and the RPD of the MS and MSD results for each analyte.
- Document all analyses not meeting holding times, MDLs, or the precision and accuracy control limits by flagging them in the analytical report and provide definitions for the flags.
- Provide a compatible electronic file with the analytical results in a format compatible with the Environmental Management Database System, to reduce errors and labor required for

data entry in the HGCMC database.

2.9. Quality Assurance

Data used for decision making are to be of known and acceptable quality. All data are reviewed by a qualified QA reviewer to determine if the DQOs have been met. A qualified QA reviewer has no bias about the data quality and can evaluate the possible impacts on data comparability introduced by the use of multiple laboratories in the analysis of samples. As a result of the QA review, data may be qualified as estimated or rejected for failure to meet the DQOs.

The requirements for field and laboratory quality control measures and methods for data verification and validation are provided in the QAPP (Appendix 1.A).

2.10. Reporting

Data specification and collection provide the foundation of a monitoring system. Review, evaluation, and reporting the data is the next essential step. Information users base decisions on the monitoring results and contents of reports.

2.10.1. Purpose of Reports

Documentation and communication of information resulting from data evaluation is the purpose of reports.

- Defined, periodic, HGCMC reports document the following:
  a) The monitoring activities.
  b) The information gained in the monitoring process.
  c) The results of information evaluation.
- Reports communicate information that is used as follows.
  a) To provide the basis for management decisions.
  b) To provide the basis for assessing the effectiveness and efficiency of the FWMP.

2.10.2. Responsibility for Reports

HGCMC is responsible for the preparation and distribution of the reports specified in this section.

2.10.3. Distribution of Reports

The reports specified in this section are to be distributed in electronic format to the Forest Service, and ADEC.

Reports of Exceptions

The purpose of a report of exception is to communicate changes or unanticipated problems and resulting actions. Exceptions are very short-term temporary conditions not requiring an FWMP modification. An example is the taking of additional samples for a short period of time to verify an unusual result. The report also documents the event for the historical record.

The content of a report of exception varies depending on the exception. The information provided should be clear and fully explained.

Reports of exception are made as needed and may be either an emergency or not an emergency. Emergencies are events with actual or potential significant resource damage. A report for an emergency such as a chemical spill affecting freshwater is distributed as soon as possible.

Events that are unanticipated and unscheduled but do not appear to cause or have the potential of causing significant resource damage are not time-critical. They may be reported along with the next scheduled report.

2.10.4. Biannual Reports

The purpose of the biannual reports is to provide information which the A D E C , Forest Service, and HGCMC use to determine the following:

a) If any changes to the monitoring schedule are needed.
b) If any other changes to the FWMP are needed including any aspects of monitoring, evaluation, or reporting.
c) If any changes in best management practices (BMPs) are needed.

The content of the biannual reports covers activities during the preceding 6 months. The reports will cover January 1 to June 30 and July 1 to December 31, and include the following items:

a) A table of contents.
b) A list of interventions (procedural changes, natural phenomena, and mine operation changes) that could possibly affect data during the reporting period and any effects detected from visual data analyses.
c) A list of any negotiated FWMP or mine BMP modifications that were made including changes to the monitoring schedule and the problems they address.
d) A list of company and agency personnel who were involved in the FWMP during the reporting period and their function or job title.
e) A list of proposed program modifications including proposed revisions to the monitoring schedule, and discussion/rationale for proposed changes based on data analysis.
f) The data analyses required for each individual monitoring site include the following:
   (1) An interpretive report of the conclusions drawn from the data analyses including comparisons to previous years' data, baseline data, and background data.
   (2) A clarification of what data were used in the analyses and identifying any data which was not included such as data that was qualified as rejected by the QA reviewer or confirmed as an outlier based on the outlier analyses and re-sampling performed by HGCMC.

   The evaluation and handling of potential outliers will be performed using the guidance found in the EPA document "Guidance for Data Quality Assessment", EPA/600/R-96/084. Section 4.4 of the EPA document provides guidance on identifying potential outliers, choosing the proper statistical test, evaluating the results and documenting the process.

   The first step is to review the data to determine whether any of the points may be potential outliers. Graphical representations are the most common method. Once potential outliers are found, the data must undergo a statistical test designed to detect outliers. The statistical test chosen must be applicable to the distribution type of the data set and the number of potential outliers in the data set.

   At this point, the results of the statistical outlier test must be evaluated fully to determine whether the potential outliers are a true outlier or simply an extreme value that may be part of the data set's distribution. No data points should ever be excluded

solely based upon statistical testing. Any potential outliers identified by proper statistical testing must be verified. The verification of outliers must include scientific support that the data point is truly an outlier. If further checking does not suggest the point is an outlier, the results of the statistical test cannot be used to label the point as an outlier. If the support is found the data point may be identified as an outlier.

The data analysis performed on the data set to which the outlier belongs must be performed once with the outlier included and again with the outlier excluded. The results are then to be reviewed to determine the impact on the data analysis with regards to the contribution of the outlier data points.

The final step for outlier designation is documentation. The rationale for the choice of the outlier test must be given, along with the results. Then, the supporting scientific facts must be given to demonstrate the outlier is not just a statistical anomaly but was, in fact, a true outlier. Finally, the impact on the outlier data point had on the statistical processing of the data must be given.

(3) A list of qualified data from the QA review reports.

(4) A chronological list by the site of all data collected during the reporting period that exceeds AWQS.

(5) A comparison of medians will be made. Data outliers shall not be used in the data set used for median comparisons. Values between the MDL and ML will be used. A notation will be included in the report that states which values used in the median comparison fall between the MDL and ML. Data values below the MDL shall be assigned a value of zero for the purposes of median comparisons. A description of applicable median comparisons follows.

Analytical results must be statistically compared to determine whether concentration changes have occurred in a geographic situation or over time. Since nearly all data is not from a normally distributed population, it is necessary to compare the medians between the data sets. Although the initial step involves difference testing of the medians, several additional steps are taken to fully evaluate the meaning of that difference testing

The first step is an analysis of variance-based upon the ranked data. Ranking must be used due to the nonparametric distributions. The results of the analysis of variance are evaluated to estimate what level of significance is attached to the difference testing of the means. The significance level is then compared to the project objectives to ascertain whether the two data sets differ. This significance level must receive equal attention as did the result of the difference testing.

Multiple comparisons testing is then performed so that the indications given in the earlier median testing and significance testing are confirmed. If the multiple comparisons testing does not support the conclusions of the earlier testing, then further examination is needed to rule out the possibility that false indications were given. If the multiple comparisons testing confirms the other testing, then there is

greater confidence the original results are indicative of site conditions. The multiple comparison methods chosen must be sufficiently robust to either confirm or countermand the simpler one-on-one testing.

(6) X-Y graphs of the analytes specified and a trend analysis if indicated by visual inspection of the graphs. The scale shall be appropriate to conduct visual trend analyses, i.e., each scale will be as confined as possible based on each data range. AWQS criteria will be displayed on the graphs. Data outliers shall not be displayed on the x-y graphs. Data qualified by the QA contractor shall be labeled as such on the x-y graphs. Data values below the MDL shall be assigned a value of zero for the purposes of the x-y graphs.
Any indeterminate trend (may or may not be a trend) shall be verified using statistical trend analysis. Data outliers shall not be used in the statistical trend analysis. Data values below the MDL shall be assigned a value of zero for the purposes of the trend analysis. Trend analyses must be performed on the data sets such that the appropriate level of confidence is achieved. This level is based upon the traditional false positive/false negative rate (related to α) that can be tolerated. Also, the statistical test chosen must be powerful enough to conclude whether a trend is present or not. In other words, the test cannot be so weak that no conclusion is reached, even on data where clear trends are evident.

Also, the test must be selected, and the test parameters are chosen such that the distribution of the data is either properly matched or is non-parametric. If the data are tested and proven to be normally distributed, then normal statistical tests shall be utilized. If the data distributions cannot be matched, then non-parametric testing is needed.

Once these two issues are resolved, the statistical test must be able to handle a seasonality component. The first step in the process is to choose a proper technique to determine whether the data have a seasonality component. If they do, the trend test must have a seasonality parameter to adjust for this component in the data. Further, the data set must contain enough data within the periodicity of the season to allow for this testing. This means that a seasonality component cannot be identified unless there are frequent enough data points within each season to allow for this conclusion to be reached. An example would be that a seasonal component of about 6 months (one wet and one dry season per the calendar year) cannot be tested if the data were only obtained quarterly or semi-annually unless independent proof of the seasonal component can be provided.

2.10.5. Data Management

This section documents information storage, access, and archive practices for both hardcopy and electronic information.

2.10.6. Reports

- Access to records is controlled by the remoteness of the location and the limited access to mine premises.
- All incoming original hardcopy laboratory reports and associated QA review reports are filed chronologically at the mine.

- Electronic copies of HGCMC's reports are stored on a local server, which is backed up and maintained by the information technology department.
- Original hardcopies never leave the premises. They are photocopied as needed for distribution and satisfying information requests.
- Hardcopy reports may be archived 6 years after the date of creation. They may be moved to a less accessible location provided the previous five years of hardcopy are kept readily accessible.

2.10.7. Electronic Data

- A relational database containing all the FWMP data is maintained by HGCMC at the mine. Copies or partial copies of the database may be distributed to others as needed to facilitate data analysis.
- Data security is maintained by limiting access rights to the database files through network login IDs and passwords. Passwords are changed as needed.
- Laboratory data are electronically imported or manually entered into the HGCMC database. Associated qualifiers are manually entered after the QA review report is finalized and received by HGCMC.
- Personnel will be trained in reading the datasheets, electronic data transfer, and using the database before data entry is performed.
- All data (100%) entered into the database manually, and a sample (10%) of the data imported into the database electronically, are verified against the hardcopy before the data are used for analysis.
- Data produced before January 1989 may be archived to maintain processing speed and reduce the size of the backups.
- If data is archived it must be reloaded before database upgrades or enhancements are made to ensure it remains accessible and compatible. After the changes are completed it may be archived again.
- Changes to the database structure or utilities may be needed as a result of changes to the FWMP, data analysis protocols, or other reasons. A log of database changes, enhancements, problems, and fixes is kept to aid in troubleshooting.

2.11. Program Audits

Program audits provide an evaluation of the efficiency and effectiveness of the QA functions of the FWMP. This feedback loop provides the information needed for continuous improvement of the FWMP. The audit procedures below evaluate how well the information goals and DQO's are being met.

2.11.1. Responsibilities

HGCMC has the primary responsibility for ensuring that the data are of known and acceptable quality and the FWMP has been implemented as designed and thus has primary audit responsibility.

The Forest Service and ADEC have regulatory oversight responsibility and may perform independent audits on a random and/or as-needed basis. Other agencies may also perform audits.

2.11.2. Data Acquisition Audits

A review of the data collection system will evaluate whether the QC procedures in the FWMP are being followed and if documentation of these activities is sufficient to establish the quality of the information collected. Findings may be used to make improvements to the FWMP or to initiate corrective action by HGCMC for lapses in execution or documentation.

- HGCMC will perform one audit per year. The results of this audit will be included in the applicable report.
- The laboratory and QA review reports for a randomly selected month in conjunction with the FWMP and the current monitoring schedule are reviewed for the following determinations:
  a) The completeness of the laboratory data versus what was planned in the monitoring schedule and if the correct analytical fractions were analyzed.
  b) Whether or not analyses were performed within holding times.
  c) Whether or not a QA review of the data was performed, and the amount of data qualified as estimated or rejected.

2.11.3. Data Management Audits

A review of data management evaluates whether the procedures for data management in the FWMP are being followed and if data integrity is being maintained. If lapses in data management are found corrective action will be taken by HGCMC and documentation kept on file at the mine site.

HGCMC will perform one audit per year. The results of this audit will be included in the applicable report.

- The data management specifications of the FWMP are reviewed for the following determinations:

  a) Whether all reports were received within the specified time and copies forwarded as required.
  b) Whether hardcopy and electronic data are stored such that unauthorized access is minimized.
  c) Whether or not laboratory data have been QA reviewed and qualified if necessary, which is documented with a report.
  d) Whether laboratory reports and QA review report originals are in the files where expected.
  e) Whether the laboratory data with appropriate qualifiers have been accurately entered into the database.
  f) Whether the statistical analysis of the data is being appropriately performed and reports are found in the files where expected.
  g) Whether the FWMP has been reviewed and updated as needed.
  h) Whether previous copies of updated versions of the FWMP are retained and found in the files where expected.

2.11.4. Laboratory Audits

A review of the laboratory's facility, equipment, personnel, organization, and management will evaluate the data reliability the laboratory can produce. The laboratory as a system is verified against the documentation provided in their QA manual, their MDLs, and the SOW defining the services to be provided to HGCMC. A complete and thorough audit may be done through contractual services. HGCMC may choose to accept the results of a third-party audit done for other purposes, such as drinking water certification or national accreditation programs such as A2LA, instead of performing their own audit.

- Laboratory audits should be performed at least every five years.
- Guidelines for laboratory audits are available from the USEPA or ASTM Standard Practice E548. The basic elements are summarized below.

a) Organization:
Well Organized
Duties/Responsibilities Clearly Defined
Supervision/Inspection/Audit/Self-Appraisal Program

b) Staff:
Technical Competence Qualifications Documented
Training/Maintenance/Upgrading of Competence Sufficient Supervision
Adequate Number of Staff

c) Equipment:
Adequate in Kind and Quality Maintained

d) Calibration/Reference Standards

e) Test Methods/Standard Operating Procedures

f) Environment/Facilities:
Space
Physical/Chemical Control Housekeeping

g) Samples:
Handling
Storage
Integrity/Chain of Custody

h) Analytical Reports and Record-Keeping

i) QA program with specified QC activities

- A copy of the letter of certification or accreditation may be used as the documentation of an audit. Otherwise, the auditor will prepare a report listing the items reviewed and the conclusions of the review with any recommendations. Copies will be provided to the Forest Service and HGCMC and kept on file at the mine site.

3. INTERNAL MONITORING OF MINE WASTE ROCK

The Greens Creek Mine has one active waste rock facility (Site 23) and multiple inactive waste rock sites. Characterization and monitoring of active and inactive mine waste rock sites is ongoing and will continue over the active life of the mine. Classification and segregation of characterized waste rock provide the basis for ongoing management at active and inactive sites. Geochemical characterization and geotechnical stability monitoring of Site 23 is required by the Waste Management Permit.

The geochemical characterization programs for the Greens Creek Mine are well established. Waste rock from the mine is visually and geochemically characterized and managed accordingly. Representative samples for the characterization of mine waste are based on operational and geological records identifying materials mined.

Material characterization is performed using one of the established analytical procedures: multi-element ICP analysis, and Acid-Base Accounting (ABA) using the Modified Sobek Method to determine acid Neutralization Potential (NP), Acid generation Potential (AP) and Net Neutralization Potential (NNP). These analytical tools are used to accurately classify the material and its potential to affect water quality.

Sites, where characterized materials have been placed for either permanent or temporary disposal, are monitored for water quality. The water quality monitoring is an internal monitoring program and not part of the FWMP. The sampling is of contact water (i.e., pore water, leachate or seepage) within the waste rock facility boundaries and is therefore not expected to be compliant with AWQS. The objective of the monitoring is to track water quality trends to support predictions regarding geochemical weathering processes and effects on water quality. The results from the internal monitoring may be used to refine facility-specific management plans or reclamation plans.

The following subsections provide an overview of the monitoring schedules and type of characterization testing for active and inactive sites.

3.1. General Classification of Mine Waste Rock

Due to its variable geochemical properties and acid generation potential, mine waste rock is managed based on the following classification system. The waste rock classification by an experienced geologist at the underground blast face or muck pile is based on visual characteristics as verified through analytical testing.

Waste Rock Types:

- **Class 1:** This material has a Net Neutralization Potential (NNP) greater than 100 tons calcium carbonate ($CaCO_3$)/1000 tons. No special handling is required.
- **Class 2:** This material has an NNP value between 100 and -100 tons $CaCO_3$/1000 tons and is placed at least two feet from the final pile surface.
- **Class 3:** This material has an NNP value between -100 and -300 tons $CaCO_3$/1000 tons and is placed at least two feet from the final pile surface.
- **Class 4:** This material has an NNP value of less than -300 tons $CaCO_3$/1000 tons and is kept underground as fill.

Waste rock at Greens Creek has two general conditions; fresh waste rock from the mine and weathered waste rock from inactive waste rock sites. New waste rock is generally alkaline (pH 7-9). Weathered waste rock from inactive sites is either near neutral (pH 6-8) or acidic (pH <6).

3.2. Characterization and Monitoring of Rock

The schedule for the monitoring and analytical testing of the active waste rock site, inactive waste rock sites, and rock used in the construction of facilities are listed in Table 3-1: Monitoring: Active / Inactive Waste Rock Sites & Quarries. Analytical suites are listed in Table 3-2: Analytical Suites: Water Quality Monitoring.

Table 5. Monitoring Active/Inactive Waste Rock Sites and Quarries

Site Name	Monitoring Type	Parameters	Frequency	Responsibility
Site 23 (Active)	site	visual inspections	monthly	SOps, Env
	groundwater	C1 or C2	annually	Env
	water levels (wells, piezometers)	depth to water, pressures	semi-annually, some sites monthly or quarterly	Env, SOps
	leachate - drains	C1 or C2, flow	quarterly	Env
	rock characterization	ABA, ICP (metals), paste pH	quarterly	Env
	rock characterization – in situ *	ABA, ICP (metals), paste pH	once every 5 years	Env
	survey hubs, inclinometers	stability, movement	semi-annually	SOps
	material placement	tons, cubic yards	daily, monthly	Mine; SOps
Inactive Waste Rock	site	visual inspections	quarterly	Env
	surface water	C1 or C2	annually	Env
	rock characterization – in situ *	ABA, ICP (metals), paste pH	once every 5 years	Env
Construction Rock**	rock characterization	ABA, ICP (metals), paste pH	as necessary – prior to use	SOps

KEY:

* Paste pH, ABA, multi-element ICP from outer pile slope or quarry wall at least every five years, at a depth deep enough to encounter Class 2/Class 3 waste rock if less than five feet.

** Five samples per lithologic unit should be considered the minimum number of samples necessary to represent a potential source area or volume of rock less than 100,000 tons. For larger tonnages collect at least 10 samples per 100,000 tons of rock produced in an individual campaign or over multiple years.

ABA = Acid Base Accounting determines NP, AP, NNP
ICP= Multi-element Inductively Coupled Plasma
VI = Visual Inspection
LY = Lysimeter (Suite L1)
SOps = HGCMC Surface Operations Department
Env = HGCMC Environmental Department
Mine = HGCMC Mine Operations Department

Table 6. Analytical Suites: Internal Water Quality Monitoring

Sampling Suite C1	Parameters		
	Arsenic	Zinc	Alkalinity
	Barium	Antimony	Silica
	Cadmium	Mercury	Chloride
	Chromium	Aluminum (total)	Sulfate
	Copper	Calcium	Orthophosphate
	Iron	Magnesium	Thiosulfate
	Lead	Sodium	Total Dissolved Solids
	Manganese	Potassium	Total Suspended Solids
	Molybdenum	Hardness	Bicarbonate
	Nickel	DOC	Alkalinity
	Silver	Thallium	Acidity
	Selenium	Ammonia, TKN	

Sampling Suite C2	Parameters		
	Arsenic	Thallium	Alkalinity
	Cadmium	Nickel	Acidity
	Chromium	Zinc	Chloride
	Copper	Calcium	Sulfate
	Iron	Magnesium	Total Dissolved Solids
	Lead	Sodium	Total Suspended Solids
	Manganese	Potassium	

Sampling Suite L1	Parameters		
	Aluminum	Manganese	Sodium
	Arsenic	Magnesium	Potassium
	Barium	Molybdenum	DOC
	Cadmium	Nickel	Ammonia
	Calcium	Silver	Chloride
	Chromium	Zinc	Sulfate
	Copper	Antimony	Thiosulfate
	Lead	Selenium	Orthophosphate

All metals are dissolved unless otherwise noted

3.2.1. Mine Waste Rock Characterization and Monitoring

Greens Creek uses the numerical system described in Section 3.1 for production waste rock classification and placement. Waste rock classification is based on rock type and pyrite content. Interpretation of development and exploration drilling information allows mine geologists and engineers to estimate the quantities of argillite and phyllite anticipated during mining. Where practical the mine plan tries to minimize development in high pyrite rock, although mining potentially acid-producing rock is unavoidable. Production geologists visually inspect the active mining face and muck piles to determine the waste rock lithology and pyrite content, estimate the NNP value and assign the material a Classification Number. Chip samples of the material are periodically collected for ABA analysis. The ABA results help document the types of material produced and validates the visual classification system.

Waste rock disposal management follows the following criteria:

- Mixing of Class 2 and Class 3 is allowed to avoid physical discontinuities in the waste rock dump;
- Priority use of Class 1 is of higher beneficial use at Site 23 and the TDF area as an outer slope encapsulating layer;
- Place Class 1 as a 0.61 m thick layer at Site 23 and the TDF.

3.2.2. Site 23 Characterization and Monitoring

Class 1, 2, and 3 waste rock are brought to the active waste rock Site 23 by underground haul trucks and placed in stockpiles. The designated placement zones linked to the three classes of rock are marked on the active lift area prior to placement of waste rock and are sampled quarterly. Quantities of Class 1 and Class 2/3 waste rock placed at Site 23 will be tracked and included in the quarterly reports to ADEC, as required by the Waste Management Permit.

Active Areas:

- Two composite samples from each stockpile of Class 1 and Class 2/3 quarterly for ABA. Samples are collected from the top 30.5 cm within active placement areas.
- Outer side slopes will be sampled at least every five years, at a depth deep enough to encounter Class 2/3 waste rock if less than five feet. Samples will be analyzed for ABA, paste pH, and ICP metals.
- Groundwater/leachate samples will be collected quarterly from the finger drains and curtain drains when the flow is greater than 1 liter per minute (Suite C1 or C2).
- Groundwater wells (EDMS Site #: 50, 51, 326, 1263) will be sampled annually (Suite C1).
- Site 23 will be visually monitored for signs of damage or potential damage from settlement, ponding, leakage, instability, frost action, erosion, thawing of the waste, or operations at the site. Monitoring will be performed weekly and documented monthly as required by the Waste Management Permit.

3.2.3. Inactive Waste Rock Sites Characterization and Monitoring

Water quality monitoring is conducted at several inactive waste rock dump sites on a semi-annual or annual basis. Geochemical samples are taken once every five years and analyzed for ABA, paste pH, and ICP metals. This monitoring is conducted until the waste rock is removed, the site is reclaimed, and stabilized. Once all the material is removed from an inactive waste rock site, that site can be removed from the sampling program.

Site E is an example of an inactive waste rock site. It is located 4.6 miles up the B Road between the Hawk Inlet port facility and the 920-mill site. Approximately 279,000 m^3 of waste rock and glacial till were placed at the site from 1988 to 1994. Waste rock removal from the site and co-disposal of the material with tailings at the tailings facility is expected to significantly improve water quality in the small drainages between Site E and Greens Creek, while also improving pore water chemistry and geotechnical stability of the TDF.

- The frequency of monitoring surface water is dependent upon the yearly activity at the site; greater activity results in increased monitoring frequency. Minimally sites are monitored annually.

- Outer side slopes of the exposed waste rock will be sampled at least every five years. Samples will be analyzed for ABA, paste pH, and ICP metals. The location of each sample will be recorded on a map.

3.2.4. Construction Rock Characterization

All construction rock currently used on-site outside of containment is shipped in from quarries not associated with the Greens Creek operation. Construction rock originating from offsite is sampled by personnel from the surface operations, environmental or geology departments (or consultants) who are familiar with acid rock drainage (ARD) and metals leaching principles. The number of samples required depends on the compositional variability of the rock and the amount of rock or aggregate to be quarried:

- Five (5) samples per lithologic unit are considered the minimum number of samples necessary to represent a potential source area or volume of rock less than 100,000 tons.
- At least 10 samples per 100,000 tons of rock or greater produced in an individual campaign or over multiple years are collected.

Samples of non-weathered rock are to be collected from outcrops or through drilling and should represent the range of compositional variability of the source area. Five to ten pounds of rock per sample is generally sufficient for routine geochemical characterization. The sample may be a composite of several pieces of rock from an area or zone representing a single rock type. Composites of mixed rock types should be avoided.

Depending on the intended use of the rock and the results of the ABA and ICP analyses, additional testing may be warranted. Additional tests may include:

- Whole-rock assay for major and trace elements reported as oxides;
- Mineral content determined by X-Ray diffraction;
- Abrasion tests to determine rock durability;
- Kinetic leach tests (40-week humidity cell) to determine the potential for metals and sulfate mobility.

4. INTERNAL MONITORING OF TAILINGS

The Internal Monitoring of Tailings describes monitoring within the tailings pile area, in contrast to the compliance monitoring (under the Fresh Water Monitoring Program) at peripheral facility boundary sites. As such, data generated by the Internal Monitoring Plan effort are not for compliance purposes but provide a continuing perspective on in-pile geochemical processes.

There are three principal issues that affect potential ARD and metal leaching from the Greens Creek tailings facility including the setting and design of the individual facility, the operation of the facility, and reclamation and closure. Aspects of the facility design, operation, and closure that serve to minimize ARD and metal leaching risk are described in Tailings, Appendix 3 and the Reclamation Plan, Appendix 14 of the General Plan of Operations.

4.1. Monitoring Objectives

Monitoring is conducted to confirm the following:

- The site is constructed according to the approved construction plans;
- The site is maintained in a stable condition over the short and long term;
- Water management system components are effective and maintained as designed;
- Geochemical and hydrologic processes are defined and meet expectations with respect to limiting oxidation and leaching and minimizing the effects on the receiving environment; and,
- The effectiveness of Best Management Practices to control fugitive dust from escaping the facility.

Inspections and monitoring for the tailings facility, including water levels, water quality and geochemical testing of the tailings and production rock, are described in this section and summarized in Table 4-1.

4.2. Tailings Characterization and Monitoring

During the period the mine is active samples of mill tailings are collected prior to transport to the TDF and post-placement samples are collected at the TDF. These samples are analyzed for ABA.

- When operating, samples are collected daily from the mill tailings filter press. From these daily samples, a monthly composite sampled is obtained for analyses.
- Six (6) samples are collected annually from active placement areas.

Every five years until final closure of the tailings facility, older tailings are sampled to determine the NP and AP values as a proactive measure to further characterize the TDF material. The intent of this sampling is to monitor the consumption of the buffering capacity of tailings.

4.3. Other Monitoring

See Table 4-1 for a summary of monitoring activities for the tailings facility. Visual observations and material sampling are used to ensure that the construction of the facility is according to approved construction plans. Visual observations and routine maintenance ensure that the water management system is functioning as designed. Water quality data, flow, and level monitoring, material sampling and information from site meteorology stations are used to define geochemical and hydrologic processes occurring at the site. This information is evaluated with respect to design expectations, and modifications are made, if necessary, to minimize effects on the receiving environment in the short and long term.

The number and location of water samples collected each year may vary due to the constantly changing conditions within this active facility. Efforts are made to extend and protect monitoring wells as the height

of the tailings pile increases, but occasionally wells get damaged or destroyed. Suction lysimeters buried within the pile can also lose their functionality due to the deterioration of the tubing over time. New suction lysimeters are installed as the pile grows. The number of wells and lysimeters located within the tailings facility ensures that sufficient data can be collected to satisfy the monitoring objectives.

Table 7. Summary of Monitoring and Sampling Activity – Tailings Facility

Monitoring Type	Parameters	Frequency	Responsibility
site	visual inspections	daily, monthly	SOps, Env
material placement	tons cubic yards	daily (load counts) monthly (survey)	SOps
groundwater	C1 or C2	annually	Env
water levels (wells, piezometers)	depth to water, pressures	semi-annually, some sites monthly or quarterly	Env, SOps
drains, wet wells	C1 or C2, flow	quarterly	Env (WQ) SOps (flow)
suction lysimeters	L1	annually	Env
tailings characterization	ABA: ICP (metals), paste pH	monthly annually	Mill Env
tailings characterization – *in situ*	ABA, ICP (metals), paste pH	once every 5 years	Env
compaction	percent moisture, wet density	quarterly or annually	SOps

KEY:
ADC = atmospheric deposition container
ABA determines AP, NP, and NNP
C1, C2, and L1 sampling suite parameters are listed in Table 3-2
SOps = HGCMC Surface Operations Department
Env = HGCMC Environmental Department
Mill = HGCMC Mill Operations Department
* The frequency of monitoring is dependent upon the season and the ambient conditions

5. FUGITIVE DUST MONITORING

The control of fugitive dust from the tailings facility is a required mitigation measure in the 2013 Final Environmental Impact Statement and Record of Decision for the Tailings Disposal Facility expansion. The monitoring of fugitive dust emissions is a requirement of the Waste Management Permit. Deposition of dust to the west, south, and southwest of the tailings facility is believed to be the source of elevated (above background) lead concentrations that have been recorded in Tributary Creek.

Monitoring conducted between 2011 and 2019, visual observations, and operational experience indicate that dust loss from the tailings pile occurs when dry, windy conditions persist at the site. These conditions typically occur for short periods between mid-November and late March when high-pressure systems produce cold, dry weather and strong northerly winds. Table 5-1 summarizes the fugitive dust monitoring program associated with the TDF.

Table 8. Summary of Fugitive Dust Monitoring

Monitoring Type	Parameters	Frequency	Responsibility
fugitive dust – ADC	total deposition mg/m^2/day, lead deposition µg/m^2/day	weekly or bi-weekly or monthly	Env
fugitive dust – real time	mg/m^3	continuous - averaged 15min interval	Env
fugitive dust – visual	presence of dust	Daily	SOps

KEY:
ADC = atmospheric deposition container

5.1. Atmospheric Depositional Containers

Atmospheric depositional container (ADC) monitoring is used to determine long term temporal changes in the fugitive dust load, along with spatial distribution of the dust. The ADC program implemented at the TDF is an adaptation of the American Society for Testing and Materials (ASTM) D1379 Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter). ADCs are a basic and rugged passive accumulator of windblown dust and the data is used to supplement other monitoring data. Though crude and non-specific this methodology is useful in the study of long-term trends.

5.1.1. Description of Sample Locations

HGCMC will monitor fugitive dust emissions with six ADCs deployed to the south, southwest, and west of the TDF (Figure 5-1). These six sites were chosen because the primary area of placement from 2020 through 2024 will be in the southern extent of the TDF, and that the predominant wind direction is from the north and northeast. Two of these sites have been monitored since 2011 and another site since 2015.

Table 9. ADC Smple Sites

Site	Direction relative to active placement (2020 through 2024)	Status
1901	northwest	Sampled since 2011
1902	west	Sampled since 2011
1904	south	Sampled since 2015
2101	southwest	New site (2020)
2102	southwest	New site (2020)
2103	south	New site (2020)

5.1.2. Sample Collection and Laboratory Analysis

ADCs will be collected and replaced with clean ADCs once a month (28 days + 7) from April 1st to October 31st and weekly (7 days + 2) or biweekly (14 days + 4), atmospheric condition-dependent, from November 1st to March 31st. Any ADC can be collected sooner than the specified minimum frequency but will not exceed the maximum frequency specified.

ADCs are filtered through a pre-weighed 90 mm filter with 1.5-micron pore size. The filters are dried and weighed to determine the total mass of material on the filter. About once a quarter, the filters are sent to an independent laboratory for total lead analysis.

5.1.3. Data Analyses and Reporting

Results from the monitoring equate to the amount of material that passes through the opening of the ADC over the sampling period. This information is used to calculate the average daily lead deposition rate.

$$D_{Pb} = W/A/P \ \mu g/(m^2/day)$$

where:

A = collection area, the cross-sectional area of the inside diameter of the top of the container, m^2,

W = particulate Pb mass from the laboratory analysis of the filter, µg, and

P = length of the sampling period, days.

The results from the ADC monitoring will be evaluated in context with the meteorological data and surface operations activities. Visual and statistical temporal analyses will be conducted using the data collected, and if statistically significant negative changes are identified and corroborated by other monitoring data, additional dust control measures will be implemented as defined in the dust mitigation plan. Biannually the monitoring data and analysis will be included in the reporting to the ADEC required under the WMP. Biennially HGCMC will propose revisions to the fugitive dust mitigation measures if WQS exceedances continue to occur at Site 9 Tributary Creek.

5.2. Real-Time Monitoring

The monitoring described under Section 5.1 Atmospheric Depositional Containers is used to determine the long-term effectiveness of the fugitive dust controls. To facilitate the short-term evaluation of the mitigation measures HGCMC plans to install a (perhaps two) real-time monitor (RTM) to the south of the TDF (Figure 5-1). This monitor will measure the volume of dust in a cubic meter of air and the data will be trended in real-time for supervisorial review.

5.2.1. Description of Sample Location

Long term monitoring (2011-2018) shows that the deposition to the south and southwest of the facility is normally the highest. HGCMC plans to install the RTM to the south of the facility, proximal to Site 1904 which is situated at the head of the Tributary watershed. If a second monitor is installed the planned location is adjacent to the Pond 10 pumphouse.

5.2.2. Data Collection and Analysis

Monitoring data will be collected and trended on a continuous basis. For analysis purposes, the data will be averaged over a fifteen-minute interval. Short-term temporal analysis of the data will be conducted in context of fugitive dust mitigation measures implemented on a daily/weekly basis. Furthermore, the data will be compared to ADC data collected over the same period.

5.2.3. Reporting

Graphs of the RTM data will be prepared and submitted biannually. These graphs will also include markers indicating when fugitive dust mitigation activities were implemented. When capable a statistical analysis will be conducted for dusting periods in which additional measures were implemented. This will allow for an evaluation of the control under consistent meteorological conditions.

5.3. Visual Monitoring and Reporting

Daily the tailings disposal facility operator will make and record their observations with regards to fugitive dust at the TDF throughout the day shift. This will include observations at the beginning of the shift as to signs of dusting from the previous night. These observations by the nature of tailings placement will be limited to daylight hours (~6.5 hours for the shortest day of the year).

It is expected that these observations will correlate well with the RTM measurements. Therefore, during periods of the day when it is dark or the operator is not present the RTM will be used to signal the need for additional mitigation controls. HGCMC will include in the biannual reporting a summary of these observations as compared to the RTM.

Figure 3. Dust Monitoring Locations

6. BIOLOGICAL MONITORING

The role of biological monitoring is to ensure the continued use of Greens Creek and its tributaries by fish and other aquatic species and to document the continued health of all levels of the biological community: primary productivity, invertebrate communities, and fish. Biological monitoring will also detect early changes to the aquatic community that may result from changes in water chemistry, either through surface or groundwater inputs to the system.

Results from biological monitoring are compared to baseline conditions, or if baseline data are unavailable, to a reference site that is unaffected by the mine. There were few baseline studies conducted before the development of the Greens Creek Mine using current state-of-the-art protocols. The existing biological monitoring program is designed to compare present conditions to future conditions, with consideration given to any previous monitoring. HGCMC contracts with the ADF&G for the monitoring and reporting for this activity. This document serves as the quality assurance plan for biological monitoring.

6.1. Elements of the Biological Monitoring Program

The biological monitoring program for the Greens Creek Mine addresses the following factors:

1. Abundance and condition of juvenile fish;
2. Whole-body concentrations of Cd, Cu, Hg, Pb, Se, Ag, and Zn in juvenile fish;
3. Periphyton biomass, estimated by chlorophyll-a concentrations;
4. Abundance and community structure of benthic invertebrates;

6.2. Summary for Biological Monitoring

Table 6-1 summarizes the sites to be sampled, factors sampled at each site, and sampling frequency.

Table 10. Summary of Biological Monitoring Sites

Site Name	Monitoring Objective	Compare to:	Frequency	Factors	Time to Sample
Upper Greens Creek (Site #63)	Routine, control		Annually	FA, FM, P, MI	July
Greens Creek Below D-Pond (Site #54)	Routine, treatment	Control	Annually	FA, FM, P, MI	July
Tributary Creek (Site #9)	Baseline	Change over time	Annually	FA, FM, P, MI	July

KEY:
WQ - water quality
FA - fish abundance
FM - fish metals content
P - periphyton biomass
MI - macroinvertebrate abundance, community
Baseline - the conditions at the beginning of the biological monitoring program

Table 11. Sutie R (Biological Monitoring Parameters)

Juvenile Fish	Periphyton	Aquatic Invertebrates
1. Relative abundance and condition. 2. Subsample from each sample site will be analyzed for whole-body concentrations of; • Cadmium, • Copper, • Mercury (added in 2012) • Lead, • Selenium, • Silver • Zinc. (Metals are to be reported as total per dried weight of tissue). 3. The laboratory shall also report the percent moisture of the samples so that wet weight values can be calculated. 4. Water temperature will be measured.	1. Samples will be collected for estimates of Chlorophylls a, b, and c.	1. Samples will be collected to determine abundance and community structure.

Biological monitoring parameters identified in Suite R further augments the surface and groundwater monitoring and sampling program to accurately track the viability of the aquatic environment in Greens Creek and its tributaries.

6.2.1. Description of Sample Locations

Upper Greens Creek: FWMP Site 63

Site 63 is located upstream of all mine and mill facilities, except for exploratory drilling, and serves as the control reach for comparing data collected downstream at Site 54. Site 63 is at approximately 260 m elevation, and about 0.7 km upstream from the concrete weir in Greens Creek, which blocks upstream fish passage.

Greens Creek below D-Pond: FWMP Site 54

Site 54 is located approximately 25 m downstream of production rock storage areas 23 and D and monitored to detect potential effects from the rock storage areas and treatment ponds, in addition to the mine, mill and shop facilities upstream. Site 54 is at about 225 m elevation and 0.4 km downstream of Site 6.

Tributary Creek: FWMP Site 9

This site was previously monitored for water quality under the former Fresh Water Monitoring Plan (FWMP) from 1981 through 1993. It was reactivated in 2001 for inclusion in the biological monitoring program. Site 9 is located 1.2 km downstream of the dry-stack tailings facility at about 25 km elevation and is monitored to detect potential effects from the tailings facility. This is the closest free-flowing stream reach suitable for biomonitoring to the TDF. As these disposal facilities were situated on the hydrographic divide, there is no comparable upstream site.

6.3. Periphyton Biomass

6.3.1. Rationale

Many fish species are highly migratory, and their presence or absence does not adequately describe the health of a specific reach of stream. Periphyton, or attached algae, is sensitive to changes in water quality.

Their abundance confirms that productivity is occurring at specific locations within a water body. Algae generally have short life cycles; therefore monitoring biomass provides an ideal indicator to detect short-term effects (Barbour et al. 1999).

6.3.2. Sample Collection and Laboratory Analysis

The protocol for collecting and analyzing stream periphyton is derived from the Freshwater Biological Sampling Manual, Resources Inventory Committee, Province of British Columbia (1997), Alaska Department of Fish and Game (1998), and Barbour et al (1999). Periphyton sampling should not occur in-stream near minnow traps that are soaking as this violates the conditions necessary for depletion trapping.

Ten rocks are collected from the streambed of the creek in each study reach for sampling. A 5 by 5 cm square of high-density foam is placed on each rock; material around the foam square is removed by scrubbing with a toothbrush and then rinsed away using a spray bottle containing stream water. The foam square is removed and the isolated area scrubbed with a toothbrush. Loosened periphyton is rinsed onto a 1 µm (47 mm diameter) glass fiber filter attached to a vacuum pump. After extracting as much water as possible from the sample on the glass fiber filter, approximately 1 ml saturated $MgCO_3$ is added to the filter to prevent acidification and conversion of chlorophyll to phaeophytin. The glass fiber filter is wrapped in a large paper filter to absorb additional water, and placed in a sealed, labeled plastic bag with desiccant. The samples are frozen on-site in a light-proof cooler with additional desiccant and transported to laboratory for analysis. Samples are kept frozen until laboratory analyses are conducted by Division of Habitat staff.

Periphyton sampling at Site 9 will occur after fish sampling to avoid disturbing juvenile fish, though biologists must work carefully to avoid disturbing stream substrate which could affect periphyton results. Alternatively, samples could be collected upstream or downstream of the fish sample reach.

Laboratory analysis requires the extraction of chlorophyll pigments and measurement of chlorophyll concentrations on a fluorometer or spectrophotometer. Measurements on a spectrophotometer require a centrifuge. Laboratory analysis follows established protocol (USEPA and standard methods).

6.4. Benthic Macroinvertebrate Density and Richness

6.4.1. Rationale

Benthic macroinvertebrates classified in the Orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddis flies), collectively known as EPT taxa, are sensitive to changes in water quality and an important food source for fish. Most benthic macroinvertebrates have a complex one-year (or more) life cycle and limited mobility, therefore, benthic macroinvertebrates provide an ideal indicator to detect short-term and long-term effects within local aquatic communities (Barbour et al. 1999). An abundant and diverse group of EPT taxa indicate a healthy local aquatic community and results can be used to assess overall stream health with other local studies (e.g. periphyton biomass).

6.4.2. Sample Collection and Laboratory Analysis

Eight benthic macroinvertebrate samples are to be collected from each site using methods modified from Barbour et al (1999). More than eight can be collected to improve calculated mean densities. There is flexibility with respect to which invertebrate sampling equipment is used as long as is it consistent with the methods described in Barbour et al. (1999) (e.g. Surber or Hess sampler). In the past, samples were collected from each site with a Hess sampler using a random sample design. Samples are to be collected

exclusively from riffle habitats where the greatest amount of taxonomic richness and density are usually observed. This sample design eliminates the variability from sampling pools or other habitats where pollution-sensitive taxa are less likely to be present. The sample collection methods should be standardized throughout the year by having one biologist collect all invertebrate samples, spend the same amount of time collecting each sample (e.g. 5 minutes), and dig to the same depth at each sample site (10-15 cm).

For sample collection, the Hess sampler is pushed into the stream bottom, encompassing 0.086 m^2 of the substrate, to define the sample site. The substrate is manually disturbed and rocks are brushed within the sample area and then removed. Fine gravels are disturbed to about 10–15 cm depth to collect buried individuals. Macroinvertebrates are collected using a 363 μm mesh net, then relocated to a pre-labeled 500 mL Nalgene® bottle and preserved in 80% denatured ethanol and shipped to the laboratory for processing. Macroinvertebrate samples are later sorted from debris and identified to the lowest practical taxonomic level by a taxonomist.

Macroinvertebrate sampling at Site 9 should occur after fish sampling to avoid disturbing juvenile fish distribution. Alternatively, samples could be collected upstream or downstream of the fish sample reach.

6.5. Juvenile Fish Populations

6.5.1. Rationale

Salmonids are highly migratory, predators, and good indicators of long-term effects and habitat conditions (Barbour et al. 1999), therefore monitoring fish populations affords another biological level to detect change within the aquatic community and assess overall stream health.

6.5.2. Sample Collection

Fish populations are sampled using a modification of a three-pass removal method described by the Forest Service (Bryant 2000). Fish are collected using 0.635 cm square mesh galvanized Gee's minnow traps baited with salmon roe that was previously treated with Betadine® disinfectant solution. Approximately 25 minnow traps are deployed within each sample reach; the final number of traps used are dependent on stream conditions and habitat availability during field sampling. Natural features such as shallow riffles or small waterfalls are used to help define the upper and lower reach boundaries, in order to minimize fish migration into the sample reach, where possible. To assist with meeting the closed-reach assumption of the three-pass removal method, baited "block" traps are also set upstream and downstream of each sample reach to capture potential migrants.

Sample reaches are identified by aluminum tree tags and flagging set during previous years' sampling. There may be slight variation in reach lengths between sites, depending on available habitat for minnow trapping. The target length for each sample reach is 50 m.

Minnow traps are placed throughout each sample reach focusing on pools, undercut banks, bank alcoves, under root-wads or logjams, and other habitats where fish are likely to be captured. In higher velocity sites, rocks are placed in the traps to increase trap weight and provide cover for fish. In each fish sample reach, the traps are set for about 1.5 hours, and then retrieved and captured fish are identified to species, measured to FL, and placed in a mesh holding bag in the stream.

Block traps are set for the entire 1.5 hours sampling period. Fish captured in block traps are counted and identified to species, but not included in further analyses. Ten Dolly Varden from the first trapping period at each site are to be retained for laboratory analysis of whole-body metals concentrations. Fish not

retained for the metals analyses are returned to the stream reach immediately after sampling is completed.

Each salmonid captured is weighed to investigate the mean fish condition between sites and years for each species.

6.5.3. Data Analyses and Presentation

Juvenile fish abundance shall be reported as the number of fish, by species, captured during a single pass (1.5 hour) depletion trapping event, following established methods.

6.6. Metals Concentrations in Juvenile Fish

6.6.1. Rationale

Monitoring whole-body metals concentrations in juvenile fish assesses metal loading in aquatic communities near the Greens Creek mine. Current year data are compared to previous years' data to detect change over time and water quality data can be compared as well to examine relationships. Weber, Scannell, and Ott (2001) documented metals accumulation in juvenile fish tissues within two months of migration into mineralized tributaries, therefore results can detect both short-term and long-term changes in tissue metal concentrations.

6.6.2. Sample Collection and Laboratory Analysis

Ten juvenile Dolly Varden within the size range 85–125 mm FL are captured in the minnow traps collected from each site for whole-body metals analyses. The specified size range improves the likelihood of sampling only resident fish, assuming the age of fish in that size class is 2–3 year Dolly Varden that have not migrated to sea. Sample fish are measured to FL, individually packed in clean, pre-labeled bags and frozen on-site until transport to the laboratory. Biologists handling the fish wear VWR Certiclean Class 100 Nitrile gloves to reduce the risk of metal contamination.

At the laboratory, the fish are weighed without removal from the bags, and correction made for the weight of the bag. The fish are submitted to a private analytical laboratory (Columbia Analytical Services, Inc. in Kelso, Washington), where they are digested, dried, and analyzed for silver (Ag), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), lead (Pb), selenium (Se), and zinc (Zn) on a dry-weight basis, with percent total solids also reported.

6.6.3. Reporting

- Periphyton Biomass

  Periphyton samples will be analyzed on either a fluorometer or a spectrophotometer.

  Chlorophylls a, b, and c will be calculated from samples measured on the spectrophotometer.

  Periphyton biomass will be reported as mg chlorophyll-a / m^2 of the stream substrate. Comparisons will be made among the control and treatment sample sites using appropriate statistical methods. Data will be presented graphically, and the data values will be contained in appendices to biomonitoring reports.

- Benthic Macroinvertebrates

Data compilation and analyses for benthic samples should follow the protocol of the Alaska Stream Condition Index (Major and Barbour 1999), as described below and with modifications.

List of Metrics:

Abundance Measures

Total invertebrates counted per subsample

Total aquatic invertebrates per subsample

Total terrestrial invertebrates per subsample

Estimated total aquatic invertebrates per sample

Estimated total terrestrial invertebrates per sample

% sample terrestrial

% sample aquatic

Taxonomic Richness Measures

Total aquatic taxa Average taxa/sample

No. of Ephemeroptera taxa

No. of Plecoptera taxa

No. of Trichoptera taxa

Community Measures (estimate of total sample)

Est. number Ephemeroptera

Est. number Plecoptera

Est. number Diptera

Percent Ephemeroptera

Percent Plecoptera

Percent Diptera

Richness Measures

Composition Measures

% EPT

% Chironomidae

% Dominant Taxon

The metrics are calculated from the data collected and recorded on the laboratory bench sheet after the laboratory identification and analysis.

- Abundance of Rearing Fish

  Analysis of fish population estimates should include a graphical display of fish abundance trends at all bio-monitoring sites, and a statistical comparison of means (or medians) between populations at control and treatment sites.

  Data analysis should include graphical displays of annual fish population trends by species for each bio-monitoring site. Graphs displaying species/length distribution by year should also be provided.

  Potential change in juvenile fish abundance between the Greens Creek control and treatment bio-sites will be analyzed. The results of this analysis should be compared with similar statistics for water quality, metals content, periphyton biomass, macroinvertebrate indices and toxicity collected at these monitoring sites for the same time periods. This information will be used to evaluate and document potential cause-effect relations between changes in water quality, and aquatic biota abundance, distribution and community structure.

- Metals Concentrations in Rearing Fish

  The median, maximum, and minimum concentrations of each metal will be reported for each sampling site. Comparisons will be made among sampling sites. Metals concentrations also will be compared to metals concentrations in whole-body juvenile fish of similar species from other regions of Alaska (e.g. Weber Scannell et al., 1995, 1998, 2000b; Snyder-Conn et al. 1992, 1993).

7. GEOTECHNICAL MONITORING AND INSPECTIONS

The Greens Creek Mine has a TDF, two waste rock areas, and three registered dams that require geotechnical monitoring for stability and structural integrity. The TDF and waste rock sites (Site 23 and Site D) are monitored for potential movement and long-term stability as part of the general plan of operations, standard operating procedures, and as required by the Waste Management Permit. The Pond 7 Dam (AK00307) and Pond 10 Dam (AK00316), referred to collectively as the Pond 7/10 Dam System, are monitored in accordance with the Pond 7/10 Operations and Maintenance Program manual. Likewise, the Sand Pit Dam (AK00317) is monitored in accordance with the Sand Pit Dam Operations and Maintenance Program manual. The respective Operation and Maintenance Program manuals have been reviewed and approved by the ADNR-Dam Safety and Construction Unit. The routine monitoring and inspection provisions pertinent to geotechnical stability that are listed in the Operation and Maintenance Program manuals are listed within this IMP, but to ensure full compliance with all provisions of the Dam Safety Permits, they should be referenced.

Table 7-1 provides a summary of monitoring and inspection requirements to verify the geotechnical stability of specific waste rock sites, the TDF, and certified embankments. Monitoring activities include visual inspections, pneumatic piezometers, vibrating wire piezometers, inclinometers, standpipe water level, and survey monuments. Water monitoring and sampling for these facilities are covered in Section 3.2 and 4.1.

Table 12. Geotechnical Monitoring and Inspection

Site Name	Daily	Weekly	Monthly	Quarterly	Semi-Annual	Annually	Other	Responsibility
Site 23/D	SI	VI	VI, PP	SL	IC	SM		SOps, Env
TDF	SI VW	VI	VI, SL		IC			SOps, Env
Pond 7/10 Dam System	SI SP VW	VI	VI		SM		PSI 3-yr	SOps, Env
Sand Pit Dam			VI SM	SM (after 7/19)			PSI 5-yr	SOps, Env

KEY:
PSI = Periodic Safety Inspection
IC = Inclinometer
PP = pneumatic piezometers
SI = Safety Inspection
SM = Survey Monument – embedded in concrete
SL = Stand Pipe Water Level
SP = Seepage return flow rate
VI = Visual Inspection
VW = Vibrating wire piezometer (recorded on data logger)
SOps = HGCMC Surface Operations Department
Env = HGCMC Environmental Department

8. QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The *Quality Assurance Project Plan (QAPP) of the General Plan of Operations Appendix 1 Integrated Monitoring Plan* (Greens Creek 2014) found in Appendix 1.A presents the rationale and technical requirements for the monitoring and methodologies that are presently used at the site to further improve site-wide monitoring.

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GPO Appendix 01 - Attachment A
Quality Assurance Project Plan

GPO Appendix 01 - Attachment A
Quality Assurance Project Plan

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Subattachment d ACZ Laboratories QAP

Subattachment e Laboratory Data Review and Validation Checklist

Subattachment f Chester LabNet Quality Assurance management Plan

Acronyms

AAC	Alaska Administrative Code
ABA	Acid Base accounting
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
AGO	Attorney General's Office
ANILCA	Alaska National Interest Land Conservation Act
APDES	Alaska Pollution Discharge Elimination System
ASTM	Alaska Sampling and Testing Methods
AWQS	Alaska Water Quality Standards
CFR	Code of Federal Regulations
CH	Clean Hands
CV	Casing Volume
CWA	Clean Water Act
DH	Dirty Hands
DI	Deionized
DOW	ADEC, Division of Water
DQO	Data Quality Objective
DW	Depth to Water
EA	Environmental Assessment
EPA	Environmental Protection Agency
EIS	Environmental Impact Statement
FWMP	Fresh Water Monitoring Plan
HGCMC	Hecla Greens Creek Mining Company
ICP	Inductively Coupled Plasma Analysis
IWMMP	Integrated Waste Management and Monitoring Plan
IDL	Instrument detection limit
LCS	Laboratory Control Standard
MAG	Management Information Goals
MDL	Method Detection Limit
MIG	Monitoring Information Goals
MQO	Measurement Quality Objective
ND	Non-Detect
NEPA	National Environmental Policy Act
NIST	National Institute of Standards and Technology

NP	Acid Neutralization Potential
NNP	Net Neutralization Potential
PQL	Practical Quantification Limit
QA	Quality Assurance
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Practice
RL	Reporting Limit
RPD	Relative Percent Difference
RIG	Regulatory Information Goals
RS	Reference Standard
SIG	Statistical Information Goals
SOP	Standard Operating Procedure
SRM	Standard Reference Material
TD	Total Depth
TDF	Tailings Disposal Facility
TDR	Time Domain Reflectometry
USDOT	United States Department of Transportation
XRD	X-Ray Diffraction

Units of Measure

ac	acre
cm	centimeter
in	inch(es)
ft	feet/foot
km	kilometer
m	meter
mm	millimeter
m^2	meter squared
mL	milliliter
µg	microgram
oz/st	troy ounces per short ton
ppm	parts per million
st	short ton
yd^3	cubic yards

1. PROJECT MANAGEMENT ELEMENTS

1.1. Title and Approvals

Title: Quality Assurance Project Plan (QAPP) of the General Plan of Operations Appendix 1 Integrated Monitoring Plan (IMP)

Name: Brian Erickson (General Manager, Vice President)

Organization Name: Hecla Greens Creek Mining Company

Name: Christopher Wallace (Project QA Officer)

Organization Name: Hecla Greens Creek Mining Company

Name: Tim Pilon (ADEC DOW Project Manager)

Organization Name: ADEC DOW-Wastewater D/C Auth Pgms

Name: Doug Kolwaite (ADEC, QA Officer)

Organization Name: ADEC DOW WQSAR Program

1.2. DISTRIBUTION LIST

This list includes the names and addresses of those who receive copies of the approved QAPP and subsequent revisions.

Distribution List				
NAME	**POSITION**	**AGENCY/ COMPANY**	**DIVISION/ BRANCH/SECTION**	**CONTACT INFORMATION**
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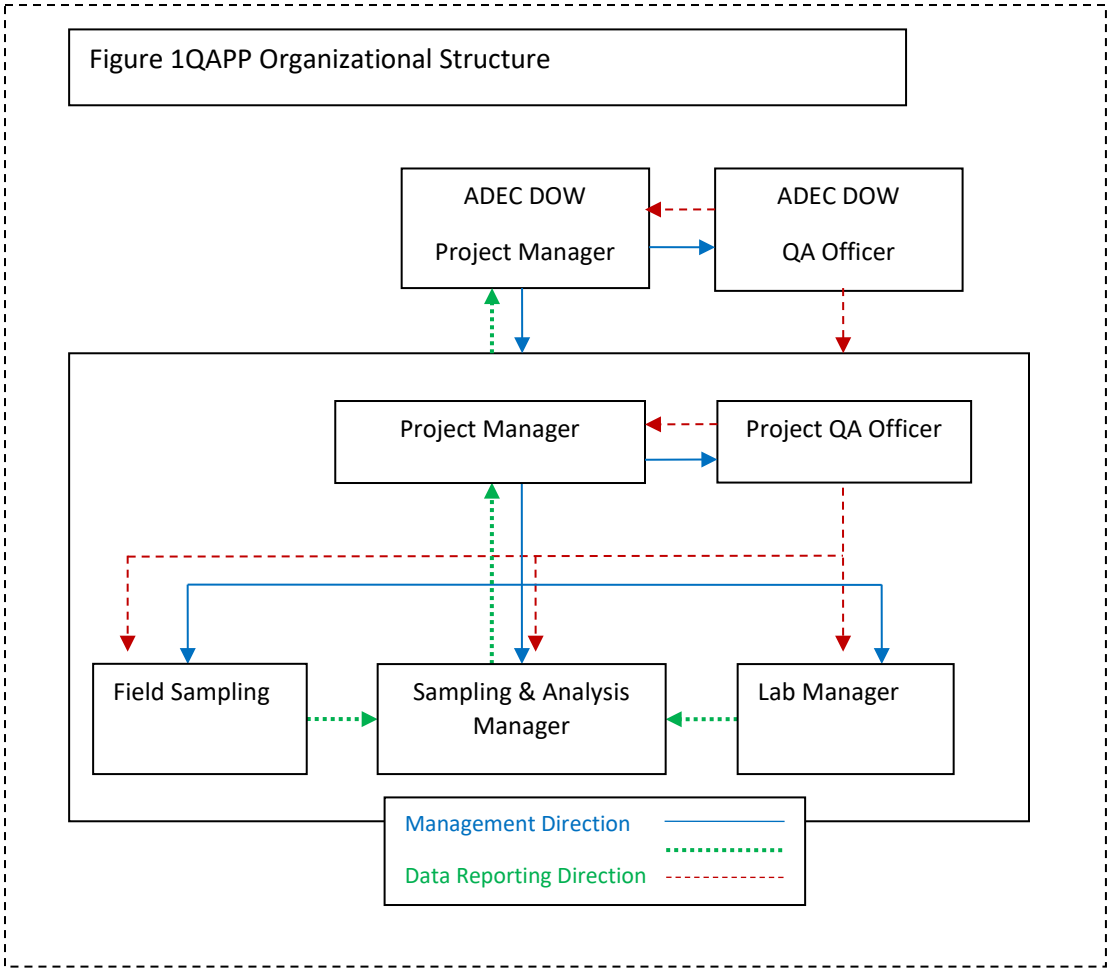
1.3. PROJECT/TASK ORGANIZATION

Duties and responsibilities of key individuals are listed below and summarized in Figure 1:

- Project Manager – Vice President and General Manager of the Hecla Greens Creek Mining Company.
- Project QA Officer – Environmental Affairs Manager responsible for permitting, regulatory compliance, and oversight of all aspects of implementing the Quality Assurance Project Plan (QAPP) and Field Procedures Manual.
- Sampling & Analysis Manager – This individual will maintain the quality of field activities, sample collection, sample handling, laboratory analysis and data analysis, and document the quality of data at each processing level. The manager identifies major aspects of the project requiring specific quality control and demonstrates that quality control is a major focus for this project.
- Data Manager – This individual identifies the procedures to be used to verify that sample and field monitoring data is accurately entered and available for analysis.
- Laboratory Manager – Responsible for the overall review and approval of contracted laboratory analytical work, responding to sample result inquiries and method specific details.
- ADEC Project Manager - Responsible for overall technical and contractual management of the project. For Permit related monitoring projects, responsible for ensuring the permit complies with permit required water quality monitoring as specified in the approved QAPP.
- ADEC Quality Assurance Officer - Responsible for QA review and approval of plan and oversight of QA activities ensuring collected data meets project's stated data quality goals.



1.4. BACKGROUND AND PROJECT OBJECTIVES

1.4.1. 1 Problem Definition

The Greens Creek Mine is a lead, zinc, silver and gold mine and mill located on the northwest portion of Admiralty Island, approximately 18 miles southwest of Juneau, Alaska. The facility has been in operation since 1989, with one temporary cessation of operations from 1993 to 1996. The mine's current production rate is 2,200 to 2,400 tons of ore per day. Major site facilities include the underground mine, mill, waste rock storage areas, dry tailing disposal facility, port facilities, and roads connecting these components. The facilities are located within the Greens Creek, Zinc Creek, Tributary Creek and Cannery Creek drainages, which flow into Hawk Inlet.

Routine monitoring is performed as described in the Greens Creek Mine Integrated Monitoring Plan (IMP) to fulfill monitoring requirements defined in the mine's Environmental Impact Statements (EIS), Records of Decision, Environmental Assessments (EA) and ADEC Waste Management Permit. The data generated from monitoring activities must be of appropriate quantity and quality to satisfy the project objectives.

1.4.2. Project Objective(s)

The objectives of the QAPP are:

- Ensure that monitoring requirements in the National Environmental Policy Act (NEPA) documents that relate to HGCMC are met. 40 CFR § 1505.3 states that agencies may provide for monitoring to assure their decisions are carried out.
- Ensure that Alaska Water Quality Standards (AWQS) are met. The State of Alaska, Department of Environmental Conservation has promulgated water quality standards to protect all uses of a water body.
- Ensure the intent of the Clean Water Act (CWA) is met. While this plan does not address discharges authorized by the mine's discharge permit under the CWA, some procedures described in this plan are similar to those described in 40 CFR § 136. This CFR referenced document describes guidelines that were established for test procedures for the analysis of pollutants discharged under Section 402 Alaska Pollution Discharge Elimination System (APDES) and Section 401 (State Certification) of the CWA.
- Ensure monitoring of surface water and groundwater and corrective actions will be in accordance with State regulations 18 AAC 60.820 – 18 AAC 60.860.
- Ensure test procedures for the analysis of water samples shall conform to the parameters, methods and procedures in the IMP and in 18 AAC 60.820 – 18 AAC 60.860.
- Ensure that the intent of the Alaska National Interest Land Conservation Act (ANILCA) is met.
- Evaluate the effectiveness of the IMP and QAPP annually.
- Collect information for specific reclamation needs and additional resource protection requirements as needed.
- Ensure the economic efficiency of the IMP and QAPP.
- Add and/or delete monitoring sites as needed; and modify schedules, protocols and methods as needed to ensure that all the goals of the IMP and QAPP are met.

This QAPP will be used to maintain the quality of field activities, sample collection, sample handling, laboratory analysis and data analysis, and to document the quality of data at each processing level. The QA/QC program identifies major aspects of the project requiring specific quality control and demonstrates that quality control is a major focus for this project.

1.5. PROJECT / TASK DESCRIPTION and SCHEDULE

1.5.1. Project Description

The Greens Creek Mine Integrated Monitoring Plan (IMP) documents the required material characterization, stability, freshwater samples, and biological samples which are collected at the prescribed frequency to ensure that the monitoring requirements defined in the mine's Environmental Impact Statements (EIS), Records of Decision, Environmental Assessments (EA) and ADEC Waste Management Permit are fulfilled. The IMP will be periodically reviewed and updated as necessary to coincide with regulatory changes, five-year environmental audit reviews, process modifications, or anomalies noted as a result of monitoring and sampling. Refer to the most current agency approved

version of the IMP for a detailed description of monitoring. Table 2 shown below provides a general overview of monitoring activities.

1.5.2. Project Implementation Schedule

Project Implementation Schedule					
Product	Media	Sampling Site	Parameters	Frequency	Time Frame
QAPP Preparation					
Monitoring	Surface Water	Project Area	Water quality, flow	Monthly/ Quarterly	Year-round
	Groundwater	Millsite, Site 23/D, and TDF	Water quality, static water level	Quarterly/ Annually	Year-round
	Tailings Characterization	Mill Tailings	ABA*	Monthly, Annually	Year-round
	Waste Rock Characterization Dump Stability Drains	Site 23	ABA* Inclinometer Water Quality	Quarterly Semi-annually Quarterly/Monthly	Year-round
	Bio-monitoring	Greens Creek and Tributary Creek	**WQ, FA, FM, P, MI****	Annually	July
Lab Analysis	All Media	All sites		Analyses within sample holding time requirements	Year-round
Field Audit	Audit of field monitoring operations	All sites		< 30 days of project start-up	1/project
Reports	All Media	All sites		Quarterly Annually	May, Sep., Nov. April 15

* ABA - Acid Base Accounting

** WQ - water quality, FA-fish abundance and distribution, FM-fish metals content, P-periphyton biomass, MI-macroinvertebrate abundance

1.6. DATA QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

1.6.1. Data Quality Objectives (DQOs)

Data Quality Objectives (DQOs) are qualitative and quantitative statements that:

- Clarify the monitoring objectives; and,
- Define the appropriate type of data needed.

The IMP describes the various types of monitoring performed throughout the project area, locations and frequency of monitoring (where applicable), and the data generated from the monitoring. Each type of monitoring has different DQOs based on the purpose for, and intended application of, the data.

The project's overall DQOs are to collect appropriate data to:

- Determine if water resources are protective of the applicable AWQS at compliance monitoring locations and identify water quality trends;
- Document the condition and long-term health of aquatic biological resources;
- Demonstrate that mine waste rock and tailings facilities are being managed in accordance with approved plans and permits; and,
- Determine if facility specific management and reclamation plans are adequate to protect the environment during operations and post-closure.

1.6.2. Measurement Quality Objectives (MQOs)

Measurement Quality Objectives (MQOs) are a subset of DQOs. MQOs are derived from the monitoring project's DQOs. MQOs are designed to evaluate and control various phases (sampling, preparation, and analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the project's DQOs. MQOs define the acceptable quality (data validity) of field and laboratory data for the project. MQOs are defined in terms of the following data quality indicators:

- Detectability
- Precision
- Bias/Accuracy
- Completeness
- Representativeness
- Comparability

Detectability **-** is the ability of the method to reliably measure a pollutant concentration above background. ADECs Division of Water uses two components to define detectability: method detection limit (MDL) and practical quantification limit (PQL) or reporting limit (RL).

- The MDL is the minimum value which the instrument can discern above background but no certainty to the accuracy of the measured value. For field measurements the manufacturer's listed instrument detection limit (IDL) can be used.

- The PQL or RL is the minimum value that can be reported with confidence (usually some multiple of the MDL).

Sample data measured below the MDL is reported as ND or non-detect. Sample data measured ≥ MDL but ≤ PQL or RL is reported as estimated data. Sample data measured above the PQL or RL is reported as reliable data unless otherwise qualified per the specific sample analysis.

The detectability criterion is addressed by specifying to the analytical laboratory the analytical methods and associated MDL and PQL required for each type of monitoring. For water quality monitoring the MDL and PQL are based on the applicable AWQS.

Precision - is a measure of the ability to replicate an analysis and is expressed as the relative percent difference (RPD). The RPD criterion for water samples is ±20% and is only applicable when the analyte concentration is more than 5 times the IDL, and as long as the native amount is not greater than 4 times the spiked amount. The RPD criterion for biological samples is ±35% due to the greater degree of variability in samples.

Bias (Accuracy) - is a measure of confidence that describes how close a measurement is to its "true" value and is expressed as %R. Methods to determine and assess accuracy of field and laboratory measurements include instrument calibrations and various types of QC checks (e.g., sample split measurements, sample spike recoveries, matrix spike duplicates, continuing calibration verification checks, internal standards, external standards, and sample blank measurements). Bias/Accuracy is usually assessed using the following formula:

$$Accuracy = \frac{MeasuredValue}{TrueValue} \times 100$$

The Matrix Spike/Matrix Spike Duplicate (MS/MSD) criteria are 75-125 %R for all metals. The criteria are only applicable for MS/MSD analyses as long as the native amount is not greater than 4 times the spiked amount. The accuracy limits for the Laboratory Control Sample (LCS) are method dependent, e.g. 90-110 %R for Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).

Completeness - is a measure of the percentage of valid samples collected and analyzed to yield sufficient information to make informed decisions with statistical confidence. Project completeness is determined for each pollutant parameter using the following formula:

$$\frac{T - (I+NC)}{T} \times (100\%) = \text{Completeness}$$

Where T = Total number of expected sample measurements.

I = Number of invalid sample measured results.

NC = Number of sample measurements not produced (e.g. spilled sample, etc).

The Fresh Water Monitoring Program (FWMP) is the only monitoring program for which completeness is a stated DQO. The completeness criterion is 95% for a water year (October 1 – September 30).

Representativeness - assigns what parameters to sample for, where to sample, type of sample (grab, continuous, composite, etc.) and frequency of sample collection. The IMP specifies these criteria for each type of monitoring.

Comparability **-** is a measure that shows how data can be compared to other data collected by using standardized methods of sampling and analysis. HGCMC utilizes standardized methods for the collection and analysis of water quality samples to ensure the comparability of data generated. Metals concentrations in water samples are measured in the dissolved fraction (filtered samples) to limit potential variability caused by mineralized sediments in surface and ground water. This enables comparison of surface water and ground water data, from both the internal monitoring program for tailings and waste rock sites and the FWMP compliance monitoring sites, to help explain water quality trends or data anomalies. Data collected from the FWMP sites are compared to the applicable AWQS.

Different laboratories are used for the analysis of FWMP samples and samples from the internal monitoring of tailings and waste rock sites. HGCMC frequently collects split samples and submits them to both laboratories for analyses of the same constituents. This QA/QC check of the laboratories validates the comparability of the data.

The Measurement Quality Objectives for the FWMP compliance monitoring are shown in Table 3. The laboratory may achieve lower MDLs than specified but not higher.

Measurement Quality Objectives (MQOs)							
Analyte	**Method**	**MDL[1]**	**PQL[2]**	**AWQS[3]**	**Precision[5,7]**	**Accuracy[6,7]**	**Complete**
Total Alkalinity, mg/L	2320	1.0	18	20	+/- 20 RPD	75-125 %R	95%
Hardness, mg/L	2340B	1.0	None	None	+/- 15 RPD	75-125 %R	95%
Conductivity, µmhos/cm	2510	10	None	None	+/- 10%	+/- 10%	95%
pH, s.u.	4500-H+			6.5 - 8.5	+/- 0.2	+/- 0.1	95%
Arsenic, diss., µg/L	1638m	2	9	10	+/- 20 RPD	75-125 %R	95%
Barium, diss., µg/L	1638m	280	900	1000	+/- 20 RPD	75-125 %R	95%
Cadmium, diss., µg/L	1638m	0.15 / 0.11	0.47 / 0.34	0.52 / 0.38	+/- 20 RPD	75-125 %R	95%
Chromium, diss., µg/L	1638m	3.1	9.9	100	+/- 20 RPD	75-125 %R	95%
Copper, diss., µg/L	1638m	1.4 / 1.0	4.6 / 3.2	5.1 / 3.6	+/- 20 RPD	75-125 %R	95%
Lead, diss., µg/L	1638m	0.25 / 0.15	0.81 / 0.49	0.90 / 0.54	+/- 20 RPD	75-125 %R	95%
Mercury, diss., µg/L	1631e	0.0003	0.011	0.012	+/- 20 RPD	75-125 %R	95%
Nickel, diss., µg/L	1638m	12.7 / 9.4	40.4 / 30.0	44.9 / 33.3	+/- 20 RPD	75-125 %R	95%
Selenium, diss., µg/L	1638m	1.42	4.5	5.0	+/- 20 RPD	75-125 %R	95%
Silver, diss., µg/L	1638m	0.21 / 0.10	0.66 / 0.33	0.73/0.37[4]	+/- 20 RPD	75-125 %R	95%
Sulfate, mg/L	M300.0-IC	70	225	250	+/- 20 RPD	75-125 %R	95%
Zinc, diss., µg/L	1638m	12.9 / 9.3	41.0 / 29.4	45.6 / 32.7	+/- 20 RPD	75-125 %R	95%

1. MDL=PQL÷3.18, rounded up to the same number of significant digits as the AWQS for that analyte. If AWQS for this constituent is hardness dependent, two numbers are listed. First number listed is for surface water sites, the second is for groundwater sites.
2. PQL based on AWQS x 0.9. If AWQS for this constituent is hardness dependent, two numbers are listed. First number listed is for surface water sites, the second is for groundwater sites.
3. If AWQS is hardness dependent, two numbers are listed for the purposes of calculating the MDL and PQL. First number listed is based on a hardness value of 37 to represent the 25th percentile of surface water hardness values, the second number listed is based on a hardness value of 25 to represent the 25th percentile of groundwater hardness values. AWQS is for chronic conditions unless otherwise noted. The actual hardness dependent AWQS for that constituent will depend on the actual hardness of the sample, not on the number that appears in this table.
4. AWQS is a 24 hour average (acute).
5. The precision DQO is only applicable when the analyte concentration is more than 5 times the IDL.
6. Listed accuracy is for MS/MSD only. The accuracy DQO for the LCS QC sample is method dependent.
7. The precision and accuracy DQOs for MS/MSD analyses are only applicable as long as the native amount is not greater than 4 times the spiked amount.

1.7. SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

All personnel collecting samples will be trained in protocols currently used for collection of water quality, geochemical characterization of materials, geotechnical stability of structures, and aquatic biological

samples. Written record must be made for training of all new personnel in either field notes/notebook or sampling sheets. Training of personnel collecting samples will be provided and documented by senior staff of HGCMC.

Contracted laboratories performing analytical work must have the requisite knowledge and skills in execution of the analytical methods being requested. Information on laboratory staff competence is usually provided in each lab's Quality Management Plan (QMP) and/or Quality Assurance Project Plan (QAPP). The QMP for PNNL Marine Sciences Laboratory (FWMP) is included as Appendix 1.A.C, and the QAP for ACZ Analytical Laboratories, Inc. (internal monitoring) is included as Appendix 1.A.D.

Training Requirements					
Specialized Training/Certification	**Field Staff**	**Lab Staff**	**Monitoring Supervisor**	**Lab Supervisor**	**Project QA Officer**
Safety training	X	X	X	X	X
Water sampling techniques	X		X		X
Instrument calibration and QC activities for field measurements	X		X		X
Instrument calibration and QC activities for laboratory measurements		X		X	X
QA principles			X	X	X
QA for water monitoring systems			X		X
Chain of Custody procedures for samples and data	X	X	X	X	X
Handling and Shipping of Hazardous Goods	X	X	X	X	X
EPA Approved Field Measurement Method Training	X		X		X
Specific EPA Approved Lab Analytical Method Training		X		X	X

1.8. DOCUMENTS AND RECORDS

1.8.1. Documentation of Measurements, Sampling, and Inspections

For each measurement or sample taken, the following information is recorded:

- Place, date, and time of inspection, observation, measurement, or sampling;
- Person(s) who inspected, observed, measured, or sampled;
- Dates the analyses were performed and by which analytical facility;
- Analytical techniques or methods used;
- Accuracy of the analytical method (detection limits); and,
- Results of all required analysis.

Chain of Custody forms accompany all samples to assure sample holding times and handling procedures are met throughout the sample and analytical process.

1.8.2. Retention of Records

During operation, closure, and reclamation all records of monitoring activities and results, calibrations, and maintenance are retained for a period of at least three years from the date that the permit expires and as long as necessary to comply with applicable laws.

1.8.3. Monitoring Reports and Submission Schedules

The ADEC Waste Management Permit requires submission of quarterly reports summarizing inspection and monitoring results. Reports for the first three calendar quarters are due within 60 days after the end of the quarter. These reports are submitted to ADEC to specifically satisfy the reporting requirements of the Waste Management Permit, with courtesy copies provided to the USFS and ADNR. The quarterly reports address the following:

- Summaries of inspections and monitoring results;
- Analytical results for monitoring performed at the FWMP compliance sites during the corresponding quarter, with comparisons to historical data;
- Quantities and disposition of tailings and waste rock; and,
- Summary of water flow and management monitoring and meteorological data during the quarter.

The report for the fourth calendar quarter will be submitted by April 15 of the following year and serve as an Annual Report. The Annual Report will satisfy the reporting requirements of the ADEC, USFS and ADNR. In addition to the information provided in the quarterly reports, the Annual Report will address the following:

- Geochemical monitoring of tailings, waste rock and construction rock;
- Geotechnical stability monitoring of the tailings disposal facility, Site 23 and Pond 7/10;
- Internal water quality monitoring of the tailings disposal facility and Site 23;
- Monitoring of fugitive dust from the tailings disposal facility; and,
- An assessment of the adequacy of the reclamation surety bond.

All work associated with the annual aquatic bio-monitoring is performed by an independent outside entity with expertise in that field. This includes data collection, analysis, interpretation of results, and preparation of a technical report. Currently, the aquatic bio-monitoring is performed by the Alaska Department of Fish and Game, Division of Habitat, under annual contract to HGCMC. The technical report on the bio-monitoring is submitted by April 15 of the following year.

In addition to the quarterly and annual reports, Waste Management Permit stipulates conditions which require notification to ADEC not later than 5:00 p.m. of the next regular work day. These conditions include:

- Wildlife casualties associated with facility activities;
- When a statistically significant increase in a constituent concentration above a WQS is discovered at a surface or ground water monitoring location; or,
- Any non-compliance with a permit condition.

If a statistically significant increase in a constituent concentration above a WQS or a non-compliance condition is discovered, HGCMC shall:

- Determine the extent of the exceedance or non-compliance;
- In consultation with ADEC and documented in writing, implement a plan to restore compliance and determine the cause of the exceedance or non-compliance;
- Submit to ADEC, within seven working days after an exceedance or non-compliance is verified by HGCMC, a plan for corrective actions to prevent adverse environmental impacts and avoid future exceedances of a similar nature; and,
- Implement the corrective action plan as approved by ADEC.

Below is a table of all documents and records that will be produced and their disposition, including location and retention time.

Project Documents and Records			
Categories	**Record/Document Types**	**Location**	**Retention Time**
Site Information	Network Description	On Site	
	Site characterization file		
	Site maps		
	Site pictures		
Environmental Data Operations	QA Project Plan		
	Field Method SOPs		
	Field Notebooks		
	Sample collection/measurement records		
	Sample Handling & Custody Records		
	Chemical labels, SDS sheets		
	Inspection/Maintenance Records		
Raw Data	Lab data (sample, QC and calibration) including data entry forms		3 years after permit expires
Data Reporting	Monitoring Reports		3 years after permit expires
	Progress reports		
	Project data/summary reports		
	Lab analysis reports		
	Investigation summary (CATS)		
	Inspection Report		
Data Management	Data management plans/flowcharts		
	Data algorithms		
Quality Assurance	Control charts		
	Data quality assessments		
	QA and PE samples		3 years after permit expires
	Site audits		
	Lab audits		
	QA reports/corrective action reports		
	Response		
	Performance Evaluation Samples		

2. DATA GENERATION AND ACQUISITION

2.1. SAMPLING

See the Integrated Monitoring Plan for specific sampling processes and designs.

Water samples are collected using protocols designed to minimize bias from systematic and/or erratic contamination introduced during sample collection. Water quality protocols are performance based and were developed from prior HGCMC sampling protocols incorporating selected procedures from EPA and U.S. Geological Survey methods. These protocols are applicable to the analytes being monitored, and the MDLs and MLs required assuring appropriate comparisons to AWQS. While these water quality sampling protocols are not required to be used, they are recommended. If other water quality sampling protocols are used, they should be based on proven methodologies such that the required MDLs and MLs can be achieved without experiencing false positive constituent levels due to introduced contamination.

2.2. SAMPLING METHOD REQUIREMENTS

2.2.1. Sampling Containers

The following applies to water samples collected under the FWMP:

- Sample containers are supplied by the laboratory conducting the analyses (PNNL Marine Sciences Laboratory).
- Sample containers will be pre-cleaned and pre-labeled at the laboratory prior to shipment to HGCMC. Filters and tubing used in the sample collection are also provided by the laboratory. They will be stored in a dry, dust free environment to avoid contamination on the outside of the bottles that could be inadvertently transferred to the sample during collection.
- Each bottle for trace metal analyses is placed within its own set of double re-sealable bags. Each bottle for the measurement of general wet chemistry analytes is placed within a single re-sealable bag. The individually bagged bottles for each site are placed together into a large clear plastic bag designated for that site.
- If a pre-cleaned bottle becomes uncapped during shipment or storage it will be returned to the laboratory and not used.
- Containers are supplied without chemical preservative. Collected samples are delivered to the laboratory within 24 hours and proper chemical preservation is performed at the laboratory.

The following applies to water samples collected under the internal monitoring program:

- Sample containers are supplied by the laboratory conducting the analyses (ACZ Laboratories, Inc.).
- Sample containers requiring chemical preservation will be pre-preserved at the laboratory prior to shipment to HGCMC. They will be stored in a dry, dust free environment to avoid contamination on the outside of the bottles that could be inadvertently transferred to the sample during collection.
- HGCMC is responsible for procuring filters and tubing that are certified as appropriate for use in the collection of environmental samples.
- HGCMC may print and affix the appropriate labels to the containers.

- All bottles for each site will be placed together into a large clear plastic bag.

The table below lists specific analyte/method criteria for parameter holding times and preservation methods. For parameters not listed in this table, see 40 CFR 136.6 for EPA-approved preservation methods and containers. 40 CFR 136.6 is available at http://www.gpoaccess.gov/cfr/index.html.

Preservation and Holding Times for the Analysis of Samples

Analyte		Matrix	Container	Volume	Sample Preparation	Maximum Holding Time
Hardness		Water	poly	500 mL	0.2% HNO_3	180 days
pH		Water	poly	500 mL	Field filter; unpreserved	24 hours[1]
Conductivity		Water	poly	500 mL	Field filter; unpreserved	14 days
Bicarbonate		Water	poly	500 mL	Field filter; unpreserved	14 days
Alkalinity		Water	poly	500 mL	Field Filter; unpreserved	14 days
Ca, Mg, Na, K		Water	poly	250 mL	Field Filter, 0.2% HNO_3	180 days
Sulfate, chloride		Water	poly	60 mL	Field Filter; unpreserved	28 days
Nitrate-Nitrite		Water	poly	250 mL	Unfiltered; H_2SO_4 to pH < 2	28 days
Hardness		Water	poly	100 mL	HNO_3 to pH < 2; < 6°C	180 days
Mercury Total		Water	poly	250 mL	Unfiltered; 0.5% HCL	90 days
Dissolved Metals	Silver Ag	Water	poly	500 mL	Field Filter, 0.2% HNO_3	180 days
	Arsenic As	Water	poly	500 mL	Field Filter, 0.2% HNO_3	180 days
	Barium Ba	Water	poly	500 mL	Field Filter, 0.2% HNO_3	180 days
	Cadmium Cd	Water	poly	500 mL	Field Filter, 0.2% HNO_3	180 days
	Chromium Cr	Water	poly	500 mL	Field Filter, 0.2% HNO_3	180 days
	Copper Cu	Water	poly	500 mL	Field Filter, 0.2% HNO_3	180 days
	Nickel Ni	Water	poly	500 mL	Field Filter, 0.2% HNO_3	180 days
	Lead Pb	Water	poly	500 mL	Field Filter, 0.2% HNO_3	180 days
	Selenium Se	Water	poly	500 mL	Field Filter, 0.2% HNO_3	180 days
	Zinc Zn	Water	poly	500 mL	Field Filter, 0.2% HNO_3	180 days

[1]From sample receipt

2.2.2. Sampling Methods

2.2.2.1. General Procedures

All personnel collecting samples will be trained in protocols currently used for collection of water quality samples. For all FWMP sampling, and whenever possible for internal monitoring, sampling will be done by teams of at least two trained people. Two people provide additional safety and overall efficiency while collecting samples in the field.

The following procedures apply regardless of the site type (ground water or surface water). Contamination will be minimized by paying strict attention to the work being done, awareness of potential contaminant sources, and minimizing atmospheric dust and debris from roads, vehicles, sampling locations, and the general environment.

- Assemble all requisite supplies for the samples scheduled to be collected that day, place them in the vehicle, and drive to the sample location(s) parking a safe distance away when the sample site is near a roadway to minimize contamination by airborne particulate.
- Open the storage cooler and remove the appropriate site bag containing the sample bottles and any QC sample bottle(s) scheduled for that site. Gather all ancillary supplies in a heavy clear plastic bag or cooler.
- Walk to the sampling location and set up to take samples.
- At each site, samplers involved in collecting samples will put on a new set of clean gloves. Only disposable, non-powdered latex gloves will be used during sample collection. The sampler will take extra care to ensure their gloves remain clean throughout the sample collection process. If there are any doubts, the glove(s) will be replaced immediately.

2.2.2.2. Surface Water Sample Collection Procedures

At each location the following information is to be recorded in a field log book: sample team, date, time, site name, sample ID, analytical suite, field parameters (pH, conductivity and temperature), flow measurement or estimate (if practicable), weather conditions, and any other information that will aid in the interpretation of the data.

Samples are collected facing upstream to minimize the potential for contamination by disturbed bottom sediments.

For each unpreserved sample bottle to be filled when conditions exist to completely submerge the sample bottle without disturbing sediments:

- Completely submerge the bottle and remove the cap. Hold the cap so that the liner is facing upstream allowing flushing of the cap interior, and partially fill the bottle.
- While the bottle is still submerged, replace the cap and remove the bottle from the water.
- Shake the bottle several times and empty the bottle downstream and/or away from the site.
- After two more rinses, submerge the bottle entirely allowing the bottle to completely fill with sample leaving as little air space as possible.
- Replace the cap and place the sample in the plastic site bag.

For collecting samples in pre-preserved bottles, samples that require filtering in the field, or from sites where conditions do not exist to completely submerge the bottle without disturbing sediments, either:

- Utilize a clean, triple rinsed, and appropriately sized sample bottle as a transfer device to fill the required sample bottle; or,
- Use a peristaltic pump with new, clean tubing to draw directly from the stream exercising care to not disturb sediments.

2.2.2.3. Ground Water Sample Procedures

Ground water samples are collected using a variety of methods that are based on the depth of the well, and whether it is artesian/flowing, has a rapid recharge rate, or a slow recharge rate. Artesian/flowing wells do not require purging prior to sample collection. Wells that recharge rapidly are purged to remove a minimum of three (3) casing volumes. Wells that recharge slowly are purged using low flow pumping techniques to minimize drawdown of the water column. For wells where pumping is not possible, a disposable bailer is used for purging and sample collection. In all cases, wells are allowed to freely flow, or are purged, until the pH, conductivity, and temperature have stabilized, or until the well runs dry.

At each location the following information is to be recorded in a field log book: sample team, date, time, site name, sample ID, static water level (before purging), total depth, purge volume, analytical suite, field parameters (pH, conductivity and temperature), flow measurement or estimate (if artesian), weather conditions, and any other information that will aid in the interpretation of the data.

2.2.2.4. After properly purging the well, groundwater samples are collected as follows:

- *If using an electric pump:* Attach a length of new tubing to the well's discharge tubing and the pump. Operate the pump and flush the tubing prior to sample collection. Both team members are careful not to touch the end of the tubing, or to let it touch anything.
- *If using a manual bailer:* Retrieve water from the well by slowly lowering the bailer into the well, minimizing the suspension of sediment if present. When practicable, retrieve and discard at least one bailer volume to rinse the bailer prior to sample collection. Pour/dispense water from the bailer into the sample bottles.
- Unpreserved sample bottles will be rinsed with water from the well by partially filling the bottle, replacing the cap, shaking vigorously to also rinse the cap, and emptying the bottle away from the site. Repeat two more times to triple rinse each bottle prior to sample collection.
- Pre-preserved bottles are not rinsed prior to sample collection.
- Collect the samples by holding the bottles under the end of the tubing or bailer, avoiding contact between the bottle and tubing or bailer. Secure the cap and place the sample bottle into the inner bag (if applicable) and re-seal it.

2.2.3. Sample Bottle Labeling

Each sample container requires a label large enough to record the information needed to readily identify the sample. The information recorded on each label will include the project name, sample point, date/time collected, filtered or unfiltered, preservation, and sampler's initials. Permanent waterproof ink or permanent marker should be used for all labeling purpose. The following are general guidelines to bottle labeling:

1. Put on a pair of clean gloves (new gloves should be used for each sample set).
2. Pull the sample set out, and fill out the necessary sections (site, date, time, and sampler) on the label, for each sample bottle.
3. To maintain consistent record keeping and to aid in efficient computer data processing, it is important to record the exact sample station identification on the sample label, corresponding to sample points contained in the IMP.

2.3. SAMPLE HANDLING AND CUSTODY REQUIREMENTS

2.3.1. Sample Custody Procedures

All water quality samples are collected by HGCMC personnel, packaged, and transported off Admiralty Island for laboratory analyses. This section describes the steps necessary to properly document the sample shipment, package the samples for shipment, and to arrange for and coordinate shipment of the samples from the mine site to the laboratory.

A chain of custody form and a bill of lading are filled out for each sample shipment. A copy of each is kept by sampling personnel to properly document and track the sample shipment. Example chain of custody forms are provided in Appendix 1.A.B. Documentation will be filed at the HGCMC mine site.

A bill of lading is completed for the shipping carrier to be used. HGCMC has accounts with Alaska Airlines Gold Streak Service and Federal Express. The carrier used is based on their ability to deliver samples to the laboratory's location, and the carrier's flight schedule. The account number is put on the bill of lading.

The samples and documentation are inspected and reviewed for accuracy, completeness, and legibility. The reviewer by initialing the chain of custody form documents the review as complete. The items to be reviewed are as follows:

1. The monitoring schedule is referenced to ensure all sample bottles including the QC samples are present.
2. The sample bottle labels and the chain of custody are reviewed.
3. The bill of lading is reviewed to ensure the correct delivery address.

2.3.2. Sample Packaging and Shipping Requirements

Packaging, marking, labeling, and shipping of samples will comply with all regulations promulgated by the U.S. Department of Transportation (USDOT) in 49 CFR 171-177. Staff should receive the necessary training for shipping samples or consult with the sub-contracted laboratory for shipping instructions.

Packaging

For the testing laboratory to generate valid test results, the integrity of field samples must be intact upon receipt at the laboratory. Protocols ensuring proper integrity of field samples from the time of collection to the time of receipt at the testing lab include:

- packing samples to prevent breakage or leakage;
- immediately cooling and maintaining unpreserved samples at <6°C;

- delivering samples to the lab in a time frame that allows analysis within the parameters' recommended holding times (see Table 6); and
- confirming the receipt and integrity of field samples with documentation generated by the shipper and the testing lab.

Packaging the samples is facilitated by the laboratory shipping empty bottle sets in the coolers that will be used for shipping the samples back to the laboratory. Coolers protect the sample containers, and provide the necessary environmental conditions (cleanliness, temperature, etc.) during transport. Blue Ice or frozen water in appropriate containers is used to maintain a temperature of <6°C within the coolers during sample shipment to the laboratory, and it is HGCMC's responsibility to freeze Blue Ice or water-filled containers prior to use. Below is a checklist of procedures for packaging water samples for shipment:

1. In a clean place without removing bottles from their resealable bag(s) ensure each sample bottle lid is tight, the bottle is properly labeled, and the cooler is clean to help minimize any contamination.
2. Ensure each sample bottle for metals analyses is within a set of double resealable bags, each sample bottle for the measurement of physical analytes is within a single resealable bag, and both are within the large clear heavy plastic bag designated for each site.
3. Place all site bags into the cooler. Set the bottles snugly in the cooler using clean packing material as necessary to prevent the sample bottles from moving within the cooler during transportation.
4. Place sufficient previously frozen Blue Ice or water filled bottles in the cooler with the samples to maintain the cooler temperature at <6°C during transportation.
5. Copy the chain of custody form, seal the original in a resealable plastic bag, and place the bag within the cooler. Retain the copy for HGCMC's files.
6. Place strapping tape around the cooler as necessary to ensure the lid does not open during transportation and to confirm the cooler has not been tampered with during transportation. Tape should be applied over the cooler lid lock mechanism if present.
7. Secure the shipping label to the top of the cooler.
8. Transport the cooler to a secure storage area or to the shipping agent.

Schedule of Shipment

The shipment of samples is coordinated between sampling personnel, laboratory personnel, and the transportation carrier(s) to be used. Samples are shipped expeditiously to the laboratory and should arrive in less than 2 days from the sample collection date. Holding time limitations must be considered when decisions are made regarding sampling and shipping times.

Notes:

- Sample shipments are not scheduled when it would result in expected delivery on weekends or holidays. Samples must be unpacked, logged, and preserved immediately upon receipt at the laboratory.

- Shipments are scheduled in consideration of the ability to get samples to town in time to meet the carrier's flight schedule. The carrier's schedule is checked beforehand for changes due to holidays or other reasons which could result in delayed delivery.
- The sample cooler(s) is brought to the drop-off point or common carrier in town and a copy of the bill of lading is returned to the mine for filing.
- A copy of the bill of lading is faxed to the Laboratory or they are called with the air bill number confirming to them the expected shipment and delivery time.

2.4. QUALITY CONTROL REQUIREMENTS

Quality Control (QC) is the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the monitoring project's data quality objectives.

2.4.1. Field Quality Control Measures

Quality Control measures in the field include but are not limited to:

- Proper cleaning of sample containers and sampling equipment.
- Maintenance, cleaning and calibration of field equipment/ kits per the manufacturers and/or laboratory's specifications, and field Standard Operating Procedures (SOPs).
- Chemical reagents and standard reference materials are used prior to expiration dates.
- Proper field sample collection and analysis techniques.
- Correct sample labeling and data entry.
- Proper sample handling and shipping/transport techniques.
- QA/QC Samples (should generally be equal to 15% of the total field and/or lab measurements or at least 1/sampling event, whichever is greater), including:
    - Field Blank (to the laboratory) samples
    - Field Replicate samples
    - Field Replicate measurements

2.4.2. Laboratory Quality Control (QC) Measures

Consistency in the use of fundamental laboratory techniques and practices over time is essential for creating a useful, reliable, and technically defensible database of analytical test results. Monitoring shall be conducted in accordance with EPA-approved analytical procedures and in compliance with 40 CFR Part 136, Guidelines Establishing Test Procedures for Analysis of Pollutants.

Quality Control in laboratories includes the following:

Calibration - Initial calibration ensures that the instruments are set up and adjusted properly to generate acceptable quantitative and qualitative test results. Initial instrument calibration procedures for most analyses require a minimum of three calibration standards and a blank. The associated calibration curve is required to have a linearity of 0.995 to be acceptable for sample analysis for most methods. Verifying

the calibration ensures that acceptable sample test results are initially and continually produced throughout the analytical test run. Calibration verification (CV) standards are analyzed after completion of initial calibration and at required frequencies (typically every 10 to 20 samples) during and at completion of analytical testing. CV test results must meet acceptance criteria (typically 90-110% recovery for most methods) in order to generate valid sample test results.

Blanks - Calibration blanks and preparation blanks or method blanks are used to monitor the background associated with the analysis and preparation procedures. Blanks are required to be analyzed as a component of the initial instrument calibration and/or at a minimum frequency of 5% of the test sample quantity analyzed during each test run or one per batch, whichever is greater. Test results on all blanks must meet acceptance criteria (typically +/- reporting limit) in order to generate valid sample test results.

Laboratory Control Standards (LCS) - Analysis of LCSs are used to monitor the overall performance of the laboratory, including both sample preparation and analysis procedures. A certified SRM also referred to as a reference standard (RS), is typically used as an LCS in most analytical laboratories. SRMs must be analyzed for all applicable test methods at a minimum frequency of 5% of the test sample quantity analyzed during each test run or one per batch, whichever is greater. Test results on all LCSs are required to meet acceptance criteria for accuracy (typically 75-125% recovery) in order for sample test results to be valid.

Matrix Spikes - These are used to monitor analytical performance with regard to accuracy within a specific sample matrix. Analysis of matrix spikes for all applicable methods is required at a minimum frequency of 5% of the test sample quantity analyzed during each test run or one per batch, whichever is greater. Test results on all matrix spikes are required to meet acceptance criteria for accuracy (typically 75-125% recovery) in order for sample test results to be valid.

Duplicates - Duplicates are used to monitor analytical performance with regard to precision. Analysis of sample duplicates for all applicable methods is required at a minimum frequency of 5% of the test sample quantity analyzed during each test run or one per batch, whichever is greater. Test results on all sample duplicates are required to meet acceptance criteria for precision (typically ≤20-25% RPD) in order for sample test results to be valid.

Sample Analysis – Sample analysis must be performed within the recommended holding times for each parameter tested (See Table 6). Sample preparation and analysis must correctly follow prescribed methodology. Reported test results must be derived from data that falls within the calibration range for each test parameter.

Contracted laboratories will provide analytical results after verification and validation by the laboratory QA Officer. The laboratory must provide all relevant QC information with its summary of data results so that the Project QA Officer or his/her designee can perform field data verification and validation, and review the laboratory reports. It is understood that Synectics is contracted to HGCMC to conduct the lab data review for the FWMP. The Project QA Officer or his/her designee (Synectics) reviews these data to ensure that the required QC measurement criteria have been met. If a QC concern is identified in the review process, the Project Sampling & Analysis Manager and Project QA Officer will seek additional information from the contracted laboratory to resolve the issue and take appropriate corrective action/s.

Laboratory Quality Control Samples			
Field/Lab Quality Control Sample	**Measurement Parameter**	**Frequency**	**QC Acceptance Criteria Limits**
Lab Blank	All parameters	1:20	<5x MDL
Lab Fortified Blank	All ICP-MS (1638) and ICP-OES (200.7) Metals and Hardness Mercury, Alkalinity, pH and Conductivity	1:20 NA	75-125% NA
Initial Calibration Verification Check Standard	All parameters	1 at beginning of analytical run	±10%
Continuing Calibration Verification Check Standard	All parameters	1:10	±15%
Matrix Spike/Matrix Spike Duplicate	All ICP-MS (1638) and ICP-OES (200.7) Metals and Hardness Mercury, Alkalinity, pH and Conductivity	1:20 NA	75-125% NA
Lab Duplicate Sample	All parameters	1:20	RPD <20%
External QC Check Standard	All parameters	1:20	75-125%

2.5. EQUIPMENT TESTING, INSPECTION AND MAINTENANCE REQUIREMENTS

This section describes the procedures and criteria used to verify that all instruments and equipment are acceptable for use.

Field equipment used for sample collection and field measurements requires a program of control, calibration, adjustment, and maintenance. Portable water quality instruments in good working order are used for the field measurement of a standard set of field parameters summarized in Table 8. Note: The make and model of these instruments may vary over time.

Field Testing Equipment TestingInstruments	
Equipment	Parameter
Solinst model 101 Depth to Water Tape	**Water Level (groundwater wells)**
Global Water FP111 Flow Probe	**Stream Flow**
Hach 2100P Portable Turbidimeter	**Turbidity**
Oakton pH/Con 10 Series	**pH** **Electrical Conductivity** **Water Temperature**
YSI EC 300	**Electrical Conductivity**
YSI 30	**Electrical Conductivity**
Solinst Model 408 Double Valve Pump **Solinst Model 464 Pump Control Unit**	**Groundwater**

All field measurement data are recorded in field log books then input into an electronic database. Field crews may use field instrumentation and equipment maintained at the project site and/or instrumentation and equipment brought in from off-site.

Calibration, Operational Checks, Maintenance, and Record-Keeping

Monitoring staff will document that required acceptance testing, inspection and maintenance have been performed. Records of this documentation should be kept with the instrument/equipment kit in bound logbooks or data sheets.

Field instrument preparations, calibration, and/or operational checks typically are performed at the beginning of each day's sampling activities. These tasks are performed following instrument manufacturer's recommended procedures or the procedures contained in this manual. A check of field instrument calibration is conducted initially (before sampling), at the completion of the day's field measurements, and as needed throughout the day, to establish and document that instruments are operated within specified tolerances.

Documentation of calibration measurements for field instruments must be completed every day prior to use and recorded in a field note book. Standards used for instrument calibration, operational checks, and calibration verification must be in accordance with applicable criteria such as the National Institute of Standards Technology (NIST), American Society for Testing and Materials (ASTM) standards, or other accepted procedures outlined in the instrument manufacturer's specifications.

Prior to use, maintenance procedures must be conducted on field instruments failing to meet acceptable operating specifications during calibration and calibration verification procedures. A record should be maintained of field instruments' make(s)/model(s), status of parts needed, working status, deficiencies (if any), instrument maintenance records, and any additional pertinent information.

Contracted and sub-contracted laboratories will follow the testing, inspection and maintenance procedures required by EPA Clean Water Act approved methods and as stated in the respective laboratory's QAP and SOPs.

Field Instrument Handling Procedures

The Greens Creek site location is subject to varying climatic conditions over the course of a typical calendar year. During the fall, winter, and spring months, air temperatures may be below freezing for extended periods of time. Electrodes used for measuring pH, oxidation reduction potential (ORP/Eh), dissolved oxygen, and conductivity may be ruined or rendered inoperable if allowed to freeze. Procedures must be followed to protect field instrumentation from freezing out in the field during water quality monitoring events. Prior to beginning field activities:

- select a cooler/insulating box of adequate size to hold all of the field instruments and associated equipment needed for performing field measurements
- equip the inside of a cooler with padding such as "bubble wrap" (sample protection)
- when freezing conditions occur, add an adequate amount of a heat source to the cooler (heat packs/hand warmers or other) to maintain temperatures above freezing inside the cooler while in the field.

Field Equipment and Instrument Decontamination Procedures

All sample collection equipment and field instrumentation that comes into contact with a sample must be decontaminated following sampling. Decontamination procedures differ depending on the instrument or equipment, as described below:

- For the water level meter, portable submersible pump, and peristaltic pump, the following procedure should be followed:
    1. rinse in water
    2. wash with an anionic detergent
    3. rinse in deionized water (DI)
    4. air dry
    5. dispose of cleaning agent at the proper waste facility.

The purpose of the water and detergent wash is to remove particulate matter and other potential contaminants. The purpose of the final DI rinse is to remove detergent and any residual contaminants.

- Hydrolab Quanta (refer to the Hydrolab Procedures Manual):
    1. thoroughly rinse all probes three times with tap water
    2. place in storage/transport cup, which should have ¼ inch of tap water or pH 4 buffer (if preferred), before traveling to the new site or for short-term storage.

If traveling to another site for sampling:

1. rinse the probe with site water at new location, to remove any residual water from the previous site.
2. between sites place probe in the transfer cup.

Using deionized water for storage purposes causes the pH probe to malfunction and require immediate replacement. Between sampling locations, the steps outlined above are recommended.

If the Quanta Multi-purpose probes appear to contain deposits or contaminants that cannot be removed from the rinse steps above, and a "drift" in parameter readout is observed, the Quanta meter can be sent into the nearest vendor for repair, or the simple cleaning methods described below can be done weekly or as needed for removing stubborn deposits:

1. Spray probes with the over-the-counter cleaning agent, "Scrubbing Bubbles," making sure that the lenses are sprayed over well, OR use Alconox solution.
2. Allow bubbles to sit for a couple of minutes.
3. Using the small tube brush is included in the maintenance kit; carefully scrub around all the probes to remove debris and build-up.
4. Rinse well with tap water, making sure to remove all the suds.
5. Dispose of any diluted cleaning agents and water at the proper waste facility.

2.6. INSPECTION / ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Field staff are responsible for ensuring that supplies and consumables (e.g., standard materials and solutions, filters, pumps, tubing, sample bottles, glassware, reagents, calibration standards, electronic data storage media, etc.) are inspected and accepted for use in the monitoring project.

All reagents, calibration standards, and kit chemicals are to be inspected to ensure that expiration dates have not been exceeded prior to use in the monitoring project. No standard solutions, buffers, or other chemical additives should be used if the expiration date has passed. It is the responsibility of the sampling manager or his/her designee to keep appropriate records, such as logbook entries or checklists, to verify the inspection/acceptance of supplies and consumables, and restock these supplies and consumables when necessary.

All sample collection devices and equipment will be appropriately cleaned prior to use in the monitoring project. All sample containers, tubing, filters, etc. provided by a laboratory or by commercial vendor, will be certified clean for the analyses of interest. Contracted and sub-contracted laboratories will follow procedures in their laboratory's Quality Assurance Plan (QAP) and SOPs for inspection/acceptance of supplies and consumables.

2.7. DATA MANAGEMENT

The success of a monitoring project relies on data and their interpretation. It is critical that data be available to users and that these data are:

- Of known quality;
- Reliable;

- Aggregated in a manner consistent with their prime use; and
- Accessible to a variety of users.

Quality Assurance/Quality Control (QA/QC) of data management begins with the raw data and ends with a defensible report, preferably through the computerized messaging of raw data.

Data management encompasses and traces the path of the data from their generation to their final use or storage (e.g., from field measurements and sample collection/recording through transfer of data to computers (laptops, data acquisition systems, etc.), laboratory analysis, data validation/verification, QA assessments and reporting of data of known quality to the respective ADEC Division of Water Program Office). It also includes/discusses the control mechanism for detecting and correcting errors.

Various people are responsible for separate or discrete parts of the data management process:

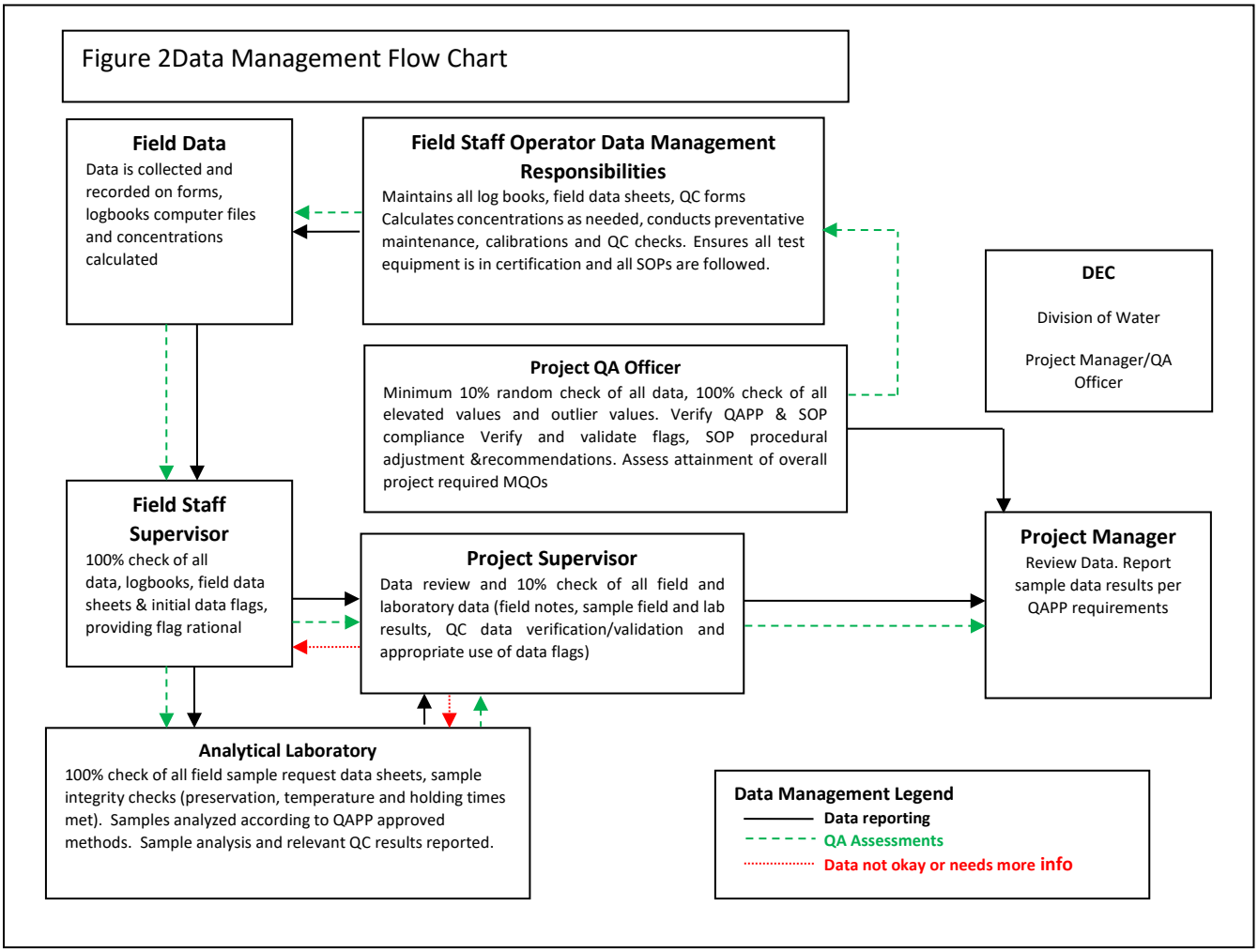
- The field samplers are responsible for field measurements/sample collection and recording of data and subsequent shipment of samples to laboratories for analyses. They assemble data files, which includes raw data, calibration information and certificates, QC checks (routine checks), data flags, sampler comments and meta data where available. These files are assembled and forwarded for secondary data review by the sampling supervisor.
- Laboratories are responsible to comply with the data quality objectives specified in the QAPP and as specified in the laboratory QAP and method specific SOPs. Validated sample laboratory data results are reported to the sampling coordinator/supervisor/project supervisor.
- Secondary reviewers (lab manager/sampling & analysis manager/project QA officer) are responsible for the review, verification and validation of field and laboratory data, and reporting validated data to the Project Manager.
- The Project QA Officer is responsible for performing routine independent reviews of data to ensure the monitoring projects data quality objectives are being met. Findings and recommended corrective actions (as appropriate) are reported directly to project management.
- The Project QA Officer is responsible for final data certification.
- ADEC DOW Project Manager/QA Officer/AQS data entry staff conducts a final review (tertiary review) and submits the validated data to STORET, AQMS, ICI-APDES, DROPS as appropriate.

The Data Management Flow Chart at the end of this section provides a visual summary description of the data flow/management process for environmental data collected in support of ADEC's Division of Water decision making processes.

Data Storage and Retention

A relational database containing all water quality data is maintained by HGCMC at the mine. Copies or partial copies of the database may be distributed to others as needed to facilitate data analysis. Data security is maintained by limiting access rights to the database files through network login IDs and passwords. Passwords are changed as needed. Laboratory data are electronically imported or manually entered into the HGCMC database. Associated qualifiers are manually entered after the QA review report is finalized and received by HGCMC. All data (100%) entered into the database manually, and a sample

(10%) of the data imported into the database electronically, are verified against the hardcopy before the data are used for analysis. Laboratory Records will be retained by the contract laboratory for a minimum of five years. Project records will be retained by HGCMC at the mine site through final reclamation.



3. ASSESSMENT AND OVERSIGHT

3.1. ASSESSMENTS AND RESPONSE ACTIONS

The following QA assessment activities are provided to serve as a guideline of activities to be performed by the Project's QA Officer or his/her designee to evaluate the overall monitoring system (data collection, analysis, and reporting).

Field Assessments (each pollutant)

- Precision (replicate) sample measurements. Project should have minimum of 1 paired measurements/sampling event or 5% of project samples, whichever is greater. Replicate measurements should be evenly spaced over project timeline. Precision criteria to be specified in the project's Measurement Quality Objectives (MQO) table, see section A.6.2.

Field samples collected for subsequent laboratory analysis (each pollutant)

- Field blank samples for each analyte to be measured. Project should have minimum of 1 field blank measurement/sampling event or 5% of project samples, whichever is greater.
- Sample splits (one split sent to lab analyzing project samples, other split sent to a reference lab).
- Matrix spike duplicates (MSD) (assesses total measurement bias for project – both precision & accuracy). Frequency of MSDs usually specified by analytical method. Accuracy and precision of criteria for each pollutant and analytical method to be specified in the project's MQO table see section A.6.2.

Note: It is the responsibility of the laboratory to enroll itself in these blind PT studies with the results mailed/emailed directly to the ADEC DOW Water Quality Assurance Office and the Monitoring Project's QA Officer. Routine laboratory performance in the blind PT sample studies will be used to assess overall laboratory data quality as well as monitoring project data quality.

On-Site Assessments

- Inspection of field monitoring operations for compliance with QAPP requirements.
- Laboratory Audit (if concerns arise regarding laboratory data quality)
- Audit of project field measurement data results.

Project Data Assessments

- Audits of Monitoring Data for reproducibility of results from recalculation/reconstruction of field/lab unprocessed data.
- Calculation of monitoring project's overall achieved precision, accuracy and data completeness compared to QAPP defined precision, accuracy and data completeness goals.

3.2. REVISIONS TO QAPP

Annually the QAPP will be reviewed and revised as needed. Minor revisions may be made without formal comment. Such minor revisions may include changes to identified project staff (but not lead project staff:

QA project officer, project manager, sampling manager, contracted laboratories), QAPP distribution list and/or minor editorial changes.

Revisions to the QAPP that affect stated monitoring Data Quality Objectives, Method Quality Objectives, method specific data validation "critical" criteria and/or inclusion of new monitoring methods must solicit input and pre-approval by ADEC DOW QA Officer/ADEC Project Management before being implemented.

3.3. QA REPORTS TO MANAGEMENT

The following table describes assessment types, frequency, content, responsible individual/s, and distribution of assessment reports to management and other recipients and actions to be taken.

QA Reports to Management					
QA Report Type	**Contents**	**Presentation Method**	**Report Issued by**	**Reporting Frequency**	
				As Required	**Year**
On-site Field Inspection Audit Report	Description of audit results, audit methods and standards/equipment used and any recommendations	Written text and tables, charts, graphs displaying results	Project QA Officer/auditor	✔	
Field Split Sample Report	Evaluation/comparison of result of split sample results from different laboratories, audit method.	Written text and tables, charts, graphs displaying results	Project QA Officer/auditor	✔	
On-site Laboratory Audit Report	Description of audit results, audit methods and standards/equipment used and any recommendations	Written text and tables, charts, graphs displaying results	Project QA Officer/auditor	✔	
3rd Party PT Audit Report	Description of audit results, methods of analysis and any recommendations	Written text and charts, graphs displaying results	Project QA Officer/auditor	✔	✔
Corrective Action Recommendation	Description of problem(s); recommended action(s) required; time frame for feedback on resolution of problem(s)	Written text/table	Project QA Officer/auditor	✔	
Response to Corrective Action Report	Description of problem(s), description/date corrective action(s) implemented and/or scheduled to be implemented	Written text/table	Project Manager overseeing sampling and analysis	✔	
Data Quality Audit	Independent review and recalculation of sample collection/analysis (including calculations, etc.) to determine sample result. Summary of data audit results; findings; and any recommendations	Written text and charts, graphs displaying results	Project QA Officer	✔	

QA Reports to Management					
QA Report Type	**Contents**	**Presentation Method**	**Report Issued by**	**Reporting Frequency**	
				As Required	**Year**
Quality Assurance Report to Management	Project executive summary: data completeness, precision, bias/accuracy	Written text and charts, graphs displaying results	Project QA Officer	✔	✔

4. DATA VALIDATION AND USABILITY

4.1. DATA REVIEW, VERIFICATION AND VALIDATION REQUIREMENTS

4.1.1. Data Validation

Data validation means determining if data satisfy QAPP defined user requirements; that is, that the data refer back to the overall data quality objectives. Data validation is an analyte and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set to ensure that the reported data values meet the quality goals of the environmental data operations (method specific data validation criteria). It is important that the data reviewers be familiar with the specific methods and QA/QC requirements associated with the Greens Creek project in order to properly review and validate associated analytical data. Water quality monitoring data is used for establishing baseline conditions, predicting water quality at various project facilities, and developing water quality discharge limitations. For these reasons, and because the data may also be the basis for future closure and reclamation decisions and strategies, it is critical that sample analyses and associated data meet method requirements and project specifications.

4.1.2. Data Verification

Data Verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements.

4.1.3. Data Review

Data Review is the process that evaluates the overall data package to ensure procedures were followed and that reported data is reasonable and consistent with associated QA/QC results.

4.2. VALIDATION AND VERIFICATION METHODS

4.2.1. Validation Methods

All data generated shall be validated in accordance with the QA/QC requirements specified in the methods and the technical specification outlined in this QAPP. Raw field data will be maintained by the Program staff who collect it. Raw laboratory data shall be maintained by the laboratory. The laboratory may archive the analytical data into their laboratory data management system. All data will be kept a minimum of 3 years.

Field data is first reviewed by field personnel performing the field measurement procedures. As with laboratory data, the field personnel have primary responsibility for the technical quality of field data, and for ensuring that field methods are properly performed and instrumentation is in good working order.

Analytical data generated by the laboratory is first reviewed by the testing laboratory and then reported to the Sampling and Analysis Manager. The laboratory has primary responsibility for correctly identifying and quantifying analytes and compounds of interest, for identifying matrix interferences, and for identifying and correcting instrument anomalies when possible. The laboratory is also responsible for the technical quality of the data, for meeting all quality control parameters by correctly following the analytical methods, and for using instrumentation that is in proper working order for the given method.

All laboratory data will be validated according to the laboratory's QAP. The rationale for any anomalies in the QA/QC of the laboratory data will be provided to the Project Manager with the data results. Completed Chain-of-Custody forms will be sent back from the laboratory to the Sampling and Analysis Manager. Data will be qualified as necessary.

The Project QA Officer or his/her designee is responsible for reviewing field log notebooks for accuracy and completeness. Synectics is contracted to HGCMC to conduct the lab data review for the FWMP. The Project QA Officer or his/her designee (Synectics) will fill out a Laboratory Data Review and Validation Checklist (example in Appendix 1.A.E) to be included with the permanent files and the monitoring report. The Laboratory Data Review and Validation Checklist will verify and validate the following items:

- Compare sample information from the field data sheets with the laboratory analytical results to ensure no transcription errors have occurred;
- Verify and validate sample results from the laboratory;
- Verify project QC criteria have been met (i.e., Blind Duplicates, Blanks, Matrix Spikes, Standards, and Completeness).

Unacceptable data (i.e., data that do not meet the QA measurement criteria of precision, accuracy, representativeness, comparability and completeness) will not be used or if used, the problems with the data will be clearly defined, flagged appropriately and data use clearly delimited and justified. Sampling may need to be repeated. Any actions taken to correct QA/QC problems in sampling, sample handling, and analysis must be noted. Under the direction of the Project QA Officer, project staff will document any QA/QC problems and QA/QC corrective actions taken.

4.2.2. Verification Methods

The primary goal of verification is to document that applicable method, procedural and contractual requirements were met in field sampling and laboratory analysis. Verification checks to see if the data were complete, if sampling and analysis matched QAPP requirements, and if Standard Operating Procedures (SOPs) were followed.

The Project QA Officer is responsible for the verification of the data and should verify at least 10% of the generated project data. The field data sheets are compared with the SOPs, sampling requirements and sample sites identified in the Greens Creek Integrated Monitoring Plan.

4.3. RECONCILIATION WITH USER REQUIREMENTS

The Project QA Officer and Sampling & Analysis Manager will review and validate data against the Project's defined MQOs prior to final reporting stages. If there are any problems with quality sampling and analysis, these issues will be addressed immediately, and methods will be modified to ensure that data quality objectives are being met. Modifications to monitoring will require notification to ADEC and subsequent edits to the approved QAPP.

Only data that have been validated and qualified, as necessary, shall be provided to ADEC Division of Water.

GPO Appendix 01
Attachment A
Subattachment a
Geotechnical Visual Inspection Checklist

Name of Dam: POND 7/10 (AK00307; AK00316)		***Date:***	
Weather:			
Pool Elevation Pond 7:	*ft-msl*	***Inflow to Pond 7 WTP:***	*gpm*
Pool Elevation Pond 10:	*ft-msl*	***14-inch Outfall Discharge:***	*gpm*
Inspector:		***Signature:***	
Supervisor:		***Signature:***	

1. Pond 7 Main Embankment	**OK**	**NOT OK**
Is the crest level and free of cracks? Is there settlement occurring? Is settlement or erosion occurring on the slopes of the embankment? Is the pond liner in tact and free of holes? Is the staff gauge in place and secure? Can an excavator and other equpmewnt use the access ramp?	☐	☐
2. Wet Well 7		
Is water from Pond 7 flowing freely into WW 7? Is the cover of WW7 intact and sturdy? Is the fall protection structure intact and sturdy? Is there signs of caisson deformation? Are the pumps functioning appropriately? Are the pump rails free and clear of obstructions?	☐	☐
3. Pond 7 Inlet Spillway		
Is the concrete structure free of cracks? Is the weir inlet clean and clear of obstructions including sediment? Are staff gauges intact and readable? Are the gabion baskets intact? Is the energy dissipater intact?	☐	☐
4. Pond 7 Emergency Spillway		
Is the weir inlet and stilling basin clear and free of obstructions? Is the concrete structure free of cracks? Are the staff gauges intact? Is the rip rap in place?	☐	☐
5. Pond 7 Underdrain System		
Is water running into the caisson from the inlet pipe? Is the caisson deformed? Is the submersible pump functioning? Is the caisson level within specified limits? Is the pump functioning normally?	☐	☐

6. Pond 7/10 Flow Control Structure	**OK**	**NOT OK**
Discharge basin clear and free of obstructions? Are the slide gates free moving and intact? Is the pipe insulation intact around the pipes and flowmeters in the vault? Are the flowmeters functioning? Is the wiring intact? Is the liner below the inlet culvert from the FCS free of wear? Is the concrete free of cracks?	☐	☐
7. Pond 7/10 Connector Culverts		
Are culverts free of obstructions? Are the pipe boots intact?	☐	☐
8. Pond 10 Main Embankment		
Is the crest free of cracks? Is there settlement occurring? Is settlement or erosion occurring on the slopes of the embankment? Is the pond liner in tack and free of holes? Is the staff gauge in place and secure?	☐	☐
9. Pond 10 Inlet Structure and Access Ramp		
Are there obstructions present? Are the gabions intact? Is the access ramp free of vegetation and other obstructions?	☐	☐
10. Wet Wells 10 & 11		
Is water from Pond 10 flowing freely into WW 10? Is water flowing into WW11 from the underdrains? Is there signs of caisson deformation WW 10 or 11? Are the pumps functioning appropriately? Are the pump rails free and clear of obstructions? Are the trends as would be expected?	☐	☐
11. WW 3		
Is the caisson showing signs of deformation? Is the pump functioning? Is there water entering the caisson through the inlet pipe?	☐	☐
12. Wet Well 14		
Is the caisson showing signs of deformation? Are the pumps functioning? Is there water entering the caisson through the inlet pipe? Do the trends look as you would expect?	☐	☐
13. Wet Wells 12, 13, 15 and 16 at South Embankment		
Are the caissons showing signs of deformation? Are the pumps functioning? Is there water entering the caisson through the inlet pipes for WW 12and 13? Is the culvert entering WW16 intact and clear? Do the trends look as you would expect?	☐	☐
14. Pond 9		
Is the pond outlet clear of obstructions?	☐	☐
15. DB-04 and Sump		
Water flowing from DB-04 to sump in building? Pumps functioning?	☐	☐
16. Pond A and Caisson B		
Is the crest free of cracks? Is there settlement occurring? Is settlement or erosion occurring on the slopes of the embankment? Is the pond liner in tack and free of holes? Is the underdrain pump functioning properly? Is the pump in Caisson B functioning?	☐	☐

17. Pond C	**OK**	**NOT OK**
Are embankments free of settlement or erosion? Are caissons showing signs of deformation? Are the pumps function normally? Are the caisson heaters on? Is access free and clear? Is the Upper Pond C liner free of holes or tares? Is Upper Pond C discharge pipeline draining?	☐	☐
18. Pond D		
Is the embankment free of settlement or erosion? Is the caisson showing signs of deformation? Are the pumps functioning properly? Is the fuel tank intact? Are the inlet and discharge lines intact?	☐	
19. Pond 23		
Is the embankment free of settlement or erosion? Are the pumps functioning? Is the underdrain functioning? Is the liner intact and free of holes? Do the trends look as they should?	☐	☐
20. 8", 10" and 18" wastewater pipelines from Pond 23 to Pond 7/10		
Are the pipelines intact? Are the AVRs functioning as they should?	☐	☐

Describe noted deficiencies (items checked "not OK"):

Describe immediate actions taken to remedy deficiencies:

Describe marginal items that are still functioning but need attention:

Other remarks:

GPO Appendix 01
Attachment A
Subattachment b
Example Analytical Lab Chain of Custody Forms

Hecla

Chain of Custody Record / Analysis Request

Lab Sent To:

Company Address:
Hecla Greens Creek Mining Company
P.O. Box 32199
Juneau, AK 99803

Telephone: (907) 790-XXXX
8482 D. Maller 8420 D. Landes
8457 C. Sell 8461 G. Fredheim

Project Name:

Report To: gcenvdata@hecla-mining.com

Sampler:

P.O.Number:

Sample I.D.	Date Collected	Time Collected	Matrix Water / Soil	Container																	pH < 2	RUSH (see below)

Comments:

Deliverable Instructions:
Use naming system below for report. XXXX will be replaced by the lab Project ID

e-mail to: gcenvdata@hecla-mining.com

Shipment Checklist
☐ _____
☐ _____
☐ _____

RELINQUISHED BY SAMPLER:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:	Condition of Sample Containers:
Signature:	Signature:	Signature:	Signature:	Temp Received: _____ °C
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GPO Appendix 01
Attachment A
Subattachment c
PNNL Marine Science Laboratory Quality Assurance Management Plan (QAMP)

PNNL Marine Sciences Laboratory Quality Assurance Management Plan (QAMP)

PNNL Marine Sciences Laboratory
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INTRODUCTION

The purpose of the PNNL Marine Sciences Laboratory (MSL) Quality Assurance Management Plan (QAMP) is to describe the Quality Program implemented at the facility. This plan summarizes the elements of the quality assurance program and discusses the quality control activities routinely used. The objective of the Quality Program is to obtain accurate and precise data consistent with project objectives. The Quality Assurance (QA) Program has evolved over time to meet client needs, but its roots are from the U.S. Environmental Protection Agency's (EPA's) document EPA QA/R-2, "EPA Requirements for Quality Management Plans". This QAMP also addresses the required elements of The NELAC Institute (TNI). While this plan sets forth Quality Program requirements, work plans and QA project plans are used to define project-specific client requirements.

Implementation of the policies and requirements specified in the QAMP and the associated procedures will provide defensible and credible data enhancing the quality of products and services.

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1.0 INTRODUCTION

The Pacific Northwest National Laboratory (PNNL) is operated by Battelle Memorial Institute, Pacific Northwest Division for the Department of Energy (DOE). For the purpose of this Quality Assurance Management Plan (QAMP), Battelle and PNNL will hereafter be referred to in general as PNNL, except in instances when specifically referring to Battelle as the Battelle Memorial Institute or "Battelle" is in a cited reference title.

Quality requirements for PNNL research and analytical work are determined through contracted customer requirements and on a risk-based graded approach. The requirements of this QAMP are only applicable to MSL's accredited quality program and projects that reference to it.

1.1 QUALITY ASSURANCE MANAGEMENT PLAN

This QAMP describes the Quality Assurance (QA) Program policies, procedures and accountabilities established and implemented at the PNNL Marine Sciences Laboratory (MSL). This QAMP summarizes elements of QA and the quality control (QC) activities used to perform work by collecting accurate, precise and reliable data consistent with project objectives. Detailed methodologies and practices are written in MSL Standard Operating Procedures (SOPs) or project planning or management documents.

This QAMP is designed to meet the requirements of many clients. It is intended to address elements of the Environmental Protection Agency's (EPA) document EPA QA/R-2, "EPA Requirements for Quality Management Plans", the Navy QA Program and the requirements for The NELAC Institute (TNI). While this plan establishes the overall QA program requirements, QA Project Plans (QAPP), sample analysis plans, and/or "kits" assembled at the time of sample receipt are used to define any project specific quality requirements not contained in or that supersede this plan.

A copy of the QAMP is available on the intranet or upon request. Where applicable, personnel are expected to be aware of and perform their assignments in accordance with the QA requirements described in this QAMP. The signature page at the front of this QAMP indicates management's review, consensus, commitment and approval.

To ensure that this QAMP remains current, it is reviewed annually and updated as needed. If only minor changes are needed, red-line changes are applied to the current version. If major changes are needed, the entire document is revised and the effective date is updated.

1.2 POLICY STATEMENT

The MSL is committed to maintaining the highest ethical and professional standards. The MSL's management team is committed to comply with the requirements of PNNL, the client, and any applicable regulations/standards (e.g. TNI standard, when applicable) and continually improve the effectiveness of the management system. Personnel shall conduct themselves in accordance with these standards and in their relationships with each other, with clients, with the public, and with PNNL.

- Personnel shall document calculations, analyses, tests and software required to substantiate results and processes used to develop products/solutions.

- Personnel shall ensure that the scientific and technical information that results from PNNL research is available for maximum possible future use by the scientific community and the public unless contrary to PNNL's interests or the client's requirements.
- Personnel shall identify and appropriately control items and materials affecting scientific results.
- Personnel shall use equipment of known accuracy for process monitoring and data collection.
- Personnel shall maintain records necessary to substantiate results and processes of research or administrative activities, protect records from loss or damage, refer requests from non PNNL personnel for access to records to the Records Manager, and retire records to approved record storage areas.
- Personnel shall be fair and ethical in business operations and not request or make unauthorized business disclosures.
- Research involving human subjects shall be conducted in a manner that will fully protect the subjects.

Personnel must be free of any influence, interest, or relationship that actually or potentially conflicts with the best interests of PNNL or its clients.

- Personnel shall be free of any influence, interest, or relationship that:
  - conflicts, potentially conflicts, or appears to conflict with the best interests of PNNL or its clients
  - could cause embarrassment or public criticism of PNNL
  - could interfere with personnel’s ability to perform job duties

Personnel shall comply with all laws, regulations, and contractual obligations and with the conditions imposed by the will of PNNL and PNNL policy.

- Personnel shall comply with applicable PNNL policies, standards, work flows, procedures, permits, and other work instructions. Any deviation from compliance with Laboratory work flows requires a documented variance.
- Personnel shall conduct work within the facility-specific operational boundaries specified in Facility Use Agreements.
- Management system owners shall develop their management systems, standards, and work flows with appropriate input from personnel enabling them to effectively conduct work activities in compliance with applicable requirements.
- Management system owners shall base their work flows on an evaluation of external requirements documents and applicable non-government standards, e.g., orders; directives; federal, state, and local laws; and PNNL policy.

In accordance with these principles, a QA Program was developed to assure that all activities affecting the quality of data or products produced for clients are thoroughly planned and coordinated by project teams. The MSL will ensure that all data generated, processed, or used in completing each task are scientifically valid, legally defensible, and of known and acceptable quality. As part of PNNL, the MSL is committed to the corporate policy of providing quality products and services and committed to their clients to ensure that sampling and analytical procedures are properly executed, sample integrity is not compromised, all QC procedures are implemented and recorded, and only valid data are reported. To attain this goal, the MSL has implemented the QA Program summarized in this QAMP.

1.3 OVERVIEW OF PROGRAM

The MSL works to business, management and quality practices specified by PNNL under the "How Do I" (HDI) system (a web-based system of policies, forms and procedures encompassing safety and QA). This system provides an infrastructure for performing day-to-day work, which includes QA activities. The PNNL system provides documentation of training, reminders for updating training, issuing of formal laboratory record books, a records archive, the chemical ordering and tracking system, and a system for tracking quality problems. The MSL has developed its own QA program as discussed in this QAMP to direct MSL-specific work and address client requirements. The goal is for the MSL QA Program to complement and agree with the HDI system, while meeting MSL needs.

The objective of the MSL's QA Program is to provide clients with quality products and services. A critical element in providing quality products is the maintenance of a QA Program that provides for conducting activities in a planned and controlled manner, thereby permitting the verification of quality performance. The consistent delivery of products of acceptable and documented quality requires commitment and adherence to QA and QC principles and procedures throughout the performance of each task. A commitment to quality is an integral part of every person's job. In addition, the MSL recognizes that formal functions are necessary to assure PNNL Management and its clients that the work performed and the technical products produced meet client needs and conform to their specific data quality objectives and requirements. These formal functions are QA and QC.

- QA includes all systems designed to assure management and the client that data were collected, processed, and interpreted in accordance with the requirements of the planning documents; that all aspects of work performance, including data generation and analysis are adequately documented; and that all data are accurate and fully traceable. For this system to be effective, each individual must understand his or her role in implementing the program. The responsibilities, authorities, and accountabilities with the MSL QA Program are defined in this QAMP.
- QC functions include all activities that are designed to assess or control precision and accuracy of measurements and data. QC functions involve performance of procedures necessary to attain and document the prescribed standards of performance in all measurement and data collection processes.

Project planning is performed in accordance with HDI work flow "Project Review and Approval". Project planning documents may be supported by SOPs, which are detailed documents that describe the tasks and/or approved methods for instrument calibration, data collection, data quality objectives (DQOs) and data processing, reduction and reporting. Planning also involves ensuring that personnel are fully qualified and trained to perform their responsibilities and that facilities and equipment are adequate and appropriate for their use. Procurement of qualified subcontractors is also a key consideration during the project planning stage and is performed in accordance with HDI work flow "Procurement".

A component of the work performed by the MSL involves the collection and analysis of environmental samples for chemical, biological, and physical parameters. A sample control system is essential to ensure that the history of each sample is documented and verifiable. QC activities are implemented during the performance of the work to measure and control the quality of the product. Additional methods of quality assessment are data validation, document reviews and QA verification activities. Deficiencies noted during the assessment process are

reported to management who take the necessary remedial action to bring the system into compliance. Quality improvement processes are implemented to ensure that problems identified are solved, and do not recur.

1.4 SCOPE

The MSL comprises various technical disciplines conducting research in support of environmental programs, primarily those related to the marine environment. The QA program defined in this document generally may be applied to any project performed by the MSL, as required by accreditations/certifications, projects, external clients and other components of PNNL.

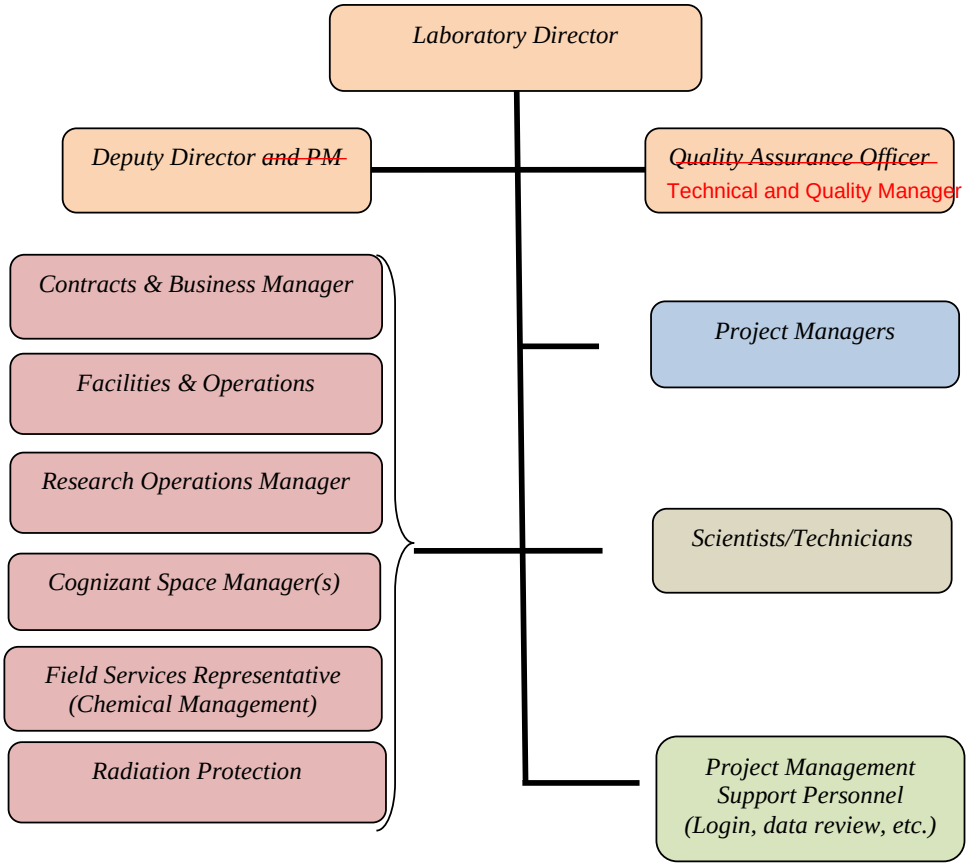
2.0 ORGANIZATION AND PERSONNEL

This section describes the organization of the MSL and defines the associated responsibilities, authorities, and accountabilities.

2.1 ORGANIZATION

QA at the MSL is an interdisciplinary line management function. The MSL's responsibility assignments are that 1) quality is achieved and maintained by those who have been assigned responsibility for performing work, and 2) quality achievement is independently verified by those not directly responsible for performing the work. The organization and key personnel of the MSL is illustrated in Figure 2.1.

FIGURE 2.1: Organization and Key Personnel



The Quality ~~Assurance Officer (QAO)~~ Manager (QM) has the authority and organizational freedom to identify quality problems, to initiate, recommend or provide solutions, and to verify implementation. All verification activity reports are made available to line and project management. Line and project management are responsible for identifying and assuring implementation of corrective action to all deficiencies.

Any personnel can initiate a stop work on the basis of a safety concern. In the case of a quality concern, the supervisor (which could be the Project Manager (PM), ~~QAO~~ QM, project supervisor, etc.) shall be immediately notified of the concern and then shall initiate investigative activities or initiate implementation of corrective actions. If the nature of the concern is such that the immediate manager cannot be approached, other avenues are also available for raising concerns. It is recommended that personnel seek resolution through the successive levels of management for their organization or through their Human Resource Manager. If personnel do not believe this will lead to resolution of the concern, they may go to a member of management with whom they are comfortable and trust, or any functional director.

2.2 RESPONSIBILIES

➢ Laboratory Director

The Laboratory Director provides overall management and has responsibility for all research operations.

The Laboratory Director is ultimately responsible for ensuring that appropriately qualified personnel are hired, resources for training are allocated, and that appropriate training and professional growth are provided, and records of training are maintained.

➢ Project Manager

The PM has overall responsibility for the management of project activities. Specific responsibilities include:

- Defining DQOs and QA/QC requirements for a project (e.g. TNI standard requirements, when applicable).
- Ensuring a project work plan and QAPP or both is prepared prior to work initiation and that it meets the requirements of the client, and any applicable regulations/standards (e.g. TNI standard, when applicable).
- Ensuring, when applicable, that PNNL, local, state and federal notifications are given, permits obtained and standards/regulations followed.
- Administering and supervising all project tasks to ensure that all project objectives are met, on time, within budget, and are of appropriate quality (e.g. complies to the TNI standard, when applicable).
- Preparing project planning documents, ensuring that the plans are reviewed and approved according to policies and ensuring that the planning documents are made available to participating project personnel.
- Assigning personnel to project tasks in accordance with their experience and skill.
- Identifying project specific personnel training needs, ensuring personnel receive necessary training to perform his/her assigned tasks and ensuring the training is documented.
- Ensuring that the project objectives are communicated to project personnel and that project personnel are trained to perform any procedures unique to the project.
- Reviewing all project reports and deliverables for scientific validity (completeness, accuracy, and appropriate qualifiers) and compliance to the TNI Standard, when applicable.
- Addressing project-specific deficiencies that are identified during verification activities.

➢ Quality ~~Assurance Officer~~ Manager

The ~~QAO~~ QM provides overall direction to, and oversight of, all QA activities. The ~~QAO~~ QM is part of the Quality & Assurance Services Department and reports to the manager of that Department, located in Richland, WA. The ~~QAO~~ QM does not report to anyone at the Sequim facility and thereby maintains independence. Specific responsibilities include:

- Developing the QAMP and updating it, as needed, to reflect policies, procedures and any applicable regulations/standards (e.g. TNI standard, when applicable).
- Ensuring the quality program is compliant to the requirements of the client and any applicable regulations/standards (e.g. TNI standard, when applicable).
- Assisting Project Managers (PMs), when applicable, reviewing project planning documents for conformance to relevant policies, procedures, regulations and requirements and defining QA and QC requirements and budgets at the proposal stage.
- Assisting PMs in defining the QA and QC (e.g. TNI standard, when applicable) procedures to be used during a project.
- Administering a training program related to QA policies and procedures.
- Scheduling, planning, and conducting verification activities (assessments, data audits) of projects and facilities.
- Data package QA reviews.
- Preparing written reports summarizing the results of verification activities for distribution to PMs and management.
- Participating in, or coordinating, inspections and audits conducted by clients and regulatory agencies.
- Preparing periodic status reports of QA activities and verification results for management.
- Reviewing and providing comments on the QA aspects of technical procedures, project planning documents, and reports.
- Preparing SOPs of exclusive QA activities, also adding input for the quality sections of all SOPs.
- Scheduling triennial SOP reviews, distributing SOPs, maintaining an SOP log, and archiving historical SOPs.
- Notifying applicable management of any concerns or conditions that could impact activities or operations and stop-work when applicable.

➢ **Cognizant Space Manager (CSM)**

The CSM is responsible for providing day-to-day oversight activities of the laboratory spaces. Specific responsibilities include:

- Identifying and mitigating hazards from activities and operations in their assigned workspaces
- Conducting periodic assessments of their assigned workspaces and acting to correct any deficiencies observed
- Restricting access to their assigned workspaces when appropriate
- Notifying applicable management of any concerns or conditions that could impact activities or operations within their assigned workspaces and stop-work when applicable..

➢ **Personnel**

- Performing work in conformance with specified procedures, project planning documents and policies and procedures, including ethical and legal responsibilities.
- Notifying applicable management of any deviations to the procedures/methods specified in the planning documents or of any circumstances that could affect the quality or integrity of the data.
- Notifying applicable management of any concerns or conditions that could impact personnel safety and stop-work when applicable.
- Communicating to the appropriate manager any deviation from established procedures or issues requiring corrective action
- Defining appropriate QA requirements for purchased items and services

➢ **Contracts and Business Manager**

- Providing acquisition, contracts, and related business support that assists in meeting the strategic goals and objectives of the MSL and its clients
- Assisting personnel in ensuring that the proposal preparation process meets MSL goals
- Ensuring that QA requirements are specified in procurement documentation
- Ensuring that the proper review of requests for contracts/projects has been completed. HDI work flow "Project Review and Approval" describes the process in detail.

➢ **Operations Manager**

- Overseeing and implementing core Environmental Safety and Health (ES&H) support services to ensure laboratory and personnel compliance with regulations
- Ensuring and assessing that proper waste handling, safety measures, and training are being performed by and for personnel in conjunction with work performed

2.3 PERSONNEL QUALIFICATIONS AND EXPERIENCE

The quality of products depends, in part, on the competence and expertise of the personnel involved. The MSL will ensure that all individuals involved in the conduct or supervision of projects (including laboratory technicians, field personnel, toxicologists, analysts, data-processing personnel, supervisors, PMs and QA personnel) have the necessary education, training, and experience to perform their assigned tasks. This objective is achieved by hiring personnel with the appropriate qualifications and providing continual training and opportunities for professional growth.

Education, work experience and other applicable qualifications are documented and maintained in personnel files. The MSL home page (http://marine.pnl.gov/) provides a list of some key personnel, including a biography and education when applicable.

2.3.1 Responsibilities

The Laboratory Director is ultimately responsible for ensuring that appropriately qualified personnel are hired, resources for training are allocated, and that appropriate training and professional growth are provided, and records of training are maintained.
Each individual's supervisor is responsible for identifying specific training needs, ensuring that the personnel receives the necessary training to perform his/her assigned tasks, and assigning personnel to project tasks in accordance with their experience and skill.

Each individual is responsible for completing required training and submitting training records and certificates to their supervisor, for updating their training file as needed, and for identifying and completing additional training that may be required, but was not assigned.

2.3.2 Training

Training begins the first day of service and continues throughout a personnel's term of employment. Training is specified by personnel's line management and may include policies and organization, QA, ethical and legal responsibilities, and ES&H. Technical training begins prior to work being performed, through reviews of procedural documents and demonstrations by experienced personnel. Introductory courses are augmented by general and project-specific training that is conducted periodically. Personnel assigned to projects receive training to acquire the necessary skills to perform their responsibilities. Technical training is accomplished through a variety of approaches, including

- Direct hands-on training. Training is accomplished by reviewing procedural documents (e.g., SOPs, project work plans), proficiency testing, and supervision by experienced personnel. Each SOP includes the training requirements associated with that procedure, including any proficiency tests.
- Project kickoff meetings. Kickoff meetings ensure that all project personnel are aware of the project objectives and the methods to be used to accomplish the objectives. This also includes field safety training at the beginning of each sampling period.
- Technical seminars. These seminars, which are available to all personnel, are conducted by PNNL personnel or guest speakers and generally cover current projects or related research programs.
- Continuous education through a tuition reimbursement program.
- Attendance at professional meetings and outside workshops.

ES&H training is monitored and provided using Integrated Operations System (IOPS) and Enterprise Learning, both available on-line.

MSL specific QA training is administered by the MSL ~~QAO~~ QM in accordance with procedure MSL-A-006, Marine Sciences Laboratory Training. Personnel complete assigned training activities and acknowledge training on a training form.

PNNL's on-line training modules are administered by the PNNL training program.

2.3.3 Documentation

Records of training and qualifications include the following:

- PNNL Integrated Operations System (IOPS) training
- PNNL Enterprise Learning training
- MSL specific training assignments, including field safety meetings or pre-job/dive briefings
- Certificates attesting to the attendance or completion of external courses
- Resumes and biographies

Records of training and qualifications are maintained in personnel or project files at the MSL by the project manager or the quality ~~assurance officer, at~~ Manager PNNL human resources (HR), on the PNNL on-line computer training system, on the MSL home page (http://marine.pnl.gov/), or on

the intranet. Qualification and training records maintained by HR or in the PNNL on-line computer training system are secure with limited approved access.

2.3.4 Improper, Unethical or Illegal Actions

Training courses in ethical and legal responsibilities including the potential punishments and penalties for violations are provided initially and annually thereafter via on-line computer training. The applicable annual refresher course number and title is 002351, “PNNL Refresher Training”. Topic areas include Business Ethics, Electronic Time Reporting, Human Resources, Property Management, Sustainability and Operational Excellence, Safety and Health, Emergency Preparedness, Safeguards and Security, and Unclassified Cyber Security. Upon completion of the course, a form is signed (manually or electronically) to obtain credit. The signed form is acknowledgement that the personnel have read and understand their personal and legal responsibilities including potential punishments and penalties for violations.

3.0 FACILITIES AND EQUIPMENT

The MSL, located in Sequim, Washington, is part of the Pacific Northwest National Laboratory (PNNL). The PNNL is operated by Battelle Memorial Institute, Pacific Northwest Division for the U.S. Department of Energy (DOE). Battelle Memorial Institute is a non-profit research and development organization.

The MSL campus is on 140 acres fronting Sequim Bay in the Salish Sea, near Puget Sound, making an excellent location for marine based research. The MSL campus consists of two separate areas; the beach area and the uplands area. In addition to general office space, the MSL consists of:

- Over 8,000 square feet of general purpose laboratory space
- Over 6,000 square feet of wet laboratory space
- A research dock and outdoor experimental tanks
- State-of-the-art water supply and treatment system
- Research boats and scientific divers

The MSL supports various researchers, scientists and support personnel, including university students, graduates and post docs.

3.1 WET LABORATORIES

Two wet laboratories provide over 6000 square feet of space for studies requiring flowing freshwater, filtered seawater, and raw seawater through several separate distribution systems. High quality, Class AA seawater is obtained from Sequim Bay through an all- Polyvinyl Chloride (PVC) system with two independent intakes. A redundant system of various pumps provides a continuous supply of filtered and unfiltered seawater to experimental tanks. An emergency diesel generator ensures continuous seawater supply and other essential services in the event of electrical failure. A 14,000-gal reserve tank provides filtered seawater to the laboratories for up to 18 hours (dependent on flow rates required) in the event of failure of all three pumps. Raw seawater at ambient temperature (9-11°C) can be provided at a rate of 250 GPM, and up to 20 GPM of filtered seawater or freshwater can be supplied at various temperatures.

Holding and breeding facilities for a variety of fish, shellfish, and freshwater, estuarine, and marine plants are provided in these laboratories and in outdoor tanks. All water used in testing is passed through a regulated treatment system to ensure no impact is made on the receiving environment.

Two isolation rooms within one of the wet labs provide the capability to isolate pathogens. The isolation rooms share a common waste sump and pumping system and disinfection system on the discharge to the main water treatment system.

3.2 GENERAL PURPOSE LABORATORIES

➢ Beach Facility

General purpose laboratories in the Beach facility consist of chemistry electronics, optics, hyperbaric, biotechnology, and BSL1-2 laboratories and support rooms (e.g., wash rooms, preparation labs, and microscopy labs). A Class-100 Clean Laboratory Facility is also present.

- **Upland Facility**

General laboratories in the Upland facility consist of ten fully-equipped chemistry laboratories, including a Class-100 Clean Laboratory Facility and a radiological laboratory occupying 600 ft^2. The chemistry laboratories are equipped with an array of instrumentation, support equipment and supplies.

Specific styles of clean rooms include: Ultra Trace Hg and Methyl Hg clean rooms for preparing sampling equipment; trace metals grade supplies are stored in clean rooms. The MSL contains a general organic chemistry laboratory for preparation of sample extracts for gas chromatography and mass spectroscopy, and analysis for physical properties of sediment. A high performance liquid chromatography (HPLC) system, with variable wavelength Ultraviolet (UV) light detector, fluorescence detector, auto injector, fraction collector, integrator, and data reduction system is available for specialized sample preparation.

The Upland facility is also equipped with secure sample login, sample holding/acclimation, sample staging/preparation/digestion/extraction. It has the capacity and ergonomic set up to address the specific style of testing to be accomplished. Equipment cleaning stations necessary to provide the level of cleanliness required to support the data generated are also housed in the Uplands facility.

3.3 COMPUTER FACILITIES

Personnel use password protected computer systems connected via a local area network and routinely backed up. The systems are linked to other on- and offsite hardware composed of workstations and servers, minicomputers, database and file repositories, Web servers, and supercomputer facilities.

The MSL has access to the numerous electronic resources available through PNNL Technical Library Services. Commercial databases such as BIOSIS, Chemical Abstracts, Oceanic Abstracts, Enviroline, Aquatic Sciences and Fisheries Abstracts, Pollution and Toxicology Abstracts, and many others can all be accessed quickly by computer. The PNNL Technical Library also provides links to other Department of Energy Laboratory libraries and electronic resources. Through such access to information, literature searches can be conducted efficiently.

3.4 SAFETY AND SECURITY

The safety of personnel is of paramount importance. Therefore, the buildings are equipped with surveillance cameras and structural safety features (e.g., fire doors and extinguishers, emergency lighting systems), alarm systems which serve to alert the personnel in the event of emergencies (e.g., fire/smoke alarm), and engineering controls designed to minimize exposure to potential hazards (e.g., fume hoods).

The security of the facility is an important consideration because of the type of work performed by the MSL. Access to the MSL grounds and buildings is controlled through a card-access and lock and key system. During business hours, all visitors must enter through the main lobby and sign in with the receptionist. Selected areas within the facility are secured at all times and their access limited to authorized personnel. Such areas include the walk-in cold room used for sample storage, the records storage area, the solvent shed, and the data archives. HDI work flow “Access and Protection Requirements at Battelle Facilities” describes the process in detail.

Computer security is a function of the PNNL network and is administered from facilities located in Richland, WA. Personnel have individual responsibility to back up files, instruments and data bases at regularly scheduled intervals which are prescribed in procedure MSL-D-004, Data Reporting, Reduction, Back Up, and Archiving.

4.0 PROCUREMENT AND CONTROL

4.1 MATERIAL PROCUREMENT AND CONTROL

Examples of items that generally have a significant influence on the quality of work, and therefore generally need defined quality requirements are the following:

- Standards and reference materials
- Reagents, chemicals and solutions
- Animals and feed
- Computer software and hardware, and
- Some miscellaneous items such as designed equipment

Procurement activities are prescribed in HDI work flow “Procurement” which should be consulted to determine appropriate QA requirements before initiating procurement actions.

4.1.1 Miscellaneous Procurements

Miscellaneous procurements of items that have a significant influence on the quality of work generally need defined quality requirements. When the purchaser does not know if quality requirements should be specified, the practice is to request the ~~QAO~~ QM or representative to make this determination and document it as a note, letter or email.

4.1.2 Material Receiving Inspection

When materials are ordered that require certification (i.e., standard or certified reference materials (SRMs, CRMs), standards, pre-cleaned sample containers, etc.), a request for certifications shall be made on the purchase order. Standards and reference materials must be traceable to the National Institute of Standards and Technology (NIST) or other nationally-recognized standard (e.g., American Society for Testing Materials [ASTM]). The traceability must be documented by a certificate or label that verifies this link. The traceability documentation must be received and found to be acceptable before material use. Acceptance of these items and certifications shall consist of verifying that the lot numbers on the certifications and the jar and/or boxes are the same. Approval shall be indicated by a signature and date of signature on the certificate. Pending receipt of this documentation and its acceptance, affected material must be segregated to prevent inadvertent use. Certifications received will be maintained by the ~~QAO~~ QM or in the Project files.

4.1.3 Reagent and Standard Inventory Procedures

The procurement of reagents, chemicals and solutions should include requirements for shipping stocked inventory materials with the longest period to the expiration date (i.e., the freshest material) possible, with lot numbers specified. In some cases where extremely high purity material is requested, a request for purity documentation may be necessary.

Procurement procedures should require that a manufacturer's recommended expiration date is provided with every standard material. If manufacturer's expiration dates are not provided, the laboratory must assign an appropriate expiration date in accordance with procedure MSL-A-008, Control of Standards, Reagents, Solutions, Test/Control Articles and Specimens.

The MSL follows the PNNL HDI system requirements for logging in reagents, chemicals and solutions into the associated Chemical Management System (CMS). This system provides policies and procedures regarding tracking and inventory and storage of samples as well as chemical use and disposal. The CMS is used to provide an up-to-date inventory to facilitate emergency response, monitor the location of various classes of materials and identify situations where acceptable limits for the building/facility determined by the assigned chemical hazard group and fire zone might be exceeded before a violation occurs. An assigned Sample Inventory Coordinator provides Radio Frequency Identification (RFID) tags for each tracked chemical item when it is received and assigns it to a location. The item then is tracked in the CMS until disposal. The system is also used to ensure that facility limits based on the chemical hazard group and the assigned fire zone determination are not exceeded.

Personnel are required to document when chemicals are received and expiration dates as prescribed in procedure MSL-A-008, Control of Standards, Reagents, Solutions, Test/Control Articles, and Specimens.

4.1.4 Computer Software and Hardware

Software and hardware is procured in accordance with the PNNL HDI system procurement requirements are maintained under the PNNL Managed Hardware Program. In general, QA requirements for the procurement of software should consider the following guidelines:

- Commercial software that has been developed under the manufacturer's QA Program and fully tested before release is preferable to other types of software developed under lesser or no QA Program
- Documents necessary to demonstrate that software was developed using a Life Cycle approach such as User's Manuals shall be requested when software is ordered.
- Licenses that come with the software and original documentation should be requested, obtained and protected.
- Software that requires a signed site license agreement can only be purchased by individuals with appropriate authority.
- Hardware/Software that exceeds the most recent established PNNL monetary limit can only be purchased with appropriate management approvals.
- Software procured as a product under a subcontract must specify detailed QA requirements for software development and use, and provide plans for testing, verification and validation tests and include acceptance criteria.

4.1.5 Solvent Storage Policies

Solvents used in the laboratory are in containers of 20 liters or less. On receipt they are logged in, RFID-tagged, and tracked, as are all chemicals. No more than a working day's supply of flammable or combustible solvents is permitted out of flammable storage in a laboratory; at the end of the day, these materials must be returned to flammable storage. Large flammable storage cabinets, located in an area separate from the building, are used for storage of solvents that exceed the lab's storage capacity.

4.1.6 Waste Disposal

Hazardous wastes are managed in accordance with Washington State Department of Ecology's (WA-DOE's) Chapter 173-303 WAC, "Dangerous Waste Regulations." The MSL is a "less than

90-day storage" facility and a large-quantity generator and, as such, fulfills all the requirements outlined in the regulation regarding proper labeling, designating, inspections, and timely disposal of hazardous waste. Personnel that generate/handle waste are initially trained in waste management procedures and updated annually of new regulations and requirements. Procedure MSL-A-015, Waste Management and Pollution Prevention, describes the waste streams and their disposal.

4.2 SUBCONTRACTORS

The MSL does not routinely subcontract analyses that can be performed in-house, but in some situations this could occur. The MSL could also subcontract project analyses when there is a project-specific requirement. The MSL is ultimately responsible for the quality of work performed by its subcontractors. Therefore, procedures have been established to ensure that subcontractors determined to have applicable associated risks are qualified to perform their responsibilities, know the project objectives, methods, and responsibilities, and the work performed is monitored to assess conformance to the project specifications.

Whenever work is to be subcontracted to others, the MSL should advise clients of this intent and obtain their permission for this approach. For projects requiring TNI certification, documented permission from the client is required and work may be subcontracted only to TNI-certified laboratories for the specific analysis and matrix of interest or it will be pre-approved and identified in a report or in the project contract that a non-TNI laboratory was used.

In addition to the requirements prescribed in HDI work flow “Acquire Product or Service via Purchase Order-Subcontract”, it is expected that all policies, procedures, and responsibilities required by the project are flowed down to the subcontractor and verified accordingly.

PNNL provides Evaluated Supplier Options which can be used as a starting point to define subcontractors. If the subcontractor does not meet any of the evaluated supplier options, then whenever it is deemed appropriate on a risk based graded approach, an audit of subcontractor may be performed. The audit may include review of the subcontractors QA program, data audits, inspection of facilities, or inspection of project activities. The contract should include a SOW in sufficient detail so that the scope of work, methods, QA requirements, responsibilities, deliverables, and due date are clearly understood between the MSL and the subcontractor.

5.0 PROJECT PLANNING DOCUMENTS

5.1 CONTENT AND FORMAT

5.1.1 General

Project planning documents (e.g., work plans, QAPP, toxicity testing plans, field sampling plans and SOWs) are documents that describe the objectives of a project and the methods, organization, and QA and QC activities necessary to meet the goals of the project. Each project conducted by the MSL must have a planning document that adequately describes the work to be performed, has been approved by the PM, and is in place prior to the start of work.

When applicable, in the absence of client-driven requirements, the following information should be identified in project planning documents:

- A descriptive title, client name, PNNL project number, and effective date;
- The identities of the PM, task leaders, and other key project personnel, including subcontractors;
- A statement of the general goals and the specific DQOs of the project;
- A description of the experimental design and procedures;
- A description of the QA and QC procedures (including DQO's) that will be applied to the project tasks;
- The project schedule, including milestones and deliverables;
- A description of the types of data to be recorded; and
- A statement of deliverable requirements.

5.1.2 Environmental Protection Agency

When work is conducted for the U.S. EPA, it is required that all environmental data-collection activities be covered by a QAPP. Therefore, all project planning documents prepared for the EPA must adhere to specific content and format requirements, as dictated by the EPA office involved. Protocols written for studies conducted under Food and Drug Administration (FDA) or EPA Good Laboratory Practices (GLP) standards must adhere to the specifications of 21 Code of Federal Regulations (CFR) Part 58 (FDA), 40 CFR Part 160 (EPA/ Federal Insecticide, Fungicide, and Rodenticide Act [FIFRA]), or 40 CFR Part 792 (EPA/Toxic Substances Control Act (TSCA), as applicable.

5.2 APPROVAL AND DISTRIBUTION

All planning documents shall be approved by the PM, at a minimum, before work is started on the project.

The project planning document is distributed, or made available to, personnel involved in the project and to the ~~QAO~~ QM. It is expected that all work will be conducted according to the planning documents. Modifications to approved planning document procedures should be made only with the concurrence of the PM and client, when applicable.

5.3 DATA QUALITY OBJECTIVES

DQOs are defined as the criteria needed to design an environmental data collection program. DQOs are developed from a multi-step, reiterative process that involves, project management, technical personnel, and the individuals who will be using the data to make decisions. The DQO process may entail the following:

- Stating the problem to be resolved, including limitations of time and resources;
- Identifying the decision that will be made using the data;
- Identifying inputs to the decision, including the environmental measurements needed and the criteria for taking action;
- Specifying how the results will be summarized and used; and
- Specifying acceptable error rates (i.e., limits on uncertainty).

The objective of the DQO development process is to design a cost-effective program that will provide the necessary amount and type of sufficient-quality data.

Once the acceptable error rate has been defined, the program's QA requirements are developed. The specific types of QC samples used to measure data quality are discussed in later in this QAMP.

The QC measurements and acceptance criteria are outlined in SOPs or project planning documents. The precision and accuracy objectives specified are based on standard method performance information (when available) and historical laboratory performance but may change based on project specific criteria. When required by the client or PM, other QC checks for accuracy, precision, comparability and completeness shall be applied to each batch of samples.

During the development of DQOs, the *PARCCS* parameters of precision, accuracy, representativeness, comparability, completeness and sensitivity are commonly considered when measuring data quality. These qualitative and quantitative parameters are described below.

5.3.1 Precision

Precision measures the similarity of individual measurements of the same property, usually under prescribed similar conditions.

Measures of analytical precision may be determined by the analysis of laboratory replicates or matrix spike/matrix spike duplicate recoveries. Laboratory replicates will be prepared by homogenizing and splitting a sample in the laboratory, and carrying the sub-samples through the entire analytical process. Precision can be expressed in terms of relative percent difference (RPD) or relative standard deviation (RSD).

For replicates where duplicates are performed, RPD will be used:

$$\boxed{RPD = \left(\frac{ABS(C_1 - C_2)}{Average(C_1 : C_2)} \right) * 100}$$

ABS = Absolute Value

For replicates where triplicates or more are performed, RSD or CV (coefficient of variation) will be used:

$RSD = \sqrt{\left(\frac{\sum(x-\bar{x})^2}{(n-1)}\right)} * 100$	$CV = \sqrt{\left(\frac{\sum(x-\bar{x})^2}{(n-1)}\right)} * 100$

$\bar{x}$ Sample mean AVERAGE(number1,number2,…)
n = Sample size

5.3.2 Accuracy

Accuracy is a measure of the bias of a system or measurement. It is the closeness of agreement between an observed value and an accepted value.

Accuracy of chemical analysis may be determined [for each matrix of interest (sediment, tissue and seawater)] through the analysis of laboratory control samples, matrix spikes, method blanks, SRMs (when applicable) and surrogate internal standards (organic analyses only).

- **Blank Spike (BS)/Laboratory Control Sample (LCS)** - an aliquot of clean matrix (e.g. reagent water) to which known concentrations are added and prepared, treated and analyzed in the same manner as the associated samples. Its purpose is to determine whether the method is within accepted control limits.
- **Matrix Spike (MS)/Matrix Spike Duplicate (MSD)** - an aliquot of a sample to which known concentrations are added and treated and analyzed in the same manner as the associated samples. Its purpose is to determine whether the sample matrix contributes bias to the results**.**
- **Method Blank (MB)** - an aliquot of clean matrix (e.g. reagent water) prepared, treated and analyzed in the same manner as the associated samples. Its purpose is to determine if method concentrations or interferences are present in the laboratory environment, the reagents, or the apparatus' used that could contribute bias to the results**.**
- **StandardReference Material (SRM)** - a material obtained from an independent source, is certified to a known concentration by a recognized authority (e.g., NIST) and is treated and analyzed in the same manner as the associated samples. Its purpose is to determine whether the method is within accepted control limits.
- **Surrogate Standard** - an analyte which is similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which is not normally found in the samples. The surrogate is spiked in the sample prior to extraction. The recovery of surrogate is used to quantify extraction efficiency and monitor method performance.

For measurements where matrix spikes or laboratory control samples are used, percent recovery will be used to assess accuracy:

$\%R = \left(\frac{S-U}{C_{sa}}\right) * 100$	%R = percent recovery S = measured concentration in spiked aliquot U = measured concentration in un-spiked aliquot C_{sa} = actual concentration of spike added

For situations where a SRM is used, percent difference (%D or PD) or percent recovery (%R) will be used:

$PD = \left(\frac{C_1 - C_2}{C_2} \right) * 100$	PD = percent difference C_1 = measured value C_2 = certified or consensus value	$\%R = \left(\frac{C_1}{C_2} \right) * 100$	%R = percent recovery C_1 = measured value C_2 = certified or consensus value

5.3.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Representativeness will be addressed primarily by the proper handling and storage of samples and analysis within the specified holding times so that the material analyzed reflects the material collected as accurately as possible. Representativeness of data will be discussed, when appropriate, in deliverable reports.

5.3.4 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability will not be quantified, but will be addressed through the use of laboratory methods that are based on EPA or other recognized methods. The use of standard reporting units also will facilitate comparability with other data sets. Comparability of other data will be discussed, when appropriate, in deliverable reports.

5.3.5 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Target completeness values are 100% for chemical sample analysis.

5.3.6 Sensitivity

Sensitivity is the capability of methodology or instrumentation to discriminate among measurement responses for quantitative difference of a parameter of interest.

6.0 STANDARD OPERATING PROCEDURES

Many routine analytical laboratory activities are directed and controlled by internal procedures or by published procedures. Where possible, U.S. EPA and consensus methods (e.g., National Oceanic and Atmospheric Administration (NOAA) Status and Trends) are used where the technique is applicable to the sample matrix and the overall objective of the analysis.

A list of SOPs is available on the intranet or upon request. The ~~QAO~~ QM maintains and updates the list of controlled documents.

6.1 SCOPE AND PURPOSE

The MSL encourages the preparation of SOPs for routine environmental measurement and analyses and related QA and QC activities. Research and development activities that are not routine, or are unique to a project, can be described in project planning documents such as work plans or in written protocols included in the project files. Subjects that are covered in SOPs include, but are not limited to:

- Sample collection
- Sample handling, preservation, and storage
- Chain of Custody (CoC) procedures
- Digestion and sample preparation
- Sample analysis
- Equipment use, maintenance, and calibration
- Record management
- Data reduction, processing, and validation
- QA verification activities

SOPs are documents that describe procedures that must be followed to ensure the integrity and quality of data. SOPs serve a multi-purpose function, including to

- Reduce the introduction of errors and variables by ensuring the consistent use of appropriate procedures
- Communicate to the necessary people (e.g., client, project personnel) how the work will be conducted, and provide a basis for training
- Increase the effectiveness of training by clearly and consistently communicating the approved method of performing a procedure
- Provide a historical record of the work performed
- Provide a basis for data comparability
- Provide a basis for maintaining reproducible results and producing defensible data

6.2 CONTENT AND FORMAT

Each SOP must be clearly written and include sufficient detail to clearly describe the operation to be carried out so that a qualified individual can perform the procedure. However, it should be flexible enough to accommodate expected variations while maintaining the integrity of the procedure and the quality of the data being generated. SOPs covering equipment must include descriptions of calibration, operation, and maintenance requirements. Procedural SOPs must contain sections on preparation, procedures, calculations, and quality control. Equipment and

procedural SOPs must also include a discussion of the safety concerns associated with the equipment or procedure. All SOPs must state the objective or application of the SOP topic and must stipulate the requirements for the successful completion of training. Specific requirements for content and format are prescribed in procedure MSL-A-003, Guideline's for SOP Format and Control.

6.3 RESPONSIBILITIES

The individual preparing the SOP is responsible for ensuring that the SOP completely and accurately describes the procedures, is based on sound scientific principles or recognized procedures, and conforms to the standards for procedure documentation prescribed in procedure MSL-A-003, Guidelines for SOP Format and Control.

The ~~QAO~~ QM is responsible for

- Assigning each SOP a unique number and entering it into the SOP controlled document log
- Reviewing all SOPs
- Distributing approved SOPs, including posting to the intranet
- Maintaining historical files of SOPs

6.4 REVIEWS AND APPROVALS

Draft SOPs go through a formal review and approval process in accordance with SOP MSL-A-003, Guidelines for SOP Format and Control.

6.5 DISTRIBUTION AND CONTROL

The official controlled copies of SOPs are the versions maintained in the SOP file on the intranet and are readily available to personnel. All other copies (printed or saved in personal electronic files) are considered uncontrolled. All PNNL personnel have signed non-disclosure documents and are trained in the sensitive nature of these documents.

6.6 MODIFICATION AND REVISION

Changes to SOPs must be controlled to ensure documentation and traceability to the modification. SOP modifications will be performed in accordance with SOP MSL-A-003, Guidelines for SOP Format and Control.

7.0 LABORATORY DOCUMENTATION AND RECORDS

A critical component in the generation quality products is proper record keeping and the maintenance of the records after project completion. Documentation must be sufficiently detailed so that the data are traceable and program data can be reconstructed based on the project records. These records must be maintained in a secure location and must be identifiable and retrievable. Should the MSL be unable to retain or maintain documents for any reason (e.g., if the laboratory transfers ownership or goes out of business) all records will be transferred to the PNNL Richland, WA archive system.

7.1 DOCUMENTATION

Data generated during the course of a project must be capable of withstanding challenges to its validity, accuracy, legibility and traceability. To meet this objective, data are recorded in standardized formats and in accordance with prescribed SOPs. Personnel whose responsibilities include recording data must be aware of, and adhere to, the SOPs during the performance of their work. Briefly, data must be entered onto data sheets or in project notebooks directly, promptly, and legibly. All entries must be made in indelible ink, and must be accompanied with the date and initials or signature of the individual making the entry. In some instances (e.g. divers writing underwater or fieldworkers writing in the rain on Rite-in-the-Rain paper), pencil may be used. Changes or corrections to data must not obliterate the original entry, but must be indicated with a single line through the original entry. All changes or corrections must be accompanied by the date and initials or signature of the individual making the change and, when not obvious, an explanation of the change. Specific requirements for documentation are prescribed in procedures MSL-D-001, Recording Data on Data Sheets and Laboratory Notebooks and MSL-D-004, Data Reporting, Reduction, Backup, and Archiving.

7.2 RECORDS

The data archive system is designed to ensure that materials are stored in an orderly manner under secure conditions, and may be easily and promptly retrieved should the need arise. Data archiving requirements and prescribed in procedures MSL-D-003, Archiving of Records, Data, and Retired SOPs and MSL-D-004, Data Reporting, Reduction, Backup, and Archiving.

All material generated during a project should be archived upon completion of the project. All records necessary for the interpretation and evaluation of project data, including planning documents, raw data and other documentation, correspondence, and reports, should be retained. The PM is responsible for ensuring the project materials are collected, organized, and forwarded to the archives at the end of the project. PNNL policy is to retain electronic data files for five years, unless otherwise specified by client request. Hard copy data are stored as prescribed in procedure MSL-D-003, Archiving of Records, Data, and Retired SOPs. Archives are controlled access (locked) storage rooms at the MSL or in Richland, WA. Data are stored and retrieved by project number or central file number.

8.0 SAMPLE HANDLING, TRACKING AND DISPOSITION

Sample handling and tracking requirements are prescribed in procedures MSL-A-001, Sample Log-In Procedure and MSL-A-002, Sample Chain-Of-Custody, and MSL-E-001, Marine Resources Field Operations and Fish Research. The processing of data collected from these activities is prescribed in procedure MSL-D-004, Data Reporting, Reduction, Backup, and Archiving (Archiving may be superseded by client requirements).

8.1 RECORDS

Sample custody responsibilities must be clearly defined and understood by personnel involved for the system to be effective. Samples are considered to be in a person's custody if:

- The samples are in a person's actual possession
- The samples are in a person's view after being in that person's possession
- The samples were in a person's possession and then were locked or sealed to prevent tampering
- The samples are in a secure area

The sample collector is responsible for the proper collection, preservation, and labeling of samples, and for documentation of sample history and custody in the field. The sample collector also is responsible for packaging the samples for shipment, maintaining sample integrity, and for arranging for transportation to the laboratory.

The sample custodian is responsible for receiving and inventorying the samples, placing them in storage, and completing the documentation associated with these procedures. The laboratory sample custodian also is responsible for informing the PM of the samples' arrival and for promptly notifying him/her of any broken, missing, or compromised samples.

8.1.1 General (Non-TNI) Samples

8.1.1.1 Chain of Custody Not required

Samples may not always require a formal log-in and/or Chain of Custody. This may occur when the samples will be returned immediately to the place it was collected, retained by the researcher, or disposed of without having previously left the custody of the researcher. Examples include:

1. While working in the field, fish are collected in beach seines, identified to species, measured, and returned to the water. Data are recorded on data forms and include the date of collection and initials of the recorder. A formal CoC is not completed for the fish sampled.
2. Eelgrass plants are collected offsite during a field project and returned to the MSL. The number of coolers containing eelgrass and being transported to the laboratory is recorded on a field data form or notebook, but a formal CoC is not completed. The exact number of plants harvested is not recorded until the plants are transplanted at the laboratory, to minimize handling of the plants. The number of plants that are transplanted is recorded in the field notebook and subsequent counts of eelgrass shoots in the tank are also recorded to document population changes over time. Each data entry includes the date and initials of the recorder.

3. Eelgrass plants are marked and later harvested from the MSL beach. A record of the location and number of plants sampled is recorded along with the date, recorder's initials and other pertinent information; however a formal CoC is not prepared. The plants are processed and dry weights are obtained to determine the plant's productivity. After the measurements are taken, the plant material is disposed of.

In these circumstances, samples are received and custody is maintained/documented according to the project planning documents.

8.1.1.2 Chain of Custody Required

When chain of custody is required, the MSL documents all sample fates for the client based on objective evidence maintained during the sample processing. Objective evidence will be defined as all information necessary to produce unequivocal, accurate records that document the applicable laboratory activities (including signatures of individuals who physically handle individual samples), accounting for all time periods associated with sample receipt, processing, analysis and storage and disposal.

In accordance with procedure MSL-A-001, Sample Chain of Custody, the PM is responsible to determine which items are required and to ensure that all relevant items are addressed because different programs have different requirements and to assist in project planning.

For test organisims, in place of a CoC a shipping form can be signed and dated and the condition of organism noted. Sample control is the formal system designed to provide sufficient information to reconstruct the history of each sample. This system involves procedural, record keeping and organizational components and is critical for any environmental program that is generating data that may be used for regulatory decisions or in support of litigation.

8.1.2 TNI Samples

Samples to be analyzed under TNI requirements require a formal log-in and Chain of Custody. Login is performed and documented in accordance with procedure MSL-A-001, Sample Log-in Procedure.

8.2 LOGIN

When samples are received from an outside source, they are logged in when received in the shipping area. If a CoC form accompanies the samples, it may used to document the date and time of sample receipt and condition; if not an internal CoC may be initiated. The sample labels are compared to the CoC and, when applicable, assigned an identification code plus sequential numbering of samples upon arrival. Sample containers are inspected for sample integrity (e.g., broken seals, broken or cracked containers, spilled samples and sample temperature). Any discrepancies identified during the process are brought to the attention of the PM who is responsible for contacting the client, when applicable.

8.2.1 Preservation

When sample preservation (e.g. temperature or pH) is indicated by the type of analysis or client specification, preservation is checked and adjusted, when applicable, in accordance with procedure MSL-A-001, Sample Log-in Procedure and/or project documents.

If the samples are not immediately required for use, they are stored under the appropriate conditions in a controlled or secure area.

8.3 SAMPLE TRACKING

Sample tracking while samples are in the laboratory is the responsibility of the individual Laboratory Supervisors and the PM. It is the responsibility of the PM to ensure that the levels of sample custody and tracking needed are specified, samples are given the appropriate priority in the laboratory, and the proper storage, analyses/tests and methods are being performed.

When living organisms are collected, the number of specimens collected is kept to the minimum the investigator determines is necessary to accomplish project goals. If vertebrate species will be collected, handled, or housed during a study, an Animal Care Committee Protocol is submitted to the Institutional Animal Care and Use Committee for review and approval prior to receiving the animals or conducting the research. It is the responsibility of the PM to ensure that sample collection, handling, storage, and/or testing are performed properly.

8.4 SAMPLE ARCHIVING AND DISPOSITION

The PM is responsible for proper disposal of residual sample material (not all samples will have residual left over for disposal). Sample disposition takes three forms: 1) dispose by appropriate means depending on sample content; 2) return to client; or 3) archive for a pre-determined amount of time. Unless arrangements have been made previously, the samples are generally disposed of by the laboratory.

8.4.1 Samples disposed of by a subcontractor laboratory

If the subcontractor laboratory or testing facility is responsible for disposing of the samples, the subcontractor is asked to notify the PM before final disposition. The PM will notify the originator that the samples are scheduled to be destroyed, or will define client requirements for an extended period of storage.

After destruction of samples, the subcontractor laboratory or testing facility is asked to return a copy of the CoC to the PM for placement in project files. The originator may be forwarded a copy of the final Chain-of Custody documentation if requested.

The PM or representative records the date of receipt on the CoC in the "Received by" section of the form space and indicates the samples were destroyed ending the chain of possession.

8.4.2 Samples disposed of by the MSL

For returned samples (should be received with CoCs) or samples that have never left MSL custody, the PM or representative will notify the originator that the samples are scheduled to be destroyed, or will define client requirements for an extended period of storage. If extended storage is not requested, the PM is responsible to ensure samples are disposed in accordance with procedure MSL-A-015, Waste Management and Pollution Prevention.

8.4.3 Samples returned to the client for disposal

Samples may be returned to the client (or the sampling site) by client request. Samples are shipped to meet Department of Transportation regulations. Generally, the samples are shipped in the same way that they were initially shipped to the MSL. Sample disposition should be documented in the central file of each project. The PM shall ensure that completed CoC are filed in the appropriate project files. The originator may be forwarded a copy of the final CoC documentation if requested.

9.0 QUALITY CONTROL

Technical personnel perform QC activities during the conduct of the project. The purpose of these functions is to measure the quality of the data and if necessary, adjust the measurement system so that the specified level of quality is attained.

9.1 GENERAL

9.1.1 Toxicity Testing and Biological Studies

For toxicity testing, each test has its own quality control criteria that are included as part of the test design established in project planning documents. Reference toxicant tests (positive controls), are performed to demonstrate that test organisms used are appropriately sensitive and that the laboratory procedures and techniques are appropriate and repeatable. A reference toxicant test is normally performed with each test, or at a minimum, once with each batch of test organisms as prescribed a procedure (e.g. MSL-T-034, Reference Toxicant Stock Solution Preparation) or project planning documents. It is the responsibility of the PM to ensure the reference toxicant database and control chart(s) are up to date with each set of test results. Each test method contains specific test acceptability criteria for controls, reference toxicant results, test conditions, etc. An individual test may be conditionally acceptable if temperature, Dissolved Oxygen (DO), or other specified conditions fall outside specifications, depending on the degree of the departure from the specified conditions and the overall impact on the test. The acceptability of the test will depend on the professional judgment of the PM or designee. Any deviation from test specifications must be noted when reporting data.

Quality control in biological studies encompasses a wide range of activities such as species identification, organism counts or density estimates, and data entry. QC activities measure the quality of the data and if necessary, adjust the measurement system so that the specified level of quality is attained. For example:

1. Fish species are often identified by two researchers and through consultation of a region-appropriate taxonomic key or guide for reference. This provides a more objective approach to species identification, especially the first time a new species is encountered or the first time a researcher performs species identification.
2. Plants and other resources are often described by the percent of open space they cover within a standardized area (e.g., 1-25%, 26-50%, 51-75%, or 76-100% cover). At the beginning of a field sampling period, researchers may standardize their estimates of percent cover by individually examining several examples of percent cover and comparing their estimates. If the estimates vary, the researchers work together until they can agree on their cover estimates before collecting actual project data individually. Periodic reassessments of standardization between researchers increases the quality of the data.

9.1.2 TNI Analyses

For analyses performed under the TNI standard, work shall be performed in accordance with approved SOPs.

9.2 LIMITS OF DETECTION

Method detection limits (MDLs) are determined for all parameters for a number of different matrices (fresh water collected from the in-house de-ionized water system, filtered seawater from Sequim Bay, Sequim Bay or other clean sediment, chicken tissue, etc.). The method used to determine MDLs is prescribed in procedure MSL-Q-007, Procedure for Determining Method Detection Limits. Limits of quantization may also be reported on request as more conservative estimates of detection limits. MDLs and their determination documentation are available on the intranet or upon request.

9.3 HOLDING TIMES AND PRESERVATION

Holding times typically begin with the day of sample collection. However, holding times can be assessed from both the date of sample collection and the date of sample receipt, depending on project planning documents. In the absence of client-specified holding times, the holding times and requirements provided in Tables 9.3.1 and 9.3.2 are used.

When samples require preservation at the MSL, a holding period before analysis may apply. Holding periods are prescribed in the applicable analytical procedures.

TABLE 9.3.1: Chemistry Sample Holding Times and Preservation

	Analysis	Preservation	Holding Time (Days)
Sediment*	Metals (including Hg)	freeze dried; 4±2°C, or -20±10°C	180[b]
	Methylmercury	±2°C, or -20±10°C	180[d]
	Organic Compounds	4±2°C, or -20±10°C	30[b] extraction; 40 analysis [c]
Tissue*	Metals (including Hg)	freeze dried; 4±2°C, or -20±10°C	180[b]
	Methylmercury	4±2°C, or -20±10°C, the freeze dry	180 [d]
	Organic Compounds	4±2°C, or -20±10°C	30[b] extraction; 40 analysis [c]
Water	Metals (except Hg)	4±2°C in transit, then <2 pH/HNO_3 and ambient	180
	Mercury	4±2°C in transit, then <2 pH/HCl and ambient	90
	Methylmercury	4±2°C in transit, then <2 pH/HCl and ambient	180
	Organic Compounds	4±2°C	7 extraction; 40 to analysis [c]

[a] Holding time = 6 months for freeze dried samples.
[b] Holding time = 6 months for frozen (-20 °C) sediments and tissues (EPA 1986 and EPA 1989).
[c] The 40 day holding time starts the day of extraction for organic analysis.
[d] No EPA holding time established; total Hg hold time used as a default.
[*] Metals sediment and tissue samples will be refrigerated (4±2°C) or frozen (-20±2°C) by the laboratory until freeze dried

TABLE 9.3.2: Toxicity Sample Holding Times and Preservation

Matrix	Preservation	Holding Time
Sediment	4±2°C dark/airtight	2 weeks is recommended; up to 6 weeks is acceptable; and in some cases up to 8 weeks
Effluent	4±2°C dark/airtight	36 hours from sample collection [a]
SPP/Elutriate	4±2°C dark/airtight	24 hours from preparation

[a] Every effort must be made to initiate the test with an effluent sample on the day of arrival in the laboratory. The holding time should not exceed 36 hours unless a variance is approved by the client.

9.4 CONTROL CHARTS AND PERFORMANCE BASED QUALITY

The TNI and the Navy have withdrawn requirements for control charts for inorganic analytes in favor of performance-based QC data assessment.

9.4.1 Control Charts

Control charts of reference toxicant results obtained from bioassays are used to demonstrate the sensitivity of the stock organism population. Reference toxicant tests are typically conducted concurrently with an aquatic or benthic toxicity test, using organisms from the same batch source. Details of the control charting process and criteria for assessing out of control events are described a procedure MSL-Q-010, Procedures for Control Charting Reference Toxicant Test Results or project planning documents.

When control charts are produced, they are based on normally distributed measurements and short-term variation. Precision is charted over time by calculating a mean recovery for the control sample parameters and then establishing upper and lower warning and control limits. The warning limit is defined as ±2 and the control li samples used for organic parameters are Blank Spikes (BS) and for inorganic parameters results from the analyses of a standard reference material are plotted. A minimum of 20 points are used to set the initial control limits for each parameter.

9.4.2 Performance-Based Quality Control

Performance-based quality control is based on a comparison between *a priori* project or method-specific data quality objectives and the results obtained for each batch of samples. In most cases, both method and project-specific DQOs are evaluated for each batch of samples analyzed. Corrective actions are specified in each analysis method and are followed to ensure that sample data obtained is of high quality and defensible. All issues regarding data quality are discussed in a narrative accompanying sample results. Documentation of the assessment of performance-based DQOs and QC sample results is provided by the use of an analyst checklist on each data package prepared by the analysts. The checklist documents issues that are addressed by completion of the appropriate corrective action during analysis and issues that could not be corrected are documented.

9.5 EQUIPMENT MAINTENANCE AND CALIBRATION

The quality of MSL products is directly related to the validity of the data produced. To produce valid data, equipment must be properly operated, maintained, and calibrated.

Preventive maintenance and primary maintenance of facilities equipment are provided through the PNNL Facilities and Operations Personnel located in Sequim, but located organizationally in Richland, WA.

The MSL maintains a wide variety of research equipment related to the collection and analysis of a variety of parameters (chemical, biological, and physical oceanographic, etc.). This research equipment is maintained to manufacture's specifications through manufacturer service contracts, service calls, factory rehab purchase requisitions, or by qualified personnel. To support the generation of data of known and acceptable quality, the following general guidelines are implemented when applicable:

1. The appropriate and necessary equipment, instruments, and supplies must be available in adequate quantities to perform the proposed work. Spare parts for critical components are maintained to minimize downtime.
2. Measuring and testing equipment is properly handled and stored to maintain accuracy.
3. All equipment involved in the collection and analysis of environmental data is operated, maintained, and calibrated according to approved procedures and specified schedules.
4. Equipment is serviced regularly by qualified individuals, either trained in-house personnel or through service contracts with the manufacturer or an authorized representative. For example, balances are cleaned and calibrated by a PNNL Evaluated Supplier, and analytical instruments have service contracts with manufacturers such as Perkin-Elmer. Most support equipment (e.g., ovens, refrigerators, freezers, hoods) servicing is done internally by PNNL's Facilities and Operations Personnel. When problems arise that cannot be corrected internally, external contractors or manufacturer's representatives are contacted.
5. Equipment that is not operational for any reason must be clearly tagged out to indicate that it is out-of-service
6. Written records of all instrument maintenance, calibration, testing, and inspection are maintained. Maintenance records contain a description of the operation or problem, the remedial action taken (if necessary), date, and the individual responsible.
7. When equipment or instrument maintenance is required, equipment is monitored to ensure correct operation. The responsible analyst monitors analytical instrument operation after maintenance by running a calibration curve and assessing results of standard reference materials (SRM), when applicable.
8. Calibrated equipment is suitably marked to indicate calibration status.
9. Written directions on equipment operation (e.g., operating manual, manufacturer's instruction, and procedures) are maintained with the equipment and are available to personnel using the equipment.
10. Balances are calibrated annually by an approved metrology laboratory and checked daily prior to use by laboratory personnel as prescribed in procedure MSL-C-009, Use and Performance Checks of Balances.
11. Applicable cold-storage facilities are monitored daily as prescribed in procedure MSL-I-026, Use of Laboratory Refrigerators and Freezers.
12. Pipettes are checked quarterly as prescribed in procedure MSL-C-010, Calibration, Verification and Use of Pipettes.

A list of equipment is maintained by the PM, when applicable. The ~~QAO~~ QM maintains and updates a list of equipment used in support of TNI work.

9.5.1 Equipment Calibrations

When applicable, calibrations or performance checks are performed on instruments and support equipment (balances, pipettes, thermometers, etc.) prior to use or at established intervals. Requirements for specific levels and frequency of calibration are described in SOPs or project planning documents. In circumstances, especially during field surveys, where calibration occurs less frequently than described in SOPs or project planning documents, the PM shall notify the client.

Calibration records are kept in the data files and are traceable to date and other applicable parameters (sample runs, standards, etc.). Corrective actions when calibration criteria are not met are described in SOPs or project planning documents.

Whenever data are recorded, the instrument model, serial number (if available), and information on whether a calibration was performed prior to sampling is recorded. If no calibration information is provided with the data, the assumption must be that the instrument was not calibrated immediately prior to use. However, calibration records that indicate the date and results of the previous calibration are acceptable (assuming it is prior to the next recommended calibration date for that instrument) may be referenced.

9.5.2 Preventive Maintenance

Instruments and support equipment are serviced regularly by qualified individuals, either trained in-house personnel or through service contracts with the manufacturer, an authorized representative or other qualified service organization. Written records of all instrument maintenance, calibration, testing, and inspection are maintained. Maintenance records should contain a description of the operation or problem, the remedial action taken (if necessary), date, the individual responsible, and where applicable, documentation of the instrument's return to acceptable use

9.6 INTERNAL QUALITY CONTROL CHECKS

The following are common types of QC analyses implemented by the MSL. It is important to note that measures made for work performed that is not under the TNI standard may be for system monitoring purposes only and are not considered as quantitative measures subject to QC requirements beyond daily calibration verification.

- **Blank Spike (BS)/Laboratory Control Sample (LCS)** - an aliquot of clean matrix (e.g. reagent water) to which known concentrations are added and prepared, treated and analyzed in the same manner as the associated samples. Its purpose is to determine whether the method is within accepted control limits. Blank spikes may be analyzed in duplicate (BSD).
- **Continuing calibration verification sample (CCV)** - A sample of known concentration that is run at the frequency described in the project planning document and/or SOP (typically after every 10 or 20 samples) to ensure that the initial calibration is still valid. The specific project planning document and/or SOP CCV % recovery range for the analysis should be followed. Analysts will attempt to run CCVs such that they bracket the analytical range of the samples run in the analytical batch.
- **Initial calibration verification sample (ICV)** – A sample of known concentration, and of a separate source from the curve is run after the calibration curve to verify instrument control. The specific project planning document and/or SOP ICV % recovery range for the analysis should be followed. For samples that are to be analyzed for the TNI, or when requested by a client, a secondary source ICV shall be run prior to running any samples.
- **Laboratory replicates** - Laboratory replicates consist of splitting a single sample or compositing and splitting two or more samples in the laboratory, and subsequently processed and analyzed as separate samples. Laboratory replicates serve as a measure of the error associated with the analytical process.
- **Matrix Spike (MS)** - an aliquot of a sample to which known concentrations are added and treated and analyzed in the same manner as the associated samples. Its purpose is to determine whether the sample matrix contributes bias to the results.

- **Method Blank (MB)** - an aliquot of clean matrix (e.g. reagent water) prepared, treated and analyzed in the same manner as the associated samples. Its purpose is to determine if method concentrations or interferences are present in the laboratory environment, the reagents, or the apparatus' used that could contribute bias to the results.
- **Standard Reference Material (SRM)** - a material obtained from an independent source, is certified to a known concentration by a recognized authority (e.g., NIST) and is treated and analyzed in the same manner as the associated samples. Its purpose is to determine whether the method is within accepted control limits.

QC samples may also be collected in the field to monitor contamination and to assess sampling error. Common field-related QC samples include

- **Equipment Blanks (EB)** - Equipment blanks are prepared in the field using the freshly decontaminated sampling equipment. De-ionized water is poured over and through the equipment, collected in an identical sampling container, and shipped to the laboratory for processing and analysis. Equipment blanks measure the contamination associated with the entire sampling and analytical process.

- **Field Replicates** - Field replicates are two or more separate samples that have been collected from the same sampling point. Field replicates also serve to measure the error associated with the entire sampling and analytical process, including variation inherent in the sampled media.

- **Reference Samples** - Reference samples are samples for which selected properties are known, generally through historical analysis. Reference samples are used as a benchmark for similar analyses.

- **Split samples** - Split samples are obtained by compositing sample material in the field and dividing the material into separate containers for processing and analysis. Split samples are used to assess the total error associated with sampling and analysis. If split samples are sent to separate laboratories for analysis, inter-laboratory variation may also be obtained.

QC checks are associated with biological toxicity testing (independent recounting of sample, reference toxicity tests, establishment of acceptable water quality measurement ranges) and data processing (proofing or double entry/comparison programs). The specific QC procedures, frequency of performance, and criteria for acceptance for all environmental data collection procedures are defined in SOPs or in the project planning documents.

The immediate monitoring of QC results by analysts allows the data collection process to be continually compared to pre-established acceptance criteria and corrected as necessary. In addition, assessment of QC results is a critical component of the data validation process and is used to interpret the accompanying sample data and to judge its acceptability and usefulness with regard to the project DQOs. QC results are reported with the project data.

10.0 APPROVALS BY EXTERNAL AUTHORITIES

10.1 ACCREDITATION/CERTIFICATIONS

A list of the most current accreditations and accredited methods is maintained by the ~~QAO~~ QM. The MSL's primary TNI accreditation is under the New Jersey Department of Environmental Protection (NJDEP).

Certification is described in procedure MSL-A-013, Laboratory Accreditation and PT Sample Analysis. Certification programs are based on the demonstration of a functional quality program, the existence of planning documents and procedures, the successful analysis of external performance samples at least twice per year for each method, parameter and matric of interest, and in some cases, periodic on-site assessments. The MSL maintains the following documentation to meet these requirements:

Quality Assurance Management Plan (QAMP)
SOPs in the following general areas

- Administration
- Conventional/General Chemistry
- Documentation, Records, and Reports
- Ecological Processes
- Inorganic Chemistry
- Organic Chemistry
- Quality Assurance
- Safety
- Toxicological/Biological Testing
- Water Quality Instrumentation

Training Files
Approved Management Signatures
Signature Log

10.2 OTHER AUTHORITIES

The MSL is inspected semi-annually by the PNNL Institutional Animal Care and Use Committee (IACUC) for compliance with Federal animal welfare regulations that require protocols for all uses of vertebrate animals to be reviewed and approved by the Committee. Approved protocols are also required for animals used in training, animals held as donors for blood and other tissues, breeding stock, and other animals held on site which are not yet assigned to a specific study protocol. Animal use requirements are prescribed in procedure MSL-A-017, Care of Animals.

11.0 PERFORMANCE EVALUATIONS

Analysts performing TNI work are degreed personnel operating analytical instruments on a daily basis. It is the PM's responsibility to ensure analysts supporting non-TNI work have experience and training required by the specific project.

The dedication of analytical personnel to the specific procedures for which they are responsible, their level of training and, daily QC assessments of proficiency through the analysis of blank samples, sample replicates, SRMs, and MSs combine to make the results produced by highly defensible, accurate, precise, and repeatable. The MSL is a specialty laboratory, providing its clients with relatively low detection limits for environmental samples. Daily proficiency is monitored at the bench level, at the level of data assessments performed on sample sets by the analyst and the Data Coordinator (data validation), and at the level of the ~~QAO~~ QM who provides data quality verification.

As part of the TNI accreditation programs, the MSL participates in performance studies at the required frequency for the accredited methods, parameters and matrices as prescribed in procedure MSL-A-013, Accreditation and Performance Testing. Performance Testing samples are purchased from a National Voluntary Laboratory Accreditation Program (NVLAP)-approved vendor. Clients are provided with the results of recent performance studies upon request.

The MSL also participates in inter-laboratory toxicology comparisons whenever offered.

12.0 DATA MANAGEMENT

12.1 DATA REDUCTION

Reduction of raw data shall be accomplished using established techniques. The calculations required for the reduction of data may be performed manually or with the aid of automated data processing systems. In either case, the applicable SOPs for the testing and analysis of samples or the project planning documents will specify the calculations and the mode for raw data processing. If manual processing is to be used for data validation, then the applicable SOP or project planning document will provide the calculation method and the units for reporting derived values. In order to reduce the potential of errors in data transcription the manual transfer of data will be minimized. All calculations performed manually will be checked for accuracy by someone other than the individual who performed the original calculation. Data validation checks shall be documented by the signature and date of the reviewer. Separate documentation is acceptable, provided traceable records are maintained. For automated data reduction methods, the accuracy of calculations will be verified through the use of standards or test case inputs with known resultant values. For TNI projects, all data is reviewed in accordance with procedure MSL-Q-003, Quality Assurance Deliverable Audits.

12.2 DATA REPORTING

Two types of technical reports are produced: Research and development (R&D) reports and data reports. R&D reports are produced from research of a non-standard or non-repetitive nature, data reports are produced from results of standard, repetitive types of analyses. All technical reports go through a formal review process consisting of an author review, technical peer review, editorial or QA review, and a management review. R&D reports must have an editorial review and data reports must have a QA review.

The purpose of the technical peer review is to evaluate the document for technical quality, including scientific validity and logic. This review is performed by senior technical personnel selected for familiarity with the technical discipline of the work being reported. The QA review is conducted by the ~~QAO~~ QM and encompasses accuracy, completeness, adequacy, and conformance to applicable standards and project planning documentation. Editorial review addresses grammatical correctness and consistency of style and format. The management review focuses on scientific validity, logic, conformance to client expectations, and for agreement with policies and procedures. The management reviews are performed by the Laboratory Director or delegate.

The following is a list of data that is typically reported for toxicant results:

- description of test sediment or water; collection, handling, manipulation, storage, and disposal
- description of test organisms; scientific name, age, size (when applicable), life stage, source, and their handling, culturing, and acclimation
- toxicity test method used
- date and time test started and terminated
- percent survival for each test treatment
- percent survival for each test treatment
- control treatment survival
- results of water quality measurements (may be reported as mean, range of measurements, number of times criteria limits were exceeded)

- number of organisms used per test chamber
- number of replicate test chambers per treatment
- summary of statistical endpoints (mortality, growth, LC50, no observed effect concentration [NOEC],)
- gender determinations (when appropriate)
- growth (when appropriate)
- reproduction (when appropriate)
- summaries of biological observations
- summaries of reference toxicant test evaluations
- summary of any problems encountered and corrective actions
- description of any deviations from prescribed laboratory protocols

The following is a list of data that is typically reported for field research results:

- description of study organisms; scientific name, age, size, collection method or other source, and their handling and disposition
- date and times for data collection
- weather and water conditions
- water visibility
- descriptions of sampling equipment (e.g., manufacturer and model number)
- summary of observations
- summary of any problems encountered and corrective actions

The following is a list of data that is typically reported for analytical chemistry results:

- sample receipt date and condition
- date and times for data collection
- the applicable method, matrix, instrument and SOPs
- summary of the results
- summary for DQO results
- summary of any problems encountered and corrective actions

12.3 DATA EVALUATION

Prior to their use, data shall be validated in accordance with project requirements. Validation is defined as the process through which data are accepted or rejected and consists of proofing, verifying, editing, and technical reviewing activities. Data validation requirements are prescribed in procedure MSL-D-004, Data Reporting, Reduction, Backup, and Archiving. Data validation is considered a technical function and should occur prior to the data being audited by the ~~QAO~~ QM.

Data validation occurs at multiple levels as data are collected and processed:

- Individuals recording data during field or laboratory operations are responsible for reviewing their work at the end of the day to ensure that the data are complete and accurate.
- Analysts and instrument users are responsible for monitoring the instrument operation to ensure that instrument has been properly calibrated.
- PMs are responsible for reviewing analytical results and supporting documentation to assess sample holding times and conditions, equipment calibration, and sample integrity. As an additional measure of acceptability, the results of QC samples are compared to the project DQOs.
- Technical personnel are responsible for reviewing the data for scientific reasonableness.

- All manual entries into databases and spreadsheets are verified, either through proofing or by double entry/comparison programs.
- All calculations performed by hand are checked for accuracy.

Data that do not meet the pre-established criteria for acceptance may be flagged (see procedure MSL-D-004, Data Reporting, Reduction, Backup, and Archiving), not reported, or reported with an explanation of the limitations, at the discretion of the PM.

12.4 DATA AUDIT PROCESS

Data produced by the MSL for work performed under the TNI standard shall be audited prior to their final release. The reported data are audited, using a process that ensures that the data are complete, accurate, traceable, and defensible. Details of the data auditing process are described in procedure MSL-Q-003, Quality Assurance Deliverable Audits.

Non TNI projects may be audited in accordance with procedure MSL-Q-003, Quality Assurance Deliverable Audits or in accordance with project planning documents.

Data shall be reviewed to ensure that the data are accurate, traceable, defensible, and complete, as compared to the project requirements. The audit procedure is a check that involves comparing selected reported values to the original data. Selection of the reported values to check can either be performed randomly or on a statistical basis. Results of the data audit are documented either on a checklist or in a summary statement. Concerns that can be corrected shall be corrected before the data are released. Deviations are required to be summarized and provided to the client.

12.5 DATA CONFIDENTIALITY

PNNL policy does not allow the release of client data or project-related information to anyone except the client unless expressly directed by the client or an authorized representative. Client confidentiality and proprietary rights are protected whenever requested by marking documents, protecting business sensitive information, sealing records, and/or protecting access on a “need-to-know” basis.

12.6 DATA RELEASE AND EXPORT

Data used for regulatory purposes or for data collection activities that require TNI accreditation will be clearly identified. Non-TNI accredited analytes will be clearly specified and identified as not meeting the TNI standard.

Data are released as electronic files (e.g. Excel, Word, pdf) or in hard copy. Hard copy and electronic files are checked before data are released for consistency and accuracy. This is part of the data audit process. Most hardcopy data is sent to the client via Federal Express, which allows for package tracking and affords a high level of confidence that tampering, does not occur. When data are electronically provided to the client, it is the client’s responsibility to verify that the hard copy matches the electronic file upon receipt. File copies of both formats are signed and dated and kept in the project file. The MSL will assist in resolving any issues that arise during data transmission. Data files will be encrypted upon request, assuming that the encryption programs are either those currently available to PNNL personnel or provided by the client. For confidential data transmissions, the client will be asked to define an acceptable mode

of data transmission that maintains confidentiality. In the past, data has been transmitted as FTP to a secured third party site arranged by the client. Hardcopy data can be footnoted on every page as to their confidentially and evidentiary status. In addition, when required by the client, “need-to-know” cover sheets can be used. A formal procedure has not been developed for these processes because confidential and secure transmission requests to date have been infrequent and very client-specific.

13.0 VERIFICATION ACTIVITIES

To insure the products generated and the services performed meet established standards and client requirements, a systematic approach has been implemented. This approach is graded and intended to provide oversight, assessment, and corrective/verification action for a variety of projects. The goal of the process is to:

- Provide personnel and management accurate technical, business and operational performance information that promotes early identification and resolution of problems that may impact achievement of critical outcomes and objectives.
- Verifies conformance to established requirements.
- Verifies effective conduct of activities to protect the environment and the health and safety of workers and the public.
- Contributes to ongoing improvement in performance

13.1 ASSESSMENTS

Assessments are performed in accordance with the HDI work flow "Integrated Assessments" by personnel and line management to evaluate performance. Assessment methods include, but are not limited to walk through, procedure and program reviews, personnel feedback, and safety, health, and environmental evaluations.

In addition, the ~~QAO~~ QM conducts QA assessments to determine if facilities, equipment, personnel, methods, practices, records and quality control are in conformance to approved planning documents, procedures, regulations, client requirements and PNNL policy. QA assessments are scheduled based on a request from the Director, the definition of critical phase inspections by PMs or clients, and by scheduling by the ~~QAO~~ QM when a new procedure is implemented or significantly revised, when a new study type is initiated, or when data quality reviews indicate technical systems problems. External assessments of suppliers are conducted through the PNNL Environment, Safety, Health and Quality Directorate in Richland, WA and are related to qualifying preferred suppliers.

QA assessments are formal or informal verification activities that are performed in accordance with procedure MSL-Q-002, Quality Assurance Inspections of MSL System and Study Activities and HDI work flow " Integrated Assessments". The purpose of a formal QA assessment is to determine verification with a requirement and includes formal corrective action and follow-up. If the assessment is determined to be informal, the purpose is to determine the status and to report the factual evidence and is not intended to be a verification activity with formal corrective action response, follow-up, etc. Informal assessments are generally requested by management to assess the status of a particular activity.

A schedule of all QA assessments is maintained by the ~~QAO~~ QM. This schedule will include verifications based on client needs, management requests and routine internal verifications (i.e., checking standards logs, sample preparation forms, QC checklists, equipment calibration and maintenance, etc.).

13.2 QA REPORTS TO MANAGEMENT

Biannually, the ~~QAO~~ QM will submit to the Laboratory Director a summary of the past two quarter's QA activities. Subjects to be covered in the biannual QA report are prescribed in procedure

MSL-Q-008, QA Reports to MSL Management, and shall include, but not be limited to, results of assessment activities, results of performance evaluation samples, trends of deficiencies, and other important QA-related issues.

13.3 DEVIATIONS

Each individual engaged in project activities should be alert to problems, deviations from approved SOPs, out-of-control events, or other issues that may require corrective action. The appropriate response is determined by the event. Procedure MSL-A-005, Deviations from Established Requirements provides methods for describes deviations from procedures, planning documents, and client requirements.

All deviations from approved procedures, project planning documents or this QAMP will be documented. Depending on the severity of the deviation, the ~~QAO~~ QM and the PM will determine how the deviation will be addressed and documented (i.e., through use of a Deviation Documentation Form or Quality Problem Report form as prescribed in procedure MSL-A-005, Deviations from Established Requirements). In some cases, the client may be involved in these discussions.

Deviations from project control limits will be documented. In some cases, deviations will be identified in the narrative accompanying the data set or package or in a letter to the client, and the impact of the deviation addressed. The documentation must clearly state the event and the corrective action taken in response, and must be approved by the appropriate management representative. Acceptance of data that exceeds pre-established criteria also must be documented and justified.

Below is a listing of deviation types.

- **Simple Deviation** – A simple deviation is a deviation from project control limits. The situation is documented either in log books, or on project paperwork including the case narrative. It is important to document if the sample integrity or data quality has been adversely affected.
  - **Corrective Action**- Document the situation to client. Look for opportunity to correct the situation.
- **Minor Deviation**- A minor deviation is defined as method or protocol deviation that does not appear to adversely impact the quality of the data. A minor deviation may evolve into a major deviation if an impact on data quality evolves or results.
  - **Corrective Action**- Document either with narration to client or deviation documentation. Determination of a minor deviation will be initiated by either the PM, or ~~QAO~~ QM. The corrective action will be established to assure that the highest quality of data is produced and that all contractual limits are met. It is possible for a minor deviation to result in a major deviation depending upon all circumstances.
- **Major Deviation** - A major deviation is defined as an occurrence or method or protocol deviation with an impact on project data quality or a negative effect on the outcome of a test or analysis.
  - **Corrective Action**- Formal documentation. Major deviation corrective action is tracked to completion, including signatories. The objective is to be able to institute “lessons learned” to improve systems and personnel awareness.

The following are guidelines to resolving deviations:

- All deviations from approved procedures, project planning documents or this QAMP will be documented.
- Issues that affect cost, schedule, or performance of the project will be reported to the PM. The PM will then be responsible for evaluating the overall impact to the project and implementing the necessary corrective actions.
- Deficiencies identified through QA assessment activities will be brought to the attention of the PM. Implementation of corrective action will be the responsibility of the PM.
- When sample integrity is compromised or questionable (e.g., mislabeling, broken or leaking sample containers, improperly preserved samples, expiration of sample holding times), it is the responsibility of the personnel who identify the problem to bring it immediately to the attention of the PM for resolution.
- In the event of an instrument problem, it is the responsibility of the operator to attempt to correct the problem (e.g., recalibrate the instrument). If the problem persists or cannot be identified, the issue should be brought to the attention of the Director for resolution.
- Corrective actions for results outside established DQOs are addressed in applicable SOPs.

13.4 CORRECTIVE ACTION

The need for corrective action may be identified by the technical personnel during the course of their work and through assessments or data audits. It is the responsibility of the analyst to monitor QC sample results, and ensure established criteria in method procedures or project specific criteria are met.

Each individual performing laboratory or data processing activities will be responsible for notifying the PM of any circumstance that could affect the quality or integrity of the data. It is the PM's responsibility to ensure completion of the resulting corrective action by the expected completion date, and to request independent verification (when required).

Corrective actions may include, but are not limited to, review of data and calculations, flagging and/or qualification of suspect data (see procedure MSL-D-004, Data Reporting, Reduction, Backup, and Archiving) or re-extraction and/or re-analysis of individual or entire batches of samples. In addition, individual analytical SOPs may contain appropriate corrective actions for various routine problems. The form of documentation is project specific, but at a minimum, the QC data that are outside the established criteria shall be flagged.

When there has been an impact on data, the PM shall ensure that there is a cross reference in the raw data that indicates there is a documented deviation and corrective action.

13.5 QUALITY IMPROVEMENT

Quality improvement is a critical aspect of the Self-Assessment Program and involves both corrective action to identified deviations and continuous improvement processes. The corrective action process involves determining, implementing, approving, and verifying the appropriate remedial action. The continuous improvement process involves determining and prioritizing improvement areas, implementing improvement action and documenting the disposition of each action.

13.6 ASSESSMENT ACTIVITIES

For all assessment activities, a system of notification and verification of corrective action is in place. An assessment report is prepared and submitted to the appropriate PM. The PM reviews the assessment results to determine overall impact and risk and then determines corrective action and prioritizes the actions. The PM assigns the corrective actions to individuals. The PM ensures that the corrective action is tracked to completion and as part of completion, documentation is included that describes the justification for completion of the corrective action. Issues that in the PM's judgment require significant corrective action should be scheduled for verification of that corrective action at a subsequent assessment.

Issues that in the PM's judgment require process improvement instead of, or in addition to, corrective action, are identified as such and any improvement actions are implemented and documented.

13.7 CLIENT COMPLAINTS

The process for tracking and addressing client complaints is the following:

- The PM is the point of contact for any client complaints.
- The client contacts the PM to discuss the concern. The contact is generally made by e-mail or telephone, although a formal written follow up letter may be sent as well.
- The PM will inform the Director of the issue(s). Concerns will be responded to in writing. A determination will be made of an appropriate response (e.g., data review and re-calculation, sample re-analysis, re-sampling and analysis, revision of deliverables), which will be discussed with the client prior to finalizing in a response letter.

A tracking system for client complaints has not been developed because client complaints are rare. If the frequency of client complaints increases (>2/year), a formal tracking system may be developed. The ~~QAO~~ QM will monitor the number of annual client complaints.

APPENDIX A: List of Acronyms

ASTM	American Society for Testing Materials
BS/BSD	Blanks Spike / Blank Spike Duplicate (aka LCS)
BIOSIS	A bibliographic database service, with abstracts and citation indexing
CCV	Continuing Calibration Verification
CDRR	Chemical Disposal Recycle Request
CFR	Code of Federal Regulations
CMS	Chemical Management System
CRM	Certified Reference Material
CSM	Cognizant Space Manager
CoC	Chain of Custody
CV	Coefficient of Variation
DO	Dissolved Oxygen
DOE	Department of Energy
DQO	Data Quality Objective
EED	Energy and Environment Directorate
EPA	Environmental Protection Agency
ES&H	Environment, Safety, and Health
ESE	Environmental and Safety Engineer
FDA	Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FSR	Field Services Representative
GLP	Good Laboratory Practices
HDI	”How Do I”
HPLC	High Performance Liquid Chromatography
Hg	Mercury
IACUC	Institutional Animal Care and Use Committee
ICV	Initial Calibration Verification
ID	Identification
IOPS	Integrated Operations System
LCS	Laboratory Control Sample
MB	Method Blank
MDL	Method Detection Limit
MSL	Marine Science Laboratory
MS/MSD	Matrix Spike / Matrix Spike Duplicate
MRO	Marine Research Operations
NIST	National Institute of Standards and Technology
NJDEP	New Jersey Department of Environmental Protection
NOAA	National Oceanic and Atmospheric Administration
NOEC	No Observed Effect Concentration
NRCC	National Research Council of Canada
NVLAP	National Voluntary Laboratory Accreditation Program
PARCCS	Precision, Accuracy, Representativeness, Comparability, completeness and Sensitivity
PM	Project Manager
PNNL	Pacific Northwest National Laboratory
PT	Performance Test
PVC	Polyvinyl Chloride
QA	Quality Assurance

QAMP	Quality Assurance Management Plan
~~QAO~~ QM	Quality ~~Assurance Officer~~ Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
QPR	Quality Problem Report
R&D	Research and Development
RFID	Radio Frequency Identification
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
RSO	Radiation Safety Officer
SOP	Standard Operating Procedure
SOW	Statement of Work
SRM	Standard Reference Material
TNI	The NELAC Institute
TSCA	Toxic Substances Control Act
U.S.	United States
UV	Ultraviolet
WA-DOE	State of Washington, Department of Ecology

GPO Appendix 01
Attachment A
Subattachment d
ACZ Laboratories QAP

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Quality Assurance Plan v.24

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1 INTRODUCTION

ACZ Laboratories, Inc. is an environmental testing laboratory that provides data to clients primarily for regulatory purposes. Samples are analyzed for compliance with federal programs including the Resource Conservation Recovery Act (RCRA), Safe Drinking Water Act (SDWA), and Clean Water Act (CWA). Environmental compliance and management decisions are based on the analytical data provided, which are critical to the expenditure of large amounts of money; are important to public health safety; are important in evaluating, monitoring, and protecting the environment; and may be essential in litigation. ACZ's data must be of known and documented quality to support sound decisions and withstand adversarial inquiry.

An effective Quality Management System is the cornerstone of the generation of reliable analytical data. ACZ's Quality Assurance Plan (QAP) outlines the quality assurance and quality control objectives, policies, and procedures determined to be necessary to meet the requirements of the EPA, federal government entities, state agencies, other regulatory authorities, and our clients. This document provides the framework to ensure all ACZ employees have sufficient knowledge and training to perform their job responsibilities in a manner that assures all data reported to ACZ's clients is accurate, reliable, technically sound, legally defensible, and impartial.

For data to be useful, it must be of known and documented quality. The word "quality" has many different meanings, but for the purposes of environmental testing activities can be stated simply as "conformance to requirements." Conforming to requirements allows objective measurements to be applied, rather than subjective opinions, to determine when work is of good quality. *Quality control* refers to all activities that measure conformance (i.e. good quality) of the data. It requires action(s) to be taken and is typically included as part of the procedure. *Quality assurance* provides the records of the results obtained from the required action(s) and refers to the ability of the laboratory to demonstrate or prove to an outside party that the quality of the data is what the laboratory states it is. Quality assurance relies heavily on documentation, and to be effective, the documentation must: (1) assure the quality control procedures are being implemented as required; (2) assure the reported data reflect the sample as it was received, meaning sample mix-up was avoided, the sample was properly preserved prior to analysis, etc.; (3) facilitate traceability of an analytical result; and (4) be subjected to reasonable precautions to protect data from loss, damage, theft, and internal or external tampering.

Quality Policy Statement: To maintain an effective QA program, continually improve the quality of our environmental testing services, and consistently provide clients with technically sound and legally defensible data in a timely manner, the management of ACZ recognizes the importance of its commitment to:

- Ensuring good professional practice by well-trained and qualified employees with the necessary experience and skills to carry out their organizational functions and to meet or exceed ACZ's standards for the quality and reliability of its testing services.
- Ensuring the data provided to our clients is of known and documented quality, and is accurate and impartial.
- Ensuring that all quality assurance and quality control policies and procedures are communicated to and understood by all employees, and that they are implemented by all employees in their work.
- Ensuring that all aspects of the business operations are conducted in a manner that adheres to the TNI Standards and all of ACZ's policies and procedures documented in the QAP, SOPs, emails, memos, etc.
- Upholding the spirit and intent of ACZ's Data Integrity Program and implementing the requirements of the program.

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2 QUALITY SYSTEM OBJECTIVES & COMPONENTS

ACZ's QAP provides a framework that guides all technical staff and administrative personnel. The information presented is necessary to ensure all employees perform their duties in a manner that allows the company to achieve its objectives, thereby ensuring the precision, accuracy, completeness, and consistency of the analytical data reported to our clients. This framework is referred to as the Quality System. The Quality System encompasses every documented quality assurance (QA) and quality control (QC) policy and procedure and guides all business functions and laboratory operations by specifying standardized protocols to control both the short-term and long-term activities that influence the quality and defensibility of our testing services.

The Quality System is designed to be appropriate to the type, range, and volume of the environmental testing undertaken. The Quality System is not a static entity and must function in a manner that allows for continuous evolution of all aspects of ACZ's business when improvements have been identified and have been determined to be necessary or beneficial. ACZ management recognizes that the staff is comprised of people who possess varied experience and knowledge and can contribute valuable insight and suggestions regarding these improvements. All employees are encouraged to be involved in this process. The following six (6) key elements form the foundation of ACZ's Quality System:

- Documents & Records
- SOPs
- Training
- Audits
- Corrective Actions
- Management Review of the Quality System

2.1 Documents & Records

The entire history of any sample must be readily understood through the associated documentation. To this extent, a formal and systematic control of documents and records is necessary for accurately reconstructing all events pertaining to any sample and for guaranteeing the quality and defensibility of the data. All information relating to the laboratory facility's equipment, analytical test methods, and related laboratory activities (such as sample receipt, sample preparation, data verification and data reporting) must be documented, and all records, including those pertaining to calibration and test equipment, certificates and reports, must be maintained. Documents and records must be safely stored (protected against fire, theft, loss, deterioration, and vermin), and must be held secure and in confidence to the client for a minimum of 10 years. Refer to §10 for details regarding the storage and control of ACZ's documents and records.

2.1.1 Documents

All official documents are reviewed for accuracy, approved for release by authorized personnel, and distributed through ACZ's LabWeb intranet. LabWeb is a computerized document control system based in HTML that can be accessed from any network computer within the facility. For printed documents to be considered controlled, the header must be in sync with the header on LabWeb. Obsolete or invalid SOPs retained for knowledge preservation or other reasons must be clearly marked to identify their purpose.

All documents are categorized by department and are assigned a unique document ID that is displayed in either the header or footer section. The ID nomenclature starts with either SOP (procedure) or FRM (form), followed by the 2-letter department code, the unique document number, the month and year of issue, and the revision. The effective date for any SOP or other document is included on the title page and header section of each subsequent page and indicates the implementation date.

The QA Officer has full responsibility of the Document Control System. Only employees with the appropriate computer access (IT and QA staff) can upload documents to LabWeb. A new or revised document is reviewed, and following approval, the document control number is updated and the SOP or form is uploaded to Labweb. When a new version of an SOP is added to Labweb, the previous version is removed from the active list, date-stamped and electronically archived in a designated location on the

network. This automatic process guarantees that ACZ can retrieve the version that was in effect at any given time.

2.1.2 Records

A record is any information or data on a particular subject that is collected and preserved. Records are produced on a daily basis and contain original, factual information from an activity or study. For ACZ's purpose, this information may be recorded by the following means: LIMS database, logbooks, raw instrument data, worksheets, and notes (or exact copies thereof) that are necessary for the reconstruction and evaluation of the report of the activity or study. The record management system provides control of records for data reduction, validation, reporting and storage, and also provides control of all laboratory notebooks and logbooks. The system must allow for historical reconstruction of all laboratory activities that produced analytical data, must document the identity of personnel involved in sample receipt, preparation, calibration, and testing; and must facilitate the retrieval of all working files and archived records for inspection and verification purposes. At a minimum, the following criteria for records must be met:

1) Instrument logbooks must be kept up-to-date on a daily basis. Document all relevant activities when the event occurs or as soon as practical thereafter.

2) Dilution factors and observations must be recorded at the time they are made, and notes regarding samples or analyses must be identifiable to the specific task.

3) A detailed description of any departure from a documented procedure, and the reason for the departure, must be provided at the time it is performed.

4) All generated data must be recorded either by an automated data collection system or must be recorded directly, promptly and legibly in permanent ink (blue or black is preferred).

5) Erroneous entries (hard copy or electronic) cannot be destroyed by methods such as erasures, overwritten files or markings. Refer to §16 for ACZ's error correction protocol.

6) Any changes to hard copy records must be clearly initialed and dated by the responsible staff. Changes to electronic records must also be traceable to the individual who made the change, and the reason for the change must be provided.

7) Records generated by computers must have hard copy or write-protected backup copies.

2.2 Standard Operating Procedures

A documented procedure is required for all phases of ACZ's business operations, from sample log-in through sample disposal. A Standard Operating Procedure (SOP) is a written document that details the manner in which an operation, analysis, or action is performed and thoroughly prescribes the techniques and procedures, which are the accepted process for performing certain routine or repetitive tasks. Analytical SOPs must be written with adequate detail to allow someone similarly qualified, other than the analysts who routinely performs the procedure, to reproduce the procedure used to generate the test result. To the extent possible, administrative SOPs [non-technical] must include specific requirements pertaining to the process; however, the procedure itself may be a more general description so as to lend a degree of necessary flexibility to account for client requests and other circumstances which may be outside of ACZ's control.

Proposed revisions to any test SOP shall be submitted by the pertinent department supervisor (exceptions may be granted on a case by case basis) and be reviewed and approved by QA prior to implementation. Changes to provide additional clarification, correct typographical errors, etc. do not require formal approval and/or training. Analytical SOPs must be reviewed annually using the SOP Review Form (FRMQA035), and Administrative SOPs must be reviewed regularly and revised if necessary to ensure the information is accurate and reflects current practice. Documenting changes in the controlled copy of any SOP is prohibited. Refer to §10.5.1 for additional information on SOPs.

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SOPs are proprietary documents and ACZ does not distribute them freely. Any copy sent electronically or otherwise to an outside party is considered uncontrolled, and the recipient understands that additional changes can be made without prior notification. Excluding method development, the use of uncontrolled copies of SOPs is not permitted.

Unless the reference method is followed exactly and contains sufficient detail to ensure consistent application, an SOP must be developed before a new procedure, application, or instrument can be implemented. The introduction of a new method must be a planned activity directed by the Production Manager, assigned to the appropriate technical director(s), and overseen by QA staff. Exceptions may be made when the client provides specific procedural instructions. In this event, the client's instructions must be followed exactly and appended to ACZ's test report package. Exceptions are primarily related to the preparation of solid materials for analytical testing (refer to SOPAD043 for additional details). An SOP template (SOPAD025) may be obtained from QA. If a client requests a procedure for which there is no published method or existing SOP, ACZ will utilize the process described in the SOP *Client Service Policies and Procedures* (SOPAD043). Analytical SOPs are written in accordance with the TNI Standards and must include or reference the following items, where applicable:

1) identification of the test method
2) summary, scope & application of the test method, including matrices & parameters to be analyzed
3) references, including documents provided by instrument / equipment manufacturer
4) sample collection, preservation, & storage
5) equipment & supplies
6) reagents & standards, including storage conditions & shelf-life for each
7) safety
8) interferences
9) complete procedure, including details and acceptance criteria for initial & continuing calibration
10) data review & assessment, including protocols for handling out-of-control or unacceptable data
11) quality control, including acceptance criteria & corrective action for handling failed quality control
12) calculation equations (dilution factors, RPD, % recovery, etc.) & calibration formulas
13) method detection limit & quantitation limit
14) method performance, including Demonstration of Capability and Method Detection Limit procedures
15) pollution prevention & waste management
16) definitions
17) tables, diagrams, flowcharts

2.3 Training

It is the responsibility of ACZ's management to ensure the competence of all employees who perform environmental tests and other specific duties, operate equipment or instrumentation, give opinions and interpretations, evaluate results, and sign test reports. Additionally, ACZ management is responsible for formulating the goals and policies with respect to the necessary education, training, and skills of all personnel and for providing training that is relevant to the company's present and anticipated tasks.

Employees must possess the appropriate combination of education, experience, and skills to adequately demonstrate a specific knowledge of their particular functions and to carry out those functions in a manner that meets ACZ's standards and expectations. Additionally, each staff member must demonstrate an understanding of laboratory operations, test methods, related quality assurance and quality control procedures, and management of records and documents to the extent necessary to successfully perform their job duties.

All full-time and part-time personnel must complete a formal training process for Safety, Ethics, Quality Assurance / Quality Control, Quarantined Materials, and Sexual Harassment on the first day of hire and are subsequently responsible for complying with all requirements that pertain to their job duties. For all technical staff, training for analytical procedures must be completed prior to independent generation of client data. In general, any staff member who is undergoing training must be provided with appropriate supervision. It is the responsibility of each supervisor or manager to ensure personnel within his or her department are supervised, competent, and working in accordance with ACZ's Quality System.

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2.3.1 Safety Training

Safety training is scheduled with ACZ's Chemical Hygiene Officer (CHO) and includes viewing a video of general laboratory safety, a complete review of ACZ's Chemical Hygiene Plan, and a building tour to identify the location of Safety Data Sheets, emergency showers, eye wash stations, and emergency exits. Following completion of the training, the employee takes an exam, which allows the CHO to evaluate their understanding of the material covered.

2.3.2 Data Integrity Training

ACZ is committed to fostering and enforcing an ethically sound work environment that encourages the conscientious production of accurate, technically sound, and legally defensible data. Data integrity training is required for all full-time and part-time employees (permanent or temporary) as described in ACZ's SOP *Data Integrity Principles & Policies* (SOPAD039). Initial training provides an orientation of ACZ's Ethics program, ACZ's Code of Conduct, Code of Ethics, and zero-tolerance policy. Each new employee is introduced to the company's Ombudsman. Data integrity training is provided for all current employees on an annual basis. At a minimum, employees must review ACZ's Data Integrity Principles & Policies (SOPAD039) and provide documented testimony indicating they have read, understood, & agree to adhere to them.

2.3.3 QA Training

All full-time and part-time employees attend an initial orientation session which is based on the most current version of ACZ's Quality Assurance Plan [QAP] and focuses on the relationship between quality control, quality assurance, environmental testing, and environmental monitoring.

2.3.4 Sexual Harassment Training

Sexual Harassment training is required for each new employee and includes viewing a video that demonstrates the identification, reporting, and remediation of harassment issues in the work place. Any complaints of sexual harassment must be brought to the attention of ACZ's Presidents as soon as possible.

2.3.5 Technical personnel must be thoroughly trained in the analytical techniques and operating principles for all pertinent method procedures. Under no circumstances may any analyst independently generate or review client data for a test procedure before completing the required training and receiving the explicit approval of the technical director overseeing the analysis. §5 provides details of ACZ's technical training program.

2.3.6 Employees may be authorized to perform AREV or SREV for a procedure by the pertinent department supervisor or the QAO. Authorization indicates the employee has been trained on applicable QC requirements, corrective actions, and data qualification. AREV & SREV shall be performed in accordance with effective version of the associated test SOP. Authorization is tracked in an excel spreadsheet located on a network drive. Computer permissions are configured so that all employees may view the spreadsheet but only QA staff may edit it.

2.3.7 Training is required for all employees whose activities are affected by any procedural change(s) to an SOP and is considered to be complete once each employee has submitted documentation attesting they have read, understand, and agree to follow the revised policy.

2.3.8 ACZ recognizes the benefit of continuing education and encourages employee participation in advanced training courses, seminars, and professional organizations and meetings.

2.4 Audits

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The purpose of an audit is to verify conformance to documented Quality Assurance and Quality Control policies and procedures, and to identify discrepancies when they exist. In the latter case, any problems shall be addressed and resolved in an appropriate manner to assure the Quality System is continuously improved on all levels.

2.4.1 External Audits

External audits are conducted to ascertain compliance with rules, regulations, and additional criteria for certification, and will have a higher degree of formality than internal audits. Where records are required, compliance will be critically evaluated. Issues of non-compliance identified in previous audits are usually reviewed to verify the laboratory has remediated them effectively. The ease with which important records and information can be retrieved is a criterion for judgment of the management practices of a laboratory and may dictate the depth of the audit. Individual state agencies, laboratory Accrediting Bodies, and current and potential clients routinely audit ACZ.

The on-site assessment is generally a two to four day process during which the regulating agency conducts an entrance interview and tours the facility before performing an in-depth review of documents, workgroups, reports, electronic data files, etc. A critical aspect of the on-site assessment is review and verification of bench-level documentation and analyst interviews to determine actual laboratory practices. ACZ's policy is to always have QA personnel present during an interview. If necessary, the President, may attend the interview. An exit interview is conducted upon completion of all on-site assessments, during which observations and findings are reviewed. The agency will submit a final report to ACZ, generally within 30 days, detailing all pertinent findings and recommendations.

Upon receipt and review of the agency's report, the QA department will meet with department managers to develop a corrective action plan, which must be submitted to the agency by the date indicated in their report. Each finding or group of similar findings is addressed as a major corrective action as described in §2.5.2. Employees shall not make changes to any laboratory or other practice based on comments or opinions expressed by the regulating agency during an interview or any other stage of the on-site assessment without first obtaining approval from QA. ACZ will revise policies and procedures as necessary as part of the major corrective action process.

2.4.2 Internal Audits

ACZ is responsible for the quality of its data and must take reasonable efforts to assure itself and all interested parties confidence can be placed in it. ACZ shall conduct internal audits of its activities to verify compliance with the Quality System. It is the responsibility of the QA Officer (QAO) to plan, direct, and organize internal audits; however, a trained and qualified individual, independent from the area or system being audited, may be designated by the QAO to conduct an internal audit. The area of activity audited, the audit findings, and subsequent corrective actions shall be documented.

The internal audit program shall address all elements of the management system. At least one test method shall be audited annually for each analytical laboratory division. Method audits encompass both qualitative evaluation of the operational details of the QA program and quantitative evaluation of the accuracy of data generated by the laboratory staff. Test method audits include step by step witnessing of the procedure. Laboratory Divisions:

- Wet Chemistry (Prep and Analytical)
- Metals (Instrument & Prep)
- Soils
- Radiochemistry (Prep and Analytical)
- Organics (Prep and Analytical)

When audit findings cast doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test or calibration results, the laboratory shall take timely corrective action, and shall notify
customers in writing if investigations show that the laboratory results may have been meaningfully affected. Client contact should be initiated within two months of discovering the error(s). If data impact

assessment cannot be completed in this timeframe management shall set a deadline commensurate to the demands of the assessment.

More frequent internal audits may be scheduled depending on the following criteria:

- Number and type of corrective actions filed for a method or activity
- Client complaints
- Continued failure to achieve acceptable results for a Proficiency Testing sample
- Findings from an external audit
- Request from management

All findings from internal audits are directed through ACZ's corrective action system. Each finding is assigned a corrective action number (similar findings may be combined). A general description of the process is as follows:

1) Findings and observations are summarized in a report.

2) The report is distributed to the department supervisor, Production Manager, and Presidents.

3) The supervisor reviews the report and composes a plan of corrective action (POC) and projected completion dates for each finding. The POC should be proportional to the finding and the projected completion date commensurate with the demands of the tasks required for the corrective action.

4) The supervisor submits the plan of corrective action to the QAO or designee for review and approval.

5) The QAO or designee reviews the plan of corrective action for each internal audit finding. Once the plan of corrective action is accepted, a major corrective action number is assigned to each planned corrective action or group of similar corrective actions.

6) The supervisor negotiates the corrective action and submits a Corrective Action Report (FRMQA001) for each major corrective action number to the QA department for final review.

7) Once all corrective actions associated with the internal audit have been completed and approved, the internal audit process is complete.

An in-depth review will be conducted if there is any evidence of inappropriate actions or vulnerabilities related to data integrity. This review shall be handled in a confidential manner until a follow up evaluation, full investigation, or other appropriate actions have been completed and the issue(s) clarified. Refer to ACZ's SOP *Data Integrity Policies & Procedures* (SOPAD039).

2.4.3 Proficiency Testing (PT) Program

ACZ is required to participate in a formal Proficiency Testing Program at the frequency stipulated by regulating agencies. These "performance evaluations" are facilitated through the introduction of blind samples, purchased from approved vendors. ACZ analyzes PT samples for most accredited parameters twice in a calendar year, with each study being approximately six (6) months apart. These tests are matrix, technology, and analyte specific, and provide useful information regarding the accuracy of the analytical data being produced. At a minimum, ACZ participates in the Water Supply (WS) study for SDWA, the Water Pollution (WP) study for CWA, a Soil study for RCRA, and a Radiochemistry PT study for Drinking Water. Refer to SOPAD011 for additional details.

2.5 Corrective Action

Corrective action shall be performed when any aspect of ACZ's testing and/or calibration work, or the results of this work, do not conform to established procedures or the agreed requirements of the customer. Corrective actions are a fundamental element of ACZ's QA Program, as a successful Quality System requires the identification of

deficiencies and depends on the development, implementation, and documentation of effective contingency plans and resolutions to effectively remediate the deficiencies. Corrective actions are classified as minor, major, or technical.

2.5.1 Minor Corrective Action

Minor corrective actions address problems or issues isolated to a specific data set or group of data sets that do not meaningfully impact reports *already* issued to clients. The minor corrective action report (FRMQA001) allows for complete documentation of any temporary deviation from the SOP or other protocol. The employee who initiates the corrective action will complete Section 1 of the report. Documentation must be accurate and must provide a complete detailed explanation of the situation for future reference. The need to qualify data shall be critically assessed and appropriately addressed. The department supervisor should always be informed of the need for a minor corrective action and may provide additional information in the appropriate section. The project manager may also provide additional information in the appropriate section if necessary. QA does not need to close a minor corrective action; however, the employee may review the report with QA personnel and request their signature in the appropriate section. Minor corrective actions do not require follow-up.

Complete documentation may be provided either on the workgroup bench sheet or on the data review checklist in lieu of using FRMQA001. Use FRMQA001 if the deviation applies to many workgroups and attach a copy of the completed form to each workgroup before the workgroup is scanned. If the report is generated after the workgroups have been scanned, then the workgroup must be retrieved and rescanned with the report included as part of the data package. In this case, a note is made on the front page of the workgroup package indicating the reason the workgroup was rescanned (i.e. “CAR attached, WG rescanned”).

2.5.2 Major Corrective Action

Major corrective actions address problems which are systematic or meaningfully impact reports which have been issued to clients. It is the responsibility of the QAO to notify laboratory management in writing of departures from the Quality System, and it is the responsibility of the laboratory management to ensure remediation is completed by the assigned due date or to negotiate an extended deadline.

A major corrective action is initiated whenever a system failure has been identified or whenever an audit finding or other circumstance casts doubt on the correctness or validity of the analytical results. The client must be notified in writing if their work is significantly affected. The QA department will work with the Project Manager to determine if a revised report must be issued to the client. See ACZ’s SOP *Client Service Policies and Procedure* (SOPAD043) for details. A major corrective action may also be initiated when the need for preventive action has been identified (refer to §2.5.4).

Only QA department personnel may open and close a major corrective action. When opened, the corrective action shall be assigned a unique tracking number (referred to as the CAR number) to ensure that ACZ maintains a complete and accessible record of all Quality System deviations or failures, root cause determinations and subsequent resolutions, and preventive actions. A remediation deadline shall be assigned for all major corrective actions.

Examples of circumstances requiring a major corrective action include, but are not limited to:

- Contamination trends as indicated by blanks routinely above acceptable levels
- Spikes, surrogates and lab control samples continually outside acceptance limits
-
- “Not Acceptable” Proficiency Testing results
- Findings from internal or external audits
- Discrepancies between what was reported to clients and what should have been reported to clients due to equation errors or incorrect LIMS configuration.

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- Hold times or deadlines routinely missed
- Evidence of insufficient or inadequate training

Following initiation, the procedure for a major corrective action proceeds to an investigation by the assigned individual to determine the root cause of the problem and identify possible resolutions to rectify the problem. The action(s) most likely to eliminate the problem and prevent recurrence of the problem must be selected, documented and implemented, and pertinent staff members must be trained, if necessary. Changes resulting from the corrective action will be monitored, if necessary, to ensure the resolution(s) are effective. A general outline of the procedure is as follows:

1) Initiation: Any employee may initiate a corrective action by notifying QA. The department manager should be notified first so that they can assess the need for a major corrective action. If determined to be necessary, QA personnel will open a corrective action, assign a unique tracking number, and a deadline for remediation. Deadlines shall be assigned based on the anticipated demands of remediation and potential threat posed to data integrity.

2) Assignment: QA assigns the corrective action to the person(s) responsible for problem characterization, Root Cause Analysis (RCA), Data Impact Assessment (DIA), corrective (including preventive) actions. Sections 1 and 2 of FRMQA001 shall be completed by the assignee(s).

3) Immediate action shall be taken to eliminate propagation of errors. Stopgap measures may be employed, including but not limited to: subcontracting analyses, imposing a moratorium on data reporting, manual data transformation. Immediate action shall be to a degree commensurate with the magnitude and risk of the problem.

4) Investigation and Action: Must be completed by the assigned deadline. Deadline extensions shall be negotiated with the QA department.

   a. The assigned individual(s) launch an investigation of the problem. There are three major components of the investigation
      1) Characterization of the problem: A thorough, but succinct, description of the problem must be composed. Whenever possible, this includes determination of the exact timeframe during which the error was present and what workgroups and samples were affected.
      2) Root Cause Analysis (RCA): Focuses on establishing the sequence of events or causal chain leading up to the problem, identifying contributing factors and elucidating relationships between them, and determining where intervention could be reasonably implemented to change performance and prevent an undesirable outcome. The depth of the RCA shall be commensurate with the risk and magnitude of the problem.
      3) Data Impact Assessment (DIA): Once the problem has been fully characterized, it shall be evaluated to determine whether client data may have been significantly impacted by the error. The DIA shall be commensurate with the risk and magnitude of the problem.

   b. A resolution to correct the problem and prevent its recurrence must be determined & implemented. Resolution may be done solely by the person(s) who investigated the root cause or it may require input from one or more additional departments.

      1) Conduct additional training if necessary. Training must be documented using the appropriate form and must include a description provided by the person who conducts the training. All trainees are required to sign and date the form to acknowledge he/she has received training, understands the change(s) and agrees to adhere to any change(s) in a policy or procedure.
      2) Revise SOP(s) as necessary. Proposed revisions must be approved by QA prior to implementation.
      3) Configure or enhance automated systems (e.g. LIMS) to correct problems or support preventive measures.

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4) Correct data in ACZ's LIMS as deemed necessary by Technical Directors, QA Staff, & Project Managers.
5) Perform additional measures (e.g. instrument or support equipment purchase, etc.) as necessary.
6) Document implementation dates for each corrective action.
7) Attach or reference all supporting documentation in the corrective action report.

5) Project Manager Review: If necessary, the PM will determine whether affected data will be accepted or rejected, contact the client, and issue revised reports accordingly. Project Manager review may not be required for every major corrective action.

6) QA reviews the corrective action. If satisfactory, the corrective action is approved and closed.

7) If deemed necessary, QA conducts follow-up. Follow-up is scheduled after sufficient time has elapsed to observe the efficacy of the corrective action and may need to be done multiple times. If the corrective action is determined to be ineffective, a new major corrective action will be initiated and the process repeated. QA follow-up may be documented on the corrective action report or the CAR spreadsheet located on ACZ's network.

2.5.3 Technical Corrective Actions

Technical corrective actions apply to departures or deviations from the quality control parameters stated in individual test SOPs. Each test SOP must include all required quality control that applies to the procedure (as stipulated by the method and other regulatory agencies) as well as the performance frequency, acceptance criteria and corrective action for handling failed quality control measurements. Each SOP must describe the procedures to be followed for reviewing and assessing data, including corrective action for handling out-of-control or unacceptable data. The required protocol for technical corrective actions is summarized below.

1) Identify the individual responsible for assessing each nonconformance and initiating or recommending corrective action [analyst who performs AREV]

2) Define how the analyst must treat data if associated quality control measurements are unacceptable [section 12 of SOP]

3) Specify how non-conformance and subsequent corrective actions are to be documented [data review checklist]

4) Specify how management reviews the corrective actions [reviewed during SREV]

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If a quality control measure is found to be out of control then the corrective action described in the SOP must be performed. Alternatively, report data with the appropriate qualifier if reprocessing and reanalysis is not possible. The qualifier must be assigned to any sample associated with the failed quality control measure. A current list of all extended qualifiers is available in the LIMS database and may be accessed by all employees.

2.5.4 Preventive Action

Preventive action is a pro-active process to identify opportunities for improvement rather than reacting to the identification of problems or complaints. Needed improvements and *potential* source(s) of any nonconformance, either technical or concerning the Quality System, must be identified and addressed. Examples of preventive action include but are not limited to: maintaining a cross-trained staff; maintaining a supply of spare consumable parts; monitoring the performance of support equipment; performing routine maintenance on instruments; maintaining an adequate supply of standards/reagents; ordering supplies before running out; completing log-in review in a timely manner; ensuring ACZ can perform work before

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samples are accepted; correcting quotes before samples are logged in; and analyzing samples by the appropriate method.

2.6 Management Review of the Quality System

At least once per calendar year, ACZ's management conducts a review of its Quality System and all activities related to its environmental testing services to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements. At a minimum, the review must take the following into account:

- Suitability of policies and procedures.
- Manager and supervisor reports
- Review of internal audits
- Status, review, and discussion of major corrective actions
- Review of recent external audits
- Results of recent PT studies and corrective actions initiated / completed
- Changes in the volume and type of work undertaken
- Customer feedback
- Complaints
- Recommendations for improvement
- Status of state certifications
- Ethics and Data Integrity
- Other pertinent issues
- Resources and training.

2.6.1 Department Reports

Each department manager completes a Department Report (FRMQA041 or FRMQA042) prior to the Management Review meeting. Each item on the report is to be evaluated as it pertains to the individual department.

2.6.2 Management Review Report

The completed department reports are submitted to ACZ's Presidents. At a time specified by the Presidents management meets as a group to discuss the reports. All reviews shall be appropriately documented.

2.6.3 Customer Feedback

ACZ solicits customer feedback on an annual basis through the use of a client survey distributed and received via email. The survey asks for feedback regarding customer service, data quality, staff, value, timeliness, and laboratory standing compared to other labs. Feedback is compiled by the CEO and discussed during management review of the quality system.

2.6.4 When a finding is identified through the management review process ACZ's corrective action protocol shall be initiated.

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3 ETHICAL AND LEGAL RESPONSIBILITY

All ACZ employees have an ethical and legal responsibility to produce data that is accurate, reliable, and legally defensible. ACZ's proactive program for the prevention and detection of improper, unethical, or illegal actions includes an Ombudsman who acts as a neutral party and serves as a confidential liaison between ACZ employees and management regarding questions, problems, complaints, suggestions, or ethical dilemmas.

Initial employee orientation includes ACZ's Code of Conduct, Code of Ethics, and zero-tolerance policy. Employees are informed of the processes in place to ensure employees are free from undue internal or external commercial, financial, or other pressures that may adversely affect the quality of an employee's work, endanger the trust in the independence of ACZ's judgment, or compromise the integrity of ACZ's environmental testing activities. A more detailed description of all aspects of the ethics program is provided in ACZ's SOP *Data Integrity Principles & Policies* (SOPAD039).

ACZ will not tolerate unethical or improper activities or behavior. Violation of company policies may lead to repercussions ranging from a warning to termination and possible criminal prosecution if warranted by the situation. ACZ has access to many resources that may be utilized at any time to help clarify any situation determined to be a "gray area." Employees are strongly encouraged to seek further guidance from a supervisor, ACZ's Ombudsman, Presidents, or QA staff whenever doubt is raised. Activities that will not be tolerated include, but are not limited to:

- **Misrepresentation of a procedure or documentation** – Intentionally performing a job duty in a manner that does not comply with a documented procedure, including but not limited to a test SOP or method used for sample analysis; providing inaccurate and misleading documentation associated with a data package or failing to provide the necessary documentation as part of a data package.

- **Falsifying Records** – Providing false information on personal credentials, resumes or educational transcripts, logbooks, raw data and client reports, or creating data without performing the procedure (also known as dry labbing).

- **Improper peak integration** – Intentionally performing improper integration of data chromatograms so quality control samples meet acceptance criteria. This is also known as peak shaving or peak enhancing.

- **Improper clock setting** – Readjusting the computer clock so that it appears samples were analyzed within hold times. Also referred to as time traveling.

- **Improper representation of Quality Control samples** – Failing to treat batch quality control samples in the same manner as client samples (including Proficiency Testing samples) or misrepresenting any type of quality control sample associated with the preparation batch and/or analytical batch.

- **Improper calibration** – Intentionally performing improper manipulation of calibration data or forging tune data so that it meets acceptance criteria.

- **File Substitution** – Replacing invalid data with valid data from a different time so the analysis appears to be successful.

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4 PERSONNEL AND RESPONSIBILITIES

ACZ Laboratories, Inc. is an S corporation with two owners.

Refer to FRMAD072 for ACZ's current organizational chart.

It is the responsibility of management to document company policies, objectives, systems, programs, procedures, and instructions to the extent necessary to assure the quality and defensibility of all data.

ACZ's Co-Presidents are responsible for the overall management of the laboratory. On an operational level, one President is the appointed Lab Director with a focus on Production, Sales, & Marketing. The other President is the appointed Quality Assurance Officer with a focus on Quality, Compliance, Information Technology, and Project Management. On a tactical level, the focus on these divisions is less acute, and on a strategic level the Presidents focus on all divisions. Finance shares equal focus across all levels. The Chairman/Owner is the ultimate authority at ACZ but has no formal responsibilities beyond those required by law.

It is the responsibility of all managers to ensure that all documented ACZ policies and procedures, including those in the QAP and associated SOPs, are communicated to, understood by, made available to, and implemented by ACZ personnel.

ACZ only uses personnel who are employed by or under contract to the laboratory.

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4.1 Co-President

The President is ultimately responsible for all analytical and operational activities of the laboratory and must ensure that 1) the laboratory carries out all environmental activities in such a way as to meet the requirements of the TNI Standards and 2) the laboratory satisfies the needs of the client and the regulatory authorities. General duties involve budgeting for all departments, making decisions on capital equipment and automation; developing company policies and benefits; addressing personnel issues such as hiring, firing, and promotions; and working with clients on various matters. Day-to-day responsibilities include providing direction to all laboratory departments including laboratory operations, accounting, marketing, QA, and client services. Additional responsibilities are as follows:

- Work directly with ACZ's Ombudsman to provide and maintain a mechanism for confidential reporting of ethical/data integrity issues as well as issues that may directly affect current ACZ policies.
- Define the minimal level of qualification, experience, and skills necessary for all laboratory positions.
- Provide the QA department with defined responsibility and authority for ensuring the successful development, implementation, and management of ACZ's Quality System.
- Provide the Production with defined responsibility and authority for ensuring the technical operations and provision of resources needed to maintain the required quality of laboratory operations.
- Provide adequate supervision of environmental staff by persons familiar with methods and procedures, purpose of each test, and assessment of the test results.
- Ensure all technical staff has demonstrated capability in the activities for which they are responsible and ensure that the training of each member of the technical staff is kept up-to-date.
- Ensure the QA department has access to the highest level of management at which decisions are made on laboratory policy or resources.
- Provide managerial staff the authority and resources needed to discharge their duties.
- Provide technical personnel the resources needed to discharge their duties.
- Specify and document the responsibility, authority, and interrelationship of all personnel who manage, perform or verify work affecting the quality of calibrations and tests.
- Implement appropriate and current guidelines for all lab methods and procedures to ensure data quality and efficiency of analyses. Ensure all method protocols utilized by ACZ meet the QC requirements as established by EPA or other governing agency.
- Document all policies and procedures related to the analytical and operational activities of the laboratory.
- Provide support to technical staff to ensure timely completion of all laboratory work, and develop contingency plans to ensure workflow progresses as planned.
- Meet quarterly (or more often) with department leaders reporting directly to the Presidents.

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4.2 QA Officer (QAO)

The QA Officer reports directly to the President; however, the QA department is considered a separate entity from operations in order to ensure data is evaluated objectively. The QAO has direct access to the President, and is therefore able to discuss and/or resolve all concerns, policies, etc. related to quality assurance or quality control. The primary responsibility of the QAO is to develop, implement, and manage all aspects of ACZ's Quality System, and he/she may take any action necessary to ensure all ACZ employees adhere to all policies, procedures, and objectives documented in ACZ's QAP, SOPs, memorandums, emails, etc. If warranted, the QAO has the authority to halt the performance of a single method or the production of a department, and if necessary, the operations of the entire laboratory, and will grant permission to resume when satisfied that the issue(s) have been resolved. Additional responsibilities include but are not limited to those stated in FRMAD060 and the following:

- Review and revise ACZ's QAP and provide training for all employees following approval of a new version.
- Provide QA orientation to new employees.
- Meet quarterly (or more often) with President/Lab Director and Laboratory Department Supervisors.
- Work with department managers to develop and improve training protocols.
- Conduct department training sessions as needed to address specific problems and questions.
- Arrange for or conduct internal audits; notify management of deficiencies; and track corrective actions.
- Organize all external audits; notify management of deficiencies; and assign and track corrective actions.
- Review and approve SOPs.
- Meet at least quarterly with Laboratory department supervisors to provide information, respond to questions, etc.
- Manage Proficiency Testing (PT) program.
- Coordinate and maintain all regulatory and client certification programs.
- Review and validate a determined percentage of all data packages from Log-in to Reporting.
- Work with marketing/client service representatives on QA aspects of proposals.
- Work with Project Managers and the Production Manager to resolve client feedback regarding data quality.
- Review and maintain records and documentation for audits, certifications and all other QA issues.

  <u>Qualifications:</u>

  - General knowledge of the analytical test methods
  - Documented training and/or experience in QA procedures
  - Knowledge of the Quality System as defined under TNI

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4.3 QA Coordinator

The QA Coordinator reports directly to the QAO and assists with the development, implementation, and management of the Quality System. Primary job responsibilities are as follows:

- Review and maintain records/documentation for employee training including DOCs, MDLs, etc.
- Provide initial QA orientation to new employees.
- Coordinate annual data integrity training.
- Schedule analyses and compile and report data for Proficiency Testing (PT) program, including DMRQA.
- Initiate and track corrective actions related to PT samples and manage all documentation associated with analyses.
- Review and approve SOPs.
- Conduct internal audits, notify management of deficiencies; and track corrective actions.
- Conduct department training sessions as needed to address specific problems and questions.
- Update control chart-generated QC limits in the LIMS database as needed.
- Monitor control & calibration of support equipment
- Assist QAO with management of certifications.
- Manage ACZ's resume compilation.
- Update ACZ organizational chart as necessary.

<u>Qualifications:</u>

- General knowledge of the analytical test methods
- Documented training and/or experience in QA procedures
- Knowledge of the Quality System as defined under TNI

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4.5 Laboratory Department Supervisor

Each Laboratory Department Supervisor is a full-time employee who reports to the President/Lab Director and exercises day-to-day oversight of laboratory operations for their specific area(s) of expertise. Each supervisor must be familiar with the test methods and related theory and instrumentation, as well as the assessment of results. In addition to monitoring the standards of performance, validity of all analyses, conformance to documented requirements, and quality of all data generated in their respective department(s), each supervisor is also responsible for ensuring that a new analyst has successfully completed all training requirements and is adequately prepared to commence work on client samples. Additional responsibilities are described in FRMAD060. If any supervisor is absent for more than 15 consecutive calendar days then another full-time staff member meeting the required qualifications will be assigned to perform the supervisor's duties.

Required Qualifications for a Laboratory Department Supervisor:

1) Chemical analyses (Organics & Metals): BS or BA in chemical, environmental, biological sciences, physical sciences or engineering, with a minimum of 24 college semester credit hours in chemistry and at least two (2) years of experience in the environmental analysis of representative inorganic and organic analytes for which the laboratory seeks or maintains accreditation. A masters or doctoral degree in one of the above disciplines may be substituted for one (1) year of experience.

2) Inorganic Chemical analyses (other than Metals): At least an earned associate's degree in the chemical, physical, or environmental sciences, or two (2) years of equivalent and successful college education, with a minimum of 16 college semester credit hours in chemistry and at least two (2) years of experience performing such analyses.

3) Radiological analyses: BS or BA in chemistry, environmental, biological sciences, physical sciences, or engineering, with at least 24 college semester credit hours in chemistry and at least two (2) years of experience in the radiological analyses of environmental samples. A masters or doctoral degree may be substituted for one (1) year of experience.

   The minimum requirements may be relaxed if the Laboratory Department Supervisor is not the appointed technical director of the laboratory division.

4.6 Business Development Manager

ACZ's Business Development Manager reports directly to the President/Lab Director and supervises all Client Service Representatives, each of who conducts marketing and sales efforts on behalf of ACZ with potential, new and existing clientele, and develops and maintains long-term relationships with customers by working with Project Managers when necessary. Additional responsibilities of the Business Development Manager are described in FRMAD060. ACZ's Client Service staff is authorized to review all contractual agreements with clients, review all proposals and develop price quotations for routine and non-routine analytical projects.

4.7 Project Manager Supervisor

The Project Manager Supervisor reports directly to the President/QAO and is responsible for overseeing the PM department. Additional responsibilities of the Project Manager Supervisor are described in FRMAD060. Each Project Manager serves as the primary laboratory contact for each ACZ client, handles all client service requests, and investigates and resolves any problem brought to ACZ's attention by the customer. In order to provide consistency, each PM is assigned a list of clients, and it is the primary responsibility of each PM to ensure all of their client project needs are managed on a day-to-day basis and met in a timely manner and that all data submitted to the client is of high quality. All PMs work directly with the Laboratory Department Supervisors regarding client data issues (due dates, hold times, retests, data quality, etc.), with Document Control regarding client reports, and with the QA department regarding data quality questions or concerns. The Project Manager Supervisor directly oversees Reporting and the Front Office.

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4.8 Instrument Operator

Instrument operators report directly to the respective Laboratory Department Supervisor. The position involves the analysis of various matrices for trace level contaminants using specialized and technical instrumentation. Each operator must be capable of performing all job duties in an accurate and proficient manner. Education will be verified by providing a copy of a college transcript or diploma, which is maintained in the employee's personnel file. Experience is verified by ACZ's CFO prior to completing the hiring process (verbal or documented verification provided by each reference listed on a resume or application is acceptable). The operator must demonstrate understanding of related theory, mathematics, analytical instrumentation, and data interpretation. This work is predominantly intellectual and involves the continuous use of professional and sound judgment. The employee must meet or exceed all requirements for generation of litigation-quality data and must also continue to demonstrate increased proficiency regarding the interpretation of the data as well as the operation and troubleshooting of the assigned instrument(s). These improvements should be attainable through ongoing efforts in-house as well as through specialized instruction at off-site locations. Exceptions pertaining to experience or education will be made on a case-by-case basis.

Qualifications:

- BA or BS in Chemistry or related science or a minimum of 3 years of relevant experience in lieu of degree
- Prior laboratory experience is preferred but is not required.
- Successful completion of training by supervisor or proficient instrument operator

4.9 Laboratory Analyst [Technician]

The laboratory technician reports directly to the respective Laboratory Department Supervisor. The position involves analysis of various matrices using appropriate analytical techniques and support equipment as well as preparation of samples for instrument analyses. Each technician must be capable of performing all job duties in an accurate and proficient manner. Education will be verified by providing a copy of a college transcript or diploma, which is maintained in the employee's personnel file. Experience is verified by ACZ's CFO prior to completing the hiring process (verbal or documented verification provided by each reference listed on a resume or application is acceptable). The technician must demonstrate understanding of related principles and mathematics, must possess common sense and mechanical skills, and must seek professional judgment from the supervisor as necessary. The employee must meet or exceed all requirements for generation of litigation-quality data as well as sample preparation tasks and routine analyses, and must also continue to demonstrate continuous improvements. These improvements should be attainable through ongoing training efforts in-house as well as through training opportunities at off-site locations. Exceptions pertaining to experience or education will be made on a case-by-case basis.

Qualifications:

- BA or BS in Chemistry or related science is preferred but is not required
- Prior laboratory experience is preferred but is not required
- Successful completion of training period by supervisor or proficient technician

4.10 Information Technology (IT) Manager

The Information Technology Manager reports directly to the President/QAO and is responsible for the oversight of the IT department regarding the installation and maintenance of ACZ's computer network and all hardware and software and related equipment deployed on the premise. Additional responsibilities are described in FRMAD060. The department is also responsible for developing, maintaining, and improving custom written applications for laboratory automation and efficiency as well as for ACZ's LIMS, Intranet (Labweb), Internet and electronic data deliverables (EDDs).

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4.11 Chemical Hygiene Officer (CHO)

The Chemical Hygiene Officer is responsible for oversight of ACZ's documented Chemical Hygiene Plan, conducting initial and refresher safety training for all employees, monitoring exposures, and maintaining records for Safety Data Sheets, injury reports, chemical exposure reports, etc. Additional responsibilities include working with management to develop and implement policies to improve the program. The person designated as CHO must have completed at least one basic laboratory safety course and have one year of experience performing laboratory work, preferably with responsibility for at least one area of laboratory safety.

4.12 Hazardous Waste Officer (HWO)

The HWO is responsible for managing and, with the collaboration of management, enforcing all aspects of ACZ's Hazardous Waste Management Plan (SOPAD007). The HWO must insure the HWP is compliant with relevant requirements in the US Code of Federal Regulations as well as any additional state regulations. Additional duties include bulking and labeling hazardous materials, filling out required documentation, and arranging for disposal; these activities may be delegated to qualified individuals under the supervision of the HWO. The HWO must know and understand the specific waste streams that ACZ uses and be able to determine how to dispose of unknown chemicals. This is best done by attending a training course on "Laboratory Waste Management." The individual responsible for hazardous waste disposal and signing the waste manifest must maintain HAZWOPER and DOT hazmat certification.

4.13 Radiation Safety Officer (RSO)

ACZ's Radioactive Materials License (RML) requires the laboratory have an RSO. The President/QAO appoints a Radiation Safety Officer to act as his/her representative in implementing the Radiation Safety Program. The RSO's responsibilities include developing radiation safety guidelines in accordance with Nuclear Regulatory Commission (NRC) and Colorado state rules and regulations, and for assuring compliance with those guidelines by ACZ personnel. The RSO will work with ACZ's administration to implement policies and seek ways to improve the safety program. The person designated as RSO must have completed a Radiation Safety Course or have at least 3 years of experience prior to being officially designated as the RSO. The RSO reports directly to the President/QAO of ACZ.

4.14 Chief Financial Officer (CFO)

ACZ's Chief Financial Officer is primarily responsible for all financial matters including payroll, accounts receivable, accounts payable and financial statements; monthly and annual balance and profit and loss statements; and assisting with annual budget preparation. In addition, the CFO maintains and monitors the security system and electronic time clock; invoices client projects from the database; updates customer account information; acts as the administrator for 401k/Profit Sharing Plan; maintains and executes the Employee Benefits Manual; and assists in hiring process by posting job openings, scheduling qualified candidates for interviews, checking references, and ensuring a new employee provides proof of education.

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5 TECHNICAL TRAINING

Prior to the independent generation or review of data for client samples (including PT samples), all analysts must undergo a formal, documented training process. Technical personnel must be thoroughly trained in the analytical techniques and operating principles and procedures for the methods utilized by ACZ. This process includes but is not limited to: reading the associated published method, reading all related SOPs, improving laboratory skills, learning troubleshooting, maintenance, calibration and operating procedures for pertinent equipment and instruments, and creating workgroups and reviewing data through the LIMS database.

It is the responsibility of the department supervisor to determine that a new analyst is properly trained, has successfully completed all initial training requirements and is prepared to commence work on client samples. Under no circumstances may an analyst independently generate client data before receiving the explicit approval of the technical director overseeing the analysis.

5.1 The effective version of the test SOP provides the training framework for all sample preparation and analysis. The SOP is typically based on published approved methodologies (EPA or other) and incorporates any necessary activities and protocols not included in the published method(s) as well as requirements stipulated by other regulatory agencies.

5.2 Training for data AREV or SREV only must be documented as specified in §2.3.6. For analysts, approval to perform a procedure includes approval to perform AREV for the procedure. For supervisors and technical directors, approval to perform a procedure includes both AREV and SREV approval. SREV-specific authorization is required for analysts.

5.3 Each employee must be trained either by the department supervisor or by an analyst within the department who is proficient in the area of testing and has been designated by the supervisor. Whenever possible, anyone performing training must meet the following requirements:

1) Documentation of training on the effective version of the test SOP.
2) Documented approval for the analysis.
3) A current IDOC or CDOC.

Exceptions may be granted on a case-by-case basis as approved by the QAO.

5.4 Initial training is documented using the Initial Method Training form (FRMQA004). The General Lab Practice Training Form (FRMQA047) is also required for an analyst's first procedure. Once training has been completed, the trainee and the instructor fill out the form together to ensure all pertinent information has been addressed and to ensure the trainee comprehends the material and is provided an opportunity to ask questions or request additional training. The trainee's signature is an attestation that he/she has read, understands, and agrees to follow the effective version of the SOP.

5.5 To demonstrate an aptitude for the procedure, the analyst must perform a successful Initial Demonstration of Capability (IDOC) prior to independent preparation and/or analysis of client samples. Performance is documented using FRMAD023. The data is reviewed initially by the trainee (AREV). SREV is performed by the pertinent technical director or designee. A new IDOC is required if an analyst does not perform the method within 12 months.

5.6 Prior to performing an IDOC, a new analyst should be provided sufficient opportunity to practice the procedure. This confirms the analyst understands the procedure and feels comfortable performing the procedure independently. Data associated with any practice is not submitted to QA.

5.7 It is not necessary for the first IDOC attempt to pass; however, the supervisor needs to review the analyst's techniques if multiple attempts do not pass.

5.8 A thorough review of the raw data is performed as part of initial method training and should include particular attention to details not presented in LIMS or on the final report, such as generating final sample concentration from the instrument response provided in the raw data (if applicable), verifying correct standard and reagent traceability.

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5.9 Where specified by the method or a regulating entity, and as stated in the test SOP, successful demonstration of performance such as Linear Calibration Range determination (LCR) or Method Detection Limit (MDL) study must be completed prior to independent analysis of client samples.

5.10 All initial training documentation must be submitted to the QA department as a complete package. At a minimum, the package must include:

1) Initial Method Training form (FRMQA004), signed by the trainee and instructor (or department supervisor).

2) IDOC documentation:
   - ✓ Completed and signed certification statement (FRMAD023)
   - ✓ Workgroup bench sheet, raw data, and all supporting documentation

3) If applicable, an MDL study. Complete FRMAD031 and attach all related raw data and supporting documentation.

4) If applicable, calibration range study. Complete FRMQA029 and attach all related raw data and supporting documentation.

5) For all determinative methods utilizing a calibration curve or average response factor, the Method Calibration Form (FRMQA050).

   NOTE: For those test methods for which no spiking solution is available only an Initial Method Training form (FRMQA004) is required.

5.11 Following review of all pertinent training documentation, the pertinent technical director will issue procedure-specific clearance for the trainee to independently generate and review data for client samples. This permission is tracked and may be viewed on a designated location on the public network drive.

1) Approval for preparation procedures is granted after the instrument data has been reviewed and approved.

2) An unapproved analyst who is “shadowing” the trainer (observing, learning the organization of the lab, reagent room, etc.) may not assist with the procedure, and the workgroup documentation must bear only the initials of the trainer, who is fully responsible for the data.

3) If the analyst has successfully completed training for a procedure and generates client data or reviews client data prior to the technical director’s approval, then any workgroups or data review checklist must also bear the initials of a proficient analyst, with current approval for the method, who oversees the analyst’s work for the procedure and assumes full responsibility for the data. The primary analyst must always be aware that he/she is responsible for the workgroup. The use of another employee’s initials without their explicit approval is expressly prohibited.

5.12 The supervisor is responsible for ensuring the training of each analyst is kept up-to-date. Each analyst must read, understand, and agree to follow the effective version of the SOP and continued proficiency must be demonstrated and documented annually for each analyst. A one month grace period is allowed for submitting CDOC documentation. Thereafter, the analyst is prohibited from performing the procedure until a successful CDOC or IDOC is submitted to QA.

5.13 Each Laboratory Department Supervisor routinely conducts department meetings to discuss procedures, work schedules, resources, questions and concerns, problems, QA, etc.

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6 SAMPLE COLLECTION AND HOLDING TIMES

Sample collection procedures are well documented by the EPA and other agencies. ACZ's clients are instructed to provide representative samples whenever possible. ACZ supplies its clients with the containers and other materials necessary to maintain sample integrity (to the extent possible) from the time of collection through analysis. Although ACZ does not perform sample collection activities, each project manager or client service representative will assist a client with specific sampling requirements as needed. When necessary, they will direct a client to other resources. The following sections include general information on sample containers, preservatives. and holding times. These are essential components in preserving the chemical and physical properties possessed by the sample at the time of collection.

6.1 Sampling Containers and Preservatives

The EPA outlines the requirements for sample container types, sample volume, and preservation. ACZ's inventory includes various sizes of plastic and glass containers that range from pre-sterilized to certified-clean by the supplier. Amber bottles are used when specified by the method. Glass containers are obtained from vendors that specialize in the sales of environmental sample containers, and all non-certified bottles are purchased from reputable lab/industry vendors. Refer to FRMAD045 and FRMAD046 for bottles types and preservation techniques for specific analyses. Refer to the pertinent test method SOP for specific information regarding EPA requirements for container types, chemical, and thermal preservation.

All sample containers shipped to our clients are new, contain the appropriate preservative(s), and are color-coded to identify preservation and storage. Out-going containers are packed in clean coolers with a copy of ACZ's Sample Acceptance Policy, general directions for sample collection, bottle labels, ice packs, sampling information, blank chain of custody, return shipping labels, and custody seals. Trip blanks and rinsette water are included when requested by the client or when mandated by a specific analytical method. After samples have been collected they are cooled to a temperature ≥ 0 °C and ≤ 6.0 °C. Samples that require thermal preservation must be maintained within this temperature range until all analyses have been completed.

6.2 Holding Times

The EPA has conducted lengthy studies of sample degradation versus time to establish a maximum holding time for each parameter, and the results of these studies are compiled into holding-time tables to provide guidelines for litigation purposes. Data for a sample prepared / analyzed outside of the established holding time may be rejected by regulators as unusable. Holding times will vary slightly from regulation to regulation, thus further emphasizing the need for a client to consult with their Project Manager prior to sample collection. The holding time typically begins at the time or date of collection in the field. Holding times observed by ACZ are specified in the laboratory's test method SOPs.

If ACZ Laboratories, Inc. receives samples past holding times or near the expiration of the holding time, sample analysis will proceed unless the client has indicated on the CCOC that an attempt to contact the client must first be made. Analyses performed outside of holding time will be appropriately qualified on the final report. Holding times ≤ 72 hours are calculated based on the hour of the sample date/time. Holding times > 72 hours are calculated based on the day of the sample date/time.

In general, and unless otherwise noted in the test SOP, sample preparation and analysis must be completed within the stated holding time. For analyses that extend beyond the intended scope of the method for an analyte or matrix, the hold time stated in the SOP must be met or the samples must be appropriately qualified.

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7 SAMPLE CUSTODY & SAMPLE HANDLING

Sample custody begins with receipt of sample containers from the client and continues beyond preparation and analysis to the proper disposal of primary and secondary sub-samples. Complete and accurate documentation must be provided at all stages of custody. There are many key elements to sample custody including laboratory security, chain of custody records, sample storage, internal custody logs, sample tracking within the laboratory, control of subcontracted work, and sample disposal. Unless otherwise specified, ACZ is contractually committed to retain samples for a minimum of 30 days after the invoice of a project[2].

7.1 Sample Receipt and Log-in

Refer to SOPAD045, *Sample Receipt & Log-In Procedure / Maintenance of Sample Integrity,* for the details of ACZ's sample receipt and log-in procedures. Upon delivery of samples to ACZ, Log-In personnel evaluate the condition of the cooler and custody seals. The custody seals are then broken to retrieve the Chain of Custody (COC), which must be signed by the sample custodian to document transfer of sample possession to ACZ.

Sample conditions are evaluated and any problems, such as expired hold times, lack of preservative or improper cooler temperature, are noted. Clients are notified of problems as soon as possible so that a contingency plan can be initiated if necessary. Samples are logged-in and are delivered to the assigned storage areas. Samples (including subsamples, extracts, etc.) must be stored away from standards, reagents, food, and other potential contaminants. Following log-in, every project is reviewed by the assigned PM. Upon completion of the review, the client receives an electronic summary that details the project information. This summary allows the client an opportunity to make changes to the project before samples are analyzed. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

7.2 Internal Custody Logs

Some clients may specify additional custody tracking of the samples once they have been logged in. Internal custody may require that samples are stored in a manner that ensures limited access. The internal custody log (FRMQA015) shall accompany the samples from log-in through completed analysis. The person responsible for the work signs and dates each entry and/or page in the logbook. When all data from a sample set is compiled, copies of all logbook entries shall be included in the final report package. For projects requiring internal custody, ACZ will adhere to the procedure described in the SOP *Client Service Policies and Procedures* (SOPAD043).

7.3 Sample Tracking

Sample flow through the laboratory is facilitated by the use of an Oracle-based LIMS database (Laboratory Information Management System). Every product (requested analysis) logged into the LIMS for a sample has a specific, pre-determined department path. All products have default paths of at least Login Review and Reporting. Between these two departments, a product may go through, for example, Soil Prep and Metal Analysis or Soil Prep, Organic Prep and GC Analysis. At each department step in a product's path, the status can be updated and viewed at any time. Analytical product statuses are defined below. Additional information regarding sample tracking is available in the SOP *Client Service Policies and Procedures* (SOPAD043).

NEED	Prep or Analysis has not been started
WIP	Prep or Analysis has been started (Work In Progress)
PREP	Sample preparation is complete and sample is ready for analysis
UPLD	Analytical data has been uploaded into LIMS
AREV	Analyst has reviewed and accepted analytical data
SREV	Supervisor has reviewed and accepted analytical data
DONE	Analysis or task has been completed
REDO	Sample requires reanalysis
REDX	Sample requires re-digestion/extraction

[2] Currently, samples scheduled for any radiochemistry parameters are held for a minimum of 90 days to facilitate radioactive material inventory monitoring. This policy is subject to change at any time in harmony with ACZ's Radiation Safety Plan.

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CANT	Sample preparation or analysis cannot be performed
NREV	Project requires PM review before work can begin
HOLD	Prep or analysis postponed
SENT	A final report has been issued to the client

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8 PROCUREMENT, INVENTORY AND TRACEABILITY OF SUPPLIES

8.1 Procurement / Inventory

All consumable supplies are purchased from reputable vendors that have been evaluated for service, quality, and price. To the extent possible, materials traceable to national or international standards of measurement are purchased for use in technical operations. Supplies are purchased using ACZ's purchase order (PO), remote inventory management system (RIMS), and the Aestiva ordering system. The Purchasing Agent is not permitted to make a substitution for any material specifically requested unless the Laboratory Department Supervisor approves the substitution. Upon receipt, reagents, chemicals, standards, and other laboratory consumables are stored in the Chemical & Supply Room, which has limited access, or are delivered to the laboratory. Refer to ACZ's SOP *Purchase, Receipt, and Storage of Consumable Materials for Technical Operations* (SOPAD037) for additional information.

8.2 Glassware

ACZ uses only laboratory grade glassware. Prior to use, glassware is cleaned to meet the sensitivity of the method. Refer to individual test SOPs for detailed cleaning procedures.

8.3 Other Supplies

Routine consumables (centrifuge tubes, autosampler tubes, pipette tips, etc.) are purchased through an automatic system managed by Fisher (RIMS). All other supplies are purchased on an as-needed basis through ACZ's Purchase Order and the Aestiva ordering system. Refer to SOPAD037 for additional information.

8.4 Traceability of Standards and Reagents

To provide complete traceability, each data package must reference every standard and reagent used for sample preparation or analysis, including but not limited to acids, bases, preservatives, color reagents, pH indicators, buffers, and instrument reagents. Each PCN and/or SCN must be documented either on the workgroup bench sheet, data review checklist, or a current standard/reagent form. The open date for all original containers is not tracked in LIMS; however, good laboratory practice dictates the open date be noted on the sample container.

8.4.1 Primary Control Number (PCN)

Upon receipt, all stock chemicals, standards, and reagents are assigned a unique PCN in LIMS for tracking and traceability purposes. A label with the PCN and the expiration date is affixed to the container and the Certificate of Analysis is scanned or downloaded and saved in the public drive (if applicable). The data for each PCN is entered using the certified value(s) supplied by the vendor, as indicated on the Certificate of Analysis. Because the certified value is entered, the final concentrations for prepared standards may vary slightly from the theoretical value indicated in the test SOP. Certified values shall be used for standards when available. If certified values are not available, informational values may be used. If the certified reference values for any PCN are changed after the PCN has been used in the laboratory, then complete documentation must be provided as a major corrective action (FRMQA001).

8.4.2 Secondary Control Number (SCN)

To ensure complete traceability, a unique SCN must be created when any intermediate or working standard is prepared from one or more stock solutions, stock chemicals, or intermediate solutions. A standardized format is used for creating the SCN: a two-letter code indicates the lab section and is followed by the prep date and then by a daily sequential number. For example, the SCN **II051128-2** denotes the second standard prepared on November 28, 2005 in the Inorganic Instrument lab. An acceptable alternative is to let LIMS assign a unique number when prompted.

An SCN for any working standard subjected to a LIMS calculation must be created electronically in LIMS. The initial volume and concentration of each constituent and the final volume of the prepared

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solution are entered in the SCN Wizard program to calculate the final concentration of each analyte using the formula $C_1V_1 = C_2V_2$. The preparation date, expiration date, and preparer's initials are included as part of this electronic record. A hard copy of the SCN report may be affixed to the standard/reagent logbook, depending on individual department practice; however, it is not required.

Prepared reagents do not require an SCN be created electronically in LIMS; however, preparation must be recorded in the department's designated logbook. At a minimum, the logbook entry must clearly identify what reagent was prepared, its subcomponents, the preparer's initials, the preparation date, and the expiration date. This information is sufficient for color reagents, buffer solutions, instrument reagents, etc. because details of the preparation are stated in the test SOP.

8.5 Preparation and Expiration of Standards and Reagents

8.5.1 Preparation of Standards and Reagents

Refer to individual test SOPs for detailed information regarding standard and reagent preparation. In general, either Class A pipettes or mechanical pipettes are used to measure and dispense aliquots of any solution used to prepare a standard or reagent. Accurate delivery of mechanical pipettes must first be verified as described in ACZ's SOP *Control, Calibration, and Maintenance of Measuring and Test Equipment* (SOPAD013).

All containers of prepared reagents and standards stored for more than one day must be properly labeled with the SCN (or other unique identifier), name/description, preparation date, and expiration date. Preparation of reagents and standards must be documented as described in §8.4.2.

8.5.2 Expiration of Purchased Standards and Chemicals (PCNs)

When provided, the manufacturer's expiration date will be assigned. If the manufacturer does not provide an expiration date, an expiration date of 5 years from receipt is assigned unless the laboratory has knowledge indicating a longer or shorter shelf life is appropriate.

An expired stock material may continue to be used if its reliability can be verified. For the purpose of ensuring transparency, the rationale for extending the expiration date must be documented on FRMQA051 and submitted to the QA department or pertinent technical director for approval. If the extension is granted, FRMQA051 is saved on a network drive. Unusable materials should be replaced and the standard or reagent remade as soon as possible. Remove the container from the lab or the supply room and dispose of properly. Contact ACZ's HWO for assistance.

8.5.3 Expiration of Prepared Standards

Storage conditions and shelf life for prepared standards are provided in the individual test SOPs. The following guidelines may be used to determine the shelf life for a prepared standard if the method does not prescribe a shelf life:

1) A standard that has been prepared in-house may continue to be used after its assigned expiration date for as long as its reliability can been verified. Whenever possible, reliability should be verified by comparison to another, unexpired standard containing the same constituents. For applicable procedures, instrument response may be considered when determining whether or not a solution is still reliable.

   - In cases where reliability has been verified, the expiration date of the SCN must be updated in LIMS and/or the standard/reagent logbook. The rationale for extending the expiration must be documented on FRMQA051 and submitted to the QA department for approval.

   - In the event the solution was used prior to updating the SCN then documentation must be provided as part of the workgroup to indicate the solution was used past the shelf life stated in the SOP (a minor corrective action or FRMQA051 may be used if more than one workgroup is affected). The expired standard must be remade as soon as its reliability becomes questionable – it is the responsibility of the analyst to use their best judgment.

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2) The shelf life of any prepared standard with any analyte concentration < 10 mg/L is 90 days from the preparation date. This is a general guideline – if any constituent does not remain in solution for 90 days, then the standard must be prepared more often. If the manufacturer's expiration date for any stock standard is sooner, then the expiration date of the SCN is the manufacturer's expiration date for a single analyte solution or the earliest manufacturer's expiration date for a multiple analyte solution.

3) The shelf life of a prepared standard with analyte concentration ≥ 10 mg/L is one year from the preparation date. This is a general guideline – if any constituent does not remain in solution for one year, then the standard must be prepared more often. If the manufacturer's expiration date for any stock standard is sooner, then the expiration date of the SCN is the manufacturer's expiration date for a single analyte solution or the earliest manufacturer's expiration date for a multiple analyte solution.

4) In general, prepared Radiochemistry standards expire one year from the preparation date. The solution may be re-evaluated using control charts, efficiency checks, or other criteria and the expiration date extended by year intervals if the solution is still deemed usable. Refer to the specific test SOP for details.

8.5.4 Expiration of Reagents

In general, a reagent is a solution, which does not contain the target analyte(s). Storage conditions and shelf life are stated in the individual test SOPs. The expiration date can be extended for a prepared reagent provided its reliability can be verified. LCS/LFB performance (QC criteria met) may be used to verify reagent stability if the control standard is a valid indication of the reagent's continued functionality/stability. Reagents used to treat samples for interference may not be verified this way. Reagents used to dissociate complexed target analytes may not be verified this way unless the LCS is an appropriate complex. FRMQA051 must be submitted to QA or the pertinent technical director for approval whenever an expiration extension is requested.

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9 MAINTENANCE AND CALIBRATION OF INSTRUMENTATION & EQUIPMENT

9.1 Maintenance of Instruments and Support Equipment

The best protocol for producing quality work is to prevent errors and non-conformances rather than react to and correct problems after they occur. An essential part of this protocol is ensuring that all laboratory instrumentation and equipment used for the generation of data have been optimized and are functioning properly before commencing work on client samples. Performing routine maintenance and optimizing instrument-operating conditions prior to sample analysis minimizes instrument downtime, thereby improving productivity and ensuring quality of the data. It is the responsibility of the designated analyst(s) to perform and properly document daily and routine maintenance, instrument optimization, troubleshooting, instrument service or repair, and repair or replacement of parts.

All manufacturer-prescribed inspection and maintenance shall be performed according to the schedule indicated in the operator's manual (or similar) provided by the manufacturer and must be documented in the instrument logbook, a separate maintenance logbook, or on the instrument maintenance checklist (available in LabWeb). ACZ management recognizes that performing all maintenance procedures at the frequency indicated by the manufacturer may not be necessary to sustain instrument optimization. Therefore, at a minimum, instrument part(s) and optimization shall be inspected according to the schedule. The analyst must use their professional judgment to determine if maintenance or replacement is necessary at that time. Decisions to deviate from the manufacturer's schedule shall be documented.

All support equipment (any device that may not be the actual test instrument, but is necessary to support laboratory operations) must be monitored regularly to confirm proper functioning. The temperature of all drying ovens, refrigerators, freezers, and incubators must be checked each day the equipment is in use and each check recorded on the associated Temperature Logsheet. Refer to SOPAD013 for more detail.

Equipment that does not meet performance specifications must be taken out of service and FRMAD029 attached to indicate the instrument or equipment is waiting for repair and cannot be used. During this downtime the department supervisor, Production Manager, and Project Manager may collectively determine it is necessary to sub-contract samples until correct performance of the repaired instrument or equipment has been demonstrated by a successful calibration or other suitable test. Document all contact with the manufacturer, as well as all repairs and other services, in the instrument or maintenance logbook to be used as a reference for solving future instrument problems. Transport and storage of measuring equipment shall be done in accordance with manufacturer recommendations. Additionally, when instrumentation or equipment goes outside of the direct control of the laboratory, the functioning and calibration status must be checked and shown to be satisfactory before it is returned to service. Refer to SOPAD013 for additional information.

To minimize downtime and prevent analytical delays, each laboratory should maintain an adequate inventory of reagents, stock standards, glassware, etc. and should keep a sufficient supply of extra "critical" parts in-house. Instrument redundancy should be established for all analyses and Instrument Qualification (IQ) should be maintained on backup instruments.

9.2 Instrument Calibration

The accuracy of all instrument-generated data relies on proper calibration. In general, calibration or standardization involves defining the relationship between instrument response and the amount or concentration of analyte introduced into the instrument. The graphical depiction of this relationship is referred to as the calibration curve.

Calibration frequency must be performed in accordance with the manufacturer's guidelines, test method or other regulatory requirements, or client contract stipulations, whichever is most stringent. Every calibration or standardization must meet the acceptance criteria stated in the SOP and shall be subsequently verified by analyzing an initial calibration verification standard (ICV) or other control standard (if specified in the SOP) that contains all target analytes and has been prepared or obtained from a different source than the one used to prepare

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the calibration standards.[3] Calibration standards and the second-source verification standard should be prepared on different days. If they are prepared concurrently, then another qualified analyst should prepare the second-source verification standard. This minimizes the risk of both solutions being prepared consistently incorrectly.

A continuing calibration verification standard (CCV) containing all analytes of interest must be analyzed at the frequency stated in the test SOP to ensure the stability of the initial calibration curve has not varied over time due to any change in the analytical instrument and its detection system, such as instability of standards, instrument cleanliness, column performance, matrix effects, flow changes, and changes within the laboratory environment.

For applicable methods, all initial and continuing calibration steps must be clearly detailed in the test SOP. Additionally, each test SOP must specify the frequency and acceptance limits for the calibration and subsequent verification (ICV and CCV). In general, acceptance criteria are method-specific; however, the SOP may also include requirements of other regulatory agencies. Prior to resuming sample analysis, immediate corrective action must be taken if the calibration, ICV, or CCV is outside of the acceptance criteria. Technical corrective actions are described in the individual test SOPs. Refer also to §11.2 for additional information.

General calibration guidelines are listed below. Additional information is provided in the individual test SOP's and ACZ's SOP *Control of Measuring & Test Equipment* (SOPAD013).

- Understand the method requirements for calibration (minimum number of standards, etc.)
- Use the correct calibration model (linear, second-order, etc.)
- Include all target analytes in the calibration standards and second-source standard
- Analyze a calibration standard with a concentration less than or equal to the quantitation limit.
- Do not remove points from the middle of the calibration (only high or low standards may be dropped).
- Calibration is a single-event process. A retest of a calibration standard must be performed immediately.
- Documentation and resolution of calibration abnormalities is critical

[3] If a second source standard is not available calibration shall be verified using a standard from a different lot. If a different lot is not available, an analyst who did not prepare the calibration standards may prepare the calibration verification standard. For some standards, it is important to consider whether manufacturers have obtained their material from the same lot.

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10 CONTROL AND STORAGE OF RECORDS AND DOCUMENTS

A formal and systematic control of records and documents is necessary to accurately reconstruct the entire history of any sample and guarantee the quality and defensibility of the data. All information pertaining to instrumentation and equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, data verification, audits, corrective actions, method validation, and data reporting must be documented, must identify all personnel involved, and must be readily understood. All records, including those pertaining to calibration and test equipment, certificates and reports, must be maintained, and the management system must facilitate the retrieval of all working files and archived records for inspection and validation purposes. Documents and records must be safely stored (protected against fire, theft, loss, environmental deterioration, and vermin) and must be held secure and in confidence to the client for a minimum of 10 years. The hard copy of all records and documents must be maintained in a designated storage area with limited access. To the extent possible, hard copies for the most recent two (2) years are stored on-site, and if necessary, may be moved to off-site storage after two years. Off-site storage conditions must meet the same criteria that apply to on-site storage.

10.1 Workgroups

10.1.1 Changes made to any workgroup record (hardcopy or electronic) must be documented.

1) If a workgroup is “dissolved” or its data deleted from LIMS, the analyst is prompted in LIMS to provide an explanation of why he/she is performing the task.

2) Changes to upload files must be documented on the hard copy of the workgroup.

10.1.2 Workgroup data that is re-uploaded *for any reason* must first be deleted. If any of the data changes, the Run Approval report shall be corrected. The workgroup shall be rescanned if necessary.

10.1.3 Document Control or other administrative personnel use a multi-page scanner with its own PDF scanning software to scan all hardcopy portions of workgroups.

1) Before the workgroup is scanned, the top page is reviewed to make sure it has both the AREV and SREV initials and dates.

2) The person scanning the workgroup must initial in the lower right hand corner of the front page of the workgroup. This provides an indication the document has been scanned.

3) The workgroup is scanned to the designated network directory and is then moved through an automated process to the appropriate read-only LabWeb directory. This directory is accessible to all employees. When a workgroup is rescanned, the previous file is maintained. A copy will be automatically created so as not to overwrite any files and will have a letter appended; starting with “A” the first time the workgroup is rescanned. <u>The most current file will not have a letter appended</u>.

10.1.4 The hard copy is filed by workgroup number in a file cabinet in the supply room by the front office. When capacity is reached, the workgroups are boxed and prepared for long-term storage. The front of the full storage box is labeled with the year and the workgroups contained in the box. The first box of each new calendar year is “1.” Full boxes are consecutively numbered, transferred to a designated location and stored in numerical order. The storage room is locked at all times and access is limited to authorized staff.

10.1.5

10.2 Electronic File Retention & Storage

All electronic records, stored either on instrument computers or on the network, are systematically

backed up to both fixed and removable media. These records include Oracle data, instrument raw data, workgroups, client reports, instrument upload files, SOPs and other controlled documents, and department data.

10.2.1 Critical system data is protected by Microsoft's Data Protection Manager. The Data Protection Manager is configured to maintain data for a period of 10 years.

10.2.2 All archived data is moved to a secondary machine on a weekly basis. From there, it is backed up to removable media to provide additional data redundancy.

10.2.3 The removable media from the first week of the month is pulled from service and moved to ACZ's safe deposit box at a local bank. The most recent 6 months of tapes are kept in the bank safe deposit box. Months 7 through 12 are placed in a secure, data rated, 4-hour fireproof safe. Note that this removable media only contains data from December 1st of the previous year to the present date.

10.2.4 At the conclusion of the calendar year, a master copy is made that comprises all of the data from December 1st of the previous year through January 31st of the following (current) year. This 14-month span of data is then moved to ACZ's safe deposit box at a local bank. At that time, the removable media that has aged 10 years is removed from the safe deposit box and its contents are destroyed. All data on the secondary machine from prior to December 1st of the previous year is removed from the system so that it is no longer included on the weekly backup.

10.2.5 Data that has aged 5 years is deleted from the Oracle Database on a monthly basis.

10.3 Instrument Data Files

Instrument raw data files are backed up by ACZ's Instrument Data Backup Application (IDBA). IDBA is a program that accesses local directories from instrument computers. Each morning the program retrieves and backs up individual data files from the specified directory on each instrument computer. Refer to ACZ's SOP *Backup and Archive of Instrument Data Files* (SOPAD044) for details.

10.4 Client Reports

10.4.1 Client reports are generated and signed electronically and are automatically stored as a PDF at a designated location on the network that has limited access. If a copy of any report exists on the network, and a new report is generated, then the existing copy will be renamed so that it is not overwritten. This way ACZ maintains a copy of all reports generated for a client.

10.4.2 Hardcopy documentation associated with a client project (CCOC, invoice, Login Review Form, etc) is filed by project number and stored in the document storage location.

10.4.3 Electronic Data Deliverables (EDD) are stored on the network at a designated location.

10.4.4 Once a project has been invoiced, the working directory is moved to the designated storage network location as a read-only PDF. If a project is un-invoiced, the project folder is copied back to the working directory where changes may take place. If an invoice is altered, a revised invoice is included with the project hardcopy.

10.4.5 In general, changes are not allowed to projects (including compilation) if the project has been invoiced. If a change needs to be made, the project must first be un-invoiced. At the time of un-invoicing, the user must provide a reason in LIMS to explain why the project was un-invoiced. This information is then stored in the Oracle database.

10.4.6 If a test report requires amendment after it has been issued to the client, the entire report shall be re-issued with the amendment. The amended report shall include a case narrative describing change(s) from the original report. Amended reports shall be uniquely identified and contain a

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reference to the original report. Typically, the laboratory number assigned to the project serves as the link to the original report. Amendments shall meet all the requirements of ACZ's quality system.

10.5 Documents

10.5.1 Standard Operating Procedures

10.5.1.1 Refer to §2.2 or SOPAD049 for additional information pertaining to SOPs.

10.5.1.2 The original master copy of each SOP is stored as a PDF in a secured public directory. The cover page indicates approval authorities. Approval is documented through emails. Whenever an SOP or SOP revision is approved, QA emails all staff whose job activities intersect the SOP or SOP revision with training instructions and a request for read receipt. The pertinent technical director or supervisor shall be included in the email distribution list. This email constitutes QA's signature of approval. Read receipts constitute training signatures and the technical director's or supervisor's signature of approval. Emails requesting read receipts for training documentation purposes shall contain a statement that by sending read receipt the sender attests they have read, understand, and agree to follow the identified policy. MS Outlook's read receipt is mimicked for this process. To send read receipt, trainees and approval authorities reply to the sender and replace "Re" with "Read" at the beginning of the subject field. Emails documenting training and/or approval shall be saved in a public outlook email folder or converted to PDF's and stored in the same directory as the SOP master copy or a subdirectory therein.

SOP master copies pre-dating the above paperless policy are located in the document control office.

10.5.1.3 A printed controlled copy of any SOP may be obtained from ACZ's LabWeb.

1) To ensure outdated information is not inadvertently used as a reference, Invalid or obsolete SOPs must be promptly removed from all points of use or clearly marked to indicate the purpose of retention

10.5.1.4 SOP Revisions: Any revision to a procedure must be approved by QA before changes may be implemented.

10.5.2 When documents are found to contain conflicting policies or procedures, the most recent document will be followed unless the conflict is prescribed as an exception to general protocol by a document more specific to the application.

10.5.3 Forms containing procedures or equations shall be controlled. Equations shall be validated and protected from inadvertent alteration.

10.5.4 All controlled forms must be printed from LabWeb and may not be stored on a separate network drive. If photocopies are used then any unused copies of the expired version must be disposed of as soon as a new version is uploaded to LabWeb. This ensures that the effective version of any controlled form is in use at all times. Exceptions may be granted by the QAO on a case by case basis.

10.5.5 The original certificate of analysis for any stock material, if provided, is stored in electronic format on ACZ's network.

10.5.6 Accreditation certificates are stored as PDF files to a designated network location. Original copies are maintained by QA. Certificates are also posted to ACZ's website.

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10.5.7 Original calibration certificates and related documentation for support equipment (including but not limited to pipettes, thermometers, and glass micro liter syringes) are maintained by the QA Department.

10.5.8 LIMS and other problems pertaining to IT are documented and managed by the electronic system called Help Desk. If an employee encounters a problem that requires attention, that employee will submit a request through Help Desk. The request requires a priority be assigned. This system allows ACZ to track all changes made to computer systems.

10.6 Records

10.6.1 Records include, but are not limited to: all logbooks; phone logs; raw data, derived data, and calibration data; training documentation (training forms, MDL studies, DOCs, etc.); proficiency testing results; calibration and certification records; internal audit reports; external audit reports; corrective action reports; management reports; and regulatory correspondence.

10.6.2 Records related to sample log-in are maintained as described in SOPAD045.

10.6.3 Records related to support equipment calibration and calibration verification are maintained as described in SOPAD013.

10.6.4 Certificates of cleanliness and volumetric accuracy received with consumable supplies (e.g. sample containers, centrifuge tubes) shall be submitted to and maintained by QA. Any other type of certificate that does not have a defined storage location shall be submitted to QA.

10.6.5 Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, dictated observations, and recorded data from automated instruments.

10.6.6 Original copies of records, except those pertaining to analytical data, are maintained by the QA department or Document Control, and access is limited.

10.6.7 Relevant qualifications, training skills, and experience of technical personnel are maintained in the employee's training file.

10.6.8 Records such as transcripts, applications for employment, performance evaluations, etc. are maintained in the personnel files, which are stored in the secured office of the CFO.

10.6.9 The DOC certification statement (FRMAD023), initial method training form (FRMQA004), General Lab Practice Training Form (FRMQA047), and Method Calibration Training Form (FRMQA050) are filed with the workgroup if the DOC was logged-in; otherwise, the DOC package is filed in the method files. An analyst training spreadsheet referencing training dates and documentation locations is maintained on a public drive.

10.6.10 Each employee's legal name, legal signature, and initials are documented on the New Employee Checklist (FRMAD043). The form is maintained in the employee's personnel file, which is stored in the CFO's office. Additionally, employee names, signatures, and initials are documented in a logbook maintained by ACZ's CFO. In the event an employee legally changes their name, the CFO is responsible for garnering new signatures and initials in the logbook; FRMAD043 is not updated in this event.

10.6.11 Each Organic Instrument ICAL data package is scanned to the designated network directory as a PDF and the hard copy stored in labeled boxes. Alternatively, a PDF may be generated directly from the instrument files. ICAL information that needs to be attached to any subsequent workgroup(s) must be printed from the PDF.

10.6.12 Logbooks shall be maintained and controlled as described in SOPAD013.

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10.6.13 Project Managers are responsible for maintaining all emails pertaining to a client and/or project. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043).

10.6.14 Changes to electronic records must be traceable to the individual who made the correction, and the reason for the change must be provided. Erroneous entries cannot be destroyed by methods such as overwritten files.

10.6.15 Record Storage and Retention

10.6.15.1 The minimum record retention period of 10 years may be increased dependent upon client request, regulatory requirement, or civil action order.

10.6.15.2 Records stored by a computer must have hard copy or software backup copies.

10.6.15.3 Records stored only on electronic media must be supported by the hardware and software necessary for their retrieval and utilization in the proper format.

10.6.15.4 Records stored on electronic media must be stored in a way to provide protection from electronic or magnetic sources.

10.6.15.5 If there is a change in ownership and/or a change in location, all records and documents will be made available to clients for 10 years. Under no circumstances shall any records or documents be destroyed – all records and analyses performed that pertain to TNI accreditation are subject to inspection by the TNI accrediting authorities for a 5 year period. (The 10 year record retention policy is client driven, TNI standards require records be retained for a minimum of 5 years.) A new owner of ACZ will assume possession of all records and documents.

10.6.15.6 If ACZ goes out of business, all records and documents will be stored and maintained according to protocol in a location to be determined at the time of closure.

10.6.16 Access to Archived Records

10.6.16.1 Access to archived information must be documented with an access log. A log is kept in each storage location, and any person entering a storage location must provide the required information in the log.

10.6.16.2 Hard copy records are stored in a locked environment with limited access. When a record is removed from its location, a "checkout card" must be filled out to indicate who removed the record, the date the record was taken, and a description of the record. The card marks the place in the storage box, and when the record is returned the card is pulled from the box.

10.6.16.3 Any changes to be made to archived electronic data will require assistance from IT to do so.

10.6.16.4 Electronic data that has been archived to removable media is stored in a bank safety deposit box. Access is limited to ACZ's Presidents, IT staff, and CFO and recorded in a logbook maintained by the IT Manager.

10.6.17 Record Disposal

10.6.17.1 Records are disposed of in a manner that ensures client confidentiality.

10.6.17.2 Stored records will be reviewed to determine which ones can be destroyed in compliance with ACZ's record retention policies.

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10.7 Computer Data and Records

10.7.1 Network File Server

Computer files pertaining to all aspects of ACZ's business are stored on a series of file servers. To gain access, an employee logs on to the "LAB" domain. Each employee has a unique network user name so that security rules may be enforced. No "guest" logon is permitted. Every employee belongs to a specific "group" and directory security is enforced through privileges granted to these groups. An employee is granted access to files that pertain to their job functions. Other files will be granted read-only or no access as appropriate to the employee's position.

Data generated and reported by ACZ is extremely confidential and the company may be liable for the consequences of the release of this data to any unauthorized person. The implementation of password security is not arbitrary and ensures data is protected and cannot be disclosed to outside parties. Weak passwords that are not changed frequently make this scenario more likely.

In general, the network will prompt employees to change their password every 30 days. The password must be at least five (5) characters. Numeric characters are optional. Passwords may not be shared with other employees, unless necessary for work purposes. The use of another employee's password without permission from ACZ's Presidents, or IT Manager (with the exception of common passwords for shared computers) is grounds for disciplinary action.

10.7.2 LIMS Server

a. Information stored in LIMS consists of all sample and client information needed for day-to-day production activities. The information is stored in an Oracle database. Access is controlled through membership in "groups." Employees may update and change database records according to their job responsibilities. Otherwise, information is restricted to read-only access or no access.

b. No modifications to data can be made through applications not authorized by ACZ's IT department unless a CAR or Help Desk ticket is submitted or documentation is provided on the hardcopy of the workgroup. Unauthorized applications include any form of direct database manipulation.

c. Tracked changes will be audited on a regular basis by the QA department or its designee to ensure sufficient information is being supplied as to why changes occur. The explanations must be both professional and specific.

10.7.3 Docs Server

For general users, access to the docs server is read-only and is permitted through Internet Information Services (IIS) authentication and is logged in IIS log files. Direct access is limited to authorized users or groups who need to bypass the IIS to perform their job duties. The server is updated on a regular basis by automated scripts.

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11 ELEMENTS OF QUALITY CONTROL

A critical focus of ACZ's quality control policies and protocols involves monitoring sample preparation and measurement processes to determine matrix effects and to evaluate laboratory performance. Quality control samples are typically analyzed with every batch of environmental samples. Each test SOP provides detailed information regarding quality control sample types, acceptance criteria, and corrective actions, if applicable to the procedure, and reflects the requirements of the method and/or other regulatory authorities.

Performance control samples demonstrate precision or accuracy and expose out-of-control events. Matrix-specific control samples indicate possible effects of the matrix on method performance and may also identify data as in-control or out-of-control. Data that is out-of-control dictates corrective action ranging from re-preparation and re-analysis to reporting data with qualifiers. The corrective action specified in the SOP shall be performed if any quality control sample does not meet the acceptance criteria.

To the extent possible, client samples are reported only if all quality control measures are acceptable. If any measure is outside of the acceptance criteria, and the data will be accepted and reported to the client, then the appropriate data qualifier(s) must be assigned to all associated samples. The list of current extended qualifiers is maintained in the LIMS database.

11.1 Method Performance

11.1.1 Negative Control – Prep Blank (Method Blank)

A prep blank or method blank shall be analyzed at a minimum of one per batch. The blank shall be processed along with and under the same conditions as the associated samples. Method blanks are not applicable for certain analyses, such as pH, Conductivity, Flash Point, and Temperature.

The prep blank is used to assess possible contamination introduced during sample processing steps. A prep blank is prepared using Type I water or other similar matrix that is free of the target analyte(s) and contains all reagents in the same volumes used to prepare the client samples. Unless specified in the test SOP, sample concentration may not be corrected for the prep blank value.

While the goal is to have no detectable contaminants, each prep blank must be carefully evaluated as to the nature of the interference and the effect on the analysis of each sample in the batch. Contamination in the prep blank results from four principle sources: the environment the analysis is performed in; the reagents used; the supplies and apparatus used; and the analyst performing the analysis. Contamination sources vary and the test SOP must be referenced to determine appropriate corrective action.

When method blanks fail acceptance criteria, potential sources shall be investigated and measures taken to correct, minimize or eliminate the problem, and associated client samples must be reprocessed and reanalyzed. Alternatively, data may be reported with the appropriate qualifier if reprocessing and reanalysis is not possible or if one of the following criteria is met:

1) The concentration of a target analyte in the blank is at or above the acceptance limit and the measured concentration of the analyte in an associated sample is greater than 10 times the measured concentration of analyte in the blank.
2) The concentration of the target analyte in the associated sample is less than the MDL.
3) Corrective actions could not be performed or are ineffective. Thoroughly document any corrective action taken and the outcome.

11.1.2 Positive Control (however named)

Laboratory Fortified Blank (LFB), Laboratory Fortified Blank Duplicate (LFBD), Laboratory Control Sample Water (LCSW), Laboratory Control Sample Water Duplicate (LCSWD), Laboratory Control Sample Solid (LCSS), Laboratory Control Sample Solid Duplicate (LCSSD).

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1) The LCS is used to evaluate the performance of the total analytical system, including all preparation and analysis steps.
2) The LCS is a quality system matrix, known to be free of the analytes of interest, spiked with known concentrations of analytes. Alternatively, an appropriate Certified Reference Material (CRM) containing the analytes of interest may be used.
3) If no separate preparation method is used (e.g. dissolved metals), an ICV or CCV may double as the LCS. If different acceptance criteria are specified, the most stringent criteria shall be observed.
4) Each test SOP must define the positive control to be used for the procedure, the required frequency, acceptance criteria, and contingencies for corrective action.
5) Unless the reference method specifies a different frequency, the LCS shall be analyzed at a minimum of one per batch, not to exceed 20 environmental samples.
6) Any affected samples associated with a failing LCS shall be re-processed for analysis or the results reported with appropriate data qualification. A failing LCS may be re-tested once to confirm the failure. Additional re-tests must be accompanied by documented corrective action taken between tests. For example, the instrument did not sample from the correct tray position in the first two tests; alignment was corrected for the third test.

   Note: In general, qualification of data for LCS failures is only permitted if there is insufficient sample for re-analysis, the data is extremely time sensitive, or the LCS failed high but the analyte was not detected above the reporting limit in the sample.
7) The components to be included in the LCS shall be as specified by the method, regulation, or as requested by the client. **In the absence of such specifications, the following rules shall be observed (Radiochemistry excluded)** :
   a) For those components that interfere with an accurate assessment, such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike shall be chosen that represents the chemistries and elution patterns of the components to be reported.
   b) For those methods that have extremely long lists of analytes, a representative number may be chosen. The analytes selected shall be representative of all analytes reported. The following criteria shall be used for determining the minimum number of analytes to be spiked. **However, the laboratory shall insure that all targeted components are included in the spike mixture over a two (2) year period**:
      i. For methods that include one (1) to ten (10) targets, spike all components.
      ii. For methods that include eleven (11) to twenty (20) targets, spike at least ten (10) or 80%, whichever is greater.
      iii. For methods with more than twenty (20) targets, spike at least sixteen (16) components.
8) An LCSW duplicate may be prepared and analyzed with the batch, typically in lieu of a matrix duplicate or spike duplicate. Data is acceptable if the LCSW and/or LCSWD is within the acceptance limits and the RPD passes. Associated samples must be re-prepped and reanalyzed if either of the following occurs:
   a) LCSW/D RPD fails the acceptance criteria specified in the SOP.
   b) % R of both the LCSW and LCSWD is outside the acceptance limits.
9) For a solid or semi-solid matrix, an LCSS and LCSSD are often prepared and analyzed.[4] The data is acceptable if the LCSS and/or LCSSD are within the acceptance limits and the RPD passes. Associated samples must be re-prepped and reanalyzed if any of the following occurs:
   a) LCSS/D RPD fails the acceptance criteria specified in the SOP.
   b) % R of both the LCSS and LCSSD is outside the acceptance limits.

[4] Corrective action for Recommendation #5 cited in the 2002 ADHS audit report.

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10) When the acceptance criteria for the LCS are exceeded [i.e. high bias] then any associated client sample with a measured concentration less than the reporting limit (MDL or PQL) may be accepted and reported with the appropriate qualifier.

11) Refer to §11.1.3.3 for additional information regarding data assessment for solid-matrix workgroups prepared with both LCSS/LCSSD and MS/MSD.

12) An LCS is not required for those analytes for which no spiking solution is available.

13) The following apply to radiochemistry only:

    a) The activity of the LCS shall be at least 10 times the Lower Limit of Detection (LLD) or Minimum Detectable Activity (MDA). Note: this requirement does not apply to DOCs.

    b) Whenever possible, the standards used to prepare the laboratory control sample shall be from a source independent of the standards used for instrument calibration.

    c) Where a radiochemical method, other than gamma-ray spectroscopy, has more than one reportable analyte isotope (e.g. plutonium, 238Pu and 239Pu, using alpha-particle spectrometry), only one of the analyte isotopes needs to be included in the laboratory control sample at the indicated activity level. However, where more than one analyte is detectable, each shall be assessed against the specified acceptance criteria.

    d) Where gamma-ray spectrometry is used to identify and quantify more than one analyte, the laboratory control sample shall contain gamma-emitting radionuclides that represent the low (e.g., Am^{241}), medium (e.g., Cs^{137}) and high (e.g., Co^{60}) energy range of the analyzed gamma-ray spectra. As indicated by these examples, the nuclides need not exactly bracket the calibrated energy range or the range over which nuclides are identified and quantified.

    e) The laboratory control sample shall be prepared with similar aliquot size to that of the routine samples for analyses.

11.1.3 Sample Specific Controls

The effect of different sample matrices on the performance of any method can be profound; therefore, matrix spikes, duplicates, and surrogate compounds are analyzed to evaluate matrix effects on data quality. Each SOP includes specific information regarding the usage and evaluation of matrix-specific QC samples and also states the required corrective action to take if any matrix QC fails.

ACZ provides analytical services to numerous and varied clients. Therefore, the possibility of routinely favoring one client or sample is highly unlikely, and over time the samples from all routine sources should be fortified. ACZ recommends that analysts, to the extent possible, select samples to spike or duplicate that are representative of the workgroup. Analysts are not to associate QC with a client sample known to be or believed to be any type of blank or Proficiency Testing sample. Several exceptions exist for selecting samples for spiking or duplicating:

1 A sample is not spiked or duplicated if the volume is inadequate and the client sample and QC sample(s) would require dilution; however, if no other option is available then the client sample and Duplicates should be prepared and analyzed on the same dilution whenever possible. Matrix spikes will not be accepted on different dilutions (minor d.f. variations in soils samples are acceptable) unless no other alternative exists. The data must be qualified in this event.

2 Use the same weights (as close as possible) to prepare duplicates of solid matrix samples.

3 A client may require that one or more of their samples be spiked or duplicated. A “RUN QC” comment is added when the sample is logged in to notify the analyst that QC must be performed for a specific sample or project. Alternatively, the Special Instructions function in ACZ’s LIMS may be used to communicate the request. If a client requests that their sample(s) be spiked or duplicated, ACZ will accommodate the client for a fee.

4 A reactive sample is unpredictable and is a poor choice for spiking or duplicating.

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5 A PT sample is not a real-world sample and is a poor choice for spiking or duplicating, because the data does not provide any useful information about possible matrix effects. When selecting samples for batch QC such as spikes or duplicates, PT samples should be avoided. If insufficient volume exists to spike or duplicate any other samples in the batch, it is appropriate to select a PT sample. It is better to use the PT sample for a duplicate than a spike if this choice is presented. If a batch consists solely of a PT sample, QC designed to assess matrix effects is not required (e.g. spike, SDL); an assessment of precision is still required and may be accomplished by duplicating the PT sample, or preferably, running a duplicate of the positive control.

11.1.3.1 Surrogates

Surrogates are organic compounds that are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but are not normally found in environmental samples. Surrogates are included in the scope of Organic methods and are used to evaluate accuracy, method performance and extraction efficiency and are added to environmental samples, controls, and blanks, in accordance with the method requirements.

When surrogate recoveries fail acceptance limits, corrective action stated in the test SOP shall be performed. If corrective action cannot be performed or is ineffective, reported data must be appropriately qualified.

11.1.3.2 Matrix Spike Samples

A matrix spike sample (however named) is used to determine the level of bias (accuracy) associated with a particular matrix. For the purposes of this document, “MS” designates a matrix spike, and “MSD” designates a matrix spike duplicate. Spikes are prepared by adding a known and appropriate quantity of each target analyte to a replicate aliquot of client sample.

The required analytical frequency is specified by the method or other regulating entity and is indicated in the test SOP. Each result is evaluated against the acceptance criteria, and matrix effects are determined and reported to the client. The following evaluation criteria apply to spikes that are subjected to processing steps and post-digestion spikes (analytical spikes).

- Percent Recovery (%R) is considered for all spikes.
- %R is evaluated only if the theoretical concentration in the spiked aliquot is greater than or equal to the PQL; otherwise, each associated client sample must be reported with the appropriate qualifier, regardless of %R, unless a representative number of analytes as described in §11.1.3.2.1 are evaluated for %R.
- If %R for the MS and/or the MSD is outside of the acceptance limits, the RPD passes, and all other pertinent prep and instrument QC passes, each associated client sample may be accepted and reported with appropriate qualification.

11.1.3.2.1 The components to be included in the MS & MSD shall be as specified by the method, regulation, or as requested by the client. **In the absence of such specifications, the following rules shall be observed (Radiochemistry excluded)**:

1) For those components that interfere with an accurate assessment, such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike shall be chosen that represents the chemistries and elution patterns of the components to be reported.
2) For those methods that have extremely long lists of analytes, a representative number may be chosen. The analytes selected shall be representative of all analytes reported. The following criteria shall be used for determining the minimum number of analytes to be spiked. **However, the laboratory shall insure that all targeted components are included in the spike mixture over a two (2) year period**:

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a) For methods that include one (1) to ten (10) targets, spike all components.

b) For methods that include eleven (11) to twenty (20) targets, spike at least ten (10) or 80%, whichever is greater.

c) For methods with more than twenty (20) targets, spike at least sixteen (16) components.

11.1.3.3 Matrix Duplicates and Matrix Spike Duplicates

The matrix-specific precision associated with an analysis is determined through the use of a matrix duplicate (DUP) or spike duplicate (MSD), which are performed at a frequency specified by the method or other regulating entity (refer to the specific test SOP). If the method does not prescribe a frequency, a duplicate shall be included in each workgroup, not to exceed 20 samples. The results are evaluated, and the matrix affect on precision are determined and reported to the client.

- Relative Percent Difference (RPD) is used to evaluate precision, unless the test SOP specifies a different technique (§12.4.6).
- RPD for a spike duplicate is evaluated only if the observed concentration is greater than or equal to the PQL; otherwise each associated client sample must be reported with the appropriate qualifier.
- RPD for a matrix duplicate is evaluated only if the observed concentration is greater than 10 times the MDL or 2 times the PQL if an MDL has not been established; otherwise each associated client sample must be reported with the appropriate qualifier, regardless of RPD.
- In the absence of other contributing factors, a DUP failure for a solid or semi-solid matrix is attributed to non-homogeneity of the sample, and each associated client sample may be reported with the appropriate qualifier.
- For an aqueous matrix, if the DUP fails then all associated samples must be retested. If permitted by the instrument software the sample and DUP can be reanalyzed at the end of the analysis in lieu of retesting all associated samples.
- For an aqueous matrix, if the MS/MSD RPD fails then the associated samples must be reanalyzed. If permitted by the instrument software the sample and MS/MSD can be reanalyzed at the end of the analysis in lieu of retesting all associated samples.
- If applicable, evaluate the LCS/LCSD if the RPD fails for a matrix duplicate or spike duplicate. Each associated client sample may be reported with the appropriate qualifier if the LCS/LCSD meets the criteria stated in §11.1.3.2.
- For a solid or semi-solid matrix, if both the LCSS and LCSSD recoveries pass but the RPD fails, then acceptable precision may be demonstrated by a passing RPD for the MS/MSD, and each associated client sample may be reported with the appropriate qualifier.
- A sample and duplicate may only be re-analyzed once before additional corrective action is required. If more than one re-analysis is performed, the workgroup documentation must include justification.

11.2 Instrument Specific Controls

All data must be associated with a passing instrument calibration and initial calibration verification. To the extent possible, all data must be associated with passing continuing calibration verification. If the initial calibration verification results (ICV/ICB) are outside of the acceptance criteria, then the source of the failure must be

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identified, necessary corrective action performed, and the instrument recalibrated if necessary before proceeding with sample analysis.

If the continuing calibration verification results (CCV/CCB) do not meet the acceptance criteria, then the source of the failure must be identified and corrective action performed, including recalibration if necessary, before continuing with sample analysis. If reanalysis of any sample associated with failing calibration verification is not possible and results will be reported, the data shall be appropriately qualified.

For instruments that permit the analysis of subsequent workgroups using the most recent calibration, two (2) consecutive attempts of the opening CCV/CCB are allowed. If both attempts fail to produce acceptable results then the sources of failure must be identified and corrective action performed, including recalibration if necessary, before commencing sample analysis.

If a CCV or ICV *retest* fails and the instrument is not recalibrated, 2 consecutive passing CCVs or ICVs are required before continuing with analysis.

Unless stated otherwise by the test SOP, passing calibration verification must bracket all batch quality control samples, and results for additional instrument check standards, if applicable, must be within the acceptance criteria stated in the SOP. However, when the acceptance criteria for a CCV or CCB are exceeded (i.e. high bias) any associated client sample with a measured concentration less than the MDL may be accepted and reported with the appropriate qualification. This exception is not allowed if the workgroup contains a batch LCS (however named) which fails low.

11.3 Other Control Indicators

11.3.3 Internal Standards

Internal Standards (IS) are measured amounts of certain compounds added after preparation or extraction of a sample to be analyzed. The IS is an analyte not likely to be found in the environment and is used in a calibration method to correct sample results affected by column injection losses, purging losses or viscosity effects. The IS is added to client samples, controls and blanks in accordance with the method requirements. When the results are outside of the acceptance limits for applicable quality control samples, corrective actions shall be performed. Once system control has been reestablished, all samples analyzed while the system was malfunctioning shall be reanalyzed. If corrective actions could not be performed or are ineffective and associated sample results will be reported, the data must be appropriately qualified.

11.3.2 Trip Blank

The trip blank is a sample container filled in the laboratory with Type I water that is shipped to the collection site in the sample cooler, returned to the laboratory, logged-in, and analyzed in the same manner as the client samples. With the exception of Hg-1631, trip blanks are not opened in the field.

11.3.3 Instrument Blank

The instrument blank is an aliquot of Type I water processed only through the instrument steps of sample analysis and is used to determine presence of instrument contamination. For Organic instrument methods, neither surrogate nor IS standards are added.

11.3.4 Equipment Blank

An equipment blank is provided by the client and is used to assess the effectiveness of equipment decontamination procedures. Type I water is poured into (or over) or pumped through the sampling device, collected in a sample container and transported to the lab to be analyzed for all parameters requested for the environmental samples collected at the site.

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11.3.5 Ambient Blank

The ambient blank consists of Type I water poured into a VOA vial at the sampling site (in the same vicinity as the associated samples). It is handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared when samples are to be analyzed for VOA analytes and are used to assess the potential introduction of contaminants from ambient sources (e.g. active runways, engine test cells, gasoline motors in operation) to the samples during sample collection. The frequency of collection for ambient blanks is specified in the client's field-sampling plan. Ambient blanks are not required for all projects.

11.3.6 Radiological Tracers & Carriers

Radiological tracers and carriers are used for radiological analyses. The control reacts in the same manner as the target isotope and is used to assess analyte recovery. The tracer is added to client samples and QC in accordance with the requirements stipulated in the test SOP. Because the tracer recovery has a direct impact on the LLD, the recovery must be high enough to yield LLDs that are within the scope of the project or meet ACZ's acceptance criteria. Refer to the test SOP for evaluation criteria and corrective action(s) for out-of-control tracer recovery.

11.4 Titrants – Where applicable, test SOPs shall include procedures for verifying the concentration of titrants prepared by the laboratory. Verification is not required for purchased titrants with certified values. If a purchased titrant is diluted, verification is required.

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12 EVALUATING QUALITY CONTROL SAMPLES

In general, acceptance criteria for quality control samples are method-specific; however, compliance with the requirements of clients and regulatory or other accrediting agencies must also be demonstrated. Immediate corrective action must be taken if any quality control is outside of the acceptance criteria. Appropriate corrective actions are described in the test SOP. To the extent possible, client samples are reported only if all quality control measurements are acceptable. If a quality control measure is outside of acceptance criteria, and the data will be reported, then all samples associated with the failed QC must be appropriately qualified. Clients will occasionally request limits different from those in a published method. Deviations from ACZ's policies pursuant to client request must be explicitly noted on client reports. ACZ will not be held liable in the event such deviations do not meet client regulatory needs.

Unless otherwise stated, for the purpose of determining conformance to specifications, ACZ employs the rounding method described in ASTM E29. When using this method, observed values are rounded to the same decimal place limits are expressed before assessing conformance. For example, if the calculated percent recovery for an LCS is 89.5% and the QC limits are 90 to 110%, the percent recovery would be rounded to 90% and evaluated as passing. (Note: double rounding is NOT permitted, e.g. 89.48 rounds to 89.5 rounds to 90.) Conversely, if limits were expressed as 90.0 to 110.0%, the same LCS would be evaluated as failing acceptance criteria. Analysts must consider whether the QC limits expressed in the test method cohere in a technically sound manner with the rounding method. If they do not, the SOP must express the limits to a technically sound numerical place value, or the absolute method must be employed. The absolute method takes a limit of 6˚C, 6.0˚C, and 6.000˚C all to mean the same thing, exactly 6 degrees Celsius.

For methods that permit the use of control charts or do not specify acceptance criteria for quality control measurement, limits may be generated by plotting historical data obtained from analytical processes considered in control. Whenever practical, a minimum of 20 data points is used. The process of rejecting data points relies heavily on the statistician's judgment and control chart activities are therefore restricted to supervisors and experienced analysts. All points must be associated with passing calibrations and calibration verification(s). Data points with known anomalies must be rejected. Data points should not be rejected solely because they fail acceptance criteria. Control chart documentation must clearly indicate rejected data points. ACZ's LIMS has a utility for querying and retrieving historical data for control chart applications. Control chart limits are typically set at ± 3σ. All control chart limits are reviewed and approved by the QA department prior to implementation. When possible, a comparison to previous limits is included in the review and may form the basis for rejecting new limits and requiring an investigation of the analytical system's condition. Previous limits are archived in a network folder. Default acceptance criteria established by the Arizona Department of Health Services (ADHS) may be used in lieu of generating a control chart to establish limits; however the SOP must specify which limits are in use. [5] **NOTE:** For all data evaluation, final results ending with 1 – 4 are rounded down and results ending with 5 – 9 are rounded up.

12.1 Accuracy

Accuracy is defined as "The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations". Control samples (LCS or LFB) and spiked samples are analyzed with every batch of samples or as stipulated by the specific test SOP to assess accuracy and matrix effects.

- Percent Recovery (%R) for a control sample is calculated as follows:

$$\%R = \frac{M}{S_p} \times 100$$

Where: M = Measured concentration of the control sample

S_p = True value of the control sample

[5] Arizona Administrative Code (A.A.C.), Title 9, Ch. 14, Table 6.4 (September, 2016)

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- Percent Recovery (%R) for a spike is calculated as follows:

$$\%R = \frac{M - S}{S_p} \times 100$$

Where: M = Measured concentration of the spiked sample
S = Measured concentration of the sample aliquot
S_p = True value of the spike concentration

12.2 Precision

Precision is defined as "The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms." Matrix duplicates and spike duplicates are analyzed with every batch of samples or as stipulated by the test SOP to determine the precision associated with the analysis. If any method does not specify acceptance criteria for the RPD, then default criteria of RPD $\leq$ 20 is used (a value that rounds to 20 is acceptable). [6] The Relative Percent Difference (RPD) as an absolute value is calculated as follows:

$$|RPD| = \frac{(S - D)}{[(S + D) / 2]} \times 100$$

Where: S = Sample Value
D = Duplicate Value

12.3 Other Calculations

- Solids Dilution Factor:

$$\text{Dilution Factor} = \frac{V}{(W)(\%\ solid)}$$

Where: V = Final digestate volume, in mL
W = Sample weight used, in g
%solid = %solid of the sample as a fraction

- Sample Concentration for Solids:
  - wet weight [biota tissue, fruit or vegetable matter, etc.]: $mg/Kg = \frac{DF * C * V}{W}$
  - dry weight [plant matter, grasses, soil, sludge, etc.]: $mg/Kg = SF * C * DF$

  Where: DF = instrument dilution factor
  C = raw data value, in mg/L
  V = Final volume of digestate, in L
  W = sample (as received) weight used, in Kg
  SF = soil dilution factor

- Percent Difference for Serial Dilution (SDL):

$$|\%D| = \frac{[I - (s * 5)]}{I} \times 100$$

Where: I = initial sample result
s = serial dilution result (raw data value)

For SDL calculations in LIMS, "s" is multiplied by 5 and the resulting "reg value" is compared to the "found value" to calculate %D.

[6] ADHS Information Update #87 (July 7, 2005)

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12.4 Radiochemistry Calculations: (**NOTE**: Specifications in the individual test SOPs supercede the information detailed below.)

12.4.3 Activity

The results of radioactivity are typically reported in terms of activity per unit volume or mass. Units are normally expressed in picocuries (pCi), which equal 2.22 disintegrations per minute (dpm). Specific formulas to determine activity are in the SOP for each method. The general formula is as follows:

$$C = \frac{R_{net}}{(e)(y)(i)(v)(u)}$$

Where: C = activity per unit volume (pCi/L)
R_{net} = net counts per minute
e = counting efficiency, cpm/dpm
y = chemical yield
i = ingrowth correction factor
v = volume or mass being counted (L)
u = units correction factor, 2.22 for cpm to pCi

12.4.4 Counting Error

Radiochemical data are considered incomplete without reporting associated random and systematic errors. For this reason all radiochemical results should be accompanied by a counting error at the 95% confidence level (1.96*standard deviation). The general counting error formula is as follows:

$$E = \frac{1.96\,(R_o/t_1 + B/t_2)^{1/2}}{(e)(y)(i)(v)(u)}$$

Where: E = counting error
R_o = gross sample, cpm
t_1 = sample count duration, min
B = background, cpm
t_2 = background count duration, min
e, y, i, v, and *u* are as previously defined.

12.4.5 Lower Limit of Detection (LLD)

LLD (also referred to as Minimum Detectable Activity or MDA) is considered the smallest quantity of sample radioactivity that will yield a net count for which there is a pre-determined level of confidence that radioactivity is present. At the 95% confidence level, the following equation calculates the LLD for any single nuclide. The calculation uses the standard deviation for the background counting rate, assuming the sample and background counting rates should be very similar at the LLD. A formula for determining LLD is as follows:

$$\mathrm{LLD}_{95} = \frac{4.66\,S_b}{(e)(y)(i)(v)(u)}$$

Where : LLD_{95} = Lower limit of detection at the 95% confidence interval
S_b = Standard deviation of the instrument background counting rate, cpm
e, y, i, v, and *u* are as previously defined

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12.4.6 Precision

The normalized absolute difference, or Replicate Error Ratio (RER), between the sample and the laboratory duplicate, given by the following equation shall be used to determine that results do not differ significantly when compared to their respective 2* sigma uncertainty.

$$RER = \frac{|Sx - Dup|}{\sqrt{(Sx_{error})^2 + (Dup_{error})^2}} \leq 2.0$$

Where: Sx = sample concentration in pCi/L
Sx_{error} = sample counting error (in pCi/L) at the 95% confidence level.
Dup = duplicate concentration in pCi/L
Dup_{error} = duplicate counting error (in pCi/L) at the 95% confidence level.

NOTE: For Radchem samples, both RPD and RER may be used to evaluate precision. RPD is the default assessment for Drinking Water samples; RER is the default assessment for non-Drinking Water samples. Data for both RER and RPD are uploaded to LIMS for all analyses. Use the following guidelines to correctly assess precision. Further details are provided in ACZ's Wiki and should be consulted to ensure data for each workgroup is correctly evaluated. Go to LabWeb \ Wiki \ Analytical Departments \ Radio Chemistry.

<u>Drinking Water:</u>

RPD $\leq$ 20, RER < 2.0 – Precision is judged to be in control
RPD $\leq$ 20, RER > 2.0 – Precision is judged to be in control;
RPD > 20, [sx] < 5x [LLD], RER < 2.0 – Precision is judged to be in control; qualify data.
RPD > 20, [sx] > 5x [LLD], RER> 2.0 – Precision of the prep batch is questionable.
RPD > 20, [sx] > 5x [LLD], RER < 2.0 – Precision of the prep batch is questionable.

<u>Non-Drinking Water</u>:

RER < 2.0, RPD $\leq$ 20 – Precision is judged to be in control.
RER < 2.0, RPD > 20 – Precision is judged to be in control;
RER > 2.0, RPD $\leq$ 20 – Precision of the sample prep batch is questionable.
RER > 2.0, RPD > 20 – Precision of the sample prep batch is questionable.
RER > 2.0, [sx] > 5x [LLD], RPD $\leq$ 20 – Precision is judged to be in control; qualify data.

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13 VALIDATION AND REVIEW OF ANALYTICAL DATA

ACZ has a responsibility to provide the best data possible to ensure our clients can make sound and cost-effective decisions regarding public health and the environment. In order to generate and report reliable data, the analytical systems used need to be properly functioning, and the review process must be conducted in a manner that is logical and reasonable and would be defensible if subjected to legal scrutiny. Decisions regarding data quality must be backed by good science and sound professional judgments.

The entire validation and review process encompasses more than solely evaluating the final results for client and quality control samples. To this extent, the necessary steps must also be performed *prior* to sample preparation or analysis to ensure the quality of the data. Following sample analysis, data is uploaded to the LIMS database and then submitted to a variety of process chains such as calculations, rounding, application of qualifiers, etc. A multi-level data review process is utilized to verify the uploaded analytical data meets all documented ACZ requirements as well as any client-specific quality objectives. At a minimum, the validation process must include the following steps, as applicable:

- Monitor the expiration dates for all stock, intermediate, and working standards, reagents, and chemicals.

- Prior to analysis, determine that holding times have not been exceeded. Unless otherwise specified by the test SOP, sample preparation and analysis must be completed within the holding time.

- Prior to analyzing samples, verify the correct set-up and operation of the instrument or equipment. Perform calibration, maintenance, and optimization as necessary to ensure proper functioning.

- QC Association
  1) In general, for QC frequency of 1 per10 or less client samples, the first set of QC is associated with samples 1 – 10. If there are fewer than 20 samples in the workgroup, then the remaining client samples are associated with the second set of QC.
  2) If sample characteristics or amount dictate that 2 of the first 10 samples be spiked or dup'd, then the first spike or DUP is associated with samples 1 through 11 excluding the 2nd sample spiked or dup'd, and the 2nd spike or dup is associated with itself and samples 12-20. For example, if samples 3 & 5 are spiked in a 20 sample batch, sample 3 is associated with 1-4 & 6-11, and sample 5 is associated with 5 and 12-20. The same principle applies if both spiked or dup'd samples reside in the 2nd set of ten within the workgroup sequence.
  3) Variations to the QC association rules noted above are permitted but must be documented with the WG. The documentation must define the altered QC association and provide a compelling, technically sound reason for the deviation. QC association may **not** be changed after data has been acquired.
  4) QC association must be properly defined in LIMS.

- Before completing workgroup creation, verify the correct PCNs and/or SCNs have been entered. Percent recovery for control samples and spikes is calculated using the information in LIMS for each.

- Verify the proper sub-sample (green dot, yellow dot, etc.) is being used for preparation or analysis.

  - Notify the supervisor or Production Manager as soon as possible if a sample cannot be located.
  - Document on the bench sheet if a sub-sample other than the type indicated in the SOP is used.

- Clearly label tubes, beakers, autosampler cups, etc. to identify the sample (and dilution factor, if applicable).

- Manage sample volume to ensure all analyses from a bottle type can be completed.

- Document all dilution factors at the time the dilution is performed.

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- Record complete and accurate observations when an analysis, sample preparation, or sample matrix is unusual or problematic.

- Ensure transcription errors do not occur. Verify all data manually entered into LIMS is correct before completing the upload process.

- The calibration workgroup must be associated with all subsequent workgroups. Record the calibration workgroup number (or calibration file name) on the data review checklist.

- Provide complete traceability for all standards and reagents used for sample preparation and analysis.

- Batch quality control samples must be treated in the same manner as client sample, including preparation.

- If it is necessary to perform a calculation manually, use the values in the raw data [do not truncate] and then round the final result to the appropriate numerical place value. If the final result passes the acceptance criteria then pass the QC in LIMS and note on the data review checklist that it passes.

- LIMS performs several additional QC calculations on the approved data including cation/anion balance (CAB) checks, calculated TDS versus actual TDS ratios, and Total versus Dissolved ratios. The Project Manager may update the status of pertinent samples to REDO if one of these calculations indicates a discrepancy with the associated data.

- If two attempts fail to produce acceptable data then notify the supervisor or Production Manager before taking further action. It may be necessary to first determine if a larger problem is interfering with the analysis. Investigate the problem before qualifying the associated data.

- If there is an indication the analytical system is out of control, the issue must be investigated. Notify the supervisor immediately. Conduct troubleshooting in a systematic, organized manner.

- All data must be reviewed initially in LIMS [AREV] by the analyst who performed the analysis or another individual authorized to perform or AREV the procedure. The department supervisor or another individual authorized for SREV performs the secondary review [SREV]. The following are data review guidelines:

  1 A data review checklist must be completed during the review process. Verify all items listed and note any errors, problems or non-compliances and the corrective action(s) taken.

  2 If applicable, review the raw data to verify the analytical system was in control and to ensure no anomalies exist. Check for notes on the bench sheet regarding the preparation or analysis.

  3 For client samples and quality control samples, ensure all results are within the measurement range and are bracketed by a passing calibration and passing calibration verification [ICV/ICB or CCV/CCB]. Sample values outside of the measurement range must be appropriately qualified if reanalysis is not possible.

  4 The corrective action specified in the SOP must be performed if any quality control sample does not meet the acceptance criteria.

  5 Data generated after the hold time has elapsed may not be usable for the client. If reprep or reanalysis will be conducted outside of the holding time, check first with the supervisor.

  6 Confirm all dilutions are appropriate. A reasonable explanation must be provided on the bench sheet if a sample was diluted and the value is less than the quantitation limit (refer also to §15).

  7 If a spike fails, determine if the sample concentration is disproportionate to the spike added. If the analyte concentration in the sample is more than **4 times** the spike concentration, note the failure on the checklist and appropriately qualify the associated samples.

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8 If a spike recovery suggests the sample was not spiked, matrix interference must be confirmed prior to qualifying samples. If matrix interference cannot be confirmed, then re-prep and/or re-test all associated samples.

9 Each associated client sample must be appropriately qualified if the matrix spike, matrix duplicate, or spike duplicate data cannot be used for validation purposes.

10 Confirm failed QC by verifying the correct PCN or SCN was entered. Make corrections if necessary before proceeding with data review.

11 Verify all assigned qualifiers are appropriate. Does use of a particular qualifier make sense? Could data be defended using the qualifier assigned to the scenario or problem?

12 If a case narrative is necessary, the reason for accepting and reporting the data must be sound and logical. Provide sufficient and accurate verbiage to ensure the data is legally defensible.

13 If a sample was retested in the same workgroup, verify the correct data will be reported. All other data for the sample must be failed; LIMS cannot report multiple datum for the same sample-product-analyte combination.

14 Confirm all samples have the correct status (PASS, FAIL, REDO, REDX) before completing the review process. For multi-parameter workgroups, all analytes must have the correct status.

15 Refer also to §11 for data evaluation criteria.

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14 DETECTION LEVELS

Current practice identifies several detection levels, each of which has a defined purpose: Instrument Detection Limit (IDL), Method Detection Limit (MDL), Reporting Limit (RL), and Practical Quantitation Limit (PQL). The MDL and PQL are stated in each test SOP and are adjusted accordingly in LIMS when data is uploaded to reflect the use of smaller sample volume (dilution) or larger sample volume (concentration).

14.1 Instrument Detection Limit (IDL)

The concentration equivalent to the analyte signal which is equal to three times the standard deviation of a series of 10
replicate measurements of the calibration blank signal at the selected analytical mass. (EPA Method 200.8 definition.)

14.2 Method Detection Limit (MDL)

The EPA defines the MDL as the "minimum concentration of substance that can be measured by a specific testing protocol and reported with 99% confidence that the analyte concentration is greater than zero…" This confidence interval means that any substance detected at a concentration equal to the MDL is 99% likely to be present, but it also means there is a 1% chance that the substance will be considered falsely present (false positive). The MDL procedure is designed so that the probabilities of both false positive and false negative errors are acceptably small; however, the procedure has limitations. Data users must understand the limitations when evaluating low level data and must proceed with caution when interpreting data reported between the MDL and PQL in order to minimize the risk of making poor environmental decisions.

MDLs are dependent on variables (temperature, instrument conditions, analysts, matrix, etc.) and are typically determined by processing, preferably over the course of several days, at least seven individual replicates of a fortified blank sample through the method's preparation and analytical schemes. MDLs determined for the same method / matrix / technology must be compared to ensure they are in agreement.

ACZ maintains a current MDL for each applicable method. A qualitative verification of the MDL must be performed annually for each applicable method, analyte, instrument, and matrix and before a new instrument or method is utilized for client samples. Refer to ACZ's SOP *Demonstration of Capability & Method Detection Limit Studies* (SOPAD001) for additional information.

14.3 Practical Quantitation Limit (PQL)

The PQL represents the lowest quantitative level that can be reported with a specified degree of confidence. Data reported at or above the PQL is considered reproducible, allowing for comparison of analytical results over a relatively long period of time, which is important to the monitoring of environmental data. ACZ *typically* defines the PQL as a value 2 – 10 times the MDL with an accuracy of 70 to 130% in a matrix free of interferents. The low calibration standard shall be at or below the PQL. Reported values less than the PQL are qualified as estimated. The region between the MDL and PQL is a continuum of uncertainty, lacking distinct cutoff points, and the error below the PQL is increased to the extent that the statistical validity of the result is questionable.

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15 SAMPLE DILUTIONS

Sample dilution may be necessary for one or more of the following reasons: (1) sample concentration exceeds the established measurement range of the procedure/method; (2) sample volume or material is limited; (3) matrix interference is indicated or suspected; (4) sample matrix is reactive; (5) aqueous sample contains high sediment; (6) color, odor or other physical characteristics are present; (7) For ICP and ICPMS, TDS is greater than 2000 mg/L. In all cases, the analyst must use good professional judgment when determining the most appropriate dilution. Whenever possible, prepare and analyze client samples and any complimentary duplicates or spikes on the same dilution.

For samples that contain high concentration of analyte(s), the analyst will use their knowledge of the measurement range of the procedure to determine an optimal dilution that yields quantifiable data with minimal error propagation. In general, prepare the dilution so the final concentration is near the mid-point of the measurement range. A sample must be retested on a smaller dilution if analyte concentration is less than the reporting limit; exceptions must be explained on the bench sheet. For multi-parameter analyses, it may not be practical to report all analytes within the desired range, and the analyst must use their best judgment when determining a reasonable dilution factor.

The following requirements pertain to all dilutions:

- Document all dilution factors when the dilution is performed.
- Assign the appropriate “D” qualifier if data for the diluted sample is less than the quantitation limit
- Retest sample on smaller dilution if the result is less than the quantitation limit (or document justification for accepting the data on the bench sheet or data review checklist)
- Document the reason for any dilution on the bench sheet [not required for sample values that exceed the measurement range of the procedure]

16 ERROR CORRECTION PROTOCOL

When an error occurs in any type of record it must be crossed out with a **single line**. The error must not be erased, deleted, overwritten, obliterated, or made illegible. Alterations to make data legible are considered error corrections. The correct value must be entered alongside. All changes to hard copy records must be initialed and dated by the person making the correction. [7]Under no circumstances may White-Out® or any other substance be used to conceal data. Concealing or improperly altering data is fraudulent and may be grounds for termination from ACZ. Equivalent measures must be taken to avoid loss or change of original data in the case of records stored electronically. Refer to §10 for details of corrections made to electronic records. The following is an example of proper error correction:

fleece BWC 10-20-06
Mary had a little lamb, it's ~~feet~~ as white as snow. And everywhere that ~~Lary~~ went, the lamb was sure to go.
Mary BWC 10-20-06

[7] There is one exception to this rule. Client identification may be obliterated from a record if it’s presence compromises client confidentiality (e.g. client ID is mistakenly entered in a logbook). In this event, the rationale for obliteration must be clearly stated and initialed and dated by the person making the correction.

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17 COMPUTER / AUTOMATED PROCESSES

ACZ employs its proprietary LIMS (Laboratory Information Management System) to acquire, record, process, store, and archive data. LIMS is the primary application for all employees and encompasses the combination of hardware and software throughout the entire facility. Tasks performed with LIMS include but are not limited to creating workgroups, reviewing data, and generating client reports. ACZ implements the defined standards of Good Automated Laboratory Practices (GALP) to establish a uniform set of procedures to assure that all LIMS data used by our clients is reliable, credible, and legally defensible.

17.1 Software

The software used to achieve GALP goals is a combination of industry standard commercial off the shelf (COTS) software and internally developed applications. COTS software is purchased through professional and well-developed companies such as Oracle, Microsoft, and Lab Vantage Systems that complete sufficient testing and quality control to assure their products function properly. Internal applications undergo testing before being implemented and distributed throughout the laboratory.

Electronic records are protected, backed up, and archived to prevent unauthorized access or amendment. Refer to §10 of this document and ACZ's SOP *Backup and Archive of Instrument Data Files* (SOPAD044) for details.

17.2 Hardware

ACZ deploys many servers using industry standard architecture. All servers run standard enterprise operating systems such as Microsoft Windows Server and SuSE Linux. All data residing on network servers is routinely backed up.

To the extent possible, instrument PCs comply with at least the minimum recommendations of the instrument manufacturer and they are connected to ACZ's network. This allows transparent backup and access to computers by system administrators.

17.3 Security

GALP security is controlled through a set of passwords. A log-in name and password are required to access ACZ's network. User passwords must be at least five characters and must be changed when the user is prompted. Each user has a given set of network rights and is restricted to software necessary to complete their job functions as well as his/her own documents. Refer also to §10.7.1 for additional information.

A firewall protects the network from internet traffic. The only traffic permitted access to the internal network is protocols approved by ACZ such as IMAP, SMTP and HTTP. Incoming and outgoing E-mails are scanned for viruses and content. Email that fails this automated scan is quarantined for further review. Web traffic that is potentially harmful or inappropriate is automatically blocked by ACZ's proxy server.

17.4 Electronic Signatures

ACZ permits the use of electronic signatures to approve documentation produced by the laboratory and to enter contractual agreements. Electronic signatures meeting the following criteria are considered equivalent to a handwritten signature:

(1) Each electronic signature shall be unique to one individual and shall not be reused by, or reassigned to, anyone else.
(2) Signing shall be password protected.
(3) Signatures shall be embedded with a timestamp.
(4) Faxed handwritten signatures are considered equivalent to a wet signature unless proven unreliable.
(5) E-documents that contain contractual commitments must be signed by an officer of the company.

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18 CLIENT SERVICES

18.1 Contracting Services

ACZ's sales representatives and project managers are responsible for reviewing requests, preparing quotes, and entering contractual commitments with clients. Prior to accepting new work, it must be verified that the laboratory has appropriate facilities and resources to meet client needs. To the extent possible and pragmatic, ACZ shall use the latest valid edition of a standard. This is dictated largely by what ACZ's accrediting authorities will issue certification for. Where an older standard is universally recognized by ACZ's accrediting authorities but the latest is not, ACZ will typically use the older standard. As necessary, sales representatives and project managers must collaborate with ACZ's Production Manager, QAO, and/or technical directors to evaluate laboratory capacity, capability, and resources. Refer to SOPAD043 for additional details.

18.2 Subcontracting

ACZ utilizes subcontract labs to perform analyses for various reasons. A subcontracted lab must meet the clients DQOs and laboratory certification requirements for the subcontracted analysis. When applicable, ACZ advises its clients in writing of its intentions to subcontract any portion of the testing to another party. Any non-accredited tests shall be clearly identified as such to the client. ACZ scans this report as an attachment to be included as part of ACZ's final report. A comment is added to ACZ's final report indicating which subcontracted laboratory performed the analyses, if the name is not indicated on the attachment. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

18.3 Data Reporting

Once all analyses and the entire review process have been completed, a client report is generated and submitted for final validation by the Project Manager. If necessary, a case narrative is written describing the details of the project and any non-conformances or other relevant issues. The PM electronically signs the report, and the Document Control department sends the report to the client in an electronic format. At a minimum, the following information appears on an ACZ analytical report:

Client Name	Sample Matrix
Client Address	Parameter/Analyte
Client Contact	Method Reference
Lab Sample ID	Result
Client Sample ID	Units
Client Project ID	LIMS Qualifier (U, B, J, H)
ACZ Report ID	MDL or LLD
Date/Time Sampled	PQL
Date/Time Received	Analyst's Initials
Date/Time Analyzed	Extended Qualifiers (as separate page)

A complete electronic data package contains the analytical reports, the external chain of custody records, sample shipping documentation, and any other relevant project information. Department Reference Sheets explaining acronyms, qualifiers, and method references are also included. All of these documents are an integral part of the final data package and must always be viewed as a whole. To prevent the separation of reports, each page identifies the project number, the sequential page number, and the total number of pages in the data package. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for more detail.

If requested by a client, custom and standard Electronic data deliverables (EDDs) are generated by the Document Control department. These deliverables, containing data in client specified format, are sent by e-mail with the client report. EDDs and analytical reports access data from the same Oracle tables, thus eliminating the possibility of inconsistent results. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for more detail.

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Results may be reported in a simplified manner for internal customers or in accordance to a written agreement with a customer.

18.3.1 ACZ Report Packages

ACZ provides different levels of data packages based on client request. ACZ defines the different levels as follows:

Level 2: Standard analytical reports

Level 3: Standard analytical reports; Electronic Data Deliverable (EDD); Standard QC summary

Level 4A: Standard analytical reports, Extended QC Summary (standard QC plus calibration verification checks, interference checks and serial dilutions) EDD, raw data and run logs. This package can be provided either on a disk or in a full paginated data package with the raw data

Level 4B: "CLP like" data package: CLP like forms 1-12; Run Logs and raw data incorporated into the full paginated data package.

NOTE: Surcharges apply for non-standard reports.

18.4 Data Confidentiality

ACZ has an obligation to each client to maintain custody of samples, data, and reports and to keep all data or other information confidential. To uphold this responsibility, ACZ retains custody of the information at all times – data or other client information obtained by ACZ is not allowed to leave the premises. This includes but is not limited to Chains of Custody, raw data, workgroups, run logs, logbooks, reports, QC summaries, data packages and other media containing data. Client data cannot be released to anyone except the client (as directed on the Chain of Custody) or the client's designated representative, and project data, including any client information, is not to be discussed with anyone other than ACZ employees and/or the client without first receiving written permission from the client. Additionally, client-specific information is not to be documented on raw data, workgroups, logbooks, or other records that may be provided to any client as part of an extended data package. All information must be referenced using only the ACZ log-In number. Refer to ACZ's SOP *Data Integrity Principles and Policies* (SOPAD039) for additional details of policies pertaining to confidentiality.

External access to the ACZ network is limited to employees that may need to access information remotely. Employees requiring such access use ACZ's Virtual Private Network (VPN). The VPN client is setup on the employee's computer so that it adheres to ACZ security standards. These standards include (1) a unique user name (2) a password with at least 12 characters, and (3) 128 bit encryption of data to and from the client from the ACZ servers. After the VPN server has authenticated the employee, the employee must logon to the ACZ domain through normal domain security in order to access any ACZ network resources. Most employees initiate a "Remote Desktop" connection to their office PCs, thus ensuring that ACZ data is never accessible from the client PC hard drive.

18.5 Client Feedback

Handling client feedback is a joint effort between QA, Project Managers, Laboratory Department Supervisors, and Client Service representatives. If a client has a concern or complaint, either a Project Manager or Client Service Representative takes the call and initiates the feedback procedure by documenting the complaint or problem and requesting the assistance of the Laboratory Department Supervisor and/or QA Officer. If the issue cannot be easily resolved, then it must be documented using FRMAD024, which is routed from the initiator to other appropriate parties, including the QAO if necessary. All client feedback is submitted to management as part of the Management Review of the Quality System. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

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19 FACILITIES

ACZ Laboratories, Inc. inhabits a modern 31,000 square foot laboratory facility architecturally designed and specifically organized to ensure efficient operation and meet the needs of a large capacity analytical laboratory. Complete lists of instrumentation, balances, thermometers, & weight sets are maintained on a network drive. Incompatible activities are effectively separated. Refer to FRMQA066 for ACZ's floor plan.

19.1 Accommodation of Environmental Test Conditions

19.1.1 Temperature and room pressure are controlled by an HVAC system which maintains 19 independent zones. The clean room, metals lab, and organic instrument lab are kept under positive pressure to prevent contaminant infiltration. The radiochemistry and organic prep labs are kept under negative pressure to prevent the migration of fire, smoke, and chemical releases from the laboratory space. All other zones are maintained at a neutral pressure.

19.1.2 In humid environments, a sudden rise in temperature can result in condensation on microcircuitry leading to problems such as reduced life cycle, inaccurate readings, corrosion, etc. Due to the laboratory's location at 6730 feet above sea level, these concerns are irrelevant and humidity monitoring is only required for desiccators and the clean room.

19.1.3 Servers have a 20 minute backup power supply. If there is an interruption in power, the IT Manager receives a text. This provides sufficient time to ramp down the servers.

19.2 Security

A secure facility is essential to maintaining sample and data integrity and to providing safety to employees and visitors. ACZ has an electronic security system, which controls and limits access to only authorized personnel. The following steps have been taken to ensure this security:

- All entryways are secured. ACZ has three entries equipped with proximity readers which allow access to an employee only after he/she presents their access card. Access to the front visitor entry is controlled by an interior push button monitored by ACZ staff.
- All employees are required to use their access cards to enter and exit the building.
- If any employee does not have their access card, they must sign in at the front desk. This ensures a record is maintained of which personnel were in the building at any time. A temporary access card will then be activated and issued to the employee for the day. These access cards are identified by the word "Temporary" written on a scenic background.
- During normal business hours, public access into the building can be made at the front entrance and the west shipping entrance. Both doors are equipped with a buzzer.
- Visitors must enter and exit through the main entrance and must sign the register at the front desk upon arrival and before departure. A visitor pass is issued at sign in and collected at sign out. There are two types of visitor passes. A red pass identified by the word "Visitor", will not function as an access card and symbolizes the visitor requires an escort. The other visitor pass is identified by the word "Visitor Pass" written on a scenic background and will not function as an access card. This visitor does not require an escort. The determination of which pass the visitor gets is made first, by the visitor's trust level and, second, by the visitors access needs. Visitor passes must be collected when the visitor leaves for the day.
- Companies or individuals under contract to perform recurring or extensive work for ACZ are assigned an access card similar to employees. Contractor passes function as an access card for a defined period of time commensurate with the contract work.
- Emergency Exit doors are to be used only for emergency purposes. If a door is opened, an alarm will sound.
- Loaning or transferring access cards to anyone, including other ACZ employees, is prohibited.

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20 RADIOCHEMISTRY

20.1 DATA TRANSFORMATION

ACZ's radiochemistry department utilizes excel spreadsheets to transform instrument response into final results. Spreadsheet equations are locked and password protected in order to reduce the likelihood of inadvertent modifications. Additionally, spreadsheet equations are validated by the radiochemistry supervisor or a sufficiently experienced analyst on an annual basis. Initial validation must be performed by hand calculating results. Annual validation may be performed by populating the current template with data that has been hand calculated in a previous validation and comparing the calculated results from the current template to the hand calculated results from the previous validation. Documented secondary review is required for all updates to spreadsheet templates (e.g. incorporating new mass attenuation coefficients).

20.2 INSTRUMENTATION

Radioanalytical instrumentation is located adjacent to the radiochemistry prep lab. In order to maintain appropriate temperature control in the instrument lab, separation must be maintained. The door between the two lab areas must be kept closed when not in use. Except as noted, instrument checks and other determinations must be performed and documented annually, or more often if necessary.

NOTE: To eliminate potential contamination, planchets must be stored in a covered container or in a drawer.

20.2.1 Gas-Flow Proportional Counter

20.2.1.1 Instrument Reliability Test (Voltage Plateau Determination) – The proper voltage plateau for alpha and beta is where the counting rate is consistent (should not exceed > 5% over a 150 volt change in anode voltage).

20.2.1.2 Cross Talk (Carryover) Check - Cross talk is defined as the percentage of alpha counts represented on the beta plateau. Once the amount of cross talk is determined, the cross talk settings are adjusted on the instrument to eliminate cross talk.

20.2.1.3 Detector Efficiency Curve (Self Absorption) - Efficiency curves are graphs plotting counts versus sample residue density and determine the efficiency of the alpha and beta counter as a function of sample residue density. This factor is part of the overall determination of sample activity.

20.2.1.4 Background Determination - Characteristic of most detectors is a background or instrument count rate attributed to cosmic radiation, radioactive contaminants in instrument parts, counting room construction material and/or the proximity of radioactive sources. The background is determined weekly by counting an empty planchet for 12 hours. On each day of use the instrument is checked for background drift by counting an empty planchet for 90 minutes. Background counts must fall within established control chart limits or corrective action must be taken before analyzing samples. Although most radiation measurement systems are noteworthy for their stability, sudden changes can occur due to instrument component failure, loss of gas pressure, vacuum, or contamination of a detector or sample chamber from a high activity sample. Subsequently, instrument drift in detector efficiency and background must be checked both before and after measuring samples used for drinking water compliance monitoring. Refer to individual test SOPs for additional details.

20.2.1.5 Instrument-Response Check (Performance Check) – This continuing calibration check verifies the instrument response and stability and is performed daily for each detector. For a performance check measurement, the same calibration sources must be used as for the calibration measurement in order to verify the current measuring results still match the results of the calibration measurement stored last. At the end of the check the count rates and the relative deviations from older calibration measurements are displayed. The system signals

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"OK" if the deviations do not exceed the maximum deviation defined by the user. Samples used for drinking water compliance monitoring must be bracketed by passing performance checks. Refer to individual test SOPs for additional detail.

20.2.2 Liquid Scintillation Counter

20.2.2.1 *Optimal Window* - When determining radionuclides by liquid scintillation, it is necessary to select the optimal window by counting a standard for five minutes and generating a sample spectrum. For better clarity, a log scale for the channel number axis should be used. On the graph, the region of interest is determined by the energy of the peak one is trying to quantitate. The optimal window is formed by extending this region by 10% on each side of the alpha peaks.

20.2.2.2 *Efficiency Quench Curve* – The liquid scintillation instrument, a Beckman LS 6000TA, automatically corrects for quenching by the H - Method. Refer to SOPRC010 for details.

20.2.2.3 *Background Check* - Three background blanks are run with every batch. The first two are run immediately after calibration. The third, the CCB, is employed as a measurement of instrument drift and is run immediately before the final LCS. For both checks, the counting duration must be equivalent to the longest sample counting duration.

20.2.2.4 *Instrument-Response Check Source* - This continuing calibration check verifies instrument response and stability and must be performed daily. If the source count is within two standard deviations (sigma) of the previously determined average count rate, instrument reliability and stability is established. If the source rate is outside the ±2 sigma-warning limit then the variability should be further investigated. If the source check is outside the ±3 sigma out of control limits, then no further samples should be analyzed until the problem is resolved. Resolution might include a new efficiency curve, background checks, and/or instrument maintenance. If insufficient data exists for control charts, ±10% of the initial source value is considered acceptable. The source for this check is a Tritium standard.

20.2.3 Alpha Spectrometer

20.2.3.1 *Energy vs. Channel Calibration* - Each alpha spectrometer has a set number of channels associated with it. To associate these channels to a specific alpha particle, the channels must be calibrated. One known calibrated solid source is placed into the detector and analyzed for five minutes to determine its associated channel to its calibrated energy peak. Since the energy is linear across the channels, all of the channels now have an associated energy. This determination is performed on an annual basis, or whenever maintenance is performed that could potentially affect the calibration.

20.2.3.2 *Background Checks* - Characteristic of most detectors is a background or instrument count rate attributed to cosmic radiation, radioactive contaminants in instrument parts, counting room construction material and/or the proximity of radioactive sources. Placing an empty sample tray in the counting chamber and counting it for as long as the longest sample-counting duration can determine the background rate (or a background check can be completed overnight). An overnight background determination must be completed at least quarterly.

20.2.3.3 *Instrument-Response Check Source* - This continuing calibration check verifies the instrument response and stability and is performed daily. If the source count is within two standard deviations (sigma) of the previously determined average count rate, instrument reliability and stability is established. If the source rate is outside the ±2 sigma-warning limit, then the variability should be further investigated. If the source check is outside the ±3 sigma out of control limits, then no further samples should be analyzed until the problem is resolved. Resolution might include a background check, and/or instrument maintenance. If insufficient

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data exists for control charts then ±10% of the true value is considered acceptable.

20.2.4 Gamma Spectrometer

20.2.4.1 *Background Checks* –Characteristic of most detectors is a background or instrument count rate attributed to cosmic radiation, radioactive contaminants in instrument parts, counting room construction material and/or the proximity of radioactive sources. A cave background must be measured monthly and the background gross activity recorded. The cave background is determined by counting the empty cave for a period of time at least as long as the longest sample-counting duration. When drinking water samples are present in the batch, and additional background check is measured at the end of the batch to monitor instrument drift.

20.2.4.2 *Instrument-Response Check (Performance Check)*- The total activity of a calibration or check source will check the efficiency calibration currently in use and the general operating parameters of the system, including source positioning, contamination, library values, and energy calibration. This activity calculation uses the general analysis program to ensure that the total system is checked. This check is performed for every workgroup. If the performance check is within the defined acceptance limits, instrument reliability and stability is established. If the performance check does not meet acceptance criteria, then no further samples should be analyzed until the problem is resolved. Samples used for drinking water compliance monitoring must be bracketed by acceptable performance checks. Resolution might include a background check, and/or instrument maintenance. Refer to SOPRC016 for additional information.

21 CERTIFICATIONS

ACZ has primary or secondary (reciprocal) certification with numerous states and EPA regions. Current certificates can be viewed at http://acz.com/certifications/. Each certificate contains a scope of accreditation listing each method the laboratory is accredited for by the issuing authority.

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APPENDIX A REFERENCES UTILIZED BY ACZ

- "TNI Standards," National Environmental Laboratory Accreditation Conference, (current version).
- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act," USEPA, Federal Register Vol. 67, No. 205, October 23, 2002.
- "Manual for the Certification of Laboratories Analyzing Drinking Water," USEPA, (current version).
- "Methods for the Chemical Analysis of Water and Wastes," USEPA, EPA-600/4-79-020, March 1983.
- "Test Methods for Evaluating Solid Waste," USEPA, SW-846 Third Edition, Update IV, January 2008.
- "Guidelines in Establishing Test Procedures for the Analysis of Wastewater Pollutants," Code of Federal Regulations 40, Parts 136, 141, 143.
- "Quality Assurance of Chemical Measurements," Taylor, J., Lewis Publishers, Michigan, 1987
- "Annual Book of Standards, Water Analysis," ASTM, 1989.
- "Quality Control in Analytical Chemistry," Kateman, G., Vol. 60, 1985.
- "Principles of Environmental Analysis, Analytical Chemistry," Keith, L.H., et al., Vol. 55, 1983.
- "Handbook for Analytical Quality Control in Water and Wastewater Laboratories," USEPA, 1979.
- "Guidance for the Data Quality Assessment: Practical Methods for Data Analysis," USEPA, EPA 600/R-96-084, July 2000.
- "Methods for the Determination of Metals in Environmental Samples," USEPA, EPA 600/4-91-010, June 1991.
- "Methods for the Determination of Metals in Environmental Samples," Supplement I [to EPA 600/4-91-010], USEPA, EPA 600/R-94-111, May 1994.
- "Methods for the Determination of Inorganic Substances in Environmental Samples," USEPA, EPA 600/R-93-100, August 1993.
- "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," USEPA, EPA 821/B-96-005, December 1996.
- "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," USEPA, EPA 600/4-80-032. August 1980.
- "Determination of Lead-210, Thorium, Plutonium and Polonium-210 in Drinking Water: Methods 909, 910, 911, 912," 01A0004860 (Region 1 Library), March 1982.
- "Good Automated Laboratory Practices - Principles and Guidance to Regulations for Ensuring Data Integrity in Automated Laboratory Operations" USEPA, 2185, 1995.
- "Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications", ASTM E29-08

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APPENDIX B DEFINITIONS OF TERMS

Acceptance Criteria: specified limits places on characteristics of an item, process, or service defined in requirement documents.

Accreditation: verification by a competent, disinterested, third party that a laboratory possesses the capability to produce accurate test data, and that it can be relied upon in its day-to-day operations to maintain high standards of performance.

Accrediting Body: The Territorial, State, or Federal agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation.

Accreditation body: Authoritative body that performs accreditation.

Accuracy: the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

Aliquot: A discrete, measured, representative portion of a sample taken for analysis.

Analyte: The specific chemicals or components for which a sample is analyzed; it may be a group of chemicals that belong to the same chemical family, and which are analyzed together. (EPA Risk Assessment Guide for Superfund; OSHA Glossary)

Analytical Spike (AS): an aliquot of client sample to which a known amount of target analyte is added and that demonstrates the absence or presence of interference in the matrix. The AS is prepared exactly the same way as the LFB, only spiking into sample instead of reagent blank, and is not prepped (digested) prior to analysis. The AS may also be referred to as a post-digestion spike.

Analytical Spike Duplicate (ASD): a second replicate analytical spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Analytical System: the combination of events, techniques, and procedures used to generate analytical results.

Analyst Review (AREV): See Primary Review.

Atomization: A process in which a sample is converted to free atoms.

Audit: a systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity.

Batch: environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same matrix, meeting the above criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of 20 or less prepared environmental samples (extracts, digestates or concentrates) that are analyzed together as a group. QC samples (e.g. LCS, MS, MSD) do not count towards the maximum of 20.

All required QC samples must be prepared and/or analyzed with each batch at the frequency required by the method, even if there are less than 20 client samples in the batch. If the workgroup has more than 20 samples, then sufficient batch QC must be analyzed for additional samples. Every batch of environmental samples is assigned a unique (i.e. traceable) six-digit numerical identifier called the LIMS Workgroup number.

Blank: a sample that has not been exposed to the analyzed sample stream utilized to monitor contamination during sampling, transport, storage, or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical

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results. See also Equipment Blank, Field Blank, Instrument Blank, Method Blank, Reagent Blank. Refer to §11.3 for types of blanks.

Blind Sample: a sub-sample for analysis with a composition known to the submitter. The analyst or laboratory may know the identity of the sample but not its composition. It is used to test the analyst or laboratory's proficiency in the execution of the measurement process.

Calibration: to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of applied calibration standard should bracket the range of planned or expected sample measurements.

Calibration Curve: the graphical relationship between the known values, such as concentrations, or a series of calibration standards and their instrument responses.

Calibration Range: The range of values (concentrations) between the lowest and highest calibration standards of a multi-level calibration curve. For metals analysis with a single-point calibration, the low-level calibration check standard and the high standard establish the linear calibration range, which lies within the linear dynamic range.

Case Narrative: Additional documentation provided in the client report that describes any abnormalities and deviations that may affect the analytical results and summarizes any issues in the data package that need to be highlighted for the data user to help them assess the usability of the data.

Certified Reference Material (CRM): A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body.

Chain of Custody Form: a legal record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses.

Client: Any individual or organization for whom items or services are furnished or work performed in response to defined requirements and expectations. (ANSI/ASQ E4-2004)

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to:

- Second column confirmation;
- Alternate wavelength;
- Derivatization;
- Mass spectral interpretation;
- Alternative detectors; or
- Additional cleanup procedures. (TNI)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ ASQC E4-1994)

Congener: A member of a class of related chemical compounds (e.g., PCBs, PCDDs)

Continuing Calibration Blank (CCB): the same solution as the calibration blank, it detects baseline drift in the calibration of the instrument. When specified by the method, analyze a CCB immediately after each CCV, including the final CCV.

Continuing Calibration Verification (CCV): a solution of method analytes of known concentrations used to confirm the continued calibration of the instrument. The CCV is analyzed at the frequency indicated in the test SOP.

Corrective Action: the action taken to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence.

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Data Audit: a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e. the data meet specified acceptance criteria)

Data Reduction: the process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form.

Definitive Data: Analytical data of known quality, concentration, and level of uncertainty. The levels of quality and uncertainty of the analytical data are consistent with the requirements for the decision to be made. Suitable for final decision-making. (UFP-QAPP)

Demonstration of Capability (DOC): a procedure to establish the ability of the analyst to generate acceptable accuracy [and precision, if applicable].

Detection Limit: the lowest concentration or amount of target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value (see Method Detection Limit).

Digestion: A process in which a sample is treated (usually in conjunction with heat) to convert the sample to a more easily measured form.

Document Control: the act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

Eluent: A solvent used to carry the components of a mixture though a stationary phase. (Skoog, West, and Holler. *Fundamentals of Analytical Chemistry*. 1992)

Elute: To extract; specifically, to remove (adsorbed material) from an adsorbent by means of a solvent. (Merriam-Webster's Collegiate Dictionary, 2000)

Elution: A process in which solutes are washed though a stationary phase by the movement of a mobile phase. (Skoog, West, and Holler. *Fundamentals of Analytical Chemistry*. 1992)

Equipment Blank: a sample of analyte-free media that has been used to rinse common sampling equipment to check the effectiveness of decontamination procedures.

False Positive (Type I or alpha error): concluding that a substance is present when it truly is not.

False Negative (Type II or beta error): concluding that a substance is not present when it truly is.

Field Blank: a blank prepared in the field by filling a clean container with Type I water and appropriate preservative, if any, for the specific sampling activity being undertaken.

Holding Time (Maximum Allowable Holding Time): the maximum time that samples may be held prior to analysis and still be considered valid or not compromised.

Homologue: One in a series of organic compounds in which each successive member has one more chemical group in its molecule than the next preceding member. For instance, CH3OH (methanol), C2H5OH (ethanol), C3H7OH (propanol), C4H9OH (butanol), etc., form a homologous series. (*The Condensed Chemical Dictionary* G.G. Hawley, ed. 1981)

Initial Calibration Blank (ICB): a solution identical to the calibration blank and confirms the absence of background contamination in the calibration blank. When specified by the method, an ICB is analyzed immediately after the ICV.

Initial Calibration Verification (ICV): a solution of method analytes of known concentrations intended to determine the validity of the instrument calibration. The ICV must be analyzed immediately after each

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calibration and must be prepared from a source independent of the calibration standards, preferably purchased from a different manufacturer.

Instrument Blank: an aliquot of Type I water or solvent processed through the instrument steps of the measurement process; used to determine presence of instrument contamination.

Interference, spectral: Occurs when particulate matter from the atomization scatters the incident radiation from the source or when the absorption or emission of an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible. (Skoog, West, and Holler. *Fundamentals of Analytical Chemistry*. 1992)

Interference, chemical: Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte. (Skoog, West, and Holler. *Fundamentals of Analytical Chemistry*. 1992)

Internal Standard (IS): a known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Isomer: One of two or more compounds, radicals, or ions that contain the same number of atoms of the same elements but differ in structural arrangement and properties. For example, hexane (C6H14) could be n-hexane, 2-methylpentane, 3-methylpentane, 2,3-dimethylbutane, 2,2-dimethylbutane. (Websters)

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

Laboratory Fortified Blank (LFB): a reagent blank spiked with a known concentration of analyte. The LFB is analyzed exactly like a sample and determines whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

Legal Chain of Custody Protocols: procedures employed to record the possession of samples from the time of sampling until analysis and are performed at the special request of the client. These protocols include the use of a Chain of Custody form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

Linear Dynamic Range (LDR): concentration range over which the instrument response to analyte is linear.

Matrix Duplicate (DUP): a second aliquot of a client sample that is prepared and analyzed in the same manner as all other samples in the same workgroup. The DUP demonstrates the precision of the method.

Matrix Spike (spiked sample or fortified sample): a sample prepared by adding a known amount of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes (MS or LFM) are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate: a second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Maximum Contamination Limit (MCL): the numerical value expressing the maximum permissible level of contaminant in water that is delivered to any user of a public water system.

May: denotes permitted action, but not required action.

Measurement Quality Objectives (MQOs): The desired sensitivity, range, precision, and bias of a measurement.

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Measurement System: A test method, as implemented at a particular laboratory, and which includes the equipment used to perform the test and the operator(s).

Method Blank: a sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as client samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for the sample analyses.

Method Detection Limit: the minimum concentration of an analyte, in a given fortified matrix, that can be measured and reported with 99% confidence that the concentration is greater than zero.

Method of Standard Additions: A set of procedures adding one or more increments of a standard solution to sample aliquots of the same size in order to overcome inherent matrix effects. The procedures encompass the extrapolation back to obtain the sample concentration. (This process is often called spiking the sample.) (Modified Skoog, Holler, and Nieman. Principles of Instrumental Analysis. 1998)

Must: denotes a requirement.

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Nonconformance: An indication or judgment that a product or service has not met the requirement of the relevant specifications, contract, or regulation; also the state of failing to meet the requirements.

Outlier (Statistical): an observation or data point that deviates markedly from other members of the population.

Performance Audit: the routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

Preservation: refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

Primary Review (AREV): The first level of data review conducted after data has been generated and uploaded to LIMS. Primary review is typically conducted by the analyst who generated the data but may be performed by another authorized individual. Quality control and corrective actions are evaluated as part of this review. Where acceptance criteria fails, samples are scheduled for re-preparation and/or re-analysis or data is appropriately qualified.

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source.

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Testing Study Provider: Any person, private party, or government entity that meets stringent criteria to produce and distribute TNI PT samples, evaluate study results against published performance criteria and report the results to the laboratories, primary accrediting authorities, PTOB/PTPA, and TNI.

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Proficiency Test Sample (PT): A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (QAMS)

Protocol: a detailed written procedure [SOP] for laboratory operation that must be strictly followed.

Quality Assurance: an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality.

Quality Control: the overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users.

Quality Manual [QAP]: a document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.

Quality System: a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products, and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance and quality control.

Quantitation Limit [Limit of Quantitation, Practical Quantitation Limit]: level, concentration, or quantity of a target variable (i.e. target analyte) below which data is reported as estimated. The quantitation limit may or may not be statistically determined, or may be an estimate that is based upon analyst experience or judgment.

Quantity Sufficient (QS): Refers to the addition of appropriate diluent to the solution to achieve the final volume.

Raw Data: any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for reconstructing and evaluating the report of the activity or study.

Reagent Blank (method reagent blank): a sample consisting only of Type I water and reagent(s) without the target analyte(s) or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.

Reference Method: a method of known and documented accuracy and precision issued by an organization recognized as competent to do so (EPA, etc.). The reference method is included on the client report.

Reporting Limit (RL): The lowest analyte level (concentration or mass) the laboratory will report as a detected result. ACZ's default reporting limit is the MDL; however the RL may be defined as the PQL or another level dependent on project needs.

Retention Time: The time between sample injection and the appearance of a solute peak at the detector. (Skoog, West, and Holler. *Fundamentals of Analytical Chemistry*. 1992)

Sample: Portion of material collected for analysis, identified by a single, unique alphanumeric code. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis

Sample Tracking: procedures employed to record the possession of the samples from the time of sampling until analysis, reporting, and archiving. These procedures include the use of a Chain of Custody form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.

Secondary Review (SREV): The second level of data review conducted after primary review (AREV) has been completed. Secondary review is typically conducted by the pertinent department supervisor but may be performed by another authorized individual. Quality control and corrective actions are evaluated as part of this review. Data qualifiers and sample statuses assigned at AREV are evaluated and corrected if necessary.

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Selectivity: (Analytical chemistry) The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. (EPA-QAD)

Sensitivity: the capability of a method or instrument to discriminate between measurement responses representing different levels (i.e. concentrations) of a variable of interest.

Shall: denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there is no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled.

Should: denotes a guideline of recommendation whenever noncompliance with the specification is permissible.

Signal to Noise Ratio (S/N): a dimensionless measure of the relative strength of an analytical signal (S) to the average strength of the background instrumental noise (N) for a particular sample.

Spike: a known amount of target analyte added to a blank sample or client sub-sample; used to determine the recovery efficiency or for other quality control purposes.

Standard Deviation: the measure of the degree of agreement (precision) among replicate analyses of a sample. The population standard deviation (n degrees of freedom) should only be used for more than 25 data points; otherwise, when referenced, standard deviation implies sample standard deviation (n-1 degrees of freedom).

Standard Operating Procedure (SOP): a written document which details the manner in which an operation, analysis, or action is performed. The techniques and procedures are thoroughly prescribed in the SOP and are the accepted process for performing certain routine or repetitive tasks.

Supervisor [however named]: the individual designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training, and experience to perform the required analyses.

Surrogate (SURR): a substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.

Test Method: adoptions of a scientific technique for a specific measurement problem, as documented in a laboratory SOP or published by a recognized authority.

The NELAC Institute (TNI): a voluntary organization of state and federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories.

Traceability: the property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.

Tuning: A check and/or adjustment of instrument performance for mass spectrometry as required by the method.

Validation: The confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

Verification: Confirmation by examination and provision of evidence that specified requirements have been met.

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APPENDIX C TECHNICAL DIRECTORS

Name	Department	Degree
Steve Pulford	Metals	BS, Chemical Engineering, Minor in Biochemistry
Gus Torde	Organics	BS, Chemistry
Alyssa Dybala	Wet Chemistry	BS, Pharmaceutical Marketing
Matt Sowards	Radiochemistry (reserve) Wet Chemistry	BA, Neuroscience
Keith Hensley	Wet Chemistry	BS, Chemistry & Biology
Brett Dalke	Geochemistry	BA, Geology & English
Mark McNeal	Radiochemistry	BS, Biology
If a technical director is absent for a period exceeding fifteen calendar days, another qualified full time employee shall be assigned to temporarily fulfill the duties of technical director. Defined reserve technical directors shall assume these duties by default. Where reserves are not yet defined, management shall appoint a qualified individual as necessary. If a technical director is absent for more than 34 days, it is the QAO's (or delegee's) responsibility to notify accrediting bodies in writing.		

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GPO Appendix 01
Attachment A
Subattachment e
Laboratory Data Review and Validation Checklist

LABORATORY DATA REVIEW AND VALIDATION CHECKLIST – GREENS CREEK PROJECT					
Sample Point(s):		Laboratory #(s):			
Parameter list requested:		Date Samples Collected:			
		Date Samples Received by Lab:			
Category		**Yes**	**No**	**N/A**	**Comments**
Reported Data					
1. COC & other field documents included?					
2. All reporting requirements satisfied?					
3. Parameters reported match parameters requested?					
4. Methods reported match methods requested?					
5. Reporting limits and units as requested?					
6. Electronic file matches hard copy?					
Sample Analysis					
1. Analysis holding times met?					
Laboratory QA/QC Requirements					
1. Blanks	proper frequency?				
	acceptance criteria met?				
2. LCSs	proper frequency?				
	acceptance criteria met?				
3. Spikes	proper frequency?				
	acceptance criteria met?				
4. Duplicates	proper frequency?				
	acceptance criteria met?				
General *Note any additional comments/observations on back of sheet.*					
1. Are sample results consistent with historical data for specific sample point(s)?					
Reviewed by:			**Date:**		

FIELD DATA REVIEW AND VALIDATION CHECKLIST – GREENS CREEK PROJECT				
Sample Point(s):	Date Collected:			
	Date Shipped to Lab:			
	Collected By:			
Category	**Yes**	**No**	**N/A**	**Comments**
Reported Data				
1. Are all appropriate data fields filled out?				
2. Are water level data measurements calculated and recorded correctly?				
3. Are flow measurements calculated and recorded correctly?				
General				
1. Are sample results for field measurements consistent with historical data for specific sample point(s)?				
2. Note additional comments/observations (use back of sheet if necessary):				
Reviewed by:	**Date:**			

CORRECTIVE ACTION FORM

Sample I.D.(s)_____ **Date Sampled** _____

Laboratory Job Number(s)_____ **Date Analyzed** _____

Reviewed By_____

Describe the deficiency:
Document all correspondence involved:
(Include date and time of the communication(s), as well as the name and position of all individuals contacted. Also include a synopsis of each communication, attach extra pages as necessary)

Define a corrective action:

Explain the resolution:

GPO Appendix 01
Attachment A
Subattachment f
Chester LabNet Quality Assurance Management Plan

Quality Assurance Management Plan

CHESTER LabNet

12242 S.W. Garden Place, Bldg. 1
Tigard, Oregon 97223
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www.chesterlab.net

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Paul Duda – President, Laboratory Director, LIMS Administrator, Client Services Technical Director

Sheri Heldstab – QA Officer, Conventional Chemistry Laboratory Technical Director, Analyst

Richard Sarver - XRF Laboratory Technical Director, XRF Analyst

Lisa Ball – Project Manager, Sample Custodian

Jennifer (Jen) Schleis – Gravimetry Laboratory Technical Director & Technician, XRF Analyst, Analyst

T. Mike May - Analyst, Gravimetry Laboratory Technician

Julie Delarue – Analyst, Gravimetry Laboratory Technician, XRF Analyst

Theodore (Ted) Perry – Analyst, Gravimetry Laboratory Technician, Chemical Hygiene Officer, Health and Safety Officer

Kevin Healey – Gravimetry Laboratory Technician

This document supplants any previous versions.

Revision Number:	**February, 2019**	**Effective Date:**	**5 March 2019**
Document Number:	QAMP March 2019		

Review History

Review Date	Changes	Author
2/13/19	Reinserted references to 2009 TNI standard. Updated changes in staffing, equipment and SOP lists. Added rounding rules, significant figures protocol, and protocol for determination of LL-LCS and LL-CCV acceptance limits. Added information on thermometer calibrations, volumetric ware verification and tracking, and sampling media being exempted from DL study. Changed initial calibration requirements.	S. Heldstab
2/27/18	Updated changes in staffing, equipment, and SOP lists. Updated to 2016 TNI Standard requirements (primarily Appendix H). Added LL-CCV and LL-LCS requirements. Changed "Limit of Detection" to "Detection Limit" per 2016 TNI Standard. Added definitions in glossary to reflect those in 2016 TNI Standard. Defined "absence" for Technical Directors and QA Officer.	S. Heldstab
1/31/17	Updated changes in staffing, equipment, and SOP lists. Typographical and grammatical errors corrected.	S. Heldstab
1/25/16	Updated changes in staffing, equipment, and SOP lists. Typographical and grammatical errors corrected.	S. Heldstab
1/28/15	Updated changes in staffing, equipment, floorplan and SOP lists. Typographical and grammatical errors corrected.	S. Heldstab
1/15/14	Updated changes in accredited methods, staffing, equipment, SOP lists. Typographical and grammatical errors corrected.	S. Heldstab
2/21/13	Updated changes in accredited methods, staffing, equipment, SOP lists. Typographical and grammatical errors corrected.	S. Heldstab
1/8/12	Updated to NELAC template. Updated Personnel and Organizational Structure to reflect current staffing, capital equipment and manuals lists. Updated floor plan to reflect current floor plan; build-out is on-going.	S. Heldstab
6/14/11	Updated to NELAC template. Updated Personnel and Organizational Structure to reflect current staffing, capital equipment and manuals lists. (Revision incomplete)	S. Heldstab
2/17/11	Updated equipment and manuals lists. Changed client surveys section.	S. Heldstab
2/26/10	Changed Personnel and Organizational Structure to reflect current staffing. Minor clarifications to text.	S. Heldstab
2/12/09	Minor changes to text.	S. Heldstab
12/16/08	Changed Personnel and Organizational Structure to reflect current staffing. Minor clarifications to text.	S. Heldstab
2/19/08	Changed Personnel Organizational Structure to reflect staffing, incorporated new equipment to Capital Equipment Inventory, added section to 'Backup of LIMS System' to include other computers containing essential information, updated final data report page, minor changes to text for clarification.	J. Schleis

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Review Date	Changes	Author
2/15/07	Changed Corrective Action Report documentation system, minor change to quality policy statement to include metric reviewable goals, moved 'Traceability of Measurements' section to Section 7, added section on client surveys, merged client complaints & corrective action documentation into a single system, added appendices "Listing of Document Locations" and "Glossary & Definitions of Terminology"	S. Heldstab
2/5/07	Changed references to staffing where staffing has changed, added text on handling of PE samples to Section 10.6, added section on detection limits (7.8), added details for clarification throughout.	S. Heldstab
2/7/06	Definition of "basic laboratory skills" added to Personnel qualifications, SOP formatting elements changed to reflect new NELAC-compliant format, acceptance/rejection criteria for non-standard methods added, section added on documentation of customer inquiries/complaints, updated staff resumes, updated SOP listing, added 'failure to report' to the list of breaches of ethical behavior in Appendix D.	S. Heldstab
7/8/05	Expanded Section 7.7, revised Section 10.4 and 10.5 to reflect new internal audit process, updated staff references.	S. Heldstab
1/5/05	Added Appendix D (Ethics training).	S. Heldstab
10/21/04	Major updating to incorporate elements of NELAC/ORLAP requirements. Sections 3.3.2.1, 7.3–7.7, 8.2.4-8.2.7, 8.3, 8.3.1–8.3.5, 8.4, 9.4, 10.6–10.8, 11.8–11.10 added.	S. Heldstab
1/23/04	Updated floor plan and Capital inventory table. Minor grammatical changes.	S. Heldstab
3/10/03	Changes in organization of Section 3. No changes to content, only to formatting.	S. Heldstab
12/10/02	Minor changes to text, some text rearranged for clarity and conciseness.	S. Heldstab
11/8/01	This document has been in existence since at least 1988. The number and types of revisions are unknown. As of this date, the document is being revised to standardize the formatting of ***CHESTER LabNet*** documents.	S. Heldstab
Unknown	No Changes - date of origination.	C.R. Lytle

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Concurrences

The following approved signatories, by their signature, attest to having read and understood the most current version of the Quality Assurance Management Plan for CHESTER LabNet:

Name	Title(s)/Responsibility(ies)	Initials	Signature	Date
Paul Duda	President Laboratory Director LIMS Administrator Customer Service Technical Director	PDD		2/27/19
Sheri Heldstab	QA Officer Conventional Chemistry Laboratory Technical Director Lead Analyst	SH		2·21·19
Lisa Ball	Project Manager Sample Custodian	LMB		3·4·19
Rick Sarver	XRF Technical Director Lead XRF Analyst	RS		3·1·19
Jennifer (Jen) Schleis	Gravimetry Laboratory Technical Director Lead Gravimetry Laboratory Technician XRF Technician Analyst	JMS		3.03.19
T. Mike May	Analyst Gravimetry Laboratory Technician	TMM		3.03.19
Julie Delarue	Analyst Gravimetry Laboratory Technician XRF Technician	JD		3·5·19
Theodore (Ted) Perry	Analyst Gravimetry Laboratory Technician Chemical Hygiene Officer Health & Safety Officer	TP		2·27·19
Kevin Healey	Gravimetry Laboratory Technician	KH		3·4·19

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Disclaimer

In 2011, ORELAP, the accrediting body for the state of Oregon, requested that the laboratory use the 2009 TNI Standard QAMP Template in creating its QAMP, to make it easier for auditors to find information. This document is organized following the 2009 TNI Standard QAMP Template, however it has been updated to include changes from the 2016 TNI Standard. Historically, all versions of the TNI Standard and its associated QAMP templates have been designed for water/soil analysis.

CHESTER LabNet specializes in inorganic air quality analyses, both ambient and source emissions. Volume 1, Module 1, Section 1.3.2 of the 2016 TNI Standard states *"This Standard applies only to fields of accreditation (FOA) that are also designated as fields of Proficiency Testing (FoPT) by the TNI Proficiency Testing Program Executive Committee (PTPEC)."* As of this writing, no ambient air or source emissions methods have FoPTs; thus, according to the 2016 TNI Standard, ***CHESTER LabNet*** is not eligible for accreditation for any ambient air or source emissions methods. However, ORELAP has accredited the laboratory for some methods since 2005, despite their ineligibility for accreditation.

Due to the significant differences between sampling gaseous samples and sampling water/soil samples, there are some requirements of the 2009 and 2016 TNI Standard which are unachievable based on the nature of the methods utilized. Throughout this document, the requirements as set forth in the 2009 and 2016 TNI Standard have been included. Also included are the reasons those requirements are not applicable to the laboratory's field of work as well as explanations of how the laboratory attempts to meet the intent, if not the letter, of the requirement.

Below is a short list of issues which are described in greater detail throughout various sections of this document:

1. "Media": This term is used throughout the 2009 and 2016 TNI Standard in reference to microbiological testing. For the purposes of air quality testing, media is generally comprised of either filters (various sizes/compositions), sorbent tubes, or solutions used in impinger trains. Most media used by the laboratory has some form of contamination present from the manufacturing process and contamination is considered a routine part of analyses. The manufacturer, not the laboratory, is responsible for the quality of the media. The laboratory does attempt to purchase the cleanest media commercially available.

2. Sampling: The laboratory performs no sampling. Most air quality methods, source or ambient, involve quite complex sampling equipment and procedures. The laboratory's clients perform the sampling, from collection to shipment. The laboratory has no control over the actions or inactions of the client in the field. Many requirements of the 2016 TNI standard make reference to sampling, sample containers and sample rejection. These requirements are not suited to the nature of air quality sampling or analysis.

3. Sample containers: To capture a gaseous sample, either a filter, an absorbing solution or a sorbent material of some sort must be used. Thus, the primary container for the sample is either "filter," "solution," or "sorbent." Secondary containers are then used for containing the sample containers. Filters may or may not be provided by the laboratory in a variety of secondary containers. Containers

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for liquids are nearly always provided by the client as the laboratory has no idea how much liquid will be collected. The absorbing solution acts as a preservative by its nature, thus, no preservatives are added to any secondary container.

4. Method selection: Air Quality methods, particularly the Code of Federal Regulations (CFR) methods, tend to not be regularly updated to incorporate technological improvements.

   CHESTER LabNet has no control over the selection of methods used during analysis. Frequently, our clients have no control over method selection either. The client is responsible to their client (the "ultimate" client), who, in turn, is typically responsible to a regulator at some governmental level (e.g., federal, state, county, city). The regulator for the particular facility or project being monitored is the body responsible for method selection. The laboratory and the laboratory's clients have little sway over the decisions of these regulators.

   In addition, some methods are in conflict with the laws of physics and are, therefore, not possible to perform as written.

   The 2016 TNI Standard has many requirements pertaining to the selection of methods to be used by the laboratory. These sections cannot be applied to the type of work performed at ***CHESTER LabNet***.

5. Proficiency Testing: Proficiency testing is required only when a field of proficiency testing table (FoPT) exists. No FoPT exists for either source or ambient air analyses, consequently, this requirement does not apply to ***CHESTER LabNet.*** Source Emissions sampling requires that an audit sample, procured from an accredited provider, be analyzed with any sample from which data will be utilized for regulatory or compliance purposes. The facility being regulated is responsible for obtaining the audit, and the regulator is responsible for choosing an appropriate concentration range for the audit. The laboratory is entirely removed from the acquisition of the audit. The client sends the audit to the laboratory along with the associated samples. This typically results in far more than two audits per year being analyzed for a given Source Emission method.

CHESTER LabNet will make every effort to meet the intent of the requirements as given in the 2009 and 2016 TNI Standard, just as it makes every effort to meet the intent and chemistry of archaic or contradictory methods.

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Section 3

INTRODUCTION AND SCOPE
(TNI V1:M2 – Sections 1, 2, 3)

The purpose of this Quality Assurance Management Plan (QAMP) is to outline the management system for ***CHESTER LabNet***. The Quality Assurance Management Plan defines the policies, procedures and documentation that assure analytical services continuously meet a defined standard of quality. That standard is designed to provide clients with data of known and documented quality and, where applicable, demonstrate regulatory compliance.

CHESTER LabNet has specialized in the inorganic analyses of ambient particulates and source emission samples since its inception as NEA, Inc. in the late 1970's. The laboratory as an organization, its management, and its personnel are committed to the production of the highest quality data achievable with current methodologies and instrumentation; and to compliance with contractual, regulatory and accreditation standards and requirements.

This QAMP is heavily based upon the 2009 TNI QAMP Template, with updates to reflect the 2009 and 2016 TNI Standard. The template is designed for water, wastewater and soil/sludge samples, and does not work well for air quality samples. As a result, many sections have been significantly modified in an effort to meet accrediting requirements. In addition, many of the requirements of the 2016 TNI Standard also do not apply to air quality sampling (ambient or source) and have been significantly modified.

The Quality Assurance Management Plan sets the standard under which all laboratory operations are performed, including the laboratory's organization, objectives and operating philosophy. The Quality Assurance Management Plan has been prepared to assure compliance with the 2009 and 2016 TNI Environmental Laboratory Sector Standard, Volume 1. This Standard is consistent with ISO/IEC 17025:2005 requirements that are relevant to the scope of environmental testing services and thus, the laboratory operates a quality system in conformance with ISO/IEC 17025:2005(E). In addition, the policies and procedures outlined are compliant with the various accreditation and certification programs listed in Appendix E of this document.

For any activity involving a service or the creation of an analytical result, quality may be defined as conformity to a given set of requirements. To ensure acceptable quality, three conditions must be met: (1) requirements and objectives must be clearly delineated before work begins; (2) the major steps in the production of the service or analytical result must have a component that allows for the control of quality, based on the end-result objectives; (3) the components of quality control must include control limits and corrective actions designed to both effectively monitor quality and modify procedures if quality is compromised.

Quality Assurance (QA) comprises the overall program elements designed to maintain any activity within the stated objectives. Examples of such program elements are: clearly stated precision and accuracy targets; written standard operating procedures for all laboratory and instrumental protocols; the selection of sample preparation and analytical methods that are most appropriate for the matrices and analytes to be encountered; etc.

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Quality Control (QC) comprises the individual checks used to monitor laboratory procedures, the precision and accuracy statistical control limits for each individual check, and the specific corrective actions to be followed when QC results are outside control limits. An example of a QC element is the matrix spike. Good quality control would set the frequency of analysis, the particular QC statistic to be used (i.e., percent recovery), the control limit (based on published statistics for the particular analysis or on QC limits developed in house), and the corrective action for QC results that are out of control.

3.1 Scope of Testing

CHESTER LabNet specializes in Inorganic Air Quality Analysis of ambient air and source emissions, including analysis of PM_{10} and $PM_{2.5}$ samples. The laboratory's scope of analytical testing services includes those listed in Appendix D.

At present, the six methods accredited are:

- Hexavalent Chromium in ambient air (modified CARB SOP MLD039 and modified ASTM D7614-12);
- 40 CFR 60 Method 202, "Condensable Particulate Matter, Rev. 12/1/2010";
- NIOSH 5040 "ELEMENTAL CARBON (DIESEL PART.)"; DRI SOP#2-216r2 (Organic & Elemental Carbon by Improve_A parameters);
- PM_{10} 40 CFR 50 Appendix J,
- $PM_{2.5}$ 40 CFR 50 Appendix L, and
- 40 CFR 60 Method 26A, "Hydrogen Halides and Halides in Stationary Sources".

Note that at present, none of these methods are contained in a FoPT table.

3.2 Table of Contents, References and Appendices

The Table of Contents is in Section 2 and Appendices are at the end of this document.

Where applicable to air quality analyses, this Quality Assurance Management Plan uses the references included in the 2009 and 2016 TNI Environmental Laboratory Sector Standard, Volume 1.

Unlike Water and Soils methods, Air Quality reference methods can be difficult to locate and, in some cases, a reference method may not exist for the analysis requested by the client. The majority of reference methods utilized at ***CHESTER LabNet*** can be found in 40 CFR Part 50, 40 CFR Part 60, 40 CFR Part 61, NIOSH Methods Compendium, OSHA Methods Compendium, US EPA IO Methods Compendium, US EPA "Other Test Methods," US EPA "Conditional Test Methods," published peer-reviewed papers, and a variety of methods developed in-house to satisfy the needs of our clients. See Appendix D for a listing of reference methods commonly used at ***CHESTER LabNet*** and Appendix B for a listing of all ***CHESTER LabNet*** SOPs.

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3.3 Glossary and Acronyms Used

Quality control terms are generally defined within the Section that describes the activity.

3.3.1 Glossary

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service and defined in requirement documents.

Accreditation: The process by which an agency evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques, and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analyte: A substance, organism, physical parameter, property, or chemical constituent(s) for which an environmental sample is being analyzed.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as a part of the analysis.

Archaic: A method that requires the use of equipment that is no longer available, no longer in use, or that has become obsolete by virtue of technological advancements (e.g., requiring the use of instrumentation that has not been supported since 1972, requiring hand-injection where autosamplers are commonly available).

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation).

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.

Batch: environmental samples that are received, prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents.

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Analytical Batch: a group of prepared samples (extracts, digests, etc.) which are analyzed together as a group, although they may have been prepared separately. An analytical batch may exceed 20 samples.

Preparation Batch: a group of ≤20 environmental samples of the same quality systems matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours and which are prepared together as a group, and which share common QC samples. [Note: Some source emission methods have preparation times exceeding 24 hours].

Sample Delivery Batch (SDG): a group environmental samples that arrive at the laboratory as one shipment or delivery group. There is no limit on the number of samples that may be delivered as a single group.

Blank: (note: "clean" for most Air Quality sampling media is defined as media that has had no sampling performed on it. Many air sampling media, including filters and sorbents materials, are not "analyte free")

Blank: a sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage, or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value.

Calibration Blank: An unspiked clean matrix of similar constitution as the sample extracts or digests (e.g., reagent Water, 5% HNO3, etc.) used to establish the zero intercept of the calibration curve.

Instrument Blank: a clean matrix (e.g., deionized water, 5% HNO3, etc.) processed through the instrumental steps of a method, used to determine instrument contamination.

Field Blank ("FB"): A blank prepared by the client in the field. The laboratory has no control over the actions of the client in the field. This blank is treated as a sample by the laboratory.

Laboratory Blank: (Gravimetric analysis only) A clean non-sampled filter or container that has been subjected to the same physical handling in the laboratory as the samples.

Method Blank ("MB"): A sample of a matrix similar to the batch of associated samples that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. No sampling media is contained in this blank (see "Sample Media Blank"). This blank demonstrates cleanliness of reagents and of the preparation process itself.

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Reagent Blank ("RB"): All reagents, mixed in correct proportion, used in the preparation of samples, however, not taken through the preparation process. In the laboratory, this blank is rarely used, and usually only used when some question arises as to the source of contamination (reagents vs. process). Clients submit reagents blanks routinely; client reagent blanks are treated as a sample.

Proof Blank ("FTPB"): A blank prepared by the client in the field. The laboratory has no control over the actions of the client in the field. This blank is treated as a sample by the laboratory.

Field Train Recovery Blank ("FTRB"): A blank prepared by the client in the field. The laboratory has no control over the actions of the client in the field. This blank is treated as a sample by the laboratory.

Sample Media Blank ("SMB"): An unspiked aliquot of unsampled sampling media, taken through the entire preparation and analytical processes associated with a method. This blank determines if the sampling media may be contributing any analyte of interest to the samples, and may be used by the client to adjust or correct analytical results. The laboratory reports the SMB results to the client, however, performs no blank corrections of sample results prior to reporting results. "Blank subtraction" is the responsibility of the client. The laboratory has no control over the actions of the client.

Train Blank ("FTB"): A blank prepared by the client in the field. The laboratory has no control over the actions of the client in the field. This blank is treated as a sample by the laboratory.

Trip Blank ("TB"): A container with unsampled sampling media that is shipped from the lab to the field and back again, or from the field to the lab, without ever having been exposed to the sample gas stream or airshed. This blank is treated as a sample by the laboratory.

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards.

Support equipment calibration: the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

Analytical equipment calibration: the values realized by the standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve: The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.

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Calibration Standard: A substance or reference material used for calibration.

Certified Reference Material (CRM): Reference material, accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute (e.g., NIST Class 0 and Class 1 weights, certified by an A2LA accredited laboratory).

Chain of Custody Form (**CoC**): A record that documents the possession of the samples from the time of collection to receipt by the laboratory. This record generally includes: the number and types of containers; the method of collection; the date of collection; and requested analyses.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: Second column confirmation, Alternate wavelength, Derivatization, Mass spectral interpretation, Alternative detectors or Additional cleanup procedures. No reference methods utilized by the laboratory require confirmation analysis.

Continuing Calibration Blank (**CCB**): A blank "standard" analyzed at the end of an analytical batch and at least every 10 samples during an analytical batch to verify that the lower end of the calibration curve remains valid during the course of the analytical run. See ICB.

Continuing Calibration Verification Standard (**CCV**): A second source standard, of a different lot or manufacturer from the calibration standards, analyzed at the end of an analytical batch and at least every 10 samples during an analytical batch to verify that the calibration curve remains valid during the course of the analytical run. See ICV.

Control Limit: A mathematical representation of acceptable limits for a given Quality Control Metric such as percent recovery or percent difference. Limits may be in the form of an absolute number or represented as a percentage.

Corrective Action: The action taken to address and/or eliminate, where possible, the causes of a non-conformity (such as exceeding a control limit) or failing to follow any documented non-analytical protocols (e.g., revising report numbers when resubmitting reports).

Corrective Action Report (**CAR**): A document, filled in by the person or persons finding a non-conformity with documented protocols, which documents the non-conformity and actions taken to correct it.

Correlation Coefficient: The statistical representation of how closely a set of x, y coordinates approaches the line of best fit. A correlation coefficient of 1.000 is considered a perfectly straight line of data points. Correlation coefficients above 0.995 are normally attainable by most instruments.

Data Integrity: The condition that exists when data are sound, correct and complete, and accurately reflect activities and requirements.

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Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more useful form.

Demonstration of Capability (**DoC**): A procedure to establish the ability of an Analyst to perform analyses with acceptable accuracy and precision.

Detection Limit: The lowest concentration of an analyte of interest that can be identified, measured and reported with 99% confidence that the analyte concentration is not a false positive value. The minimum result which can be reliably discriminated from a blank with 99% confidence.

Frequency: The number of occurrences of a specified event within a given interval. The number of samples or analytical runs with which a given QC sample or metric must be analyzed or verified.

Holding Time: The maximum time that can elapse between two specified events.

In-depth Data Monitoring: When used in the context of data integrity activities, a review and evaluation of documentation related to all aspects of the data generation process that includes items such as preparation, equipment, software, calculations, and quality controls. Such monitoring shall determine if the laboratory uses appropriate data handling, data use and data reduction activities to support the laboratory's data integrity policies and procedures.

Initial Calibration Blank (**ICB**): A blank "standard" analyzed at the beginning of an analytical batch immediately after calibration to verify that the calibration curve is valid at the beginning of the analytical run.

Initial Calibration Verification Standard (**ICV**): A second source standard analyzed at the beginning of an analytical batch immediately after calibration that verifies that the calibration curve is valid at the beginning of the analytical run. This standard must be of a different source than the standards used to calibrate the instrument.

Laboratory Control Standard (**LCS**): A sample matrix, free from analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. Used to establish intra-laboratory or Analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

Laboratory Control Standard Duplicate (**LCS-D**): A second LCS prepared and analyzed in the same manner, with the same preparation batch as the LCS. Used to assess precision when the sample or reference method precludes the ability to run a sample duplicate or sample spike duplicate.

Laboratory Information Management System (**LIMS**): A comprehensive computerized database system that the laboratory uses for sample tracking and data management, from sample receipt to reporting and disposal.

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Limit of Quantitation (LoQ): The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The laboratory sets the LoQ at five times the detection limit. It is used in setting acceptance limits for precision targets between duplicate analyses and determining concentration levels for LL-CCVs and LL-LCSs (see below).

Lot: A definite amount of material produced during a single manufacturing cycle, and intended to have uniform character and quality.

Low Level Calibration Verification Standard (LL-CCV): Formerly Contract Required Detection Limit standard (CRDL or CRI or CRA). A standard at the LoQ used to verify the low end of the calibration curve. May be a primary or secondary standard. For instruments with only two points in the calibration curve (e.g., ICP), the LL-CCV will always be made from a second source standard.

Low Level Laboratory Control Sample (LL-LCS): A sample matrix, free from analytes of interest, spiked at a concentration between the DL and the LoQ, and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. Used to verify performance of the method at the low end of the calibration curve and to determine detection limits.

Matrix/Matrices: The component or substrate of a test sample. For the purposes of NELAP, this is comprised of "aqueous," "solid," or "air" matrices.

For the purposes of ***CHESTER LabNet***, the matrix is more specifically designated as size/type of filter, chemical composition of impinger solution, type of sorbent tube or other descriptor of the substance used to capture the analyte of interest. In addition, the matrix may also refer to characteristics of the gas stream from which the sample was obtained, such as moisture content, acidity, or interfering compounds present.

Matrix Duplicate ("Dup"): A second aliquot of a sample prepared and analyzed in the same manner, with the same preparation batch as the original sample aliquot. Used to assess precision.

Matrix Replicate ("Rep"): A second aliquot of prepared sample, analyzed when insufficient sample is present to perform a true duplicate analysis.

Matrix Spike ("spike"): A sample prepared by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. The spiked sample is taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. Matrix spikes are used to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (MSD): a second matrix spike of the same sample as used in the initial matrix spike sample, prepared and analyzed in the same manner, with the same preparation batch as the initial matrix spike sample. Used to obtain a measure of the precision of the recovery for each analyte. Only possible when sufficient sample is present to take a third aliquot from the original sample.

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Measurement System: A method, as implemented at a particular laboratory, which includes the equipment used to perform the test and the operator(s).

Media: This term is used throughout the 2016 TNI Standard in reference to microbiological testing. For the purposes of air quality testing, media is generally comprised of either filters (various sizes/compositions), sorbent tubes, or solutions used in impinger trains.

Method: A body of procedures and techniques for performing an activity (e.g., chemical analysis, quantification, reporting), systematically presented in the order in which they are to be executed.

Method Detection Limit: See Detection Limit

National Institute of Standards and Technology (NIST): A federal agency of the US Department of Commerce's Technology Administration that is designated as the United States' National Metrology Institute (NMI).

NEAT (adj.): "Nothing Else Added To". The physical state of having not been altered (e.g., diluted, solubilized, etc.) from an unadulterated state.

Physical Parameter: A physical characteristic or property of a sample as distinguished from the concentrations of chemical components.

Post-Digestion Spike or Analytical Spike ("post spike"): an aliquot of prepared sample to which a known amount of target analyte is added for which an independent test result of target analyte concentration is available. Analyzed when a true spike is not possible which typically occurs with small sample sizes, or when the entirety of the sample is reduced to a single digestate.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms (e.g., relative percent difference, RPD).

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis (e.g., kept cold).

Procedure: A specified way to carry out an activity or process. Procedures can be documented or not.

Proficiency Evaluation Samples (Audit sample): A sample, the composition of which is unknown to the laboratory, designed to test whether the laboratory can produce analytical results within the specified acceptance criteria. Not all air methods have audit samples commercially available. It is not possible to create audit samples for some air methods.

Protocol: A detailed, written procedure for laboratory operation which must be strictly followed (see "Standard Operating Procedure").

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Quality Assurance (**QA**): An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality Control (QC): The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality.

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as spikes, blanks, and duplicates, intended to demonstrate that a measurement system or activity is in control.

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to users. This document.

QC Statistic: Any of a number of statistical permutations performed on raw data to generate a metric capable of being subjected to control limits and corrective actions.

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products, and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities.

Quality System Matrix: This definition is to be used for the purpose of batch and QC requirements. Air and Emissions Matrices consist of whole gas or vapor samples. The matrix also includes the analytes of interest from a gas or vapor stream that are collected and the media with which the analytes are collected (e.g., sorbent tube, impinger solution, filter, or other media).

This laboratory primarily analyzes gas samples captured on filters, on sorbent media (filter or tube), and in impinger solutions.

Reagent: A single chemical, combination of chemicals, or a chemical solution used in the preparation or analyses of samples. Note: media, for the purposes of this document, is <u>not</u> a reagent.

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, electronic data, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records.

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Reference Material: Material or substance, one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Reference Method: A reference method is a published method issued by an organization generally recognized as competent to do so. ISO 17025:2015 also refers to this as a "standard method".

When a laboratory is required to analyze an analyte by a specified method due to a regulatory requirement, the analyte/method combination is recognized as a reference method.

Replicate: See "Matrix Duplicate."

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte from another component that may be a potential interferent or that may behave similarly to the target analyte within the measurement system.

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.

Standard (analytical): A solution or matrix (solid or liquid, prepared in the laboratory or purchased from a vendor such as a standard weight for balances) of a known amount of analyte(s).

Stock standard: a standard received from a vendor with NIST or equivalent traceability.

Working standard: any standard created when mixing, diluting or otherwise manipulating aliquots of primary standards; may be called "working standards" or "intermediate standards."

Primary Standard: A standard typically used for calibration and no other purpose, received from a vendor with NIST or equivalent traceability.

Secondary Standard: A standard of a different lot, manufacturer, or serial number from the primary standard received from a vendor with NIST or equivalent traceability typically used to verify calibration.

Standard (**NELAP**): The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and that meets the approval requirements of standard adoption organizations procedures and policies.

Standard (adjective): usual or typical; as in "The *standard* way to extract a solid for metals is with a hot acid digestion."

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Standard (ambiguous): use of the word "standard" more than once in a sentence without enough context to make the meaning comprehensible, as in "The standard must be in keeping with the standard standard."

Standard Deviation (ambiguous): a quantity calculated to indicate the extent of deviation for a group as part or all of a whole.

Sample Standard Deviation: a quantity calculated to indicate the extent of deviation for a data set, where the deviation only of the data points contained within the set is being described. This calculation is what is most commonly meant when "standard deviation" is discussed. The Excel formula is "=stdev"

Population Standard Deviation: a quantity calculated to indicate the extent of deviation for a data set, where the calculated deviation of a data set is considered to be a subset of the entire population of data points being considered. This number is smaller than the results for Sample Standard Deviation. The Excel formula is "=stdev.p"

Standard Operating Procedure (**SOP**): A written document that details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. SOPs are not training manuals and thus may not contain all of the fine details a trained Analyst should know.

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.

Verification: Confirmation by examination and objective evidence that specified requirements have been met. In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation, or specification peculiar to the management of the measuring equipment.

For further definitions, please refer to the 2016 TNI Environmental Laboratory Sector Standard – Volume 1.

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3.3.2 Acronyms

A list of acronyms used in this document and their definitions are:

AB	–	Accrediting Body
ASTM	–	American Society for Testing and Materials
Blk	–	Blank
°C	–	degrees Celsius
cal	–	calibration
CAR	–	Corrective Action Report
CARB	–	California Air Resources Board
CAS	–	Chemical Abstract Service
CCV	–	Continuing calibration verification
CFR	–	Code of Federal Regulations
CLP	–	Contract Laboratory Program (US EPA)
CoA	–	Certificate of Analysis
CoC	–	Chain of custody
CVAA	–	Cold Vapor Atomic Absorption Spectrophotometer
DL	-	Detection Limit (formerly "LoD")
DoC	–	Demonstration of Capability
DQO	–	Data Quality Objective
dscf	–	dry standard cubic feet
dscm	–	dry standard cubic meters
EPA	–	Environmental Protection Agency
FoPT	–	Field of Proficiency Table
IC	–	Ion Chromatograph(y)
IC-PCD	-	Ion Chromatography with Post Column Derivatization
ICP	–	Inductively Coupled Plasma (Atomic Emission Spectrophotometer)
ICV	–	Initial calibration verification
IO	–	Inorganics Air Compendium
ISO	–	International Organization for Standardization
LCS	–	Laboratory Control Sample
LCS-D	-	Laboratory Control Sample Duplicate
LL-CCV	-	Low Level Continuing Calibration Verification
LL-LCS	-	Low Level Laboratory Control Sample
LoQ	–	Limit of Quantitation
MB	-	Method Blank
mg/Kg	–	milligrams per kilogram
mg/L	–	milligrams per liter
mg/Sx	–	milligrams per sample
MS	–	matrix spike
MSD	–	matrix spike duplicate
NELAC	–	National Environmental Laboratory Accreditation Conference
NELAP	–	National Environmental Laboratory Accreditation Program
NIOSH	–	National Institute of Safety and Health
NIST	–	National Institute of Standards and Technology
OC/EC	–	Organic Carbon/Elemental Carbon (analyzer)
ODEQ	-	Oregon Dept. of Environmental Quality
ORELAP	-	Oregon Laboratory Accreditation Program
OSHA	–	Occupational Safety and Health Administration
PE	–	Proficiency/Performance Evaluation sample

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PM	–	Particulate Matter
$PM_{2.5}$	–	Particulate Matter 2.5 µm or smaller
PM_{10}	–	Particulate Matter 10 µm or smaller
PTP	–	Proficiency Testing Provider
PTPA	–	Proficiency Testing Provider Accreditor
QA	–	Quality Assurance
QAMP	–	Quality Assurance Management Plan
QAO	–	Quality Assurance Officer
QC	–	Quality Control
RE	-	Relative Error (percent, also %RE)
RO	–	Reverse Osmosis
RPD	–	Relative Percent Difference
RSD	–	Relative Standard Deviation
SMB	-	Sample Media Blank
SOP	–	Standard Operating Procedure
spk	–	Spike
std	–	Standard (analytical)
TNI	–	The NELAC Institute
TSP	–	Total Suspended Particulate
µg/L	–	micrograms per liter (air or liquid volume, dependent on context)
$\mu g/m^3$	–	micrograms per cubic meter
µg/Sx	–	micrograms per sample
UV	–	Ultraviolet
XRF	–	Thin Film X-ray Fluorescence spectrophotometer

3.4 Management of the Quality Assurance Management Plan

The Quality Assurance Officer (QA Officer) or their designated alternate is responsible for maintaining the currency of the Quality Assurance Management Plan (QAMP).

The Quality Assurance Management Plan is reviewed annually by the QA Officer and laboratory personnel to ensure that it reflects current practices and meets the requirements of any applicable regulations or client specifications. The manual is updated and the revision number is changed to the month and calendar year of the revision. If more than one revision in a given month/year is required, a letter is added after the year to indicate the new revision (e.g., “February, 2012B”). The cover sheet of the Quality Assurance Management Plan is then signed and the Table of Contents is updated.

The Quality Assurance Management Plan is considered confidential and proprietary, and may not be altered in any way except by approval of the QA Officer. If it is distributed to external users, it is for the purpose of reviewing ***CHESTER LabNet***'s management system for accreditation or contractual purposes and may not be used for any other purpose without the written consent of the laboratory.

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3.5 Data Quality Objectives (DQOs)

For environmental laboratory activities, data quality objectives (DQOs) may be defined as qualitative and quantitative statements that specify the quality of the data required to support defined analytical requirements (U.S. EPA 1987). Data quality objectives provide the driving force for the level of quality control (QC) required for any analytical task. For example, a field laboratory providing only screening data would have DQOs much less stringent than a laboratory providing data to be used in enforcement actions. Thus the Quality Assurance Management Plan (QAMP) must be written to provide the level of quality control demanded by the end use of the data.

The paramount analytical requirement for ***CHESTER LabNet*** is that all measurement data be of the quality required to withstand the scrutiny of litigation. To meet this DQO, the ***CHESTER LabNet*** QAMP is structured to enable the laboratory to provide data of known and acceptable quality. The quality of data is considered known when all components associated with its derivation are thoroughly documented and traceable back to NIST standards. Data are of acceptable quality when a QA/QC program is carried out and the QC indicators fall within predefined limits of acceptability. One of the primary functions of the QAMP is to detail the methods of documentation and to define the mechanisms to be used in generating data traceable to NIST.

QA/QC requirements vary widely depending on the task being performed and the methodology utilized in performing said task. As such, it is the responsibility of the Analysts performing the work to be familiar with the QA/QC requirements of each analytical test performed, the SOPs describing those tests, and to ensure that work they are performing meet these requirements.

3.5.1 QA Mechanisms for Attaining DQOs

The quality assurance mechanisms used to attain predefined data quality objectives fall with five broad categories: precision, accuracy, comparability, representativeness, and completeness. The characteristics of these mechanisms are defined below. Targets for DQO's are summarized in Section 3.5.2.

3.5.1.1 Precision.

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. For two measurements (duplicates), the relative percent difference (RPD) is used to represent precision. For more than two measurements, the percent relative standard deviation (%RSD, also known as the coefficient of variation or CV) is used to represent precision.

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3.5.1.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator. The accuracy is represented by percent recovery (%R).

3.5.1.3 Comparability

Comparability is defined as the confidence with which one data set can be compared to another. Comparability in laboratory operations is important in analyzing samples for large projects where sample analysis may occur continuously over many days or may occur sporadically over a long period of time. Comparability is evaluated primarily on the basis of accuracy and precision statistics. There are no quality control estimators specific to comparability, and comparability must be approached as a data assessment task at a level above that of simply compiling QC statistics. In order to ensure data comparability, ***CHESTER LabNet*** has standard operating procedures and accepted analytical methods, and data is reported in units of measurement usable by the client.

3.5.1.4 Representativeness

Representativeness can be defined both qualitatively and quantitatively, and is dependent upon the selection of sampling site and choice of sampling methods. The degree of representativeness is important in planning for the collection of samples and has significant ramifications in the subsequent uses of the data. Sample collection methodology is the most significant contributor to sample representativeness. Unless the laboratory is directly involved in the sampling process, this element of representativeness is beyond the laboratory's control.

For air sampling, the laboratory can assist in the collection of representative data by minimizing spurious results caused by defective filter and sorbent media. This is accomplished by acceptance testing filter media and by conducting pre-sampling operations (e.g., tare weighing) in a controlled environment designed to prevent media contamination.

3.5.1.5 Completeness

Completeness is the amount of valid data actually obtained compared to the amount of data that was expected to be obtained under anticipated sampling/analytical conditions. As in the case for representativeness, the laboratory can assist in sampling completeness by providing air sampling media that have been acceptance tested, and have been prepared and shipped to ensure that samples are not lost due to physical deficiencies or higher than normal contamination.

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The analytical component of completeness is controlled by employing qualified Analysts; by adhering to training protocols; and by using written standard operating procedures.

3.5.2 Targets for the DQO Mechanisms

The basis for the targets for the quantifiable DQO mechanisms is that of the U.S. EPA Contract Laboratory Program (U.S. EPA 1990). The default targets are as follows:

TNI Matrix	Sampling Medium	Precision	Accuracy	Completeness
Air	Impinger solution	20%	75 - 125%	99%
Air	Filter	20%	75 - 125%	99%
Air	Sorbent Tube	20%	75 - 125%	99%

Complete directives for all Precision and Accuracy limits are located in the QA/QC section of the Standard Operating Procedure for each analytical technique. DQOs vary from one analytical methodology to another; the table shown above is to be considered a general guideline.

DQOs may also vary from project to project, and from client to client. ***CHESTER LabNet*** works closely with the client to ensure that the quality of data generated is of a caliber suitable for the client's purposes.

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Section 4

ORGANIZATION
(TNI V1:M2 – Section 4.1)

The laboratory is a legally identifiable organization. The laboratory is responsible for carrying out testing activities that meet the requirements of the 2009 and 2016 TNI Standard and ISO 17025:2005, and that meet the needs of the client, their client or their client's regulatory agency. Through application of the policies and procedures outlined in this Section and throughout the Quality Assurance Management Plan, the laboratory assures that:

- It is impartial, and that personnel are free from undue commercial, financial, or other pressures that might influence their technical judgment.
- Management and technical personnel have the authority and resources to carry out their duties, and the procedures to identify and correct departures from the laboratory's management system.
- Personnel understand the relevance and importance of their duties as related to the maintenance of the laboratory's Quality Management system.
- Ethics and data integrity procedures ensure personnel do not engage in activities that diminish confidence in the laboratory's capabilities (see Section 5 and Section 19 of Appendix A).
- Confidentiality is maintained.

4.1 Organization

CHESTER LabNet is an employee-owned, independent, commercial laboratory, incorporated in the state of Oregon as LabCor, Inc. DBA ***CHESTER LabNet.*** The laboratory has no legal ties to any other entity that might have any influence over or conflict of interest with the testing performed on site. The federal tax identification number is available upon request, solely on an as-needed basis.

The laboratory operates in Tigard, Oregon.

Additional information regarding responsibilities, authority and interrelationship of personnel who manage, perform or verify testing is included in Section 5, "Management" and Section 20, "Personnel". These Sections also include information on supervision, training, technical management, job descriptions, quality personnel and appointment of deputies for key managerial personnel.

The laboratory has the resources and authority to operate a management system capable of identifying departures from that system and from procedures during testing; and initiates actions to minimize or prevent departures.

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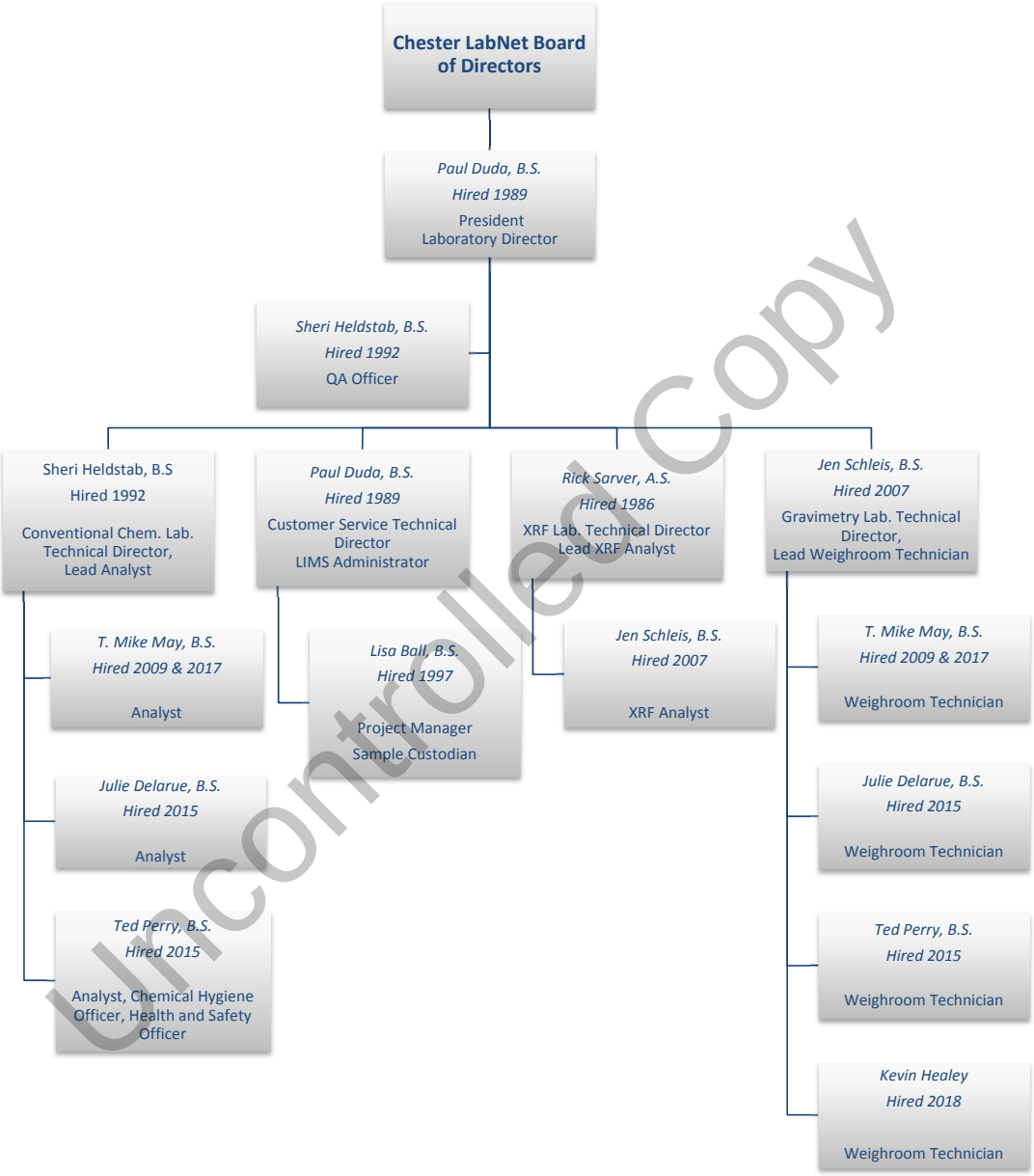

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Figure 4-1. ***CHESTER LabNet*** Organizational Chart

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4.2 Conflict of Interest and Undue Pressure

The organizational structure minimizes the potential for conflicting or undue interests that might influence the technical judgment of analytical personnel. In addition, procedures are in place to prevent outside pressures or involvement in activities that may affect competence, impartiality, judgment, operational integrity, or the quality of the work performed at the laboratory.

Due to the small size of the laboratory, some conflicts of interest are inevitable. For instance, the QA Officer and Analyst may be the same person. In some situations, it may be necessary for a person to audit an area of the laboratory in which they perform analysis or to verify their own data. The corporate culture of ***CHESTER LabNet*** is such that this is not considered by Management to be a significant conflict of interest. All employees understand the need for ethical integrity and perform their current task without regard for any previous or future tasks they may be performing. In other words, when the QA Officer puts on her QA Officer hat, she is acting as a QA Officer, not as an Analyst. All employees, from the time they begin working at ***CHESTER LabNet*** are imbued with the understanding that a failure to uphold ***CHESTER LabNet***'s ethics will result in an investigation and possible termination of the employee. See Section 5.4, "Ethics and Data Integrity" and Appendix A, "Ethics and Data Integrity Policy."

Policies and procedures to prevent commercial, financial or other influences that may negatively affect the quality of the work or negatively reflect on the competence, impartiality, judgment or operational integrity are described in the Ethics and Data Integrity Policy found in Appendix A.

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Section 5

MANAGEMENT
(TNI V1:M2 – Section 4.2)

The laboratory maintains a management system that is appropriate to the scope of its activities.

5.1 Management Requirements

Top management includes the Laboratory Director, Technical Directors, and the QA Officer.

Management's commitment to good professional practice and to the quality of its data is defined in the Quality Policy statement, Section 5.3.

Management has overall responsibility for the technical operations and the authority needed to generate the required quality of laboratory operations. Management ensures communication within the organization to maintain an effective management system and to communicate the importance of meeting customer, statutory and regulatory requirements. Management assures that the system documentation is known and available so that appropriate personnel can implement their part. When changes to the management system occur or are planned, managers ensure that the integrity of the system is maintained.

Management is responsible for carrying out testing activities that meet the requirements of the 2009 and 2016 TNI Standard and ISO 17025:2015 Standard, and that meet the needs of the client.

Managers implement, maintain and improve the management system, and identify non-compliance with the management system of procedures. Managers initiate actions to prevent or minimize non-compliance.

Management ensures technical competence of personnel operating equipment, performing tests, evaluating results or signing reports, and limits authority to perform laboratory functions to those appropriately trained and/or supervised. Competence is ensured via review of previous experience/education, signed training documentation, DoC's, and Managerial oversight. Continuing competence is evaluated and documented during the annual employee review cycle, or more often if necessary. See Section 20, "Personnel."

All personnel performing work at ***CHESTER LabNet*** possess the necessary knowledge, skills and abilities to perform the work required. No duties or activities will be assigned to staff members not having the qualifications, training and experience to conduct such work. Training is provided as needed to each employee by a Lead Analyst or Technical Director (this excludes method development, which is performed by a Technical Director or designated alternate). Refer to SOP QA-001 "Laboratory Training" for further detail.

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All personnel performing work at ***CHESTER LabNet*** are degreed professionals. See Appendix G for resumes of all personnel. Each employee's QC file contains a copy of their diploma or university transcripts and résumé as evidence of their educational background and laboratory skills.

All personnel performing analytical duties possess basic laboratory skills such as the ability to use an analytical balance, to properly read a meniscus line, to use autopipets and burettes, to perform basic mathematical calculations including proper dimensional analysis, and to properly identify glassware and its functions. In addition, these personnel possess knowledge of general laboratory vocabulary (e.g., "buffer", "titrant", "reflux", etc.), fundamental computer skills (e.g., saving files, opening software applications, finding files on a computer, etc.), and general laboratory safety.

Management is responsible for defining the minimal level of education, qualifications, experience and skills necessary for all positions in the laboratory, and assuring that technical staff have demonstrated capabilities in their tasks.

Training is kept up to date as described in Section 20, "Personnel" by periodically reviewing training records, examining QC data from each analysis, and reviewing employee performance annually via DoC's, ongoing QC checks, and annual employee competency reviews.

Management bears specific responsibility for maintenance of the management system. This includes defining roles and responsibilities for personnel, approving documents, providing required training, providing a procedure for confidential reporting of data integrity issues, and periodically reviewing data, procedures and documentation. The assignment of responsibilities, authorities and interrelationships of the personnel who manage, perform, or verify work affecting the quality of environmental tests is documented in Section 20, "Personnel."

Management ensures that audit findings and corrective actions are completed within required time frames.

Designated deputies may be appointed by management during the absence of the Laboratory Director, Technical Director(s) or the QA Officer, and are always appointed if the absence is more than 15 days. The accrediting body will be notified if the QA Officer or Technical Director is absent for more than 35 days. A Manager is not considered to be absent if still available electronically or telephonically and if the Manager is capable of making rational decisions and giving pertinent and timely instructions to other staff.

5.2 Management Roles and Responsibilities

5.2.1 Laboratory Director

The Laboratory Director is responsible for the financial, human resource and service performance of the laboratory. The Laboratory Director provides the resources necessary to implement and maintain an effective quality and data integrity program.

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5.2.1.1 Responsibilities

The Laboratory Director is responsible for:

- ensuring that personnel are free from any commercial, financial and other undue pressures that might adversely affect the quality of their work;
- overseeing company financials, to include the purchase of new instrumentation and equipment;
- reviewing of all tenders and contracts;
- overseeing accreditation(s);
- ensuring adequate staffing (in tandem with Technical Directors);
- ensuring that the management system related to quality is implemented and followed at all times;
- engaging in management reviews of laboratory systems;
- ensuring clients are notified within 5 business days if events cast doubt on the validity of reported data; and
- overseeing client-specific analytical requirements.

5.2.2 Quality Assurance Officer

The QA Officer (or designee) is responsible for the oversight and review of quality control data. Due to the small size of the laboratory, the QA Officer is not free from other obligations in the laboratory. Refer to Section 4.2 for a description of ***CHESTER LabNet***'s resolution of conflicts of interest. The QA Officer's training and proof of experience in QA/QC procedures, knowledge of analytical methods, and the laboratory's management system can be found in the QA Officer's resume in Appendix G, "Staff Resumes."

5.2.2.1 Responsibilities

The QA Officer is responsible for:

- serving as a focal point for QA/QC;
- arranging or conducting annual internal audits without outside (e.g., managerial) influence;
- overseeing accreditation(s);
- notifying management of deficiencies;
- overseeing and reviewing quality control data;
- monitoring corrective actions;
- ensuring that the management system related to quality is implemented and followed at all times;

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- monitoring and maintaining laboratory certifications;
- keeping this Quality Assurance Management Plan current;
- ensuring all SOPs are reviewed annually and keeping them current;
- ensuring that all Analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and that this training has been documented;
- ensuring that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits - procedures that do not meet the standards set forth in the Quality Manual, laboratory SOPs or laboratory policies may be temporarily suspended by the QA Officer;
- reviewing all logbooks for completeness and correct usage (in tandem with Technical Directors);
- ensuring all project specific data quality objectives and QA/QC targets are satisfied;
- ensuring all mandated systems requirements are met;
- issuing and archiving laboratory logbooks;
- reviewing and approving all SOPs and policies prior to their implementation; and
- ensuring availability of and adherence to all approved SOPs and policies.

5.2.3 Technical Director

The Technical Directors are laboratory staff members, and supervise laboratory operations and data reporting. The Technical Directors' proof of experience in the fields of accreditation can be found in their resumes in Appendix G.

If a Technical Director is absent for fifteen (15) calendar days or more, a deputy (see Table 5-1 below) with appropriate qualifications will perform the Technical Director's duties. If no employee has "appropriate qualifications," the most senior Analyst will become the deputy or work will cease in that department until such time as the Technical Director returns. Beyond a thirty-five (35) calendar day absence, management will notify the primary accreditation body in writing of the absence of the Technical Director and the appointment of the deputy. A Technical Director is not considered to be absent if still available electronically or telephonically, is capable of making rational decisions, and is capable giving pertinent and timely instructions to other staff.

The Technical Director is not the Technical Director of more than one accredited environmental laboratory. Due to the wide variation in Air Quality methods and analytical techniques, each department has its own Technical Director.

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5.2.3.1 Responsibilities

The Technical Director is responsible for:

- meeting the general and education requirements and qualifications found in Sections 4.1.7.2 and 5.2.6.1 of the 2009 and 2016 TNI (note: no requirements are given for gravimetry or thin-film XRF laboratories);
- monitoring performance data and the validity of the analyses for the laboratory;
- providing technical direction to staff and clients;
- overseeing instrument and equipment certification, maintenance and repairs;
- monitoring data compilation and interpretation;
- training new employees or delegating training to a qualified Analyst;
- assessing qualifications of employees (education, experience, training, and performance);
- ensuring training records are completed for employees;
- where feasible, ensuring completion of an Initial DoC before newly trained Analysts are released from training;
- officially releasing newly trained Analyst(s) from training;
- coordinating operations within the laboratory to ensure smooth flow of samples through the analytical process (may need to be done in tandem with other Technical Directors); and
- supervising all Analysts to ensure compliance with all accreditations, regulations and client specific requirements.

5.2.4 Current Technical Directors and qualifications:

Rick Sarver: XRF Laboratory Technical Director
A.S. Science, 1980 (Chemekta Community College)
College Credit Hours in Chemistry: 33
Year hired at ***CHESTER LabNet***: 1986

Paul Duda: Customer Service Technical Director
B.S. Engineering Management, 1987 (University of Portland)
College Credit Hours in Chemistry: N/A
Year hired at ***CHESTER LabNet***: 1989

Sheri Heldstab: Conventional Chemistry Laboratory Technical Director
B.S. Biology, 1990 (University of Oregon)
College Credit Hours in Chemistry (B.S.): 37
Year hired at ***CHESTER LabNet***: 1992

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Jennifer Schleis: Gravimetry Laboratory Technical Director
B.S. Environmental Management, 2003 (The University of Georgia)
College Credit Hours in Chemistry: 4
Continuing Education – Portland Community College, Portland State University
College Credit Hours in Chemistry: 21
Year hired at ***CHESTER LabNet***: 2007

Note that 2009 and 2016 TNI Volume 1, Module 2, Section 5.2.6.1 does not make reference to any requirements for the Technical Director of a laboratory or laboratory department in which only gravimetric analysis is performed. ***CHESTER LabNet***'s Laboratory Director and QA Officer have, together and in unison, agreed that 2 years of work experience in the Gravimetry Laboratory, coupled with a thorough understanding of the QA/QC requirements given in the various appendices of 40 CFR 50, other similar reference methods, and the applicable QA guidance documents, are grounds for promoting a person into the Gravimetry Laboratory Technical Director position.

5.2.5 Laboratory Key Personnel Deputies

The following table defines who assumes the responsibilities of key personnel in their absence:

Table 5-1 Key Personnel Deputies

Key Personnel	Deputy	Comment
Laboratory Director	QA Officer/Project Manager	Choice of deputy is dependent on nature of task.
QA Officer	Laboratory Director/most experienced Analyst	Choice of deputy is dependent on nature of task.
Technical Director – Conventional Chemistry	Most Experienced Analyst	
Technical Director – XRF	Most senior XRF Analyst	
Technical Director – Gravimetry	Most senior Gravimetry Laboratory Technician	

5.3 Quality Policy

Management's commitment to quality and to the management system is stated in the Quality Policy below, which is upheld through the application of related policies and procedures described in the laboratory's Quality Assurance Management Plan, SOPs and policies.

Quality Policy Statement: Our goal is to provide the most informed and accurate inorganic analyses of air quality samples available from a commercial laboratory by supplying our clients with data of known and documented quality. ***CHESTER LabNet***'s management is committed to good professional practice and to the quality of its environmental testing in servicing its clients. This policy is implemented and enforced through the unequivocal commitment of management, at all levels, to the Quality Assurance (QA) principles and practices outlined in this manual. All

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personnel are familiar with the quality documentation requirements, and implement the policies and procedures in their work as attested to by their signatures on the Concurrences page of this document. The laboratory and its management are committed to complying with all requirements of any accreditations, contracts and governmental mandates.

CHESTER LabNet is proud of having specialized in the inorganic analysis of ambient particulates and source emission samples since its inception (as NEA, Inc.) in the late 1970's. The laboratory as an organization, its management and its personnel are all committed to the production of the highest quality data achievable with current methodologies and instrumentation, as well being committed to complying with contractual, regulatory and accreditation standards and requirements.

5.4 Ethics and Data Integrity System

The laboratory has an Ethics and Data Integrity policy that is included in Appendix A. The laboratory's Ethics and Data Integrity program, training and investigations are discussed in Section 19, "Data Integrity Investigations".

5.5 Documentation of Management/Quality System

The management system is defined through the policies and procedures provided in this Quality Assurance Management Plan and written laboratory Standard Operating Procedures (SOPs) and policies.

5.5.1 Quality Assurance Management Plan

The Quality Assurance Management Plan contains the following required items:

5.5.1.1 document title;

5.5.1.2 laboratory's full name and address;

5.5.1.3 identification of all major organizational units covered by this Quality Assurance Management Plan and the effective date of the version;

5.5.1.5 identification of the laboratory's approved signatories;

5.5.1.6 the signed and dated concurrence (with appropriate names and titles) of all responsible parties including the QA Officer, Technical Director(s) and the Laboratory Director;

5.5.1.7 the objectives of the management system and references to the laboratory's policies and procedures (where not explicitly contained herein);

5.5.1.8 the laboratory's official quality policy statement including the management system objectives and management's commitment to ethical laboratory practices and to upholding the requirements of all contractual, regulatory and accreditation standards and requirements; and

5.5.1.9 a table of contents and applicable lists of references, glossaries and appendices.

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This Quality Assurance Management Plan contains or references all required elements as defined by the 2009 and 2016 TNI Standard, Volume 1, Module 2, Section 4.2.8.4.

5.5.2 Standard Operating Procedures (SOPs)

Standard operating procedures (SOPs) represent all phases of current laboratory operations and include an effective date, revision number and signature of the approving authorities as described in SOP QA-003, "Implementation, distribution and control of Standard Operating Procedures." SOPs are available to all personnel, and contain sufficient detail such that someone with similar qualifications could perform the procedures. There are two types of SOPs used in the laboratory: 1) administrative SOPs which document non-analytical procedures, and 2) method SOPs, which have specific requirements as outlined below.

Each accredited analyte or method has an SOP. The laboratory's method SOPs include the following topics:

i. identification of the method;
ii. applicable matrix or matrices;
iii. limits of detection and quantitation;
iv. scope and application, including parameters to be analyzed;
v. summary of the method;
vi. definitions;
vii. interferences;
viii. safety;
ix. equipment and supplies;
x. reagents and standards;
xi. sample collection, preservation, shipment and storage;
xii. quality control;
xiii. calibration and standardization;
xiv. procedure;
xv. data analysis and calculations;
xvi. method performance;
xvii. pollution prevention;
xviii. data assessment and acceptance criteria for quality control measures;
xix. corrective actions for out-of-control data;
xx. contingencies for handling out-of-control or unacceptable data;
xxi. waste management;
xxii. references;
xxiii. any tables, diagrams, flowcharts and validation data; and
xxiv. Deviations from reference methods and technical justifications for those deviations.

Refer to SOP QA-003, "Implementation, distribution and control of Standard Operating Procedures" for more detail on the written structure of each SOP.

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5.5.3 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows unless otherwise noted:

- Client Directives ("client trumps all")
- Quality Assurance Management Plan
- SOPs and Policies
- Reference methods and associated QA Guidance documents

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Section 6

DOCUMENT CONTROL
(TNI V1:M2 – Section 4.3)

This Section describes how the laboratory establishes and maintains a process for document management. Procedures for document management include controlling, distributing, reviewing, and accepting modifications. The purpose of document management is to preclude the use of invalid and/or obsolete documents.

Documents can be SOPs, "Quick Guides", policy statements, specifications, calibration tables, charts, textbooks, posters, notices, memoranda, software, drawings, plans, etc. These may be on various media, whether hardcopy or electronic, and they may be digital, analog, photographic, or written.

The laboratory manages four major types of documents: 1) controlled and approved, 2) suspended, 3) deactivated and 4) obsolete. In addition, they fall into three broad categories: Administrative documents (e.g., QAMP, Chemical Hygiene Plan), SOPs, and laboratory logbooks.

A controlled document is one that is uniquely identified, issued, tracked and kept current as part of the management system. Controlled documents are always internal and, consequently, must be approved.

An approved document means it has been reviewed, signed and dated by the issuing and approving authorities.

A suspended document is one which has not been used for an extended period of time, typically three to five years. These documents could be unsuspended at any time and brought back into use if needed. For example, ***CHESTER LabNet*** did not analyze pH using an electrode for over a decade, during which time the SOP for pH by electrode was suspended. A massive change to a reference method required the use of a pH electrode, consequently, the method was unsuspended, updated and brought back into use again. The suspension of a document is not necessarily permanent. While suspended, the document does not go through the annual review cycle. Once unsuspended, the document resumes its place in the annual review cycle. The purpose of this designation is to avoid the loss of time in reviewing a method which is not being actively utilized.

A deactivated document is one which the laboratory believes will never be used again. Frequently, these are project or client specific documents or documents for an instrument no longer in service. Deactivation of a document may also be the result of merging that document with another (e.g., combining two SOPs into one). Deactivated documents are not reviewed annually and are retained for evidentiary purposes only. By definition, a deactivated document is also an obsolete document.

Obsolete documents are documents that have been superseded by more recent versions or are no longer needed. These documents have an "effective until:" date noted at the bottom of the Cover Page and are retained in the QA Officer's files. In addition to the "effective until:" date, these documents are stapled together along the right-hand margin to indicate that it is not to be used.

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6.1 Controlled Documents

Documents will be reviewed, revised (as appropriate) and approved for use by the QA Officer and the pertinent Technical Director prior to issue. In cases where the QA Officer is the person most familiar with the document requirements, a second person with or without the same degree of knowledge shall read and sign the document.

Documents are reviewed annually by all pertinent staff to ensure the contents are suitable, in compliance with the current management systems and requirements, and accurately describe current operations. A master list of SOPs is maintained electronically by the QA Officer to ensure annual review. Internal documents are uniquely identified with: 1) a unique name and number identification 2) date of issue, 3) revision identification. All documents are fully paginated in the form of "Page X of Y."

Original, signed SOPs are kept in 3-ring binders in the main office area of the laboratory. The obsolete versions are stapled along the right margin and retained in the archived SOPs file drawers. Deactivated or suspended SOPs are kept in the binders, are clearly marked as being deactivated or suspended, and are stapled along their right-hand edge. The production of new SOPs and the revision of existing SOPs are under the supervision and control of the QA Officer. Each SOP must be approved, signed and dated by a minimum of two people. The Annual Review is signed by the pertinent Technical Director.

Within the laboratory, original SOPs are always used as references. Copies are only made for submission to outside authorities and only on specific contractor or accreditor request. Electronic copies are watermarked on each page with "Uncontrolled Copy." Any physical copies of SOPs used for submission materials for new projects or for proposals are scanned and watermarked "Uncontrolled Copy" prior to printing for submission. "Controlled copies" do not exist for SOPs within the confines of the laboratory.

Originals of the general laboratory QAMP, project-specific Quality Assurance Management Plans, and the laboratory Chemical Hygiene Plan are kept with the original SOPs in the main office area of the laboratory. Production of new QA Manuals and revision of existing QA Manuals is under the supervision and control of the QA Officer. Each QA Manual must be signed and dated by the author. In addition, QA Manuals must be read, signed and dated by all affected laboratory personnel. This process is conducted annually for the general laboratory QA Manual and for all project-specific QA Manuals where an annual review is required. The date of issue is clearly marked on the title page.

As copies are only made for submission to outside organizations, ***CHESTER LabNet*** does not allow for a controlled copy within the laboratory. This makes the need to trace dispersed documents moot.

A master list of controlled copies submitted to outside organizations is maintained by the Laboratory Director. The list includes, by reference, the title, author, copyright date, date of publication and location. The controlled copy list is maintained

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electronically and is updated each time a new document is sent to a requesting entity.

6.1.1 Document Changes to Controlled Documents

6.1.1.1 Paper Document Changes

Document changes are approved by the QA Officer or pertinent Technical Director during the annual review cycle.

The document management process allows for handwritten modifications to documents. As no controlled copies are distributed throughout the laboratory, and as Analysts must always refer to the original document, there is no need to track the changes (changes are "tracked" by their existence in the one master copy). Changes must be written in the original document in non-black ink, and dated and initialed by the person making the change.

All document modifications are approved by the personnel making the change. Changes that are not process modifications but clarifications may be performed without revision, but must still be dated and initialed. Process amendments/modifications to documents are incorporated into a new revision. The document is reissued when it has been reviewed and updated during its scheduled review cycle. Approval of changes by the QA Officer or pertinent Technical Director is required for the issuance of a new version or clean copy of the document.

A reason for the modification or change is provided as historical information in the revised document. All internal documents have a Cover Page and a Review History Page. The Review History Page tabulates the changes made over time to the document. Any major changes to the document content will be noted in this table (see Review History Page of this document).

6.1.1.2 Electronic Document Changes

CHESTER LabNet does not maintain electronically available documents. All documents, including SOPs and quality manuals, whether laboratory or project specific, are used by personnel in hardcopy form only. The QA Officer is responsible for maintaining the electronic versions of the documents. No other personnel are involved in the electronic maintenance or use of documents. Anytime a new electronic version of a document is created, such as during annual reviews, the QA Officer will rename the electronic version of the document by appending a year, or if necessary, a the year and a letter (i.e., 2016B), to the electronic file name of the document. Changes to the document are tracked by comparing the obsolete document to the current hardcopy document in use. Scanned versions of the current hardcopy are in .pdf format, and, aside from the "uncontrolled version" watermark, are unchanged from the original.

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6.2 Obsolete Documents

All suspended, deactivated, invalid or obsolete documents are prevented from unintended use.

Obsolete documents retained for legal use or historical knowledge preservation are appropriately marked and retained. The obsolete versions have an "effective until:" date noted at the bottom of the Cover Page and are retained in the QA Officer's files. In addition to the "effective until:" date, these documents are stapled together along the right-hand margin to indicate that it is not to be used. Deactivated, suspended, invalid or obsolete documents are retained for a minimum of five years.

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Section 7

REVIEW OF REQUESTS, TENDERS AND CONTRACTS
(TNI V1:M2 – Section 4.4)

The review of all new work assures that oversight is provided so that requirements are clearly defined, the laboratory has adequate resources and capability, and the method is applicable to the customer's needs or requirements. If the method is mandated by a regulator despite being archaic or contradictory, the laboratory will follow that method as closely as possible and in keeping with the chemistry or intent of the method.

This process assures that all work will be given adequate attention without shortcuts that may compromise data quality. Note: Air Quality methods not applicable to the needs of the client may be stipulated by a regulatory body. In such cases, the regulatory body has the final decision in methodology, even if the methodology is not suitable to the process being regulated.

A contract is defined as an agreement between the laboratory and their client to perform work and report results in a manner agreeable to both parties. This includes analytical methods, reporting formats, and any ancillary work requested such as cleaning of field sampling equipment or loading filters into cassettes.

Contracts for new work may be in the form of formal bids, signed documents, or verbal or electronic agreement. The client's requirements, including the methods to be used, must be clearly defined, documented and understood. Requirements might include target analyte lists, project specific reporting limits (if any), project specific quality control requirements (if any), turnaround time, and requirements for data deliverables. The review must also cover any work that will be subcontracted by the laboratory.

7.1 Procedure for the Review of Work Requests

The Laboratory Director and the appropriate Technical Director(s) for the area(s) being affected determine if the laboratory has the necessary accreditations, resources (including schedule), equipment, deliverables and personnel to meet the work request. The review for most work is documented in email exchanges between the Project Manager and the client. Note that many samples may arrive without forewarning. This process only applies to work requests made in advance of the receipt of samples. A notice of impending receipt of samples is not considered to be a contractual request (e.g., an email received from a client saying "we shipped the samples today, you should receive them tomorrow" does not qualify as a work request made in advance, nor does "we might be sending you samples in six months").

The Laboratory Director, Project Manager or Technical Director informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily.

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The client is informed of any deviation from the contract, including the method or sample handling processes. All differences between the request and the final contract are resolved *and documented* before any work begins. It is necessary that the contract be acceptable to both the laboratory and the client. This information may be documented in email exchanges between the client and the personnel listed above. For large or ongoing projects, the Laboratory Director prints email exchanges and retains them in a project/contract specific file. For small or one-time projects, documentation may be recorded by hand on the Chain of Custody or Sample Receipt Checklist.

The review process is repeated when there are amendments to the original contract by the client. The participating personnel are notified, verbally or by email, of the amendments. For small projects or one-time-only projects (e.g., one sampling event) the amendments are maintained in email exchanges between the client and the laboratory or by handwritten changes on the Chain of Custody. For large or ongoing contracts requiring more stringent documentation, a contract specific hardcopy file is maintained by the Laboratory Director.

For routine projects and other simple tasks, a review by the Laboratory Director, Project Manager or Technical Director is considered adequate. The aforementioned person confirms that: the laboratory has all required certifications, can meet the client's data quality and reporting requirements, and has the capacity to meet the client's turn around needs.

For new, complex, or large projects, the proposed work contract is given to the Laboratory Director and the Technical Director(s) whose area(s) will be affected by the contract. The Laboratory Director, in tandem with the QA Officer and relevant Technical Director(s), will evaluate such items as:

- contractual obligations, bonding issues and payment terms;
- method capabilities, analyte lists, reporting limits and quality control limits;
- turnaround time feasibility;
- QA/QC issues, including certification/accreditation;
- formal laboratory quote;
- final report formatting and electronic deliverable documents;
- post-analytical sample storage requirements;
- final sample disposal requirements; and
- review of audit sample results, if any.

The Laboratory Director submits the bid and formal quote to the client, and maintains copies of all signed contracts.

For repetitive routine tasks, the review may be made only at the initial inquiry stage or on granting of a contract for on-going routine work performed under a general agreement with the client, provided the client's requirements don't change.

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Any changes to contractually agreed upon processes are documented in a manner that is easily retrievable and in proportion to the change in the contract. If the client changes the scope of the project, but fails to notify the laboratory, the laboratory is not required to perform the review as described above.

7.2 Documentation of Review

Records are maintained for every contract or work request, when appropriate. This includes pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. Refer to Section 7.1 of this document for record keeping procedures.

Records of all project-related communication with the client (including e-mails, telephone conversations, etc.) are generally kept in each project file. For large contracts, the Laboratory Director creates a contract specific files and records are retained in this file, not in each project file/report. Refer to Section 7.1 of this document for record keeping procedures.

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Section 8

SUBCONTRACTING OF ENVIRONMENTAL TESTS
(TNI V1:M2 – Section 4.5)

A subcontract laboratory is defined as a laboratory external to this laboratory, or at a different location than the address indicated on the front cover of this manual, that performs analyses for this laboratory.

When subcontracting analytical services, the laboratory assures work is placed with a laboratory that meets applicable statutory and regulatory requirements for performing the tests, unless otherwise requested by client.

8.1 Procedure

CHESTER LabNet very rarely subcontracts work. The Laboratory Director maintains a list of subcontractors.

For the rare occasions that the laboratory does subcontract work, ***CHESTER LabNet*** uses a laboratory with current NELAC accreditation status, unless otherwise requested by the client. The majority of subcontracting requests made by clients involve specialty laboratories that are not NELAC accredited. In these cases, the subcontracted lab is typically specified by the client. If the client requests that a non-NELAC accredited laboratory be used, the status of the subcontracting laboratory's accreditation will be noted in the Case Narrative of the final data report.

The laboratory may send sub-samples, or the samples or sample residues in their entirety, to the subcontracted lab(s), or the client may ship samples directly to the subcontracted lab(s) with a request to report the results to ***CHESTER LabNet*** for final reporting. The subcontracted laboratory's report is included *in toto* in the final report issued by ***CHESTER LabNet***. Billing is then performed by ***CHESTER LabNet.***

CHESTER LabNet reports do not contain data generated by another laboratory, unless that data is clearly indicated to have originated from another laboratory.

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Section 9

PURCHASING SERVICES AND SUPPLIES
(TNI V1:M2 – Section 4.6)

The laboratory ensures that purchased supplies and services that affect the quality of environmental tests are of the required or specified quality.

The laboratory has procedures for purchasing, receiving and storage of supplies that affect the quality of environmental tests.

9.1 Procedure

The Laboratory Director reviews and approves the supplier of services and supplies, and verifies or approves technical content of purchasing documents prior to ordering.

Most frequently used services are provided by companies with known reputations and are procured from the manufacturers when possible. For servicing of instruments where the Analyst cannot repair the failure on site, the instrument manufacturer's field service technician is called. For the ICP servicing, this is primarily performed by Perkin-Elmer. IC servicing is performed by a Thermo field technician. OC/EC servicing is performed by Sunset Laboratories. The CVAA is serviced by a Nippon field representative. XRF's are serviced by Thermo-Electron. Balances are serviced annually by Quality Control Services, which is also the company responsible for recertifying all weights used in the calibration and verification of the balances, and all thermistors, thermometers, and thermometer/hygrometers. The HVAC system and fume hoods are serviced by USA Mechanical.

Evaluation of suppliers is accomplished by reviewing the packing slips, Certificates of Analysis, or other supply receipt documents to ensure the supplier has shipped the product or material ordered and that the material is of the appropriate quality and arrives fit for use, then stamping the packing slips and any accompanying Certificates of Analysis "received [date of receipt]." The purchasing documents, including Certificates of Analysis, contain the data that adequately describe the services and supplies ordered. The description may include type, class, grade, identification, specifications or other technical information.

The supplies received are inspected for breakage, leaks or any other damage. The supplies and chemicals are checked for expiration dates, then are marked "r: [date and initials of person receiving the supply]". They are stored according to manufacturer's recommendations, laboratory SOPs or reference method specifications. Consumable non-perishable supplies such as gloves, pipet tips, paper towels, etc., do not have a received date noted on the container.

Any documents received with the supplies and services including specifications, certificates of analyses, warranties, maintenance records, calibration records, etc., are kept on file. For further information, refer to SOP AD-005, "Reagent Procurement and Control."

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The Conventional Chemistry Laboratory maintains 3-ring binders for the retention of certificates of analysis for: 1) dry chemicals, 2) inorganic liquids, 3) organic liquids, 4) standards, and 5) conventional chemistry laboratory support equipment calibrations. The person who writes the "r:" date on the container is responsible for obtaining the certificate of analysis, recording the received date (and their initials) on the certificate of analysis, verifying the expiration date (if any) on the certificate of analysis, and placing the certificate in the appropriate 3-ring binder.

The Gravimetry Laboratory maintains a 3-ring binder containing all the certifications of all NIST traceable weights currently in use, as well as balance maintenance and servicing records for all balances and NIST traceable weights. NIST traceability certificates for all NIST traceable electronic thermometers and hygrometers are maintained in the same binder. NIST traceable glass bodied thermometer certificates are retained in the Conventional Chemistry Laboratory's Support Equipment binder.

The purchased supplies and reagents that affect the quality of the tests are not used until they are inspected or otherwise verified as complying with requirements defined in the reference method.

9.2 Approval of Suppliers

As previously detailed (see Section 9.1), evaluation of suppliers is accomplished by reviewing the packing slips or other supply receipt documents to ensure the supplier has shipped the product or material ordered, that the material is of the appropriate quality, and then stamping the packing slips or other supply receipt documents "received [date of receipt]". The purchasing documents contain the data that adequately describes the services and supplies ordered. The description may include type, class, grade, identification, specifications or other technical information.

9.3 Reagent Water

Reagent water is manufactured onsite using a Millipore system. The manufacture of reagent water is discussed thoroughly in SOP AD-006. Briefly, water is generated using the system noted above. At the time of production, the resistivity of the water is measured by the De-ionizing system, and, at the start of each day of use, the resultant measurement is recorded in a reagent Water Control Chart located near the system. Resistivity is verified, but not documented, with each use throughout the day.

Reagent water is produced in compliance with, and meets the resistivity and TOC requirements of, ASTM D1193-06(2018), "Standard Specification for Reagent Water".

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Section 10

SERVICE TO THE CLIENT
(TNI V1:M2 – Section 4.7)

The laboratory collaborates with clients and/or their representatives on clarifying their requests and monitoring laboratory performance related to the client's work. Each request is reviewed to determine the nature of the request and the laboratory's ability to comply with the request within the confines of prevailing statutes and/or regulations and without risk to the confidentiality of other clients.

10.1 Client Confidentiality

The laboratory confidentiality policy is to not divulge or release any information to a third party without proper authorization. A "third party" is defined as a person or entity who did not pay for the data generated, and therefore has no legal rights of ownership to the data. Third party requests for data and information are referred to the client. Data and records are not disclosed to third parties without permission from the owner (client), except in the case of subpoena. All subpoenas are sent to the laboratory's attorney prior to being acted upon.

All electronic data (storage or transmissions) are kept confidential, based on technology and laboratory limitations, as required by client or regulation.

All data produced by ***CHESTER LabNet*** is the property of the client. As such, ***CHESTER LabNet*** will not and does not release data to any other person, agency or business without prior verbal or written consent of the client. Verbal consent is documented and maintained in the data report.

In cases where data is subpoenaed, ***CHESTER LabNet*** will contact the laboratory's attorney prior to submitting data. In these rare instances, only the data directly mentioned in the subpoena are released to the subpoenaing authority. Data which may be related to the subpoena but was generated for a different client must be subpoenaed independently. Any situations that arise involving legal action are brought to the attention of the Laboratory Director and shall involve ***CHESTER LabNet***'s representing attorney to ensure the subpoena is correct, pertinent, legally viable and that any actions taken by ***CHESTER LabNet*** in releasing data are legally defensible.

In a situation where the laboratory goes out of business or changes ownership, each client shall be contacted and their wishes regarding the disposition of their data shall be carried out. The laboratory will not release any data to any organization who is not the client without the client's permission. The laboratory will follow the client's wishes in regards to all data, be it hardcopy, electronic, data packages, or electronic raw data.

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10.2 Client Support

Communication with the client, or their representative, is maintained to provide proper instruction and modification for testing. Technical staff are available to discuss any technical questions or concerns the client may have.

The client, or their representative, is provided reasonable access to laboratory areas for witnessing testing or for auditing purposes. The laboratory reserves the right to limit access in the case of potential business competitors.

Delays or major deviations to the testing are communicated to the client immediately by phone or email. Communication may be made by the Project Manager, applicable Technical Director, or Analyst, depending on the nature of the communication. Major deviations may also be documented in the Case Narrative of the report.

The laboratory will provide the client with all requested information pertaining to the analysis of their samples. An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or not previously agreed upon.

If events cast doubt on the validity of results already reported to a client, the client will be notified of the concerns not more than five business days from the time of discovery. The laboratory will attempt to resolve or document the cause of concern prior to notifying the client. Documentation may be in the form of the email notifying the client of the concerns, or in the form of a Corrective Action Report.

10.3 Client Feedback

The laboratory seeks both negative and positive feedback following the completion of projects and periodically for ongoing projects. Feedback provides acknowledgement, corrective actions, where necessary, and opportunities for continuous improvement.

Negative customer feedback is documented as a customer complaint (see Section 11, “Complaints”).

For the duration of one month per year, ***CHESTER LabNet*** sends customer surveys out to every client receiving a data report that month. The highest rate of return of these surveys has been 40%, while the typical rate of return is around 20% – 25%. ***CHESTER LabNet***’s clients tend to be highly brand-loyal, and thus it is the laboratory’s experience that customer surveys always yield positive responses for the surveys returned.

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Section 11

COMPLAINTS
(TNI V1:M2 – Section 4.8)

The purpose of this Section is to ensure that customer complaints are addressed and corrected. This includes requests to verify results or analytical data. Complaints provide the laboratory an opportunity to improve laboratory operation and client satisfaction.

Complaints by customers or other parties are reviewed by management and an appropriate action is determined. All customer complaints are documented by the person receiving the complaint and addressed to the appropriate member of Management.

If it is determined that a complaint is without merit, that is documented and the client is contacted by the person receiving the complaint, the appropriate Project Manager or the appropriate Technical Director.

While inquiries into data are not uncommon, complaints requiring action by the laboratory are rare. In either case, once contacted by the client, the Project Manager notifies the appropriate Technical Director or the QA Officer of the nature of the issue. That person locates the original data report and investigates the client's concern. If it is determined that the complaint has merit, the procedures outlined in Section 14, "Corrective Action" are utilized.

Errors Made by the Laboratory: While rare, errors do occasionally occur. If the issue at hand is the result of an error made by the laboratory (i.e., miscalculation, transposed numbers, decimal point errors, incorrect sample IDs, etc.), the laboratory will correct the error and issue a revised report to the client. In some cases, the client may request that the samples be re-analyzed. Where possible, this is performed.

Issues resulting from sample characteristics: Air Quality sampling is not a simple matter. Issues may arise over which the laboratory has little or no control (e.g., filter deposits not adhering to the filter, source emission samples having interfering analytes, impinger solutions with large quantities of particulate matter, etc.). In these cases and where possible, the client is notified prior to work being performed, and client agreement as to how to reconcile the matter is noted in the report. Where the client had been previously notified of such issues, the client complaints are referred back to the client's original statements. In cases where the issue could not be detected until after analysis (such as interfering compounds), the client will be notified prior to receiving the data if the problem is severe, otherwise the issue will be documented in the Case Narrative of the data report. The laboratory will explain the cause of the problem to the client, as well as what, if any, other courses of action may be taken to resolve the issue. In some cases, the client may request that the samples be re-analyzed or analyzed following a different method. Where possible, this is performed.

Unethical or Illegal requests by clients: On very rare occasions, client complaints take the form of the laboratory refusing to commit unethical or illegal actions. Requests made by clients to perform such actions are declined and an explanation given as to why the request is declined. Such requests have taken the form of asking the laboratory to analyze Sample A, but report the results as Sample B due to the loss of Sample B during shipping;

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requesting that re-analysis be performed until the number desired by the client is obtained; or requesting that the laboratory take legal liability for actions performed in the field.

CHESTER LabNet does not and will not report false data or make false claims to any client. Samples from clients who persist in making such requests are refused in the future. ***CHESTER LabNet*** will not knowingly participate, directly or indirectly, in fraudulent activity. Any indications that the client may be using the laboratory's data in a fraudulent manner are documented in the Case Narrative and/or other areas of the data report. Requests for the laboratory to oversee or otherwise assume legal liability for actions occurring outside the laboratory's control are summarily refused, to include development of sampling plans and monitoring of field activities.

Billing Complaints: Client complaints regarding billing errors are directed to the Laboratory Director, who also executes all accounting functions for the company. The Laboratory Director will investigate the billing in question. Where errors are found, a revised invoice or credit memo to rectify the financial records will be issued.

Media and Supplies Complaints: Complaints regarding sampling media are referred to either the Project Manager or the Technical Director responsible for that particular media. In instances where the incorrect media was shipped to a client, the error will be corrected and appropriate media sent in a timely fashion to the client. It is ***CHESTER LabNet***'s policy that media, once sent to a client, cannot be returned unused as the laboratory cannot vouch for the integrity of the media once outside of its control. Complaints about the inability to return unused media are explained by this policy, with which most clients agree once they understand the logic behind it.

A complaint such as a concern that data is repeatedly late should be reviewed for preventative action (see Section 15, "Preventative Action") to minimize a future occurrence.

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Section 12

CONTROL OF NON-CONFORMING ENVIRONMENTAL TESTING WORK
(TNI V1:M2 – Section 4.9)

Non-conforming work is work that does not meet acceptance criteria or requirements. Non-conformances can include departures from standard operating procedures or reference methods, or unacceptable quality control results (see Section 27, "Quality Assurance for Environmental Testing"). Identification of non-conforming work can come through various means including customer complaints, quality control, instrument calibration, consumable materials evaluation, staff observation, final report review, management reviews, and internal and external audits.

12.1 Exceptionally Permitting Departures from Documented Policies and Procedures

Requests for departures from laboratory procedures are approved by the Technical Director for the department in which the departure occurs and documented in the Case Narrative of the report to the client. Planned departures from procedures or policies do not require audits or investigations, and are also documented in the Case Narrative of the report to the client. In the field of Air Quality testing, departures at the request of the client or as a result of sample characteristics are quite common.

12.2 Non-Conforming Work

The laboratory's policy for control of non-conforming work is to identify the non-conformance, determine if it will be permitted, and take appropriate action. All employees have the authority to stop work on samples when any aspect of the process does not conform to laboratory requirements.

The responsibilities and authorities for management of non-conforming work are as follows: The employee who discovers the non-conformance is responsible for notifying their Technical Director. The Technical Director then notifies the appropriate client services personnel, as needed, and in proportion to the magnitude of the non-conformance. If the non-conformance affects data either in process or already reported, the client will be contacted by the QA Officer, Project Manager or Laboratory Director. The client is responsible for making the decision as to what to do with the non-conforming work (proceed, stop, change methodology, etc.).

The procedure for investigating and taking appropriate corrective actions of non-conforming work are described in Section 14, "Corrective Actions". Section 14.3 describes procedures for Technical Corrective Actions. Formal corrective action procedures must be followed for non-conforming work that could recur (beyond expected random QC failures) or where there is doubt about the laboratory's compliance with its own policies and procedures.

The investigation of and associated corrective actions for non-conforming work involving alleged violations of the company's Ethics and Data Integrity policies must follow the procedures outlined in Section 19, "Data Integrity Investigations".

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The laboratory evaluates the significance of the non-conforming work and takes corrective action immediately. The customer is notified if their data has been impacted within five business days of discovery. The laboratory allows the release of non-conforming data only with approval by the appropriate Technical Director on a case-by-case basis. Non-conforming data is clearly identified in the Case Narrative of the final report (see Section 28, "Reporting the Results").

The discovery of a non-conformance for results that have already been reported to the customer must be immediately evaluated for significance of the non-conformance, its acceptability to the customer, and determination of the appropriate corrective action.

Corrective action for routine, non-recurring exceedances can be documented on raw data worksheets, logbooks, e-mail, a database or other documents. More serious corrective actions (non-conforming work that could recur or where there is doubt that the laboratory is in compliance with its own policies and procedures) will require a more formal corrective action process that typically includes the use of a corrective action report.

12.3 Stop Work Procedures

Personnel notify the appropriate Technical Director of any non-conformance not addressed in the SOP for that method. The Technical Director reviews the significance of the non-conformance and develops a course of action. If data are questionable, the QA Officer may be involved in the review and clients are notified.

When an investigation of non-conformance indicates that the cause of the non-conformance requires a method be restricted or not used until modifications are implemented, the Laboratory Director and Technical Director will immediately notify all personnel of the suspension/restriction. The lab will hold all relevant reports to clients pending review. The QA Officer must be involved in resolution of the issue and must verify that the issue is resolved before work may resume. Personnel are notified by the Technical Director when resumption of work is authorized. The Technical Director and QA Officer will document the issue, root cause and resolution using the corrective action procedures described in Section 14, "Corrective Action".

The Technical Director for the affected department authorizes resumption of work after it has been stopped.

The reporting of non-conforming work involving alleged violations of the company's Ethics and Data Integrity policies must be reported to the QA Officer and applicable Technical Director. Procedures described in Section 19, "Data Integrity Investigations" are followed.

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Section 13

IMPROVEMENT
(TNI V1:M2 – Section 4.10)

Improvement in the overall effectiveness of the laboratory management system is a result of the implementation of the various aspects of the laboratory's management system: quality policy and objectives (Section 5, "Management"); internal auditing practices (Section 17, "Internal Audits"); the review and analysis of data (Section 27, "Quality Assurance for Environmental Testing"); the corrective action (Section 14, "Corrective Action") and preventative action (Section 15, "Preventative Action") processes; and the annual management review of the quality management system (Section 18, "Management Reviews") in which the various aspects of the management/quality system are summarized and evaluated, and plans for improvement are developed. The resulting Annual Managerial Report is the primary means by which Management monitors, and works to improve, laboratory systems (Section 18, "Management Reviews").

The Annual Managerial Review includes a detailed summary of the previous twelve months' records (see Section 18.1, "Management Review Topics").

Based on the Annual Managerial Review, Management may make changes to improve overall systems. When the Annual Managerial Review is completed, a staff meeting is held, the results are discussed, and input from all employees is taken for means of improving the laboratory's performance and client service.

All staff are expected to share ideas for improvement with their Technical Director or QA Officer. Most improvements implemented are the result of employees seeing novel approaches to various systems and methods. If an employee has an idea that is approved by the pertinent Technical Director or QA Officer, that idea is communicated to all affected personnel either verbally or by email. All employee-generated improvement schemes must be approved by either the pertinent Technical Director or QA Officer prior to being implemented on a regular basis.

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Section 14

CORRECTIVE ACTION
(TNI V1:M2 – Section 4.11)

Corrective action is the action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence.

Deficiencies cited in external assessments, internal quality audits, data reviews, customer feedback/complaints, control of non-conforming work or managerial reviews are documented and require corrective action. Corrective actions taken are appropriate for the magnitude of the problem and the degree of risk.

14.1 General Procedure

All corrective actions not specified in method SOPs or other in-house documents are documented using a Corrective Action Report (CAR). This includes corrective actions by Analysts, client services personnel, findings from internal audits, customer inquiries and complaints, etc.

The first section of the CAR is completed by the person who discovers the issue. The second section is completed by the person who investigates the issue, determines the root cause and causes the corrective action to be carried out (may be a Technical Director or Analyst). The third and fourth sections are completed by the QA Officer, with the fourth section being completed after a check to ensure that the corrective action has been effective.

Completed Corrective Action Reports are retained in a 3-ring binder with a copy of the CAR placed in the client's job file, if applicable.

The person who discovers the non-conformity is responsible for initiating the corrective action where a non-conformance is found that could recur (beyond expected random QC failures) or where there is doubt about the compliance of the laboratory with its own policies and procedures. The QA Officer is responsible for monitoring and recording the corrective action.

All deficiencies are investigated and a corrective action plan is developed and implemented, when it is determined to be necessary. The implementation is monitored for effectiveness.

14.1.1 <u>Cause Analysis</u>

When failures due to systematic errors have been identified, the first step of the corrective action process starts with the initial investigation and determination of root cause(s) of the problem. Records of non-conformances requiring corrective action are maintained in a 3-ring binder of Corrective Action Reports including the results of the investigation to show that the root cause(s) was investigated.

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Where there may be non-systematic errors, the initial cause is readily identifiable, or the failure is an expected random event (e.g., failed quality control), a formal root cause analysis is not performed. In this case, the process begins with selection and implementation of corrective action (also see Section 14.3, "Technical Corrective Actions").

14.1.2 Selection and Implementation of Corrective Actions

Where uncertainty arises regarding the best approach for analysis of the cause of exceedances that require corrective action, involved personnel will recommend corrective actions that are appropriate to the magnitude and risk of the problem and will be most likely to eliminate the problem and prevent recurrence.

The QA Officer, in tandem with affected personnel, ensures that corrective actions are discharged within the agreed upon time frame. It is not uncommon for the corrective action to have been implemented immediately upon discovery of the non-conformance.

14.1.3 Monitoring of Corrective Action

The QA Officer will monitor implementation and documentation of the corrective action to ensure that the corrective actions were effective.

After a Corrective Action Report (CAR) has been initiated and the root cause determined and addressed, the report is given to the QA Officer. The QA Officer allows the CAR to "age" for a period of 30 to 60 days. The QA Officer then interviews the involved personnel to ensure that the corrective action was both taken and effective, and that the problem has not recurred. At this point, the QA Officer signs off on the Corrective Action Report and places it in the 3-ring binder. A copy of the CAR is also placed in the affected job file, where applicable, for traceability.

14.2 Additional Audits

Where the identification of non-conformances or departures from normal lab procedures cast doubt on the laboratory's compliance with its own policies and procedures or on its compliance with the 2009 and 2016 TNI Standard, the laboratory ensures that the appropriate areas of activity are audited in accordance with Section 17, "Internal Audits" as soon as possible.

These additional audits are follow-ups after the corrective action has been implemented to ensure that it was effective. These are rare and done only when a serious issue or risk to the laboratory has been identified. Since 1994, there has not been a single need to implement this policy.

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14.3 Technical Corrective Action

Sample data associated with a failed quality control parameter are evaluated for the need to be re-analyzed or qualified. Unacceptable quality control results are documented in the data report and, if the evaluation requires cause analysis, the cause and solution are recorded on a Corrective Action Report (also see Section 12, "Control of Non-conforming Environmental Testing Work").

Analysts routinely implement corrective actions for data with unacceptable QC measures. First level correction may include re-analysis without further assessment. If the method SOP addresses the specific actions to take, they are followed. Otherwise, corrective actions start with assessment of the cause of the problem.

Corrective actions for non-systematic errors or expected random failures are documented in the Case Narrative of the data report. Depending on the severity of the non-conformance, documentation may be noted in the raw data or the non-conformance may be discussed in the Case Narrative of the report. Corrective actions for non-conformances that may recur (beyond expected random QC failures) or where there is concern that the laboratory is not in compliance with its own policies and procedures require that a Corrective Action Report be completed (see Section 14.1).

The QA Officer, in tandem with the Technical Directors and Analysts, reviews the Corrective Action Reports and suggest improvements, alternative approaches and procedures where needed.

If the data reported are affected adversely by the non-conformance, the affected data is clearly identified in the Case Narrative of the report and the customer is notified. It is common to contact the client for direction prior to the issuance of a report.

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Section 15

PREVENTATIVE ACTION
(TNI V1:M2 – Section 4.12)

Preventative action is a proactive process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints.

Preventative actions include, but are not limited to: encouraging staff to discuss any ideas they may have for improving processes with the appropriate Technical Director, review of QC data to identify quality trends, review of client feedback to look for improvement opportunities, review of proficiency testing data to look for analytes that were nearly missed, annual managerial reviews, scheduled instrument maintenance, and other actions taken to prevent problems.

When improvement opportunities are identified or if preventative action is required, action plans are developed by the pertinent Technical Director, implemented, then monitored to reduce the likelihood of the occurrence of non-conformities.

Procedures for preventative actions include initiation of the actions and subsequent monitoring to ensure that they are effective.

All personnel have the authority to offer suggestions for improvements and to recommend preventative actions. Management is responsible for coordinating, implementing, and monitoring preventative action.

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Section 16

CONTROL OF RECORDS
(TNI V1:M2 – Section 4.13)

Records are a subset of documents, usually data recordings, which include annotations such as daily refrigerator temperatures posted to a laboratory form, lists, spreadsheets, or Analyst notes on a chromatogram. Records may be on any form of media including electronic and hardcopy. Records allow for the historical reconstruction of laboratory activities related to sample-handling and analysis.

The laboratory maintains a record system appropriate to its needs, documents all laboratory activities, and complies with applicable standards or regulations as required. Records of original observations and derived data are retained to establish an audit trail. Records help establish factors affecting the uncertainty of the test and enable test repeatability under conditions as close as possible to the original.

16.1 Records Maintained

Records (or copies of records) are kept of all procedures to which a sample is subjected while in the possession of the laboratory. The laboratory retains all original observations, calculations and derived data (with sufficient information to produce an audit trail), calibration records, personnel records and a copy of the test report for a minimum of five years from generation of the last entry in the records. At a minimum, the following records are maintained by the laboratory to provide the information needed for historical reconstruction:

i) all raw data, whether hardcopy or electronic, for calibrations, samples, and quality control measures, including Analysts' worksheets and data output records (chromatograms and other instrument response readout records);

ii) a written description of, or reference to, the specific method(s) used, including a description of the specific computational steps used to translate parametric observations into reportable analytical values (a copy of all pertinent Standard Operating Procedures);

iii) laboratory sample ID code;

iv) date of analysis;

v) time of analysis, required when the holding time is seventy-two (72) hours or less, or when time-critical steps are included in the analysis (e.g., extractions);

vi) instrument identification and operating conditions/parameters (or reference to such data);

vii) all manual calculations (including manual integrations);

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viii) Analyst's or operator's initials/signature or electronic identification;

ix) sample preparation, ID codes, volumes, weights, filter deposit area, instrument printouts, and reagents;

x) test results (including a copy of the final report);

xi) standard and reagent origin, receipt, preparation and use;

xii) calibration criteria, frequency and acceptance criteria;

xiii) data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;

xiv) quality control protocols and assessment;

xv) electronic data security, software documentation and verification, software and hardware audits, backups and records of any changes to automated data entries;

xvi) method performance criteria including expected quality control requirements;

xvii) proficiency evaluation sample results;

xviii) records of demonstration of capability for each Analyst;

xix) a record of names, initials and signatures for all individuals who are responsible for signing or initialing any laboratory record;

xx) correspondence relating to laboratory activities for a specific project;

xxi) corrective action reports;

xxii) preventative action records;

xxiii) copies of internal and external audits including audit responses;

xxiv) copies of all current and historical laboratory SOPs, policies and Quality Manuals;

xxv) sample receiving records;

xxvi) sample storage records;

xxvii) data review and verification records;

xxviii) personnel qualification, experience and training records;

xxix) archive records; and

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xxx) management reviews.

16.2 Records Management and Storage

Program Documents: Process, Approval and Distribution

Currently, ***CHESTER LabNet*** has two program documents: Laboratory Quality Assurance Management Plan (QAMP) and the Chemical Hygiene Plan (CHP). All program documents are written and polished to a draft condition by the QA Officer or designated alternate prior to being submitted to the Laboratory Director as a draft version for review. The Laboratory Director makes comments on the draft version and returns it for revision. After making the requested revisions, program documents are circulated to the rest of the staff for comments. Once all comments have been addressed, the final copy is read and signed by all ***CHESTER LabNet*** personnel. The documents are stored in the main office area of the premises and are reviewed annually by all personnel.

Document Control

All original program documents and SOPs are stored in a bookcase in the main office area. Original finalized copies of these documents or binders containing documents may not be removed from the premises under any circumstances. Photocopies, electronic copies and/or draft copies of documents may only be removed from the premises with the approval of the QA Officer or Laboratory Director.

Due to the small size of ***CHESTER LabNet***, the laboratory has no formal document control system, nor does the laboratory have an SOP describing document control within the company. As no controlled copies of documents are permissible, excepting use for accreditation or project proposals, the need to trace dispersed copies is moot. SOP QA-003 does include a thorough description of the processes the laboratory uses to govern document generation, control, and archiving of obsolete documents. The QA Officer maintains an electronic master list of all in-house written documents on the QA Officer's computer. Technical Directors and Analysts are responsible for maintaining control of equipment/instrument specific manuals and literature.

All laboratory employees have access to the original documents at all times. All laboratory documents are reviewed on an annual basis by the QA Officer, the appropriate Technical Director or an alternate designated by them, and the employee(s) who perform the procedure. The QA Officer is also responsible for the preparation, approval and issuance of new documents.

Copies are not allowed to be made, except for submission to the client for the purposes of meeting contractual or proposal obligations. Any photocopy or electronic copy must be approved by either the Laboratory Director or the QA Officer. No copies of client specific documents (QAMP or any SOP) will be submitted to any other client. All original SOPs or laboratory documents must be signed on their Cover Page by at least two laboratory employees in BLUE ink. The Review History Page is signed by the appropriate Technical Director or QA Officer.

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Any physical copy of a document will be clearly stamped with the word "COPY" on the Cover Page and can be distinguished from the original by a lack of signatures in blue ink. Electronic copies are distinguishable by a watermark reading "uncontrolled copy" on each page of the document.

Instrument Manuals are kept in a location near the instrument to which they apply, with the exception of support instrumentation/equipment, which may be kept in a binder in the laboratory where the support instrumentation/equipment is used. Instrument manuals are available at all times to all personnel. A listing of all manuals and their locations is located in Section 23.1, "General Equipment Requirements," of this document.

Standard Operating Procedures (SOPs) and "Quick Guides"

Original signed SOPs are kept in 3-ring binders in the main office area of the laboratory. Obsolete versions are stapled along the right margin and retained in the archived SOPs file drawers for a minimum of 5 years from their last effective date. The production of new SOPs and the revision of existing SOPs are under the supervision and control of the QA Officer. Each SOP must be approved, signed, and dated by a minimum of two people. In cases where the author is the person most familiar with the technique, a second person with or without the same degree of technical knowledge shall read and sign the SOP. Within the laboratory, originals are always used as references. Copies are only made for submission to outside authorities and only by specific contractual request. Electronic copies are notable by a watermark reading "uncontrolled copy" on each page of the document. Any physical copies of SOPs (e.g., to be used for submission materials for new projects or for proposals) must be stamped "COPY" in red ink across the title page. All SOPs are reviewed annually and a master list of SOPs is maintained electronically by the QA Officer to ensure annual review.

"Quick Guides" are appendices to some SOPs which contain frequently referenced information contained in the SOP. The production of new Quick Guides and the revision of existing Quick Guides are under the supervision and control of the QA Officer. Quick Guides are reviewed and approved annually as part of the SOP review.

QA Guidance Manuals

Originals of the general laboratory Quality Assurance Management Plan, project-specific Quality Assurance Management Plans, and the general laboratory Chemical Hygiene Plan are kept along with the original SOPs in the main office area of the laboratory. The production of new QA manuals and the revision of existing QA manuals are under the supervision and control of the QA Officer. Each QA manual must be signed and dated by the author. In addition, Quality Assurance Management Plans must be read, signed and dated by all affected laboratory personnel. This process is conducted annually for the general laboratory Quality Assurance Management Plan and for all project-specific Quality Assurance Management Plans where an annual review is required. The date of issue is clearly marked on the title page and the total number of pages is clearly marked at the top of each page, next to the specific page number.

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Laboratory Logbooks

Bound laboratory logbooks are assigned numbers and dispensed by the QA Officer who maintains a bound logbook containing the dispensed logbook number, date of origination, use, and date the logbook is retired. The master logbook-tracking logbook is kept in the main office area of the laboratory. Filled logbooks are decommissioned by the QA Officer. The decommission date and archive location are noted in the same bound book and the decommissioned logbooks are kept in a series of labeled banker's boxes in the laboratory archive area.

Documentation stored in 3-ring binders is decommissioned by the QA Officer. The decommission date and archive location are noted in the same bound logbook as decommissioned logbooks. Decommissioned 3-ring binders are stored on archive shelves near the front office.

Document Production and Maintenance

All internal documents have a Cover Page and a Review History Page. The Review History Page tabulates the changes made over time to the document. Any major changes to the document content will be noted in this table (see Review History Page of this document). Minor changes can be noted in the original document in NON-BLACK ink, as long as those changes are dated and initialed by the person making the change. If a document is in the process of a major revision, handwritten changes do not need to be dated or initialed as those changes will propagate immediately to the new version, and the date will be noted in the revision history at the front of the document. Upon the introduction of a newly revised document, the obsolete version is retained in the QA Officer's files. Upon introduction of a newly revised SOP, the obsolete version is marked with an "effective until" date, stapled along its right-hand margin, and retained in the archived SOPs file drawer.

The production of new documents and the revision of existing documents are under the supervision and control of the QA Officer. Each document is approved, signed, and dated by the QA Officer and at least one other laboratory employee. Any copies of documents (e.g., to be used for submission materials for new projects or for proposals) must be stamped "COPY" in red ink across the title page. Electronic copies are notable by a watermark reading "uncontrolled copy" on each page of the document.

All documents are reviewed annually by the QA Officer and all pertinent employees for currency, accuracy, and clarity. Any revisions are noted in the Review History table at the front of the document. If no significant changes are needed, the review is documented by signing and dating the annual review line of the Review History Page. The Review History Page is signed by the pertinent Technical Director or QA Officer. Program documents are signed by, at a minimum, the QA Officer and Laboratory Director.

All electronic versions of documents are maintained on the QA Officer's computer. Changes to electronic documents are performed by the QA Officer, or, rarely, by the Laboratory Director. Handwritten corrections may be made to the original hardcopy by any employee, as long as that change is dated and initialed. If there

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are numerous significant changes to content, the document is re-issued as soon as practicable. If the changes are minor, such as typographical errors, re-issuance may be delayed until such time as a major change requires it. The review history of each document notes changes made to the document and the name of the person making the changes. Electronic copies of all SOPs and Administrative Documents (such as this document) are password protected.

Analytical Record Keeping

Data are recorded immediately and legibly in permanent ink. Data generated by automated data collections systems are recorded electronically. Corrections are initialed and dated with the reason noted for corrections (other than transcription errors). A single line strikeout is used to make corrections such that the original record is not obliterated.

Analytical records associated with analysis are retained in varying formats and locations such as to create a documentation trail sufficient to create a historical account of the analysis of any given sample. These records and their locations are listed in the table below:

Record	**Location**
Client/Laboratory Sample ID	LIMS and final data report
Date/time of analysis	Raw data (final data report)
Instrument ID (may be in the form of analysis type – e.g., only one IC is used for the determination of Anions.)	Header of the instrumental printout or data sheets (final data report), LIMS
Instrument operating conditions	Instrumental method is usually noted in the header of the instrumental printout (final data report)
Analysis type	Final data report (data sheets or Case Narrative)
Manual calculations	Raw data (final data report)
Analyst's initials	Raw data (final data report)
Sample Preparation Logs	Raw data (final data report)
Sample Analysis	Raw data (final data report)
Standard and reagent origin, receipt, preparation and use;	Ordering and Receipt files, Certificate of Analysis, standards/reagents logs, SOPs (for reagents needing preparation immediately prior to use), sample preparation logs.
Calibration Criteria, frequency and acceptance criteria	Applicable SOPs
Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions	Final data report, applicable SOPs
Quality control protocols and assessment	Protocols contained in applicable SOPs. Assessment found in raw data and final

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Record	Location
	report.
Method performance criteria	Applicable SOPs

The following records are maintained in the finalized hardcopy or electronic data report that is retained for a period of at least 5 years:

- all original data, in hardcopy format, or a record of where the hardcopy data is located;
- reference to the specific reference method used, where one exists;
- Cover Page, Case Narrative and copies of final data sheets;
- correspondence relating to the specific project;
- the identity of the personnel involved in sample receipt and log in;
- the identity of the personnel involved in sample preparation;
- the identity of the personnel involved in sample analysis;
- the identity of the instrumentation used during analysis;
- original observations;
- derived data;
- calibration records;
- staff records; and
- the identity of the person who checks the data QC indicators prior to reporting.

In addition to the above, the record keeping system allows for the retrieval of all working files and archived records via run logs, dates, data file names, preparation logs, etc. All handwritten changes to any logs are lined out using a single line so as not to obscure the original entry, then dated and initialed, and the reason for the change (other than transcription errors) is noted. All data recorded manually are recorded directly, promptly and in indelible black ink. Erasures or intentional overwriting of files are not permissible. Observations, data and calculations are labeled so as to link them unequivocally to the specific task and are recorded at the time they are made.

Changes to electronic files are rare and are usually performed by a Project Manager during the final report production stage. The person making the change is evident by which Project Manager is working with that data package. Entries to electronic records are made in such a way as to not erase or overwrite files. Reasonable measures are taken to avoid loss or change of original data in electronic records; however, unforeseen catastrophic electronic failures can occur, resulting in loss of electronic records.

Control of Data Reports

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SOPs AD-007 and QA-008 document the production of data reports. Each data report will have all associated hardcopy documents necessary for the historical reconstruction of data contained within it, or within appropriate bound logbooks. This includes, but is not limited to: final data report pages, case narratives, chains of custody, raw data, digestion logs, any notes concerning client directives, observations of the samples, QC summary pages and any other documentation required by verbal or written contract with the client. All software-generated data are stored in hardcopy format within the data report.

Hardcopy data reports of all documentation not easily regenerated by the LIMS are retained for a period of no less than 5 years (e.g., raw data, CoC's, correspondence, Case Narratives, etc.). Copies of all reports submitted to clients, including documentation easily regenerated by the LIMS, are retained in .pdf format. Disposal of old records is carried out per client specifications (e.g., shredded, recycled, returned, etc.). Archived hardcopy reports are stored on-site in banker's boxes on ventilated shelves in a location with fire suppression devices. Active hardcopy reports are stored in lateral file cabinets. All documents pertaining to data generation are stored in a safe and secure environment, and held in confidence to the client.

Electronic Data Control

Primary control of electronic data occurs at the physical security level, by preventing any non-authorized persons access to the premises without an escort. Secondary control of electronic data is achieved by employing only personnel with proven ethical understanding of data integrity. Tertiary data control at the instrument level is controlled by the software auditing mechanisms built into the major instrumental software utilized by the laboratory. Quaternary electronic data control is achieved by retaining hardcopy records of all electronic data produced by the laboratory in appropriate project files.

The laboratory backs up electronic data including instrument data files, company data files, client data reports, emails, company financials, accreditation information, Standard Operating Procedures and administrative documents, detection limit studies and spreadsheets used for data reduction (for non-electronically generated data). This backup is performed daily, first to a different dedicated backup hard drive and then to 'cloud' storage.

Contract or Accreditation Specific Records

Contract or accreditation specific records are maintained for a period of time in keeping with the contract- or accreditation-specific requirements. These documents are stored safely and securely, as are all other documents, and are available at all times to the accrediting authority or contract representative.

Records, including electronic records, are easy to retrieve, legible and protected from deterioration or damage; held secure and in confidence; and are available to accrediting bodies for a minimum of five years or as required by regulation or contract. Records that are stored *only* on electronic media are supported by the hardware and software necessary for their retrieval. To prevent unauthorized

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access or amendment, access to protected records is limited to employees in the department in which the records were generated.

Additional information regarding control of data is included in Section 22.5, "Control of Data".

The QA Officer or pertinent Technical Director notes when repositories of Quality and Technical records need archiving. The responsible person collects and, if necessary, binds the records. Records are then archived by the QA Officer using the master tracking logbook.

Archived information and access logs are protected against fire, theft, loss, environmental deterioration, vermin and, in the case of electronic records, electronic or magnetic sources. Archived records have limited access, and are checked out through an access log. Both hardcopy and electronic archived records are stored onsite, with the exception of 'cloud' backup records.

In the event that the laboratory transfers ownership or goes out of business, records will be maintained or transferred according to client instructions. Appropriate regulatory and state legal requirements concerning laboratory records are followed. Note that the laboratory is owned in shares. Sales of shares does not constitute a change of ownership unless the laboratory changes names, Taxpayer Identification Number (TIN), or is otherwise no longer the legal entity responsible for the data produced.

16.3 Legal Chain of Custody Records

Evidentiary sample data are used as legal evidence. ***CHESTER LabNet*** does not *knowingly* analyze data for evidentiary purposes.

To establish the documentation necessary to trace sample possession, a chain of custody record should be filled out at the time of collection and accompany every sample. The record should contain the following minimum information:

- sample identification (***CHESTER LabNet*** laboratory identification number or client sample ID);
- sample tag number (if separate tag present);
- site (client sample ID or site location identifier);
- signature of sampler;
- date and time of sample collection;
- type of sample or referenced method number;
- signatures of all persons involved in the chain of custody;
- inclusive dates of possession; and
- analyses requested.

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Each person who has custody must sign the chain of custody form. Samples must not be left unattended unless secured and sealed. Note that ***CHESTER LabNet*** has no control over whether or not a client submits a legally defensible chain of custody.

Due to its small and secured facilities, ***CHESTER LabNet*** does not utilize internal chains of custody. Samples are kept in a secure part of the facilities at all times, and visitors are not allowed within the confines of the facilities without an escort.

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Section 17

AUDITS
(TNI V1:M2 – Section 4.14)

Audits measure laboratory performance and verify compliance with accreditation/ certification and project requirements. Audits specifically provide management with an on-going assessment of the management system. They are also instrumental in identifying areas where improvement in the management/quality system will increase the reliability of data. Audits are of four main types: internal, external, performance and system. Section 17.5 discusses the handling of audit findings.

17.1 Internal Audits

Internal Audits are conducted annually (every 12 – 14 months). These audits verify compliance with the requirements of the management/quality system, including analytical methods, SOPs, the Quality Assurance Management Plan, ethics policies, data integrity, other laboratory policies and the 2009 and 2016 TNI Standard.

It is the responsibility of the QA Officer to plan, organize, and ensure the performance of audits as required by the schedule. These audits are carried out by trained and qualified personnel who are, wherever resources permit, independent of the activity to be audited.

In addition to the scheduled internal audits, it may sometimes be necessary to conduct special audits as a follow-up to corrective actions, PE results, complaints, regulatory audits or alleged data integrity issues. These audits address specific issues. If deficiencies found affect data, the client shall be notified and the issue shall be addressed.

The area audited, the audit findings, and corrective actions are recorded. Audits are reviewed after completion to assure that corrective actions were implemented and effective.

17.2 External Audits

It is the laboratory's policy to cooperate and assist with all external audits, whether performed by clients or an accrediting body. Management ensures that all areas of the laboratory are accessible to auditors as applicable and that appropriate personnel are available to assist in conducting the audit.

17.2.1 <u>Confidential Business Information (CBI) Considerations</u>

During on-site audits, on-site auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such

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information is entitled to such treatment." When information is claimed as business confidential, the laboratory includes the word "proprietary" in the title page of the document. Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory, however, sample identifiers may not be obscured from the information.

17.3 Performance Audits

Performance audits may be SSAS Audit Samples, internal single-blind samples, double-blind samples through a provider or client, or anything that tests the performance of the Analyst and method.

Proficiency Evaluation Samples are discussed in Section 27, "Quality Assurance for Environmental Testing".

Note that no TNI-defined Field of Proficiency Testing table (FoPT) exists for the Quality Matrix of "Air", therefore, the requirement for biennial analysis of PE Samples does not apply to the laboratory.

17.4 System Audits

The Laboratory's management system is audited though annual management reviews. Refer to Section 18, "Management Reviews" for further discussion of management reviews.

17.5 Handling Audit Findings

Internal or external audit findings are responded to within the time frame agreed upon at the time of the audit. The response may include action plans that could not be completed within the response time frame. A completion date is established by management for each action item and included in the response.

Development and implementation of corrective actions to findings is the responsibility of the QA Officer in tandem with affected personnel. Corrective actions are documented through the corrective action process described in Section 14, "Corrective Actions". If the corrective action reports described in Section 14 are unmanageable due to the size of the document required, a separate response to audit findings is created by the QA Officer. The response to audit findings is retained by the Laboratory Director in a file pertinent to the auditing body.

Audit findings that cast doubt on the ability of the laboratory to produce data of known and documented quality or that question the correctness or validity of sample results must be investigated. Corrective action procedures described in Section 14, "Corrective Action" must be followed. Clients must be notified in writing if the investigation shows the laboratory results have been negatively affected and the client's requirements have not been met. The client must be notified within five business days, verbally or in writing, electronically or hardcopy,

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after the laboratory discovers the issue. Laboratory management will ensure that this notification is carried out within the specified time frame.

All investigations resulting in findings of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. See Section 19, "Data Integrity Investigation," for additional procedures for handling inappropriate activity.

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Section 18

MANAGEMENT REVIEWS
(TNI V1:M2 – Section 4.15)

Top management reviews the management system on an annual basis and maintains records of review findings and actions.

18.1 Management Review Topics

The following are reviewed to ensure their suitability and effectiveness:

- policies and procedures;
- reports from managerial and supervisory personnel;
- the outcome of recent internal audits;
- corrective and preventative actions;
- assessments by external bodies;
- the results of inter-laboratory comparisons or audit samples;
- changes in the volume and type of the work;
- customer feedback;
- complaints;
- recommendations for improvement;
- completeness record; and
- other relevant factors, such as quality control activities, resources and staff training.

18.2 Procedure

Once annually, the QA Officer, with the help of the Laboratory Director, shall gather records pertinent to the topics listed in Section 18.1. The Annual Managerial Review document compiles a detailed analysis of those items. This review is then presented to the entire company during a company meeting for input and discussion.

Managerial reviews are part of the annual internal audit/review process. If needed, at the end of the annual audit cycle, an annual audit summary report is written. This report summarizes the findings, corrective actions, follow-up procedures and any other items of note found during the annual audit. The report is retained by the QA Officer in that year's internal audit file.

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The managerial review shall take account of:

- the suitability of policies and procedures including a review of the QAMP to verify that all elements are being followed;
- reports from managerial and supervisory personnel;
- the outcome of the annual internal audits;
- corrective and preventative actions;
- assessments by external bodies;
- the results of SSAS audit samples (See Section 18.1);
- changes in the volume and type of work;
- summary of client surveys;
- completeness record;
- quality control activities;
- resources: facilities and equipment;
- resources: staff and training; and
- goals, objectives and corrective action plans.

Findings and follow-up actions from management reviews are recorded. Management will determine appropriate completion dates for action items and ensure they are completed within the agreed upon time frame.

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Section 19

DATA INTEGRITY INVESTIGATIONS
(TNI V1:M2 – Section 4.16)

In addition to covering data integrity investigations, this Section covers all topics related to ethics and data integrity policies, procedures and training.

CHESTER LabNet is committed to ensuring the integrity of its data and providing valid data of known and documented quality to its clients. The elements in ***CHESTER LabNet***'s Ethics and Data Integrity program include:

- annual data integrity training (held in tandem with the annual safety training);
- an audit program that monitors data integrity (see Section 17, "Audits") and procedures for handling data integrity investigations and client notifications;
- procedures for confidential reporting of alleged data integrity issues; and
- documented data integrity procedures in the form of an Ethics and Data Integrity Policy signed and dated by all management and staff (see Appendix A) as well as the signatures on this QAMP. All staff shall read and sign the Policy annually (see Appendix A). This policy is an integral part of the QAMP, and is signed, dated, and distributed by the QA Officer as part of the annual QAMP review cycle. It is available to all staff at any point in time by referencing the QAMP.

19.1 Ethics and Data Integrity Procedures

The Ethics and Data Integrity Policy provides an overview of the program. Written procedures that are considered part of the Ethics and Data Integrity program include:

- the Ethics and Data Integrity Policy (see Appendix A);
- manual integration procedures (see SOP QA-012);
- corrective action procedures (see Section 14);
- Data Integrity Investigations (see below);
- data recall procedures (see Section 14);
- data integrity training procedures (see Section 19.2);and
- annual management review of data integrity.

19.2 Training

Data integrity training is provided as a formal part of new employee orientation and a refresher is given annually for all employees. Employees are required to read and sign the Personal Ethics and Data Integrity Policy included in this

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document (see Appendix A) during new employee orientation and again annually. This policy clearly states that any infractions of the laboratory data integrity procedures shall result in a detailed investigation that could lead to very serious consequences including immediate termination or civil/criminal prosecution. Attendance for required training is documented through the signatures and accompanying dates on the Data Integrity and Ethics Policy.

Data integrity training emphasizes the importance of proper written narration on the part of the Analyst in those cases where analytical data may be useful, but are in one sense or another partially deficient. All topics contained in the Personal Ethics and Data Integrity Policy are covered, and employees are given the opportunity to ask questions at the end of the training session.

The following topics and activities are covered:

- the organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting;
- how and when to report data integrity issues;
- record keeping;
- training, including discussion regarding all data integrity procedures;
- data integrity training documentation;
- in-depth data monitoring and data integrity procedure documentation; and
- specific examples of breaches of ethical behavior such as improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards.

When contracted technical or support personnel are used, the QA Officer is responsible for ensuring that they are trained in the laboratory's management system and data integrity procedures, are competent to perform the assigned tasks, and are appropriately supervised. These personnel are treated in the same manner as a regular employee and often become regular employees.

Topics covered are provided to all trainees in writing in the form of the Personal Ethics and Data Integrity Policy located in Appendix A of this document.

19.3 Confidential Reporting of Ethics and Data Integrity Issues

Confidential reporting of data integrity issues is assured through the following procedure: All staff members have the authority and responsibility to bring any problems, discrepancies, or concerns to the attention of their appropriate Technical Director. In situations where privacy is of concern, all staff have access to all other staff members' phone numbers. It is understood and encouraged that when needed, employees contact each other via their private phone numbers. All employees are required to inform their Technical Director or other member of Management if they have reason to believe that an investigation into data integrity is necessary.

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19.4 Investigations

All investigations resulting from data integrity issues are conducted confidentially. They are documented and notifications are made to clients who received any negatively affected data that did not meet the client's data quality requirements.

The first stage of investigation is data inspection including, but not limited to: all associated documentation including reagents logbooks, calibrations, run logbooks, computer clocks and/or date/time stamps on the raw data, computer controlled environmental monitoring, etc. The inspection is conducted by the appropriate Technical Director, in conjunction with the Laboratory Director/President and QA Officer. If the inspection results raise concerns, those results and the concerns they raised, along with copies of the associated documentation are retained in the employee's personnel file.

If, in their opinion, a breach of ethical conduct has occurred (as opposed to an honest mistake or oversight), the same Management staff member shall then interview the employee. If the interview raises concerns, other employees may be interviewed and the results of the interviews are documented.

If the situation is deemed to be a breach of ethics by Management, documentation from both the records inspection and any subsequent interviews, along with a record of any actions taken, is placed in the employee's personnel file maintained by the Laboratory Director/President. The employee will be informed of the outcome of the investigation.

CHESTER LabNet does not tolerate unethical behavior of any sort by its employees, whether said behavior is related or unrelated to data production. If a breach of ethics is found to be supported by evidence, the employee may expect to be terminated. Conversely, Management begins with the assumption that errors are unintentional and oversights are honest mistakes. Management avoids the judgment error of assuming intent by testing against Hanlon's Razor.

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Section 20

PERSONNEL
(TNI V1:M2 – Section 5.2)

CHESTER LabNet employs competent personnel based on education, training, experience and demonstrated skills as required. The laboratory's organization chart is located in Section 4, "Organization," of this document.

Competency is defined for three sub-sets of employees: Technical, Client Services, and Management. See Appendix J. Employees must achieve "Fair" or better ratings for all applicable competencies to be deemed competent. Competency is monitored and documented annually during the annual employee performance reviews. Documentation is stored in employee personnel files.

20.1 Overview

All personnel are responsible for complying with all quality and data integrity policies and procedures that are relevant to their area of responsibility.

All personnel who are involved in activities related to sample analysis and/or the evaluation of results, or who sign test reports must demonstrate competence in their area of responsibility. See above for definition of "competence." Appropriate supervision is given to any personnel in training or not fully competent, and the trainer is accountable for the quality of the trainee's work. Personnel are qualified to perform the tasks for which they are responsible based on education, training, experience, and demonstrated skills as required for their area of responsibility.

The laboratory provides goals with respect to education, training, and skills of laboratory staff. These goals are outlined in the specific job descriptions in Section 20.2.

Training needs are identified at the time of employment and when personnel are moved to a new position or new responsibilities are added to their job responsibilities. Ongoing training, as needed, is also provided to personnel in their current jobs. The effectiveness of the training must be evaluated before the training is considered complete.

Contracted personnel, when used, must meet the same competency standards and follow the same policies and procedures that laboratory employees must meet.

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20.2 Job Descriptions

Job descriptions are available for all positions that manage, perform, or verify work affecting data quality, and are located below. Job descriptions include the specific tasks, minimum education, qualifications, skills and experience required for each position. An overview of top Managements' responsibilities is included in Section 5, "Management."

President

Goal:
- Ensure the business operates within compliance of all local, state, federal laws, including financial tracking and reporting;
- Communicate with board of directors.

Area of Responsibility: Corporate Affairs

Minimum education required: Higher degree in a hard science

Training required: Minimum 5 years as an employee of ***CHESTER LabNet***. Training, by necessity, may be autodidactic.

Minimum experience required: 5 years Project Management with ***CHESTER LabNet*** or 2 years equivalent Presidential job duties at another laboratory (environmental or other).

Qualifications:
- Knowledge of legal requirements of running a business;
- knowledge of bookkeeping and legal financial reporting; and
- knowledge of submission of Requests for Proposals (RFPs).

Brief description (including Managerial Duties):
- Oversees marketing and sales;
- performs legal financial reporting including calculating and disbursing dividend checks to owners, ensuring all taxes are paid in a timely manner, and managing payroll and pay rates for employees; and
- where possible, performs no functions related to testing, reporting or method development/modification.

Laboratory Director

Goal:
- Ensure human resource and service performance of the laboratory.
- Provide the resources necessary to implement and maintain an effective quality and data integrity program.

Area of Responsibility: Laboratory Management

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Minimum education required: Higher degree in a hard science

Training required: Minimum 5 years as an employee of ***CHESTER LabNet***. Training, by necessity, may be autodidactic.

Minimum experience required: 3 years Project Management or Technical Director experience with ***CHESTER LabNet*** or 1 year equivalent Laboratory Director job duties at another laboratory (environmental or other).

Qualifications:

- Knowledge of legal requirements of human resource management; and
- knowledge of submission of Requests for Proposals (RFPs).

Brief description (including Managerial Duties):

- Ensures that personnel are free from any commercial, financial and other undue pressures that might adversely affect the quality of their work;
- oversees company financials, to include the purchase of new instrumentation and equipment;
- reviews all tenders and contracts;
- oversees accreditation(s);
- ensures adequate staffing (in tandem with Technical Directors);
- engages in management reviews of laboratory systems;
- oversees client specific analytical requirements; and
- where possible, performs no functions related to testing, reporting or method development/modification.

Quality Assurance Officer (QA Officer)

Goal:

- Review all data prior to reporting;
- write/maintain all Quality documents including SOPs and this document;
- ensure compliance with this Quality Assurance Management Plan; and
- ensure compliance with Data Integrity and Ethics Policy.

Area of Responsibility: Laboratory Management

Minimum education required: Higher degree in a hard science

Training required: Minimum 5 years as an Analyst with ***CHESTER LabNet***. Training, by necessity, may be autodidactic.

Minimum experience required: 5 years analytical experience with ***CHESTER LabNet*** or 1 year equivalent QA Officer job duties at another laboratory (environmental or other).

Qualifications:

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- Knowledge of current TNI Standard requirements;
- knowledge of all QC requirements associated with methods performed; and
- knowledge of the general chemistry and techniques of all methods performed.

Brief description (including Managerial Duties):

- Serves as a focal point for QA/QC;
- arranges or conducts annual internal audits without outside (e.g., managerial) influence;
- notifies management of deficiencies and monitors corrective actions;
- oversees and reviews quality control data;
- monitors corrective actions;
- ensures that the management system related to quality is implemented and followed at all times;
- monitors and maintains laboratory certifications/accreditations;
- maintains currency of this Quality Assurance Management Plan;
- ensures all SOPs and Administrative Documents are reviewed annually and maintains currency of all SOPs and Administrative Documents;
- ensures that all Analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented;
- ensures that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits - procedures that do not meet the standards set forth in the Quality Manual, laboratory SOPs or laboratory policies may be temporarily suspended by the QA Officer;
- reviews all logbooks for completeness and correct usage;
- ensures all project-specific data quality objectives and specific QA/QC targets are satisfied;
- ensures compliance with mandated systems requirements;
- issues and archives laboratory logbooks;
- reviews and approves all SOPs and policies prior to their implementation, and ensures availability of and adherence to all approved SOPs and policies;
- evaluates all results based upon QA elements described above and QC requirements for the pertinent testing;
- ensures new methods brought online meet QC criteria for Precision and Bias studies as required;
- ensures new methods brought online meet QC requirement for detection limit studies as required;
- performs statistical analysis for annual DL verifications or Initial DL studies for new methods; and,
- reports opinions and interpretations of data, where applicable.

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Technical Director (all departments)

Goal:
Supervise laboratory department operations, data generation and reporting.

Area of Responsibility: Laboratory Management

Minimum education required: Higher degree in a hard science. In addition, the Technical Director must have a minimum of 24 credit hours of college level chemistry for departments where chemical analysis occurs (does not apply to gravimetry or customer service).

Training required: Minimum 3 years as an employee of ***CHESTER LabNet***. At the discretion of the QA Officer and Laboratory Director, an employee's past work experience may be substituted for 2 of the 3 years. Training, by necessity, may be autodidactic.

Minimum experience required: 2 years Analyst or technician experience with ***CHESTER LabNet*** or 1 year equivalent Technical Director job duties at another laboratory (environmental or other).

Qualifications:

- Knowledge of the general chemistry and techniques of all methods performed in respective department;
- knowledge of all instruments used in respective department;
- knowledge of all QC requirements associated with methods performed in respective department;
- knowledge of reporting requirements associated with methods performed in respective department; and
- meets the general and education requirements and qualifications found in Sections 4.1.7.2 and 5.2.6.1 of the 2009 and 2016 TNI Standard, Volume 1, Module 2, unless not specified.

Brief description (including Managerial Duties):

- Monitors performance data and the validity of the analyses for the laboratory;
- provides technical direction to staff and clients;
- oversees instrument and equipment installation, maintenance and repairs, to include preventative maintenance;
- monitors data compilation and interpretation;
- trains new employees (or delegates training to a qualified Analyst);
- assesses qualifications of employees (education, experience and training);
- ensures training records are completed for employees;

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- ensures completion of initial DoC before newly trained Analyst may be released from training, where feasible;
- officially releases newly trained Analyst from training;
- coordinates operations within the laboratory to ensure smooth flow of samples through the analytical process (may need to be done in tandem with other Technical Directors);
- supervises all Analysts to ensure compliance with all accreditations, regulations and client specific requirements;
- plans tests and ensures adequate flow of work through the department;
- evaluates results against QC criteria as required;
- reports opinions and performs data interpretation, where applicable;
- oversees all method development, modifications and validation in the department; and
- coordinates day to day operations of the department including: flow of work, resource allocations, sample disposal, laboratory hygiene, supplies procurement and instrument maintenance and repair.

LIMS Administrator

Goal:
Ensure proper functioning, configuration and use of the LIMS.

Area of Responsibility: Administrative

Minimum education required: Higher degree in a hard science

Training required: Minimum 2 years as an employee of ***CHESTER LabNet***. Training, by necessity, may be autodidactic.

Minimum experience required: 2 years LIMS usage at ***CHESTER LabNet*** or 1 year equivalent job duties at another laboratory using NWA LIMS software (environmental or other).

Qualifications:
- Computer literate, and
- a general understanding of database operations.

Brief description:
- Operates and maintains (hardware/software) Laboratory Information Management System (LIMS);
- creates/edits/validates report scripts and worklists in tandem with the appropriate Technical Director; and
- where possible, performs no functions related to testing, reporting or method development/modification.

Project Manager

Goal:

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& Lead Project Manager

Coordinate sample receipt, log-in, analysis and reporting to suit the clients' needs.

Area of Responsibility: Administrative

Minimum education required: Higher degree in a hard science

Training required: Minimum 2 years as an employee of ***CHESTER LabNet*** or Project Management training/experience at another laboratory (environmental or other). Training by LIMS Administrator in all functions of the LIMS.

Minimum experience required:

- Lead Project Manager: 2 years Project Management at ***CHESTER LabNet***
- Project Manager: none

Qualifications:

- Computer literate;
- professional demeanor, both written and spoken; and
- good communication skills.

Brief description (including Managerial Duties):

- Functions as primary contact person for client interactions;
- receives samples;
- performs chain of custody procedures;
- interfaces with client and Laboratory on corrective actions;
- packages and ships sample media to clients;
- performs data entry in LIMS;
- reports data;
- coordinates sample receipt, sample analysis and data reporting activities to ensure project turnaround times; and
- performs no functions related to testing or method development/modification.
- Additionally, the Lead Project Manager acts as a resource to other Project Managers, may act as another layer of Quality Control prior to submission of reports, and is responsible for adequate flow of work through the department.

Analyst / Lead Analyst

Goal:
Produce the most accurate data possible that meets QC and documentation requirements of all applicable methods, accreditations and contracts.

Area of Responsibility: Analytical

Minimum education required: Higher degree in a hard science

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Training required: Must be trained in all areas, including the Quality System and Technical/Analytical procedures by a Lead Analyst. For the Lead Analyst, training may, by necessity, be autodidactic.

Minimum experience required:

- Lead Analyst: 2 years as an Analyst at ***CHESTER LabNet***.
- Analyst: none.

Qualifications:

- Computer literate;
- professional demeanor, both written and spoken;
- good communication skills;
- mathematical skills at the algebraic level or higher; and
- 1 year college-level general chemistry OR 1 year experience in performing laboratory analysis at another laboratory.

Brief description (including Managerial Duties):

- Analyzes samples under the direction/coordination of either the Technical Director or Lead Analyst in compliance with requirements of this document, pertinent SOPs, contracts or guideline documents;
- keeps records in compliance with requirements of this document, pertinent SOPs, contracts or guideline documents;
- enters data into LIMS;
- safely handles chemicals and laboratory equipment;
- troubleshoots, maintains and repairs instrumentation, with or without input from the Technical Director or Lead Analyst;
- evaluates data against pertinent QC requirements;
- reports opinions and performs data interpretation, where applicable;
- Lead Analyst is defined as the person with the most experience with a given method or analytical technique; and
- the Lead Analyst acts as a resource to other Analysts and may act as another layer of Quality Control prior to submission of data.

XRF Analyst / Lead XRF Analyst

Goal:
Produce the most accurate data possible that meets QC and documentation requirements of all applicable methods, accreditations and contracts.

Area of Responsibility: Analytical

Minimum education required: Higher degree in a hard science

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Training required: Must be trained in all areas, including the Quality System and Technical/Analytical procedures by a senior Analyst.

For the Lead Analyst, training may, by necessity, be autodidactic.

Minimum experience required:

- Lead XRF Analyst: 2 years as an XRF Analyst at ***CHESTER LabNet***.
- XRF Analyst: none.

Qualifications:

- Computer literate;
- professional demeanor, both written and spoken;
- good communication skills;
- mathematical skills at the algebraic level or higher; and
- 1 year college physics or 1 year experience operating a thin-film XRF spectrophotometer (experience may include on-the-job training).

Brief description (including Managerial Duties):

- Analyzes samples under the direction/coordination of the Technical Director in compliance with requirements of this document, pertinent SOPs, contracts or guideline documents;
- keeps records in compliance with requirements of this document, pertinent SOPs, contracts or guideline documents;
- performs data compilation and spectral interpretation;
- enters data into LIMS;
- troubleshoots, maintains and repairs instrumentation, under the supervision of the Technical Director;
- evaluates data against pertinent QC requirements; and
- reports opinions and performs data interpretation, where applicable; and
- the Lead Analyst acts as a resource to other Analysts and may act as another layer of Quality Control prior to submission of data.

Gravimetry Laboratory Technician

Goal:
Produce the most accurate data possible that meets QC and documentation requirements of all applicable methods, accreditations and contracts.

Area of Responsibility: Analytical

Minimum education required: High School Diploma

Training required: Must be trained in all areas, including the Quality System and Technical/Analytical procedures by a Lead

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Technician or Technical Director.

Minimum experience required: none

Qualifications:

- Computer literate;
- extremely good attention to detail;
- extremely good organizational skills;
- professional demeanor, both written and spoken; and
- good communication skills.

Brief description (including Managerial Duties):

- Performs all Gravimetry Laboratory operations and QA/QC, including acceptance testing and gravimetry;
- maintains appropriate inventory levels of filters and supplies;
- archives analyzed samples;
- follows all QA/QC protocols; and
- evaluates data against pertinent QC requirements.

20.3 Training

All personnel, including non-analytical personnel, are appropriately trained and competent in their assigned tasks before they contribute to functions that can affect data quality unsupervised. It is Management's responsibility to ensure personnel are trained. Training records are used to document Management's approval of completed training. The date on which authorization is confirmed is included.

Training records are generated by the person who performs the training and are maintained by the QA Officer. Records include the dates that training occurred and a brief description of what the training was, along with a "training completed" date.

An Analyst is considered trained when they can pass an IDoC study with no input from any other employee and the department Technical Director evaluates the Analyst's competency and finds is satisfactory. Training on a given method typically takes less than six months.

For further detail, refer to SOP QA-001, "Laboratory Training."

20.3.1 Training for New Staff

New staff members are trained in the following:

- requirements of the Quality Assurance Management Plan;
- requirements of the Chemical Hygiene Plan;
- relevant reference methods or SOPs which they will be performing;
- LIMS operation to the extent necessary for their job requirements; and

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- administrative tasks to the extent necessary for their job requirements.

20.3.2 Ongoing Training

Refer to SOP QA-001, "Laboratory Training."

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Section 21

ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS
(TNI V1:M2 – Section 5.3)

21.1 Environmental

The laboratory facility is designed and organized to facilitate testing of environmental samples. Environmental conditions are monitored to ensure that conditions do not invalidate results or adversely affect the required quality of any measurement, such as the temperature and humidity in the Gravimetry Laboratory.

If the laboratory environment is required to be controlled by a method or regulation, the adherence is recorded. Gravimetry Laboratory temperature and humidity are recorded using a combination temperature and humidity digital data logger, and the balances are placed upon marble slabs to avoid problems with vibration. Environmental tests are stopped when the environmental conditions jeopardize the results. Relevant temperature/humidity readings are recorded in the raw data for methods that have specific temperature/humidity requirements, but are not performed in the Gravimetry Laboratory.

21.2 Work Areas

Work areas include access and entryways to the laboratory, the administrative area (which may serve as a sample receipt area), sample storage areas, sample processing and analysis areas, and chemical and waste storage areas.

Access to and use of areas affecting the quality of the environmental tests is controlled by restriction of areas to authorized persons only. See Section 21.4 below. Due to the small size of the laboratory, all employees are, by default, authorized personnel in all areas of the laboratory. Unauthorized persons could be people such as plumbers, field service technicians, visitors, etc.

The laboratory work spaces are adequate for their use, and appropriately clean to support environmental testing and ensure an unencumbered work area.

Laboratory space is arranged to minimize cross-contamination between incompatible areas of the laboratory. The Gravimetry Laboratory is on a separate HVAC system from the rest of the laboratory areas to ensure proper temperature and humidity control. Areas with high mineral acid usage are located in a different part of the conventional chemistry laboratory from where ion chromatography is performed. Sulfuric acid is not utilized near areas where reference Method 202 is being performed. Resuspension of particulates onto filters is performed in a separate area to prevent particulate contamination of other samples.

Testing occurs only within the laboratory's analytical areas (e.g., Conventional Chemistry laboratory, Source Particulate Laboratory, XRF Laboratory or Gravimetry Laboratory). Adequate laboratory space is maintained for the testing performed in

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each area. Electronic balances are located away from drafts and doorways, and are mounted on marble slabs in areas where their use is affected by vibrations. Neighboring test areas of incompatible activities are effectively separated. Specific work areas are defined and access is controlled. (Only authorized laboratory personnel and escorted visitors may enter the work areas.) Good housekeeping measures are employed to avoid the possibility of contamination. Smoking is prohibited.

All equipment and reference materials required for accredited tests are available on-site. Records are maintained for all equipment, reference measurement materials and services used by the laboratory.

Reference materials traceable to national standards of measurement (NIST) or to national standard reference materials (SRM's) are stored away from heavy use areas or major equipment that may affect the proper operation of the materials. Certificates of Traceability are available for NIST traceable thermometers and hygrometers, for Class 0 and Class 1 weights, and for all commercially prepared aqueous standards. The reference materials are used only for calibration or calibration verification in order to maintain the validity of performance. Certificates of Analysis are available for all standards and reagents.

21.3 Floor Plan

See Appendix C.

21.4 Building Security

The laboratory is kept secure during off hours by the use of locks and an alarm system.

Access to the facilities is by cardlock during non-business hours, seven days a week. During business hours, the main door is unlocked and is monitored by personnel. The back door is locked 24/7 and only accessible via cardlock. Visitors are allowed in the laboratory under escort only.

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Section 22

ENVIRONMENTAL METHODS AND METHOD VALIDATION
(TNI V1:M2 – Section 5.4 and Sections 1.4, 1.5 and 1.6 of Technical Modules TNI V1:M 3-7)

Methods and/or procedures are available for all activities associated with the analysis of the sample including preparation and testing. For purposes of this Section, the term "method" refers to both the sample preparation and determinative methods, except where the term "reference" precedes the word "method". See Appendix B for a listing of all ***CHESTER LabNet*** SOPs. See Section 25, "Collection of Samples," and Appendix D, "***CHESTER LabNet*** utilized reference methods" for a listing of the most common reference methods in use at ***CHESTER LabNet***.

Before being put into use, a method is confirmed by a demonstration of capability or method validation process, where possible.

All methods are published or documented. Deviations from the methods are allowed only if the deviation is documented, technically justified, authorized by management and accepted by the customer. Note that most source sampling methods (CFR methods) are extremely outdated and archaic, and ***CHESTER LabNet***'s clients are well aware of this. The laboratory does not notify clients of changes to methods necessitated either by the laws of chemistry and physics, or by the EPA's failure to update methods to reflect current technology.

Every SOP has an appendix which lists all of the differences between the laboratory's SOP and the reference method. Examples include using a computer rather than a strip chart recorder, using correct stoichiometry in calculations, and using instrument software to generate calibration curves rather than hand-plotting on graph paper.

22.1 Method Selection

A reference method is a method issued by an organization generally recognized as competent to do so. When ISO refers to a "standard method", that term is equivalent to "reference method". When a laboratory is required to analyze a parameter by a specified reference method due to a regulatory requirement, the parameter/method combination is recognized as a reference method.

The laboratory will use methods that meet the needs of the customer. Such methods will be based on the latest edition of the reference method unless it does not meet the needs of the customer. Generally speaking, the customer has little room for guesswork as there are a very limited number of reference methods for the analysis of either ambient air or source emissions. Both the client and the laboratory may be forced by a regulatory agency to use a reference method that is not appropriate to the ultimate client's needs. When the regulatory authority mandates a specific reference method, the laboratory will follow that method as closely as possible and in keeping with the chemistry and intent of the reference method. This statement is most commonly applicable to archaic methods found in the CFR for source emission testing.

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CHESTER LabNet does not inform the client when a reference method is considered to be inappropriate or out-of-date, as our clients are already aware of those issues.

If a reference method is not specified by the client, the client is contacted and clarification is obtained prior to proceeding with any analytical work. Air quality methods (ambient or source) have two major components to them: sampling and analytical. ***CHESTER LabNet*** only performs the analytical portion of the method. The client will be aware of what method/analytes are needed. Typically, the omission of a reference method request is a simple documentation error.

All communications between the laboratory and the client are documented via printed email correspondence or notes on the Chain of Custody that have been dated and initialed by the laboratory agent contacting the client.

22.2 Laboratory-Developed Methods

If the laboratory develops a method, the process of designing and validating the method is carefully planned and documented. One person, usually the Technical Director of the affected department, will be responsible for developing the method.

In some cases, methods may be developed to fill in gaps found in other published or reference methods. On rare occasions, a method will be developed due to a lack of a reference method (e.g., Alkalinity in Teflon Filters). All methods developed in house, for whatever reason, will have an associated SOP. The in-house methods will undergo the same annual review cycle as all other SOPs, and shall contain the following information:

a) appropriate identification;
b) scope;
c) description of the type of sample to be tested;
d) parameters or quantities and ranges to be determined;
e) apparatus and equipment, including technical performance requirements;
f) reference standards and reference materials required;
g) environmental conditions required and any stabilization period needed;
h) description of the procedure, including:
    i. affixing of identification marks, handling, transporting, storing and preparation of samples,
    ii. checks to be made before the work is started,
    iii. checks that the equipment is working properly and, where required, calibration and adjustment of the equipment before each use,
    iv. the method of recording the observations and results,

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v. any safety measures to be observed;

i) criteria and/or requirements for approval/rejection;

j) data to be recorded and method of analysis and presentation; and,

k) the uncertainty or the procedure for estimating uncertainty.

Laboratory-developed methods are only used if they are validated by a demonstration of capability study (where possible) and only if they are appropriate for the intended use. As with other new methods, the Technical Director is responsible for ensuring that the laboratory is capable of performing the method in such a manner as to meet all applicable QC requirements. This is achieved via a Demonstration of Capability Study and a Precision and Bias Study, where possible. Where not possible, other method specific QC criteria may be utilized to demonstrate capability. The development of new methods will always be assigned to the staff member with the greatest knowledge relating to that method and the ability to obtain all the resources needed to carry out the method.

When an occasion arises in which the employment of a non-reference method is needed, the method will be developed in conjunction with the client. These methods are almost never used by any other client or for any other project, and tend to fall into one of two categories: contingency and contractual.

Contractual methods are usually developed based on a method or methods supplied by the client. These may or may not be publicly available reference methods. Method development then proceeds until such time as the laboratory can demonstrate method proficiency and Precision and Bias, where possible (see SOP QA-006). Methods developed for contractual reasons must meet the client's approval prior to samples being analyzed. As method development may generate large quantities of documentation, most documentation is kept in a 3-ring binder in chronological order with notes as to what changes were being made during the maturation of the method.

Contingency methods tend to be utilized on a one-time basis, for engineering purposes or for the purposes of testing obscure/difficult/non-regulated matrices. As such, full validation of the method may not be possible and presents an undue burden on the laboratory. Such analyses will be documented fully, all directives issued by the client will be noted in the data file, and attempts are always made to get written confirmation from the client as to the acceptance of the proposed methodology. Documentation by the Analyst will include specifics, where not obvious, pertaining to the analysis.

The acceptance/rejection criteria for non-reference methods default to methods of similar chemistries or to CLP guidelines, if at all possible. When not possible, acceptance/rejection criteria may be based upon Precision and Bias studies and/or DL studies, or other method specific QC where DL and Precision and Bias Studies are not applicable (e.g., Method 202, filter impregnation, etc.).

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22.3 Method Validation

Validation is the confirmation, by examination and objective evidence, that the particular requirements for a specific intended use are fulfilled.

At a minimum, reference methods are validated by performing an initial demonstration of capability, where possible. Additional requirements are discussed for each technology.

All non-reference methods are validated before use, where possible. The validation is designed to enable the laboratory to demonstrate that the method is appropriate for its intended use. All records (e.g., planning, method procedure, raw data and data analysis) are retained while the method is in use. Based on the validation process, the method's SOP will contain a statement of the intended use of the method and whether or not the validated method meets the use requirements.

Method validation and Demonstration of Capability procedures for methods in use at ***CHESTER LabNet*** is located in Appendix H, "Chemistry."

22.4 Estimation of Analytical Uncertainty

Analytical Uncertainty is a subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.

When requested and where possible, the laboratory will provide an estimate of the analytical uncertainty (reported as a percent or absolute numbers) determined by calculating the standard deviation of a statistically significant set of recovery values for known standards analyzed by the same method, then multiplying the standard deviation by the appropriate 99% confidence Student *t* value for the degrees of freedom present in the data set.

Due to the unique analytical requirements for air testing, this may not always be possible, as is the case with all gravimetric analyses (e.g., particulate measurements).

Two methods utilized at the laboratory issue uncertainties as part of standard reporting formats: analysis of metals by XRF and analysis of Carbon by OC/EC. A full explanation of determination of uncertainty for measurements by XRF is contained within SOP XR-005. Determination of uncertainties for OC/EC is performed by the instrument software.

22.5 Control of Data

To ensure that data are protected from inadvertent changes or unintentional destruction, the laboratory uses procedures to check calculations and data transfers (both manual and automated).

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22.5.1 Computer and Electronic Data Requirements

The laboratory assures that computers, user-developed computer software, automated equipment, or microprocessors used for the acquisition, processing, recording, reporting, storage, or retrieval of environmental test data are:

- documented in sufficient detail and validated as being adequate for use;
- protected for integrity and confidentiality of data entry or collection, data storage, data transmission and data processing;
- maintained to ensure proper functioning and provided with the environmental and operating conditions necessary to maintain the integrity of environmental test data; and
- held secure, including the prevention of unauthorized access to, and the unauthorized amendment of, computer records. Data archive security is addressed in Section 16, "Control of Records" and building security is addressed in Section 21, "Accommodations and Environmental Conditions".

Primary control of electronic data occurs at the physical security level, by preventing any non-authorized persons access to the premises without an escort. Secondary control of electronic data is achieved by employing only personnel with proven ethical understanding of data integrity. Tertiary data control at the instrument level is controlled by the software auditing mechanisms built into the major instrumental software utilized by the laboratory. Quaternary electronic data control is achieved by retaining hardcopy records in appropriate job files of all electronic data produced by the laboratory.

Note that due to the small staff size of the laboratory, all employees are considered "authorized users" on all computers. For analytical computers, the user's initials will appear on the electronic files and in the associated run logs for that instrument.

The laboratory uses spreadsheets to calculate final results from the raw data for some analyses. Before reporting any results derived from these spreadsheets, the laboratory validates the underlying calculations by performing a sample calculation on at least 10% of the total data, selected at random throughout the spreadsheet. All mathematical steps from raw data to final reported data are verified manually. If a new calculation is created within the LIMS, the procedure for verifying spreadsheets is used.

After a spreadsheet has been developed and verified, subsequent use of the spreadsheet is verified by testing each set of cells used for input and output of the calculation. Any changes made to the spreadsheet are revalidated manually as described above. Some spreadsheets may be used only rarely; any spreadsheet that has not been used in more than 3 months will be revalidated as described above.

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Electronically stored data from all electronic media, including the LIMS, emails, company financials, client contracts, SOPs and program documents, and all computers governing instruments are backed up to both a separate hard drive and to 'cloud' storage daily. See SOP AD-009 for further details.

22.5.2 Data Reduction

In cases where the Analyst calculates final results manually from raw data, all manual calculations will be verified by a second individual. The second individual shall document their verification by writing out the formula(e) they used to determine the final results on the raw data, then placing a tick or check mark next to each calculation they verified and, finally, writing "QC OK" at the top right corner of the raw data sheet along with their initials and the date they verified the data.

In addition and wherever possible, 100% of all manual data transfers (e.g., hand transcription, data entry into the LIMS) will be checked for accuracy by a different Analyst than the one performing the transfer. The second individual shall document their verification by placing a tick or check mark next to each entry they verified, and writing their initials and the date they verified the data at the top right corner of the page.

Appropriate computer programs may provide the results in a reportable format, although that is not typical for air quality methods. Usually, several different data sets are entered into the LIMS and the LIMS reports the data in the units as requested by the client. Typical units requested by the client include: ng/Sample, mg/Sample or µg/Sample; ng/m^3, mg/m^3 or $\mu g/m^3$; and µg/L (gas volume, not liquid volume).

The methods may provide required concentration units, calculation formulae and any other information required to obtain final analytical results, but do not always do so in a manner that meets the clients' needs. The clients' requests shall always be honored above any calculations given in any method. For example: 40 CFR 60 Method 8 requires reporting units of "meq SO_x/m^3", with an intermediary calculation of "meq SO_x/sample". Most clients request results in µg H_2SO_4/sample or µg SO_2/sample. In these cases, the client's requested reporting units are the units reported, regardless of the calculations in the reference method.

Some reference methods, particularly CFR methods, have errors in the reference calculations. In such cases, the laboratory calculates the data using correct formulae, regardless of that contained in the reference method. Any changes from the reference method calculations are documented in the "Differences from Reference Method" appendix in each SOP.

The laboratory has manual integration procedures that must be followed when integrating peaks during data reduction. These procedures are taught to new Analysts by the Technical Director or Lead Analyst overseeing the instrument that the trainee is learning to operate. Manual integration procedures are described in SOP QA-012.

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The laboratory reports data to the number of significant figures specified by the method or client, or, if not specified by method or client, to three significant figures.

In cases where dilutions are performed solely to remove matrix interferences (not for samples over the calibration range), the same rules apply; however, the reported detection limit will be multiplied by the dilution factor.

Data is rounded following the guidelines in Section 7 of ASTM E29. Any "5" followed by a non-zero digit will round up. Any "5" followed by a "0" or lacking a trailing digit will round to the even number. Thus, 52.052 will round to 52.1, whereas 52.050 will round to 52.0 and 52.150 will round to 52.2.

All raw data are retained in hardcopy form in the report folder and in the form in which it was generated (e.g., computer files, logbooks, spreadsheets, etc.). It is maintained as described in Section 16, "Control of Records".

22.5.3 Confidentiality, Storage, Transmission and Processing

Data confidentiality is discussed in Section 10.1, "Client Confidentiality," and applies to all stages of data production.

Data storage is described in Section 16, "Control of Records" and Section 22.5, "Control of Data."

Data transmission is described in Section 28, "Reporting the Results."

Data processing is described in Section 22.5, "Control of Data."

22.5.4 Data Review Procedures

Data review procedures are located in Section 27.4, "Data Review".

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Section 23

CALIBRATION REQUIREMENTS
(TNI V1:M2 – Sect 5.5 and Section 1.7 of Technical Modules TNI V1:M 3-7)

23.1 General Equipment Requirements

The laboratory provides all the necessary equipment required for the correct performance of the scope of environmental testing performed by the laboratory.

All equipment and software used for testing and sampling are capable of achieving the accuracy required for complying with the specifications of the environmental methods as specified in the laboratory SOPs.

Equipment is operated only by authorized and trained personnel (see Section 20, "Personnel").

The laboratory has procedures for the use, maintenance, handling and storage of equipment, and they are readily available to laboratory personnel. Manuals received from the manufacturer of the equipment provide information on use, maintenance, handling and storage of the equipment. Below is an equipment manual table that includes additional information on storage location:

Document	Title	Location
OC/EC Manual	Sunset Laboratory OC/EC Instruction Manual	Drawer below instrument
ICP Manual	Perkin Elmer Optima 8300 Hardware Guide	Drawer below instrument
WinLab32 software guide	Perkin Elmer WinLab32 for ICP software CD-ROM	Drawer below instrument
XRF Manuals	XRF Instruction Manual	Cabinet in center island near XRFs & bookshelf by Quant'X
Sartorius Manual (B120S)	Sartorius 120 Basic Series Instrument Manual & Operating Instructions	Drawer in center island in XRF room
CAHN Manual	CAHN C30/31 Instruction Manual	Drawer in center island in XRF room.
Sartorius Manual (ME5)	Sartorius ME & SE Series Operating Instructions	Drawer in center island in XRF room
Sartorius Manual (CPA224S)	Sartorius GemPlus Series	Drawer under balance in conventional chemistry lab
Sartorius Manual (MSA225S)	Sartorius Cubis Series	Drawer under balance in SPM laboratory

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Document	Title	Location
Dehumidifier Manual	Kenmore Dehumidifier Manual	Drawer in center island in XRF room.
Humidifier Manual	Kenmore Humidifier Manual	Drawer in center island in XRF room.
Dehumidifier Manual	Whirlpool Dehumidifier Manual	Drawer in center island in XRF room.
Humidifier Manual	LASKO Recirculating Console Humidifier Model 1128	Drawer in center island in XRF room.
Humidifier Manual	Holmes Console Humidifier	Drawer in center island in XRF room.
Humidifier Manual	Duracraft Moisture Humidifier Owner's Manual	Drawer in center island in XRF room.
Reagent Water system manual	User Manual Milli-Q Direct 8/16 System	Countertop next to system cartridges
Air compressor dryer	Hankison Compressed Air Dryer Instruction Manual	Black bookcase in laboratory
CVAA Manual	Nippon 3320A Instruction Manual	Drawer under CVAA computer
UV/Vis Manual	Spectronic UV/Vis Model 20D Owner's Manual and Bench Manual	Black bookcase in laboratory
Hot Plate manuals	Cimarec Hot Plate/Stirrer Operating Instructions	Black bookcase in laboratory
	Thermolyne Hot Plate Operating Instruction	
Vortex Mixer	Vortex Mixer User Manual	Black bookcase in laboratory
Centrifuge	CL2 Centrifuge	Black bookcase in laboratory
Sonicator Manual	Branson Model 8510 and Model 8800 Operator's Manuals	Black bookcase in laboratory
Heated Sonicator Manual	ElmaSonic P Ultrasonic Cleaning Units	Black bookcase in laboratory
Hot bath Manual	Precision Water Bath 280 Series Installation and Service Manual	Black bookcase in laboratory
Oven Manual (VWR)	VWR Utility Oven Operating Instructions	Drawer near muffle furnace
Oven Manual (Binder)	Binder Operating Manual Heating Oven with Forced Convection	Drawer near muffle furnace
Muffle furnace manual	American Scientific Products FP-41 Furnace Owner's Manual	Drawer near muffle furnace
pH/mV meters (2)	VWR SympHony benchtop model	Center drawer, titration desk

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The laboratory also has a policy for planned equipment maintenance. A summarized plan for equipment maintenance is located in table 23.5. These procedures ensure proper functioning of the equipment and prevent contamination or deterioration.

Each instrument has a bound maintenance logbook in which all malfunctions, repairs, preventative maintenance, and service visits are documented. Support equipment for each department has one common maintenance logbook. The maintenance logbooks are stored next to the appropriate instrument or in the department in which they are used. Every entry in a maintenance logbook shall have the following elements:

- date and initials of the Analyst making the entry;
- name of the person performing the repair or maintenance, if different than the Analyst;
- a complete description of the nature of the problem, symptoms or preventative maintenance;
- a description of the parts repaired/replaced/realigned; and
- proof that equipment is functioning properly after service.

The description of the maintenance/repair shall be thorough enough that another person reading the entry can identify what the symptoms were (if any), what the suspect parts were (if any), and what steps were taken to repair or maintain the instrument. Any hardware or software upgrades shall be noted in the maintenance logbook.

Preventative maintenance is scheduled based on guidance from the manufacturer and Analyst familiarity with their respective instruments. Preventative maintenance is noted in each instrument's maintenance logbook. All Technical Directors are responsible for scheduling/performing preventative maintenance on their instruments. Corrective maintenance can be performed either by the Technical Director, an Analyst, or by a field service technician, depending on the complexity of the repair needed. Both corrective and preventative maintenance is noted in the maintenance logbook and the name of the field service technician (if any) is included in the description of the repair. These procedures ensure proper functioning of the equipment and help prevent contamination or deterioration.

All equipment is calibrated or verified before being placed in use to ensure that it meets laboratory specifications and relevant standard specifications. Records are maintained by the QA Officer in tandem with the Laboratory Director for each major item of equipment and its software used for testing. The records include checks that equipment complies with the specifications; dates, results and copies of reports; and certificates of all calibrations, adjustments, acceptance criteria and the due date of next calibration where applicable; and the date received and date placed in service (if available). This record is the same record as described below.

Test equipment, including hardware and software, are safeguarded from adjustments that would invalidate the test result measurements by limiting access

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to the equipment to authorized personnel only (see Section 22.5, "Control of Data").

Equipment that has been shown to be defective or outside specifications, has been subject to overloading or mishandling, or has given suspect results, is taken out of service. The equipment is isolated to prevent its use or clearly labeled as being out of service until it has been shown to function properly. In addition, it is the Technical Director's responsibility to notify all people within their domain, and all Project Managers, of the condition of the equipment. If it is shown that previous tests are affected, then procedures for non-conforming work are followed and results are documented (see Section 12, "Control of Non-conforming Environmental Testing Work" and Section 14, "Corrective Action").

No equipment outside of the permanent control of the laboratory is used.

Each item of equipment and software used for testing, and significant to the results, is uniquely identified. Records of equipment and software are maintained. This information includes the following:

a) identity of the equipment and its software;

b) manufacturer's name, type, identification, serial number or other unique identifier;

c) checks that equipment complies with specifications of applicable tests;

d) current location;

e) manufacturer's instructions, if available, or a reference to their location;

f) dates, results and copies of reports and certificates of all calibrations, adjustments, acceptance criteria and the due date of next calibration;

g) maintenance plan, where appropriate, and maintenance carried out to date;

h) documentation on all routine and non-routine maintenance activities and reference material verifications;

i) any damage, malfunction, modification or repair to the equipment;

j) date received and date placed into service (if available); and

k) condition when received, if available (new, used, reconditioned).

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Table 23-1 Laboratory Equipment				
Name - Unique Identifier	**Location**	**Brand / Model**	**Serial Number** ***(Italicized numbers are capital equipment inventory numbers)***	**Month / Year Placed into Service**
Gravimetry Laboratory				
Cahn 1 microbalance (not in use since 2008)	Gravimetry Laboratory	Cahn C31	73139	2/1988
ME5 microbalance	Gravimetry Laboratory	Sartorius ME5	22006645	9/2007
Sartorius B120S balance	Gravimetry Laboratory	Sartorius B120S	38070080	6/1990
100 mg Class 1 Daily weight	Gravimetry Laboratory	unknown	69699	Date put into service changes annually
300 mg Class 1 Daily weight	Gravimetry Laboratory	unknown	69699	Date put into service changes annually
500 mg Class 1 Daily weight	Gravimetry Laboratory	unknown	69699	Date put into service changes annually
3.0000g Class 1 Daily weight	Gravimetry Laboratory	unknown	10139	Date put into service changes annually
5.0000g Class 1 Daily weight	Gravimetry Laboratory	unknown	10139	Date put into service changes annually
100.0000g Class 1 Daily weight	Gravimetry Laboratory	unknown	14091	Date put into service changes annually
100 mg Class 0 Monthly weight	Gravimetry Laboratory	unknown	1000155857	Date put into service changes annually
300 mg Class 0 Monthly weight	Gravimetry Laboratory	unknown	1000155856	Date put into service changes annually
500 mg Class 0 Monthly weight	Gravimetry Laboratory	unknown	1000155858	Date put into service changes annually
3.0000g Class 1 Monthly weight	Gravimetry Laboratory	unknown	10147	Date put into service changes annually

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Table 23-1 Laboratory Equipment

Name - Unique Identifier	Location	Brand / Model	Serial Number *(Italicized numbers are capital equipment inventory numbers)*	Month / Year Placed into Service
5.0000g Class 1 Monthly weight	Gravimetry Laboratory	unknown	10147	Date put into service changes annually
Computer tracked thermometer/ hygrometer	Gravimetry Laboratory	Dickson TP125	(unreadable)	2/2007
Computer tracked thermometer/ hygrometer	Gravimetry Laboratory	Dickson TP125	16305824	5/2018
Secondary thermometer/ hygrometer	Gravimetry Laboratory	VWR Traceable	Serial number changes with expiration date	Date put into service changes annually
Max/Min thermometer	OC/EC Freezer #5	VWR 89094-770	Serial number changes with expiration date	Date put into service changes annually
Max/Min thermometer	Standards Refrigerator #5	VWR 89094-770	Serial number changes with expiration date	Date put into service changes annually
Max/Min thermometer	Conventional Lab Fridge/Freezer #6	VWR 89094-770	Serial number changes with expiration date	Date put into service changes annually
IR thermometer	Sample Receiving	VWR Traceable	Serial number changes with expiration date	Date put into service changes annually
Cabinet Desiccator (small)	Gravimetry Laboratory	Boekel	None	3/2011
Humidifier	Gravimetry Laboratory	LASKO 1128	225651	3/2013
Humidifier	XRF	Holmes HM3650	unknown	Pre-1992
Humidifier	SPM Laboratory	DuroCraft DH-836/837	unknown	Pre-1992
Humidifier	Gravimetry Laboratory	Kenmore 758.154120	08128	Pre-1992
Dehumidifier	Gravimetry Laboratory	Kenmore 106.57500790	QG1104204	8/1997
Dehumidifier	XRF	Whirlpool AD5OUSLI	QM1328295	8/2002
Dehumidifier	XRF	Hisense	KGFGHJA0439	6/2018

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Table 23-1 Laboratory Equipment				
Name - Unique Identifier	**Location**	**Brand / Model**	**Serial Number** ***(Italicized numbers are capital equipment inventory numbers)***	**Month / Year Placed into Service**
Dehumidifier	SPM Laboratory	Whirlpool AD5OUSLI	QM3743639	8/2002
Dehumidifier	Gravimetry Laboratory	HISENSE IKD070	0113Z0PKK69Y5 A0174	6/2015
Laminar flow hood	Gravimetry Laboratory	ATMOSTECH Industries	*436*	Pre-1992
XRF & Resuspension Laboratory				
XRF 772	XRF Laboratory	Kevex 770	8003407A1327	8/2001
Pulse Processor for 772	XRF Laboratory	IXRF/4460	128	8/2001
Vacuum pump for 772	XRF Laboratory	Alcatel	164208	9/2015
X-ray tube chiller for 772	XRF Laboratory	Kevex	1349	8/2001
Quant'X XRF	XRF Laboratory	Thermo	1111540	(1/2012) Data generation started in 8/2012
Vacuum pump for Quant'X	XRF Laboratory	Edwards RV8	119493083	1/2012
Refrigerator (dorm sized)	XRF Laboratory	Sanyo	960825190	Pre-1992
Sieve Catch Pans (3)	Compressor Room	USA Standard	None	Pre-1986
#400 Sieve Pans (3)	Compressor Room	USA Standard	38 µm	Pre-1986
#200 Sieve Pans (3)	Compressor Room	USA Standard	75 µm	Pre-1986
#80 Sieve Pans (2)	Compressor Room	USA Standard	180 µm	Pre-1986
#60 Sieve Pans (3)	Compressor Room	USA Standard	250 µm	Pre-1986
#40 Sieve Pans (4)	Compressor Room	USA Standard	425 µm	Pre-1986
#18 Sieve Pans (3)	Compressor Room	USA Standard	1 mm	Pre-1986
#10 Sieve Pans (3)	Compressor Room	USA Standard	2 mm	Pre-1986
#6 Sieve Pans (2)	Compressor Room	USA Standard	3.35 mm	Pre-1986

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Table 23-1 Laboratory Equipment				
Name - Unique Identifier	**Location**	**Brand / Model**	**Serial Number** ***(Italicized numbers are capital equipment inventory numbers)***	**Month / Year Placed into Service**
#5 Sieve Pans (3)	Compressor Room	USA Standard	4 mm	Pre-1986
Sieve Pan Lids (2)	Compressor Room	USA Standard	None	Pre-1986
Dicot inlet	SPM room	Sierra/Anderson	165	Pre-1986
Dicot pump	SPM room	11/244	165	Pre-1986
Pump	SPM room	Gast/0322-V103-G8DX	0784	Pre-1986
Digital flow meter	SPM room	Kurz/545-1-SP	NE2243	Pre-1986
Resuspension apparatus	SPM room	In-house	In-house	Pre-1986
Conventional Chemistry Laboratory				
Air compressor for ICP	Compressor room	PowerEx OTS015242	(H) 6/24/2002 1860271-02	8/2002
Microwave oven	Conventional Chemistry Lab	Westinghouse	WCM11100B16200400	12/2016
100.0000g Class 1 weight	XRF Laboratory	Troemner	20190106	Date put into service changes annually
Cabinet Desiccator 1	XRF Laboratory	Boekel	None	Pre-1992
Cabinet Desiccator 2	XRF Laboratory	Unknown	None	4/2011
Cabinet Desiccator 3	XRF Laboratory	Fisher	None	6/2011
Cabinet Desiccator 4	XRF Laboratory	Boekel	None	10/2011
Cabinet Desiccator 5	XRF Laboratory	Fisher	None	10/2011
Cabinet Desiccator 6	XRF Laboratory	Unknown	None	8/2016
Cabinet Desiccator 7	XRF Laboratory	Unknown	None	8/2016
Cabinet Desiccator 8	XRF Laboratory	Unknown	None	8/2016
Combination thermometer/ hygrometers	Laboratory Desiccators	VWR 36934-164	Serial numbers change with expiration date	Dates put into service change when expired

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Table 23-1 Laboratory Equipment

Name - Unique Identifier	Location	Brand / Model	Serial Number *(Italicized numbers are capital equipment inventory numbers)*	Month / Year Placed into Service
Freezer/ Refrigerator #5	Conventional Chemistry Lab	Amana TR18KW	8810077163 *467*	Pre-1992
Freezer #10	SPM Laboratory	GE FP21DSCRWH	SL163859 *901*	11/1994
Freezer #11	SPM Laboratory	GE FP21DSCRWH	TL162281 *902*	11/1994
Freezer/ Refrigerator #6	Conventional Chemistry Lab	Frigidaire FFHT1814QW1	BA52800708	8/2015
AND static eliminator	XRF	AND AD1683	None	7/2009
Lab balance	Conventional Chemistry Lab	Sartorius CPA 224S	25650404	12/2010
SPM balance	XRF	Sartorius MSA 225S	33503396	12/2015
Milli-Q RO/DI Unit	Conventional Chemistry Lab	Millipore	F2KA41704D	1/2013
ICS-5000 (Anion & Cation IC)	Conventional Chemistry Lab	Thermo ICS-5000	17030857	1/2018
AS-AP Autosampler (ICS-3000)	Conventional Chemistry Lab	Thermo AS-AP	17030857	1/2018
AXP anion regenerant pump (ICS-5000)	Conventional Chemistry Lab	Thermo AXP	17030857	1/2018
AXP cation regenerant pump (ICS-5000)	Conventional Chemistry Lab	Thermo AXP	17030857	1/2018
pH/mV meter	SPM Laboratory	VWR SympHony	D04910	1/2011
pH/mV meter	Conventional Chemistry Lab	Orion 3 Star	B43712	2012
pH electrode	SPM Laboratory	Orion 8102BNUWP	(lot code) QX1	2/2013
Small sonicator	SPM Laboratory	AmericanBrand	48L5287	Pre-1992
Big Sonicator (8510)	Conventional Chemistry Lab	Branson	RPA02112447G	2/2011

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Table 23-1 Laboratory Equipment

Name - Unique Identifier	Location	Brand / Model	Serial Number *(Italicized numbers are capital equipment inventory numbers)*	Month / Year Placed into Service
Big Sonicator (8800)	Conventional Chemistry Lab	Branson	BGQ041693220B	8/2016
Heated Sonicator	Conventional Chemistry Lab	Elmasonic P	102048034	4/2014
ICS-1100 (Cr6 IC)	Conventional Chemistry Lab	Dionex	11050922	8/2011
Autosampler (1100)	Conventional Chemistry Lab	Dionex AS-DV	11050840	8/2011
UV/Vis Cr6 detector (1100)	Conventional Chemistry Lab	Dionex VWD	11050494	8/2011
Auxiliary Pump (1100)	Conventional Chemistry Lab	Dionex	Z0042664	8/2011
Aquion IC (Cr6 IC)	Conventional Chemistry Lab	Thermo-Dionex	160540158	8/2016
Autosampler (Aquion)	Conventional Chemistry Lab	Thermo-Dionex AS-DV	160510939	8/2016
UV/Vis Cr6 detector (Aquion)	Conventional Chemistry Lab	Thermo-Dionex VWD	16031453	8/2016
Auxiliary Pump (Aquion)	Conventional Chemistry Lab	Thermo-Dionex	Z0055802	8/2016
OC/EC analyzer	Conventional Chemistry Lab	Sunset Labs	141A	1/2002
CVAA	Conventional Chemistry Lab	Nippon Instruments 3320A	08400784	8/2010
CVAA autosampler	Conventional Chemistry Lab	SC-3	09410401	8/2010
CVAA Reagent Dispenser	Conventional Chemistry Lab	RD-3	08420583	8/2010
Water bath	Conventional Chemistry Lab	Thermo 280 Series	206799-339	1/2009
Thermometer – electronic for sonicators	Conventional Chemistry Lab	VWR	140774934	9/2015
Oven – Forced Air	SPM room	Baxter DIV48	198002	Pre-1992
Oven – Forced Air	Conventional Chemistry Lab	Binder	13-21559	10/2014

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Table 23-1 Laboratory Equipment				
Name - Unique Identifier	**Location**	**Brand / Model**	**Serial Number** ***(Italicized numbers are capital equipment inventory numbers)***	**Month / Year Placed into Service**
Oven – muffle	Conventional Chemistry Lab	American Scientific Products FP-41	132028	Pre-1992
Centrifuge	Conventional Chemistry Lab	Thermo CL2	42620462	4/2011
ICP	Conventional Chemistry Lab	PerkinElmer Optima 8300	078S1401204	4/2014
Chiller for ICP	Conventional Chemistry Lab	PolyScience	2F1411787	4/2014
ICP Autosampler	Conventional Chemistry Lab	PerkinElmer AS S10	102513020605	4/2014
ISE: fluoride	Conventional Chemistry Lab	Thermo	249030-A01	9/2008
Thermometers – Fluoride distillation	Conventional Chemistry Lab	Various	Various (considered consumable)	Various (considered consumable)
5mg Class 1 weight	Conventional Chemistry Lab	Troemner	31235	Dates put into service change when expired
5mg Class 1 weight	Conventional Chemistry Lab	Troemner	1000085970	Dates put into service change when expired
50g Class 1 weight	Conventional Chemistry Lab	Troemner	1000085970	Dates put into service change when expired
50g Class 1 weight	Conventional Chemistry Lab	Troemner	1000143398	Dates put into service change when expired
500mg Class 1 weight	Conventional Chemistry Lab	Troemner	1000137823	Dates put into service change when expired
500mg Class 1 weight	Conventional Chemistry Lab	Troemner	1000085970	Dates put into service change when expired
Separatory funnel shaker	Conventional Chemistry Lab	In-house	In-house	Pre-1994
Stirplate 663	SPM Laboratory	Thermolyne Syborn	30708171	Pre-1992
Stirplate 652	SPM Laboratory	Thermo Cimarec 1	46402186	Pre-1992
Stirplate	Conventional Chemistry Lab	Thermo Cimarec 2	63891800366 *1006*	1/2011

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Table 23-1 Laboratory Equipment				
Name - Unique Identifier	**Location**	**Brand / Model**	**Serial Number** ***(Italicized numbers are capital equipment inventory numbers)***	**Month / Year Placed into Service**
Stirring Hotplate (Hotplate no longer functional)	Conventional Chemistry Lab	Thermo Cimarec 3	Unreadable	Pre-1992
Hotplate, 12" yellow	Conventional Chemistry Lab	Thermo Cimarec 3	Unreadable	Pre-1992
Hotplate, 12" yellow	Conventional Chemistry Lab	Thermo Cimarec 3	1073990872646	Pre-2006
Hotplate, 10" gray	Conventional Chemistry Lab	Corning	Unknown *948*	5/2005
Hotplate, 10" yellow digital	SPM Laboratory	Thermo Cimarec	C1757110206628 *1012*	4/2011
Hotplate, 10" yellow digital	SPM Laboratory	Thermo Cimarec	C1757110104596 *1008*	4/2011
Hotplate, 12" Gray	Conventional Chemistry Lab	Cole-Parmer HP11C-P	50002174	11/2015
Stirring Hotplate, 12"	Conventional Chemistry Lab	Thermo Cimarec 3	1072000428345	unknown
UV/Vis Spectrometer	Conventional Chemistry Lab	MiltonRoy Spec 20D	3321025001	Pre-1992
Orbital Shaker	Conventional Chemistry Lab	LabLine	3520	Pre-1992
Laminar Hood	Conventional Chemistry Lab	LabConco (unreadable model#)	195468	Pre-1992
Vortex Mixer	Conventional Chemistry Lab	Labnet	00017305042	2/2018

23.2 Support Equipment

Support Equipment includes but is not limited to: balances, ovens, refrigerators, freezers, water baths, chillers, temperature/humidity measuring devices, humidifiers, dehumidifiers, vacuum pumps where needed by instrumentation, and volumetric dispensing devices.

All support equipment is maintained in proper working order. Records are kept for all repair and maintenance activities including service calls. For NIST-traceable items (including weights, thermometers, and hygrometers), certifications are maintained near their point of use. For the reagent water system, cartridge replacement is noted on the daily control chart. All refrigerators containing samples are monitored with a max/min thermometer and recorded on each

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business day. As water baths, ovens and sonicators tend to fail catastrophically, the equipment is usually replaced rather than repaired. One common maintenance log is maintained for the water bath, ovens, heated ultrasonicator, muffle furnace, lab thermometers (glass body), and other support equipment.

All raw data records are retained to document equipment performance where performance is an integral part of the method being performed. These records include primarily logbooks. Some records however, may take the form of certificates by certifying laboratories or invoices retained by the Laboratory Director.

23.2.1 Support Equipment Maintenance

Regular maintenance of support equipment, such as balances, ovens, water baths, furnaces, Class 0 and Class 1 weights and fume hoods, is conducted at least annually.

Maintenance of other support equipment, especially those with manufacturer's expiration dates, such as thermometers, thermometer/hygrometers, is conducted on an as-needed basis.

Records of maintenance to support equipment are documented in various locations depending on the department, as follows:

- For the gravimetry lab, maintenance is documented in the NIST certificates three ring binder, the balance maintenance log, or the temperature & Humidity log.
- For the XRF laboratory, maintenance is documented in the run log for each instrument or the QS control charts.
- For the Conventional Chemistry laboratory, maintenance is documented in the Support Equipment Maintenance Log.

Table 23-2 includes a summary of support equipment maintenance.

Table 23-2 Summary of Support Equipment Calibration And Maintenance

Instrument	Activity	Frequency	Documentation
Gravimetry Laboratory			
100 mg Class 1 Daily Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
300 mg Class 1 Daily Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate

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Table 23-2 Summary of Support Equipment Calibration And Maintenance

Instrument	Activity	Frequency	Documentation
500 mg Class 1 Daily Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
3.0000 g Class 1 Daily Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
5.0000 g Class 1 Daily Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
100.0000 g Class 1 Daily Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
100 mg Class 0 Monthly Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
300 mg Class 0 Monthly Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
500 mg Class 0 Monthly Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
3.0000 g Class 1 Monthly Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
5.0000 g Class 1 Monthly Weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
Computer Tracked NIST thermometer/hygro meter (Secondary standard)	Recertify when NIST traceability expires, calibrate against primary standard as needed.	Annually and as needed	Keep certificate. "as-needed" adjustments recorded in Daily Temp/RH logbook.
Primary NIST Thermometer/ hygrometer	Recertify or buy new when NIST traceability expires	As needed	Keep certificate
Max/Min thermometer(s)	Recertify when NIST traceability expires	As needed	Keep certificate
Cabinet Desiccator (small)	Verify seal maintaining	Day of use	Record percent humidity in raw data

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Table 23-2 Summary of Support Equipment Calibration And Maintenance

Instrument	Activity	Frequency	Documentation
IR thermometer	Recertify or buy new when NIST traceability expires	As needed	Keep certificate
Humidifier	Fill with water	As needed	N/A
Dehumidifiers	Empty water	As needed	N/A
Laminar Flow Hood	Check flow rate with vanometer	Annually	Label on side of hood
XRF Laboratory			
Pulse Processor for 772	Energy Calibration	As needed	QS control charts
Vacuum pump for 772	Maintain oil level	As needed	QS control charts
X-ray tube chiller for 772	Maintain water level	Weekly	Maintenance log
Vacuum pump for Quant'X	Maintain oil level	As needed	QS control charts
Refrigerator (dorm sized)	Check with IR gun thermometer	Day of use	Control chart
Sieve Catch Pans (3)	Clean with warm water and dry at 60 °C	After each use	none
#400 Sieve Pans (3)	Clean with warm water and dry at 60 °C	After each use	none
#200 Sieve Pans (3)	Clean with warm water and dry at 60 °C	After each use	none
#80 Sieve Pans (2)	Clean with warm water and dry at 60 °C	After each use	none
#60 Sieve Pans (3)	Clean with warm water and dry at 60 °C	After each use	none
#40 Sieve Pans (4)	Clean with warm water and dry at 60 °C	After each use	none
#18 Sieve Pans (3)	Clean with warm water and dry at 60 °C	After each use	none
#10 Sieve Pans (3)	Clean with warm water and dry at 60 °C	After each use	none
#6 Sieve Pans (2)	Clean with warm water and dry at 60 °C	After each use	none
#5 Sieve Pans (3)	Clean with warm water and dry at 60 °C	After each use	none
Sieve Pan Lids (2)	Clean with warm water and dry at 60 °C	After each use	none
Dicot pump	Calibrate with rotameters	As needed	None
Pump	Calibrate with digital flow meter	Each use	None

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Table 23-2 Summary of Support Equipment Calibration And Maintenance

Instrument	Activity	Frequency	Documentation
Digital flow meter	N/A	N/A	N/A
Cabinet Desiccator 1	Verify seal maintaining	Day of use	Record percent humidity in raw data
Cabinet Desiccator 2	Verify seal maintaining	Day of use	Record percent humidity in raw data
Cabinet Desiccator 3	Verify seal maintaining	Day of use	Record percent humidity in raw data
Cabinet Desiccator 4	Verify seal maintaining	Day of use	Record percent humidity in raw data
Cabinet Desiccator 5	Verify seal maintaining	Day of use	Record percent humidity in raw data
Cabinet Desiccator 6	Verify seal maintaining	Day of use	Record percent humidity in raw data
Cabinet Desiccator 7	Verify seal maintaining	Day of use	Record percent humidity in raw data
Cabinet Desiccator 8	Verify seal maintaining	Day of use	Record percent humidity in raw data
(Desiccator) Combination thermometer/ Hygrometers	Recertify when NIST traceability expires	As needed	Keep certificate
Conventional Chemistry Laboratory			
Microwave oven	Verify working by determining if digestion bombs are hot to the touch	Each use	none
5 mg Class 1 weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
500 mg Class 1 weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
50.0000g Class 1 weight	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
Millipore RO/DI Unit	Verify MΩ within control	Day of use	Control chart
Refrigerator #11	check temperature with NIST-traceable max/min thermometer	Daily	control chart
Refrigerator #12	check temperature with NIST-traceable max/min thermometer	Daily	control chart

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Table 23-2 Summary of Support Equipment Calibration And Maintenance

Instrument	Activity	Frequency	Documentation
Refrigerator #4	check temperature with NIST-traceable max/min thermometer	Daily	control chart
Freezer #4	check temperature with NIST-traceable max/min thermometer	Daily	control chart
Refrigerator #5	check temperature with NIST-traceable max/min thermometer	Daily	control chart
Freezer #5	check temperature with NIST-traceable max/min thermometer	Daily	control chart
Water bath	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
Thermometer – sonicator bath (electronic)	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
Ovens – Forced Air	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
Oven – muffle	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
Chiller for ICP	Keep fins clean of dust/debris Replace chiller fluid	As needed As needed	None Maintenance Log
Air compressor for ICP	Drain water from tank	Weekly	None
Thermometers – Fluoride distillation (glass)	Accuracy determined by A2LA-accredited weights and measurement laboratory	Annually	Keep certificate
Laminar Hood	Check flow rate with vanometer	Annually	Label on side of hood
Fume Hoods	Check flow rate with vanometer	Annually	Label on side of hood

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23.2.2 Support Equipment Calibration

Calibration requirements for analytical support equipment are found in Tables 23-3 and 23-4.

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All NIST-traceable support equipment is calibrated or verified annually, across the entire range of use, using NIST traceable references where available. If the results of the calibration or verification of support equipment are not within specifications: (1) the equipment is removed from service until repaired or (2) records are maintained of correction factors to correct all measurements. If correction factors are used, this information is clearly marked on or near the equipment.

Each day prior to use, support equipment such as balances, refrigerators and freezers are verified with an NIST traceable reference, if available, to ensure operation is within the expected range for the application for which the equipment is to be used. Analytical thermometers (e.g., Fluoride distillation thermometers), and water bath/oven thermistors are verified annually by an A2LA certified laboratory

Volumetric devices, including dispensing devices and fixed-volume devices (except Class A glassware), are checked for accuracy on a monthly basis. Plastic, disposable volumetrics, such as centrifuge tubes, are checked once per shipping box. Plastic volumetric ware such as volumetric flasks or graduated cylinders are checked quarterly. Class A glassware is verified upon receipt. All volumetric ware is given a unique ID and is traceable to each sample result for which it was used.

Table 23-3 Calibration Acceptance Criteria for Support Equipment

Equipment	Type of Calibration / Number of Standards	Frequency	Acceptance Limits	Corrective Action
Gravimetric Laboratory (Gravimetry Laboratory)				
100 mg Class 1 Daily Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.003 mg	Send back for recertification
300 mg Class 1 Daily Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.003 mg	Send back for recertification
500 mg Class 1 Daily Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.003 mg	Send back for recertification
3.0000 g Class 1 Daily Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.0005 g	Send back for recertification
5.0000 g Class 1 Daily Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.0005 g	Send back for recertification

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Table 23-3 Calibration Acceptance Criteria for Support Equipment

Equipment	Type of Calibration / Number of Standards	Frequency	Acceptance Limits	Corrective Action
100.0000 g Class 1 Daily Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.0000 g (used for calibration, must be exact)	Send back for recertification
100 mg Class 0 Monthly Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.005 mg	Send back for recertification
300 mg Class 0 Monthly Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.005 mg	Send back for recertification
500 mg Class 0 Monthly Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.005 mg	Send back for recertification
3.0000 g Class 1 Monthly Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.0005 g	Send back for recertification
5.0000 g Class 1 Monthly Weight	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.0005 g	Send back for recertification
Computer Tracked secondary thermometer/ hygrometer	Inspected and calibrated by A2LA accredited laboratory annually. Adjusted as needed against primary NIST-traceable thermometer/hygrometer	Annually or as needed	±0.5 °C from Primary	Recertify or replace
Primary Thermometer/ hygrometer(s)	Inspected and calibrated by A2LA accredited laboratory annually.	When NIST traceability expires	Per manufacturer	Recertify
Max/Min thermometer(s)	Inspected and calibrated by A2LA accredited laboratory annually.	When NIST traceability expires	Per manufacturer	Recertify
IR thermometer	Inspected and calibrated by A2LA accredited laboratory annually.	When NIST traceability expires	Per manufacturer	Recertify

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Table 23-3 Calibration Acceptance Criteria for Support Equipment

Equipment	Type of Calibration / Number of Standards	Frequency	Acceptance Limits	Corrective Action
Humidifier	Adjust controller	When humidity is out of acceptance	Refer to Gravimetry Laboratory SOPs	Adjust controller or replace unit.
Dehumidifier	Adjust controller	When humidity is out of acceptance	Refer to Gravimetry Laboratory SOPs	Adjust controller or replace unit.
Conventional Chemistry Laboratory				
Refrigerator #11	Adjust thermostat	When temperature is out of acceptance	0 - 6 °C (as verified by NIST traceable thermometer)	Adjust thermostat or replace
Refrigerator #12	Adjust thermostat	When temperature is out of acceptance	0 - 6 °C (as verified by NIST traceable thermometer)	Adjust thermostat or replace
Refrigerator #5	Adjust thermostat	When temperature is out of acceptance	≤4 °C (as verified by NIST traceable thermometer)	Adjust thermostat or replace
Freezer #5	Adjust thermostat	When temperature is out of acceptance	≤0 °C (as verified by NIST traceable thermometer)	Adjust thermostat or replace
Freezer #6	Adjust thermostat	When temperature is out of acceptance	≤0 °C (as verified by NIST traceable thermometer)	Adjust thermostat or replace
Refrigerator #6	Adjust thermostat	When temperature is out of acceptance	≤4 °C (as verified by NIST traceable thermometer)	Adjust thermostat or replace
5mg, 500mg, 50g Class 1 weights	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	± 0.00010 g or within Class 1 specifications	Send back for recertification or replace
Combination thermometer/ hygrometers	Inspected and calibrated by A2LA accredited laboratory annually.	When NIST traceability expires	Per NIST	Send back for recertification or replace

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Table 23-3 Calibration Acceptance Criteria for Support Equipment

Equipment	Type of Calibration / Number of Standards	Frequency	Acceptance Limits	Corrective Action
Water bath	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±2.0°C from set value	Have re-inspected and recalibrated by A2LA accredited laboratory.
Thermometer – sonicator bath (electronic)	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±0.5 °C from 15 - 30 °C	Have re-inspected and recalibrated by A2LA accredited laboratory.
Ovens – Forced Air	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±2.0°C from set value in range of 95 – 105 °C	Have re-inspected and recalibrated by A2LA accredited laboratory.
Oven – muffle	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±50°C from set value in range of 550 – 600 °C	Have re-inspected and recalibrated by A2LA accredited laboratory.
Thermometers – Fluoride distillation (glass)	Inspected and calibrated by A2LA accredited laboratory annually.	Annually	±2.0 °C from 180 °C	Have re-inspected by A2LA accredited laboratory.
Fume Hoods	N/A	Annually	100 fpm with sash in marked position	Service as needed.

Table 23-4 Acceptance Criteria for Support Equipment

Equipment Identification	Use	Acceptance Criteria
Gravimetric Laboratory (Gravimetry Laboratory)		
100 mg Class 1 Daily Weight	Verification of ME5 balance	± 0.003 mg
300 mg Class 1 Daily Weight	Verification of ME5 balance	± 0.003 mg
500 mg Class 1 Daily Weight	Verification of ME5 balance	± 0.003 mg
3.0000 g Class 1 Daily Weight	Verification of B120S balance	± 0.0005 g
5.0000 g Class 1 Daily Weight	Verification of B120S balance	± 0.0005 g
100.0000 g Class 1 Daily Weight	Calibration of B120S balance	± 0.0000 g

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Table 23-4 Acceptance Criteria for Support Equipment

Equipment Identification	Use	Acceptance Criteria
100 mg Class 0 Monthly Weight	Verification of ME5 balance	± 0.005 mg
300 mg Class 0 Monthly Weight	Verification of ME5 balance	± 0.003 mg
500 mg Class 0 Monthly Weight	Verification of ME5 balance	± 0.005 mg
3.0000 g Class 1 Monthly Weight	Verification of B120S balance	± 0.0005 g
5.0000 g Class 1 Monthly Weight	Verification of B120S balance	± 0.0005 g
Computer Tracked thermometer/hygrometer	Daily verification of room temperature and humidity; weekly compilation of environmental data	Matches secondary thermometer/hygrometer
Secondary Thermometer/hygrometer	Verification of computer tracked thermometer/hygrometer	Within NIST expiry date
Max/Min thermometers	Daily freezer/refrigerator monitoring	Within NIST expiry date
IR thermometer	Sample receipt temperature	Within NIST expiry date
Cabinet Desiccator (small)	Desiccation	Maintains humidity ≤10%
Conventional Chemistry Laboratory		
Freezer #6	Sample storage	≤0 °C
Refrigerator #6	Sample storage	0 - 6 °C
Refrigerator #11	Sample storage	≤0 °C
Refrigerator #12	Sample storage	≤0 °C
Refrigerator #5	Sample storage	0 - 6 °C
Freezer #5	Sample storage	≤0 °C
5mg, 500mg, 50g, Class 1 weights	Verification of Lab balance calibration	± 0.00010 g or as given on certification whichever is greater
Cabinet Desiccator 1	Desiccating M5/M201/M202 samples	Maintains humidity ≤10%
Cabinet Desiccator 2	Desiccating M5/M201/M202 samples	Maintains humidity ≤10%
Cabinet Desiccator 3	Desiccating M5/M201/M202 samples	Maintains humidity ≤10%

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Table 23-4 Acceptance Criteria for Support Equipment

Equipment Identification	Use	Acceptance Criteria
Cabinet Desiccator 4	Desiccating M5/M201/M202 samples	Maintains humidity ≤10%
Cabinet Desiccator 5	Desiccating M5/M201/M202 samples	Maintains humidity ≤10%
Cabinet Desiccator 6	Desiccating M5/M201/M202 samples	Maintains humidity ≤10%
Cabinet Desiccator 7	Desiccating M5/M201/M202 samples	Maintains humidity ≤10%
Cabinet Desiccator 8	Desiccating M5/M201/M202 samples	Maintains humidity ≤10%
Combination thermometer/ hygrometers	Monitoring desiccators	Within NIST expiry date
Water bath	Digesting Hg and other metals (range 90 – 95 °C)	Within NIST certification expiry date
Thermometer – sonicator bath (electronic)	Monitoring sonicator water temperature	Within NIST certification expiry date
Ovens – Forced Air	Drying/Evaporating (range 30 – 300 °C)	Within NIST certification expiry date
Oven – muffle	Pre-firing quartz filters to remove carbon; Sodium fusion for M13B (range 500 – 600 °C)	Within NIST certification expiry date
Thermometers – Fluoride distillation (glass)	Monitoring distillation temperature (range 180°C)	Within NIST certification expiry date
Fume Hoods	Exhausts fumes from laboratory air	100 fpm draw when sash is at mark
RO/DI water unit (Millipore)	Making reagent water	≥18.0 MΩ

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23.3 Analytical Equipment

23.3.1 Maintenance for Analytical Equipment

All equipment is properly maintained, inspected and cleaned.

Maintenance of analytical instruments and other equipment may include regularly scheduled preventative maintenance or maintenance on an as-needed basis. Instrument malfunction is documented in the pertinent instrument maintenance log, which becomes part of the laboratory's permanent records. A description of the problem, what was done to repair the malfunction, and proof of return to control are also documented in the log.

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Table 23-5 Analytical Equipment Maintenance		
Instrument	**Procedure**	**Frequency**
Gravimetry Laboratory (Gravimetry Laboratory)		
ME5 microbalance	Check level of balance Clean surrounding area with air and Ethanol Clean inside chamber with air and Ethanol Calibrate Verify calibration Service and certify by A2LA lab	Day of use Day of use As needed Day of use Day of use Annually
B120S balance	Check level of balance Clean inside chamber and surrounding area with air and Ethanol Calibrate Verify calibration Service and certify by A2LA lab	Day of use Day of use Day of use Day of use Annually
XRF Laboratory		
XRF 772	Fill liquid Nitrogen dewar Clean excitation chamber	Weekly Weekly
Quant'X XRF	Perform energy calibration Clean excitation chamber	Weekly Weekly
Dicot inlet	Disassemble and clean	After each use
Resuspension apparatus	Disassemble and clean	After each use
Conventional Chemistry Laboratory		
Lab balances	Clean Check level Calibrate Verify calibration Service and certify by A2LA lab	As needed Day of use Day of use Day of use annually
ICS-5000 Anion/Cation IC	Check background pressure Check suppressor flow Check background conductivity Check all fluid levels (eluent & regenerant) Check autosampler water level Calibrate Replace columns & pump seals Replace suppressors Rebuild injector switches	Day of use Day of use Day of use Day of use Day of use As needed Annually or as needed Bi-annually or as needed Annually or as needed
pH/mV meter	Calibrate	Day of use

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Table 23-5 Analytical Equipment Maintenance

Instrument	Procedure	Frequency
pH electrode	Inspect frit for build-up Calibrate with minimum of 2 standards Verify Nernst slope	Day of use Day of use Day of use
ICS-1100 (Cr^{6+} IC)	Prime AXP Clean colorimetric reagent carboy with acetone Check waste container level Check background pressure Check all fluid levels (eluent & colorimetric) Calibrate Replace columns Rebuild injector switches Replace UV lamp	Day of use Once per week of use Day of use Day of use Day of use Once per week of use Annually or as needed Annually or as needed As needed
Aquion (Cr^{6+} IC)	Prime AXP Clean colorimetric reagent carboy with acetone Check waste container level Check background pressure Check all fluid levels (eluent & colorimetric) Calibrate Replace columns Rebuild injector switches Replace UV lamp	Day of use Once per week of use Day of use Day of use Day of use Once per week of use Annually or as needed Annually or as needed As needed
OC/EC analyzer	Clean oven by pre-firing Monitor temperature steps during pre-fire Clean surrounding area with ethanol Record calibration area, psig, and transmittance for trend comparison	Day of use Day of use Day of use Day of use
CVAA	Check reagent delivery tubing Prime reagent delivery tubing three times Rinse/drain tubing after use Check level of/fill 1% HCl rinse solution	Annually or as needed Day of use Day of use Day of use
ICP	Check torch for debris/dirt Rebuild torch assembly Check waste container level, empty Clean/replace windows Check tubing Replace tubing Check Argon level in tank Drain compressor Replace nebulizer Replace spray chamber	Day of use As needed Day of use, as needed As needed Day of use As needed Day of use End of week of use As needed As needed
Reagent Water	Check conductivity Replace cartridges Sanitize System Replace UV lamp	Day of use As needed As needed As needed

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Table 23-5 Analytical Equipment Maintenance

Instrument	Procedure	Frequency
Fluoride ISE (rarely used)	Empty/refill filling solution Verify Nernst slope	Day of use Day of use
UV/Vis spectrometer (has not been used in >10 years)	Check cell for cleanliness Zero out absorbance Set 100% T to 100 Check/replace light bulb	Day of use Day of use Day of use As needed

23.3.2 Instrument Calibration

Information on instrument calibration is located in Appendix H and the relevant SOPs for that instrument.

Initial instrument calibration verification and continuing instrument calibration verifications are an important part of ensuring data of known and documented quality. If more stringent calibration requirements are included in a mandated reference method or by regulation, those calibration requirements override any requirements outlined here or in laboratory SOPs, unless the method is archaic (see Appendix A of pertinent SOPs). Generally, procedures and criteria regarding instrument calibrations are provided in the laboratory SOPs.

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Section 24

MEASUREMENT TRACEABILITY
(TNI V1:M2 – Section 5.6)

Measurement quality assurance comes in part from traceability of standards to certified materials.

All equipment used affecting the quality of test results are calibrated prior to being put into service and on a continuing basis (see Section 23, "Calibration Requirements"). These calibrations are traceable to national standards of measurement where available.

If traceability of measurements to NIST is not possible or not relevant, evidence for correlation of results through inter-laboratory comparisons, audit samples, or independent analysis is provided, if possible.

24.1 Reference Standards

Reference standards are standards of the highest quality available at a given location, from which measurements are derived. These standards are used to verify standards used on a daily basis such as weights used to check balance calibrations, or thermometers used to verify other thermometers. They are the standards by which other standards are verified.

Reference Standards, such as NIST Class 0 and Class 1 weights, are used for calibration and to verify other standards, unless it is shown that their performance as reference standards becomes invalidated by use.

Where possible, reference standards are calibrated by an A2LA certified reference lab that can provide traceability to national or international standards. An example of a situation in which this is not possible is the NIST thin film standards for XRF analysis. NIST no longer manufactures these standards and, although they are "expired," there is no other NIST traceable provider, and it is highly unlikely that the standard will degrade without visible signs of deterioration due to the physical nature of the standard and the limited use to which the standards are put.

The following reference standards are calibrated and traceable to a national standard as indicated in Section 23:

- Standard weights;
- reference thermometers;
- Max/Min thermometers;
- balances; and
- combination thermometer/hygrometers.

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Note: For cost efficiency purposes, some thermometers and combination thermometer/hygrometers are simply replaced rather than recalibrated as recalibration is more expensive than replacing the unit with a new NIST traceable one. (See Table 23-3.)

24.2 Reference Materials

Reference materials are substances that have concentrations that are sufficiently well established to use for calibration or as a frame of reference.

Reference materials, where commercially available, are traceable to national standards of measurement, or to Certified Reference Materials, usually by a Certificate of Analysis. Purchased reference materials require a Certificate of Analysis.

Laboratory-generated reference materials, such as working standards or intermediate stock solutions, are checked as far as is technically and economically practical.

Where possible, working standards or intermediate stock solutions are checked against a second source at first time of use. When a second source is not available, a vendor-certified different lot is accepted as a second source. In most cases, the analysis of an Initial Calibration Verification (ICV) standard or a Laboratory Control Sample (LCS) can be used as a second source confirmation. Working standards and intermediate stock solutions are given unique IDs and expiration dates when they are prepared based on method requirements, regulatory requirements, Technical Director's knowledge of the method, or, where none exist, the earliest expiration date of the primary standards from which the working standards are prepared. These standards are used in their entirety or disposed of by the expiration date.

Additional working standards such as working Class 1 weights or internal thermometers are checked using the frequency summarized in Table 23-3.

24.3 Transport and Storage of Reference Standards and Materials

The laboratory handles and transports reference standards and materials in a manner that protects the integrity of the materials. Reference standards and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials.

Reference standards and materials are stored according to manufacturer's recommendations, method SOP requirements and separately from samples. See Table 24-1 below and SOP QA-011.

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Table 24-1 Standard Storage and Preparation

Instrument	Stock Storage	Preparation	Intermediate Stock Solution or Working Standard Storage	Frequency of Preparation
ICP	Room Temperature, metals cabinet	Working Standards from Stock	Room Temperature	As needed
IC – Anions and Cations	Standards Refrigerator	Working Standards from Stock	Room Temperature	As needed
IC-PCD (Cr6)	Room Temperature, metals cabinet	Working Standards from Stock	Room Temperature	As needed
CVAA	Room Temperature, Hg hood	Working Standards from Stock	Room Temperature	Daily
OC/EC	Room Temperature (dry chemical)	Working Standard from dry chemical	Standards Refrigerator	Every 6 months
pH meter	Room Temperature, pH supplies	N/A	N/A	N/A
All Class 1 weights	Room Temperature, gravimetric areas	N/A	N/A	N/A
XRF	Room Temperature, XRF laboratory	N/A	N/A	N/A

24.4 Labeling of Reference Standards, Reagents and Reference Materials

The laboratory has procedures for purchase, receipt and storage of standards, reagents and reference materials. Purchase procedures are described in Section 9, "Purchasing Services and Supplies".

All standards and reagents are disposed of after their expiration date.

Reagent quality is verified upon receipt by examination of the Certificate of Analysis and again upon use for blank analysis.

24.4.1 Stock Standards, Reagents, Reference Materials and Media

Records, in the form of Certificates of Analysis, for all standards, reagents, reference materials and media* include:

- the manufacturer/vendor name and lot number (or traceability to purchased stocks or neat compounds);
- the manufacturer's Certificate of Analysis or purity (if available);

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- the date of receipt (stamped or hand-written on the CoA and container); and
- recommended storage conditions (if available).

*Note: It is assumed that "media" here is referring to microbiological media. However, as the term is not well defined, ***CHESTER LabNet*** defines the term to mean "air filters and sorbent tubes." Most media for Air Quality do not have Certificates of Analysis available.

If the original container does not have an expiration date provided by the manufacturer or vendor, either on the container or on the Certificate of Analysis, "X NG" shall be written on the label in indelible ink to indicate that the expiration date was "none given". If an expiration date is provided on the Certificate of Analysis but not printed on the label, the expiration date as given on the Certificate shall be written on the label in indelible ink.

In methods where the purity of reagents is not specified, analytical reagent grade or better is used. If the purity is specified, that is the minimum acceptable grade. Purity is verified and documented according to Section 9, "Purchasing Services and Supplies". Certificates of Analysis are maintained in appropriate binders throughout the laboratory.

24.4.2 Prepared Standards, Reagents, Reference Materials and Media

Prepared standards and reagents are recorded in the applicable bound standards and reagents logbook. Records for standards and reagents preparation include:

- traceability to purchased stock compounds;
- reference to or description of the method of preparation;
- date of preparation;
- an expiration date after which the material shall not be used;
- preparer's initials; and
- unique standard ID.

Reagents used NEAT have the following information recorded with the raw data at time of usage:

- manufacturer and lot number; and
- expiration date.

All containers of prepared standards, reagents or materials are labeled with a unique ID and an expiration date. The unique ID is in the format of LLL-PPP-SS where:

LLL = laboratory logbook number as issued from the QA Officer;
PPP = page number within the logbook; and
SS = sequential number on the page.

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Prepared reagents are verified to meet the requirements of the reference method through the blank analysis performed with each run (e.g., Cal blank, ICB, etc.). If the blank results are suspect, an investigation into the cause of the suspect results will be undertaken and the reagent shall be made fresh if deemed necessary, even if it is still within its expiry date. Prepared standards are verified against existing non-expired standards where possible.

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Section 25

COLLECTION OF SAMPLES
(TNI V1:M2 – Section 5.7)

CHESTER LabNet does not provide sampling services and has no control over the actions or inactions of the client in the field or the reagents used by the client, unless the reagents are purchased directly from the laboratory. The laboratory does not supply the sampler with the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, ice or packing materials. The nature of most air quality methods (ambient or source) makes doing so prohibitively expensive to the laboratory and the client. The laboratory does, upon request, supply clients with Chain of Custody forms and filter or sorbent media.

25.1 Sampling Containers

The 2009 TNI Standard QAMP Template states, *"…The laboratory's responsibility in the sample collection process lies in supplying the sampler with the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, ice, and packing materials required to properly preserve, pack, and ship samples to the laboratory."* The 2016 TNI Standard makes no references to the provision of sampling containers by the laboratory.

The nature of air quality sampling generally requires clients to provide their own coolers, reagent water, sample containers (as defined in the disclaimer at the beginning of this document), secondary sample containers, custody seals (if needed), ice and packing materials. The laboratory does not offer clean bottles for use by clients unless specifically requested by the client.

For ambient sampling, the laboratory may or may not be asked to provide filters or sorbent tubes in appropriate secondary containers. The laboratory does offer filters of various types and cassette rental for filters loaded in cassettes (not all filters are loaded prior to shipment, this occurs at the request of the client).

The laboratory also offers shipment of sorbent media, but makes no guarantees as to the cleanliness of the media (e.g., Anasorb tubes, acidified silica gel tubes). For sorbent media, the laboratory is acting as a middle-man and not a supplier.

For the vast majority of media used during sampling, attempting to clean the media prior to sampling would destroy the media. This situation is so well understood in the air quality industry that the majority of methods include processes for media blank subtraction prior to finalizing data. The client is responsible for any blank subtraction as the laboratory is blind to the field activities. The quality of the media rests solely on the manufacturer.

25.1.1 Preparing "Container" (Media) Orders

Filters and sorbent tubes are provided to the client upon request.

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The Gravimetry Laboratory Technical Director is informed of the request by the Project Manager or personnel who accepted the order. The request is filled as soon as possible based upon availability, the type of analysis the client is performing, the need or lack thereof for cassettes, and the client's sampling schedule.

Once ready to be shipped, the media are given to the Project Manager. The Project Manager packages the media in a suitable shipping container (suitability depends upon the type of media and the reference method). Shipping is by common carrier (e.g., USPS, UPS, FedEx, DHL) and sometimes performed using the client's account number.

Media is packaged and shipped in such a manner as to prevent harm or breakage of the media under typical shipping conditions. The laboratory will ship to any address specified by the client and in the manner specified by the client. For example, shipping filters to Antarctica involves following very specific instructions from the client. Shipping to foreign countries involves following the customs regulations of that country carefully. All factors involving receipt of the media by the client must be taken into account during the shipping process.

25.1.2 Sampling Containers, Preservation Requirements, Holding Times

Sampling container, preservation and holding time requirements are documented in in the reference methods. ***CHESTER LabNet*** has no control over the activities of clients in the field, the sample containers used, impinger solutions used, whether or not the clients keep the samples at the temperature specified in the method, or any other activity which occurs prior to the samples being received at the laboratory. ***CHESTER LabNet*** has no control over the quality of filters or sorbent material produced by manufacturers, with the exception of attempting to find the least problematic media available on the open market.

For instance, a client may request sodium bicarbonate impregnated acid hardened cellulose filters for the purposes of sampling for Hexavalent Chromium in air. The laboratory will impregnate the filters, load them in cassettes, and store the filters (loaded or unloaded) frozen. The client then may take the filters out to the field where sampling may take 24 hours at ambient temperatures, and the samples may not be retrieved from the sampler for up to 3 days after the sampler has shut off, thereby allowing the sample 4 days at ambient outdoor temperatures (ranging from below freezing to over 100 °F). After the samples are collected, they may or may not be stored frozen prior to the samples being returned to the laboratory, where the samples will again be stored frozen. ***CHESTER LabNet*** has no control over the actions or inactions of the clients once the filters have left the laboratory's possession. This lack of control is true for all filters, impinger solutions and sorbent media.

Since air samples cannot be collected in the same manner as water or soil samples, "containers" is an inappropriate term for sample collection devices and solutions; and the collection itself is an integral part of the "preservation". Below is a table listing the Analyte(s), Reference Method, type of "container", "Preservation" and Holding Time as given in the reference method.

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If preservation or holding time requirements are not met, and the cause of not meeting the requirements is under the laboratory's control, the procedures in Section 12, "Control of Non-conforming Environmental Testing Work" are followed. If samples are received by the laboratory after the hold time has expired, this shall be noted in the final report.

Table 25-1 Summary of Sampling Container, Preservation and Holding Time Requirements

Analyte(s)	Reference Method	Method specified "Container"	Preservation	Holding Time
Ambient Air (note: filters or sorbent tubes are the "container" for ambient air samples)				
TSP	40 CFR 50, Appendix B	8"x10" Glass Fiber or Quartz Filter	None Given	None Given
PM_{10}	40 CFR 50, Appendix J	8"x10" Glass Fiber or Quartz Filter	None Given	None Given
PM_{10} Dichotomous	IO 2.2	37mm Teflon or Quartz Filter	None Given	None Given
$PM_{2.5}$	40 CFR 50, Appendix L	47mm Teflon filter	None **OR** <4 °C	10 days with no refrigeration, **OR** 30 days if stored at <4 °C
Total Metals (ambient air)	40 CFR 50, Appendix G; IO 3.2; IO 3.4	8"x10" Glass Fiber; IO 3.0 specifies a filter "meeting specifications" but not the actual matrix or size	None Given	None Given
Mercury	EPA 7471, by reference in other methods	Any type of filter the client uses	None Given for ambient air samples	None Given for ambient air
Total Metals	IO 3.3 (XRF)	IO 3.0 specifies a filter "meeting specifications" but not the actual matrix or size	None Given	None Given
Anions & Cations	IO 4.2	Teflon filter & denuder rinses	None Given	"analyze as soon as possible after collection"; also "analyze on day of extraction"
Organic Carbon/Elemental Carbon	NIOSH 5040; IMPROVE A Method	Pre-fired Quartz filters (37mm or 47mm)	"frozen"	None Given
Hexavalent Chromium	CARB SOP MLD 039 (not reference)	Bicarb impregnated cellulose	"frozen"	90 days prior to extraction, 24 hours after extraction
Hexavalent Chromium	ASTM D7614-12	Bicarb impregnated cellulose	"frozen"	None for filters/samples. "...extraction should be performed immediately prior to analysis."
Total Nuisance Dust	NIOSH 0500	37mm Teflon or PVC filter	None Given	None Given
Respirable Particles	NIOSH 0600	37mm Teflon or PVC filter	None Given	None Given

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Table 25-1 Summary of Sampling Container, Preservation and Holding Time Requirements

Analyte(s)	Reference Method	Method specified "Container"	Preservation	Holding Time
Arsine	NIOSH 6001	Coconut Charcoal sorbent Tube	None Given	6 days
Phosphine	NIOSH 6002	$Hg(CN)_2$-coated silica gel sorbent tube	None Given	7 days
SO_2	NIOSH 6004	0.8µm cellulose ester membrane filter FOLLOWED BY bicarb impregnated cellulose fiber filter	None Given	None Given
Diborane	NIOSH 6006	PTFE membrane filter, 13-mm diameter, 1-µm pore size FOLLOWED BY oxidizer-impregnated charcoal sorbent tube	None Given	7 days
Mercury	NIOSH 6009	Hopcalite Tube (no longer manufactured)	None Given	30 days
Br_2 & Cl_2	NIOSH 6011	Teflon filter with 0.5-µm pore size FOLLOWED BY a 25mm silver membrane filter with 0.45-µm pore size	None Given	30 days
NO_2	NIOSH 6014	7mm sorbent tube containing 400 mg TEA-coated molecular sieve (type 13x, 30-40 mesh) FOLLOWED BY 7mm sorbent tube containing 800 mg oxidizer (chromate) FOLLOWED BY 7mm sorbent tube containing 400 mg TEA-coated molecular sieve (type 13x, 30-40 mesh)	None Given	7 days
Ammonia	NIOSH 6016	Acidified silica gel sorbent tube	None Given	35 days
Ammonia	OSHA ID188	H_2SO_4 acidified carbon bead sorbent tube	None Given	29 days
Elements by ICP [metals]	NIOSH 7302	37mm mixed cellulose ester	None Given	None Given
Elements by ICP [metals]	NIOSH 7304	37mm PVC filter [unimpregnated]	None Given	None Given
Chromium (VI)	NIOSH 7605	37mm PVC filter [unimpregnated]	None Given	14 days at room temp; 28 days "refrigerated"

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Table 25-1 Summary of Sampling Container, Preservation and Holding Time Requirements

Analyte(s)	Reference Method	Method specified "Container"	Preservation	Holding Time
Fluorides	NIOSH 7902	37mm cellulose ester membrane filter 0.8-µm pore size FOLLOWED BY bicarb impregnated cellulose pad	None Given	None Given
Volatile Acids	NIOSH 7907	Quartz filter FOLLOWED BY bicarb impregnated quartz filter	None Given	7 days at 20° C, 28 days at 4° C
Non-volatile Acids	NIOSH 7908	37mm quartz or Teflon filter	None Given	7 days at 20° C, 28 days at 4° C
Source Emissions Sampling (note: impinger solutions are the "container" for source emission gases)				
Particulates	40 CFR 60, Appendix A, Methods 5 – 5F	Glass or polyethylene petri dishes for filter (filter type not specified); 500 or 100mL glass bottles for Acetone	None Given	None Given
SO_2	40 CFR 60, Appendix A, Method 6	100 mL polyethylene bottles for H_2O_2 solution	None Given	None Given
NO_x	40 CFR 60, Appendix A, Method 7A	Polyethylene bottles for H_2SO_4/H_2O_2 solution	None Given	None Given
NO_x	40 CFR 60, Appendix A, Method 7D	Polyethylene bottles for $NaOH/KMnO_4$ solution	None Given	None Given
H_2SO_4 & SO_2	40 CFR 60, Appendix A, Method 8	1L polyethylene bottles, 1 each for IPA solution and H_2O_2 solution	None Given	None Given
Pb	40 CFR 60, Appendix A, Method 12	1000 mL borosilicate glass bottles for 0.1N HNO_3 solution	None Given	None Given
Total Fluoride	40 CFR 60, Appendix A, Method 13B	1L wide mouth HDPE bottles for impinger water and filter	None Given	None Given
HX & X_2	40 CFR 60, Appendix A, Method 26	100- or 250-mL HDPE bottles with Teflon screw cap liners for both H_2SO_4 and NaOH fractions	None Given	None Given
HX & X_2	40 CFR 60, Appendix A, Method 26A	1L HDPE bottles with Teflon screw cap liners for both H_2SO_4 and NaOH fractions	None Given	None Given

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Table 25-1 Summary of Sampling Container, Preservation and Holding Time Requirements

Analyte(s)	Reference Method	Method specified "Container"	Preservation	Holding Time
Multi-metals	40 CFR 60, Appendix A, Method 29	500 - 1000 mL glass for $KMnO_4/H_2SO_4$ impinger solution; HDPE or glass for all other solutions; Glass or plastic petri dishes for filter.	None Given	None given for any metal except Hg. Hg has a "suggested maximum" hold time of 28 days by reference to SW-846 method 7470.
Hg	40 CFR 61, Appendix B, Method 101	100 mL & 1000 mL glass with Teflon-lined caps for ICl solution	None Given	None Given
Hg	40 CFR 61, Appendix B, Method 101A	100 mL & 1000 mL glass with Teflon-lined caps for $KMnO_4/H_2SO_4$ solution	None Given	"suggested maximum" hold time of 28 days by reference to SW-846 method 7470
Hg	40 CFR 61, Appendix B, Method 102	100 mL & 1000 mL glass with Teflon-lined caps for ICl solution	None Given	None Given
Be	40 CFR 61, Appendix B, Method 103	Glass bottles for filter and acetone washes	None Given	None Given
Be	40 CFR 61, Appendix B, Method 104	1L glass bottles with Teflon-lined lids for water impinger solution combined with acetone rinses; Glass or plastic petri dishes for filter	None Given	None Given
As	40 CFR 61, Appendix B, Method 108	500mL – 1000mL polyethylene or polypropylene for water impinger solution combined with NaOH rinse solutions	None Given	None Given
Particulates 201A	40 CFR 51, Appendix M, Method 201A	Any leak-proof container for acetone rinses; Glass or plastic petri dishes for filter	None Given	None Given
Particulates 202	40 CFR 51, Appendix M, Method 202	500 mL amber glass bottles for water impinger solutions; and Hexane/Acetone rinses	None Given	None Given
Hexavalent and Total Chromium	40 CFR 63, Appendix A, Method 306	250 mL, 500 mL or 1,000 mL polyethylene, with leak-free screw cap for 0.1N NaOH or 0.1N $NaHCO_3$ impinger solution	4 °C for Cr(VI); None Given for total Cr	14 days at 4 °C for Cr(VI); 60 days at room temperature for total Cr

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Table 25-1 Summary of Sampling Container, Preservation and Holding Time Requirements

Analyte(s)	Reference Method	Method specified "Container"	Preservation	Holding Time
Hexavalent Chromium	SW-846, Method 0061	250 mL, 500 mL or 1,000 mL polyethylene, with leak-free screw cap for 0.1M KOH impinger solution	None Given	14 days
$H2SO_4$ & SO_2 (Titration)	CTM-013 (aka NCASI 8A)	None Given for water rinse or H_2O_2 impinger solution	None Given	None Given
$H2SO_4$ & SO_2 (IC)	CTM-013A	125 mL Nalgene bottles for water rinse or H_2O_2 impinger solution	None Given	None Given
Ammonia	EPA CTM-027 ("draft" as of 1997, not yet given reference method status)	250 mL – 500 mL HDPE bottles for 0.1N H_2SO_4 impinger solutions	4 °C	"2 weeks"
HF/F_2 & HCl/Cl_2	CARB 421	"…borosilicate glass bottles for impinger solutions and washes, 1000 mL. Teflon or high-density polyethylene or polypropylene bottles may be used. Use screw-cap liners that are either rubber-backed Teflon or leak-free" for impinger solution of 1.7 mM Sodium Bicarbonate and 1.8 mM Sodium Carbonate.	None Given	None Given
Total and Hexavalent Chromium	CARB 425	500 ml or 1000 ml borosilicate glass bottles, screw cap liners shall either be rubber-backed Teflon or shall be constructed so as to be leak-free. Alternatively, polyethylene bottles may be used for 0.1N NaOH impinger solutions.	None Given	None Given

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Table 25-1 Summary of Sampling Container, Preservation and Holding Time Requirements

Analyte(s)	Reference Method	Method specified "Container"	Preservation	Holding Time
Multi-metals	CARB 436	Glass or polyethylene petri dishes for Quartz fiber or glass fiber filters without organic binders; 500 ml or 1000 ml borosilicate glass bottles, screw cap liners shall either be rubber-backed Teflon or shall be constructed so as to be leak-free. Alternatively, polyethylene bottles may be used for HNO_3/H_2O_2 impinger solutions, $KMnO_4/H_2SO_4$ impinger solutions, 0.1N HNO_3 rinse solutions and 8N HCl rinse solutions.	None Given	None Given
Ammonia	BAAQMD ST-1A & ST-1B	250 mL – 500 mL HDPE bottles for 0.1N HCl impinger solutions	"store them in the Refrigerator"	"within five days of their submission to the laboratory."
Particulates	Oregon DEQ 5	[By reference to EPA Method 5] Glass or polyethylene petri dishes for filter (filter type not specified); 500 or 100mL glass bottles each for Acetone rinse, water impinger solution and Dichloromethane	None Given	None Given
Particulates	Oregon DEQ 8	Acetone or Methanol is given as the rinse solution; Glass fiber filters are given as the filter matrix; No guidance is given for containers for the rinse solution or filters.	None Given	None Given

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25.2 Sampling Plan

The laboratory does not perform sampling. For purposes of remaining independent from the sampling group and the ultimate client, the laboratory does not act as a consultant for determining sampling plans.

25.3 Sampling Records

Sampling records are maintained by the client. If sampling records are given to the laboratory, they will be used as directed by the client and retained in the client's job folder.

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Section 26

HANDLING SAMPLES AND TEST ITEMS
(TNI V1:M2 – Section 5.8 and Section 1.7 of Technical Modules TNI V1:M 3-7)

26.1 Sample Receipt

When samples are received at the laboratory, chain-of-custody is reviewed, sample condition is documented, samples are given unique identifiers, and they are logged into the sample tracking system.

26.1.1 Chain of Custody

The chain of custody is reviewed. The chain of custody form provides information on what type of testing is being requested and can act as an order for laboratory services in the absence of a formal contract. An example chain of custody form is located in Figure 26-1. Chain of custody and any additional records received at the time of sample submission are maintained by the laboratory in each client's job file.

26.1.1.1 Legal Chain of Custody

The laboratory does not *knowingly* receive samples for evidentiary purposes.

26.2 Sample Acceptance

Procedures for opening shipping containers and examining samples are provided in SOP AD-008. Samples received outside normal business hours are handled in the same manner as those received during normal business hours.

The 2009 and 2016 TNI Standard QAMP template states, "*The laboratory has a sample acceptance policy that is made available to sample collection personnel. An example is provided in Figure 26-2. It emphasizes the need for use of water resistant ink, providing proper documentation (to include sample ID, location, date and time of collection, collector's name, preservation type, sample type and any special remarks about the sample), labeling of sample containers to include a unique sample ID, use of appropriate containers, adherence to holding times, and sample volume requirements. In addition the laboratory has nonconformance/corrective action procedures to handle samples that don't meet the requirements above or show signs of damage, contamination or inadequate preservation. Data will be appropriately qualified where samples are reported that do not meet sample acceptance requirements.*" This list is a required element of the QAMP by the 2009 and 2016 TNI Standard, although not typically applicable to air quality samples.

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The laboratory has a sample acceptance policy provided in SOP AD-008 and below in Figure 26-2. As the laboratory does not perform sampling, the policy is not provided to sample collection personnel.

The incompatibilities between ambient/source gas stream sampling and water/soil sampling encountered with the above requirements are as follows:

- water resistant ink is rarely needed as the vast majority of samples are filters, and these samples are destroyed if they become wet, or the client labels the samples in the field. The laboratory is not responsible for the actions of the client in the field;
- sample location may not be provided to the laboratory by the client;
- date of sampling is usually known and often provided to the laboratory; however, many samples may have a collection "time" of 2 hours to 14 days and this timing is rarely reported to the laboratory;
- collector's name is rarely reported to the laboratory, and more than one person may be involved in collecting the sample, particularly if the sample has a long collection time;
- samples do not have "preservation" except in a few cases where thermal preservation is called for. Preservation is typically achieved by the media on/in which the sample is collected;
- sample type is usually identified by method number and is understood within the air quality industry;
- filters sent to clients for ambient air sampling have unique IDs assigned to them prior to leaving the laboratory, however, source samples rarely have a unique ID as each project/job site constitutes a unique identifying characteristic and the laboratory has no control over the actions, including identification of containers, of the client in the field;
- appropriate containers are the responsibility of the client, and as they often must travel to extremely remote locations, by necessity, they may be forced to use what they have on-hand;
- very few methods utilized by the laboratory have holding times required within the reference method; and,
- sample "volume" may mean either the gas volume pulled during sampling or the liquid volume of impinger contents post-sampling and is dictated by the amount of gas volume pulled by the clients in the field, the method utilized to capture said gasses, and in the case of source emission samples, the moisture content of the source.

The laboratory has non-conformance/corrective action procedures to handle samples that don't meet the requirements of the reference method, or that show signs of damage or contamination. Data will be appropriately qualified where samples are reported that do not meet sample acceptance requirements.

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The laboratory checks samples for the following to evaluate sample acceptance:

- samples are intact;
- samples are not damaged; and
- samples appear to be submitted in good faith and are not, to the laboratory's knowledge, fraudulent.

Criteria regarding holding time, sample matrix, and sample containers is located in Table 25-1 of this document. If these conditions are not met, the client is contacted prior to any further processing, then 1) the sample is rejected as agreed with the client, 2) the decision to proceed is documented and agreed upon with the client, 3) the condition is noted on the Chain of Custody form and/or lab receipt documents, and/or 4) the data are qualified in the Case Narrative of the report. Samples are never rejected without the consent of the client.

26.2.1 Preservation Checks

The following preservation checks are performed and documented upon receipt:

26.2.1.1 *Thermal preservation:*

a) For temperature preservation, the temperature must be within the guidelines specified by the reference method. Note that some methods merely say "ship with blue ice" and do not specify a temperature.

b) The 2009 and 2016 TNI Standard states, "*Samples that are delivered to the laboratory on the same day they are collected may not meet the requirements of [thermal preservation]. In these cases, the samples shall be considered acceptable if the samples were received on ice.*" The laboratory very rarely receives samples on the same day they are collected due to the complexity and length of duration of sample collection for air quality methods.

c) Where applicable, record the received temperature on the Chain of Custody and note if ice ("wet" or dry) is present.

Chlorine checks:

CHESTER LabNet performs no methods requiring Chlorine checks.

pH checks:

CHESTER LabNet performs no methods requiring pH checks; however, the laboratory performs pH checks on a few select methods. These checks are typically performed after analyses of the samples to prevent contamination of the sample.

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26.3 Sample Identification

The 2009 and 2016 TNI Standard states, "*The laboratory shall have a documented system for uniquely identifying the sample containers that hold samples to be tested, to ensure that there can be no confusion regarding the identity of such samples at any time. This system shall include identification for all samples, sub-samples, preservations, sample containers, tests, and subsequent extracts and/or digestates.*"

See SOP AD-008, "Sample Receipt and Log-in".

Samples are uniquely identified, based on the needs of the client and the reference method requested in the laboratory's LIMS. The LIMS maintains an unequivocal link with the field ID code assigned to each sample by the client. Digests, subsamples, and multi-fraction samples are assigned separate unique IDs, depending on the reference method. The laboratory ID is placed as a durable mark on the sample container in the form of an adhesive label or indelible ink.

Samples are assigned sequential numbers that reference more detailed information electronically stored in the LIMS. Refer to SOPs AD-007 and AD-008 for the laboratory's sample identification procedure.

The following information is included in the LIMS:

- client and, where known, project name;
- date and time of receipt at the lab;
- unique laboratory identification number; and
- initials of the person making the entries.

In addition, the following information, where known, is maintained and linked to the log-in record:

- date and time of sampling;
- unique field identification number linked to the laboratory sample ID *(note: the laboratory has no control over the Field ID. Field ID's may not be unique. Assignation of Field ID's is the responsibility of the client)*;
- analyses requested (including applicable approved method numbers) linked to the laboratory sample ID; and
- comments regarding rejection or other issues (if any).

All documentation received regarding the sample, such as memos or chain of custody, are retained in the job file.

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26.4 Sample Aliquots / Subsampling

In order for analysis results to be representative of the sample collected in the field, the laboratory has subsampling procedures. Note that the vast majority of subsampled samples consist of 8" x 10" filters. Refer to SOP ME-008 for subsampling of 8" x 10" filters. Very few other samples are subsampled as most other methods are either non-destructive (gravimetry and XRF analyses) or the entire sample is consumed.

26.5 Sample Storage

Storage conditions are monitored for any required criteria, verified, and the verification recorded where appropriate.

Samples that require thermal preservation are stored in a manner compliant with the reference method. For samples with a specified storage temperature of 4 °C, storage at a temperature above the freezing point of water to 6 °C is acceptable. For samples required to be kept "frozen", any temperature below 0 °C is acceptable.

Samples are held secure, as required. Samples are accessible only to laboratory personnel.

Samples are stored apart from standards, reagents, food or potentially contaminating sources, and in a manner that minimizes cross-contamination. All portions of samples, including extracts, digestates, leachates or any product of the sample is maintained according to the required conditions.

The majority of samples, based upon reference method requirements, are stored at room temperature, or in a temperature- and humidity-controlled room.

26.6 Sample Disposal

Samples are retained for a minimum of 60 days after the report is sent unless other arrangements have been made with the client.

Samples are disposed of according to Federal, State and local regulations. Procedures are described in SOP AD-002 for the disposal of samples, digestates, leachates and extracts.

26.7 Sample Transport

Samples transported under the responsibility of the laboratory, where necessary, are transported safely and according to storage conditions. This includes moving samples within the laboratory. Specific safety operations are addressed outside of this document in method specific SOPs and the laboratory's Chemical Hygiene Plan. Samples are not shipped by the laboratory.

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Figure 26-1

Example Chain-of-Custody

Company Name			
Contact		Phone	
E-Mail Address		Fax	
Report Address			
City	State	Zip	
Billing Address			
City	State	Zip	
P.O./Project #			

Chester LabNet
12242 SW Garden Place
Tigard, OR 97223
(503) 624-2183
Fax (503) 624-2653
CLN@ChesterLab.Net

CHAIN-OF-CUSTODY RECORD

Page ___ of ___

LabNet ID	Field Sample ID	Site	Sample Date	Volume (m^3)	Particle Size	Analysis Requested									Turn Around Time ☐ Standard ☐ Rush ______ Specify / Remarks

Relinquished By: (Signature) Date/Time	Received By: (Signature) Date/Time	Notes:
Relinquished By: (Signature) Date/Time	Received By: (Signature) Date/Time	

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Figure 26-2

Example Sample Acceptance Policy

Disclaimer: The 2009 and 2016 TNI Standard have a number of requirements for sample acceptance. As these requirements are designed for water or soil samples, most are not generally applicable to the analysis of ambient air or source samples. For example, the laboratory rarely knows the name of the sample collector, there may be two or three people involved in sample collection, and the "time of collection" may range from 2 hours to 2 weeks.

CHESTER LabNet will not reject any sample except at the request of the client, unless the acceptance of the sample would be fraudulent. The laboratory will note its opinion if the data are suspected to be of dubious usefulness to the client or to the client's client or regulator. The laboratory will notify clients if their samples are received in such a state as to make analysis impracticable or lead to suspect data. Notification will occur, wherever possible, upon receipt of the samples

To demonstrate the laboratory's good-faith effort to fulfill the 2009 and 2016 TNI requirements, a checklist is completed at the time of sample receipt. The checklist is maintained with the job file. It is not, however, reported to the client.

CHESTER LABNET

SAMPLE RECEIPT CHECKLIST FOR NELAC REQUIREMENTS

Client _____ Method _____ Date _____

Archaic methods or methods that can't be analyzed as written: M26/26A; M202; M12; M101/101A/102 (This is not a complete listing)

NELAC Required Sample Condition	(circle one)	
Received in condition required by method? [1]	Y N N/A	
Samples in appropriate containers? [1]	Y N N/A	
Correct temperature?	Y N N/A	*
Within hold time?	Y N N/A	*
Broken/damaged?	Y N N/A	!!
Sufficient sample present to perform analysis? [1]	Y N N/A	!!
Preserved appropriately? [1]	Y N N/A	

Chain of Custody	(circle one)	
Chain of Custody present?	Y N N/A	!!
Client contact information present on CoC? [1]	Y N N/A	
All requested analyses definitively identified? [2]	Y N N/A	!!
If no, is this a long-standing project with understood analyses?	Y N N/A	

Additional NELAC Requirements		
All samples identified uniquely? [1]	Y N N/A	!!
Labels water resistant? [1]	Y N N/A	
Indelible ink used on labels? [1]	Y N N/A	
Location of Sample collection listed? [1]	Y N N/A	
Sample collector's name listed? [1]	Y N N/A	
Preservation type listed? [1]	Y N N/A	
Sample type listed? [1]	Y N N/A	

NELAC required Method information		
Method requested the latest valid edition? [3]	Y N N/A	
Method appropriate for the analyses requested? [3]	Y N N/A	
Is it possible to use the method requested? [3]	Y N N/A	
Method out of date (wrong revision number)? [3]	Y N N/A	
Is the method archaic? [3]	Y N N/A	
Can the method be performed as written? [3]	Y N N/A	

[1] ***CHESTER LabNet*** will not notify clients of these "deficiencies" to avoid alienating clients by perpetual contact.

[2] may be identified by Method number if method contains no room for doubt as to analytes of interest.

[3] Many Air Quality/Soure Emission methods are archaic, contradict themselves or are inappropriate. Some regulators require the use of older versions of a method. ***CHESTER*** will follow, to the best of their ability, the method requested by the client.

!! address ***prior to any analytical work being started****.* ** **note in case narrative** upon reporting of results to client.*

Signed _____

Notes _____

Note: NELAC requirements are designed for Water/Soils, and are often incompatible with Ambient or Source Air Promulgated Methods.

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For Source Sampling, a second, more specific and applicable checklist (below) was created prior to the advent of TNI or ORELAP and has been in use by the laboratory for many years. This checklist is reported to the client.

CHESTER LABNET
SOURCE SAMPLE RECEIPT CHECKLIST

Client _____ Date _____

Runs _____ Time _____

Custody Seals Inspected, If Present	☐	
Chain-of-Custody Form Inspected	☐	
CoC present with samples?	☐	*
CoC indicate analytical methodology to be used? (eg M29 etc)	☐	!!
CoC indicate if compliance testing? (esp. M26)	☐	!!
M26 samples have Thiosulfate added in field?	☐	!!
M29 indicate FH/BH separate or combined?	☐	!!
Has Form Been Signed?	☐	
Have Date and Time Custody Released Been Noted on Form?	☐	
All Sample Containers Inspected	☐	
Does Number of Samples Match Number on CoC Form?	☐	!!
Do All Sample ID Numbers Match Those on the CoC Form?	☐	!!
Did client mark sample volumes prior to shipment?	☐	*
If required by method, did client vent samples prior to shipment?	☐	
Are the Sample Containers Intact?	☐	!!
Are signs of leakage present?	☐	*
Chain-of-Custody Form Signed and Dated by CLN	☐	
Corrective Actions		
Client Contacted Due to Mismatching Sample ID Numbers	☐	
Client Contacted Due to Broken Sample Container(s)	☐	
Client Contacted Due to Leaking Sample Container(s)	☐	
Client contacted for verification of methodology?	☐	
Corrective Actions Documented?	☐	
Corrective Actions Accomplished?	☐	

Items marked !! shall be addressed ***prior to any analytical work being started****.*
*Items marked * shall be* ***noted in case narrative*** *upon reporting of results to client.*

Signed _____

Notes _____

_____

_____

_____

_____

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Section 27

QUALITY ASSURANCE FOR ENVIRONMENTAL TESTING*(TNI V1:M1, V1:M2 – Section 5.9 and Section 1.7 of Technical Modules TNI V1:M 3-7)*

CHESTER LabNet has procedures for monitoring the validity of the testing it performs. The qualities of test results are recorded in such a way that trends are detectable, and where practicable, are statistically evaluated. To evaluate the quality of test results, the laboratory utilizes certified reference materials, audit samples (where available), interlaboratory comparisons (where available), replicate testing using different methods (e.g., Methods 6 and 8) and results for non-sample-based QC elements (e.g., ICV's, LCS's, etc.).

In addition to procedures for calibration, the laboratory monitors quality control measurements such as blanks, laboratory control samples (LCS), matrix spikes (MS), duplicates and certified Class 1 weights to assess precision and accuracy. Proficiency Testing samples are required by the 2009 and 2016 TNI Standard, however there are none available from a Proficiency Testing Provider Accreditor approved Proficiency Test Provider for any *accredited* method performed by ***CHESTER LabNet***. Audit Samples are required by the EPA with every set of compliance samples sent to the laboratory for which audit samples are available.

Quality control data are analyzed and, when found to be outside pre-defined criteria, action is taken to correct the problem and to prevent incorrect results from being reported. Data associated with quality control data outside of criteria and still deemed reportable will be qualified such that the end user of the data may make a determination of the usability of the data (see Section 28, "Reporting of Results").

27.1 Essential Quality Control Procedures

When not archaic, the quality control procedures specified in reference methods are followed by laboratory personnel. The 2009 and 2016 TNI Standard requires that "*When it is not apparent which is more stringent, the QC in the mandated method or regulations is to be followed.*" The most stringent of control procedures is used in cases where multiple controls are offered. If it is not clear which is the most stringent, that mandated by reference method or listed in the 2009 and 2016 TNI Standard (Appendix H) is followed. Often a hybrid of the TNI, CLP and method specific QC elements and control limits is used. The laboratory rarely knows what the applicable regulation is for any set of samples, as each source and project may have different regulatory limits, regulatory agencies and QC requirements. In such situations, the laboratory defaults to its own internally-generated quality control procedures or defers to client request.

For reference methods that do not provide acceptance criteria for an essential quality control element or where no regulatory criteria exist, acceptance criteria are developed. The criteria used vary from method to method and are documented in in the method-specific SOPs.

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For the Gravimetry Laboratory, criteria are set based upon the narrowest ranges of quality control which meet all of the methods being utilized in that department.

For the XRF lab, criteria are set based upon the determination of uncertainties for the instruments. Static limits are set for the percent recovery of the quality control standard analyzed with each run and the replicate analyses of samples.

The conventional chemistry lab generally relies on CLP guidelines for static limits on most quality control elements. Where CLP guidelines are not applicable, other means of determining limits for quality control elements are defined.

Written procedures to monitor routine quality controls, including acceptance criteria, are located in the method SOPs, except where noted, and include such procedures as:

- positive and negative controls to monitor tests such as blanks and matrix spikes;
- tests to define the variability and/or repeatability of the laboratory results such as replicates;
- measures to assure the accuracy of the method including calibration and/or continuing calibrations, used of certified reference materials, audit samples, or other measures;
- measures to evaluate method capability, such as detection limit and limit of quantitation or range of applicability, such as linearity;
- selection of appropriate formulae to reduce raw data to final results such as regression analysis, comparison to internal/external standard calculations, and statistical analyses;
- selection and use of reagents and standards of appropriate quality;
- measures to assure constant and consistent test conditions (both instrumental and environmental) where required by the method such as temperature, humidity, light or specific instrument conditions; and
- " … *measures to assure the selectivity of the test method for its intended purpose*" as required by the 2009 and 2016 TNI Standard. However, it is rare that the laboratory has any discretion when it comes to the method utilized. Method selection lies with the laboratory's clients, their clients and/or their clients' regulatory agencies. The laboratory attempts to follow the method chosen by the aforementioned entities to achieve results which are, at a minimum, useable, and preferably accurate.

27.2 Internal Quality Control Practices

Analytical data generated with QC samples that fall within all prescribed acceptance limits indicate that the method is deemed to be in control.

QC samples that fall outside QC limits indicate that the method is out of control (non-conforming) and corrective action is required, and/or that the data need to be

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qualified (see Section 12, "Control of Non-conforming Environmental Testing Work" and Section 14, "Corrective Actions").

Detailed QC procedures and QC limits are included in method standard operating procedures (SOPs).

All QC measures are assessed and evaluated on an on-going basis so that trends are detected.

27.2.1 General Controls

The following general controls are used, where possible:

27.2.1.1 Positive and Negative Controls such as:

a) blanks (negative); and,

b) laboratory control samples (positive).

27.2.1.2 Selectivity is assured through:

a) absolute and relative retention times in chromatographic analyses;
b) use of the correct method according to its scope assessed during method validation;
c) use of qualitative spikes where sample matrices may "push" peaks around;
d) presence of mass for gravimetric analyses;
e) use of element specific wavelengths for analysis by ICP;
f) use of element specific KeV excitation lines for analysis by XRF; and,
g) use of temperature and transmittance/reflectance for analysis by OCEC.

27.2.1.3 Consistency, Variability, Repeatability and Accuracy are assured through:

a) proper installation and operation of instruments according to manufacturer's recommendations or the processes used during method validation;
b) monitoring and controlling environmental conditions (temperature, access and proximity to potential contaminants);
c) selection and use of reagents and standards of appropriate quality;
d) cleaning glassware appropriate to the level required by the analysis as demonstrated with Method Blanks (See SOP AD-004);
e) following SOPs and documenting any deviation, assessing for impact, and treating data appropriately;

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f) testing to define the variability and/or repeatability of the laboratory results, such as replicates; and

g) use of measures to assure the accuracy of the method, including calibration and/or continuing calibrations, use of certified reference materials, audit samples, or other measures.

27.2.1.4 Method Capability (also see Section 22, "Environmental Methods and Method Validation") is assured through:

a) establishment of the detection limit where applicable;

b) establishment of the limit of quantitation or reporting level where applicable; and/or

c) establishment of the acceptable concentration range where applicable, such as linearity.

27.2.1.5 Data reduction is assured to be accurate by:

a) selecting appropriate formulae to reduce raw data to final results, such as regression;

b) following specific procedures for data reduction, such as manual integration procedures; and

c) reviewing data reduction processes periodically to assure applicability.

27.2.1.6 Sample specific controls are used, where possible, to evaluate the effect of sample matrix on the performance of the selected analytical method (not a measure of laboratory performance). For example:

a) Matrix Spike and Matrix Spike Duplicate (MS/MSD)

b) Sample Duplicates

c) Post digestion/extraction Replicates

d) Post digestion/extraction Spikes

27.2.1.7 The following tables summarize the key elements of a quality control system for a laboratory performing chemical testing. Note that many air methods consume the entirety of the sample and do not allow for redigestion or reanalysis. Many also are not compatible with some of the QC elements listed below (e.g., Method 5 and Method 202 cannot have an LCS). Some instrumentation used in air quality analyses does not lend itself to all of the elements listed below (e.g., LCS or blanks for XRF analysis, spikes for $PM_{2.5}$ analysis). All QC elements defined in Table 27-1 are understood to be "where applicable."

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Table 27-1 Essential Quality Control Elements for Chemistry

Item	Frequency	Acceptance Criteria	Corrective action
Initial Calibration	As required by method or technology	Laboratory defined based on 2009 and 2016 TNI Standard, Volume 1, Module 4.	Recalibrate.
Initial Calibration Verification - ICV	Immediately after successful calibration	Method specific or 90% - 110% Recovery	Corrective action as given in SOP
Initial Calibration Blank - ICB	Immediately after ICV	Method specific or <DL	Corrective action as given in SOP
Low Level Calibration Verification – LL-CCV	1/analytical run where instrument is calibrated with single point standard (ICP).	Method specific or 60% - 140% Recovery	Corrective action as given in SOP
Negative Control (Method Blank)	1/digestion batch	Laboratory defined	Reprocess, reanalyze, or qualify data.
Negative Control (Sample Media Blank)	1/digestion batch	Method specific, client specific, regulatory specific, contract specific or as determined by the laboratory	Reprocess, reanalyze, or qualify data.
Positive Control (Laboratory Control Sample - LCS)	1/digestion batch	Method specific or 80% - 120% Recovery	Reprocess, reanalyze, or qualify data.
Positive Control (Laboratory Control Sample Duplicate – LCS-D)	1/digestion batch	Method specific or 80% - 120% Recovery	Reprocess, reanalyze, or qualify data.
Positive Control (Low Level Laboratory Control Sample – LL-LCS)	1/digestion batch	Method specific or 50% - 150% Recovery	Reprocess, reanalyze, or qualify data.
Matrix Spike; Matrix Spike Duplicates (pre - digestion) *Note: Spiked samples are designed as data quality indicators for a specific sample using the designated method. These controls alone are not used to judge a laboratory's performance.*	Minimum of 1/digestion batch where possible. Per method requirement, client request, or laboratory discretion.	Method specific or 75% - 125% Recovery	Reprocess, reanalyze, or qualify data.

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Table 27-1 Essential Quality Control Elements for Chemistry

Item	Frequency	Acceptance Criteria	Corrective action
Matrix Duplicates/Replicates *See note above.*	Minimum of 1/digestion batch where possible. Per method requirement, client request, or laboratory discretion.	Method specific or ±20% RPD	Reprocess, reanalyze, or qualify data.
Continuing Calibration Verification - CCV	1 every 10 analytical readings	Method specific or 90% - 110% Recovery	Corrective action as given in SOP
Continuing Calibration Blank - CCB	Immediately after every CCV	Method specific or <DL	Corrective action as given in SOP

Note1: Control Limit for LL-CCV based on twice the LCS control limit, with a larger allowable tolerance due to the LL-CCV being at the LoQ.

Note 2: Control Limit for LL-LCS based on the LL-CCV control limit plus an additional 10%, due to the concentration of the LL-LCS being below the LoQ.

27.2.2 Specific Controls

27.2.2.1 Blanks

Laboratory blanks (Lab Blanks) are used for Air Quality Methods requiring evaporation and/or gravimetry (Appendix B, J and L; Methods 5, 5A – 5F, 201A, 202, and similar). Laboratory blanks consist of an empty weighing vessel (e.g., beaker, pan, or filter) which follows the other weighing vessels through the process, to the extent possible, and are then gross weighed with the rest of the weighing vessels. A lab blank must be analyzed at a minimum of one per sampling batch, which may exceed 20 samples although it rarely does. For Appendices B, J and L analyses, a lab blank is a blank filter which has been tare weighed, but has never left the confines of the laboratory. It is gross weighed along with its associated samples and must meet the same QC criteria as those samples. Control limits exist only for $PM_{2.5}$ Lab Blanks (± 15µg). The other gravimetric methods have no controls for lab blanks. Per the reference method, the data is reported "as-is" since even negative numbers have interpretive value to the client. Filter Laboratory Blanks are only performed at the request of the client.

Method Blanks are processed along with and under the same conditions as the associated samples to include all steps in the method and all reagents used. They do not, however, contain any of the matrices on or in which a sample is captured (e.g., no filter or sorbent material). A

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Method Blank must be analyzed at a minimum of one per preparation batch.

When no separate preparation method is used, the batch is defined as the environmental samples that are analyzed with the same method and personnel, using the same lots of reagents, not to exceed the analysis of twenty environmental samples, not including Sample Media Blanks, LCS, matrix spikes and matrix duplicates. In the case of no separate preparation method, an ICB or CCB is considered equivalent to a Method Blank.

Sample Media Blanks are processed along with and under the same conditions as the associated samples to include all steps and matrices (e.g., filter type, sorbent material) in the method. A Sample Media Blank must be analyzed at a minimum of one per preparation batch, whenever the laboratory has media available from the same manufacturer's lot number as used during sampling. If no media from the same manufacturer's lot number as used during sampling is available, reagent water is used for QC elements and no Media Blank is analyzed. Nearly all media used in the sampling of ambient or source air have some background contamination from the manufacturing or sampling processes. Due to the complex nature of many source sampling methods, Sample Media Blanks may have detectable levels of analytes of interest present.

The Sample Media Blank results should be lower than the lowest sample result, or within 20% of the sample result in cases where the result is greater than five times the detection limit. Sample Media Blanks are not required for some analyses such as XRF, OC/EC and pH.

Contaminated blanks are identified according to the acceptance limits in the method SOPs. Note that all filter media are not created equal and all filter media may have some form of contamination present. The laboratory has no control over filter manufacturing or the choice of filter matrix and, thus, it is expected that some filters for some analyses will show detectable quantities for some analytes.

The laboratory identifies a media blank as contaminated based upon the method being used. For Method 29 Mercury analysis, for example, a Method Blank is considered contaminated if the result is higher than the detection limit. For Glass Fiber filter analysis, the list of commonly seen contaminants is quite long, thus the performance of the laboratory would not be considered insufficient if the Sample Media Blank were to have analytes of interest present. For Quartz filters, the list is somewhat shorter. Cellulose filters will always be very high in Organic Carbon if analyzed by OC/EC as cellulose is very high in Carbon. Teflon filters are generally very clean for most analytes, but if used for Method 13B, will yield high amounts of fluoride. Each matrix, analyte and method must be taken into account when determining if a Sample Media Blank is considered contaminated enough to induce corrective actions.

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When a blank is determined to be contaminated, the cause must be investigated and measures taken to minimize or eliminate the problem.

Data that are unaffected by the blank are reported unqualified. Data is considered unaffected if the result for the analyte of interest in the blank is <DL or <10% of the lowest sample value obtained.

Sample data that are suspect due to the presence of a contaminated blank are reanalyzed if possible, or noted in the Case Narrative of the final report. If the blank results are less than the sample results and the contaminant is common in the media being analyzed, no notation is made in the report.

Regardless of whether the blank(s) affect the sample results or not, all Method Blank and Sample Media Blank results are reported to the client in the form of a QC report. It is the policy of the laboratory to never blank subtract results submitted to the client. The client is responsible for performing or not performing any blank subtraction. Most reference methods using filter media have blank subtraction protocols.

Client-provided Field Blanks, Trip Blanks, Proof Blanks, Recovery Blanks, Train Blanks and Reagent Blanks have no control limits and are treated as samples.

27.2.2.2 Laboratory Control Samples

Laboratory Control Samples (LCS), Duplicate Laboratory Control Samples (LCS-D), and Low Level Laboratory Control Samples (LL-LCS) are prepared from analyte-free water and spiked with verified and known amounts of analytes for the purpose of establishing precision or bias measurements and for collection of data to perform DL verification studies (See Appendix H). Not all methods are amenable to LCS's (e.g., OCEC, XRF, PM_{10}, $PM_{2.5}$, Method 202, etc.).

Laboratory Control Samples (LCS and LCS-D) are analyzed at a frequency mandated by method, regulation, laboratory discretion or client request, whichever is more stringent. The standard frequency of LCS preparation and analysis is one per preparation batch of 20 or fewer samples, or as otherwise stated in a laboratory SOP. LCS-Dups are only prepared when the method or sample size prevents the laboratory from analyzing a Sample Duplicate. Low Level Laboratory Control Samples (LL-LCS) are analyzed once per preparation batch of 20 or fewer samples, or as otherwise stated in a laboratory SOP. Exceptions would be for those analytes or methods where no spiking solution is available, such as Method 202, OCEC and XRF analysis, PM_{10} or $PM_{2.5}$ analysis, etc.

When no separate preparation method is used, the batch is defined as the environmental samples that are analyzed with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples. In the case of no separate preparation

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method, an ICV or CCV is considered equivalent to an LCS/LCS-D.

When there is no separate preparation method, a Low Level Laboratory Control Standard (LL-LCS) is prepared and analyzed in a similar manner as a CCV standard. Results from the LL-LCS are used to verify the low end of the calibration curve (LoQ) and to gather data for verification of the detection limit. No reference method in use by the laboratory as of this writing has a requirement for an LL-LCS.

The analytes to be spiked in the LCS are the same as the analytes specified by the client or in the method SOP. The client's requests take precedence over the reference method.

The results of laboratory control samples (LCS, LCS-D and LL-LCS) are calculated in percent recovery. The calculation for percent recovery is given below:

$$\%R = (AV/KV) \times 100$$

Where:
AV = Analyzed Value
KV = "known value" (True Value Spiked)

The individual LCS percent recovery is compared to the acceptance criteria as published in the reference method, or the laboratory established limits when there are no established criteria, as described above. Where no established criteria exist, the laboratory defaults to ±20% of the true value for LCS's and LCS-D's, per CLP guidelines, and to 50% - 150% for LL-LCS's. See Note 2, Table 27-1.

27.2.2.3 Matrix Spikes and Matrix Spike Duplicates

Matrix Spikes and Matrix Spike Duplicates (MS/MSD) are a second/third aliquot of an environmental sample fortified with a known amount of analyte to help assess the effect of the matrix on method performance. ***CHESTER LabNet*** rarely performs Matrix Spike Duplicates. In some cases, a second aliquot of the sample may not be possible, in which case a second aliquot of the extract/digestate will be utilized (called a Post-Digestion Spike or "post spike" to differentiate it from a true spiked analysis).

The laboratory procedure for a matrix spike includes spiking appropriate analytes at appropriate concentrations, calculating percent recoveries, and evaluating and reporting the results. The procedure is documented in in the pertinent method SOPs. The calculation for percent recovery is given below:

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$$\%R = \frac{(AV - SV) \times 100}{KV}$$

Where:
AV = Analyzed Value
SV = Sample Value
KV = "known value" (True Value Spiked)

The individual spike percent recovery is compared to the acceptance criteria as published in the mandated reference method, or the laboratory established limits when there are no established criteria. Where there are no established criteria, the laboratory defaults to the CLP guidelines of 75% - 125% Recovery.

For spike results outside established criteria, the data are reported with annotations in the report. For some methods, such as Fluoride by Method 26, it is common to have matrix interferences which cause the spike to fall out of control. For other methods, it is not possible to spike the sample (e.g., OCEC, XRF, Method 202, $PM_{2.5}$, PM_{10}).

27.2.2.4 Matrix Duplicates

Matrix Duplicates ("dups") are a second aliquot of an environmental sample processed along with and under the same conditions as the associated sample to include all steps in the method. In some cases, a second aliquot of the sample may not be possible, in which case a second aliquot of the extract/digestate will be utilized (called a Replicate or "rep" to differentiate it from a true duplicate analysis).

The laboratory procedure for a matrix duplicate/replicate includes calculating the relative percent difference (RPD) and evaluating and reporting the results. The calculation for Relative Percent Difference is given below:

$$\%RPD = \frac{|(SV - DV)| \times 100}{\overline{X}_{SV,DV}}$$

Where:
SV = Sample Value
DV = Duplicate Value
$\overline{X}_{SV,DV}$ = average of sample and duplicate values

Some methods, notably Method 26/26A and most Source Mercury methods, require <u>all</u> samples to be analyzed in duplicate. These methods stipulate that the RPD of a given sample analysis be within 5% RPD or 3% RPD (method dependent). Method 12 requires triplicate analyses, with no more than 5% relative standard deviation (RSD) between data points for the same sample. That calculation is not shown here. Where no established criteria exist, the laboratory defaults to ±20% RPD, per CLP guidelines.

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27.2.2.5 Calibration

All instruments requiring a multi-point calibration must use a minimum of 5 calibration points for a linear curve, and six calibration points for a quadratic curve. The correlation coefficient of the curve must be greater than 0.995.

The accuracy of all calibration points is verified by determining the Percent Relative Error of each standard. Standards with concentrations at or below the LoQ must have a Relative Error ≤50%. Standards above the LoQ must have a Relative Error ≤10%.

The calculation for Relative Error (expressed as a percent) is given below:

$$RE\ (or\ \%RE) = 100 - \frac{(AV - KV) \times 100}{KV}$$

Where:
AV = Analyzed Value
KV = "known value" (True Value Spiked)
%RE is presented as an absolute value

27.3 Proficiency Test Samples or Interlaboratory Comparisons

27.3.1 Compliance with Accreditation Requirements

The 2009 and 2016 TNI Standard states, "*The laboratory shall analyze and report a PT study at least twice per year for each accreditation FoPT for which it seeks to maintain accreditation…*" No FoPT exists for the TNI defined Quality Matrix of "Air".

In June, 2013, the US EPA required all source samples analyzed for regulatory or compliance purposes be analyzed with an audit sample, where an audit sample is available. In 2017, the laboratory analyzed 100 audit samples for Method 26/26A compliance sampling events, or approximately two audit samples per week.

The SSAS expert committee of NELAC applies to Source Emissions samples. An FoPT does not exist for source emissions or ambient air sampling. At this time, the only method for which the laboratory is accredited and for which an audit sample exists is 40 CFR 60 Method 26A. Audit samples are also available for Method 29, Method 101A, Method 6 and Method 8.

The client is responsible for providing the audit sample to the laboratory, as the regulator is responsible for requesting a specific concentration range of the audit sample for the facility from which the client is collecting samples. Based upon client demand, the laboratory may run audit samples for a given method once per year or in excess of once per week. All SSAS-related TNI laboratory requirements are followed.

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27.3.2 Audit Sample Handling, Analysis and Reporting

Audit samples are obtained by the client and sent to the laboratory with the client's associated samples. The laboratory does not share audit samples with other laboratories, except at the request of the client, and does not communicate with other laboratories regarding current audit sample results. In cases where audit or inter-laboratory samples are provided by the client, the laboratory does not attempt to obtain the assigned value of any audit sample from the audit provider or client prior to submission of results.

Per the SSAS Module, which is functionally parallel to the water/soil TNI PT programs, audit samples for source samples are to be reported simultaneously and directly to the audit Provider, the regulator and the client. To determine whether the laboratory's method is in control, the laboratory determines the assigned value of the audit sample from the audit provider (agency, client or manufacturer). If the assigned value cannot be obtained, the laboratory makes a good faith effort to determine, at the very least, whether the laboratory passed or failed the audit sample.

It is highly unusual for the laboratory to request an audit sample from a third party. In the rare cases where *the laboratory* requests an audit from a third-party provider, the laboratory may give the audit provider a concentration range to ensure that the audit samples are neither higher than the high end of the calibration curve nor below the detection limit. The laboratory may request a "trip blank" audit sample, in addition to the usual audit samples requested, to prove that no contamination occurred during the shipping and handling of the sample media.

Audit samples are treated in the same manner as regular samples in the normal production process where possible, including the same Analysts, preparation, calibration, quality control and acceptance criteria, sequence of analytical steps, number of replicates, and sample log-in. Audit samples are not analyzed multiple times unless routine samples are analyzed multiple times. Where audit samples present special problems in the analysis process, they will be treated as laboratory samples where samples present special problems.

The type, composition, concentration and frequency of quality control samples analyzed with the audit samples are the same as with typical samples.

Prior to the reporting of an audit sample, laboratory personnel do not:

- subcontract analysis of an audit sample to another laboratory being run for compliance purposes;
- knowingly receive and analyze an audit for another laboratory being run for compliance purposes, unless at the request of the client;
- communicate with an individual from another laboratory concerning the analysis of the audit sample; or
- attempt to find out the assigned value of an audit from the audit provider.

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The laboratory's procedure for handling low level audit samples is to treat the audit sample in exactly the same manner as it would treat any other sample of low concentration. This may include the reporting of "< [DL]" as a result.

As there are no FoPT PT or PE or audit samples available for *source emissions or ambient air* sampling methods, the laboratory cannot participate in the TNI FoPT PT or PE study for ambient air methods.

For interlaboratory comparison samples submitted with other samples (e.g., "Round Robin" samples), the laboratory reports the data alongside the data for the samples received in conjunction with the interlaboratory comparison.

Any result at or above the detection limit is reported as the resultant value. Any result less than the detection limit is reported as < [DL]. No reference methods performed by the laboratory have LoQ requirements.

The laboratory institutes corrective action procedures for failed audit samples following the guidelines in Section 14, "Corrective Action". Following the TNI SSAS Volume 1, Module 3, corrective action for a failed audit sample is the responsibility of the regulator, not the laboratory or field tester.

Retention of audit records is similar to that maintained for typical analytical records, and audit results and all documentation pertinent to those results are maintained in the report file containing the samples to which the audit sample pertains. In addition, the Laboratory Director maintains a 3-ring binder containing all audit results.

Note: It has been the laboratory's experience to date that most audit providers do not understand the methods for which the audit is supplied, and consequently, it is very common for the laboratory to need to heavily modify the instructions and calculations in order to meet the criterion of treating the audit sample in the same manner as the samples. For example, a Method 29 audit sample's instructions may say "dilute 5 mL to 1000 mL and analyze by ICP" where the method requires the entire impinger catch to be evaporated down to 50 mL at sub-boiling temperatures. The audit instructions to 'dilute and shoot' do not reflect the preparation process that the actual samples undergo. The laboratory will, to the best of its ability, treat the audit sample as closely as possible to the reference method.

27.4 Data Review

The laboratory reviews all data generated in the laboratory for compliance with method, laboratory, and, where appropriate, client requirements.

Three levels of data validation are performed. Levels 0 and I are performed on all samples received by ***CHESTER LabNet***. Level II data validation is only performed when required by contractual obligation. The purpose of data validation is to ensure that the reported data are free from transcription and calculation errors (manual or electronic), and that all quality control measures are reviewed and evaluated prior to data being reported.

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27.4.1 Level 0

Level 0 validation occurs at the sample receipt and log in stage of sample analysis. Elements of Level 0 validation include:

- examining the integrity of custody seals, if present;
- taking the temperature of the transit temperature bottle, if present, and record on chain of custody;
- examining integrity of shipping bottles or containers;
- examining the chain of custody (COC) form(s) for the presence of all required information and signatures;
- verifying the number of samples and sample IDs against those listed on the COC form(s);
- Completing the Sample Receipt Checklist(s) appropriate to the samples received;
- retaining Sample Receipt Checklist(s) in the job file;
- contacting the appropriate authority upon finding irregularities;
- documenting and performing corrective actions; and,
- completing the project specific checklist confirming Level 0 validation, and place in the project file (for CLP or CLP-like reports only).

For projects requiring additional documentation of the level 0 validation process, ***CHESTER LabNet*** provides a written checklist covering the above steps. This checklist is filled out, signed, and dated by the Sample Custodian or designated alternate. The completed checklist is added to the project file.

27.4.2 Level I

Level I data validation begins during sample analysis and is carried out at the instrument by the Analyst. This phase of level I validation involves performing and maintaining instrument calibration and assessing precision and accuracy of the data via the analysis of all of the appropriate QC checks, as discussed in Section 27.1 and 27.2. The Analyst ensures that the QC statistics are within control limits and takes appropriate corrective actions during analysis, if needed.

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For projects requiring additional documentation of the level I validation process, the laboratory provides a written Analyst's checklist. This checklist is filled out, signed and dated by the Analyst. The completed checklist is added to the project file.

The second phase of level I data validation is performed by the QA Officer or Technical Director for that particular department. During this phase, raw data is verified as being in control with the appropriate QC parameters, worklists are checked for accuracy against the raw data, raw data is checked for any discrepancies which may have been missed by the Analyst (e.g., spike lot numbers or expiration dates) and any corrective actions are taken to remedy deficiencies prior to the data being submitted to the Project Manager.

The third phase of level I data validation is performed by the QA Officer or Project Manager, who confirms all keyboard entries and electronic data entries into the LIMS, then confirms that the correct analyses have been completed on the correct samples. The Project Manager then reviews all of the data and QC results for a given project or report and, for certain clients, prepares QC summary tables and data assessments. Problem data discovered during this review are annotated in the report.

If any analytical errors are found in any of these stages of data review, and there is enough sample extract remaining, and holding times have not been exceeded, the preparation and/or analysis will be repeated and the new results will be subjected to the same QC/validation.

The final report is reviewed by the Laboratory Director, who signs the report prior to its release to the client. SOPs QA-002 and AD-007 are relevant to this stage of review.

27.4.3 Level II (by client request only)

Level II data validation is only performed for CLP style reports, is carried out by the QA Officer, and occurs after the data package has been correctly assembled. The first step is to recalculate, by hand, the final result for a randomly chosen sample. This is accomplished by first taking the raw calibration data and recalculating the appropriate calibration statistics (i.e., slope, intercept and correlation coefficient). Next, using the raw instrument response, the instrument concentration result is recalculated. Finally, the sample preparation data (i.e., digestate volume, filter aliquot size, etc.) are used to recalculate the final result as reported to the client. All of these steps are documented on a Sample Calculation form, which is signed and dated by the reviewer and included in the final data report.

The second step is to review all QC statistics and raw data for compliance with control limits, frequency of application, and correct sequences. In addition, flagging is checked as well as reporting units, holding times and the correct use of significant figures. Finally, corrective actions (if applied) are noted. The review is aided by following a preprinted checklist, which is signed and dated by the QA Officer and placed in the data report. Results for all data review, verification and cross checking procedures are documented within

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each data package, to the extent that is required for each particular client's needs. At a very minimum, documentation shall consist of at least one person's signature or initials attesting to the performance of data review.

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Section 28

REPORTING THE RESULTS
(TNI V1:M2 – Section 5.10)

The result of each test performed is reported accurately, clearly, unambiguously and objectively, and complies with all specific instructions contained in the reference method and/or required by client or regulator.

The 2009 and 2016 TNI Standard states, "*The results … shall be reported accurately, clearly, unambiguously and objectively, and in accordance with any specific instructions in the test or calibration methods. The results shall be reported, usually in a test … and shall include all the information requested by the customer and necessary for the interpretation of … results and all information required by the method used.*" For Aqueous samples, this usually includes both sampling and analysis. As the laboratory's clients perform the sampling from collection to shipment (see Disclaimer prior to Section 3), the laboratory has no knowledge of the sampling methods nor control over the actions or inactions of the clients in the field. Accordingly, the laboratory cannot include in its report information which it is neither responsible for nor privy to. Thus, if a method requires samples be reported in µg/dscm, but the client does not provide air volumes, temperature or humidity data, it is impossible for the laboratory to report all information required by the method used. The laboratory reports do include all the information requested by the client and necessary for the interpretation of the test results where possible.

Data are reported without qualification if they are greater than the LoQ, lower than the highest calibration standard, and without compromised sample or method integrity. The detection limit (DL) is reported with each sample/analyte for all reports where the method is amenable to a detection limit study. The LoQ is defined as five-times the detection limit. Data falling between the DL and the LoQ are reported as qualified data. Note: For air quality methods, meeting the requirement of reporting the LoQ places the lab in violation of reporting data "clearly, concisely and *unambiguously*" as air quality methods report to the detection limit, and consequently most of the laboratory's clients do not understand the meaning of an LoQ, and the inclusion of LoQs on the report causes confusion to the client.

28.1 Test Reports

The report formats have been designed to accommodate each type of test performed and to minimize the potential for misunderstanding or misuse. The laboratory does not issue multiple reports for the same samples where there is different information on each report unless requested to do so by the client (e.g., one report for regulatory purposes, a second report for engineering purposes).

A typical test report contains the following elements:

- a Cover Page/Title Page;
- a Case Narrative page;
- qualification of results with values outside the calibration range as appropriate (usually in the Case Narrative);

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- data summary sheets;
- a QA/QC summary section (does not contain qualifiers, see Note below);
- a Chain of Custody form; and,
- a page stating that raw data are available upon request.

Note: The LL-LCS is set at approximately three-times the detection limit, while the LoQ is set at five-times the detection limit. Consequently, all QA/QC summary sections would require flagging of the LL-LCS. This would create added confusion for the client which would violate the need to report results "*clearly and unambiguously*", thus, no flagging is performed in the QA/QC summary.

Raw data are not included in a report unless specifically requested by the client. If requested, raw data are then reported as an Appendix.

Each test report generated, electronic or hardcopy, contains the following information:

a) a title, in the format of [Client Name; Project Name or Number*, Client Number, Report Number] (*if the project name or number has been provided by the client);

b) the name and address of the laboratory, the laboratory's phone number and name of a laboratory contact person;

c) unique identification of the test report, in the form of a report number, on each page and a pagination system that ensures that each page is recognized as part of the test report and a clear identification of the end of the report, such as "page 3 of 10";

d) the name and address of the client (typically on the CoC), where provided by the client;

e) the identification of the method used including revision number where there is one. Revision numbers may be the date of online promulgation if none is given in the method. Not all air quality methods have revision numbers;

f) the date of sampling for each sample, where provided by the client;

g) a description of, the condition of, and unambiguous identification of the sample(s) tested, including the client identification code;

h) the date of sample receipt, the time of sample preparation and analysis if the required holding time for either activity is less than or equal to 72 hours and, date(s) of analysis;

i) procedures used by the laboratory where these are relevant to the validity or application of the results;

The 2009 and 2016 TNI Standard requires the reports to include a reference to

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"the location of sampling, including any diagrams, sketches or photographs;" and *"a reference to the sampling plan and procedures used,"* and *"details of any environmental conditions during sampling that may affect the interpretation of the test results,"* and *"any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned."* As the client - not the laboratory - performs sampling, the laboratory does not include this in test reports. It is the responsibility of the client collecting the samples to have a copy of their own sampling plan. It is exceedingly rare that the laboratory has a copy of the client's sampling plan. For some samples, a sampling plan may not even exist, and the laboratory would have no means of discerning this fact based upon the samples at time of receipt.

j) the test results, units of measurement, DL and LoQs for methods where DL studies are possible, failures identified (See Appendix F for a list of laboratory qualifiers);

k) the name, function and signature or an equivalent electronic identification of the person authorizing the test report and the date of issue;

l) a statement to the effect that the results relate only to the samples;

m) any non-accredited tests or parameters are clearly identified as such to the client when claims of accreditation to this Standard are made in the analytical report or in the supporting electronic or hardcopy deliverables; and

n) A statement that the report shall not be reproduced, except in full, without written approval of the laboratory.

28.2 Supplemental Test Report Information

When necessary for interpretation of the results or when requested by the client, test reports include the following additional information, usually found in the Case Narrative:

a) deviations from, additions to, or exclusions from the method SOP, information on specific test conditions such as environmental conditions, any non-standard conditions that may have affected the quality of the results, and any information on the use and definitions of data qualifiers;

b) where relevant, a statement of compliance/non-compliance with requirements and/or specifications;

c) where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a customer's instruction so requires, or when the uncertainty affects compliance to a specification limit;

d) opinions and interpretations, where appropriate and needed (When opinions and interpretations are included, the basis of those opinions and interpretations is documented. Opinions and interpretations are clearly marked as such in the test report.);

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e) additional information which may be required by specific methods or client(s); and

f) qualification of results with values outside the calibration range as appropriate.

28.3 Environmental Testing Obtained from Subcontractors

Test results obtained from tests performed by subcontractors are most commonly sent directly to the client by the subcontractor and are not included in the laboratory's test report. Where the laboratory submits subcontracted data to the client, the entire subcontractor's report is submitted to the client, unless otherwise requested by the client.

28.4 Electronic Transmission of Results

All test results transmitted by e-mail or other electronic means comply with the requirements of the 2009 and 2016 TNI Standard and associated procedures to protect the confidentiality and proprietary rights of the client (see Section 22, "Environmental Methods and Method Validation").

CHESTER LabNet provides electronic data deliverables in a variety of formats on a client specific basis. E-reports are most commonly sent as email attachments. Files have been formatted as: CSV files, MS Excel files, fixed width column files, Adobe Acrobat files (.pdf), spreadsheet files, text files or proprietary client software files. ***CHESTER LabNet*** works closely with the client to ensure that e-reports are in a useable and acceptable format, to include the use of password protected delivery where requested by client. Preparation of electronic deliverables is highly specific to the client and/or project (some clients may have more than one project in progress, and each project may have a different electronic reporting format requirement).

28.5 Amendments to Test Reports

Material amendments to a test report after it has been issued are made only in the form of another document or data transfer. All supplemental reports meet all the requirements for the initial report and the requirements of this *Quality Manual*.

Amended test reports are re-issued and the re-issuance is documented by appending a chronological revision number to the report number (i.e., "Report #12-421 revision 1").

When it is necessary to issue a complete new report, the new report is uniquely identified and contains a reference to the original that it replaces, using the same nomenclature as above (i.e., "Report #12-421 revision 1"). The only exception to this is editorial changes, such as typographical errors, to a single page in the report.

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28.6 Exceptions

Due to the highly complex nature of air quality testing, the wide variances between each regulatory jurisdiction, the wide variances between each individual client's preferences, attempting to list exceptions to the reporting procedures above would be a monumental undertaking.

Reporting shall meet the needs of the client first, then, whenever possible, the requirements of the 2009 and 2016 TNI standard.

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Appendix A

Personal Ethics and Data Integrity Policy

A.1 Introduction

CHESTER LabNet's goal is to provide the most informed and accurate inorganic analysis of air quality samples possible from a commercial laboratory. ***CHESTER LabNet***'s management is committed to good professional practice and to the quality of its environmental testing in servicing its clients.

To achieve this goal, it is critical that all employees understand:

- the need for honesty and full disclosure of variances in all areas of analyses performed;
- when and how to report data integrity issues; and,
- the documentation of such issues when they arise.

Data integrity is defined as data of known (traceable and documented) quality, analyzed by documented procedures, fulfilling all Quality Control requirements established by those procedures, and meeting the requirements of the client. Inherent in the concept of data integrity is that no false manipulations of data or samples or omissions of pertinent information be performed to meet the Quality Control criteria. This inherent need is governed by the personal ethics of each employee and the overall corporate culture of ***CHESTER LabNet***.

The personal ethics of each and every employee results in the laboratory's ability to:

- Produce accurate results, which include QA/QC information that meets the client's or method's pre-defined Data Quality Objectives (DQOs);
- Present services in a confidential, honest and forthright manner;
- Provide employees with guidelines and an understanding of the ethical and quality standards of our industry;
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same;
- Educate clients as to the extent and kinds of services available;
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made; and
- Promote the status of environmental laboratories, their employees and the value of services rendered by them.

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A.2 Management Responsibilities

Management responsibilities are many and begin with creating a culture of trust and honesty within the organization. Technical directors of each department understand that employees are human and do make mistakes. Honest mistakes are corrected and discussed with the employee. Technical Directors are charged with upholding the intent of this policy and implementing the specific requirements not only of this policy, but also of each documented procedure practiced by the laboratory. In addition, Technical Directors must perform their oversight duties with a positive attitude, maintaining focus on the goal of producing high quality data, and without personal attacks or negative attitudes which might lower morale or decrease the likelihood of employees being open and honest. Managers and Technical Directors must do their utmost to encourage a corporate culture of honesty and security for each employee, such that no employee is ever afraid to bring forth issues or problems they might encounter.

Technical Directors monitor the adherence of this document by supervising their employees and the data and/or reports produced by their employees. Prior to initiating an investigation into unethical behavior, Managers are required to challenge the evidence against Hanlon's Razor. If the challenge is passed, evidence of unethical behavior such as improper manipulations of data, clock rolling, inappropriate changes in concentrations of standards, failure to follow written procedures to bypass Quality Control checks, insufficient documentation, etc., are addressed to the employee and are documented via the annual employee review or addenda to the annual employee review, which are kept in the employee's personnel file. Technical Directors are charged with monitoring the breach after such a discussion to ensure that the employee's behavior has changed. If no change has occurred, the Technical Director and Laboratory Director shall decide upon the appropriate action to be taken. Actions may include termination of the employee, moving the employee to a different department, revoking some of the employee's duties or other actions to resolve the issue and prevent its further occurrence. The worst-case scenario may result in criminal or civil prosecution of the individual employee, fines or possible prison sentences. The laboratory does not and will not defend any employee charged in a court of law who, despite management's best efforts, knowingly submits false, incomplete or undocumented flawed data.

The QA Officer is responsible for initial data integrity and ethics training for all new personnel. In addition, the QA Officer performs annual refresher training for all staff. The QA Officer is responsible for maintaining documentation of the Data Integrity and Ethics training of all personnel in the form of signatures in this appendix.

In addition, the QA Officer is responsible for performing in depth data monitoring on a regular basis. This monitoring occurs during data review, periodic and random logbook checks, periodic and random standards checks, the internal audit process, review of corrective action reports, and investigations of any issues brought up by other employees.

Management has a zero tolerance policy for unethical behavior. ***CHESTER LabNet*** does not tolerate unethical behavior of any sort by its employees, whether said behavior is related or unrelated to data production. If a breach of ethics is found to be supported by evidence, the employee may expect to be terminated.

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A.3 Employee Responsibilities

"Employees" include both managerial and non-managerial staff. Employee responsibilities include following written procedures and known scientific principles to produce data of the highest degree of scientific defensibility possible within the limitations of the sample matrices and currently available instrumentation. Each employee is responsible for ensuring that the data and/or reports they produce are accurate and complete (to include observations), and meet the Quality Control criteria described in the method or written procedure for the task.

An employee's personal ethics play a large role in maintaining data integrity. While ethics are more difficult to define and certainly more difficult to instill and enforce, for the purposes of this document, the most fundamental ethic required by ***CHESTER LabNet*** is honesty. Intent to deceive, either by data manipulation, verbal falsification of procedures followed, or by omission, is not supported in any way by ***CHESTER LabNet***.

If the issue is not addressed in the relevant SOP, all employees are charged with reporting any data integrity issue, be it their own or that of others to their Technical Director or supervisor in a timely manner. If that person seems unresponsive, employees should report their concern to the QA Officer or to the Laboratory Director. Non-reporting of known breaches of ethics is considered equally as damaging as having performed the breach oneself, and is subject to the same consequences as described in Section A.4. A Corrective Action Report is initiated by the person discovering the issue.

Breaches of ethical behavior include, but are not limited to:

- blatant falsification of data;
- improper data manipulations, such as questionable hand integrations, peak shaving, undocumented blank subtractions, not following established rounding rules in order to meet quality control criteria, etc.;
- changing computer clocks to show a different time in order to meet holding time criteria;
- changing standard or QC sample concentrations to force them to meet QC criteria (e.g., diluting or spiking LCSs);
- intentional failure to record information as described in the relevant SOPs (e.g., not recording balance calibration data or temperature/humidity during gravimetric analysis, etc.); and
- intentional failure to record information which may be of value to the client in interpreting results (e.g., "filter corner missing" for negative mass filters, "Acetone fraction shipped in plastic bottles" for gravimetric analysis, "non-homogenous sample deposit" for chemical analysis of filters, etc.).

Given the wide variety of matrices, sampling methods, background contaminants and physical states of samples analyzed at ***CHESTER LabNet***, it is to be expected that Quality Control criteria will occasionally fail. It is the responsibility of the employee to properly document the failure, attempt to meet the Quality Control criteria, where possible, and ensure the client is informed of such deviations from normal protocol.

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Any errors must be lined out with a single line, such that the original entry is still legible. The line out must be dated and initialed by the employee correcting the mistake. With the exception of obvious typographical or handwritten errors, the reason for the correction or redaction of the entry is noted.

In cases where non-conforming data is submitted to a client anyway, the client must be notified, usually in the Case Narrative, as to the nature of the non-conformance and the reason(s) and/or opinions as to why the non-conformances could not be rectified. In addition, any opinions about the possible value of the data are included in the Case Narrative.

Other observations of samples, such as possible interfering peaks, mass changes as a result of filter defects, precipitation occurring during sample preparation which are out of the norm for a given method or any other observance which is not typical for a particular method must be noted in the raw data and/or the Case Narrative. Any opinions of the laboratory concerning data quality, integrity, accuracy or legal defensibility must be clearly documented, and must be noted to be the opinion of the laboratory. This documentation must be contained in the Case Narrative or conveyed to the client by some written means.

A.4 Ramifications of Unethical Behavior

All employees of ***CHESTER LabNet*** understand the ramifications of unethical behavior, and by their signatures on this document, attest to knowing the possible outcomes of such behavior. By their signatures on this document, the employees also attest that they are free from any undue pressures or influences which may adversely affect the quality of their work, and will avoid involvement in activities that would diminish confidence in their competency, impartiality, judgment or operational integrity.

A.5 Summary

CHESTER LabNet endeavors to foster an open and non-retaliative corporate atmosphere where all employees are not only encouraged, but also expected, to bring any data integrity issues to the notice of the appropriate personnel. All employees understand the need to produce the highest quality data possible. While management holds the ultimate responsibility for data integrity issues, it is the personal ethics of every employee that support the production of high quality data, and, thereby, the reputation of the laboratory.

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Personal Ethics and Data Integrity Agreement

The following employees, by their signature, attest to having read, understood, and agreed to the most current version of the Personal Ethics and Data Integrity Policy for ***CHESTER LabNet***:

Name	Title/Responsibility	Signature	Date
Paul Duda	President Laboratory Director LIMS Administrator Client Services Technical Director		3/27/19
Sheri Heldstab	QA Officer Conventional Chemistry Technical Director Lead Analyst		2-21-19
Rick Sarver	XRF Technical Director Lead XRF Analyst		3.1.19
Lisa Ball	Project Manager Sample Custodian		3.4.19
Jennifer Schleis	Gravimetry Laboratory Technical Director XRF Analyst Lead Grav. Lab. Tech. Analyst		3.03.19
T. Mike May	Analyst Gravimetry Laboratory Technician		3.03.19
Julie Delarue	Analyst XRF Analyst Gravimetry Laboratory Technician		3.5.19
Theodore ("Ted") Perry	Analyst Gravimetry Laboratory Technician Chemical Hygiene Officer Health & Safety Officer		2.27.19
Kevin Healey	Gravimetry Laboratory Technician		3.4.19

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Appendix B

CHESTER LabNet Standard Operating Procedures

SOP #	SOP Title
AD-001.06	Laboratory Safety and Security Procedures
AD-002.04	Waste and Sample Disposal
AD-003.05	Refrigerated Storage Monitoring
AD-004.04	Glassware Cleaning for Inorganics Laboratory
AD-005.06	Reagent Procurement and Control
AD-006.06	Laboratory Deionized Water Supply
AD-007.05	Laboratory Information Management System (LIMS)
AD-008.06	Sample Receipt and Log In
AD-009.02	Electronic Data Backup and Recovery
GR-001.08	8x10 Quartz & Glass Fiber Filter Inspection and Gravimetry
GR-001a.02	Punching of Exposed 8x10" Quartz or Glass Fiber Filters (renamed ME-008)
GR-002.06	80-125 mm Filter Inspection and Gravimetry **DEACTIVATED 7/14**
GR-003.02	Gravimetric Processing of 25-47mm Quartz Filters **DEACTIVATED 2/02**
GR-004.04	Chemical Impregnation of Cellulose Filters
GR-005.02	Impregnation of Cellulose Filters with Sodium Carbonate **DEACTIVATED 1/02**
GR-006.09	Filter Cassette Loading and Unloading
GR-007.02	Inspection & Preparation of 25-47mm Teflon Filters **MERGED W/GR-010, 5/03**
GR-008.04	Oil Coating of Teflon Filters
GR-009.01	Inspection & Preparation of 82.6-125mm Quartz & Glass Fiber Filters **DEACT 3/02**
GR-010.05	Teflon & Quartz Fiber Filter … Cahn I - **SUSPENDED 1/2013 **
GR-011.02	Inspection and Preparation of … Carbon Impregnated Filters **SUSPENDED 6/05**
GR-012.01	Inspection & Preparation of 102mm Teflon Filters **DEACTIVATED 3/02**
GR-013.02	Inspection & Preparation of 8x10" Pallflex Weave Filters **DEACTIVATED 1/02**
GR-014.01	Gross Weighing of 25-47mm Teflon Filters **DEACTIVATED 3/02**
GR-015.04	Quartz Filter Preparation for Carbon Analysis
GR-016.07	Preparation & Use of Control Charts for Gravimetric Analysis **DEACTVATED 7/18**
GR-017.03	Acceptance Testing of 47mm Teflon Filters, CFR 50 Part 50 App. L (Drop Test)
GR-018.03	Dickson Temperature and Humidity Data Logger
GR-019.04	Sartorius ME5 Microbalance: Teflon and Quartz fiber filter preparation and gravimetry.
GR-020.03	Use of Balance Run Logbooks and Filter Tracking Logbooks

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SOP #	SOP Title
IC-001.02	Borate Eluant Anions ** DEACTIVATED 4/2000 **
IC-002.02	Preparation of Air Filters for Fluoride Analysis ** DEACTIVATED 4/2000 **
IC-003.06	Extraction of Media for Ion Chromatographic Analysis
IC-004.02	Clean-Up of Anion Columns **DEACTIVATED 1/2002**
IC-005.04	Ion Chromatography: Anions **DEACTIVATED 4/2008**
IC-006.04	Ion Chromatography: Cations **DEACTIVATED 4/2008**
IC-007.02	Clean-Up of Cation Columns **DEACTIVATED 1/2002**
IC-008.04	Hexavalent Chromium by IC-PCD (Air filters) **DEACTIVATED 8/2011**
IC-009.02	Ion Chromatography: Anions & Cations **DEACTIVATED 12/2017**
IC-010.06	Hexavalent Chromium by IC-PCD (Thermo-Dionex ICS-1100 and Aquion instruments)
IC-011.03	Ion Chromatography: Anions & Cations ICS-5000
IC-012.01	Preparation & Extraction of Filters for Cr6+ by IC-PCD
ME-001.03	Analysis of Elements by ICP-AES (P40) **DEACTIVATED 3/2003**
ME-002.05	Analysis of Elements by Graphite Furnace **DEACTIVATED 10/2014**
ME-003.06	Sample Digestion for Analysis of Elements by ICP (EPA Method 3050)
ME-004.02	Analysis of Mercury in Aqueous Samples **DEACTIVATED 9/2010**
ME-005.02	Analysis of Mercury in Solid Samples **DEACTIVATED 9/2010**
ME-006.03	Analysis of Mercury in Hopcalite Sorbent Tubes **DEACTIVATED 9/2010**
ME-007.02	Analysis of Elements by ICP (Optima 2000) **DEACTIVATED 4/7/14**
ME-008.05	Subsectioning of Exposed 8x10" ... Filters Modified 40CFR50 Appendix G
ME-009.02	Analysis of Mercury in Aqueous and Solid Samples EPA 7470 & 7471 (Nippon 3320A)
ME-010.03	Analysis of Mercury by NIOSH 6009 (Nippon 3320A)
ME-011.02	Analysis of Elements by Inductively-Coupled Plasma Emission (Optima 8300)
ME-012.01	Digestion of Filters for Metals Analysis (Appendix G - Hot Sonication)
OC-001.06	Organic & Elemental Carbon by the Thermal-Optical Method (NIOSH 5040 & IMPROVE_A)
QA-001.06	Laboratory Training
QA-002.05	Laboratory Data and Report Validation
QA-003.06	Implementation, Distribution, & Control of Std. Operating Procedures
QA-004.04	Distribution and Control of Laboratory Logbooks
QA-005.02	Control of Laboratory QA/QC Records **DEACTIVATED 9/11/01**
QA-006.07	Determination of Detection Limits, Precision & Bias, & DoC
QA-007.05	Calibration of Variable Volumetric Dispensing Devices
QA-008.04	Assembly and Preparation of Data Reports (Original QA-008 merged with QA-002)
QA-009.03	Internal Auditing
QA-010.03	Laboratory Balance Calibration and Verification
QA-011.02	Control and Handling of Standards and Reference Materials

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SOP #	SOP Title
QA-012.01	Manual Integrations of Chromatographs, Thermographs or Spectrographs
QA-013.01	Removal or Replacement of Calibration Points
ST-001.03	Halide & Hydrogen Halide Emissions from Stationary Sources (M26/26a)
ST-002.04	Particulate Emissions from Stationary Sources (M5-5F, ODEQ M5, "old" M202))
ST-003.05	Sulfur Dioxide Emissions from Stationary Sources (M6)
ST-004.04	Nitrogen Oxide (NOx) Emissions from Stationary Sources (M7D)
ST-005.03	Sulfuric Acid Mist & Sulfur Dioxide Emissions from Stationary Sources (M8)
ST-006.03	Elements by EPA Method 29 or CARB Method 436 (M29)
ST-007.01	Hydrogen Sulfide Content of Fuel Gas Streams **SUSPENDED 3/2006**
ST-008.02	Inorganic Lead Emissions from Stationary Sources (M12)
ST-009.03	Total Fluoride Emissions (From Source Samples) (M13B)
ST-010.04	Total Reduced Sulfur Emissions (M15/16) **DEACTIVATED 5/2015**
ST-011.02	Total Reduced Sulfur ** DEACTIVATED** 6/05 (merged w/ ST010 6/14/05)
ST-012.01	Sulfur Dioxide Emissions **DEACTIVATED** 8/2005
ST-013.04	Particulate & Gaseous Mercury (M101, 101A, 102)
ST-014.04	Beryllium Screening (M103)
ST-015.03	Beryllium Emissions from Stationary Sources (M104)
ST-016.01	Mercury in Sewage Sludge **SUSPENDED** 6/2005
ST-017.01	Particulate & Gaseous Arsenic Emissions **SUSPENDED** 6/2005
ST-018.03	Ammonia in Stationary Sources (CTM027 & ST-1B)
ST-019.06	Condensable Particulate Matter Method 202 & NCASI modification (M202)
ST-020.04	Determination of PM10 & PM2.5 from Stationary Sources (M201A)
ST-021.01	Use of BERT Proprietary Software for Particulate Matter Analysis
ST-022.01	Sample Preparation for Total Chromium (M306, SW846 0061, CARB 425)
WC-001.01	Chemical Oxygen Demand (COD) **DEACTIVATED** 9/11/09
WC-002.01	Specific Conductance **DEACTIVATED 9/11/09**
WC-003.02	Fluoride by Ion Selective Electrode **SUSPENDED 3/20/18**
WC-004.01	Ammonia-Nitrogen by Ion Selective Electrode **DEACTIVATED** 10/2005
WC-005.01	Gravimetric Oil & Grease in Liquids ** DEACTIVATED ** 4/2005
WC-006.01	Soil pH **SUSPENDED** 1/2005
WC-007.01	Gravimetric TPH. ** DEACTIVATED ** 4/2000
WC-008.01	Alkalinity. **SUSPENDED** 1/2005
WC-009.01	Cation Exchange Capacity. **SUSPENDED** 1/2005, DEACTIVATED 1/2019
WC-010.01	Redox Potential (eH). **DEACTIVATED**9/11/09
WC-011.01	Hardness. **SUSPENDED** 1/2005, DEACTIVATED 1/2019
WC-012.01	Nitrite-Nitrogen. **SUSPENDED** 1/2005, DEACTIVATED 1/2019
WC-013.01	Organic Matter. Walkley-Black Method **DEACTIVATED** 9/11/09
WC-014.005	pH in Aqueous Solutions. (Unsuspended 1/11/10)
WC-015.01	Phosphorous/Phosphate, All Species **SUSPENDED** 1/2005, DEACTIVATED 1/2019
WC-016.01	Total Dissolved Solids. **SUSPENDED** 1/2005, DEACTIVATED 1/2019

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SOP #	SOP Title
WC-017.01	Total Kjeldahl Nitrogen. **DEACTIVATED** 10/2005
WC-018.01	Total Suspended Solids. **SUSPENDED** 1/2005, DEACTIVATED 1/2019
WC-019.01	Turbidity. **DEACTIVATED** 9/11/09
WC-020.01	Hexavalent Chromium. **SUSPENDED** 1/2005, DEACTIVATED 1/2019
WC-021.03	Alkalinity in Teflon Filters
WC-022.01	Dustfall - Suspended and Dissolved Particulate Matter (ASTM D1739-98)
XR-001.03	Resuspension of Particulate Matter onto Filter Media
XR-002.07	Analysis of Elements in Air Particulates by X-Ray Fluorescence (Kevex 770)
XR-003.03	Preparation of Samples for Resuspension
XR-004.04	Kevex XRF Spectrometer Calibration
XR-005.03	Kevex Spectrometer Data Generation, Interpretation and Reporting
XR-006.02	X-Ray Fluorescence (Kevex-771) **DEACTIVATED 1/2009**
XR-007.03	Analysis of Elements in Air Particulates by X-Ray Fluorescence (Thermo ARL QUANT'X)

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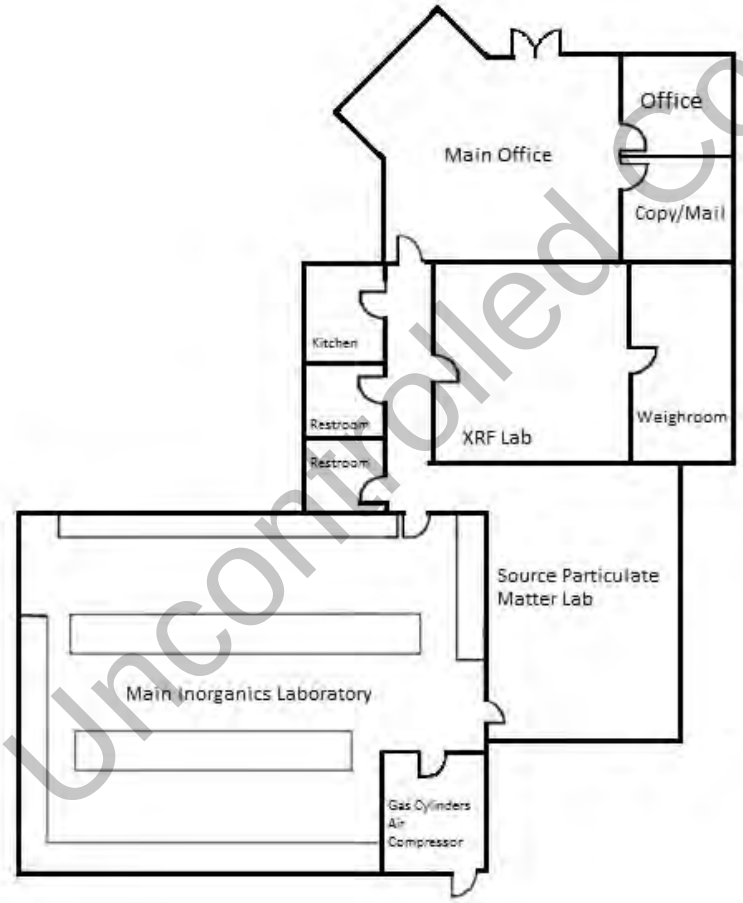
Appendix C

Laboratory Floor Plan



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Appendix D

CHESTER LabNet Most Commonly Utilized* Methods (by Issuing Authority and Method Number)

*Note: The laboratory has the capability to perform many other methods. This listing contains the laboratory's most commonly performed methods.

NELAC Accredited Method(s)

Method Number	Analyte/Element	Instrumentation
CARB MLD 039	Hexavalent Chromium (ambient air)	IC-PCD
ASTM D7614-12	Hexavalent Chromium (ambient air)	IC-PCD
40 CFR 60 Method 202	Condensable Particulate Matter (source emissions)	Balance (gravimetry)
40 CFR 50 Appendix J	PM_{10} (ambient air)	Balance (gravimetry)
40 CFR 50 Appendix L	$PM_{2.5}$ (ambient air)	Balance (gravimetry)
NIOSH 5040	Diesel PM (elemental Carbon)	OC/EC
DRI SOP#2-216r2 (IMPROVE_A)	Organic/Elemental Carbon	OC/EC
40 CFR 60 Method 26A	HF, HCl, HBr, Cl2, Br2	IC

US EPA IO Methods

Method Number	Analyte/Element	Instrumentation
3.1	Gravimetry and metals prep.	Balance and wet chemical
3.3	metals	XRF
3.4	metals	ICP
4.2	Anions and cations	IC

EPA Water/Wastewater Methods (by reference from other methods)

Method Number	Analyte/Element	Instrumentation
EPA 300.0	Anions	IC
ASTM Method D6919-03	Cations	IC
EPA 340.2	F	Ion Selective Electrode

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EPA SW-846 Methods (by reference from other methods)

Method Number	Analyte/Element	Instrumentation
3050	metals prep.	wet chemical
6010	metals	ICP-OES
7470/7471	Hg	CVAA
0061	Hexavalent & Total Cr	IC-PCD and ICP

ODEQ Methods

Method Number	Analyte/Element	Instrumentation
5	Particulates	Balance (gravimetry)

40 CFR 50, 51 & 60 Promulgated Source Testing Methods

Method Number	Analyte/Element	Instrumentation
5	Particulates	Balance (gravimetry)
6	SO_2	titrimetric
7 (A & D)	NO_x	IC
8	H_2SO_4/SO_2	titrimetric
12	Pb	ICP
13B	F	IC or ISE
26/26A	H_X, H_X & X_2	IC
29	Multi-metals (inc. Hg)	ICP (& CVAA if Hg requested)
101A	Hg	CVAA
201A	Particulates	Balance (gravimetry)
202	Particulates	Balance (gravimetry)
306	Hexavalent and Total Cr	IC-PCD and ICP
CTM 027*	NH_4	IC
CTM 013 & 013A*	H2SO4/SO2	IC or titration

*CTM: Conditional Test Method

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NIOSH Methods

Method Number	Analyte/Element	Instrumentation
5040	Elemental Carbon	OC/EC
6009 (revoked)	Hg	CVAA
7907	Volatile Acids (Anions)	IC
7908	Non-volatile Acids (Anions)	IC

CARB Methods

Method Number	Analyte/Element	Instrumentation
421	HF & HCl	IC
425	Hexavalent and Total Cr	IC-PCD and ICP-OES
436	multiple metals	ICP (& CVAA if Hg requested)
SOP MLD039	Hexavalent Cr (ambient air)	IC-PCD

40 CFR 50, Ambient Air Methods

Method Number	Analyte/Element	Instrumentation
Appendix B	TSP	Balance (gravimetry)
Appendix G	Metals prep (hot sonication)	wet chemical
Appendix J	PM_{10}	Balance (gravimetry)
Appendix L	$PM_{2.5}$	Balance (gravimetry)
Appendix Q	Pb	XRF

ASTM Ambient Air Methods

Method Number	Analyte/Element	Instrumentation
ASTM D7614-12	Hexavalent Chromium	IC-PCD
ASTM 1739-98	Dustfall	Balance (gravimetry)

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Appendix E

Laboratory Accreditation / Certification / Recognition

CHESTER LabNet maintains the following certifications and accreditations:

Organization	Certificate Number	Parameter List
ORELAP	OR100051-010	PM_{10}; $PM_{2.5}$; CARB SOP MLD039 - CrVI (ambient air); ASTM D7614-12 - CrVI (ambient air); Carbon (Improve_A); Carbon (NIOSH 5040); Condensable PM (Method 202); Hydrogen Halides and Halides (Method 26A).

The certificates and parameter lists (which may differ) for each organization is located in files maintained by the Laboratory Director.

If accreditation is terminated or suspended, the laboratory will immediately cease to use the certificate number reference in any way and inform clients impacted by the change.

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Appendix F

Data Qualifiers

List of CHESTER LabNet Data Qualifiers		
Location	Qualifier	Meaning
Standard Reports		
Data Summary (on request)	U	Non-detect
Data Summary	B	Greater than DL, less than LoQ
QC Summary	N/C	Duplicate RPD can't be calculated as one or both data points are less than the DL
QC Summary	#	Duplicate RPD control limits do not apply as one or both of the data points is less than the LoQ
QC Summary	*	Spike recovery limits do not apply where spiked amount is less than ¼ sample result.
Special "CLP-like" Reports		
Data Summary (Form I)	J	Concentration greater than DL but less than contract required detection limit
Data Summary (Form I)	U	Concentration less than DL
Data Summary (Form I)	E	Concentration is estimated based upon interferents
Data Summary (Form I)	N	Spike recovery not in control
Data Summary (Form I)	*	Duplicate analysis not in control
Data Summary (Form I)	D	Reported value is from a dilution
Data Summary (Form I)	P	Analyzed by ICP-AES
Data Summary (Form I)	MS	Analyzed by ICP-MS
Data Summary (Form I)	CV	Analyzed by CVAAS
Data Summary (Form I)	C	Analyzed by manual spectrophotometric equipment
Data Summary (Form I)	" "	Where no data has been entered
Data Summary (Form I)	NR	Analyte is not required
QC Summary (Form II – ICV/CCV)	M	Analyzed for analyte
QC Summary (Form II – ICV/CCV)	NR	Analyte is not required
QC Summary (Form II – CRI/CRA)	J	Concentration greater than DL but less than contract required detection limit
QC Summary (Form II – CRI/CRA)	U	Concentration less than DL
QC Summary (Form III – blanks)	J	Concentration greater than DL but

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List of CHESTER LabNet Data Qualifiers		
Location	Qualifier	Meaning
		less than contract required detection limit
QC Summary (Form III – blanks)	U	Concentration less than DL
QC Summary (Form III – blanks)	P	Analyzed by ICP-AES
QC Summary (Form III – blanks)	MS	Analyzed by ICP-MS
QC Summary (Form III – blanks)	CV	Analyzed by CVAAS
QC Summary (Form III – blanks)	C	Analyzed by manual spectrophotometric equipment
QC Summary (Form V – spikes)	N	Spike amount is less than ¼ sample result
QC Summary (Form V – spikes)	P	Analyzed by ICP-AES
QC Summary (Form V – spikes)	MS	Analyzed by ICP-MS
QC Summary (Form V – spikes)	CV	Analyzed by CVAAS
QC Summary (Form V – spikes)	C	Analyzed by manual spectrophotometric equipment
QC Summary (Form V – spikes)	NR	Analyte is not required
QC Summary (Form V – post-spikes)	P	Analyzed by ICP-AES
QC Summary (Form V – post	MS	Analyzed by ICP-MS
QC Summary (Form V – post	CV	Analyzed by CVAAS
QC Summary (Form V – post	C	Analyzed by manual spectrophotometric equipment
QC Summary (Form V – post	NR	Analyte is not required
QC Summary (Form VI – duplicates)	*	Both sample results are greater than the LoQ, AND the RPD is out of control
QC Summary (Form VI – duplicates)	P	Analyzed by ICP-AES
QC Summary (Form VI – duplicates)	MS	Analyzed by ICP-MS
QC Summary (Form VI – duplicates)	CV	Analyzed by CVAAS
QC Summary (Form VI – duplicates)	C	Analyzed by manual spectrophotometric equipment
QC Summary (Form VII – LCS)	J	Concentration greater than DL but less than contract required detection limit
QC Summary (Form VII – LCS)	U	Concentration less than DL
QC Summary (Form VIII – Serial Dilutions)	E	RPD greater than 10% and original sample concentration is greater than 50 times the DL.
QC Summary (Form VIII – Serial Dilutions)	P	Analyzed by ICP-AES
QC Summary (Form VIII – Serial Dilutions)	MS	Analyzed by ICP-MS
QC Summary (Form VIII – Serial Dilutions)	CV	Analyzed by CVAAS
QC Summary (Form VIII – Serial Dilutions)	C	Analyzed by manual spectrophotometric equipment

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Note: many of the larger projects will have their own reporting guidelines, Contract Required Quantitation Limits, Action Limits and Data Qualifier Codes. The laboratory will use the guidelines issued by the client in all regards when reporting data, to include reported Quantitation limits and Qualifier Codes.

List of Common Sample Observations	
Comment	Meaning
Filter Gravimetry Laboratory	
Loose deposit/PM	Material in deposit not adhering to filter
GPM (gross particulate matter)	Insect, plastic, other non-suspended particulate present that does not resemble the rest of the deposit.
Tear in filter	Tear in the filter that may have occurred before, during or after the sampling event.
Scratch on deposit	Filter is intact, but deposit is marred by something sharp, leaving a small scratch. Loss of deposit possible.
Deposit on back of filter	Filter loaded into sampler backwards
[insect/object] on filter (removed or not?)	Notes presence of non-deposit object, notes whether object was removed prior to weighing.
PM on/in cassette	Particulate in or on the cassette in addition to being on the filter. May indicate loss of deposit.
PM on support ring	Particulate in or on the support ring in addition to being on the filter. May indicate loss of deposit.
Scrape on deposit	Filter is intact, but deposit is marred by something blunt, leaving a scraped area on the deposit. Loss of deposit possible.
Hole in membrane	Hole in the filter that may have occurred before, during or after the sampling event.
Corner torn/tattered	Filter corner torn, abraded. Possible loss of filter material during sampling.
Edge torn/tattered	Filter edge torn, abraded. Possible loss of filter material during sampling.

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List of Common Sample Observations	
Comment	Meaning
Non-uniform deposit	Deposit is not uniform across deposit area. Could mean sampler was operating incorrectly, sample was composed of coarse particulate that would not adhere to filter well, too much particulate was loaded on the filter, or any number of issues. Loss of deposit is possible.
Desiccated	Filters arrived wet or damp and were desiccated to dryness before equilibrating in weighroom.
Indentation	Dent in filter. May show mishandling of filter.
Received wet	Filter received damp or wet. Deliquescence possible.
PM in folder/glassine	Particulate present inside filter container, indicating loss of deposit in container.
Unloading error	May mean filter was dropped, scratched or otherwise damaged during removal from cassette. Possible loss or gain of mass as a result.
Deposit in margin	Deposit in margins of filter where it should have been covered by the cassette or filter holder. Indicates misloading of filter.
Filter punching/preparation for digestion/extraction	
loose deposit	Particulate matter shifts on surface of filter
heavy deposit	Heavy loading of particulate on filter
non-homogeneous deposit	Part of deposit is visibly different than other areas of the deposit
deposit off filter edge	Deposit area is off the edge of the filter, indicating incorrect loading into sampler. Probably indicates loss of capture efficiency due to gas flowing around the filter rather than through it.
skewed deposit	Deposit not square on filter. Filter margins vary from one side of the filter to the other. Probably indicates incorrect loading into

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List of Common Sample Observations	
Comment	Meaning
	sampler.
fold skewed	Filter folded at an angle, causing deposit to rub off on the margins of the filter.
spots w/appearance of water droplets on deposit	Part(s) of deposit look like drops of a liquid fell onto it (may be rain water).
deposit on back of filter	Filter loaded into sampler backwards. May or may not affect capture efficiency.
[identifiable thing] on deposit	Object on filter that is visibly and obviously not part of the air shed suspended particulate (e.g., moths, boot prints, mud, etc.)
filter not folded	Deposit exposed to filter container in such a manner that the deposit may have transferred to the container, possibly decreasing the amount of particulate remaining on the filter.
filter in [inappropriate container]	Filter arrived in a container that may affect the results, such as filters being wrapped in Aluminum foil prior to being tested for aluminum.
Source Particulate Matter (M5/M202)	
particles with the appearance of glass shards/glass dust in sx deposit	Glass shards or dust present in sample, adding mass to the sample. Probably from loading/unloading the sampling train.
[object] in sx	Object that is visibly and obviously not part of the condensable particulate present in sample. This could be pieces of O-Ring, fluff from clothing, dead insects, etc. Presence will bias results high.
edge(s) of filter(s) frayed	Filter edge torn, abraded. Possible loss of filter material during sampling.
thick deposit falling off filter/deposit inside petri dish	Loss of deposit from filter, which will bias results low.
pieces of filter missing	Piece of filter visibly missing and not included in the filter container at the time of receipt by the laboratory.
deposit on back of filter	

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List of Common Sample Observations	
Comment	Meaning
	Filter loaded into filter assembly backwards. May or may not affect capture efficiency.
IC analysis of impinger solutions	
doublet/triplet/quadruplet [analyte] peak in spiked sx	Some species of target analyte form complexes in solution that do not reach equilibration. The most commonly encountered is Fluorosilicates and Phosphofluorosilicates, which can cause triplet or quadruplet peaks to form, all of which are integrated as a single peak.
interfering peak riding on/merged with [analyte] peak	A non-target analyte is riding on, merged with or interfering with the ability of the software to accurately determine a baseline. The Analyst will note how the sample or chromatogram was modified to attempt to resolve the interference.

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Appendix G

Employee Resumés

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Paul D. Duda
President, Laboratory Director, Lead Project Manager, LIMS Administrator

Background:

Hire date: 1989. Experience in air quality filter analysis by X-Ray Fluorescence; experience as Project Manager; experience with SAS and CLP data package requirements. Experience as Laboratory Information Management System (LIMS) administrator, coordinating all LIMS activities; special expertise in interfacing laboratory data to client-specific databases and end-user data programs.

Career Chronology:

Employment Information	Responsibilities and Duties
President; Laboratory Director; Lead Project Manager; LIMS Administrator; ***CHESTER LabNet*, Tigard, OR** **2001 – Present**	Corporate affairs for laboratory, including proposal writing, marketing and sales, program and Project Management, overall profit/loss for company, all accounting/payroll and purchasing; report production for all projects requiring EPA, CLP deliverables. Oversee all procedures, QA/QC and corrective actions associated with sample receipt, log-in, chain-of-custody and storage; Project Management, and general and specialized report production; client management; oversees operation and maintenance of laboratory information management system (LIMS), including all software and hardware, general data entry, QA/QC, coordination with other Project Managers and technical staff, training of new users.
Project Manager, LIMS Administrator, Sample Custodian, ***CHESTER LabNet*, Tigard, OR** **1992 - 2001.**	Project management, all accounting/payroll and purchasing; report production for all projects requiring EPA, CLP deliverables. Oversees all procedures, QA/QC and corrective actions associated with sample receipt, log-in, chain-of-custody and storage; Project Management, and general and specialized report production; client management; oversees operation of laboratory information management system (LIMS), including all software and hardware, general data entry, QA/QC, coordination with other Project Managers and technical staff, training of new users.
Gravimetry Laboratory and XRF Analyst, ***CHESTER LabNet*, Tigard, OR** **1989 - 1992.**	Performed all operations of the filter gravimetry laboratory, including maintaining supplies, filter media acceptance testing, gravimetric analysis of filter media following EPA protocols, all QA/QC and corrective actions, maintenance of log books and QC documentation. Also served as XRF technician, including preparation of samples for analysis, instrument operation, interpretation of spectral results, QA/QC.
1987 - 1988	Miscellaneous employment.

Education:

- Graduate Studies, Business Administration, Portland State University, Portland, OR, 1991-1992.
- B.S., Engineering Management, University of Portland, Portland, OR, 1987.

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Sheri Heldstab
QA Officer, Conventional Chemistry Laboratory Technical Director,
Lead Analyst

Background:
Hire date: 1992. Experience in inorganic analysis of environmental samples, method development for unusual sample matrices, and data interpretation and validation; experience with SAS and CLP data package preparation and requirements; experience in technical writing of Standard Operating Procedures, QA/QC project plans; experience with TNI/ORELAP accreditation requirements and documentation.

Career Chronology:

Employment Information	Responsibilities and Duties
QA/QC Officer, Conventional Chemistry Technical Director, Lead Analyst, H&SO and CHO (until 2019) ***CHESTER LabNet*, Tigard, OR** **1999 – Present** Member: TNI (2017) Vice Chair TNI SSAS committee (2019) Voting member: ASTM D22 (2018)	Oversee all operations of the conventional chemistry laboratory; analyze samples; ensure data meets QA/QC requirements; general technical guidance for clients and staff; manage the flow of samples and data through the laboratory; oversee and train other Analysts; oversee day to day operation of the laboratory; ensure meeting of due dates, proper maintenance of instruments, and adherence to all QA/QC protocols. Oversight of standard operating procedure and program document production and implementation, oversight of accreditation specific requirements, QC review of data reporting, technical guidance on general QA issues, report production for all projects requiring EPA CLP deliverables.
Account Manager, Lab Support, Portland, OR 1998 - 1999	Performed all duties required to run a one person branch office, including service calls, resolution of client disputes, marketing to new clients, filling of orders and recordkeeping.
Chemist, ChemTrace, Portland, OR 1997 – 1998	Primary operator for IC and GFAA. Performed analysis on high purity water for various nutrients, microbiological testing and silica content.
Lead Analyst, ***CHESTER LabNet*, Tigard, OR** **1994 – 1997**	Primary operator for IC, ICP, GFAA, CVAA. Analyzed variety of air quality samples using primarily CFR methods. Supervised one Analyst. Generated CLP QC reports. Managed sample throughput and Level I data validation of laboratory.
Associate Chemist, ***CHESTER LabNet*, Tigard, OR** **1992 – 1994**	Primary operator for IC and performance of bench methods. Analyzed variety of environmental samples using CFR, SW846, DW, SM, NIOSH, OSHA, and a variety of other methods.
Laboratory Technician, ASiMI, Washougal, WA 1991 – 1992	Analyzed high purity raw silicon for contaminants utilizing specialized equipment. Generated QC reports to be used in the preparation of Certificates of Lot Analysis.
Chemist, Coffey Laboratories, Portland, OR 1990 – 1991	Analyzed a variety of environmental samples for inorganic constituents using DW, SW846 and SM methods.

Education:
- B.S., Biology (Chemistry minor), University of Oregon, 1989
- Secondary Teaching Certification, University of Oregon School of Education, 1990

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Richard H. Sarver
XRF Technical Director, Lead XRF Analyst

Background:

Hire date: 1986. Experience in analytical chemistry, including biochemical applications and environmental air quality analysis, specializing in the analysis of air particulates by x-ray fluorescence.

Career Chronology:

Employment Information	Responsibilities and Duties
XRF Technical Director, Lead XRF Analyst, ***CHESTER LabNet*,** **Tigard, OR** **1986 - Present.**	Coordinate all XRF activities with Project Managers as needed; train XRF technicians and oversee all XRF operations; market XRF capabilities to outside clients; responsible for maintenance and repair of instruments, supervise sample flow, data interpretation, QA/QC and report generation from XRF analysis; perform highly specialized sample preparation for non-deposit samples, including size fraction and resuspension; technical guidance for clients and in-house staff. Perform XRF analysis and provide technical assistance for state and federal agencies, industrial, consulting and university clients. Ensure adherence to all QA/QC protocols. Awarded EPA equivalency method EQL-0589-072, "Determination of Lead Concentration in Ambient Particulate Matter by EDXRF Spectrometry in May 1989. Principal scientist for the XRF analysis of air particulates for the U.S. EPA national PM2.5 Chemical Speciation Program. Developed XRF method of analysis for the Hazardous Element Sampling Train (HEST), which used activated carbon to trap volatile metals. Continues to participate in the ongoing effort to obtain equivalent method status to EPA Method 29.
Analytical Chemist, Pioneer Hi-Bred International Portland, OR 1980-1986.	Utilized FID/GC analysis to determine metabolic pathways of resident microorganisms in the digestive tract of stressed mice. Handled animals and performed analytical work. Developed SOPs for in house use.

Education:

A.A.S., Chemical Technology, Chemeketa Community College, Salem, OR 1980.

Selected Publications and Presentations:

Sarver, R. H. 1996. Aerosolization as a Means of Sample Preparation of Geological Materials for XRF Analysis and its Validity Compared to EPA Method 3050A Digestion. Journal of the Air & Waste Management Association. 46: 234-240.

Sarver, R.H. and Lytle, C.R. 2000. Parameter optimization for the analysis of PM2.5 by energy dispersive x-ray fluorescence (EDXRF). Presented at PM2000: Particulate Matter and Health, Air & Waste Management Association Specialty Conference, Charleston, SC, January 24-28, 2000.

Sarver, R.H., Mace, J.C. and Duda, P.D. 2002. XRF: Inter-Excitation Quality Assurance and Deposit Uniformity. Presented at Symposium on Air Quality Measurement Methods & Technology, Air & Waste Management Association Conference, San Francisco, CA, November 13–15, 2002.

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Jennifer Schleis
Gravimetry Laboratory Technical Director, Lead Gravimetry Laboratory Technician, XRF Analyst, Analyst

Background:
Hire date: 2007. General laboratory experience. Prior experience in NELAC accredited laboratory. Experience in filter weighing using CFR methods. Instrument experience including IC-PCR, ICP, IC, OC/EC, CVAA. Experience with inorganic analytical methods including CFR, NIOSH, and OSHA methods.

Career Chronology:

Employment Information	Responsibilities and Duties
Gravimetry Laboratory Technical Director; XRF Analyst Lead Gravimetry Laboratory Technician; Analyst (inactived 2019); ***CHESTER LabNet*,** **Tigard, OR** **2010 - Present**	Oversees and performs all operations of the filter gravimetry laboratory to include acceptance testing, QA/QC, inventory and archives. Ensures data meets QA/QC requirements; provides general technical guidance for clients and staff; manages the flow of samples and data through the laboratory; oversees and trains other technicians; oversees day to day operation of the laboratory; manages flow of samples and data through the laboratory; ensures meeting of due dates, proper maintenance of instruments and adherence to all QA/QC protocols. Performs XRF analyses, ensures adherence to all QA/QC protocols. Performs other analytical duties in the Conventional Chemistry lab (as needed).
Analyst; Gravimetry Laboratory Technician ***CHESTER LabNet*,** **Tigard, OR** **2007 - 2010**	Analyzed a variety of air quality samples using primarily CFR methods, performed level I data review in real time. Analyzed samples for metal constituents by ICP, CVAA; analyzed samples by IC, IC-PCD and wet chemical methods. Performed all operations of the filter gravimetry laboratory, including filter media acceptance testing, gravimetric analysis of filter media following CFR protocols, all QA/QC and corrective actions, maintenance of log books and QC documentation.
Laboratory Technician Aquatic Biotech & Environmental Lab, Athens, GA 2005 – 2006	Analyzed mutant strains of transgenic fish via specialized assays, gel electrophoresis, PCR, sequencing, DNA isolation; performed in-vitro fertilization and dissections; maintained aquaria and stocks of fresh and saltwater fish.
Laboratory Technician The University of Georgia, Athens, GA 2004 – 2005	Performed high-throughput DNA sequencing; maintained and operated all laboratory equipment; provided weekly presentation of data summaries and quality assurance; provided technical assistance to students and research staff.

Education:
B.S. Environmental Economics and Management, The University of Georgia, 2003
Continuing Education (Chemistry), Portland Community College & Portland State University, 2015 - 2016

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Lisa Ball
Project Manager, Sample Custodian

Background:

Hire date: 1997. Experience as Project Manager. Experience as environmental Analyst performing wet chemical analysis.

Career Chronology:

Employment Information	Responsibilities and Duties
Project Manager, Sample Custodian, ***CHESTER LabNet*,** **Tigard, OR** **2003 - Present.**	Project management. Performs all procedures, QA/QC and corrective actions associated with sample receipt, log-in and chain-of-custody, Project Management and general and specialized report production; client management; general data entry; coordination with other Project Managers and technical staff; training of new users. Provides technical guidance to clients.
Project Manager, Sample Custodian, Gravimetry Laboratory Coordinator, ***CHESTER LabNet*,** **Tigard, OR** **2001 - 2003.**	Project management. Performs all procedures, QA/QC and corrective actions associated with sample receipt, log-in and chain-of-custody, Project Management and general and specialized report production; client management; general data entry; coordination with other Project Managers and technical staff; training of new users. Provides technical guidance to clients. Oversee and perform all operations of the filter gravimetry laboratory.
Analyst, Gravimetry Laboratory Coordinator, ***CHESTER LabNet*,** **Tigard, OR** **1997 - 2001.**	Performed all operations of the filter gravimetry laboratory, including maintaining supplies, filter media acceptance testing, gravimetric analysis of filter media following EPA protocols, all QA/QC and corrective actions, maintenance of log books and QC documentation. Analyzed air quality samples using primarily CFR methods, including: sample preparation, and digestion and analysis of samples. Principal Operator of IC, ICP, CVAA. Responsible for Level I data review and reporting.
Extraction Chemist, Oregon Analytical Laboratory, Beaverton, OR, 1997 (full-time, temporary).	Performed extractions for total petroleum hydrocarbons (TPH and TPHD), hydrocarbon identification (HCID), PAHs and oil and grease. Analyzed water and soil samples for a variety of inorganic constituents including: CODs, pHs, alkalinity, flashpoints, TKN analysis, and Cyanide analysis.
Chemist, American Environmental Network, Durham, OR, 1996-1997.	Primary wet chemist. Brought new wet chemistry methods on line and wrote corresponding SOPs for wet chemistry methods.

Education:

B.S., Integrated Science, Portland State University, 1996. OSHA 1910.120: 24-hour, 1996.

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T. Mike May
Analyst, Gravimetry Laboratory Technician

Background:

Hire date: 2009 – 2011 and 2017. Prior experience as an analytical chemist for production facility.

Career Chronology:

Employment Information	Responsibilities and Duties
Analyst Gravimetry Laboratory Technician ***CHESTER LabNet,*** **Tigard, OR** **2017 - Present**	Analyzes a variety of air quality samples using conventional chemistry techniques utilizing primarily CFR methods; performs instrumental analysis using IC, IC-PCD, OC/EC, ICP and CVAA; performs level I data review in real time. Performs all operations of the filter gravimetry laboratory, including filter media acceptance testing, gravimetric analysis of filter media following CFR protocols, all QA/QC and corrective actions, maintenance of log books and QC documentation.
Sales/Applications Engineer MCAM NW Oregon City, OR 2011 – 2017	Acted as primary sales and support for Quality programs; implemented and improved overall clients' shop Quality; trained client employees in gathering and reporting reliable quality data; supported clients in troubleshooting and expanding operation to new projects.
Analyst Gravimetry Laboratory Technician ***CHESTER LabNet,*** **Tigard, OR** **2008 - 2011**	Analyzed a variety of air quality samples using primarily CFR methods; performed instrumental analysis using ICP, IC, IC-PCD, OC/EC and CVAA; performed level I data review in real time. Performed all operations of the filter gravimetry laboratory, including filter media acceptance testing, gravimetric analysis of filter media following CFR protocols, all QA/QC and corrective actions, maintenance of log books and QC documentation.
Chemist Bodycote Materials Testing, Portland, OR 2006 - 2008	Analyzed samples by ICP-MS, GFAA XRF, IR and Thermal Conductivity gas analyzers, and ICP-OES; developed and wrote procedure for digestion and analysis of trace metals; trained new employees; analyzed chemical composition of various metals and coatings,

Education:

B.S., Biology, Portland State University, 2005

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Julie Delarue
Analyst, Gravimetry Laboratory Technician, XRF Analyst

Background:

Hire date: 2015. Prior experience as an analytical chemist for production facility. General laboratory experience, instrumental experience including ICP, UV/Vis and IR spectrophotometer, GC, and XRF.

Career Chronology:

Employment Information	Responsibilities and Duties
Analyst Gravimetry Laboratory Technician ***CHESTER LabNet,*** **Tigard, OR** **2015 - Present**	Analyzes a variety of air quality samples using conventional chemistry techniques utilizing primarily CFR methods; performs instrumental analysis using IC, IC-PCD, OC/EC, ICP and CVAA; performs level I data review in real time. Performs all operations of the filter gravimetry laboratory, including filter media acceptance testing, gravimetric analysis of filter media following CFR protocols, all QA/QC and corrective actions, maintenance of log books and QC documentation.
Laboratory Technologist, Husky Energy, Lloydminster, SK (CAN) 2010 – 2014	Performed troubleshooting and method development; analyzed solid, liquid and gaseous samples by GC and XRF; prepared diesel fuel certification for sale. Responsible for all analytical documentation.
QA Laboratory Technologist, Nestle Purina Petcare, Innisfail, AB (CAN) 2009 - 2010	Performed Protein, Moisture and Fat analyses on pet food; responsible for formal release of product. Responsible for all analytical documentation.
Analytical Laboratory Technologist, Nova Chemicals, Calgary, AB (CAN) 2008 - 2009	Analyzed solid, liquid and gas samples by GC; performed troubleshooting and method development. Responsible for all analytical documentation.

Education:

- B.S., Environmental Sciences, University of Alberta (CAN), 1999
- A.S., Chemical Technology, SAIT Polytechnic (CAN), 2009

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Theodore ("Ted") Perry
Analyst, Gravimetry Laboratory Technician, Chemical Hygiene Officer,
Health and Safety Officer

Background: Hire date: 2015. Prior experience as an analytical chemist.

Career Chronology:

Employment Information	Responsibilities and Duties
Analyst Gravimetry Laboratory Technician Chemical Hygiene Officer Health & Safety Officer ***CHESTER LabNet,*** **Tigard, OR** **2019 - Present**	Analyzes a variety of air quality samples using conventional chemistry techniques utilizing primarily CFR methods; performs instrumental analysis using IC, IC-PCD, OC/EC, ICP and CVAA; performs level I data review in real time. Performs all operations of the filter gravimetry laboratory. Ensures safe and proper storage and handling of Chemicals. Ensures safety and laboratory hygiene protocols are followed.
Analyst Gravimetry Laboratory Technician ***CHESTER LabNet,*** **Tigard, OR** **2015 - 2018**	Analyzes a variety of air quality samples using conventional chemistry techniques utilizing primarily CFR methods; performs instrumental analysis using IC, IC-PCD, OC/EC, ICP and CVAA; performs level I data review in real time. Performs all operations of the filter gravimetry laboratory.
Chemist, Thornton Laboratory, Tampa, FL 2013 - 2015	Prepared and analyzed fertilizer samples for Nitrogen content, including TKN, Ammonium content, insoluble nitrogen, Nitrate and slow release nitrogen. Responsible for all analytical documentation.
Chemist Mission Mountain Labs Arlee, MT 2012 – 2013	Prepared and analyzed primarily nutraceutical samples for metals analysis by GFAA, FAA and FTIR. Responsible for all analytical documentation.
Work Study Oregon State University Corvallis, OR 2011 -2012	Moved surplus supplies and equipment from buildings or storage into other buildings or storage.
2008 - 2010	Miscellaneous employment.

Education:

B.S., Chemistry (Environmental Chemistry option), Oregon State University, 2012

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Kevin Healey
Gravimetry Laboratory Technician

Background:

Hire date: 2019. Prior experience in Plant Tissue Culturing, Field Biodiversity studies, Agricultural field studies.

Career Chronology:

Employment Information	Responsibilities and Duties
Analyst Gravimetry Laboratory Technician ***CHESTER LabNet,*** **Tigard, OR** **2019 – Present**	Performs all operations of the filter gravimetry laboratory, including filter media acceptance testing, gravimetric analysis of filter media following CFR protocols, all QA/QC and corrective actions, maintenance of log books and QC documentation.
Technician, Phytelligence, Tigard, OR 2018 - 2019	Performed *in vitro* propagation of apple species, trained new employees in aseptic laboratory technique, trained new employees in lab support duties.
Research Assistant Colorado State University Pueblo, CO 2017 - 2018	Developed protocol for field plant biodiversity survey; identified plants and grasses; pressed and cataloged field specimens; supervised and trained undergraduate field research assistants.
Tissue Culture Technician CSS Farms Colorado City, CO 2016 (summer)	Performed *in vitro* micropropagation of *Solanum tubersum*; sterilized equipment; identified in vitro pathogens; made Murashige and Skoog gel media; disposed of genetically modified plant materials.
Research Assistant CSS Farms Pueblo, CO 2016	Performed confidential experiment with genetically modified potato tubers; managed greenhouse irrigation system; created weekly reports.

Education:

B.S., Biology (Chemistry Minor), Colorado State University, 2018.
A.A., English, Pueblo Community College, 2015.

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Appendix H

Chemistry

H.1 Method Validation

Reference methods are validated using the following criteria where possible:

- DL study;
- Precision and Bias study; and
- Evaluation of Selectivity.

H.1.1 a) Detection limit (DL)

The Detection limit (DL) is the laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can detect with 99% confidence that the result is not a false positive. It does not grant any confidence that the result is not a false negative. None of the reference methods performed at ***CHESTER LabNet*** require DL studies.

DLs are not required for any component for which spiking solutions or quality control samples are not available. These include XRF analysis, gravimetric analysis (both Gravimetry Laboratory and Conventional Chemistry), and OC/EC analysis.

The 2009 and 2016 TNI Standard states, "*the DL determination shall incorporate the entire analytical process;*" and "*the DL shall be determined for the analytes of interest in each test method in the quality system matrix of interest in which there are neither target analytes nor interferences at a concentration that would impact the results, or the DL shall be performed in the sample matrix of interest.*"

The quality system matrix is "Air", in the case of all work performed at ***CHESTER LabNet***. Due to the fact that sampling is part of the reference method, it is not possible for the laboratory to perform a DL study incorporating "*the entire analytical process.*" Also, due to the need for sampling media, the large variety of types of media, the large variation between manufacturer's lots of the same type and size of media, it is not possible to find a sampling matrix "*in which there are neither target analytes nor interferences at a concentration that would impact the results.*" The laboratory determines the DL for each reference method where a DL is possible to be determined, using a matrix free from the target analytes of interest or interfering analytes that impact the DL (e.g. reagent water). Sampling media, to include filters, sorbent tubes, passive sampling materials, and impinger solutions, are not included in the detection limit study, as including said media would determine the variability of the media provided by vendors, rather than the laboratory's detection limit.

The 2009 and 2016 TNI Standard states, *"If a mandated test method or applicable regulation includes protocols for determining detection limits, they shall be followed. The laboratory shall document the procedure used for determining the DL."*

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No method performed at ***CHESTER LabNet*** requires a DL study. DL studies or DL verifications are performed annually for each method/analyte combination for which samples have been analyzed in the previous year. The procedure can be found in SOP QA-006. The DL/LoQ procedures utilized at the laboratory are based on the EPA method "*Definition and Procedure for the Determination of the Method Detection Limit, Revision 2"* (EPA 821-R-16-006, December 2016).

H.1.1 b) Initial Detection Limit Study:

Briefly, the initial Detection Limit Study is performed as follows: Three sets of three method blanks and three low level standards with a concentration of three-times the estimated Detection Limit are prepared on three separate days and analyzed on three separate days. All preparatory and analytical steps of the method are followed. For methods in which no preparation exists, the requirement to prepare three standards shall hold, however, standards may be prepared on the same day as analysis.

Example Timeline for Initial DL study		
	Prepare:	Analyze:
Day 1	Set 1	N/A
Day 2	Set 2	Set 1
Day 3	Set 3	Set 2
Day 4	N/A	Set 3

(where a "Set" consists of three Method Blanks and three low level standards at a concentration approximately three times the estimated DL)

The DL study is performed on all instruments, if more than one instrument is in operation that analyzes for the same analyte using the same technologies.

Two detection limits are determined, one from the blanks' results and one from the standards' results. The higher of the two calculated DLs is utilized as the claimed DL. The DL determined from the standard data is derived by calculating the standard deviation of the standards and multiplying this by the Student *t* test multiplier for the appropriate degrees of freedom of the data set (typically 8, must be at least 6). The DL determined from the blank data is derived by adding the standard deviation of the blanks multiplied by the Student *t* test multiplier for the appropriate degrees of freedom to the average of the blanks (or zero, if the average is <0).

Example calculations:

DL_{std} = stdev*Student *t* for 99% confidence

DL_{blk} = $Average_{blk}$‡ + stdev*Student *t* for 99% confidence
‡(if $Average_{blk}$ is <0, then 0 is used as the average)

Refer to SOP QA-006 for treatment of blank result data sets where some or all results are non-numerical.

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H.1.1 c) Ongoing Verification of the Detection Limit:

A Method Blank (MB) and a Low Level Laboratory Control Standard (LL-LCS) spiked at approximately three times the DL are prepared and analyzed with every batch of samples for a given method and analyte. The results are collated in a proprietary Detection Limit spreadsheet that has the ability to sort by dates, analytes, instruments, methods and more. Once every 12 – 14 months, the previous data, up to the previous 24 months and including the initial DL study data if applicable, are processed through the same calculations as the initial DL study. A minimum of seven data points must exist. If there are not seven results in the data set, then additional runs are performed to reach the seven-data-point threshold.

If the calculated DL from the verification data is with ½ to 2 times the Initial Detection Limit as determined above, the DL is considered verified and will not be changed. If it is not within ½ to 2 times the Initial Detection Limit as determined, a new Initial Detection Limit study is performed within 30 days of the finding.

If the method has not been used in the previous twelve months, no verification is necessary, however, another Initial Detection Limit study must be performed prior to reporting any data from that method.

Air quality sampling media are often used to capture the samples (filter, sorbent tube, impinger solution, etc.). These media are considered to be part of the samples and are not included in the blanks or standards used in the detection limit study or verification.

H.1.2 a) Limit of Quantitation

No reference method performed by the laboratory has a requirement for a Limit of Quantitation, by any name. All methods are assumed to report to the Detection Limit, excepting those that specify that the absolute result shall be reported, even if negative. The 2009 and 2016 TNI Standard states *"The laboratory shall select an LoQ for each analyte, consistent with the needs of its clients, and greater than the DL."* The laboratory sets the LoQ at a level five-times the DL, based on CLP guidelines. The LoQ is used for the following:

- Setting control limits for duplicate analysis, where not specified in the method;
- Setting the concentration for the LL-CCV, and the LL-LCS; and,
- Setting a concentration which can be utilized in the DL and LoQ verification process.

LoQs are not required for components or properties for which spiking solutions or QC samples are not available. These include XRF analysis, gravimetric analysis (both Gravimetry Laboratory and Conventional Chemistry), and OC/EC analysis.

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The laboratory verifies the LoQ by the analysis of a verification sample consisting of a spiked method blank at or below the concentration of the selected LoQ. The initial verification sample(s) is typically the same sample(s) used in determining the DL.

H.1.2 b) Initial LoQ Verification:

Existing data may be used if the data was generated within a minimum of three batches generated within the past two years. The LoQ is verified if the following is met:

- All results are greater than zero
- All results meet the qualitative identification criteria of the method (e.g., peak present)
- Recovery of each analyte is within the laboratory established accuracy acceptance criteria (50% - 150%)
- The LoQ is greater than the DL (by default, this will always be true)
- The LoQ is at or above the spiking concentration of the verification sample.

H.1.2 c) Ongoing verification of the LoQ:

A Low Level Laboratory Control Standard (LL-LCS) is prepared and analyzed with each batch of samples for a given method and analyte. The LL-LCS is spiked at the same concentration as the initial LoQ verification (approximately three times the DL).

Each LL-LCS (LoQ verification sample) is evaluated at the time of testing. The ongoing verification of the LoQ is met when:

- The results meet the qualitative identification criteria of the method (e.g., peak present);
- Recovery of each analyte is within the laboratory established accuracy acceptance criteria (50% - 150%); and
- The LoQ verification sample (LL-LCS) result is greater than the DL.

If an LoQ verification result does not meet the above requirements, the laboratory:

- Corrects the method of instrument performance and repeats testing, where possible;
- Evaluates the laboratory established control limits to ensure they reflect current performance; or,
- Raises the spiking level and repeats the Initial LoQ verification study within 30 calendar days of the initial failure.

Any samples analyzed with a failing LoQ verification are reported as qualified data.

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H.1.3) Precision and Bias

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms.

Bias is the systematic error that contributes to the difference between the mean of a significant number of test results and the accepted reference value.

Precision and bias using non-reference, modified-reference or laboratory-developed methods are established using the procedure outlined below and compared to the criteria established by the laboratory. The Precision and Bias study is only performed when the method is first brought online or when a change in instrumentation gives cause to believe that precision and bias of the method may have changed.

The 2009 and 2016 TNI Standard states that the laboratory shall "*process the samples through the entire measurement system.*"

Due to the fact that sampling is part of the reference method and therefore part of the measurement system, it is not possible for the laboratory to perform a Precision and Bias study by "*[processing] the samples through the entire measurement system.*"

The laboratory uses the same matrices as described in subsection "a)" above (DLs) in performing Precision and Bias studies. Refer to SOP QA-006 for further detail. Briefly, the Precision and Bias study is as follows:

- A Method Blank and three standards are prepared following all analytical preparatory steps contained in the method (if any). Standards are prepared at the following concentrations: the LoQ, the mid-point of the calibration curve, and at 80% of the highest standard. In instances where no preparation is performed on the samples (samples are run as received), the standard is prepared in a clean matrix (e.g., reagent water). Following the steps in the appropriate standard operating procedure, measure the Method Blank and one standard at each concentration level together in one analytical run.
- Calculate the mean recovery for each of the three results.
- On a second, non-consecutive day, repeat above for the second set.
- On a third, non-consecutive day, repeat steps above for the third set.
- Calculate mean recovery for each concentration level over the three days, and for all nine samples.
- Calculate the relative standard deviation of each of the separate mean recoveries obtained.

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- Compare the standard deviations for the different days and different concentrations with established criteria; compare the overall mean and standard deviation with established criteria.

H.1.4) Selectivity

Selectivity is the capability of a method or instrument to respond to a target substance or constituent in the presence of non-target substances (EPA-QAD).

The laboratory evaluates selectivity through the use of sample spikes, where possible. With many source emissions samples, the chemistry occurring in one source can be wildly different from another source. Often, the chemistry occurring in the gas stream of the source includes pollution control device emissions containing non-target substances specifically designed to remove the target substance. Selectivity using any substance other than a sample from the source is moot.

Some methods are incompatible with Selectivity tests. Gravimetric analyses, both on filters and source emission samples, do not lend themselves to selectivity.

H.2 Demonstration of Capability

Demonstration of Capability (DoC): A procedure to establish the ability of the Analyst to generate analytical results of acceptable accuracy and precision.

Before reporting any data with a given method, a satisfactory DoC is performed. Thereafter, each Analyst demonstrates continuing proficiency through the procedures outlined in Ongoing Demonstration of Capability.

H.2.1) Initial Demonstration of Capability (IDoC)

An IDoC is performed:

- before using any method;
- when an Analyst learns a method new to the Analyst;
- each time there is a change in instrument type, personnel or method; and
- if the laboratory or Analyst has not performed the method in a twelve-month period.

The IDoC(s) for each Analyst is documented on a DoC form retained in the Analyst's DoC folder maintained by the QA Officer. The document identifies the Analyst(s) involved in preparation and/or analysis; matrix; analyte(s); the method(s) performed; the laboratory-specific SOP used for analysis (including revision number); the date(s) of analysis; and a summary of the results used to calculate the mean recovery and standard deviations.

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All raw data, preparation records and calculations for each IDoC are retained either in hardcopy or electronically and are available for review.

When the method specifies a DoC procedure to be followed, only those procedures will be used. If no procedures are specified, the laboratory uses its own procedure. No reference methods utilized by the laboratory require or reference an LoQ by any name. The laboratory uses the same matrices as described in subsection H.1.1.a above (DLs) in performing IDoC studies. Refer to SOP QA-006 for further detail. Briefly, the IDoC study is as follows:

- Prepare four samples in a clean matrix following the entire procedure described in the associated SOP (including any preparatory steps), spiking the clean matrix at a level one to four times the LoQ.
- Following the steps in the appropriate standard operating procedure, measure the Method Blank and the low level standards.
- Using all of the standard results, calculate the mean recovery and the standard deviation of the samples in the same units as the reporting units for samples.
- Compare the recovery and standard deviation to the corresponding acceptance criteria in the method.
- Complete the Demonstration of Capability Certification Statement and place in the appropriate employee's QA file.

H.2.2) Ongoing Demonstration of Capability

After the demonstration of capability is completed, on-going proficiency is maintained and demonstrated at least annually. Each Analyst is expected to consistently meet the QC requirements of the method, the laboratory SOP, client requirements and/or the 2009 and 2016 TNI Standard. Ongoing DoC's for each Analyst are documented on a DoC form retained in the Analyst's DoC folder maintained by the QA Officer, and all records related to the demonstration are retained.

The laboratory follows SOP QA-006 to demonstrate ongoing DOC. The same process as IDoC is used for ongoing DoC's with the exception that ongoing DoC's typically utilize the most recent four consecutive second source standards (e.g., ICV's, LCS's) in the calculation of the statistics, rather than a low level standard. Note that these standards must only be consecutive, not necessarily on the same day or in the same run.

H.3 Calibration

Section 23.2.2 includes information on calibration of support equipment. This Section covers calibration of analytical equipment.

Initial instrument calibration and continuing instrument calibration verification are an important part of ensuring data of known and documented quality. If more stringent calibration requirements are included in a mandated reference method or by

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regulation, those calibration requirements override any requirements outlined here or in laboratory SOPs. Generally, procedures and criteria regarding instrument calibrations are provided in the SOPs governing the instruments. XRF has a separate SOP discussing calibration of the instruments due to the complexity of the calibration.

H.3.1 Initial Instrument Calibration

- Records:

  Initial instrument calibration includes calculations, integrations, acceptance criteria and associated statistics referenced in the pertinent SOPs.

  Sufficient raw data records are collected to allow reconstruction of the initial instrument calibration. These include, at a minimum, calibration date, instrument, analysis date, analyte names, Analyst's signature or initials, concentration and response, calibration curve or response factor, or unique equation or coefficient used to reduce instrument responses to concentration.

  Calibration date and expiration date (when recalibration is due) is documented for equipment requiring calibration, where practicable (see Section 23.1).

  Calibration standards are traceable to NIST, when commercially available, and are of a manufacturer's lot different from standards used in all other applications (e.g., spiking, ICVs, etc.).

- Number of Standards and Concentrations:

  If the reference or mandated reference method does not specify the number of calibration standards to use, the minimum number is five for a linear fit curve and six for a quadratic fit curve, not including blanks or a zero standard.

  The 2009 and 2016 TNI Standard states that *"the lowest calibration standard shall be at or below the lowest concentration for which quantitative data are to be reported without qualification."* However, reference methods performed by the laboratory report to the DL without qualification, therefore, this is not possible for all instruments. The lowest calibration standard is at or above the DL and below the Limit of Quantitation (LoQ).

  The highest calibration standard is the highest concentration for which quantitative results can be reported. Data reported exceeding the highest calibration standard *without dilutions* is considered to have increased uncertainty and are reported with an explanation of the reason for the reporting of said data in the Case Narrative (e.g., re-analysis not possible). This does not apply to gravimetric data, XRF results or OC/EC results, where the technologies do not permit a detection limit study as described previously.

  For instrumentation where a single point calibration is recommended by manufacturer's instructions, such as with ICP (with a zero and single point calibration), the following apply:

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a) For single point plus zero blank calibrations, the zero point and the single point standard are analyzed prior to the analysis of samples and the linear range of the instrument is established by analyzing a series of standards, one of which is at the lowest quantitation level.

b) Zero blank and single point calibration standards are analyzed with each analytical batch.

c) A standard corresponding to the limit of quantitation (LL-CCV) is analyzed with each analytical batch and must meet established acceptance criteria (60% - 140% Recovery) when using single point plus zero blank calibrations.

d) The linearity of single point plus zero blank calibrations is verified at a frequency established by the method or the manufacturer. Linearity may also be verified with each analytical batch by not reporting any data higher than the calibration standard.

Note that the 2009 and 2016 TNI Standards do not address either thin-film XRF or OC/EC analyses, both of which are used almost solely for air quality analyses. Both of these instrumentations also retain their calibrations for extended periods of time (over 12 months, sometimes several years), and both do not have detection limits, instead reporting to their uncertainties.

- Evaluation, Verification and Corrective Action:

All initial instrument calibrations are verified with a standard made from a second source standard traceable to NIST, when commercially available. The concentration of the calibration verification standard is less than or equal to half that of the highest calibration standard. If a second source is not available, a standard prepared from a different lot may be used. If no standard is commercially available, the laboratory will make a standard in-house, where possible, or find alternate means of ensuring the accuracy of the calibration, where possible.

Criteria for the acceptance of an initial instrument calibration are established and defined in the pertinent SOPs. The criteria used are appropriate to the calibration technique. For instruments with multipoint calibration curves, all calibration standard results are assessed using percent Relative Error (RE or %RE, see Section 27.2.2.5) and correlation coefficients.

Where appropriate, the laboratory has manual integration procedures that are adhered to when evaluating calibration data. These procedures are documented in SOP QA-012.

Any samples that are analyzed after an unacceptable initial calibration are re-analyzed where possible, or the data are reported with qualifiers appropriate to the scope of the unacceptable condition (see Section 12, “Control of Non-conforming Environmental Testing”).

Quantitation is always determined from the most recent initial calibration unless the test or reference method or applicable regulations require quantitation from the continuing instrument calibration verification, except in the case of OC/EC

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analysis. OC/EC analysis includes an internal single point calibration standard with every sample analysis, which is necessary to compensate for minor fluctuations in gas flows, furnace temperatures, and FID functioning.

Corrective actions are performed when the initial calibration results are outside acceptance criteria. Calibration data points are never removed from a calibration. If a calibration fails to pass acceptance criteria, the problem is corrected and the calibration standards are re-analyzed to generate a completely new calibration curve.

H.3.2 Instrument Calibration Verification

- Records:

  Sufficient raw data records are collected to allow reconstruction of the continuing instrument calibration verification. These include, at a minimum, method, instrument, analysis date, analyte names, Analyst's signature or initials, concentration and response, calibration curve or response factor, or unique equation or coefficient used to reduce instrument responses to concentration. The Quant'X XRF and all balances used for gravimetric analyses are an exception as the instruments/software do not show the raw counts used during calibration.

  The acceptance criteria, calculations and associated statistics for continuing instrument calibration verification are documented in in the pertinent SOPs.

  Where appropriate, the laboratory has manual integration procedures that are adhered to when evaluating calibration verification data. Refer to SOP QA-012.

- Frequency:

  Calibration is verified for each compound, element, or other analyte being reported, to include mass.

  Calibration verifications are performed:

  - at the beginning and end of each analytical batch. Many methods require the CCV to be analyzed every 10 measurements. Some methods have more frequent CCV requirements (see pertinent SOPs).
  - whenever it is expected that the analytical system may be out of calibration or might not meet verification acceptance criteria.
  - when the time period for calibration or the most recent calibration verification has expired.
  - for all analytical systems that have a calibration verification requirement. Requirements are documented in in the pertinent SOPs.

- Evaluation, Verification and Corrective Actions:

  The validity of the initial calibration is verified prior to sample analysis by use of an initial instrument calibration verification (ICV) standard, and throughout the

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run by use of a continuing calibration verification standard (CCV). Thin film XRF verifies the calibration once at the end of a run of 10 samples for the Quant'X or 15 samples for the Kevex 770. Source Particulate Matter balances are verified once, after initial calibration, and prior to every weighing batch thereafter.

The acceptance criteria and corrective actions are documented in in the pertinent SOPs.

Corrective action is initiated for ICV/CCV results that are outside of acceptance criteria (see Section 12, "Control of Non-Conforming Environmental Testing").

H.3.3 Unacceptable Continuing Instrument Calibration Verifications

If routine corrective action for continuing instrument calibration verification fails to produce a second consecutive (immediate) calibration verification within acceptance criteria, then a new calibration is performed.

For any samples analyzed on a system with an unacceptable calibration, some results may be useable if qualified and under the following conditions:

a) If the acceptance criteria are exceeded high (high bias) and the associated samples are below detection, then those sample results that are non-detects may be reported as non-detects.

b) If the acceptance criteria are exceeded low (low bias) and there are samples that exceed the maximum regulatory limit, then those exceeding the regulatory limit may be reported.

CHESTER LabNet only reports data associated with failed ICVs/CCVs/ICBs/CCBs if there is no other option. The data reported under such conditions is heavily annotated.

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Appendix I

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Appendix J

Employee Competency Reviews

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Technical Employee Performance Review

Employee Name: _____

Title: _____

Date: _____

Reason for review: _____ Annual Performance Review
_____ End of Probationary Period
_____ Critical Incident Review

		Unsatisfactory	Fair	Good	Excellent	Not Applicable
Technical Competency						
Procedures	Follows SOPs, documents necessary deviations.					
Documentation	Completes all pertinent documentation in a timely manner, records all supporting information.					
Technical Knowledge	Understands the technical basis of methods and instrumentation (chemistry, physics, mechanics).					
Mathematics	Correctly performs all mathematical operations necessary for the performance of assigned tasks.					
Computers/Software	Performs computer/peripherals/software troubleshooting.					
Troubleshooting	Able to locate and understand user's manuals, follow verbal troubleshooting instructions, troubleshoot on basis of knowledge.					
Precision	Performs tasks following the same protocols, without deviations, consistently over time.					
Accuracy	Routinely passes batch QC elements; failing QC elements are rare or traceable to issues unrelated to analyst proficiency.					
Corrective Actions	Takes appropriate and technically justified corrective actions. Seeks input from others if necessary.					
Data Reporting	Reports data in correct units, in a timely manner, accurately and completely.					
Reading Comprehension	Able to read, understand, and follow reference documents, including reference methods.					

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Administrative Employee Performance Review

Employee Name: _____

Title: _____

Date: _____

Reason for review: _____ Annual Performance Review
_____ End of Probationary Period
_____ Critical Incident Review

		Unsatisfactory	Fair	Good	Excellent	Not Applicable
Administrative Competency						
Procedures	Follows SOPs, documents necessary deviations. Fills in all required checklists accurately and completely.					
Documentation - log in	Verifies CoC's complete and accurate, logs into LIMS and documents client communications completely and accurately.					
Documentation - internal	Creates appropriate and accurate internal worklists, records requested methods/analytes clearly and legibly.					
Method Knowledge	Understands the necessary parts of each method such that samples are logged in correctly for each method.					
Computers/Software	Performs computer/peripherals/software troubleshooting.					
Troubleshooting	Able to locate and understand user's manuals, follow verbal troubleshooting instructions, troubleshoot on basis of knowledge.					
Client Communication 1	Communicates in a timely and professional manner with clients.					
Client Communication 2	Ensures client's requirements, including methods to be used and desired analytes, are clearly defined, documented and understood.					
Internal Communication	Communicates clients' needs accurately and completely to involved personnel, including changes to work in progress.					
Corrective Actions	Takes appropriate and technically justified corrective actions. Seeks input from others if necessary.					
Data Reporting	Follows SOPs for data reporting, communicates with client for reporting needs, reports data following NELAC requirements.					
Reading Comprehension	Able to read, understand, and follow written communication from clients, analysts or other client services personnel.					

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Manager Performance Review

Employee Name: _____

Title: _____

Date: _____

Reason for review: _____ Annual Performance Review
_____ End of Probationary Period
_____ Critical Incident Review

		Unsatisfactory	Fair	Good	Excellent	Not Applicable
Management Competency						
Procedures	Follows NELAC requirements, QAMP requirements and SOPs where applicable.					
Documentation - annual	Completes all annual documentation requirements, such as ORELAP application, internal document review, and others.					
Documentation - internal	Maintains all internal documentation, including SOPs, DOC's, employee files, training logs, etc.					
Training	Performs and documents company-wide training as needed (e.g., Safety training, Data Integrity and Ethics training, etc.)					
Computers/Software	Performs computer/peripherals/software troubleshooting.					
Client Communication	Communicates in a timely and professional manner with clients, as needed.					
Internal Communication	Communicates company expectations and requirements clearly, concisely, and unambiguously to employees.					
Corrective Actions	Reviews Corrective Action Reports and performs root cause analysis as needed.					
Human Resources	Follows all pertinent employment laws, performs hiring and firing processes in a professional manner.					
Morale	Fosters open, non-retaliative environment in the workplace. Is receptive to feedback from employees.					
Reading Comprehension	Able to read, understand, follow, and respond to written communication from clients and employees.					

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General Plan of Operations
Appendix 02
Marine Water and Sediment Sampling Programs

May 2020

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1. MARINE WATER SAMPLING PROGRAMS 2

Attachments

Attachment A - APDES Quality Assurance Project Plan (QAPP)

1. MARINE WATER SAMPLING PROGRAMS

Marine water sampling programs are discussed in the APDES Quality Assurance Project Plan (QAPP) included in Attachment A.

GPO Appendix 02
Attachment A
APDES Quality Assurance Project Plan (QAPP)
Project Monitoring Manual

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DOCUMENT COPY NUMBER: _____

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REVISIONS:

REVISION DATE AND INITIALS:	SECTION AND SUBSECTION REVISED
Updates after EPA visit 6/09: 8/09: JS	All reviewed
12/31/09: JS	All reviewed; Changed QAPP to QAP; H. Mooney changed to R. Jung Table 1; no current laboratory manager at Analytica
11/30/15: DL	All reviewed; Changed QAP to QAPP; Changed NPDES to APDES; Update laboratory and contact information; Revise sampling requirements to match new permit
24 May 2018; CDW	Updated contact information.
18 May 2020; CDW	Updated document format.

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Subattachment b - OAKTON pH/CON 10 Meter Instrument and Procedure Manual

Subattachment c - YSI Model 30 Instrument and Procedure Manual

Subattachment d - HACH Portable Turbidimeter 2100P Instrument and Procedure Manual

Subattachment e - ROSEMOUNT 56 Advanced Dual-Input Analyzer Instrument and Procedure Manual

Subattachment f - ROSEMOUNT General Purpose 3900 pH Sensor Instrument and Procedure Manual

1. INTRODUCTION

This Quality Assurance Project Plan (QAPP) is designed to relate the objectives of the Greens Creek Mining Company's (GCMC) Alaska Pollutant Discharge Elimination System (APDES) monitoring program to the specific measurements required to achieve those objectives. Section 2.1 of the APDES permit, with an effective date of October 1, 2015, details the requirements for this Quality Assurance Project Plan. The GCMC monitoring program is designed to provide a continuum of data throughout the life of the mine operation including planning, operation, and closure. Specifically, the QAPP describes:

- Intended measurements that are appropriate for achieving objectives, and
- Quality control procedures sufficient to collect data of known and adequate quality.

The QAPP is necessary to meet the Alaska Department of Environmental Conservation (ADEC) needs for information relative to the GCMC request for an APDES discharge permit. The QAPP provides unambiguous instructions to project personnel (e.g., sampling technicians) who are responsible for data generation.

GCMC maintains a long-term database of over 25 years of baseline, predevelopment, development, operational, and temporary closure monitoring data. Information contained in the database is critical to understanding long-term water quality trends and the relationship between background conditions and the effect mining activities may have on site environmental conditions. Monitoring reports concerning the sites described in this document are regularly submitted to the ADEC. The database also provides necessary background needed for future permit applications. The QAPP meets the ADEC's needs for information relative to the GCMC implementation of the APDES discharge permit. The general content and format (monitoring procedures, site descriptions, etc.) of the QAPP will be maintained as the mine progresses through the current and future phases of the mine operation. Provisions for future monitoring activities are included so that the QAPP can be modified and revised for use throughout the life of the mine.

1.1. Personnel and Contacts

Information including the names, titles, and phone numbers of company contacts, project laboratory contacts, company contractors and consultants, and other personnel who are involved with the administration and implementation of this QAPP is presented in **Table 1**.

Table 1. Personnel and Contacts

Company	
Greens Creek Mining Company P.O. Box 32199 Juneau, AK 99803-2199 Phone: 907 790-8474 Fax: 907 789-8119	**Permitting and Environmental Compliance Coordinator** Christopher Wallace Phone: 907 790-8473 Fax: 907 790-8478
	QAPP Environmental QC Manager Cameron Sell Phone: 907 790-8457 Fax: 907 790-8478
	Environmental Department Staff David Landes 907 790-8420 Cameron Sell 907 790-8457 Gunnar Fredheim 907 790-8461 Doug Maller 907 790-8482 Fax - Environmental 907 790-8478
Effluent Water Testing	
ACZ Laboratories, Inc. 2773 Downhill Drive Steamboat Springs, CO 80487	**Project Manager** Sue Webber Phone: 970 879-6590, x110
Admiralty Environmental 641 W. Willoughby Ave., Suite 301 Juneau, AK 99801 Phone: 907 463-4115	**Laboratory Manager** Hope O' Neill
Receiving Water Testing	
Battelle Marine Sciences Laboratory 1529 West Sequim Bay Road Sequim, WA 98382	**Project Manager** Nicholas Ward Phone: 360 681-3604 Fax: 360 681-3699
Express North America Courier Phone: 206 767-0205	

ACZ Laboratories, Inc. 2773 Downhill Drive Steamboat Springs, CO 80487	**Project Manager** Sue Webber Phone: 970 879-6590, x110
Admiralty Environmental 641 W. Willoughby Ave., Suite 301 Juneau, AK 99801 Phone: 907 463-4115	**Laboratory Manager** Hope O' Neill
Sediment and In-Situ Bioassays	
Marine Taxonomic Services, Ltd. 5125 NW Crescent Valley Drive Corvallis, OR 97330-9721 Phone: 541 753-7609 Fax: 541 753-7609	**Project Manager Senior Scientist** Seth Jones Phone: 541 753-7609
ALS Environmental 13117 South 13th Avenue P.O. Box 479 Kelso, WA 98626 Phone: 360 577-7222 Fax: 360 636-1068	**Project Manager** Kurt Clarkson Phone: 360 501-3356 Fax: 360 636-1068

1.2. Site Description

The Greens Creek Mine is located 18 miles southwest of the city of Juneau, Alaska, on Admiralty Island. Dense forests cover the mountain slopes up to an elevation of 2500 feet, above which the vegetation is alpine. The climate is maritime, with precipitation similar to that in Juneau, averaging 90 to 100 inches per year at the mine site, and 60 to 70 inches per year at the facilities at Hawk Inlet. The mine and mill facilities are located over 6 miles up Greens Creek from Hawk Inlet tidewater.

Zinc, lead, silver, and gold are the target recovery metals. The GCMC operations began in 1989 and operated approximately 4 years before production was suspended in April 1993. The mine and mill were recommissioned, and operations restarted in mid-1996. A 2200 ton/day milling facility and appurtenant support facilities are in place. Dry tailings from the milling process are backfilled in the mine and deposited in a surface dry-stack tailings pile near Hawk Inlet.

Support facilities to the mining and milling operation include a passenger dock in Young Bay (Stephens Passage) for daily commuting of the work force. A road system carries personnel, materials, and equipment to a port site in Hawk Inlet and on to the mine. The Hawk Inlet port facility provides core storage, concentrate storage and shipping, barge port facilities, and temporary/emergency housing.

Domestic waste water treatment plants are located at the Hawk Inlet port site and at the 920 mine/mill site.

One waste water discharge outfall and 10 representative storm water discharge sites are authorized by the GCMC Alaska Pollutant Discharge Elimination System (APDES) Permit Number AK-004320-6. Previous permits authorized the discharge of treated domestic wastewater from Outfall 001 to Hawk Inlet. This outfall has been abandoned and will be excluded from future permit reissuances. The Hawk Inlet Camp treated sewage is combined with area surface runoff and pumped up to the Tailings Area. At the Tailings area, it is combined with effluent streams from the 920 mine/mill area, and Tailings Basin areas, and treated at the Waste Water Treatment Plant. Treated water is discharged through APDES Outfall 002. Outfall 002 discharges a combined effluent from process waste water, site runoff, mine drainage, tailings runoff, treated domestic sewage, and other effluent streams after treatment.

1.3. Purpose of Monitoring Program

The Environmental Protection Agency (EPA) issued the original National Pollutant Discharge Elimination System (NPDES) permit for the GCMC facility on Admiralty Island effective April 30, 1987, with an expiration date of April 29, 1992. Following timely application for renewal, EPA Region 10 reissued this permit with an effective date of November 16, 1998 and an expiration date of November 17, 2003. GCMC submitted a timely application for permit renewal, and Permit No. AK-004320-6 was again reissued to GCMC by EPA Region 10, with an effective date of July 1, 2005 and an expiration date of July 1, 2010. GCMC submitted a timely application for permit renewal in December 2009. Because GCMC submitted a timely application for reissuance, the 2005 permit was administratively extended and remained fully effective and enforceable until the effective date of a new permit per 18 AAC 83.155(c). The ADEC assumed primacy to administer the NPDES permit program for mining discharges in October 2010. The ADEC issued Permit No. AK0043206, with an effective date of October 1, 2015, marking the first APDES permit issuance for the subject discharge.

The APDES permit establishes, among other things, effluent limitations for the discharge of treated mine and mill process waste water, area runoff, and treated domestic waste water from all GCMC facilities on Admiralty Island through Outfall 002 into Hawk Inlet. Monitoring, recordkeeping, and reporting requirements to track mine related effects on biological life, sediments, and seawater in Hawk Inlet also are contained in the permit. The monitoring program under the APDES permit is comprised of the following discrete elements:

- Effluent monitoring of treated domestic wastewater from the Hawk Inlet and 920 Area sequencing batch reactors
- Effluent monitoring of Outfall 002
- Receiving water column monitoring
- Marine environment sediment monitoring
- Marine environment in-situ bioassay monitoring
- Storm water quality monitoring

1.4. Statement of Data Quality Objectives

1.4.1. Primary Program Objectives

1. Demonstrate that treated domestic waste water, mine and mill process waste water, and storm water discharged from the mine and associated facilities, meets APDES permit effluent limitations.
2. Ensure that sampling and analytical methods used in the monitoring program meet regulatory agency criteria.
3. Document the water quality, sediment, and biological conditions in receiving waters and marine environments that may be impacted by the mine and related facilities.

1.4.2. Individual Element Data Quality Objectives

Effluent Monitoring of Treated Domestic Wastewater

The objective of this element of the monitoring program is to provide scientifically valid data on specific physical and chemical parameters for the domestic waste water effluent. These data are used to validate that the effluent from the domestic wastewater treatment systems meets secondary treatment standards for BOD_5 as required under 18 AAC 72.050.

Effluent Monitoring of Outfall 002

The objective of this element of the monitoring program is to provide scientifically valid data on specific physical and chemical parameters for effluent constituents from the mine and mill process waste water effluent, domestic waste water effluent, captured area runoff and intercepted groundwater. These data are used to evaluate and report compliance in meeting the effluent limitations of the APDES permit for Outfall 002.

Receiving Water Column Monitoring

The objective of this element of the monitoring program is to provide scientifically valid data on specific physical and chemical parameters for Hawk Inlet water quality. These data are used to evaluate potential changes in the Hawk Inlet marine environment and are reported to ADEC, as required by the APDES permit.

Marine Environment Sediment Monitoring

The objective of this element of the monitoring program is to provide scientifically valid data on five specific trace metal parameters from sediments at five locations in Hawk Inlet. These data are used to evaluate potential changes in the Hawk Inlet marine environment and are reported to ADEC, as required by the APDES permit.

Marine Environment In-Situ Bioassay Monitoring

The objective of this element of the monitoring program is to provide scientifically valid data on five specific trace metal parameters from the tissues of two polychaete worms, and bay mussels at seven locations in Hawk Inlet. These data are used to evaluate potential changes in the Hawk Inlet marine environment and are reported to ADEC, as required by the APDES permit.

Storm Water Quality Monitoring

The objective of this element of the monitoring program is to provide scientifically valid data on specific physical and chemical parameters from storm water runoff at 10 representative locations around the GCMC facilities on Admiralty Island, as well as receiving waters potentially affected by the storm water discharges. These data are used to evaluate the potential effects of storm water runoff to nearby water bodies and are reported to ADEC, as required by the APDES permit.

1.5. Project Organization and Responsibilities

The organization of the GCMC environmental monitoring program and the roles and responsibilities of the personnel assigned to implement the requirements of the program are discussed below, and shown on the organizational chart for the QAPP, presented in **Figure 1**.

1.6. Project Administration

GCMC is responsible for carrying out the monitoring requirements of all permits and other agency environmental data requests. The administration of GCMC's APDES monitoring program is conducted by the Environmental Manager.

The Environmental Manager is responsible for the following tasks:

- Ensure that appropriate personnel and financial resources are available to carry out the work outlined in this plan.
- Act as a key liaison between the regulatory agencies and GCMC.
- Complete the Discharge Monitoring Reports required by the APDES permit.
- Prepare and complete the additional permit required reporting.
- Manage the contract commercial laboratory services.
- Supervise the Environmental staff.

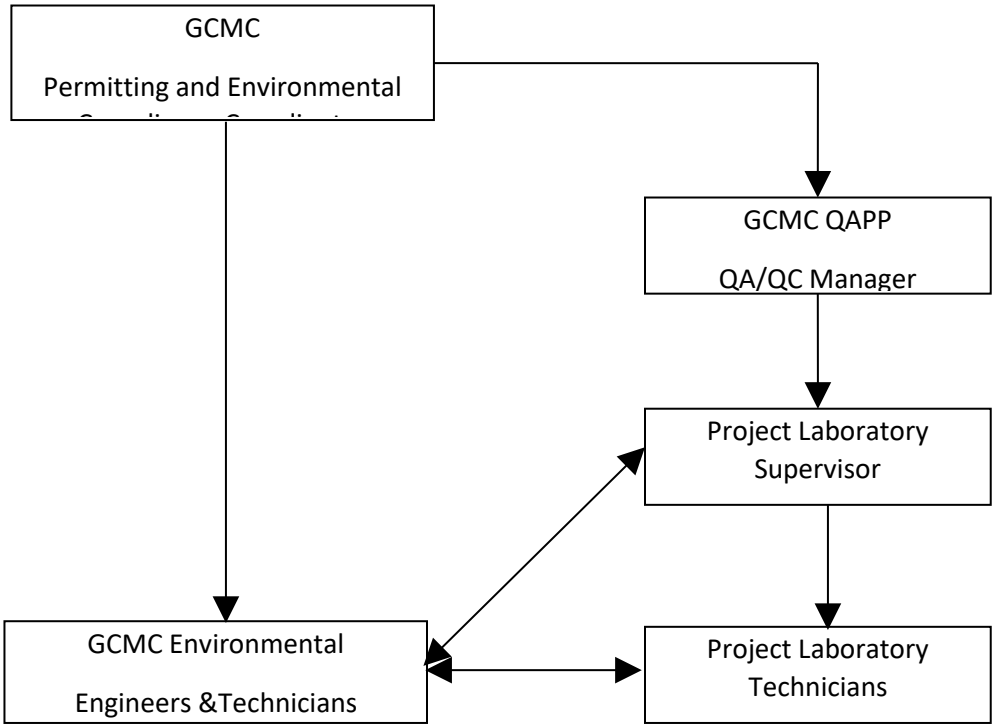
The Environmental Manager is also responsible for authorizing or negotiating any changes or modifications to the monitoring program. The Manager may pursue modifying the monitoring program based on ongoing systems review and analysis, audits of the data, and changes to the monitoring program requested by the involved permitting agencies. <u>No changes or modifications to the APDES monitoring program may be made without the consent of the ADEC.</u>

1.6.1. Administration of Field Operations

The Environmental Engineers and Environmental Technicians are responsible for the performance of the details of the monitoring activities and assuring that they are conducted using methods approved by the regulatory agencies. The Environmental Manager has supervisory authority over the Environmental Technicians. Specifically, the Environmental Engineers and Environmental Technicians are responsible for:

- Maintaining field analytical instruments and monitoring stations.
- Collecting samples and conducting the field measurements.
- Shipping samples to the contract laboratory(s).
- Checking laboratory analytical reports and entering the data into the electronic database.
- Monitoring and data QA/QC
- Preparing the DMR documents

Figure 1. Organizational Chart



Names of Responsible Individuals

GCMC:

- Permitting and Environmental Compliance Coordinator: Christopher Wallace
- QAPP QA/QC Manager: Cameron Sell
- Environmental Engineer: David Landes
- Environmental Technicians: Gunnar Fredheim, Doug Maller

Project Laboratories:

- ACZ Laboratories, Inc,: Sue Webber (Effluent Monitoring, Receiving Water – Water Column Monitoring, Storm Water Monitoring)
- Admiralty Environmental: Hope O'Neill (Effluent Monitoring, Receiving Water – Water Column Monitoring)
- Battelle Marine Sciences Laboratory: Brenda Lasorsa (Receiving Water - Water Column Monitoring)
- Marine Taxonomic Services, Ltd: Howard or Seth Jones (Sediment and In-Situ Bioassays)
- ALS Environmental: Gregory Salata, PhD (Sediment and In-Situ Bioassays)

In the GCMC organizational system, the Environmental Manager has ultimate responsibility for the Environmental Department efforts, Environmental Department staff members, and all others who are employees or contractors that perform environmental related duties.

1.6.2. QA/QC Roles and Responsibilities

Quality Assurance/Quality Control (QA/QC) is designed to assure that quality of the monitoring program is maintained in a systematic way. The responsibilities for quality assurance and quality control are as follows:

> Quality Assurance (QA) - determines that the GCMC QC system is effectively operating to ensure compliance.
>
> Quality Control (QC) - ensures that GCMC activities are conducted according to approved monitoring specifications and permits.

QC operates in a daily on-site monitoring mode while QA pertains to systems review, data analysis, and audit of program records. Together the two form a coordinated program monitoring and oversight function which keeps management personnel informed of the program's progress and quality. The QC function of the program is carried out and administrated by the GCMC Environmental Engineer, and the QA function is the responsibility of the GCMC Environmental Manager.

The responsibilities for QA and QC are further defined below, within each section of this document.

Reporting of any potential violation will be made to the Environmental Manager as soon as practical after data confirmation. The Environmental Manager is responsible for reporting any exceedance(s) of discharge limitations defined in the APDES permit.

1.6.3. Contract Laboratory Roles and Responsibilities

The administrative and management personnel of the contract laboratories and companies are responsible for carrying out the specific details of laboratory analytical procedures performance, laboratory reports, and administrative oversight for analytical work performed by any subcontract laboratories.

1.6.4. Contract Laboratory Organization

The Contract Laboratory Project Manager is the point of contact between the laboratory and GCMC personnel and is responsible for ensuring that the laboratory data meet the project goals as outlined in this QAPP.

Additional information regarding laboratory organization and chain of command is presented in the laboratory QA/QC plans (available upon request from the Laboratories). The organization charts are accompanied by job descriptions of specific laboratory administrative and management personnel responsible for the administration and management of the GCMC analytical requirements.

1.7. Communication

Communication between the Environmental Manager, Environmental Engineer, and additional Environmental Department staff includes:

- Reports from the Environmental Technicians to the Environmental Engineer.
- Field Data Sheets or log books documenting field procedures by the Environmental staff.

- Daily verbal and/or written reports on the Environmental staff routine field and administrative activities.
- Reports from the Environmental Engineer and Environmental staff to the Environmental Manager.
- Unscheduled reports regarding non-routine events or special occurrences which would trigger additional monitoring and/or unscheduled communication with the appropriate regulatory authorities.

Communications between the contract laboratory and GCMC include:

- Analytical reports usually are provided within thirty days after the receipt of samples by the laboratory for most tests.
- Within 24 hours of sample receipt, ACZ Laboratories will provide to GCMC (via email) project detail information. This includes the laboratory project number, Sample Receipt Form, hold-time review, and Login Review detailing how the project has been input into their database based on the chain-of-custody, requested analyses, and any other communication provided by GCMC. The Environmental staff reviews this information and promptly notifies the laboratory if any errors or omissions are discovered.

1.8. QA/QC Objectives

The QA program assures that the data use and quality requirements of each element of the monitoring program are met. The QA elements listed below provide the mechanism for ongoing control, measurement, and evaluation of data quality throughout the monitoring program.

The following elements of a good QA program are included in this program:

- Staff organization
- Standard operating procedures (SOPs)
- Training requirements for various categories of personnel
- Calibration procedures
- Performance audits
- Procedures for data assessment, reduction, validation, entry in the database and reporting

For laboratory work, QA includes quality control (QC) procedures. Laboratory QC in this program refers to a program consisting of at least the following elements:

- Certification of operator competence
- Recovery of known additions
- Analysis of externally supplied standards
- Analysis of reagent blanks
- Calibration with standards
- Analysis of duplicates
- Maintenance of control charts

1.9. Quantitative QA Objectives: Precision, Accuracy, and Completeness

Table 2 presents a comprehensive list of parameters for the various sampling elements. The sample parameters are cross referenced to the EPA or Standard Methods analytical test methods, and permit

method detection limits/units (MDLs). The methods used for estimating and measuring precision, accuracy and completeness are presented in the contract laboratories' data reports.

Table 2. List of Sampling Parameters

Parameter	Required Sampling Frequency	Sample Type	Sample Container	Sample Preservation	Laboratory	Holding Time	Analytical Method(s)	APDES Permit Limit(s)	Minimum Required Method Detection Limit	Units
EFFLUENT MONITORING OF DOMESTIC WASTE WATER (Internal Locations 010 and 011)										
BOD_5	Monthly	Grab	1 ea. 1-liter plastic bottle	Cool to 4°C	AE	48 hours	EPA 405.1, SM 5210B	None	1.00	mg/L
EFFLUENT MONITORING OF OUTFALL 002										
Flow	Continuous	Continuous monitor	NA	NA	NA	NA	NA	3.7 (avg monthly) 4.6 (max daily)	0.01	mgd
Temperature	Weekly							None	NA	°C
pH	Continuous							6.0 minimum 9.0 maximum	NA	s.u.
Cadmium - TR	Weekly	24-hour composite	1 ea. 250 ml plastic bottle	HNO_3 to pH <2	ACZ	6 months	EPA 200.8	50 (avg monthly) 100 (max daily)	NA	µg/L
Copper - TR	Weekly	(1 sample for all metals)	(1 bottle for all metals)		ACZ		EPA 200.8	39 (avg monthly) 99 (max daily)	NA	µg/L
Lead - TR	Weekly				ACZ		EPA 200.8	123 (avg monthly) 327 (max daily)	NA	µg/L
Total Mercury	Weekly				ACZ	28 days	EPA 245.1	1.0 (avg monthly) 1.9 (max daily)	NA	µg/L
Zinc - TR	Weekly				ACZ	6 months	EPA 200.8	500 (avg monthly) 1,000 (max daily)	NA	µg/L
Total Suspended Solids	Weekly	24-hour composite	1 ea., 500 ml plastic bottle	Cool to 4°C	ACZ	None	EPA 160.2, SM 2540D	20 (avg monthly) 30 (max daily)	NA	mg/L
BOD_5	Monthly	Grab	1 ea., 1 liter plastic bottle	Cool to 4°C	AE	48 hours	EPA 405.1, SM 5210B	None	NA	mg/L
Fecal Coliform Bacteria	Monthly	Grab	1 ea., 125 mL plastic bottle	Cool to 4°C	AE	6-24 hours	SM 9221E	None	NA	MPN/100ml
WAD Cyanide	Weekly	Grab	1 ea., 1 liter plastic bottle	NaOH to pH >12, cool to 4°C	ACZ	14 days	EPA 335.2, SM 4500-CN I,E	9.2 (avg monthly) 19 (max daily)	5	µg/L
RECEIVING WATER COLUMN MONITORING										
Cadmium, Dis.	Quarterly	Grab	1 ea. 250 ml Teflon bottle (1 bottle for all metals)	HNO_3 to pH <2 by lab	BMS	6 months	EPA 213.2/ 1638	NA	0.10	µg/L
Copper, Dis.	Quarterly	Grab				6 months	EPA 220.2/ 1638	NA	0.03	µg/L
Lead, Dis.	Quarterly	Grab				6 months	EPA 239.2/ 1638	NA	0.05	µg/L
Zinc, Dis.	Quarterly	Grab				6 months	EPA 289.2/ 1638	NA	0.20	µg/L
Total Mercury	Quarterly	Grab				28 days	EPA 1631	NA	0.002	µg/L

Parameter	Required Sampling Frequency	Sample Type	Sample Container	Sample Preservation	Laboratory	Holding Time	Analytical Method(s)	APDES Permit Limit(s)	Minimum Required Method Detection Limit	Units
Total Suspended Solids	Quarterly	Grab	1 ea. 500 ml plastic bottle	Cool to 4°C	ACZ	7 days	EPA 160.2, SM 2540D	NA	5.00	mg/L
Turbidity	Quarterly	Grab	1 ea. 125 ml plastic bottle	NA	GCMC	48 hours	EPA 180.1	NA	1.00	NTU
WAD Cyanide	Quarterly	Grab	1 ea 1 liter plastic bottle	NaOH to pH >12, cool to 4°C	ACZ	14 days	EPA 335.2, SM 4500-CN I,E	NA	5.00	µg/L
pH	Quarterly	Grab	NA	NA	Field	15 min	EPA 150.1, SM 4500-H, B	NA	NA	s.u.
Conductivity	Quarterly	Grab	NA	NA	Field	20 days	EPA 120.1	NA	NA	µmhos/cm
Temperature	Quarterly	Grab	NA	NA	Field	15 min	NA	NA	NA	°C
SEDIMENT MONITORING										
Total Cadmium	Annually	Grab	6 each 8 oz Plastic or Glass jar	Freeze sample	ALS		PSEP/GFAA	NA	0.30	mg/Kg
Total Copper	Annually	Grab			ALS		PSEP/ICP	NA	15.00	mg/Kg
Total Lead	Annually	Grab			ALS		PSEP/ICP	NA	0.50	mg/Kg
Total Mercury	Annually	Grab			ALS		PSEP/ EPA 7471A	NA	0.02	mg/Kg
Total Zinc	Annually	Grab			ALS		PSEP/ICP	NA	15.00	mg/Kg
IN-SITU BIOASSAY MONITORING										
Total Cadmium	Annually	Grab	6 each 8 oz Plastic or Glass jar	Freeze sample	ALS		EPA 200.8/ 6020	NA	0.02	mg/Kg
Total Copper	Annually	Grab			ALS		EPA 200.8/ 6020	NA	0.02	mg/Kg
Total Lead	Annually	Grab			ALS		EPA 200.8/ 6020	NA	0.004	mg/Kg
Total Mercury	Annually	Grab			ALS		EPA 7471A	NA	0.01	mg/Kg
Total Zinc	Annually	Grab			ALS		EPA 200.8/ 6020	NA	0.04	mg/Kg
STORM WATER MONITORING										
Oil and Grease (6 of 10 outfalls)	Semi-annual	Grab	1 ea. 1000 ml amber glass jar	Cool to 4°C, H_2SO_4 or HCl	ACZ	28 days	EPA 1664A	None	2.00	mg/L
Lead - TR	Semi-annual	Grab	1 ea. 250 ml plastic bottle	HNO_3 to pH <2	ACZ	6 months	EPA 200.8	0.5	0.10	µg/L
Zinc - TR	Semi-annual	Grab			ACZ	6 months	EPA 200.8	20	2.00	µg/L
Total Suspended Solids	Semi-annual	Grab	1 ea. 500 ml plastic bottle	Keep cool	ACZ	None	EPA 160.2, SM 2540D	None	5.00	mg/L
pH	Semi-annual	Grab	NA	NA	Field	15 min	EPA 150.1, SM 4500-H, B	None	NA	SU
Flow	Semi-annual	Measurement or estimate	NA	NA	Field	NA	NA	None	NA	gpm

Parameter	Required Sampling Frequency	Sample Type	Sample Container	Sample Preservation	Laboratory	Holding Time	Analytical Method(s)	APDES Permit Limit(s)	Minimum Required Method Detection Limit	Units
Hardness	Semi-annual	Grab	1 ea. 250 ml plastic bottle	HNO_3 to pH <2	ACZ	NA	By Calc./EPA 130.2	None	NA	mg/L

1.10. Qualitative QA Objectives: Comparability and Representativeness

Comparability of the data is assured by using EPA or other approved procedures that specify sample collection, handling, and analytical methods. Approved sample collection, handling and analytical methods are presented in the respective sections of this plan.

In addition, comparability can be determined by verifying laboratory analytical results using the following methods:

- Comparison of analytical results from duplicate samples sent to the same laboratory.
- Comparison to laboratory internal QA/QC procedures (e.g. blank analyses, initial calibration verification (ICV), continuing calibration verification (CCV), laboratory control samples (LCS), matrix spike analyses, laboratory replicate analytical results, laboratory reference material analytical results, etc.).
- Comparison of the analytical results from duplicate (split) samples sent to different laboratories.

Representativeness is a measure of how closely the results reflect the actual concentration of the chemical parameters in the medium sampled. Sampling procedures, as well as sample-handling protocols for storage, preservation, and transportation are designed to preserve the representativeness of the samples collected. Proper documentation will confirm that protocols are followed. Representativeness of the samples collected for laboratory analysis is also maintained using QC samples such as trip blanks, field blanks and laboratory method blanks. Documentation procedures and proper sample collection and handling procedures are presented in the following sections of this document.

2. APDES MONITORING SCHEDULE

The APDES monitoring schedule (Table 3) shows the schedule for the six APDES permit program elements, plus the annual Outfall 002 diffuser inspection. Note that the sediment monitoring and the in-situ bioassay monitoring are combined in the Table 3 schedule.

GCMC's Environmental Department staff collects samples for the effluent monitoring of domestic wastewater treatment systems, effluent monitoring of Outfall 002, receiving water column monitoring, and storm water monitoring elements of the program. Marine Taxonomic Services, Ltd., an independent contractor, collects samples for the sediment monitoring and in-situ bioassay monitoring elements, as well as performing the annual Outfall 002 diffuser inspection.

Table 3. Greens Creek Mining Company APDES Sampling Schedule

GCMC SITE NO.	SITE NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
EFFLUENT MONITORING OF DOMESTIC WASTEWATER TREATMENT													
1828	Hawk Inlet SBR, internal monitoring site 010	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]
1469	920 Area SBR, internal monitoring site 011	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]	BOD_5[1]
EFFLUENT MONITORING OF OUTFALL 002													
Site 35	Mine/Mill/Tailings Wastewater Discharge	Group A[2] Group B[3]	Group A[2] Group B[3]	Group A[2] Group B[3]	Group A[2] Group B[3]	Group A[2] Group B[3]	Group A[2] Group B[3]	Group A[2] Group B[3]	Group A[2] Group B[3]	Group A[2] Group B[3]	Group A[2] Group B[3]	Group A[2] Group B[3]	Group A[2] Group B[3]
RECEIVING WATER COLUMN MONITORING													
Site 106	Chatham Strait off of Hawk Point		Group C[4]			Group C[4]			Group C[4]			Group C[4]	
Site 107	Mid-Hawk Inlet off of Cannery		Group C[4]			Group C[4]			Group C[4]			Group C[4]	
Site 108	Hawk Inlet above diffuser of Outfall 002		Group C[4]			Group C[4]			Group C[4]			Group C[4]	
SEDIMENT AND IN-SITU BIOASSAY MONITORING													
Stn 1	Hawk Inlet, off Greens Ck delta, near Outfall 002					TM[5]							
Stn 2	Entrance to Hawk Inlet					TM[5]							
Stn 3	Fjord wall, Hawk Inlet west of Outfall 002					TM[5]							
ESL	Hawk Inlet East Shoal Light aid to navigation piles					TM[5]							
S-1	Hawk Inlet, off Greens Ck delta, near Outfall 002					TM[5], SM[6]							
S-2	Piledriver Cove, South Hawk Inlet					TM[5], SM[6]							
S-4	Hawk Inlet under ore loading facility					TM[5], SM[6]							
S-5N [7]	Hawk Inlet off ship's berth					SM[6]							
S-5S [7]	Hawk Inlet off ship's berth					SM[6]							
STORM WATER MONITORING [8]													

GCMC SITE NO.	SITE NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
527	Southern part of Hawk Inlet facilities near Cannery buildings (Site 003)				Group D[9] Group E[10]						Group D[9] Group E[10]		
520	Pit 7: active rock quarry at 1.8 mile on A-Road (Site 004)				Group D[9] Group E[10]						Group D[9] Group E[10]		
539	West side of Zinc Ck. Bridge at 3.0 mile on B-Road (Site 005.2)				Group D[9] Group E[10]						Group D[9] Group E[10]		
545	Site E: inactive waste rock storage area at 4.5 mile B-Road (Site 005.3)				Group D[9] Group E[10]						Group D[9] Group E[10]		
547	Pit 6: inactive rock quarry and topsoil storage area at 4.6 mile on B-Road (Site 005.4)				Group D[9] Group E[10]						Group D[9] Group E[10]		
560	Culvert at 7.8 mile on B-Road (Site 005.5)				Group D[9] Group E[10]						Group D[9] Group E[10]		
562	Pond D: sediment pond below inactive waste rock storage Site D, off of 8.0 mile on B-Road (Site 006)				Group E[10]						Group E[10]		
565	Pond C: sediment pond below inactive waste rock storage Site C, off of 8.2 mile on B-Road (Site 007)				Group E[10]						Group E[10]		
570	960 Laydown site: inactive waste rock storage site (Site 008)				Group E[10]						Group E[10]		
580	Site 1350 adit: inactive waste rock storage area (Site 009)				Group E[10]						Group E[10]		
OTHER													
108	Annual video inspection of Outfall 002 diffuser					X							

NOTES:

1. Monthly BOD_5, collected on same day as Outfall 002 BOD_5 sampling.
2. Group A: Continuous Flow, pH, temperature measurements.

GCMC SITE NO.	SITE NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC

3. Group B: Weekly total recoverable cadmium, copper, lead and zinc; total mercury; total suspended solids; and WAD cyanide. Monthly BOD_5, and fecal coliform bacteria. See APDES Permit, Table 2, note (d) for cyanide monitoring requirements.

4. Group C: Dissolved cadmium, copper, lead, and zinc; total mercury; total suspended solids; pH, WAD cyanide; temperature; conductivity; and turbidity. Samples collected quarterly, based upon tides. Samples collected on the same day as Outfall 002 sampling, when practicable.

5. TM: Tissue samples analyzed for total levels of cadmium, copper, lead, mercury, and zinc. Samples are collected annually.

6. SM: Sediment analyzed for total cadmium, copper, lead, mercury, and zinc. Samples are collected annually.

7. Sediment samples to be collected at sites S-5S and S-5N once every five years.

8. Per the APDES permit Part 1.6.2.1, monitoring of receiving water upstream and downstream of each storm water outfall shall be conducted semiannually and at the same time each associated outfall is monitored. Parameters are the same as for each outfall. See Section 9 of this QAPP for additional details.

9. Group D: Oil and grease. Samples are collected semi-annually between January - June, and July - December.

10. Group E: Total recoverable lead and zinc, total suspended solids, flow, hardness, and pH. Samples are collected semi-annually between January - June, and July - December.

3. EFFLUENT MONITORING OF DOMESTIC WASTEWATER

Domestic waste water produced at the Greens Creek Mine is treated in two Sequencing Batch Reactor (SBR) treatment units, one located at the Hawk Inlet Camp and one located at the 920 mine/mill area. Effluent from the SBR units is routed to Pond 7 at the Tailings area, where it is combined with mill process water, mine contact water, storm water and intercepted groundwater prior to additional treatment at the Pond 7 Water Treatment Plant and discharge from Outfall 002. Internal monitoring location 010 is the effluent monitoring location for the discharge of treated domestic wastewater from the Hawk Inlet SBR, and internal monitoring location 011 is the effluent monitoring location for the discharge of treated domestic wastewater from the 920 Area SBR.

The monitoring requirements originate from Section 1.4.1 and Table 4 of the APDES permit. The objective is to provide scientifically valid data on specific physical and chemical parameters for the domestic waste water effluent. These data are used to validate that the effluent from the domestic wastewater treatment systems meets secondary treatment standards for BOD_5 as required under 18 AAC 72.050.

The following pages present standard site data (in a format which is common for all APDES sites in this manual), along with information on QA/QC, sampling procedures, and sample preservation and handling. Chain of custody forms, shipping procedures, and data verification are described in **Section 10** of this manual.

Standard Site Data

Monitoring Program Element	Effluent Monitoring of Domestic Wastewater
Site Numbers	010: EDMS Site No. 1828 011: EDMS Site No. 1469
Site Names	010: Hawk Inlet SBR 011: 920 Area SBR
Permit requirement	1.4.1 – Table 4
Objective	Validate that the effluent from the domestic wastewater treatment systems meets secondary treatment standards for BOD_5 as required under 18 AAC 72.050.
Site Identified by	ADEC
History	Routine sampling of both sites began in January 2013
Sampling Frequency	Monthly on same day as Outfall 002 sampling
Sample Parameters (field)	None
Sample Parameters (laboratory)	Monthly grab sample for BOD_5 BOD_5: 1.00 mg/L MDL required
Sample Bottle Set	1 each, 1 liter plastic bottle, preserve by cooling to 4 °C
Laboratory	Admiralty Environmental, Juneau, AK (907 463-4415)

Quality Assurance / Quality Control

3.1.1. Field QA

Environmental monitoring staff shall be required to read this manual and to be fully trained by experienced personnel before being authorized to independently collect field samples. The Environmental Engineer or Manager, who is familiar with the sampling program, shall accompany the technicians once each year on a normal round of sampling for the purpose of evaluating their performance.

Field instrumentation used for measuring field parameters shall be calibrated in accordance with the manufacturer's instructions. All maintenance of field instrumentation required for reliable operation shall be carried out on a regularly scheduled basis. Each calibration effort and all maintenance work shall be entered in the field log. Appendix A of this manual contains field calibration monitoring forms and Appendix B contains field calibration procedures for the continuous monitoring and other instruments used.

Field parameter data (provided on field sheets or log books) and laboratory parameter data (submitted on laboratory reporting forms) shall be entered into the database and checked for accuracy after entry is complete. See Section 10 entitled "Sample Custody and Shipping Procedures and Verification of Data Records" for additional details.

3.1.2. Laboratory QA/QC

A copy of the Admiralty Environmental Quality Assurance/Quality Control Manual is available from the laboratory upon request.

3.2. Sampling Procedures

Sampling is generally conducted on the same day of the week using specific bottle sets, as described in the Standard Site Data table. Field and laboratory parameters, as listed in that table, shall be carried out for each sample collection event.

Pre-cleaned sample containers and caps, as described in the Standard Site Data table, shall be used, and the containers filled to a level which allows for the mixing and preservation of the sample.

Sample parameters for field measurement are listed in the Standard Site Data table and shall be measured after the sample is collected, to minimize the potential for contamination.

Containers for each sample shall be marked at the time of sampling with the name and number of the sample site, date, time of collection, and type of preservative used, if any. Each sample shall be recorded in a log book documenting:

- Name of sample collector(s)
- Identification of sampling site
- Date and time of collection
- Comments on site conditions

3.3. Sample Preservation and Handling

The preservation requirements for each sample set are specified in the Standard Site Data table above and also in Table 2. Sample preservation methods are intended to retard biological activity, hydrolysis,

and container surface sorption effects. Preservation methods include pH control (acid or base addition), refrigeration, and protection from light.

A pH controlled sample is one in which an acid (nitric acid in the case of metals samples) or a base (e.g. sodium hydroxide) is added to the sample container before the sample is taken or as soon as possible after the sample is collected. pH control preserves the true concentrations of the compounds or elements of interest that might be in solution. A non-preserved sample is one in which no preservative is added because such an addition might change the concentration of an analyte of interest (such as pH, turbidity, and suspended solids).

Sample containers shall be stored in a refrigerator prior to shipping. A sample temperature of 4°C is preferable for sample storage and shipment.

4. EFFLUENT MONITORING OF OUTFALL 002

The process waste water discharge is identified in the APDES permit as "Outfall 002", and is identified as Site 35 in GCMC's database. Under normal operating conditions all collected waste waters from the Hawk Inlet Camp area, the 920 mine/mill area, as well as the adjacent Tailings area are pumped to the Tailings area collection facilities, where they are combined prior to treatment and discharge from Outfall 002.

The sampling site is physically located inside the water treatment plant. Sampling equipment and instrumentation collect continuous flow, pH, and water temperature data. Samples are collected weekly by GCMC Environmental Department staff and sent to a laboratory for metals, total suspended solids, and WAD cyanide analyses. Monthly samples are collected for BOD_5 and fecal coliform bacteria.

The monitoring requirements originate from Section 1.2.1 and Table 2 of the APDES permit. The objective is to provide scientifically valid data on specific physical and chemical parameters for the combined mine and mill process waste water effluent, treated domestic waste water effluent, and collected area runoff waste water effluent discharge. These data are used to evaluate and report compliance in meeting the effluent limitations of the APDES permit for Outfall 002.

The following pages present standard site data (in a format which is common for all APDES sites in this manual), along with information on QA/QC, sampling procedures, and sample preservation and handling. Chain of custody forms, shipping procedures, and data verification are described in **Section 10** of this manual.

Standard Site Data

Monitoring Program Element	Effluent Monitoring of Outfall 002
Site Number	35
Site Name	Mine and Mill Site Process Waste Water effluent, treated domestic waste water, and area runoff effluent discharge
Permit requirement	1.2.1 – Table 2
Objective	To provide scientifically valid data on specific physical and chemical parameters for the mine and mill process waste water effluent. These data are used to evaluate and report compliance in meeting the effluent limitations of the APDES permit for Outfall 002.
Site Identified by	ADEC
History	Sampling began in February, 1989 and continues
Sampling Frequency	Continuous/Daily/Weekly/Monthly (see APDES sampling schedule for specifics)
Sample Parameters (field)	Continuous flow (mgd), pH (su) and Temperature (°C)
Sample Parameters (lab)	Weekly 24-hour composite samples for TR or total metals, total suspended solids, and WAD cyanide, : Total recoverable Cadmium Total recoverable Copper Total recoverable Lead Total Mercury Total recoverable Zinc Total Suspended Solids WAD Cyanide Monthly grab samples for: 5-day Biological Oxygen Demand Fecal Coliform Bacteria;
Sample Bottle Set	1 each Metals: 250 ml plastic bottle; preserved with HNO_3 to pH <2 1 each Total Suspended Solids: 500 ml plastic bottle; no preservative (keep cool) 1 each WAD Cyanide: 250 ml plastic bottle; preserved with NaOH to pH >12 1 each, 1 liter cubitainer for BOD5, preserve by cooling to 4 °C 1 each, 125 ml plastic bottle for fecal coliform bacteria; preserved with $Na_2S_2O_3$, cool to 4 °C
Laboratory	ACZ Laboratories, Inc., Steamboat Springs, CO (800 334-5493) Admiralty Environmental, Juneau, AK (907 463-4415)

4.1. Quality Assurance / Quality Control

4.1.1. Field QA

Environmental monitoring staff shall be required to read this manual and to be fully trained by experienced personnel before being authorized to independently collect field samples. The Environmental Engineer or Manager, who is familiar with the sampling program, shall accompany the technicians once each year on a normal round of sampling for the purpose of evaluating their performance.

Field instrumentation used for measuring field parameters shall be calibrated in accordance with the manufacturer's instructions. All maintenance of field instrumentation required for reliable operation shall be carried out on a regularly scheduled basis. Each calibration effort and all maintenance work shall be entered in the field log. Appendix A of this manual contains field calibration monitoring forms and Appendix B contains field calibration procedures for the continuous monitoring and other instruments used.

Field parameter data (provided on field data sheets or log books) and laboratory parameter data (submitted on laboratory reporting forms) shall be entered into the database and checked for accuracy after entry is complete. See Section 10 entitled "Sample Custody, Shipping Procedures and Verification of Data Records" for additional details.

4.2. Laboratory QA/QC

Copies of the ACZ Laboratories, Inc. and Admiralty Environmental Quality Assurance/Quality Control Manual are available from the labs upon request.

4.3. Sampling Procedures

On a weekly basis, an automated composite sampler will collect flow proportioned aliquots of the effluent discharge over a 24-hour period. Samples will be collected from the 24-hour composite on the same day each week (generally between 2pm-5pm Monday to between 2pm-5pm Tuesday) unless an alternate day is necessary due to facility maintenance activities or laboratory schedule.

To collect the weekly composite samples:

- Halt the program on the Sigma sampler.
- Disconnect the sample feed tubing and float sensor from the top of the composite bottle and remove the bottle from the refrigerator.
- Gently swirl the bottle to mix the contained water and place the bottle on the laboratory bench.
- Wearing clean gloves, rotate the spigot on the bottom of the composite bottle and then fill the required sample bottles from the spigot.
- Once the required samples are collected, empty the container by pouring the remaining water into the WTP sink.
- Clean the composite bottle and spigot using a brush and de-ionized water with a mild detergent (e.g., alconox) and then thoroughly rinse with de-ionized water.
- Rotate the spigot on the composite bottle 90 degrees, place it in the refrigerator and connect the sample feed tubing and thermometer.
- Program the Sigma sampler for the next week's composite sample. Refer to the sampling schedule posted on the cabinet in the laboratory and the programming flow chart.

The monthly grab samples for BOD_5 and fecal coliform will be collected at the same time as the corresponding weekly composite samples. These samples are collected from the fresh effluent supply valve and port located at the sink. The valve shall be opened and the line allowed to flush for at least ten seconds prior to filling the sample bottles.

Pre-cleaned sample containers and caps, as described in the Standard Site Data table, shall be used, and the containers shall be filled to a level which allows for the mixing of the preservative and the sample.

Containers for each sample shall be marked at time of sampling with the name and number of the sample site, date, time of collection, and type of preservative used, if any. Each sample shall be recorded on field data sheets documenting:

- Name of sample collector(s)
- Identification of sampling site
- Date and time of collection
- Field analysis data and comments on site conditions

Instrumentation for the continuously monitored field parameters is permanently installed in the sampling room at the water treatment plant, and is downloaded at least daily via a Campbell Scientific CR1000 datalogger.

4.4. Sample Preservation and Handling

The preservation requirements for each sample set are specified in the Standard Site Data table above. Sample preservation methods are intended to retard biological activity, hydrolysis, and container surface sorption effects. Preservation methods include pH control (acid or base addition), refrigeration, and protection from light.

A pH controlled sample is one in which an acid (nitric) or a base (sodium hydroxide) is added to the sample container before the sample is taken or as soon as possible after the sample is collected. pH control preserves the true concentrations of the compounds or elements of interest that might be in solution. A non-preserved sample is one in which no preservative is added because such an addition might change the concentration of an analyte of interest (such as pH, turbidity, and suspended solids). Nitric acid preservation requires the addition of just enough HNO_3 to preserve the sample to a pH <2 S.U. Sodium hydroxide preservation requires the addition of 1 to 2 sodium hydroxide granules to a 250 ml sample.

Sample containers shall be stored in a refrigerator prior to shipping, and during compositing. A sample temperature of 4°C is preferable for sample storage and shipment (40 CFR 136.3(e) table ii).

5. EFFLUENT TOXICITY TESTING OF OUTFALL 002

Effluent toxicity testing, conducted since the mining operations began, was discontinued with the NPDES Permit #004320-6 reissued effective 1 July 2005. Over the 21 years of initially acute toxicity testing (February 1989 – October 1998), and then chronic toxicity testing (November 1998 – June 2005) no sublethal deleterious effects to marine organisms in Hawk Inlet from prolonged exposure to the treated GCMC effluent was determined to be likely. "The data show that the effluent from Outfall 002 has no reasonable potential to contribute to an exceedence of the (Alaska) WQS for toxicity." (USEPA Fact Sheet dated October 28, 2004; page 14, Section VI.B Whole Effluent Toxicity Testing). The ADEC concluded that "[S]ince the characteristics of the effluent remain unchanged, this permit does not require WET monitoring" (Alaska Pollutant Discharge Elimination System Permit Fact Sheet; page 19, Section 5.7 Whole Effluent Toxicity Monitoring).

6. RECEIVING WATER COLUMN MONITORING

Three ocean sites in Hawk Inlet are sampled to monitor potential water quality effects from the mine. Seawater samples are collected quarterly from the sites on an outgoing tide, with the Chatham Strait sample (Site 106) collected just after low slack water. A map showing the sampling locations is provided as Figure 2 in the APDES permit. Samples are collected and sent to Battelle Marine Science Laboratory in Sequim, Washington, for low level trace metals analyses, and to ACZ Laboratories in Steamboat Springs, Colorado for WAD CN, and total suspended solids. Temperature, conductivity, pH and turbidity are measured in the field by the Environmental staff.

The monitoring requirements originate from Section 1.6.1 and Table 5 of the APDES permit. The objective of the receiving water column monitoring element of the sampling program is to provide scientifically valid data on specific physical and chemical parameters for Hawk Inlet water quality. These data are used to evaluate potential changes in the Hawk Inlet marine environment and are reported to ADEC, as required by the APDES permit.

The following pages present standard site data (in a format which is common for all APDES sites in this manual), along with information on QA/QC, sampling procedures, sample preservation and handling. Details on chain of custody forms, shipping procedures, and data verification are presented in **Section 10** of this manual.

Standard Site Data

Monitoring Program Element	Receiving Water Column Monitoring
Site Numbers	106, 107, and 108
Site Names	106: Chatham Strait off Hawk Inlet 107: Mid-Hawk Inlet off of Cannery 108: Hawk Inlet, above Outfall 002 diffuser
Permit requirement	1.6.1 – Table 5
Objective	To provide scientifically valid data on specific physical and chemical parameters for Hawk Inlet water quality. These data are used to evaluate potential changes in the Hawk Inlet marine environment and are reported to ADEC, as required by the APDES permit
Site Identified by	EPA and ADEC
History	Sampling began in November, 1982 and continues
Sampling Frequency	Quarterly (see APDES sampling schedule for specifics)
Sample Parameters(field)	Temperature (°C), Conductivity (µmhos), Turbidity (NTU), and pH (SU) at a depth of 5 feet
Sample Parameters (laboratory)	<u>Battelle Marine Sciences:</u> Dissolved Cadmium: 0.10 µg/L MDL required Dissolved Copper: 0.03 µg/L MDL required Dissolved Lead: 0.05 µg/L MDL required Total Mercury: 0.002 µg/l MDL required Dissolved Zinc: 0.20 µg/L MDL required <u>ACZ Laboratories:</u> WAD cyanide 5.00 ug/L MDL required Total Suspended Solids 5.00 mg/L MDL required
Sample Bottle Set	<u>Battelle:</u> 1 each per location (metals): 500 ml Teflon bottle; filtered; preserved with HNO_3 to pH <2 by laboratory 1 each per location (mercury): 250 ml Teflon bottle; preserved with HNO_3 to pH <2 by laboratory <u>ACZ Laboratories:</u> 1 each per location (WAD-cyanide): 500 ml plastic bottle; preserve with NaOH 1 each per location (pH, conductivity, TSS, and turbidity): 500 ml plastic bottle; preserve by keeping cool
Laboratory	Battelle Marine Sciences Laboratory. Sequim, WA (360-681-3627) ACZ Laboratories, Steamboat Springs, CO (800 334-5493)

6.1. Quality Assurance / Quality Control

6.1.1. Field QA

Environmental monitoring staff shall be required to read this manual and to be fully trained by experienced personnel before being authorized to independently collect seawater samples. The Environmental Engineer or Manager shall accompany the field staff once each year on a normal round of sampling for the purpose of evaluating their performance.

Field instrumentation used for measuring field parameters shall be calibrated in accordance with the manufacturer's instructions. All maintenance of field instrumentation required for reliable operation shall be carried out on a regularly scheduled basis. Each calibration effort and all maintenance work shall be entered in the instrument log.

For each site, the field data sheet or log book shall include the following information:

- Name of sample collectors
- Identification of sampling site
- Date and time of collection
- Weather and wind conditions
- Temperature, conductivity and pH data
- Depth of each sample
- Comments on site conditions or problems

Field parameter data (provided on field data sheets or log books) and laboratory parameter data (submitted on laboratory reporting forms) shall be entered into the database and checked for accuracy after entry is complete. See Section 10 under the paragraph entitled "Data Verification" for additional details.

6.1.2. Laboratory QA/QC

A copy of Battelle Marine Sciences Laboratory's Quality Assurance/Quality Control Manual is available from the Laboratory upon request. A copy of ACZ Laboratories' Quality Assurance/Quality Control Manual is available from the Laboratory upon request.

6.2. Sampling Procedures

On a quarterly basis, samples are collected from the Hawk Inlet receiving water sample locations. To the extent practicable, receiving water sample collection must occur on the same day as effluent sample collection (Permit section 1.6.3.2). Sampling is scheduled to occur during low tide. The samples are collected in pre-cleaned bottle sets provided by the laboratories involved in the program. Field and laboratory parameters listed on the Standard Site Data table shall be carried out for each sample collected.

Field measurements for water temperature, conductivity, and pH are taken at each sampling site by lowering the probe from the meter into the water. Field measurements shall be conducted before samples are collected and must be recorded on a field data sheet or log book documenting:

- Name of the sample collectors
- Identification of the sampling site
- Date and time of collection
- Field analysis

- Comments on site conditions and weather

Equipment needed to collect the field measurements and water samples consists of:

- Peristaltic pump sampler (clean outer case prior to placing in boat)
- Bottles and cleaned tubing from the laboratory
- Water meters for field measurements
- Ice chest & blue ice
- Clean gloves

To collect a water sample requires three people: one to steady the boat at the sample location, and two others to collect the sample. Both the field measurements and laboratory samples are taken at a depth of 5 feet. Sample collection will follow the clean hands/ dirty hands procedure. The person holding the peristaltic pump and sample line to depth will be designated as "dirty hands" while "clean hands" fills the sample bottles. Use extreme care to not contaminate the sampling equipment.

While wearing clean gloves, clean hands will complete label identification on the WAD-cyanide bottle and 500 ml TSS, pH and conductivity bottle. The total mercury bottle and dissolved metals bottle will be removed from their outer bag. Dirty hands will start the peristaltic pump and discharge a small volume to rinse the tubing. Clean hands will triple-rinse and then fill the 500 ml bottle for TSS, pH and conductivity. Next, the WAD-cyanide bottle will be filled (this bottle is pre-preserved with NaOH and is not rinsed prior to filling). Clean hands will then change gloves prior to removing the 250 ml total mercury bottle from its inner bag. With clean gloves, remove the cap and triple-rinse the total mercury bottle prior to filling with sample. When full to within ¼ inch below the neck, promptly secure the cap and re-seal within the inner zip-lock bag. Dirty hands will turn off the pump while clean hands attaches the laboratory supplied 0.45 micron filter to the tubing. Dirty hands will turn on the pump and flush a small volume of water through the filter. Clean hands will open the inner zip-lock bag on the 500 ml dissolved metals bottle, remove the cap and triple-rinse the bottle prior to filling with sample. When full to within ¼ inch below the neck, promptly secure the cap and re-seal within the inner zip-lock bag. Seal the total mercury and dissolved metals bottles in their outer zip-lock bags and stow in the shipping container on gel-ice.

The trace metals samples should be kept cool and shipped as soon as possible via Alaska Airlines air freight to Battelle Pacific Northwest Laboratories in Sequim, Washington.

6.3. Sample Preservation and Handling

Battelle samples are preserved by the laboratory, using nitric acid (HNO_3) to a pH of less than 2 S.U. (<2). The samples are not analyzed sooner than 24 hours after preservation. Regulations (40 CFR 136.3 Table II) state that an aqueous sample can be sent unpreserved and then preserved by the laboratory, if acid is added at least 24 hours prior to analysis to dissolve any metals that absorb to the container walls. The ACZ Laboratories WAD-cyanide sample is preserved using sodium hydroxide (NaOH) to a pH of greater than 12 S.U. (>12). No preservative is used in the other ACZ samples, but these must also be kept cool.

Sample preservation methods are intended to retard biological activity, hydrolysis, and container surface sorption effects. Preservation methods include pH control (acid or base addition), refrigeration, and protection from light.

A pH controlled sample is one in which an acid (nitric) or a base (sodium hydroxide) is added to the sample container before the sample is taken or as soon as possible after the sample is collected. pH control

preserves the true concentrations of the compounds or elements of interest that might be in solution. A non-preserved sample is one in which no preservative is added because such an addition might change the concentration of the particular water properties of interest (such as pH, turbidity, and suspended solids).

Nitric acid preservation requires the addition of just enough HNO_3 to preserve the sample to a pH of <2 S.U. Sodium hydroxide preservation requires the addition of 2 to 3 sodium hydroxide granules to a 500 ml sample. The preservation requirements for each sample set are specified in the Standard Site Data table above.

Sample containers are kept cold prior to shipping. A sample temperature of 4° C is preferable for sample storage and shipment.

7. SEDIMENT MONITORING

In 1983 environmental studies were conducted in Hawk Inlet in the shallow area adjacent to the Greens Creek Delta to aid in selecting a location for the tailing impoundment discharge. Physical studies demonstrated that this area, known as the sill site, has a high tidal velocity so the resultant dispersion and mixing would minimize the size of a proposed outfall effluent dilution zone. The high tidal velocities also keep sediment deposition in the sill area to a minimum, so the potential for heavy metal buildup from a discharge would be greatly reduced. Biological studies at the sill area further identified a resilient intertidal fauna which would recover quickly from disturbance during pipeline construction. Consequently, the sill area was selected as the location and the tailings impoundment discharge diffuser was installed there in 1988. In most areas of Hawk Inlet, other than the sill, the bottom is covered with sediment. Sediment samples are collected at four sites in lower Hawk Inlet and analyzed for trace metals concentrations.

The requirements for the sediment monitoring element originate from Section 1.6.1.2, Sediment Monitoring, and Table 6 of the APDES permit. The objective of this element of the monitoring program is to provide scientifically valid data on five specific trace metal parameters from sediments at four locations in Hawk Inlet. These data are used to evaluate potential changes in the Hawk Inlet marine environment and are reported to ADEC, as required by the APDES permit.

Detection of very small changes in the Hawk Inlet ecosystem requires a high-resolution sampling program that has the ability to detect longer-term, subtle changes in specific metals to determine if they are increasing in concentration in the sediments of the inlet. Based on existing geology and testing for background levels of trace metals, sediment monitoring had focused on copper, zinc, lead, mercury, cadmium, arsenic, chromium, nickel, selenium, and silver in sediments throughout the inlet. With reissuance of the NPDES permit in November 1998, continued monitoring focused specifically on cadmium, copper, lead, mercury, and zinc in the sediments. The July 2005 reissued NPDES permit continued this focus. With the exception of frequency and number of samples, the sediment monitoring requirements in the October 1, 2015 APDES permit are the same as required in the 2005 permit.

Changes to the sediment monitoring requirements include reducing the frequency from twice annual sampling events at S-1 (Greens Creek delta), S-2 (Pile Driver Cove near mouth of inlet), and S-4 (near the ore dock) to once annually and adding a requirement to collect six samples at each site annually. In addition, the sampling sites under the ship's berth near the old cannery (sites S-5N and S-5S) are required to be sampled once every five years. A map showing the sampling locations is provided as Figure 2 in the APDES permit. The samples are analyzed at ALS Environmental in Kelso, Washington for total concentrations of the five trace metals.

The following pages present standard site data (in a format which is common for all NPDES sites in this manual), along with information on QA/QC, sampling procedures, and sample preservation and handling. Details on chain of custody, shipping procedures, and verification of data records are presented in **Section 10** of this manual.

Standard Site Data

Monitoring Program Element	Sediment Monitoring
Site Number	Stations S-1, S-2, S-4, and S-5
Site Name	S-1: Greens Creek Delta S-2: Pile Driver Cove S-4: Ore Loading Facility S-5: Ship's Berth (5N and 5S)
Permit requirement	1.6.1.2 - Table 6
Objective	To provide scientifically valid data on five specific trace metal parameters in the sediments of Hawk Inlet. These data are used to evaluate potential changes in the Hawk Inlet marine environment and are reported to ADEC, as required by the APDES permit.
Site Identified by	ADEC
History	Sampling began in September 1984 and continues
Sampling Frequency	Annually (see APDES sampling schedule for specifics)
Sample Parameters (field)	None
Sample Parameters (laboratory)	Total Cadmium: 0.30 mg/Kg MDL required Total Copper: 15.00 mg/Kg MDL required Total Lead: 0.50 mg/Kg MDL required Total Mercury: 0.020 mg/Kg MDL required Total Zinc: 15.00 mg/Kg MDL required
Sample Set	6 each for each sampling location: 8 oz. plastic or glass jar (plastic or glass) for sediment. Preserve by freezing.
Laboratory	ALS Environmental, Kelso, WA (360-577-7222)

7.1. Quality Assurance / Quality Control

7.1.1. Field QA

Field monitoring staff involved in this element of the APDES sampling program shall be professional oceanographers (or equivalent discipline) with direct experience collecting sediment samples. The sampling shall be done in accordance with normally accepted professional standards for this type of work.

Laboratory parameter data (submitted on laboratory reporting forms) shall be entered into a database and checked for accuracy after entry is complete. See Section 10 for additional details.

7.1.2. Laboratory QA/QC

A copy of the ALS Environmental Quality Assurance Manual and Standard Operating Procedures are available from the laboratory upon request.

7.2. Sampling Procedures

Annual sampling for the sediment monitoring element of the APDES monitoring program is carried out on a contract basis by professional oceanographers who are experienced in this type of sampling. Each time they travel to Hawk Inlet to perform in-situ bioassay sampling, they also complete the required sediment sampling. Sampling procedures are summarized in the following paragraphs

Sample bottles, as described in the Standard Site Data table, are prepared with blank labels by the professional sampling staff prior to traveling to Hawk Inlet. A sampling staff of three generally performs the field work, and all sampling must occur during periods when the tide elevation is below +1 foot. One site, Station S-5 "Ship's Berth," must be accessed by divers using scuba gear, or through the use of a dredge. The professional sampling staff is responsible for providing their own scuba equipment, for maintaining current diving certificates for all individuals who dive, and for providing adequate safety training for this activity.

Once on site, samples of the sediment as described in the applicable Standard Site Data table shall be collected. After each sample is collected, the following information shall be provided on the label:

- Date
- Time sample was collected
- Site number and name
- Name of person collecting sample
- Sample matrix

Immediately after collection, the sample jars shall be placed in a cooler while they are being transported to the GCMC field laboratory (which is located near the Hawk Inlet port facilities). There is a freezer at the field laboratory and all samples shall be placed in the freezer as soon as possible after they are collected. All samples shall be completely frozen within 6 hours of having been collected. Once all samples have been collected and frozen, they shall be air freighted to the analytical laboratory specified on the applicable Standard Site Data tables. Chain of custody protocol, as described in **Section 10** of this manual, shall be followed for sample shipments.

7.3. Sample Preservation and Handling

The preservation requirements for each sample set are specified in the Standard Site Data table above. Sample preservation methods are intended to retard biological activity, hydrolysis, and container surface sorption effects. Preservation of all sediment samples shall be by freezing.

Sample containers shall be stored in a freezer prior to shipping, and in a cooler during shipment.

8. IN-SITU BIOASSAY MONITORING

The requirements for the in-situ bioassay element of the monitoring program originate from Section 1.6.1.3, In-Situ Bioassy, and Table 7 of the APDES permit. The objective of this element of the monitoring program is to provide scientifically valid data on five specific trace metal parameters from the tissues of two polychaete worm species and bay mussels located at seven locations in Hawk Inlet. These data are used to evaluate potential changes in the Hawk Inlet marine environment and are reported to ADEC, as required by the APDES permit.

Detection of very small changes in the Hawk Inlet ecosystem requires a high-resolution sampling program that has the ability to detect longer-term, subtle changes in specific metals to determine if they are biomagnifying in the tissues of selected organisms in the inlet. Based on existing geology and testing for background levels of trace metals, bioassay monitoring had focused on copper, zinc, lead, mercury, cadmium, arsenic, chromium, nickel, selenium, and silver in three species of polychaete worms, littleneck and soft shelled clams throughout the inlet. With reissuance of the NPDES permit in November 1998, continued monitoring then focused specifically on cadmium, copper, lead, mercury, and zinc in two species of polychaetes and bay mussels at a total of seven locations in Hawk Inlet. The July 2005 reissued NPDES permit continued this focus. Changes to the in-situ bioassay monitoring requirements in the October 1, 2015 APDES permit include addition of a requirement to conduct six analyses at each site annually and reducing the minimum monitoring frequency from twice annually to once per year.

In-situ bioassay sampling in Hawk Inlet consists of annual testing of trace metal tissue burdens of selected species of invertebrate organisms with different feeding guilds. The specimens are collected from a series of sites within and around the APDES Outfall 002 mixing zone and at reference sites throughout Hawk Inlet. Four sampling sites are used only for bay mussel sampling, while three other sites are used for polychaete worm sampling. A map showing the sampling locations is provided as Figure 2 in the APDES permit.

Sediment dwelling polychaete worms (Nephthys procera and Nereis sp.) must be collected from three pre-existing sampling location (locations S-1, S-2 and S-4). These locations are the same as required for the sediment sampling, except bioassays are not required at location S-5 since the polychaete test organisms do not occur at location S-5. Samples of the filter feeding mussel (*Mytilus edulis*) are collected from Stations 1, 2, 3 and East Shoal Light (ESL). Sites Stn 2 and Stn 3 represent background conditions. Locations ESL and Stn 1 are in the area influenced by outfall 002. All tissue samples are analyzed for cadmium, copper, lead, mercury and zinc.

The following pages present standard site data (in a format which is common for all APDES sites in this manual), and information on QA/QC, sampling procedures, sample preservation and handling. Details on chain of custody forms, shipping procedures, and data verification are presented in **Section 10** of this manual.

Standard Site Data

Monitoring Program Element	In-Situ Bioassay Monitoring
Site Number	Stations 1, 2, 3, East Shoal Light (ESL), S-1, S-2, and S-4
Site Name	Bay Mussels: Station 1: Outfall Terminus Station 2: West Entrance to Hawk Inlet Station 3: Fjord Wall West of Terminus ESL: East Shoal Light Polychaete species. worms: S-1: Greens Creek Delta S-2: Pile Driver Cove S-4: Port Facility
Permit requirement	1.6.1.3 – Table 7
Objective	To provide scientifically valid data on five specific trace metal parameters in the tissues of polychaete worms and bay mussels located in Hawk Inlet. These data are used to evaluate potential changes in the Hawk Inlet marine environment and are reported to ADEC, as required by the APDES permit.
Site Identified by	ADEC
History	Sampling began in September 1984 and continues
Sampling Frequency	Annually (see APDES Sampling Calendar for specifics)
Sample Parameters (field)	None
Sample Parameter (laboratory)	Total Cadmium: 0.02 mg/Kg MDL required Total Copper: 0.02 mg/Kg MDL required Total Lead: 0.004 mg/Kg MDL required Total Mercury: 0.01 mg/Kg MDL required Total Zinc: 0.04 mg/Kg MDL required
Sample Set	6 analyses for each sample location: 8 oz. jar (plastic or glass) for mussel or polychaete worm tissue. Preserve sample by freezing.
Laboratory	ALS Environmental, Kelso, WA (360-577-7222)

8.1. Quality Assurance / Quality Control

8.1.1. Field QA

Field monitoring staff involved in this element of the APDES sampling program shall be professional oceanographers (or equivalent discipline) with direct experience identifying and sampling invertebrate species. The sampling shall be done in accordance with normally accepted professional standards for this type of work.

Laboratory parameter data (submitted on laboratory reporting forms) shall be entered into a database and checked for accuracy after entry is complete. See Section 10 for additional details.

8.1.2. Laboratory QA/QC

A copy of the ALS Environmental Quality Assurance Manual and Standard Operating Procedures are available from the Laboratory upon request.

8.2. Sampling Procedures

Annual in-situ bioassay sampling is carried out on a contract basis by professional oceanographers who are experienced in this type of sampling. Each time they travel to Hawk Inlet to perform in-situ bioassay sampling they also complete the required sediment sampling. Sampling procedures are summarized in the following paragraphs.

Sample bottles, as described in the Standard Site Data table, are prepared with blank labels by the professional sampling staff prior to traveling to Hawk Inlet. A sampling staff of three generally conducts the field work, and all sampling must occur during periods when the tide elevation is below +1 foot. The professional sampling staff is responsible for providing their own scuba equipment and for maintaining current diving certificates for all individuals who dive, and for providing adequate safety training for this activity.

It is essential that the person collecting the invertebrate samples be able to correctly identify the various species. Samples of bay mussels (*Mytilus edulus*) shall be shucked and cleaned before being placed in the sample jar. Samples of polychaete worms shall be washed before being placed in the sample jar.

After each sample is collected, the following information shall be provided on the label:

- Date
- Time sample was collected
- Site number and name
- Name of person collecting sample
- Sample matrix

Immediately after collection, the sample jars shall be placed in a cooler while they are being transported to the GCMC field laboratory (which is located near the Hawk Inlet Cannery). There is a freezer at the field laboratory and all samples shall be placed in the freezer as soon as possible after they are collected. All samples shall be completely frozen within 6 hours of having been collected. Once all samples have been collected and frozen they shall be air freighted to the analytical laboratory specified on the Standard Site Data table. Chain of custody protocol, as described in **Section 10** of this manual, shall be followed for sample shipments.

8.3. Sample Preservation and Handling

The preservation requirements for each sample set are specified in the Standard Site Data table above. Sample preservation methods are intended to retard biological activity, hydrolysis, and container surface sorption effects. Preservation of all in-situ bioassay samples shall be by freezing.

Sample containers shall be stored in a freezer prior to shipping and in a cooler during shipment.

9. STORM WATER MONITORING

Storm water monitoring is required by Section 1.3 and Table 3 of the APDES permit. Samples are collected once during the spring runoff or snow melt and once during the fall rainfall events, at each of 10 representative sites identified in Section 1.3, Table 3 of the permit. Samples from all 10 sites are analyzed for total recoverable lead and zinc, total suspended solids, hardness and pH. Samples from six of the sites also are analyzed for oil and grease. Storm water discharge volume (in gallons) for each location must be estimated based on observation of the outfall, duration of the event, and best professional judgment.

The objective of the storm water monitoring element is to provide scientifically valid data on specific physical and chemical parameters from storm water runoff at the 10 specified locations around the Mine. These data are used to evaluate the potential effects of storm water runoff to nearby water bodies and are reported to ADEC, as required by the APDES permit.

A map showing the approximate location of each storm water outfall is provided as Figure 1 in the APDES permit. The following pages present standard site data (in a format which is common for all APDES sites in this manual) and information on QA/QC, sampling procedures, and sample preservation and handling. Chain of custody forms, shipping procedures, and data verification are described in **Section 10** of this manual.

The APDES permit effective October 1, 2015 additionally requires development of a Storm Water Receiving Waterbody Monitoring Program in Section 1.6.2, with reference to Table 3 Storm Water Outfall Monitoring Requirements of the permit. The new sampling sites are:

- to be situated "…in the receiving water directly upstream and downstream of where each storm water outfall enters the receiving water. The storm water outfalls and parameters which must be monitored are shown in Table 3."
- to be monitored "…semiannually and at the same time (within three hours) as each associated outfall sample."
- to be monitored with "…grab samples."
- to have the samples analyzed using "…methods that can achieve an MDL less than 0.5 ug/l for lead and 20 ug/l for zinc."

Standard Site Data

Monitoring Program Element	Storm Water Monitoring
Site Numbers	527, 520, 539, 545, 547, 560, 562, 565, 570, and 580
Site Names	527: Southern part of Hawk Inlet facilities near "cannery" buildings (APDES site 003) at pipe under facilities 520: Pit 7 (APDES site 004) north side of access road 539: North side of Zinc Creek Bridge (APDES site 005.2) off the uphill side 545: Waste Rock Site "E" (APDES site 005.3) off downhill side of B road at 4.5 mile 547: Pit 6 (APDES site 005.4) uphill side of B road at 4.6 mile 560: Culvert at mile 7.8 on "B" Road (APDES site 005.5) 562: Pond "D" (APDES site 006) overflow 565: Pond "C" (APDES site 007) effluent at bottom of pond structure 570: 980 Laydown Site (APDES site 008) 580: 1350 Adit Waste Rock Storage Area (APDES site 009)
Permit Requirement	1.3 – Table 3 and 1.6.2
Receiving Water Site Names	532: Pit 7 upstream of 004 524: Pit 7 downstream of 004 529: Floatplane dock at Hawk Inlet for 003 371: Zinc Creek upstream of 005.2 368: Middle Zinc Creek below bridge downstream of 005.2 595: Greens Creek upstream of 005.3 and 005.4 591: Greens Creek downstream of 005.3 and 005.4 590: Greens Creek below 7.6 mile B road downstream of 005.5 and 006 6: FWMP Site 6; upstream for 005.5 and 006, downstream for 007 and 008 1: Inactive FWMP site at Greens Creek weir; upstream for 007 and 008, downstream for 009 48: FWMP Site 48, upstream for 009
Objective	Provide scientifically valid data on storm water runoff to evaluate its potential effects to nearby water bodies and report that data to ADEC, as required by the APDES permit.
Site Identified by	ADEC
History	Sampling began in 1997 and continues
Sampling Frequency	Semi-annual (see APDES sampling schedule for specifics)

Sample Parameters (field)	Flow: gpm estimated; pH (SU)
Sample Parameters (laboratory)	<u>Sites 527, 520, 539, 545, 547, 560, 532, 524, 529, 371, 368, 591, 595, and 590:</u> Oil and Grease <u>All sites:</u> Total recoverable Lead: 0.5 µg/L MDL required Total recoverable Zinc: 20.00 µg/L MDL required Total Suspended Solids Hardness
Sample Bottle Set	<u>Sites 527, 520, 539, 545, 547, 560, 532, 524, 529, 371, 368, 591, 595, and 590</u> Oil and Grease: 1 each (for each site),1000 ml amber glass bottle; preserve with H_2SO_4 or HCl (~2 ml) <u>All sites:</u> Metals: 1 each (for each site), 250 ml plastic bottle; preserve with HNO_3 to pH <2 Total Suspended Solids and pH: 1 each (for each site), 500 ml plastic bottle; no preservative (keep it cool) Total Hardness: 1 each (for each site), 125 ml plastic bottle; preserve with HNO_3 to pH <2
Laboratory	ACZ Laboratories, Steamboat Springs, CO (800 334-5493)

9.1. Quality Assurance / Quality Control

9.1.1. Field QA

Environmental monitoring staff shall be required to read this manual and to be fully trained by experienced personnel before being authorized to independently collect field samples. The Environmental Engineer or Manager, who is familiar with the sampling program, shall accompany the technicians once each year on a normal round of sampling for the purpose of evaluating their performance.

Field instrumentation used for measuring field parameters shall be calibrated in accordance with the manufacturer's instructions. All maintenance of field instrumentation required for reliable operation shall be carried out on a regularly scheduled basis. Each calibration effort and all maintenance work shall be entered in the field log. Appendix A of this manual contains field calibration monitoring forms and Appendix B contains field calibration procedures for the continuous monitoring and other instruments used.

Field parameter data (provided on field data sheets or log books) and laboratory parameter data (submitted on laboratory reporting forms) shall be entered into the database and checked for accuracy after entry is complete. See Section 10 entitled "Sample Custody and Shipping Procedures and Verification of Data Records" for additional details.

9.1.2. Laboratory QA/QC

A copy of the ACZ Laboratories Quality Assurance/Quality Control Manual is available from the Laboratory upon request.

9.2. Sampling Procedures

Samples must be collected once during the spring runoff or snow-melt and once during the fall rainfall events. Field measurements and laboratory analyses, as listed on the Standard Site Data table shall be carried out for each sample collection event.

Pre-cleaned sample containers and caps, as described in the Standard Site Data table, shall be used. The containers shall be filled to a level which allows for the mixing of the preservative and the sample.

Sample parameters for field measurement are listed and shall be measured after the sample is collected, minimizing the potential for contamination.

Containers for each sample shall be marked, at the time of sampling, with the name and number of the sample site, date, time of collection, and type of preservative used if any. Each sample shall be recorded on field data sheets documenting:

- Name of sample collector
- Identification of sampling site
- Date and time of collection
- Field analysis
- Comments on site conditions
- Outfall flow estimate

9.3. Sample Preservation and Handling

The preservation requirements for each sample set are specified in the Standard Site Data table above. Sample preservation methods are intended to retard biological activity, hydrolysis, and container surface sorption effects. Preservation methods include pH control (acid or base addition), refrigeration, and protection from light.

A pH controlled sample is one in which an acid (nitric) or a base (sodium hydroxide) is added to the sample container before the sample is taken or as soon as possible after the sample is collected. pH control preserves the true concentrations of the compounds or elements of interest that might be in solution. A non-preserved sample is one in which no preservative is added because such an addition might change the concentration of an analyte of interest (such as pH, turbidity, and suspended solids).

Nitric acid preservation requires the addition of just enough HNO_3 to preserve the sample to a pH <2 S.U. Sodium hydroxide preservation requires the addition of 3 to 5 sodium hydroxide granules to a 1000 ml sample.

Sample containers are kept cold prior to shipping. A sample temperature of 4°C is preferable for sample storage and shipment.

10. SAMPLE CUSTODY, SHIPPING PROCEDURES, AND VERIFICATION OF DATA RECORDS

10.1. Field Data

At the conclusion of each monitoring event, the Environmental Department staff will review all field data sheets or log book entries to ensure the required information is recorded. When field data is recorded in a log book, photocopies will be taken of the log book pages and placed in the appropriate file. A complete set of original data sheets and log book photocopies are filed in the GCMC Environmental office.

10.2. Chain of Custody Forms

All samples shipped to any of the contract laboratory(s) are shipped using a chain of custody form. A record of the sample analytical requirements and sample delivery conditions is provided on the chain of custody form. The chain of custody form shall be filled out and sealed inside each sample shipping container prior to shipment. The form shall include the following information:

- Sample numbers
- Signature of collector
- Date and time of collection
- Sample type
- Identification of sampling site
- Number of containers
- Parameters requested for analysis (suite designation)
- Signature(s) of person(s) involved in the chain of possession
- Inclusive dates of possession (excluding common carrier transportation)

Before the samples are packed in coolers for final shipping to the contract laboratory(s), verify that they are exactly described on the Chain of Custody form. Check the container's labels, and verify that the information on the labels is correctly identified on and cross referenced to the information designated on the Chain of Custody form.

The technician who collected the samples must sign the first entry on the Chain of Custody form as samples "received" and notes the date and time. If a separate person packs the samples, the first person who collected the samples relinquishes them to the second; this is also noted on the Chain of Custody form. Whoever signs a Chain of Custody form verifies that the samples that have been shipped are described exactly on the form. When the samples are packed, the last person in the chain "relinquishes" them (i.e., signs the Chain of Custody form as relinquished), and packs it in the cooler. An example chain-of-custody form is included as **Appendix A**.

At least one copy of the Chain of Custody form(s) must be provided to the contract laboratory(s). The original copy is retained by GCMC. When the sample shipment arrives at the laboratory, the chain of custody record shall be signed by the laboratory sample custodian. Any evidence of tampering or damage shall be noted on the chain of custody record and brought to the attention of GCMC field staff.

Upon receipt of a monitoring event's laboratory analytical report, GCMC environmental personnel will examine the laboratory report and compare it to the records provided on the original Chain of Custody form. The report is examined to determine if it is complete and matches the container inventory and

analytical request(s), provided on the original Chain of Custody. The laboratory records are then entered into the Environmental database. Hard copies of the laboratory results are appropriately filed in the mine's Environmental office.

10.3. Sample Shipping

The sampling technician who is the "last" person to sign-off on the Chain of Custody sequence, is also the person responsible for conducting the final packing and sample shipping procedures. Pack samples carefully taking special care with glass containers. It is imperative that the samples are packed tightly in the shipping cooler(s). If available, vermiculite or bubble wrap make the best packing. Add enough frozen Blue Ice (4 to 6 packages) to keep the samples chilled at 4°C. Place the Chain of Custody form inside a Ziploc plastic bag and make sure it does not get wet or damaged during shipping. Enclose the Ziploc bag inside the cooler(s). Tape the lid of the cooler closed with strapping tape or duct tape. Ensure that each cooler has a clearly marked address label, if necessary, covered with clear tape.

Send the samples to the laboratory using the most expeditious delivery method such as direct delivery to the local laboratory upon the GCMC crew boat's return from the Admiralty Island facilities to the Auke Bay dock in Juneau or first thing the subsequent morning, or Alaska Air Gold Streak delivery, or a next day twenty-four (24) hour air express service. Samples must be received by the project laboratory within twenty-four (24) hours of shipping. <u>If samples are shipped by common carrier (air), packaging of samples must conform to IATA regulations</u>.

For samples shipped via air to laboratories outside of Juneau, the laboratory contact person (noted in each program's Site Standard Data table above) should be contacted via phone or e-mail the day of the shipment to make them aware the samples are being sent to them. If air billing numbers are available, provide those to the receiving laboratory to facilitate their tracking of the shipment if necessary.

10.4. Data Verification

Data verification is conducted by the GCMC Environmental staff following sampling, and when data are received from the laboratory.

First, after field measurements are made or samples are collected, an experienced environmental technician reviews field data sheets and notes and evaluates whether the measurements and samples were collected and handled in accordance with the QAPP. The technician shall note any significant deviations that could affect data validity and usability. Proper measurement and sampling location, use of proper measurement (including instrument calibration) and sampling procedures, use of proper sample containers and preservation, and sample labeling, chain-of custody, storage, and shipping are among the elements of data verification that follow field measurements and sample collection.

Second, after data is received from the laboratory, an experienced environmental technician scans the incoming data to verify that the proper analytical procedures were used by the laboratory and whether unusual data might indicate either an analytical problem or an environmental problem in the field. When such unusual data are discovered, the technician makes an immediate inquiry to the laboratory to determine if there was an analytical error made. If the laboratory verifies the accuracy of the data as originally submitted, then GCMC management must decide if additional samples are necessary to determine if the data represents an environmental problem in the field.

Third, spot checks of the data entered into the Environmental database are made against the actual hard copy data received from the laboratory. The purpose of these checks is to verify that the data is being accurately entered into the database.

Finally, graphs are compiled and checked for abnormalities. If an abnormality is noted, then the database entry is checked against the actual hard copy data that is on file in the project field office. If the database entry agrees with the laboratory reporting sheet, then steps are immediately taken to determine if the laboratory data is accurate. If the laboratory verifies the data as accurate, then GCMC management must decide whether additional samples are necessary to determine if the abnormality represents an environmental problem in the field.

11. CALIBRATION PROCEDURES AND FREQUENCY

11.1. Field

Field instruments are calibrated prior to each sampling event. At the conclusion of the daily sampling, a calibration check is performed to verify that the instrument measurements are within acceptable ranges. Calibration procedures for field instruments are presented in Appendix B. Continuous monitors on Outfall 002 are calibrated at least monthly in accordance with manufacturer's instructions.

11.2. Laboratory

Analytical measurements will be conducted after the measuring devices have been properly calibrated and the calibrations have been checked according to the methods described in the contract laboratories' Quality Assurance (QA) plans. A calibration standard or quality control sample will be analyzed at the end of every run to verify that the measuring system was within calibration limits through the last sample. Samples with concentrations higher than the calibration range will be diluted and reanalyzed. Sample dilution information will be included in project laboratory analytical reports.

Calibration procedures by instrument type, calibration frequency, reference standards used, calibration acceptance criteria, and calibration documentation procedures are available through the subcontracting laboratories and will be supplied on request to the appropriate regulatory agencies for data validation and review.

12. ANALYTICAL PROCEDURES

Standard Operating Procedures (SOPs) documenting laboratory analytical procedures are available at the project laboratory. The specific methods that will be used for various aspects of compliance monitoring are listed on Table 2. Other sample preparation information is included on the Standard Site Data Sheet for each monitoring element.

13. DATA REDUCTION, VALIDATION AND REPORTING

This section describes the data reduction, validation and reporting procedures used by GCMC and the contract laboratories. The company record filing systems are also described.

Information regarding contract laboratory data reduction, validation and reporting procedures is presented in the project laboratories' Quality Assurance (QA) plans, which are available upon request.

13.1. Record Filing Systems

GCMC's environmental monitoring records are filed using both hard copy and electronic database methods. Field monitoring hard copy records are filed after each field monitoring event. Analytical reports are filed and electronically processed after receipt of the records from the contract laboratory(s).

13.2. Hard Copy Records

Hard copy monitoring records consist of laboratory analytical/QA reports and field records (i.e., Chain of Custody forms, field data sheets and notes, calibration forms, etc.). Hard copy records are compiled and filed in the GCMC Environmental office.

Records on file in the GCMC Environmental office consist of copies of laboratory reports, field data sheets, Rite in the Rain field notebooks and calibration logs. Field data sheets and laboratory reports are filed and identified according to the monitoring station and sample type. Records are organized in chronological order and are filed within individually separated 3-ring binders or within file folders in file cabinets.

Field notebooks are numbered consecutively, and the pages are numbered as the data is entered. Whenever data is transcribed from field notebooks to field data sheets, the page and field notebook number are entered on the transcribed sheet.

All original hard copy documents are retained by GCMC for a period of no less than 5 years. Documents are retained even if they are illegible or contain inaccuracies that require correction. If necessary, additional copies of laboratory reports can be obtained from the contract laboratory(s). Raw laboratory data is kept on file by the contract laboratory for a period of no less than 5 years as specified in their contract. GCMC will check contract laboratories on a regular basis to ensure this condition is being met.

13.3. Electronic Database, Electronic File Management System and Validation

The environmental database management system uses an automated menu driven process. Instructions on the operating procedures, management, report generation capabilities of the electronic database are in the Environmental office and are available for review upon request.

Both field and laboratory monitoring records are reduced and processed into the environmental database using the following procedures:

Records Submittal: Most contract laboratory(s) are required to submit monitoring reports via electronic media. Each electronic submittal is a complete record of analytical reports that are sent to GCMC via hard copy. Laboratory reports are submitted to GCMC in Microsoft Excel or *.csv file format. Company personnel are familiar with and are capable of processing data submitted by this electronic file management method.

Electronic laboratory data files received by GCMC are processed by electronically importing the data into GCMC's electronic file management program. Data is permanently stored into the environmental database after it is validated as received, reviewed for completeness and initialed by the personnel conducting the data entry procedures. Once the data has been entered, it is validated and checked for completeness by visually comparing it to the hard copy files. If a discrepancy is discovered between hard copy and electronic data file(s) or if the data submitted by the project laboratory is incomplete, the project laboratory is immediately notified and asked to review their records and to submit a correction or provide an explanation describing why the data was submitted as incomplete.

Field Monitoring Data Processing: Field monitoring data and continuous monitoring data are also entered into GCMC's electronic database management system. Information entered into the system includes the specific parameters that are measured and recorded during the individual monitoring events. Individual field measurements are hand entered into the database, and then verified for accuracy against the field data sheets. Continuous monitoring data is collected and stored in an electronic datalogger, which is automatically downloaded and imported into the database electronically.

Electronic database files are retained by GCMC for a period of no less than 5 years.

13.4. Data Reporting

Monitoring results are summarized each month for specific APDES stations on the Discharge Monitoring Report (DMR) form provided by the ADEC. The reports are submitted monthly and are postmarked by the 15th day of the following month in accordance with the ADEC report submittal requirements. Legible copies of these and all other reports will be signed and certified in accordance with the signatory requirements stipulated by the ADEC. Records of all monthly monitoring and sampling reports will include:

1. The date, exact place, and time of sampling or measurement;
2. The names of the individual(s) who performed the sampling or measurements;
3. The date(s) the analysis were performed;
4. The individual(s) who performed the analysis;
5. The analytical techniques or methods used; and
6. The results of the analysis.

14. CORRECTIVE ACTION

Corrective action may be required when there is a failure to meet quality control acceptance criteria, or when internal or external audit samples are not acceptable. Potential sampling and QC problems are identified by GCMC review of field forms and other records generated during sampling and review of data received from the laboratories.

14.1. Laboratory Corrective Action Measures

Laboratory quality control and corrective action measures for which control limits are established and maintained include the use of: Laboratory Control Samples (LCS), duplicates, method blanks, surrogate recoveries, matrix spike recoveries (MS/MSD), calibrations, continuing calibrations and sensitivity checks. Further details on laboratory corrective actions are presented in the project laboratories' QA/QC plans.

14.2. Field Monitoring Corrective Action Measures

Field monitoring corrective action measures are conducted when: data quality objectives are not met (i.e., precision, accuracy and completeness goals); sample integrity is compromised by container contamination; monitoring data exceeds the water quality limits established by the ADEC; field parameters appear outside the range of reasonableness, etc. Corrective actions may include the following measures:

- Reanalyzing samples
- Conducting additional monitoring procedures including additional sampling
- Collecting duplicate samples
- Splitting samples and submitting them for analysis to independent laboratories
- Analyzing sample containers or preservatives for contamination
- Conducting independent field monitoring procedures with outside contractors or agency personnel

In the event a corrective action monitoring activity is required, the ADEC will be contacted and the procedures for conducting the corrective action will be worked out on a case by case basis.

GPO Appendix 02
Attachment A
Subattachment a
Example Forms

FIELD INSTRUMENT CALIBRATION LOG

	Date					
	Time					
	Operator					
	Instrument					
	Serial Number (s)					
	Calibrant	**Units**	**Expiration Date**	**Pre Calibration**	**Post Calibration**	**Quality control post sampling**
pH						
		su				
		su				
		su				
Conductivity						
		µS/cm				
		µS/cm				
		µS/cm				
ORP						
		mv				
		mv				
		mv				
Turbidity						
		NTU				
		NTU				
		NTU				
Temparature						
		C°				
		C°				
Notes						
Signatures						
Operator				Validator		
				Date		

HECLA GREENS CREEK MINING COMPANY
035APDES FIELD DATA SHEET

Date: (M/D/Y) _____ **Time Collected:** (24 Hour) _____

Sampling Crew: Morales, Brooks, Fredheim, Sell, Landes, Wallace, Other: _____

Weekly Sampling Parameters: Total Recoverable: (Zn, Pb, Cu, Cd), Total Hg, CN (WAD), TSS

Monthly Sampling Parameter: BOD, Fecal Coliform **Additional Parameters:** _____

Field Parameters

Storet	Parameter	Unit	CR1000 Value		
10	Water Temperature	°C			
58	Flow	GPM			
400	Monitor pH	SU			
45613	Floating solids, visible foam or oily sheen		☐ NO (0)	☐ YES (1)	

Comments: _____

_____

_____

Weather: _____

_____

Full Signature of Data Sampler(s) / Recorder: _____

Hecla

Chain of Custody Record / Analysis Request

Lab Sent To:

Company Address:
Hecla Greens Creek Mining Company
P.O. Box 32199
Juneau, AK 99803

Telephone: (907) 790-XXXX
8473 C. Wallace 8420 D. Landes
8457 C. Sell 8482 M. Brooks
8461 G. Fredheim 8472 T. Morales

Project Name:
Report To: gcenvdata@hecla-mining.com
Sampler:
P.O.Number:

Sample I.D.	Date Collected	Time Collected	Matrix Water / Soil	Container															pH < 2	RUSH (see below)

Comments:

Deliverable Instructions:
Use naming system below for report. XXXX will be replaced by the lab Project ID

e-mail to: gcenvdata@hecla-mining.com

Shipment Checklist
☐ _____
☐ _____
☐ _____

RELINQUISHED BY SAMPLER:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:	Condition of Sample Containers:
Signature:	Signature:	Signature:	Signature:	Temp Received: _____ °C
Printed Name:	Printed Name:	Printed Name:	Printed Name:	# of Coolers: _____
Firm: HGCMC	Firm:	Firm:	Firm:	Seals Intact: _____
Date / Time:	Date / Time:	Date / Time:	Date / Time:	Page _____ of _____

GPO Appendix 02
Attachment A
Subattachment b
OAKTON pH/CON 10 Meter
Instrument and Procedure Manual

12. Warranty

OAKTON warrants this meter to be free from significant deviations in material and workmanship for a period of one year from date of purchase. OAKTON warrants this probe to be free from significant deviations in material and workmanship for a period of six months from date of purchase. If repair or adjustment is necessary and has not been the result of abuse or misuse within the warrantied time period, please return—freight prepaid—and correction will be made without charge. OAKTON alone will determine if the product problem is due to deviations or customer misuse.

Out-of-warranty products will be repaired on a charge basis.

13. Return of items

Authorization must be obtained from our Customer Service Department before returning items for any reason. When applying for authorization, please include data regarding the reason the items are to be returned. For your protection, items must be carefully packed to prevent damage in shipment and insured against possible damage or loss. We will not be responsible for damage resulting from careless or insufficient packing. A restocking charge will be made on all unauthorized returns.

NOTE: We reserve the right to make improvements in design, construction, and appearance of products without notice.

For Sales & Service Contact
geotech
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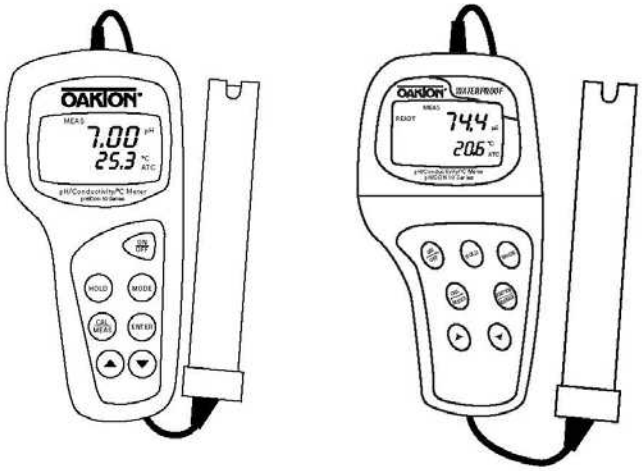
OAKTON®

OPERATING INSTRUCTIONS

OAKTON® 35630-00, 35630-02

Portable pH/CON 10 and Waterproof pH/CON 10 Meter



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OAKTON®

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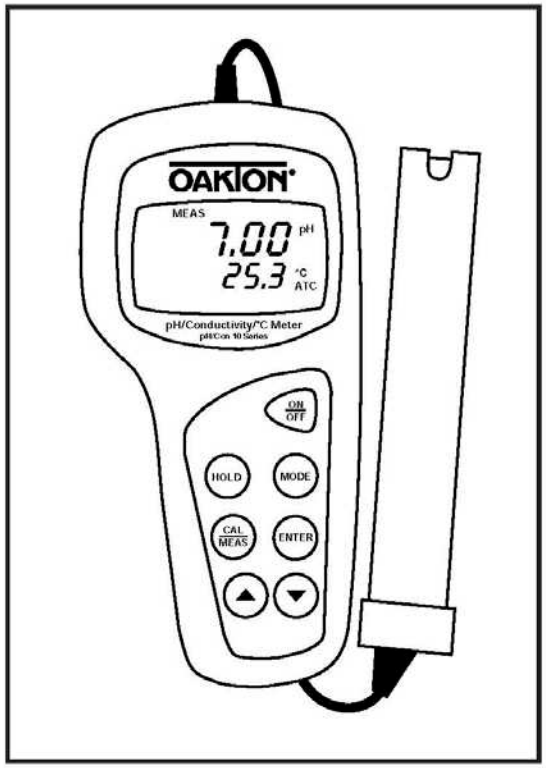
1. Introduction

Thank you for selecting an OAKTON meter. The OAKTON pH/CON 10 series meters are microprocessor-based instruments that measures pH, conductivity, and temperature with just one probe. This meters have many user-friendly features—all of which are completely accessible through the water-resistant membrane keypad.

Your meter includes a combination pH electrode/conductivity/temperature probe with 10-ft submersible cable; batteries.

Please read this manual thoroughly before operating your meter.



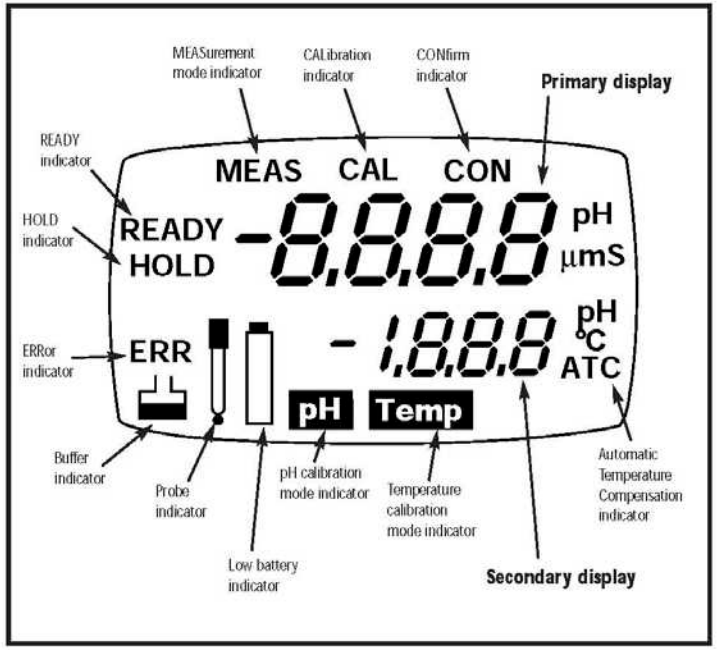
2. Display and Keypad Functions

2.1 Display

The LCD has a primary and secondary display.

- The primary display shows the measured pH or Conductivity (µS or mS) reading.
- The secondary display shows the temperature of the reading in °C.

The display also shows error messages, keypad functions and program functions.



2.2 Keypad

The large membrane keypad makes the instrument easy to use. Each button, when pressed, has a corresponding graphic indicator on the LCD.

ON/OFF.....Powers and shuts off the meter.

HOLD .....Freezes the measured reading. To activate, press HOLD while in measurement mode. To release, press HOLD again.

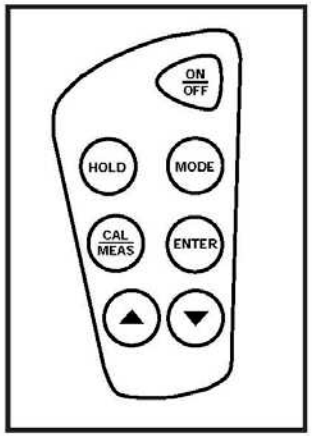
MODE.....Selects the measurement parameter (conductivity or pH). Press MODE to toggle between pH and Conductivity mode.

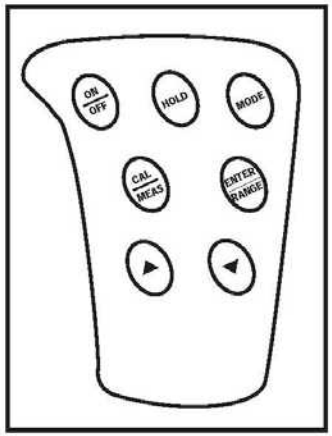
CAL/MEAS.....Toggles user between Calibration and Measurement mode.
- In Conductivity Measurement mode, press CAL/MEAS to enter Conductivity Calibration mode.
- In pH Measurement mode, press CAL/MEAS to enter pH Calibration mode.

NOTE: Temperature calibration is accessible from pH Calibration mode; see pages 14-15 for instructions.

ENTER .....Press to confirm your calibration values in Calibration mode.

▲/▼ .....Scrolls values up and down in Calibration mode.
- In pH mode, ▲/▼ scrolls through the auto buffer values 4.00, 7.00 and 10.00.
- In Conductivity and Temperature Calibration mode, ▲/▼ lets you increase or decrease the value incrementally.



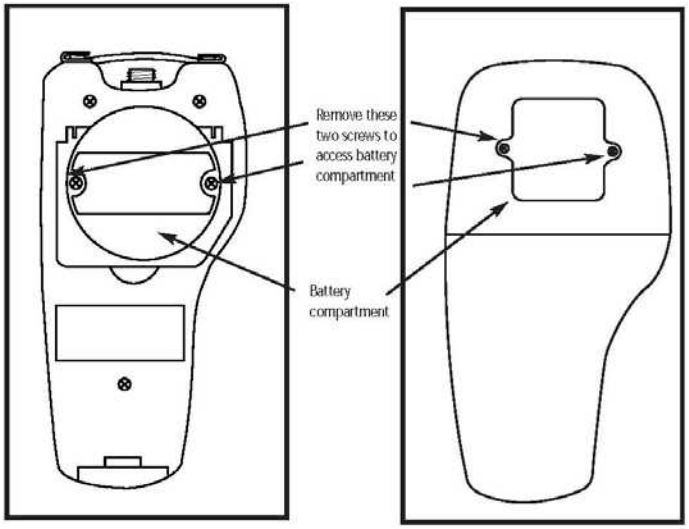


3. Preparation

3.1 Inserting the Batteries

Four AAA batteries are included with your meter.

1. Use a Phillips screwdriver to remove the two screws holding the battery cover. See Figure below.
2. Lift meter stand to expose battery cover. Remove battery cover.
3. Insert batteries. Follow the diagram inside the cover for correct polarity.
4. Replace the battery cover into its original position using the two screws removed earlier.



3.2 Connecting the probe

The OAKTON pH/Con meter uses a specialty combination pH/conductivity/temperature probe. The probe cable has a notched 6-pin connector to attach the probe to the meter.

NOTE: Do not substitute other probes or electrodes. For a replacement probe, see the "Accessories" section, page 22.

NOTE: Keep connector dry and clean. Do not touch connector with soiled hands.

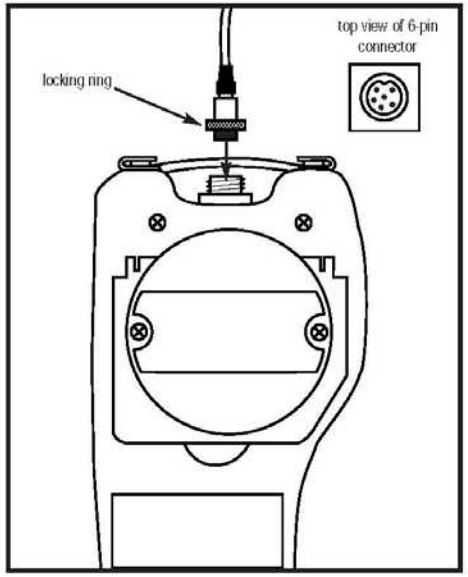
To connect the pH/Conductivity probe:

1. Line up the notch and 6 pins on the meter with the holes in the connector located on the probe connector. Push down and turn the locking ring to lock into place.

See figure below.

2. To remove probe, turn the locking ring on the probe connector. Pull probe away from the meter.

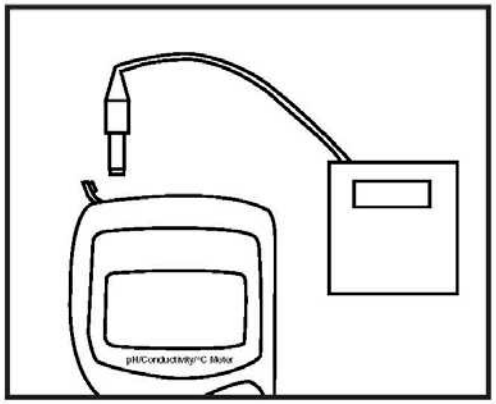
CAUTION: Do not pull on the probe cord or the probe wires might disconnect.



3.3 Connecting the AC Adapter (35630-00 only)

The AC adapter is not included with your meter; order separately on page 22.

1. Insert the AC jack as shown in figure below.
2. **Switch off the meter before plugging the adapter into the power source.** This safety precaution protects the software in your meter.
3. Press the ON/OFF button to switch meter on.



4. Calibration

4.1 Important Information on Meter Calibration

When you recalibrate your meter, old pH and conductivity calibration data are replaced on a point by point basis. For example, if you previously calibrated your meter at pH 4.0, 7.0, and 10.0, and you recalibrate at pH 7.0, the meter retains the old calibration data at pH 4.0 and pH 10.0.

To completely recalibrate your meter, or when you use a replacement probe, it is best to set the meter to its factory defaults and recalibrate the meter at all points. To reset pH, make sure meter is in pH mode. To reset conductivity, make sure meter is in conductivity mode. To reset the meter to its factory defaults in either mode:

1. While in Measurement mode, press CAL/MEAS and hold for 3 seconds.
2. The meter will prompt RST in the upper display and CAL in the lower display.

See figure A

3. Press ENTER to reset your meter to its factory defaults. The screen will flash all characters, then returns to measurement mode once the meter is reset. If you do not want to erase existing calibration data, press CAL/MEAS to escape this mode.

For information on how to calibrate your meter:
- See section 4.3 on pages 10-11 for pH calibration
- See section 4.4 on pages 12-13 for conductivity calibration
- See section 4.5 on pages 14-15 for temperature calibration

4.2 Preparing the Meter for Calibration

The pH/conductivity/temperature probe included with this meter is designed for use with this meter only. Do not substitute other types of probes or electrodes. For a replacement probe, see the "Accessories" section, page 22.

Before starting calibration, make sure you are in the correct measurement mode. When you switch on the meter, the meter starts up in the units you shut it off in (either pH or Conductivity). For example, if you shut the meter off in "mS" units, the meter will read "mS" units when you switch the meter on.

Be sure to remove the protective rubber cap of the probe before calibration or measurement. Wet the probe in tap water for 10 minutes before calibrating or taking readings to saturate the pH electrode surface and minimize drift.

Wash your probe in deionized water after use, and store in pH 4.0 or 7.0 electrode storage solution.

Do not reuse buffer solutions after calibration. Contaminants in the solution can affect the calibration, and eventually the accuracy of the measurements.

4.3 pH calibration

This instrument is capable of up to 3-point pH calibration to ensure accuracy across the entire pH range of the meter. You can perform 1-, 2-, or 3-point calibration with standard pH buffers 4.00; 7.00 and 10.00.

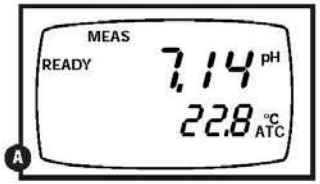
We recommend that you perform at least a 2-point calibration using standard buffers that bracket (one above and one below) the expected sample range. You can also perform a 1-point calibration, but make sure that the buffer value is close to the sample value you are measuring.

This meter features three preprogrammed pH buffers (pH 4.00, 7.00 and 10.00). The meter automatically recognizes and calibrates to these standard buffer values, which makes pH calibration faster and easier. See pages 22-23 for information on our high-quality OAKTON pH buffers.

Calibrating for pH:

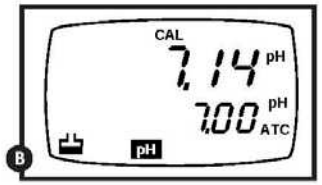
1. **If necessary, press the MODE key to select pH mode.** The pH indicator appears in the upper right hand corner of the display.
2. **Rinse the probe thoroughly with de-ionized water or a rinse solution.** Do not wipe the probe; this causes a build-up of electrostatic charge on the glass surface.
3. **Dip the probe into the calibration buffer.** The end of the probe must be completely immersed into the sample. Stir the probe gently to create a homogeneous sample.
4. **Wait for the measured pH value to stabilize.** The READY indicator will display when the reading stabilizes.

See figure A



5. **Press CAL/MEAS** to enter pH calibration mode. The primary display will show the measured reading while the smaller secondary display will indicate the pH standard buffer solution.

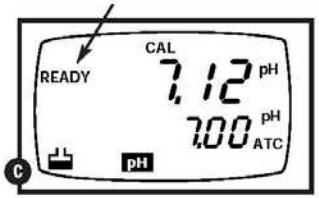
See figure B



NOTE: If using a pH buffer other than pH 7, press the ▲ or ▼ keys to scroll up or down until the secondary display value is the same as your pH buffer value (pH 4.00, 7.00 or 10.00).

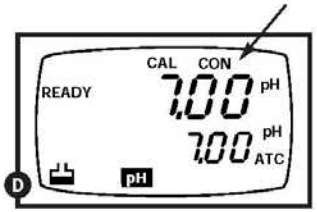
6. **Wait for the measured pH value to stabilize.** The READY indicator will display when the reading stabilizes.

See figure C



7. After the READY indicator turns on, **press ENTER to confirm calibration.** A confirming indicator (CON) flashes and disappears. The meter is now calibrated at the buffer indicated in the secondary display.

See figure D

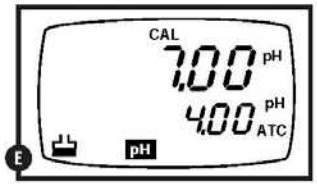


The secondary display automatically scrolls to the next buffer calibration option.

- If you are performing multipoint calibration, go to step 7.
- If you are performing one-point calibration, go to step 10.

8. **Press the ▲ or ▼ keys** to select the next buffer value you want to calibrate (pH 4.00; 7.00 or 10.00).

See figure E



9. **Rinse the probe with de-ionized water or a rinse solution, and place it in the next pH buffer.**
10. Follow steps 5 to 8 for additional calibration points (up to 3 values).
11. When calibration is complete, **press CAL/MEAS to return to pH measurement mode.**

Notes

To exit from pH Calibration mode without confirming calibration, DO NOT press ENTER in step 6. Press CAL/MEAS instead.

If the selected buffer value is not within ±1.00 pH from the measured pH value: the electrode and buffer icon blink and the ERR annunciator appears in the lower left corner of the display. These indicators also flash if the buffer used is not the same as the buffer value on the secondary display.

4.4 Conductivity Calibration

Ideally, you should select a conductivity standard with a value near the sample value you are measuring. The next best method is to choose a calibration solution value that is approximately ⅔ the full scale value of the measurement range. For example, in the 0 to 1999 µS range, use a 1413 µS solution for calibration. Conductivity standards which are lower than 20% of the range should not be used for calibration. It is not possible to make adjustments for values which are in the lower 20% of the working range. See "Specifications", page 21.

Preparing the Meter for Conductivity Calibration

You can calibrate at one point per range of the meter (a total of up to four calibration points). *However, only the ranges that have been calibrated have maximum ±1% full-scale conductivity accuracy. If a range was not calibrated, the meter automatically detects the closest range calibrated and uses that calibration information.*

To maintain ±1% F.S. accuracy, you need to calibrate your meter at least once a week if:
- you take measurements at extreme temperatures
- you are measuring in conductivity ranges lower than 100 µS

To maintain ±1% F.S. accuracy, you need to calibrate your meter at least once a month if:
- you are measuring in mid range solutions, and you wash the cell in deionized water between usages.

The conductivity of solution varies greatly with temperature. The automatic temperature compensation (ATC) feature adjusts the fluctuations of conductivity readings in varying temperatures to a standard temperature. These conductivity meters feature a temperature coefficient of 2.00% per °C and normalize the readings at 25°C.

Calibrating for Conductivity:

1. **Pour out two separate portions of your calibration standard and one of deionized water into separate clean containers.**
2. **If necessary, press the MODE key to select Conductivity Mode.** The µS or mS indicator will appear on the right side of the display.
3. **Rinse your probe** with deionized water, then rinse the probe in one of the portions of calibration standard.
4. **Immerse the probe into the second portion of calibration standard.** The meter's autoranging function selects the appropriate conductivity range (four ranges are possible). *Be sure to tap the probe to remove air bubbles. Air bubbles will cause errors in calibration.*

5. **Wait for the reading to stabilize.** The READY indicator lights when the reading is stable.

See figure A

6. **Press the CAL/MEAS key.** The CAL indicator appears above the primary display. The primary display shows the factory default and the secondary display shows the temperature.

See figure B

7. **Press the ▲ or ▼ keys** to scroll to the value of your conductivity standard. Press and hold the ▲ or ▼ keys to scroll faster. The meter automatically compensates for temperature differences using a factor of 2.00% per °C.

See figure C

8. **Press the ENTER key** to confirm calibration.

Upon confirmation, the CON indicator appears briefly. The meter automatically switches back into Measurement mode. The display now shows the calibrated, temperature compensated conductivity value.

See figure D

9. For calibration in other ranges (maximum: four ranges) repeat steps 1 through 9 with the appropriate calibration standards. See pages 22-23 for our selection of high-quality OAKTON conductivity calibration solutions.

Notes

To exit from Conductivity Calibration mode without confirming calibration, DO NOT press ENTER in step 8. Press CAL/MEAS instead.

If the calibration value input into the meter is different from the factory default value displayed by more than 30%, the ERR annunciator appears in the lower left corner of the display. Clean probe with alcohol. Verify that your calibration standard is fresh and accurate.

4.5 Temperature Calibration

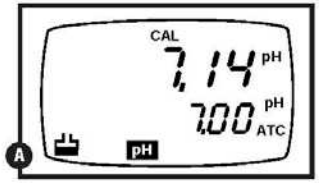
The built-in temperature sensor included in the probe is factory calibrated. Calibrate your sensor only if you suspect temperature errors that may have occurred over a long period of time or if you have a replacement probe.

1. Turn the meter on. Press MODE to select pH Measurement mode.
2. **Press the CAL/MEAS key to enter pH calibration mode.** The CAL indicator will appear above the primary display.

See figure A

3. **While in pH calibration mode, press the MODE key to enter temperature calibration mode.** The primary display shows the temperature reading with zero offset and the secondary display shows you what the temperature value was initially.

See figure B



4. **Compare the primary display reading to a NIST-traceable thermometer or another thermometer known to be accurate.**
5. **Press the ▲ or ▼ keys** to adjust the primary display reading to agree with your temperature standard.

See figure C

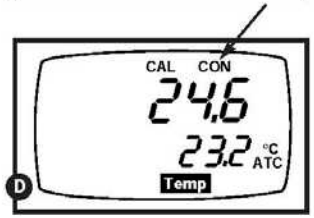
6. **Press the ENTER key** to confirm temperature calibration. The CON indicator will flash to confirm calibration.

See figure D

Notes

To exit from Temperature Calibration mode without confirming calibration, DO NOT press ENTER in step 6. Press CAL/MEAS instead.

Temperature calibration is restricted to ±5°C from the factory default value displayed during calibration (shown in the secondary display).



5. Measurement

The READY indicator appears on the display when the readings stabilize. The reading holds until the measured value exceeds the tolerance, then the READY annunciator turns off.

NOTE: Be sure to remove the protective rubber cap of the electrode before measurement.

To take readings:

1. Rinse the probe with deionized or distilled water before use to remove any impurities adhering to the probe body. If the pH electrode has dehydrated, soak it for 30 minutes in OAKTON electrode storage solution or a 2M–4M KCl solution.
2. Switch on the meter. The MEAS annunciator appears on the top center of the LCD. The ATC indicator appears in the lower right hand corner to indicate Automatic Temperature Compensation. Press MODE to select desired measuring parameter (pH or conductivity).

See Figure A

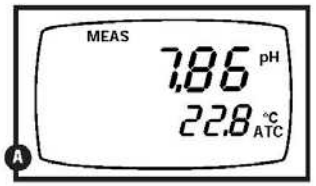
3. Dip the probe into the sample.

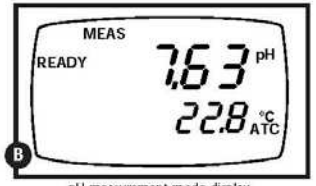
NOTE: When dipping the probe into the sample, make sure the tip of the probe is completely immersed. Stir the probe gently in the sample to create a homogenous sample. *Be sure to tap probe to remove air bubbles. Air bubbles will cause errors in the reading.*

4. Allow time for the reading to stabilize. Note the reading on the display. When the reading is stable, the READY annunciator appears.
5. To toggle between pH and conductivity readings, press the MODE key.

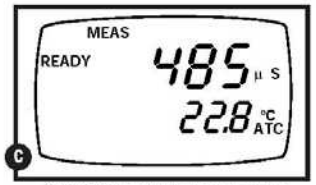
See figures B and C

NOTE: Conductivity readings are auto-ranging and will automatically move to the correct range (four ranges possible).





pH measurement mode display



Conductivity measurement mode display

6. HOLD function

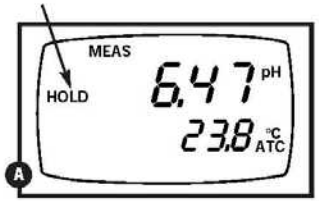
This feature lets you freeze the value of the pH or conductivity reading for a delayed observation. HOLD can be used any time when in MEAS mode.

1. To hold a measurement, press the HOLD key while in measurement mode. "HOLD" will appear on the display.

See Figure A

2. To release the held value, press HOLD again. Continue to take measurements.

NOTE: This meter will hold a reading for up to 30 minutes, because it features automatic shutoff after 30 minutes to conserve batteries.



7. Probe Care and Maintenance

Under typical operating conditions, the probe will need to be replaced every 6 to 12 months. In extreme applications, the probe may wear out sooner. Proper care and maintenance will help you receive the maximum probe life and ensure more accurate readings.

Keep the probe clean. Before use, rinse the probe twice. For the best accuracy, soak your probe in electrode storage solution, pH 4.0 buffer, or tap water for at least 5 to 10 minutes before calibration.

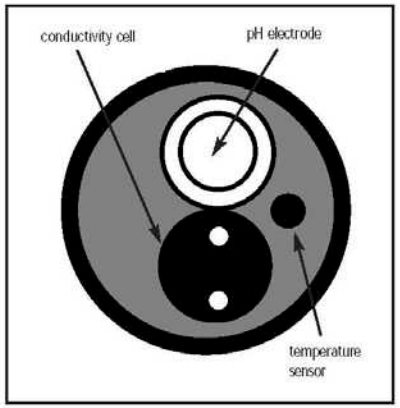
Gently swirl the probe in the solution while you take readings. Tap the probe gently against the bottom and sides of your container to remove any air bubbles, which may interfere with accuracy.

Clean the probe thoroughly by immersing it in an agitated mild detergent bath. To clean the conductivity cell, use a cotton swab soaked in isopropyl alcohol and clean the steel pins. Wipe the steel pins with a soft tissue paper. DO NOT wipe the pH bulb with tissue as it may cause static build-up. After cleaning the probe, wash the probe with deionized or tap water before storing it. Recalibrate the meter after cleaning the probe.

Store the probe in its cap filled with electrode storage solution.

Do not strike the probe against any hard surface. Do not immerse the probe in oily solutions.

To order a replacement probe, see page 22.



Probe from end view

8. Troubleshooting

Problem	Cause	Solution
Power on but no display	a) Batteries not in place.	a) Check that batteries are in place and making good contact.
	b) Batteries not in correct polarity (+ and –).	b) Reinsert batteries with correct polarity.
	c) Weak batteries.	c) Replace batteries or attach optional AC adapter.
Unstable readings	a) Air bubbles in probe.	a) Tap probe to remove bubbles.
	b) Dirty probe.	b) Clean the probe and recalibrate.
	c) Probe not deep enough in sample.	c) Make sure sample entirely covers the probe sensors.
	d) External noise pickup or induction caused by nearby electric motor.	d) Move or switch off interfering motor.
	e) Broken probe.	e) Replace probe. See page 22.
"OR" on upper display	a) Probe is shorted.	a) Test probe. Make sure probe is fully connected to meter.
	b) Probe is in an out-of range solution.	b) Use different solution.
	c) Broken probe.	c) Replace probe. See page 22.
Temperature reading erratic or lower display reads "OR"	a) Temperature sensor is dirty.	a) Clean temperature sensor with isopropyl alcohol.
	b) Temperature of solution is out of range.	b) Heat or cool solution.
	c) Probe is shorted	a) Test probe. Make sure probe is fully connected to meter.
	c) Broken probe.	c) Replace probe. See page 22.
Slow response	a) Dirty/Oily probe.	a) Clean probe. See "Probe Care & Maintenance", p. 18.

9. Error Messages

LCD Display	Indicates	Cause	Solution
Err annunciator	Unrecognized input from keypad	Wrong input in selected mode.	Release key. Select valid operations depending on mode.
CAL & Err annunciators blink	Calibration error	Wrong value input at calibration. Dirty probe.	Check your input value, clean probe. See Calibration sections or Probe Maintenance section.
Battery indicator blinks	Low battery level	Need new batteries or battery connection is bad	Clean battery contacts. Replace batteries with fresh ones, noting polarity
Err. 1 (in primary display)	Memory write error	Instrument too old (>10 years). Hardware failure	Turn meter on and off again. If message persists, return unit*
Err. 2 (in primary display)	Checksum error	Batteries too weak. Hardware failure.	Press ENTER, then turn off meter. Change batteries. Recalibrate Return*
Err. 3	A/D converter error	Faulty hardware	Return*

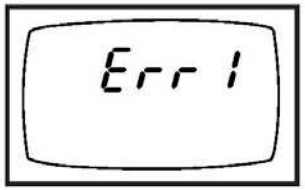
* See "Warranty" and "Return of Items" on page 24

If an error message appears in the primary display (the upper row of larger digits), switching off the meter and switching it on again may eliminate the error message.

See figure below.

If error persists, or the meter shows incorrect values, return the meter.

For a complete diagram of the display, see page 4.



ERR 1 in primary display

10. Specifications

Mode	pH	Temperature	Conductivity
Range	0.00 to 14.00 pH	0.0 to 100.0°C	0 to 19.99 µS, 0 to 199.9 µS, 0 to 1999 µS, 0 to 19.99 mS
Resolution	0.01 pH	0.1°C	0.01 µS, 0.1 µS, 1.0 µS, 0.01 mS
Accuracy	±0.01 pH	±0.5°C	±1% full scale or ±1 digit
Calibration	Up to three points (pH 4.01, 7.00, 10.01) with automatic buffer recognition	Offset in 0.1°C increments	Up to four points (one point per range)

Temperature compensation: automatic from 0 to 50°C

Conductivity cell constant (K): 1.0

Conductivity temperature coefficient: 2.00% per °C

Operating temperature: 0 to 50°C

Power: four 1.5 V AAA batteries (included) or AC adapter (optional; order separately on page 22)

Battery life: > 50 hours

Dimensions:
35630-00
Meter: 7.5"L x 3.5"W x 1.75"H (19.1 cm x 8.9 cm x 4.5 cm)
Boxed: 9.2"L x 8.5"W x 2.75"H (23.3 cm x 21.6 cm x 7 cm)
Probe: 6.8"L x 1.3" dia (173 mm L x 32 mm dia)

35630-02
Meter: 7.5"L x 3.5"W x 1.75"H (19.1 cm x 8.9 cm x 4.5 cm)
Boxed: 9.2"L x 9.2"W x 2.75"H (23 cm x 23 cm x 7 cm)
Probe: 6.8"L x 1.3" dia (17.3 cm L x 3.2 cm dia)

Shipping weight: 1.4 lbs (0.64 kg)

11. Accessories

Replacement meter and meter accessories

WD-35630-00 pH/CON 10 pH/Conductivity/°C meter.
Includes pH/Conductivity/°C probe with 10-ft submersible cable

WD-35630-02 Waterproof pH/CON 10 pH/Conductivity/°C meter.
Includes pH/Conductivity/°C probe with 10-ft submersible cable

WD-35630-50 Replacement pH/Conductivity/°C probe
with10-ft submersible cable

WD-00653-04 Electrode storage solution, 1 pint bottle. Keeps electrode bulb moist for faster, more accurate readings. Shpg wt 1.1 lbs/510 gms

WD-00653-06 Electrode cleaning solution, 1 pint bottle. Removes buildup from electrodes and maintains electrode sensitivity. Shpg wt 1.1 lbs/510 gms

WD-35630-60 pH/CON 10 meter kit. Includes pH/CON 10 meter, pH/Conductivity/°C probe with 10-ft submersible cable, 9 pH and 8 conductivity calibration solution pouches, 3 rinse water pouches, sample bottle, instructions and hard shell carrying case

WD-35630-69 pH/CON kit. Includes 9 pH and 8 conductivity calibration solution pouches, 3 rinse water pouches, sample bottle, instructions and hard shell carrying case. Meter not included.

WD-35615-75 Belt loop portable meter carrying case. Soft case with clear plastic front panel protects your meter while allowing you to take measurements. Top and side openings let probe and probe connections remain accessible

WD-35615-07 AC adapter, 9 VDC to 110 VAC.

WD-35615-08 AC adapter, 9 VDC to 220 VAC.

OAKTON calibration solution bottles

Each contain 1 pint of premixed calibration solution. pH solutions have ±0.01 pH accuracy at 25°C. Conductivity solutions have ±1% accuracy at 25°C and include NaCl, KCl and 442 TDS conversion factors. Shpg wt 1.1 lb/510 gms

WD-00654-00 Solution bottle, pH 4.01

WD-00654-04 Solution bottle, pH 7.00

WD-00654-08 Solution bottle, pH 10.00

WD-00653-16 Solution bottle, 84 µS
(40.38 ppm KCl, 38.04 ppm NaCl, 50.50 ppm 442)

WD-00653-47 Solution bottle, 447 µS
(225.6 ppm KCl, 215.5 ppm NaCl, 300.0 ppm 442)

WD-00653-18 Solution bottle, 1413 µS
(744.7 ppm KCl, 702.1 ppm NaCl, 1000 ppm 442)

WD-00653-89 Solution bottle, 8974 µS
(5101 ppm KCl, 4487 ppm NaCl, 7608 ppm 442)

WD-00653-50 Solution bottle, 15,000 µS
(8759 ppm KCl, 8532 ppm NaCl, 13,455 ppm 442)

OAKTON "Singles" calibration solution pouches

Each individually sealed, single use pouch contains 20 ml of fresh, contamination free calibration solution. pH "Singles" have ±0.01 pH accuracy at 25°C. Conductivity "Singles" have ±1% accuracy at 25°C and include NaCl, KCl and 442 TDS conversion factors. 20 pouches/box. Shpg wt 1.1 lb/454 gms

WD-35653-01 pH "Singles"; pH 4.01

WD-35653-02 pH "Singles"; pH 7.00

WD-35653-03 pH "Singles"; pH 10.00

WD-35653-04 pH "Singles" assortment pack;
five each of pH 4.01, 7.00, 10.00, and rinse water pouches

WD-35653-10 Conductivity "Singles", 447 µS

WD-35653-11 Conductivity "Singles", 1413 µS

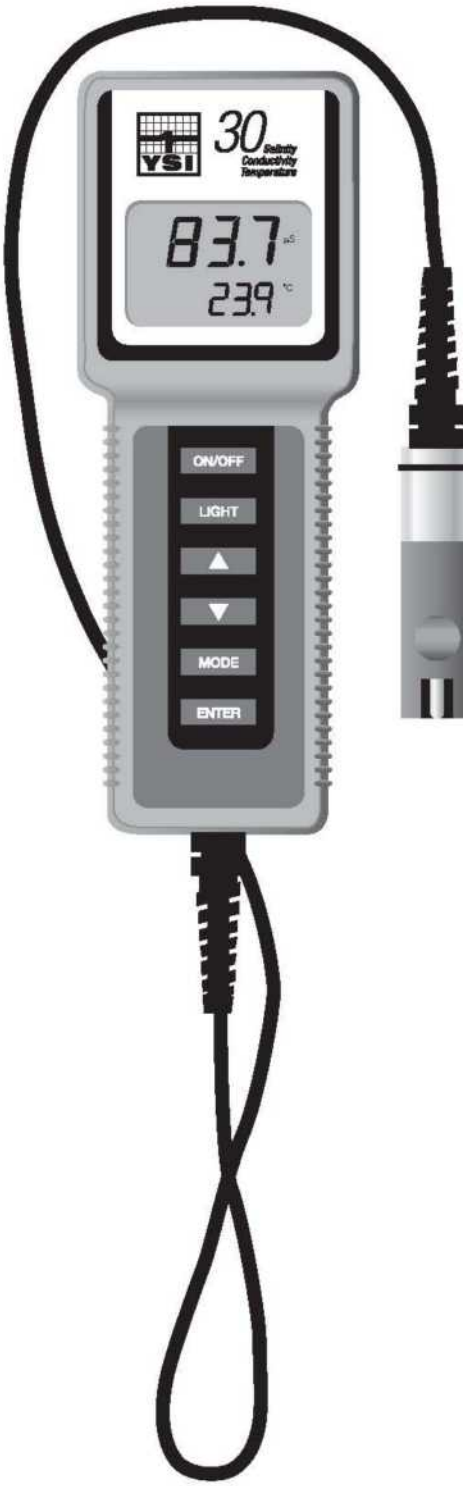
WD-35653-13 Conductivity "Singles", 15,000 µS

WD-35653-00 "Singles"; rinse water

To order OAKTON accessories, contact your OAKTON distributor.

GPO Appendix 02
Attachment A
Subattachment c
YSI Model 30
Instrument and Procedure Manual

YSI *incorporated*



YSI Model 30
YSI Model 30M

Handheld Salinity, Conductivity and Temperature System

Operations Manual

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SECTION 1 INTRODUCTION

The YSI Model 30 Handheld Salinity, Conductivity, & Temperature System is a rugged, micro-processor based, digital meter with an attached YSI four electrode conductivity cell. The Model 30 is designed for use in field, lab, and process control applications and is available with cable lengths of either 10, 25 or 50 feet. The body of the probe has been manufactured with stainless steel to add rugged durability and sinking weight. The large Liquid Crystal Display (LCD) is easy to read and is equipped with a back-light for use in dark or poorly lighted areas.

The Model 30's micro-processor allows the system to be easily calibrated with the press of a few keys. Additionally, the micro-processor performs a self-diagnostic routine each time the instrument is turned on. The self-diagnostic routine provides you with useful information about the cell constant, function of the instrument circuitry, and the quality of the readings you obtain. For a list of these diagnostic features, see Section 9, Tr*oubleshooting*.

The system simultaneously displays temperature (in ^{o}C), along with one of the following parameters: conductivity; temperature compensated conductivity; (in µS/cm or mS/cm), and salinity (in parts per thousand [ppt]). Though calibration is **NOT** required, a single calibration will adjust the instrument, regardless of which parameter you wish to read. You can switch back and forth from salinity, conductivity, and temperature compensated conductivity with a single push of the **MODE** key.

A probe storage chamber is built into the instrument. This chamber provides a convenient place to store the probe when the system is not in use, and provides protection for the electrodes within the probe.

The instrument is powered by six AA-size alkaline batteries. A new set of alkaline batteries will provide approximately 100 hours of continuous operation. When batteries need to be replaced, the LCD will display a **"LO BAT"** message.

The YSI Model 30 instrument case is waterproof (rated to IP65). You can operate your Model 30 in a steady rain without damage to the instrument.

The YSI Model 30M contains all the features of the Model 30, but has a 100ft cable length and also has internal memory for saving 50 sets of data for later on screen recall. It meets CE requirements for EMC Directive 89/336/EEC. For simplicity, this manual will refer to the Model 30 when discussing functions that apply to both the Model 30 AND the Model 30M. References to the Model 30M indicate functions that apply to the Model 30M ONLY.

SECTION 2 PREPARING THE METER

2.1 UNPACKING

When you unpack your new YSI Model 30 Handheld Conductivity, Salinity & Temperature System for the first time, check the packing list to make sure you have received everything you should have. If there is anything missing or damaged, call the dealer from whom you purchased the Model 30. If you do not know which of our authorized dealers sold the system to you, call YSI Customer Service at 800-765-4974 or 937-767-7241, and we'll be happy to help you.

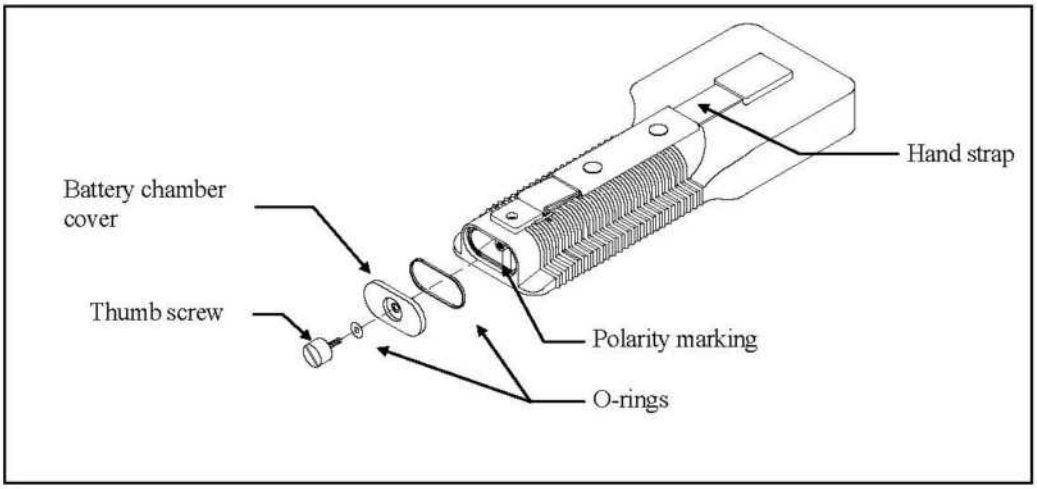
2.2 WARRANTY CARD

Before you do anything else, please complete the Warranty Card and return it to YSI. This will record your purchase of this quality instrument in our computer system. Once your purchase is recorded, you will receive prompt, efficient service in the event any part of your YSI Model 30 should ever need repair.

2.3 BATTERIES

There are a few things you must do to prepare your YSI Model 30 for use. First, locate the six AA-size alkaline batteries that were included. Use a screwdriver or a small coin to remove the thumbscrew on the bottom of the instrument. This thumbscrew holds the battery-chamber cover in place. The battery-chamber cover is marked with the words "OPEN" and "CLOSE."

NOTE: On some models, the battery cover thumbscrew may be unscrewed by hand (a screwdriver may not be required).



There is a small label inside each of the two battery-chamber sleeves. These labels illustrate the correct way to install the batteries into each sleeve of the battery-chamber.

NOTE: It is very important that the batteries be installed ONLY as illustrated. The instrument will not function if the batteries are installed incorrectly.

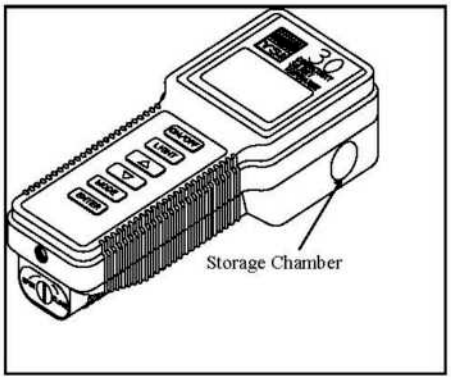
Turn the instrument on by pressing and releasing the **ON/OFF** key on the front of the instrument. The liquid crystal display (LCD) should come on. Allow a few seconds for the instrument to complete its diagnostic routine. Notice that the instrument will display the specific cell constant of the probe at the completion of its diagnostic routine. If the instrument does not operate, consult Section 9, *Troubleshooting*.

You may also want to take the instrument into a dark room and, with the instrument ON, hold down the **LIGHT** key. The instrument back-light should illuminate the LCD so that the display can be easily read.

2.4 STORAGE CHAMBER

The Model 30 has a convenient storage chamber built into the instrument's side. This chamber provides an ideal storage area for the probe during transport and extended non-use.

An optional sponge is available from YSI that will fit inside the storage chamber and provide a moist environment for probe storage should your application or operational procedures require it. See Appendix B, *Accessories and Replacement Parts*.



2.5 HAND STRAP

The hand strap is designed to allow comfortable operation of the Model 30 with minimum effort. If the hand strap is adjusted correctly, it is unlikely that the instrument will be easily dropped or bumped from your hand.

To adjust the hand strap on the back of the meter, unsnap the leather cover and pull the two Velcro strips apart. Place your hand between the meter and the strap and adjust the strap length so that your hand is snugly held in place. Press the two Velcro strips back together and snap the leather cover back into place.

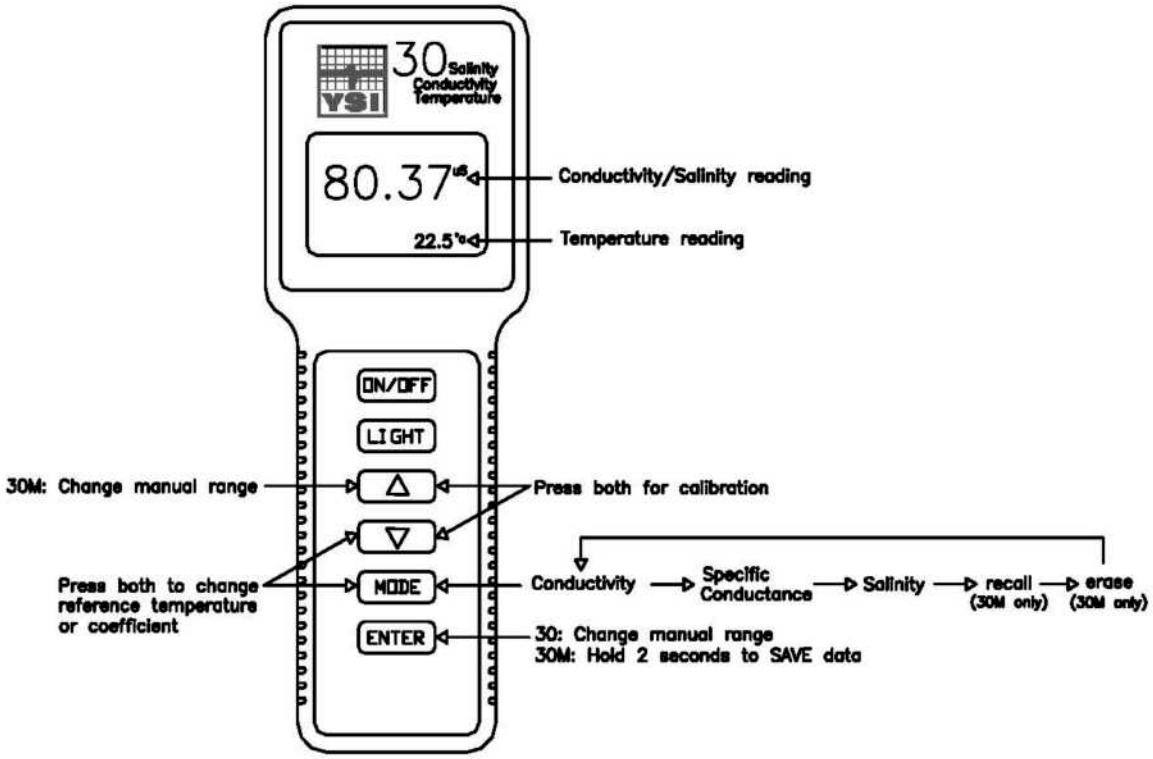
2.6 THE METER CASE

The meter case is sealed at the factory and is not intended to be opened, except by authorized service technicians. Do not attempt to separate the two halves of the meter case as this may damage the instrument, break the water-proof seal and may void the manufacturer's warranty.

SECTION 3 MAKING MEASUREMENTS

The YSI Model 30 is factory calibrated. This means that once you have put batteries in the instrument, you are ready to begin taking readings immediately.

The following diagram is an overview of the operation of the Model 30 and 30M. Note the difference in key strokes between some of the 30 and 30M functions. See the following pages for details of operation.



3.1 TURNING THE INSTRUMENT ON

Once the batteries are installed correctly, press the **ON/OFF** key. The instrument will activate all segments of the display for a few seconds, which will be followed by a self test procedure which will last for several more seconds. During this power on self test sequence, the instrument's microprocessor is verifying that the instrument is working properly and will display the cell constant of the probe when the self test is complete. If the instrument were to detect a problem, a **continuous** error message would be displayed. See Section 9, *Troubleshooting* for a list of error messages.

After the self test procedure is complete, the temperature will be displayed in the lower right of the display and the instrument is ready to make a measurement. Simply insert the probe into the liquid sample about which you would like to receive information. It is important that the probe be inserted into the liquid deep enough so that the hole on the side of the probe is completely covered by the liquid. If possible, do not allow the probe to touch any solid object while you are taking readings; this may effect the reading slightly. Additionally, it is important that there not be any air bubbles

around the probe electrodes. To dislodge any bubbles which might have formed, move or shake the probe vigorously several times before recording the measurement.

3.2 MEASUREMENT MODES

The Model 30 has three modes as follows:

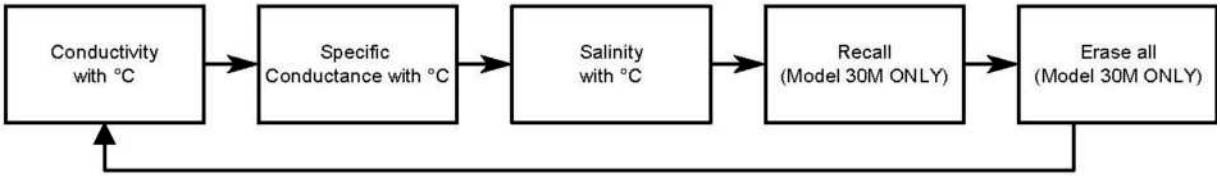
- **Conductivity** -- A measurement of the conductive material in the liquid sample without regard to temperature
- **Specific Conductance** -- Also known as temperature compensated conductivity which automatically adjusts the reading to a calculated value which would have been read if the sample had been at 25° C (or some other reference temperature which you choose). See Section 6, *Advanced Setup.*
- **Salinity** -- A calculation done by the instrument electronics, based upon the conductivity and temperature readings.

Temperature is displayed in conductivity, specific conductance and salinity modes.

The Model 30M has two additional modes:

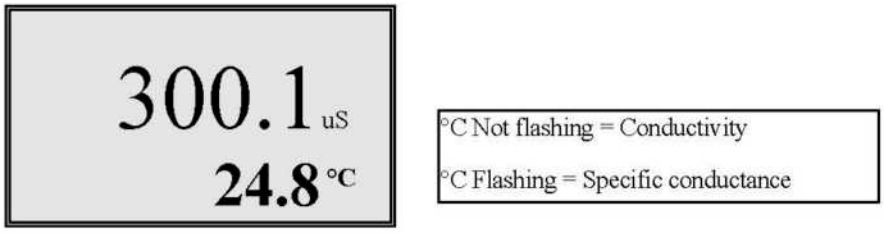
- **Recall** -- Allows previously stored data to be displayed.
- **Erase all** -- Allows ALL previously stored data to be deleted.

To change between modes, simply press and release the **MODE** key. The instrument will cycle through the modes as follows:



NOTE: When you turn the instrument off, it will "remember" which measurement mode you used last and will return to that mode the next time it is turned on.

When changing modes, carefully observe the small legends at the far right side of the LCD. If the instrument is reading **Specific Conductance,** the large numbers on the display will be followed by either a **µS** or an **mS.** Additionally, the small portion of the display will show the **°C** flashing on and off .



If the instrument is reading **Conductivity,** the large numbers on the display will be followed by either a **µS** or an **mS.** Additionally, the small portion of the display will show the **°C** **NOT** flashing.

If the instrument is reading **Salinity,** the large numbers on the display will be followed by a **ppt.**

3.3 AUTORANGING & RANGE SEARCHING

The YSI Model 30 is an autoranging instrument. This means that, regardless of the conductivity or salinity of the solution (within the specifications of the instrument), all you need to do to get the most accurate reading is to put the probe in the sample. This feature makes the Model 30 as simple as possible to operate.

When you first place the Model 30 probe into a sample or calibration solution, and again when you first remove the probe, the instrument will go into a range search mode that may take as long as 5 seconds. During some range searches, the instrument display will flash **rANG** to indicate its movement from one range to another.

The length of the range search depends on the number of ranges which must be searched in order to find the correct range for the sample. During the range search, the instrument will appear to freeze on a given reading for a few seconds then, once the range is located, will pinpoint the exact reading on the display. The display may also switch to **00.0** for a second or two during a range search before it selects the proper range.

During normal operation, the **ENTER** key (**UP ARROW** key on Model 30M) enables and disables the autoranging feature of the instrument. We recommend that the instrument always be operated using the autoranging feature. See Section 6, *Advanced Setup* if you need to switch to manual ranging.

3.4 THE BACKLIGHT

At times it may be necessary to take measurements with the Model 30 in dark or poorly lit areas. To help in this situation, the Model 30 comes equipped with a backlight which will illuminate the display so that it can be easily read. To activate the backlight, press and hold down the **LIGHT** key. The display will remain lit as long as the key is held down. When you release it, the light goes out to preserve battery life.

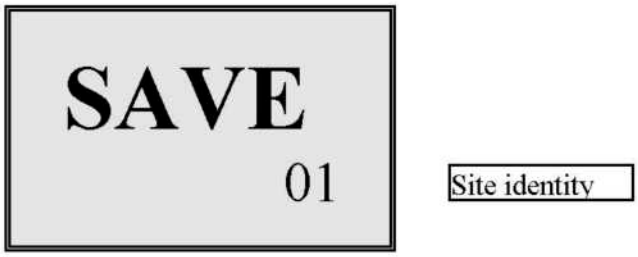
SECTION 4 SAVING DATA

The Model 30M is equipped with non-volatile memory that is capable of storing up to 50 different sets of readings. Non-volatile means that you do not need to worry that your data will be lost due to a power failure or interruption, such as when the batteries are removed. The Model 30M will also assign a site identity number to each set of readings to allow easy review of the data. This feature is useful in situations where transcribing data is difficult or not available.

NOTE: The Model 30 is NOT equipped with memory and cannot save data.

4.1 SAVING DATA TO MEMORY

1. While any parameter is displayed on the screen, press the **ENTER** key and hold for approximately 2 seconds.



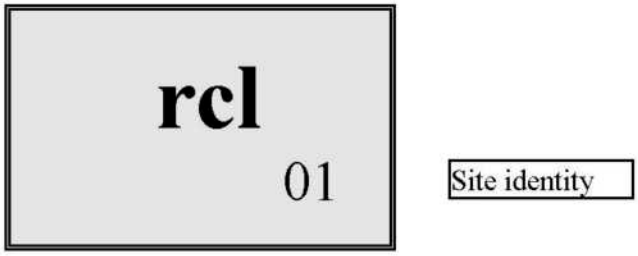
The meter will flash **SAVE** on the display along with the current site identity is being used.

2. When all 50 sites are full, the display will flash **FULL** on the screen. This message will remain on the screen (even after power down) until a key is pushed.

Once you have acknowledged the memory is full, any subsequent saved data will begin overwriting existing data starting with site #1.

4.2 RECALLING STORED DATA

1. To put the Model 30M into the **RECALL** mode, press the **MODE** key until **rcl** is displayed on the screen along with the site ID number in the lower right corner.



2. Press the **ENTER** key to review the last set of data that was saved. The Model 30M will display the conductivity and temperature. Another press of the **ENTER** key will display the specific conductance and the temperature. Press the **ENTER** key again to review the salinity which is also displayed with the temperature.
3. Press the **UP ARROW** key to increment through the saved sets of data.
4. Press the **DOWN ARROW** key to decrement through the saved sets of data.

NOTE: The Model 30M will recall data as a list. When the **UP ARROW** is pressed the Model 30M will display the Site ID# for the previously recorded data. For example: If you are reviewing Site ID# 5 and the **UP ARROW** is pressed, the Model 30M will display Site ID# 4. If you are reviewing Site ID# 5 and Site ID# 5 was the last set of data stored, the **DOWN ARROW** key will display Site ID# 1.

Here is an example of the Model 30M memory.

Site ID #1
Site ID #2
Site ID #3 —— If the **UP ARROW** key was pressed the Model 30M would display Site ID #2
Site ID #4
Site ID #5

4.3 ERASING STORED DATA

1. To erase the data that is stored into the Model 30M's memory, press the **MODE** key until the Model 30M displays **ErAS** on the screen.

2. Press and hold both the **DOWN ARROW** and **ENTER** keys simultaneously for approximately 5 seconds.
3. Successful erasure is indicated by the Model 30M flashing **DONE** on the display for 1 to 2 seconds. The instrument will automatically change to normal operation after completion.

dOnE

IMPORTANT: Data in all 50 site ID's will be erased completely and will be lost forever. Do not use the erase function until all recorded data has been transcribed to an archive outside the Model 30M.

SECTION 5 CALIBRATION

5.1 BEFORE YOU CALIBRATE

IMPORTANT: **System calibration is rarely required because of the factory calibration of the YSI Model 30. However, from time to time it is wise to check the system calibration and make adjustments when necessary.**

Before you calibrate the YSI Model 30, complete the procedures discussed in the *Preparing the Meter* and *Making Measurements* sections of this manual.

To accurately calibrate the YSI Model 30, it is important to remember the following:

1. **Always use clean, properly stored, NIST traceable calibrator solutions** (see Appendix B, *Accessories and Replacement Parts*). When filling a calibration container prior to performing the calibration procedures, make certain that the level of calibrant buffers is high enough in the container to cover the entire conductivity cell. Gently agitate the probe to remove any bubbles in the conductivity cell.
2. Rinse the probe with deionized water (and wipe dry) between changes of calibration solutions.
3. During calibration, allow the probe time to stabilize with regard to temperature (approximately 60 seconds) before proceeding with the calibration process. **The readings after calibration are only as good as the calibration itself.**
4. Perform sensor calibration at a temperature as close to 25°C as possible. This will minimize any temperature compensation error.

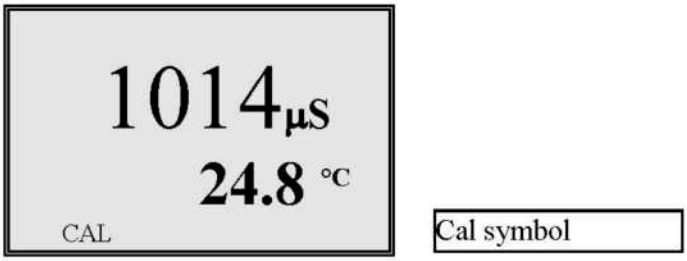
5.2 THE CALIBRATION PROCESS

System calibration is rarely required because of the factory calibration of the YSI Model 30. However, from time to time it is wise to check the system calibration and make adjustments when necessary.

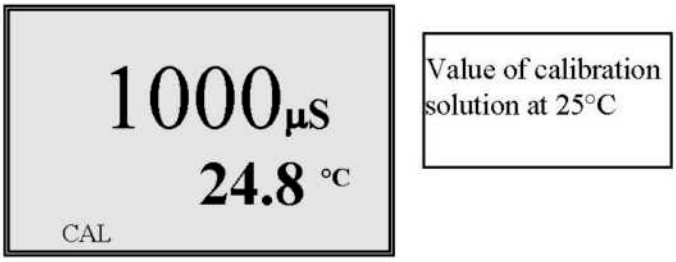
Follow these steps to perform an accurate calibration of the YSI Model 30:

1. Turn the instrument on and allow it to complete its self test procedure.
2. Select a calibration solution which is most similar to the sample you will be measuring.
   - For sea water choose a 50 mS/cm conductivity standard (YSI Catalog# 3169).
   - For fresh water choose a 1 mS/cm conductivity standard (YSI Catalog# 3167).
   - For brackish water choose a 10 mS/cm conductivity standard (YSI Catalog # 3168).
3. Place at least 3 inches of solution in a clean glass beaker.
4. Insert the probe into the beaker deep enough to completely cover the oval shaped hole on the side of the probe. Do not rest the probe on the bottom of the container -- suspend it above the bottom at least 1/4 inch.
5. Press the **MODE** key until the instrument is reading conductivity or specific conductance.

6. Allow at least 60 seconds for the temperature reading to become stable.
7. Move the probe vigorously from side to side to dislodge any air bubbles from the electrodes.
8. Press and release both the **UP ARROW** and **DOWN ARROW** keys at the same time. The **CAL** symbol will appear at the bottom left of the display to indicate that the instrument is now in Calibration mode.



9. Use the **UP ARROW** or **DOWN ARROW** key to adjust the reading on the display until it matches the value of the calibration solution you are using.



10. Once the display reads the exact value of the calibration solution being used (the instrument will make the appropriate compensation for temperature variation from 25°C), press the **ENTER** key. The word "**SAVE**" will flash across the display for a second indicating that the calibration has been accepted.

NOTE: If the up or down arrow keys are not pressed during the calibration process, the "SAVE" message will not be displayed since the calibration value has not changed. If an error occurs during calibration, see Section 9, *Troubleshooting*.

SECTION 6 ADVANCED SETUP

The default settings of the YSI Model 30 are appropriate for the vast majority of measurement applications. However, some measurement applications require very specific measurement criteria. For that reason, we have made the YSI Model 30 flexible to accommodate these "advanced users."

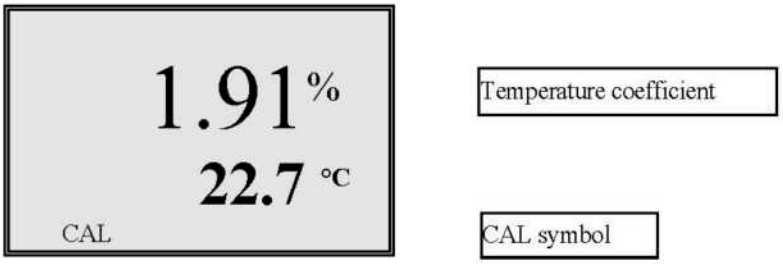
If, for example, you are using the YSI Model 30 for a process control application which requires that the conductivity readings be compensated to 20 °C instead of 25 °C -- this is the section to read. Or, if your application for the YSI Model 30 involves the measurement of a very specific saline solution, the default temperature coefficient may need to be changed to get the very best measurement of that specific salt.

IMPORTANT: There is never a need to enter Advanced Setup Mode unless your special measurement application calls for a change in reference temperature and/or temperature coefficient. Therefore, unless you are certain that your application requires a change to one or both of these criteria, do not modify the default reference temperature (25°C) or the default temperature coefficient (1.91%).

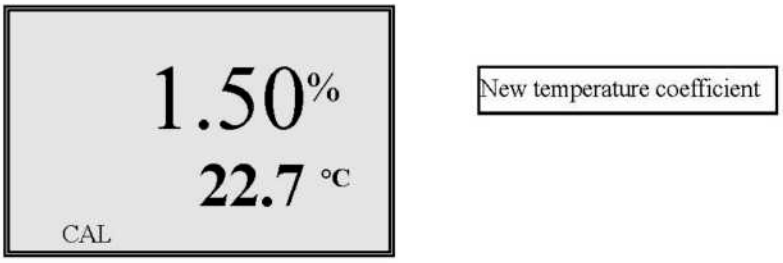
6.1 CHANGING THE TEMPERATURE COEFFICIENT

Follow these steps to modify the temperature coefficient of the Model 30.

1. Turn the instrument on and wait for it to complete its self test procedure.
2. Press and release both the **DOWN ARROW** and **MODE** keys at the same time. The **CAL** symbol will appear at the bottom left of the display and the large portion of the display will show **1.91%** (or a value set previously using Advanced Setup).



3. Use the **UP ARROW** or **DOWN ARROW** key to change the value to the desired new temperature coefficient.



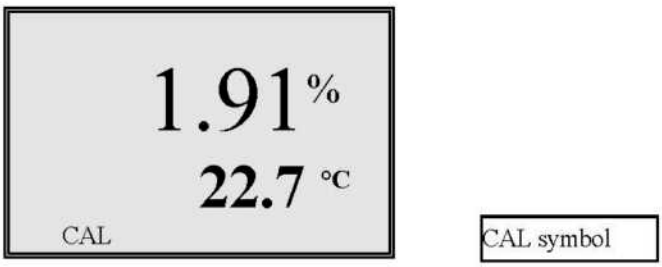
4. Press the **ENTER** key. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted.
5. Press the **MODE** key to return to normal operation; the **CAL** symbol will disappear from the display.

See *Appendix C* for charts of common salt solutions at various temperatures.

6.2 CHANGING THE REFERENCE TEMPERATURE

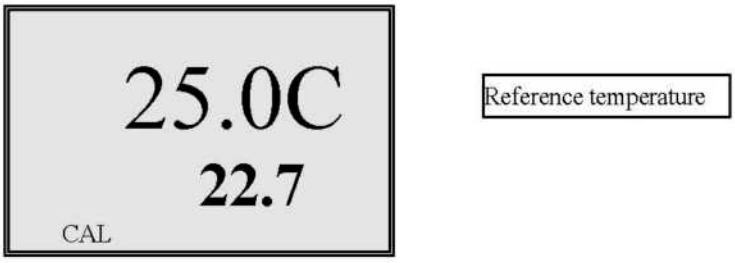
Follow these steps to modify the reference temperature of the Model 30.

1. Turn the instrument on and wait for it to complete its self test procedure.
2. Press and release both the **DOWN ARROW** and **MODE** keys at the same time.

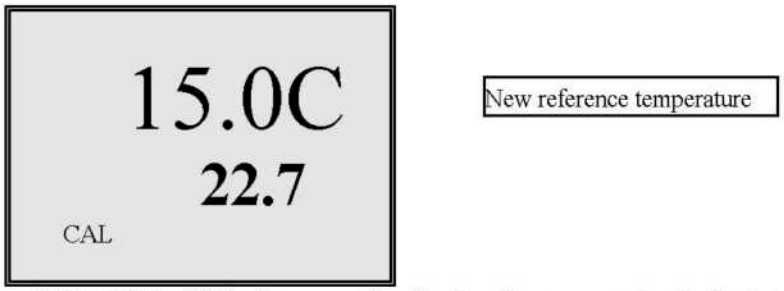


The **CAL** symbol will appear at the bottom left of the display and the large portion of the display will show **1.91%** (or a value set previously using Advanced Setup).

3. Press and release the **MODE** key; the large portion of the display will show **25.0C** (or a value set previously using Advanced Setup).



4. Use the **UP ARROW** or **DOWN ARROW** key to change the value to the desired new reference temperature (any value between 15 °C and 25 °C is acceptable).



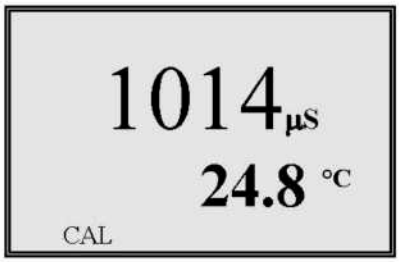
5. Press the **ENTER** key. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted. The instrument will automatically return to normal operation mode.

6.3 CHANGING FROM AUTORANGING TO MANUAL RANGING

If your application is easier to perform using a manual range which you select, the YSI Model 30 and Model 30M allow you to turn off the default autoranging feature. Follow the instructions for your model as shown below.

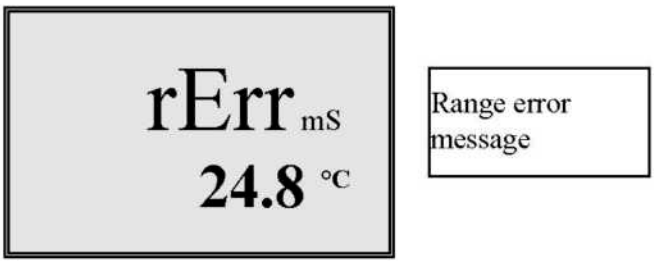
Model 30

While you are making conductivity or specific conductance measurements with the Model 30, simply press and release the **ENTER** key to select manual ranging.



Each additional press of the **ENTER** key will cycle the Model 30 to a different manual range until you return again to autoranging. Five pushes of the **ENTER** key will cycle the Model 30 through the four manual ranges and return the instrument to autoranging.

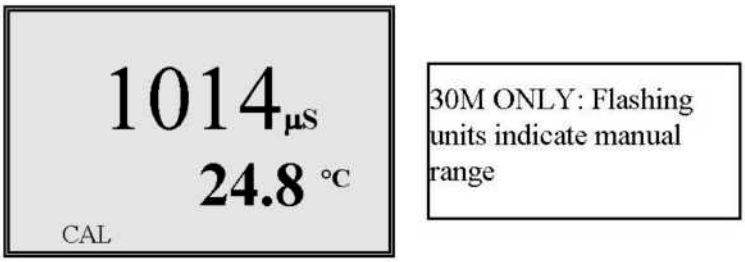
NOTE: You may see an error message in some manual ranges if the manual range selected is not adequate for the sample you are measuring.



If this happens, simply press and release the **ENTER** key until a range is selected which is suitable for your sample. If you get lost and don't know if you're in a manual range or autoranging, simply turn the instrument off and back on. The instrument will always default to autoranging when first turned on.

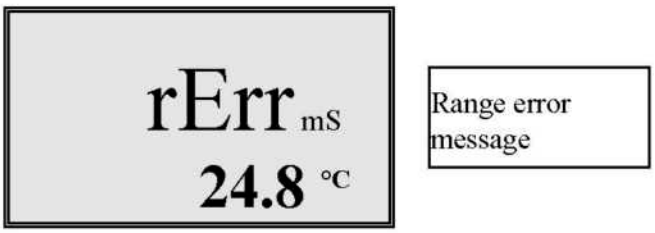
Model 30M

While you are making conductivity or specific conductance measurements with the Model 30M, simply press and release the **UP ARROW** key to select manual ranging. Note that the conductivity units will flash on the Model 30M to indicate that the instrument is in a manual range.



Each additional press of the **UP ARROW** key will cycle the Model 30M to a different manual range until you return again to autoranging. Five pushes of the **UP ARROW** key will cycle the Model 30M through the four manual ranges and return the instrument to autoranging.

NOTE: You may see an error message in some manual ranges if the manual range selected is not adequate for the sample you are measuring.



If this happens, simply press and release the **UP ARROW** key until a range is selected which is suitable for your sample. Note that the instrument will always default to autoranging when first turned on.

The four ranges of the YSI Model 30 are:

Range 1	Range 2	Range 3	Range 4
0 to 499.9 μS/cm	0 to 4999 μS/cm	0 to 49.99 mS/cm	0 to 200.0 mS/cm

SECTION 7 PRINCIPLES OF OPERATION

The Model 30 utilizes a cell with four pure nickel electrodes for the measurement of solution conductance. Two of the electrodes are current driven and two are used to measure the voltage drop. The measured voltage drop is then converted into a conductance value in milliSiemens (millimhos). To convert this value to a conductivity value in milliSiemens per cm (mS/cm), the conductance is multiplied by the cell constant which has units of reciprocal cm (cm^{-1}). The cell constant for the Model 30 conductivity cell is 5.0/cm ±4%. For most applications, the cell constant is automatically determined (or confirmed) with each deployment of the system when the calibration procedure is followed; see section 6.2. Solutions with conductivities of 1.00, 10.0, 50.0, and 100.0 mS/cm, which have been prepared in accordance with recommendation 56-1981 of the Organisation Internationale de Métrologie Légale (OIML), are available from YSI. The instrument output is in µS/cm or mS/cm for both conductivity and specific conductance. The multiplication of cell constant times conductance is carried out automatically by the software.

7.1 TEMPERATURE EFFECT

The conductivity of solutions of ionic species is highly dependent on temperature, varying as much as 3% for each change of one degree Celsius (temperature coefficient = 3%/°C). In addition, the temperature coefficient itself varies with the nature of the ionic species present. Because the exact composition of a natural media is usually not known, it is best to report a conductivity at a particular temperature, e.g. 20.2 mS/cm at 14°C. However, in many cases, it is also useful to compensate for the temperature dependence in order to determine at a glance if gross changes are occurring in the ionic content of the medium over time. For this reason, the Model 30 software also allows the user to output conductivity data in either raw or temperature compensated form. If "Conductivity" is selected, values of conductivity which are **NOT** compensated for temperature are output to the display. If "Specific Conductance" is selected, the Model 30 uses the temperature and raw conductivity values associated with each determination to generate a specific conductance value compensated to a user selected reference temperature (see section 6, *Advanced Setup*) between 15°C and 25°C. Additionally the user can select any temperature coefficient from 0% to 4% (see Section 6, *Advanced Setup)*. Using the Model 30 default reference temperature and temperature coefficient (25°C and 1.91%), the calculation is carried out as in equation (1) below:

$$\text{Specific Conductance } (25°C) = \frac{\text{Conductivity}}{1 + TC * (T - 25)}$$

As noted above, unless the solution being measured consists of pure KCl in water, this temperature compensated value will be somewhat inaccurate, but the equation with a value of TC = 0.0191 will provide a close approximation for solutions of many common salts such as NaCl and NH_4Cl and for seawater.

Salinity is determined automatically from the Model 30 conductivity readings according to algorithms found in *Standard Methods for the Examination of Water and Wastewater (ed. 1995).* The use of the Practical Salinity Scale 1978 results in values which are unitless, since the measurements are carried out in reference to the conductivity of standard seawater at 15°C. However, the unitless salinity values are very close to those determined by the previously-used method where the mass of dissolved salts in a given mass of water (parts per thousand) was reported. Hence, the designation "ppt" is reported by the instrument to provide a more conventional output.

For further information on conductivity and the above standard information, refer to the ASTM document, *Standard Methods of Test for Electrical Conductivity of Water and Industrial Wastewater*, ASTM Designation D1125-82, and OIML *Recommendation Number 56.* ASTM symbols for conductivity, cell constant, and path length differ from those preferred in the general literature and also from those used in this manual.

7.2 DISCUSSION OF MEASUREMENT ERRORS

System accuracy for conductivity measurements is equal to the sum of the errors contributed by the environment and the various components of the measurement setup. These include:

- Instrument accuracy
- Cell-constant error
- Solution temperature offset
- Cell contamination (including air bubbles)
- Electrical noise
- Galvanic effects

Only the first three are of major concern for typical measurements, although the user should also be careful to see that cells are clean and maintained in good condition at all times.

Instrument Accuracy = ± .5% maximum

The accuracy specified for the range being used is the worst case instrument error.

Cell-Constant Error = ± .5% maximum

Although YSI cells are warranted to be accurate to within one percent, you should still determine the exact cell constant of your particular cell. Contamination or physical damage to the cell can alter the cell constant. Performing a calibration will eliminate any error which might arise because of cell constant change.

YSI cells are calibrated to within one percent of the stated cell constant at a single point. We consider these products to be usefully linear over most instrument ranges. The cell constant can be calibrated to ±0.35% accuracy with YSI conductivity calibrator solutions.

Temperature Error = ± 1% maximum

The solution temperature error is the product of the temperature coefficient and the temperature offset from 25°C, expressed as a percentage of the reading that would have been obtained at 25°C.

The error is not necessarily a linear function of temperature. The statement of error is derived from a 25°C temperature offset and a 3%/°C temperature coefficient.

Total Error

Considering only the above three factors, system accuracy under worst case conditions will be ±2%, although the actual error will be considerably less if recommended and properly calibrated cells and instrument ranges are used. Additional errors, which can essentially be eliminated with proper handling, are described below.

Cell Contamination

This error is usually due to contamination of the solution being measured, which occurs when solution is carried-over from the last solution measured. Thus, the instrument might be correctly reporting the conductivity seen, but the reading does not accurately represent the value of the bulk solution. Errors will be most serious when low conductivity solutions are contaminated by carry-over from high conductivity solutions, and can then be of an order of magnitude or more.

Follow the cleaning instructions carefully before attempting low conductivity measurements with a cell of unknown history or one that has been previously used in higher value solutions.

An entirely different form of contamination sometimes occurs due to a buildup of foreign material directly on cell electrodes. While rare, such deposits have, on occasion, markedly reduced the effectiveness of the electrodes. The result is an erroneously low conductance reading.

Electrical-Noise Errors

Electrical noise can be a problem in any measurement range, but will contribute the most error and be the most difficult to eliminate when operating in the lowest ranges. The noise may be either line-conducted or radiated or both, and may require, grounding, shielding, or both.

Galvanic and Miscellaneous Effects

In addition to the error sources described above, there is another class of contributors that can be ignored for all but the most meticulous of laboratory measurements. These errors are always small and are generally completely masked by the error budget for cell-constant calibration, instrument accuracy, etc. Examples range from parasitic reactances associated with the solution container and its proximity to external objects to the minor galvanic effects resulting from oxide formation or deposition on electrodes. Only trial and error in the actual measurement environment can be suggested as an approach to reduce such errors. If the reading does not change as the setup is adjusted, errors due to such factors can be considered too small to see

SECTION 8 MAINTENANCE

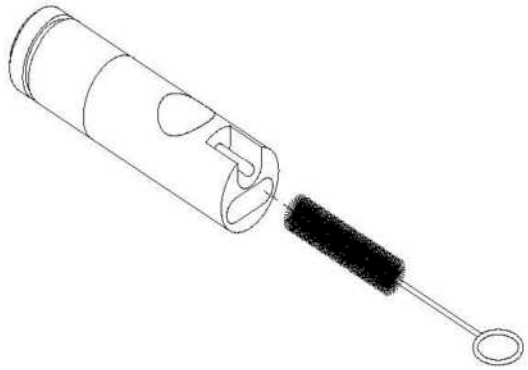
8.1 CLEANING AND STORAGE

The single most important requirement for accurate and reproducible results in conductivity measurement is a clean cell. A dirty cell will change the conductivity of a solution by contaminating it.

NOTE: ALWAYS RINSE THE CONDUCTIVITY CELL WITH CLEAN WATER AFTER EACH USE.

To clean the conductivity cell:

1. Dip the cell in cleaning solution and agitate for two to three minutes. Any one of the foaming acid tile cleaners, such as Dow Chemical Bathroom Cleaner, will clean the cell adequately. When a stronger cleaning preparation is required, use a solution of 1:1 isopropyl alcohol and 1 N HCl. Remove the cell from the cleaning solution.
2. Use the nylon brush (supplied) to dislodge any contaminants from inside the electrode chamber.



3. Repeat steps one and two until the cell is completely clean. Rinse the cell thoroughly in deionized, or clean tap water.
4. Store the conductivity cell in the meter storage chamber.

8.2 PROBE PRECAUTIONS

Observe the following precautions to ensure accurate, repeatable results:

1. The cell must be clean before making any measurements. When working with substances having low conductivity, extraordinary cleanliness may be required.
2. Suspend the cell in the solution deep enough to submerge the vent hole. The electrode chamber should be free of trapped air. You may need to tap the probe gently to dislodge any air bubbles.
3. Ideally, the cell should be at least ¼ inch away from any other object, including the sides or bottom of the solution container.

4. Stirring may be necessary for highest accuracy measurements, especially in low-conductivity solutions.
5. If possible, isolate from ground potential the container or system in which measurements are to be made.
6. Electrical fields and stray currents caused by stirrer motors, heaters, etc., can interfere with measurements. The user should determine the effects of these and make the necessary corrections, either by shielding or by disconnecting those units that cause trouble.
7. Always rinse the cell carefully before transferring it from one solution to another.
8. Never store a dirty or contaminated cell.

SECTION 9 TROUBLESHOOTING

The following is a list of error codes for the Model 30 and Model 30M. The Model 30M also has additional error codes (see the following page).

SYMPTOM	POSSIBLE CAUSE	ACTION
1. Instrument will not turn on	A. Low battery voltage B. Batteries installed wrong C. Meter requires service	A. Replace batteries B. Check battery polarity. C. Return system for service
2. Instrument will not calibrate	A. Incorrect calibration procedure B. Cell needs cleaning C. Instrument requires Service	A. See section 5 *Calibration* B. See section 8 *Maintenance* C. Return system for service
3. Instrument "locks up"	A. Instrument has received a shock B. Batteries are low or damaged C. System requires service	A. Remove battery lid, wait 15 seconds for reset, replace lid. B. Replace batteries C. Return system for service
4. Instrument readings are inaccurate	D. Calibration is required E. Cell is contaminated F. Temperature coefficient has been set incorrectly G. Reference temperature incorrect H. Readings are or are not temperature compensated.	D. See section 5 *Calibration* E. See section 8 *Maintenance* F. See section 6 *Advanced Setup* G. See section 6 *Advanced Setup* H. See section 3 *Making Measurements*
5. LCD displays "LO BAT"	A. Batteries are low or damaged	A. Replace batteries
6. Main Display reads "OVEr"	I. Conductivity Reading is >200 mS J. Temp. Reading is > 95° C K. Temp. Reading is <-5° C L. Salinity reading is > 80 ppt M. During calibration, calculated cell constant is >K=5.25	I. In all cases, check calibration values and procedure; check Advanced Setup settings. J. If each of these is set correctly, return system for service.
7. Main Display reads "Undr"	A. During calibration, calculated cell constant is <K=4.9	A. Recalibrate instrument using known good conductivity standard B. Follow cell cleaning procedure see section 8 *Maintenance*.
8. Main Display reads "rErr"	N. User has selected manual ranging & sample exceeds selected range	K. Use the mode key to select a higher or lower manual range, or to set system to Autoranging.
9. Main Display reads "PErr"	O. Incorrect sequence of key strokes	A. Refer to manual section which provides step by step procedures for the function you are attempting.

SYMPTOM	POSSIBLE CAUSE	ACTION
10. Main Display reads "LErr"	A. In specific conductance mode, temperature exceeds the values computed using user defined temperature coefficient and/or reference temperature B. During calibration, temperature exceeds the values computed using user defined temperature coefficient and/or reference temperature	A. & B. Adjust user defined temperature coefficient and/or reference temperature (See section 6 *Advanced Setup*)
11. Main Display reads "Err" Secondary Display reads "ra"	A. System has failed its RAM test check procedure	A. Turn instrument OFF and back ON. B. Return the system for service.
12. Main Display reads "Err" Secondary Display reads "ro"	A. System has failed its ROM test check procedure	A. Turn instrument OFF and back ON. B. Return the system for service.
13. Secondary Display reads "ovr"	A. Temperature is > 95° C	A. Read solution of lower temperature B. Return system for service C. Replace Probe/Cable assy.
14. Secondary Display reads "udr"	A. Temperature is < -5° C	A. Read solution of higher temperature B. Return system for service C. Replace Probe/Cable assy.
15. Secondary Display reads "rEr"	A. Temperature jumper is set to ° F and reading is >199.9 ° F but < 203 ° F	A. Set jumper to read ° C. B. Return system for service

The Model 30M has additional error codes as follows:

SYMPTOM	POSSIBLE CAUSE	ACTION
1. Readings on main display don't change	A. Meter is in recall mode.	A. Press MODE key to return to Normal Operation
2. Main Display reads "nOnE"	A. During recall, no data is currently stored in memory.	A. Store data before attempting to recall

SECTION 10 WARRANTY AND REPAIR

YSI Model 30 Salinity, Conductivity and Temperature Meters are warranted for two years from date of purchase by the end user against defects in materials and workmanship. YSI Model 30 probes and cables are warranted for one year from date of purchase by the end user against defects in material and workmanship. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

Limitation of Warranty

This Warranty does not apply to any YSI product damage or failure caused by (i) failure to install, operate or use the product in accordance with YSI's written instructions, (ii) abuse or misuse of the product, (iii) failure to maintain the product in accordance with YSI's written instructions or standard industry procedure, (iv) any improper repairs to the product, (v) use by you of defective or improper components or parts in servicing or repairing the product, or (vi) modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI's LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

AUTHORIZED SERVICE CENTERS

Please visit www.ysi.com or contact YSI Technical Support for all authorized service centers both in the United States and internationally.

YSI Technical Support
+1 937-767-7241
800-897-4151 (US)
environmental@ysi.com

CLEANING INSTRUCTIONS

NOTE: Before they can be serviced, equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected.

Biological contamination is presumed for any instrument, probe, or other device that has been used with body fluids or tissues, or with waste water. Radioactive contamination is presumed for any instrument, probe or other device that has been used near any radioactive source.

If an instrument, probe, or other part is returned or presented for service without a Cleaning Certificate, and if in our opinion it represents a potential biological or radioactive hazard, our service personnel reserve the right to withhold service until appropriate cleaning, decontamination, and certification has been completed. We will contact the sender for instructions as to the disposition of the equipment. Disposition costs will be the responsibility of the sender.

When service is required, either at the user's facility or at YSI, the following steps must be taken to insure the safety of our service personnel.

1. In a manner appropriate to each device, decontaminate all exposed surfaces, including any containers. 70% isopropyl alcohol or a solution of 1/4 cup bleach to 1 gallon tap water are suitable for most disinfecting. Instruments used with waste water may be disinfected with .5% Lysol if this is more convenient to the user.
2. The user shall take normal precautions to prevent radioactive contamination and must use appropriate decontamination procedures should exposure occur.
3. If exposure has occurred, the customer must certify that decontamination has been accomplished and that no radioactivity is detectable by survey equipment.
4. Any product being returned to the YSI Repair Center, should be packed securely to prevent damage.
5. Cleaning must be completed and certified on any product before returning it to YSI.

PACKING INSTRUCTIONS

1. Clean and decontaminate items to insure the safety of the handler.
2. Complete and include the Cleaning Certificate.
3. Place the product in a plastic bag to keep out dirt and packing material.
4. Use a large carton, preferably the original, and surround the product completely with packing material.
5. Insure for the replacement value of the product.

Cleaning Certificate

Organization _____

Department _____

Address _____

City _____ State _____ Zip _____

Country _____ Phone _____

Model No. of Device _____ Lot Number _____

Contaminant (if known) _____

Cleaning Agent(s) used _____

Radioactive Decontamination Certified?

(Answer only if there has been radioactive exposure)

_____Yes _____ No

Cleaning Certified By _____

Name Date

APPENDIX A REQUIRED NOTICE

The Federal Communications Commission defines this product as a computing device and requires the following notice:

This equipment generates and uses radio frequency energy and if not installed and used properly, may cause interference to radio and television reception. There is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- re-orient the receiving antenna
- relocate the computer with respect to the receiver
- move the computer away from the receiver
- plug the computer into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet, prepared by the Federal Communications Commission, helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 0004-000-00345-4.

APPENDIX B ACCESSORIES AND REPLACEMENT PARTS

The following parts and accessories are available from YSI or any Franchise Dealer authorized by YSI.

YSI Order Number	Description
3161	Conductivity Calibrator Solution 1,000 µS/cm (1 Quart)
3163	Conductivity Calibrator Solution 10,000 µS/cm (1 Quart)
3165	Conductivity Calibrator Solution 100,000 µS/cm (1 Quart)
3167	Conductivity Calibrator Solution 1,000 µS/cm (8 pints)
3168	Conductivity Calibrator Solution 10,000 µS/cm (8 pints)
3169	Conductivity Calibrator Solution 50,000 µS/cm (8 pints)
5520	Carrying Case
110030	Replacement Probe & Cable Assembly (10 feet)
110031	Replacement Probe & Cable Assembly (25 feet)
110032	Replacement Probe & Cable Assembly (50 feet)
030131	Replacement Front Case Cover
055242	Replacement Rear Case Cover
055244	Replacement Battery Cover Kit
055204	Replacement Case Gasket and Screw, Model 30
055219	Storage Chamber Sponge
038213	Replacement Electrode Cleaning Brush
030133	Replacement PCB Assy., Model 30
030155	Replacement PCB Assy., Model 30M

APPENDIX C TEMPERATURE CORRECTION

This data is for typical applications of the YSI sondes.

A. Potassium Chloride** (KCl)

Concentration: 1 mole/liter			Concentration: 1 x 10^{-1} mole/liter		
°C	mS/cm	%/°C (to 25°C)	°C	mS/cm	%/°C (to 25°C)
0	65.10	1.67	0	7.13	1.78
5	73.89	1.70	5	8.22	1.80
10	82.97	1.72	10	9.34	1.83
15	92.33	1.75	15	10.48	1.85
20	101.97	1.77	20	11.65	1.88
25	111.90	1.80	25	12.86	1.90
			30	14.10	1.93
			35	15.38	1.96
			37.5	16.04	1.98
			40	16.70	1.99
			45	18.05	2.02
			50	19.43	2.04

Concentration: 1 x 10^{-2} mole/liter			Concentration: 1 x 10^{-3} mole/liter		
°C	mS/cm	%/°C (to 25°C)	°C	mS/cm	%/°C (to 25°C)
0	0.773	1.81	0	0.080	1.84
5	0.892	1.84	5	0.092	1.88
10	1.015	1.87	10	0.105	1.92
15	1.143	1.90	15	0.119	1.96
20	1.275	1.93	20	0.133	1.99
25	1.412	1.96	25	0.147	2.02
30	1.553	1.99	30	0.162	2.05
35	1.697	2.02	35	0.178	2.07
37.5	1.771	2.03	37.5	0.186	2.08
40	1.845	2.05	40	0.194	2.09
45	1.997	2.07	45	0.210	2.11
50	2.151	2.09	50	0.226	2.13

** Charts developed by interpolating data from *International Critical Tables*, Vol. 6, pp. 229-253, McGraw-Hill Book Co., NY.

B. Sodium Chloride* (NaCl)

Saturated solutions at all temperatures			Concentration: 0.5 mole/liter		
°C	mS/cm	%/°C (to 25°C)	°C	mS/cm	%/°C (to 25°C)
0	134.50	1.86	0	25.90	1.78
5	155.55	1.91	5	29.64	1.82
10	177.90	1.95	10	33.61	1.86
15	201.40	1.99	15	37.79	1.90
20	225.92	2.02	20	42.14	1.93
25	251.30	2.05	25	46.65	1.96
30	277.40	2.08	30	51.28	1.99
			35	56.01	2.01
			37.5	58.40	2.02
			40	60.81	2.02
			45	65.65	2.04
			50	70.50	2.05

Concentration: 1 x 10^{-1} mole/liter			Concentration: 1 x 10^{-2} mole/liter		
°C	mS/cm	%/°C (to 25°C)	°C	mS/cm	%/°C (to 25°C)
0	5.77	1.83	0	0.632	1.87
5	6.65	1.88	5	0.731	1.92
10	7.58	1.92	10	0.836	1.97
15	8.57	1.96	15	0.948	2.01
20	9.60	1.99	20	1.064	2.05
25	10.66	2.02	25	1.186	2.09
30	11.75	2.04	30	1.312	2.12
35	12.86	2.06	35	1.442	2.16
37.5	13.42	2.07	37.5	1.508	2.17
40	13.99	2.08	40	1.575	2.19
45	15.14	2.10	45	1.711	2.21
50	16.30	2.12	50	1.850	2.24

Concentration: 1 x 10^{-3} mole/liter		
°C	mS/cm	%/°C (to 25°C)
0	0.066	1.88
5	0.076	1.93
10	0.087	1.98
15	0.099	2.02
20	0.111	2.07
25	0.124	2.11
30	0.137	2.15
35	0.151	2.19
37.5	0.158	2.20
40	0.165	2.22
45	0.180	2.25
50	0.195	2.29

* Charts developed by interpolating data from the *CRC Handbook of Chemistry and Physics*, 42nd ed., p. 2606, The Chemical Rubber Company, Cleveland.

C. Lithium Chloride* (LiCl)

Concentration: 1 mole/liter			Concentration: 1 x 10^{-1} mole/liter		
°C	mS/cm	%/°C (to 25°C)	°C	mS/cm	%/°C (to 25°C)
0	39.85	1.82	0	5.07	1.87
5	46.01	1.85	5	5.98	1.85
10	52.42	1.89	10	6.87	1.85
15	59.07	1.92	15	7.75	1.85
20	65.97	1.95	20	8.62	1.85
25	73.10	1.98	25	9.50	1.86
30	80.47	2.02	30	10.40	1.88
35	88.08	2.05	35	11.31	1.91
37.5	91.97	2.07	37.5	11.78	1.92
40	95.92	2.08	40	12.26	1.94
45	103.99	2.11	45	13.26	1.98
50	112.30	2.15	50	14.30	2.02

Concentration: 1 x 10^{-2} mole/liter			Concentration: 1 x 10^{-3} mole/liter		
°C	mS/cm	%/°C (to 25°C)	°C	mS/cm	%/°C (to 25°C)
0	0.567	1.88	0	0.059	1.93
5	0.659	1.92	5	0.068	2.03
10	0.755	1.96	10	0.078	2.12
15	0.856	2.00	15	0.089	2.19
20	0.961	2.04	20	0.101	2.25
25	1.070	2.08	25	0.114	2.28
30	1.183	2.12	30	0.127	2.31
35	1.301	2.16	35	0.140	2.32
37.5	1.362	2.18	37.5	0.147	2.32
40	1.423	2.20	40	0.154	2.31
45	1.549	2.24	45	0.166	2.29
50	1.680	2.28	50	0.178	2.25

D. Potassium Nitrate** (KNO_3)

Concentration: 1 x 10^{-1} mole/liter			Concentration: 1 x 10^{-2} mole/liter		
°C	mS/cm	%/°C (to 25°C)	°C	mS/cm	%/°C (to 25°C)
0	6.68	1.78	0	0.756	1.77
5	7.71	1.79	5	0.868	1.80
10	8.75	1.81	10	0.984	1.83
15	9.81	1.83	15	1.105	1.86
20	10.90	1.85	20	1.229	1.88
25	12.01	1.87	25	1.357	1.90
30	13.15	1.90	30	1.488	1.93
35	14.32	1.92	35	1.622	1.95
37.5	14.92	1.94	37.5	1.690	1.96
40	15.52	1.95	40	1.759	1.97
45	16.75	1.97	45	1.898	1.99
50	18.00	2.00	50	2.040	2.01

* Charts developed by interpolating data from the *CRC Handbook of Chemistry and Physics*, 42nd ed., p. 2606, The Chemical Rubber Company, Cleveland.

** Charts developed by interpolating data from *International Critical Tables*, Vol. 6, pp. 229-253, McGraw-Hill Book Co., NY.

E. Ammonium Chloride* (NH_4Cl)

Concentration: 1 mole/liter			Concentration: 1 x 10^{-1} mole/liter		
°C	mS/cm	%/°C (to 25°C)	°C	mS/cm	%/°C (to 25°C)
0	64.10	1.60	0	6.96	1.82
5	74.36	1.53	5	7.98	1.88
10	83.77	1.45	10	9.09	1.93
15	92.35	1.37	15	10.27	1.97
20	100.10	1.29	20	11.50	2.00
25	107.00	1.21	25	12.78	2.03
			30	14.09	2.06
			35	15.43	2.07
			37.5	16.10	2.08
			40	16.78	2.08
			45	18.12	2.09
			50	19.45	2.09

Concentration: 1 x 10^{-2} mole/liter			Concentration: 1 x 10^{-3} mole/liter		
°C	mS/cm	%/°C (to 25°C)	°C	mS/cm	%/°C (to 25°C)
0	0.764	1.84	0	0.078	1.88
5	0.889	1.86	5	0.092	1.90
10	1.015	1.88	10	0.105	1.91
15	1.144	1.91	15	0.119	1.93
20	1.277	1.94	20	0.133	1.95
25	1.414	1.97	25	0.148	1.98
30	1.557	2.02	30	0.162	2.01
35	1.706	2.06	35	0.178	2.04
37.5	1.782	2.08	37.5	0.186	2.06
40	1.860	2.10	40	0.194	2.07
45	2.020	2.14	45	0.210	2.11
50	2.186	2.18	50	0.227	2.15

* Charts developed by interpolating data from the *CRC Handbook of Chemistry and Physics*, 42nd ed., p. 2606, The Chemical Rubber Company, Cleveland.

APPENDIX D CONVERSION CHART

To Convert From	To	Equation
Feet	Meters	Multiply by 0.3048
Meters	Feet	Multiply by 3.2808399
Degrees Celsius	Degrees Fahrenheit	$9/5\times(^{o}C)+32$
Degrees Fahrenheit	Degrees Celsius	$5/9\times(^{o}F-32)$
Milligrams per liter (mg/l)	Parts per million (ppm)	Multiply by 1

APPENDIX E GLOSSARY

ampere (A) - SI unit of electric current

amplitude - The maximum deviation of an alternating current from its average value during its cycle.

ASTM - American Society for Testing and Materials

calibrate - To determine, check, or rectify the graduation of any instrument giving quantitative measurements.

calibrator solution - A solution of known value used to calibrate.

capacitance (C) - The ratio of the total charge on an isolated conductor to its potential; the property of being able to collect a charge of electricity. C = Q/V.

capacitor - An electrical component able to accumulate and hold an electric charge.

cell constant (K) - The ratio of the distance between two electrodes to the area normal to the current flow. K=d/A.

cgs - Abbreviation for the centimeter-gram-second system of units. Mostly superseded by SI units.

conductance (k) - The ratio of the current in a conductor to the potential difference between its ends; the ability of a conductor to transmit current; the reciprocal of resistance. The SI unit is siemens (S), also measured in mhos.

conductivity (ℵ) - The ratio of the current density in a conductor to the electric field causing the current to flow; the inverse of resistivity; the conductance between opposite faces of a cube of the measured material of 1 cm (cgs units) or 1 m (SI units) edge. Measured in mhos/cm (cgs units) or S/m (SI units)

conductivity cell - Any cell with electrodes used to measure the conductivity of liquid.

current (I) - The rate of flow of an electric charge, usually expressed in amperes.

electrode - A conductor whereby an electric current enters or leaves a liquid, gas, or vacuum.

ion - Any atom or molecule that has an electric charge due to the loss or gain of valence electrons.

mks - Abbreviation for the meter-kilogram-second system of units.

mho - A unit of conductance; the reciprocal of an ohm.

micro (μ) - The metric prefix indicating 10^{-6}.

milli (m) - The metric prefix indicating 10^{-3}.

NIST - National Institute of Standards and Technology. The US government agency that defines measurement standards in the United States.

ohm (Ω) - SI unit of resistance

OIML - Organisation Internationale de Métrologie Légale

polarization - The separation of the positive and negative charges of a molecule by an external agent.

Pyrex - A trademark name for heat-resistant and chemical-resistant glass.

reference voltage - A closely controlled d.c. or a.c. voltage used as a reference.

SI - Système International

siemens (S) - SI unit of electrical conductance; the reciprocal of an ohm; equivalent to a mho.

temperature correction - An adjustment made to a measurement to compensate for the difference between the measured and nominal temperatures.

temperature coefficient - The change in any particular physical quantity per degree change in temperature.

voltage - Electromotive force or potential expressed in volts.

APPENDIX F GENERAL SPECIFICATIONS

Probe Operating Environment

Medium: fresh, sea, or polluted water and most other liquid solutions.

Temperature: -5 to +95°C

Depth: 0 to 10, 0 to 25, or 0-50 feet (depending on cable length); 0-100 feet (30M Only)

Meter Ambient Operating/Storage Temperature: -10 to +50°C

Material: ABS, Stainless Steel, and other materials.

Dimensions:

Height:	9.5 inches	(24.13 cm)
Thickness:	2.2 inches	(5.6 cm)
Width:	3.5 inches max.	(8.89 cm)
Weight:	1.7 pounds (w/ 10' cable)	(0.77 kg)
Display	2.3"W x 1.5"L	(5.8 cm W x 3.8 cm L)

Power: 9 VDC - 6 AA-size Alkaline Batteries (included)

Approximately 100 hours operation from each new set of batteries

Water Tightness: Meets or exceeds IP65 standards

Extensive testing of the YSI Model 30 indicates the following typical performance:

MEASUREMENT	RANGE	RESOLUTION	ACCURACY
Conductivity	0 to 499.9 µS/cm	0.1 µS/cm	± 0.5% FS*
	0 to 4999 µS/cm	1.0 µS/cm	± 0.5% FS
	0 to 49.99 mS/cm	0.01 mS/cm	± 0.5% FS
	0 to 200.0 mS/cm	0.1 mS/cm	± 0.5% FS
Salinity	0-80 ppt	0.1 ppt	± 2%, or ± 0.1 ppt
Temperature	-5 to 95° C	0.1° C	± 0.1° C (± 1 lsd)

* For 50 Ft. cables, specification is for specific conductance > 100 µS/cm

Adjustable Reference Temperature: 15° C - 25° C

Adjustable Temperature Compensation Factor: 0% - 4%

Temperature Compensation: Automatic

Range: User selected or Autoranging

Data Storage: 50 points with ID (Model 30M only)

YSI *incorporated*

1700/1725 Brannum Lane
Yellow Springs, Ohio 45387 USA
(800) 765-4974 (937) 767-7241
FAX: (937) 767-9320
Website: http://www.ysi.com
E-Mail: info@ysi.com

DRW # A30136E-Web
May 1998 - Jan 2007 Web
Item # 030136

GPO Appendix 02
Attachment A
Subattachment d
HACH Portable Turbidimeter 2100P
Instrument and Procedure Manual

CAT. NO. 46500-88

PORTABLE TURBIDIMETER

Model 2100P

Instrument and Procedure Manual

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CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The Model 2100P Portable Turbidimeter has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

Battery/Eliminator Power Supply Only:
120 Vac, 60 Hz, UL Listed & CSA Certified, Class 2
230 Vac, 50 Hz, VDE Approved, GS & CE marked

Immunity

2100P Turbidimeter Tested with external Battery/Eliminator Power Supply:
EN 50082-1 (European Generic Immunity Standard) **per 89/336/EEC EMC:** Supporting test records with Dash Straus and Goodhue, Inc. (now Intertek Testing Services), certified compliance by Hach Company.

Standards include:
IEC 801-2 Electro-Static Discharge
IEC 801-3 Radiated RF Electro-Magnetic Fields
IEC 801-4 Electrical Fast Transients/Burst

Emissions

2100P Turbidimeter Tested with external Battery/Eliminator Power Supply:
EN 50081-1 (Emissions) **per 89/336/EEC EMC:** Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company

Standards include:
EN 55022 (CISPR 22) Emissions, Class B Limits

Canadian Radio Interference-Causing Regulation, Chapter 1374, Class A: Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

CERTIFICATION, continued

FCC Part 15, Class "A" Limits: Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. this device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference in which case the user will be required to correct the interference at his own expense.

The following techniques of reducing interference problems are applied easily:

1. Disconnect the battery eliminator from it's power source and from the 2100P Portable Turbidimeter to verify if it is the source of the interference
2. If the battery eliminator for the 2100P Portable Turbidimeter is plugged into the same outlet as the device with which it is interfering, try another outlet.
3. Move the 2100P Portable Turbidimeter away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

SAFETY PRECAUTIONS

Please read this entire manual before unpacking, setting up, or operating this instrument. Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTE
Information that requires special emphasis.

Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

⚠ This symbol, if noted on the instrument, references the instruction manual for operational and/or safety information.

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SPECIFICATIONS

Specifications subject to change without notice.
Operating specifications applicable at 25 °C unless noted.
Program software copyrighted by Hach Company, 1991.

Measurement Method: Ratio Nephelometric signal (90°) scatter light ratio to transmitted light

Range: 0-1000 NTU with automatic decimal point placement or manual range selection of 0-9.99, 0-99.9 and 0-1000 NTU

Accuracy: ± 2% of reading plus stray light from 0-1000 NTU

Resolution: 0.01 NTU on lowest range

Repeatability: ±1% of reading or 0.01 NTU, whichever is greater (with Gelex standards)

Response Time: 6 seconds for full step change without signal averaging in constant reading mode

Stray Light: <0.02 NTU

Standardization: StablCal® Stabilized Formazin primary standards or Formazin primary standards

Secondary Standards: Gelex® Secondary Standards

Display: Four-digit liquid crystal; 10.16 mm (0.4 in) high digits with custom icons

Light Source: Tungsten filament lamp; lamp life typically greater than 100,000 readings

Detectors: Silicon photovoltaic

Signal Averaging: Operator selectable on or off

Sample Cells: (Height X width) 60.0 X 25 mm (2.36 X 1 in) Borosilicate glass with screw caps, marking band and fill line

Sample Required: 15 mL (0.5 oz.)

Storage Temperature: -40 to 60 °C (-40 to 140 °F) (instrument only)

SPECIFICATIONS, continued

Operating Temperature: 0 to 50 °C (32 to 122 °F) (instrument only)

Operating Humidity Range: 0 to 90% RH noncondensing at 30 °C;
0 to 80% RH noncondensing at 40 °C;
0 to 70% RH noncondensing at 50 °C

Power Requirements: Four AA Alkaline cells or optional battery eliminator

Battery Life: Typically 300 tests with signal average mode off;
180 tests with signal average mode on

Battery Eliminator (optional):

For 120 V eliminator: CSA and UL approved for 120 VAC ±10%, 60 Hz, 6 V at 800 mA DC output

For 230 V eliminator: CE (VDE) approval pending for 230 VAC ±10%, 50 Hz, 6 V at 900 mA DC output

Enclosure: High impact ABS plastic

Dimensions: 22.2 X 9.5 X 7.9 cm (8.75 X 3.75 X 3.12 in)

Instrument Weight: 520 kg (1 lb 2.5 oz)

Shipping Weight: 3.1 kg (6 lbs 8.5 oz)

OPERATION

DANGER

Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.

DANGER

La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les Fiches de Données de Sécurité des Produits (FDSP) et se familiariser avec toutes les procédures de sécurité avant de manipuler tous les produits chimiques.

PELIGRO

La manipulación de muestras químicas, estándares y reactivos puede ser peligrosa. Revise las fichas de seguridad de materiales y familiarícese con los procedimientos de seguridad antes de manipular productos químicos.

GEFAHR

Das Arbeiten mit chemischen Proben, Standards und Reagenzien ist mit Gefahren verbunden. Es wird dem Benutzer dieser Produkte empfohlen, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.

PERIGO

A manipulação de amostras, padrões e reagentes químicos pode ser perigosa. Reveja a folha dos dados de segurança do material e familiarize-se com todos os procedimentos de segurança antes de manipular quaisquer produtos químicos.

PERICOLO

La manipolazione di campioni, standard e reattivi chimici può essere pericolosa. La preghiamo di prendere conoscenza delle Schede Techniche necessarie legate alla Sicurezza dei Materiali e di abituarsi con tutte le procedure di sicurezza prima di manipolare ogni prodotto chimico.

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SECTION 1 DESCRIPTION

1.1 General Description

The Hach Model 2100P Portable Turbidimeter (*Figure 1*) measures turbidity from 0.01 to 1000 NTU in automatic range mode with automatic decimal point placement. The manual range mode measures turbidity in three ranges: 0.01 to 9.99, 10 to 99.9 and 100 to 1000 NTU. Designed primarily for field use, the microprocessor-based Model 2100P has the range, accuracy, and resolution of many laboratory instruments. The instrument operates on four AA batteries or with an optional battery eliminator. Rechargeable nickel-cadmium cells may be used, but cannot be recharged in the instrument. The instrument automatically shuts off after 5.5 minutes if no keystrokes occur (does not influence operation). If this occurs, simply turn the instrument on – the 2100P will resume operation as if the power had not been interrupted. The instrument, all standard accessories, and the optional battery eliminator may be conveniently stored in the carrying case.

Figure 1 2100P Turbidimeter and Accessories

Note: *Avoid prolonged exposure to ultraviolet light and sunlight.*

Note: *Do not hold the instrument during measurements; place the instrument on a flat, steady surface.*

SECTION 1, continued

1.2 Accessories

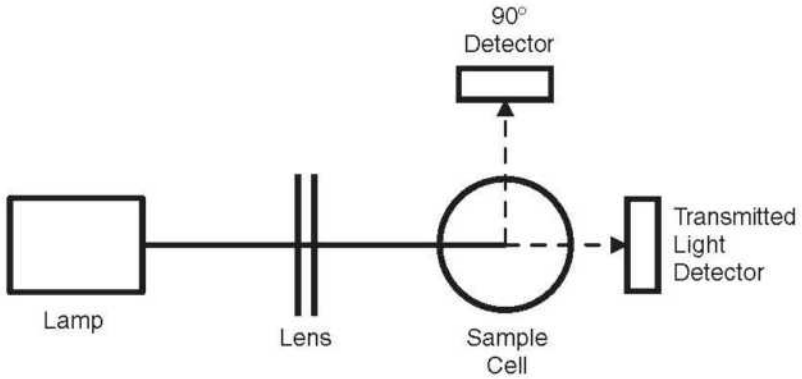
Accessories supplied with the turbidimeter include nine sample cells; three Gelex® Secondary Standards (included with 4650000 only); one sealed vial each of:
<0.1-NTU, 20-NTU, 100-NTU, and 800-NTU StablCal® Stabilized Formazin Standards; 4 AA alkaline batteries; 15 mL of silicone oil; oiling cloth; carrying case; instrument manual; and quick reference card.

1.3 Principle of Operation

The Model 2100P Portable Turbidimeter operates on the nephelometric principle of turbidity measurement. This instrument meets the design criteria specified by the United States Environmental Protection Agency, Method 180.1.

The optical system* (*Figure 2*) includes a tungsten-filament lamp, a 90° detector to monitor scattered light and a transmitted light detector. The instrument's microprocessor calculates the ratio of the signals from the 90° and transmitted light detectors. This ratio technique corrects for interferences from color and/or light absorbing materials (such as activated carbon) and compensates for fluctuations in lamp intensity, providing long-term calibration stability. The optical design also minimizes stray light, increasing measurement accuracy.

Figure 2 Ratio Optical System



* Patent number 4,198,161; other patents pending.

SECTION 1, continued

1.4 Preparation for Use

1.4.1 Unpacking

Remove the instrument and accessories from the shipping box and inspect them for damage that may have occurred due to rough handling or extreme weather conditions. Verify the following are present:

- Model 2100P Portable Turbidimeter
- Instrument Manual (with quick reference card)
- Set of StablCal Primary Standards in sealed vials, one each of:
  <0.1 NTU*
  20 NTU
  100 NTU
  800 NTU
- Standardization Kit containing Gelex Secondary Standards (0-10, 0-100 and 0-1000 ranges) (included with 4650000 only) plus nine sample cells with caps.
- Silicone Oil, 15-mL (0.5 oz) dropping bottle
- Oiling Cloth
- Carrying Case
- Four AA alkaline batteries

If any of the items are missing or damaged, please contact the Customer Service Department, Hach Company, Loveland, Colorado. The toll-free number in the United States is 800-227-4224. International customers should contact the Hach office or authorized distributor serving your area. Refer to *REPAIR SERVICE* on page 77. **Please do not return the instrument without prior authorization from Hach.**

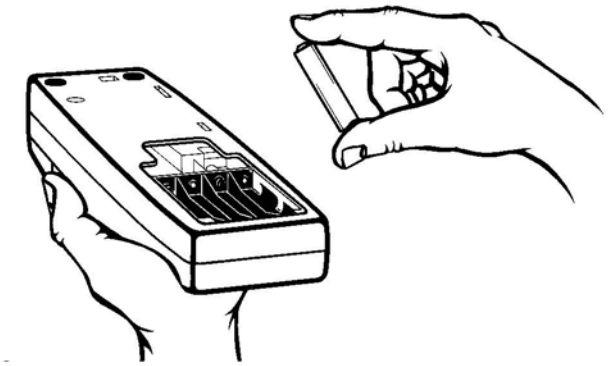
* Used in place of the dilution water standard when performing a calibration.

SECTION 1, continued

1.4.2 Battery Installation

The instrument is shipped completely assembled without the batteries installed. Before use, install the four AA alkaline batteries or connect the battery eliminator (*Figure 3*). For battery operation, remove the battery compartment cover on the instrument bottom and install the batteries. Correct battery polarity is shown on the battery holder. The instrument will not function if the batteries are not installed correctly. Reinstall the battery compartment cover.

Figure 3 Battery Installation



1.4.3 Using the Battery Eliminator and Rechargeable Batteries

For operation with the optional battery eliminator, plug the eliminator jack into the connector on the turbidimeter side. The battery eliminator may be used with or without the batteries installed. **The eliminator will not charge batteries.** Rechargeable batteries may be used in the instrument, but must be removed for recharging. See *HOW TO ORDER* on page *76* for ordering information. To prolong battery life, the instrument lamp turns on temporarily when the **READ** key is depressed. Batteries are not necessary for battery eliminator operation.

1.4.4 Calibration

The 2100P Portable Turbidimeter is calibrated with Formazin Primary Standard at the factory. However, the instrument should be calibrated upon receipt for best results. Hach recommends recalibration with

SECTION 1, continued

formazin once every three months, or more often as experience dictates. The Gelex Secondary Standards supplied with the instrument (included with 4650000 only) are labelled with general ranges for application, but must be assigned values before use from formazin calibration. See *Section 3.6* on page *37* for calibration instructions.

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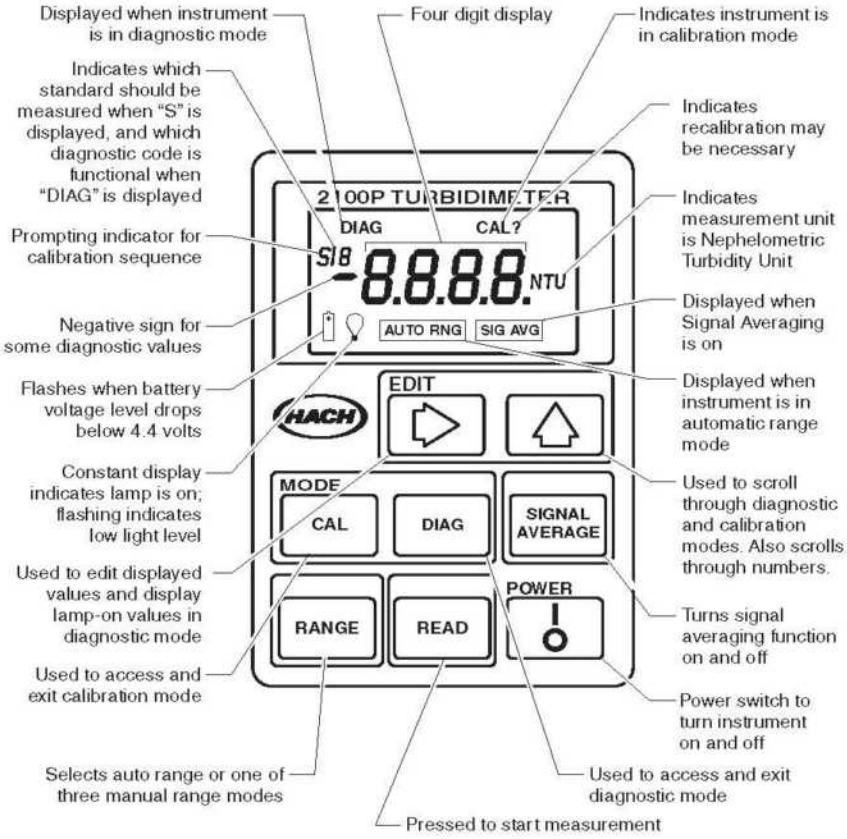
SECTION 2 TURBIDITY MEASUREMENT

2.1 Operating Controls and Indicators

Figure 4 shows the 2100P controls and indicators. Refer to *SECTION 3* for a detailed description of each control and indicator.

Figure 4 Keyboard and Display with Descriptions



2.2 Turbidity Measurement

Measurements may be made with the signal average mode on or off and in manual or automatic range selection mode. Using automatic range selection is recommended. Signal averaging uses more power and should be used only when the sample causes an unstable reading. Signal averaging measures and averages ten measurements while displaying

SECTION 2, continued

intermediate results. The initial value is displayed after about 11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 20 seconds). After this, the lamp turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When not in signal average mode, the final value is displayed after about 13 seconds.

Accurate turbidity measurement depends on good measurement technique by the analyst, such as using clean sample cells in good condition and removing air bubbles (degassing). Refer to *Section 2.3* on page *22* for a detailed discussion of measurement techniques.

2.2.1 Turbidity Measurement Procedure

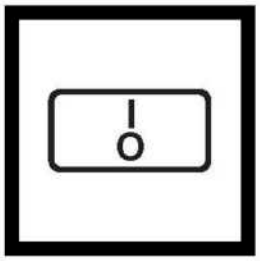
1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL), taking care to handle the sample cell by the top. Cap the cell. (See *Section 2.3* on page *22* for more information about collecting a representative sample).

Note: *The instrument automatically shuts off after 5.5 minutes if no keystrokes occur. To resume operation, press* **I/O**.

2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.

3. Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface.

SECTION 2, continued

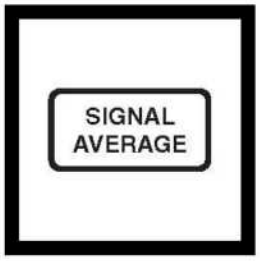


4. Press: **I/O**.

The instrument will turn on. Place the instrument on a flat, sturdy surface. Do not hold the instrument while making measurements.

5. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment.
Close the lid.

6. Select manual or automatic range selection by pressing the **RANGE** key. The display will show **AUTO RNG** when the instrument is in automatic range selection.



7. Select signal averaging mode by pressing the **SIGNAL AVERAGE** key. The display will show **SIG AVG** when the instrument is using signal averaging. Use signal average mode if the sample causes a noisy signal (display changes constantly).

8. Press: **READ**

The display will show - - - - **NTU**, then the turbidity in NTU. Record the turbidity after the lamp symbol turns off.

Note: *The instrument defaults to the last operating mode selected. If automatic range mode and signal averaging were used on the previous measurements, these options will automatically be selected for subsequent samples.*

SECTION 2, continued

2.2.2 Measurement Notes

- Always cap the sample cell to prevent spillage of sample into the instrument.
- When taking a reading, place the instrument on a level, stationary surface. It should not be held in the hand during measurement.
- Always close the sample compartment lid during measurement and storage.
- Always use clean sample cells in good condition. Dirty, scratched, or damaged cells can cause inaccurate readings.
- Do not leave a sample cell in the cell compartment for extended periods of time. This may compress the spring in the cell holder.
- Remove sample cell and batteries from instrument if the instrument is stored for extended time period (more than a month).
- Avoid operating in direct sunlight.
- Make certain cold samples do not "fog" the sample cell.
- Avoid settling of sample prior to measurement.
- Keep sample compartment lid closed to prevent dust and dirt from entering.

2.3 Measurement Techniques

Proper measurement techniques are important in minimizing the effects of instrument variation, stray light and air bubbles. Regardless of the instrument used, measurements are more accurate, precise and repeatable if the analyst pays close attention to proper measurement techniques.

Measure samples immediately to prevent temperature changes and settling. Avoid sample dilution when possible. Particles suspended in the original sample may dissolve or otherwise change characteristics when the sample temperature changes or when the sample is diluted, resulting in a non-representative sample measurement.

SECTION 2, continued

2.3.1 Cleaning Sample Cells

Cells must be extremely clean and free from significant scratches. The glass used to make cells is easily scratched – manufacturing cells free of minor scratches and other imperfections is difficult. However, minor imperfections are effectively masked by applying silicone oil as outlined in *Section 2.3.2*.

Clean the inside and outside of the cells by washing with laboratory detergent. Follow with multiple rinses of distilled or deionized water. Allow cells to air dry. Handle cells only by the top to minimize dirt, scratches and fingerprints in the light path.

2.3.2 Oiling the Sample Cell

Applying a thin coat of silicone oil will mask minor imperfections and scratches which may contribute to turbidity or stray light. Use silicone oil equivalent to Hach Cat. No. 1269-36. This silicone oil has the same refractive index as glass. When applied in a thin, uniform coat, the oil fills in and masks minor scratches and other imperfections in the glass. Apply the oil uniformly by wiping with a soft, lint-free cloth.
Avoid application of excess oil. Applying excess oil may retain dirt and contaminate the instrument's cell compartment.

1. Thoroughly clean the sample cell.

2. Apply a small bead of silicone oil from the top to the bottom of the cell-- just enough to coat the cell with a thin layer of oil.

3. Using a soft, lint-free cloth, spread the oil uniformly, then wipe off the excess so that only a thin coat of oil is left. The cell should appear nearly dry with little or no visible oil.

SECTION 2, continued

Note: Soft, lint-free cloth (velvet) works well for oiling. Store the oiling cloth with the sample cells and keep it free of dirt. After a few applications of oil, the cloth will contain enough residual oil that simply wiping the cell with the oiled cloth will provide a sufficient oil coat on the sample cell. Periodically, add a small amount of oil to the sample cell surface to replenish the oil in the cloth.

Note: Only a thin coat of oil on the sample cells is necessary. ***Avoid using excessive amounts of oil.***

2.3.3 Orienting Sample Cells

Note: When orienting and matching cells, it may be more efficient to use the continuous reading mode. The instrument performs continuous readings if the **READ** *key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds. The instrument cannot be used in continuous read mode if the Signal Averaging mode is on.*

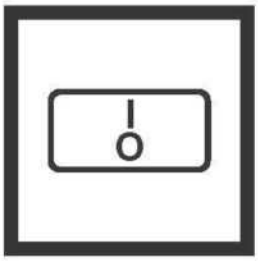
Precise measurements for very low turbidity samples require using a single cell for all measurements or optically matching the cells. Using one cell provides the best precision and repeatability. When one cell is used, an orientation mark (other than the factory-placed diamond) can be placed on the cell so it's inserted into the instrument with the same orientation each time.

2.3.3.1 Orienting a single cell

When using a single cell, make an index or orientation mark on the cell as follows:

SECTION 2, continued

1. Fill the clean sample cell to the line with high quality water (< 0.5 NTU). Cap and wipe with lint-free cloth. Apply silicone oil. See *Section 3.6.2.2* on page *40* for more information about high quality water.



2. Press: **I/O** to turn the instrument on.

3. Insert the sample cell into the sample compartment. Close the cover.

4. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading.

Note: *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*

5. Remove the cell, rotate it slightly and reinsert it into the cell compartment. Close the cover, then press **READ**. Record the cell's position and the displayed reading.

6. Repeat *step 5* until the lowest reading is displayed. Place an orientation mark on the cell's marking band near the top of the cell so the cell can be consistently inserted in the position that yields the lowest reading. When using the cell, always place it in the instrument so the orientation mark aligns with the raised mark on the instrument.

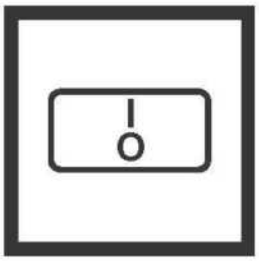
SECTION 2, continued

2.3.4 Matching multiple sample cells

Precise measurements of very low turbidity samples require the cells be optically matched or a single cell be used for all measurements. If more than one cell is used, follow this procedure to match (index) the cells:

1. Clean and oil the sample cells as instructed in *Section 2.3.1* on page *23* and *Section 2.3.2* on page *23*.

2. Fill the clean sample cells to the line with the same sample.



3. Press: **I/O** to turn the instrument on.

4. Insert the **first** sample cell into the sample compartment and close the cover.

5. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading. Place an orientation mark on the cell's marking band.

Note: *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*

6. Insert the **second** sample cell into the cell compartment and close the cover.

SECTION 2, continued

7. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading.

8. Remove the cell, rotate it slightly and reinsert into the cell compartment. Close the cover, then press **READ** again. Record the cell's position and the displayed reading.

9. Repeat *step 8* until the value displayed for the second cell is within 0.01 NTU (or 1%) of the value obtained for the first cell. Place an orientation mark on the second cell's marking band so it is consistently inserted in this position.

Note: *Due to variability in glass, it may not be possible to match all cells.*

10. Repeat *step 6* through *step 9* if matching other sample cells.

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SECTION 2, continued

2.3.5 Removing Bubbles (Degassing)

Before measurement, removing air and other trapped gasses from the sample is strongly recommended, even if bubbles are not visible. Four degassing methods are commonly used:

1. applying a partial vacuum
2. adding a surfactant
3. using an ultrasonic bath
4. heating the sample

In some cases, more than one method may be necessary for effective bubble removal. For example, use of both a surfactant and ultrasonic bath may be necessary for some severe conditions. Use care with these techniques. If misused, sample turbidity can be altered.

Removing air bubbles by letting the sample stand for a period of time is not recommended. Particulates that cause turbidity may settle and the sample temperature may change. Both conditions may alter sample turbidity, resulting in measurements not representative of the original turbidity.

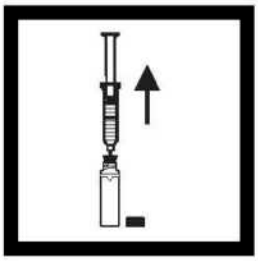
2.3.5.1 Application of vacuum

Apply a vacuum with any convenient, clean, oil-free vacuum source. The vacuum lowers the atmospheric pressure, allowing trapped bubbles to escape into the air above the sample. Vacuum works well with non-viscous samples (such as water) that don't contain volatile components. Applying vacuum to viscous, volatile-containing samples (paint resins) may cause the volatile components to come out of solution and aggravate the bubble problem.

To apply a vacuum, use a sample degassing kit equivalent to Cat No. 43975-00 (Degassing Kit) or 43975-10 (Degassing and Filtration Kit). These kits contain a syringe and rubber stopper for vacuum degassing. An electric or hand-operated pump equivalent to Cat No. 14283-00 or 14697-00, respectively, may also be used.

SECTION 2, continued

1. Fill a sample cell to the mark with sample. Insert a #2 single-hole rubber stopper and syringe into the cell. If using a pump, insert a piece of glass tubing into the stopper.



2. **Slowly** apply the vacuum by carefully pulling the plunger upward, then holding it. If using a hand or electric pump, connect the tubing to the vacuum pump with vacuum hose. Apply vacuum until visible gas bubbles disappear. **Slowly** release the vacuum. Remove the vacuum apparatus and cap the cell.

2.3.5.2 Adding a surfactant

Surfactants should be limited to severe problems when other degassing methods are ineffective. Surfactants change the surface tension of the water, which releases trapped gases. Hach recommends a surfactant such as Triton X-100 or the equivalent, Hach Cat No. 14096-37. Put one drop of Triton X-100 in the sample cell before adding sample.

Note: *Any turbidity contributed by surfactant addition is negligible.*

This technique is very effective when the water is super-saturated with air. However, changing the surface tension may accelerate settling of turbidity-causing particles. Mix the sample gently, but thoroughly, and analyze as soon as possible after adding the surfactant. Avoid vigorous mixing as the surfactant may foam. Rinse the sample cells thoroughly between samples to prevent surfactant accumulation.

SECTION 2, continued

2.3.5.3 Using an ultrasonic bath

Note: The time necessary to expel bubbles may vary from a few seconds to a minute or more. To avoid excessive application of ultrasound, a simple procedure can be followed. First, apply ultrasound until all visible bubbles are absent. Then measure the sample turbidity. Apply ultrasound for a short time period and again measure turbidity. Continue for several repetitions, noting the treatment time and turbidity readings. If turbidity begins to increase instead of decrease, the ultrasound waves have probably started to alter the suspended particles. Note the time it takes for this to occur and record it as the maximum time limit for ultrasonic treatment.

Ultrasonic baths effectively remove gas bubbles from most samples, especially viscous liquids. However, the ultrasonic waves which cause degassing may also alter the characteristics of the particles causing the turbidity. Turbidity depends on the size, shape, composition and refractive index of the suspended particles. Excessive ultrasound application may alter particle size and shape, thus changing sample turbidity. In some cases, ultrasound may aggravate air bubble removal by fracturing the bubbles, making degassing more difficult.

1. Fill a clean sample cell to the line with sample. Leave uncapped.
2. Immerse the cell (1/2 to 2/3 immersed) in an ultrasonic bath and allow it to stand until visible bubbles are expelled.
3. Remove the cell, cap, then thoroughly dry the cell. Apply silicone oil as directed.

2.3.5.4 Application of heat

Whenever possible, avoid using heat to degas samples because heat may change the characteristics of the suspended particles and cause volatile components to come out of solution. Gentle heating may be helpful for degassing some very viscous samples when combined with application of vacuum or ultrasound. If heat is necessary, heat the sample only until degassing occurs. The simplest technique is to prepare a warm water bath and partially immerse the filled sample cell. Use the shortest time necessary for expelling visible bubbles. Cool sample to original sample temperature before taking measurements.

SECTION 2, continued

2.3.6 Measuring Overrange Samples

Nephelometric turbidity measurement depends on detection of light scattered from particles suspended in the liquid. If the turbidity is very high, a significant amount of light is blocked or absorbed by the particles and only a small amount of light reaches the detector. This results in a negative interference – the measured turbidity is lower than the actual turbidity. This condition is called "going blind". A multidetector ratioing instrument, such as the Hach 2100P Turbidimeter, minimizes this effect and extends the instrument range. Highly turbid samples may also be diluted, but this should be avoided when possible since it may alter the characteristics of the suspended particles and produce erroneous results.

Light absorbing particles such as activated carbon and highly colored samples may also cause an instrument to "go blind". Dilution may not correct for these interferences. A ratioing instrument will correct for the presence of light absorbing particles and color.

2.3.7 Condensation (fogging)

Condensation may occur on the outside of the sample cell when measuring a cold sample in a warm, humid environment. Condensation interferes with turbidity measurement, so all moisture must be thoroughly wiped off the sample cell before measurement. If fogging recurs, let the sample warm slightly by standing at room temperature or immersing it in a warm bath for a short period. After warming, mix the sample thoroughly before measurement. Allowing samples to warm can alter sample turbidity, so it is best to avoid warming samples before measurement when possible.

2.3.8 Calibration

Turbidimeters must be properly calibrated with a primary standard. Hach recommends formazin or StablCal Stabilized Formazin for calibration. For U.S. Environmental Protection Agency (USEPA) reporting, calibrate at least as often as required by the appropriate regulatory agencies. The frequency of calibration depends on environmental conditions (humidity, temperature) and use. If necessary, calibrate more frequently.

SECTION 2, continued

Use secondary standards for periodic calibration checks. Please note that Gelex® standards must be assigned values after StablCal Stabilized Formazin calibration or formazin calibration and before use as secondary standards. Gelex standards must be recalibrated (values assigned) each time the instrument is calibrated with StablCal Stabilized Formazin or formazin. See *Section 3.6* on page *37* for detailed information on the use of StablCal Stabilized Formazin, formazin, and Gelex standards.

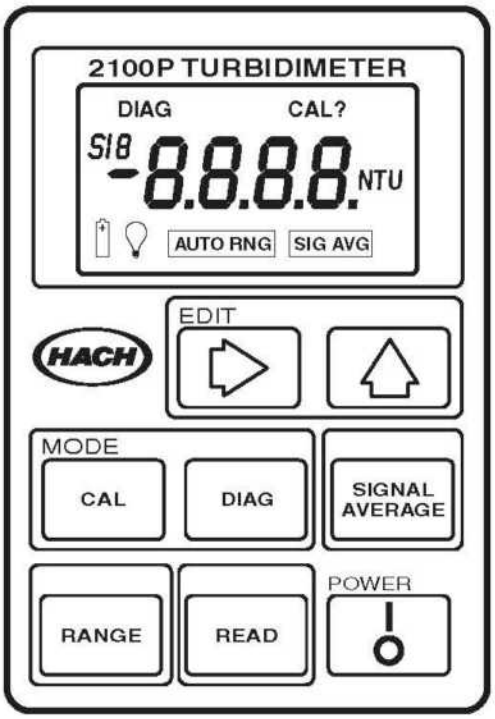
2.3.9 Representative Sampling

A representative sample accurately reflects the true condition of the water source from which the sample was taken. To ensure a representative sample, gently, but thoroughly, mix every sample before aliquots are taken. Do not allow the sample to settle.

When sampling from a tap in a distribution system or treatment plant, allow the water to run for at least five minutes before sampling. When sampling from a stream, reservoir, clarifier, or storage tank, collect at least one liter (1 quart) and thoroughly mix before measurement. If the water source is not uniform, it may be necessary to sample several locations at varying depths and combine the samples into a single, well-mixed composite sample before measurement.

SECTION 3 OPERATION

3.1 Operational Controls and Indicators



Key	Description
	Power key to turn instrument on and off. If no keys are pressed for 5.5 minutes, the instrument turns off automatically.
READ	Depressed to perform a measurement. To conserve battery power, the lamp turns on only when **READ** is depressed. A reading is displayed about 12 seconds after the key is depressed. During the delay, a flashing **NTU** is displayed. After the reading is displayed, the lamp turns off and the reading continues to be displayed. Continuous readings may be done by holding this key if **not** in the Signal Averaging mode. After the initial delay, the reading is updated every 1.2 seconds.
CAL	Used to perform a calibration or review calibration data. Also terminates a calibration or calibration review and returns to the 2100P measurement mode.

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SECTION 3, continued

Key	Description
△	Edits a flashing digit in the calibration mode or sequences through the calibration standards (S0,S1, S2, S3) or diagnostic menu.
▷	Used to move the editing cursor to the digits being edited in the calibration mode or initiate editing of a standard value.
SIGNAL AVERAGE	Turns the signal averaging function on or off.
DIAG	Selects the diagnostic mode.
RANGE	Selects Auto Range or Manual Range (one of three manual modes).

Display Icon	Description
DIAG	Turns on after the **DIAG** is pressed to access the diagnostic mode. A number displayed under the **DIAG** icon (1-9) indicates which diagnostic function is active. See *Section 5.1* on page *67* for more information on diagnostic codes.
CAL	Turns on after the **CAL** key is pressed to access the calibration mode and remains on during the calibration.
CAL?	Appears after calibration if a value entered during calibration is outside an acceptable range. May indicate an operator error or possible instrument malfunction. Flashing **CAL?** indicates the default calibration coefficients are being used (even after a user-calibration has been done) or that no calibration data is currently stored.
S__	Displayed during calibration. The S is followed by a number to indicate which standard value is currently being edited or displayed. Flashing number is prompting user for measurement of **S0**, **S1**, **S2** or **S3** to establish a calibration. Steady number identifies which standard's value is being displayed.
+	Flashes when the battery voltage drops to 4.4 volts as an indication to change batteries. At <4.0 volts, the instrument automatically shuts off.
	The lamp symbol is constantly on when the lamp is on and flashes after a reading if a marginal light level reaches the transmitted light detector. A flashing icon indicates the sample may be too turbid (not within measurement range) and needs dilution or the lamp needs replacing.
SIGNAL AVERAGE	Indicates the signal averaging mode is on. The icon turns off if signal averaging is not selected.

SECTION 3, continued

Display Icon	Description
AUTO RNG	Indicates instrument is in automatic range mode. The icon turns off when manual range mode is selected.
8888	The 4-digit display is active when the instrument is on (measurements are displayed to three digits). After the **READ** key is pressed - - - - is displayed during wait periods.
NTU	Identifies the measurement units- Nephelometric Turbidity Units. This icon is active during measurements and in the calibration mode.

3.2 Using the Read Key

To preserve battery power and prolong lamp life, the lamp turns on only after the **READ** key is pressed. Pressing the key turns the instrument lamp on; after about 12 seconds, the lamp turns off, but the measurement value continues to be displayed. After the first measurement, a four-second recovery time occurs before another measurement can be started. If **READ** is pressed during the recovery time, the display will begin flashing, but the lamp will not turn on until the full four seconds have passed. If no other key strokes occur within 5.5 minutes, the instrument turns off.

3.2.1 Continuous Reading

The instrument cannot be used in continuous read mode if the Signal Averaging mode is on.

The instrument will perform continuous readings if the **READ** key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds.

3.3 Using the Signal Averaging Key

The signal averaging mode compensates for reading fluctuations caused by drifting of sample particles through the light path. Signal averaging is turned on or off by pressing the **SIGNAL AVERAGE** key. The **SIG AVG** icon is displayed when signal averaging is on.

Signal averaging measures and averages ten measurements while displaying intermediate results. The initial value is displayed after about 11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 22 seconds). After 22 seconds, the lamp

SECTION 3, continued

turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When signal averaging is off, the instrument takes three measurements, the microprocessor averages them, then displays the average. If the **READ** key is held during measurement, the initial value is displayed in 12 seconds and is updated every 1.2 seconds as long as the **READ** key is held.

When the instrument is turned on, the instrument defaults to the signal averaging mode which was used during the last measurement.

3.4 Using the Range Selection Key

As shipped, the instrument defaults to automatic range mode. The first time the **RANGE** key is pressed, the instrument goes into manual range mode. The second, third, and fourth key strokes put the instrument in the 0.00-9.99, 10 to 99.9 or 100-1000 NTU range, respectively. Another key stroke brings the selection back to automatic range mode. When the automatic range mode is selected, the **AUTO RNG** icon is displayed. Range selection can be done any time except when a measurement or calibration is in progress.

When the instrument is turned on, the instrument defaults to the range mode and measurement range which was used during the last measurement.

3.5 Restoring the Default Calibration

To restore and use the default calibration, turn the instrument off. Press and hold **DIAG**, then press and release **I/O**. Release **DIAG** when the software version number disappears from the display. (For models with serial number less than 920300000800, **2100** disappears). This clears any user-entered calibration from memory; the 2100P will use the default calibration for measurement. **CAL?** will appear and continue to flash until a user-entered calibration is successfully completed.

For best results, a user-entered calibration should be done every three months.

SECTION 3, continued

3.6 Calibration

Calibration of the 2100P Turbidimeter is based on formazin, the primary standard for turbidity. The instrument's electronic and optical design provide long-term stability and minimize the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. A **formazin recalibration should be performed at least once every three months,** more often if experience indicates the need. When calibration is necessary, use a primary standard such as StablCal™ Stabilized Standards or formazin standards.

Hach Company only recommends the use of StablCal® Stabilized Formazin or formazin standards for the calibration of Hach turbidimeters. Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinylbenzene beads or other suspensions.

Important Note: DO NOT calibrate with Gelex® Secondary Standards. Gelex standards are designed for instrument verification, not calibration.

3.6.1 StablCal Stabilized Formazin Standards*

Most consistent results will be achieved with the use of StablCal Stabilized Formazin Standards for calibration. Refer to *Section 3.6.1.2* and *Section 3.6.1.3* for information on preparing the standards for use.

Note: Hach StablCal Stabilized Formazin in 20-, 100-, and 800-NTU values is packaged in convenient sets for calibration of the 2100P Turbidimeter. The set may be ordered in 500-mL size bottles by specifying Cat. No. 26594-00, in 100-mL size bottles by specifying Cat. No. 26594-10 or in sealed vials by ordering Cat. No. 26594-05. (See OPTIONAL ACCESSORIES AND REAGENTS on page 74.)

3.6.1.1 Storing and Handling StablCal Stabilized Standards

For optimum results when using StablCal Stabilized Standards, adhere to the following recommendations:

* StablCal Stabilized Formazin is cited as a primary standard in Hach Method 8195, an acceptable version of USEPA Method 180.1.

SECTION 3, continued

- Do not transfer the standard to another container for storage.
- Do not return standard from the sample cell back into the its original container. Standard contamination will result.
- Store standards between 0 and 25 °C.
- For long-term storage, refrigeration at 5 °c is recommended. Do not store above 25 °C.
- Allow the standard to acclimate to ambient instrument conditions before use (not to exceed 40 °C).
- Store away from direct sunlight. Store vials in their respective kit or shipping box with the cover in place.

3.6.1.2 Preparing Bulk StablCal Stabilized Standards

Bulk standards that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*.

Important Note: These instructions do not apply to <0.1-NTU* StablCal Standards; <0.1NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to resuspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the bottle of StablCal 5 to 7 times.
4. Prepare the sample cell for measurement using traditional preparation techniques. This usually consists of oiling the sample cell (see*Section 2.3.2* on page *23*) and marking the cell to maintain the same orientation in the sample cell compartment (see *Section 2.3.3* on page *24*). This step will eliminate any optical variations in the sample cell.

* Used in place of the dilution water standard when performing a calibration.

SECTION 3, continued

5. Rinse the sample cell at least one time with the standard and discard the rinse.

6. Immediately fill the sample cell with the standard. Cap the sample cell and let it stand for one minute. The standard is now ready for use in the calibration procedure, *Section 3.6.3*.

3.6.1.3 Preparing StablCal Stabilized Standards in Sealed Vials

Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*

Important Note: These instructions do not apply to <0.1-NTU* StablCal Standards; <0.1NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to resuspend any particles.

2. Allow the standard to stand undisturbed for 5 minutes.

3. Gently invert the vial of StablCal 5 to 7 times.

4. Prepare the vial for measurement using traditional preparation techniques. This usually consists of oiling the vial (see *Section 2.3.2* on page *23*) and marking the vial to maintain the same orientation in the sample cell compartment (see *Section 2.3.3* on page *24*). This step will eliminate any optical variations in the sample vial.

5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure, *Section 3.6.3*.

SECTION 3, continued

3.6.2 Formazin Primary Standards

Perform the procedure in *Section 3.6.2.1* to prepare a 4000-NTU standard. Alternately, order a 4000-NTU stock solution from Hach by specifying Cat. 2461-49. Prepare the dilutions from the 4000-NTU stock solution by following the instructions in *Section 3.6.2.4*.

3.6.2.1 Preparing Formazin Stock Solution

Dilute formazin standard solutions from a 4000 NTU stock solution equivalent to Hach Cat. No. 2461-49. The prepared stock solution is stable for up to one year when properly prepared. An alternative to purchasing the 4000 NTU stock solution is preparing a stock solution as follows:

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($N_2H_4 \cdot H_2SO_4$) in 400 mL of distilled water.
2. Dissolve 50.000 grams of pure hexamethylenetetramine in 400 mL of distilled water.
3. Pour the two solutions into a 1000-mL volumetric flask and dilute to the mark with distilled water.
4. Let the solution stand for 48 hours at 25 °C (77 °F) to develop the 4000-NTU stock suspension. The standing temperature is critical for correct formation of formazin polymers.
5. Mix the 4000 NTU suspension for at least ten minutes before use. Then it can be diluted with distilled or demineralized water to achieve a solution of the desired NTU value.

Instead of diluting a formazin stock solution, StablCal Stabilized Formazin Standards may be used. Order the StablCal Calibration Set for the 2100P Turbidimeter, Cat.No. 26594-00 (500-mL bottles), Cat. No. 26594-10 (100 mL bottles), or Cat. No. 26594-05 (sealed vials). (See *OPTIONAL ACCESSORIES AND REAGENTS* on page *74*.)

3.6.2.2 Correcting for Turbidity of Dilution Water

The 2100P Turbidimeter automatically compensates for turbidity contributed by dilution water when calculating the true value of the lowest formazin standard. Use high quality distilled or deionized water less than 0.5 NTU. The instrument will display E 1 after calibration if

SECTION 3, continued

the dilution water turbidity is greater than 0.5 NTU. In this case, prepare the water as directed below.

The value of the dilution water can be arbitrarily forced to zero (see calibration procedure). This is not recommended for most applications and, if done, should be done only if the dilution water turbidity is less than 0.2 NTU.

3.6.2.3 Preparing Dilution Water

Note: Use the same dilution water for all dilutions and the sample blank.

Collect at least 1000 mL of high quality dilution water (distilled or deionized water). The 2100P Turbidimeter, as received from the factory, is precalibrated and may be used to check the dilution water turbidity. If the turbidity is greater than 0.5 NTU, filter the water with the Sample Filtration and Degassing Kit (Cat. No. 43975-10) or equivalent. When measuring low range turbidity, clean all glassware with 1:1 hydrochloric acid and rinse several times with dilution water. If the glassware is not used immediately, use stoppers to prevent contamination from small particles.

SECTION 3, continued

1. Attach the syringe to the 3-way valve by gently twisting the square end into the syringe tip. Attach the connector, tubing and a 0.2 micron filter (clear part faces syringe) as shown. Be sure the connections are tight.

2. Fill a beaker or container with the water to be filtered. Insert the tubing into the container. Slowly draw the water into the syringe by pulling up on the syringe plunger.

3. Draw about 50 mL of sample into the syringe. Slowly push on the plunger to force the water through the filter and into a graduated cylinder or volumetric flask. Repeat Steps 2 and 3 until the desired amount of water is obtained.

Note: *As the filter clogs, it gets more difficult to push water through it. At this point, discard the filter and attach a new filter. Replacement filters are available in packages of 10 (Cat. No. 23238-10).*

3.6.2.4 Preparing Formazin Dilutions (Factory recommended)

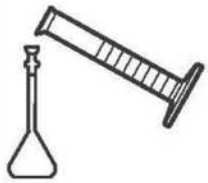
Hach Company recommends using 20, 100, and 800 NTU formazin standards for calibrating the 2100P Turbidimeter. Dilutions with other NTU values can be prepared and used (see *Section 3.6.3.1* on page *48*). If problems occur when using alternate solutions, use the dilutions specified here.

Prepare all formazin dilutions immediately before use and discard after calibration. The 4000 NTU solution is stable for up to a year, but dilutions deteriorate more rapidly. Use the same high quality water (turbidity <0.5 NTU) for the dilutions and the blank.

SECTION 3, continued

Preparing the 20, 100 and 800 NTU standards

Table 1 Formazin Standard Preparation

	Step 1	Step 2	Step 3
Standards			
20 NTU	Add 100 mL of dilution water to a clean **200-mL** class A volumetric flask.	With a TenSette* pipet, add 1.00 mL of well-mixed 4000 NTU Formazin stock solution to the 200-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
100 NTU	Add 100 mL of dilution water to a clean **200-mL** class A volumetric flask.	With a TenSette pipet, add 5.00 mL of well-mixed 4000 NTU Formazin stock solution to the 200-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
800 NTU	Add 50 mL of dilution water to a clean **100-mL** class A volumetric flask.	With a TenSette pipet, add 20.00 mL of well-mixed 4000 NTU Formazin stock solution to the 100-mL flask.	Dilute to the mark with dilution water. Stopper and mix.

* A class A volumetric pipet may be used in place of a TenSette Pipet.

SECTION 3, continued

3.6.3 Calibrating the Turbidimeter

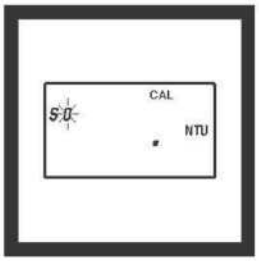
Note: For best accuracy use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the cell so the orientation mark placed on the cell during the matching procedure is correctly aligned. (See Section 2.3.4 on page 26 for matching sample cells).

1. Rinse a clean sample cell with dilution water several times. Then fill the cell to the line (about 15 mL) with dilution water or use StablCal <0.1 NTU standard.

Note: *The same dilution water used for preparing the standards must be used in this step.*

2. Insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid. Press **I/O**.

Note: *Choose signal average mode option (on or off) before pressing* **CAL** *– the* **SIGNAL AVERAGE** *key is not functional in calibration mode.*



3. Press: **CAL**

The **CAL** and **S0** icons will be displayed (the **0** will flash). The 4-digit display will show the value of the S0 standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank (as shown). Press → to get a numerical display.

Hach Company only recommends the use of StablCal® Stabilized Formazin or formazin standards for the calibration of Hach turbidimeters. Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinylbenzene beads or other suspensions. DO NOT calibrate with Gelex® Secondary Standards.

SECTION 3, continued

4. Press: **READ**

The instrument will count from 60 to 0, (67 to 0 if signal average is on), read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is ≥ 0.5 NTU, E 1 will appear when the calibration is calculated (See *Section 3.6.2.3* on page *41* for more dilution water information). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

Note: *The turbidity of the dilution water can be "forced" to zero by pressing → rather than reading the dilution water. The display will show* **S0 NTU** *and the ↑ key must be pressed to continue with the next standard.*

5. The display will show the **S1** (with the 1 flashing) and **20 NTU** or the value of the S1 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 20 NTU StablCal Standard or 20 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

6. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

Note: *For potable water applications with low turbidity values the instrument calibration may be stopped after the 20 NTU StablCal Standard has been read. Press* **CAL** *after reading the 20 NTU standard. The instrument calibration is now complete for the range of 0-20 NTU only. The instrument will continue to read turbidity values above 20 NTU. These values were not updated during the 0-20 NTU calibration.*

SECTION 3, continued

7. The display will show the **S2** (with the 2 flashing) and **100 NTU** or the value of the S2 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 100 NTU StablCal Standard or 100 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

8. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then, the display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

9. The display will show the **S3** (with the 3 flashing) and **800 NTU** or the value of the S3 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 800 NTU StablCal Standard or 800 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

SECTION 3, continued

10. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then the display will increment back to the S0 display. Remove the sample cell from the cell compartment.

11. Press: **CAL** to accept the calibration. The instrument will return to measurement mode automatically.

Note: *Pressing* **CAL** *completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after* **CAL** *is pressed. If* **E 1** *or* **E 2** *appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If* **CAL?** *appears, an error may have occurred during calibration. If* **CAL?** *is flashing, the instrument is using the default calibration.*

SECTION 3, continued

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑, and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

3.6.3.1 Preparing User-selected Formazin Dilutions

The formazin solutions should span the entire range of the instrument. Hach recommends preparing three standards:

1. 10 to 30 NTU
2. 90 to 110 NTU
3. 700 to 900 NTU

The standards must have a difference of at least 60 NTU.
In addition, a blank made from the dilution water should be prepared.

Prepare the formazin standard solutions from the well mixed 4000 NTU stock solution as specified in *Section 3.6.2.4* on page *42* and dilution water as specified in *Section 3.6.2.2* and *Section 3.6.2.3* on page *41*. Make the standards **immediately** before use and discard them after calibration is done.

SECTION 3, continued

3.6.3.2 Calibrating with User-selected Standards

Note: For best accuracy use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the sample cell with the same orientation.

1. Fill a clean sample cell to the line (about 15 mL) with dilution water.

Note: The same dilution water used for preparing the standards must be used in this step.

2. Insert the sample cell into the cell compartment and close the lid. Press **I/O**.

Note: Choose signal average mode option (on or off) before pressing **CAL** *– the* **SIGNAL AVERAGE** *key is not functional in calibration mode.*

3. Press: **CAL**.

The **CAL** and **S0** icons will appear (the **0** will flash). The 4-digit display will show the value of the S0 standard for the previous calibration.

SECTION 3, continued

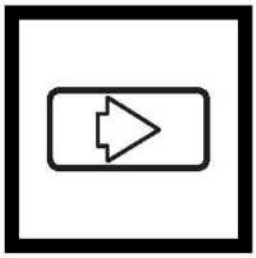
4. Press: **READ**.

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the blank and use it to calculate a correction factor for the lowest standard. If the dilution water is ≥0.5 NTU, **E 1** will appear (see *Section 3.6.2.3* on page *41* for more dilution water information). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

5. Thoroughly mix the 10 to 30 NTU range standard, then fill a clean sample cell to the line with the standard. Insert the sample cell into the cell compartment

6. The display will show the **S1** icon (with the **1** flashing) and **20 NTU** or the value of the S1 standard for the previous calibration.

SECTION 3, continued



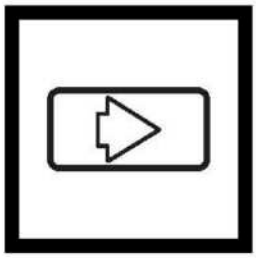
7. Edit the standard concentration by pressing →. The **1** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.

8. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

9. Thoroughly mix the 90 to 110 NTU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.

SECTION 3, continued

10. The display will show the **S2** icon (with the **2** flashing) and **100 NTU** or the value of the S2 standard for the previous calibration.

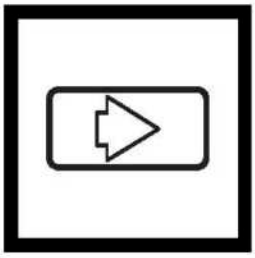


11. Edit the standard concentration by pressing →. The **2** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.

12. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Remove the sample cell from the cell compartment.

13. Thoroughly mix the 700 to 900 NTU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.

14. The display will show the **S3** icon (with the **3** flashing) and **800 NTU** or the value of the S3 standard for the previous



15. Edit the standard concentration by pressing →. The **3** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.

SECTION 3, continued

16. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The instrument will increment back to **S0**. Remove the sample cell from the cell compartment.

17. Press: **CAL**.

The instrument will store the new calibration data and return the instrument to the measurement mode. It will use the new calibration to calculate turbidity for subsequent measurements.

Note: *Pressing* **CAL** *completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after* **CAL** *is pressed. If* **E 1** *or* **E 2** *appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If* **CAL?** *appears, an error may have occurred during calibration. If* **CAL?** *is flashing, the instrument is using the default calibration.*

SECTION 3, continued

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑, and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. If the error messages recur, calibrate using the factory specified standards, *Section 3.6.2.4* on page *42* and *Section 3.6.3* on page *44*. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then only ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** isn't flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

3.6.4 Using Gelex® Secondary Turbidity Standards

Note: *Store Gelex standards at room temperature. Do not allow to freeze or exceed 50 °C.*

Gelex Secondary Standards (included with 4650000 only) are particulate suspensions similar to formazin primary standards in light scattering characteristics. NTU values on the Gelex standards indicate the range for which they should be used. Due to minor variations in glass and individual instrument optical systems, the true value of the Gelex standards must be determined against formazin in the same instrument they will be used with for later calibration checks.

SECTION 3, continued

3.6.4.1 Assigning Values to Gelex Standards

1. Calibrate the instrument with formazin.

2. Select automatic range mode using the **RANGE** key.

3. Thoroughly clean the outside of the Gelex vials and apply a thin coating of silicone oil.

4. Place the 0-10 NTU Gelex standard in the cell compartment so the diamond on the vial aligns with the orientation mark on the instrument. Close the sample lid.

Note: *Correct cell orientation is essential to obtain accurate Gelex values. Always orient the cell so the diamond mark aligns with the orientation mark on the instrument.*

5. Press: **READ**.

Record the displayed value, remove the vial from the instrument and mark the value on the band near the top of the vial.

6. Repeat *step 3* through *step 5* for the other Gelex standards, being careful to orient the cells properly.

SECTION 3, continued

Re-assign with every formazin calibration

7. Re-assign values to the Gelex standards each time the instrument is calibrated with formazin.

3.6.4.2 Routine Calibration Check With Gelex Standards

The 2100P Turbidimeter does not require standardization before every measurement as some turbidimeters do. Periodically, as experience dictates, check the instrument calibration using the appropriate Gelex Secondary Standard. Be sure the Gelex standards are aligned correctly when inserting them (diamond aligns with orientation mark). If the reading is not within 5% of the previously established value, recalibrate the instrument with StablCal Stabilized Formazin Primary Standard or formazin primary standard (*Section 3.6.3* on page *44*).

Important Note: DO NOT calibrate with Gelex® Secondary Standards. Gelex standards are designed for instrument verification, not calibration.

MAINTENANCE

Some of the following manual sections contain information in the form of warnings, cautions and notes that require special attention. Read and follow these instructions carefully to avoid personal injury and damage to the instrument. Only personnel qualified to do so, should conduct the maintenance tasks described in this portion of the manual.

Certains des chapitres suivants de ce mode d'emploi contiennent des informations sous la forme d'avertissements, messages de prudence et notes qui demandent une attention particulière. Lire et suivre ces instructions attentivement pour éviter les risques de blessures des personnes et de détoriation de l'appareil. Les tâches d'entretien décrites dans cette partie du mode d'emploi doivent être seulement effectuées par le personnel qualifié pour le faire.

Algunos de los capítulos del manual que presentamos contienen muy importante información en forma de alertas, notas y precauciones a tomar. Lea y siga cuidadosamente estas instrucciones a fin de evitar accidentes personales y daños al instrumento. Las tareas de mantenimiento descritas en la presente sección deberán ser efectuadas únicamente por personas debidamente cualificadas.

Einige der folgenden Abschnitte dieses Handbuchs enthalten Informationen in Form von Warnungen, Vorsichtsmaßnahmen oder Anmerkungen, die besonders beachtet werden müssen. Lesen und befolgen Sie diese Instruktionen aufmerksam, um Verletzungen von Personen oder Schäden am Gerät zu vyyyermeiden. In diesem Abschnitt beschriebene Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.

Algumas das seguintes secções do manual contêm informações em forma de advertências, precauções e notas que requerem especial atenção. Leia e siga atentamente as presentes instruções para evitar ferimentos pessoais e não danificar o instrumento. As tarefas de manutenção descritas nesta parte do manual só poderão ser executadas por pessoal qualificado.

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SECTION 4 MAINTENANCE

4.1 Cleaning

Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills up promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings. See *Section 2.3.1* on page *23* for more information about sample cell care.

4.2 Battery Replacement

AA alkaline cells typically last for about 300 tests with the signal averaging mode off, about 180 tests if signal averaging is used. The "battery" icon flashes when battery replacement is needed. Refer to *Section 1.4.2* on page *16* for battery installation instructions. If the batteries are changed within 30 seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings.

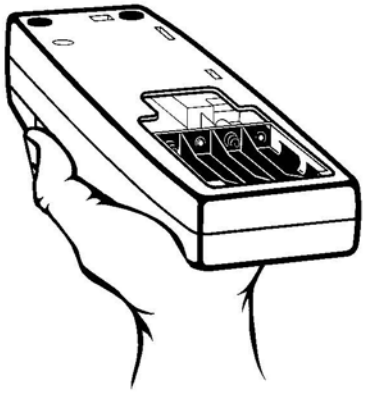
If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them. If the instrument still won't function, contact Hach Service or the nearest authorized dealer.

4.3 Lamp Replacement

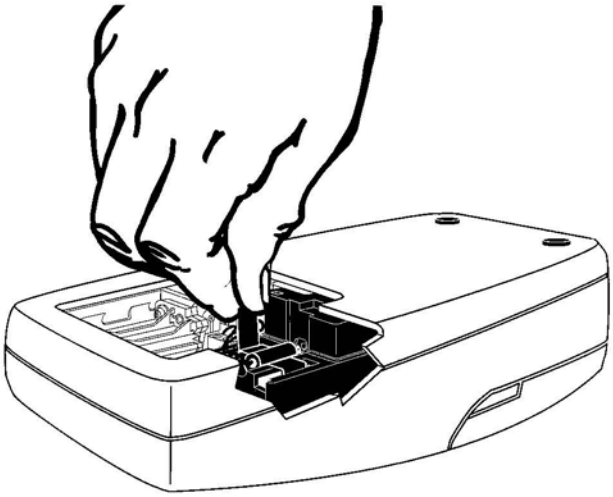
The procedure below explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

SECTION 4, continued

1. Orient the instrument so it is upside down and the top faces away from you. Remove the battery cover and at least one battery.



2. Remove the lamp assembly by grasping the tab on the left side of the assembly. Firmly, but gently, slide the assembly towards the rear of the instrument.



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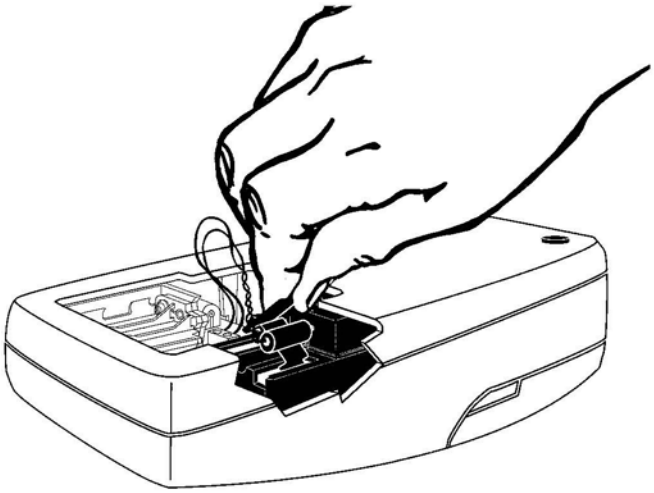
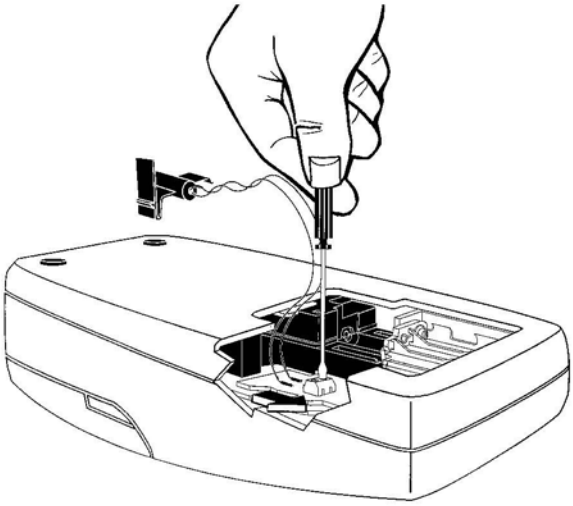
SECTION 4, continued

3. Rotate the tab towards the nearest outside edge. The assembly should release and slip out easily.



4. Back the terminal block screws **partially** out (1 to 2 turns) and remove the old lamp leads.



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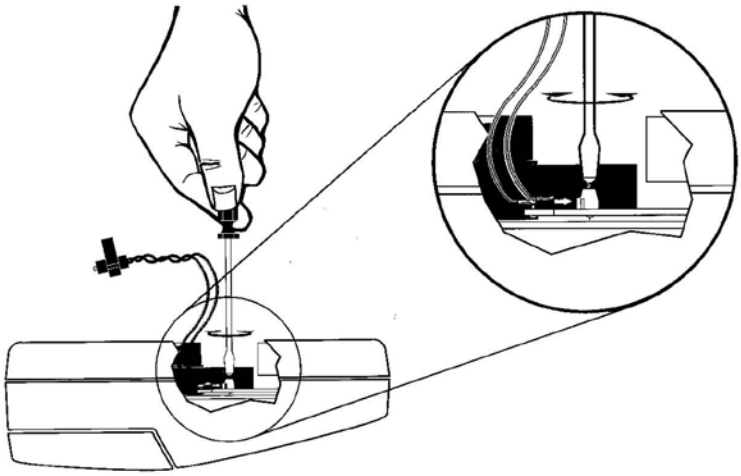
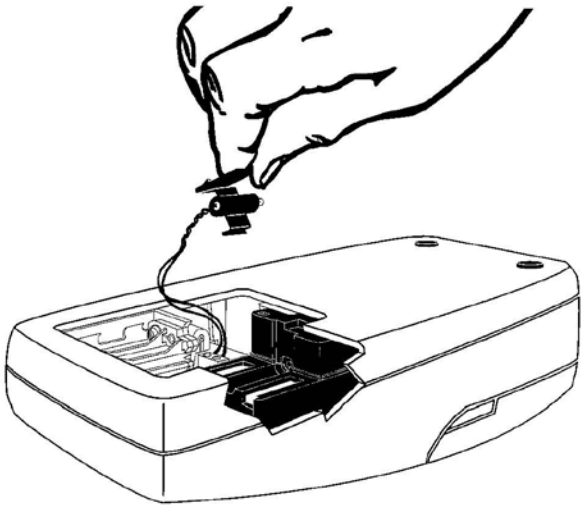
SECTION 4, continued

5. Gently bend the wires of the new lamp assembly into an "L" shape so they fit easily into the housing. Insert the leads into the terminal screws and tighten with clockwise turns. Gently tug on the wires to make sure they are connected to the terminal block.



6. Hold the new lamp assembly by the tab with the lamp facing the tope (keyboard) of the instrument. Slide the small catch on the other side of the assembly into the black plastic slot (towards the nearest edge of the instrument).



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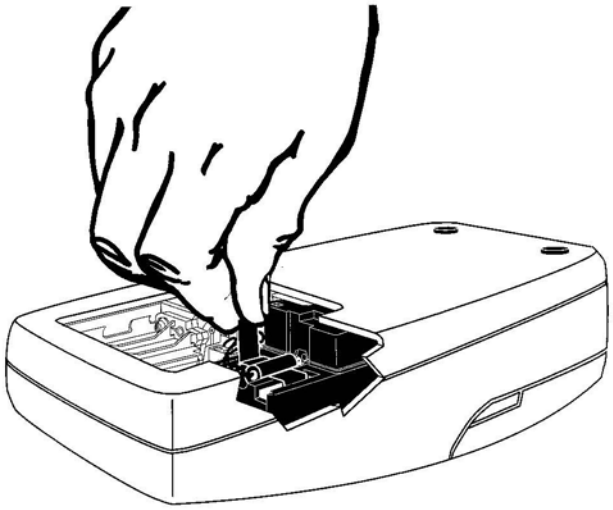
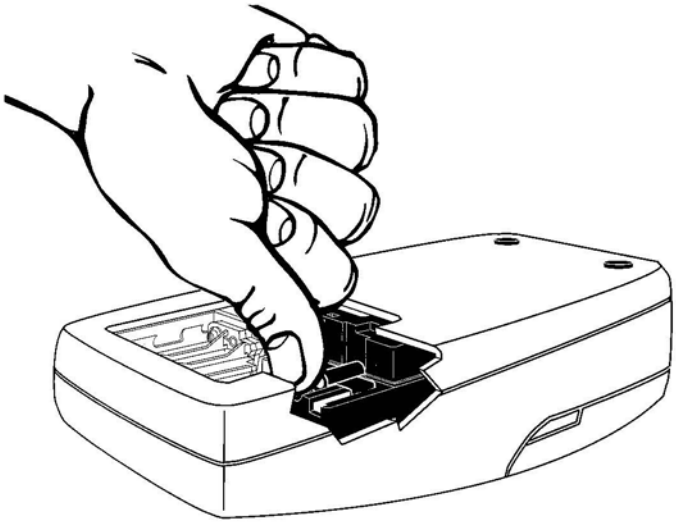
SECTION 4, continued

7. Snap the U-shaped bottom of the tab into the slot on the left side of the black plastic that holds the lamp assembly.

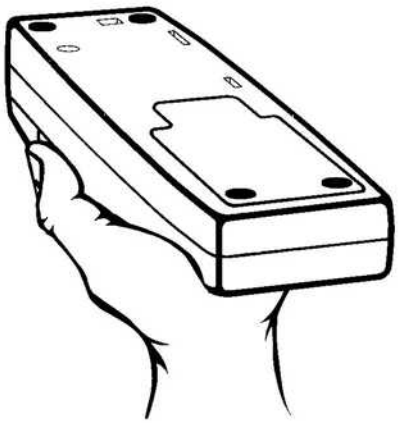


8. With your thumb, firmly slide the assembly forward until it stops. Again, push firmly against the tab to make sure the lamp is seated correctly.

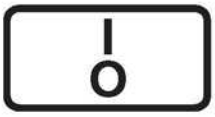


SECTION 4, continued

9. Replace the battery(s) and battery cover.

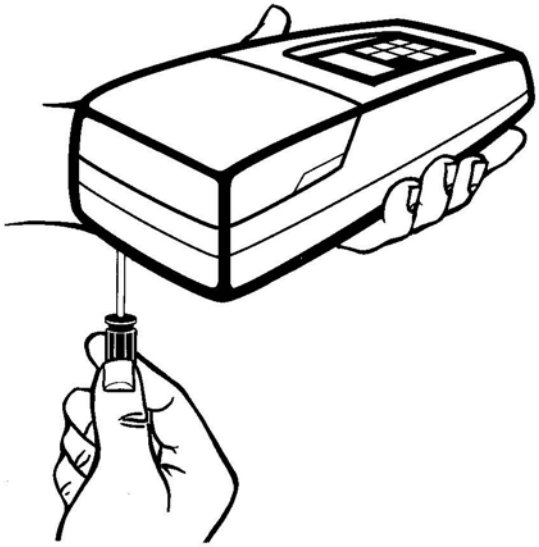


10. Insert the 800 NTU formazin standard into the sample cell. Press and hold **READ**. Then press **I/O**. Release the **READ** key after the software version number disappears from the display (for models with serial numbers less than 920300000800, **2100** disappears).



SECTION 4, continued

11. Adjust the scattered light amplifier output by inserting a small flat-bladed screwdriver into the trimpot hole (located on bottom). Adjust the display to read 2.5 ± 0.3 volts (2.0 volts for models that display **2100** when turned on).



12. Press **I/O** to exit gain adjust mode.

13. Perform a formazin calibration according to *Section 3.6.3* on page *44* or *Section 3.6.3.1* on page *48*.

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SECTION 5 TROUBLESHOOTING

5.1 Using the Diagnostic Functions Key

Enter the diagnostic mode by pressing the **DIAG** key. Exit this mode at any time by pressing the key again. The diagnostic mode allows access to information about instrument function which may be useful for servicing and troubleshooting.

5.1.1 Basic Diagnostic Codes

The diagnostic codes are:

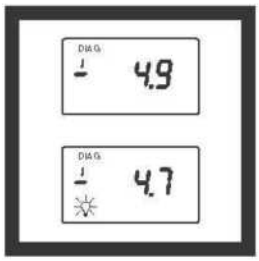
Code	Description
1	Checks the battery voltage with the lamp on, then with the lamp off. This is a dual diagnostic code.
2	Displays calibration coefficient a_o
3	Displays calibration coefficient a_1
4	Displays calibration coefficient b_o
5	Displays calibration coefficient b_1
6	Displays the lamp voltage (about 3 volts)
7	Displays the dark voltage of the transmitted light detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.
8	Displays the high gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.*
9	Displays the low gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.

* Samples with turbidity >10 NTU may display - - - for the lamp-on amplifier voltage.

SECTION 5, continued

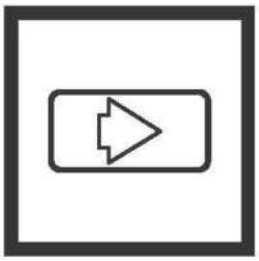
5.2 The Diagnostic Procedure

1. Fill a clean sample cell to the line with clear water, cap the cell and place it in the cell compartment. Press the **READ** key and wait until the reading is finished.



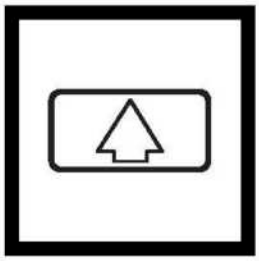
2. Press: **DIAG**

The **DIAG** icon will turn on and **1** will be displayed below the icon. The instrument will measure the battery voltage with the lamp off and display the result in volts (V). Then the lamp icon will turn on and the instrument will measure the voltage with the lamp on. The value is briefly displayed before defaulting to the lamp-off reading. To repeat the measurement, press **READ**.



3. To continuously display the lamp-on voltage, press →. The lamp icon will flash. Press → to turn the lamp icon off (the lamp is not on during this display).

SECTION 5, continued



4. Press the ↑ key to scroll through the other diagnostics. Each press of the key increments the digit in the small numerical display below the **DIAG** icon and the result of the diagnostic measurement is then displayed. Each press of the **READ** key updates the value. For measurements made with the lamp off and again with the lamp on, the measurement with the lamp off is displayed when the diagnostic is entered. To see the second measurement with the lamp on, press the → key (only works with diagnostic codes 1, 7, 8, & 9). The lamp icon will flash and the lamp-on measurement will be displayed in volts. Press → to turn the lamp icon off.

Note: *DIAG 8 will display ---- for the lamp-on voltage if a of >10 NTU is placed in the cell compartment.*

SECTION 5, continued

5.3 Other Instrument Diagnostics

5.3.1 Display Test

Pressing and holding the **I/O** key turns on all the display icons and elements so you can determine if all the elements and icons are functioning. The display test sequence will cycle as long as the key is held down.

5.4 Error Messages

Error messages indicate sample interferences and/or instrument malfunction.

5.4.1 Flashing Numeric Display

If the highest value in the range selected is flashing in the display, the sample is too turbid (or overrange) for the selected range. In automatic or manual range, **1000** flashes if the sample is over the instrument's range. In manual range mode, select the next higher range mode if **9.99** or **99.9** flashes. See *Section 2.3.6* on page *31* for measuring overrange samples. The display will stop flashing if a sample within range is inserted and read.

5.4.2 E Messages

An error message indicates either an instrument failure or an operation cannot be performed. **An error message can be cleared by pressing DIAG** (display will return to previous measurement or calibration value). The meter continues to operate as best it can. If the message occurs during a calibration, calibration can continue. If the error message occurs when a calibration is being calculated, the instrument will discard the new calibration and retain the old calibration. Error messages and corrective actions are listed below.

5.4.3 CAL?

A flashing **CAL?** appears when the instrument is using the default calibration programmed at the factory. It will appear if the analyst has erased the user-entered calibration using the procedure to restore the default calibration or after and E 4 error is cleared by pressing DIAG. Recalibrate as soon as possible when **CAL?** appears. **CAL?** (not flashing) appears when a calibration has questionable validity.

SECTION 5, continued

Message*	Probable Cause	Corrective Action
E1	Dilution water is ≥ 0.5 NTU.	Start calibration over with better quality dilution water or use a membrane filter to filter the water before use.
E2	Two standards have the same value or their difference is less than 60 NTU. Not all standards were read during the calibration. Standard 1 is too low (<10 NTU).	Recheck preparation of standards and repeat calibration.
E3	Low light error.	Re-read measurement. Check lamp** Check for obstructed light path. Dilution may be necessary.
E4	EEPROM malfunction.	Check sum failed. Press **I/O**. If E 4 reappears, call Hach service. If **CAL?** appears, recalibrate.
E5	A/D overrange.	Check for obstructed light path. Call Hach Service.
E6	A/D underrange.	Check for open lid during reading and re-read. Check for obstructed light path. If persists, call Hach Service.
E7	Light Leak.	Close lid before pressing **READ** key.
E8	Bad lamp circuit.	Reinsert lamp leads at terminal block-make sure the lead ends are not touching each other.If this fails, call Hach Service.

* Error messages 4, 5, and 6 may indicate a failure in the internal electronics.
** Check lamp by inserting a pencil or piece of paper into the cell compartment and pressing READ. Light should be visible on the inserted object.

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GENERAL INFORMATION

At Hach Company, customer service is an important part of every product we make.

With that in mind, we have compiled the following information for your convenience.

Replacement Parts & Accessories

REPLACEMENT PARTS

Description	Cat. No.
StablCal Calibration Set for 2100P, Sealed Vials: <0.1 NTU, 20 NTU, 100 NTU, and 800 NTU	26594-05
AA Batteries, 4/pkg	19380-04
Battery Door	46005-00
Carrying Case	46506-00
Gelex® Standards, set (includes standards and 3 sample cells)	24641-05
Instrument Manual	46500-88
Lamp Assembly, with leads	46539-00
Oiling Cloth	47076-00
Sample Cells, 1 inch, with cap, 6/pkg	24347-06
Silicone Oil, 15 mL	1269-36

OPTIONAL ACCESSORIES AND REAGENTS

Deionized Water, 3.78 L	272-17
Bath, Ultrasonic, 2.8 L (0.75-gal), w/heater	24895-00
Battery Eliminator, 120 V	46079-00
Battery Eliminator, 230 V	46080-00
Filter, 0.2 micron, 10/pkg	23238-10
Formazin, 4000 NTU, 500 mL	2461-49
Formazin, 4000 NTU,100 mL	2461-42
Hexamethylenetetramine, 500 g	1878-34
Hydrazine Sulfate, 100 g	742-26
NiCad Rechargeable Battery (4 required)	16077-00

Replacement Parts & Accessories, continued

OPTIONAL ACCESSORIES AND REAGENTS, continued

Description	Cat. No.
Pipet, TenSette®*, 1-10 mL	19700-10
Pipet Tips, for 1-10 mL TenSette Pipet, 50/pkg	21997-96
Pipet Tips, for 1-10 mL TenSette Pipet, 1000/pkg	21997-28
Pipet, Volumetric, Class A, 1.00 mL	14515-35
Pipet, Volumetric, Class A, 5.00 mL	14515-37
Pump, Vacuum, Hand-Operated	14283-00
Sample Degassing Kit	43975-00
Sample Filtration and Degassing Kit	43975-10
StablCal® Calibration Set for 2100P Turbidimeter	
<0.1, 20, 100, 800 NTU, 500 mL each	26594-00
<0.1, 20, 100, 800 NTU, 100 mL each	26594-10
<0.1 NTU** StablCal®*** Stabilized Formazin Standard,100 mL	26597-42
20 NTU StablCal® Stabilized Formazin Standard, 100 mL	26601-42
100 NTU StablCal® Stabilized Formazin Standard, 100 mL	26602-42
800 NTU StablCal® Stabilized Formazin Standard, 100 mL	26605-42
Triton-X Solution, 118 mL (4 oz)	14096-32
Volumetric Flask, 100 mL	14574-42
Volumetric Flask, 200 mL	14574-45

* TenSette™ is a Hach Company trademark.

** <0.1 NTU StablCal® Standard is used in place of dilution water standard when performing a calibration.

*** StablCal® is a registered trademark of Hach Company.

HOW TO ORDER

By Telephone:
6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH
(800-227-4224)
By FAX: (970) 669-2932

By Mail:
Hach Company
P.O. Box 389
Loveland, CO 80539-0389
U.S.A.

Ordering information by E-mail: orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you. Call **1-800-227-4224** or E-mail **techhelp@hach.com**.

International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send E-mail to **intl@hach. com** or contact:

In Canada, Latin America, Africa, Asia, Pacific Rim:
Telephone: (970) 669-3050; FAX: (970) 669-2932

In Europe, the Middle East, or Mediterranean Africa:
HACH Company, c/o
Dr. Bruno Lange GmbH
Willstätterstr. 11
D-40549 Düsseldorf
Germany
Telephone: +49/[0]211.52.88.0
Fax: +49/[0]211.52.88.231

REPAIR SERVICE

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the HACH Service Center serving your location.

In the United States:
Hach Company
100 Dayton Avenue
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
Telephone: (515) 232-2533
FAX: (515) 232-1276

In Canada:
Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

In Latin America, the Caribbean, the Far East, the Indian Subcontinent, Africa, Europe, or the Middle East:
Hach Company World Headquarters
P.O. Box 389
Loveland, Colorado, 80539-0389
U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932
E-mail: intl@hach.com

GPO Appendix 02
Attachment A
Subattachment e
ROSEMOUNT 56 Advanced Dual-Input Analyzer Instrument and Procedure Manual

Reference Manual
00809-0100-3056
Rev. AC
October 2019

Rosemount™ 56

Advanced Dual-Input Analyzer

EMERSON

Essential Instructions

Read this page before proceeding

Your instrument purchase from Emerson is one of the finest available for your particular application. These instruments have been designed, and tested to meet many national and international standards. Experience indicates that its performance is directly related to the quality of the installation and knowledge of the user in operating and maintaining the instrument. To ensure their continued operation to the design specifications, personnel should read this manual thoroughly before proceeding with installation, commissioning, operation, and maintenance of this instrument. If this equipment is used in a manner not specified by the manufacturer, the protection provided by it against hazards may be impaired.

- Failure to follow the proper instructions may cause any one of the following situations to occur: Loss of life; personal injury; property damage; damage to this instrument; and warranty invalidation.
- Ensure that you have received the correct model and options from your purchase order. Verify that this manual covers your model and options. If not, call 1-800-854-8257 or 949-757-8500 to request correct manual.
- For clarification of instructions, contact your Rosemount representative.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Use only qualified personnel to install, operate, update, program and maintain the product.
- Educate your personnel in the proper installation, operation, and maintenance of the product.
- Install equipment as specified in the Installation section of this manual. Follow appropriate local and national codes. Only connect the product to electrical sources specified in this manual.
- Use only factory documented components for repair. Tampering or unauthorized substitution of parts and procedures can affect the performance and cause unsafe operation of your process.
- All instrument enclosures must be closed and protective covers must be in place unless qualified personnel are performing maintenance.

⚠ WARNING

RISK OF ELECTRICAL SHOCK

⧈ Equipment protected throughout by double insulation.

- Installation and servicing of this product may expose personnel to dangerous voltages.
- Main power wired to separate power source must be disconnected before servicing.
- Do not operate or energize instrument with case open!
- Signal wiring connected in this box must be rated at least 240 V for European mains operation.
- Non-metallic cable strain reliefs do not provide grounding between conduit connections! Use grounding type bushings and jumper wires.
- Unused cable conduit entries must be securely sealed by non-flammable closures to provide enclosure integrity in compliance with personal safety and environmental protection requirements. Unused conduit openings must be sealed with Type 4X or IP66 conduit plugs to maintain the ingress protection rating (Type 4X)
- Electrical installation must be in accordance with the National Electrical Code (ANSI/NFPA-70) and/or any other applicable national or local codes.
- Operate only with front panel fastened and in place.
- Safety and performance require that this instrument be connected and properly grounded through a three-wire power source.
- Proper use and configuration is the responsibility of the user.

⚠ CAUTION

This product generates, uses, and can radiate radio frequency energy and thus can cause radio communication interference. Improper installation, or operation, may increase such interference. As temporarily permitted by regulation, this unit has not been tested for compliance within the limits of Class A computing devices, pursuant to Subpart J of Part 15, of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area may cause interference, in which case the user at his own expense, will be required to take whatever measures may be required to correct the interference.

⚠ WARNING

Physical access

Unauthorized personnel may potentially cause significant damage to and/or misconfiguration of end users' equipment. This could be intentional or unintentional and needs to be protected against.

Physical security is an important part of any security program and fundamental to protecting your system. Restrict physical access by unauthorized personnel to protect end users' assets. This is true for all systems used within the facility.

Section i: Quick Start Guide

1. Refer to Section 2.0 for mechanical installation instructions.
2. Wire sensor(s) to the signal boards. See Section 3.0 for wiring instructions. Refer to the sensor instruction sheet for additional details. Make current output, alarm relay and power connections
3. Once connections are secured and verified, apply power to the analyzer.

⚠ WARNING

RISK OF ELECTRICAL SHOCK

Electrical installation must be in accordance with the National Electrical Code (ANSI/NFPA-70) and/or any other applicable national or local codes.

CAUTION: This symbol identifies a risk of electrical shock.

CAUTION: This symbol identifies a potential hazard. When this symbol appears, consult the manual for appropriate action.

4. When the analyzer is powered up for the first time, Time/Date and Quick Start screens appear. Quick Start operating tips are as follows:
   a. Window screens will appear. The field with the focus will appear with dark blue back-lighting. The field with focus can be edited by press ENTER/MENU.
   b. The Time and Date screen to set the real-time clock will appear. Accept the displayed time by pressing ENTER on Time and date OK or press the down key to Change the time and date.
   c. The first Quick Start screen appears. Choose the desired language by pressing ENTER/MENU to edit the active field and scrolling to the language of choice. Press ENTER/MENU and press the down arrow to highlight NEXT.
   d. The Navigation Rules for operating the keypad will be displayed.
   e. Choose the measurement for Sensor 1 (and Sensor 2) and proceed to the remaining Quick Start steps.
   f. Keypad operation guidelines will appear to guide the user how operate the user interface.
   g. NOTE: To edit a field with backlit focus, press ENTER/MENU. To scroll up or down, use the keys to above or below the ENTER key. To move the cursor left or right, use the keys to the left or right of the ENTER key. To edit a numeric value including decimal points, use the alphanumeric keypad then press ENTER.
   h. NOTE: Press ENTER to store a setting or value. Press EXIT to leave without storing changes. Pressing EXIT during Quick Start returns the display to the initial start-up screen (select language). To proceed to the next Quick Start step, use the right key or the down key to highlight NEXT. Press ENTER.
5. After the last step, the main display appears. The current outputs are assigned to default values before probes are wired to the analyzer. After the last step, the main display appears. The outputs are assigned to default values.
6. To change output, and all settings, press ENTER/MENU from the live screen. Using the down and right arrow keys, select one of the following menus and navigate the screen of choice.
7. To return the analyzer to the default settings, choose Reset under the Menu selection screen.

SAFETY MESSAGES

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol ( ). This symbol identifies a potential hazard.

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Section 1: Description and Specifications

1.1 Features and Applications

This multi-parameter unit serves industrial, commercial and municipal applications with the widest range of liquid measurement inputs and digital communications available.

The 56 advanced dual-input analyzer supports continuous measurement of liquid analytical inputs from one or two sensors. The modular design allows signal input boards to be field replaced, making configuration changes easy. The high resolution full-color display gives unsurpassed visibility and functionality for liquid analytical instrumentation.

Dual Input Instrument: single or dual measurement of pH/ORP, Resistivity/ Conductivity, % Concentration, Total Dissolved Solids, Total Chlorine, Free Chlorine, Monochloramine, Dissolved Oxygen, Dissolved Ozone, Turbidity, Pulse Flow, Temperature, and 4-20 mA input from any device.

Full Color Display: The high resolution full-color display allows at-a-glance viewing of process readings – indoors or outdoors. Six additional process variables or diagnostic parameters are displayed for quick determination of process or sensor condition. The contrast of back-lit display can be adjusted and the main screen can be customized to meet user requirements.

Digital Communications: HART® version 5 and 7 digital communications are available on the 56. An optional Profibus® DP digital communications board is available for Profibus installations. 56 HART units communicate with the 475 HART hand-held communicator and HART hosts such as AMS Intelligent Device Manager. 56 Profibus units are fully compatible with Profibus DP networks and Class 1 or Class 2 masters. HART and Profibus DP configured units will support any single or dual measurement configurations of the 56.

Menus: Easily-managed window screens for easy navigation to local configuration and routine calibration. Quick Start and all menu screens are available in multiple locally displayed languages. Alpha-numeric keypad allows easy entries during configuration and calibration.

Quick Start Programming: Popular Quick Start screens appear the first time the unit is powered. The instrument auto-recognizes each measurement input type and prompts the user to configure each sensor loop in a few quick steps for immediate commissioning.

User Help Screens: A complete user guide and troubleshooting manual is embedded in the instrument's memory and easily accessed via the INFO key on the local display. Detailed instructions and troubleshooting tips in multiple languages are intended to provide adequate guidance to resolve most problems on site.

Hazardous Area Approvals and Safety Approvals: None.

Enclosure: The instrument enclosure fits standard ½ DIN panel cutouts. The versatile enclosure design supports panel-mount, pipe-mount, and surface/wall-mount installations. No Enclosure ratings – None.

Security Access Codes: Two levels of security access are available. Program one access code for routine maintenance and hold of current outputs; program another access code for all configuration menus and functions.

Diagnostics: The analyzer continuously monitors itself and the sensor(s) for fault and warning

conditions. A display banner flashes red to indicate a Fault condition and yellow for a Warning condition to visually alert field personnel. Details and troubleshooting information for any specific fault or warning can be readily accessed by pressing the INFO key.

Local Languages: Rosemount extends its worldwide reach by offering nine menu languages – English, French, German, Italian, Spanish, Portuguese, Chinese, Russian and Polish. Every unit includes user programming menus; calibration routines; faults and warnings; and user help screens in all nine languages.

Current Outputs: Every unit includes four 4-20 mA or 0-20 mA electrically isolated current outputs giving the ability to transmit the measurement value and the temperature for both sensors. Users have wide latitude to assign any measurement value or live diagnostic to any current output for reporting. Output dampening can be enabled with time constants from 0 to 999 seconds. HART digital communications transmitted via current output 1 is standard on all units (option code HT).

1.2 Enhanced Features

Process Trending Graphs: High-resolution color graphs of measurement data can be displayed on-screen to pinpoint process disruptions or measurement problems and to estimate probe maintenance frequency. The analyzer gives the user the ability to zoom in to a specific narrow timeframe of process measurements for detailed on-screen evaluation.

Data Logger and Event Logger: Extensive onboard data storage captures measurement data from both channels every 30 seconds for 30 days for on-screen display or local upload to a USB 2.0 memory device. 300 significant analyzer events are recorded including start-up time, calibrations, hold outputs, configurations, alarms, power interruptions, faults, and more. All process data and events are time/date stamped.

USB 2.0 Data Transfer Port: A USB port is built-in to allow local data transfer of process data and events using a standard USB memory device. Cleanly formatted EXCEL data is useful for evaluation of process data on a computer and identification of critical alarm or fault events.

PID Control: Proportional, Integral and Derivative settings allow the analog current outputs to adjust a control device that has continuous adjustability by acting on process measurements or temperature. PID is typically used on modulating control devices such as automated control valves or variable volume pumps. Any current output can be programmed for PID functions.

Alarm Relay Capabilities: Four Single Pole Double Throw alarm relays are fully assignable and programmable to trigger alarms upon reaching measurement or diagnostics setpoints or fault conditions. Further relay settings include TPC, synchronized interval timers and four specialized timer functions described below. All relays are independently activated. Failsafe operation and programming of relay default state (normally open or normally closed) is software selectable.

Timer Functions: Basic TPC (Time Proportional Control) settings are available. Interval timers set relays by interval time, on-time and recovery time for discrete on/off control devices based on measurement inputs. In addition, four real-time clock relay functions are implemented including: bleed and feed, day and time interval timers, delay timer and a flow totalizer. These advanced timer features support a number of specialized applications that normally require dedicated timer control devices or DCS programming.

Wireless Thum Adaptor Compatible: Enable wireless transmissions of process variables and diagnostics from hard-to-reach locations where it is impractical to run wires for current outputs. When commissioned with the THUM Adaptor, 56 HART® units can communicate on Emerson wireless networks using HART 7 wireless protocol.

Smart-Enabled pH: Rosemount SMART pH capability can eliminate field calibration of pH probes through automatic upload of calibration data and history – fully calibrating the pH loop. pH probe changes are literally plug and play using SMART pH sensors with VP cables connections.

Advanced Functions: Several specialty measurements are supported including: high reference impedance pH sensors, Ion Selective Electrode measurements, pH loop calibration by entering pH slope and reference offset, Isopotential point for pH, inferred pH determination using dual contacting conductivity inputs, differential conductivity, differential flow, totalized flow, current input from any 4-20 mA source, dual range calibration for chlorine sensors, programmable polarizing voltage for amperometric oxygen sensors and software selectable normally open or normally closed alarm relays – to name a few.

1.3 Specifications - General

Case: Polycarbonate. Type 4X, IP66.

NOTE:

To ensure a water-tight seal, tighten all four front panel screws to 6 in-lbs of torque.

Dimensions: 6.2 x 6.2 x 5.2 in. (157 x 157 x 132 mm)

Conduit openings: Accepts (6) PG13.5 or 1/2 in. conduit fittings

Display: Large 3.75 x 2.2 in. (95.3 x 55.9mm) high resolution color LCD displays large process variables and user-definable display of diagnostic parameters. Calibration, programming and information screens display clear, easy-to-read characters. The color display is back-lit and backlighting intensity is user adjustable. Measurement character height: (.5") 13mm. Main display can be customized to meet user requirements.

Ambient temperature and humidity: -10 to 60 °C, (14 to 140 °F) RH 5 to 95% (non-condensing). For Turbidity only: 0 to 55 °C (32 to 131 °F). RH 5 to 95% (non-condensing).

NOTE:

The analyzer is operable from -5 to 55 °C (-23 to 131 °F) with some degradation in display response or performance. Above 60 °C, the following components will progressively and automatically shut down: display, USB communications port, current outputs, alarm relays, main circuit board.

⚠ WARNING

Always remove USB memory device at ambient temp above 60 °C. Do not access USB port if combustible atmosphere is present.

Storage temperature: -20 to 60 °C, (-4 to 140 °F)

Power: Code -02: 20 to 30 VDC. 20 W
Code –03: 85 to 264 VAC, 47.5 to 65.0 Hz, 20 W

Real time clock back-up: 24 hours.

Hazardous Location Approvals:

Options for CSA: 02, 03, 20, 21, 22, 24, 25, 26, 27, 30, 31, 32, 34, 35, 36, 37, 38, HT and DP

-LR 34186
C US

Class I, Division 2, Groups A, B, C, & D
Class II, Division 2, Groups E, F, & G
Class III
T4 Tamb = 60 °C
Enclosure Type 4X, IP66

See Non-Incendive Field Wiring drawing 1400668. The 'C' and 'US' indicators adjacent to the CSA Mark signify that the product has been evaluated to the applicable CSA and ANSI/UL Standards, for use in Canada and the U.S. respectively. Evaluated to CSA Standards: 22.2 Numbers: 1-10. 0.4-04, 25-1996, 94-M1991, 142-M1987, 213-M1987, 60529:05. ANSI/IEC 60529:04. ANSI/ISA:12.12.01:2007. UL No. 50:11th Ed. and No. 508:17th Ed.

Note: Single-input Turbidity configurations (models 56-02-27-38 or -HT, 56-03-27-38 or -HT) and dual-input Turbidity only configurations (56-02-27-37 or -HT, 56-03-27-37 -HT) are CSA approved class I Div. 2 for hazardous area installation.

Options for FM: -02, 03, 20, 21, 22, 23, 24, 25, 26, 27, 30, 31, 32, 33, 34, 35, 36, 37, 38, HT and DP.

FM APPROVED

Class I, Division 2, Groups A, B, C, & D
Class II & III, Division 2, Groups E, F, & G
T4 -10 °C ≤ Tamb ≤ 60 °C
IP66

See Non-Incendive Field Wiring drawing 1400667.

Evaluated to FM Standards: 3600:2011, 3611:2004, 3810:2005, ANSI/IEC 60529:2004.

Note: Single-input Turbidity configurations (models 56-02-27-38 or -HT, 56-03-27-38 or -HT) and dual-input Turbidity only configurations (56-02-27-37 or -HT, 56-03-27-37 or -HT) are FM approved class I Div. 2 for hazardous area installation.

Ordinary Locations (only with -UL ordering option):

C UL US LISTED Options for UL: -02, 03, 20, 21, 22, 24, 25, 26, 27, 30, 31, 32, 34, 35, 36, 37, 38, HT and DP.

Pollution Degree 2: Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.

Altitude: for use up to 2000 meter (6562 ft.)

EMI/RFI Effect
Meets all industrial requirements of EN 61326.
HART Analog and Digital Communication
No effect on the values being given if using 4-20 mA analog or HART digital signal with shielded, twisted pair wiring.
Profibus DP Digital Communication
No effect on the values being given if using Profibus DP digital signal.

Note 1
During EMI disturbance, the maximum sensor deviation is ±0.004 ppm (4 ppb) for options 24, 25, 26, 34, 35, and 36.

LVD: EN-61010-1:2010 CE

Input: One or two isolated sensor inputs. Measurement choices of pH/ORP, resistivity/conductivity/ TDS, % concentration, ratio conductivity, total and free chlorine, monochloramine, dissolved oxygen, dissolved ozone, turbidity, pulse flow, temperature and raw 4-20 mA input. For contacting conductivity measurements, temperature element can be a Pt100 RTD or Pt1000 RTD. For other measurements (except ORP, flow and turbidity), use either a PT100 RTD, PT1000 RTD, or 22k NTC (D.O. only).

Outputs: Four 4-20 mA or 0-20 mA isolated current outputs. Fully scalable. Max Load: 550 Ohms. Output 1 superimposes the HART® digital signal. Outputs can be programmed for PID control. Output dampening can be enabled with time constants from 0 to 999 seconds. HART digital communications transmitted via current output 1 is standard on all units (option code HT).

Alarms: Four alarm relays for process measurement(s) or temperature. Any relay can be programmed for any measurement, timer, TPC or fault alarm operation, instead of a process alarm. When selected, a fault alarm will activate the relay when a sensor or analyzer fault occurs. Each relay can be configured independently. Alarm logic (high or low activation or USP*) and deadband are user-programmable.

*USP alarm can be programmed to activate when the conductivity is within a user-selectable percentage of the limit. conductivity/resistivity measurement only)

Maximum Relay Current	
Power Input	Resistive
28 VDC 5.0 A	5.0 A
115 VAC 5.0 A	5.0 A
230 VAC 5.0 A	5.0 A

Relays: Form C, SPDT, epoxy sealed

Inductive load: 1/8 HP motor (max.), 115/240 VAC

Terminal Connections Rating:
Power connector (02 order code, 24 VDC power supply and 03 order code, 85-264 VAC power supply): 24-12 AWG wire size.

Signal board terminal blocks: 26-16 AWG wire size.

Current output connectors: 26-16 AWG wire size.

Alarm relay terminal blocks: 24-12 AWG wire size.

Weight/Shipping Weight: (rounded up to nearest lb or nearest 0.5 kg): 3 lbs/4 lbs (1.5 kg/2.0 kg)

1.4 Contacting Conductivity (Codes -20 and -30)

Measures conductivity in the range 0 to 600,000 µS/cm (600 mS/cm). Measurement choices are conductivity, resistivity, total dissolved solids, salinity, and % concentration. Temperature compensation can be disabled, allowing the analyzer to display raw conductivity.

NOTE:

When two contacting conductivity sensors are used, The 56 can derive an inferred pH value. Inferred pH is calculated pH, not directly measured pH. Inferred pH is calculated from straight and cation conductivity. It is applicable only if the alkalizing agent is NaOH or NH_3 and the major contaminant is NaCl. It is strictly an application for power plants.

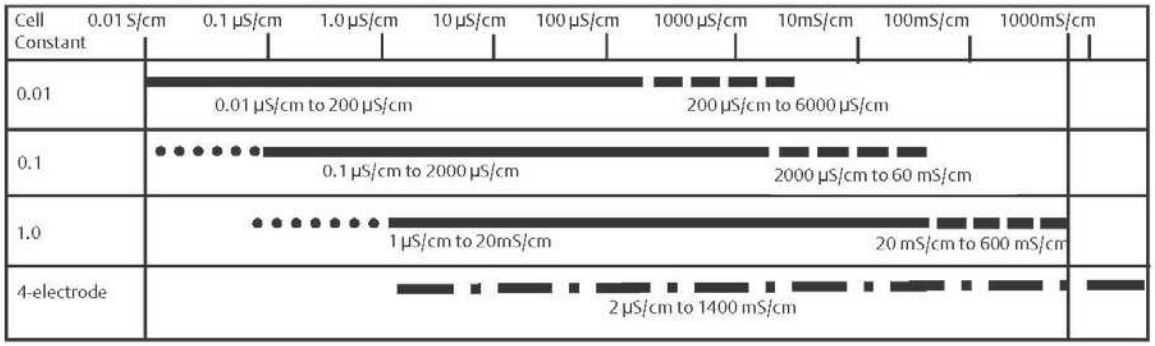
Performance Specifications - Analyzer

Measurement Range: see table below
Solution temperature compensation: manual slope (X% / °C), high purity water (dilute sodium chloride), and cation conductivity (dilute hydrochloric acid).
Salinity: uses Practical Salinity Scale
Total Dissolved Solids: Calculated by multiplying conductivity at 25 °C by 0.65
Five percent concentration curves: 0-12% NaOH, 0-15% HCl, 0-20% NaCl, 0-25% or 96-99.7% H_2SO_4. The conductivity concentration algorithms for these solutions are fully temperature compensated.
Four temperature compensation options: manual slope (X% / °C), high purity water (neutral salt), cation conductivity (dilute hydrochloric acid) and raw.
Input filter: time constant 1 - 999 sec, default 2 sec.
Response time: 3 seconds to 95% of final reading

Recommended Sensors for Contacting Conductivity:

All Rosemount ENDURANCE 400 series conductivity sensors (Pt 1000 RTD) and 410VP 4-electrode high-range conductivity sensor.

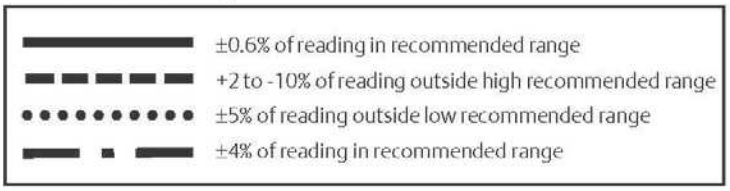
PERFORMANCE SPECIFICATIONS
Recommended Range – Contacting Conductivity



Temperature Specifications:

Temperature range	0-200 °C
Temperature Accuracy, Pt-1000, 0-50 °C	±0.1 °C
Temperature Accuracy, Pt-1000, Temp. > 50 °C	±0.5 °C

Cell Constant Linearity



1.5 Toroidal Conductivity (Codes -21 and -31)

Measures conductivity in the range of 1 (one) µS/cm to 2,000,000 µS/cm (2 S/cm). Measurement choices are conductivity, resistivity, total dissolved solids, salinity, and % concentration. Temperature compensation can be disabled, allowing the analyzer to display raw conductivity.

For more information concerning the use and operation of the toroidal conductivity sensors, refer to the product data sheets.

Performance Specifications- Analyzer

Measurement Range: see table below
Repeatability: ±0.25% ±5 µS/cm after zero cal
Salinity: uses Practical Salinity Scale
Total Dissolved Solids: Calculated by multiplying conductivity at 25 °C by 0.65
Five percent concentration curves: 0-12% NaOH, 0-15% HCl, 0-20% NaCl, 0-25% or 96-99.7% H2SO4. The conductivity concentration algorithms for these solutions are fully temperature compensated. For other solutions, the analyzer accepts as many as five data points and fits either a linear (two points) or a quadratic function (three or more points) to the data. Reference temperature and linear temperature slope may also be adjusted for optimum results.
Three temperature compensation options: manual slope (X% / °C), neutral salt (dilute sodium chloride) and raw.
Input filter: time constant 1 - 999 sec, default 2 sec.
Response time: 3 seconds to 95% of final reading

Recommended Sensors:

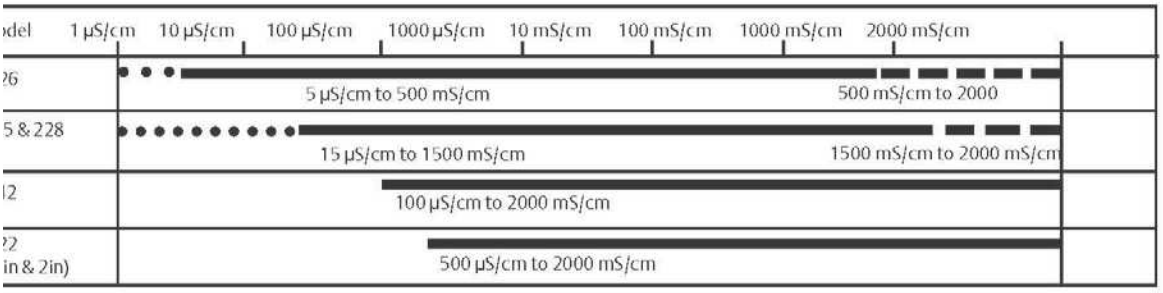
All Rosemount submersion/immersion and flow-through toroidal sensors.

emperature range	-25 to 210 °C (-13 to 410 °F)
emperature Accuracy, t-100, -25 to 50 °C	± 0.5 °C
emperature Accuracy, t-100,. 50 to 210 °C	± 1°C

Loop Performance (Following Calibration)

- 226: ±1% of reading ±5 µS/cm in recommended range
- 225 & 228: ±1% of reading ±10 µS/cm in recommended range
- 222, 242: ±4% of reading in recommended range
- 225, 226 & 228: ±5% of reading outside high recommended range
- 226: ±5 µS/cm outside low recommended range
- 225 & 228: ±15 µS/cm outside low recommended range

RFORMANCE SPECIFICATIONS Recommended Range - Toroidal Conductivity



1.6 pH/ORP (Codes -22 and -32)

For use with any standard pH or ORP sensors. Measurement choices are pH, ORP, Redox, Ammonia, Fluoride or custom ISE. The automatic buffer recognition feature uses stored buffer pH values and their temperature curves for the most common buffer standards available worldwide. The analyzer will recognize the pH value of the buffer being measured and perform a self stabilization check on the sensor before completing the calibration. Manual or automatic temperature compensation is menu selectable. Change in process pH due to temperature can be compensated using a programmable temperature coefficient. For more information concerning the use and operation of the pH or ORP sensors, refer to sensor product data sheets. The 56 can also derive an inferred pH value. Inferred pH can be derived and displayed when two contacting conductivity sensors are used.

Performance Specifications (pH input) - Analyzer

Measurement Range [pH]: 0 to 14 pH
Accuracy: ±0.01 pH
Diagnostics: glass impedance, reference impedance
Temperature coefficient: ±0.002pH / °C
Solution temperature correction: pure water, high pH (dilute base), Ammonia and custom
Buffer recognition: NIST (including non-NIST pH 7.01 buffer), DIN 19267, Ingold, Merck, and Fisher
Input filter: Time constant 1 - 999 sec, default 4 sec.
Response time: 5 seconds to 95% of final reading

Recommended Sensors for pH:

Compatible with standard pH sensors with and without integral preamps. Supports Smart pH sensors from Rosemount (includes Smart integral preamps).

General purpose and high performance pH 396PVP, 3900VP and 3300HT sensors

Performance Specifications (ORP input) - Analyzer

Measurement Range [ORP]: -1500 to +1500 mV
Accuracy: ± 1 mV
Temperature coefficient: ±0.12mV / °C
Input filter: Time constant 1 - 999 sec, default 4 sec.
Response time: : 5 seconds to 95% of final reading

Recommended Sensors for ORP:

Compatible with standard ORP sensors with and without integral preamps.

NOTE:

Some older sensor preamps may not be compatible with the 56 (contact the factory for details).

1.7 Flow (Code -23 and -33)

For use with most pulse signal flow sensors, the 56 user-selectable units of measurement include flow rates in GPM (gallons per minute), GPH (gallons per hour), cu ft/min (cubic feet per min), cu ft/hour (cubic feet per hour), LPM (liters per minute), LPH (liters per hour), or m3/hr (cubic meters per hour), and velocity in ft/sec or m/sec. When configured to measure flow, the unit also acts as a totalizer in the chosen unit (gallons, liters, or cubic meters). Dual flow instruments can be configured as a % recovery, flow difference, flow ratio, or total (combined) flow.

Performance Specifications - Analyzer

Frequency Range: 3 to 1000 Hz
Flow Rate: 0 - 99,999 GPM, LPM, m3/hr, GPH, LPH, cu ft/min, cu ft/hr.
Totalized Flow: 0 – 9,999,999,999,999 Gallons or m3, 0 – 999, 999,999,999 cu ft.
Accuracy: 0.5%
Input filter: Time constant 0-999 sec., default 5 sec.

1.8 4-20 mA Current Input (Codes -23 and -33)

For use with any transmitter or external device that transmits 4-20 mA or 0-20 mA current outputs. Typical uses are for temperature compensation of live measurements (except ORP, turbidity and flow) and for continuous pressure input for continuous measurement of % oxygen gas. External input of atmospheric pressure for oxygen measurement allows continuous partial pressure compensation while the 56 enclosure is completely sealed.

Externally sourced current input is also useful for calibration of new or existing sensors that require temperature measurement or atmospheric pressure inputs. In addition to live continuous compensation of live measurements, the current input board can also be used simply to display and trend the measured temperature or the calculated partial pressure from the external device. This feature leverages the large display variables on the 56 as a convenience for technicians. Temperature can be displayed in °C or °F. Partial pressure can be displayed in inches Hg, mm Hg, atm (atmospheres), kPa (kiloPascals), bar or mbar. The current input board serves as a power supply for loop-powered devices that do not actively power their 4-20 mA output signals.

Performance Specifications

Measurement Range *[mA]: 0-20 or 4-20
Accuracy: ±0.03 mA
Input filter: Time constant 0-999 sec., default 5 sec.
*Current input not to exceed 22 mA

1.9 Chlorine (Code -24 and -34)

Free and Total Chlorine

The 56 is compatible with the 499ACL-01 free chlorine sensor and the 499ACL-02 total chlorine sensor. The 499ACL-02 sensor must be used with the TCL total chlorine sample conditioning system. The 56 fully compensates free and total chlorine readings for changes in membrane permeability caused by temperature changes.

For free chlorine measurements, both automatic and manual pH corrections are available. For automatic pH correction, select code P and an appropriate pH sensor. For more information concerning the use and operation of the amperometric chlorine sensors and the TCL measurement system, refer to the product data sheets.

Performance Specifications - Analyzer

Resolution: 0.001 ppm or 0.01 ppm – selectable
Input Range: 0nA – 100 µA
Automatic pH correction (requires Code P): 6.0 to 10.0 pH
Temperature compensation: Automatic or manual (0-50 °C).
Input filter: Time constant 1 - 999 sec, default 5 sec.
Response time: 6 seconds to 95% of final reading

Recommended Sensors

Chlorine: 499ACL-01 Free Chlorine or 499ACL-02 Total Chlorine
pH: The following pH sensor is recommended for automatic pH correction of free chlorine readings: 3900

Monochloramine

The 56 is compatible with the 499A CL-03 Monochloramine sensor. The 56 fully compensates readings for changes in membrane permeability caused by temperature changes. Because monochloramine measurement is not affected by pH of the process, no pH sensor or correction is required. For more information concerning the use and operation of the amperometric chlorine sensors, refer to the product data sheets.

Performance Specifications - Analyzer

Resolution: 0.001 ppm or 0.01 ppm – selectable
Input Range: 0 nA – 100 µA
Temperature compensation: Automatic or manual (0-50 °C).
Input filter: Time constant 1 - 999 sec, default 5 sec.
Response time: 6 seconds to 95% of final reading

Recommended Sensors

Rosemount 499ACL-03 Monochloramine sensor

1.10 Dissolved Oxygen (Codes -25 and -35)

The 56 is compatible with the 499ADO, 499ATrDO, Hx438, Gx438 and BX438 dissolved oxygen sensors and the 4000 percent oxygen gas sensor. The 56 analyzer displays dissolved oxygen in ppm, mg/L, ppb, µg/L, % saturation, % O_2 in gas, ppm O_2 in gas. The analyzer fully compensates oxygen readings for changes in membrane permeability caused by temperature changes. An atmospheric pressure sensor is included on all dissolved oxygen signal boards to allow automatic atmospheric pressure determination during air calibration. Calibration can be corrected for process salinity if removing the sensor from the process liquid is impractical. The analyzer can be calibrated against a standard instrument. For more information on the use of amperometric oxygen sensors, refer to the product data sheets.

Performance Specifications - Analyzer

Resolution: 0.01 ppm; 0.1 ppb for 499A TrDO sensor (when O2 <1.00 ppm); 0.1%
Input Range: 0 nA – 100 µA
Temperature Compensation: Automatic or manual (0-50 °C).
Input filter: Time constant 1 - 999 sec, default 5 sec
Response time: 6 seconds to 95% of final reading

Recommended Sensor

Rosemount amperometric membrane and steam-sterilizable sensors listed above

1.11 Dissolved Ozone (Code -26 and -36)

The 56 is compatible with the 499AOZ sensor. The 56 fully compensates ozone readings for changes in membrane permeability caused by temperature changes. For more information concerning the use and operation of the amperometric ozone sensors, refer to the product data sheets.

Performance Specifications - Analyzer

Resolution: 0.001 ppm or 0.01 ppm – selectable
Input Range: 0 nA – 100 µA
Temperature Compensation: Automatic or manual (0-35 °C)
Input filter: Time constant 1 - 999 sec, default 5 sec.
Response time: 6 seconds to 95% of final reading

Recommended Sensor

Rosemount 499A OZ ozone sensor.

Dissolved Oxygen 499ADO sensor with Variopol connection

Dissolved Ozone 499AOZ sensors with Polysulfone body Variopol connection and cable connection

1.12 Turbidity (Codes -27 and -37)

The 56 instrument is available in single and dual turbidity configurations for the Clarity II turbidimeter. It is intended for the determination of turbidity in filtered drinking water. The other components of the Clarity II turbidimeter – sensor(s), debubbler/measuring chamber(s), and cable for each sensor must be ordered separately or as a complete system with the 56.

The 56 turbidity instrument accepts inputs from both USEPA 180.1 and ISO 7027-compliant sensors. Four fully programmable relays with timers are included.

Note: the 56 Turbidity must be used with Clarity II sensor, sensor cable and debubbler.

Performance Specifications - Analyzer

Units: Turbidity (NTU, FTU, or FNU); total suspended solids (mg/L, ppm, or no units)
Display resolution-turbidity: 4 digits; decimal point moves from x.xxx to xxx.x
Display resolution-TSS: 4 digits; decimal point moves from x.xxx to xxxx
Calibration methods: User-prepared standard, commercially prepared standard, or grab sample. For total suspended solids user must provide a linear calibration equation.
Inputs: Choice of single or dual input, EPA 180.1 or ISO 7027 sensors.
Field wiring terminals: Removable terminal blocks for sensor connection.
Accuracy after calibration at 20.0 NTU:
0-1 NTU ±2% of reading or 0.015 NTU, whichever is greater. 0-20 NTU: ±2% of reading.

1.13 Ordering Information

The 56 Analyzer offers single or dual sensor input with an unrestricted choice of dual measurement combinations. Measurements capabilities include pH/ORP, Resistivity/ Conductivity, % Concentration, Total Chlorine, Free Chlorine, Monochloramine, Dissolved Oxygen, Dissolved Ozone, Turbidity, Pulse Flow, Temperature, and 4-20mA input.

The device includes two isolated inputs, nine local languages, four 4-20mA current outputs, removable connectors for power and current outputs, and four solid plugs for closure of openings. HART digital communications is included at no additional charge. Profibus digital communications is optional.

56 Advanced Dual-Input Analyzer

Level 1	POWER
02	24 VDC with four alarm relays
03	85-265 VAC switching, 50/60 Hz with four alarm relays

Level 2	MEASUREMENT 1
20	Contacting Conductivity
21	Toroidal Conductivity
22	pH/ORP
23	Flow/Current Input
24	Chlorine
25	Dissolved Oxygen
26	Ozone
27	Turbidity

Level 3	MEASUREMENT 2
30	Contacting Conductivity
31	Toroidal Conductivity
32	pH/ORP/ISE
33	Flow/Current Input
34	Chlorine
35	Dissolved Oxygen
36	Ozone
37	Turbidity
38	None

Level 4	COMMUNICATIONS
HT	HART® digital communication
DP	Profibus DP digital communication

Section 2.0 – Installation

2.1 Unpacking and Inspection

Inspect the shipping container. If it is damaged, contact the shipper immediately for instructions. Save the box. If there is no apparent damage, unpack the container. Be sure all items shown on the packing list are present. If items are missing, notify Rosemount immediately.

2.2 Installation

2.2.1 General Information

1. Although the transmitter is suitable for outdoor use, installation is direct sunlight or in areas of extreme temperatures is not recommended unless a sunshield is used. Make sure to note the Ambient temperature specifications in section 1. The analyzer cannot be operated in ambient (shaded) conditions greater than 60 °C.
2. Install the analyzer in an area where vibration and electromagnetic and radio frequency interference are minimized or absent.
3. Keep the analyzer and sensor wiring at least one foot from high voltage conductors. Be sure there is easy access to the analyzer.
4. The analyzer is suitable for panel, pipe, or surface mounting. See Figures 2-1 and 2-2.
5. Install cable gland fittings and plugs as needed to properly seal the analyzer on all six enclosure openings. The USB port cover must be fully installed on the front cover to ensure proper analyzer sealing.

⚠ WARNING

RISK OF ELECTRICAL SHOCK

Electrical installation must be in accordance with the National Electrical Code (ANSI/NFPA-70) and/or any other applicable national or local codes.

CAUTION: This symbol identifies a risk of electrical shock.

CAUTION: This symbol identifies a potential hazard. When this symbol appears, consult the manual for appropriate action.

Fig. 2-1 Panel Mounting Installation dimensions

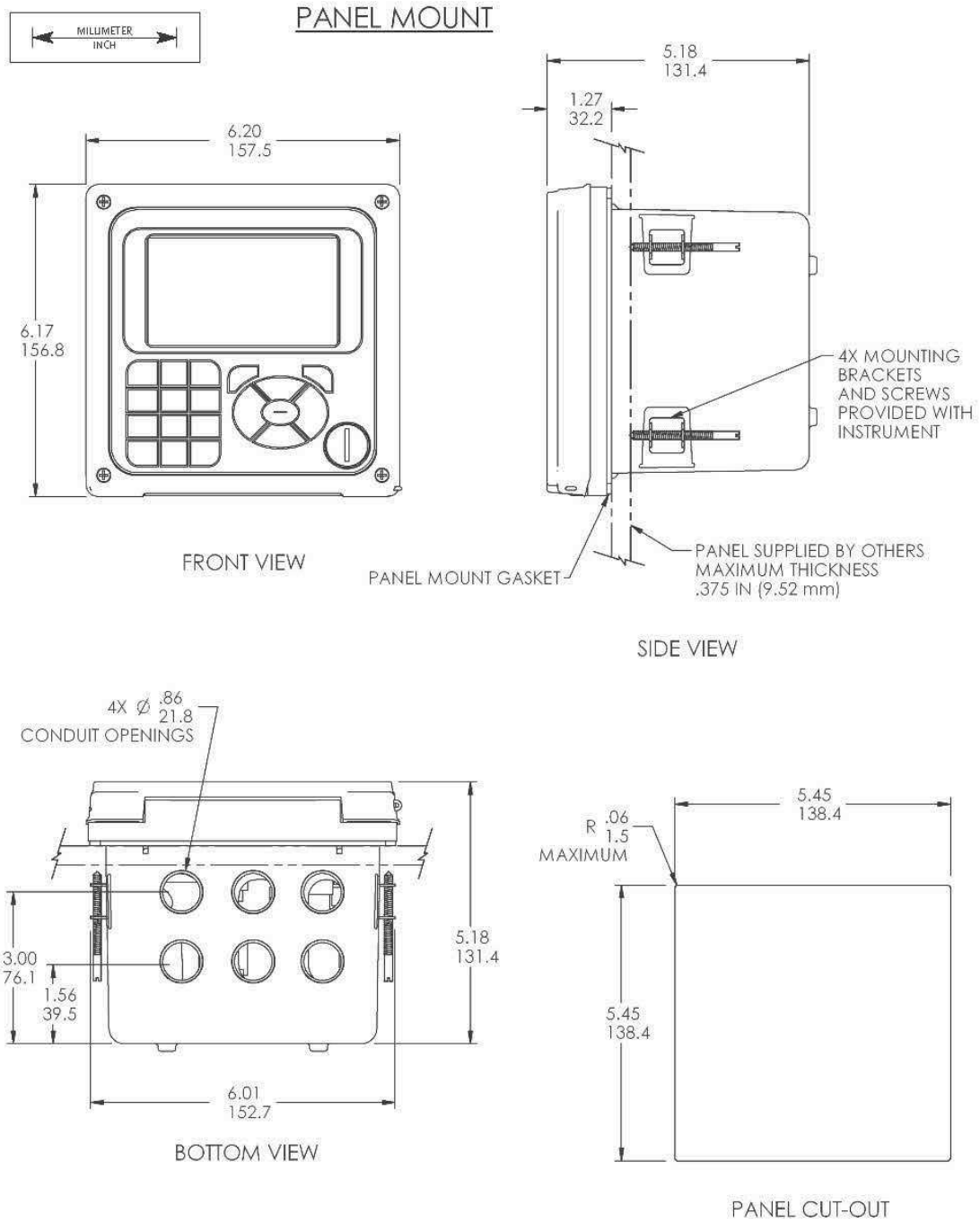


Fig. 2-2 Pipe and Wall Mounting Installation dimensions

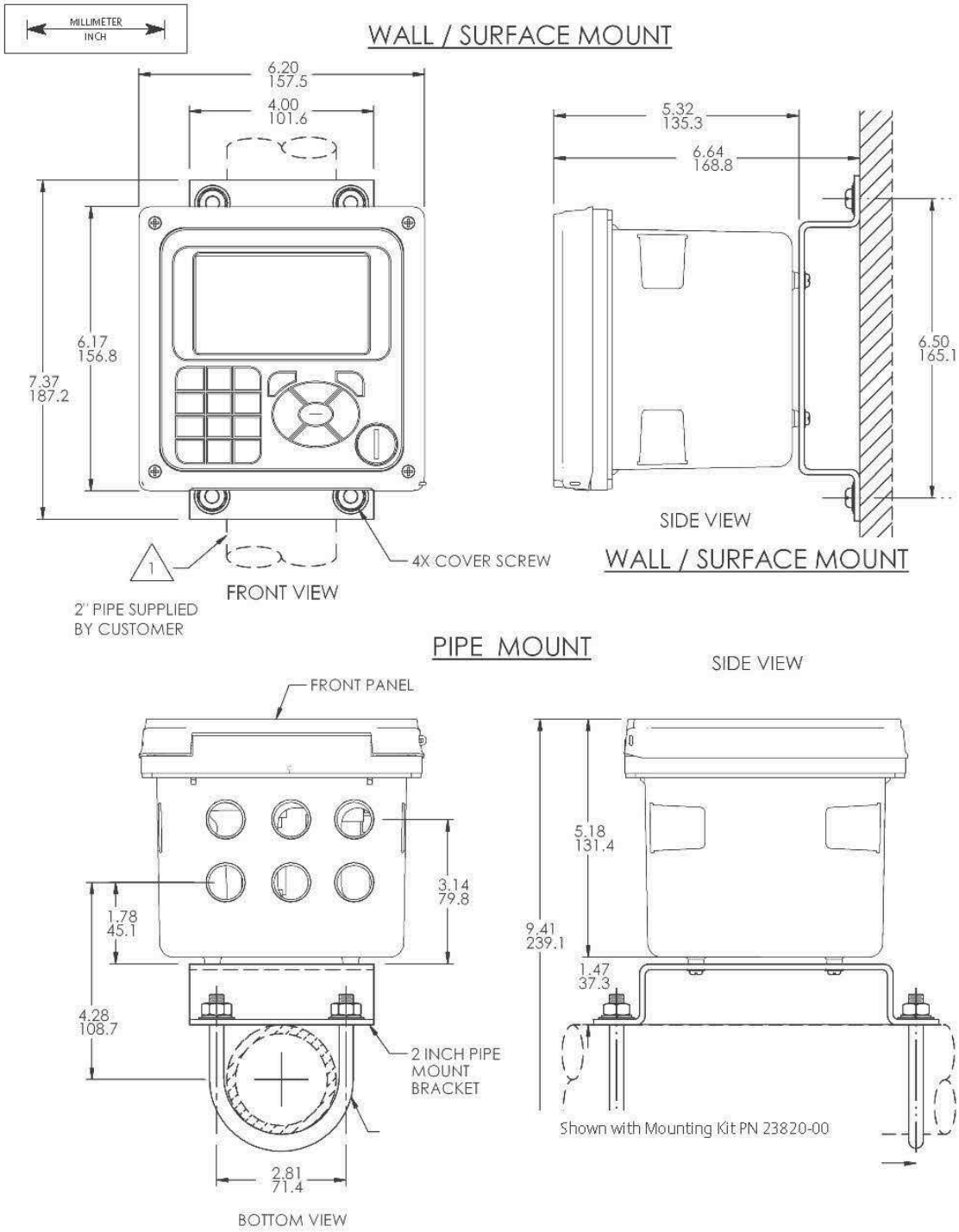


Fig. 2-3 FM Non-incendive field wiring installation for the 56-27-37 Analyzer

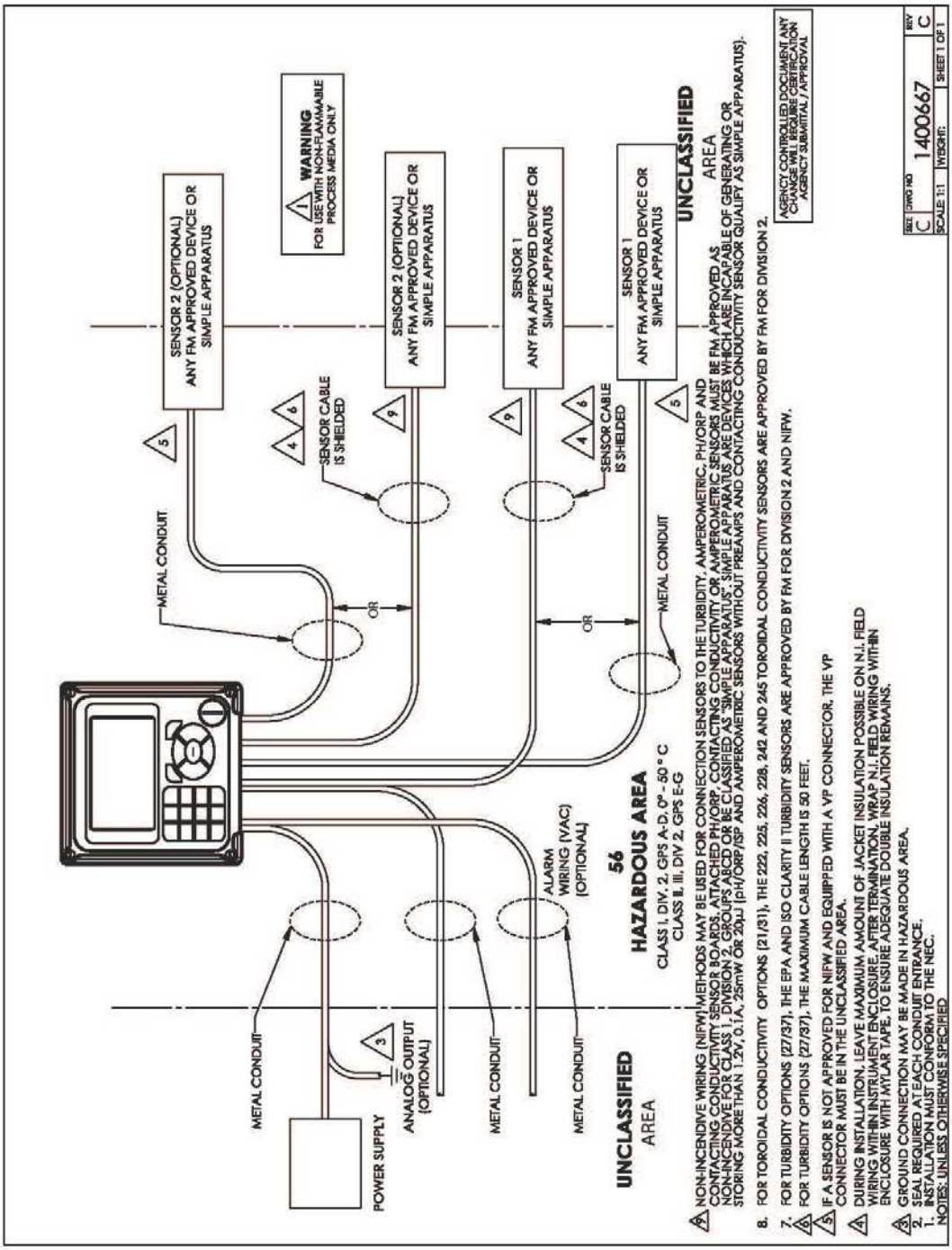
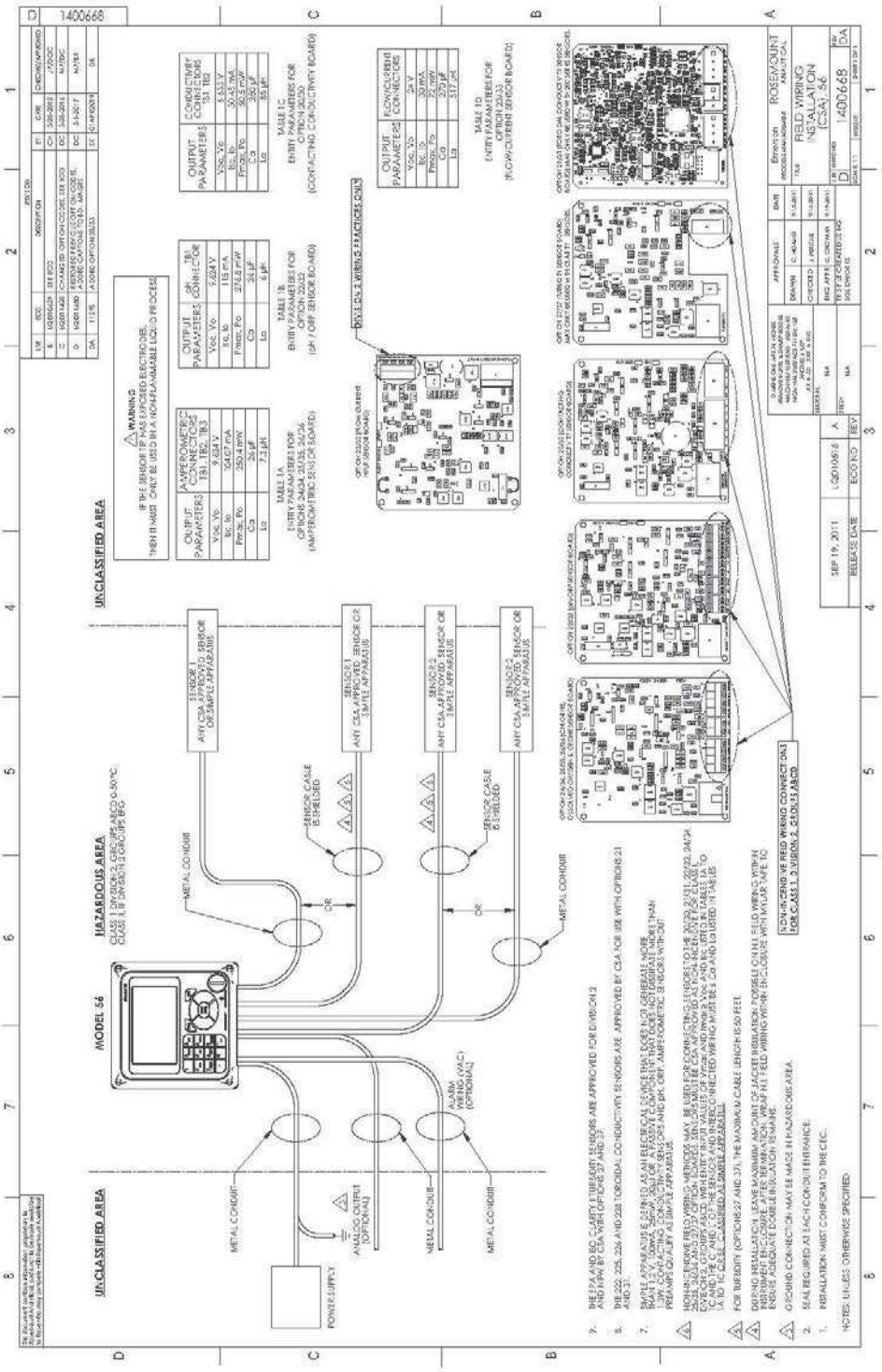


Fig. 2-4 CSA Non-incendive field wiring installation



Section 3.0 Wiring

3.1 General

The 56 is easy to wire. It includes removable connectors and slide-out signal input boards The front panel is hinged at the bottom. The panel swings down for easy access to the wiring locations.

3.1.1 Removable connectors and signal input boards

The 56 uses removable signal input boards and communication boards for ease of wiring and installation. Each of the signal input boards can be partially or completely removed from the enclosure for wiring. The 56 has three slots for placement of up to two signal input boards and one communication board

Slot 1-Left	Slot 2 – Center	Slot 3 – Right
Profi board	Signal Board 1	Signal Board 2

3.1.2 Signal input boards

Slots 2 and 3 are for signal input measurement boards. Wire the sensor leads to the measurement board following the lead locations marked on the board. After wiring the sensor leads to the signal board, carefully slide the wired board fully into the enclosure slot and take up the excess sensor cable through the cable gland. Tighten the cable gland nut to secure the cable and ensure a sealed enclosure.

NOTE:

For the purpose of replacing factory-installed signal input boards, Rosemount® Analytical Inc. is the sole supplier.

3.1.3 Digital communications

HART® digital communications is standard on 56. HART® versions 5 and 7 are available on the 56 and can be switched using the local keypad. A Profibus DP communication board is available as options for 56 communication with a host. HART communications supports Bell 202 digital communications over an analog 4-20 mA current output. Profibus DP is an open communications protocol which operates over a dedicated digital line to the host.

3.1.4 Alarm relays

Four alarm relays are supplied with the switching power supply (85 to 264 VAC, -03 order code) and the 24 VDC power supply (20-30 VDC, -02 order code). All relays can be used for process measurement(s) or temperature. Any relay can be configured as a fault alarm instead of a process alarm. Each relay can be configured independently and each can be programmed as an interval timer, typically used to activate pumps or control valves. As process alarms, alarm logic (high or low activation or USP*) and deadband are user-programmable. Customer-defined failsafe operation is supported as a programmable menu function to allow all relays to be energized or not-energized as a default condition upon powering the analyzer. The USP* alarm can be programmed to activate when the conductivity is within a user-selectable percentage of the limit. USP alarming is available only when a contacting conductivity measurement board is installed.

3.2 Preparing Conduit Openings

There are six conduit openings in all configurations of 56 analyzer. (Note that four of the openings will be fitted with plugs upon shipment.)

Conduit openings accept 1/2-inch conduit fittings or PG13.5 cable glands. To keep the case watertight, block unused openings with Type 4X or IP66 conduit plugs.

NOTE:

Use watertight fittings and hubs that comply with your requirements. Connect the conduit hub to the conduit before attaching the fitting to the analyzer.

3.3 Preparing Sensor Cable

The 56 is intended for use with all Rosemount sensors. Refer to the sensor installation instructions for details on preparing sensor cables.

3.4 Power, Output, and Sensor Connections

3.4.1 Power wiring

Two Power Supplies are offered for the 56:

a. 24 VDC (20 – 30V) Power Supply (-02 order code)
b. 85 – 265 VAC Switching Power Supply (-03 order code)

AC mains leads and 24 VDC leads are wired to the Power Supply board which is mounted vertically on the left side of the main enclosure cavity. Each lead location is clearly marked on the Power Supply board. Wire the power leads to the Power Supply board using the lead markings on the board.

The grounding plate is connected to the earth terminal of the -03 order code (85-265 VAC) power supply. The green colored screws on the grounding plate are intended for connection to some sensors to minimize radio frequency interference. The green screws are not intended to be used for safety purposes.

3.4.2 Current output wiring

All instruments are shipped with four 4-20 mA current outputs. Wiring locations for the outputs are on the Main board which is mounted on the hinged door of the instrument. Wire the output leads to the correct position on the Main board using the lead markings (+/positive, -/negative) on the board. Male mating connectors are provided with each unit.

NOTE:

Twisted pairs are required to minimize noise pickup in the 4-20 mA Current outputs. For high EMI/RFI environments, shielded sensor wire is required and recommended in all other installations.

3.4.3 Alarm relay wiring

Four alarm relays are supplied with the switching power supply (85 to 265 VAC, -03 order code) and the 24 VDC power supply (20-30 VDC, -02 order code). Wire the relay leads on each of the independent relays to the correct position on the power supply board using the printed lead markings (NO/Normally Open, NC/Normally Closed, or Com/Common) on the board.

3.4.4 Sensor wiring to signal boards

Wire the correct sensor leads to the measurement board using the lead locations marked directly on the board. After wiring the sensor leads to the signal board, carefully slide the wired board fully into the enclosure slot and take up the excess sensor cable through the cable gland.

For best EMI/RFI protection use shielded output signal cable enclosed in an earth-grounded metal conduit. Connect the shield to earth ground. AC wiring should be 14 gauge or greater. Provide a switch or breaker to disconnect the analyzer from the main power supply. Install the switch or breaker near the analyzer and label it as the disconnecting device for the analyzer.

Keep sensor and output signal wiring separate from power wiring. Do not run sensor and power wiring in the same conduit or close together in a cable tray.

⚠ WARNING

RISK OF ELECTRICAL SHOCK

Electrical installation must be in accordance with the National Electrical Code (ANSI/NFPA-70) and/or any other applicable national or local codes.

CAUTION: This symbol identifies a risk of electrical shock.

CAUTION: This symbol identifies a potential hazard. When this symbol appears, consult the manual for appropriate action.

NOTE:

Twisted pairs are required to minimize noise pickup in the Flow and Current sensor inputs. For high EMI/RFI environments, shielded sensor wire is required and recommended in all other installations.

FIGURE 3-1 Power Wiring for 56 24 VDC Power Supply (-02 order code) PN 24365-00

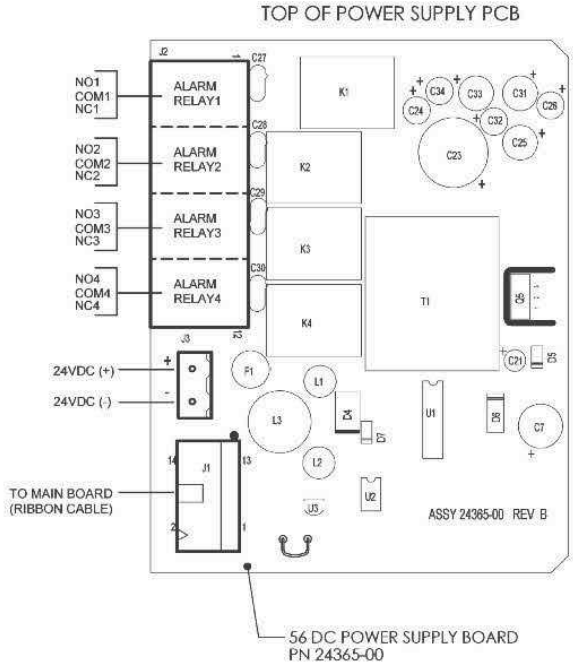


FIGURE 3-2 Power Wiring for 56 85-264 VAC Power Supply (-03 order code) PN 24358-00

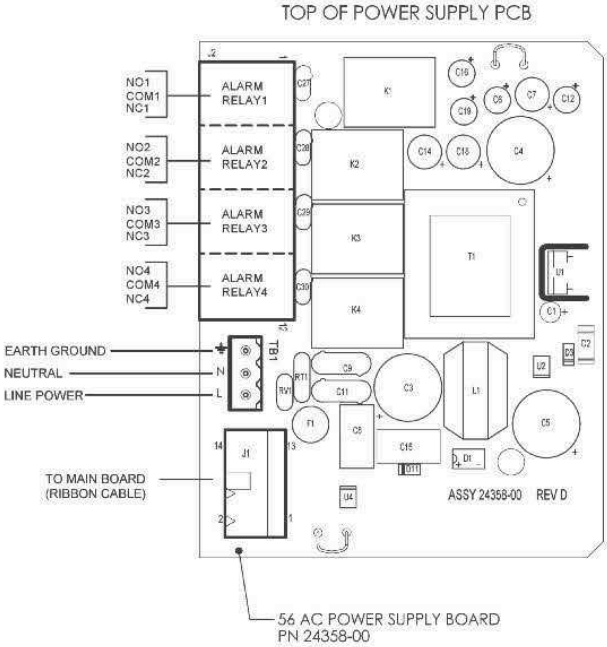


FIGURE 3-3 Output Wiring for 56 Main PCB PN 24308-00

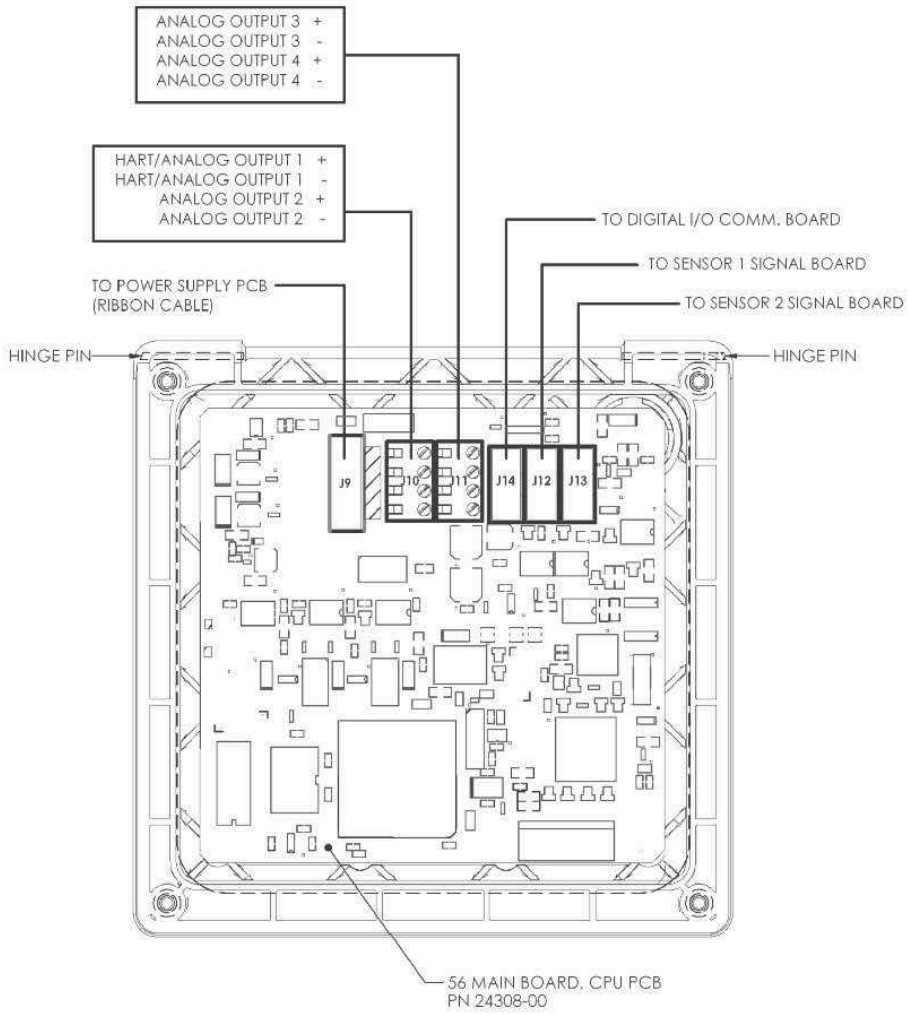


Figure 3-4 56 Recommended Wire Entry Points

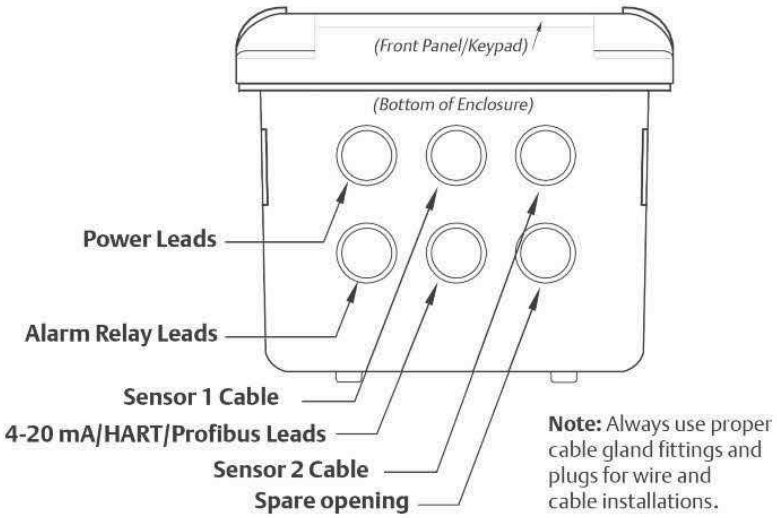


Figure 3-5 56 Recommended Wire Entry and THUM Adaptor Installation

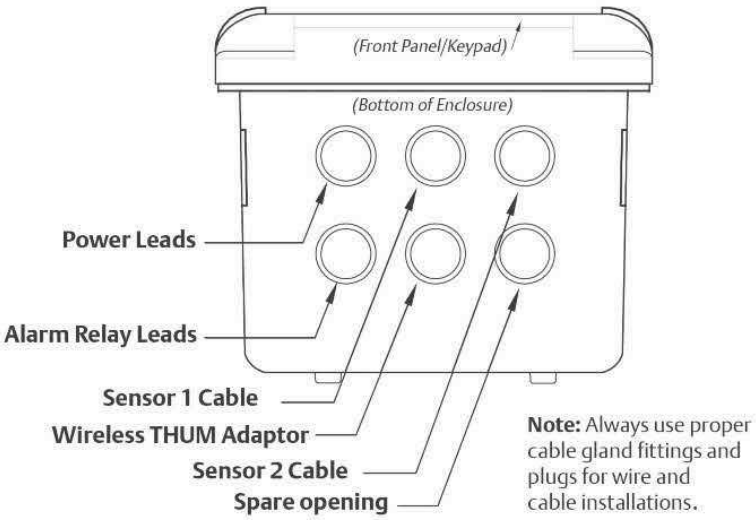


Figure 3-6 Contacting Conductivity signal board and Sensor Cable Leads

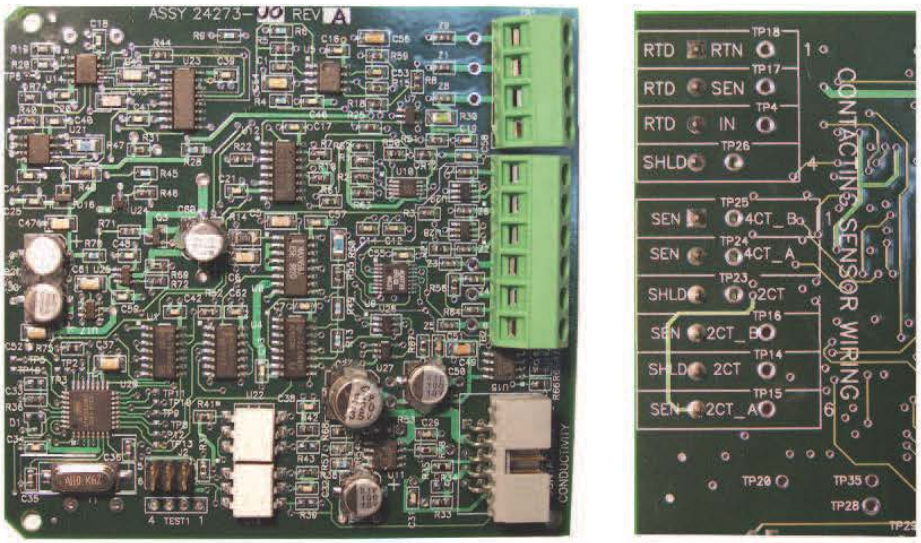


Figure 3-7 Toroidal Conductivity Signal board and Sensor Cable Leads

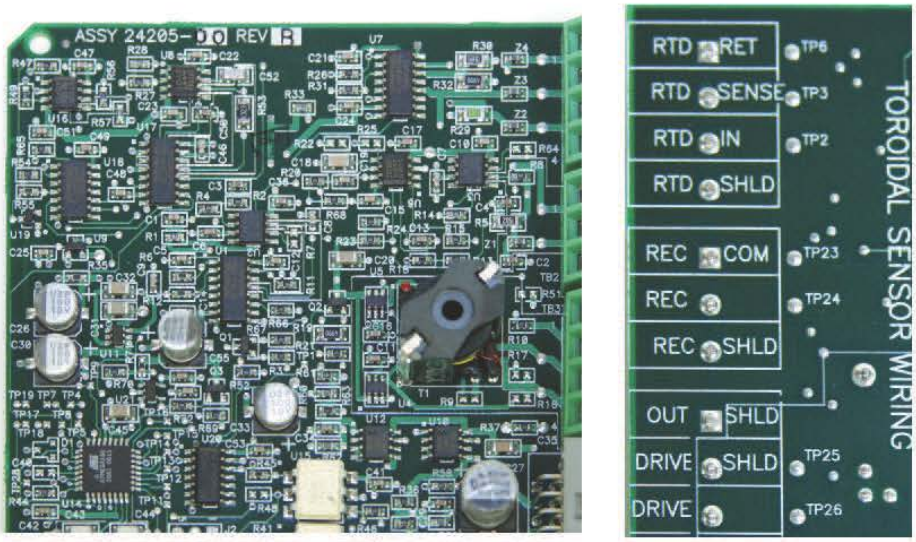


Figure 3-8 pH/ORP/ISE Signal Board and Sensor Cable Leads

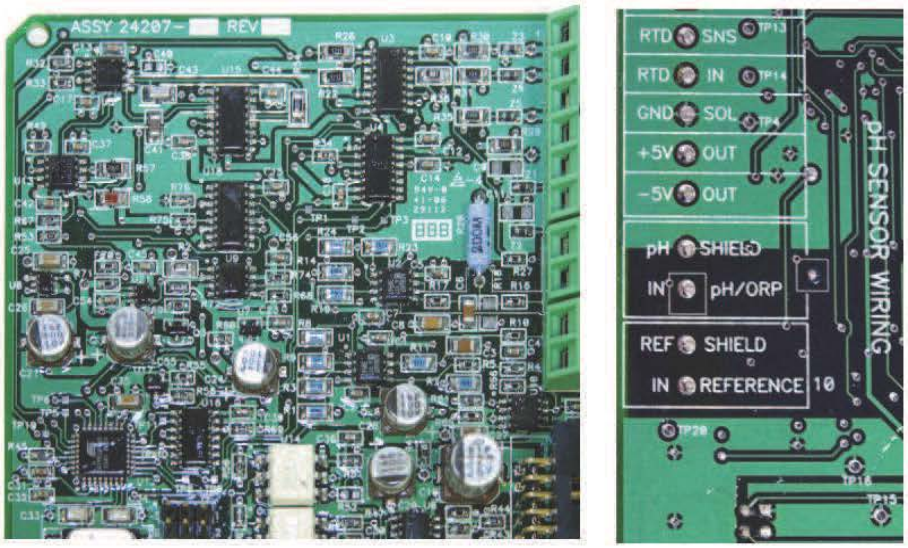


Figure 3-9 Amperometric signal (Chlorine, Oxygen, Ozone) board and Sensor cable leads

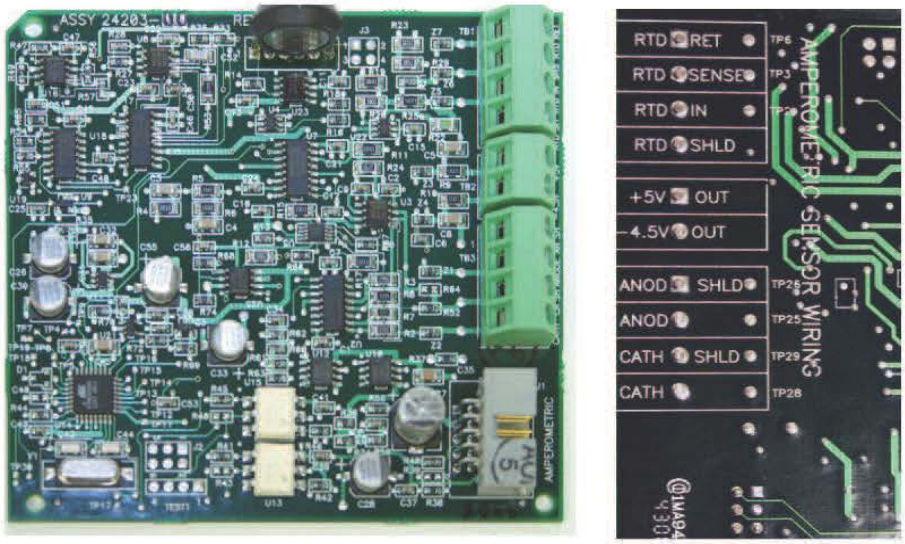


Figure 3-10 Turbidity Signal Board with Plug-in Sensor Connection

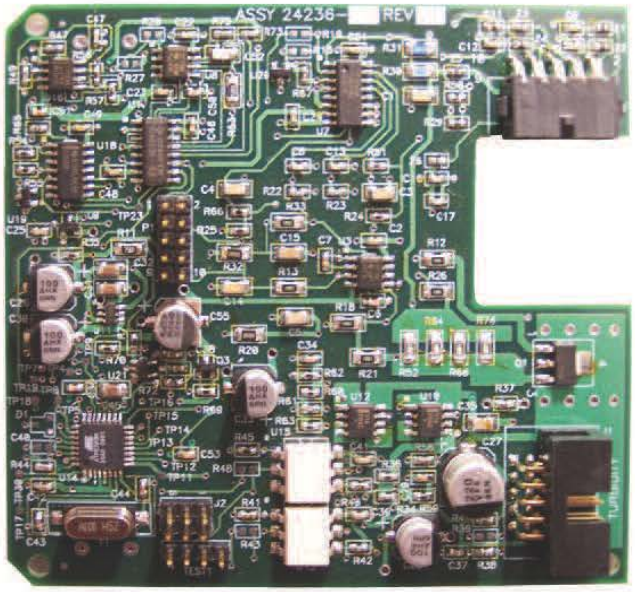
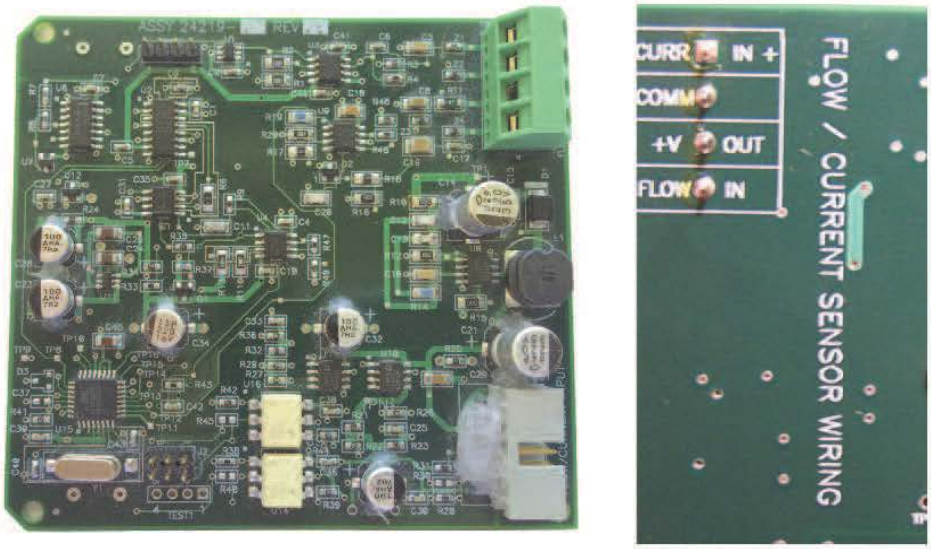


Figure 3-11 Flow/Current Input Signal Board and Sensor Cable Leads



Section 4.0 Display and Operation

4.1 User Interface

The 56 has a large display which shows two live measurement readouts in large digits and up to six additional process variables or diagnostic parameters concurrently. The display is back-lit and the format can be customized to meet user requirements. The ENTER/MENU key allows access to Calibration, Hold (of current outputs), Programming, Display, Data and HART® functions. In addition, a dedicated INFO key is available to provide access to useful diagnostic and instrument information regarding installed sensor(s) and any problematic conditions. The display flashes a red banner to indicate a Fault condition and a yellow banner for a Warning condition. Help screens are displayed for fault and warning conditions to guide the user in troubleshooting. During calibration and programming, key presses guide the user step-by-step through procedures. An alpha-numeric keypad similar to a cell phone keypad is available to allow the user to enter data during programming and calibration or lengthy tags to describe process points, sensors, or instrumentation.

4.2 Instrument Keypad

There are three Function keys, four Navigation keys and an alpha-numeric keypad on the instrument keypad.

Function keys

The ENTER/MENU key is used to access menus for programming and calibrating the instrument as well as retrieving stored data. Eight top-level menu items appear when pressing the ENTER/MENU key from the main display of live readings:

- Calibrate: calibrate attached sensors and analog outputs.
- Program: Program outputs, relays, measurement, temperature, and security codes.
- Hold: Suspend current outputs.
- Display Setup: Program graphic trend display, brightness, main display format, tags, language, and warnings.
- Data storage and retrieval: Enable data and event storage, download data, and vie events.
- HART or Profibus: Program HART and Profibus communication parameters.
- Time and Date: Set and view real-time clock settings.
- Reset: Reset all instrument settings, calibration settings or current outputs to factory defaults.

Calibrate	Data storage and retrieval
Program	HART
Hold	Time and Date
Display setup	Reset
Software upgrade	

The **ENTER/MENU key** is also used to enter selections or enable programming and calibration steps.

The **EXIT key** returns to the previous menu level.

The **INFO key** provides detailed instructions and explanations during programming and calibrating procedures. It also provides troubleshooting tips for all faults and warnings that may occur during calibration or continuous operation in process.

Navigation Keys

The four **Navigation keys** arranged around the **ENTER/MENU key** operate in an intuitive manner similar to the navigation keys on a computer keyboard. During menu operation, these keys are used to move the highlighted screen selection to another adjacent screen item. During tag entry, the left key is used to delete entries during active alpha-numeric character entry.

Alpha-numeric Keypad

The **alpha-numeric keypad** has 12 keys as outlined below.

- Nine keys are alpha-numeric
- One key is a dedicated "1" key
- One key is a dedicated "0" key
- One key is a dedicated "." (decimal point) key

The **alpha-numeric keypad** operates the same as entries on a mobile phone. The nine alpha-numeric keys have multiple characters that can be entered for tag entries or during programming and calibration steps. Character selections are made by pressing the key multiple times to toggle to characters that are available on each key.

4.3 Main Display

The 56 displays one or two primary measurement values, up to six secondary measurement values, fault and warning banner, alarm relay flags, and a digital communications icon.

Process Measurements:

Two process variables are displayed if two signal boards are installed. One process variable and process temperature is displayed if one signal board is installed with one sensor. The Upper display area shows the Sensor 1 process reading. The Center display area shows the Sensor 2 process reading. For dual conductivity, the Upper and Center display areas can be assigned to different process variables as follows:

For single input configurations, the Upper display area shows the live process variable and the Center display area can be assigned to Temperature or blank.

Secondary Values:

Up to six secondary values are shown in six display quadrants at the bottom half of the screen. All six secondary value positions can be programmed by the user to any display parameter available. Possible secondary values include:

4.4 Menu System

The 56 menu system is similar to a computer. Pressing the ENTER/MENU key at any time opens the top-level menu including Calibration, Hold, Programming, Display, Data and

HART functions. To find a menu item, use the directional Navigation keys to highlight a menu item. Press ENTER/MENU and simply direct the cursor to the desired operation and follow the screen prompts. Pressing the BACK screen control available on some menu screens will revert to the immediate previous menu screen. Pressing the EXIT key will return to the previous hierarchical menu level.

Fault and Warning banner:

If the analyzer detects a problem with itself or the sensor the word Fault banner (red) and/or Warning banner (yellow) will appear at the bottom of the main display. A fault requires immediate attention. A warning indicates a problematic condition or an impending failure. For detailed troubleshooting assistance, press INFO.

4.5 USB Data Port

The 56 menu system is similar to a computer. A USB 2.0 data port is accessible on the front panel of the 56 instrument. The USB data port can be used for download of measurement data and events using a USB memory device. It can also be used to download and upload complete analyzer configurations to copy all programmed settings to another 56 analyzer. NOTE: only 56 units which display the "Transfer Configurations" tab under the Data Storage and Retrieval menu are capable of downloading and uploading analyzer configurations.

The USB data port is easily accessed by inserting a coin in the vertical slot of the cover and rotating counterclockwise one quarter turn to remove the cover and Type 4 seal.

Caution: not all USB memory devices will physically fit into the 56 data port. After removing the USB cover and seal, make sure that the USB memory device can be easily and fully inserted into the USB data port without any mechanical conflict with the USB data port flange. The USB communications port is protected by a Type 4-rated seal and cover. Do not remove the cover during cleaning of the analyzer housing. Never remove the USB port cover when the instrument is operated in a hazardous rated area.

NOTE: the data logger and event logger are disabled by default setting upon initial startup from the factory. Always enable the data logger and event logger under the "Data Storage and Retrieval" menu to initiate internal recording of process data and event data.

4.6 56 Data Logger and Event Logger Download Procedure

4.6.1 Description

The 56 supports download of stored data logger and event logger data at the device. The download process is performed using a USB 2.0 flash drive memory device inserted into the USB data port on the front panel of the 56 analyzer. The data can be uploaded to a PC for viewing in preformatted EXCEL tables.

4.6.2 56 Data Logger Download Procedure

1. From the main menu, select Data storage and retrieval.
2. Select the Download tab.
3. Select "Download measurement" data.

4. With the 56 analyzer powered, remove the NEMA cap from the front display by inserting a coin into the cap's vertical slot and rotating counterclockwise. Remove the USB cap to access the data port.
5. Carefully insert a USB 2.0 flash drive into the USB port on the 56. Note that the USB insertion connector is keyed.
6. The Download screen will report Earliest data available and Latest data available that can be downloaded from the internal data logger file.
7. With a USB 2.0 flash drive properly inserted, choice Selected Range (default) or All Data.
8. If Selected Range is chosen, define the Start Date and End Date in the screen fields. Note that the Start Date and End Date reported will default to the current data that is recognized by the analyzer.
9. If All Data is selected, all stored date (up to 30 days) will be downloaded.
10. Select START and press ENTER.
11. A Data download information and instruction screen is displayed while data logger files are being downloaded. The download process will be completed in a few minutes.
12. When the data logger download is complete, a confirmation screen is display with the reported range of dates that were downloaded to the USB flash drive.
13. Carefully remove the USB 2.0 flash drive from the USB port.
14. Insert the NEMA cap into the 56 USB front display opening.
15. You may exit the Download completed screen by selecting BACK.
16. To view data logger files, insert the USB flash drive into a computer. On the designated drive associated with the USB flash drive, individual data logger files for each day can be opened as EXCEL formatted files in the root directory of the USB drive. Note that the data codes are assigned file names based on the analyzer's recognized dates.

4.6.3 56 Event Logger Download Procedure

1. From the main menu, select Data storage and retrieval.
2. Select the Download tab.
3. Select "Download events".
4. With the 56 analyzer powered, remove the NEMA cap from the front display by inserting a coin into the cap's vertical slot and rotating counterclockwise. Remove the USB cap to access the data port.
5. Carefully insert a USB 2.0 flash drive into the USB port on the 56. Note that the USB insertion connector is keyed.
6. A Download events information screen is briefly displayed while events files are being downloaded. The download process may require a few minutes to complete.
7. When the events download is complete, a confirmation screen appears.
8. Carefully remove the USB 2.0 flash drive from the USB port.
9. Insert the Type 4 cap into the 56 USB front display opening.
10. You may exit the Download completed screen by selecting BACK.
11. To view event logger files, insert the USB flash drive into a computer. On the designated drive associated with the USB device, the single event logger file can be opened as an EXCEL formatted file in the root directory of the USB drive. Note that the data codes are assigned file names based on the analyzer's recognized dates.

4.7 Software Upgrade

4.7.1 Description

All 56 advanced analyzers with serial number J12- or later (October 2012) allow software upgrades using the device's USB data port. To download and install software upgrades, refer to Liquid Software Download.

4.7.2 Software upgrade checklist

Before upgrading, please confirm:

- Serial Number date codes of the 56 analyzer is J12 (October 2012) or later.
- Confirm that Safe Area requirements are met before installing software
- USB 2.0 flash drive memory device is available

4.7.3 Software upgrade procedure

1. Download the 56 software upgrade file to a computer. Access software HERE. Save the file to the main root directory of a USB flash drive memory stick. Only one 56 software upgrade file should be present at the root directory.
2. Save all user settings before upgrading the software by copying the analyzer's configuration to a flash drive. Access this procedure at the local 56 device menu location: MENU/Data storage and retrieval/Transfer Configuration.
3. Download the Data Logger measurement data and the Events before upgrading the software. Access these procedures at 56 menu location: MENU/Data storage and retrieval/Download/Download measurement data and at /Download/Download Events.
4. With the 56 analyzer powered up and the front enclosure panel completely closed, remove the Type 4 cap from the front display by inserting a coin into the cap's vertical slot and rotating counterclockwise. Remove the USB cap and seal to access the data port.
5. Carefully insert a USB 2.0 flash drive into the USB port on the 56. The USB insertion connector is keyed. Note that some USB devices will not fit into the USB port due to mechanical restrictions.
6. Press the ENTER/MENU key. Select Software upgrade in the main menu.
7. Select NEXT. Press ENTER/MENU to start software upgrade. The current software version and the new software version are reported on the screen.
8. Select NEXT. Press ENTER/MENU. "Software upgrade in process" and a progress bar will appear. The process may require up to 5 minutes to complete.
9. The Time and Date screen will appear. Enter local real time clock and date information. Press ENTER/MENU.
10. The main screen will appear reporting live process values. Programming of settings and calibration may be required.

4.8 Configuration Transfer

4.8.1 Description

All 56 unit with serial number J12- or later (October 2012) will support the function of Configuration Transfer from one 56 analyzer to another, or multiple 56 analyzers. The

transfer is done by using a version 2.0 USB flash drive (USB memory stick) for downloading the existing configuration and uploading to another instrument.

4.8.2 Transfer Configuration Process User Notes

1. Configuration Transfer can only be performed between instruments of identical configuration. The analyzers must have the same signal boards installed.
2. Several text files downloaded to the flash drive can be saved to a PC and used later.
3. Only one set of configuration files will be stored on the flash drive. The files that are downloaded will over-write any existing files stored in the root directory of the flash drive.

4.8.3 Transfer Configuration Procedure - User Notes

1. Confirm all user settings before transferring configuration.
2. From the main menu, select Data storage and retrieval.
3. Select the Transfer Configuration tab
4. Select "Copy analyzer configuration to the flash drive".
5. With the 56 analyzer powered, remove the NEMA cap from the front display by inserting a coin into the cap's vertical slot and rotating counterclockwise. Remove the USB cap to access the data port.
6. Carefully insert a USB 2.0 flash drive into the USB port on the 56. Note that the USB insertion connector is keyed.
7. Select Copy data. Press ENTER.
8. An information screen appears warning users that any configuration files that exist in the root directly of the flash drive will be over-written upon configuration transfer. If No is selected (default setting), existing configuration files will not be overwritten. Select Yes to transfer the configuration file to the flash drive.
9. The configuration file will be transferred (downloaded) in about 20 seconds. A screen will report that the configuration file has been transfused.
10. Carefully remove the USB 2.0 flash drive from the USB port.
11. Insert the NEMA cap into the 56 USB front display opening.
12. Follow steps 2-3 above on the instrument that will receive the copied configuration.
13. On the 56 analyzer instrument that will receive the copied configuration, remove the Type 4 cap from the front display.
14. Carefully insert the USB 2.0 flash drive containing the configuration file into the USB port.
15. Select "Copy configuration from the flash drive to the analyzer". Press ENTER.
16. You have two options for configuration transfer. Select one of the following and press ENTER:
    a. Copy configuration data only to the analyzer.
    b. Copy configuration and calibration data to the analyzer.
17. Select Copy data. Press ENTER.
18. The configuration file will be transferred (uploaded) in about 20 seconds. A screen will report that the configuration file has been transfused.
19. Carefully remove the USB 2.0 flash drive from the USB port.
20. Insert the NEMA cap into the 56 USB front display opening.

Section 5.0. Programming the Analyzer - Basics

5.1 General

Typical programming steps include the following listed procedures. Each of these programming functions are easily and quickly accomplished using the intuitive menu systems.

- Changing the measurement type, measurement units and temperature units.
- Choose temperature units and manual or automatic temperature compensation mode
- Configure and assign values to the current outputs
- Set a security code for two levels of security access
- Accessing menu functions using a security code
- Enabling and disabling Hold mode for current outputs
- Choosing the frequency of the AC power (needed for optimum noise rejection)
- Resetting all factory defaults, calibration data only, or current output settings only

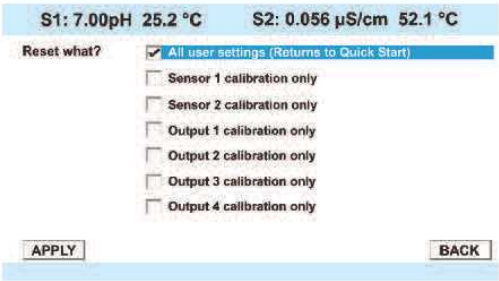
5.2 Changing Startup Settings

To change the measurement type, measurement units, or temperature units that were initially entered in Quick Start, choose the Reset function or access the Program menus for sensor 1 or sensor 2. The following choices for specific measurement type, measurement units are available for each sensor measurement board.

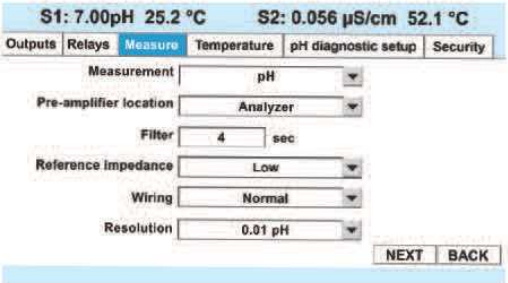
TABLE 5-1. Measurements and Measurement Units

Signal board	Available measurements	Measurements units:
pH/ORP (-22, -32)	pH, ORP, Redox, Ammonia, Fluoride, Custom ISE	pH, mV (ORP) %, ppm, mg/L, ppb, µg/L, (ISE)
Contacting conductivity (-20, -30)	Conductivity, Resistivity, TDS, Salinity, NaOH (0-12%), HCl (0-15%), Low H2SO4, High H2SO4, NaCl (0-20%), Custom Curve	µS/cm, mS/cm, S/cm % (concentration)
Toroidal conductivity (-21, -31)	Conductivity, Resistivity, TDS, Salinity, NaOH (0-12%), HCl (0-15%), Low H2SO4, High H2SO4, NaCl (0-20%), Custom Curve	µS/cm, mS/cm, S/cm % (concentration)
Chlorine (-24, -34)	Free Chlorine, pH Independ. Free Cl, Total Chlorine, Monochloramine	ppm, mg/L
Oxygen (-25, -35)	Oxygen (ppm), Trace Oxygen (ppb), Percent Oxygen in gas, Salinity	ppm, mg/L, ppb, µg/L % Sat, Partial Pressure, % Oxygen In Gas, ppm Oxygen In Gas
Ozone (-26, -36)	Ozone	ppm, mg/L, ppb, µg/L
Temperature (all)	Temperature	°C / °F

To change the measurement type, measurement units, or temperature units, access the Reset screens by pressing ENTER/MENU from the main screen.



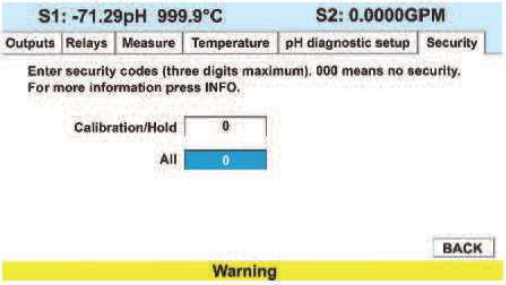
To change the measurement type, measurement units, or temperature units, access the Program screens by pressing ENTER/MENU from the main screen.



5.3 Programming Temperature

Most liquid analytical measurements (except ORP) require temperature compensation. The 56 performs temperature compensation automatically by applying internal temperature correction algorithms. Temperature correction can also be turned off. If temperature correction is off, the 56 uses the temperature entered by the user in all temperature correction calculations.

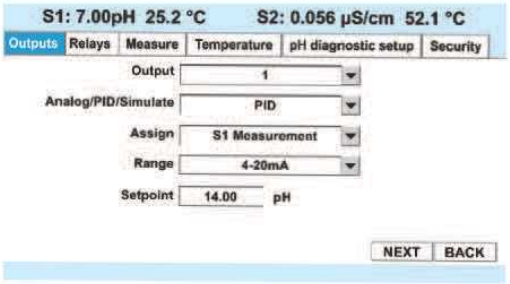
To select automatic or manual temp compensation, set the manual reference temperature, and to program temperature units as °C or °F, access the Temperature screens by pressing ENTER/MENU from the main screen.



5.4 Configuring and Ranging the Current Outputs

The 56 accepts inputs from two sensors and has four analog current outputs. Ranging the outputs means assigning values to the low (0 or 4 mA) and high (20 mA) outputs. This section provides a guide for configuring and ranging the outputs. ALWAYS CONFIGURE THE OUTPUTS FIRST.

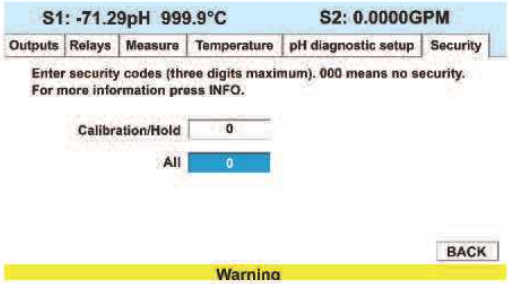
To configure the outputs, access the Outputs screen by pressing ENTER/MENU from the main screen.



5.5 Setting a Security Code

The security codes prevent accidental or unwanted changes to program settings, displays, and calibration. The 56 has two levels of security code to control access and use of the instrument to different types of users.
The two levels of security are:

- All: This is the Supervisory security level. It allows access to all menu functions, including Programming, Calibration, Hold and Display.
- Calibration/Hold: This is the operator or technician level menu. It allows access to only calibration and Hold of the current outputs.



To set security codes, access the Security screen by pressing ENTER/MENU from the main screen. Upon entry of the proper code, the following security screen will appear.

5.6 Security Access

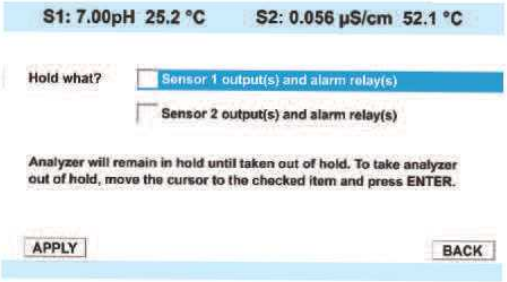
When entering the correct access code for the Calibration/Hold security level, the Calibration and Hold menus are accessible. This allows operators or technicians to perform routine maintenance. This security level does not allow access to the Program or Display menus. When entering the correct access code for All security level, the user has access to all menu functions, including Programming, Calibration, Hold and Display.

The 56 menus use a security code, access the Security screen by pressing ENTER/MENU from the main screen.
If a security code is currently programmed, the follow security screen will appear. Enter the code.

1. If a security code has been programmed, selecting the Calibrate, Hold, Program or Display top menu items causes the security access screen to appear.
2. Enter the three-digit security code for the appropriate security level.
3. If the entry is correct, the appropriate menu screen appears. If the entry is incorrect, the Invalid Code screen appears. The Enter Security Code screen reappears after 2 seconds.

5.7 Using Hold

The analyzer output is always proportional to measured value. To prevent improper operation
of systems or pumps that are controlled directly by the current output, place the analyzer in hold before removing the sensor for calibration and maintenance. Be sure to remove the analyzer from hold once calibration is complete. During hold, all outputs remain at the last value. Once in hold, all current outputs remain on Hold indefinitely.

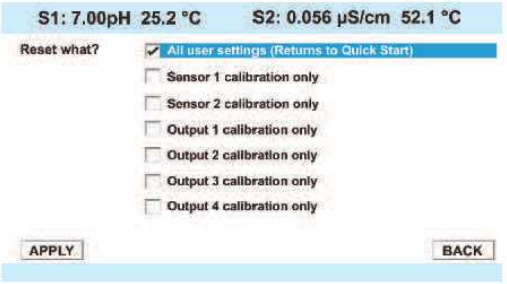


To hold the outputs and alarm relays, access the Hold screen by pressing ENTER/MENU from the main screen.

5.8 Resetting Factory Default Settings

This section describes how to restore factory calibration and default values. The process also clears all fault messages and returns the display to the first Quick Start screen. The 56 offers three options for resetting factory defaults.

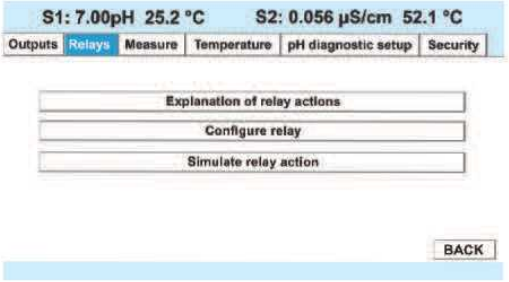
a. reset all settings to factory defaults
b. reset sensor calibration data only
c. reset analog output settings only



To reset to factory defaults, reset calibration data only or reset analog outputs only, access the Reset screen by pressing ENTER/MENU from the main screen.

5.9 Programming Alarm Relays

The 56 24 VDC (02 order code) and the AC switching power supply (03 order code) provide four alarm relays for process measurement or temperature. Each alarm can be configured as a fault alarm instead of a process alarm. Also, each relay can be programmed independently and each can be programmed as an interval timer or one of four advanced timer functions. This section describes how to configure alarm relays, simulate relay activation, and synchronize timers for the four alarm relays.

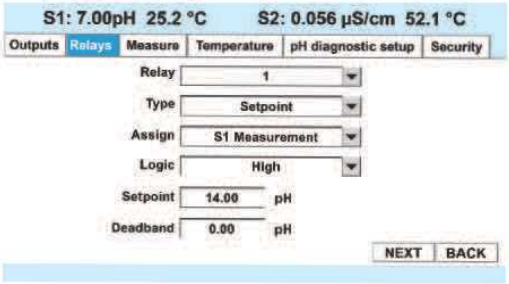


This section provides details to program the following alarm features. To program the alarm relays, access the Program screen by pressing ENTER/MENU from the main screen and then select the Relay tab and the Configure relay control.

The following relay functions can be programmed to any relay from the Configure Relay screen:

1. assign a relay
2. define a relay function
3. assign a Measurement
4. set relay logic
5. enter setpoints
6. set deadband
7. set normal state
8. set USP Safety level (contacting conductivity)

To program these relay functions, access the Configure Relay screen by pressing ENTER/MENU from the main Relay programming screen.

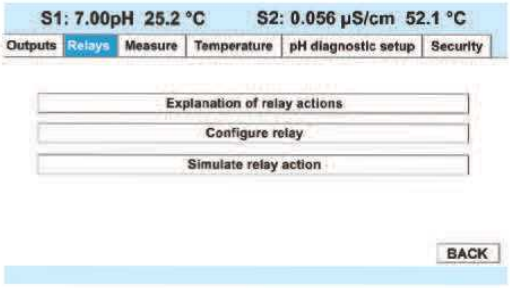


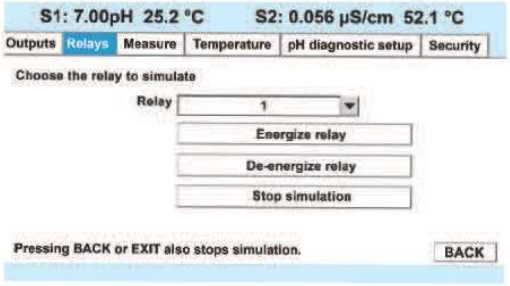
1. To assign a relay, highlight the desired Relay 1-4 and press ENTER/MENU.
2. To define a relay function, select from Setpoint, Interval Timer, TPC, Bleed and Feed, Water Meter, Delay timer, Date and Time, Fault or None and press ENTER/MENU.
3. To assign a measurement to a specific relay, select the desired measurement or temperature input and press ENTER/MENU.
4. To set relay logic to activate alarms at a High reading or a Low reading, select high or low and press ENTER/MENU.
5. To enter setpoints for relays, enter the desired value for the process measurement or temperature at which to activate an alarm event and press ENTER/MENU.
6. To set deadband as a measurement value, enter the change in the process value needed after the relay deactivates to return to normal (and thereby preventing repeated alarm activation) and press ENTER/MENU.
7. To set the Normal alarm condition, select Open or Closed and press ENTER/MENU. Program the normal state to define the desired alarm default state to normally open or normally closed upon power up.
8. To set USP Safety, enter the percentage below the limit at which to activate the alarm and press ENTER/MENU. NOTE: USP Safety only appears if a contacting conductivity board is installed.

This section provides details to simulate relay action. To simulate relays, access the Program screen by pressing ENTER/MENU from the main screen and then select the Relay tab.

To simulate alarm relay conditions, access the Simulate Relay Action screen by pressing ENTER/MENU from the main Relay programming screen.

Alarm relays can be manually set for the purposes of checking devices such as valves or pumps. Under the Alarms Settings menu, this screen will appear to allow manual forced activation of the alarm relays. Select the desired alarm condition to simulate.





Section 6.0 Programming - Measurements

6.1 Programming Measurements – Introduction

The 56 automatically recognizes each installed measurement board upon first power-up and each time the analyzer is powered. Completion of Quick Start screens upon first power up enable measurements, but additional steps may be required to program the analyzer for the desired measurement application. This section covers the following programming and configuration functions:

1. Selecting measurement type or sensor type (all sections)
2. Identifying the preamp location (pH-see Sec. 6.2)
3. Enabling manual temperature correction and entering a reference temperature (all sections)
4. Enabling sample temperature correction and entering temperature correction slope (selected sections)
5. Defining measurement display resolution (pH and amperometric)
6. Defining measurement display units (all sections)
7. Adjusting the input filter to control display and output reading variability or noise (all sections)
8. Selecting a measurement range (conductivity – see Sections 6.4, 6.5)
9. Entering a cell constant for a contacting or toroidal sensor (see Sec's 6.4, 6.5)
10. Entering a temperature element/RTD offset or temperature slope (conductivity-see Sec's 6.4)
11. Creating an application-specific concentration curve (conductivity-see Sec's 6.4, 6.5)
12. Enabling automatic pH correction for free chlorine measurement (Sec. 6.6.1)

To fully configure the analyzer for each installed measurement board, you may use the following:

1. Reset Analyzer function to reset factory defaults and configure the measurement board to the desired measurement. Follow the Reset Analyzer menu (Fig. 5-5) to reconfigure the analyzer to display new measurements or measurement units.
2. Program menus to adjust any of the programmable configuration items. Use the following configuration and programming guidelines for the applicable measurement.

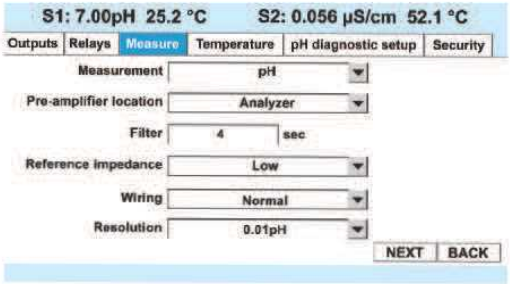
6.2 pH Measurement Programming

The section describes how to configure the 56 analyzer for pH measurements. The following programming and configuration functions are covered.

1. Measurement type: pH Select pH, ORP, Redox, Ammonia, Fluoride, Custom ISE
2. Preamp location: Analyzer Identify preamp location
3. Filter: 4 sec Override the default input filter, enter 0-999 seconds
4. Reference Z: Low Select low or high reference impedance
5. Sensor wiring scheme: Normal or Reference to Ground
6. Resolution: 0.01pH Select 0.01pH or 0.1pH for pH display resolution

7. Enabling pH sensor diagnostics

To configure the pH measurement board, access the Program screen by pressing ENTER/MENU from the main screen and then select the Measurement tab.

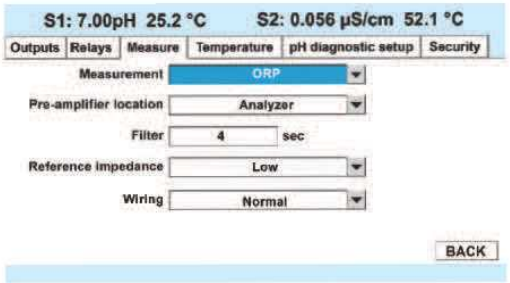


1. To Select a Measurement type, select from: pH, ORP, Redox, Ammonia, Fluoride, and Custom ISE and press ENTER/MENU.
2. To program the Preamp location, select Analyzer or Sensor/JBox, and press ENTER/MENU.
3. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.
4. To program Reference Impedance. Select Low or High and press ENTER/MENU.
5. To choose the wiring scheme, Select Normal or Reference to Ground and press ENTER/MENU.
6. To program the display resolution, Select 0.01 pH or 0.1 pH and press ENTER/MENU.
7. To enable pH sensor diagnostics, select the "pH diagnostic setup" tab under Programming. Select Sensor 1 or Sensor 2. Select NEXT. Select On under sensor diagnostics to enable pH diagnostics.

NOTE: pH sensor diagnostics must be enabled to include diagnostic values such as Glass Impedance and Reference Impedance in EXCEL data log sheets after data download to USB. Enabling pH sensor diagnostics also allows assignment of Glass Impedance and Reference Impedance to the two-dimensional on-screen process graph accessible under "Display Setup/View Graph".

6.3 ORP Measurement Programming

The section describes how to configure the 56 analyzer for ORP measurements.
The following programming and configuration functions are covered:



1. Measurement type: pH Select pH, ORP, Redox, Ammonia, Fluoride, Custom ISE
2. Preamp location: Analyzer Identify preamp location
3. Filter: 4 sec Override the default input filter, enter 0-999 seconds
4. Reference Z: Low Select low or high reference impedance
5. Sensor wiring scheme: Normal or Reference to Ground

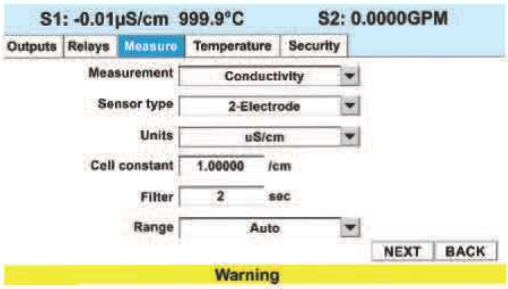
To configure the ORP measurement board, access the Program screen by pressing ENTER/MENU from the main screen and then select the Measurement tab.

1. To Select a Measurement type, select ORP and press ENTER/MENU.
2. To program the Preamp location, select Analyzer or Sensor/JBox, and press ENTER/MENU.
3. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.

4. To program Reference Impedance. Select Low or High and press ENTER/MENU.
5. To choose the wiring scheme, Select Normal or Reference to Ground and press ENTER/MENU.

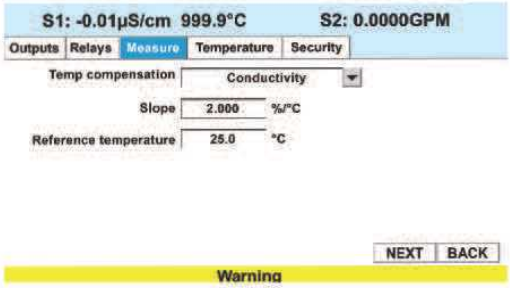
6.4 Contacting Conductivity Measurement Programming

The section describes how to configure the 56 analyzer for conductivity measurements using contacting conductivity sensors. The following programming and configuration functions are covered.



1. Measure: Conductivity, Select Conductivity, Resistivity, TDS. Salinity or % conc
2. Type: 2-Electrode Select 2-Electrode or 4-Electrode type sensors
3. Cell K: 1.00000/cm Enter the cell Constant for the sensor
4. Measurement units
5. Filter: 2 sec Override the default input filter, enter 0-999 seconds
6. Range: Auto Select measurement Auto-range or specific range
7. Temp Comp: Slope Select Temp Comp: Slope, Neutral Salt, Cation or Raw
8. Slope: 2.00% / °C Enter the linear temperature coefficient
9. Ref Temp: 25.0 °C Enter the Reference temp
10. Cal Factor: default=0.95000/cm Enter the Cal Factor for 4-Electrode sensors from the sensor tag

To configure the contacting conductivity measurement board, access the Program screen by pressing ENTER/MENU from the main screen and then select the Measurement tab.

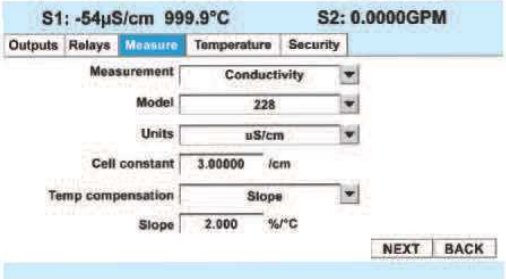


1. To program a Measurement type, select Conductivity Select Conductivity, Resistivity, TDS. Salinity or % conc. and press ENTER/MENU.
2. To program a sensor type, select 2-Electrode Select 2-Electrode or 4-Electrode type sensors and press ENTER/MENU.
3. To program the Cell constant, enter the exact cell constant value expressed as 1.XXXXX/cm the for the sensor and press ENTER/MENU.
4. To program Measurement units, select uS/cm or mS/cm and press ENTER/MENU.
5. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.
6. To program the measurement range, select a specific range appropriate for your process and press ENTER/MENU.
7. To program the Temp Comp method, choose Slope, Neutral Salt, Cation or Raw and press ENTER/MENU.

8. To change the Temperature compensation Slope, enter the linear temperature coefficient expressed as X.XX% / °C and press ENTER/MENU.
9. To program the Reference Temperature for Manual temperature compensation (not from probe RTD), enter the Reference temp expressed as XX.X °C and press ENTER/MENU.
10. To program the Cal Factor for 4-Electrode sensors, enter the value shown on the sensor tag, expressed as X.XXXXX/cm and press ENTER/MENU.,

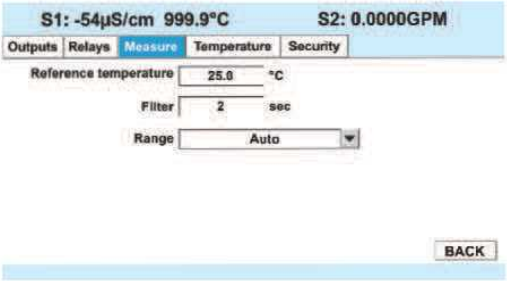
6.5 Toroidal Conductivity Measurement Programming

The section describes how to configure the 56 analyzer for conductivity measurements using inductive/toroidal sensors. The following programming and configuration functions are covered:



1. Measure: Conductivity Select Conductivity, Resistivity, TDS. Salinity or % conc
2. Sensor model: 228 Select sensor type
3. Measurement units
4. Cell K: 3.00000/cm Enter the cell Constant for the sensor
5. Temp Comp: Slope Select Temp Comp: Slope, Neutral Salt, Cation or Raw
6. Slope: 2.00% / °C Enter the linear temperature coefficient
7. Ref Temp: 25.0 °C Enter the Reference temp
8. Filter: 2 sec Override the default input filter, enter 0-999 seconds
9. Range: Auto Select measurement Auto-range or specific range

To configure the Contacting conductivity measurement board, access the Program screen by pressing ENTER/MENU from the main screen and then select the Measurement tab.



1. To program a Measurement type, select Conductivity Select Conductivity, Resistivity, TDS. Salinity or % conc. and press ENTER/MENU.
2. To program the sensor model, select 228 or other toroidal model number and press ENTER/MENU.
3. To program Measurement units, select uS/cm or mS/cm and press ENTER/MENU.
4. To program the Cell constant, enter the exact cell constant value expressed as 3.XXXXX/cm the for the sensor and press ENTER/MENU.
5. To program the Temp Comp method, choose Slope, Neutral Salt, Cation or Raw and press ENTER/MENU.
6. To change the Temperature compensation Slope, enter the linear temperature coefficient expressed as X.XX% / °C and press ENTER/MENU.

7. To program the Reference Temperature for Manual temperature compensation (not from probe RTD), enter the Reference temp expressed as XX.X °C and press ENTER/MENU.
8. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.
9. To program the measurement range, select a specific range appropriate for your process and press ENTER/MENU.

6.6 Chlorine Measurement Programming

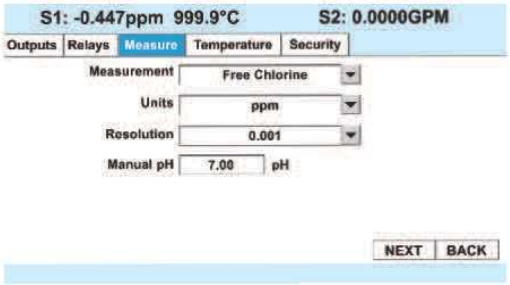
With a Chlorine measurement board installed, The 56 can measure any of four variants of Chlorine:

- Free Chlorine
- Total Chlorine
- Monochloramine
- pH-independent Free Chlorine

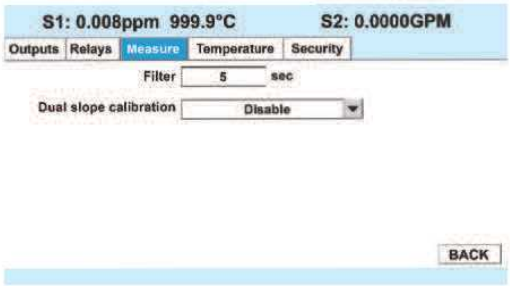
The section describes how to configure the 56 analyzer for Chlorine measurements.

6.6.1 Free chlorine measurement programming

This Chlorine sub-section describes how to configure the 56 analyzer for Free Chlorine measurement using amperometric chlorine sensors. The following programming and configuration functions are covered:



1. Measure: Free Chlorine Select Free Chlorine, pH Ind. Free Cl. Total Cl, Monochloramine
2. Units: ppm Select units ppm or mg/L
3. Resolution: 0.001 Select display resolution 0.01 or 0.001
4. Free Cl Correct: Live Select Live/ Continuous pH correction or Manual
5. Manual pH: 7.00 pH For Manual pH correction, enter the pH value
6. Filter: 5 sec Override the default input filter, enter 0-999 seconds
7. Dual Slope Calibration: Enable or Disable



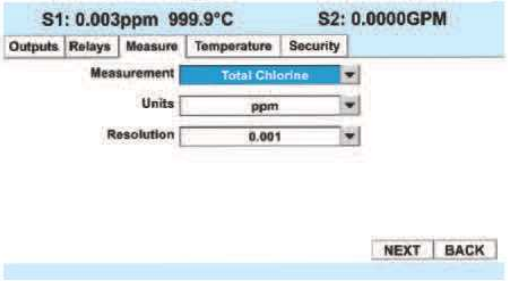
1. To program the Measurement type, select Free Chlorine, pH Ind Free Cl., Total Cl, or Monochloramine and press ENTER/MENU.
2. To program the Measurement Units: select ppm mg/L and press ENTER/MENU.
3. To program the Measurement Resolution: Select 0.01 or 0.001 and press ENTER/MENU.
4. To program Free Cl Correction, select Live/Continuous pH correction or Manual and press ENTER/MENU

5. To program for Manual pH correction, enter the pH value and press ENTER/MENU.
6. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.
7. To use Dual Slope Calibration, select Enable or Disable and press ENTER/MENU.

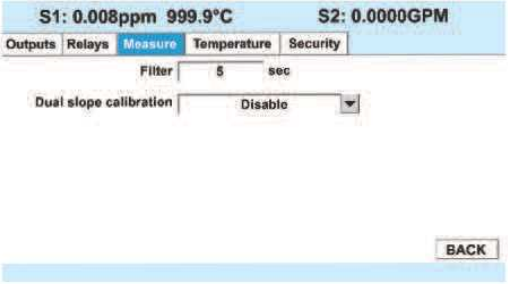
6.6.2 Total chlorine measurement programming

This Chlorine sub-section describes how to configure the 56 analyzer for Total Chlorine measurement using amperometric chlorine sensors. The following programming and configuration functions are covered:

1. Measure: Free Chlorine Select Free Chlorine, pH Ind. Free Cl. Total Cl, Monochloramine
2. Units: ppm Select units ppm or mg/L
3. Resolution: 0.001 Select display resolution 0.01 or 0.001
4. Filter: 5 sec Override the default input filter, enter 0-999 seconds
5. Dual Slope Calibration: Enable or Disable



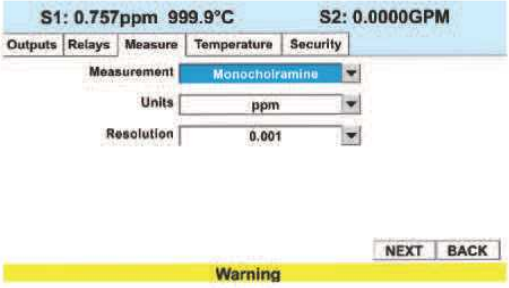
1. To program the Measurement type, select Free Chlorine, pH Ind Free Cl., Total Cl, or Monochloramine and press ENTER/MENU.
2. To program the Measurement Units: select ppm mg/L and press ENTER/MENU.
3. To program the Measurement Resolution: Select 0.01 or 0.001 and press ENTER/MENU.
4. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.
5. To use Dual Slope Calibration, select Enable or Disable and press ENTER/MENU.

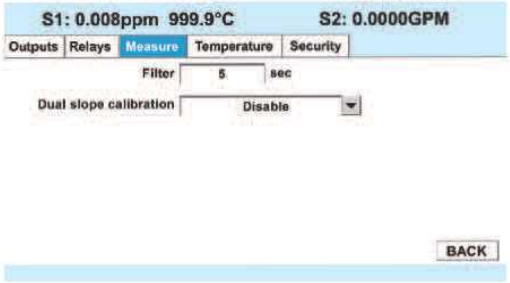


6.6.3 Monochloramine measurement programming

This Chlorine sub-section describes how to configure the 56 analyzer for Monochloramine measurement using amperometric chlorine sensors. The following programming and configuration functions are covered:

1. Measure: Free Chlorine Select Free Chlorine, pH Ind. Free Cl. Total Cl, Monochloramine
2. Units: ppm Select units ppm or mg/L
3. Resolution: 0.001 Select display resolution 0.01 or 0.001
4. Filter: 5 sec Override the default input filter, enter 0-999 seconds
5. Dual Slope Calibration: Enable or Disable

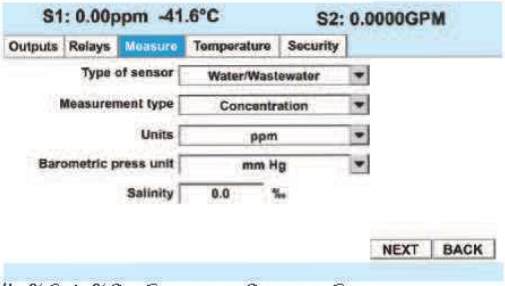




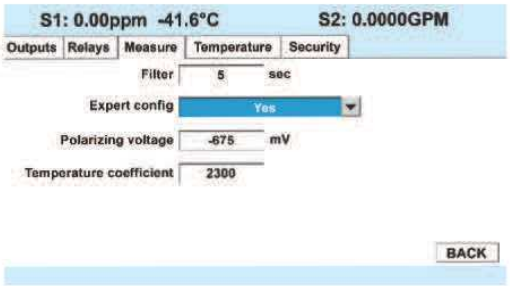
1. To program the Measurement type, select Free Chlorine, pH Ind Free Cl., Total Cl, or Monochloramine and press ENTER/MENU.
2. To program the Measurement Units: select ppm mg/L and press ENTER/MENU.
3. To program the Measurement Resolution: Select 0.01 or 0.001 and press ENTER/MENU.
4. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.
5. To use Dual Slope Calibration, select Enable or Disable and press ENTER/MENU.

6.7 Oxygen Measurement Programming

This section describes how to configure the 56 analyzer for dissolved and gaseous oxygen measurement using amperometric oxygen sensors. The following programming and configuration functions are covered:



1. Sensor type: Select Water/Waste, Trace. BioRx, BioRx-Other, Brew, $\%O_2$ In Gas
2. Measure type: Select Concentration, % Saturation, Partial Pressure, Oxygen in Gas
3. Units: ppm Select ppm, mg/L, ppb, µg/L, % Sat, $\%O_2$-Gas, ppm Oxygen-Gas
4. Pressure Units: bar Select pressure units: mm Hg, in Hg,. Atm, kPa, mbar, bar
5. Use Press: At Air Cal Select atmospheric pressure source – internal or mA Input
6. Salinity: 00.0‰ Enter Salinity as ‰
7. Filter: 5 sec Override the default input filter, enter 0-999 seconds
8. Partial Press: mmHg Select mm Hg, in Hg. atm, kPa, mbar or bar for Partial pressure



1. To program Sensor type, Select Water/Waste, Trace. BioRx, BioRx-Other, Brew, or $\%O_2$ In Gas and press ENTER/MENU.
2. To program Measure type: Select Concentration, % Saturation, Partial Pressure, or Oxygen in Gas and press ENTER/MENU.
3. To program measurement Units, Select ppm, mg/L, ppb, g/L, % Sat, $\%O_2$-Gas, or ppm Oxygen-Gas and press ENTER/MENU.
4. To program Pressure Units: Select pressure units: mm Hg, in Hg,. Atm, kPa, mbar, or bar and press ENTER/MENU.

5. To program which atmospheric Pressure source to use during Air Cal, Select internal or mA Input and press ENTER/MENU.
6. To program Salinity, Enter the known Salinity value as ‰ and press ENTER/MENU.
7. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.
8. To program Partial Press: Select mm Hg, in Hg. atm, kPa, mbar or bar for Partial pressure and press ENTER/MENU.

6.8 Ozone Measurement Programming

This section describes how to configure the 56 analyzer for ozone measurement using amperometric ozone sensors. The following programming and configuration functions are covered:

1. Units: ppm Select ppm, mg/L, ppb, µg/L
2. Resolution: 0.001 Select display resolution 0.01 or 0.001
3. Filter: 5sec Override the default input filter, enter 0-999 seconds

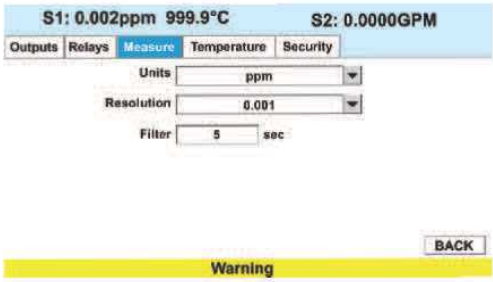
6.9 Oxygen Measurement Programming

1. To program measurement Units, Select ppm, mg/L, ppb, µg/L, % Sat, %O2-Gas, or ppm Oxygen-Gas and press ENTER/MENU.
2. To program the Measurement Resolution: Select 0.01 or 0.001 and press ENTER/MENU.
3. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.

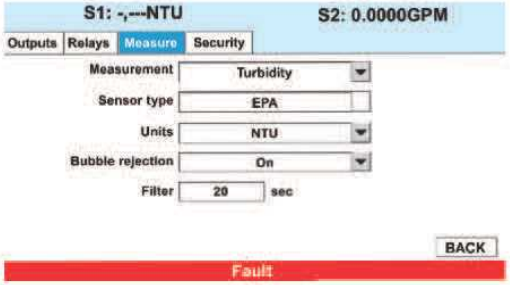
6.10 Turbidity Measurement Programming

This section describes how to configure the 56 analyzer for Turbidity measurements. The following programming and configuration functions are covered.

1. Measurement type: Turbidity Select Turbidity or TSS calculation (estimated TSS)
2. Sensor type: Select EPA or ISO
3. Measurement units: NTU, FTU, FNU
4. Filter: 20 sec Override the default input filter, enter 0-999 seconds
5. Bubble Rejection: On Intelligent software algorithm to eliminate erroneous readings caused by bubble accumulation in the sample



1. To program the Measurement type, Select Turbidity or TSS calculation (estimated TSS) and press ENTER/MENU.
2. To program the Sensor type: Select EPA or ISO and press ENTER/MENU.
3. To program Measurement units: NTU, FTU, FNU and press ENTER/MENU.



4. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.
5. To program Bubble Rejection, select On or Off and press ENTER/MENU.

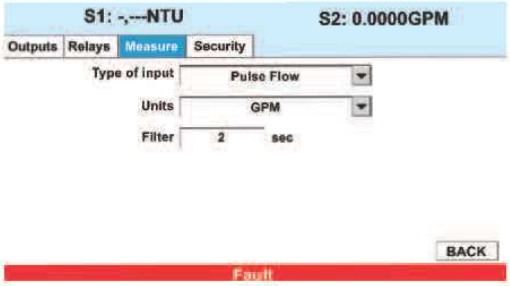
6.11 Flow Measurement Programming

This section describes how to configure the 56 analyzer for flow measurement when used with a compatible pulse flow sensor. The following programming and configuration functions are covered:

To program pulse flow, scroll to the desired item and press ENTER.

The following sub-sections provide you with the initial display screen that appears for each programming routine.

1. Measurement type Pulse Flow Select Pulse Flow or mA Current Input
2. Measurement units: GPH Select GPM, GPH, cu ft/min, cu ft/hour, LPM, L/hour, m3/hr. or
3. Filter: 5sec Override the default input filter, enter 0-999 seconds

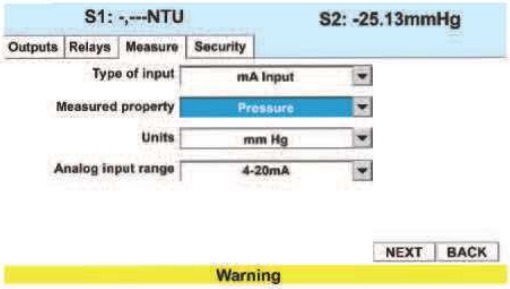


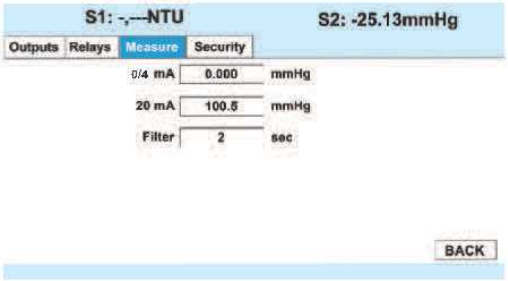
1. To program Measurement type, Select Pulse Flow or mA Current Input and press ENTER/MENU.
2. To program Measurement units: Select GPM, GPH, cu ft/min, cu ft/hour, LPM, L/hour, or m3/hr. and press ENTER/MENU.
3. To Override the default input filter, enter 0-999 seconds and press ENTER/MENU.

6.12 Current Input Programming

This section describes how to configure the 56 analyzer for current input measurement when wired to an external device that transmits 4-20 mA or 0-20 mA analog current output. The following programming and configuration functions are covered.

1. Measurement type mA input Override the default (Flow) and select mA current input
2. mA Input Temperature Select Temperature, Pressure, Flow or Other
3. Measurement units: °C. Select measurement units based on selected input device type
4. Input Range: 4-20 mA Select 4-20 mA or 0-20 mA
5. Low Value: 0.000oC Enter the low measurement value to assign to 4 mA
6. High Value: 100.0oC Enter the high measurement value to assign to 20mA
7. Filter: 05 sec Override the default input filter, enter 0-999 seconds





1. To override the default the Measurement type (Flow) select mA current input and press ENTER/MENU.
2. To program the mA Input type, Select Temperature, Pressure, Flow or other and press ENTER/MENU.
3. To program measurement units, Select measurement units based on selected input device type and press ENTER/MENU.
4. To program the Input Range: Select 4-20 mA or 0-20 mA and press ENTER/MENU.
5. To program the Low input Value, enter the low measurement value to assign to 4mA and press ENTER/MENU.
6. To program the High input Value, enter the high measurement value to assign to 20mA and press ENTER/MENU.
7. To override the default input filter, enter 0-999 seconds and press ENTER/MENU.

Section 7.0 PID Control

7.1 Introduction

7.1.1 Measurement and Set Point (Feedback Control)

The 56 controller is given two items of information: measurement and set point. The controller reacts to the difference in value of these two signals and produces an analog output signal to eliminate that difference. As long as the difference exists, the controller will try to eliminate it with the output signal. When measurement and set point are equal, the condition of the controller is static and its output is unchanged. Any deviation of measurement from set point will cause the controller to react by changing its output signal.

7.1.2 Proportional Mode

The simplest control is proportional control. In this control function, the error from set point, divided by the control range, is multiplied by the Gain constant to produce the output.

The control range is the percent of the analog output span (the difference between the 4 (or 0) mA and 20 mA settings) through which the measured variable must move to change the output from minimum to maximum.

The smaller the Gain, the less the controller reacts to changes in the measured variable. The larger the Gain, the more the controller reacts to changes in the measured variable.

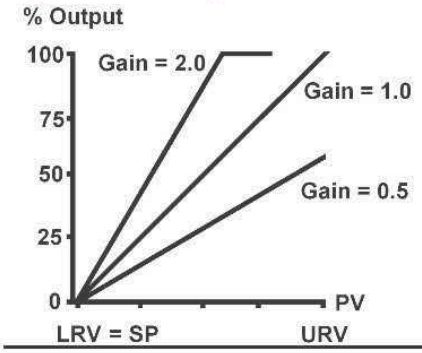
The proportional control output is given by the expression below. As can be seen, the overall gain is determined by the control range chosen (URV and LRV) and the Gain:

Proportional Output (%) = Gain * (PV – SP) * 100 / (URV, upper range value and LRV, lower range value).

7.1.2.1 Direct Acting Control Action

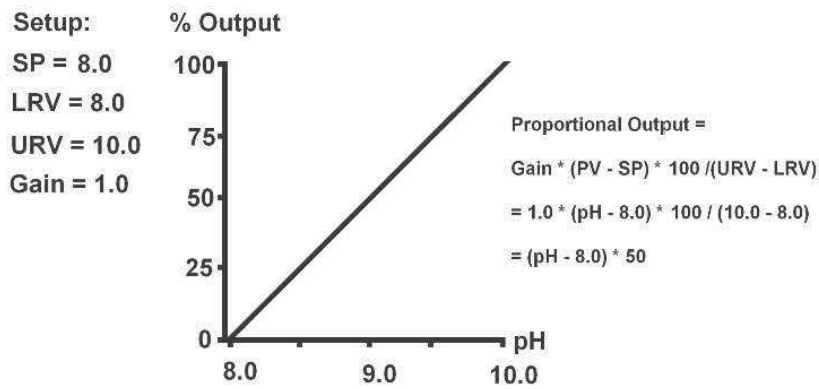
Direct acting control action increases the control output as the measured variable increases above the setpoint. The LRV is usually set to the setpoint value, so that the control output is 0% at the setpoint, and the URV is greater than the setpoint so that the 100% control output is at a higher measurement value. The Gain parameter can then be adjusted to produce the desired gain.

Fig. 7-1 Direct Acting Control



Example of direct acting control: Lower the pH of a solution at 10 pH by adding acid to control it at 8 pH with the Gain parameter assumed to be 1.0. The higher the measured pH, the more acid is required to lower the pH toward the setpoint, but as the pH approaches the setpoint less acid is required:

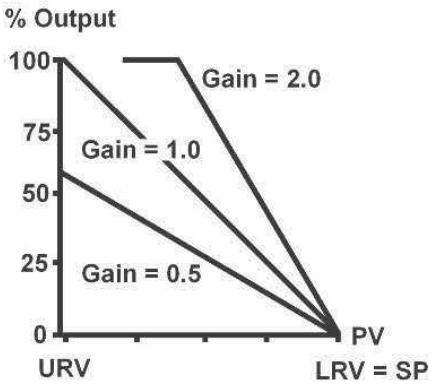
Fig. 7-2 Example of Direct Acting Control



7.1.2.2 Reverse Acting Control Action

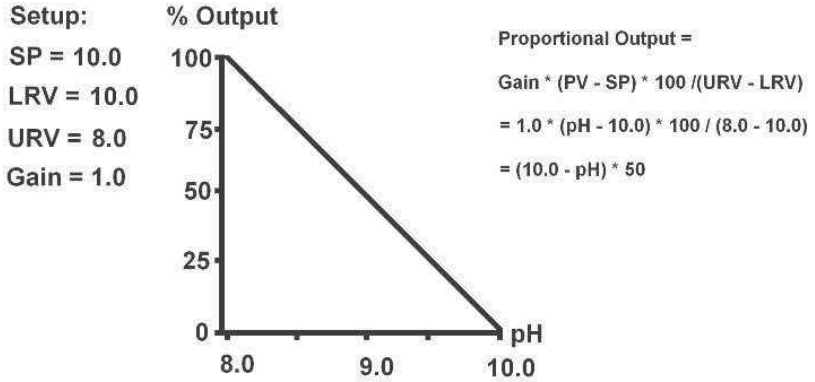
Reverse acting control action, decreases the control output as the measured variable increases toward the setpoint. The LRV is usually set to the setpoint value, so that the control output is 0% at the setpoint, and the URV is less than the setpoint value so that the 100% control output is at a lower measurement value. The Gain can then be adjusted to produce the desired gain.

Fig. 7-3 Reverse Acting Control



Example of reverse acting control: Add base to a solution at 8.0 pH, to control the pH to 10.0 pH with an assumed Gain parameter of 1.0. The lower the measured pH, the more base is required to raise the pH toward the setpoint, but as the pH approaches the setpoint less base is required:

Fig. 7-4 Example of Reverse Acting Control



7.1.3 Proportional Bias

Most processes require that the measured variable be held at the set point. The proportional mode alone will not automatically do this, if an output greater than 0% is needed to keep the PV at setpoint. At setpoint, the control output is 0%, and if a non-zero control output is needed to keep the PV at the setpoint, proportional alone will only stabilize the measured variable at some offset (deviation) from the desired setpoint.

Bias is used to provide a constant control output at the setpoint to maintain PV at the setpoint. The effect of Bias is expressed as follows:

Proportional Output ( ) = [Gain * (PV – SP) * 100 / (URV – LRV)] + BIAS

Fig. 7-5 Direct Acting Control with Bias

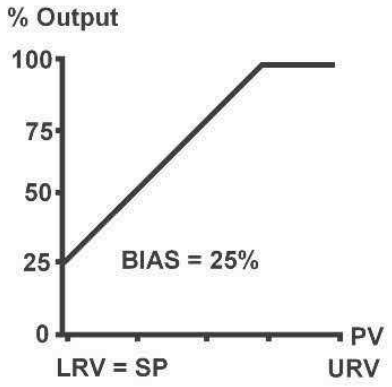
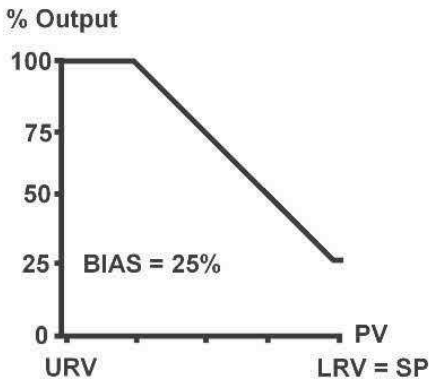


Fig. 7-6 Reverse Acting Control with Bias



7.1.4 Proportional Plus Integral (Reset)

For the automatic elimination of deviation, Integral mode, also referred to as Reset, is used. The proportional function is modified by the addition of automatic reset, rather than a constant Bias value. With the reset mode, the controller continues to change its output until the deviation between measurement and set point is eliminated.

The action of the reset mode depends on the overall gain. The rate at which it changes the controller output is based on the overall gain band size and the reset time (I). The reset time is the time required for the reset mode to repeat the proportional action once. It is expressed as seconds per repeat, adjustable from 0-3,000 seconds.

The reset mode repeats the proportional action as long as an offset from the set point exists. Reset action is cumulative. The longer the offset exists, the more the output signal is increased. If the PV overshoots the setpoint, the reset action will decrease. When the measurement reaches the setpoint and the proportional control action becomes zero, there will be an accumulated integral control action to keep the process at the setpoint.

The controller configured with reset continues to change until there is no offset. If the offset persists, the reset action eventually drives the controller output to its 100% limit - a condition known as "reset windup".

Once the controller is "wound up", the deviation must be eliminated or redirected before the controller can unwind and resume control of the measured variable. The integral time can be cleared and the "windup" condition quickly eliminated by manually overriding the 56 analog output using the manual mode to reduce the control output and then setting the reset time to 0 seconds to make integral control action 0%. The reset time can then be changed to avoid reset windup.

The proportional plus integral control output is given below. Note that the larger the reset time (I), the slower the integral response will be:

$$\text{Output} = [\text{Gain} \times 100 / (\text{URV} - \text{LRV})] \times [(\text{PV} - \text{SP}) + 1/\text{I} \quad (\text{PV}_t - \text{SP})\,\Delta t]$$

7.1.5 Derivative Mode (Rate)

Derivative mode provides a 3rd control mode, which responds to the rate of change of the Proportional control output, multiplied by the Derivative parameter D which has units of seconds. The contribution of the derivative response is given below:

$$\text{Output} = [\text{Gain} \times 100 / (\text{URV} - \text{LRV})] \times D \times [(PV_t - SP) - (PV_{t-1} - SP)] / \Delta t$$

The purpose of derivative action is to provide a quick control response to changes in the measured parameter. In general, it is not often used in concentration control, and in fact, it has been estimated that 90 to 95% of all control applications use only Proportional plus Integral control. Any noise in the measurement causes problems with derivative action. Temperature measurements tend to be less noisy than other measurements, and derivative action is most often used for temperature control.

7.1.6 Process Characterization and Tuning

Control loops are tuned by the choice of the control range and the selection of the control parameters. How these parameters are chosen should depend on how the process responds to controller output. The process response is characterized by certain behaviors, which are due to such factors as mixing and reaction time, response time of the process to control output changes, and the characteristics of the final operator, i.e. control values, pumps, heaters, etc. With these characteristics known, initial control settings can be developed.

A good reference to PID control is provided by the book, "Control Loop Foundation—Batch and Continuous Processes", by Terrence Blevins and Mark Nixon, International Society of Automation, Research Triangle Park, NC, © 2011.

A guide to tuning control is provided by the book, "Good Tuning: A Pocket Guide", by Gregory K. McMillan, International Society of Automation, Research Triangle Park, NC, © 2005.

7.2 PID Setup

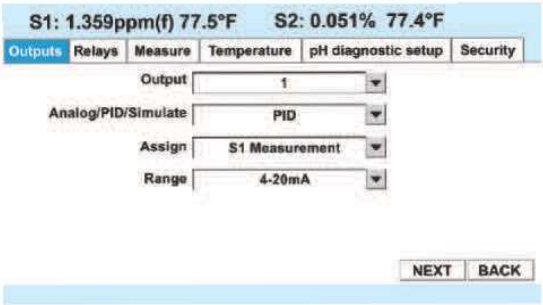
7.2.1 PID Control

The 56 current ¬outputs (one or all four) can be programmed for PID control. PID control can be applied to any of the measurements provided by the sensor boards, such as pH, conductivity, and concentrations. In addition, PID control can be applied to temperature and any measurement input to the 56 using the flow/4-20 mA board.

The output signal of PID control is used with a final control element, which can vary is output from 0 to 100% in response to the control signal. Final control elements can include control valves, pumps or heaters.

7.2.2 Selecting PID Control

Select PID control, the analog output to be used, and the measurement and range from the main analog output setup window:



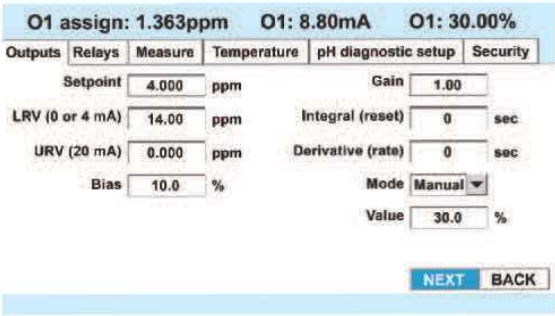
Basic Definitions

- Output – Select the analog output (1 through 4) to be configured for PID control.
- Analog/PID/Simulate – Choose PID
- Assign – Select the Measurement to be controlled. Note: This measurement can also be a 4-20 mA signal input brought in by the flow/ 4-20 mA board.
- Range – Select either 0-20 mA or 4-20 mA range, depending on the signal range used by the final control element, e.g. a pump or valve.
- Select Next to go to the PID Setup parameters.

7.2.3 PID Setup Parameters

The PID control setup window contains the PID control tuning parameters.

Also note that the upper portion of the screen shows the measurement chosen for control (PV), and the control output in mA and % Output. This makes it possible to observe the primary variable (PV) and the control output, in terms of percent and milliamps, while tuning PID control.



PID Control Parameters: Basic Definitions

- Setpoint – Select the desired setpoint.
- URV – The value of PV (in the above example, 14.00 pH) at which the control will be 20 mA or 100% output.
- LRV – The value of PV (in the above example 0.00 pH) at which the control will be 0 or 4 mA or 0% output.

Note: If you want the control output to increase as PV (in this case pH) increases, URV should be greater than LRV. This is direct acting control action. Examples of direct acting control are the addition of acid to decrease pH and adding water to a solution to decrease the concentration.

If you want the control output to decrease as PV increases, i.e. reverse acting control action, the URV should be less than LRV. Examples of reverse acting control are adding caustic to increase pH and adding a concentrated solution to water to make a solution of lower concentration.

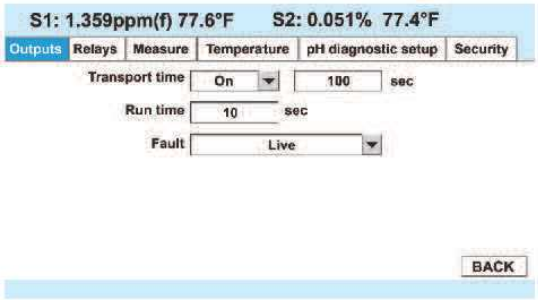
- **Bias** (range: 0 to 100%; default 0%) – Bias is a fixed control output which allows the control output to be greater than zero when the measurement (PV) is at setpoint. It is used in proportional only control to prevent cycling resulting from the control output going to zero at the setpoint.
- **Gain** (range: 0.0 to 1000.0; default 0.0) – In proportional (P) only control, the output is directly proportional to the difference between the process variable (PV) and the setpoint divided by the output span (URV – LRV). Gain is a factor which multiplies the proportional output to meet the requirements of the process being controlled. Using Gain values less than 1 reduce the proportional output while Gain values greater than 1 increase the proportional output.
- **Integral (Reset, I)** (range: 0 to 3,000 seconds; default 0 seconds) – Integral repeats the proportional action in a time period given by the reset time (I). The reset time is given in seconds per repeat and is adjustable from 0 to 3,000 seconds. Integral control acts as an automatic bias which increases or decreases the overall control output in response to the error (PV – SP) to keep the PV at the setpoint.
- **Derivative (Rate, D)** (range: 0 to 3,000 seconds; default 0 seconds) –Derivative action, gives an immediate control output in response to changes in the proportional output with time (derivative). The amount of increase or decrease depends on the rate of change of the error. The rate constant (D) allows the user to adjust the amount derivative control contributes to the control signal. Smaller values reduce the effect of derivative control.
- **Mode:** Mode has two settings, Auto (Automatic) and Man (Manual). In the Auto mode the control output is controlled automatically by the PID algorithm. In manual mode, the control output can be set to a constant value; this is useful during transmitter calibration or servicing.
- **Value (Manual)** (range: 0 100%) – When the Manual mode is chosen; this control appears on the screen and allows you to write the constant control output value in the Manual mode.

Using the **Next** button lead to the final PID control window:

7.2.4 Transport Time

Transport Time makes it possible to apply PID control action to a process flowing in a pipe for a short period of time (run time), and then hold the control output fixed to allow the treated sample time to mix and travel to the pH or other analytical sensor (transport time). If properly tuned the PV should reach the setpoint after successive time periods.

It is best used when raw sample pH (or concentration) remains relatively steady for long periods of time, as is the case for samples flowing from a large body of water. It should not be used where process upsets are possible because the delay in applying control will make recovery from the upset slow, and can result in overshoot after the incoming sample has



Transport Time Parameters: Basic Definitions

- Transport Time (On/Off) – Turns the Transport Time feature on or off.
- Transport Time (range 1 to 600 seconds) – When Transport Time is turned On; a control appears at the right of it, which allows the value of the Transport Time to be enter. This will be the time period that PID control output is held constant, while the treated sample travels to the sensor.
- Run Time (range 0 to 60 seconds) – This is the time period that PID control action is automatic. It always must be a shorter time than Transport Time.

Fault: Basic Definitions

1. Fault – When a measurement fault occurs (either sensor or transmitter) the control output can be setup to continue providing a live control output or the output can be set to a fixed value.

   If the live reading is used during a fault condition, the control output could be based on an erroneous measurement, which might cause problems. Using a fixed value for control output during a fault condition can ensure that the control output goes to an acceptable value.

2. Fault Current – If a fixed value on fault is chosen, this parameter selects the output. The control output on fault can be set to a value to prevent a major upset or an unsafe condition.

Note: If a fixed fault current output is chosen and PID control Mode is set to Manual, the Manual output value will override the Fault Current value.

Section 8.0 Time Proportional Control

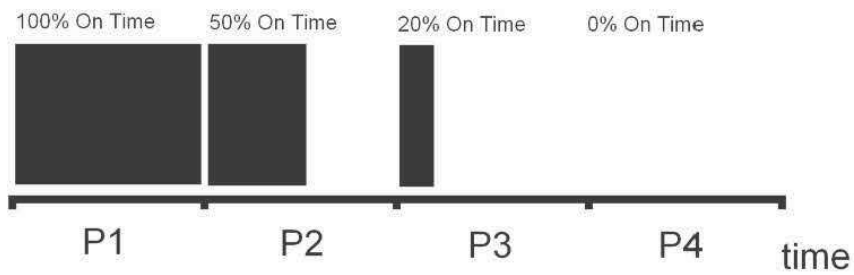
8.1 Introduction

8.1.1 Time Proportional Control

Time Proportional Control is more commonly known as Duty Cycle or Pulse Width Modulation. It applies PID control to the activation of a relay rather than using an analog output.

The TPC output is defined as the percent of time that a relay is on (% On Time), during a user selected time period (Time Period). As the control output increases the on time increases:

Fig. 8-1 TPC Periods and On Time



The proportional, integral, and derivative are defined the same as analog PID control, but use % On Time instead of % Output:

Proportional On Time ( ) = [Gain × (PV – SP) x 100 / (URV – LRV)] + BIAS

Proportional and Integral Control:

On Time = [Gain × 100 / (URV – LRV)] + [(PV – SP) + 1/I (PV$_t$ – SP) Δt]

Derivative Mode:

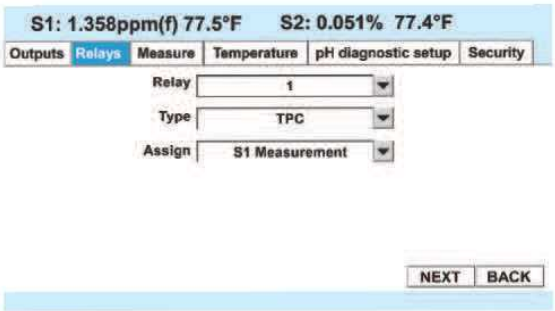
On Time = [Gain × 100 / (URV – LRV)] × D × [(PV$_t$ – SP) – (PV$_{t-1}$ – SP)] / Δt

As with analog PID control, TPC can be direct acting (URV > LRV) or reverse acting (LRV > URV). For more detail see Section X.1, PID Control Introduction.

8.2 TPC Setup

8.2.1 Selecting TPC

Select TPC control, the relay to be used, and the measurement to be controlled from the main relay setup window:



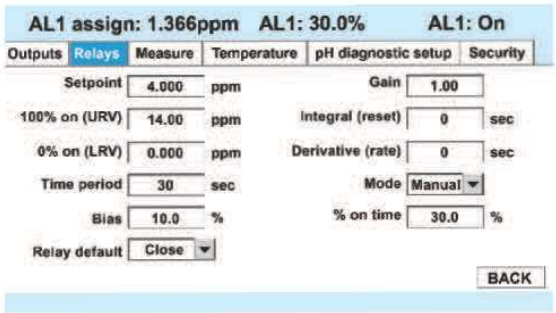
Basic Definitions

- Relay – Select the relay (1 through 4) to be use for TPC control.
- Type – Choose TPC
- Assign – Select the Measurement to be controlled. Note: This measurement can also be a 4-20 mA signal input brought in by the flow/ 4-20 mA board.
- Select Next to go to the PID Setup parameters

8.2.2 TPC Setup Parameters

The TPC setup window contains the PID control tuning parameters.

Also note that the upper portion of the screen shows the relay number and the value of the measurement assigned to it, the % On Time for the relay, and the current state of the relay, i.e. On or Off. This makes it possible to observe the primary variable (PV), the % On Time, and the relay state, while tuning time proportional control.



PID Control Parameters: Basic Definitions

- **Setpoint** – Select the desired setpoint.
- **URV** – The value of PV (in the above example, 14.00 pH) at which the control will be 100% On Time.
- **LRV** – The value of PV (in the above example 0.00 pH) at which the control will be 0% On Time.

Note: If you want the control output to increase as PV (in this case pH) increases, URV should be greater than LRV. This is direct acting control action. Examples of direct acting control are the addition of acid to decrease pH and adding water to a solution to decrease the concentration.

If you want the control output to decrease as PV increases, i.e. reverse acting control action, the URV should be less than LRV. Examples of reverse acting control are adding caustic to increase pH and adding a concentrated solution to water to make a solution of lower concentration.

- **Time Period** (range: 10 to 3,000 seconds; default 30) -- The time period for each cycle of TPC.
- **Bias** (range: 0 to 100%; default 0%) – Bias is a fixed control output which allows the % on time to be greater than zero when the measurement (PV) is at setpoint. It is used in proportional only control to prevent cycling resulting from the % on time going to zero at the setpoint.
- **Relay default** (Close, Open, None) – Select the relay action during a fault condition.
- **Gain** (range: 0.0 to 1000.0; default 0.0) – In proportional (P) only control, the output is directly proportional to the difference between the process variable (PV) and the setpoint divided by the output span (URV – LRV). Gain is a factor which multiplies the proportional output to meet the requirements of the process being controlled. Using Gain values less than 1 reduce the proportional output while Gain values greater than 1 increase the proportional output.
- **Integral (Reset, I)** (range: 0 to 3,000 seconds; default 0 seconds) – Integral repeats the proportional action in a time period given by the reset time (I). The reset time is given in seconds per repeat and is adjustable from 0 to 3,000 seconds. Integral control acts as an automatic bias which increases or decreases the overall control output in response to the error (PV – SP) to keep the PV at the setpoint.
- **Derivative (Rate, D)** (range: 0 to 3,000 seconds; default 0 seconds) –Derivative action, gives an immediate control output in response to changes in the proportional output with time (derivative). The amount of increase or decrease depends on the rate of change of the error. The rate constant (D) allows the user to adjust the amount derivative control contributes to the control signal. Smaller values reduce the effect of derivative control.
- **Mode:** Mode has two settings, Auto (Automatic) and Man (Manual). In the Auto mode the control output is controlled automatically by the PID algorithm. In manual mode, the control output can be set to a constant value; this is useful during transmitter calibration or servicing.
- **On Time (Manual)** (range: 0 100%) – When the Manual mode is chosen; this control appears on the screen and allows you to write the constant On Time value in the Manual mode.

Section 9.0 Alarm Relay Functions

9.1 General

An alarm is a relay that closes a set of contact points (a switch) inside the analyzer. In doing so, the relay closes an electrical circuit and turns on a device wired to the contacts. The 56 Advanced Analyzer has four alarm relays and seven relay control functions. The relays are turned on and off by the analyzer based on the control points, setpoints or control parameters that you program into the analyzer through the keypad. See Section 9.2 through 9.7 to program the alarm relay functions. Each relay functions section includes a description, a figure detailing its operation, a step-by-step setup procedure, and a table or default and programmable limit settings.

The 56 has the following relay control functions:

Table 9-1. Alarm Relay Functions

Relay Control Functions	Common applications	Section
High/Low Concentration Alarm	measurement setpoint control	Sec. 9.2
Delay Timer	chemical mixing and neutralization	Sec. 9.3
Bleed and Feed	blowdown and chemical addition	Sec. 9.4
Totalizer Relay Activation	chemical dosing in reactors	Sec. 9.5
Interval Timer	periodic probe cleaning	Sec. 9.6
Date and Time Activation	seawater-cooled condensers	Sec. 9.7

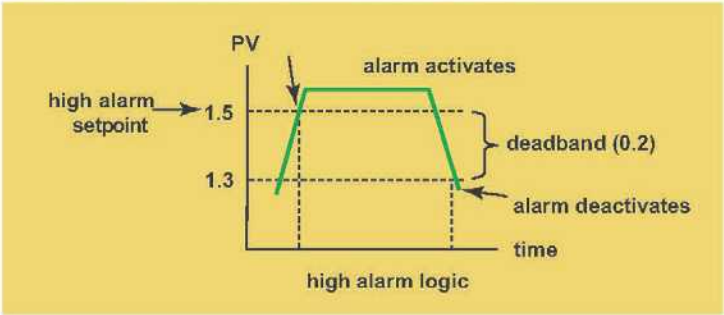
9.2 High/Low Concentration Alarm

9.2.1 Description

High/Low concentration alarms are setpoint alarms with adjustable deadband. These operate as simple on/off alarms used for applications requiring discrete on/off control of pumps and valves. Typical applications include demineralizer bed regeneration and blowdown in boilers and cooling towers. Any active device variable in the 56 analyzer can be programmed as a high/low concentration alarm including the primary or secondary variables, temperature, raw values and diagnostics.

A schematic of the high/low concentration (setpoint) alarm operation is shown below.

Figure 9-1. High/Low Concentration Alarm operation



9.2.2 Setup

Access high/low concentration (setpoint) alarms by pressing ENTER/MENU from the main screen and then Program/Relays/Configure Relay. From the main relay programming screen, program this feature as follows:

1. **Relay:** Assign a relay by highlighting the desired relay 1-4 and press ENTER/MENU.
2. **Type:** Select Setpoint as the relay type and press ENTER/MENU.
3. **Assign:** Assign S1 (sensor 1), S2 (sensor 2 if available) or other available parameters to the designated relay and press ENTER/MENU.
4. **Logic:** Set High for a high setpoint or Low for a low setpoint and press ENTER/MENU.
5. **Setpoint:** Enter the desired setpoints value. Press ENTER/MENU.
6. **Deadband:** To set deadband as a measurement value, enter the change in the process value needed after the relay deactivates to return to normal (and thereby preventing repeated alarm activation). Press ENTER/MENU.
7. Select **NEXT.** Press ENTER/MENU to advance to the next setup screen.
8. **Normal state:** Set the normal alarm condition as Open or Closed and press ENTER/MENU. Program the normal state to define the desired alarm default state to normally open or normally closed upon power up.

Table 9-2. Defaults and programmable limits

Relay Function	Limits and Selections	Default
Setpoint	NA	NA
Logic	Low/High	High
Setpoint	*	*
Deadband	*	0.000
On time	0 to 999.9 min	0 min
Delay time	0 to 999.9 min	0 min
Normal state	Close/Open	Open

* See Appendix 1 – HART and Device Variables

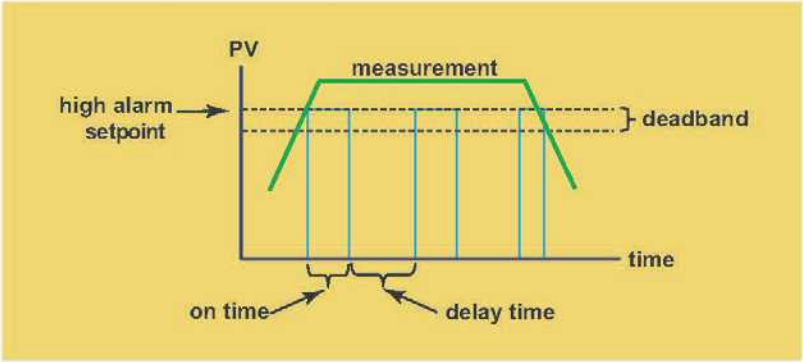
9.3 Delay Timer

9.3.1 Description

Delay Timer is a concentration control scheme which delays live measurement after chemical addition using (one or all four of) of the 56 alarm relays. This ensures sufficient mixing time in a vessel or recirculation loop before live sensor measurement, preventing unmixed readings that might cause overshooting. Relay On time and Delay times are field-programmable. Typical applications that would utilize the Delay Timer are: concentration control in vessels, pH adjustments for neutralization and endpoint control for oxidation-reduction reactions.

A schematic of the Delay Timer operation is shown:

Figure 9-2. Delay Timer Alarm operation



9.3.2 Setup

Access Delay Timer by pressing ENTER/MENU from the main screen and then Program/Relays/ Configure Relay. From the main relay programming screen, program this feature as follows:

1. **Relay:** Assign a relay by highlighting the desired relay 1-4 and press ENTER/MENU.
2. **Type:** Select Delay Timer as the relay type and press ENTER/MENU.
3. **Assign:** Assign S1 (sensor 1), S2 (sensor 2 if available) or other available parameters to the designated relay and press ENTER/MENU.
4. **Logic:** Set High for high reading setpoint logic or Low relay logic for low reading setpoint logic and press ENTER/MENU.
5. **Setpoint:** Enter the desired setpoints value. This will activate an alarm event when the process measurement reaches the entered setpoint value. Press ENTER/MENU. See Table 9-2 for entry limits.
6. **Deadband:** To set deadband as a measurement value, enter the change in the process value needed after the relay deactivates to return to normal (and thereby preventing repeated alarm activation). Press ENTER/MENU.
7. Select **NEXT** Press ENTER/MENU to advance to the next setup screen.
8. **On time:** Enter the time in minutes (X.X min) for the relay to remain energized. The assigned measurement value will be on hold during this time.
9. **Delay time:** Enter the time in minutes (X.X min) to take the assigned measurement off hold after the relay is re-energized to begin reporting live values.
10. **Normal state:** Set the normal alarm condition as Open or Closed and press ENTER/MENU. Program the normal state to define the desired alarm default state to normally open or normally closed upon power up.

Table 9-3. Defaults and programmable limits

Relay Function	Limits and Selections	Default
Delay Timer	NA	NA
Logic	Low/High	High
Setpoint	*	*
Deadband	*	0.000
Normal state	Close/Open	Open

* See Appendix 1 – HART and Device Variables

9.4 Bleed and Feed

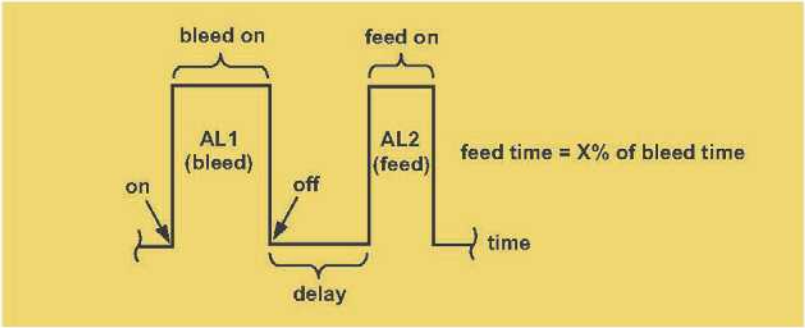
9.4.1 Description:

A bleed and feed timer is typically used to replace chemicals lost during blowdown. It involves two or more relays. The bleed relay is a normal setpoint alarm relay. Once the bleed relay deactivates, one or more feed relays activate for a percentage of the time the bleed relay was on.

Bleed and Feed supports continuous monitoring of blow-down water conductivity to determine the point of excessive conductivity. At a programmable maximum concentration value, dumping (bleeding) of the excessively dirty blow-down water is triggered. Subsequently, pumping (feeding) of additional make-up water chemicals is enabled to account for lost blow-down water. Through level control, make-up water is added in proportion to the volume of blowdown material lost through dumping and evaporation.

A schematic of the Bleed and Feed timer operation is shown:

Figure 9-3. Bleed and feed timer alarm operation



9.4.2 Setup

Access Bleed and Feed Timers by pressing ENTER/MENU from the main screen and then Program/Relays/Configure Relay. From the main relay programming screen, program this feature as follows:

1. **Relay:** Assign relay 1 for Bleed and Feed and press ENTER/MENU.
2. **Type:** Select Bleed and Feed as the relay type and press ENTER/MENU.
3. **Assign:** Assign S1 (sensor 1), S2 (sensor 2 if available) or other available parameters to the designated relay and press ENTER/MENU.
4. **Logic:** Set High for high setpoint or Low for low setpoint and press ENTER/MENU.

5. **Setpoint:** Enter the desired setpoints value. This will activate an alarm event when the process measurement reaches the entered setpoint value. Press ENTER/MENU. See Table 9-3 for entry limits.

6. Select **NEXT** Press ENTER/MENU to advance to the next setup screen.

7. **Deadband:** To set deadband as a measurement value, enter the change in the process value needed after the relay deactivates to return to normal (and thereby preventing repeated alarm activation). Press ENTER/MENU.

8. **Normal state:** Set the normal alarm condition as Open or Closed and press ENTER/MENU. Program the normal state to define the desired alarm default state to normally open or normally closed upon power up.

9. Select **NEXT** Press ENTER/MENU to advance to the next setup screen: Configure feed relay.

10. **Feed relay:** Assign relay 2, 3, or 4 as a feed relay and press ENTER/MENU.

11. **Linked to bleed relay:** No entry required. The relay originally programmed as the Bleed relay is displayed.

12. **Delay time:** Enter the time in minutes (X.X min) after the Bleed time is activated before triggering this feed relay.

13. **Feed time equals:** Enter the percent of time that the Bleed timer is on (X.X%) to activate this feed relay (for pumping make-up water chemicals).

Relay Function	Limits and Selections	Default
Bleed and Feed	NA	NA
Logic	Low/High	High
Setpoint	*	*
Deadband	*	0.000
Normal state	Close/Open	Open
Feed relay	1, 2, 3, 4	not assigned
Linked to bleed relay	1, 2, 3, 4	1
Delay time	0 - 999.9 min	1.0 min
Feed time equals	0 - 999.9% of bleed time	10.0% of bleed time
Normal state	Close/Open	Open

* See Appendix 1 – HART and Device Variables

9.5 Totalizer Based Relay Activation

9.5.1 Description:

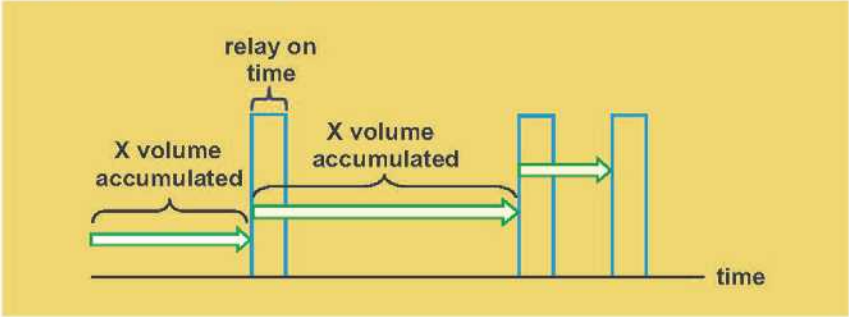
A totalizer based timer feeds chemicals for a preset period every time a programmed volume of liquid has been added to or removed from a vessel. The relay energizes when the volume has been reached and remains energized for a fixed time. The process repeats once the volume has been reached again.

Totalizer Based Relay Activation triggers a relay at user-defined intervals based on accumulated totalized flow. The scheme uses pulse inputs from a flow meter or 4-20mA current input(s) from a flow transmitter to calculate total flow (as volume).

A typical application for totalized flow relay activation is controlling chemical dosing in reactors.

A schematic of the Totalizer timer operation is shown:

Figure 9-4. Totalizer alarm operation



9.5.2 Setup

Access Totalizer Timers by pressing ENTER/MENU from the main screen and then Program/Relays/ Configure Relay. From the main relay programming screen, program this feature as follows:

1. **Relay:** Assign a relay by highlighting the desired relay 1-4 and press ENTER/MENU.
2. **Type:** Select Totalizer timer as the relay type and press ENTER/MENU.
3. **Assign:** Assign Pulse flow S1 (sensor 1) or S2 (sensor 2) as the measurement input and press ENTER/MENU.
4. **Active relay after:** Enter accumulated volume (XX.XXXX) and units of measurement (gal, thousand gal, million Gal, trillion Gal).
5. **On time:** Enter the time in minutes (X.X min) for the relay to remain energized. The assigned measurement value will be on hold during this time.
6. **Normal state:** Set the normal alarm condition as Open or Closed and press ENTER/MENU. Program the normal state to define the desired alarm default state to normally open or normally closed upon power up.

Table 9-5. Defaults and programmable limits

Relay Function	Limits and Selections	Default
Totalizer Based Timer	NA	NA
Activate relay after	0 to 99.9990	10
units	Gal, Liters, cuft,m3 accumulated	E3gal (x1000 gal) accumulated
On time	0 to 999.9 min	0 min
Normal state	Close/Open	Open

9.6 Interval Timer

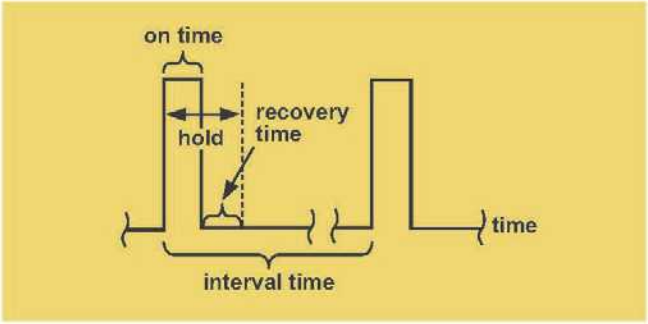
9.6.1 Description:

The interval timer may be used for periodic sensor cleaning or periodic process adjustment. The cycle begins at the Interval time when the switch is turned on. When the Interval time

has expired, the analyzer activates hold mode on the assigned measurement and the relay is energized for the On time period.

A schematic of the Interval timer operation is shown:

Figure 9-5. interval timer Alarm operation



9.6.2 Setup

Access Interval timer by pressing ENTER/MENU from the main screen and then Program/Relays/ Configure Relay. From the main relay programming screen, program this feature as follows:

1. **Relay:** Assign a relay by highlighting the desired relay 1-4 and press ENTER/MENU.
2. **Type:** Select Interval timer as the relay type and press ENTER/MENU.
3. **Interval time:** Enter the time in hours (XX.X hours) between complete interval cycles.
4. **On time:** Enter the time in minutes (X.X min) for the relay to remain energized. The assigned measurement value will be on hold during this time.
5. **Recovery time:** Enter the time in minutes (XX min) before the process is restored and live measurements can resume.
6. ***Hold while active:** Select which sensors outputs should be on hold (S1, S2 or both) during the interval timer activation time. Press ENTER/MENU.
7. Select **NEXT** Press ENTER/MENU to advance to the next setup screen.
8. **Normal state:** Set the normal alarm condition as Open or Closed and press ENTER/MENU. Program the normal state to define the desired alarm default state to normally open or normally closed upon power up.

*56 units with software ver. 2.1X and greater allow override of interval timer to ensure that all relays and outputs are held if desired.

Table 9-6. Defaults and programmable limits

Relay Function	Limits and Selections	Default
Interval timer	NA	NA
Interval time	0 to 999.9 hr	24.0 hr
On time	0 to 999.9 sec	10 sec
Recovery time	0 to 999 sec	60 sec
Hold while active	0 to 999 sec	0 sec
Normal state	Sensor 1, Sensor 1, both	Sensor 1

9.7 Date and Time Activation

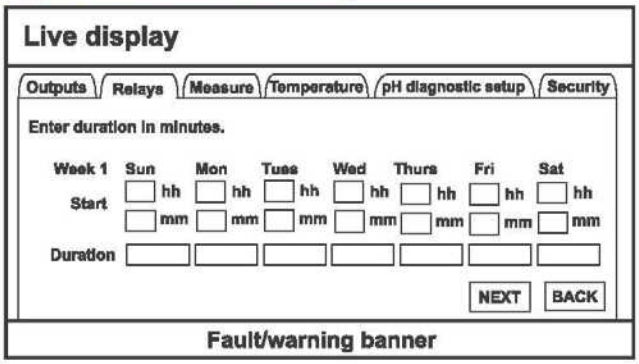
9.7.1 Description:

This relay feature allows programming of 1 to 4 relays to activate on an assigned day of the week and time of day or night for an assigned interval. They function like sprinkler timers. The programmable timeframe cycle is two weeks.

An example application for Date and Time Activation is daily chlorine dosing in seawater-cooled condensers.

The Date and Time relay setup screen is shown:

Figure 9-6. Date and Time alarm operation



9.7.2 Setup

Access Date and Time timer by pressing ENTER/MENU from the main screen and then Program/Relays/Configure Relay. From the main relay programming screen, program this feature as follows:

1. **Relay:** Assign a relay by highlighting the desired relay 1-4 and press ENTER/MENU.
2. **Type:** Select Date and time timer as the relay type and press ENTER/MENU.
3. Select **NEXT** Press ENTER/MENU to advance to the next setup screen.
4. The **Week 1** calendar will appear. Program the start relay activate time by entering day(s) of week, hour(s) of day and minutes for each hour. Enter the duration of time in minutes (XX min) for relay activation. Up to four relays can be simultaneously energized for any programmed times
5. Select **NEXT** Press ENTER/MENU to advance to the next setup screen.
6. The **Week 2** calendar will appear. Repeat the programming entries for week 2 in the same manner as week 1. Up to four relays can be simultaneously energized for any programmed times.

⚠ CAUTION

Date and Time timer operation depends on accurate setup of the internal real time clock. Continuous powered operation of the 56 analyzer is recommended to preserve programmed Date and Time timer clock settings.

Section 10.0 Calibration

10.1 Calibration – Introduction

Calibration is the process of adjusting or standardizing the analyzer to a lab test or a calibrated laboratory instrument, or standardizing to some known reference (such as a commercial buffer). The auto-recognition feature of the analyzer will enable the appropriate calibration screens to allow calibration for any single sensor configuration or dual sensor configuration of the analyzer. Completion of Quick Start upon first power up enables live measurements but does not ensure accurate readings in the lab or in process. Calibration should be performed with each attached sensor to ensure accurate, repeatable readings. This section covers the following programming and configuration functions:

1. Auto buffer cal for pH (pH Cal - Sec.7.2)
2. Manual buffer cal for pH (pH Cal - Sec.7.2)
3. Set calibration stabilization criteria for pH (pH Cal - Sec.7.2)
4. Standardization calibration (1-point) for pH, ORP and Redox (pH Cal - Sec.7.2 and 7.3)
5. Entering the cell constant of a conductivity sensor (Conductivity Cal - Sec. 7.4 and 7.5)
6. Calibrating the sensor in a conductivity standard Conductivity Cal - Sec. 7.4 and 7.5)
7. Calibrating the analyzer to a laboratory instrument (Contacting Conductivity Cal - Sec.7.4)
8. Zeroing an chlorine, oxygen or ozone sensor (Amperometric Cal - Sec's 7.6, 7.7, 7.8)
9. Calibrating an oxygen sensor in air (Oxygen Cal - Sec's 7.6)
10. Calibrating the sensor to a sample of known concentration (Amperometric Cal - Sec's 7.6, 7.7, 7.8)
11. Enter a manual reference temperature for temperature compensation of the process measurement

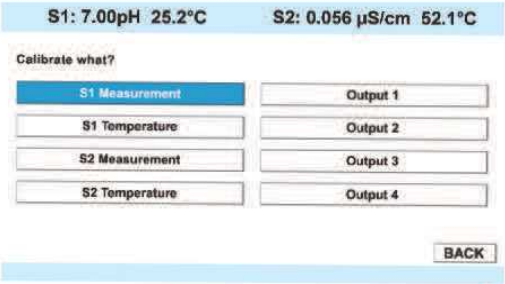
10.2 pH Calibration

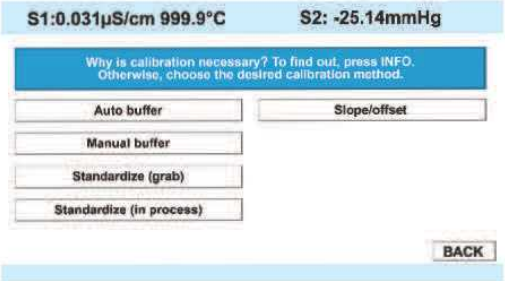
New sensors must be calibrated before use. Regular recalibration is also necessary. Use auto calibration instead of manual calibration. Auto calibration avoids common pitfalls and reduces errors. The analyzer recognizes the buffers and uses temperature-corrected pH values in the calibration. Once the 56 successfully completes the calibration, it calculates and displays the calibration slope and offset. The slope is reported as the slope at 25 °C.

To calibrate the pH loop with a connected pH sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

The following calibration routines are covered:

1. Auto Calibration - pH 2 point buffer calibration with auto buffer recognition
2. Manual Calibration - pH 2 point buffer calibration with manual buffer value entry
3. Standardization - pH 1 point buffer calibration with manual buffer value entry



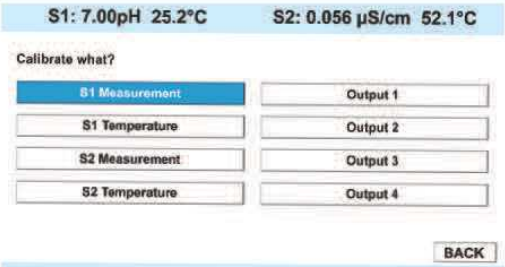


4. Entering A Known Slope Value - pH Slope calibration with manual entry of known slope value
1. To Auto Calibrate the pH loop using 2 point buffer calibration with auto buffer recognition, select Auto Buffer and follow the step-by-step procedures displayed on-screen.
2. To Manual Calibrate the pH loop using 2 point buffer calibration with manual buffer value entry, select Manual Buffer and follow the step-by-step procedures displayed on-screen.
3. To Standardization Calibrate the pH loop using 1 point buffer calibration with manual buffer value entry, select Standardize and follow the step-by-step procedures displayed on-screen.
4. To Calibrate the pH loop using with manual entry of a Known Slope Value and Reference offset value, select Slope/Offset and follow the step-by-step procedures displayed on-screen.

10.3 ORP Calibration

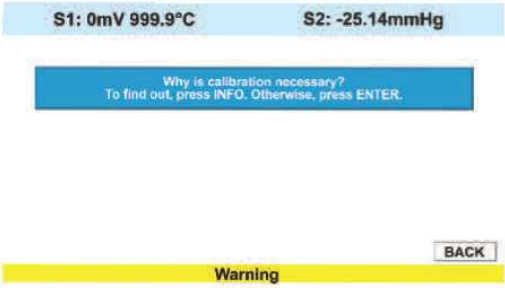
For process control, it is often important to make the measured ORP agree with the ORP of a standard solution. During calibration, the measured ORP is made equal to the ORP of a standard solution at a single point.

To calibrate the ORP loop with a connected ORP sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.



The following calibration routine is covered:

1. To Standardization the ORP loop using 1 point buffer calibration with manual buffer value entry, follow the step-by-step procedures displayed on-screen.



10.4 Contacting Conductivity Calibration

New conductivity sensors rarely need calibration. The cell constant printed on the label is sufficiently accurate for most applications.

CALIBRATING AN IN-SERVICE CONDUCTIVITY SENSOR

After a conductivity sensor has been in service for a period of time, recalibration may be necessary. There are three ways to calibrate a sensor.

a. Use a standard instrument and sensor to measure the conductivity of the process stream. It is not necessary to remove the sensor from the process piping. The temperature correction used by the standard instrument may not exactly match the temperature correction used by the 56. To avoid errors, turn off temperature correction in both the analyzer and the standard instrument.

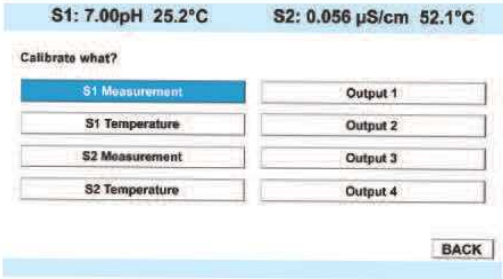
b. Place the sensor in a solution of known conductivity and make the analyzer reading match the conductivity of the standard solution. Use this method if the sensor can be easily removed from the process piping and a standard is available. Be careful using standard solutions having conductivity less than 100 µS/cm. Low conductivity standards are highly susceptible to atmospheric contamination. Avoid calibrating sensors with 0.01/cm cell constants against conductivity standards having conductivity greater than 100 µS/cm. The resistance of these solutions may be too low for an accurate measurement. Calibrate sensors with 0.01/cm cell constant using method c.

c. To calibrate a 0.01/cm sensor, check it against a standard instrument and 0.01/cm sensor while both sensors are measuring water having a conductivity between 5 and 10 µS/cm. To avoid drift caused by absorption of atmospheric carbon dioxide, saturate the sample with air before making the measurements. To ensure adequate flow past the sensor during calibration, take the sample downstream from the sensor. For best results, use a flow-through standard cell. If the process temperature is much different from ambient, keep connecting lines short and insulate the flow cell.

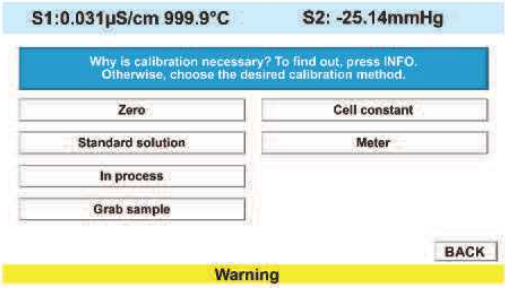
To calibrate the conductivity loop with a connected contacting conductivity sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

The following calibration routines are covered:

1. Zero Cal Zero the analyzer with the sensor attached
2. In Process Cal Standardize the sensor to a known conductivity
3. Cell K: 1.00000/cm Enter the cell Constant for the sensor
4. Meter Cal Calibrate the analyzer to a lab conductivity instrument
5. Cal Factor: 0.95000/cm Enter the Cal Factor for 4-Electrode sensors from the sensor tag



1. To Zero Calibrate the analyzer with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform an In-Process Calibration of the conductivity loop by Standardizing the sensor to a known conductivity, follow the step-by-step procedures displayed on-screen.



3. To calibrate the conductivity loop by entering a Cell constant, Enter the cell Constant for the sensor and follow the step-by-step procedures displayed on-screen.
4. To Meter Cal Calibrate the analyzer to a lab conductivity instrument, follow the step-by-step procedures displayed on-screen.
5. To enter the Cal Factor to support calibration of a 4-Electrode sensors, enter the Cal Factor for the 4-Electrode sensors from the sensor tag and follow the step-by-step procedures displayed on-screen.

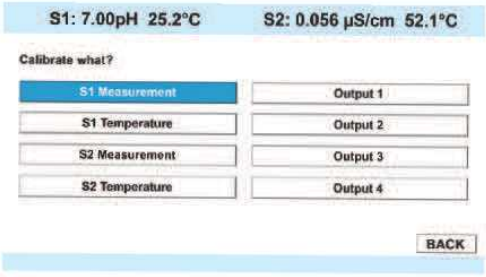
10.5 Toroidal Conductivity Calibration

Calibration is the process of adjusting or standardizing the analyzer to a lab test or a calibrated laboratory instrument, or standardizing to some known reference (such as a conductivity standard). This section contains procedures for the first time use and for routine calibration of the 56 analyzer.

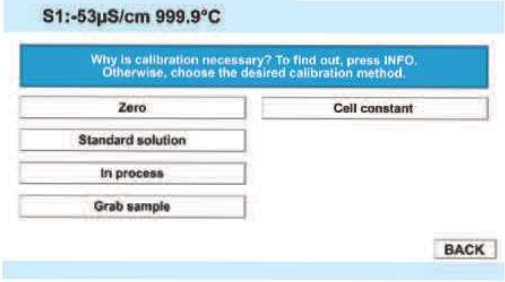
To calibrate the conductivity loop with a connected contacting conductivity sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

The following calibration routines are covered:

1. Zero Cal Zero the analyzer with the sensor attached
2. In Process Cal Standardize the sensor to a known conductivity
3. Cell K: 1.00000/cm Enter the cell Constant for the sensor



1. To Zero Calibrate the analyzer with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform an In-Process Calibration of the conductivity loop by Standardizing the sensor to a known conductivity, follow the step-by-step procedures displayed on-screen.
3. To calibrate the conductivity loop by entering a Cell constant, Enter the cell Constant for the sensor and follow the step-by-step procedures displayed on-screen.



10.6 Calibration —Chlorine

With a Chlorine measurement board and the appropriate sensor, the 56 can measure any of four variants of Chlorine:

- Free Chlorine
- Total Chlorine
- Monochloramine
- pH-independent Free Chlorine

The section describes how to calibrate any compatible amperometric chlorine sensor. The following calibration routines are covered in the family of supported Chlorine sensors:

- Air Cal
- Zero Cal
- In Process Cal

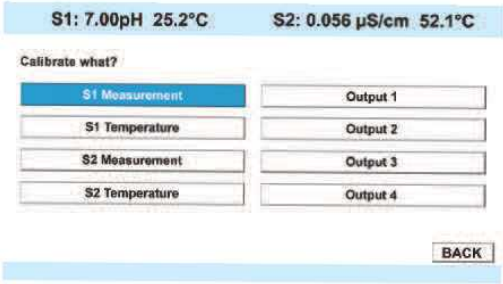
10.6.1 Calibration — Free Chlorine

A free chlorine sensor generates a current directly proportional to the concentration of free chlorine in the sample. Calibrating the sensor requires exposing it to a solution containing no chlorine (zero standard) and to a solution containing a known amount of chlorine (full-scale standard). The zero calibration is necessary because chlorine sensors, even when no chlorine is in the sample, generate a small current called the residual current. The analyzer compensates for the residual current by subtracting it from the measured current before converting the result to a chlorine value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced.

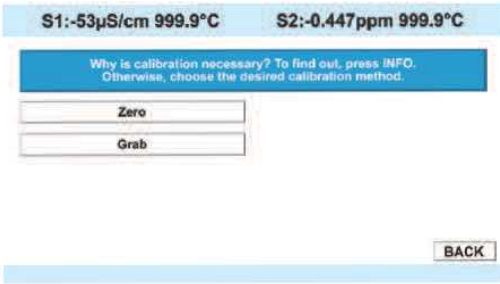
To calibrate the chlorine sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

The following calibration routines are covered:

1. Zero Cal Zeroing the sensor in solution with zero free chlorine
2. Grab Cal Standardizing to a sample of known free chlorine concentration



1. To Zero Calibrate the analyzer with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform a Grab Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.



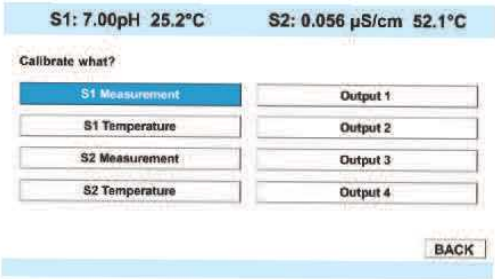
10.6.2 Calibration — Total Chlorine

Total chlorine is the sum of free and combined chlorine. The continuous determination of total chlorine requires two steps. First, the sample flows into a conditioning system (TCL) where a pump continuously adds acetic acid and potassium iodide to the sample. The acid lowers the pH, which allows total chlorine in the sample to quantitatively oxidize the iodide in the reagent to iodine. In the second step, the treated sample flows to the sensor. The sensor is a membrane-covered amperometric sensor, whose output is proportional to the concentration of iodine.
Because the concentration of iodine is proportional to the concentration of total chlorine, the analyzer can be calibrated to read total chlorine. Because the sensor really measures iodine, calibrating the sensor requires exposing it to a solution containing no iodine (zero standard) and to a solution containing a known amount of iodine (full-scale standard). The Zero calibration is necessary because the sensor, even when no iodine is present, generates a small current called the residual current. The analyzer compensates for the residual current by subtracting it from the measured current before converting the result to a total chlorine value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced. The best zero standard is deionized water. The purpose of the In Process Calibration is to establish the slope of the calibration curve. Because stable total chlorine standards do not exist, the sensor must be calibrated against a test run on a grab
sample of the process liquid. Several manufacturers offer portable test kits for this purpose.

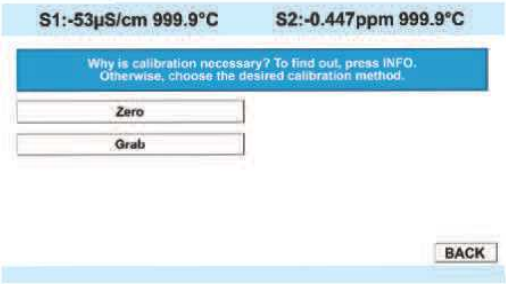
To calibrate the chlorine sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

The following calibration routines are covered:

1. Zero Cal Zeroing the sensor in solution with zero total chlorine
2. Grab Cal Standardizing to a sample of known total chlorine concentration



1. To Zero Calibrate the analyzer with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform a Grab Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.



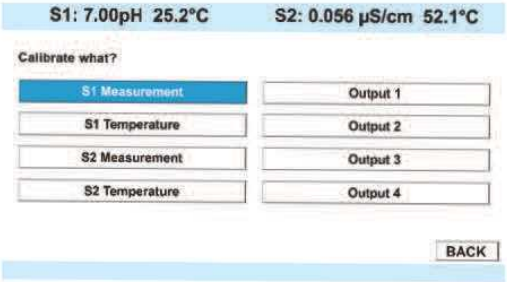
10.6.3 Calibration — Monochloramine

A monochloramine sensor generates a current directly proportional to the concentration of monochloramine in the sample. Calibrating the sensor requires exposing it to a solution containing no monochloramine (zero standard) and to a solution containing a known amount of monochloramine (full-scale standard). The Zero calibration is necessary because monochloramine sensors, even when no monochloramine is in the sample, generate a small current called the residual or zero current. The analyzer compensates for the residual current by
subtracting it from the measured current before converting the result to a monochloramine value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced. The best zero standard is deionized water.
The purpose of the In Process calibration is to establish the slope of the calibration curve. Because stable monochloramine standards do not exist, the sensor must be calibrated against a test run on a grab sample of the process liquid. Several manufacturers offer portable test kits for this purpose.

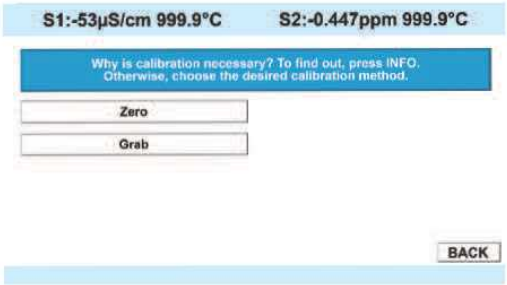
To calibrate the chlorine sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

The following calibration routines are covered:

1. Zero Cal Zeroing the sensor in solution with zero total chlorine
2. Grab Cal Standardizing to a sample of known monochloramine concentration



1. To Zero Calibrate the analyzer with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform a Grab Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.



10.6.4 pH-Independent Free Chlorine Measurement

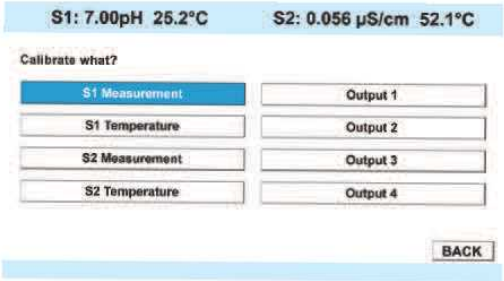
A free chlorine sensor generates a current directly proportional to the concentration of free chlorine in the sample. Calibrating the sensor requires exposing it to a solution containing no chlorine (zero standard) and to a solution containing a known amount of chlorine (full-scale

standard). The zero calibration is necessary because chlorine sensors, even when no chlorine is in the sample, generate a small current called the residual current. The analyzer compensates for the residual current by subtracting it from the measured current before converting the result to a chlorine value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced.

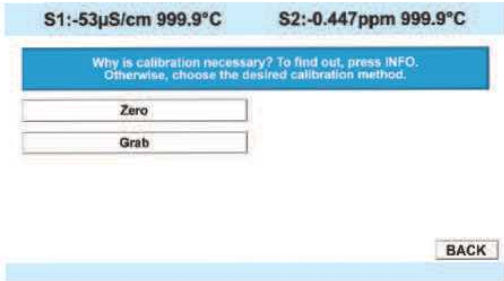
To calibrate the chlorine sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

The following calibration routines are covered:

1. Zero Cal Zeroing the sensor in solution with zero total chlorine
2. Grab Cal Standardizing to a sample of known chlorine concentration



1. To Zero Calibrate the analyzer with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform a Grab Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.



10.7 Calibration — Oxygen

Oxygen sensors generate a current directly proportional to the concentration of dissolved oxygen in the sample. Calibrating the sensor requires exposing it to a solution containing no oxygen (zero standard) and to a solution containing a known amount of oxygen (full-scale standard). The Zero Calibration is necessary because oxygen sensors, even when no oxygen is present in the sample, generate a small current called the residual current. The analyzer compensates for the residual current by subtracting it from the measured current before converting the result to a dissolved oxygen value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced. The recommended zero standard is 5% sodium sulfite in water, although oxygen-free nitrogen can also be used. The 499A TrDO sensor, used for the determination of trace (ppb) oxygen levels, has very low residual current and does not normally require zeroing. The residual current in the 499A TrDO sensor is equivalent to less than 0.5 ppb oxygen. The purpose of the In Process Calibration is to establish the slope of the calibration curve. Because the solubility of atmospheric oxygen in water as a function of temperature and barometric pressure is well known, the natural choice for a full-scale standard is air-saturated water. However, air-saturated water is difficult to prepare and use, so the universal practice is to use air for calibration. From the point of view of the oxygen sensor, air and air-saturated water are identical. The equivalence

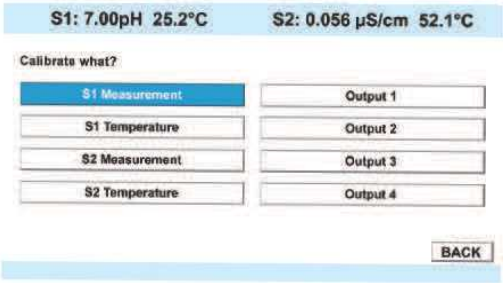
comes about because the sensor really measures the chemical potential of oxygen. Chemical potential is the force that causes oxygen molecules to diffuse from the sample into the sensor where they can be measured. It is also the force that causes oxygen molecules in air to dissolve in water and to continue to dissolve until the water is saturated with oxygen. Once the water is saturated, the chemical potential of oxygen in the two phases (air and water) is the same. Oxygen sensors generate a current directly proportional to the rate at which oxygen molecules diffuse through a membrane stretched over the end of the sensor. The diffusion rate depends on the difference in chemical potential between oxygen in the sensor and oxygen in the sample.

An electrochemical reaction, which destroys any oxygen molecules entering the sensor, keeps the concentration (and the chemical potential) of oxygen inside the sensor equal to zero. Therefore, the chemical potential of oxygen in the sample alone determines the diffusion rate and the sensor current. When the sensor is calibrated, the chemical potential of oxygen in the standard determines the sensor current. Whether the sensor is calibrated in air or air-saturated water is immaterial. The chemical potential of oxygen is the same in either phase. Normally, to make the calculation of solubility in common units (like ppm DO) simpler, it is convenient to use water-saturated air for calibration. Automatic air calibration is standard. The user simply exposes the sensor to water-saturated air. The analyzer monitors the sensor current. When the current is stable, the analyzer stores the current and measures the temperature using a temperature element inside the oxygen sensor. The user must enter the barometric pressure. From the temperature the analyzer calculates the saturation vapor pressure of water. Next, it calculates the pressure of dry air by subtracting the vapor pressure from the barometric pressure. Using the fact that dry air always contains 20.95% oxygen, the analyzer calculates the partial pressure of oxygen. Once the analyzer knows the partial pressure of oxygen, it uses the Bunsen coefficient to calculate the equilibrium solubility of atmospheric oxygen in water at the prevailing temperature. At 25 °C and 760 mmHg, the equilibrium solubility is 8.24 ppm. Often it is too difficult or messy to remove the sensor from the process liquid for calibration. In this case, the sensor can be calibrated against a measurement made with a portable laboratory instrument. The laboratory instrument typically uses a membrane-covered amperometric sensor that has been calibrated against water-saturated air.

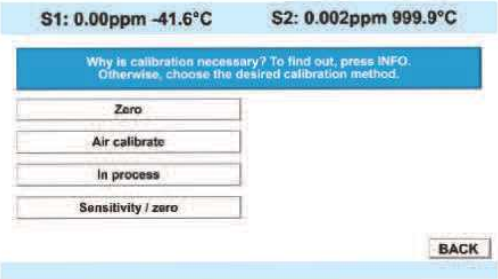
To calibrate the oxygen sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

The following calibration routines are covered:

1. Zero Cal Zeroing the sensor in a medium with zero oxygen
2. Air Cal Calibrating the sensor in a water-saturated air sample
3. In Process Cal Standardizing to a sample of known oxygen concentration
4. Sen@ 25 °C:2500 µA/ppm Entering a known slope value for sensor response.



1. To Zero Calibrate the analyzer with the sensor attached, follow the step-by-step procedures displayed on-screen.

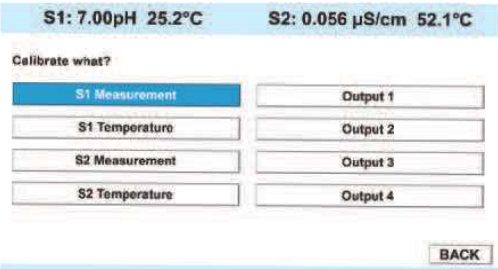


2. To Air Cal Calibrating the sensor in a water-saturated air sample, follow the step-by-step procedures displayed on-screen.
3. To perform an In-Process Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.
4. To calibrate the oxygen sensor by manually Entering a known slope value for sensor response, follow the step-by-step procedures displayed on-screen.

10.8 Calibration — Ozone

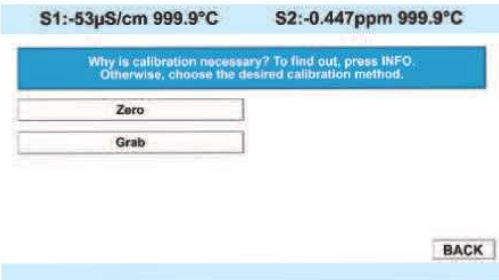
An ozone sensor generates a current directly proportional to the concentration of ozone in the sample. Calibrating the sensor requires exposing it to a solution containing no ozone (zero standard) and to a solution containing a known amount of ozone (full-scale standard). The Zero Calibration is necessary because ozone sensors, even when no ozone is in the sample, generate a small current called the residual or zero current. The analyzer compensates for the residual current by subtracting it from the measured current before converting the result to an ozone value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced. The best zero standard is deionized water. The purpose of the In Process Calibration is to establish the slope of the calibration curve. Because stable ozone standards do not exist, the sensor must be calibrated against a test run on a grab sample of the process liquid. Several manufacturers offer portable test kits for this purpose.

To calibrate the ozone sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.



The following calibration routines are covered:

1. Zero Cal Zeroing the sensor in solution with zero total chlorine
2. Grab Cal Standardizing to a sample of known ozone concentration

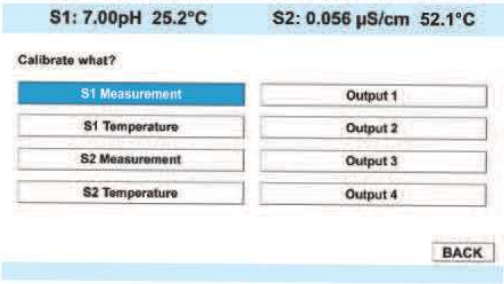


1. To Zero Calibrate the analyzer with the sensor attached, follow the step-by-step procedures displayed on-screen.
2. To perform a Grab Calibration by Standardizing the sensor, follow the step-by-step procedures displayed on-screen.

10.9 Calibrating Temperature

Most liquid analytical measurements require temperature compensation (except ORP). The 56 performs temperature compensation automatically by applying internal temperature correction algorithms. Temperature correction can also be turned off. If temperature correction is off, the 56 uses the manual temperature entered by the user in all temperature correction calculations.

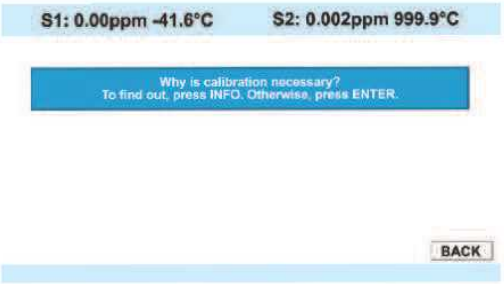
To calibrate temperature, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Temperature and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.



The following calibration routine is covered:

1. Temperature with manual temperature entry

2. To Calibrate Temperature, follow the step-by-step procedures displayed on-screen.

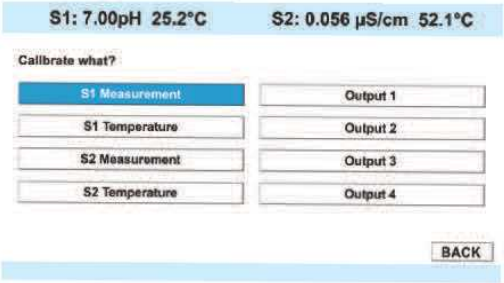


10.10 Turbidity

This section describes how to calibrate the turbidity sensor against a user-prepared standard as a 2-point calibration with deionized water, against a 20 NTU user-prepared standard as a single point calibration, and against a grab sample using a reference turbidimeter.

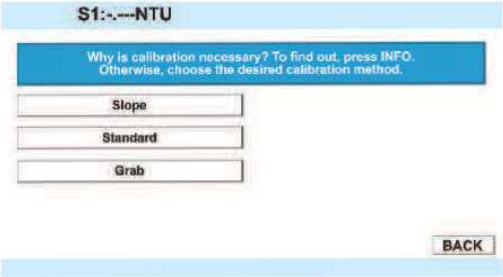
To calibrate the turbidity sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

The following calibration routine is covered:



1. Slope Calibration Slope cal with pure water and a standard of known turbidity
2. Standardize Calibration Standardizing the sensor to a known turbidity
3. Grab Calibration Standardizing the sensor to a known turbidity based on a reference turbidimeter

1. To calibrate the turbidity loop using Slope Calibration with pure water and a standard of known turbidity, follow the step-by-step procedures displayed on-screen.
2. To calibrate the turbidity loop using Standardize Calibration by Standardizing the sensor to a known turbidity, follow the step-by-step procedures displayed on-screen.



3. To calibrate the turbidity loop using Grab Calibration by Standardizing the sensor to a known turbidity based on a reference turbidimeter, follow the step-by-step procedures displayed on-screen.

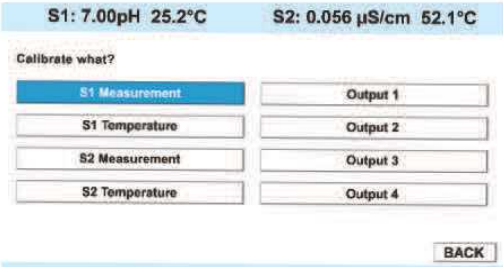
10.11 Pulse flow

A variety of pulse flow sensors can be wired to the Flow signal input board to measure flow volume, total volume and flow difference (if 2 Flow signal boards are installed). The 56 Flow signal board will support flow sensors that are self-driven (powered by the rotation of the impeller paddle-wheel).

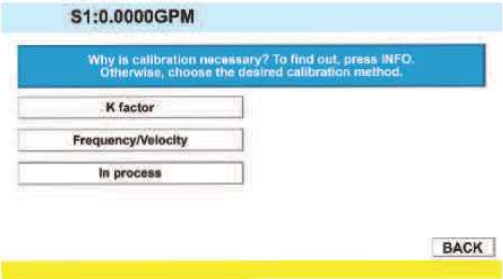
To calibrate the pulse flow sensor, access the Calibration screen by pressing ENTER/MENU from the main screen, select S1 or S2 Measurement and press ENTER/MENU. Press INFO at any time to learn more about this procedure. A yellow screen will appear with detailed instructions and information.

The following calibration routine is covered:

1. K Factor A constant value representing pulses/Gal of flow
2. Frequency/Velocity & Pipe Alternate cal method – requires manual entry of frequency (Hz) per velocity and Pipe diameter used
3. In process Calibration based on known volume per unit of time
4. Totalizer Control User settings to stop, restart and reset total volume meter



1. To enter a K Factor constant value representing pulses/Gal of flow, follow the step-by-step procedures displayed on-screen.
2. To calibrate pulse flow Frequency/Velocity & Pipe as an alternate cal method, follow the step-by-step procedures displayed on-screen.



3. To In-process Calibration the pulse flow sensor based on known volume per unit of time, follow the step-by-step procedures displayed on-screen.
4. To stop, restart and reset Totalizer Control total volume meter, follow the step-by-step procedures displayed on-screen.

Section 11.0 HART® Communications

11.1 Introduction

The 56 can communicate with a HART host using HART Revision 5 or HART Revision 7. The revision of HART used by the 56 can be selected using the keypad/display or a HART master such as AMS or the 475 Handheld Communicator. The default version of HART is Revision 5. Since some HART hosts cannot accommodate HART 7, the choice of HART Revision should be based on the capabilities of the host, and should be chosen as a first step in configuration.

When HART 5 is chosen, the Device Revision of the 56 is Device Revision 1; when HART 7 is chosen the Device Revision is Revision 2, or higher, for later revisions of the 56. The Device Revision of the DD (Device Description) and install files for AMS and DeltaV used should be the same as the Device Revision of the 56.

HART 5 Device Identification (56 Revision 1):

Manufacturer Name: Rosemount

Model Name: 56

Manufacturer ID: 46 (0x2E)

Device Type Code: 86 (0x0056)

HART Protocol Revision: 5.1

Device Revision: 1

Capabilities: Supports all signal boards except the turbidity and flow/4-20mA input signal boards.

HART 7 Device Identification (56 Revision 2):

Manufacturer Name: Rosemount

Model Name: 56

Manufacturer ID: 46 (0x2E)

Device Type Code: 11862 (0x2E56)

HART Protocol Revision: 7.1

Device Revision: 2

Capabilities: Supports all signal boards.

HART 7 Device Identification (56 Revision 3):

Manufacturer Name: Rosemount

Model Name: 56

Manufacturer ID: 46 (0x2E)

Device Type Code: 11862 (0x2E56)

HART Protocol Revision: 7.1

Device Revision: 3

Capabilities: Supports all signal boards and the complete set of parameters for standardized PID with PID transport time feature and TPC control.

11.2 Physical Installation and Configuration

11.2.1 HART Wiring and Output Configuration

HART communications is superimposed on Analog Output 1 for all of the measurements and parameters of the 56. The 4-20 mA current of Analog Output 1 can be configured by the keypad display to be powered by the 56 (Output 1 power: Internal), or by an external 24 VDC power supply, or an I/O that provides power (Output 1 power: External).

11.2.2 HART Multidrop (Bus) Configuration

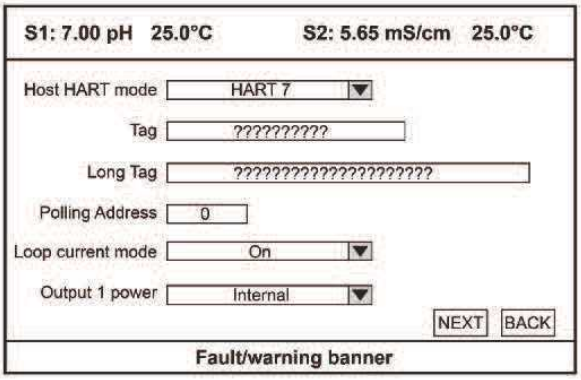
The HART Polling Address should be left at its default value of "0", unless the 56 is used in a Multidrop configuration with up to 14 other transmitters. When the Polling Address is greater than "0", the 4-20 mA output is held at 4 mA or below, and does not change in response to changes in the measurement in HART 5.

In HART 7, Loop Current Mode should be set to "On" to hold the current output to a minimum value. In both HART 5 and HART 7, Output Power should be set to "External" so that an external 24 VDC power supply can be used to power the multidrop bus.

11.2.3 HART Configuration

To access the HART Configuration screens, press the "HART" button in the Main Menu. The following controls are available:

HART Configuration Screen 1: Basic Definitions



- Host HART mode – toggles between HART version 5 and HART version 7. If the HART host being used can accommodate HART 7, HART 7 should be chosen due to its larger feature set. If the host can only use HART 5, then HART 5 must be chosen.

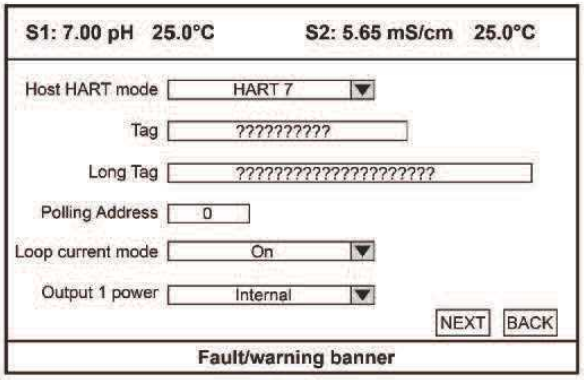
  NOTE: If the 56 is connected to a HART host and the HART version is changed, the host will likely detect the transmitter as a new transmitter with a different device revision number.
- Tag – The traditional 8 character HART tag number
- Long tag – HART tag number of up to 32 characters (HART 7 only).
- Polling address – Choose "0" unless Multidrop is being used. If Multidrop is being used, each transmitter should have its own polling address of from 1 to 15.
- Loop current mode – Set Output 1 current to a minimum value for multidrop applications (HART 7 only).

- Output 1 Power – Select "Internal" to power Output 1 with the 56. Select "External" to power the current loop with an external power supply, e.g. a host I/O that provides power (source) to the transmitter (sink).

HART Configuration Screen 2 Basic Definitions

- Burst command:

  Off – Turns burst mode off



  Cmd 1 – Bursts the Primary Value

  Cmd 2 – Bursts Loop Current + % of range of the Primary Value

  Cmd 3 – Bursts Dynamic Variables (PV, SV, TV, & QV) + Loop Current

  Cmd 9 – Bursts up to 8 Device Variables with time stamp and status (HART 7 only)

  Cmd 33 – Bursts 4 Device Variables

  Cmd 48 – Bursts Additional Transmitter Status Bits (HART 7 only)

  Cmd 93 – Bursts Trend Data (HART 7 only)

- Find device cmd – Setting Find Device to "On", enables the 56 to be indentified by the host. The transmitter returns identity information including device type, revision level, and device ID.
- Response preambles – Preambles synchronize the receiver to the incoming data. Response preambles are the number of bytes of preambles (2 to 20) sent by the 56 at the start of a response packet.

11.3 Measurements Available via HART

A number of live measurements are made available by HART in addition to the main measurements such as pH or Conductivity. All of these measurements are called Device Variables, which can be mapped to the Dynamic Variables PV, SV, TV, and QV for regular reading by the typical HART host.

The 56 assigns the Dynamic Variables PV, SV, TV, and QV to Analog Outputs 1, 2, 3, and 4 respectively. Conversely, measurements assigned to Outputs 1 through 4, will automatically be assigned to PV through QV.

Each measurement board will have its own set of Device Variables, based on the secondary measurements used in making the main measurement. Appendix 1 shows the Device Variable for the each sensor boards used in the 56, and the Dynamic Variables, which they can be mapped to.

11.4 Diagnostics Available via HART

11.4.1 Status Information -- Device Status Bits

Bit 0 **Primary Variable out of Limits:**

This bit is set when PV is out of its limits.

Bit 1 **Non-primary Variable out of Limits:**

This bit is set when non PV is out of its limits.

Bit 2 **Loop Current Saturated:**

This bit is set when the Analog Output 1 current is less than 1.0 mA or greater than 22.0 mA and the Device Status Bytes bit 3 is not set.

Bit 3 **Loop Current Fixed:**

This bit is set when Analog Output 1 does not follow the process. This bit is cleared when Analog Output 1 follows the process.

Bit 4 **More Status Available:**

The "more status available" bit will be set when the device status condition occurs (i.e. bit goes from 0 to 1) on at least one of the Additional Transmitter Status bits are set.

Bit 5 **Cold Start:**

This bit is set when a Master Reset is performed either by Command 42, or a power cycle. This bit is cleared after the first response or burst. In the case of a burst, the first burst always goes to the primary master.

Bit 6 **Configuration Changed:**

This bit is set when the last bytes of an EEPROM writing sequence is completed. Since EEPROM writes are delayed until after the response, the immediate acknowledgement will not have the bit set, however, after the EEPROM write completes, the bit will be set. This bit applies to all EEPROM writes whether or not they apply directly to the configuration of the instrument or not. This bit is cleared when Command 38 is executed.

Bit 7 **Field Device Malfunction:**

This bit is set when any of the following conditions is true, and cleared when all of the following conditions are false:

a) There is at least one main board fault.

b) There is at least one Sensor 1 fault.

c) There is at least one Sensor 2 fault.

11.4.2 Status Information – Extended Device Status Bits (HART 7 only)

Bit 0 **Maintenance Required:**

Any calibration error will set this bit. Any calibration for either Sensor 1 or Sensor 2 that fails will set this bit. This bit gets cleared if all device variables are calibrated successfully.

This bit is set to indicate that, while the device has not malfunctioned, the Field Device requires maintenance.

Bit 1 **Device Variable Alert:**

This bit will get set when at least one of device status byte of all the valid Device Variables does not equal to "good and not limited" (i.e. the higher 4 bits not equal to

0x1100).

This bit is set if any Device Variable is in an Alarm or Warning State. The host should identify the Device Variable(s) causing this to be set using the Device Variable Status indicators.

Bit 3 Critical Power Failures:

This bit will always be cleared on the 56.

11.4.3 Additional Transmitter Status (Command 48)

Additional Transmitter Status provides diagnostic status bits specific to the condition of sensors, sensor boards, and the main board of the 56. Calibration errors and notification of events, such as calibration in progress and relay activation are also indicated by status bits. Appendix 2 shows these bits organized according to the main board or applicable sensor board.

11.5 HART Hosts

A HART host can access live measurements, diagnostic messages, and provide a tool for configuring the measurement and calibrating the 56. Two examples are shown below:

11.5.1 AMS Intelligent Device Manager

The AMS Device Intelligent Device Manager is member of the AMS Suite of asset management applications, which provides tools for configuration, calibration, diagnosing, and documenting transmitters and valves. The following AMS windows are examples of these functions:

11.5.2 475 Field Communicator

HART (and Fieldbus) devices can be access in the field using the 475, which provides the same basic functionality as the AMS Intelligent Device Manager. Asset management information can be uploaded into the AMS database from the 475 for a common database for asset management data. The 475 uses a color menu driven display.

11.6 Wireless Communication using the 56

The 56 can communicate by Wireless HART using the Smart Wireless THUM Adaptor and

FIGURE 11-1 Main Measurement and Overall Status

FIGURE 11-2 Device Variables and Dynamic Variables

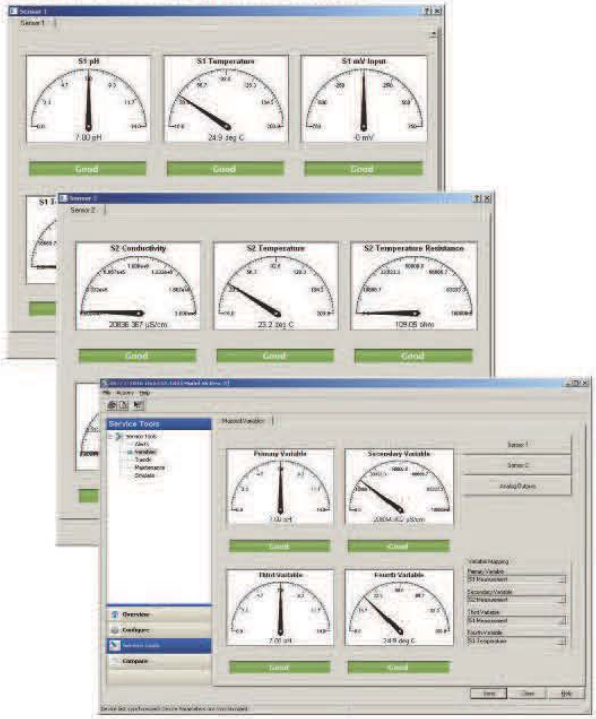


FIGURE 11-3 Diagnostic Messages (Additional Transmitter Status)

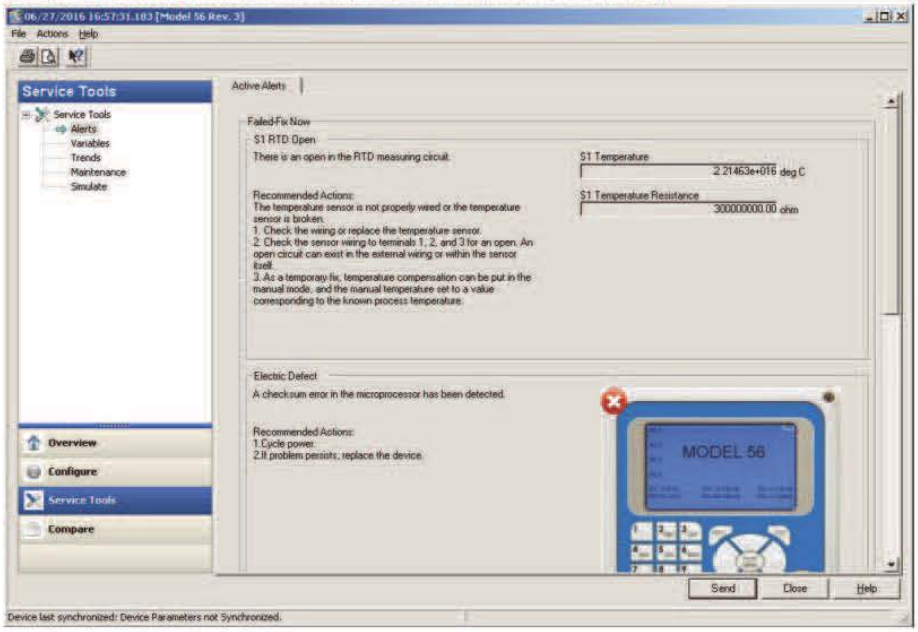


FIGURE 11-4 Configuration

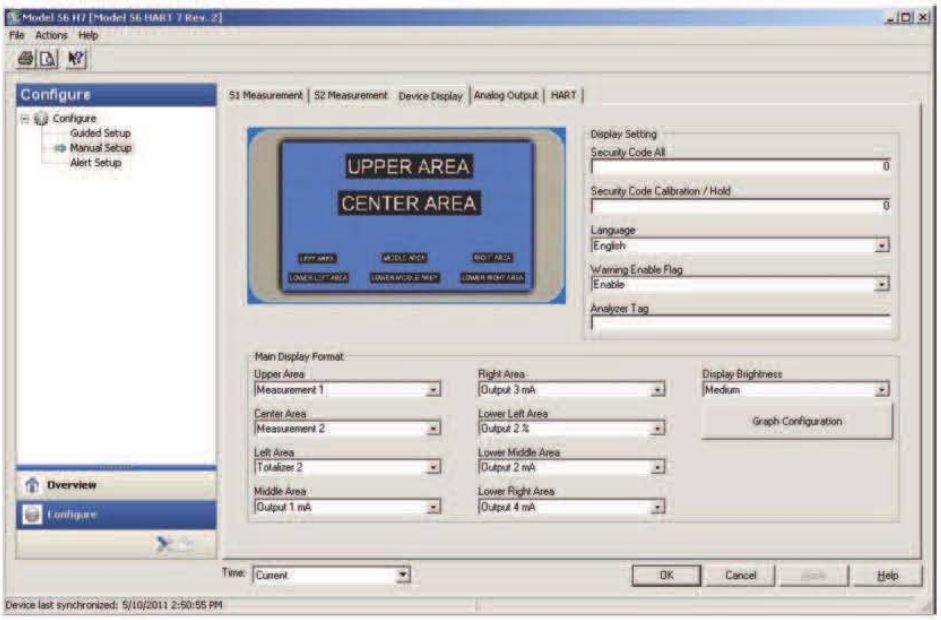
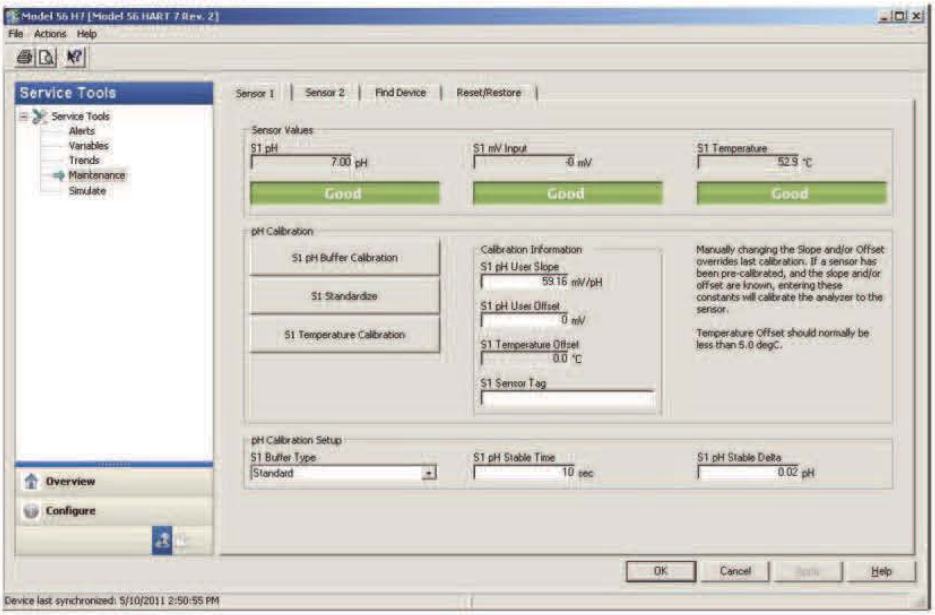


FIGURE 11-5 Calibration



the 1420 Smart Wireless Gateway. All the information available with the wired device can be accessed wirelessly, making it possible to have the measurements and benefits of HART communication in locations where running cable would be difficult or prohibitively expensive.

Although HART 5 or HART 7 can burst the Dynamic Variables (PV, SV, TV, & QV), HART 7 should be used with the THUM because up to 8 Device Variables can be continually burst using Command 9.

11.7 Field Device Specification (FDS)

For more details on the implementation of HART in the 56 and its command structure, the Field Device Specification for the relevant Device Revision should be consulted. They can be downloaded from our website.

Section 12.0 Profibus Communications

12.1 General

The 56 can communicate using Profibus DP-V1 by purchasing a 56 with a Profibus communication board installed (model code 56-PC-02-DP), or by adding a Profibus communications board to the standard 56 with HART communications.

The standard HART 56 analyzer can be converted to Profibus DP by adding a Profibus board. There are two different Profibus boards for the 56, which must be chosen to be compatible with the main board software version of the 56.

- If the 56 software version begins with a 2 (2.XX), Profibus board PN 24285-02 should be chosen.
- If the 56 software version begins with a 1 (1.XX), Profibus board PN 24285-01 should be chosen.

A 56 with Profibus communications retains all the analog and discrete functionality of the standard HART 56 transmitter. The four 4 to 20 mA analog outputs can be configured as analog outputs or PID control outputs.

The four discrete relay outputs can be configured for concentration control (high/low alarms with or without a delay timer), event based activation, timer based activation, or TPC (Duty Cycle/ Pulse Width Modulation) control.

12.2 Profibus Features

As outlined in the Device Description Data Field (GSD), the 56 has the following Profibus DP-V1 identification and capabilities:

Identification:

GSD Revision: 5

Vendor Name: Rosemount

Model Name: MODEL 56 PROFIBUS DP

Revision: V1.00

Identification Number: 0x10AA

Hardware Release: V1.00

Software Release: V1.00

Implementation Type: VPC3+C

Device: DP-V1 Slave

Baud Rates Supported:

All Profibus DP baud rates are supported, from 9.6 kbps to 12 Mbps.

Additional Capabilities:

- The 56 Profibus board supports the **automatic transmission rate recognition**. It automatically sets its baud rate to the transmission rate of the Profibus network, specified by the master.

- The DP device supports the function **Set_Slave_Add** for setting the slave address via the PROFIBUS. The slave address for the 56 can be set automatically or manually by the Profibus master.

  The DP device supports DP-V0 cyclic services and Identification and Maintenance (I&M) function: - I&M 0
- The **Minimum Slave Interval** is 100 sec minimum interval between two poll cycles.

56 Modules

The 56 is a multiparameter device, which supports a number of combinations of 2 analytical measurements, and four relays which can be configured for a number of discrete functions. As a result, the 56 is defined as a modular station, to allow it to cover these measurements, relay status, and associated information. The 56 has 36 modules available and 33 can be inserted into the device. They include:

- The two main measurements, their units, and the measurement
- The temperature measurements from each board and their units
- Dual conductivity measurements: conductivity ration, percent passage and percent rejection
- Dual flow board measurements: flow recovery, flow difference, and flow unit
- Alarm relays (4 possible): their type, state, logic assignment and simulate status

Details of the module are in Section 12.3 Profibus Communications.

56 Device Diagnostics

A number of diagnostic bits are provided via Profibus, which cover the fault and warning messages for the 56 main board, signal boards, and measurements. They are organized as follows:

Table 12-1. Device Diagnostic Bits

Diagnostic Bits*	Bit Description
16	Change in Diagnostic Data
24-27	Main Board Faults
33-38	Main Board Warnings
40-57	Signal Board 1 and Measurement Faults
72-89	Signal Board 2 and Measurement Faults
104-121	Signal Board 1 and Measurement Warnings
136-153	Signal Board 2 and Measurement Warnings

*Bit position after the header byte.

Details of the diagnostic bits appear in Tables 12.3.10 and 12.3.11.

12.3 Profibus Communications

12.3.1 Configuring the 56 for Profibus Communications

Baud Rates

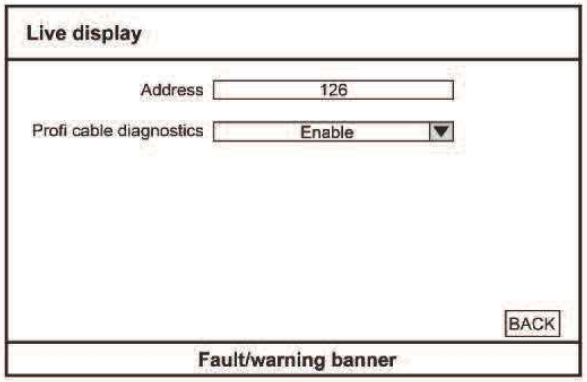
The 56 supports all the baud rates of Profibus DP as shown in Table 12.2.1 below. Since the 56 supports transmission rate recognition, it will recognize the baud rate used on the network, and set its own baud rate to match the network's rate.

Table 12-2. Baud Rates Supported

Baud Rate	Maximum Response Time for Responders (unit is bit time)
9.6 kbps	60
19.2 kbps	60
45.45 kbps	60
93.75 kbps	60
187.5 kbps	60
500 kbps	100
1.5 Mbps	150
3 Mbps	250
6 Mbps	450
12 Mbps	800

Slave Address

The 56 supports the set slave address function, which makes it possible for the Profibus master to set the slave address of the 56. Some Profibus masters cannot set slave addresses, and the slave addresses have to be set in each slave device. If this is case, the slave address can be set in the 56 by pressing the Enter/Menu key and selecting DP: Profibus, which will launch the Profibus configuration window:



- The Profibus address is writeable up to a value of 126.
- At the same time the slave address is being set, Profibus cable diagnostics should be enabled. These diagnostics provide a useful tool for troubleshooting cable connection problems.

12.3.2 Profibus Faults and Warnings

Faults

The 56 displays the following hardware faults associated with problems related to the Profibus board and its connection to the main board:

- **Profibus board mismatch** - The revision of the installed Profibus board is not compatible with the main board of the transmitter. Note the revisions of the Profibus board and the main board of the transmitter and contact the factory.
- **Self-test failed** - At power up, the Profibus board conducts several internal self tests. At least one of them failed.
  1. Try to reset the analyzer by cycling the power.
  2. Replace the Profibus board
- **Internal communication failed** - The main board detects the Profibus board, but the Profibus board is not communicating with the main board.
  1. Try to reset the analyzer by cycling the power.
  2. Check the interconnecting cable between the Profibus and main board.
  3. Replace the Profibus board.

Warnings

Warnings related to cable problems and software compatibility are also displayed, if Profibus cable diagnostics are enabled:

- **Cable shorted or open** - No Profibus cable is connected, or the A and B leads of the cable are shorted.
- **Check Profibus Cable** - The A and B leads in the Profibus cable may be reversed. If standard Profibus cable is used, the green lead should be wired to position A and the red lead to position B. The bus may not have a terminator, or it may not be turned on. Check to see that a terminator is present and turned on.
- **Profibus function limited** - The Profibus board has new features that the main board software does not support. If this is the case, the minor revision number of the Profibus board will be greater than the minor revision number of the main board. Replace the main board.

Details on these faults and warnings are accessed like any other fault or warning in the 56: Press the INFO key and then select "Faults – fix now" or "Warnings – fix soon."

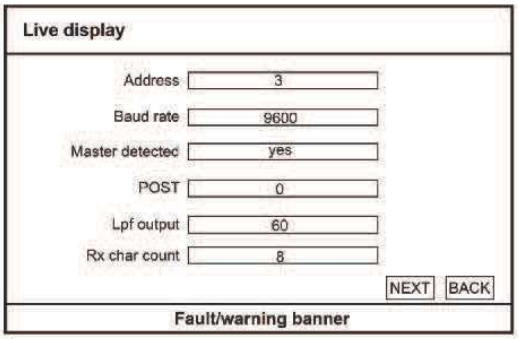
LED Diagnostics

The Profibus board itself displays diagnostic information via an LED, which is located on the upper right side of an installed board:

- **Slow blink** – No cable is present or the connection is shorted
- **Slow, even blinking** – reversed A and B cable connection
- **Quick flashing** – Profibus message detected
- **1 second blinking** – self-test failure
- **Off** – no power or a defective or missing ribbon cable

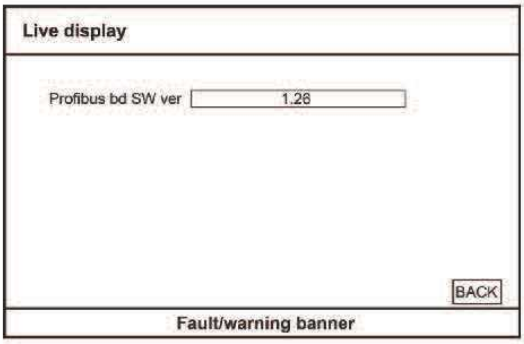
Diagnostic Information

The 56 provides diagnostic information on Profibus communications, which is accessed by pressing the INFO key and then selecting "Profibus information" to launch the window below:



- Address – displays the address being used by the 56 on the network
- Baud rate – the baud rate of the 56 and the network
- Master detected – If the master is not detected, the host and analyzer are not communicating. Check wiring connections, make sure the addresses match, and try changing the baud rate.
- POST, Lpf output, Rx character count – POST is the power-on self test. POST and the remaining parameters on this window are used as factory diagnostics only.

Pressing the NEXT button brings up the final diagnostic parameter, the software version used by the Profibus board:



12.4 Data Transmission

General

The 56 uses RS-485 communication technology for transmission. When messages are transmitted on Profibus networks, for word transfer (more than one byte), the high byte is transferred first, followed by the low byte (Big-Endian/Motorola format).

56 Modules

The details of measurement modules and relay modules are shown below in the following tables:

12.4.1 Measurement Modules

Table 12-3. Measurement Modules

Module	Module Name	Data Type	Size Bytes	Identifiers
	Signal Input Board 1			
1	PV1 Value	float	4	0x41,0x83,0x01
2	PV1 Unit	uint	2	0x41,0x81,0x02
3	PV1 Type	uchar	1	0x41,0x80,0x03
4	Temperature1	float	4	0x41,0x83,0x04
5	Temperature1 Unit	uint	2	0x41,0x81,0x05
	Signal Input Board 2			
6	PV2 Value	float	4	0x41,0x83,0x06
7	PV2 Unit	uint	2	0x41,0x81,0x07
8	PV2 Type	uchar	1	0x41,0x80,0x08
9	Temperature 2	float	4	0x41,0x83,0x09
10	Temperature 2 Unit	uint	2	0x41,0x81,0x0A
	Dual Conductivity Input Boards			
11	Conductivity Ratio	float	4	0x41,0x83,0x0B
12	% Passage	float	4	0x41,0x83,0x0C
13	% Rejection	float	4	0x41,0x83,0x0D
	Dual Flow Input Boards			
14	Flow Recovery	float	4	0x41,0x83,0x0E
15	Flow Difference	float	4	0x41,0x83,0x0F
16	Flow Unit	uint	2	0x41,0x81,0x10

Table 12-4. Measurement Unit Codes and Units

Unit Code	Unit	Unit Code	Unit	Unit Code	Unit
1001	°C	1212	µA	1364	GPH
1002	°F	1213	nA	1423	ppm
1034	m3	1243	mV	1424	ppb
1038	L	1274	pH	1425	ppth
1043	ft3	1281	Ohm	1521	ppb-ppm
1048	Gallon	1282	Gohm	1522	ug/L-mg/L
1059	h	1283	Mohm	1523	None
1060	d	1284	Kohm	1524	% Oxygen in Gas
1061	m/sec	1289	mS	1525	ppm Oxygen in Gas
1067	ft/sec	1290	µS	1526	NTU
1105	g/L	1295	Ohm-cm	1527	FTU
1133	kPa	1302	mS/cm	1528	FNU
1137	bar	1342	%	1551	S/cm
1138	mbar	1349	m3/hour	1552	µS/cm
1140	atm	1352	L/min	1555	M Ohm-cm
1155	in Hg	1353	L/hour	1556	k Ohm-cm
1157	mm Hg	1357	cu ft/min	1558	mg/L
1190	kwatt	1358	cu ft/hour	1559	µg/L
1211	mA	1363	GPM	1560	% Saturation

Table 12-5. Measurement (PV 1 and PV 2) Types

Types	Measurement	Types	Measurement
0	Unknown	14	Custom Concentration
1	pH	15	Total Dissolve Solids
2	ORP	16	Salinity
3	Redox	17	Oxygen
4	Ammonia	18	Ozone
5	Fluoride	19	Free Chlorine
6	Custom ISE	20	pH Independent Free Chlorine
7	Conductivity	21	Total Chlorine
8	Resistivity	22	Chloramine
9	NaOH	23	Flow
10	HCl	24	mA Input
11	Low Range H_2SO_4	25	Turbidity
12	High Range H_2SO_4	26	Total Suspended Solids
13	NaCl		

Measurement modules provide the PV value for each signal board, the PV unit (Table 12-3), and the PV type (Table 12-4)

12.4.2 Relay Modules

Table 12-6. Measurement Modules

Module	Module Name	Data Type	Size Bytes	Identifiers
	Relay 1			
17	Alarm1 Type	uchar	1	0x41,0x80,0x11
18	Alarm1 State	uchar	1	0x41,0x80,0x12
19	Alarm1 Logic	uchar	1	0x41,0x80,0x13
20	Alarm1 Assignment	uchar	1	0x41,0x80,0x14
21	Alarm1 Simulate Status	uchar	1	0x41,0x80,0x15
	Relay 2			
22	Alarm2 Type	uchar	1	0x41,0x80,0x16
23	Alarm2 State	uchar	1	0x41,0x80,0x17
24	Alarm2 Logic	uchar	1	0x41,0x80,0x18
25	Alarm2 Assignment	uchar	1	0x41,0x80,0x19
26	Alarm2 Simulate Status	uchar	1	0x41,0x80,0x1A
	Relay 3			
27	Alarm3 Type	uchar	1	0x41,0x80,0x1B
28	Alarm3 State	uchar	1	0x41,0x80,0x1C
29	Alarm3 Logic	uchar	1	0x41,0x80,0x1D
30	Alarm3 Assignment	uchar	1	0x41,0x80,0x1E
31	Alarm3 Simulate Status	uchar	1	0x41,0x80,0x1F
	Relay 4			
32	Alarm4 Type	uchar	1	0x41,0x80,0x20
33	Alarm4 State	uchar	1	0x41,0x80,0x21
34	Alarm4 Logic	uchar	1	0x41,0x80,0x22
35	Alarm4 Assignment	uchar	1	0x41,0x80,0x23
36	Alarm4 Simulate Status	uchar	1	0x41,0x80,0x24

Table 12-7. Alarm Types

Alarm Type Code	Alarm Type
0	Set Point Alarm
1	Interval Timer
2	TPC (Duty Cycle)
3	Bleed Alarm
4	Feed Alarm
5	Setpoint Alarm + Delay Timer
6	Date and Time Timer
7	Totalizer Timer
8	Fault Alarm
9	No Alarm Assigned to Relay

Table 12-8. Alarm States

0	Off
1	On

Table 12-9. Alarm Logic

Code	Logic
0	High Alarm
1	Low Alarm
2	USP Alarm (Contacting Conductivity Only)

Table 12-10. Alarm Simulation

Code	State
0	Off
1	De-Energize
2	Energize

Table 12-11. Alarm Assignment Codes

Sensor 1	Sensor 2	Variable Assigned
1	41	Process Variable
2	42	Temperature
4	44	Amperometric Sensor Current
7	47	Millivolt Input
9	49	Glass electrode Impedance
11	51	Reference Electrode Impedance
14	54	Raw Conductivity
15	55	Raw Resistivity
16	56	Turbidity
18	58	Flow Velocity
19	59	Totalized Flow
33	73	Free Ions
Dual Sensor and Main Board Assignments:		
	0	Main Board Temperature
	201	Conductivity Ratio
	202	% Rejection (Conductivity)
	203	% Passage (Conductivity)
	204	Calculated pH (Conductivity)
	205	Flow Ratio
	206	Percent Flow Ratio
	207	Flow Recovery
	208	Flow Difference
	209	Totalized Flow Difference

Relay Modules provide the alarm type, state, logic, assignment, and simulation status as shown in Tables 12-5 to 12-10:

12.4.3 Transmitter Diagnostic Bits

The 56 transmits diagnostic bits associated with main board and signal board faults and warnings, as well as faults and warning specific to the sensors used to make the various measurements. These bits are shown organized by main board, signal board and measurement, with and explanation of the fault or warning in Tables 12-11 to 12.13.

Table 12-12. Main Board Diagnostic Bits – Main Board Faults

Main Board Faults		
Bit	GSD Descriptor	Help
16	Change In Diagnostic Data	A diagnostic bit has changed state
24	Main Board CPU Error	The main board software is corrupted. 1. Try to reset the analyzer by turning the power off then on again. 2. Call the factory. The main board must be replaced (at the factory).
25	Main Board User Data Error	The main board user EEPROM data is corrupted. 1. Try to reset the analyzer by turning the power off then on again. 2. Reset the analyzer to factory default settings. Go to main menu and select Reset. Re-enter user settings and repeat calibra-
26	Main Board Factory Data Error	The main board factory EEPROM data is corrupted. 1. Try to reset the analyzer by turning the power off then on again. 2. Call the factory. The main board must be replaced (at the factory).
27	Main Board Wrong Power Supply	The existing power supply is incorrect for the turbidity sensor. Replace power supply.

Table 12-13. Main Board Diagnostic Bits – Main Board Warnings

Main Board Warnings		
Bit	GSD Descriptor	Help
33	Unknown Power Supply	The main board software cannot identify the power supply. 1. Check the ribbon cable connections between the power supply board and main board. 2. Check the ribbon cable for damage. 3. Consult the factory.
34	Line Frequency Unknown	The analyzer has detected an AC power source, but the frequency is not 50 Hz or 60 Hz. 1. Check the ribbon cable connections between the power supply board and main board. 2. Check the mains frequency.
35	Main Board Factory Cal	The analyzer was not calibrated at the factory. 1. Try to reset the analyzer by turning the power off then on again. 2. Call the factory.
36	Keypad Error	The analyzer has detected shorted contacts in at least one key. Call the factory.
37	Overheating LCD Warning	High ambient temperature and high temperature inside the analyzer is causing the LCD to overheat, reducing the operating life of the display. The analyzer automatically begins reducing the brightness of the display at 55 °C (131 °F). At 78 °C (172 °F) analyzer turns off the display and stops storing data in the flash drive (if one is installed). At 85 °C (185 °F) the analyzer turns off the analog current outputs. At 90 °C (194 °F) the analyzer turns off the relays. As the temperature cools, the functions are restored. To prevent shutdown of the display and loss of other analyzer functions, move the analyzer to a cooler place.
38	Excess Output Current	One or more analog outputs are drawing too much current, and all outputs have been shut down. The analyzer will check the current every 30 seconds and will return the outputs to normal operation once the current drops below the shutdown limit. Check analog output wiring. A short from the positive terminal to ground will cause excessive current to flow. Even if only one output is shorted, all four outputs will be shut down. If no wiring problems are found, the main board has been damaged and must be replaced.

Table 12-14. Signal Board Diagnostic Bits

Diagnostic Bits		
Signal Board 1 / 2	GSD Descriptor	Help
40 / 72	SN 1/2 Board Unknown (Fault)	The analyzer automatically recognizes the sensor board on power up. Sensor board unknown implies the sensor board is new and not supported or there is a bad connection between the sensor board and the main board. 1. Check ribbon cable connections at the main board and sensor board. 2. Inspect ribbon cable for damage and replace if necessary. 3. Replace sensor board.
41 / 73	SN 1/2 HW SW Mismatch error (Fault)	The main board software does not match the sensor board software. 1. Check ribbon cable connections at the main board and sensor board. 2. Inspect ribbon cable for damage and replace if necessary. 3. Replace sensor board.
42 / 74	SN 1/2 Incompatible Error (Fault)	The sensor board software is not supported by the main board. Either the sensor board software is too old or the main board software is too old. Replace the main board with one compatible with the sensor board. Call the factory for assistance. The main board must be replaced at the factory.
43 / 75	SN 1/2 Not Detected	The sensor board is no longer being detected. 1. Check ribbon cable connections at the main board and sensor board. 2. Inspect the ribbon cable for damage and replace if necessary. 3. Replace the sensor board.
44 / 76	SN 1/2 Not Communicating (Fault)	The analyzer automatically recognizes the sensor board on power up. Sensor not communicating implies there is a bad connection between the sensor board and the main board or there is a bad component on the sensor board. 1. Check ribbon cable connections at the main board and sensor board. 2. Inspect the ribbon cable for damage and replace if necessary. 3. Replace the sensor board.
45 / 77	SN 1/2 CPU error (Fault)	The sensor board software is corrupted. 1. Try to reset the analyzer by turning the power off then on again. 2. If cycling the power does not help, replace the sensor board.
46 / 78	SN 1/2 Factory Data Error (Fault)	The factory-entered EEPROM data on the sensor board is corrupted. 1. Try to reset the analyzer by turning the power off then on again. 2. Replace the sensor board.
47 / 79	SN 1/2 ADC Error (Fault)	There is a bad hardware component on the sensor board. Replace the sensor board.
50 / 82	SN 1/2 Hardware Error (Fault)	Hardware error means there is a missing or bad hardware component on the sensor board. Replace the sensor board.
54 / 86	SN 1/2 User Data Error (Fault)	The user-entered EEPROM data on the sensor board is corrupted. 1. Try to reset the analyzer by turning the power off then on again. 2. Replace the sensor board.
55 / 87	SN 1/2 EEPROM Write Error (Fault)	There is a bad CPU on the sensor board. 1. Try to reset the analyzer by turning the power off then on again. 2. Replace the sensor board.
104 / 136	SN 1/2 Need Factory Cal (Warning)	The sensor board was not calibrated at the factory. Call the factory.

Table 12-14. Signal Board Diagnostic Bits – continued

Temperature Faults and Warnings		
Signal Board 1 / 2	GSD Descriptor	Help
48 / 80	SN 1/2 RTD Open (Fault)	The temperature measuring circuit is open. The RTD is improperly wired or the RTD IN or RTD RTN are broken. 1. Check RTD wiring connections. 2. Check RTD for open or short circuits.
49 / 81	SN 1/2 RTD Out Of Range (Fault)	The resistance of the temperature sensing element (RTD) is too large or too small. The sensor is wired improperly, or the temperature sensor is not recognized by the sensor board. 1. Check sensor wiring. 2. Check that the temperature sensing element is compatible with the analyzer. It must
105 / 137	SN 1/2 Temperature High (Warning)	**pH and Amperometric Measurements** The measured temperature is greater than 155 °C. 1. Check wiring. 2. Disconnect the sensor and check the resistance between the RTD in and RTD return wires. It should be about 110 ohm at room temperature. 3. Replace the sensor if the RTD has failed.
		Contacting Conductivity Measurements The measured temperature is greater than 300 °C. 1. Check wiring. 2. Disconnect sensor and check resistance between RTD in and RTD return wires. It should be about 1100 ohm at room temperature. 3. Replace sensor if RTD has failed.
		Toroidal Conductivity Measurements The measured temperature is greater than 200 °C. 1. Check wiring. 2. Disconnect sensor and check resistance between RTD in and RTD return wires. It should be about 110 ohm at room temperature. 3. Replace sensor if RTD has failed.
106 / 138	SN 1/2 Temperature Low (Warning)	**pH and Amperometric Measurements** The measured temperature is less than -20 °C. 1. Check wiring. 2. Disconnect the sensor and check the resistance between the RTD in and RTD return wires. It should be about 110 ohm at room temperature. 3. Replace the sensor if the RTD has failed.
		Contacting and Toroidal Conductivity Measurements The measured temperature is less than -40 °C. 1. Check wiring. 2. Disconnect the sensor and check the resistance between the RTD in and RTD return wires. It should be about 110 ohm at room temperature. 3. Replace the sensor if the RTD has failed.
107 / 139	SN 1/2 RTD Sense Line Open (Warning)	The analyzer uses the sense line to correct for the resistance of the RTD leads and for changes in the lead wire resistance caused by variations in ambient temperature. 1. Check wiring. 2. Disconnect the sensor and check for continuity between the RTD return and RTD sense leads at the sensor. 3. If sensor has failed, use a wire jumper to connect the RTD sense and return terminals. 4. Replace the sensor.

Table 12-14. Signal Board Diagnostic Bits – continued

pH / ISE Faults and Warnings		
Signal Board 1 / 2	GSD Descriptor	Help
51 / 83	SN 1/2 Ref Z Too High (Fault)	The impedance of the reference junction is too high. 1. Confirm that the sensor is fully immersed in the process liquid. 2. High reference impedance implies the reference junction is fouled or depleted. Replace the sensor. 3. Some sensors are designed to have high reference impedance. If this is the case, change the reference impedance setting (in the measurement menu) to high.
52 / 84	SN 1/2 Glass Z Too High (Fault)	The sensing element in a pH sensor is a thin glass membrane. Normally, the impedance of the membrane is 80 – 100 megohm. As the glass ages, impedance increases. A large increase in impedance implies the sensor is near the end of its useful life. Certain ion selective electrodes (fluoride, ammonia, and ammonium) also have high impedance sensing elements. 1. Confirm that the sensor is fully immersed in the process liquid. 2. If sensor performance in buffers and the process is acceptable, increase the impedance limit. 3. Replace the sensor.
53 / 85	SN 1/2 Broken Glass Fault (Fault)	The sensing element in a pH sensor is a thin glass membrane. In a good sensor, the glass impedance is very high. If the glass bulb breaks or cracks, the impedance drops to a very low value, and the broken glass fault appears. Certain ion selective electrodes (fluoride, ammonia, and ammonium) also have high impedance sensing elements. 1. Inspect the sensor for obvious damage. 2. Check the sensor in buffers. If the sensor does not respond to pH changes, the glass is broken. 3. Replace the sensor.
108 / 140	SN 1/2 Out Of Range pH Brd (Warning)	The pH input is outside the range -750 mV to +750 mV or the ORP or ISE input is outside the range -1500 mV to +1500 mV. Check sensor wiring. Replace sensor.
111 / 143	SN 1/2 No Solution Gnd (Warning)	The sensor is not properly wired. Check wiring.
115 / 147	SN 1/2 Broken Glass Disabled (Warning)	The impedance of the sensing glass in a pH sensor is a strong function of temperature. For the impedance to be a useful indicator that the sensing glass is cracked or broken, it must be corrected for temperature. If the process temperature exceeds the correction cut-off temperature, the broken glass fault is automatically disabled. The analyzer recalculates the cut-off temperature every time the sensor is calibrated. The cutoff temperature is about 115 °C.

Table 12-14. Signal Board Diagnostic Bits – continued

Conductivity Faults and Warnings		
Signal Board 1 / 2	GSD Descriptor	Help
109 / 141	SN 1/2 Out Of Range Cont/Tor Brd	**Contacting Conductivity Measurements** The raw conductance is greater than 1 S. 1. Check sensor wiring. 2. Check sensor cleanliness. 3. Check the sensor electrodes for shorts.
		Toroidal Conductivity Measurements The raw conductance is greater than 2 S. 1. Check sensor wiring. 2. Check sensor electrodes for shorts.
112 / 144	SN 1/2 -ve Rdng Cont/Tor Brd (Warning) (Negative conductivity reading)	**Contacting Conductivity Measurements** Negative Reading: During zero calibration, the analyzer makes a correction for the conductance equivalent of the cable capacitance. If the difference between the measured conductance and the zero correction is less than -2 uS, the negative reading warning appears. 1. Repeat zero calibration. Be sure the sensor is completely dry. 2. Confirm that the sensor is completely submerged in the process liquid.
		Toroidal Conductivity Measurements Negative Reading: During zero calibration, the analyzer makes a correction for small offsets in the signal that exist even when the conductance is zero. If the difference between the measured conductance and the zero correction is less than -50 uS, the negative reading warning appears. 1. Repeat zero calibration. Be sure the sensor is completely dry. 2. Confirm that the sensor is completely submerged in the process liquid.
113 / 145	SN 1/2 Out Of Range (Warning)	The calculated concentration or temperature is out of range. 1. NaOH: 0 – 12.00%, 0 - 100 °C. 2. HCl: 0 – 15.00%, 0 - 65 °C. 3. H_2SO_4 (low): 0 – 25.00%, -1 - 99 °C. 4. H_2SO_4 (high): 96.0 – 99.7%, 4 - 110 °C. 5. NaCl: 0 – 20.00%, 0 - 100C. 6. Salinity: 2 – 42 part per thousand, -2 - 35 °C.

Amperometric Faults and Warnings		
Signal Board 1 / 2	GSD Descriptor	Help
110 / 142	SN 1/2 -ve Rdng Amp/Oxy Brd (Warning) (Negative amperometric reading)	The analyzer subtracts the zero current (the current generated by the sensor when no analyte is present) from the measured current before converting the result into a concentration value. A negative reading implies the zero step was done before the sensor reached a stable zero current. Repeat the zero calibration. It may require several hours or as long as overnight for the zero current to stabilize.
114 / 145	SN 1/2 Pressure Sensor Broken (Warning)	The pressure sensor on the oxygen sensor board has failed, or it is not installed, or it is installed backwards. Replace the sensor board.

Table 12-14. Signal Board Diagnostic Bits – continued

Flow / 4 to 20 mA Input Faults and Warnings		
Signal Board 1 / 2	GSD Descriptor	Help
117 / 149	SN 1/2 No Flow Detected (Warning)	The analyzer has sensed no flow for at least ten seconds. 1. Check that the flow exceeds the minimum flow recommended for the sensor. 2. Check wiring. 3. Check the sensor
118 / 150	SN 1/2 -ve Current (Warning) (Negative 4-20 mA input current)	The input current from the device is less than -0.1 mA. 1. The polarity is wrong. Reverse wiring. 2. Check the current source.
119 / 151	SN 1/2 Execessive Current (Warning)	The input current from the device is greater than 22.00 mA. 1. Check wiring. 2. Check the current source.
120 / 152	SN 1/2 Low Current (Warning)	The input current range has been set to 4-20 mA, and the input current is less than 3.6 mA. 1. Check the input current range configuration. 2. Check configuration of current source.

Turbidity Faults and Warnings		
Signal Board 1 / 2	GSD Descriptor	Help
27	Main Board Wrong Power Supply (Fault)	The existing power supply is incorrect a the turbidity sensor. Replace power supply.
56 / 88	SN 1/2 Lamp Led Fail (Fault)	The lamp or LED has failed. 1. Try to reset the analyzer by turning the power off then on again. 2. Replace the sensor.
57 / 89	SN 1/2 Disconnected (Fault)	The turbidity sensor cable is disconnected at either the sensor or the sensor board. 1. Confirm that the cable is tightly connected to the sensor receptacle. If necessary, completely disconnect the cable and reconnect it. Check connectors for cleanliness. 2. Confirm that the cable is tightly connected to the board receptacle. If necessary,
116 / 148	SN 1/2 Weak Lamp (Warning)	The lamp intensity has decreased below the lower limit. The lamp is aging and should be replaced as soon as possible.
121 / 153	SN 1/2 Needs calibration (Warning)	The analyzer continuously measures the intensity of the lamp and uses the measured intensity to correct for the effect of lamp drift on measured turbidity. As the lamp ages and its intensity drops, the target intensity is adjusted. Readjusting the target intensity introduces a significant error. To remove the error, the sensor must be recalibrated. 1. Recalibrate the sensor in 20 NTU standard. 2. Order replacement sensor.

12.5 Installation and Wiring

12.5.1 General

This section shows the recommended method of wiring the Profibus cable to the Profibus card of the 56.

Recommended Wiring Steps

1. Feed the Profibus cable through a cable gland fitting. Install the cable gland fitting into the enclosure opening on the leftmost side of the enclosure nearest the front of the door hinge. See photo. Note that the power cable should be installed in the leftmost side of the enclosure farthest from the front of the door hinge, as shown in the photo below:

FIGURE 12-1. Proper enclosure opening locations for cable installation.

2. Secure the Profibus cable with a cable gland fittings and nut from the outside of the enclosure to ensure a proper seal. Note that the cable gland fittings (PN 23554-00 - Cable Gland Kit, Quantity 5) do not require the securing nut inside the enclosure to properly install the fitting. Simply thread the fitting into the grounding plate inside the enclosure and tighten.

Once the gland fitting is tightly screwed into the enclosure and internal grounding plate, only the external nut needs to be tightened to properly seal the Profibus cable.

FIGURE 12-2, Cable gland fittings secured on internal grounding plate.

3. Remove the 4-lead terminal block which is installed on the Profibus slide-in board. This photo shows the 4-lead terminal block installed onto the board:

FIGURE 12-3. Profibus board showing removable 4-lead terminal block

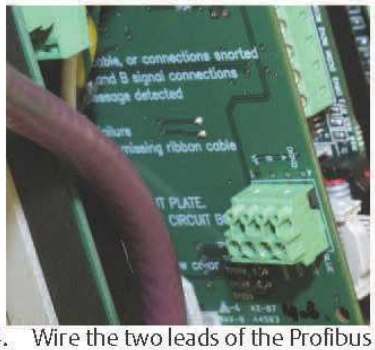
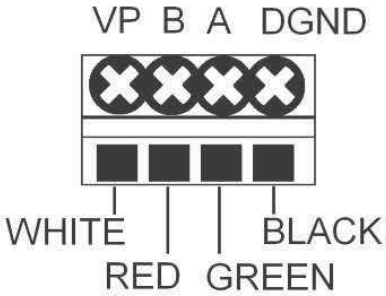


FIGURE 12-4. 4-Lead Terminal Block



4. Wire the two leads of the Profibus cable (red and green) to the A and B positions of the 4-lead removable terminal block. A #0 Philips head screw driver is required to open and close the terminal posts on the terminal block. The lead positions are labeled on the Profibus card (A and B) to assist in wiring.

Note: For successful communication using standard Profibus cable:
The Green color lead must be wired to lead position A (RxD/TxD-N).
The Red color lead must be wired to lead position B (RxD/TxD-P).
The VP and DGND (digital ground) positions are used to a power bus terminator if required.

⚠ CAUTION

Make sure the Profibus cable is properly prepared. Unshielded wire leads can lead to poor signal integrity from the Profibus device to the Master

5. After wiring the Profibus cable to the terminal block, slide the wired 4-lead terminal block onto the 4 pins protruding from Profibus board on the left side.

   Photo shows the 4-lead terminal block properly wired to the Profibus board and installed onto the board.

Note: the Profibus cable must be directed downwards. The Profibus board can be partially or fully removed to allow easy insertion of the 4-lead terminal block onto the Profibus board.

6. Ensure that the 10-lead ribbon cable is properly connected from the Profibus board to the left-most connector of the 3 10-pin shrouded connectors on the right side of the main circuit board.

   Once power is wired to the unit (as shown in photo), the Profibus-configured 56 is ready for power up and communication on a Profibus network.

FIGURE 12-5. Complete Profibus board installation with ribbon cable attached.

Section 13.0 Maintenance

13.1 Overview

This section gives general procedures for routine maintenance of the 56 advanced analyzer. The analyzer needs almost no routine maintenance. Sensors require periodic inspection and cleaning. The calibration of the transmitter-sensor combination should be checked regularly, and the loop recalibrated if necessary.

⚠ CAUTION

Always depower the analyzer or disconnect the analyzer from the main power supply before opening the enclosure in a hazardous area.

⚠ WARNING

RISK OF ELECTRICAL SHOCK

Electrical installation must be in accordance with the National Electrical Code (ANSI/NFPA-70) and/or any other applicable national or local codes.

CAUTION: This symbol identifies a risk of electrical shock.

CAUTION: This symbol identifies a potential hazard. When this symbol appears, consult the manual for appropriate action.

13.2 Analyzer Maintenance

Periodically clean the analyzer window and housing as needed with a cloth dampened with water. Do not use abrasives or cleaning solutions.

13.3 USB Port

The USB communications port is protected by a NEMA-rated seal and cover. Do not remove the cover during cleaning. Never remove the USB port cover when the instrument is operated in a hazardous rated area.

Section 14.0 Return of Material

14.1 General

To expedite the repair and return of instruments, proper communication between the customer and the factory is important. Before returning a product for repair, call 1-949-757-8500 for a Return Materials Authorization (RMA) number.

14.2 Warranty Repair

The following is the procedure for returning instruments still under warranty:

1. Call Emerson for authorization.
2. To verify warranty, supply the factory sales order number or the original purchase order number. In the case of individual parts or sub-assemblies, the serial number on the unit must be supplied.
3. Carefully package the materials and enclose your "Letter of Transmittal" (see Warranty). If possible, pack the materials in the same manner as they were received.
4. Send the package prepaid to:

   Emerson

   8200 Market Blvd,

   Chanhassen, MN 55317

   RMA No. _____

   Mark the package: Returned for Repair

   Model No. _____

IMPORTANT

Please see second section of "Return of Materials Request" form. Compliance with the OSHA requirements is mandatory for the safety of all personnel. MSDS forms and a certification that the instruments have been disinfected or detoxified are required.

14.3 Non-Warranty Repair.

The following is the procedure for returning for repair instruments that are no longer under warranty:

1. Call Emerson for authorization.
2. Supply the purchase order number, and make sure to provide the name and telephone number of the individual to be contacted should additional information be needed.
3. Do Steps 3 and 4, above.

NOTE

Consult the factory for additional information regarding service or repair.

Appendix 1: HART and Device Variables

pH Device Variables		
Device Variable Name	Assignable to Dynamic Variables	Variable Range
Sensor 1 / 2 Measurement Type		
pH (1)	PV, SV, TV or QV	0 to 14 pH
ORP (2), Redox (3)	PV, SV, TV or QV	-1500 to 1500 mV
Ammonia (4), Fluoride (5), Custom ISE (6)	PV, SV, TV or QV	0 to 1000 ppm
		0 to 1000 ppb
		0 to 1000 mg/L
		0 to 1000 µg/L
		0 to 100 %
Measurement Parameters		
Sensor 1 / 2 Temperature	PV, SV, TV or QV	-15 to 200 °C
		5 to 360 °F
Sensor 1 / 2 Temperature resistance	TV or QV	0 to 100000 ohm
Sensor 1 / 2 mV input	PV, SV, TV or QV	-750 to 750 mV
Sensor 1 / 2 Glass impedance	PV, SV, TV or QV	0 to 2000 M
Sensor 1 / 2 Sensor impedance	PV, SV, TV or QV	0 to 2000 M
Sensor 1 / 2 Reference impedance	PV, SV, TV or QV	0 to 10000 k

Contacting and Toroidal Conductivity Device Variables		
Device Variable Name	Assignable to Dynamic Variables	Variable Range
Sensor 1 / 2 Measurement Type		
Conductivity (7)	PV, SV, TV or QV	0 to 2000000 µS/cm
Resistivity (8)	PV, SV, TV or QV	0 to 50000000 ohm-cm
Concentration:		
NaOH (9)	PV, SV, TV or QV	0 to 12 %
HCl (10)	PV, SV, TV or QV	0 to 15 %
Low H2SO4 (11)	PV, SV, TV or QV	0 to 25 %
High H2SO4 (12)	PV, SV, TV or QV	96 to 99.7 %
NaCl (13)	PV, SV, TV or QV	0 to 25 %
Custom Concentration (14)	PV, SV, TV or QV	0 to 1000 ppm
		0 to 1000 mg/L
		0 to 100 g/L
		0 to 100 %
		0 to 1000 None
TDS (15)	PV, SV, TV or QV	0 to 10000 ppm
Measurement Parameters		
Sensor 1 / 2 Temperature	PV, SV, TV or QV	-15 to 200 °C
		5 to 360 °F
Sensor 1 / 2 Temperature resistance	TV or QV	0 to 100000 ohm
Sensor 1 / 2 Conductance	TV or QV	0 to 2000000 µS
Sensor 1 / 2 Input resistance	TV or QV	0 to 500 k
Sensor 1 / 2 Raw Conductivity	PV, SV, TV or QV	0 to 2000000 µS/cm
Sensor 1 / 2 Raw Resistivity	PV, SV, TV or QV	0 to 50000000 ohm-cm
Dual Conductivity Measurments:		
Conductivity Ratio	PV, SV, TV or QV	0 to 10000
% Rejection	PV, SV, TV or QV	0 to 100 %
% Passage	PV, SV, TV or QV	0 to 100 %
Calculated pH (Contacting only)	PV, SV, TV or QV	0 to 14 pH

Turbidity Device Variables		
Device Variable Name	Assignable to Dynamic Variables	Variable Range
Sensor 1 / 2 Measurement Type		
Turbidity (25)	PV, SV, TV or QV	0 to 200 FNU
		0 to 200 FTU
		0 to 200 NTU
TSS (26)	PV, SV, TV or QV	0 to 1000 ppm
		0 to 1000 mg/L
		0 to 1000 None
Measurement Parameters		
Sensor 1 / 2 Lamp Voltage	TV or QV	0 to 2000 mV

Amperometric Device Variables		
Device Variable Name	Assignable to Dynamic Variables	Variable Range
Sensor 1 / 2 Measurement Type		
Salinity (16)	PV, SV, TV or QV	0 to 36 ppth
Oxygen (17)	PV, SV, TV or QV	0 to 100 ppm
		0 to 1000 ppb
		0 to 100 mg/L
		0 to 1000 µg/L
		0 to 300 % Saturation
		0 to 760 mmHg
		0 to 30 inHg
		0 to 1 bar
		0 to 1000 mbar
		0 to 100 kPa
		0 to 1 atm
Ozone (18), Free Chlorine (19), pH Independent Free Chlorine (20), Total Chlorine (21), Chloramine (22)	PV, SV, TV or QV	0 to 20 ppm
		0 to 1000 ppb
		0 to 20 mg/L
		0 to 1000 µg/L
Measurement Parameters		
Sensor 1 / 2 Temperature	PV, SV, TV or QV	-15 to 200 °C
		5 to 360 °F
Sensor 1 / 2 Temperature resistance	TV or QV	0 to 100000
Sensor 1 / 2 Sensor input current	PV, SV, TV or QV	0 to 100000 nA
Sensor 1 / 2 Polarizing voltage	TV or QV	-1000 to 1000 mV
Sensor 1 / 2 Pressure	TV or QV	0 to 5000 mmHg
		0 to 200 inHg
		0 to 7 bar
		0 to 7000 mbar
		0 to 700 kPa
		0 to 7 atm

Flow / mA Input Device Variables		
Device Variable Name	Assignable to Dynamic Variables	Variable Range
Sensor 1 / 2 Measurement Type		
Flow Rate (23)	PV, SV, TV or QV	0 to 100000 gal/min
		0 to 100000 gal/hr
		0 to 100000 cu.ft/min
		0 to 100000 cu.ft/hr
		0 to 100000 liter/min
		0 to 100000 liter/hr
		0 to 100000 m3/hr

Flow / mA Input Device Variables (continued)		
Device Variable Name	Assignable to Dynamic Variables	Variable Range
Sensor 1 / 2 Measurement Type		
Scaled mA Input (24)	PV, SV, TV or QV	As per Configuration
	Input Type:	Units:
	Temperature	°C, °F
	Pressure	mmHg, inHg, bar, mbar, kPa, atm
	Flow	gal/min, gal/hr, cu.ft/hr, cu.ft/min, liter/hr, m3/hr
	Other	ft/sec, m/sec, None
	pH/ORP	pH, mV
	Conductivity	µS/cm, mS/cm
	Resistivity	M -cm, K -cm
	Concentration	%, parts per thousand, ppm, ppb
	Weight per Volume	mg/L, µg/L, g/L
	Turbidity	FNU, FTU, NTU
Measurement Parameters		
Sensor 1 / 2 Frequency	TV or QV	0 to 1000 Hz
Sensor 1 / 2 Velocity	PV, SV, TV or QV	0 to 10 ft/sec
		0 to 10 m/sec
Sensor 1 / 2 Totalizer	PV, SV, TV or QV	0 to 1000000 gal
		0 to 1000000 liter
		0 to 1000000 m3
		0 to 1000000 cu.ft
Sensor 1 / 2 mA input	TV or QV	3.6 to 22 mA
Dual Flow Measurements		
Flow ratio	PV, SV, TV or QV	0 to 1000 NA
% Flow ratio	PV, SV, TV or QV	0 to 100 %
% Recovery	PV, SV, TV or QV	0 to 100 % Recovery
Flow difference	PV, SV, TV or QV	-10000 to 10000 gal/min
		-10000 to 10000 gal/hr
		-10000 to 10000 cu.ft/min
		-10000 to 10000 cu.ft/hr
		-10000 to 10000 liter/min
		-10000 to 10000 liter/hr
		-10000 to 10000 m3/hr
Flow total difference	PV, SV, TV or QV	-100000 to 100000 gal
		-100000 to 100000 liter
		-100000 to 100000 m3
		-100000 to 100000 cu.ft

Appendix 2: HART Status Bits

Common Transmitter Status Bits				
Byte	Bit	Message	Severity	Device Status Bits Set
2	2	Sensor 1 Hardware Error	Error	Device Status: bit 7, 3
2	6	Sensor 1 User Data Error	Error	Device Status: bit 7, 3
2	7	Sensor 1 EEPROM Write Error	Error	Device Status: bit 7, 3
3	0	Sensor 1 Sensor Board Unknown	Error	Device Status: bit 7, 3
3	1	Sensor 1 Hardware/Software Mismatch	Error	Device Status: bit 7, 3
3	2	Sensor 1 Sensor Incompatible	Error	Device Status: bit 7, 3
3	3	Sensor 1 Sensor Not Detected	Error	Device Status: bit 7, 3
3	4	Sensor 1 Sensor not communicating	Error	Device Status: bit 7, 3
3	5	Sensor 1 CPU Error	Error	Device Status: bit 7, 3
3	6	Sensor 1 Factory Data Error	Error	Device Status: bit 7, 3
3	7	Sensor 1 ADC Error	Error	Device Status: bit 7, 3
5	2	Sensor 2 Hardware Error	Error	Device Status: bit 7, 3
5	6	Sensor 2 User Data Error	Error	Device Status: bit 7, 3
5	7	Sensor 2 EEPROM Write Error	Error	Device Status: bit 7, 3
6	0	Sensor 2 Sensor Board Unknown	Error	Device Status: bit 7, 3
6	1	Sensor 2 Hardware/Software Mismatch	Error	Device Status: bit 7, 3
6	2	Sensor 2 Sensor Incompatible	Error	Device Status: bit 7, 3
6	3	Sensor 2 Sensor Not Detected	Error	Device Status: bit 7, 3
6	4	Sensor 2 Sensor not communicating	Error	Device Status: bit 7, 3
6	5	Sensor 2 CPU Error	Error	Device Status: bit 7, 3
6	6	Sensor 2 Factory Data Error	Error	Device Status: bit 7, 3
6	7	Sensor 2 ADC Error	Error	Device Status: bit 7, 3
7	0	Maintenance required	Warning	Extended Device bit 0
7	1	Device variable alert	Warning	Extended Device bit 1
9	0	Simulation active	Mode	
9	1	Non-volatile memory defect	Error	
9	2	Volatile memory defect	Error	
9	3	Watchdog reset executed	--	
9	4	Voltage condition out of range	--	
9	5	Environmental condition out of range	--	
9	6	Electric defect	Error	
11	0	Analog channel-2 saturated	Warning	
11	1	Analog channel-3 saturated	Warning	
11	2	Analog channel-4 saturated	Warning	

Common Transmitter Status Bits (continued)

Byte	Bit	Message	Severity	Device Status Bits Set
14	0	Analog channel-2 fixed	Mode	
14	1	Analog channel-3 fixed	Mode	
14	2	Analog channel-4 fixed	Mode	
21	0	Main board CPU Error	Error	Device Status: bit 7, 3
21	1	User Data Error	Error	Device Status: bit 7, 3
21	2	Factory Data Error	Error	Device Status: bit 7, 3
22	1	Unknown power supply	Warning	Device Status: bit 4
22	2	Unknown line frequency	Warning	Device Status: bit 4
22	3	Factory calibration error	Warning	Device Status: bit 4
22	4	Keypad error	Warning	Device Status: bit 4
22	5	Overheating LCD	Warning	Device Status: bit 4
22	6	Excess output current	Warning	Device Status: bit 4
23	0	Relay-1 Energized	Mode	
23	1	Relay-2 Energized	Mode	
23	2	Relay-3 Energized	Mode	
23	3	Relay-4 Energized	Mode	
24	0	Sensor 1 Zeroing in Progress	Mode	Device Status: bit 4
24	1	Sensor 1 Calibration in Progress	Mode	Device Status: bit 4
24	2	Sensor 1 Standardization in Progress	Mode	Device Status: bit 4
24	3	Sensor 1 Stabilization in Progress	Mode	Device Status: bit 4
25	0	Sensor 2 Zeroing in Progress	Mode	Device Status: bit 4
25	1	Sensor 2 Calibration in Progress	Mode	Device Status: bit 4
25	2	Sensor 2 Standardization in Progress	Mode	Device Status: bit 4
25	3	Sensor 2 Stabilization in Progress	Mode	Device Status: bit 4

Temperature Status Bits

Byte	Bit	Message	Severity	Device Status Bits Set
2	0	Sensor 1 RTD Open	Error	Device Status: bit 7, 3
2	1	Sensor 1 RTD Out Of Range	Error	Device Status: bit 7, 3
5	0	Sensor 2 RTD Open	Error	Device Status: bit 7, 3
5	1	Sensor 2 RTD Out Of Range	Error	Device Status: bit 7, 3
17	1	Sensor 1 Temperature High	Warning	Device Status: bit 4
17	2	Sensor 1 Temperature Low	Warning	Device Status: bit 4
17	3	Sensor 1 RTD Sense Line Open	Warning	Device Status: bit 4
20	1	Sensor 2 Temperature High	Warning	Device Status: bit 4
20	2	Sensor 2 Temperature Low	Warning	Device Status: bit 4
20	3	Sensor 2 RTD Sense Line Open	Warning	Device Status: bit 4

pH Board Status Bits

Byte	Bit	Message	Severity	Device Status Bits Set
2	3	Sensor 1 Reference Impedance Too High	Error	Device Status: bit 7, 3
2	4	Sensor 1 Glass Impedance Too High	Error	Device Status: bit 7, 3
2	5	Sensor 1 Broken Glass	Error	Device Status: bit 7, 3
5	3	Sensor 2 Reference Impedance Too High	Error	Device Status: bit 7, 3
5	4	Sensor 2 Glass Impedance Too High	Error	Device Status: bit 7, 3
5	5	Sensor 2 Broken Glass	Error	Device Status: bit 7, 3
16	3	Sensor 1 Broken Glass Disabled	Warning	Device Status: bit 4
17	7	Sensor 1 No Solution Ground	Warning	Device Status: bit 4
19	3	Sensor 2 Broken Glass Disabled	Warning	Device Status: bit 4
20	7	Sensor 2 No Solution Ground	Warning	Device Status: bit 4
24	6	Sensor 1 Offset Error	Mode	Device Status: bit 4
24				Extended Device Status: bit 0
24	7	Sensor 1 Slope Error	Mode	Device Status: bit 4
24				Extended Device Status: bit 0
25	6	Sensor 2 Offset Error	Mode	Device Status: bit 4 Extended Device Status: bit 0
25	7	Sensor 2 Slope Error	Mode	Device Status: bit 4 Extended Device Status: bit 0

Contacting and Toroidal Conductivity Status Bits

Byte	Bit	Message	Severity	Device Status Bits Set
16	0	Sensor 1 Conductivity Negative Reading	Warning	Device Status: bit 4
	1	Sensor 1 Percent Out Of range	Warning	Device Status: bit 4
17	5	Sensor 1 Conductivity Board Out Of Range	Warning	Device Status: bit 4
19	0	Sensor 2 Conductivity Negative Reading	Warning	Device Status: bit 4
	1	Sensor 2 Percent Out Of range	Warning	Device Status: bit 4
20	5	Sensor 2 Conductivity Board Out Of Range	Warning	Device Status: bit 4
24	5	Sensor 1 Zero Error	Mode	Device Status: bit 4 Extended Device Status: bit 0
25	5	Sensor 2 Zero Error	Mode	Device Status: bit 4 Extended Device Status: bit 0

Amperometric Status Bits

Byte	Bit	Message	Severity	Device Status Bits Set
16	2	Sensor 1 Pressure Broken	Warning	Device Status: bit 4
17	6	Sensor 1 Amperometric Board Negative Reading	Warning	Device Status: bit 4
19	2	Sensor 2 Pressure Broken	Warning	Device Status: bit 4
20	6	Sensor 2 Amperometric Board Negative Reading	Warning	Device Status: bit 4

Flow / mA Input Status Bits

Byte	Bit	Message	Severity	Device Status Bits Set
15	0	Sensor 1 Low Current	Warning	Device Status: bit 4
16	5	Sensor 1 No Flow Detected	Warning	Device Status: bit 4
16	6	Sensor 1 Negative Current	Warning	Device Status: bit 4
16	7	Sensor 1 Excessive Current	Warning	Device Status: bit 4
18	0	Sensor 2 Low Current	Warning	Device Status: bit 4
19	5	Sensor 2 No Flow Detected	Warning	Device Status: bit 4
19	6	Sensor 2 Negative Current	Warning	Device Status: bit 4
19	7	Sensor 2 Excessive Current	Warning	Device Status: bit 4

Turbidity Input Status Bits

Byte	Bit	Message	Severity	Device Status Bits Set
1	0	Sensor 1 Lamp/LED Failed	Error	Device Status: bit 7, 3
1	1	Sensor 1 Disconnected	Error	Device Status: bit 7, 3
4	0	Sensor 2 Lamp/LED Failed	Error	Device Status: bit 7, 3
4	1	Sensor 2 Disconnected	Error	Device Status: bit 7, 3
15	1	Sensor 1 Need Calibration	Warning	Device Status: bit 4
18	1	Sensor 2 Need Calibration	Warning	Device Status: bit 4
21	3	Wrong Power Supply	Error	Device Status: bit 7, 3

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October 2019

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ROSEMOUNT™

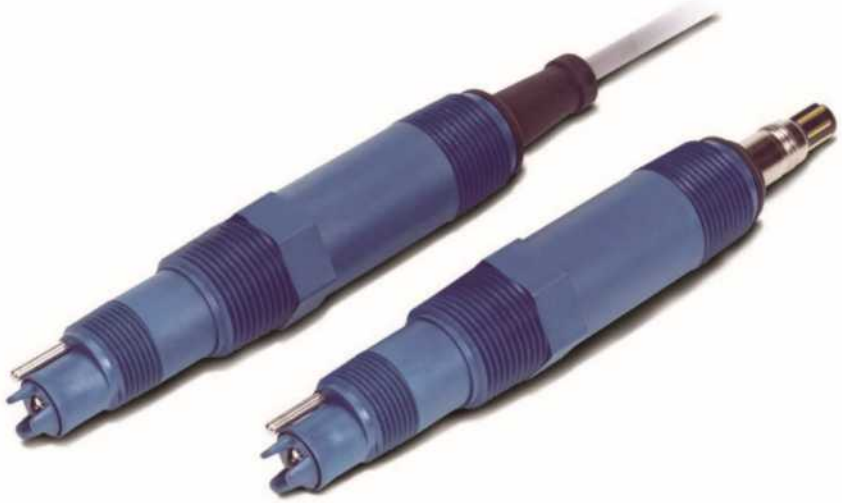
EMERSON

GPO Appendix 02
Attachment A
Subattachment f
ROSEMOUNT General Purpose 3900 pH Sensor Instrument and Procedure Manual

Reference Manual
00809-0100-3900
Rev. AA
February 2019

Rosemount™ 3900/3900VP

General Purpose pH/ORP Sensor



EMERSON.

Essential Instructions
Read this page before proceeding!

Emerson designs, manufactures, and tests its products to meet many national and international standards. Because these sensors are sophisticated technical products, you MUST properly install, use, and maintain them to ensure they continue to operate within their normal specifications. The following instructions MUST be adhered to and integrated into your safety program when installing, using, and maintaining Rosemount Analytical products. Failure to follow the proper instructions may cause any one of the following situations to occur: loss of life; personal injury; property damage; damage to this sensor; and warranty invalidation.

- Read all instructions prior to installing, operating, and servicing the product.
- If you do not understand any of the instructions, contact your Emerson representative for clarification.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation, and maintenance of the product.
- Install your equipment as specified in the Installation Instructions of the appropriate Reference Manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program, and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Emerson. Unauthorized parts and procedures can affect the product's performance, place the safe operation of your process at risk, and VOID YOUR WARRANTY. Third-party substitutions may result in fire, electrical hazards, or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

The information contained in this document is subject to change without notice.

⚠ CAUTION

SPECIAL CONDITIONS FOR SAFE USE

1. All pH/ORP sensors have a plastic enclosure which must only be cleaned with a damp cloth to avoid the danger due to a build up of an electrostatic charge.

2. All pH/ORP sensor models are intended to be in contact with the process fluid and may not meet the 500V r.m.s. a.c. test to earth.

This must be taken into consideration at installation.

⚠ CAUTION

SENSOR/PROCESS APPLICATION COMPATIBILITY

The wetted sensor materials may not be compatible with process composition and operating conditions. Application compatibility is entirely the responsibility of the user.

⚠ WARNING

Before removing the sensor, be absolutely certain that the process pressure is reduced to 0 psig and the process temperature is lowered to a safe level!

⚠ CAUTION

The solution used during calibration is an acid and should be handled with care. Follow the directions of the acid manufacturer. Wear the proper protective equipment. Do not let the solution come in contact with skin or clothing. If contact with skin is made, immediately rinse with clean water.

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Section 1: Specifications

1.1 Specifications

Measurements and Ranges: pH : 0-14 / ORP: -1500 to +1500 mV

Percent Linearity Over pH Range:

Range	Linearity
0-7	97%
1-7	98%
4-7	98%
7-10	99%
7-12	97%
7-13	96%
7-14	95%

Materials of construction:

Sensor Body: Ryton -- polyphenylene sulfide (PPS)

O-ring: EPDM

pH Electrode: Glass

ORP Electrode: Glass, platinum

Solution Ground: Stainless Steel

Reference Junction: PTFE (Teflon)

Maximum Pressure: 790 kPa [abs] (100 psig) at 212 °F (100 °C)
CRN rating: 60 psig up to 212 °F (100 °C).

Operating Temperature: 14 °F to 212 °F (-10 °C to 100 °C)

Automatic temperature compensation 14 °F to 212 °F (-10 °C to 100 °C)

Conductivity: Responds to changes in pH at a minimum conductivity of 0.1µS/cm when used with the low flow cell panel. The sample flow rate must be controlled to 2 gph (7.6L/hr).

Process Connections:

Front facing: 3/4 inch and 1 inch MNPT

Rear facing: 1 inch MNPT

Weight/Shipping Weight: 1 lb./2 lb. (0.45 kg/0.9 kg)

Integral Cable: 32 ft (10m) cable with integral preamp; 15 ft (4.7m) cable without preamp

VP8 Cable: Use 24281-XX, 2.5 ft (0.8m) to 100 ft (31m) (see accessories)

NOTICE

The Rosemount 3900/3900VP Sensor responds to changes in pH at a minimum conductivity of 0.1µS/cm in deionized water. Sample flow rate must be controlled to 2 gph (7.6L/hr). The offset is approximately -0.2 pH after 3 months at ambient temperature.

1.2 Product Certifications

IECEx

3900/3900VP without preamp (pH and ORP) – Ex ia IIC T4 Ga (-20 °C ≤ Ta ≤ +60 °C)

3900/3900VP with SMART preamp (pH only) – Ex ia IIC T4 Ga (-20 °C ≤ Ta ≤ +60 °C)

Per standards IEC60079-0 : 2011, IEC 60079-11 : 2011

ATEX

3900/3900VP without preamp (pH and ORP) – II 1 G Ex ia IIC T4 Ga (-20 °C ≤ Ta ≤ +60 °C)

3900/3900VP with SMART preamp (pH only) – II 1 G Ex ia IIC T4 Ga (-20 °C ≤ Ta ≤ +60 °C)

Per standards EN 60079-0: 2012+A11:2013, EN 60079-11:2012

FM

3900/3900VP with SMART preamp (pH only), with standard preamp (ORP only), and without preamp (pH and ORP):

Intrinsically Safe for use in Class I, II, and III, Division 1, Groups A, B, C, D, E, F, and G; Temperature Class T6 Ta = -20 °C to +60 °C

Intrinsically Safe for use in Class I, Zone 0, AEx ia IIC T6 Ta = -20 °C to +600 °C

Nonincendive for use in Class I, Division 2, Groups A, B, C, and D; Temperature Class T6 Ta = -20 °C to +60 °C

Suitable for use in Class II and III, Division 2, Groups E, F, and G; Temperature Class T6 Ta = -20 °C to +60 °C Hazardous (Classified) Locations

IS/I,II,III/1/ABCDEFG/T6 Ta = 60 °C - 1400332; Entity; I/0/AEx ia IIC/T6 Ta = 60 °C - 1400332; Entity;

NI/I/2/ABCD/T6 Ta = 60 °C; S/II,III/2/EFG/T6 Ta = 60 °C

Per standards 3600:1998, 3610:2010, 3611:2004, 3810:2005

CSA

3900/3900VP with SMART preamp (pH only) – Intrinsically Safe:

Class I, Division 1, Groups ABCD; Class II, Division 1, Groups EFG; Class III; Class I, Division 2, Groups ABCD; Ambient temperature rating -20 °C to +60 °C; Ex ia IIC; T6

3900/3900VP without preamp (pH and ORP) – Intrinsically Safe and Non-Incendive:

Class I, Division 1, Groups ABCD; Class II, Division 1, Groups EFG; Class III; Class I, Division 2, Groups ABCD; Ex ia IIC; T6; Ambient temperature rating -20 °C to +60 °C: (Simple Apparatus)

Per standards C22.2 No. 0-10, C22.2 No. 0.4-M2004, C22.2 No. 94-M1991, C22.2 No. 142 – M1987, C22.2 No 157 – M1992, CAN/CSA E60079-0:07, CAN/CSA E60079- 11:02, UL50 11th Ed, UL508 17th Ed, UL913 7th Ed, UL 60079-0: 2005, UL 60079-11: 2002

1.3 Ordering Information

The Rosemount 3900/3900VP General Purpose pH/ORP sensors feature a chemically resistant Ryton plastic body, along with a built-in solution ground for advanced diagnostics and a Pt-100 RTD for temperature compensation. These sensors are available with either an integral cable connection or Variopol (VP8) connector. Variopol cables sold separately (see Accessories).

Table 1-1: Rosemount 3900 pH/ORP Sensor ordering information

Model	Sensor Type
3900	pH/ORP Sensor
Preamplifier Option	
01	Preamplifier (1)
02	No preamplifier (2)
Measuring Electrode	
10	General Purpose Low Resistivity (GPLR) pH glass
12	Platinum ORP
Typical Model Number: 3900-01-10	

1. Preamplifier is SMART with -10 option and a standard preamplifier if with -12 option. Comes with 32 ft. (10 m) of integral cable.
2. Comes standard with 15 ft. (4.7 m) of integral cable.

Table 1-2: Rosemount 3900VP pH/ORP Sensor with Variopol cable connection ordering information

Model	Sensor Type
3900VP	pH/ORP Sensor
Preamplifier Option	
01	Preamplifier (1)
02	No preamplifier
Measuring Electrode	
10	General Purpose Low Resistivity (GPLR) pH glass
12	Platinum ORP
Typical Model Number: 3900VP-01-10	

1. Preamplifier is SMART with -10 option and a standard preamplifier if with -12 option.

Section 2: Installation

2.1 Storage

1. It is recommended that electrodes be stored in their original shipping containers until needed.
2. Do not store at temperatures below 14 °F (-10 °C).
3. Electrodes should be stored with a protective cap containing KCl solution (PN 9210342).
4. For overnight storage, immerse the sensor in tap water or 4 pH buffer solution.
5. pH glass electrodes slowly deteriorate in storage. There is no specific expiration date. However, the calibration procedure described below should be followed to determine that the sensor calibrates properly.

2.2 Electrode Preparation

1. Remove electrode from shipping container.
2. Remove the protective boot covering the electrode bulb.
3. Rinse away salt film with clean water; then shake the electrode so that the internal solution fills the bulb, thus removing any air trapped there.

2.3 Sensor Installation

1. Wrap the sensor threads with six or seven turns of Teflon tape to prevent leakage.
2. Do not over tighten the sensor into its receptacle.
3. Hand tighten the sensor, and then tighten one or two turns with a wrench.

Figure 2-1 Sensor Orientation

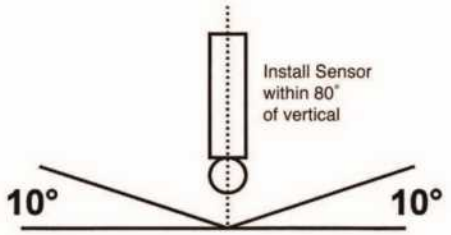


Figure 2-2 Rosemount 3900/3900VP Sensor Dimensions

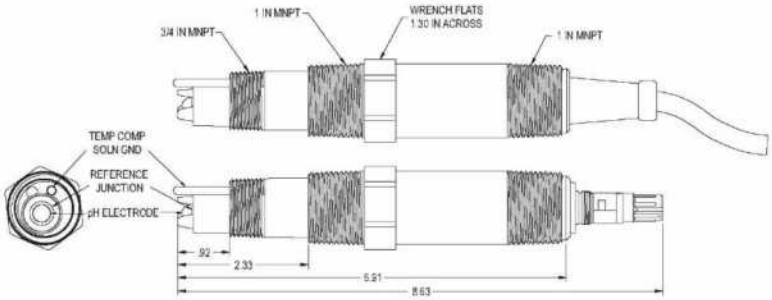
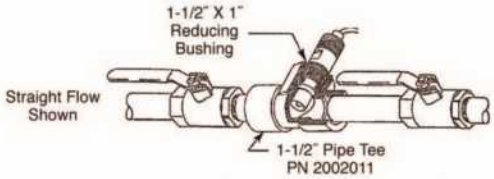


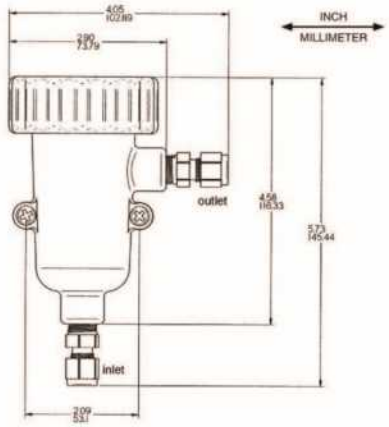
Figure 2-3 Typical flow through insertion installation using PN 2002011 Pipe Tee



Note: Sensor must be installed at least 10° above the horizon)

Horizontal Pipe Tee (PN 2002011) Pressure/Temperature Ratings	
psig (kPa [abs])	°F (°C)
150 (1136)	150 (65)
128 (984)	160 (71)
102 (805)	170 (77)
80 (653)	180 (82)
57 (494)	200 (93)
48 (432)	210 (99)

Figure 2-4 Low Flow Cell PN 24091-00/24091-02



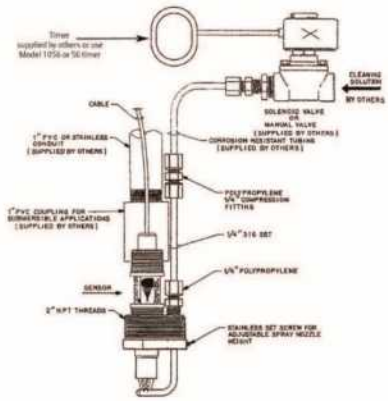
Inlet and outlet connections are stainless steel and take 1/4-inch OD tubing. Flow cell is polycarbonate with 1/4-inch FNPT fittings.

Wetted Materials:
Body and Nut: Polyester/Polycarbonate
Fittings: 316 SST
Seals: Silicone

Flow Cell Ratings:
Temperature: 32 °to 158 °F (0 to 70 °C)
Max. Pressure: 90 PSIG (721 kPa [abs])
Flow rate: 2 to 5 GPH (7.6 to 18.9 LPH)

Sensor Threaded Connection:
24091-00: 1 inch NPT Adapter
24091-02: 3/4 inch NPT Adapter"

Figure 2-5 Jet Spray Cleaner PN 12707-00



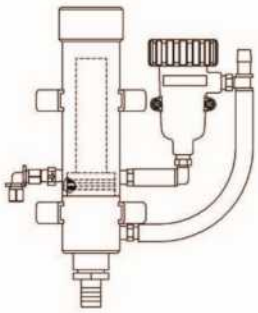
The jet spray cleaner eliminates routine, manual sensor maintenance by cleaning the sensor with water or compressed air. Flow through the cleaner can be controlled by a solenoid valve.

Note: The jet spray cleaner can be used with handrail mounting assembly (PN 11275-01, not shown) or can be mounted through conduit as shown below.

Jet Spray Cleaner with pH sensor

Note: Sensor must be installed at least 10° above the horizon)

Figure 2-6 Low Flow Panel PN SQP10077-LQD



Low Flow Panel Specification	
Inlet flow	3-80 gph (11.4 – 304 L/hr)
Inlet pressure	3-65 psig (122 – 549 kPa abs)*
Temperature	32 to 122 °F (0 to 50 °C)

** The minimum inlet pressure is required to open a check valve, which prevents the flow cell from draining if sample flow is lost. Removing the check valve lowers the inlet pressure requirement to a few feet of water head.*

2.3.1 Wiring

For additional wiring information on this product, including sensor combinations not shown here, please refer to the Liquid Transmitter Wiring Diagrams.

Figure 2-7: Rosemount 3900/3900VP with Preamplifier to Rosemount 56/1056/1057/1066 Transmitter Wiring

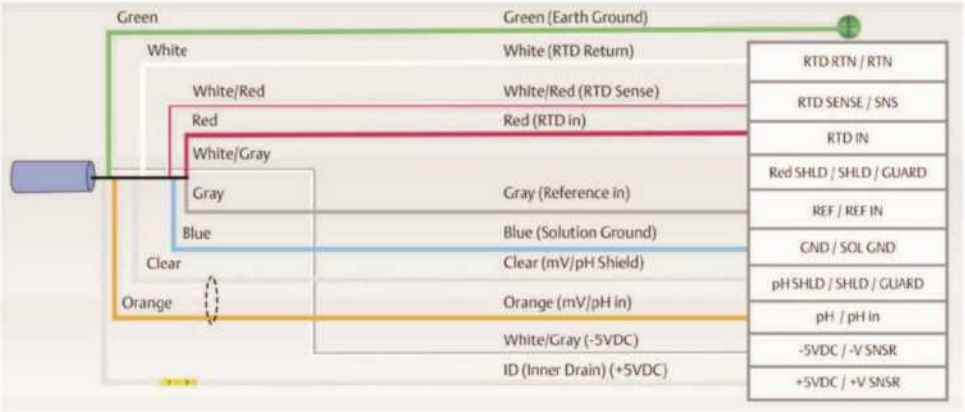


Figure 2-8: Rosemount 3900/3900VP with Preamplifier to Rosemount 56/1056/1057/1066 Transmitter, Junction Box without Preamplifier (PN 23550-00) Wiring

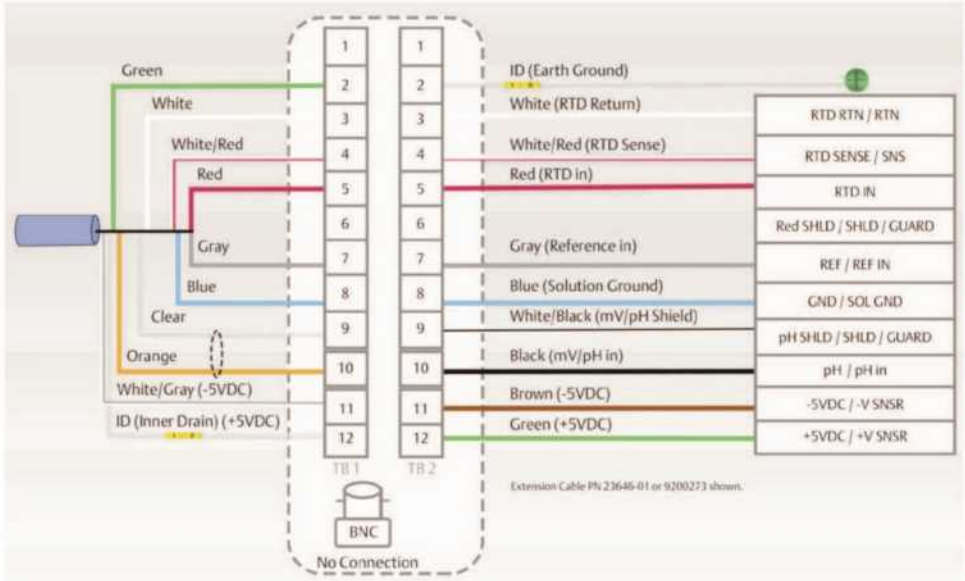


Figure 2-9: Rosemount 3900/3900VP without Preamplifier to Rosemount 56/1056/1057/1066 Transmitter Wiring

Figure 2-10: Rosemount 3900/3900VP without Preamplifier to Rosemount 56/1056/1057/1066 Transmitter, Junction Box with Preamplifier (PN 23555-00) Wiring

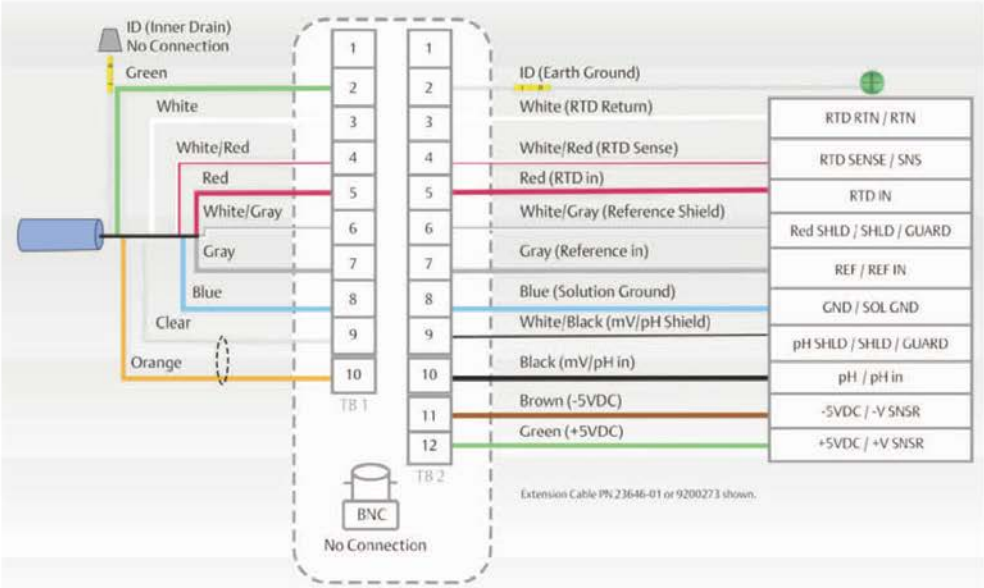


Figure 2-11: Rosemount 3900/3900VP with Preamplifier to Rosemount 5081 Transmitter Wiring

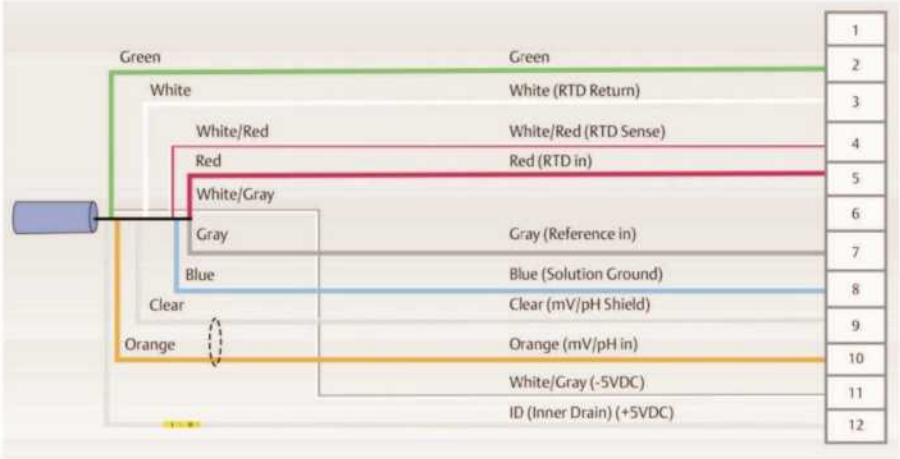


Figure 2-12: Rosemount 3900/3900VP with Preamplifier to Rosemount 5081 Transmitter, Junction Box without Preamplifier (PN 23550-00) Wiring

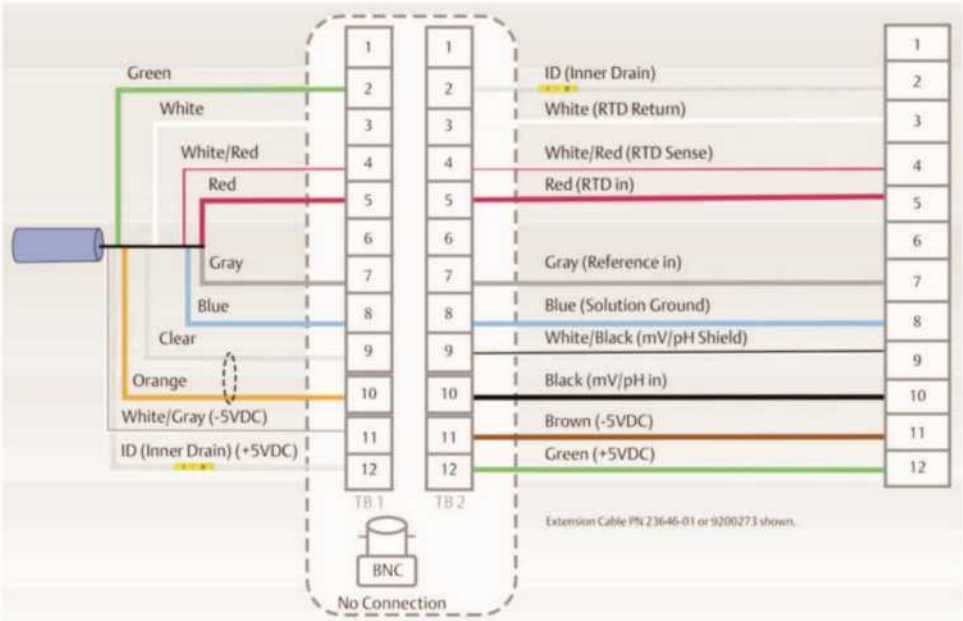
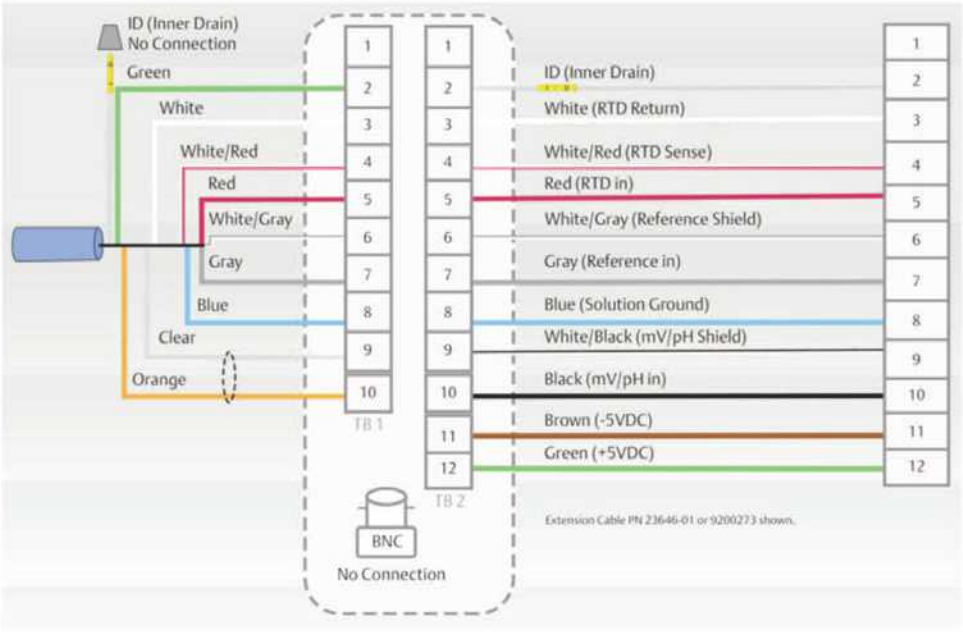


Figure 2-13: Rosemount 3900/3900VP without Preamplifier to Rosemount 5081 Transmitter Wiring

Figure 2-14: Rosemount 3900/3900VP without Preamplifier to Rosemount 5081 Transmitter, Junction Box with Preamplifier (PN 23555-00) Wiring



Section 3: Calibration and Maintenance

3.1 pH Two Point Buffer Calibration

Select two stable buffer solutions, preferably pH 4.0 and 7.0 (pH buffers other than pH 4.0 and pH 7.0 can be used as long as the pH values are at least two pH units apart).

NOTICE

A pH 7 buffer solution reads a mV value of approx. zero, and pH buffers read approximately ± 59.1 mV for each pH unit above or below pH 7. Check the pH buffer manufacturer specifications for millivolt values at various temperatures since it may affect the actual value of the buffer solution mV/pH value.

1. Immerse sensor in the first buffer solution. Allow sensor to equilibrate to the buffer temperature (to avoid errors due to temperature differences between the buffer solution and sensor temperature) and wait for reading to stabilize. Value of buffer can now be acknowledged by transmitter.
2. Once the first buffer has been acknowledged by the transmitter, rinse the buffer solution off the sensor with distilled or deionized water.
3. Repeat the steps 1 and 2 using the second buffer solution.
4. The theoretical slope value, according to the Nernst equation for calculating pH, is approximately 59.1 mV/pH. Over time the sensor will age, both in the process and in storage, which will result in reduced slope values. To ensure accurate readings, it is recommended that the electrode be replaced when the slope value falls below 47 to 49 mV/pH.

3.2 Recommended pH Sensor Standardization

For maximum accuracy, the sensor can be standardized on-line or with a process grab sample after a buffer calibration has been performed and the sensor has been conditioned to the process. Standardization accounts for the sensor junction potential and other interferences. Standardization will not change the sensors slope, but will simply adjust the transmitter's reading to match that of the known process pH.

3.3 pH Electrode Maintenance

Electrodes should respond rapidly. Sluggishness, offsets, and erratic readings are indicators that the electrodes may need cleaning or replacement.

1. To remove oil deposit, clean the electrode with a mild non-abrasive detergent.
2. To remove scale deposits, soak electrodes for 1 to 5 minutes in a 5% hydrochloric acid solution.
3. Temperature effect on life expectancy: If glass electrode life expectancy is 100% at 77 °F (25 °C), then it will be approximately 25% at 176 °F (80 °C), and approximately 10% at 212 °F (100°C).

CAUTION

Hydrochloric acid is toxic and highly corrosive. Avoid skin contact; wear protective gloves. Use only in a well ventilated area. Do not inhale fumes. In case of an accident, consult a doctor immediately.

3.4 ORP Calibration

1. After making an electrical connection between the sensor and the instrument, obtain a standard solution of saturated quinhydrone PN R508-8OZ (475mV). This can also be made quite simply by adding a few crystals of quinhydrone to either pH 4 or pH 7 buffer. Quinhydrone is only slightly soluble; therefore only a few crystals will be required.

2. Immerse the sensor in the standard solution. Allow 1-2 minutes for the ORP sensor to stabilize.

3. Standardize the instrument to the solution value shown in the Table 3-1 below. The resulting potentials, measured with a clean platinum electrode and saturated KCl/AgCl reference electrode, should be within +/- 20 millivolts of the value shown in the table below. Solution temperature must be noted to ensure accurate interpretation of results. The ORP value of saturated quinhydrone solution is not stable over long periods of time. Therefore, these standards should be made up fresh each time they are used.

Table 3-1 ORP of Saturated Quinhydrone Solution (millivolts)

	pH 4 Solution			pH 7 Solution		
Temperature °C	20	25	30	20	25	30
mV Potential	268	264	260	94	87	80

4. Remove the sensor from the buffer, rinse, and install in the process.

3.5 ORP Electrode Maintenance

Electrodes should respond rapidly. Sluggishness, offsets, and erratic readings are indicators that the electrodes may need cleaning or replacement.

1. To remove oil deposit, clean the electrode with a mild non-abrasive detergent.

2. To remove scale deposits, soak electrodes for 1 to 5 minutes in a 5% hydrochloric acid solution.

3 ORP (metallic) electrodes should be polished with moistened baking soda.

Section 4: Accessories

Table 4-1 Accessories Information

Part Number	Description
24281-00	15 ft. cable with mating VP8 connector
24281-01	25 ft. cable with mating VP8 connector
24281-02	2.5 ft. cable with mating VP8 connector
24281-03	50 ft. cable with mating VP8 connector
24281-04	100 ft. cable with mating VP8 connector
24281-05	4 ft. cable with mating VP8 connector
24281-06	10 ft. cable with mating VP8 connector
24281-07	20 ft. cable with mating VP8 connector
24281-08	30 ft. cable with mating VP8 connector
12707-00	Jet Spray Cleaner
23242-02	Insertion Mounting Adapter, 1.5" MNPT Process Connection, 1" x 3/4" FPT Sensor Adapter/Union Thread
24091-00	Low flow cell, 1" NPT Adapter
24091-02	Low flow cell, 3/4" NPT Adapter
23555-00	Weatherproof Junction Box, with Preamplifier
2002011	CPVC In-Line Tee, 1.5" Size, 1.0" Threaded Process Connection
11275-01	Handrail Mounting Assembly
9210012	pH 4.01 Buffer Solution, 16 oz
9210013	pH 6.86 Buffer Solution, 16 oz
9210014	pH 9.18 Buffer Solution, 16 oz
9200273	Conductor Extension Cable, Shielded and Unprepped (for use with Remote Junction Box)
SQP10077-LQD	Low Flow Control Panel

Note: Please see website for most recent Declaration.

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EU Declaration of Conformity

No: RAD 1119 Rev. B

pH/ORP Sensors

We,

Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317-9685
USA

declare under our sole responsibility that the product,

Rosemount™ Sensor Models:

328A, 385, 385+ -04, 385+ -02/03, 385+-03-12, 389-01, 389-01-10/11-50, 389-01-10/11-54, 389-01-12-50, 389-01-12-54, 389-01-12-55, 389-02, 389VP, 389VP-70, 396, 396P-01-10/13-50, 396P-01-10/13-54, 396P-01-12-50, 396P-01-12-54, 396P-01-12-55, 396P-01-55, 396VP, 396VP-70, 396R, 396RVP, 396RVP-70, 396P-02, 396PVP, 396PVP-70, 397, 398, 398VP, 398R, 398RVP, 398RVP-70, 3200HP, 3300HT, 3300HT VP, 3300HTVP-70, 3400HT, 3400HT VP, 3400HTVP-70, 3500P-01, 3500P-01-12, 3500P-02, 3500VP-01, 3500VP-01-12, 3500VP-02, 3800, 3800VP, 3900-01, 3900-02, 3900VP-01, 3900VP-02

manufactured by,

Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317-9685
USA

to which this declaration relates, is in conformity with the provisions of the European Union Directives, including the latest amendments, as shown in the attached schedule.

Assumption of conformity is based on the application of the harmonized standards and, when applicable or required, a European Union notified body certification, as shown in the attached schedule.

(signature)	Vice President of Global Quality (function)
Chris LaPoint (name)	1-Feb-19; Shakopee, MN USA (date of issue & place)

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EU Declaration of Conformity

No: RAD 1119 Rev. B

ATEX Directive (2014/34/EU)

Baseefa10ATEX0156X– Intrinsically Safe

Equipment Group II, Category 1 G Ex ia IIC T4 Ga (-20°C ≤ Ta ≤ +60°C) (exceptions noted below)

Model 328A Steam sterilizable pH sensor with integral cable
Model 385 Retractable pH/ORP sensor with integral cable
Model 385+ -04 pH/ORP sensor with integral cable
Model 385+ -02/03 pH/ORP sensor with integral cable & Smart preamplifier
Model 385+ -03-12 ORP sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C), T5 (-20°C ≤ Ta ≤ +40°C)
Model 389-01 pH sensor with integral cable & Smart preamplifier
Model 389-01-10/11-50 pH sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C) or T5 (-20°C ≤ Ta ≤ +40°C)
Model 389-01-10/11-54 pH sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C) or T5 (-20°C ≤ Ta ≤ +40°C)
Model 389-01-12-50 ORP sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C)
Model 389-01-12-54 ORP sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C)
Model 389-01-12-55 ORP sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C)
Model 389-02 pH/ORP sensor with integral cable
Model 389VP-70 pH sensor with Variopole connector & Smart preamplifier
Model 389VP pH/ORP sensor with Variopole connector
Model 396 TUpH sensor with integral cable
Model 396P-01-10/13-50 polypropylene pH sensor with integral cable & preamp: T4 (-20°C ≤ Ta ≤ 80°C) or T5 (-20°C ≤ Ta ≤ 40°C)
Model 396P-01-10/13-54 polypropylene pH sensor with integral cable & preamp: T4 (-20°C ≤ Ta ≤ 80°C) or T5 (-20°C ≤ Ta ≤ 40°C)
Model 396P-01-12-50 ORP sensor with integral cable & preamp: T4 (-20°C ≤ Ta ≤ +80°C)
Model 396P-01-12-54 ORP sensor with integral cable & preamp: T4 (-20°C ≤ Ta ≤ +80°C)
Model 396P-01-12-55 ORP sensor with integral cable & preamp: T4 (-20°C ≤ Ta ≤ +80°C)
Model 396P-01-55 pH sensor with integral cable & Smart preamp
Model 396VP TUpH sensor with Variopole connector
Model 396VP-70 TUpH sensor with Variopole connector & Smart preamplifier
Model 396R TUpH Retractable pH/ORP sensor with integral cable
Model 396RVP TUpH Retractable pH/ORP sensor with Variopole connector
Model 396RVP-70 TUpH Retractable pH sensor with Variopole connector & Smart preamplifier
Model 396P-02 TUpH Polypropylene pH/ORP sensor with integral cable
Model 396PVP TUpH Polypropylene pH/ORP sensor with Variopole connector
Model 396PVP-70 TUpH Polypropylene pH sensor with Variopole connector & Smart preamplifier
Model 397 TUpH sensor with integral cable
Model 398 TUpH pH/ORP sensor with integral cable
Model 398VP TUpH pH/ORP sensor with Variopole connector
Model 398R TUpH Retractable pH/ORP sensor with integral cable
Model 398RVP TUpH Retractable pH/ORP sensor with Variopole connector
Model 398RVP-70 TUpH Retractable pH sensor with Variopole connector & Smart preamplifier
Model 3200HP Flowing junction pH sensor with Variopole connector
Model 3300HT Insertion/submersion pH sensor with integral cable
Model 3300HTVP Insertion/submersion pH sensor with Variopole connector

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No: RAD 1119 Rev. B

Model 3300HTVP-70 Insertion/submersion pH sensor with Variopole connector & Smart preamplifier
Model 3400HT Retractable pH sensor with integral cable
Model 3400HTVP Retractable pH sensor with Variopole connector
Model 3400HTVP-70 Retractable pH sensor with Variopole connector & Smart preamplifier
Model 3500P-01 High performance pH sensor with integral cable & Smart preamplifier
Model 3500P-01-12 PerpH-X ORP sensor with integral cable & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C)
Model 3500P-02 High performance pH sensor with integral cable
Model 3500VP-01 High performance pH sensor with Variopole connector & Smart preamplifier
Model 3500VP-01-12 PerpH-X ORP sensor with Variopole connector & preamplifier: T4 (-20°C ≤ Ta ≤ +80°C)
Model 3500VP-02 High performance pH sensor with Variopole connector
Model 3800 Steam sterilizable pH sensor with single pole Eurocap connector
CE marking was first affixed to this product in 2011
Model 3800VP Steam sterilizable pH sensor with Variopole connector
Model 3900-01 pH/ORP sensor with integral cable & Smart preamplifier
Model 3900-02 pH/ORP sensor with integral cable
Model 3900VP-01 pH sensor with Variopole connector & Smart preamplifier
Model 3900VP-02 pH/ORP sensor with Variopole connector

Special conditions for safe use:
1) All pH/ORP sensor models with a plastic enclosure or exposed plastic parts may provide an electrostatic ignition
hazard and must only be cleaned with a damp cloth to avoid the danger of ignition due to a buildup of electrostatic
charge.
2) All pH/ORP sensor models with a metallic enclosure may provide a risk of ignition by impact or friction. Care should be
taken during installation to protect the sensor from this risk.
3) External connections to the sensor must be suitably terminated and provide a degree of protection of at least IP20.
All pH/ORP sensor models are intended to be in contact with the process fluid and may not meet the 500V r.m.s test to earth. This must
be taken into consideration at installation.

Harmonized Standards:
EN 60079-0:2012+A11:2013
EN 60079-11:2012

ATEX Notified Body for EC Type Examination Certificate & Quality Assurance
SGS FIMKO OY [Notified Body Number: 0598]
P.O. Box 30 (Särkiniementie 3)
00211 HELSINKI
Finland

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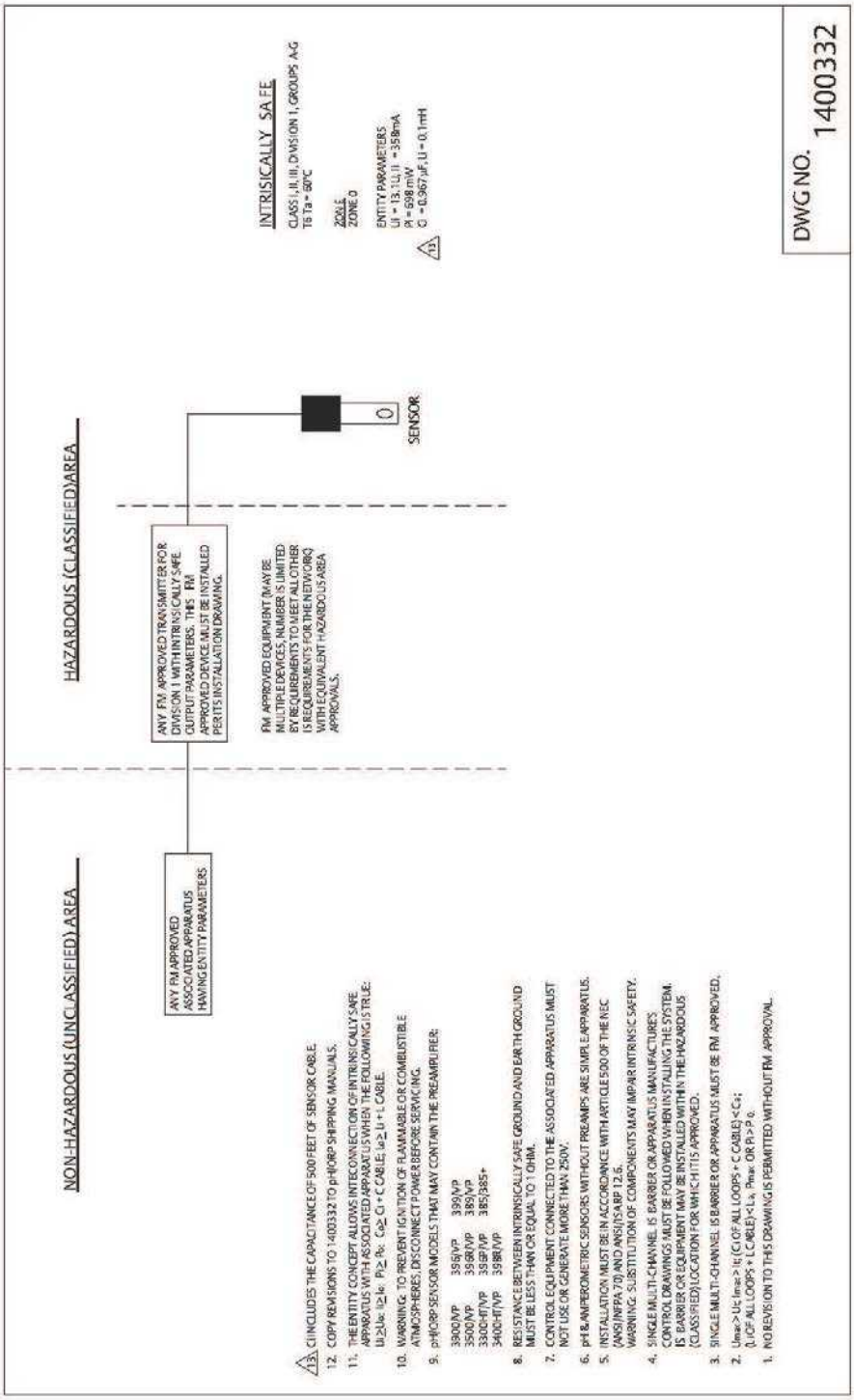
表格 1: 含有 China RoHS 管控物质超过最大浓度限值的部件型号列
Table 1: List of Model Parts with China RoHS Concentration above MCVs

部件名称 Part Name	有害物质 / Hazardous Substances					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr +6)	多溴联苯 Polybrominated biphenyls (PBB)	多溴联苯醚 Polybrominated diphenyl ethers (PBDE)
电子组件 Electronics Assembly	X	O	O	O	O	O
传感器组件 Sensor Assembly	X	O	O	O	O	O

本表格系依照 SJ/T11364 的规定而制作。
This table is proposed in accordance with the provision of SJ/T11364
O: 意为该部件的所有均质材料中该有害物质的含量均低于 GB/T 26572 所规定的限量要求。
O: Indicate that said hazardous substance in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.
X: 意为在该部件所使用的所有均质材料里，至少有一类均质材料中该有害物质的含量高于 GB/T 26572 所规定的限量要求。
X: Indicate that said hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T 26572.

Intrinsically Safe Sensor Installation Drawing - FM



00809-0100-3900
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General Plan of Operations
Appendix 03
Tailings Disposal Facility Disposal Plan

May 2020

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Acronyms

AAC	Alaska Administrative Code
ABA	Acid-Base Account
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
APDES	Alaska Pollutant Discharge Elimination System
ARD	acid rock drainage
EA	Environmental Assessment
FEIS	Final Environmental Impact Statement
GPO	General Plan of Operations
HDPE	high-density polyethylene pipe
HGCMC	Hecla Greens Creek Mining Company
IMP	Integrated Monitoring Plan
KCB	Klohn Crippen Berger, Ltd.
MSHA	Mine Safety and Health Administration
NEPA	National Environmental Policy Act
QA	quality assurance
QC	quality control
QA/AC	quality assurance/quality control
SOP	Standard Operating Procedure
TDF	Tailings Disposal Facility
USDA	United States Department of Agriculture
USFS	United States Forest Service
WMP	Waste Management Permit

1. INTRODUCTION

The Greens Creek Mine is operated by Hecla Greens Creek Mining Company (HGCMC) in accordance with the General Plan of Operations (GPO) approved by the United States Forest Service (USFS), hereafter referred to as the Forest Service. The GPO has several appendices which describe the management activities conducted at the Greens Creek Mine, the location and timing of those activities, and how the environment and resources in the area are protected through compliance with federal and state requirements. This document, GPO Appendix 3 Tailings Disposal Facility Management Plan, provides information on the management objectives, operations, and monitoring and inspection requirements for the Greens Creek Mine Tailings Disposal Facility (TDF).

Table 1. Record of Changes and Amendments

Date	Section(s) Changed or Amended
August 2000	Submittal by Kennecott Greens Creek Mining Company
April 2004	Submittal by Kennecott Greens Creek Mining Company Revisions associated with the Record of Decision and Final Environmental Impact Statement (FEIS) supporting an expansion of the tailings disposal facility (Stage 2 expansion). Updated pertinent information and references (USFS 2003). Acknowledged criteria associated with 2003 Waste Management Permit identifying a total projected tailings footprint area of 62.2 acres.
February 2014	Submittal by Hecla Greens Creek Mining Company. Revisions associated with Record of Decision and FEIS supporting an expansion of the tailings disposal facility (Stage 3 expansion). Updated pertinent information and references (USFS 2013).
November 2014	Submittal by Hecla Greens Creek Mining Company. Revisions to incorporate reference to ADEC Waste Management Permit 2014DB0003, issued August 11, 2014.
August 2015	The ratio for codisposal at tailings is 1:1 to 3:2, the previous version had it as 1:1 to 3.2 (waste rock to tails) – 3.2 was a typographic error
June 2017	Allow for codisposal of waste rock at amounts ranging from 0 percent to 60 percent waste rock (3 waste rock to 2 tailings). Simplified placement language to provide more flexibility to adjust to environmental and material constraints.
July 2018	Modified for the disposal of 100% waste rock into discreet cells.

Certain areas of the mine's operation are subject to federal and state permits and approvals issued by other federal and state agencies. The State of Alaska Department of Environmental Conservation (ADEC) regulates mill tailings and waste rock disposal facilities at the Greens Creek Mine, as well as other aspects of the operation, primarily through Title 18 of the Alaska Administrative Code (AAC), Chapters 50, 60, 70, 72 and 83. ADEC's Waste Management Permit (WMP) authorizes tailings and waste rock disposal and prescribes monitoring, reporting, closure, post-closure and financial responsibility requirements. The Forest Service has issued special use permits and leases for various aspects of the operations.

Closure requirements for the Greens Creek Mine are described in more detail in Greens Creek Mine GPO Appendix 14, Reclamation and Closure Plan. The Alaska Department of Natural Resources (ADNR) regulates the reclamation of the TDF, by issuing the Reclamation Plan approval for the entire site,

including the tailings and waste rock disposal sites per 11 AAC 97.310. The Forest Service also sets requirements for reclamation. Permits and authorizations are further discussed in Section 2.1.

Management objectives associated with the TDF consider risk due to potential acid rock drainage (ARD) and metals leaching, and geotechnical stability, all of which can potentially create adverse environmental conditions. These risks are evaluated with respect to local hydrology, climate, geochemistry, and other associated factors to ensure the methods employed best match site-specific conditions while still providing the operational flexibility to improve procedures as needed. Specific aspects of the operational practices used to achieve management objectives outlined in this document are presented in the TDF standard operating procedure (SOP) provided in Attachment A. The SOP format allows flexibility for regular updates as site conditions and needs change. Modifications to the SOP are summarized in the annual report, and substantial modifications are identified which may affect the WMP. This appendix is updated through coordination with the USFS, the ADEC, and the ADNR. If there is a conflict between the terms established in the GPO, applicable regulations, or the WMP, then the terms with the most recent written approval from the ADEC, the USFS, and the ADNR govern.

2. BACKGROUND

The mill at the Greens Creek Mine generates approximately 1,800 dry tons of filter-pressed tailings per day, or approximately 650,000 tons of tailings annually. These tailings are dewatered in a filter press at the mill, with about 50% of the tailings being mixed with cement and hauled back into the underground mine for disposal in mined-out areas as mine backfill. The remaining 50% of the tailings are trucked from the along the B Road and placed in a surface tailings disposal area (TDF). The TDF is situated 7 miles from the mine site near the port facility (refer to Attachment B, Figures 1 and 2) and are placed using dry-stack tailings disposal techniques (refer to Attachment A, SOP).

All designs for expansion and placement since 1998 have been accomplished by Klohn Crippen Berger Ltd. (KCB). Design processes address foundation, operations, and closure geotechnical stability factors, as well as water management. Construction plans are submitted to agencies for approval prior to implementation of expansion efforts.

A summary of the TDF historical waste placement areas is provided in Attachment B, Figure 3. Refer to the Greens Creek Mine annual reports for further details.

2.1. Permits and Authorizations

The Forest Service and the ADEC regulate the TDF. ADNR Dam Safety issues the Certificate of Approval to operate the Pond 7 and Pond 10 pond system and appurtenances. The discharge of waters from the water treatment facility, to the marine environment, is permitted under the ADEC Alaska Pollutant Discharge Elimination System (APDES) program. Reclamation requirements are established by the USFS, with Reclamation approval issued by the ADNR-Mining Section. For a complete summary of federal, state, and local agencies involved in the permitting approval processes for Greens Creek Mine, refer to the 2013 Final Environmental Impact Statement (USFS 2013).

NEPA/EIS Processes

The initial FEIS for Greens Creek Mine was completed in 1983 (USFS 1983). Eight alternatives were identified in the 1983 FEIS with number six being selected as the preferred alternative. Under the preferred alternative, tailings generated by the milling process would be transported and disposed as slurry into a settling pond within a 150-acre tailings basin.

In 1988, two major changes were introduced by the Mine Ownership regarding development and operation of the mine. The proposed changes were addressed in the 1988 Environmental Assessment (EA) for Proposed Changes to the General Plan of Operation for the Development and Operation of the Greens Creek Mine (USFS 1988). Under the EA proposed action alternative, tailings generated by the milling process would be dewatered at the mill site and transported by truck to a smaller dry tailings facility. Wastewater from the mill site would be transported through an eight-inch, single-walled, high-density, polyethylene (HDPE) pipeline to a 3.5 acre settling pond within the tailings basin (additional 10-inch and 18-inch single-walled HDPE pipelines have been installed to carry storm water and process water from the mill area to the pond system at the TDF. The Greens Creek Mine TDF was constructed according to guidelines consistent with the 1988 EA Decision Notice (USFS 1988).

Greens Creek Mine applied for an expansion of the existing TDF in January 2001, the expansion area was referred to as the Stage 2 expansion area. The Forest Service issued a Record of Decision on October 24, 2003 which approved the Stage 2 expansion of the TDF area using Alternative C in the FEIS (USFS 2003). With approval of the expansion based on a thorough National Environmental Policy Act (NEPA) review, Greens Creek Mine updated the GPO Appendix 3, Tailings Disposal Facility Management Plan. The subsequent revision of this GPO was undertaken concurrent with the renewal of the Waste Management Permit.

In late 2010, Greens Creek Mine under the ownership of HGCMC applied for further expansion of the TDF; the expansion area was referred as the Stage 3 expansion area. The Forest Service issued a Record of Decision on August 30, 2013, which approved the expansion of the TDF area using Alternative D with modifications as described in the Record of Decision and FEIS (USFS 2013). This expansion provides accommodations for an additional 10 to 15 years of tailings and waste rock disposal.

ADEC Solid Waste Management Processes

The ADEC determined on July 26, 1999 that tailings placed in the TDF are subject to the 18 AAC 60, Solid Waste Management regulations which stipulate that a Waste Management Permit (WMP) must be obtained. Mining waste is regulated under the monofill standards described in Article 4 which gives ADEC discretion to incorporate applicable provisions of 18 AAC 60 into a WMP. The WMP contains applicable provisions of Articles 1, 2, and 4 that pertain to general standards, limitations, prohibitions and administrative procedures to be followed; monofill standards such as locational, operational, and design related requirements, as well as closure and post-closure plans, notifications, monitoring, and reporting requirements.

The Greens Creek Mine facilities are also subject to Article 6, User Fees and Article 7, Monitoring and Corrective Action Requirements. The Article 7 monitoring requirements specify visual, surface water and groundwater requirements. Detection monitoring, and if necessary, assessment monitoring is also required under Article 7. Specific inspection and monitoring requirements are detailed in Section 3.0 of this document. Waivers to any provision of 18 AAC 60 may be applied for per 18 AAC 60.900.

2.2. Tailings Characterization

The geochemical characteristics of tailings affect the design, operation, monitoring requirements, environmental performance, and eventual closure and reclamation of the dry stack tailings disposal site. Given that the Greens Creek Mine ore is from a high-grade sulfide-hosted polymetallic deposit, pyritic sulfur is a component of the tailings. Mineralogy and geochemical studies have established the nature of tailings material.

The weathering characteristics and acid generating and/or neutralization potential of the various materials disposed of in the TDF are discussed in the Greens Creek Mine GPO Appendix 1, Integrated Monitoring Plan (IMP).. Inspection and monitoring requirements for the TDF, which include water levels, water quality, and geochemical testing of the tailings, are described in the IMP.

Acid-base accounts (ABAs) completed by HGCMC (2012) and Petros (2011) show that the tailings are acid generating but that the high carbonate content provides substantial buffering capacity. These results are consistent with previous studies of the tailings. Tailings that have been exposed to weathering for close to 3 decades have been shown to still have a high neutralization potential, equivalent to approximately 20% calcium carbonate. This suggests that the potential lag time to acid generation of exposed tailings is on the order of decades. This long lag time allows time for construction and adequate closure of the site (including covering the pile with a composite soil cover designed to minimize oxygen ingress). Actual oxidation rates are likely to be much less under field conditions due to passivation of reactive surfaces, reduced oxygen supply, and low temperatures.

Under neutral pH conditions, concentrations of metals (particularly zinc) can be released in a soluble form into water that contacts the tailings. To a lesser degree, other metals such as cadmium, nickel, lead, and metalloids (selenium and arsenic) are found in water that infiltrates through tailings.

3. TAILINGS DISPOSAL FACILITY MANAGEMENT

HGCMC manages the TDF through its Surface Operations Department. Management responsibility will transfer to the Environment Department after the completion of closure activities. The WMP, as issued by the ADEC, defines wastes that may be disposed of in the TDF. Refer to the most recent WMP (2014DB0003) for a list of authorized wastes and conditionally approved wastes.

Facility management also includes implementing management controls to maintain surface and ground water quality. This requires a thorough understanding of the site water balance. Site water balance components are periodically evaluated through modeling the primary elements of the mine that include the underground mine, the mill, the TDF, the TDF water treatment plant, and the Port Facility Camp water treatment plant (EDE 2018).

Attachment B, Figure 2 includes the TDF as-built; refer to HGCMC annual reports for the most recent facility as-built.

3.1. Management Objectives

HGCMC plans, designs, constructs, operates, monitors, and will eventually close the TDF with the intent of meeting the following management objectives:

- Construct facility expansions per approved construction drawings.

- Safely receive approved waste material within the designed TDF capacity constraints during the operational period of the mine.
- Minimize run-on water from entering the TDF from upgradient sources.
- Maintain water management system components as designed with an understanding of geochemical and hydrological processes. Control surface water, ground water, and interior facility waters to prevent offsite water quality impacts.
- Minimize fugitive dust impacts from the TDF operations to surrounding land and wetland areas.
- Maintain pile geotechnical stability (short-term and long-term).
- Reduce impacts to the receiving environment and ultimately reclaim the facility in a manner that will support and protect designated beneficial uses.

3.2. Surface Operations

HGCMC surface operations place tailings in the facility in general accordance with criteria established by KCB in 1999 for the placement of tailings in the TDF (KCB 1999). A summary of the applicable criteria includes:

- Tailings shall generally be placed in a cellular pattern centered around the tailings access road(s).
- New tailings shall not be placed on uncompacted saturated tailings.
- The tailings shall be placed in lifts and compacted with a smooth drum roller to a density of no less than 90 percent of the maximum dry density as determined by a Standard Proctor (ASTM D698). If the tailings cannot be placed and compacted upon arrival at the tailings facility, they shall be stockpiled to minimize any additional moisture absorption during wet periods, or drying during warm periods. The tailings shall be handled such that specified placement densities are achieved.
- The top surface of the tailings shall be graded to control surface runoff and be compacted with a smooth drum roller to minimize infiltration from ruts or indentations.
- Placement shall then continue at another location/cell to allow time for any construction pore pressures to dissipate.
- Construct with compacted outside side slopes that are no steeper than 3H:1V. Slopes during operation may be less than 3:1 if future operation or slope work is planned, or HGCMC receives approval for steeper slopes provided pile stability requirements are met.

HGCMC has established a SOP generally based on these criteria established by KCB with the intent of achieving the TDF management objectives presented in Section 3.1. A copy of the SOP is provided in Attachment A.

HGCMC uses off-highway, lidded trailer trucks to transport the tailings from the mill to the TDF. Temporary access roads are constructed as required to access the placement areas (the number of access roads are minimized as much as practicable). The material is end dumped, spread and “track-walked” in using a bulldozer. Before the end of each shift and before any significant rainfall the surface of the placement area is compacted or “sealed” with a smooth-drum vibratory compactor to minimize moisture infiltration into the pile. Compaction checks of pure tailings are periodically completed using methods such as the water balloon or sand cone method, or a nuclear density gauge. Field samples are collected for moisture determination by the HGCMC laboratory. Proper placement requires achievement of 90 percent or greater compaction relative to a standard Proctor density. Though a standard density cannot be identified for co-disposed material because of mixture variability, periodic moisture samples are collected, and density tests completed.

HGCMC places tailings, co-disposed waste rock and tailings, and waste rock into quasi discreet cells at the TDF to provide for better control over compaction, drainage control, and pore-pressure dissipation. The term cell is used to refer to relatively small areas within the tailings facility. Material is placed and compacted in each cell as needed and then placement progresses to another cell, allowing time for construction pore pressures to dissipate.

Water management at the facility consists of a complex network of drains under the pile, bentonite slurry walls around the perimeter of the site, and ditches to divert up-slope water and collect surface runoff. The site is underlain by a low permeability silt/clay till and other glacial/marine deposits and/or an engineered HDPE liner. These features minimize the potential for the downward migration of contact waters. An upward hydrologic gradient under portions of the site further aids in contact water collection.

Co-disposal practices at the TDF have been approved by the agencies (HGCMC 2009). Co-disposal refers to the placement of a mixture of waste rock and tailings. The primary purpose of co-disposal is to reduce pyrite oxidation and metal leaching from waste rock by surrounding it with a matrix of fine-grained material (tailings). The geotechnical, geochemical and operational aspects of co-disposed materials have been studied, and the results demonstrate that co-disposal of waste rock and tailings will significantly improve the drainage and stormwater runoff quality at uncontained inactive waste rock sites by relocating this material to the TDF, without negatively impacting drainage or stormwater runoff from the TDF, and can be done in a manner that minimizes effects on the environment.

3.3. Monitoring and Inspections

All monitoring shall be conducted in accordance with the WMP, 18 AAC 60.820-860 (surface water and ground water), and GPO Appendix 1, Integrated Monitoring Plan. GPO Appendix 1 contains information regarding water quality compliance monitoring, including monitoring requirements, test procedures, frequency, parameters, field procedures, and quality assurance/quality control (QA/QC) plans.

Visual observations and material sampling are used to ensure that the facility is constructed according to approved construction plans. Monitoring hub, inclinometer, piezometer and topographic survey data are used in conjunction with engineering assessments to determine if the site is stable in the short and long term. Visual observations and routine maintenance ensure that the water management system is functioning as designed. Water quality data, flow and level monitoring, material sampling and site meteorology station data are used to define geochemical and hydrologic processes occurring at the site. This information is evaluated with respect to design expectations, and modifications are made as necessary to minimize effects on the receiving environment in the short and long term.

Monthly inspections of the facility are performed when operations are in process, using an inspection checklist (refer to Attachment C). Daily and weekly visual inspections are made as part of operations for which an inspection checklist is not required or used. A person who is familiar with the WMP requirements conducts the inspection. Visual monitoring is conducted on routine facility operations, leachate collection and diversion systems, leachate pumping systems, and the facility perimeter, where possible. Structural changes or leakage noted during the inspections shall be documented. Inspections shall include but may not be limited to the following:

- Signs of damage or potential damage to any component of the facility from settlement, ponding, leakage, thermal instability, frost action, erosion, slip failure, thawing of the waste, or operations that contribute to a problem;
- Exceptions to conditions of the waste management permit;

- Escape of waste or leachate;
- Unauthorized waste disposal;
- Damage to the structural integrity of a monitoring device, containment or seepage structure; retaining wall, erosion control or diversion structure; and,
- Evidence of death or stress to fish, wildlife, or vegetation caused by the facility.

If visible detrimental structural change, damage to the facility, or noncompliance with a waste management permit condition is observed, during an inspections, HGCMC shall orally notify ADEC no later than the end of the next working day and appropriate action shall be taken to correct the exception or damage, prevent the escape of waste or leachate, and clean up any improper waste disposal. The Forest Service shall also be notified in a timely manner. Refer to the WMP for additional requirements for corrective actions.

HGCMC submits reports on the TDF to the ADEC per WMP requirements, and to the Forest Service in consideration of the GPO. These reports include:

- An as-built topographic survey (in plan and cross section);
- A running total of tailings and other materials placed at the site and a current remaining volume estimate;
- A summary of piezometer readings;
- A summary of key activities, observations, problems and corrective actions;
- A summary of water and tailings monitoring, including a description of the geochemical and hydrological processes occurring at the site; and
- A summary of pertinent reclamation/closure activities and studies.

Refer to the WMP for additional details on reporting requirements and schedule for submittals.

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USFS, R10-MB-744c. *Greens Creek Mine Tailings Disposal Facility Expansion, Final Environmental Impact Statement and Record of Decision*. *Tongass National Forest, Admiralty Island National Monument, Juneau, Alaska.* September 2013.

GPO Appendix 03
Attachment A
Tailings Disposal Facility
Standard Operating Procedure

Hecla Greens Creek Mining Company (HGCMC) uses the following operational procedures for the tailings disposal facility (TDF):

General Requirements

- Only those wastes approved in the Waste Management Permit (WMP) will be disposed of at the facility.
- Facility expansions shall be per agency approved construction design drawings and specifications, within the permitted lease boundary and footprint approved by the USFS. Expansion designs shall be adequate to ensure geotechnical stability.
- Best Management Practices shall be utilized with regards to storm water and sediment management.

Safety

- Conduct operations per HGCMC and MSHA safety standards. This includes:
    - Constructing safety berms per MSHA standards.
    - Providing adequate lighting for night operations.
    - Maintaining proper signage for traffic.
    - Maintaining radio or visual contact with site operator.
    - Maintaining awareness of uneven surfaces, slips trips and falls.
    - Providing adequate health and hygiene training for operators in the TDF.

Site Access

- Construct internal access roads on the surface of the tailings material with quarry rock, waste rock, or tailings to access placement areas. These roads are known as “dirty roads” and are needed to prevent rutting of tailings material, particularly during wet weather. The number and extent of internal cross roads vary given the location and size of the placement area(s) and weather conditions. Compacted tailings can support truck traffic (particularly in dry weather) making it practical to limit the number of crossroads; however, during wet weather, cross roads may be used. The number of internal access roads shall be minimized as much as practicable.
- Recover cross road rock where practical for use in new cross road construction. If areas of rock cannot be recovered, ensure they are isolated from surface drainage by at least two feet of tailings or codisposal material.
- Require wheeled vehicles to remain on dirty roads and trafficable areas on the tailings pile and to pass through a truck wheel-wash facility prior to accessing a clean road or the B road. This prevents tracking of tailings material away from the contained facility.
- During freezing conditions, the truck wheel-wash is not used due to safety restrictions including potential for creating icy roads and creating a situation where the brakes of the trucks may freeze. Instead, operations ensure that the roads are in good condition within the tails facility with the intent of keeping tailings off the rock roads. The truck tires have minimal potential to pick-up and transport/track tails materials under frozen conditions.

Placement Methods

- Placement methods are designed to minimize water infiltration, sediment runoff, oxygen intrusion, and potential for development of acid rock drainage conditions. Per 18 AAC 60.485(c),

construct outer slopes at a minimum of 3 horizontal to 1 vertical (3H:1V) to ensure slopes are stable and do not erode or slough.

- Placement cells are defined as placement areas and generally do not exceed 2500 to 3000 sf with average dimensions of 250-ft x 100-ft.
- Prior to tailings placement, ensure that positive surface drainage is occurring for each cell to prevent water pooling or ponding. During winter, ensure snow has been removed from the placement area.
- Deliver tailings from the mill with moisture content of around 10 to 14 percent. Alternative moisture contents may be accepted based on material properties and ability of placement methods to meet compaction standards.
- Spread tailings in approximate one-foot lifts on the areas that have been graded for drainage and compact by several passes with a bulldozer followed by at least two overlapping passes of the vibratory roller (compactor). This compaction is designed to promote runoff, reduce the potential for oxygen and water infiltration, and ensure geotechnical stability.
- Placement will routinely shift to allow dissipation of construction pore pressures.
- Compaction of pure tailings in placement areas will be periodically verified by field measurements of wet density by Surface Operations Technical Services staff. These measurements are used to calculate the dry unit weight after determining the moisture content. The calculated dry unit weight is then compared against the maximum dry unit weight as determined by the laboratory Compaction verification methods may include the water balloon or sand cone method, or a nuclear density gauge.
- When waste rock is delivered to the tailings facility the material will be disposed in discreet waste rock cells or blended as uniformly as practicable with tailings. Waste rock material will be encapsulated with at least 5 feet of tailings.
- Periodic moisture and density tests will be obtained within co-disposed placement areas by Surface Operations Technical Services staff; however, the variability of co-disposed material precludes the development of a moisture/density standard.
- Place Class 1 waste rock (argillite) on outer slopes, if available.
- If Class 1 waste rock is not available in the interim: coat exposed slopes with any other available rock, or mulch with hydroseeder.
- All final slopes will be covered with Class 1 waste rock.

Water Management

- Divert surface runoff from undisturbed areas around the tailings facility.
- Within the facility provide diversion ditches to prevent surface water from running into placement areas and ensure site runoff is conveyed via appropriately designed and sized conveyance channels to ponds or discharge points to minimize erosion and sediment loss.
- Collect and route runoff on the tailings facility via ditching and piping into the pond system for subsequent water treatment and discharge into Hawk Inlet.
- Minimize tailings contact with groundwater using acceptable engineering practices which may include engineered liners, finger and blanket drains beneath the tailings, and/or slurry walls surrounding to the facility.

Fugitive Dust Control

- Monitor fugitive dust generated from the tailings facility following methods described in the Integrated Monitoring Plan (IMP).
- Install wind breaks such as wind fencing and/or other appropriate mechanical controls on the crest of the tailings pile to reduce wind speed and dust dispersal through this area.
- Limit snow removal to active placement areas only.
- Cover interim slopes with rock or other cover materials (e.g. mulch) as practicable.
- Hydroseed outer slopes, where appropriate.
- Use dust suppression aids where approved/appropriate.
- Utilize water for dust suppression in all seasons

Sediment Control

- Maintain access roads in a manner that minimizes sediment production
- Construct and maintain rock settling basins to reduce sediment loading in site drainage.
- Use flocculent or polymer aids where appropriate and approved.

Snow Removal

- Do not place tailings on snow or ice.
- Remove snow from active placement zones prior to placement.
- Avoid mixing tailings with snow during snow removal.

Reclamation

- Permanent closure requirements are provided in the ADEC waste management permit.
- Conform to stipulations in GPO Appendix 14, Reclamation and Closure Plan.
- Conduct operations in a manner that minimizes closure/reclamation liability.
- Manage materials to maximize availability for reclamation use (separate and stockpile where appropriate).
- Grade final slopes to design specifications and hydroseed with approved seed mix.
- Construct approved reclamation cover when slopes are at final configuration and potential for contamination of cover surface is low (applies to concurrent reclamation).

Emergency Action Plan

Issues identified during inspections shall be addressed in a timely manner before an emergency arises. In the event of unforeseen slope movement within the facility and/or water control issues that could result in a discharge of contaminated water to the environment, the following procedure will be followed:

- Remove non-critical personnel from the area and barricade the area per approved safety standards.
- For slope movement issues, assess the site condition with input from a geotechnical engineer. Prepare and implement an action plan appropriate for the identified site condition(s).
- For water control issues, work with Surface Operations and/or Water Operations personnel to prepare and implement an action plan appropriate for the identified site condition(s).

Monitoring

Monitoring includes visual inspections, and environmental and water quality monitoring. Inspections and environmental monitoring shall be conducted as described in the GPO Appendix 1, Integrated Monitoring Plan. Monitoring activities include:

- General Site Inspections
- Surface water, ground water (wells and lysimeters), and wet wells water quality monitoring
- Acid-base accounting and geochemical analysis of the tailings
- Water levels (wells, piezometers)
- Fugitive dust monitoring
- Meteorological conditions

GPO Appendix 03
Attachment B
Tailings Disposal Facility
Figures

Figure 1. Mine Site Location Map

Figure 2. Tailings Facility as Built

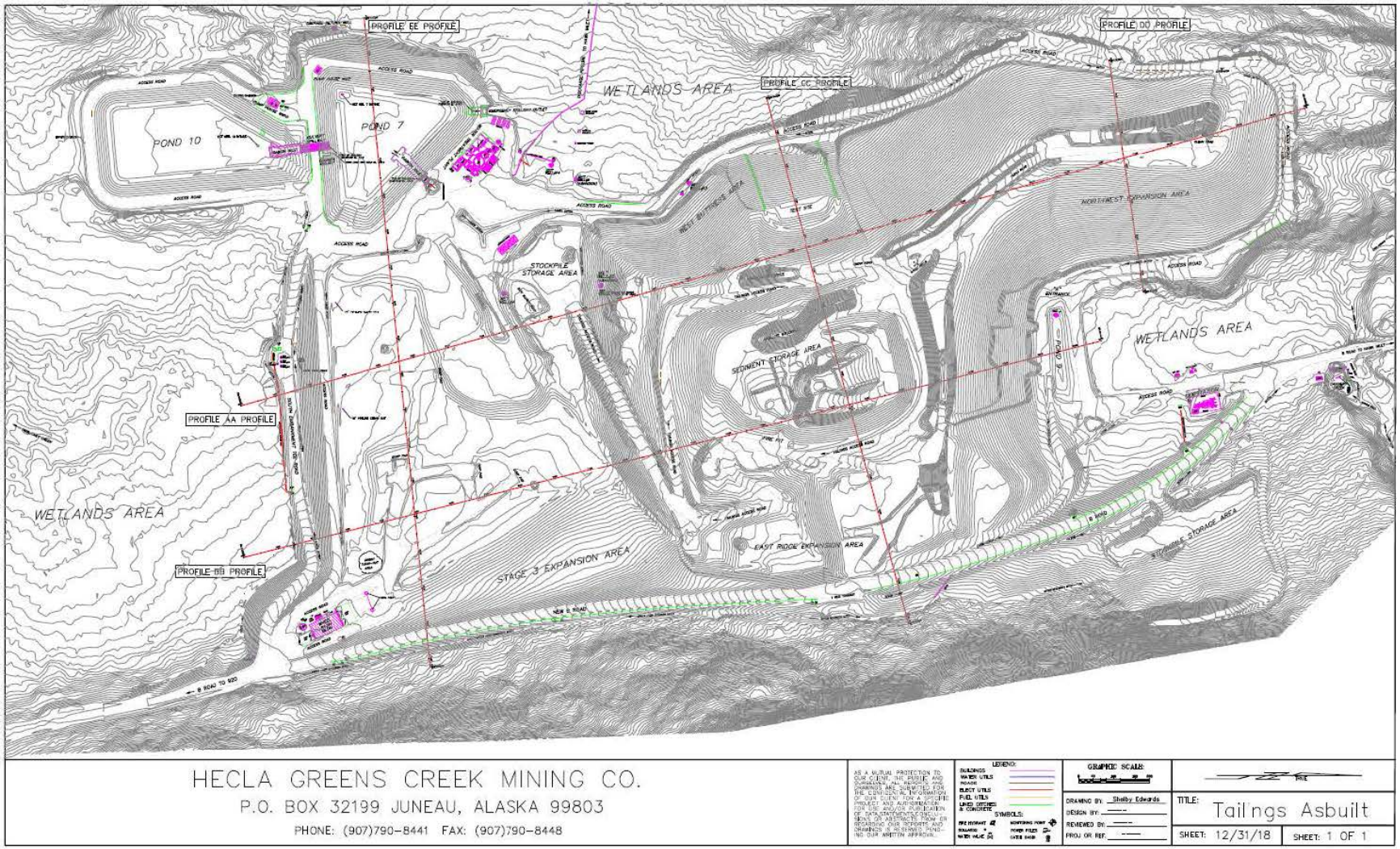


Figure 3. Tailings Facility as Built Cross Sections

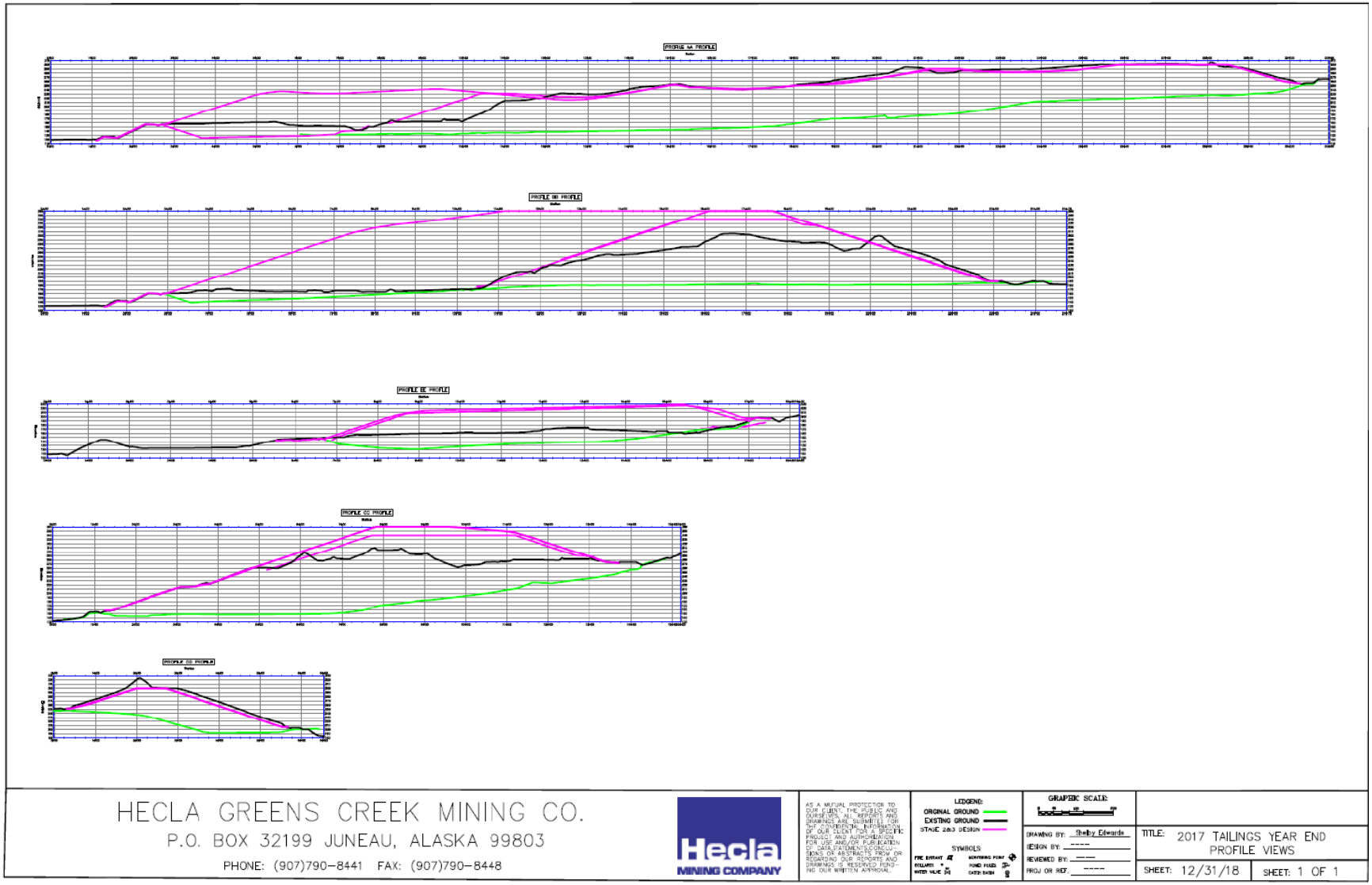
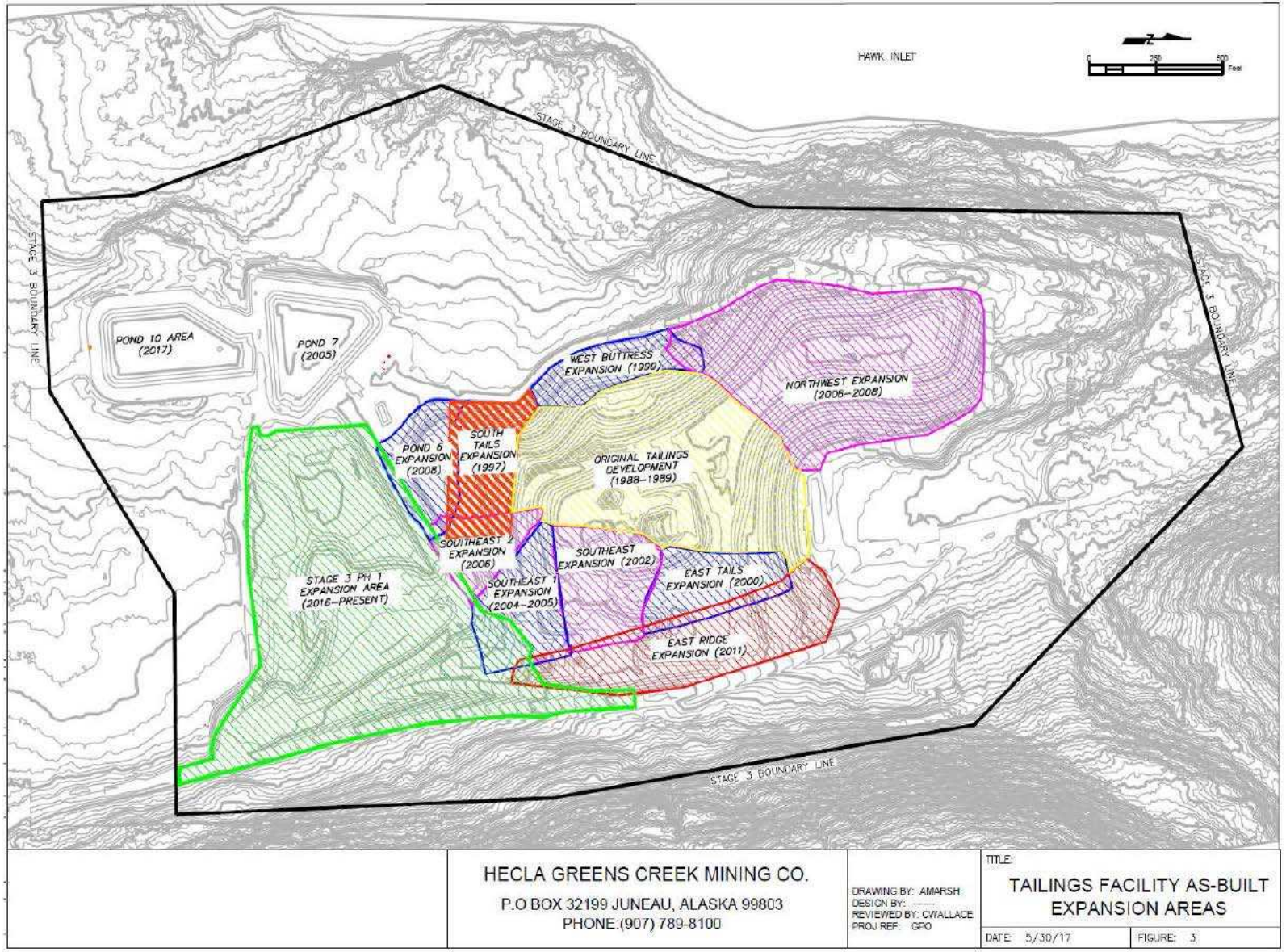


Figure 4. Tailings Facility Expansion Areas



General Plan of Operations
Appendix 04
Fish and Wildlife Monitoring

May 2020

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1. BEAR MONITORING PROGRAM

As a requirement of the final Environmental Impact Statement in 1983, Greens Creek Mining Company funded a Brown Bear Study in conjunction with the Alaska Department of Fish and Game (ADF&G), Division of Wildlife Conservation.

In 1990, Greens Creek Mining Company started to take a more active role in the Brown Bear Study. ADF&G conducted worker training on Bear Safety at the mine and a closer working partnership between Greens Creek Mining Company and ADF&G was established. ADF&G along with Greens Creek Mining Company conducted radio telemetry from the Greens Creek road system to determine the concentration of collared bears in proximity to the road for several years.

The paper entitled "Population and Habitat Ecology of Brown Bears on Admiralty and Chichagof Islands" December 1993, by Kimberly Titus and Lavern R. Beier, ADF&G, Division of Wildlife Conservation, concluded that the brown bear management program instituted by Greens Creek Mining Company was successful in maintaining bear populations over the study period.

2. EAGLE MONITORING PROGRAM

2.1. Introduction

Bald Eagle monitoring was a requirement of the Final Environmental Impact Study. The study has been performed by the U.S. Fish and Wildlife Service with assistance by Greens Creek Mining Company. The last survey was conducted in 2019.

2.2. Monitoring

Monitoring is conducted in late April or early May, and in July. Observations were made by flying the coastal regions of Young Bay and Hawk Inlet to observe birds and nests. Each nest was marked on a topographical map, eggs and young were also marked on the map.

2.3. Study Results

The latest helicopter survey was conducted in 2019. The survey marked locations of active and inactive nest sightings as compared to the previous survey. No conclusions were drawn. U.S. Fish & Wildlife Service in Juneau may be contacted for information concerning the latest results of these studies.

3. FISH MITIGATION

Fish mitigation originally was proposed because fish spawning and rearing habitat would have been destroyed as a result of the original tailings dam. That dam was never built, because the Company installed a dry tailings system which reduced the tailing area and did not remove spawning or rearing habitat. During the 1988 EA which changed the tailings plan, the Company did not withdraw plans for fish mitigation. Because of this, fish mitigation at Greens Creek is still active.

3.1. History of the Mitigation Issue

Discussions regarding the obligation for mitigation of potential project development impacts on fisheries resources began in the middle of 1981. As discussion proceeded, the Forest Service generally felt that most of the fishery-related effects of mine development would be from tailings disposal, with some potential effects of water withdrawal from Greens Creek.

Discussions tended to focus heavily on coho salmon as the species of primary interest as far as mitigation was concerned. Fisheries resources in Greens Creek itself were previously identified as consisting of pink salmon, chum salmon and coho salmon. Dolly Varden char and cutthroat trout were known to inhabit waters of Greens Creek but were not the objects of particular interest in the earlier environmental studies with the exception of the determination of body burdens for heavy metals.

It was suggested by the Forest Service that passage over Greens Creek Falls, opening about four miles of stream to anadromous access previously denied by the barrier (not counting lower extremities of tributaries), would mitigate for any anticipated effects of the mining project. A fish ladder was installed during the summer of 1988 following the guidelines set out in Greens Creek Fishway, Guidelines for Fishway Construction Evaluation (Ott Water Engineers, Inc., June 1988).

A memorandum to Jack Cottrell, Greens Creek Mining Company from J.W. Buell, Ph.D. dated March 13, 1991, summarizes the Greens Creek Mine, Anadromous Fish Mitigation in detail (Buell, March 1991).

3.2. Mitigation Efforts

Following the plan outlined in the 1988 EA by Buell and Associates, Greens Creek initiated studies in the fall of 1988 to determine the effectiveness of the fish ladder by migrating salmon.

Initially, studies concluded that adult Coho salmon did not migrate to the fish ladder area and spawn above or below that particular reach of Greens Creek.

In order to meet mitigation requirements, a trap and haul plan was initiated in 1991. However, after the plan had been approved, salmon fry was discovered above the fish pass and the trap and haul plan was tabled until population studies could be implemented. By early 1992, two surveys found fry and yearlings above the pass, but, due to high stream flows, finite populous numbers were not established. A third attempt was scheduled for August 1992 when stream flows are historically lower. Coho, chinook, pink and chum were found above the waterfall, almost to the portal. Pink and chum salmon access was established by visual observation of adults. Coho and chinook access above the waterfall were established by the capture of juveniles of those species (Buell, 1995).

Annual monitoring conducted by the ADF&G since 2001 at a Greens Creek site adjacent to waste rock storage Site 23, upstream of the fish ladder, has resulted in the capture of juvenile coho salmon during most years. During the 2018 and 2019 monitoring, two age classes of juveniles were observed demonstrating successful adult coho salmon passage occurred during the prior fall spawning seasons (Kane, 2020).

3.3. Fish Ladder Maintenance

The original fish ladder, constructed of timber, was damaged during a heavy rainstorm in 2005. In the years following there was a substantial reduction in the number of juvenile coho salmon captured upstream of the fish ladder, likely attributable to the increased difficulty for adult salmon to migrate past the damaged weirs. The ADF&G issued HGCMC a Fish Habitat Permit to repair the damaged weirs to the minimum specifications of the original design. Also, the 2013 Record of Decision for the Tailings Disposal Facility Expansion included a required mitigation measure for HGCMC to repair and maintain, in perpetuity, the existing fish passage facility on Greens Creek. Due to the requirement to maintain the fish ladder in perpetuity, and the fact that the original timber design had failed, HGCMC requested and obtained approval for a modified design. In March 2016, the three weirs were reconstructed using reinforced concrete with a steel cap.

A quarterly survey of the fish ladder site is conducted to assure that the fish ladder is clear of rocks and other debris and is determined to be passable by fish. With the strength and durability of the concrete weirs, the fish ladder is expected to remain essentially maintenance free for many years.

3.4. Aquatic Biomonitoring

Aquatic Biomonitoring is performed annually. Details on this monitoring are included in GPO Appendix 01 Integrated Monitoring Plan.

4. SPAWNING GRAVEL

The major thrust of the Spawning Gravel Monitoring Program was to determine whether mining and related activities have resulted in deposition of excess sediment in anadromous fish streams to the extent that salmon spawning and incubation would be adversely affected. The major inspiration for the design and execution of this monitoring program was the then-ongoing work of Sheridan, et al., reported in 1984. The authors compared the results of analysis of over 2,000 stream bed samples from disturbed and undisturbed watersheds. The percent fines (<0.83 mm), which Sheridan et al. found to be strongly correlated with the "fredle index" of spawning substrate quality (Lotspeich and Everest, 1981), was used by the authors to make their comparisons.

Gravel samples taken as part of Greens Creek Mining Company's monitoring requirements were gathered from pre-determined sites representative of spawning habitat in Zinc Creek, "Tributary Creek", and Greens Creek.

4.1. Findings

The gravel monitoring data did not suggest any adverse impact (increased fines or decreased spawning habitat quality) due to mining or related activities in the Greens Creek or Zinc Creek watersheds. On the contrary, the data showed consistency among samples within sites and, to a somewhat lesser degree, among sites, before and after commencement of mining activities. The only significant difference in fines content of samples was associated with a natural channel change event. This was a significant finding, since potential fine sediment sources, such as runoff from the haul road and the mill site and small slides have been greatly reduced in number and potential output since startup. A May 9, 1991 memorandum to Jack Cottrell of Greens Creek Mining Company, from J.W. Buell, Ph.D. summarizes the Spawning Gravel Monitoring Program in detail. On the recommendation of the Forest Service, the spawning gravel study has been concluded. In a letter from the U.S. Forest Service to Greens Creek Mining Company dated May 2, 1994, the Forest Service stated that the monitoring program has provided the information required in the EIS and associated study plan, and that continued limited monitoring would not be necessary.

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General Plan of Operations
Appendix 05
Best Management Practice Plan

May 2020

STATEMENT OF MANAGEMENT COMMITMENT

HELCA HECLA GREENS CREEK MINING COMPANY

BEST MANAGEMENT PRACTICE PLAN

This Best Management Practice Plan has been prepared to control and contain potential pollutants at the Hecla Greens Creek Mining Company (HGCMC) site.

This plan is approved for implementation as herein described. HGCMC management is committed to provide the necessary financial, staff, equipment and training resources as required in accordance with this plan on a continuing basis.

Signature: _____ Date: 1/30/20

Name: Brian Erickson

Title: General Manager HGCMC

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Attachment B - Listing of Significant Spills
Attachment C – Example Monthly Inspection Checklist
Attachment D - Yearly BMP Reports
Attachment E - BMP Maintenance Log
Attachment F - BMP Details

Acronyms

ADEC	Alaska Department of Environmental Conservation
AML	Alaska Marine Lines
BMPs	Best Management Practices
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CWA	Clean Water Act
FEIS	Final Environmental Impact Statement
GCJV	Greens Creek Joint Venture
GPO	General Plan of Operations
HDPE	High-density Polyethylene
ISO	International Standardization Organization
HGCMC	Hecla Greens Creek Mining Company
kg/ha	kilograms per hectare
lbs/acre	pounds per acre
mgd	million gallons per day
MIBC	methyl isobutyl carbinol
SDS	material safety data sheet
MSHA	Mine Safety and Health Administration
APDES	Alaska Pollution Discharge Elimination System
PVC	polyvinyl chloride
SAG	semi-autogenous
SPCC	Spill Prevention, Control, and Countermeasure
SWPPP	Storm Water Pollution Prevention Plan
tpd	Tons Per Day
TSS	Total Suspended Sediment
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency

Forest Service	United States Forest Service

1. INTRODUCTION

This document describes the Plan for the implementation of Best Management Practices (BMP) to control and contain potential pollutants at the Hecla Greens Creek Mining Company (HGCMC) site. The fundamental concept of this BMP plan is to outline appropriate measures that can be used to prevent sediment or hazardous chemicals from reaching waters of the United States while effectively and economically meeting the requirements of state, federal, and local agencies that have jurisdiction over such matters in this project's operations. This document has been reviewed by the engineering and environmental staff of HGCMC. The document is believed to be complete, with data available at this time, and comprehensive in addressing the relevant environmental concerns of the project.

1.1. GENERAL INFORMATION

NAME OF FACILITY:

Hecla Greens Creek Mine

TYPE OF FACILITY:

Underground Mining and Milling Operation

LOCATION:

Northwestern Admiralty Island, Alaska,
18 air miles southwest of Juneau

NAME AND ADDRESS OF OWNER OR OPERATOR:

Hecla Greens Creek Mining Company
P.O. Box 32199
Juneau, Alaska 99803-2199
(907) 789-8100

DESIGNATED PERSONS ACCOUNTABLE FOR SPILL PREVENTION, REPORTING, & EMERGENCY PROCEDURES AT THE FACILITY:

Brian Erickson, General Manager
Office (907) 789-8136

Chris Wallace, Permitting and Environmental Compliance Coordinator
Office (907) 790-8473

Bryan Morgen, Surface Manager
Office (907) 789-8147

Bob Haecker, Mill Manager
Office (907) 789-8140

1.2. STATEMENT OF HECLA GREENS CREEK MINING COMPANY POLICY

The HGCMC policy on environmental concerns is to take actions deemed necessary to prevent accidental release of hazardous or toxic materials or chemicals into the natural environment. In the event that an accidental release should occur, the policy of HGCMC is to immediately mitigate the effects of such a release using equipment and techniques which are available, practical, and proven for such use. Cooperation with local, state, and federal regulatory and advisory agencies will be maintained to the greatest extent possible.

1.3. SITE TOPOGRAPHIC MAPS

This BMP plan includes site topographic maps that indicate site boundaries, access, and haul roads; locations of stormwater outfalls and outlines of drainage areas; storage and maintenance areas for equipment, fuel, chemicals, and explosives; materials handling areas; areas used for storage of overburden, materials, soils, tailings, or wastes; locations and points of permitted discharges; and springs, streams, wetlands, and other surface waters. The following maps include:

Figure 1 – Site Map

Figure 2 – Tailings Facility Area

Figure 3 – Hawk Inlet Facilities Area

Figure 4 – Mine and Mill Area

2. BMP COMMITTEE

The BMP Committee is composed of HGCMC personnel involved in the development, implementation, maintenance, and updates of the BMP program. Members of the committee are knowledgeable in their specific department's operations, include environmental specialists, and facility supervisors.

2.1. COMMITTEE RESPONSIBILITIES

The Greens Creek BMP Committee is responsible for:

- Development of the BMP plan
- Implementation, maintenance, and updates of the BMP plan
- Identification of toxic and hazardous materials on site
- Identification of potential spill sources
- Establishment and continued evaluation of incident reporting procedures
- Development of BMP inspections and records procedures
- Coordination of incident response, cleanup, and notification of authorities
- Establishment of BMP training for personnel
- Assistance in interdepartmental coordination to carry out the BMP plan
- Review of new construction and changes in processes and procedures for spill prevention and control
- Evaluation of the effectiveness of the BMP plan
- Recommendations to HGCMC management on BMP-related matters

3. APDES STORMWATER SITE-SPECIFIC BEST MANAGEMENT PRACTICES

The following sections provide details and figures on the specific APDES permitted outfalls and document the establishment of BMPs for each permitted site. These figures are designed to be used as an aid during monthly and annual inspections of the sites.

Final reclamation and closure plans for the sites include removing all facilities, re-contouring the area, and allowing natural re-vegetation to occur. Topsoil removed and stored on site during mining activities, meeting state-specified standards, will be used as a growth medium cover as required during reclamation. This material will be inert rocky soil which will not contribute to pollution of the waters of the U.S.

3.1. APDES OUTFALL 002 – Treated Water Discharge to Saltwater

The APDES discharge site designated 002 is an underwater discharge point in Hawk Inlet. All mine, mill, process, and the majority of on-site stormwater runoff is collected, treated, and discharged through this outfall. Discharge is limited and monitored per APDES permit requirements.

3.2. APDES OUTFALL 003 - North Cannery Building Culvert

The APDES storm water sampling site designated 003 is located at a culvert outfall under the north cannery building where the HGCMC dining facility and offices are located. This culvert previously discharged storm water from the truck pad as well as water from the vegetated areas near the buildings. Now most of the water is collected for water treatment, prior to discharge through Outfall 002.

Figure 5 details this area and shows the flow patterns on the site.

Water Quality Concerns

Water samples from this outfall had exceeded the allowable limits for zinc, during storm event monitoring. To correct the situation HGCMC now collects most of the water that once flowed through 003.

3.3. APDES OUTFALL 004 - 1.8 mile “A” Road - Pit 7

The APDES storm water sampling site designated 004 is located at one of the discharge sites from a reclamation material storage area in an old road construction quarry named Pit 7. Most of the water discharging from this pit drains through a constructed wetland consisting of two ponds linked with vegetated areas. Additional BMP measures employed at this site include diversion ditches, check dams, settling ponds, water bars, and hydroseeding of the ditches and slopes.

Figure 6 details this area and shows the flow patterns on the site.

Water Quality Concerns

This outfall has the potential to impact the receiving water primarily with total suspended sediment (TSS), and iron and manganese resulting from the reductive dissolution of the material stored at the site. The purposed benefit of channeling runoff through the wetlands is to increase sediment deposition and metal abatement.

3.4. APDES OUTFALL 005.2 - 3.0 Mile “B” Road - Zinc Creek Bridge

The APDES storm water sampling site designated 005.2 is located at the bottom of the North abutment, upstream side, of the Zinc Creek Bridge. Most of the water that discharges from this area originates as

rainwater on a short section of road and the abutment itself. BMP measures in place at this site include check dams, straw wattles, compost filter socks, hydroseeding, liming, and settling ponds.

Figure 7 details this area and shows the flow patterns on the site.

Water Quality Concerns

Water samples from this outfall have exceeded the allowable limits for pH. The rock material the abutment is constructed of is acid-generating. During reclamation the offending material will be removed and disposed of in a contained facility (e.g. tailings storage facility). In the interim runoff is routed away from the site, vegetation has been established to decrease oxygen and water infiltration, and a lime solution is occasionally applied to the abutment.

3.5. APDES OUTFALL 005.3 - 4.5 Mile "B" Road - Waste Rock Area E

The APDES storm water sampling site designated 005.3 is located on a small drainage adjacent to the north side of a waste rock pile designated Site E. This drainage concentrates storm water from the north side of the waste rock pile and a portion of the B Road. Runoff from a majority of the pile surface is routed to a storm water collection pond that is actively managed by pumping to treatment facilities during the non-freezing months. BMP measures in place at this site include vegetated ditches, check dams, settling ponds, hydroseeding, and natural re-vegetation.

Figure 8 details this area and shows the flow patterns on the site.

Water Quality Concerns

Water samples from this site have exceeded the allowable limits for zinc and lead. The waste rock in this area is potentially acid-generating. The process of reclaiming the site by co-disposing the waste rock in the tailings disposal facility was started in 2008.

APDES OUTFALL 005.4 - 4.6 Mile "B" Road - Pit 6

The APDES storm water sampling site designated 005.4 is located at the end of a diversion ditch that is designed to collect the storm water from a reclamation material storage area in an old road construction quarry called Pit 6. BMP measures in place at this site include vegetated ditches, diversion berms, check dams, water bars, and settling basins.

Figure 9 details this area and shows the flow patterns on the site.

Water Quality Concerns

Storm water quality from this site has been compliant with AWQS since 2010. The last water quality exceedance occurred in 2009 following the haulage and placement of reclamation material in Pit 6 for storage. The area is now stabilized and well vegetated, and runoff is appropriately managed through grading and BMPs. There are no water quality concerns unless soil disturbance activities occur.

3.6. APDES OUTFALL 005.5 - 7.8 Mile "B" ROAD CULVERT

The APDES storm water sampling site designated 005.5 is located on a small culvert that drains a portion of the road surface and ditch areas near mile 7.8 of the B Road. BMP measures in place at this site include vegetated ditches, settling basins, and check dams.

Figure 10 details this area and shows the flow patterns on the site.

Water Quality Concerns

Water samples from this outfall have exceeded the allowable limits for lead, zinc, and TSS. To reduce the runoff volume and suspended solid load reporting to this culvert, the road was regraded near 7.9-mile and a diversion ditch was constructed to route road runoff from above this area to D Pond for collection and treatment. The reduced runoff volume increases the effectiveness of BMPs in the roadside ditch near the outfall.

For the 7.8-mile culvert, and all other culverts along the road system, several BMP measures have been added. Rock check dams with upstream sumps have been added to the ditch system, replacing less effective straw bale check dams. In addition, the ditches have been vegetated with a grass mixture, and where practicable a settling basin has been constructed at culvert outfalls.

3.7. APDES OUTFALL 006 – D Pond Overflow - Waste Rock Area D

The APDES storm water sampling site designated 006 is located at the overflow culvert from a storm water retention pond designated D Pond. This pond collects storm water from an inactive waste rock storage pile and a portion of the B Road. During normal operations, this water is pumped from the pond and eventually to Pond 7, where it is treated and then discharged through Outfall 002. Additional BMP measures in place at this site include diversion ditches, hydroseeding, natural re-vegetation, check dams, and settling ponds.

Figure 11 details this area and shows the flow patterns on the site.

Water Quality Concerns

Water samples from this outfall have exceeded allowable limits for TSS and lead. The currently inactive waste rock storage pile is designed to maximize storm water runoff to D Pond while minimizing infiltration. However, this does not completely prevent contaminants from entering the water. To prevent the release

of contaminants to the environment the pump system associated with the pond was upgraded in 2008. Since completing the upgrade, the pond level has been maintained below the Outfall 006 elevation, with one exception. In May 2016, a pump failure during a storm event resulted in a discharge through the outfall.

3.8. APDES OUTFALL 007 – C Pond Overflow - Waste Rock Area C

The APDES storm water sampling site designated 007 is located at the overflow culvert from a storm water retention pond designated C Pond. This pond collects storm water from an inactive waste rock storage pile, the 860 area, a section of the Site 23 access road, and a portion of the B Road. During normal operations, this water is pumped from the pond and eventually to Pond 7, where it is treated and then discharged through Outfall 002. Additional BMP measures in place at this site include diversion ditches, hydroseeding, natural re-vegetation, check dams, and settling sumps.

Figure 12 details this area and shows the flow patterns on the site.

Water Quality Concerns

Water samples from this outfall have exceeded the allowable limits for lead, zinc, and TSS. This is primarily due to sediment laden runoff from roads within this drainage area. To prevent the release of contaminants to the environment the pond infrastructure has been upgraded (e.g. increased storage, additional pump). Since completing the upgrades, the pond level has been maintained below the Outfall 007 elevation, with one exception. In January 2018, the pump discharge line froze resulting in a release of storm water.

3.9. APDES OUTFALL 008 - Waste Rock Area 960

The APDES storm water sampling site designated 008 is located at the outfall of a ditch that collects storm water from a small area that used to be waste rock storage from the initial mine portal development. This area is designated the 960 waste storage site. Most of the waste rock has been removed, and the area has naturally re-vegetated.

Figure 13 details this area and shows the flow patterns on the site.

Water Quality Concerns

Water samples from this outfall have exceeded the allowable limits for pH in previous years. However, storm water runoff has been compliant with AWQS since late-2012. This positive result reflects the removal of previously stored production rock from this site, the continued stability of this small site's new surface, and its reclamation progress back to native vegetation cover. This site is not anticipated to further contribute to pollution of the waters of the U.S.

3.10. APDES OUTFALL 009 - Waste Stock Pile 1350

The APDES storm water sampling site designated 009 is located at the outfall from a storm water collection area near the 1350 adit. This drains an area that was previously covered with waste rock from the 1350 adit development. A multi-year project, ending in 2015, removed a majority of the waste rock from the 1350 site. Waste rock left is for maintaining access to the adit, which serves as the exhaust for the mine ventilation system and a secondary escapeway.

Figure 14 details this area and shows the flow patterns on the site.

Water Quality Concerns

Water samples from this site have exceeded the allowable storm water monitoring limit for zinc since the completion of the 2014 waste rock removal activities. It was anticipated that a spike in metals concentrations would occur following the waste rock removal activities due to the flushing of residual oxidation products that had accumulated in the underlying soils. Zinc concentrations in storm water samples have decreased significantly since 2014, and the trend of improvement is expected to continue.

To further improve the water quality at Outfall 009, in 2016 a collection trench was constructed along the toe of the remaining waste rock pile to intercept runoff. During non-freeing months, captured water is pumped to the 1350 adit where it enters the mine water collection system. Mine water is eventually routed to Pond 7 for treatment. Seasonal operation of the runoff collection system will continue until either the remaining waste rock is removed, or runoff is compliant with AWQS.

4. SITE SPECIFIC BEST MANAGEMENT PRACTICES FOR AREAS OF CONCERN

4.1. 1.4 Mile A-Road Sand Pit

The Sand Pit is located at 1.4-mile on the A Road between the Hawk Inlet Facility and the ferry dock. This area was a quarry for sand material used at the mine. The extractable resource was exhausted in 2016 from the permitted 15-acre site. Once the sand resource was extracted, the area was then developed into a repository for overburden material to be available for use during mine reclamation. A berm was constructed along the north and west sides of the sand pit creating a large impoundment that is under the jurisdiction of the Alaska Dam Safety Program. The impoundment was then partially filled with clay, soil, and organic peat excavated during the construction of Pond 10. A spillway and outlet channel were constructed through the berm to limit the accumulation of storm water in the impoundment. The outlet channel directs runoff into the forest duff north of the Sand Pit.

BMP measures in effect in this area include a rip-rap lined ditch along the east and south sides to divert upland runoff around the impoundment, a rip-rap lined spillway and outlet channel with settling sumps, and vegetation establishment on the outer face of the berm and hillside to the east and south. The impoundment serves as a large settling basin to minimize suspended solids in storm water flows through the outlet channel. There are currently no water quality concerns with the Sand Pit area.

Figure 15 details this area and shows the flow patterns on the site.

4.2. Waste Rock at Site 23

The waste stockpile is located west the mill, uphill from the C and D ponds. Waste rock material with low to no acid-generating potential is deposited here. Waste rock with no acid-generating potential is used to cap the material with greater potential to produce acid water. Non-contact storm water is diverted around the site where possible. All contact water is managed via gravity flow through ditches, sumps, and culverts, collected in Pond 23, and conveyed to Pond 7 for treatment before discharging through Outfall 002.

Figure 16 details this area and shows the flow patterns on the site.

Water from this area could exceed TSS, lead and zinc limits if not managed. The BMP measures in place are considered sufficient for the conditions at this site.

4.3. Tailings Disposal Facility and Ponds 7/10

The Tailings Disposal Facility and Ponds 7/10 are contained within an area where all on-site storm water is collected and treated before discharge through Outfall 002. Non-contact storm water is diverted from the site in a diversion ditch along the eastern uphill side of the facility. Other BMP measures include using larger rock to 'cap' the fine tailings material and hydroseeding of all exposed slopes. A road system and associated ditches encircle the facility, enabling the collection of the contact storm water.

Figure 2, listed previously, details this area and shows the flow patterns on the site.

Water from this area could exceed TSS, lead and zinc limits if not managed. The BMP measures in place are considered sufficient for the conditions at this site.

4.4. B Road and Bridges

The B Road is an approximately 8.5-mile long, single lane with turnouts, gravel road that connects the Hawk Inlet facilities near sea level with the mine and mill complex at elevation 920 feet. There are three bridges along the road, located at 3.0-mile (Zinc Creek), 3.4-mile (Falls Creek), and 7.4-mile (Killer Creek). The road also crosses Cannery Creek, and a few smaller unnamed creeks, that are culvert crossings. The road is extensively travelled daily for haulage of tailings, concentrates, freight, fuel, and transport of mine personnel. Due to the extensive use, and being located within a temperate rain forest, management of runoff and sediment from the road is a specific area of concern, particularly at stream crossings. Figure 18, which consists of 14 sheets, shows the B Road with locations of culverts, mile markers and turnouts.

There are several types of BMPs employed on the B Road to minimize sediment release to the environment. Ditches are established along the inside edge and/or outside edge, where possible. The road surface is frequently graded to remove ruts and promote water running off the road surface as quickly as possible and into the ditches. When necessary, the road is resurfaced with an imported aggregate that meets a Department of Transportation specification of 'very hard' to reduce the rate of degradation and production of fine sediment. Approximately 160 culverts are placed in the road, at appropriate spacing based on the road gradient, to limit the flow volume in the ditches. Nearly all culverts have settling sumps located at the inlet, outlet, or both. The ditch system is cleaned and reestablished annually during the spring, and then hydroseeded to establish vegetation to provide erosion control. Rock check dams and straw wattles are also installed in the ditch to provide velocity breaks in the higher gradient sections.

There are several types of BMPs employed at the bridges to minimize sediment release to streams. The bridges all have 4-feet high splash guards on both sides to minimize sediment splashing over as vehicles cross the bridges. A posted 5 mile per hour speed limit improves the effectiveness of the splash guards. Sediment deflectors (2"x12" boards) are located at each end of the bridges to prevent runoff from flowing onto the face of the abutments beneath the bridges. An 80-mil HDPE liner is placed beneath the timber decking to reduce sediment falling through bridge surface. Beneath the bridges, a combination of compost filter socks, straw wattles, and hydroseeding are used to contain and stabilize sediment on the abutments.

With proper maintenance, these BMPs are sufficient to minimize sediment release from the B Road and bridges.

4.5. Hawk Inlet Freight Barge Ramp

Incoming and outgoing freight is transported by barge from the port facility in Hawk Inlet. Cargo is loaded and off-loaded from the barge via forklifts using a transfer bridge that extends from shore to the barge. The approach ramp to the transfer bridge had been a gravel surface that required frequent grading to direct storm water runoff to a catch basin located adjacent to the top of the transfer bridge. From the catch basin, runoff is pumped to de-grit basin DB-04 and then pumped to Pond 7 for treatment and discharge through Outfall 002.

During an ADEC compliance inspection in November 2016, turbidity was observed in Hawk Inlet underneath the transfer bridge. It was raining at the time of the inspection and a freight barge had been in port a few hours prior. Shallow wheel ruts in the gravel approach ramp left by the heavy forklifts enabled surface runoff to bypass the catch basin and flow into Hawk Inlet under the transfer bridge. The ADEC issued HGCMC a Notice of Violation for the observed turbidity in Hawk Inlet.

As an immediate corrective action, HGCMC installed a BMP known as a 'rubber razor bar' at the head of the transfer bridge to direct all runoff from the approach ramp to the catch basin. This BMP proved to be very effective but required periodic maintenance and replacement due to damage sustained by the heavy forklifts. To provide a more permanent, low maintenance solution, HGCMC installed a large concrete apron on the gravel approach ramp. The thick concrete apron will prevent the formation of ruts by the forklifts and is sloped to direct all runoff to the catch basin. Current maintenance practices for freight barge ramp BMPs involve periodic sweeping of the apron to remove sediment, cleaning of the catch basin, and ensuring that the transfer pump is in good working order.

5. GENERAL BEST MANAGEMENT PRACTICES

The following descriptions provide details on specific management techniques applicable to the Greens Creek Mine site. Appendix 05.C contains the detailed implementation direction for many of these BMPs. Appendix 05.C is to be utilized in both the office and the field for planning, construction, and maintenance of storm water control structures.

5.1. Preserving Existing Vegetation

BMP Description: Preserve existing vegetation where possible. Delineate all areas to be preserved so that it is clear to equipment operators where the limits of operation are.

Installation: See BMP Details in Attachment F.

5.2. Vegetative Buffer Strip

BMP Description: A vegetative buffer strip is an undisturbed area or strip of natural vegetation that provides a filter to intercept and detain storm water runoff, reduce runoff flow velocity, and promote infiltration. The buffer strip may be natural, undeveloped land or may be graded and planted with grass or other vegetation. The buffer strips may be placed between a source of sediment and a waterway or drainage area, can be used as a location to divert drainage to and can be used as a perimeter control measure. Additional information on this measure can be found in Appendix 05.C. This measure can be either permanent or temporary, depending on the area.

Installation: See BMP Details in Attachment F.

5.3. Check Dam

BMP Description: A check dam is a small berm of rocks, reinforced or non-reinforced, designed to withstand overtopping, that is placed in a ditch or other drainage way. The purpose of the check dam is to reduce flow velocities, and to trap sediment in the backwater zone upstream of the check dam. The frequency of the check dam should be such that the toe of the uphill break is the same elevation as the crest of the downhill break. Check dams with upstream sumps have been added to the ditches along the road system.

Installation: See BMP Details in Attachment F.

5.4. Diversion Ditch

BMP Description: Diversion ditches, dikes or excavated channels or a combination of any of these are used to intercept or divert runoff or flowing water away from disturbed areas, such as excavated areas and toward stabilized areas. It is a small earth channel used to divert and convey runoff, generally to a sediment basin, energy dissipater, or to divert the flow around a site. Depending on slope, the diversion ditch may need to be lined with erosion control matting, plastic (for temporary installations only), or riprap.

Installation: See BMP Details in Attachment F.

5.5. Diversion Berm

BMP Description: A diversion berm is a semi-permanent ridge of compacted soil constructed to divert stormwater from leaving a contaminated site. They are typically designed to force stormwater to travel

into ditches, sediment basins, or other structures where the water can be treated before being released. Diversion berms are typically constructed of the local soil and vegetated to minimize erosion.

Diversion berms are essential in keeping erosion, sediment, and contaminants confined to the disturbed or industrialized areas of a site. At the Green's Creek Mine, the berms are used to prevent stormwater from exiting the pads and work areas which have little or no natural slope to direct the stormwater into the ditch system.

Installation: See BMP Details in Attachment F.

5.6. Water Bar

BMP Description: A water bar is a cross-drainage diversion ditch and/or hump (4 inches to 1 foot high) in a trail or road for the purpose of diverting surface water runoff into the roadside vegetation, duff, ditch, or dispersion area to minimize the volume and velocity, which can cause soil movement and erosion.

Water bars are typically constructed of the local soil, well compacted, and vegetated if possible. If this is not practical, then imported material may be used. In any case, the material used to construct the water bar should be resistant to erosion. Water Bars should be placed at a diagonal to the direction of water flow. This will prevent damming and subsequent overtopping of the structure.

Installation: Install as a fix for roads that are getting 'washed' out.

5.7. Culvert Water Diversion

BMP Description: Culvert diversions serve to divert sediment-laden stormwater from directly entering a stream or waterway. These are used primarily at stream crossings to ensure that water flowing off the road surface and into side ditches will be diverted into vegetation and not allow sediment deposition directly into the stream. A culvert diversion is constructed by placing smaller culverts approximately 50 to 100 feet upgradient from the primary stream culvert. The diversion culverts are placed behind check dams and positioned so that the flow on the outfall side of the culvert has to travel through vegetation or the forest floor duff before reaching the stream.

5.8. Hydroseeding

BMP Description: Hydroseeding is a hydraulic application method which incorporates seed, water, fertilizer, and mulch into a homogeneous mixture (slurry) that is sprayed onto the soil. The objective of hydroseeding is to establish a vegetative cover on disturbed areas by seeding the appropriate and rapid growing annual grasses. The purpose of seeding is to stabilize the soil and reduce erosion damage from stormwater. Seeding is applicable to any area that is exposed and subject to erosion if additional construction or disturbance activities are not expected to occur within three months. Areas specifically targeted for seeding include roadside ditches, exposed slopes, stockpiles, and berms.

The following specific seed mix has been approved by the United States Forest Service (USFS) for use at the Greens Creek Mine.

Seeding Mixture:

- 60 percent 'Nortran' Tufted hairgrass (*Deschampsia caespitosa*)
- 20 percent 'Boreal' Red fescue (*Festuca rubra*, Boreal variety)
- 10 percent 'Arctared' Red fescue (*Festuca rubra*, Arctared variety)
- 10 percent "Gruening' Alpine bluegrass (*Poa alpine)*

Application rate for this mixture is 43 pounds per acre for areas completely devoid of vegetation or when native species may be inhibited from moving into the site. For other areas adjust the application, typically 15-30 pounds per acre, accordingly for surface contours, grade, aspect, rockiness of site.

Seed mixture contains no more than 0.01 percent other seed, whether identified or not.

Fertilizer:

- 10-20-10 (10 percent nitrogen, 20 percent phosphorus, and 10 percent potassium): 200 lbs/acre (225 kg/ha)
- 46-0-0 (nitrogen urea): 100 lbs/acre (110 kg/ha)

Hydroseed:

The mix recipe for the hydroseeding system in use at the Greens Creek Mine is shown below. This works out to a seed application rate of 30 lbs/acre.

Recipe for a 3 loads/acre mix (devoid of vegetation):

- 1,000 gal Water
- 4 bags EcoFibre mulch (50 lbs/bag)
- 1 bag Seed (14 lbs/bag)
- 2 bags Fertilizer (50 lbs/bag)

Adjust mixture accordingly for other conditions.

Inspection:

Inspect newly seeded areas on a regular basis and particularly after each storm event. Check for areas where the mulch has failed or the application has been washed away before the seed could establish. Reseed as needed.

Installation: See BMP Details in Attachment F.

5.9. Silt Fence

BMP Description: A silt fence is a temporary sediment barrier used to remove sediment from runoff. The fence works by intercepting sheet flow from slopes, causing the runoff to pond behind the fence, thereby promoting deposition of sediment on the uphill side of the fence. Silt fence consists of a geotextile fabric that is trenched or sliced into the ground. The bottom of the fence is anchored into the ground by compacting the disturbed soil along both sides of the trench or slice. The top of the fence is attached to posts for support, creating a barrier to the flow of contaminated stormwater runoff.

Installation: See BMP Details in Attachment F.

5.10. Fiber Roll

BMP Description: Fiber rolls are tubes made of UV degradable polypropylene netting, coconut, jute, burlap or coir. They are filled with compost, mulch, fiber, wood chips, straw, flax, rice, or coconut fiber. They are used to slow, filter and spread overland water flows to prevent erosion and trap sediment.

Installation: Additional information and spacing along contours is available in Appendix 05.C BMP Descriptions.

5.11. Temporary Construction Entrances

BMP Description: A stabilized construction entrance provides a stabilized area that is placed where traffic enters or exits the construction site. This measure establishes a buffer area for vehicles to deposit their mud and sediment, and minimizes the amount of sediment transported onto public roadways. Mud on a road can create a safety hazard as well as a sediment problem. Construction entrances can be made of gravel or use a mud mat.

Installation: Install before sediment is likely to get tracked onto paved areas. See BMP Details in Attachment F.

5.12. Wind Erosion Control

BMP Description: Dust will be controlled by spraying all disturbed areas, stockpiles and roads with water. Borrow material that is being hauled to the project site shall be kept slightly moist or covered to prevent wind transport during hauling. Use water trucks to increase the soil moisture levels. Re-apply as necessary to keep dust to a minimum. The minimum amount of water will be used to perform dust control. Avoid overwatering. Use reduced speeds on un-paved areas. Limit material loading during high winds. This is a temporary measure.

Installation: Spray with water when soil is dry enough to be picked up when vehicles drive over it. See BMP Details in Attachment F.

5.13. Settling Pond (Sediment Trap)

BMP Description: A settling pond is a place where fine particles are removed from water by means of gravity. The dirty water enters the basin at one end, and the cleaner water is transferred out at the other end through a culvert. The water must be in the basin long enough for the desired particle size to be removed. Smaller particles require longer periods for removal and thus larger basins. Sometimes a flocculent may be added to help smaller particles stick together and form larger particles. Stoke's Law can be used to calculate the size of a settling basin needed in order to remove a desired particle size.

Installation: See BMP Details in Attachment F.

5.14. Dewatering Operations

BMP Description: Dewatering activities will be accomplished with a rock lined sump and a 6" pump in a localized depression. The pump will transfer water to a dewatering bag or a series of hardline eventually discharging to Hecla's existing water treatment system.

Installation: See BMP Details in Attachment F.

5.15. Mulching

BMP Description: Mulching is the application of a uniform, protective layer of gravel, straw, wood fiber, compost, wood chips, tackifier, bonded fiber matrix (BFM) or other material to protect soil from rain and overland flow to foster the growth of vegetation, increase infiltration, reduce evaporation, insulate the soil, suppress weed growth, and hold fertilizer, water and seed.

Installation: See BMP Details in Attachment F.

5.16. Covers

BMP Description: Soil stabilization matting is long rolls of matting which can be rolled on unvegetated cut or fill slopes. This is a temporary measure.

Installation: See BMP Details in Attachment F.

6. HISTORY OF SPILLS AND LEAKS

See Appendix 05.B for a list that meets the permit requirement of listing significant spills and leaks of toxic or hazardous pollutants that drain to a permitted outfall, a stormwater conveyance, or otherwise drain to surface waters. The list includes spills from October 1, 2012 to the present. The Spill Reporting forms are provided and maintained in the Spill Prevention Countermeasures and Control Plan (SPCC) available in the HGCMC Compliance Binder.

7. INSPECTIONS, RECORDS, AND TRAINING

7.1. Monthly BMP Inspections

Qualified personnel will have access to and responsibility of inspecting BMPs, designated equipment, and facility areas at least monthly, except when weather conditions would preclude safe access to a site. Inspections must include, at a minimum, all material handling and storage areas, wastewater and stormwater control and containment structures, and erosion control systems. The monthly inspection checklist is provided as Attachment C.

7.2. Comprehensive Site Compliance Evaluations

Qualified personnel will conduct comprehensive site compliance evaluations annually, focusing specifically on: Areas that contribute to wastewater and stormwater discharges, areas that are susceptible to leaks or spills (which must be visually inspected for evidence of, or the potential for, pollutants entering the permitted outfalls), stormwater drainage systems, and surface waters. Structural and non-structural BMPs and other measures to reduce pollutant loadings must be evaluated to determine whether they are adequate and properly implemented. Equipment needed to implement the BMP plan, such as spill response equipment, must be inspected.

Based on the results of the site evaluation, the BMP plan will be revised, as appropriate, within 30 days of the inspection and will provide for implementation of any changes to the BMP plan in a timely manner, not more than 90 days after the inspection.

7.3. Inspection Records

Records of all inspections will be maintained. The required monthly and annual inspections will be kept on site and incorporated into the BMP plan annually.

7.4. Annual Report and Certification

HGCMC will submit an annual report by March 1 each year summarizing the comprehensive site evaluations and inspections performed during the preceding year. The report will include the scope and dates of the inspections/evaluations, major corrective actions taken as a result of the inspections/evaluations, description of the quantity and quality of stormwater discharged, and BMP plan modifications made during the year. The report will also identify any incidents of non-compliance. This report will be incorporated into the BMP plan and will be made available to the Alaska Department of Environmental Conservation (ADEC) upon request. The annual report will also contain a certified statement to the effect that the inspections and evaluations required by this BMP plan were completed, and that the BMP plan fulfills the requirements set forth in APDES Permit No. AK0043206.

7.5. Employee Training

Employee training approved by the Mine Safety and Health Administration (MSHA) is conducted annually (40 hours initially for underground employees, 24 hours initially for surface employees, and 8 hours annual refresher courses for all employees). Training includes inexperienced and experienced personnel in all levels of responsibility. The training program is designed to provide an understanding of the BMP plan, the processes and materials with which they are working, the safety hazards, the practices for preventing discharges, and the procedures for responding properly and rapidly to toxic and hazardous materials.

Topics included in the training programs are:

- Identification of any hazardous materials in their work place
- The physical and health hazards of such chemicals
- Protective measures, procedures, and equipment to be used to protect employees from hazardous chemicals
- Methods to be used to detect the presence or release of a hazardous chemical in the workplace (these may include observations such as color, odor, or form and/or sampling or continuous monitoring techniques)
- How labeling is accomplished
- How the employee can obtain and use hazard information, particularly safety data sheets (SDS)
- Response to hazardous materials spills
- Details of hazards communication and transportation systems
- Treatment and cleanup techniques for spills
- Hazardous emergency response procedures
- First aid procedures
- Federal and state laws

Spill drills are conducted annually as part of the SEAPRO program. Specific job training is also provided prior to starting a particular job or new position to ensure that employees not only understand the particular job and process operation, but also that they understand potential discharge problems. In addition, employees working in an area where hazardous chemicals are present are provided with appropriate SDS (HGCMC MSHA "Right to Know").

Records of the initial and annual refresher training courses for all employees are maintained at the Health and Safety Manager's office. These records include the dates, instructors, subject matter, and lesson plans of the training sessions.

Key personnel have also completed the Alaska Certified Erosion and Sediment Control Lead (AK-CESCL) storm water training program. The AK-CESCL certification is for a period of three years from the date of training. Refresher training is provided as needed to maintain a core group of personnel with current certification.

8. BACKGROUND

8.1. Site History

The HGCMC facilities are located on Admiralty Island, approximately 18 miles from Juneau, Alaska. Mineralization was recognized near Greens Creek in 1975 by the Pan Sound Joint Venture consisting of Noranda Exploration, Marietta Resources International, Exalas Resources Corporation, and Texas Gas Exploration. Subsequent extensive underground drilling and inspection of the ore body was conducted in 1978.

Environmental baseline studies were initiated resulting in the preparation of a Draft Environmental Impact Statement (USFS, 1982), and a Final Environmental Impact Statement (FEIS) which was approved by the USFS in January of 1983. A general plan of operations was completed and approved by the USFS early in 1994.

Companies involved in the project have changed several times in subsequent years. Interest was originally held by Pan Sound Joint Venture, composed of Noranda Exploration, Marietta Resources International,

Exalas Resources Corporation, and Texas Gas Exploration. In 1978, Pan Sound Joint Venture was dissolved, and the Greens Creek Joint Venture (GCJV) was formed. GCJV consisted of the four original companies plus Bristol Resources, Incorporated. Anaconda Minerals Company acquired the interest of Marietta Resources, Inc. in 1982. Amselso Minerals, Inc. acquired Anaconda's share of the project in 1985, Noranda's share in 1986, and ultimately assumed management of the project. Amselco began a review of existing information and developed a detailed mining plan and design modifications that led to the preparation of an Environmental Assessment to supplement the 1983 FEIS.

In February 1988, as a result of the merger of Standard Oil and British Petroleum, assumed control of the project. In March 1988, the Environmental Assessment was approved by the USFS.

In July 1989, RTZ purchased British Petroleum's mineral holdings, and Hecla Greens Creek Mining Company were part of this purchase.

The HGCMC project involves an underground mine to annually recover approximately one million tons of ore containing significant quantities of zinc, silver, lead, and gold. The direct products of the project are concentrates of zinc and lead, with significant quantities of silver and metallic gold. Major facilities include the underground mine, surface mill and concentrator, surface tailings facility, port facilities, a gravel-surfaced road system, associated storage facilities, and remote exploration drilling sites.

8.2. Facility Descriptions

8.2.1. Mine / Mill SIte s

The mine, located on the south side of Greens Creek, has a main access portal at an elevation of 920 feet. Personnel and supplies are brought into the mine at the 920 portal and distributed throughout the mine with rubber-tired vehicles. Ore and waste are removed from the 920 portal with rubber-tired vehicles, and all other levels are interconnected with ore and waste passes accessed with these same rubber-tired vehicles. Ventilation exhaust is directed out of the 1350 adit, which also serves as an emergency escape way from the underground workings.

Underground mining methods incorporate rubber-tired diesel-powered equipment. Drift and fill is the primary mining method used to extract the ore. Long-hole stopes are also utilized in ore zones conducive to this bulk mining method. These methods use cemented tailings as backfill in mined out areas to support vehicles and equipment and to provide ground support allowing subsequent mining of adjacent ore. Excess water from the mining operations is collected and piped to A Pond located on the north side of Greens Creek.

The mill site is located on the north side of Greens Creek directly across from the mine. Access to the mine site from the mill site is via a bridge that crosses Greens Creek. The mill site consists of the mill buildings, fuel storage tanks, an office complex, a coarse ore stockpile and waste pile, water supply pumphouse, switch gear building, and a warehouse and storage area. A minimum of 2 weeks' worth of supplies, including reagents, will typically be stored at the mine/mill site.

A selective flotation milling process is used to concentrate valuable minerals from the raw ore following grinding. The flotation process consists of size reduction, mineral concentration, and moisture reduction of the concentrate. Size reduction involves grinding the ore in semi-autogenous (SAG) and ball mills. Ore will enter the SAG mill at a size of 15 inches or smaller and leave in the 0.5-inch (-16 mesh) size range. The ore will then enter the ball mill to be further reduced in size to 80 percent at minus 74 microns. This material is then used to produce slurry.

The slurry is transported in pipes to flotation cells, where carbonaceous wastes, then valuable minerals, will be separated from gangue materials in a series of froth flotation processes. The ore minerals in this case will be sulfides of lead, zinc, copper, silver, and uncombined gold. Waste includes various silicate, carbonate, and sulfide minerals. The valuable minerals adhere to air bubbles that rise to the surface of the tank and are removed. To make the process work, air and various reagents are selectively added to the flotation tanks. This allows the bubbling or frothing action to float different minerals selectively so that differing metal concentrates can be produced. The concentrator recovers various valuable minerals into one of three concentrates for sale: zinc, lead, and bulk. No reduction of sulfides to base metals, or other changes in the chemical composition of ore minerals, takes place in the concentrator or at the project site.

Following separation of ore minerals from tailings, the concentrate slurries are piped to separate thickener tanks, where the water content is reduced. The thickened slurries are then compression-filtered to remove most of the remaining water.

Currently, the target production rate is 2,300 tons per day (tpd) of ore.

8.2.2. Tailings

Of the approximate 1,800 tpd of tailings produced, on average half is returned to the underground mine and used as backfill in mine voids. The remainder of the dewatered tailings will be placed in a stockpile at the mill site, loaded by front-end loaders onto covered haul trucks of approximately 50-ton capacity, and transported to the surface tailing facility.

The approximate 900 tpd of tailings are deposited daily in the dry tailings facility. The facility is located at the upper end of the Tributary Creek drainage. The total area of the site is approximately 123 acres, which includes retention ponds. The dry tailings are situated proximal to, and upstream of Pond 7/10.

Pond 7, with an approximate storage capacity of 33 acre-feet, receives water via the drain system under the tailings pile, runoff from the tailings basin watershed, runoff from the Site 23 rock storage area, process water piped from the mill, and from combined wastewater and treated sewage effluent piped from mill/mine and Hawk Inlet facilities. Pond 10, with a storage capacity of 35.2 acre-feet, was constructed adjacent to Pond 7 and interconnected via five, 36-inch diameter pipes. The pipes are set at an elevation that flow between the ponds occurs when Pond 7 reaches approximately 70 percent capacity. Water collected in the ponds is passed through the water treatment plant in the tailings area prior to discharge into Hawk Inlet in accordance with the APDES permit requirements.

8.2.3. Ship Loading/Unloading Facility

Supplies, such as fuels and reagents, are transported by barge to the Hawk Inlet port facility and unloaded at the marine terminal complex. The cargo dock is located at the same site as the old cannery dock structure. The barge dock consists of breasting dolphins and a floating ramp to land.

Concentrate ore ships are scheduled at approximately two per month. A yearly average of 80 barges bringing goods, rock, and fuel come into Hawk Inlet. Chemicals and containers are unloaded from barges by forklifts and transported to the process site by truck. HGCMC wastes and return materials are placed back onto these barges by forklifts.

Concentrates are transported from the mill to Hawk Inlet port facility by covered haul truck. An enclosed telescoping boom conveyor is used to transport concentrates from within the shore storage area directly into the holds of bulk cargo ships. Some 12 to 24 concentrate ships are loaded annually in Hawk Inlet.

9. DRAINAGE AND ENVIRONMENTAL CRITICAL AREAS

Drainage from the Greens Creek facility flows into four water bodies. These are Greens Creek, Zinc Creek, Cannery Creek, and Hawk Inlet (which all three of the creeks naturally drain into). These creeks in relation to project features can be seen in Figure 1.

9.1. Greens Creek

Greens Creek drainage basin occupies 23.5 square miles. Low flows in Greens Creek occur during mid-winter and late summer, with annual average monthly minimum flows of 40 cubic feet per second (cfs) at the mouth and 6 cfs upstream near the mine/mill site. High rainfall in the fall results in a mean monthly flow of 250 cfs during October (USFWS 1983). The drainage basin includes the mine/mill site and more than half of the roadway between the Hawk Inlet docking facility and the mine/mill site. A bridge crosses Zinc Creek, and the roadway crosses several tributaries to Greens Creek over two other smaller bridges and over 100 culverts.

9.2. Zinc Creek

Adjacent to and north of Greens Creek is the Zinc Creek drainage basin, which encompasses an area of 4.7 square miles. A small channel sometimes connects Greens Creek and Zinc Creek near their mouths. A portion of the roadway and the entire tailings facility is within the Zinc Creek drainage basin. The roadway crosses Zinc Creek over a bridge located 3 miles up from the Hawk Inlet facility. The tailings facility is located on the upper reaches of Tributary Creek (not labeled on Fig 1), which runs into Zinc Creek.

9.3. Cannery Creek

Cannery Creek is located at the southern end of the Hawk Inlet port facility. Its drainage area is less than 2 square miles. The roadway crosses Cannery Creek over a culvert at 0.7 mile. Most of the area at the Hawk Inlet port facility is drained to de-grit basin 4, which is treated prior to discharge through Outfall 002, and not into Cannery Creek. Cannery Creek is the potable water source for the cannery facility; this take-up point comes from a weir immediately upstream of the road crossing.

9.4. Hawk Inlet

Greens Creek, Zinc Creek, and Cannery Creek all flow into Hawk Inlet. The predicted annual flow of both Greens Creek and Zinc Creek into Hawk Inlet is 120,000 acre-feet per year.

10. RISK IDENTIFICATION AND ASSESSMENT

10.1. Summary of Potential Pollutant Sources

The following describes the toxic and hazardous substances employed in the Greens Creek Mining operations which are listed under Sections 307(a)(1) and 311 of the Clean Water Act (CWA) and required to be addressed under the APDES Permit No. AK0043206. These include the chemical reagents used in the milling process, products of the milling process, and petroleum products.

Dischargers who use, manufacture, store, handle or discharge any pollutant listed as toxic under Section 307 (a)(1) of the CWA or any pollutant listed as hazardous under Section 311 of the CWA are subject to the requirements of 40 CFR 125 applicable to BMP programs for all activities which may result in significant amounts of those pollutants reaching waters of the United States. The following section lists the toxic (priority) pollutants under Section 307 (a)(1) and the hazardous substances under Section 311 of the CWA. The presence of each of the listed chemicals is indicated if used or produced at the Greens Creek Mine in significant quantity. Both lead and zinc compounds are listed as Priority Pollutants under Section 307(a) of the CWA. These compounds will be found in both the concentrate and tailings. Trace amounts of several other compounds listed under Section 307 (a) and 311 of the CWA are in the ore and will be found in the concentrate and tailings. These compounds and their presence are detailed in an annual Toxic Chemical Release Inventory, incorporated into this document by reference.

Under Section 311 of the CWA, oil is also subject to BMP program requirements. Oil is defined under Section 311 of the CWA as "oil of any kind or in any form, including but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil."

Under the APDES Permit No. AK0043206, specific objectives for the control of toxic and hazardous pollutants include an examination of reagents and supplies including sodium carbonate, sodium sulfite, lime, copper sulfate, flotation reagents, flocculants, and petroleum products. Although these milling reagents are not considered toxic or hazardous under Section 307(a) or 311 of the CWA, they are addressed in the BMP as requested by the APDES permit.

Specific information on the physical, chemical, toxicological, and health aspects of the milling reagents and petroleum products is provided on their respective SDS. SDS are available to HGCMC employees during their regular work shifts through the Site Hawk system.

10.2. Reagent and Materials Inventory

The following describes the mill reagents which are generally stored at the mine site and utilized within the process.

- Copper sulfate – This substance is used as an activator in the zinc and bulk floatation. Vapors and mists are extremely corrosive to the skin, eyes, nose, throat, and mucous membranes. Breathing high concentrations may be fatal. High temperatures, alkalis, oxidizing or reducing materials, cyanides, sulfides, combustible materials, and hydroxylamines should be avoided.
- Ferric chloride – This substance is used as a coagulant and also aids in the coprecipitation reaction in water treatment plants to remove metals and particulates.
- Flocculant (Gold Floc 114 Goldenwest 2525) - Flocculants are added to thickeners Goldenwest 2525 and water treatment plants (Gold Floc 114) to increase settling rates. They are not classified as hazardous, but become slick when wetted. Dust generated in handling can be explosive if

sufficient quantities are mixed with air, in which case, ignition sources should be avoided. Contact with strong oxidants should be avoided.

- Methyl isobutyl carbinol (MIBC) – This substance is an alcohol frother. Its vapors are moderately toxic and may cause irritation to eyes and skin with contact. Heat, flame, and contact with strong oxidizing agents should be avoided, and it should not be stored or handled in aluminum equipment at high temperatures.
- Sodium isopropyl xanthate – This substance is used throughout the mill as a collector for lead, zinc, gold, and silver. Inhalation of xanthates can cause irritation to the nose and throat.
- Aerophine 3418A - This substance is a collector used to enhance lead and precious metals recoveries. Contact with Aerophine can cause eye and skin burns or severe irritation.
- Lime – This substance is used as a depressant for iron in the zinc and bulk floatation circuit and as a pH regulator. When lime is mixed with water, heat is generated. Lime will burn the skin, and the dust can irritate eyes, throat, and lungs. It should be stored in a cool, dry, well-ventilated place away from all other chemicals and potential sources of contamination.
- Sulfuric acid (93 percent) – This substance is used in the mill wastewater treatment plant process to adjust the effluent pH. Sulfuric acid is corrosive, and it can burn skin and eyes from direct contact. Its vapors are irritating to eyes, nose, and skin. It can react with organic materials, chlorates, water, and powdered metals and can ignite finely divided combustible materials.
- Zinc sulfate – this substance is used as a depressant for zinc. Zinc sulfate dust may cause irritation to eyes, nose, throat, and may cause chest discomfort if inhaled. Heat, acids, and oxidizing materials should be avoided.
- Unimax SD-200 – used as a pyrite depressant in the precious metals scavenger circuit. Can cause severe burns to the skin, eyes, and digestive tract.
- Liquid carbon dioxide – mixed with water to form carbonic acid. pH modifier used in the lead circuit. As a vapor can increase respiration and heart rate, potential in large quantities to cause asphyxiation.
- Other reagents may be used as a result of future test studies that reveal that various reagent substitutions would improve plant performance.

All hazardous materials, including incoming shipments, portable containers (sea vans, drums, and bags), and stationary bulk containers (tanks, process vessels, etc.), are labeled with the name of the chemical they contain and its associated hazards. Warehouse personnel are responsible for confirming that received containers are properly labeled. The safety coordinator is responsible for ensuring that in-plant containers are properly labeled.

Combustible and flammable fuels are used at both the mine/mill site and the Hawk Inlet site for power production, equipment, and heating. These are addressed further in the Spill Prevention Control and Countermeasure Plan (SPCC) in Appendix 6 of the General Plan of Operation (GPO).

Products of the milling process include lead, bulk, and zinc concentrate and tailings. Approximately 500 tpd of concentrate and 1,800 tpd of tailing are produced.

10.3. Materials Compatibility

Materials and process chemicals are stored in separate containers at the mill site until they are used. The containers have been approved for the transport and storage of each chemical and have the appropriate materials, construction, and coatings to prevent corrosion, degradation, or other destruction of the containers by the chemicals involved.

Chemicals are only mixed in their appropriate bins inside the mill building. The mixing of chemicals is by tested and proven methods of the mining and recovery industry; no experimental mixing or testing is involved. All chemicals are compatible with each other except acids.

11. PROJECT AREAS SUBJECT TO BMP REQUIREMENTS

Areas of the project which are subject to BMP requirements include materials storage areas, loading, unloading, and material transport areas; plant transfer, processing, and handling of materials; and areas of material disposal. The following paragraph summarizes the flow of materials.

Raw ore is removed from the mine and stored in an uncovered stockpile. The ore is transported from the stockpile to the mill for processing via conveyor belt, and then loaded through a grizzly bay by a front-end loader. All mill size reduction, flotation, and dewatering are wet processes accomplished by pumping liquid and slurries. Process chemicals are delivered to the island by barge, unloaded by forklift, and transported to the mill by truck. Within the mill, the process chemicals are mixed with ground milled ore, and the desired products are separated and concentrated. The concentrates are then loaded by front-end loader into Max Haul trucks inside the mill and transported by these covered trucks to the Hawk Inlet dock storage area. From there, the product is transported to outbound ships by conveyor system. Tailings leftover from the process are transported back into the mine by underground trucks for re-deposition or to the tailings impoundment by the covered Max Haul trucks for permanent disposal.

Each of the areas subject to BMP requirements due to chemical storage are described below. On-site runoff for each of these areas is also discussed. The direction of flow of potential spills and surface runoff is shown in Figures 2 and 5.

11.1. Materials Storage Areas

Material storage areas include areas adjacent to and inside of the mill building for the storage of mill reagents, fuel storage at the mine site and at the Hawk Inlet site, and storage of ore concentrate and tailings in the mill building and storage of ore concentrate at the Hawk Inlet site. Figures 3 and 4 show the locations of material storage at the Hawk Inlet site and mine/mill site, respectively.

11.2. Mill Reagent Storage and Transport

With the exception of lime and CO_2, chemicals used for processing are stored inside the mill reagent area and in sea vans located peripherally to the mill. Reagents are transported by sea van to the mill. Sea vans are designed for extreme environmental conditions such as those found in Southeastern Alaska. They are thick-ribbed steel containers which are air- and watertight, can be stacked on top of each other, and are transported easily from one area to another by forklift. Individual containers within sea vans are transported by forklift into the mill building dry reagent storage area for unloading. Approximately 2 weeks' worth of reagents is stored within the mill building.

Lime is stored in a silo located on the northwest corner of the mill building reagent storage area. The silo is a steel bin and holds 50 tons of powdered lime. The lime silo has a floor sump to contain and recycle any spills.

Other mill reagents are transported in drums and shrink-wrapped bags within sea vans. Compatible reagents may be combined in sea vans, but care is taken to keep incompatible reagents in separate sea vans.

Some reagents, when received at Hawk Inlet, after being unloaded from the freight barge are stored in containment containers on the upper Hawk Inlet truck pad, the rest are transported to the mill in the sea van in which they arrive. The sea vans are unloaded when they arrive at the mill as the chemicals are needed.

Individual containers for each reagent include:

- Sodium isopropyl xanthate - Contained in 1,500 lb super sacks in plywood boxes
- MIBC - Contained in 330-gallon totes
- SD-200 - Contained in 330-gallon totes
- Aerophine 3418A - Contained in 55-gallon drums
- Zinc sulfate - Contained in 2.000 lb super sacks
- Copper Sulfate - Contained in 2,000 lb super sacks
- Flocculant (Goldenwest 2525) - Contained in sacks as a dry solid
- Ferric chloride - Contained in bulk tank as a liquid
- Sulfuric acid - Contained in bulk tank as a liquid
- Gold Floc 114 - Contained in 55-gallon drums
- Lime - Contained in bulk tanks
- Liquid Carbon Dioxide - Contained in a 50 ton pressurized storage tank

Individual reagent containers, including drums, and bags, are stored inside the mill building on concrete chemical containment pads. Spills of any chemical outside are recovered to the extent possible for recycling or routed to the tailings facility. Any spills inside of the mill building are routed to sump pumps for recycling.

Surface runoff at the mine/mill site is shown on Figure 4. All process areas, including most areas where chemicals are stored, drain across concrete surfaces to the lined containment ditch, which flows to A Pond. Water in A Pond is pumped either into the mill, or through an 8-inch high-density polyethylene (HDPE) pipeline to Pond 23 or the tailings facility. In an emergency, if A Pond pumps are turned off, the mill will go to recirculation or shut down. Some remaining water will flow to A Pond from the pump wet well and surface runoff. The ponds are designed for a 10-year, 24-hour storm event. All runoff from the disturbed process area flows into lined containment, none of these flows run into Greens Creek or any other water body.

Under catastrophic conditions, A Pond water can be treated in one of the two mill water treatment plants to neutralize or remove the specific contaminants. Under conditions above a 10-year storm event, excess water would flow to B Pond from A Pond, and then into Greens Creek. However, runoff would be highly diluted under these circumstances, and impacts would be minimal. During a spill incident, samples would be taken from both ponds to have an accurate record of what entered Greens Creek.

Leaks or spills from reagent containers stored within the mill building are washed to the reagent sump pump. The lime silo has its own sump to collect any spills.

Some chemicals and hydrocarbons are stored in areas without concrete surfaces and direct drainage to A Pond. In these areas containment will be provided for by using containment systems.

11.3. Fuel Storage

Bulk fuel tanks are located at the mill site and at Hawk Inlet. Storage of fuel is discussed in detail in the SPCC.

11.4. Ore Concentrate and Tailings

Segregated storage for a maximum of 300 tons of lead concentrate, 200 tons of combined lead and zinc concentrate, and 300 tons of zinc concentrate exists in a room on the southwestern side of the mill building. Concentrates are held in this room prior to transport to Hawk Inlet in covered Max Haul trucks. The concentrates are completely enclosed with concrete floors and side walls. Transfer of concentrates to trucks is also conducted within this mill building room. Therefore, spills to receiving water bodies at the mill site from loading concentrate are impossible.

Generally, about 12,000 tons of concentrate will be in storage at the Hawk Inlet Concentrate Storage Building. This building can hold some 40,000 tons of concentrate if necessary while awaiting a ship for loading. Bulk, zinc, and lead concentrate are stored in this 120-foot-by-280-foot covered storage building. The concentrate storage building is designed for chemical containment with a concrete slab floor and lower side walls. Runoff from the concentrate storage building area is routed to the DB-04 settling pond prior to being pumped up to the tailings area water handling and treatment facilities prior to discharge through Outfall 002 into Hawk Inlet. In the event of a spill of concentrates, the solids are immediately scraped up with the surrounding rock and either returned to the concentrates within the storage building, returned to the mill for reprocessing, or disposed of in the tailings area.

A maximum of 9,000 tons of tailings from the milling process is stored at the southeastern corner of the mill building. This area is covered, contained on a concrete floor, and partially enclosed by concrete walls. Surface water runoff is routed through sediment traps into the lined ditch which flows to Pond A prior to being pumped to the tailings facility. No tailings are directly discharged into Greens Creek.

11.5. Loading, Unloading, and Transport Areas

Materials and chemicals are transported by truck over an 8.5–mile, single-lane, gravel-surfaced road between Hawk Inlet and the mine/mill site. Chemicals are transported to the mill site in containers. Concentrate is carried in covered Max Haul trucks from the mill to the Hawk Inlet storage building. These trucks dump into the Concentrate Storage Building from outside of the building through an opening for this purpose. Any wheeled vehicle which enters this building must have the wheels cleaned in a Truck Wash Building prior to leaving the concrete covered travel area surrounding these facilities. Concentrates are loaded by an enclosed, telescoping conveyor and chute system from within this storage building directly into ocean-going vessel holds. Covered Max Haul trucks also transport tailings from the mill site some 7.5 miles to the tailings basin.

11.6. Mill Reagent Loading, Unloading, and Transport

Milling reagents, contained in sea vans, are delivered as needed on weekly freight barges to the Hawk Inlet facility. Sea vans are off-loaded with large forklifts from barges at Hawk Inlet, which then transport them to the nearby Hawk Inlet warehouse. Mill reagents are transported by a freight truck to the mill site in these sea vans for storage. Sea vans are unloaded by forklift at the mill site for storage in and adjacent to the mill building. Lime is also delivered weekly by barge and transported in special lime ISO-containers (freight containers that conform to the International Standardization Organization manufacturing standards). Lime is pneumatically transferred from the container into the silo for storage.

If an accident were to occur enroute to the mill site, spillage is unlikely due to the construction of the containers. These containers are built for transport and rough handling. In addition, reagents inside the sea van containers are separately packaged, as described in the previous section, and incompatible materials are not packed together in the same sea vans.

Lime ISO-containers are also durable and built for transport. During the transfer of lime powder from its transport container to the silo, lime powder will occasionally spill. Drainage around this area is directed to Pond A. Lime addition to Pond A will improve the settling performance, as lime is a primary coagulant used to enhance settling.

Sea vans and lime containers will be inspected by Alaska Marine Lines (AML) shipping personnel in Seattle prior to transport to ensure that there are no faults in construction.

11.7. Mill Site Loading of Concentrates and Tailings

Bulk, zinc, and lead concentrates are loaded in the mill building concentrate room by front-end loader onto 50-ton covered Max Haul trucks. Trucks must pass through a spray truck wash prior to driving outside of this mill building room. Runoff water from the truck wash collects in the sump and is pumped to the bulk thickener. No runoff water from the concentrate loading area leaves the building. A spill into Greens Creek from concentrate loading operations is highly unlikely.

On average, approximately 900 tons per day of filter-pressed tailings are loaded by front-end loaders from the tailings stockpile area of the mill to 50-ton covered Max Haul trucks for transport to the surface tailings facility. Similarly, on average, approximately 900 tons per day of tailings are loaded by front-end loaders to the backfill feeder conveyor loading hopper, where they are mixed with cement for transport in 16- to 20-ton teletram trucks to the mine and used as backfill.

Tailings may spread from the tailings storage area to the loading area during loading. This entire area is roofed to keep precipitation from contacting the tailings. When loading the tailings, care will be exercised to keep tailings within the covered area.

Concentrate and tailings are transported by covered trucks to the Hawk Inlet site and the surface tailings facility, respectively. Approximately 11 to 12 truckloads per day of concentrate travels between the mill site and Hawk Inlet storage site. Approximately 15 to 24 truckloads per day of tailings also travel between the mill site and the tailings facility. In addition, materials, supplies, and fuels are transported by truck daily between Hawk Inlet and the mine/mill site.

Greens Creek runs close to the upper portion of the roadway. The road route also crosses Zinc Creek, several creeks that are tributaries to Greens Creek, and Cannery Creek. The significant amount of traffic on this road and its location to the mentioned creeks increases the risk of spills into water bodies.

The worst-case scenario for a spill of truck-hauled concentrate or tailings would be the introduction of up to 50 tons of bulk zinc or lead concentrate or tailings directly into a creek. The most likely scenario for an accident would involve spillage of bulk zinc or lead concentrate or tailings onto the slopes of the road corridor. Immediate mobilization of workers to place sediment impediments around the spill covers over the spilled material, and timely recovery of the spill by manual and mechanized equipment, has minimized the impact of such spills. Similar techniques would also be employed in the unlikely event of a direct spill into the creek. However, a direct spill would result in a greater volume of concentrate or tailings washing downstream before response measures could be taken.

In the event of a direct spill of truck-hauled concentrate or dry tailings into a creek, it is possible that acute effects would occur to aquatic organisms in the immediate area of the spill. Most effects would be caused by smothering by the sediment, although lead and zinc concentrates could introduce long-term effects to the aquatic habitat. The concentrate and dry tailings would not readily move under conditions of normal discharge, however, and would be largely recoverable.

In the event of road spills of concentrate or tailings, the following events would take place. Surface Operations and road traffic is notified of the spill by in-vehicle radio transmission. Mechanical equipment (225 backhoe, front-end loader, receiving truck) is mobilized to the site. The material remaining in the tipped truck may be removed, placed in a second receiving truck, and taken to its proper area (concentrate or tailings). The tipped truck is righted and returned back onto the road. All spilled material and surrounding soils and road material is placed in a serviceable truck and returned to the mill for re-processing or disposed of in the tailings area.

To reduce the potential for truck accidents, the numbers of trucks is minimized to the extent possible. All surface vehicles are equipped with a GPS collision avoidance system and extensive radio communication is employed to communicate for traffic movement, hazards, or any spill occurrences. Surface Operations has developed a road traffic Standard Operating Procedure which details travel on the road as well as proper meeting protocols including vehicle type priorities. Loaded work vehicles have priority over smaller vehicles.

11.8. Concentrate and Tailings Unloading

The Max Haul trucks unload concentrate through a designated dump opening into the storage building at Hawk Inlet. Max Haul trucks deposit concentrate from outside the contained areas to prevent the tires of the truck from spreading concentrates. A front-end loader translocates bulk, zinc, and lead concentrates to contain designated areas within the concentrate storage building. The potential for concentrate to reach Hawk Inlet is unlikely. Any concentrate spills from the storage building or from truck tires run off to the DB-04 settling pond over the concrete pad around these facilities and not directly into Hawk Inlet.

A covered, telescoping conveyor and chute system is employed for loading concentrate product from within the storage building directly into the ship’s holds. This conveyor system is covered to prevent concentrate from blowing or falling off the system into the environment. At the end of the conveyor system is an elephant trunk feeder which also telescopes to reach down into the ship's hold to distribute the concentrates. During the first ship loading in 1989, concentrate spilled into Hawk Inlet. This spillage was caused by improper design of the transfer chutes. This entire initial concentrate loading system has been replaced with the current covered telescoping conveyor and chute system, and further spillage or loss to the environment is improbable. Ships of 10,000- to 40,000-ton capacity transport concentrates from the Hawk Inlet site monthly.

Dry tailings are unloaded in the tailings facility. Max Haul trucks will unload tailings from crossroads which extend into the tailings pile to the active placement area. All vehicles exiting the tailings facility pass through a truck wash before entering onto the B-Road.

11.9. Transport of Mill Site Wastewater

Wastewater from the mill and mine site area is composed of mill wastewater, site runoff water, mine drainage, and domestic wastewater. During dry periods, site runoff would be minimal and would result in minimal dilution of the wastewater. All site runoff from process areas at the mine/mill site drains to A Pond. Water in A Pond is piped to the tailings basin sediment pond. The wastewater is

transported to the tailings basin through a single 8-inch-diameter HDPE pipe. This line is installed along the roadway from the mill site to the basin and covered with soil and rock to prevent damage from falling rocks or equipment. The transit time through the roughly 7 miles of this water transfer line has been measured at 4 hours.

Since operations began, the wastewater line has been broken by HGCMC or contractor operations (ditch or road maintenance, facility installations) and accidents (falling trees and rocks). In the event of an incident, the following procedure is followed:

1. Pumping into the damaged line is stopped at either the A Pond sump or Pond 23 pump house.
2. The mill is placed on recirculation or shut down.
3. Mill maintenance crews and/or water operations staff are dispatched to assess the damage and make repairs.
4. The Environmental Department takes spill-specific samples of the wastewater and affected creeks to determine water quality effects.

A maximum probable volume of a spill would be approximately two pipe volumes or 250,000 gallons.

When a spill occurs, it takes time for the mill to go to recirculation or shutdown. During this time, the water flowing from the mill waste water treatment plant will enter Pond A directly. If these conditions happen to take place during one of the 24-hour design storm events, there is a possibility that this water could enter Greens Creek and or Hawk Inlet. Pipe repair material is kept at the 920 mill site and Hawk Inlet.

11.10. Plant Transfer, Process, and Materials; or Chemical Handling Areas

Areas of transfer, process, and materials handling involve processes within the mill building where raw ore is ultimately separated into concentrates for sale and tailings waste. Chemicals are transported from their respective sea vans into the mill building by forklift. Inside the mill building, the chemicals are mixed in dedicated tanks in the reagent area and applied as part of the ore flotation separation process. Mixing, handling, and process locations inside the building all have floors which slope to sump pumps.

Two weeks' worth of reagents is stored in bags, and drums in the mill building reagent storage area. All mixing is carried out in this isolated area of the mill. Holding tanks maintain 3 days' storage of mixed reagent. Lime is pumped in a continuous loop from the holding tank through the points of addition area and returned to the holding tanks. Reagent is removed from the loop at its point of addition and controlled by timer-activated solenoid valves. All other reagents are pumped from their holding tanks to the direct point of addition. Passage rates are controlled by timer-actuated solenoid valves and monitoring pumps.

Lime is routed from the storage bin to a slaking unit and then to the mixing tank, all located in the lime silo. The lime silo is equipped with an exhaust fan and blower, and a sump is located under the silo to collect any spills and route them back into the adjacent mill building. From the mixing tank, the lime mixture is transferred to the storage tank located inside of the mill building. From the storage tank, the mixture is routed to various areas for addition into the milling process. The lime area is also equipped with a sump pump to collect and recycle any spills.

Other reagents used in the milling process are transferred in bags or drums by forklift from the reagent storage area, inside the mill building, to their respective mixing tanks. Bags or drums are manually dumped into mixing tanks by personnel wearing protective equipment including protective clothing,

respirators, and face shields. Reagents are then withdrawn from the respective mixing tanks and directed through dedicated piping for use in various areas in the mill process. The reagent sump pump collects and recycles any spills or leaks in the reagent area.

Reagent mixing and storage tanks are made of steel, except for those associated with copper sulfate, which are made of fiberglass. All reagents are routed by polyvinyl chloride (PVC), HDPE pipes, stainless steel pipes, or braided hoses to various areas in the milling and flotation separation processes. The entire milling process is underlain by a concrete chemical containment pad and is entirely enclosed within the mill building. Exceptions are the zinc, lead, bulk, and tailings thickeners and the tailings stock tank, which are located outside, adjacent to the mill building.

All gangue, concentrate, or tailings slurry transfer in the milling process is either through HDPE or steel pipes. All pipes are aboveground and above concrete floors in the mill building. Any leaks or spills are routed to appropriate sump pumps for recycling.

In addition to the reagent area sump pumps described above, the mill building is equipped with a sump pump located under the SAG mill, plane tables, and shaking tables; two lead and bulk area sump pumps, one under the lead and bulk flotation circuits and the other under the lead and bulk thickeners and stock tanks; two zinc area sump pumps, one under the zinc floatation circuit and the other under the zinc thickener and stock tanks; a concentrate storage and loading area sump pump; and a tailings thickener area sump pump.

The working surface surrounding the mill building and other associated surface facilities is generally finished with a concrete liner. This impervious surface drains through a series of sediment traps into an HDPE-lined containment ditch running downgradient the length of these surface facilities to the lined containment A Pond. Pumps in this pond withdraw accumulated waters which can then be directed either into the mill for treatment in one of its two water treatment plants or sent directly to the tailings area for treatment and discharge under the APDES permit provisions. Collected sediments are removed and carried to the ore pad to be fed through the mill process, placed underground as backfill, or incorporated into the controlled surface waste piles.

The potential for any spills or leaks in the mill building to reach the outside environment and any receiving water bodies is unlikely. All pipes, pumps, filter, tanks, and electrical equipment will be inspected routinely to avoid major leaks or spills. In the event of a major spill or leak, the plant will be shut down until the potential for environmental danger is controlled and repairs are made.

11.11. Material Disposal Area

The approximate 1,800 tpd of tailings from the milling process is wet filtered to reduce the water content to approximately 10 to 12 percent by weight. The water from the tailings dewatering process is recycled within the mill process. The tailings are loaded with front-end loaders to a cement mixing plant and then to slinger trucks for deposition as backfill into the mine, or they are placed directly into covered Max Haul trucks for transport to the surface tailings facility. Annually, approximately one half of the tailings are placed back into the mine workings, with the remainder placed in the surface tailings facility.

The surface tailings facility is a dry-stack tailings pile. Facility features include an associated main embankment and saddle embankment; slurry walls to all four sides of the tailings placement area; drainage ditches around the perimeter of the tailings pile which collect runoff; tailings area underdrains and

associated wet wells; site water collection ponds; a high-density sludge water treatment plant; and an outfall pipeline and spillway which discharge to Hawk Inlet.

Both the main and saddle embankment have relatively impervious clay cores to reduce seepage losses. In addition, seepage cutoff walls surrounding the pile area extend through the highly permeable peat and sand lenses immediately beneath and are keyed into an underlying impermeable clay layer or bedrock. The amount of vertical seepage loss is minimized due to the low permeability and artesian pressure of the aquitard soils at depths which underlie the tailings basin.

Bedrock groundwater discharge from the tailings facility is estimated to be small. Groundwater monitoring wells are installed downstream of the tailings facility to the south, west, and north to monitor water levels and water quality. If significant degradation of the groundwater quality were to result from seepage, cutoff trenches or pump-back wells would be constructed to intercept the seepage and pump it to the pond system for treatment.

The tailings collection pond system is sized to retain the 25-year, 24-hour storm event from facilities covered by the ADEC Waste Management Permit, and the 10-year, 24-hour storm from the rest of the HGCMC surface facilities. These contact waters are combined with treated mill process water and treated domestic sewage from the HGCMC facilities in the collection ponds. From here, they are sent to the tailings area water treatment plant. Treated effluent from the tailings water treatment plant is routed out the outfall line, monitored as required by the APDES permit, and discharged through a diffuser into the approved mixing zone on the ocean floor. End-of-pipe pollutant concentrations cannot exceed the following limits, as specified by APDES Permit No. AK0043206, to assure meeting Alaska Water Quality Standards in Hawk Inlet at the edge of the approved mixing zone.

APDES Water Quality Permit Limits (AK 004320-6)

Parameter	Units	Daily Maximum	Monthly Average	Sample Frequency	Sample Type
Flow	mgd	4.6	3.7	continuous	recording
Cadmium	µg/L	100	50	weekly	24-hr composite
Copper	µg/L	99	39	weekly	24-hr composite
Lead	µg/L	327	123	weekly	24-hr composite
Mercury	µg/L	1.9	1.0	weekly	24-hr composite
Zinc	µg/L	1,000	500	weekly	24-hr composite
TSS	Mg/L	30	20	weekly	24-hr composite
pH	s.u.	max 9.0	min 6.0	continuous	recording
Cyanide	µg/L	19	9.2	weekly	24-hr composite
Temperature	°C	-	-	monthly	grab
BOD_5	mg/L	-	-	monthly	grab
Fecal Coliform	#100/ mL	-	-	monthly	grab

The collection pond system is sized to provide sediment storage, working storage (equalizing), and storage for the above described storm events with freeboard. However, during excess storm events, discharges through the designed Emergency Spillway could occur for several hours but would be diluted by runoff in the adjacent upland muskeg and the waters of Hawk Inlet. These events would be infrequent and of short duration and are guarded against by keeping the pond elevation at the minimal levels during storm periods. Localized water quality could be degraded in Hawk Inlet during the overflow. Although these discharges would not occur through the effluent diffuser, because of dilution and short contact time, they are not believed to present a threat of acute or chronic toxicity to marine life.

12. MEASURES AND CONTROLS

12.1. Capping

Where capping of a contaminant source is necessary, the BMP plan must identify the source being capped and procedures and materials used to cap the contaminant source.

Capping is a procedure used to isolate potentially contaminated or pollution-generating soils from the environment. For final reclamation, inert or clean soils may be used to 'cap' an area to reduce infiltration, enhance vegetation establishment, and protect the quality of storm water runoff. At the HGCMC project site, interim capping using the Class 1 waste rock (argillite) is employed on both the waste stockpile and the tailings facility. This is done to prevent acid generation in the underlying material, and to minimize erosion from wind and runoff. Outer slopes of the tailings facility have also been covered with a thick layer of organic peat from recent tailings expansions.

The tailings facility will be covered with a composite soil cap at closure to reduce infiltration of meteoric water and oxygen to prevent long term acid rock drainage.

12.2. Water Treatment

The BMP plan must describe how wastewater and stormwater will be treated prior to discharging to the waters of the United States if treatment is necessary.

Water discharged from Outfall 002, located in the Hawk Inlet, is treated prior to discharge.

There are three water treatment plants on site, two at the mill and one at the tailings disposal facility, that treat all wastewater and stormwater collected at Greens Creek. These treatment plants are co-precipitation, high-density sludge water treatment plants. Effluent generally achieves at least an order of magnitude below the APDES permit discharge limits for zinc, lead, copper, and cadmium. A process flow sheet for the tailings area water treatment plant is provided as Figure 17.

12.3. Housekeeping Practices

Good housekeeping practices are encouraged and emphasized throughout the HGCMC project site for reasons of health, safety, morale, and environmental awareness.

Sufficient solid waste containers are made available throughout the site to accommodate cleanup of debris. Cleanup of hazardous or toxic substances is addressed in other sections of this BMP plan.

Regular maintenance activities are not considered complete until cleanup has been accomplished. Building floors are routinely washed down to provide clean, safe walking surfaces. Floor sweeping and wash-down within the mill building route any reagents and process materials to appropriate sump pumps. Supervisors and managers regularly inspect the facilities. Posters, suggestions boxes, bulletin boards, slogans, employee publications, safety meetings, and other techniques promote good housekeeping practices.

Cleaning chemicals and spill absorption materials are stocked in appropriate locations throughout the site to facilitate efficient cleanup of the site. All areas of the project have sufficient access to brooms, mops, buckets, shovels, cleaning agents, and absorption materials to implement good housekeeping standards and to immediately mitigate any spills and/or spill debris.

12.4. Preventive Maintenance

A comprehensive and complete preventive maintenance program is in place at the HGCMC site. Facilities are shut down and inspected periodically. The water treatment plants are shut down frequently so that facilities can be regularly inspected. Pipes, pumps, tanks, and circuit lines are visually inspected daily.

Maintenance personnel are employed full-time with coverage on every shift, 365 days per year, primarily for preventive maintenance purposes in the concentrator. Plant operators continuously check pipes, pumps, etc. daily during their regular work schedule.

The preventive maintenance program applies to the chemical storage areas; transportation vehicles; embankments; ditches; settling and holding ponds; pipelines; conveyor systems; and other transfer, containment, and control systems such as pipes, valves, containers, pumps, meters, and other facilities. These facilities are inspected and maintained daily during operations. Parts or systems are appropriately adjusted, repaired, or replaced in a timely fashion.

A preventive maintenance computer software program "Ellipse" is used to record inspections, tests, lifetime of parts, and history of past activities. Printouts are distributed weekly to plant foremen, which detail preventive maintenance activities that need to be conducted for the week. The program is updated continuously to document all activities that have been completed and reschedule preventive maintenance activities for the following week. The "Ellipse" program has in its database all parts used at the Greens Creek facility, inspection schedule for these parts, and their replacement or repair dates. The program orders parts automatically ahead of time to ensure that parts are on site and available when needed.

The Maintenance Facilities of the HGCMC project are fully equipped with the necessary tools, machinery, and test equipment to manage maintenance practices on any scale. Located on an isolated island, the project is stocked with sufficient spare parts to replace most any weak or failing part or system before a major incident occurs. The maintenance personnel are fully trained and experienced to repair and/or replace any system which might need attention and thus prevent accidents or incidents.

12.5. Exploration Drilling

HGCMC annually conducts an active exploration drilling program in conjunction with the ongoing active mining and associated activities. HGCMC conducts exploration activities both from within the underground workings and from the surrounding surface. All underground activities occur within the extant HGCMC mine. As such, all disturbance is contained within those underground mine working areas, controlled, and handled as a composite whole.

The surface exploration program consists of three general activity types: reconnaissance, prospect work, and drilling. Due to the very limited road access in the vicinity of the HGCMC facilities, virtually all surface exploration occurs in "remote" sites and is either accessed by walking from established facilities or through helicopter support.

Reconnaissance and prospect work activities involve ground examination and detailed geological mapping, ground surveying, geochemical sampling (rocks, soils, and stream silts), and ground geophysical surveying. These are road- and helicopter-based activities, entailing no significant surface disturbances or degradation. Reconnaissance work involves geologists traversing the ground, observing the surface, and conducting geologic mapping. This activity may entail periodic collection of small rock, soil, and stream sediment samples. Most surface exploration work is conducted for HGCMC by contractor, or temporary seasonal employees, all under the direction of HGCMC staff.

Similarly, non-invasive prospect work activities consist of grid surveying, detailed grid mapping and sampling (rock, soil, and silt), and grid geophysical surveying (magnetics and electromagnetics). Grid work generally entails a minimal amount of brush clearing to facilitate surveying and the ingress and egress of field equipment for geophysical crews. When utilized, helicopter landing sites are often located on open ridges, creek bottoms, and meadows or muskegs to minimize vegetative cover or underlying soils disturbance. No new landing sites will be cleared for either reconnaissance or prospect work activities, except near drill sites (as described below).

Drilling at surface exploration sites is seldom situated to allow direct access from the limited available road system. Therefore, these sites are generally exclusively serviced via helicopter. Detailed grid work, similar to the prospect work described above, will generally precede drilling at each site.

Drill sites will not be cleared until HGCMC is committed to drill from that site. Typical drill site clearance dimensions are 60 feet by 80 feet, but vary greatly with terrain and prevailing wind conditions. Drill site clearance only involves tall plant life, trees, and other plant life high enough to endanger helicopter landings or slinging of material into the site. These drill sites include area to accommodate a 20-foot–by-20-foot drill deck, storage area for all supplies associated with drilling, and allow for the safe helicopter long-line slinging of equipment and supplies. Drill deck frames will be constructed using trees cleared for the drill site and decked with 2-inch-by-12-inch rough-cut boards. Rough-cut lumber may be flown in (and out upon completion of drilling) for drill decks located above the tree line or within natural clearings. Only portable hand tools, including gas-powered chainsaws, will be used in drill site clearing and construction. Separate helicopter landing pads may be constructed in areas where no suitable landing zones are located within 800 feet of the drill pad. In all drill site construction, surface disturbance is minimized to control erosion potential.

HGCMC will transport materials via helicopter daily to and from the drill sites. All diesel fuel will be stored in drums placed within a secondary containment or within specially constructed double-walled aluminum tanks, both capable of holding 110 percent of the primary volume. Domestic waste will be removed daily. All drilling materials that may attract bears (salad oil, drilling muds, etc.) will be stored in steel lock boxes when not in use. HGCMC personnel will frequently visit the drill rigs to ensure environmental compliance.

Water for the drilling operations will be sourced from nearby streams under Temporary Water Right and Fish Habitat permits obtained from the Alaska Department of Natural Resources. The water will be gravity fed to the drill sites wherever feasible using a 2-inch supply hose lain across the forest floor. A diesel-powered supply pump will be used where gravity feeding is not possible. The supply pump and its fuel tank will be permanently mounted within a secondary containment system.

The drilling fluids to be used include a partially hydrolyzed polyacrylamide, a copolymer of acrylamide and sodium acrylate, and bentonite. These are the same drilling support fluids HGCMC has required when needed in past drilling activities. The driller captures and re-circulates the drilling fluids, minimizing the total quantity utilized at any site. Drill cuttings will be contained within the cleared drill site using settling tanks and sumps. The sumps will either be dug into the ground or, where that is too difficult, they will be constructed using the cut timber and lined with burlap or geofabric. Drill water will not be allowed to enter any live streams. Whenever drilling water effluent is found to approach within 200 feet of running water, drilling activities are to cease until this problem is rectified.

For each shift, prior to initiating activities at a surface drilling site, drill crews are required to complete a Surface Drilling Pre-Shift Environmental Checklist. This checklist covers examination of the water feed to the site, the drill site facilities, and the control of drill discharge water and cuttings.

Upon termination of drilling at a drill pad, all non-native materials, contaminated native materials, and equipment will be removed. Drill cuttings will remain within the constructed sumps, excess geo-fabric or burlap will be removed. Areas cleared to the mineral soil will be reseeded with the seed mixture formulated for Greens Creek. Camera-dated digital photographs of each site will be taken within 2 weeks of cessation of operations.

12.6. Spill Prevention and Response Procedures

Per APDES Permit No. AK0043206, the areas where spills could result in the discharge of pollutants must be identified clearly in the BMP plan. The description of each area must include procedures for spill prevention and procedures for cleaning up spills.

Spill prevention and cleanup procedures are addressed in the SPCC Plan.

13. REFERENCES

Toxic Chemical Release Inventory for HGCMC:

Hecla Greens Creek Mining Company TRI

Figure 1. Site Map

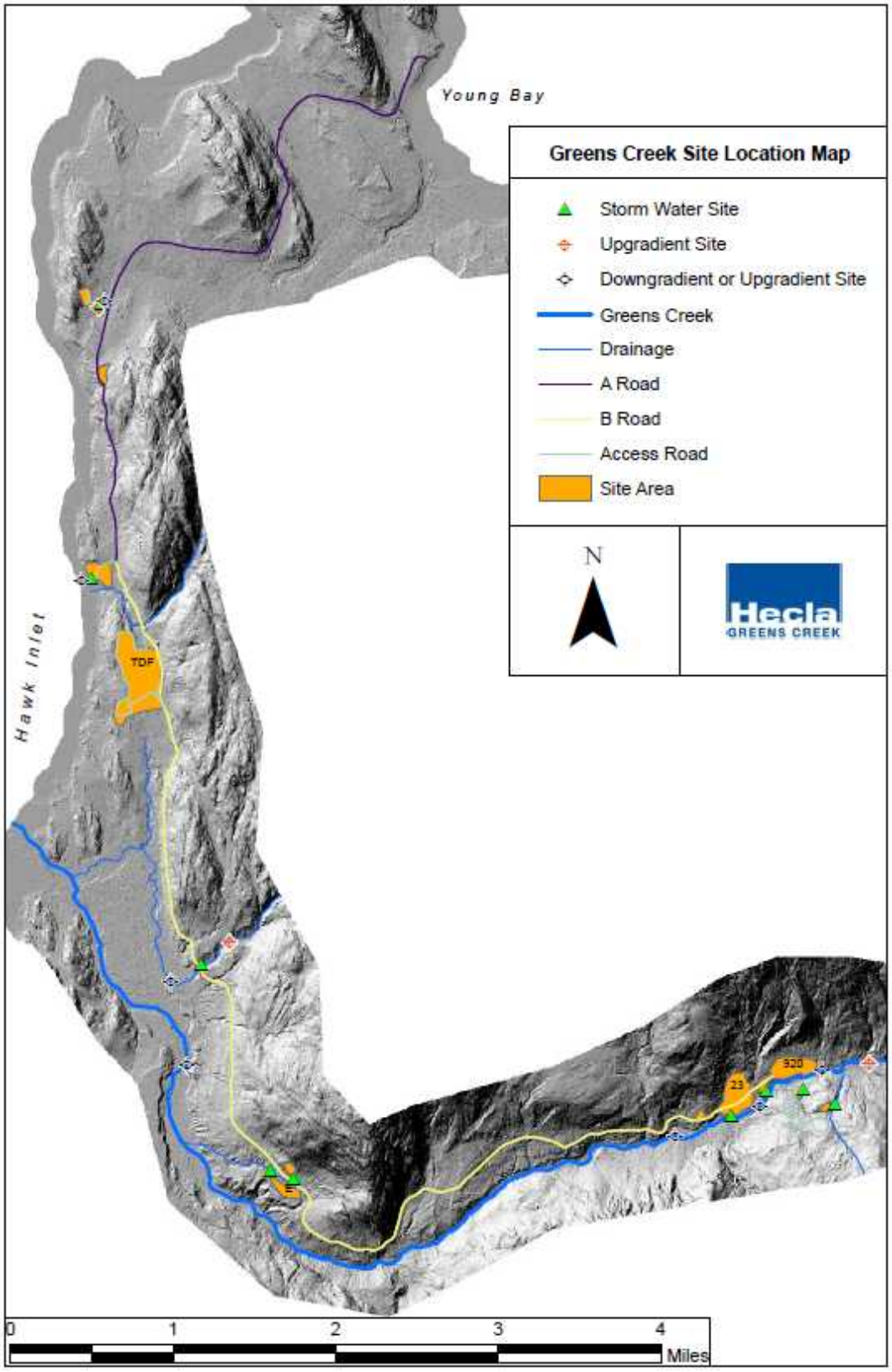


Figure 2. Tailings Facility Area

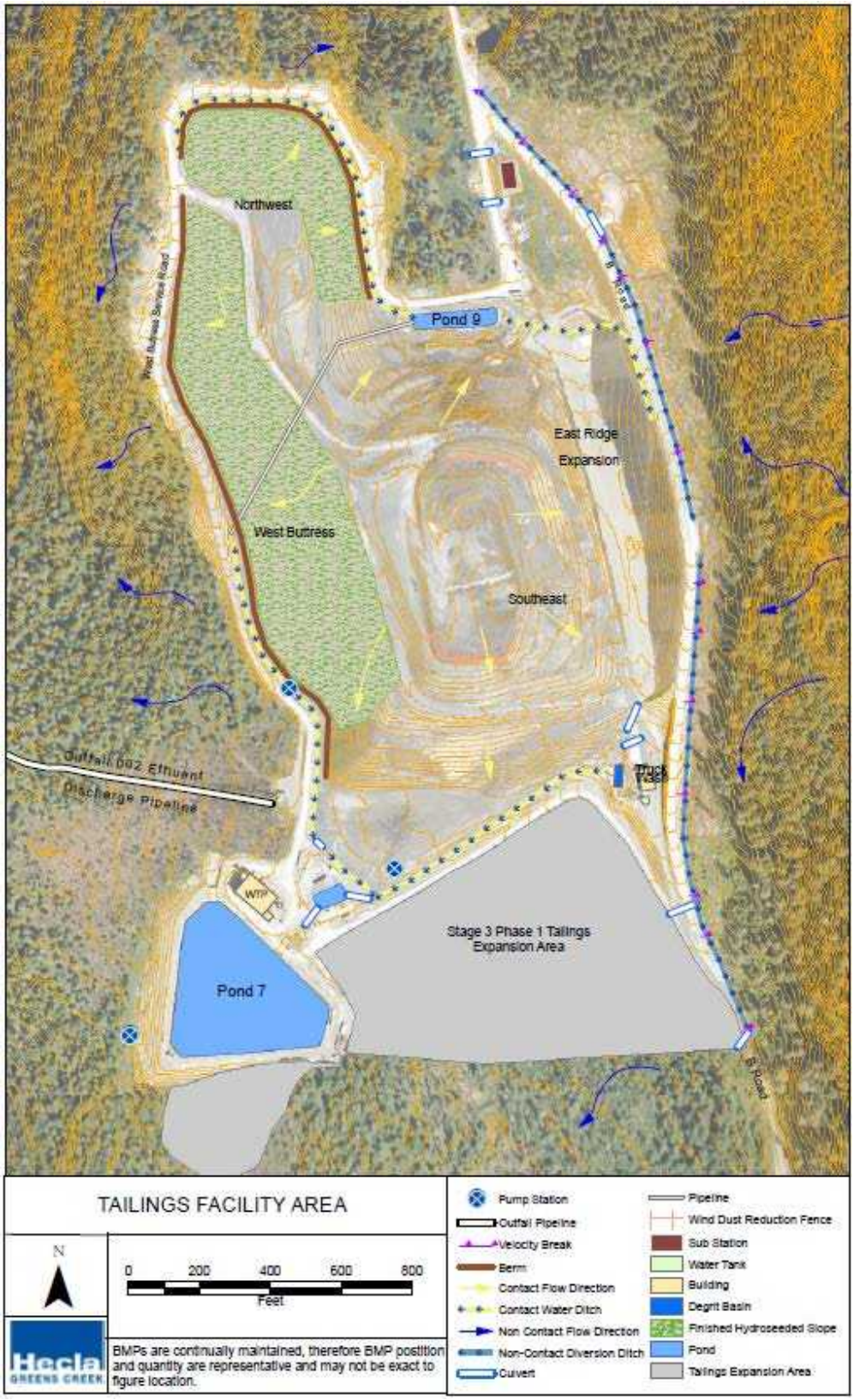


Figure 3. Hawk Inlet Facilities Area

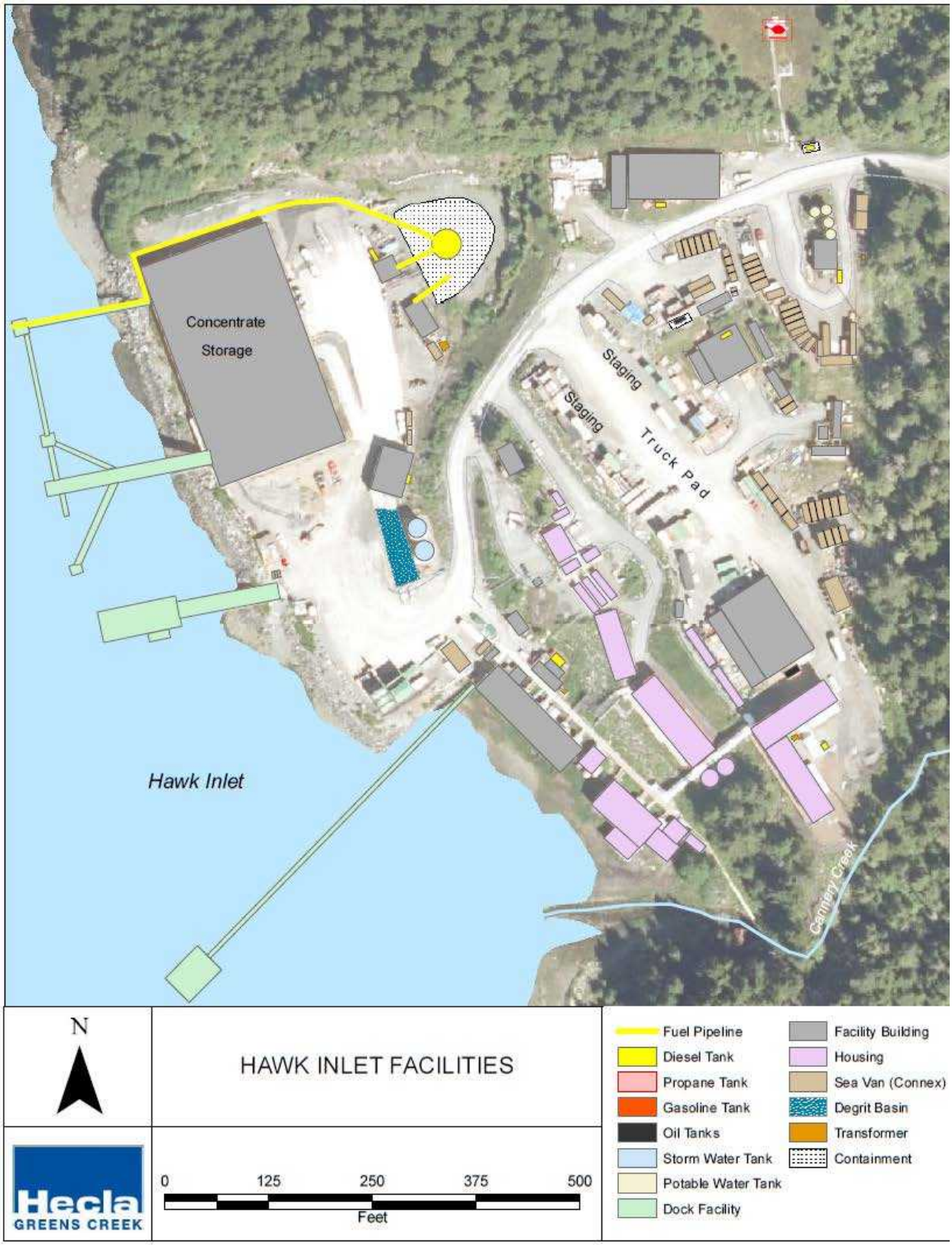


Figure 4. Mine and Mill Area

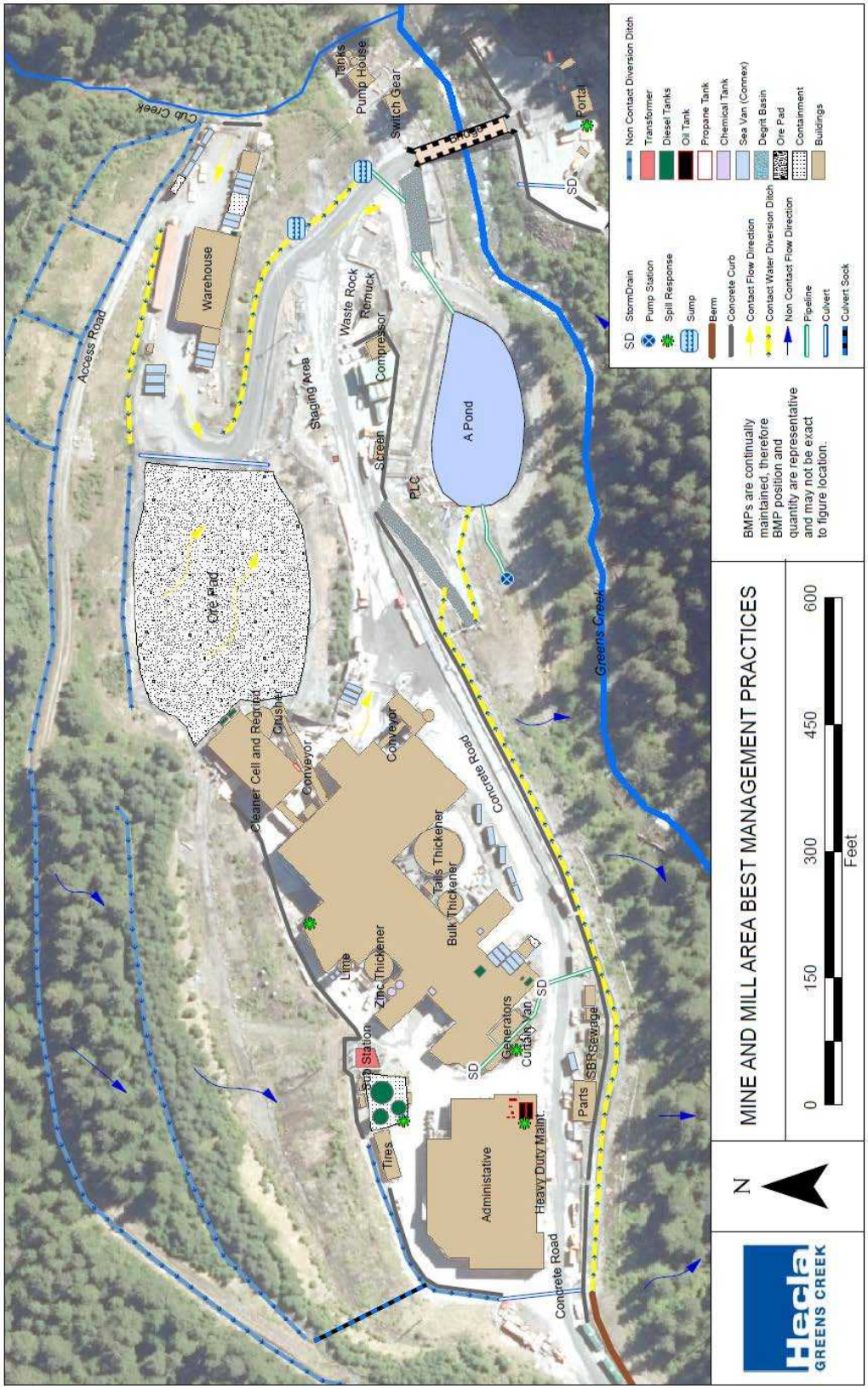


Figure 5. APDES Outfall 003

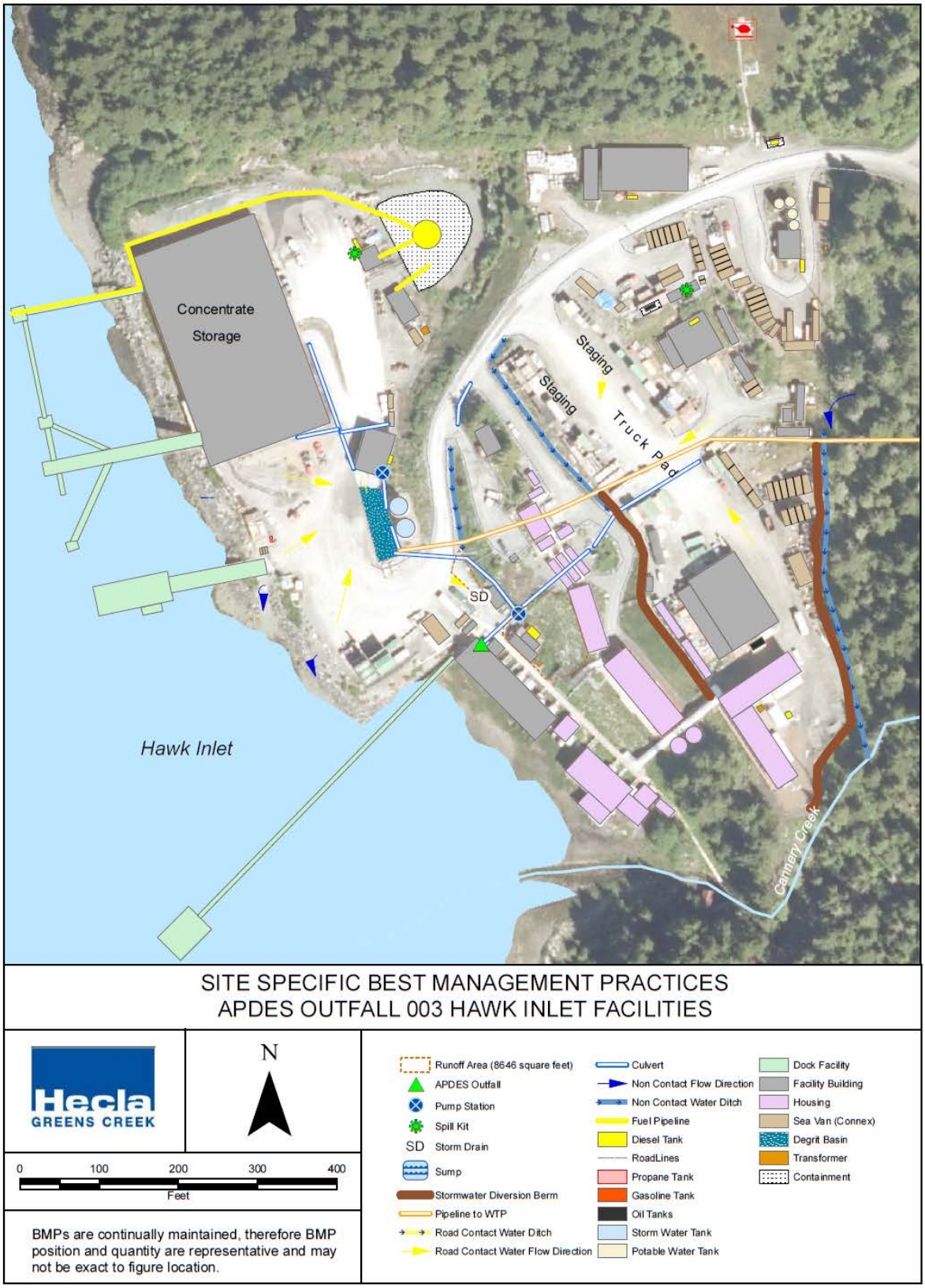
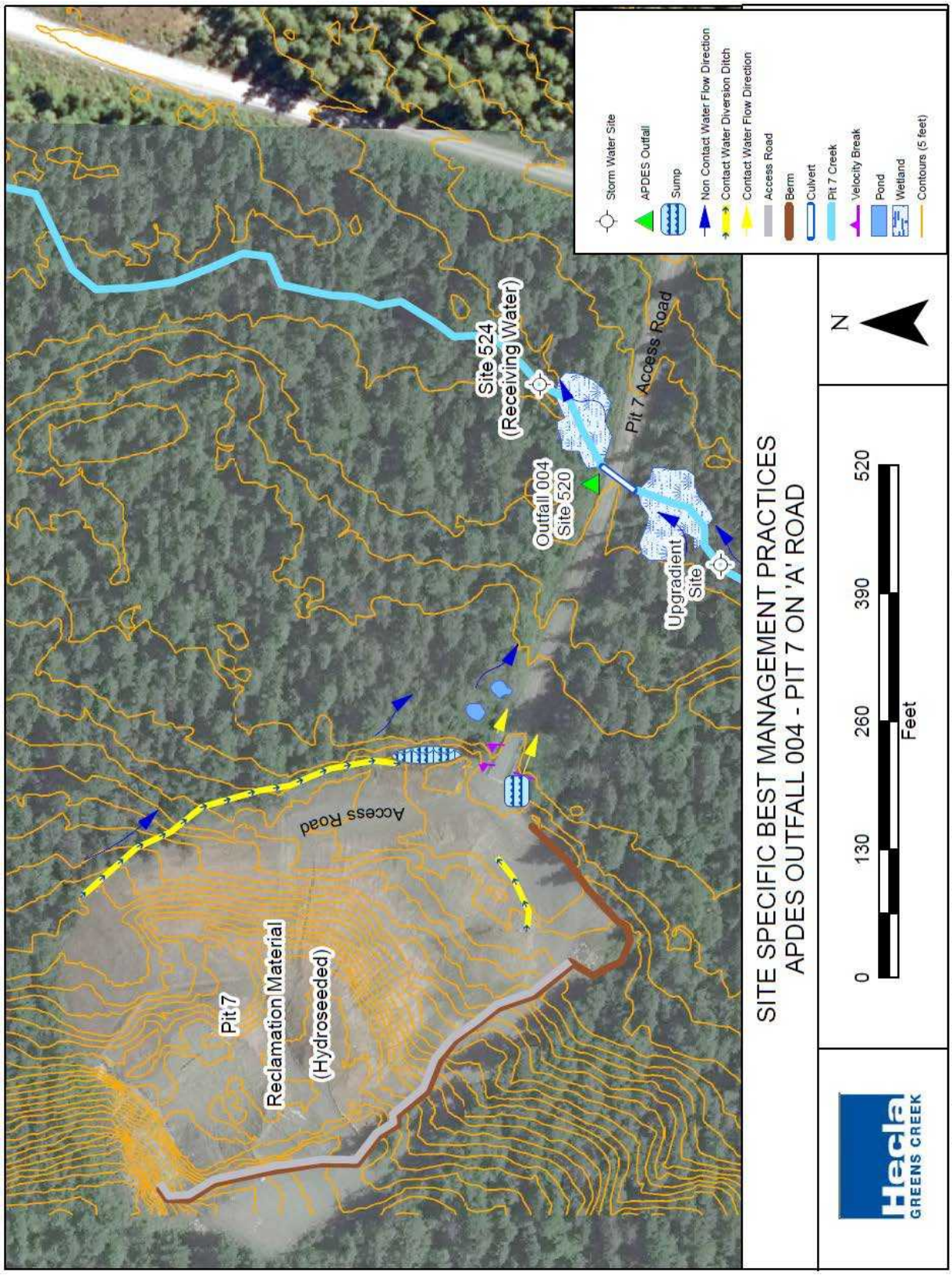


Figure 6. APDES Outfall 004



BMPs are continually maintained, therefore BMP position and quantity are representative and may not be exact to figure location.

Figure 7. APDES Outfall 005.2

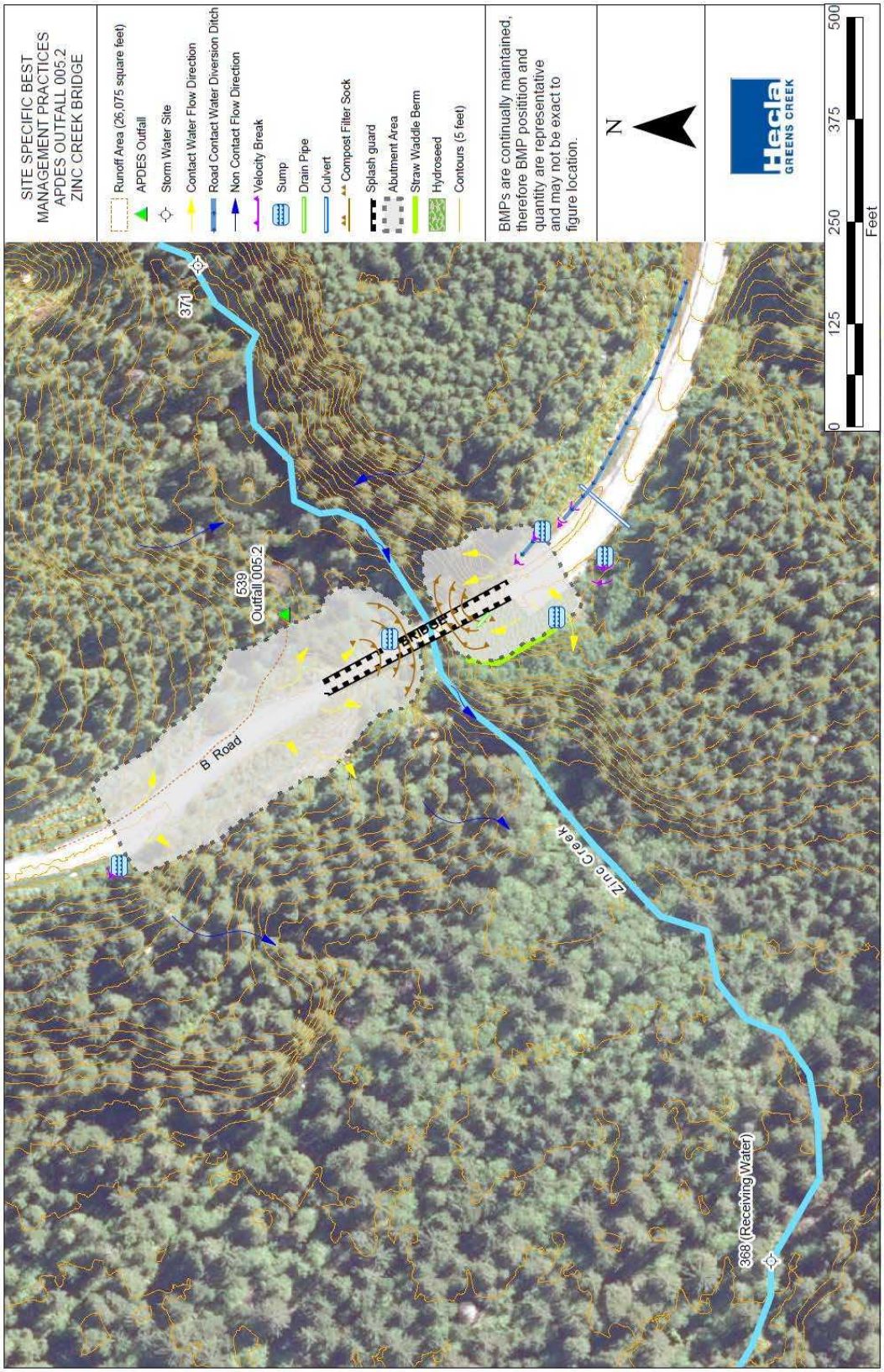


Figure 8. APDES Outfall 005.3

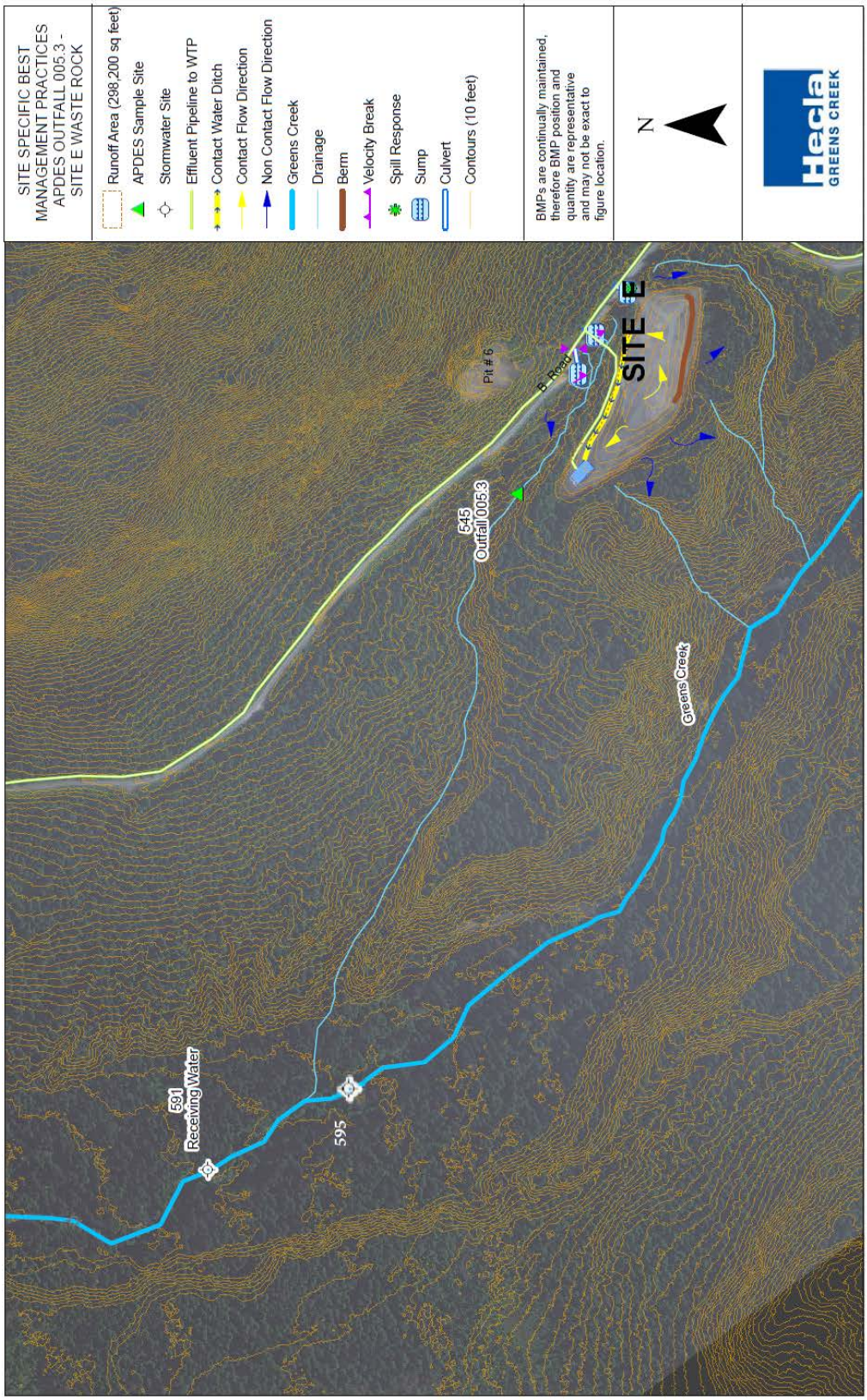
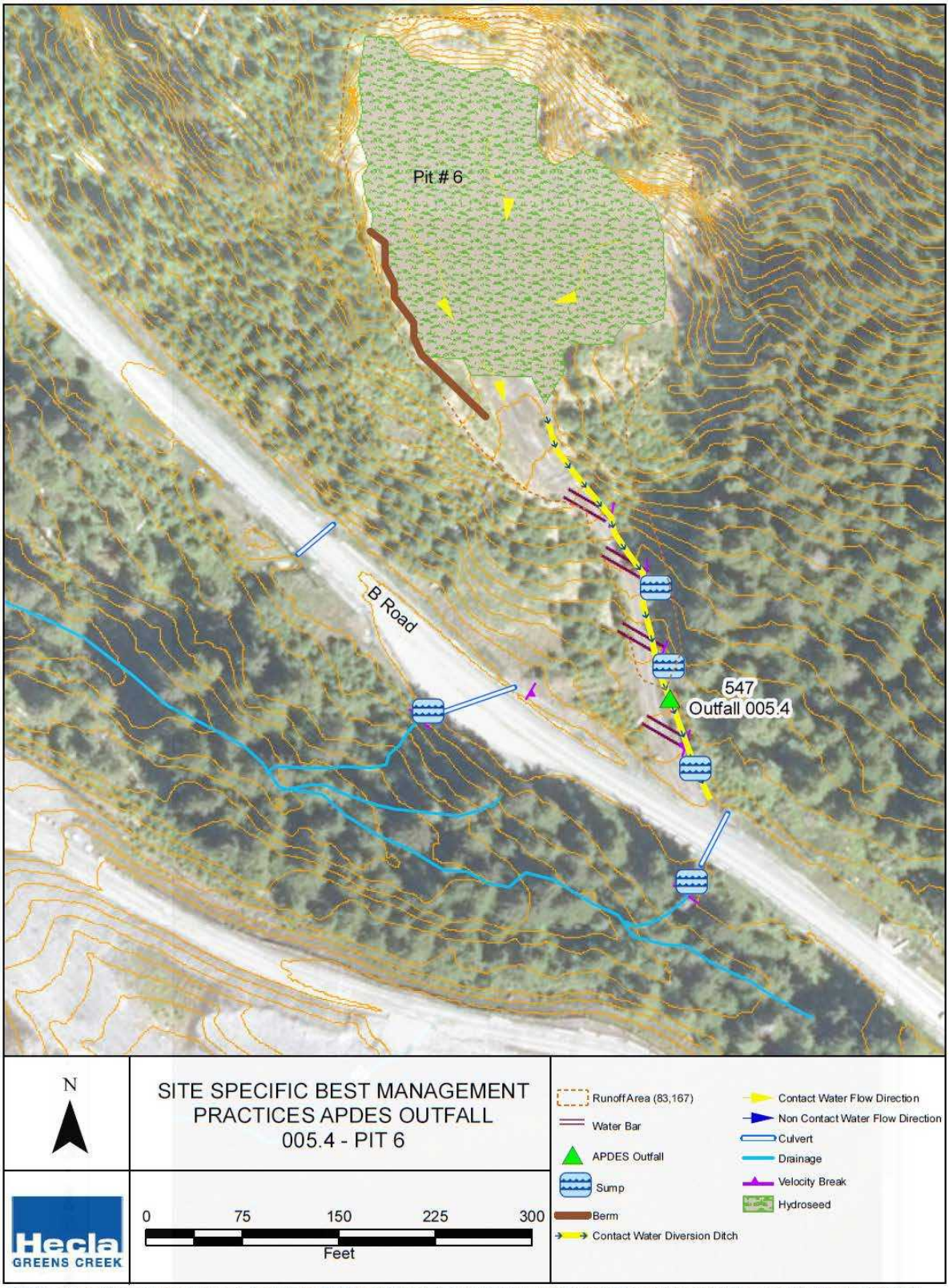


Figure 9. APDES Outfall 005.4



BMPs are continually maintained, therefore BMP position and quantity are representative and may not be exact to figure location.

Figure 10. APDES Outfall 005.5

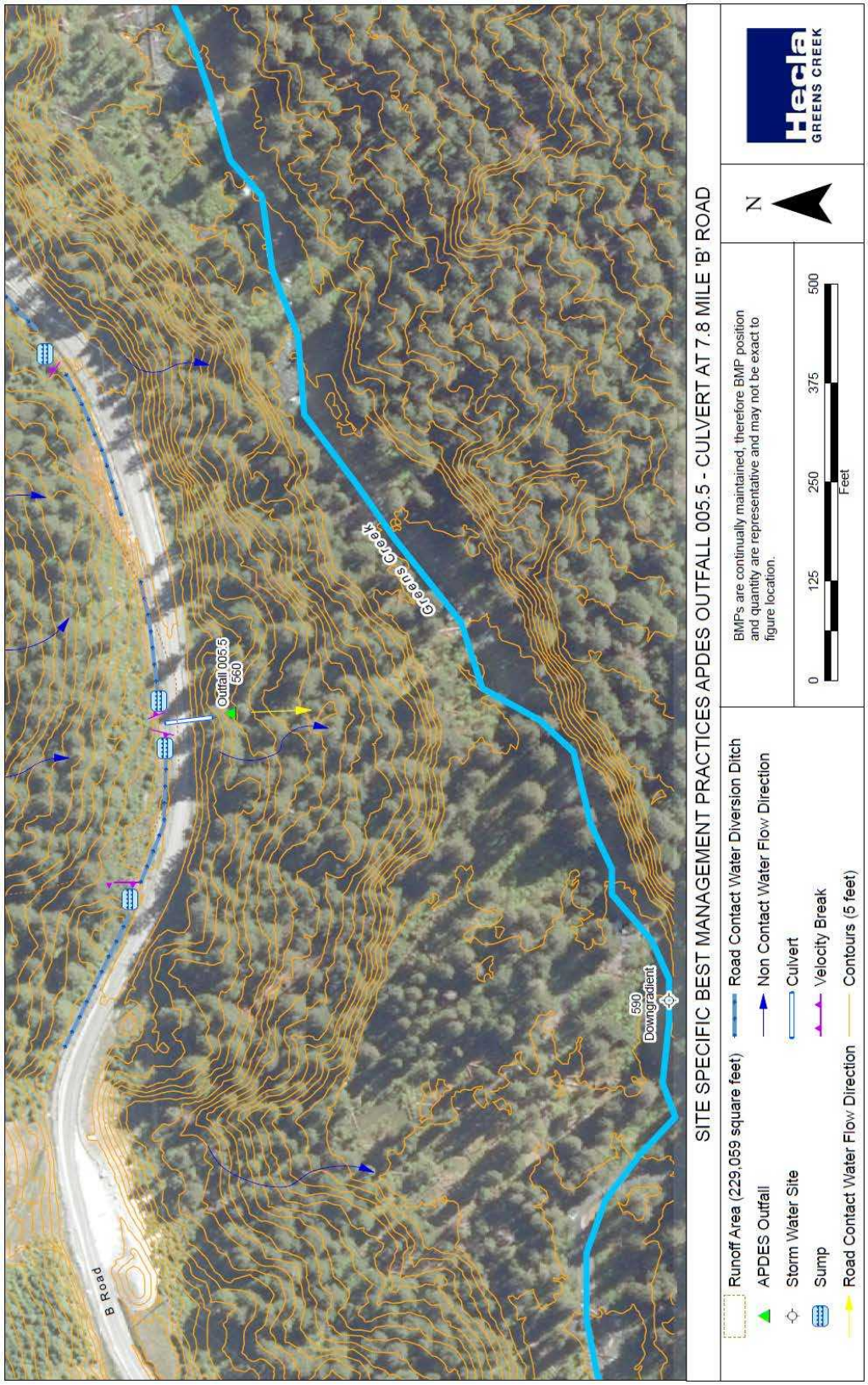


Figure 11. APDES Outfall 006

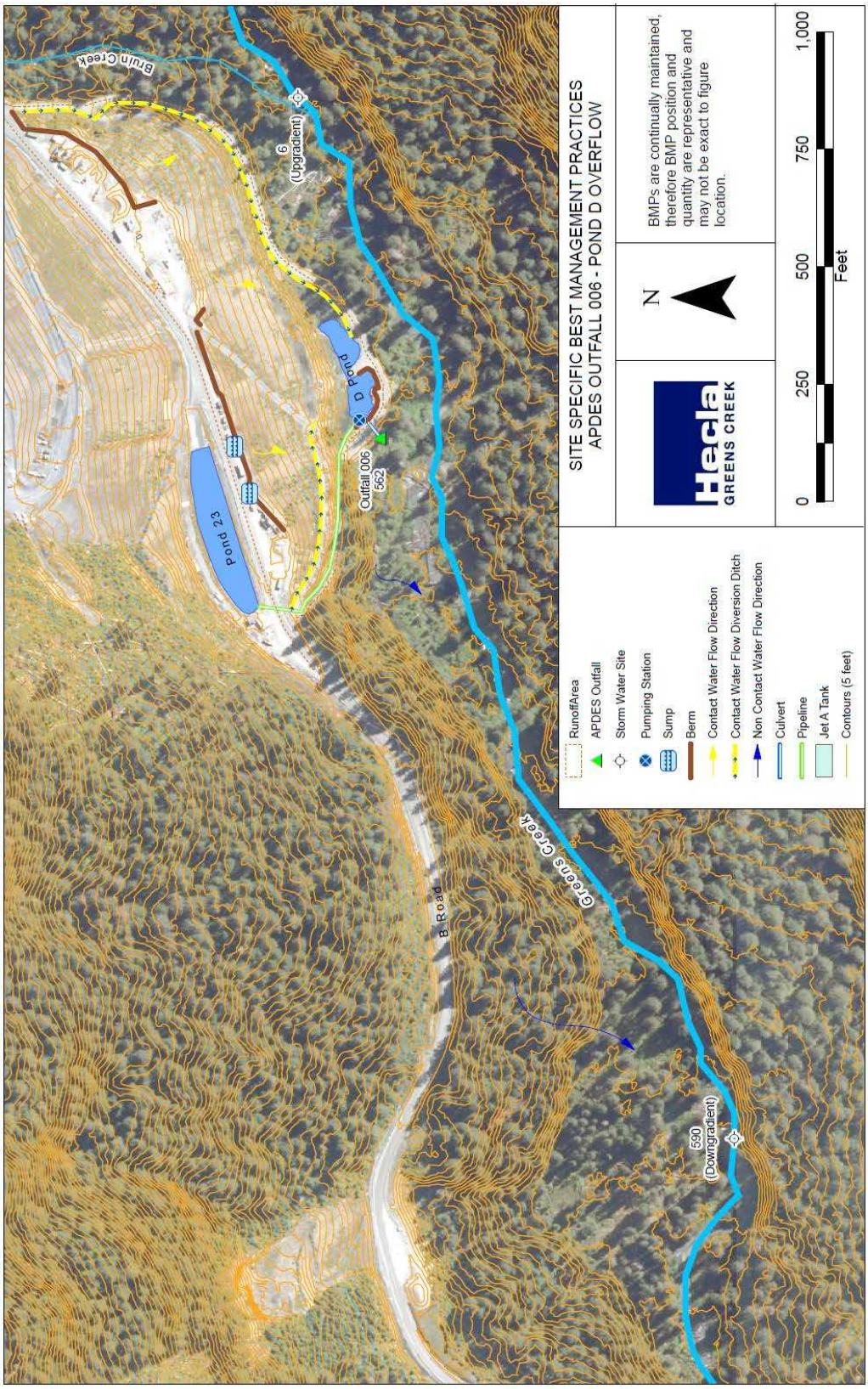


Figure 12. APDES Outfall 007

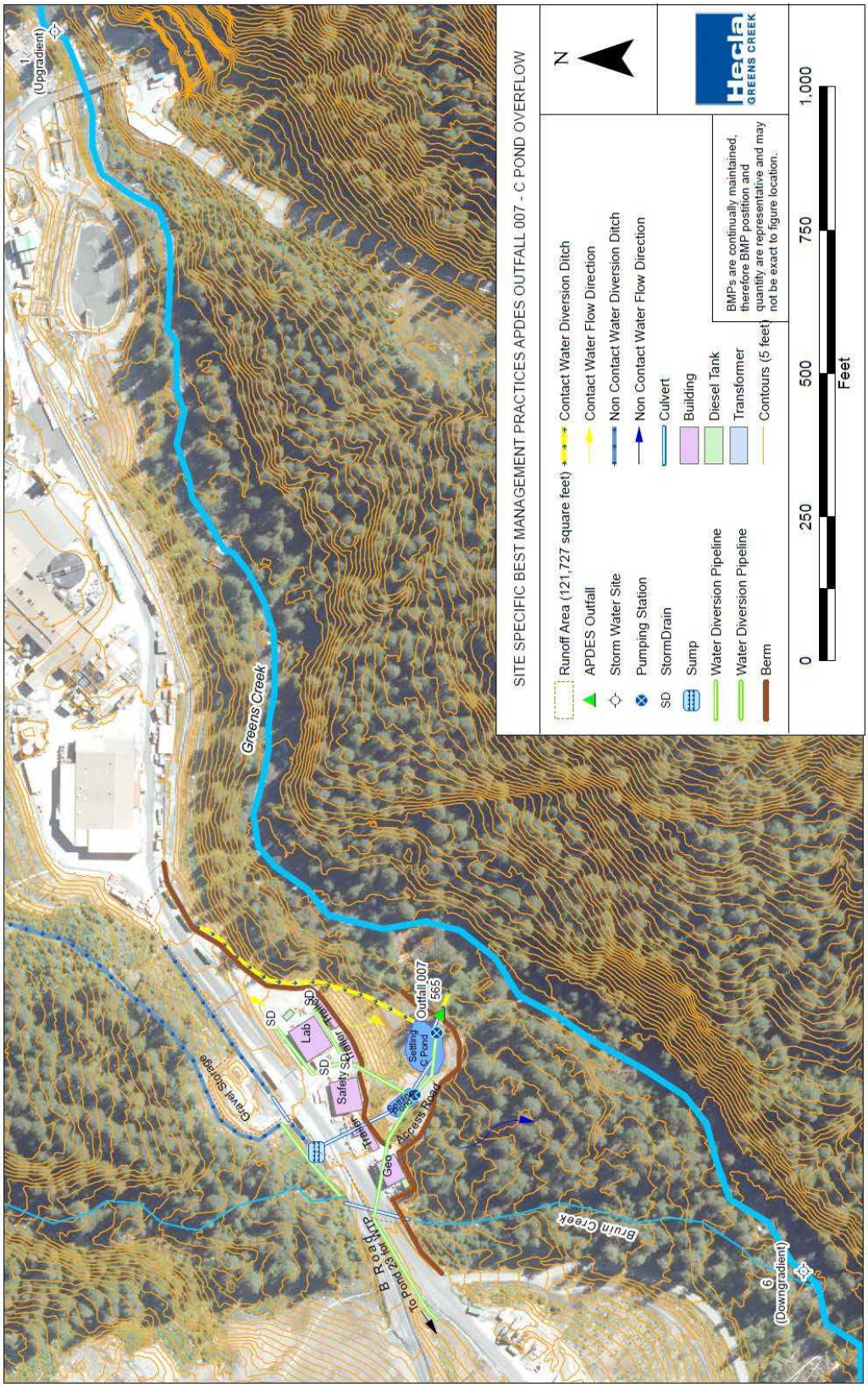


Figure 13. APDES Outfall 008

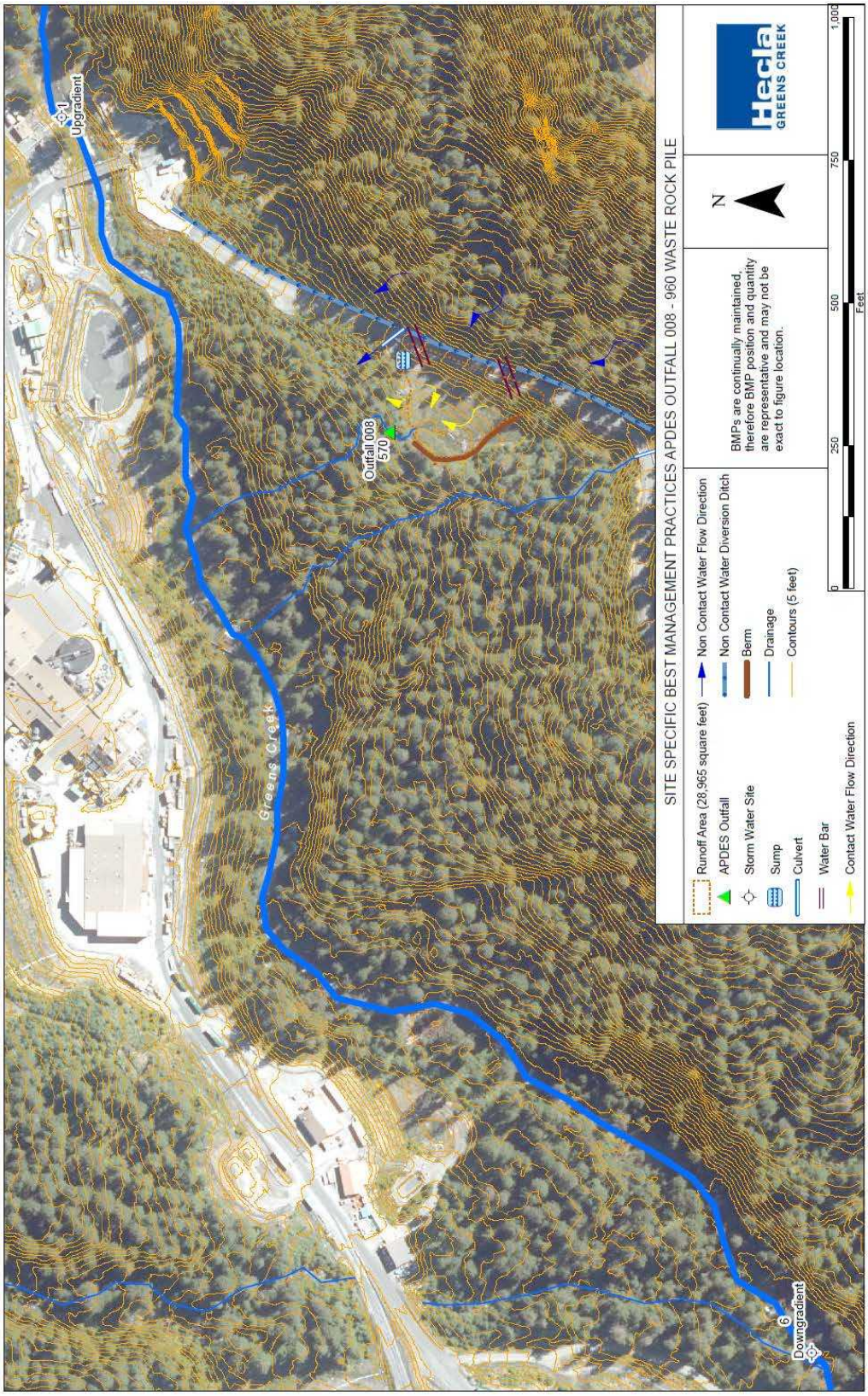


Figure 14. APDES Outfall 009

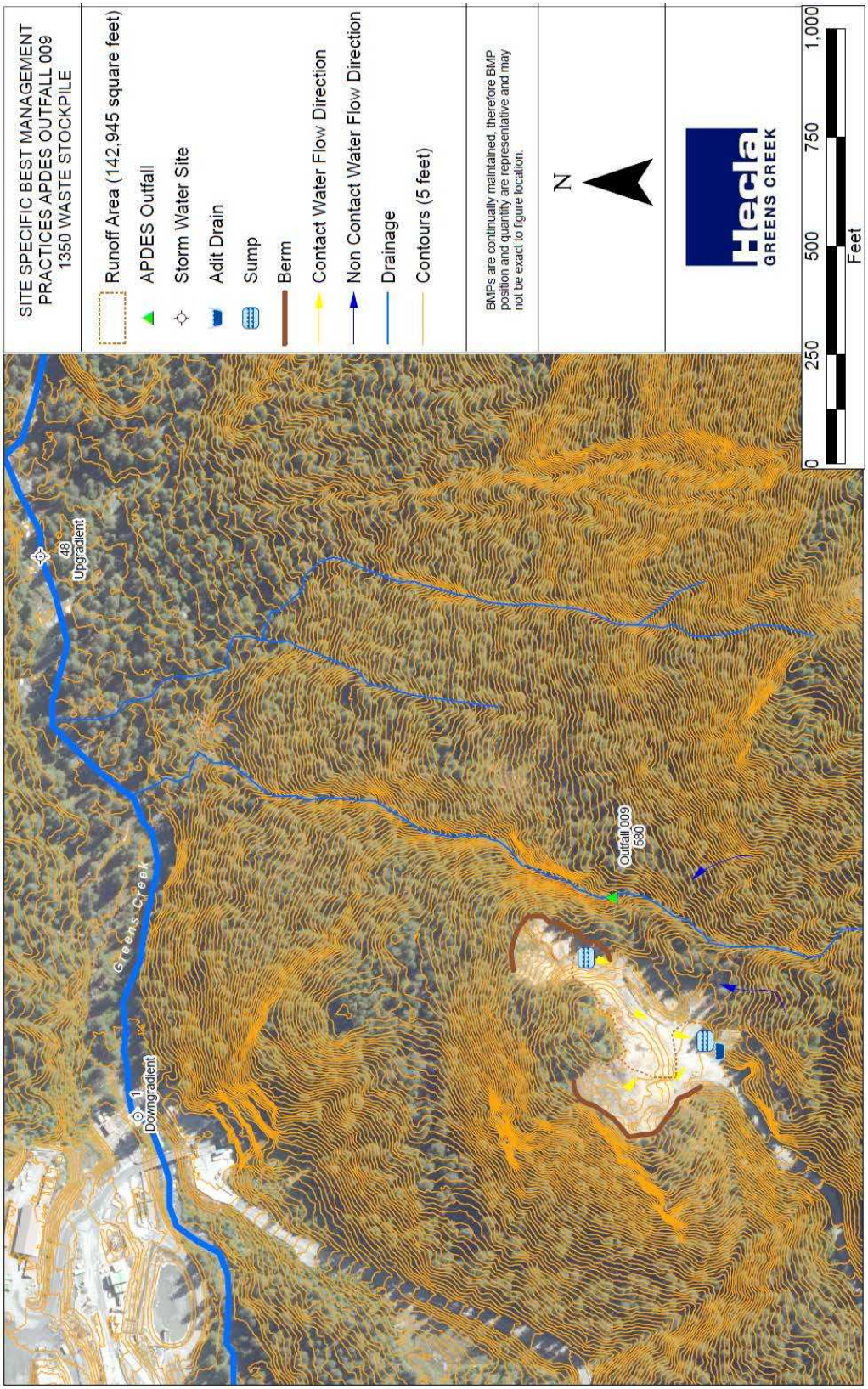


Figure 15. Sand Pit Area

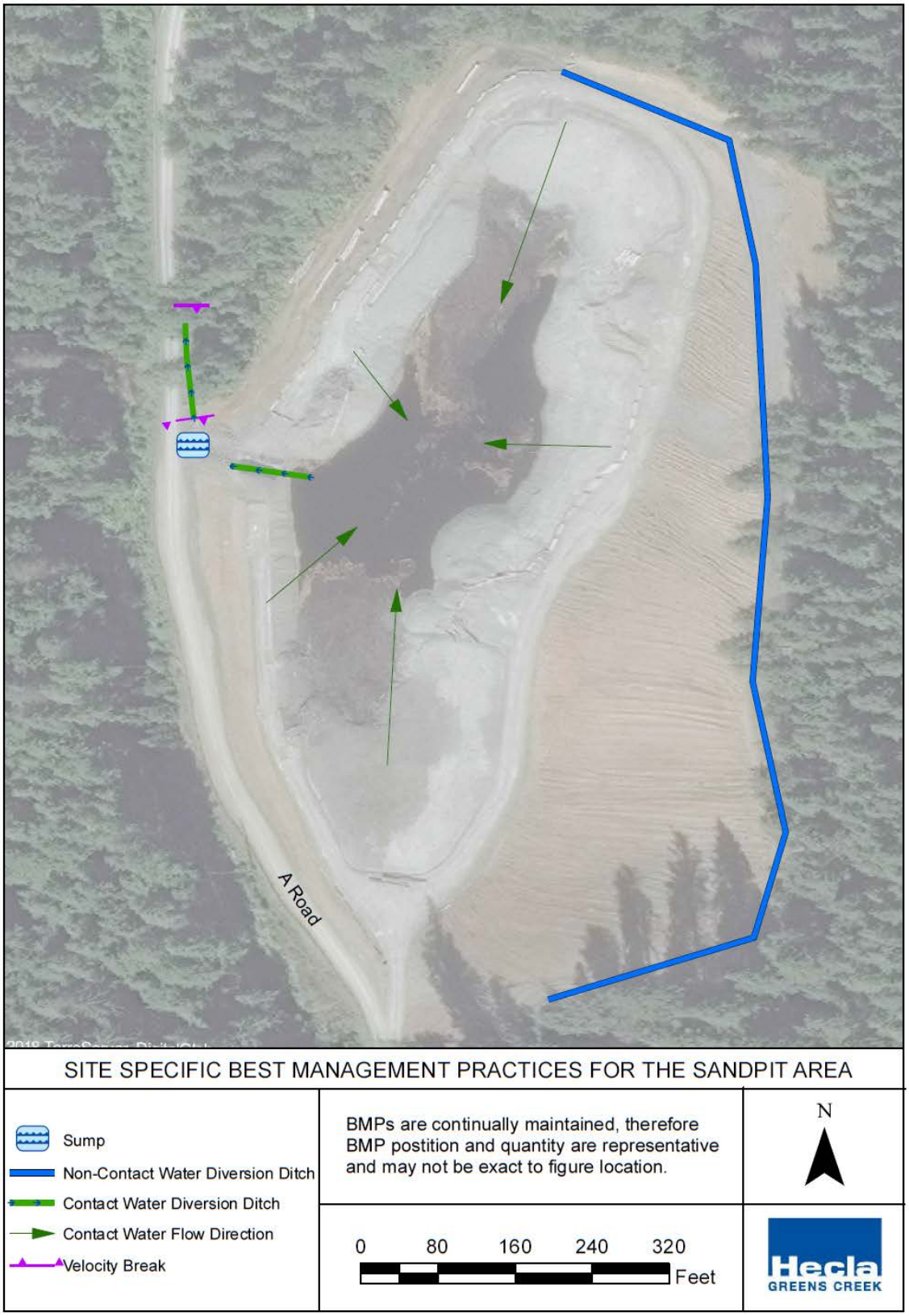


Figure 16. Waste Rock Site 23

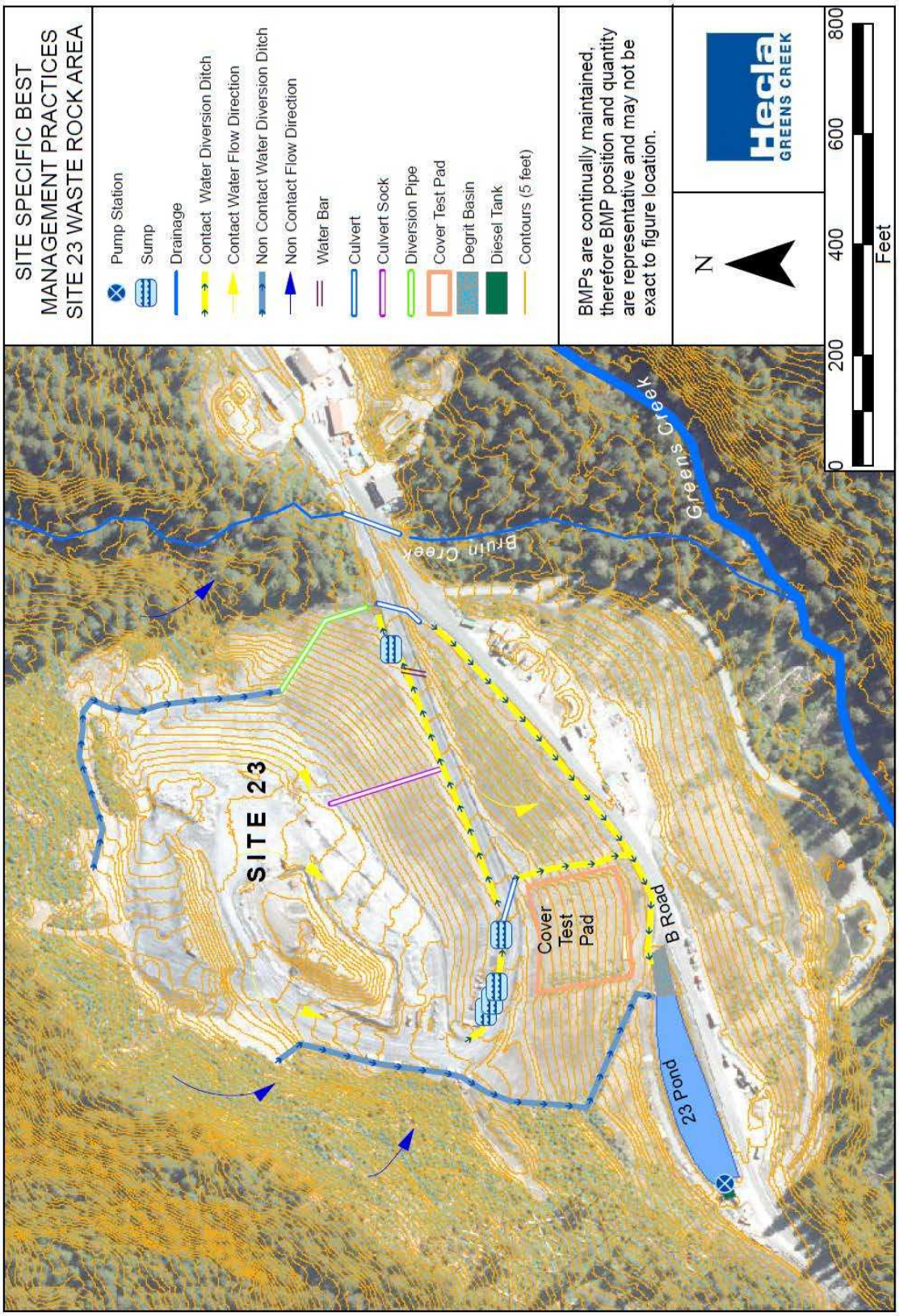


Figure 17. Tailings Area Water Treatment Process Flowsheet

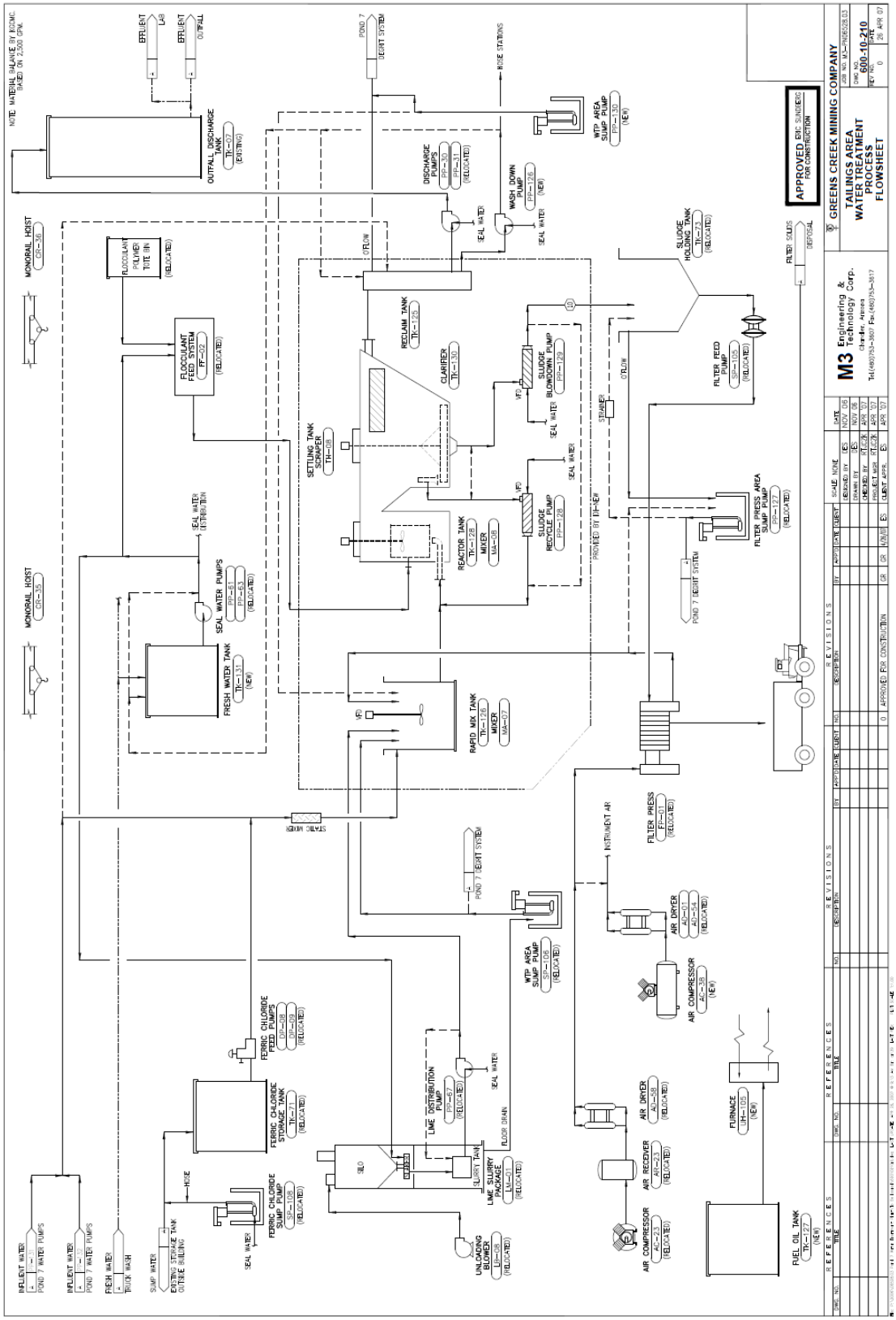


Figure 18. Road Culverts 1 of 14

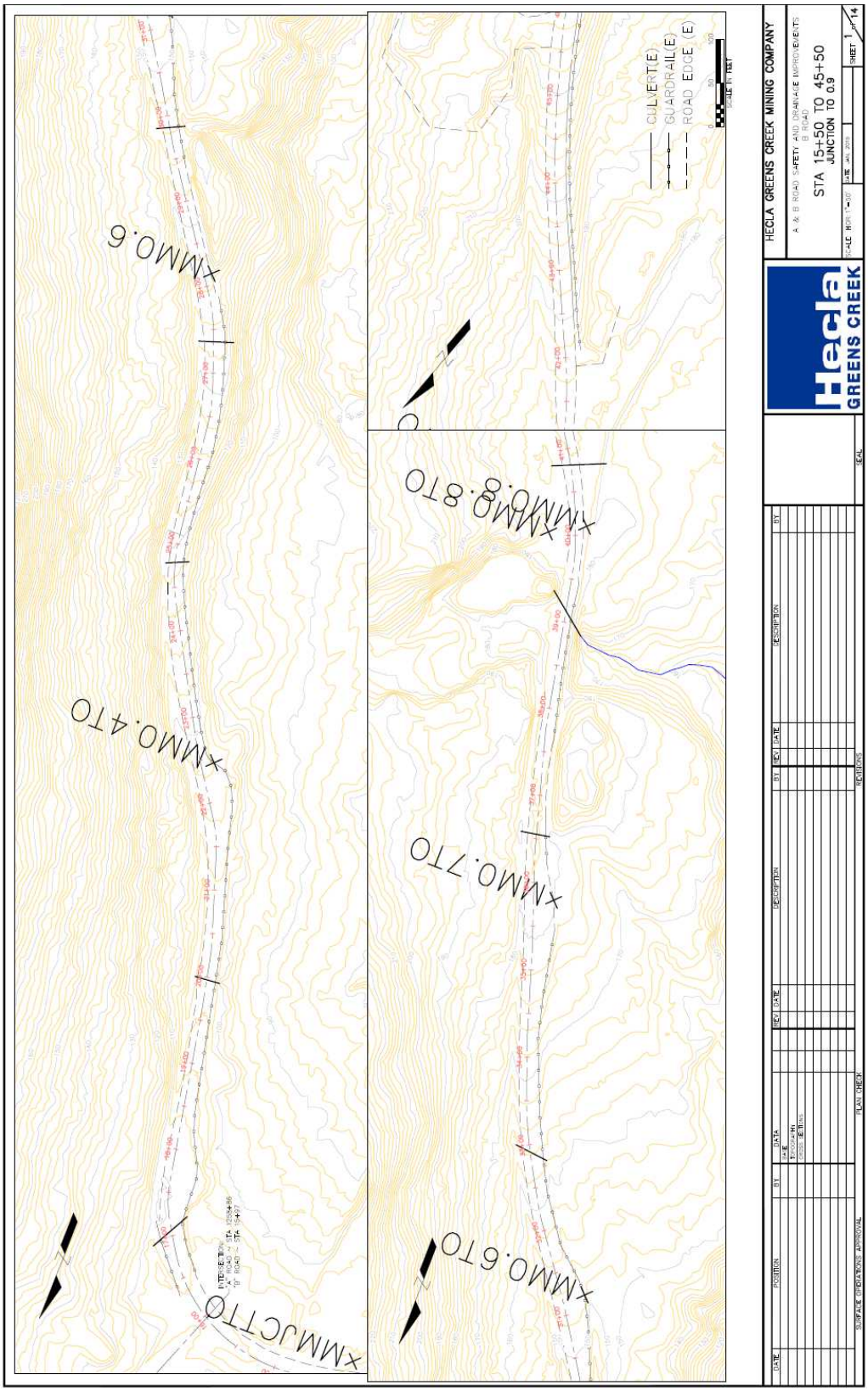


Figure 19. Road Culverts 2 of 14

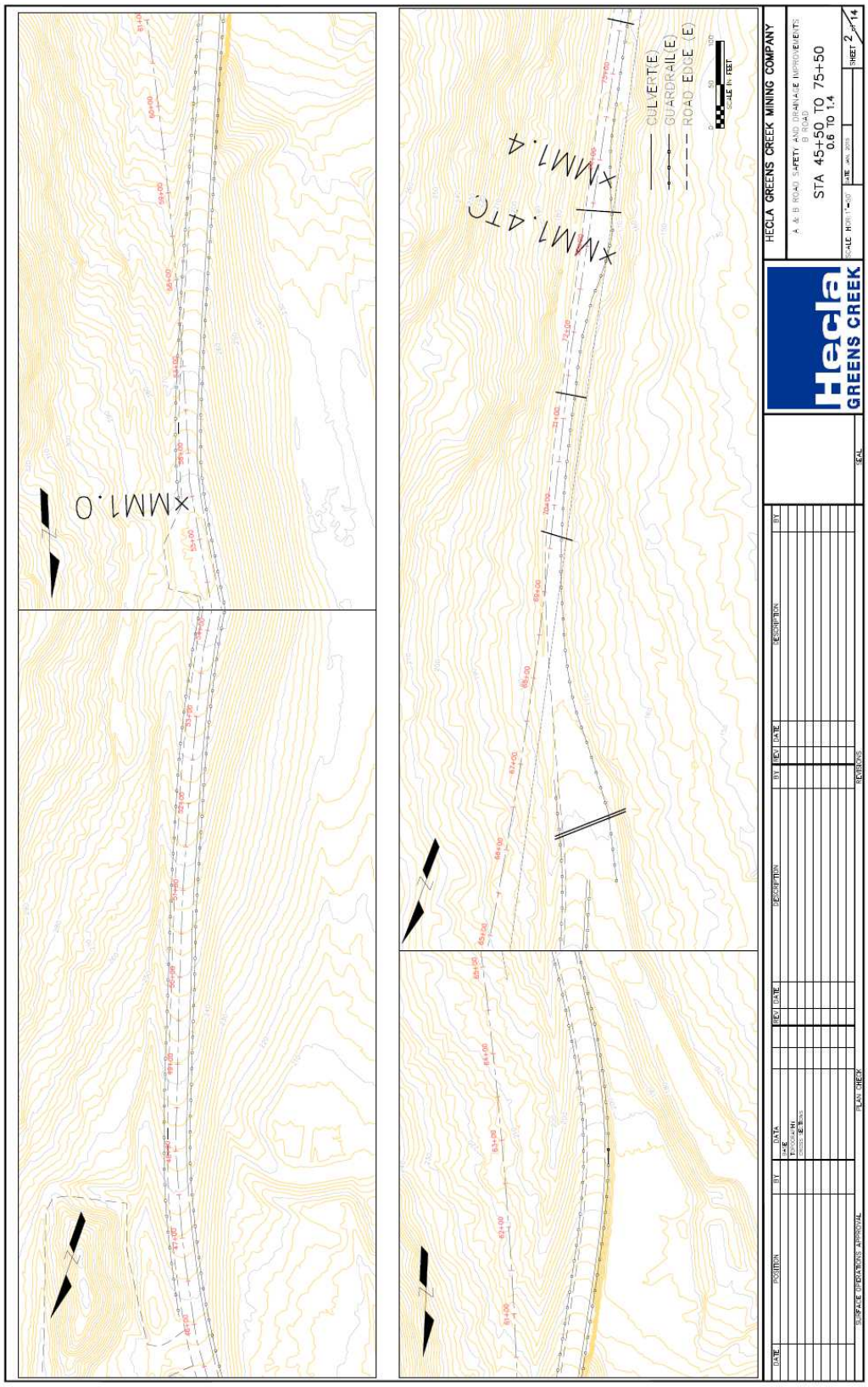


Figure 20. Road Culverts 3 of 14

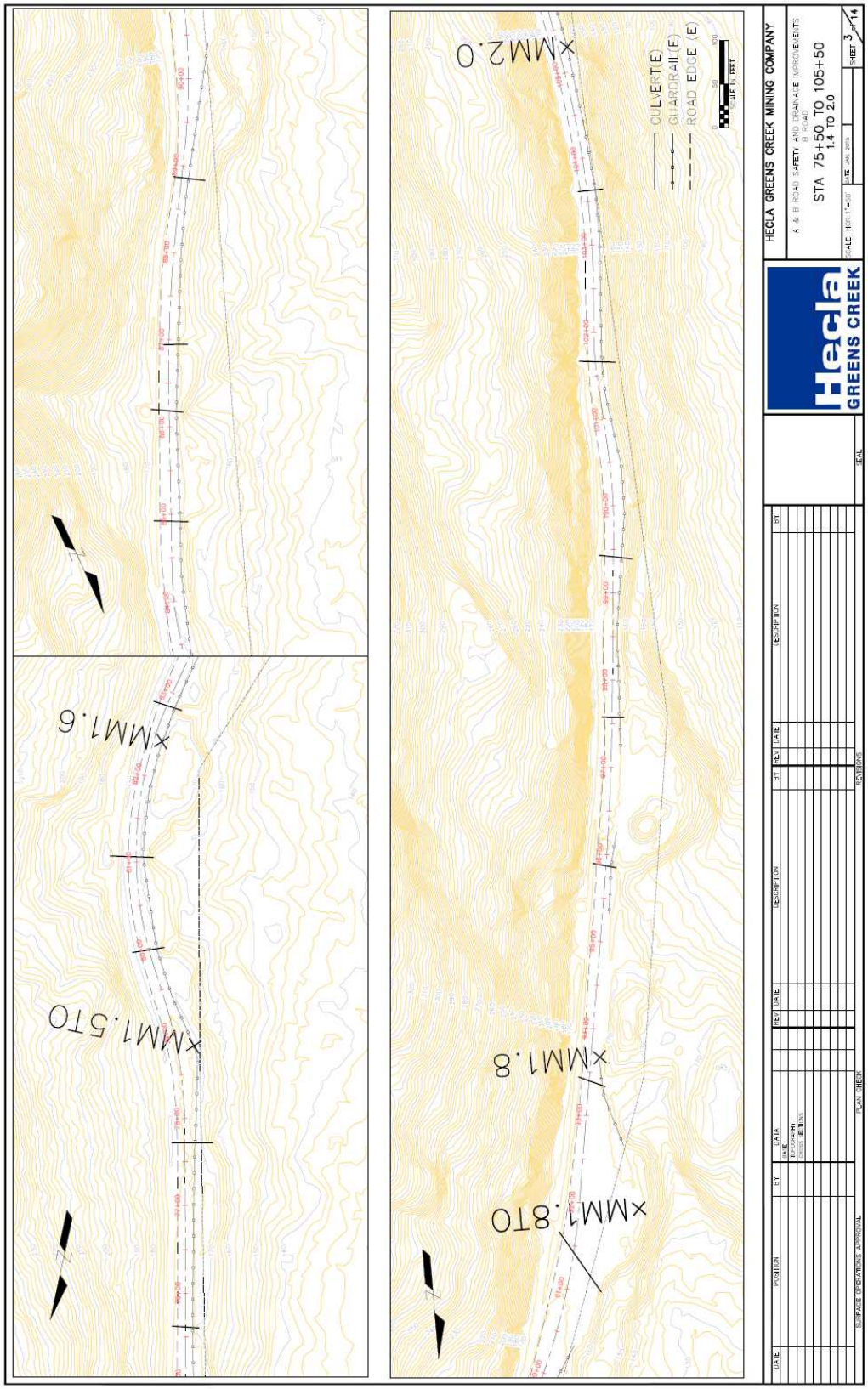


Figure 21. Road Culverts 4 of 14

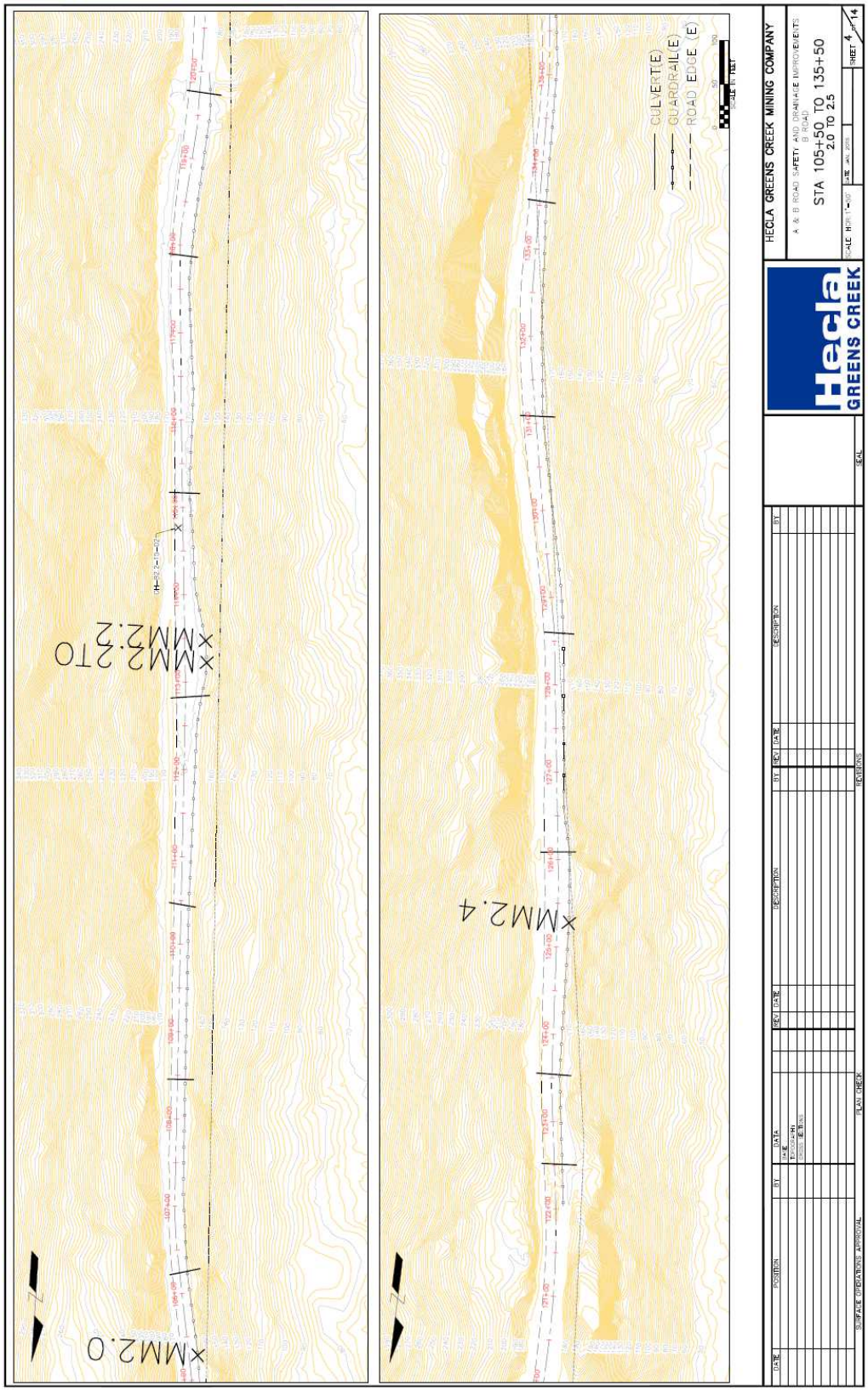


Figure 22. Road Culverts 5 of 14

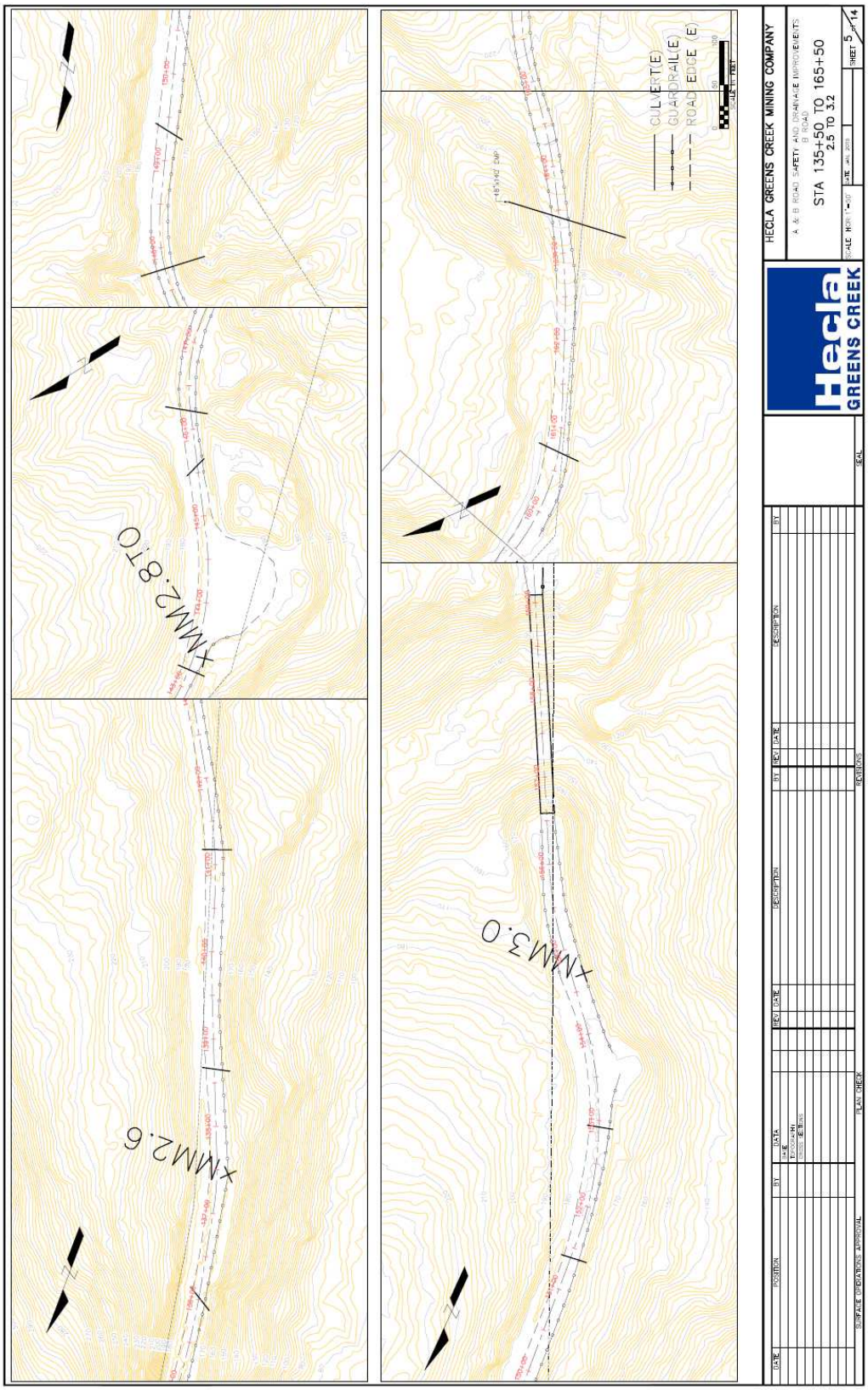


Figure 23. Road Culverts 6 of 14

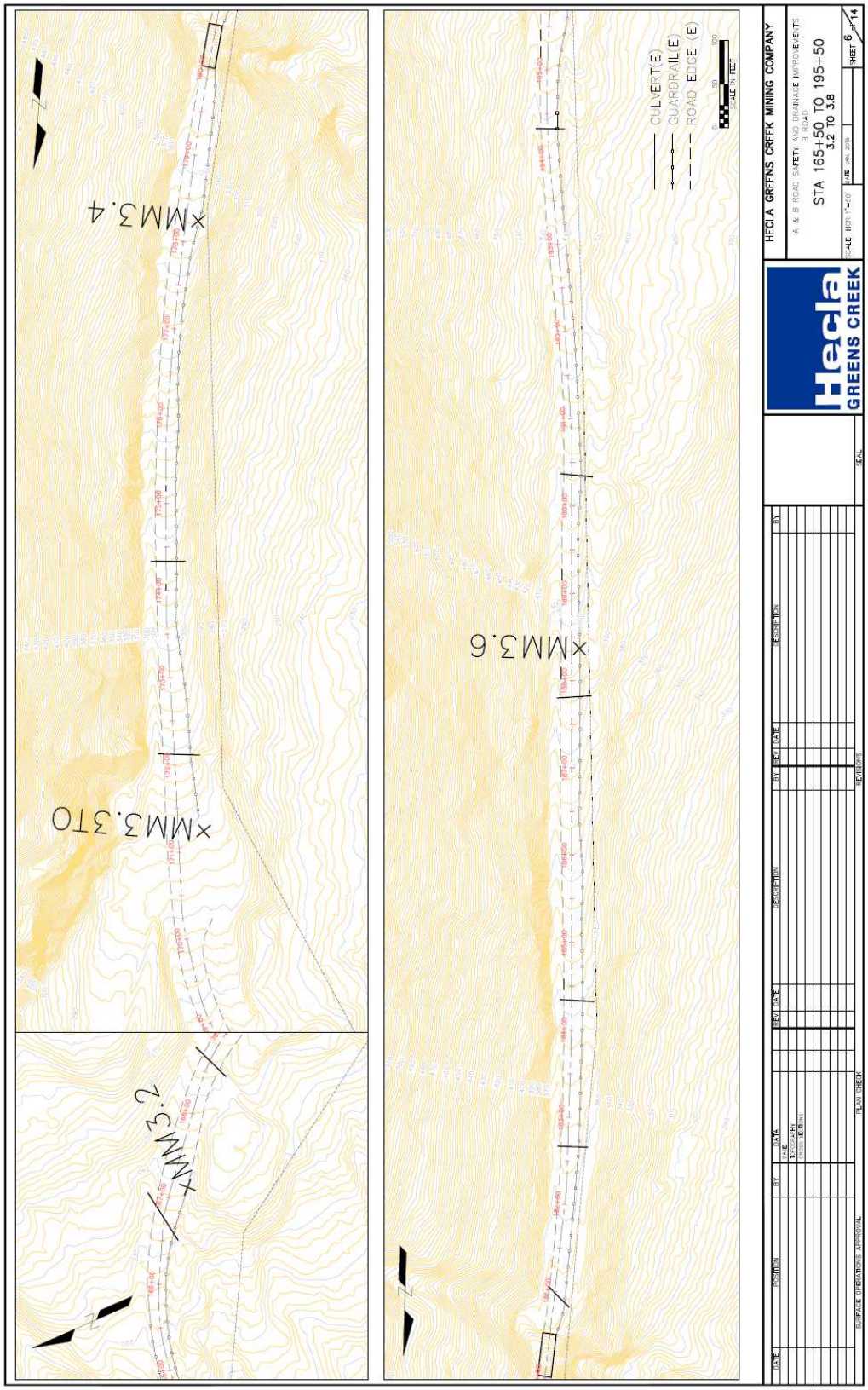


Figure 24. Road Culverts 7 of 14

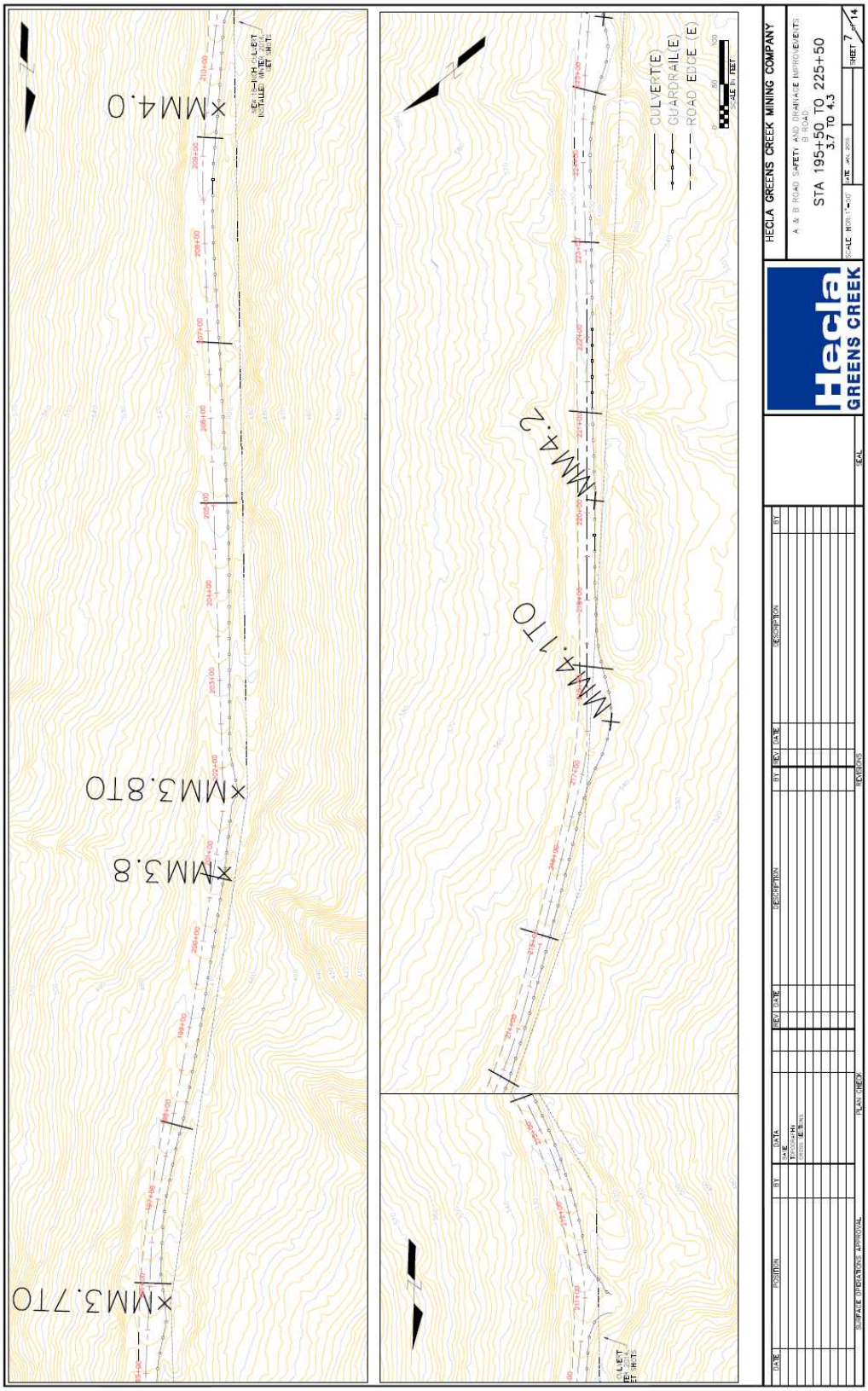


Figure 25. Road Culverts 8 of 14

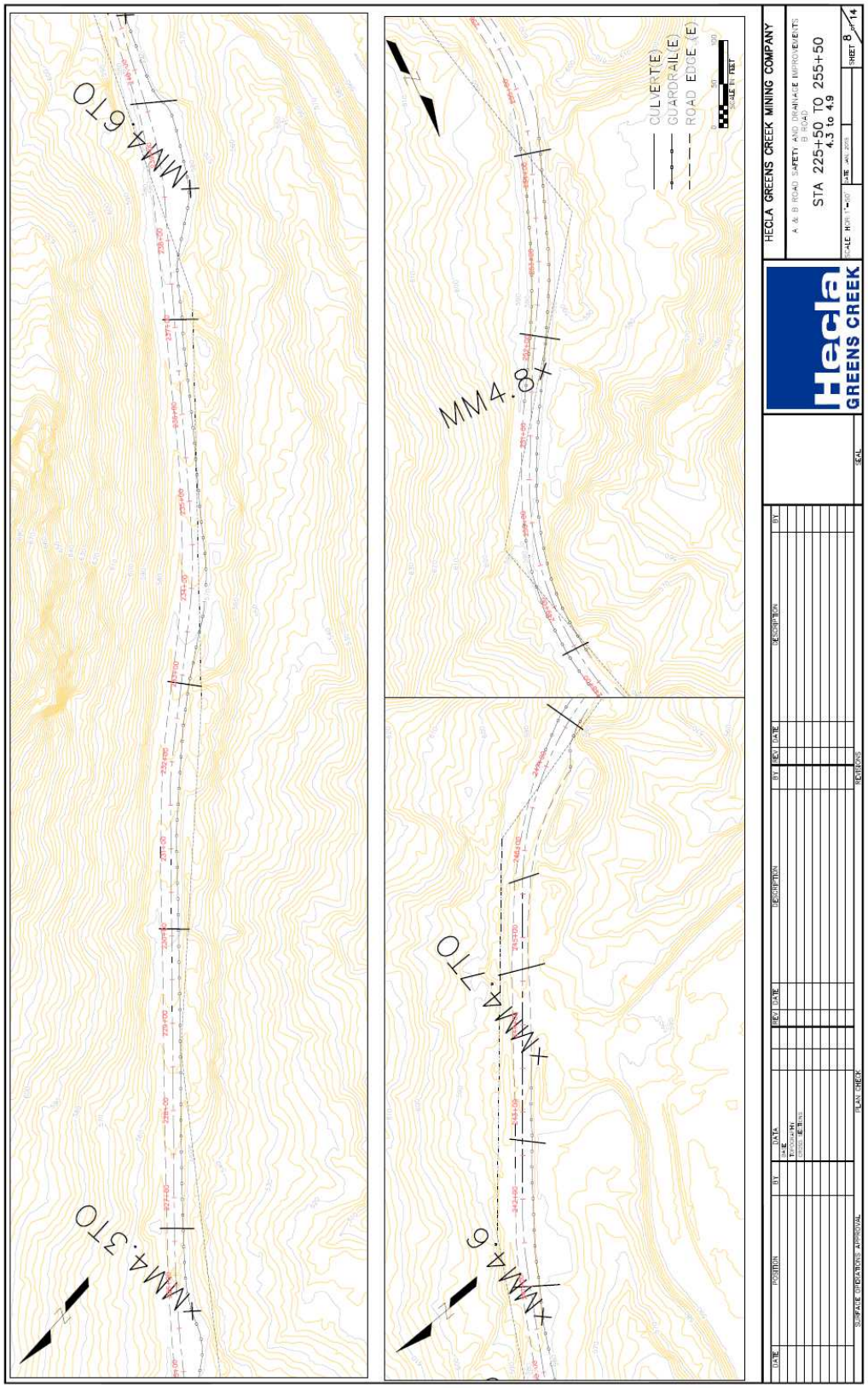


Figure 26. Road Culverts 9 of 14

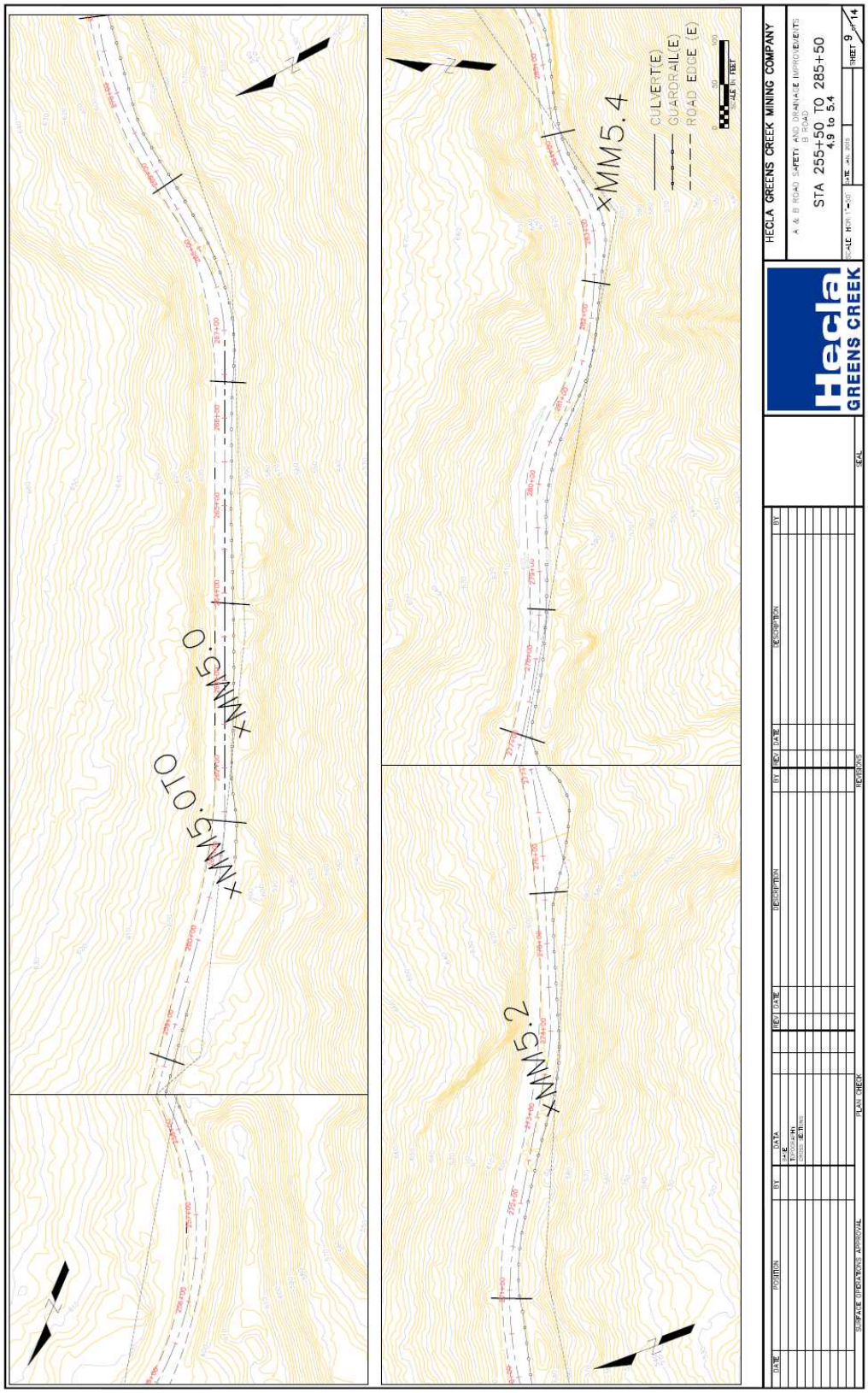


Figure 27. Road Culverts 10 of 14

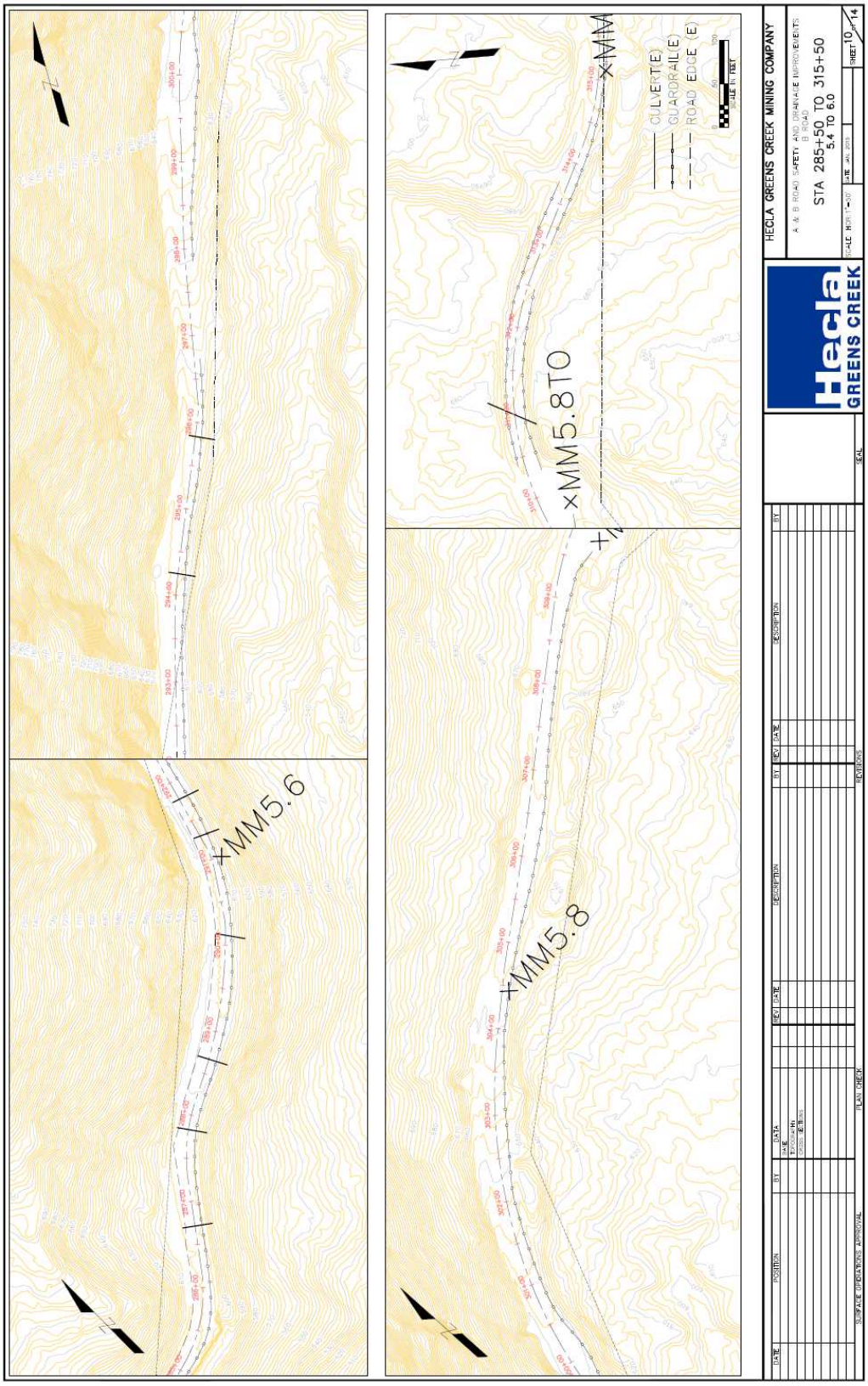


Figure 28. Road Culverts 11 of 14

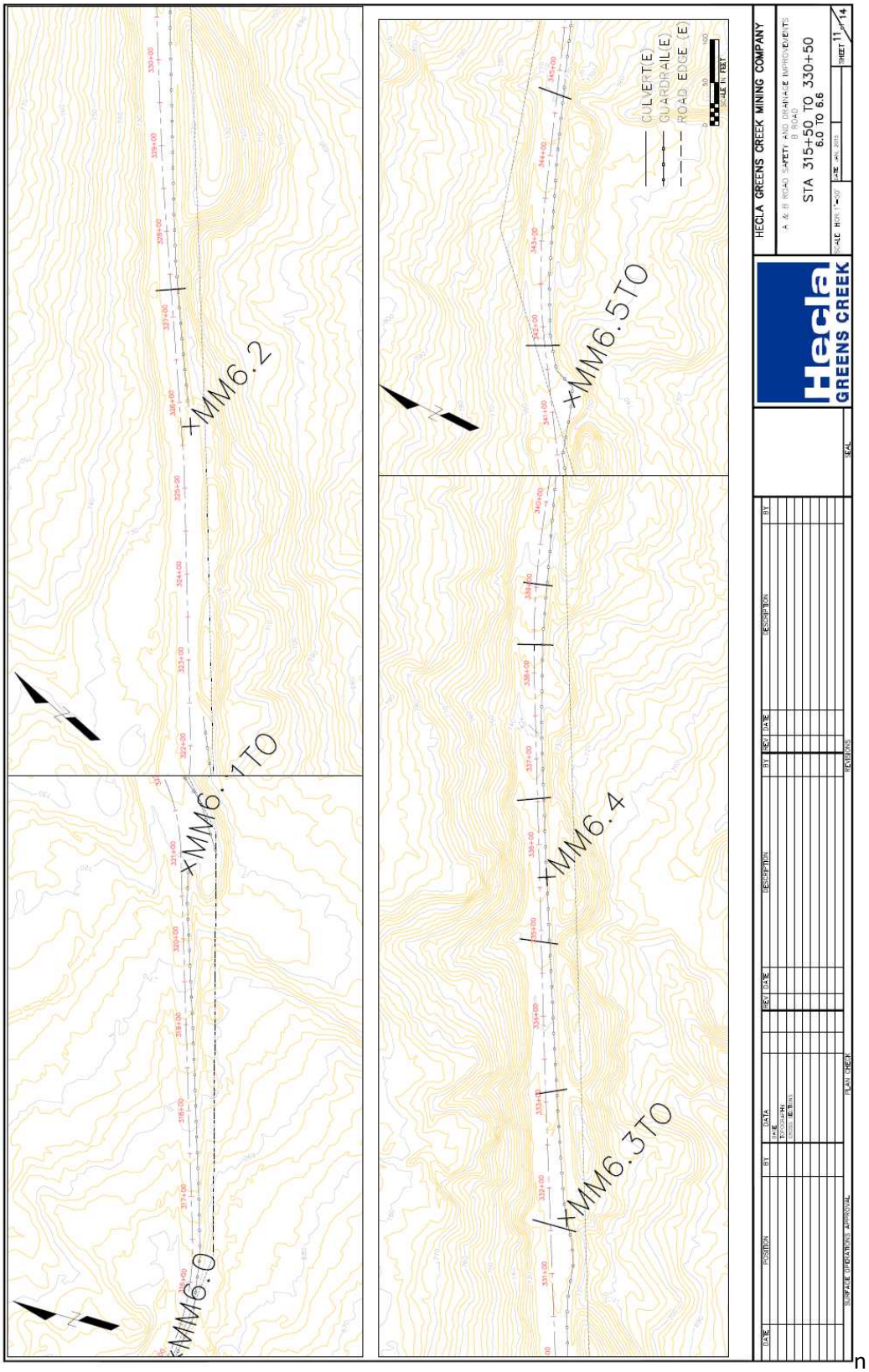
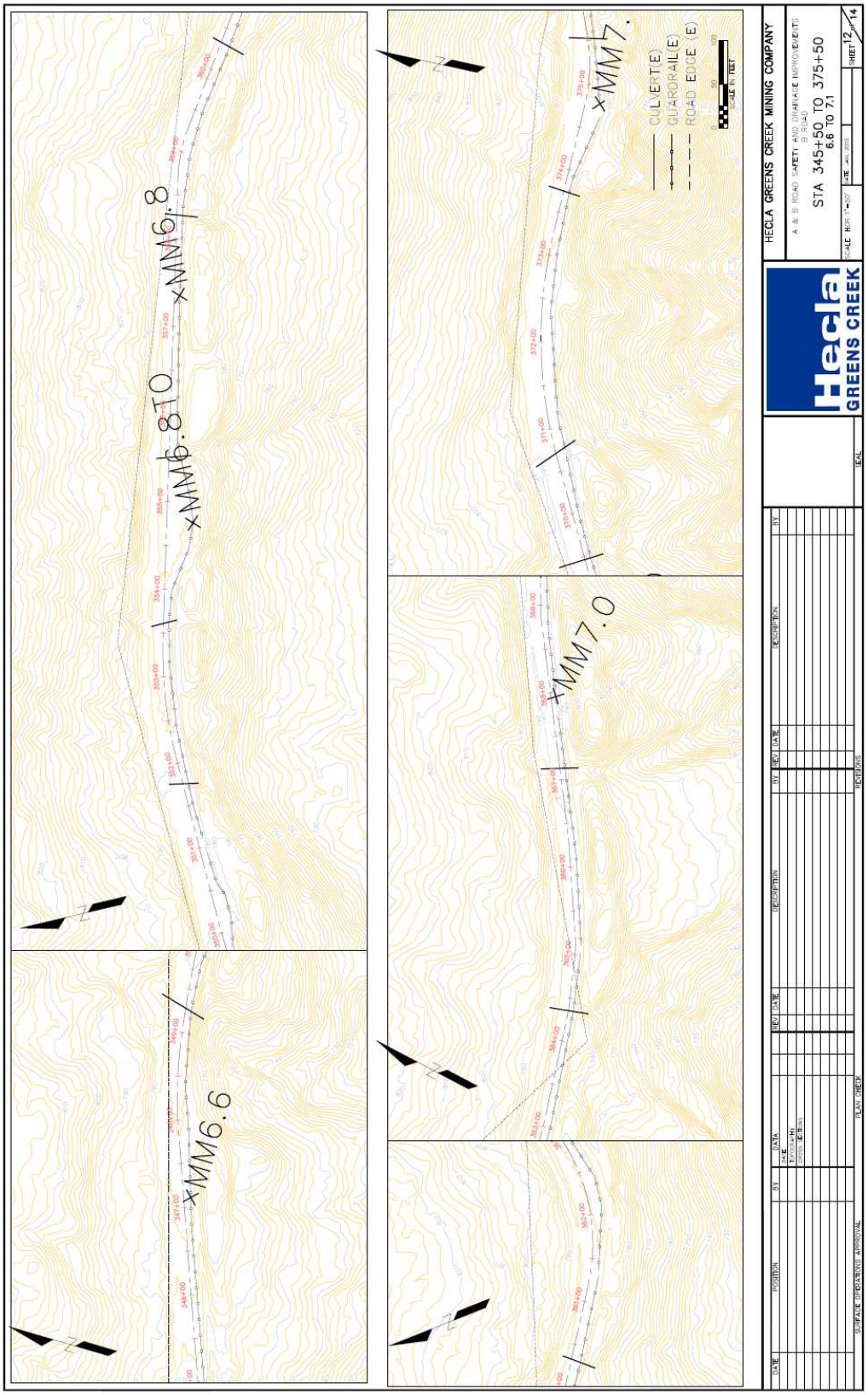


Figure 29. Road Culverts 12 of 14



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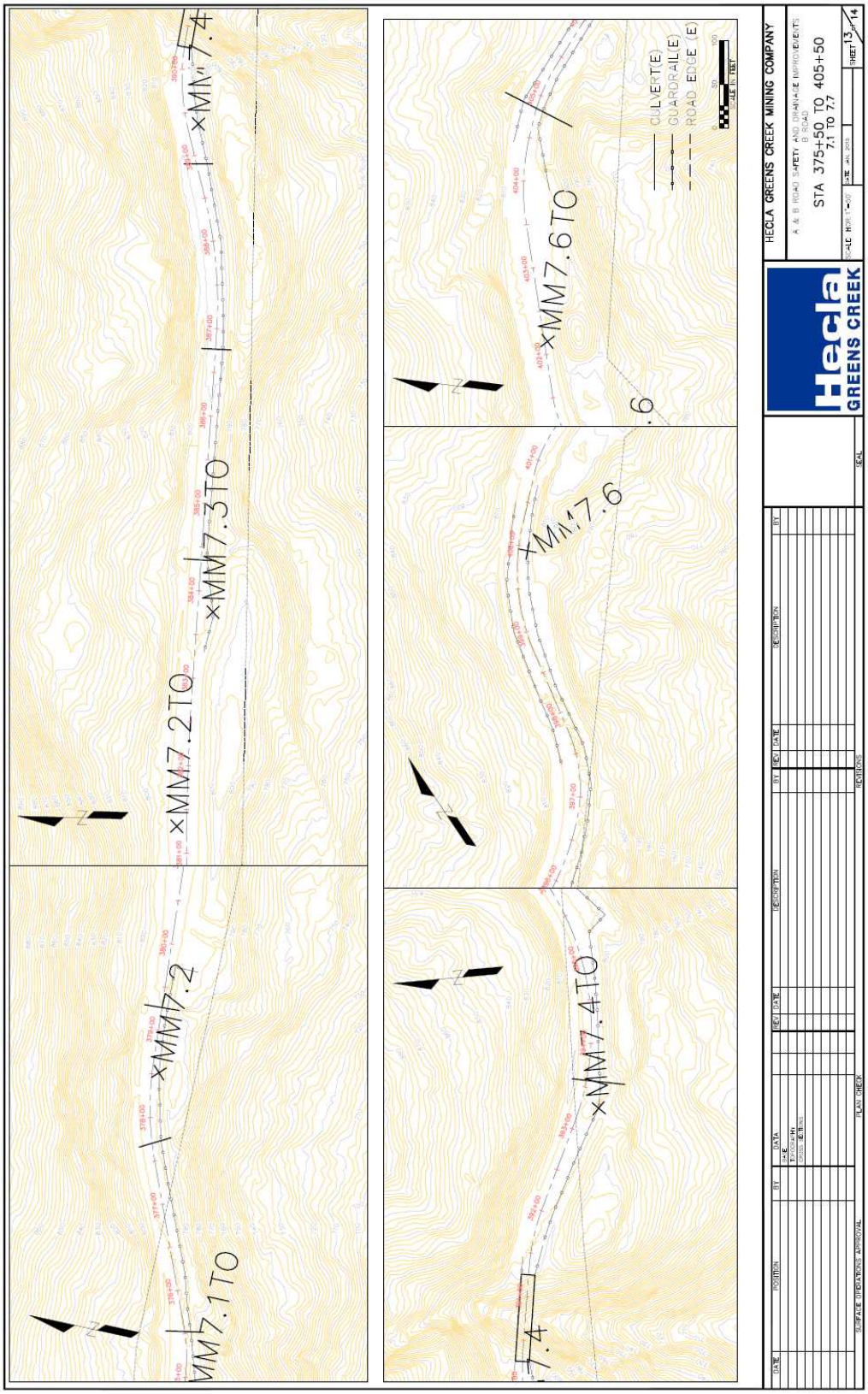
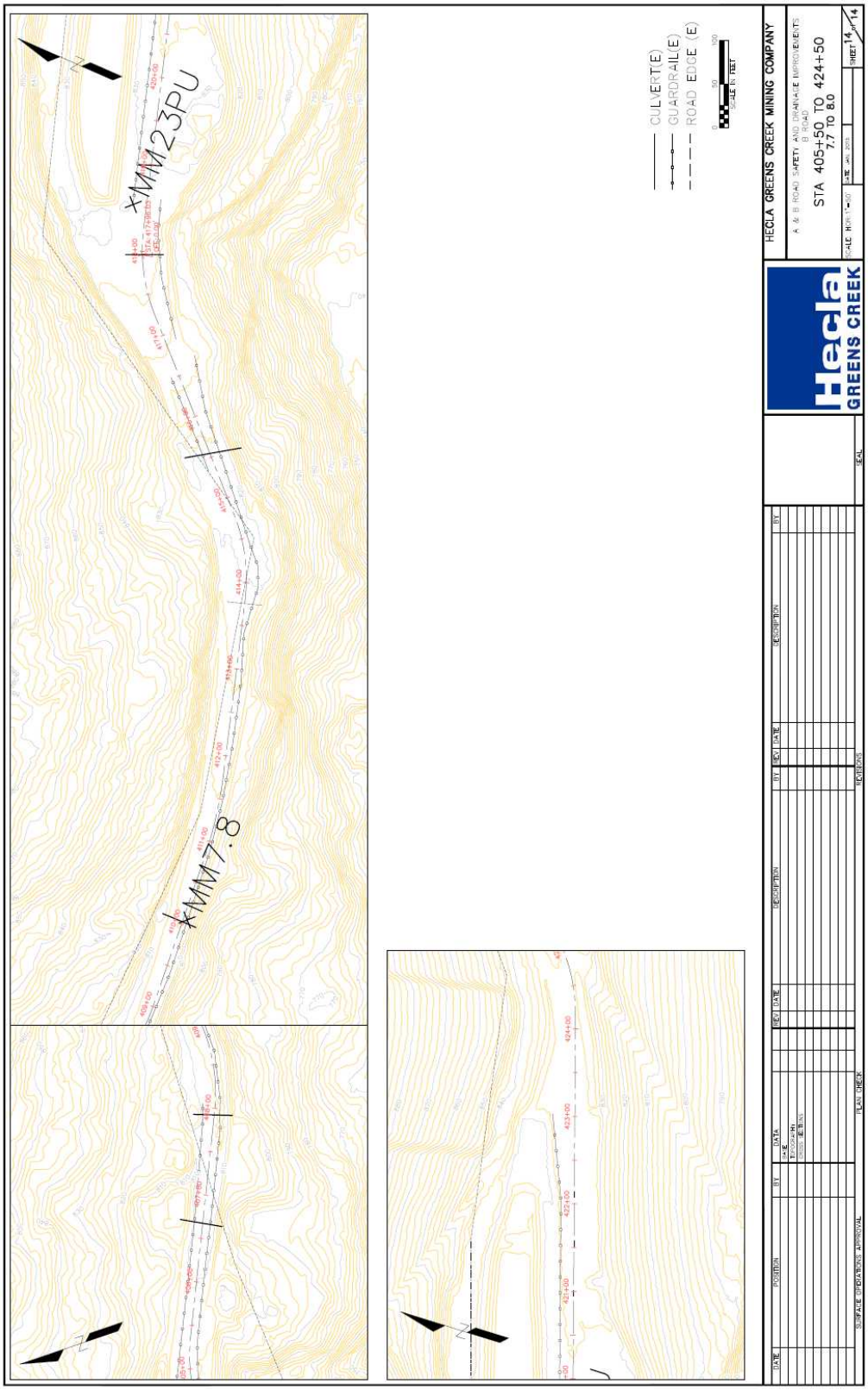


Figure 31. Road Culverts 14 of 14



GPO Appendix 05
Attachment A
Record of Changes

Whenever a change in facility design, construction, operation, or maintenance occurs which materially affects the facility's potential for discharge of significant amounts of hazardous or toxic pollutants into the waters of the United States, 40 Code of Federal Regulations (CFR) Part 125.104(e) requires the facility owners or operators to amend the Best Management Practices (BMP) plan. In addition, 40 CFR Part 125.104(f) requires that, if the BMP plan proves to be ineffective in achieving the general objective of preventing the release of significant amounts of toxic or hazardous pollutants, the BMP plan shall be subject to modification.

Changes in the BMP plan shall be duly reported and recorded below:

January 2008
Jennifer Saran
Minor changes per EPA/Eva Chun comments

April 2009
Jennifer Saran
Removed Kennecott, updated contacts: no content changes

August 2009
Jennifer Saran
Site E changes (figure and text)

December 2009
Jennifer Saran
Personnel changes

May 2010
Jennifer Saran
Updated figures

February 2012
Jennifer Saran
Updated figures

December 2013
Christopher Wallace
Personnel changes, updated storage containment needs

December 2015
Christopher Wallace
The BMP was updated in accordance with the Alaska Pollutant Discharge Elimination System Permit Number AK0043206. Changes to the document were made based on input from the BMP Committee.

December 2018
David Landes

Personnel changes, updated mill reagents, added Pond 10 to tailings area, added figures for B-Road, updated Attachment E – BMP maintenance log.

GPO Appendix 05
Attachment B
History of Spills and Leaks

Date	Location	Spilled material	Quantity spilled	Units	Equipment	Description of Incident	Description of cleanup	Corrective Actions
17-Feb-13	920 Fuel Farm	Diesel	60	gallon	Fuel transfer nozzle	The transfer nozzle was left partially open		
7-Apr-13	Port Facility	Diesel	250	gallon	Lube Truck	The transfer line rupture, while the truck was idling		
28-May-13	Underground	Hydraulic Oil	55	gallon	Underground haul truck	Failure of a hydraulic line		
2-Jun-13	920 Mill Complex	Process Water	100	gallon	Tails filter press	The launder drain was plugged on the press causing process water to run out of the mill		
24-Jun-13	Hawk Inlet	Treated Process Water	2,000,000 - 9,000,000	gallon	AVR	A broken AVR valve		
23-Oct-13	Underground	Hydraulic Oil	60	gallon	LR49	Failure of a hydraulic line		
20-Dec-13	920 Mill Complex	Zinc Sulfate	1,200	pound	Super sack	Super sack tore when it was being removed from the shipping container		
3-Mar-14	Tailings	Hydraulic Fluid	30	gallon	BH29	BH29 blew a hydraulic line.	Absorbents	Use the appropriately rated hydraulic line.
9-Mar-14	0.8 B-Road	Diesel Fuel	1	gallon	Portable Air Compressor	A loose fuel filter on an air compressor resulted in fuel being sprayed on the ground. The operator immediately shut the system off, stopping the spray.	Absorbents were used to clean up the majority of the fuel. An excavator was then used to scoop up the snow, which was taken to a contained area where the residual product will be collected as the snow melts.	The air compressor is to be in a containment when it is in use at Cannery Creek.
16-Apr-14	DB02	Process Water	50-100	gallon	HDPE pipe	A pipe nipple connecting a sprayer to a HDPE pipeline located at DB02 failed. This sprayer is used in the winter months for melting snow, that is plowed into the degrit basin. Without the sprayer the stream could shoot across the basin. A portion of the stream went over the outer wall of the basin on to the ground where it soaked in. The water used in this system is from the 800 gallon water treatment plant at the 920.	There was no cleanup.	When the system was repaired the correct saddle clamps were used instead of side tapping the pipe.
31-May-14	920	Process Water	50	gallon	HDPE pipe	A discharge line from the mill complex had been plugged while repairing the 920 ditch. The end of the pipe came free releasing the water stored in the pipe.	There was no cleanup.	
19-Jun-14	WTP Pond 7	Process Water		gallon	10" Pipeline	An unanticipated bypass of the WTP. The valve connecting 10" pipeline to the Tank 7 partially opened, allowing water to be discharged without passing through the WTP.	There was no cleanup.	The power was disconnected from the valve and it was chained closed.
24-Jun-14	Underground	Diesel Fuel and 50 Weight Oil	300	gallon	LT15	The drive line failed on the LT15 Getman A64 lube truck, the drive line failure resulted in the breaking of the 2" supply elbow on the fuel tank and 1" elbow on the 50wt tank.	Initially, oil absorbent pads were put down to absorb and clean up the fuel/oil that was on the surface of the 48 decline. The pads were placed into a 48"x48"x48" tall plastic tote. After the raw fluid was cleaned up, the contaminated dirt was taken from the road bed down to clean dirt and then taken to a plastic lined containers to be shipped off.	A protective plate was added to the truck to prevent the elbows from being struck if the driveline was to fail again.

Date	Location	Spilled material	Quantity spilled	Units	Equipment	Description of Incident	Description of cleanup	Corrective Actions
28-Jun-14	Surface shop	Hydraulic Oil	250	gallon	TK14	The suction line from the tank is both hard pipe and hose. One of the connections between the hose and pipe failed.	Clean up will occur over several days. Free product is being pumped into barrels and a waste oil tank, the two bulk tanks will be drained and moved. Once the tanks are moved equipment will be used to excavate the contaminated material.	The area the tank was sitting was concreted. The tank was cleaned and inspected.
6-Jul-14	Potable water building Hawk Inlet	Diesel Fuel	50	gallon	TK92	A pickup truck backed into the fuel tank causing the tank to slide about 3 inches. The fuel supply line coming off of the tank cracked resulting in fuel being spilled.	Absorbents were used to recover free product and the contaminated ground was excavated and placed into super sacks for disposal at an approved facility.	The tank was bolted to the concrete slab it sits on.
8-Jul-14	Forest	Treated Water	5,400,000	gallon	AVR	Broken air release valve on the outfall discharge pipeline from the water treatment plant	None	Installing a remote monitoring station to automatically shut a valve if this AVR fails.
10-Aug-14	DB02	Storm water	100	gallon	920 Ditch	While working on relining A Pond water is being pumped directly from DB02 to 23 Pond. During a rain event on Sunday morning DB02 overflowed into the ditch that normally flows into A Pond. This was recognized by an operator in the area and actions were taken to stop the overflow. The flow out of the ditch emptied into berm of the pond. Drainage from this section of the A Pond berm would report to the lower B Pond area which being collected.	None	None
13-Dec-14	Underground	Hydraulic Oil	80	gallon	HT47	A leaking face seal on the drive system of the haul truck.	Haul truck HT47 was being moved to allow access to haul truck HT38 for maintenance. After moving HT47 the mechanic notice the leak and began to place absorbents under the truck. The mechanic disassembled and capped the brake cooling circuit to slow and limit the volume of hydraulic oil that could spill. As the remaining fluid leaked out the mechanic continued to use absorbents to capture the fluid, spent absorbents were place in a barrel for disposal.	
1-Jan-15	Underground	Hydraulic Fluid	50	gallon	LR46	The grease pump failed on the loader, resulting in hydraulic oil being sprayed on the ground.	About 15 gallons of the spilled product was recovered using absorbents.	
17-Jul-15	Bulk Oil Storage	Hydraulic Fluid	200	gallon	TK14	Human error resulted in TK-14 being overfilled during routine transfer of hydraulic oil from ISO-container into bulk tank	All product was recovered with no release to environment. Recovered product pumped into waste oil tank. Residual oil cleaned up using absorbents.	Changes were made to the alarm and transfer system.
24-Aug-15	WTP Pond 7	Treated Water	17,500	gallon		Unmonitored discharge from the WTP during a planned power outage. Water was being supplied to the plant by diesel pumps. Because the pumps were not shut off during the outage, the PLC still showed flow through the plant and did not open the direction valve on Tank 7.		Changes were made to the program that controls the directional valve.
23-Sep-15	860 Batch Plant	Hydraulic Oil	25	gallon	UT23	Blown hydraulic line on UT-23	Absorbents were used to clean up the hydraulic oil, a minimal amount (~2 cu. ft.) of sand was excavated and place in buckets for disposal.	

Date	Location	Spilled material	Quantity spilled	Units	Equipment	Description of Incident	Description of cleanup	Corrective Actions
28-Sep-15	1350 Adit	Mine drainage	Unknown	gallon	N/A	It is thought that intercepted ground and surface drainage at the 1350 adit overflowed and ran down an adjacent ditch. The reason that this was thought to have occurred is that the sump drain valve had been closed inside the mine. A miner recognized that this valve should not be closed, opened it, and drove to the 1350 adit to investigate. He reported that water was not flowing from the sump, however that there was gray sediment in the ditch. The following day when it was light, other miners began to investigate the incident, but found no signs of sediment in the ditch. Though there was conflicting observations and no water seen flowing from the sump, Hecla Greens Creek Mining Company decided to take the conservative approach and reported the incident.	NA	
25-Dec-15	M135	Diesel	400	gallon	Fuel tank	The compressed air was left on to the fuel pump. After awhile the delivery line failed and the fuel in the tank was pumped on to the ground.	Excavated to the hard pan. Material was brought to the surface (3 half highs) for disposal.	
3-Jan-16	Tailings	Hydraulic Fluid	32	gallon	BH32	Failed hydraulic line.	About 30 gallons of free product was recovered the remaining residual was picked up with absorbents.	
14-Jan-16	Port Facility	Hydraulic Fluid	2.5	gallon	loading bridge	A hydraulic fitting was pulled out of the hydraulic piston by a nylon strap that was caught around the fitting, while the bridge was being extended.	Approximately 2 gallons of product was recovered. The remaining material was washed out of the rip rap on the incoming tide.	
14-Mar-16	653 Lube Bay	Diesel	150	gallon	lube truck	Broken fitting on fuel line. Air pump left on pressurizing system and causing leak.	Absorbent pads were used to soak up the spilled material.	
6-Apr-16	860 helipad	Hydraulic Oil	20	gallon	BH29	Ruptured hydraulic hose while loading excavator onto transport trailer. Spill was on trailer, conservatively estimate 20 gallons reached ground.	Shut off excavator and used absorbent pads to soak up spilled hydraulic oil. Spill occurred on hard packed road surface, wet with rain. Wet road surface prevented oil from soaking in and was able to be effectively cleaned up with absorbents	
10-Apr-16	1.2 B-road	Water from the 8" pipeline	300	gallon	8" pipeline	While excavating near the 8" storm water pipeline a SECON operator hit the line causing a small leak of ~20 gpm. The hole was temporarily sealed within 15 minutes.	None - the water reported to the drain system in the S3P1 project.	
9-Jun-16		Hydraulic Oil	15	gallon	Haul Truck			
1-Jul-16	Tailings	Hydraulic Oil	45	gallon	MT13 KT19	A hydraulic line failed on a max haul trailer while it was being dumped, in the tailings disposal facility.	Absorbent pads were used immediately to start the cleanup. Absorbent booms were place in the ditch line to collect residual runoff from the surface. These booms were changed out as needed during the night. Used absorbents were place into plastic bags for later disposal off site.	
5-Apr-17	Surface Batch plant	Hydraulic Oil	15	gallon	Haul Truck	An underground haul truck blew a hydraulic line near the surface batch plant.	Absorbents were used to cleanup the hydraulic fluid. Used absorbents will be shipped to Waste Management for disposal.	
5-Apr-17	Tails Loadout	Hydraulic Oil	20	gallon	Haul Truck	A surface haul truck blew a hydraulic filter.	Absorbents were used to cleanup the hydraulic fluid. Used absorbents will be shipped to Waste Management for disposal.	

Date	Location	Spilled material	Quantity spilled	Units	Equipment	Description of Incident	Description of cleanup	Corrective Actions
23-Apr-17	3.4 B-road	Storm water / Process water	166	gallon	8" Pipeline	Discharge of storm water collected at Site 23, to land from the 8" pipeline. The pipeline had previously been damaged while plowing snow.		1) An approximate 42' section of the pipeline was replaced, water flow was reestablished, and the repaired pipe was inspected for leaks. 2) Looking at improving the guarding on the pipeline in this location, however the proximity to the road may preclude it.
27-Apr-17	Tailings	Hydraulic Oil	20	gallon	MT21 KT27	A hydraulic line failed on a max haul trailer while it was being dumped, in the tailings disposal facility.	Absorbents were used to cleanup the hydraulic fluid. Used absorbents will be shipped to Waste Management for disposal.	
25-Sep-17	Tailings	Hydraulic Oil	30	gallon	Haul Truck	A hydraulic line failed on a max haul trailer while it was being dumped, in the tailings disposal facility.	Absorbents were used to cleanup the hydraulic fluid. Used absorbents will be shipped to Waste Management for disposal.	
18-Oct-17	Tailings	Hydraulic Oil	20	gallon	MT11 KT28	A hydraulic line failed on a max haul trailer while it was being dumped, in the tailings disposal facility.	Absorbents were used to cleanup the hydraulic fluid. Used absorbents will be shipped to Waste Management for disposal.	
14-Nov-17	Surface Shop	Engine Oil	620	gallon	TK13	Human error resulted in TK-13 being overfilled during routine transfer of engine oil from ISO-container into bulk tank.	Spill occurred within impermeable concrete secondary containment. All product was recovered with no release to environment. Recovered product pumped into waste oil tank. Residual oil cleaned up using absorbents.	The sensors that monitor the volume of material in the tank are being upgraded.
14-Dec-17	Wetland 0.8 mile B road	Hydraulic Oil	1/128	gallon	Drilling equipment	The drillers were finishing up a drill hole, located in the wetland adjacent to the sub-station at 0.8 mile B road, when they notice a sheen of the water. There was no obvious source for the sheen. The water was thought to have the characteristic smell of hydraulic fluid.	A few absorbents were used to recover what product there was.	The drill equipment was moved to the road adjacent to the wetland and inspected.
3-Jan-18	C Pond	Storm Water	16,350	gallon	C Pond	Frozen discharge line on upper C Pond resulted in lower C Pond discharging to the Greens Creek.	There was no cleanup.	A diesel pump was moved used while the discharge line on the electric pump was thawed.
3-Jan-18	Woods	Treated Process Water	5,000	gallon	AVR	Corroded pipe nipple connecting the AVR to the flange plate. The AVR is on the 002 Outfall pipeline and is located near the mouth of Greens Creek.	There was no cleanup.	The corroded pipe nipple was replaced.
27-Feb-18	2.8 Mile B-road	Glycol	15	gallon	MT17	A loose hose clamp allowed the coolant line to disconnect .	The glycol along with snow and ice was scooped up and place in a large tote. The tote was moved to an area where the snow and ice would melt and the glycol was recovered for disposal.	
5-Jun-18	920 Road	Hydraulic Oil	38	gallon	HT60	A hydraulic hose failed prematurely as a result of rubbing on the frame.	A large quantity of absorbents were used to recover the material.	The hose was replaced and precautions were taken to reduce the possibility of rubbing.

Date	Location	Spilled material	Quantity spilled	Units	Equipment	Description of Incident	Description of cleanup	Corrective Actions
11-Jun-18	Ore Pad	Hydraulic Oil	15	gallon	HT58	A hydraulic fitting failed.	A large quantity of absorbents were used to recover the material.	The fitting was repaired
25-Jun-18	Tailings	Hydraulic Oil	60	gallon	MT23	Hydraulic oil leaked from break in cast metal filter housing on a haul truck (MT23)	Absorbents used to clean up as much as possible. Estimated 50 gallons recovered with absorbents and remainder soaked into tailings and gravel road surface.	The fitting was repaired
15-Nov-18	Underground	Concrete Accelerant	200	gallon	675 shotcrete plant	Open valve on bulk container.	Rinsed into local sump and recovered with a pump. Generated ~400 gallons of waste.	
1-Feb-19	Tailings	Treated Water	50	gallon	AVR	An AVR failed to auto-shut after being turned on by a surface engineer. The AVR was located downstream of the 14" flow meter on the 002 Outfall line.	The AVR was turned off. None of the water was collected.	If the AVR is to be used precautions will be taken to prevent further releases.
2-Feb-19	Tailings	Hydraulic Oil	50	gallon	MT23	Hydraulic oil leaked from filter housing on a haul truck (MT23). At the time of the spill, the volume spilled was estimated to be less than 10 gallons. After the unit was repaired the estimate was increased to 50 gallons, prompting reporting of the incident.	Absorbents used to clean up as much as possible; estimated 49.5 gallons recovered with absorbents.	The filter was replaced.
4-Feb-19	Tailings	Hydraulic Oil	30	gallon	MT23	Hydraulic oil leaked from filter housing on a haul truck (MT23).	Absorbents used to clean up as much as possible; estimated 29.5 gallons recovered with absorbents.	The filter was replaced.
6-Feb-19	Tailings	Hydraulic Oil	20	gallon	KT20	Failed hydraulic fitting on max haul trailer (KT20) ram.	Absorbents used to clean up as much as possible; estimated 19.5 gallons recovered with absorbents.	The fitting was repaired
1-Feb-19	Tailings	Treated Water	50	gallon	AVR	The spill occurred when the surface engineer opened an AVR on the outfall pipeline. The valve failed to automatically shut off.	no cleanup was possible for this spill.	The AVR was closed.
23-Mar-19	Hawk Inlet	Hydrualic Oil	0.03125	gallon	Hydraulic cylinder	Four ounces of hydraulic oil was spilled in the ship loader's winch house, some of the oil made it into Hawk Inlet. The spill was from a small hydraulic cylinder that came apart. This spill was immediately reported to the National Response Center.	Absorbents were used to clean up the oil.	

Date	Location	Spilled material	Quantity spilled	Units	Equipment	Description of Incident	Description of cleanup	Corrective Actions
4-Jun-19	920	Glycol	125	gallon	Pipeline	There was a leak in a 2-inch heating system pipeline. The pipeline is part of the heating system for transferring heat from the boilers / engines in the powerhouse to the administrative/maintenance building. These facilities are connected by a below ground concrete utility corridor and this is where the leak occurred. The top of the of the corridor is part of the road system, made of concrete, and is not water tight. Atmospheric precipitation can enter the corridor; water is automatically removed by a sump pump on a float switch. Greens Creek personnel on the morning of 3 June 2019 recognized that the heating system was losing glycol and began to look for a leak. When the utility corridor was opened free glycol was found in the corridor. Approximately 100 gallons of product was recovered, by pumping into a plastic tote. Prior to recovery, potentially up to 25 gallons was pumped by the sump pump to the water management system, which reports to treatment facilities, ultimately discharging to Hawk Inlet via the APDES permitted outfall. The 25 gallons is an estimate based upon the difference between the volume recovered and the volume of product (125 gallons) it took to fill the system after the pipeline was repaired; volume in the system at the time of the spill was unknown. It is not actually known if any glycol was pumped to the water management system, however HGCMC personnel felt that there was a reasonable potential that it had and decided to take the conservative approach and report the spill to both the ADEC SPAR Division and the ADEC Compliance and Enforcement Division (under the authority of the APDES permit).	Pumped into a tote.	Repaired the pipeline.
6-Jul-19	920	Hydraulic Oil	35	gallon	HT59	There was a failing of a hydraulic line on HT-59. The line was too short and was rubbing on the frame of the truck.	Absorbents were used to clean up the oil.	The maintenance group determined that the failed component had been a rebuilt component and the hose was too short to begin with. This component was going to be inspected on the other haul trucks.
8-Aug-19	Hawk Inlet	Lubricant Spray	0.001	gallon	Barge	Aerosol lubricant spray can fell from the AML barge. The lubricant spray can was retrieved from the ocean.	There was not free product to be recovered. The can was punctured and drained. The contents and can will be properly disposed of.	None
21-Feb-20	Hawk Inlet	Glycol	170	gallon	Pipeline	A leak in the glycol heating loop for the camp housing. The majority of the spill was contained in the concrete utility corridor in which the heating pipes are running. Only a small amount seeped out onto the soil.	The spilled product was recovered from the utility corridor using a pump. The quarter gallon that seeped out along pipe penetrations was recovered with absorbents.	Replacing the pipeline

Date	Location	Spilled material	Quantity spilled	Units	Equipment	Description of Incident	Description of cleanup	Corrective Actions
22-Mar-20	Tailings	Runoff	600	gallon	Ditch	Snowmelt from the southwest corner (inactive portion) of the tailings disposal facility escaped the ditch, ran across the road, and was diverted into Pond 7. Snow and ice throughout the ditch likely restricted the flow capacity. This resulted in water backing up and the flow line being at an elevation above the top of the liner, but not overtopping the ditch. Water exfiltrated from the ditch over the top of the liner and through the road base fill. Water was also observed coming up out of the roadway. Though it appears some of the flow reached the upland ditch on the east side of Pond 10. Likely a minimal volume over a short duration and further diluted by additional snowmelt from the roadway. There was no visual turbidity in any of the flow, other than by the grader cutting the diversion.		Grading to direct any additional flows into Pond 7. Shoveled snow and ice in the ditch around the corner section. Added lots of salt (ice melt) to the ditch.
29-Apr-20	5.1 Mile B-road	Treated Waste Water	600,000	gallon	10" Pipeline	Discharge of treated process water from a damaged 10" HDPE pipeline at ~5.1-mile on the B-Road. The shallow buried pipeline was nicked by a frontend loader during snow removal activities (attached photo). The leak was not discovered until the snow had melted from the roadside ditch. The pipeline is typically under low pressure gravity flow conditions. The water flowed through the ditch to a culvert and then down a steep hillside.	Process water from the 920 Area has been transferred to a different pipeline until repairs can be completed. The damaged section of pipe will be cut out and a new section fused in.	Will look to improve marking or guarding on the pipeline.

GPO Appendix 05
Attachment C
Example Monthly Inspection Checklists

NPDES Permitted Outfall Monthly Inspection Form

003 –North Cannery Building at Culvert Outfall

	Yes	No	N/A	
Stormwater Control & Containment Structures				Are B-Road sediment control structures draining into the T7 pond operating as designed?
				Is the T7 diversion ditch functioning and has adequate capacity to divert flows to Cannery Creek?
				Describe degree of turbidity where ditch enters Cannery Creek.
				Is the diversion ditch below the upper pad stairs in good condition? (It should be a minimum of 12 inches deep)
				Are the stormwater drain and culvert inlet at the bottom of the lower pad stairs unobstructed?
				Is the 003 caisson pump operational and capturing outfall flow?
				Is Hawk Inlet free of discharge from beneath the barge ramp?
				Is the drainage in the vicinity of the barge ramp directed to the stormwater inlet?

At the discharge point:

Total Flow: _____ (gpm)

Are any of these visible?

Floating Solids: Yes No

Foam: Yes No

Garbage: Yes No

Oily Sheen: Yes No

Comments: _____

Inspected by: Date:

Directions for the use of this form: Use the BMP maintenance inspection checklists in section 3 of the Best Management Practices Plan as a guide to answer the questions above. Mark n/a if a question is not applicable for this month's inspection. Describe any deficiencies in the comments section, including personnel notified, any follow-up actions and the date they occurred. Note any unusual environmental conditions encountered, as well as suggestions for additonal BMP's that may improve water quality.

NPDES Permitted Outfall Monthly Inspection Form

004 – A Road at 1.8 mile – Pit 7

	Yes	No	N/A	
Stormwater Control & Containment Structures				If there are current activities, are the BMP procedures being followed?
				Are ditches directing stormwater through appropriate BMPs, vegetated, & maintained?
				Does the wetlands vegetation appear to be in good condition?
				Is color and turbidity staying unchanged in the North pond?
				Is color and turbidity staying unchanged at the South discharge point to the wetland?
				Is the creek free of discharge from either north or south roadside? If discharging, describe character and flow
				Is the "rip rap" ditch and settling pond in good condition?
Erosion Control Systems				Is the area free of new disturbances or soil placement requiring hydroseeding?

At the discharge point:

Total Flow: _____ (gpm)

Are any of these visible?

Floating Solids: Yes No

Foam: Yes No

Garbage: Yes No

Oily Sheen: Yes No

Comments: _____

Inspected by: Date:

Directions for the use of this form: Use the BMP maintenance inspection checklists in section 3 of the Best Management Practices Plan as a guide to answer the questions above. Mark n/a if a question is not applicable for this month's inspection. Describe any deficiencies in the comments section, including personnel notified, any follow-up actions and the date they occurred. Note any unusual environmental conditions encountered, as well as suggestions for additonal BMP's that may improve water quality.

NPDES Permitted Outfall Monthly Inspection Form

005.2 – B Road at 3.0 Mile – Zinc Creek Bridge

	Yes	No	N/A	
Stormwater Control & Containment Structures				Are all ditches along B-Road clear of debris and in good condition?
				Are ditches directing stormwater through appropriate BMPs, vegetated, & maintained?
				Are check dams in the ditch system above the settling pond in good condition?
				Is the settling pond above the parking area in good condition?
				Is the bridge surface in good condition? (i.e., Is there more than 3" buildup at edges? Can you see 90% of the wood decking?)
				Are the bridge splash guards in good condition?
				Is the outfall in good condition?
				Are the silt fences/straw wattles in good condition? (i.e., <6" behind silt fence, <3" behind straw wattles)
Erosion Control Systems				Is the North access road free of erosion?
				Is the area free of soils that need hydroseeding?

At the discharge point:

Total Flow: _____ (gpm)

Are any of these visible?

Floating Solids: Yes No

Foam: Yes No

Garbage: Yes No

Oily Sheen: Yes No

Comments: _____

Inspected by: Date:

Directions for the use of this form: Use the BMP maintenance inspection checklists in section 3 of the Best Management Practices Plan as a guide to answer the questions above. Mark n/a if a question is not applicable for this month's inspection. Describe any deficiencies in the comments section, including personnel notified, any follow-up actions and the date they occurred. Note any unusual environmental conditions encountered, as well as suggestions for additonal BMP's that may improve water quality.

Updated 20170814 G. F.

NPDES Permitted Outfall Monthly Inspection Form

005.3 – B Road at 4.5 Mile – Waste Rock Area E

	Yes	No	N/A	
Stormwater Control & Containment Structures				If material is being removed, are BMP procedures being followed?
				Are ditches directing stormwater through appropriate BMPs, vegetated, & maintained?
				Is the clean road well maintained?
				Is the settling pond in good condition per BMP maintenance checklist?
				Are the flow and color of the seeps around the perimeter of Site E unchanged?
Erosion Control Systems				Is the area free of new disturbances requiring hydroseeding?
				Is the area free of any signs of sluffage?

At the discharge point:

Total Flow: _____ (gpm)

Are any of these visible?

Floating Solids: Yes No

Foam: Yes No

Garbage: Yes No

Oily Sheen: Yes No

Comments: _____

Inspected by: Date:

Directions for the use of this form: Use the BMP maintenance inspection checklists in section 3 of the Best Management Practices Plan as a guide to answer the questions above. Mark n/a if a question is not applicable for this month's inspection. Describe any deficiencies in the comments section, including personnel notified, any follow-up actions and the date they occurred. Note any unusual environmental conditions encountered, as well as suggestions for additonal BMP's that may improve water quality.

NPDES Permitted Outfall Monthly Inspection Form

005.4 – B Road at 4.6 Mile – Pit 6

	Yes	No	N/A	
Stormwater Control & Containment Structures				If current activities, are BMP procedures being followed?
				Are ditches directing stormwater through appropriate BMPs, vegetated & maintained?
				Are the settling ponds on the downhill side of the B Road in good condition?
				Are entrance ramp water bars effectively diverting water into the ditch?
Erosion Control Systems				Is the area free of new disturbances requiring hydroseeding?

At the discharge point:

Total Flow: _____ (gpm)

Are any of these visible?

Floating Solids: Yes No

Foam: Yes No

Garbage: Yes No

Oily Sheen: Yes No

Comments: _____

Inspected by: Date:

Directions for the use of this form: Use the BMP maintenance inspection checklists in section 3 of the Best Management Practices Plan as a guide to answer the questions above. Mark n/a if a question is not applicable for this month's inspection. Describe any deficiencies in the comments section, including personnel notified, any follow-up actions and the date they occurred. Note any unusual environmental conditions encountered, as well as suggestions for additonal BMP's that may improve water quality.

Updated 20170814 G. F.

NPDES Permitted Outfall Monthly Inspection Form

005.5 – B Road at 7.8 Mile – Culvert Outfall

	Yes	No	N/A	
				Is Pond 23 in good condition?
				Is DB03 in good condition?
				Are the sediment traps and check dams along the ditch in good condition?

At the discharge point:

Total Flow: _____ (gpm)

Are any of these visible?

Floating Solids: Yes No

Foam: Yes No

Garbage: Yes No

Oily Sheen: Yes No

Comments: _____

Inspected by: _____ Date: _____

Directions for the use of this form: Use the BMP maintenance inspection checklists in section 3 of the Best Management Practices Plan as a guide to answer the questions above. Mark n/a if a question is not applicable for this month's inspection. Describe any deficiencies in the comments section, including personnel notified, any follow-up actions and the date they occurred. Note any unusual environmental conditions encountered, as well as suggestions for additonal BMP's that may improve water quality.

Updated 20170814 G. F.

NPDES Permitted Outfall Monthly Inspection Form

006 – Pond D Overflow – Waste Rock Area D

	Yes	No	N/A	
				Is the access road and ditch in acceptable condition?
				Is road runoff from 7.9-Mile adequately routed to pond?
				Is the piping leading to or from the pond free of leaks?
				Is drain back valve open?
				Is the pump in good working condition?
				Are the flow and color of the seeps along the bottom of D Pile unchanged?
Erosion Control Systems				Is the pond berm free of signs of erosion?
				Is the area free of new disturbances requiring hydroseeding?

At the discharge point:

Total Flow: _____ (gpm)

Are any of these visible?

Floating Solids: Yes No

Foam: Yes No

Garbage: Yes No

Oily Sheen: Yes No

Comments: _____

Inspected by: _____ Date: _____

Directions for the use of this form: Use the BMP maintenance inspection checklists in section 3 of the Best Management Practices Plan as a guide to answer the questions above. Mark n/a if a question is not applicable for this month's inspection. Describe any deficiencies in the comments section, including personnel notified, any follow-up actions and the date they occurred. Note any unusual environmental conditions encountered, as well as suggestions for additonal BMP's that may improve water quality.

Updated 20170814 G. F.

NPDES Permitted Outfall Monthly Inspection Form

007 – Pond C Overflow – Waste Rock Area C

	Yes	No	N/A	
				Is the pumping system working properly?
				Are pipeline drain valves open?
				Is the upper to lower pond culvert unobstructed?
				Is exterior of lower pond berm free of seeps?
				Is culvert inlet at base of 23 Ramp unobstructed?
				Is runoff between the 920 and the 860 being adequately captured?
				Are storm drain inlets around 860 Lab (4 total) unobstructed?
Erosion Control Systems				Is the area free of new disturbances requiring hydroseeding?
				Is the pond berm free of signs of erosion?

At the discharge point:

Total Flow: _____ (gpm)

Are any of these visible?

Floating Solids: Yes No

Foam: Yes No

Garbage: Yes No

Oily Sheen: Yes No

Comments: _____

Inspected by: _____ Date: _____

Directions for the use of this form: Use the BMP maintenance inspection checklists in section 3 of the Best Management Practices Plan as a guide to answer the questions above. Mark n/a if a question is not applicable for this month's inspection. Describe any deficiencies in the comments section, including personnel notified, any follow-up actions and the date they occurred. Note any unusual environmental conditions encountered, as well as suggestions for additonal BMP's that may improve water quality.

Updated 20170814 G. F.

NPDES Permitted Outfall Monthly Inspection Form

008 – Waste Rock Area 960

	Yes	No	N/A	
Stormwater Control & Containment Structures				Are the diversion ditches and berms allowing the lower bench to drain?
				Are ditches directing stormwater through appropriate BMPs, vegetated, & maintained?
				Are check dams in the ditch system in good condition?
				Is the vegetative cover well established?
				Are the water bars operating as designed?
Erosion Control Systems				Is the road free of tension cracks?

At the discharge point:

Total Flow: _____ (gpm)

Are any of these visible?

Floating Solids: Yes No

Foam: Yes No

Garbage: Yes No

Oily Sheen: Yes No

Comments: _____

Inspected by: Date:

Directions for the use of this form: Use the BMP maintenance inspection checklists in section 3 of the Best Management Practices Plan as a guide to answer the questions above. Mark n/a if a question is not applicable for this month's inspection. Describe any deficiencies in the comments section, including personnel notified, any follow-up actions and the date they occurred. Note any unusual environmental conditions encountered, as well as suggestions for additonal BMP's that may improve water quality.

Updated 20170814 G. F.

NPDES Permitted Outfall Monthly Inspection Form

009 – 1350 Area – East Below Sediment Pond

	Yes	No	N/A	
Stormwater Control & Containment Structures				If the area has current activity, are BMP procedures being followed?
				Are ditches directing stormwater through appropriate BMPs, vegetated, & maintained?
				Are check dams in the ditch system in good condition?
				Is the portal drainhole clear and free-draining?
				Is pump in collection trench operating properly?
Erosion Control Systems				Is the area free of new disturbances requiring hydroseeding?

At the discharge point:

Total Flow: _____ (gpm)

Are any of these visible?

Floating Solids: Yes No

Foam: Yes No

Garbage: Yes No

Oily Sheen: Yes No

Comments: _____

Inspected by: Date:

Directions for the use of this form: Use the BMP maintenance inspection checklists in section 3 of the Best Management Practices Plan as a guide to answer the questions above. Mark n/a if a question is not applicable for this month's inspection. Describe any deficiencies in the comments section, including personnel notified, any follow-up actions and the date they occurred. Note any unusual environmental conditions encountered, as well as suggestions for additonal BMP's that may improve water quality.

Updated 20170814 G. F.

GPO Appendix 05
Attachment D
BMP Plan Annual Report

BMP Plan annual reports are submitted to the ADEC by March 1 of the following year. These reports are part of the public record. Onsite the yearly BMP Plan Annual Reports are readily available in print or electronic form.

GPO Appendix 05
Attachment E
BMP Maintenance Log

2018 BMP Maintenance Log

Date	Location	Description of Activity
3/31/2018	B Road bridges	Sweep bridges at 3.0, 3.4, and 7.4
4/1/2018	DB-04	Clean and haul to tails
4/1/2018	DB-05	Clean and haul to tails
4/2/2018	Junction to 3.3 B Road	Clean rock check dams and sumps; ~80 yds sediment
4/3/2018	3.4-6.0 mile B Road	Clean rock check dams and sumps; ~72 yds sediment
4/4/2018	5.3-5.4 mile B Road	Clean ditch and culvert inlets; ~80 yds sediment
4/5/2018	Site 23 sumps	Clean and haul to top of Site 23
4/6/2018	Ore Pad Hill	Clean ditch and sumps
4/24/2018	1.8-4.7 mile B Road	Road resurfacing - 23 loads
4/24/2018	6.0-8.0 mile B Road	Road resurfacing - 13 loads
4/25/2018	Ore Pad Hill	Clean ditch and sumps
4/27/2018	4.7-6.0 mile B Road	Road resurfacing - 7 loads
4/28/2018	3.1-3.3 mile B Road	Clean rock check dams and sumps
4/29/2018	B Road bridges	Sweep bridges at 3.0, 3.4, and 7.4
5/23/2018	0.8-0.9 mile B Road	Hydroseed disturbed areas
5/26/2018	2.0-8.0 mile B Road	Road resurfacing - 8 loads
5/29/2018	3.2-3.3 mile B Road	Clean settling ponds
5/29/2018	4.3-5.3 mile B Road	Hydroseed ditches
5/30/2018	5.6-6.0 mile B Road	Clean ditch and culvert inlets; ~60 yds sediment
5/30/2018	5.7-6.2 mile B Road	Hydroseed ditches
5/30/2018	DB-03	Clean and haul to Site 23
5/31/2018	5.3-5.6 B Road	Clean ditch and culvert inlets; ~40 yds sediment
6/1/2018	3.1 mile B Road	Clean settling ponds and remove cut trees
6/2/2018	3.1 mile B Road	Clean and rebuild settling ponds
6/2/2018	Ore Pad Hill	Clean ditch and sumps
6/2/2018	Shop sump	Clean and haul to DB-01
6/3/2018	3.1 mile B Road	Complete settling pond rebuild; install filter rock
6/3/2018	3.1 mile B Road	Clean roadside ditch, culvert and install rock check dams
6/4/2018	2 mile section B Road	Clean ditch and culvert inlets
6/4/2018	DB-04	Clean and haul to tails
6/23/2018	3.2 mile B Road	Clean settling ponds

Date	Location	Description of Activity
6/23/2018	Ore Pad Hill	Clean ditch and sumps
6/23/2018	Site 23 sumps	Clean and haul to top of Site 23
6/24/2018	0.9 mile B Road	Hydroseed slopes above road
6/26/2018	7.4 mile B Road	Remove sediment below bridge
7/15/2018	Ore Pad Hill	Hydroseed disturbed areas
7/18/2018	DB-07	Clean and haul to tails
7/19/2018	Tails West Buttress	Hydroseed
7/21/2018	3.0 mile B Road bridge	Remove sediment, Replace old silt fence with compost filter socks
7/22/2018	Site 23 sumps	Clean and haul to top of Site 23
7/22/2018	DB-03	Clean and haul to Site 23
7/22/2018	3.0 mile B Road bridge	Install compost filter socks and new straw wattles
7/23/2018	3.0 mile B Road bridge	Hydroseed below 3.0 mile bridge
7/24/2018	3.0 mile B Road bridge	Hydroseed below 3.0 mile bridge
7/24/2018	920 Pump House	Hydroseed disturbed areas
7/31/2018	7.4 mile B Road bridge	Install compost filter socks and new straw wattles
8/7/2018	Site 23	Hydroseed slopes
8/7/2018	3.1 mile B Road	Clean settling ponds and hydroseed
8/9/2018	5.2-5.4 mile B Road	Road resurfacing - 7 loads
8/13/2018	1.3-1.8 mile B Road	Road resurfacing - 16 loads
8/17/2018	1.3-1.8 mile B Road	Road resurfacing - 50 cubic yards
8/18/2018	3.0-3.2 mile B Road	Road resurfacing - 40 cubic yards
8/20/2018	3.2 mile B Road	Clean settling ponds
8/22/2018	DB-04	Clean and haul to tails
8/22/2018	B Road sumps	Clean sumps
8/22/2018	Tails S3P1	Hydroseed south embankment
8/23/2018	Tails West Buttress	Hydroseed
8/24/2018	B Road bridges	Sweep bridges at 3.0, 3.4, and 7.4
8/24/2018	Tails West Buttress	Hydroseed
8/26/2018	Tails	Hydroseed backside of TDF
8/27/2018	7.4 mile B Road	Remove sediment below bridge
9/6/2018	920 Area	Clean sumps
9/7/2018	920 Area	Clean sumps

Date	Location	Description of Activity
9/8/2018	1.4 mile A Road	Hydroseed embankment spillway and outlet channel
9/10/2018	8.0 mile B Road	Clean 23 lined ditch
9/27/2018	Above 7.9 mile B Road	Road resurfacing - 146 cubic yards
9/28/2018	2.3-4.7 mile B Road	Road resurfacing - 144 cubic yards
10/2/2018	DB-03	Clean and haul to Site 23
10/3/2018	3.1 mile B Road	Clean settling ponds
10/4/2018	920 Area	Clean sumps
10/12/2018	DB-04	Clean and haul to tails
10/12/2018	6.1-8.3 mile B Road	Road resurfacing - 190 cubic yards
10/15/2018	5-mile A Road	Clean ditches shale pit to Young Bay
10/16/2018	4.0-3.9 mile A Road	Clean ditches and culverts
10/17/2018	3.9-3.8 mile A Road	Clean ditches and culverts
10/17/2018	2 mile section B Road	Clean ditch and culvert inlets
10/18/2018	3.8-3.6 mile A Road	Clean ditches and culverts
10/21/2018	Ore Pad Hill	Clean ditch and sumps
10/21/2018	3.1-3.3 mile B Road	Clean settling ponds and sumps
10/27/2018	1.3-7.6 mile B Road	Road resurfacing - 100 cubic yards
11/18/2018	0.8-4.7 mile B Road	Road resurfacing - 30 cubic yards

GPO Appendix 05
Attachment F
BMP Details

BMP AK-1
Preservation of Existing Vegetation

Purpose and Description

- The purpose of preserving existing vegetation is to limit site disturbance and to minimize soil erosion by identifying and protecting pre-existing vegetation on the construction site.[1]

Applicability

- Natural vegetation must be preserved in all areas where no construction is planned or will occur at a later date.
- Clear only land that is needed for building activities or vehicle traffic.[2]
- This BMP is not to supersede existing guidelines, restrictions or law, preserve vegetation as required by local governments (such as stream buffers).
- The preservation of existing vegetation is an applicable practice in all regions and climates in Alaska.

Design and Installation

- Before any clearing begins, vegetation selected for preservation must be clearly marked with established barriers.[3] These barriers must be about 1 meter in height, must be highly visible and be anchored by wood or metal fence posts at spacing and depth that will adequately support the fence for the entirety of the project.[1]
- A site map must be prepared clearly outlining all areas of vegetation that is to be preserved.[2]
- Vehicle traffic, equipment storage and parking shall be kept away from these areas to prevent soil and root compaction.[1]
- Ground disturbance must be kept from these areas at least as far out as the leaf drip line.[3]
- Maintain pre-existing irrigation systems that may supply water to vegetation selected for preservation.[1]
- To increase chances of survival it is best to limit grade changes in these areas and areas within the drip line.[3]

Maintenance and Inspection

- Repair or replace damaged vegetation immediately.[2]
- Inspect preservation areas regularly, if barrier has been removed or visibility reduced repair or replace barrier so that visibility is restored.[3]
- If roots are exposed or damaged, prune ends just above damage with pruning shears or loppers and recover with native soil.[3]

References

[1]Caltrans Storm Water Quality Handbooks, March 2003, Construction Site Best Management Practices Manual, SS-2 Preservation of Existing Vegetation, Uhttp://www.dot.ca.gov/hq/construc/stormwater/CSBMPM_303_Final.pdf

(Continued on next page)

[2]USEPA (United States Environmental Protection Agency), October 2000, National Menu of Best Management Practices, Preserving Natural Vegetation, http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=34&minmeasure=4

[3]Washington State Department of Ecology, February 2005, Storm Water Management Manual for Western Washington, Construction Storm Water Pollution Prevention, BMP C101: Preserving Natural Vegetation, http://www.ecy.wa.gov/pubs/0510030.pdf

BMP AK-16
Vegetative Buffer Strip

Objectives and Applications

A vegetative buffer strip is an undisturbed area or strip of natural vegetation, or an established suitable planting that will provide a living filter to reduce soil erosion and runoff velocities.

Buffer strips act as living sediment filters that intercept and detain storm water runoff. They reduce the flow and velocity of surface runoff, promote infiltration, and reduce pollutant discharge by capturing and holding sediments and other pollutants in the runoff water. They may be natural, undeveloped land, or may be graded and planted with grass or other vegetation; and may be placed at many locations between the source of sediment (road surface, side slopes) and a natural or constructed waterway or other drainage area that could be impacted by deposits of sediment. Buffer strips may be used at any site that can support vegetation, but are best suited where soils are well drained and where the bedrock and water table are well below the surface. Buffer strips are particularly effective on flood plains, along stream banks, and at the top and bottom of a slope. Buffer strips may be either temporary or permanent.

Common Failures - Generally due to faulty installation or maintenance.

- Excessive sediment or oil and grease loads resulting in clogging.
- Introduction of storm water flows onto buffer strip before vegetation is established.

Other Considerations

- Not effective for filtering high velocity flows from large, paved areas, steep slopes, or hilly areas.
- May be more viable than silt fence where silt fence installation and removal will cause more harm than good.
- Avoid flow concentration
- Buffer strips generally only trap coarse sediments. Depending upon vegetative type, clay and fine silt particles will generally pass through a buffer strip during periods of heavy rain.
- Preserve natural vegetation in clumps, blocks or strips where possible, particularly in areas adjacent to waterways.
- Do not use planted or seeded ground as a buffer strip for sediment trapping until the vegetation is established.
- Extensive constructed buffers may increase development costs.

Relationship to Other ESC Measures

Buffer strips are used in conjunction with diversion measures such as earth dikes, diversions, and slope drains for slope protection. Silt fences placed upslope may prevent sediment overloading.

Alternate Sediment Control Measures

Diversion; Slope Drain

Other Names

Buffer Zone, Vegetated Filter Strip.

Design

Location: *Should be determined by considering slope, soil type, anticipated flow, and vegetation type.*

Capacity: *2 year peak runoff storm*

Width: 25 *ft. - 60 ft., depending on type of vegetation and length of slope*

Grading: *smooth and uniform*

Permitting: *Wetland use as a vegetative buffer strip requires approval from the Corps of Engineers.*

Flow Distribution: *evenly distributed; avoid flow concentration*

Materials

Natural vegetation, seed or sod; fertilizer, mulch, water; fencing or flagging

Installation

Natural Vegetation

Delineate undisturbed natural areas of vegetation that have been identified on the plans with flagging prior to the start of construction activities. Ensure that other sediment control measures to be used in conjunction with the buffer strip are in place and functioning properly. Minimize construction activities and traffic in the buffer strip and immediate surrounding areas.

New Buffer Strip

Ensure that sediment control measures such as silt fence and diversions are in place to protect waterways or drainage areas until the buffer strip is established. Clear and grade the land according to the plans and specifications. Establish vegetation using specified seeding, mulching, watering, and fertilizer.

Inspection

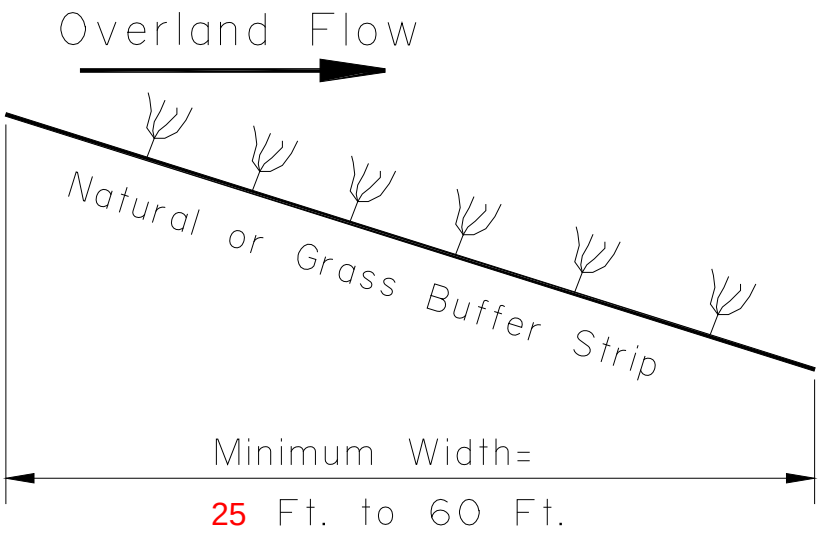
Inspect natural vegetation buffer strip areas at regular intervals to ensure that the fencing or flagging used to delineate non-disturbance areas are in place. Check for damage by equipment and vehicles. Inspect new buffer strip areas for the progress of germination and plant growth. Ensure that water flowing through the area is not forming ponds, rills, or gullies due to erosion within the buffer strip.

Maintenance

Replace or repair fencing or flagging as necessary. Repair any damage by equipment or vehicles. Provide additional seed, fertilizer, and water to ensure adequate establishment of vegetation. Repair and reseed areas damaged by erosion or ponding of water.

Removal

Temporary buffer strips - Provide and compact fill to existing or specified grade. Seed and mulch.



VEGETATIVE BUFFER STRIP

BMP AK-7
Check Dam

Objectives and Applications

A check dam is an expedient (or emergency) temporary measure to protect narrow erosion-susceptible waterways and/or reduce the sediment loads in channeled flows. Check dams may also be used as permanent measures. Rock or a triangular silt dike may be used.

Temporary check dams are placed in series in ditches, swales, gullies, or other minor drainageways intended to be filled or stabilized at a later time. They are used to slow stormwater velocities and direct scouring flows away from channel surfaces. The dam configuration supports sediment settling from silted waters pooled behind the weir. When rock is used, small sediment particles become lodged in the dam's interior.

Permanent check dams may be used as gradient control structures in ditches adjacent to elevated roadway sections.

Common Failures - Check dams are vulnerable to failure from concentrated flow.

- Undercut/washout of channel banks beside the structure due to improper installation (e.g. dam not built high enough onto the banks).
- Increased bank erosion (e.g. at channel bends) or inadequate protection of channel surfaces due to improper location or installation of check dams.
- Water backup and bank overflow due to overly tall dam structure.
- When rock is used, rocks washed downstream may clog culverts, misdirect flow, etc.
- Check dams installed in grass lined structures may kill the vegetative lining if siltation is excessive or the dam remains submerged for extended periods of time.

Other Considerations

- Check dams are used in narrow ditches and gullies.
- Check dam rocks interfere with the establishment of vegetation.
- Check dams left as permanent structures interfere with grass mowing (maintenance).
- Steep channel slopes reduce effectiveness.
- Coupling check dams with a small adjacent upstream sump improves velocity slowing and sediment trapping ability.
- The area downstream from the last dam should be stabilized or flow diverted.

Relationship to Other ESC Measures

As part of the perimeter control ESC network, check dams are used for channel protection prior to establishment of permanent or stabilized erosion controls. Although check dams do some sediment filtering, they are not intended to replace filters or sediment basins. A depression in the bottom of the channel at the upstream edge of a check dam augments velocity slowing and sediment removal. Digging a sump through stabilized in-channel protection (e.g. grassed lining) should be avoided, however. Check dams interfere with localized vegetative channel protection. Rocks prohibit establishment of in-situ vegetation and the protective lining is subject to disturbance/ destruction during check dam removal.

Alternate Sediment Control Measures

- Drainage diversion during channel stabilization.
- Protective channel linings (e.g. grassed waterway, concrete or rock-lined ditch, erosion control blankets or mattings), , sediment settling ponds, permanent ditch blocks, brush barriers or combinations or these measures.

Other Names

In Stream/Channel Energy Dissipator

Design

The design of rock check dams (high at channel banks, lower in the middle) directs overtopping flows centrally to avert scouring of channel surfaces. The dam is keyed into channel slopes to prevent bank undercut and erosion.

Spacing between dams is based on waterway grade, height of adjacent check dams and desired length of backwater effect. The distance shown in the table below has been calculated for the protection of channel banks between successive structures. Placement of check dams at abrupt bends should be avoided since erosive waters could be misdirected by the check dam into channel banks.

Check dam structures are sized to stay in place during peak flow and should pass 2-year storm runoff without overtopping the roadway or ditch side-slopes. Generally, dams are not constructed higher than recommended as follows since excessive weir depth seriously impacts the flow characteristics of the ditch.

The following dimensions may be modified for site-specific applications:

Standard Check Dam

Maximum drainage area: *not to exceed 10 acres*

Normal flow velocity*: no greater than* 6 ft/sec.

Maximum height at dam center*: not greater than 2 ft. or one half the channel depth*

Minimum height difference between center and (bank) sides*: 6 in.*

Structure slope*: 1:2*

Maximum spacing between standard (2 ft. high) check dams: *align top of check dam level with toe elevation of the upstream dam*

Channel Slope (%)				
2	*3*	*4*	*5*	*6*
Spacing (ft.)				
100	*67*	*50*	*40*	*33*

.

Materials

Rock. Clean hard angular (e.g. crushed, shot) rock graded according to expected flows. Two- to three-inch stone is usually adequate.
Alternate materials: logs, brush and twigs, sandbags partially filled with pea gravel. Use only clean materials. Avoid introduction of fines.

Tirangular Silt Dike. These are foam encased in geotextile, with extra fabric to make an apron. They are usually 10 to 14” high at the center and 20 to 28” at the base.

Installation

Install dams as soon as drainage routes are established. Place rock by hand or mechanical means, distributing smaller rocks to the upstream side to prevent transport. Attach the leading edge of the triangular silt dike with rocks, sandbags or staples and a key slot. Check structures key into a trench that spans the complete width of the channel. Extend dams high onto the channel banks (above anticipated high water level) to prevent localized undermining and erosion. In unlined channels, a small sump dug at the upstream side of the dam facilitates sediment collection and removal.

Inspection

Observe dam function during/after each rainfall event that produces runoff and note conditions of channel surfaces. Visually compare upstream and downstream flows to determine relative turbidity levels and effectiveness of velocity checks. Inspect channel banks for evidence of undermining and erosion. Look for dam deterioration and for migration of structural components downstream. Observe level of sediment buildup behind dam. It should not exceed ⅓ dam height. Observe ESC effectiveness during flows to determine if adjunct measures are needed. The dam should be stable and appropriately sized to withstand high velocity events.

Maintenance

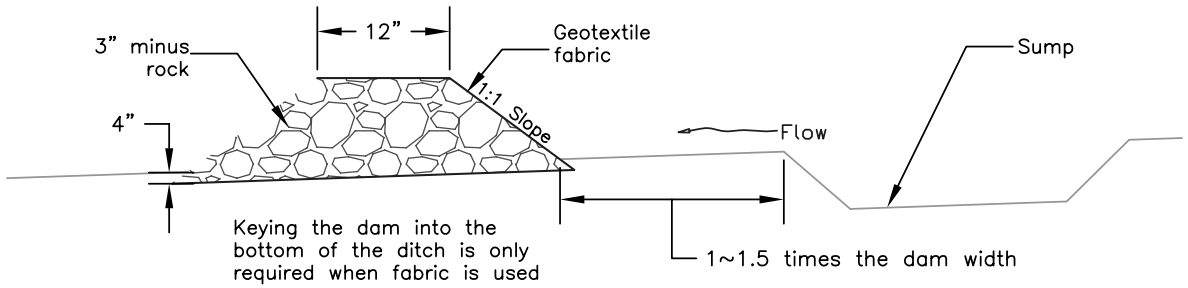
Rock. Repair check dam voids and bank undercuts. Fortify disintegrating dams and install additional dams or other ESC measures as needed. Correct undesirable effects of rock migration (e.g. clogged culvert, flow construction). Periodically remove sediment deposits.

Triangular Silt Dike. Remove accumulated sediment when it reaches half the height of the dam. Repair right away if there is any undercutting or flow around the edges.

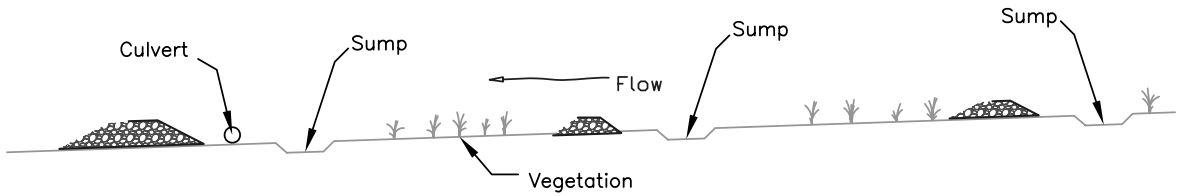
Removal

Care should be taken since the waterway surfaces are susceptible to damage during check dam removal. Damaged or unprotected areas should be seeded immediately or other forms of protection provided as warranted. Some check dams are left as a permanent control measure. Removal may be indicated because of unsightliness or interference with maintenance activities.

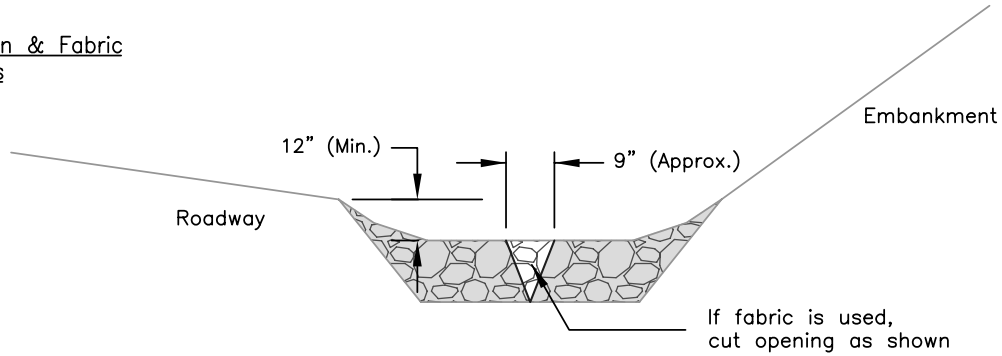
Profile 1: Detail



Profile 2: Culvert



Section & Fabric Details



Notes	
1.	Dam should be constructed to be the minimum width that will be stable when holding water. For typical ditch applications, that will be approximately 12" wide at the top with 1 to 1 side slopes.
2.	The use of fabric in the construction of the dam is dependent on conditions, and should only be used if necessary to provide additional stability to the dam material.
3.	For typical ditch applications, space check dams so that the toe of the uphill dam is the same elevation as the crest of the downhill dam.

Maintenance Inspection Checklist	
1.	Remove sediment from behind check dams as necessary to maintain functionality. For check dams in series in a typical ditch application, remove sediment when it has accumulated to approximately 3/4 the height of the dam, unless the next lower dam continues to have sufficient capacity. For check dams immediately above a culvert, remove sediment when it has accumulated to approximately 1/2 the height of the dam.
2.	Minimize damage to ditch vegetation during sediment removal activities.
3.	If dam has been constructed with filter fabric, ensure that the fabric is not impeding flow through the dam. If necessary, enlarge the opening in the fabric to increase flow.
4.	If the check dam shows signs of frequent overtopping, raise dam height if possible, or increase check dam frequency.

(NOT TO SCALE)

K:\Alaska-Derek\Working\RockCheckDam.dwg

Program Manager	ARCADIS Infrastructure, environment, facilities	ROCK CHECK DAM DETAILS	Project Number MH000969.0001
Project Manager			Drawing Date 9/20/2007
Task Manager	420 L Street, Suite 100 Anchorage, AK 99501 Phone: 907-277-3770, Fax: 907-277-3776 www.arcadis-us.com		Figure 17
Technical Review D. Helmericks			

BMP AK-2
Interception/Diversion Ditch

Objectives and Applications

An interception/diversion ditch, berm or excavated channel, or combination berm and channel constructed across a slope that functions to intercept runoff and divert it to a stabilized area where it can be safely discharged.

This measure should be used in construction areas where runoff can be diverted and disposed of properly to control erosion, sedimentation, or flood damage. Specific locations and conditions include above disturbed existing slopes, and above cut or fill slopes to prevent runoff over the slope; across unprotected slopes, as slope breaks, to reduce slope length; below slopes to divert excess runoff to stabilized outlets; where needed to divert sediment laden water to sediment traps; at or near the perimeter of the construction area to prevent sediment from leaving the site; above disturbed areas before stabilization to prevent erosion and maintain acceptable working conditions; around buildings or areas that are subject to damage from runoff, and during culvert installations where water must be temporarily diverted around the construction area. Diversions may be either temporary or permanent.

Common Failures - Generally due to faulty installation or maintenance.

- Berm not properly compacted during construction, resulting in uneven settling.
- Sediment accumulation against berm/channel not removed periodically, resulting in berm not functioning properly.

Other Considerations

- Berms to intercept and divert runoff should not be used where the drainage area exceeds 10 ac.
- Interception/diversion ditches should be carefully designed where longitudinal ditch slopes are steeper than 10 per cent.

Diversions are preferable to other types of man-made storm water conveyance systems because they more closely simulate natural flow patterns and characteristics, and flow velocities are generally kept to a minimum.

Relationship to Other ESC Measures

Diverted runoff should outlet to a stabilized area such as a sediment basin, detention or retention basin, or stabilized outlet, which should be established prior to introducing runoff from the diversion.

Alternate Sediment Control Measures

Slope Drain (can be used in association with this measure).

Other Names

Interceptor Ditch, Crown Ditch

Design

Location: *Should be determined by considering outlet conditions, topography, land use, soil type, and length of slope.*

Capacity: *permanent: 10 year peak runoff storm.*
temporary: 2 year peak runoff storm.

Berm

Berm Top Width: *minimum 2 ft.*
Berm Base Width: *minimum 4.5 ft.*
Berm Height: *minimum 18 in.*
Berm Side Slopes: *2:1 or flatter*

Ditch

Channel Freeboard: *minimum 6 in.*
Channel Side Slopes: *2:1 or flatter*

Materials

Compacted soil or coarse aggregate, riprap, filter fabric, plastic lining, seed and mulch, sandbags

Installation

Interception Ditch
Remove and properly dispose of all trees, brush, stumps, or other objectionable material. Fill and compact all ditches, swales, or gullies that that will be crossed to natural ground level. Excavate, shape, and stabilize the diversion to line, grade, and cross section as required . Compact the berm to prevent unequal settlement and to provide stability against seepage. Stabilize the diversion with vegetation after installation.

Diversions for Culvert Installations

Excavate the diversion channel to the specified dimensions, leaving temporary plugs at both ends. Place channel lining and stabilize with riprap or sandbags. Remove plugs at both ends (down-stream first) and divert water into the diversion with sandbags. After installation of the culvert is complete, replug the diversion, salvage the diversion lining, and backfill in the channel.

Inspection

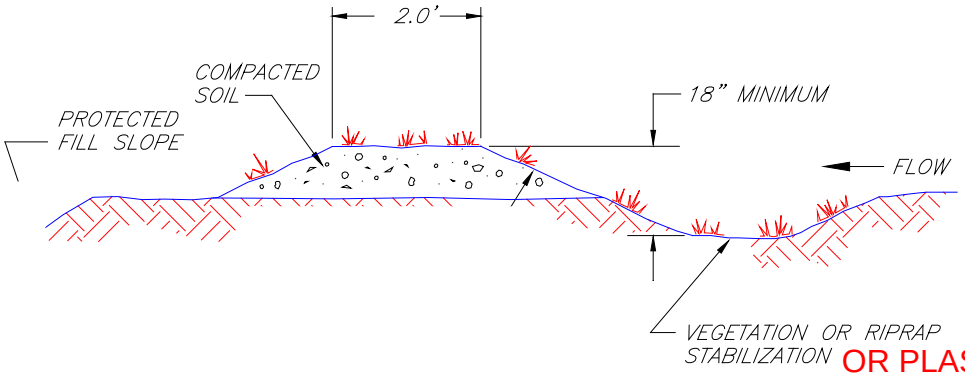
Inspect the diversion every week and after each rainfall during construction operations.

Maintenance

Remove any sediment or other obstructions from the diversion channel. Check outlets and make repairs as necessary. Reseed areas that fail to establish a vegetative cover.

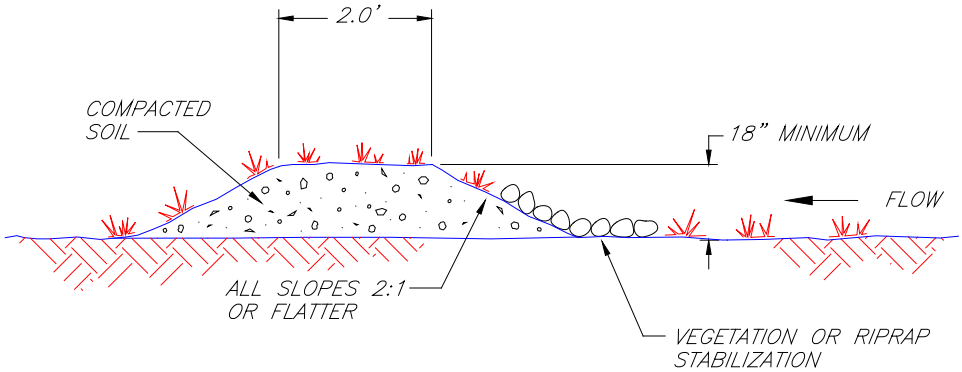
Removal

Temporary installations – Restore to existing or constructed grade. Seed and mulch.



OR PLASTIC SHEETING OR GEOTEXTILE

TYPICAL FILL DIVERSION



TYPICAL TEMPORARY DIVERSION DIKE

NOTES:
1. THE CHANNEL BEHIND THE DIKE SHALL HAVE POSITIVE GRADE TO A STABILIZED OUTLET.
2. THE DIKE SHALL BE ADEQUATELY COMPACTED TO PREVENT FAILURE.
3. THE DIKE SHALL BE STABLILIZED WITH TEMPORARY OR PERMANENT SEEDING OR RIPRAP.

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FILE: TEMPDIKE

INTERCEPTION/DIVERSION DITCH

SILT FENCE

A silt fence is a temporary sediment barrier used to remove sediment from runoff. The fence works by intercepting sheet flow from slopes, causing the runoff to pond behind the fence, thereby promoting deposition of sediment on the uphill side of the fence. Silt fence consists of a geotextile fabric that is trenched or sliced into the ground. The bottom of the fence is anchored into the ground by compacting the disturbed soil along both sides of the trench or slice. The top of the fence is attached to posts for support, creating a barrier to the flow of contaminated stormwater runoff.

Design considerations

Silt fence should be installed along the contour of the slope (i.e., the entire length should be at the same elevation). At each end of the silt fence, a 20-foot segment should be turned uphill ("J"-hook) to prevent ponded water from flowing around the ends of the silt fence. Individual sections of silt fence should be limited to 200-foot lengths. This limits the impact if a failure occurs. Silt fence should be located to maximize the storage volume created behind the fence. Larger storage volumes increase the sediment removal efficiency of the silt fence and decrease the required replacement/cleanout intervals. Silt fence is commonly placed at the toe of a slope. When used for this application, the silt fence should be located as far away from the toe of the slope as practical to ensure that a large storage volume is available for runoff and sediment.

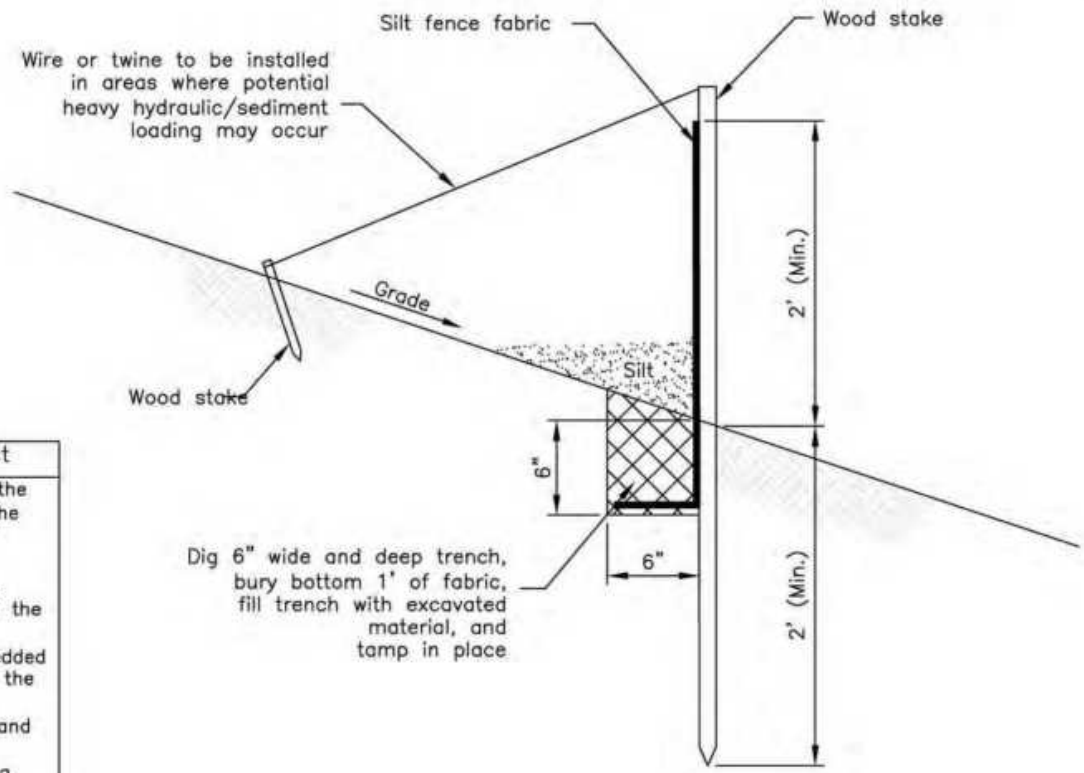
For sediment control applications, the maximum contributing area should not exceed 0.25 acre per 100 feet of fence. If the contributing area exceeds this value, additional silt fence should be installed to break up the runoff into multiple storage areas.

When used as a velocity control measure for sheet flow on long slopes of disturbed ground, silt fence should be placed at intervals of not more than 100 feet. When silt fence is used under concentrated flow, as a ditch check to intercept soil and debris from water flowing through ditches or swales, silt fence should be placed at intervals of 25 to 150 feet, depending on the steepness of the ditch and the volume of runoff anticipated.

Maintenance

When accumulated sediment reaches approximately one third of the fence height, new silt fence should be installed, leaving the existing fence in place, and locating the new silt fence a sufficient distance away from it to provide area for sediment accumulation. When site conditions require that the silt fence be cleaned out rather than replaced, extreme care must be taken to ensure that the silt fence is not damaged. Removed sediment should be spread out and stabilized. Any areas of damaged silt fence should be replaced immediately. Upon project completion, fence fabric, posts, and accumulated sediment should be removed. Any areas disturbed by the removal of the silt fence or sediment should be stabilized.

December 30, 2013



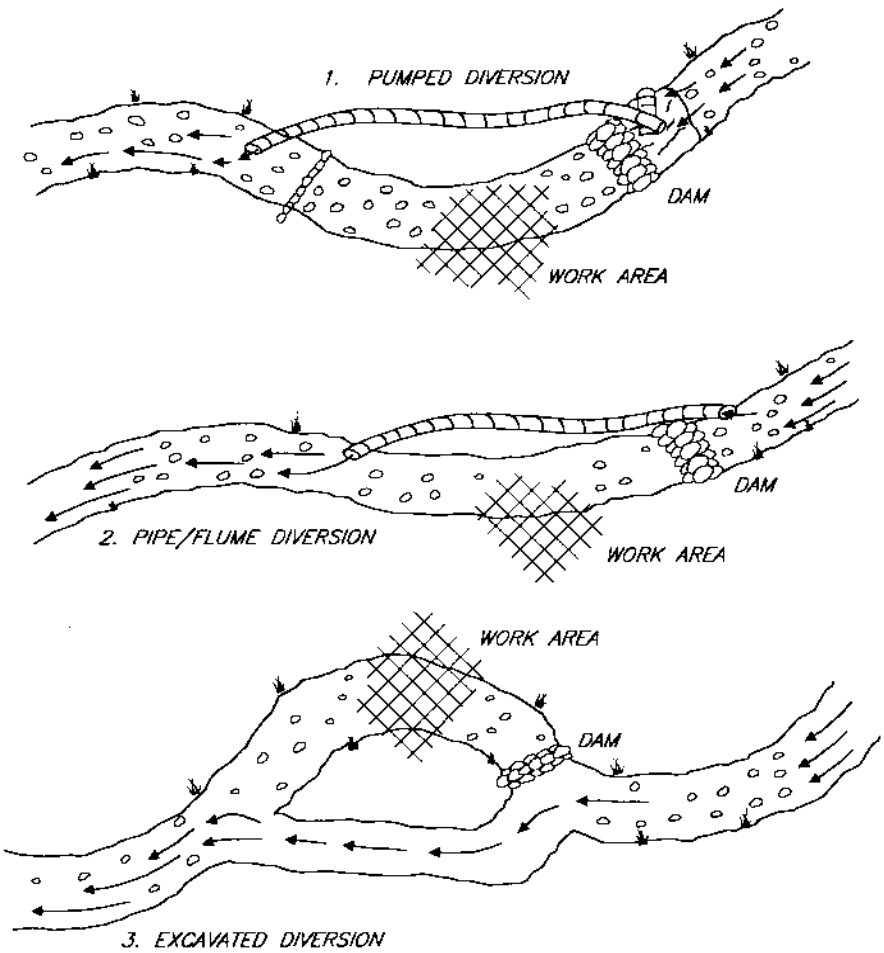
Maintenance Inspection Checklist
1. Check the sediment load captured by the fence. Remove sediment if it is 1/3 the height of the fence, or appears to be damaging the fence installation.
2. Check for tears in the fabric or areas where the fabric has come loose from the stakes.
3. Check that the fence is securely embedded in the ground along the full length of the installation.
4. Check that all the stakes are upright and not broken.
5. Check that stormwater has not found a way around the installation. Add fence as necessary.

(NOT TO SCALE)

Program Manager	ARCADIS 420 L Street, Suite 100 Anchorage, Alaska 99501 Phone: 907-277-3770, FAX: 907-277-3776 www.arcadis-us.com	SILT FENCE DETAILS	Project Number MH000969.0001
Project Manager			Drawing Date 7/30/2007
Task Manager			Figure 19
Technical Review D. Helmericks			

Clear Water Diversion

NS-5



TYPICAL STREAM DIVERSION TECHNIQUES

Clear Water Diversion

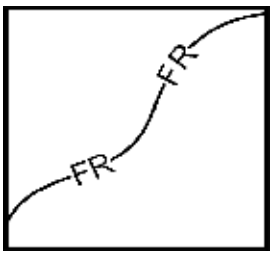
BMP Description: A clear water diversion is a way to divert water away from the work area. A dam is constructed using rock or a supersack or other measure and the flowing water is diverted using a pipe or excavated channel to move around the work area and back into existing flow pathway downstream. The water can flow through the channel by gravity flow or can be pumped. Fish are protected from harm throughout the diversion process.

Installation: Install before beginning any in-water work.

Maintenance and Inspection: Make sure the dam is holding, no fish are being harmed and the diversion is working as intended.

Fiber Rolls

SC-5



Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A fiber roll consists of wood excelsior, rice or wheat straw, or coconut fibers that is rolled or bound into a tight tubular roll and placed on the toe and face of slopes to intercept runoff, reduce its flow velocity, release the runoff as sheet flow and provide removal of sediment from the runoff. Fiber rolls may also be used for inlet protection and as check dams under certain situations.

Appropriate Applications

- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible
- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- Below the toe of exposed and erodible slopes.
- Fiber rolls may be used as check dams in unlined ditches
- Fiber rolls may be used for drain inlet protection
- Down-slope of exposed soil areas.
- Around temporary stockpiles.
- Along the perimeter of a project.

Fiber Rolls

SC-5

Limitations

- Runoff and erosion may occur if fiber roll is not adequately trenched in.
- Fiber rolls at the toe of slopes greater than 1:5 may require the use of 500 mm (20” diameter) or installations achieving the same protection (i.e., stacked smaller diameter fiber rolls, etc.).
- Fiber rolls may be used for drainage inlet protection if they can be properly anchored.
- Difficult to move once saturated.
- Fiber rolls could be transported by high flows if not properly staked and trenched in.
- Fiber rolls have limited sediment capture zone.
- Do not use fiber rolls on slopes subject to creep, slumping, or landslide.

Standards and Specifications

Fiber Roll Materials

- Fiber rolls shall be either:

  (1) Prefabricated rolls.

  (2) Rolled tubes of erosion control blanket.

Assembly of Field Rolled Fiber Roll

- Roll length of erosion control blanket into a tube of minimum 200 mm (8 in) diameter.
- Bind roll at each end and every 1.2 m (4 ft) along length of roll with jute-type twine.

Installation

- Slope inclination of 1:4 or flatter: fiber rolls shall be placed on slopes 6.0 m apart.
- Slope inclination of 1:4 to 1:2: fiber rolls shall be placed on slopes 4.5 m apart.
- Slope inclination 1:2 or greater: fiber rolls shall be placed on slopes 3.0 m apart.
- Stake fiber rolls into a 50 to 100 mm (2 to 4 in) trench.

Fiber Rolls

SC-5

- If more than one fiber roll is placed in a row, the rolls shall be overlapped; not abutted.

Removal

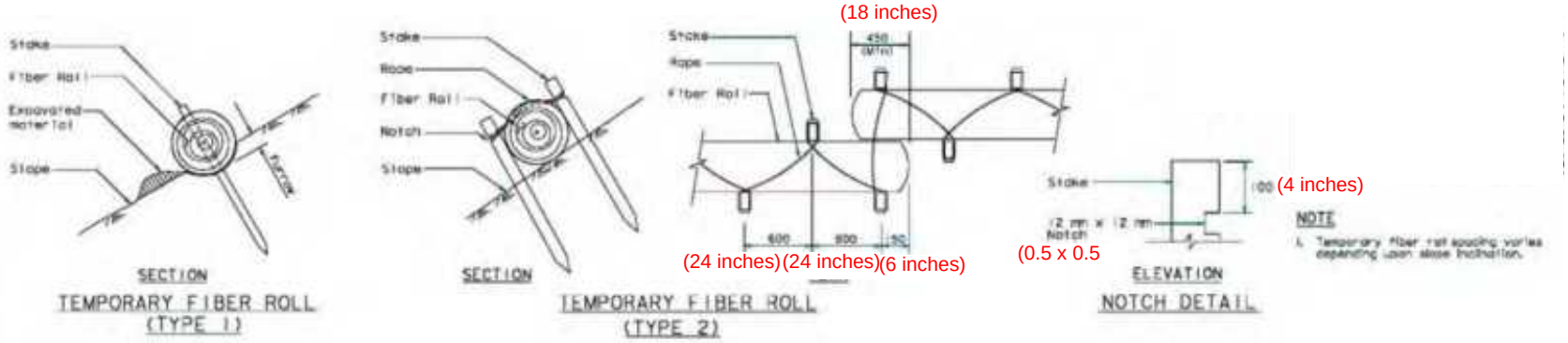
- Fiber rolls are typically left in place.
- If fiber rolls are removed, collect and dispose of sediment accumulation, and fill and compact holes, trenches, depressions or any other ground disturbance to blend with adjacent ground.

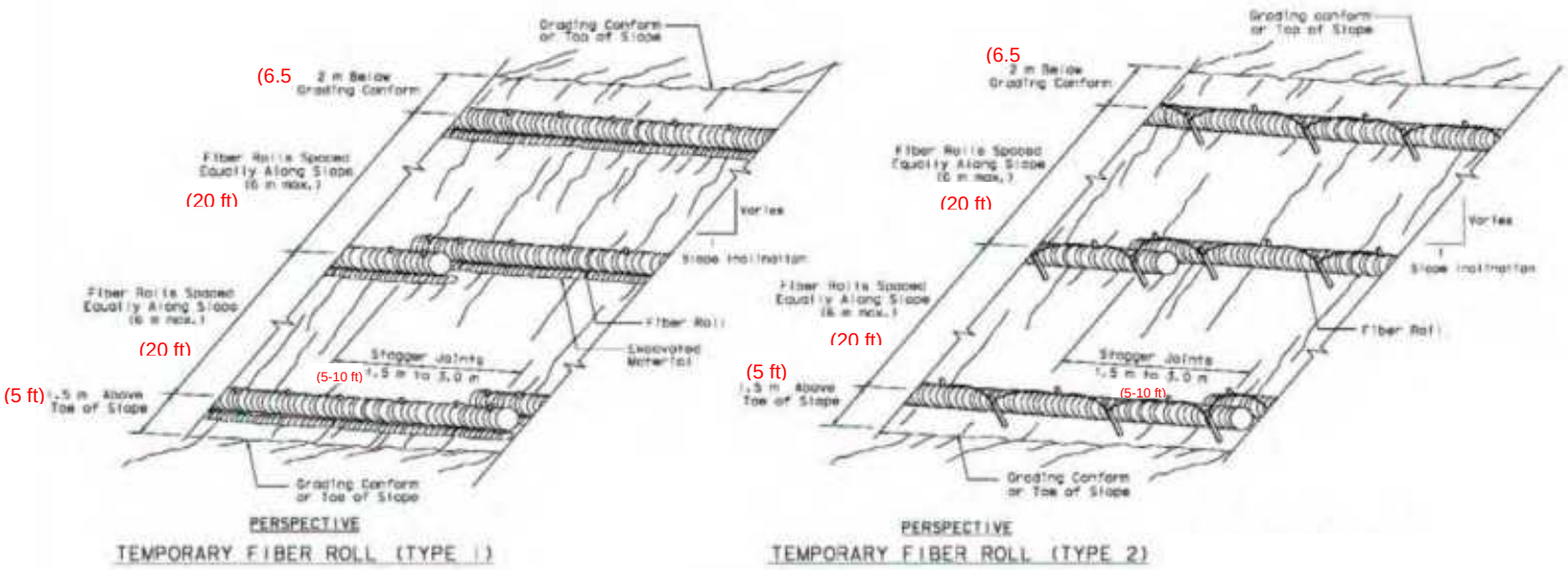
Maintenance and Inspection

- Repair or replace split, torn, unraveling, or slumping fiber rolls.
-
- Maintain fiber rolls to provide an adequate sediment holding capacity. Sediment shall be removed when the sediment accumulation reaches one half (1/2) of the above ground capacity. Removed sediment shall be incorporated in the project at locations designated or disposed of outside the highway right-of-way in conformance with the Standard Specifications.

Fiber Rolls

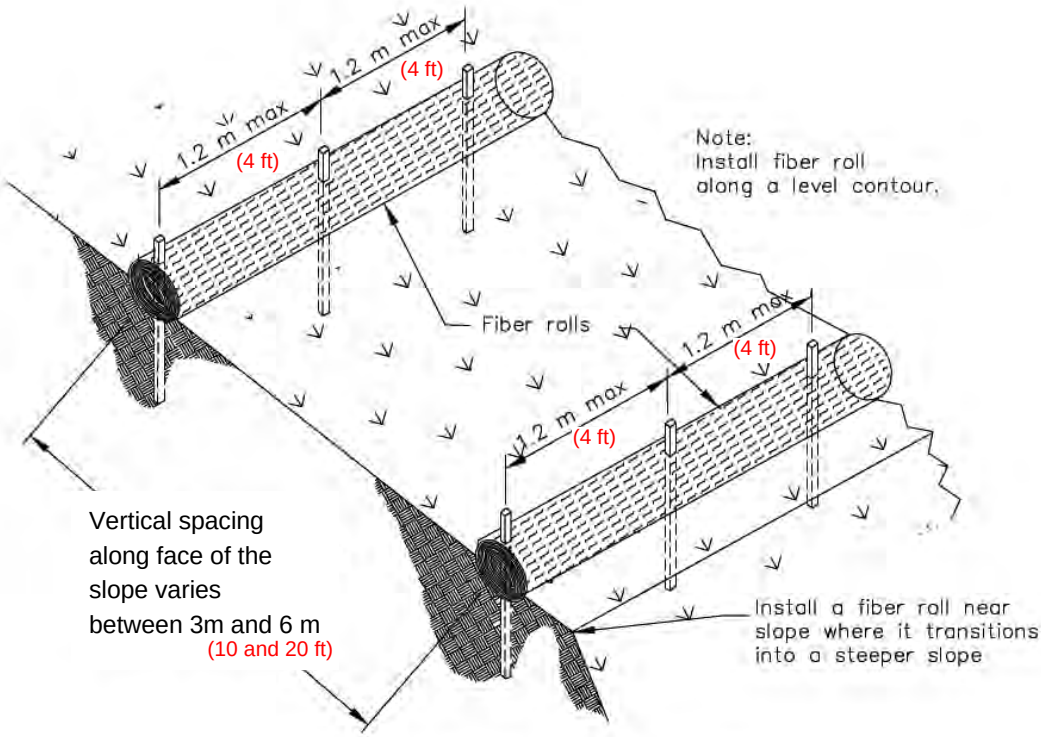
SC-5



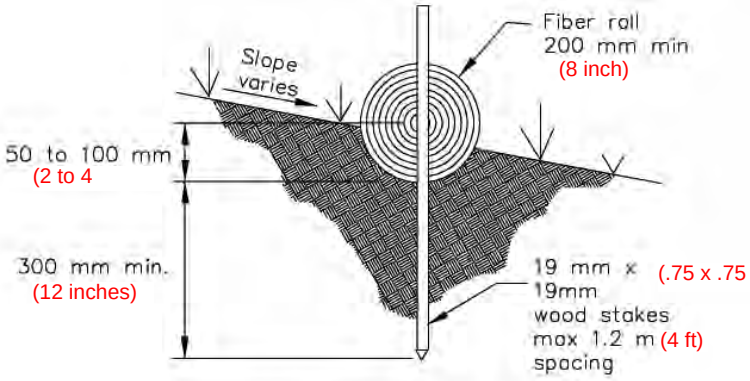


Fiber Rolls

SC-5



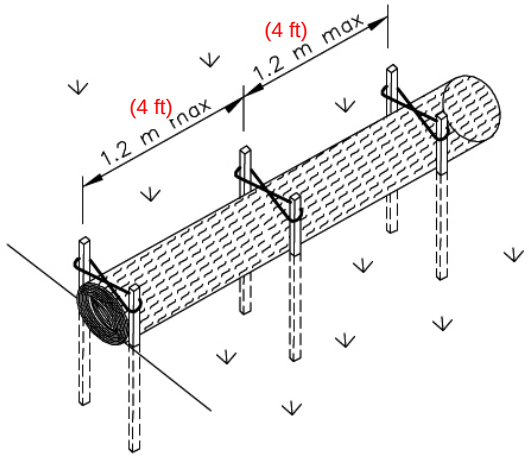
TYPICAL FIBER ROLL INSTALLATION
N.T.S.

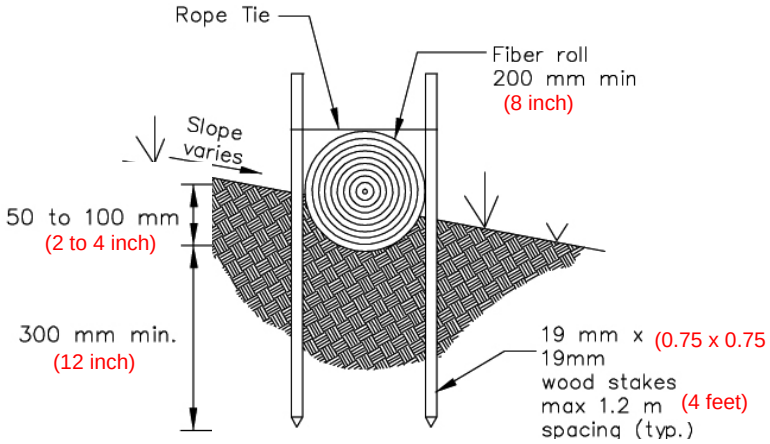


ENTRENCHMENT DETAIL
N.T.S.

Fiber Rolls

SC-5





OPTIONAL ENTRENCHMENT DETAIL

N.T.S.

SC-11 TEMPORARY CONSTRUCTION ENTRANCES

Refer to: ITD Standard Specifications, Sections 104, 205, & 212.
ITD Standard Drawings P-1-F.

BMP Objectives

- ☒ **Perimeter Control**
- ☐ **Slope Protection**
- ☐ **Borrow and Stockpiles**
- ☐ **Drainage Areas**
- ☒ **Sediment Trapping**
- ☐ **Stream Protection**
- ☒ **Temporary Stabilizing**
- ☐ **Permanent Stabilizing**

Definition and Purpose

A temporary sediment removal device made of a pad of crushed stone or rock at the approach from a temporary road to a public road or a detour. This BMP is used to limit tracking of mud off of temporary unpaved roads

Appropriate Applications

A stabilized construction entrance should be considered where:

- Vehicles are entering or leaving a construction site to a public road.
- Any unpaved entrance or exit where there is risk of tracking mud or sediment to the public road.

Limitations

- Management measures may not be needed for entrances or approaches solely contained within the construction site.
- Linear construction may result in limited right-of-way. Adequate control of sediment track-out may require additional measures.

Design Parameters

- At sites where volume is high, the entrance shall be wide enough to pass two vehicles and shall have an adequate turning radius where it meets existing roads.
- Geotextile, if required, shall be installed on properly prepared surfaces prior to placement of aggregate. Place aggregate at sufficient depth to support heavy equipment and protect

existing pipe culverts from crushing. The material and geotextile shall be removed after use and prior to placement of the final aggregate layer(s). or use a mud mat.

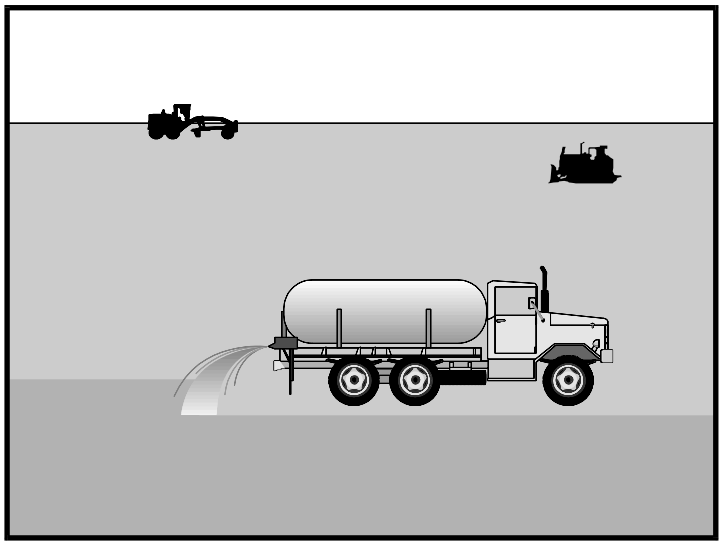
Maintenance and Inspection

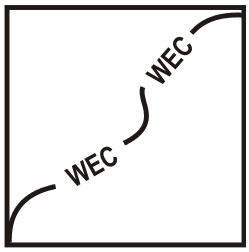
- Conduct inspections as required
- Remove temporary construction entrances after they are no longer needed.

- Make adjustments as necessary and have accumulated sediment and other debris removed and disposed of properly.
- At the end of construction, return to natural conditions using permanent erosion and sediment control BMPs. Remove or stabilize trapped sediment and permanently stabilize disturbed areas.

Wind Erosion Control

WE-1





Standard Symbol

BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Wind erosion control consists of applying water and/or other dust palliatives as necessary to prevent or alleviate erosion by the forces of wind.

Appropriate Applications

- This practice is implemented on all exposed soils subject to wind erosion.

Limitations

- Effectiveness depends on soil, temperature, humidity and wind velocity.

Standards and Specifications

- Water shall be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution equipment shall be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit shall be available at all times to apply water or dust palliative to the project.
- If reclaimed water is used, the sources and discharge must meet all local. state and federal requirements.
- Materials applied as temporary soil stabilizers and soil binders will also provide wind erosion control benefits.

Maintenance and Inspection

- Check areas that have been protected to ensure coverage.

11. Temporary Sediment Trap

Objectives and Applications

A temporary sediment trap is a small temporary ponding area, with a rock outlet, formed by excavating below grade and/or by constructing an earth embankment.

A sediment trap is a temporary structure that is used to detain runoff from small drainage areas so that sediment can settle out. Sediment traps generally are used for drainage areas less than five acres, and should be located in areas where access can be maintained for sediment removal and proper disposal. A sediment trap can be created by excavating a basin, utilizing an existing depression, or constructing a dam on a slight slope downward from a project area. Sediment laden runoff from the disturbed site is conveyed to the trap via ditches, slope drains, or diversion dikes. After being treated, the flow from the structure is controlled by a rock spillway. The trap is a temporary measure, with a design life of approximately six months, and is to be maintained until the site is permanently protected against erosion by vegetation and/or structures.

Common Failures - Generally due to faulty installation or maintenance

- Inadequate spillway size; this results in overtopping of dam, poor trap efficiency, and possible failure of the structure.
- Low point in embankment caused by inadequate compaction and settling; this can result in overtopping and possible failure.
- Outlet not extended to stable grade; this can result in erosion below the dam.
- Spillway stone size too small or backslope too steep; this may result in stone displacement.
- Inadequate storage capacity; the sediment is not removed from basin frequently enough.

Other Considerations

- The location of sediment traps should be determined based on the existing and proposed topography of the site.
- As a perimeter control, locate the trap where up to 5 disturbed acres drain to one location.
- Choose a location where maximum storage can be obtained from natural topography. This will minimize excavation.
- Locations should be selected where interference with construction activities will be minimized and will allow the trap to remain in service until the site is stabilized.
- The site must be accessible for future clean-out of the trap.
- Sediment traps are most effective at removing sand particles and are less effective at removing fine silt and clay particles. Longer retention times using engineered structures such as sediment basins or retention ponds may be necessary to remove these smaller particles.

Relationship to Other ESC Measures

Sediment traps are usually located at the outlets of diversions, channels, slope drains, or other runoff conveyances that discharge sediment laden water.

Alternate Sediment Control Measures

A sediment basin should be considered if the drainage area exceeds five acres. Sediment basins may be either temporary or permanent, and due to additional and more complex design and construction considerations, should be designed by a registered engineer.

Other Names

Catch Basin

Design

Design life: *1 season (6 months) or less*

Contributing flow drainage area: *not to exceed 5 acres*

Storage volume: Size to fit the available area

Wet storage area depth: *minimum 2 ft.- 3 ft., maximum 4 ft.*

Ideal shape: *rectangular and shallow trap, with a length to width ratio of 2:1 or greater*

Berm: *compacted earth, maximum height 5 ft.*

Slopes (cut and fill): *2:1 or flatter*

Outlet*: rock spillway, crest of spillway* 1.0 ft. below top of embankment.

Spillway weir length (minimum)	
Drainage area (Acres)	**Weir length (Feet)**
1 ac.	4 ft.
2 ac.	5 ft
3 ac.	6 ft.
4 ac.	10 ft.
5 ac.	12 ft.

Stone size: *construct outlet using well graded stones with a median stone size of 9 in. and a maximum stone size of 14 inches. A 12-in. thick layer of ½ to ¾ in. aggregate should be placed on the inside face to reduce seepage flow rate.*

Materials

Filter fabric, coarse aggregate or riprap 2 inches to 14 inches in diameter; washed gravel 1/2 inch to 3/4 inch in diameter, seed and mulch for stabilization.

Installation

Clear, grub, and strip the area under the berm of any vegetation and root mat. Clear the pool area to reduce debris buildup and facilitate cleanout. Excavate as required in the plan to obtain the necessary storage volume. Use fill material for the berm that is free of roots, other woody vegetation, organic materials, and large stones. Make all cut and fill slopes 2:1 or flatter. Compact the berm in 8 in. layers by traversing with construction equipment. Construct the rock spillway to the dimensions shown on the plan, placing filter fabric beneath the rock. Provide temporary or permanent stabilization (seed and mulch) on the berm immediately after the construction.

Inspection

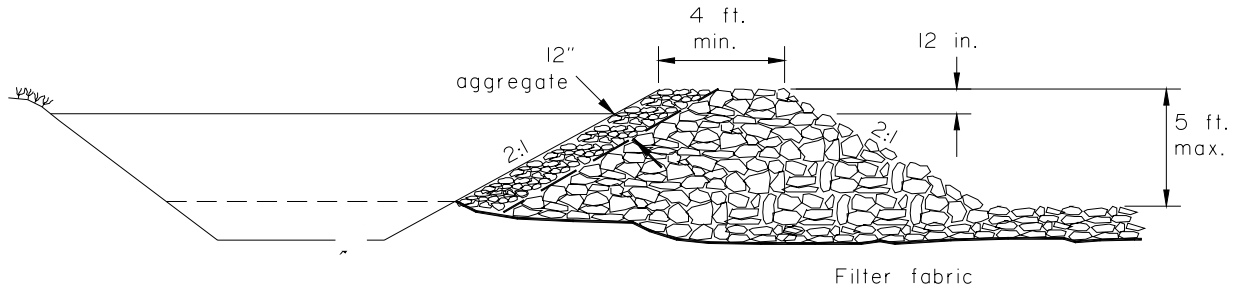
Check the structure for damage from erosion, and check rocks in the outlet for clogging with sediment. Check the height of the stone outlet to ensure that the crest is at least 12 in. below the top of the berm.

Maintenance

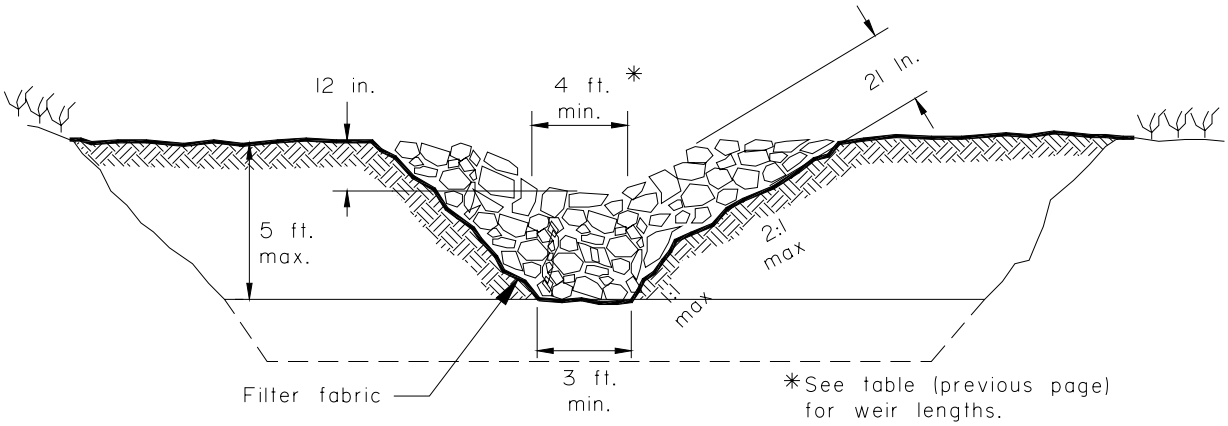
Remove sediment and restore trap to its original dimensions when the sediment has accumulated to one-half the design depth of the trap. Deposit sediment removed from the basin in a suitable area and in such a manner that it will not erode and cause sedimentation problems. Clean or replace the filter stone in the outlet structure if clogged with sediment. Adjust the height of the stone outlet if the crest is not at least 12 in. below the top of the berm.

Removal

Remove sediment traps after the contributing drainage area is stabilized. Grade and stabilize the site of the sediment trap after removal as shown in the plans.



CROSS SECTION



ELEVATION

TEMPORARY SEDIMENT TRAP

Description

The BMPs selected for construction dewatering vary depending on site-specific features such as soils, topography, anticipated discharge quantities, and discharge location. Dewatering typically involves pumping water from an inundated area to a BMP, and then downstream to a receiving waterway, sediment basin, or well-vegetated area. Dewatering typically involves use of several BMPs in sequence.

Photograph DW-1. A relatively small dewatering operation using straw bales and a dewatering bag.

Appropriate Uses

Dewatering operations are used when an area of the construction site needs to be dewatered as the result of a large storm event, groundwater, or existing ponding conditions. This can occur during deep excavation, utility trenching, and wetland or pond excavation.

Photograph DW-2. Dewatering bags used for a relatively large dewatering operation.

Design and Installation

Dewatering techniques will vary depending on site conditions. However, all dewatering discharges must be treated to remove sediment before discharging from the construction site. Discharging water into a sediment trap or basin is an acceptable treatment option. Water may also be treated using a dewatering filter bag, and a series of straw bales or sediment logs. If these previous options are not feasible due to space or the ability to passively treat the discharge to remove sediment, then a settling tank or an active treatment system may need to be utilized. Settling tanks are manufactured tanks with a series of baffles to promote settling. Flocculants can also be added to the tank to induce more rapid settling. This is an approach sometimes used on highly urbanized construction sites. Contact the state agency for special requirements prior to using flocculents and land application techniques.

Some commonly used methods to handle the pumped water without surface discharge include land application to vegetated areas through a perforated discharge hose (i.e., the "sprinkler method") or dispersal from a water truck for dust control.

Dewatering Operations	
Functions	
Erosion Control	Moderate
Sediment Control	Yes
Site/Material Management	Yes

Dewatering discharges to non-paved areas must minimize the potential for scour at the discharge point either using a velocity dissipation device or dewatering filter bag.

Design Details are provided for these types of dewatering situations:

DW-1. Dewatering for Pond Already Filled with Water

DW-2 Dewatering Sump for Submersed Pump

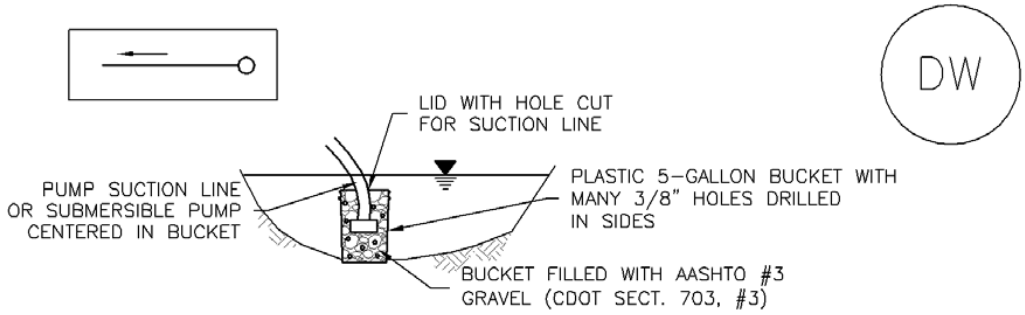
DW-3 Sump Discharge Settling Basin

DW-4 Dewatering Filter Bag

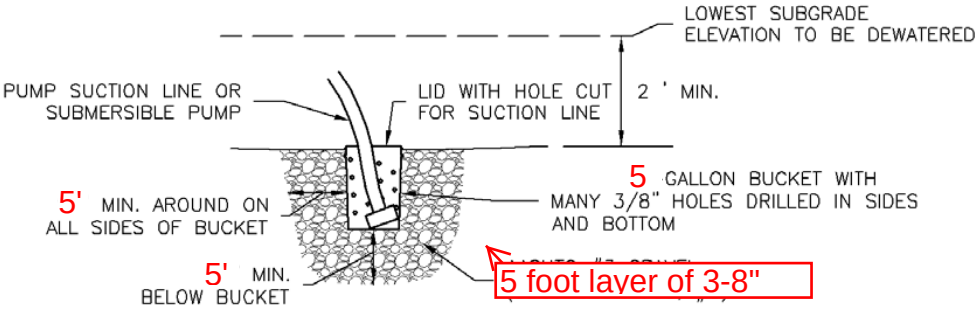
Maintenance and Removal

When a sediment basin or trap is used to enable settling of sediment from construction dewatering discharges, inspect the basin for sediment accumulation. Remove sediment prior to the basin or trap reaching half full. Inspect treatment facilities prior to any dewatering activity. If using a sediment control practice such as a sediment trap or basin, complete all maintenance requirements as described in the fact sheets prior to dewatering.

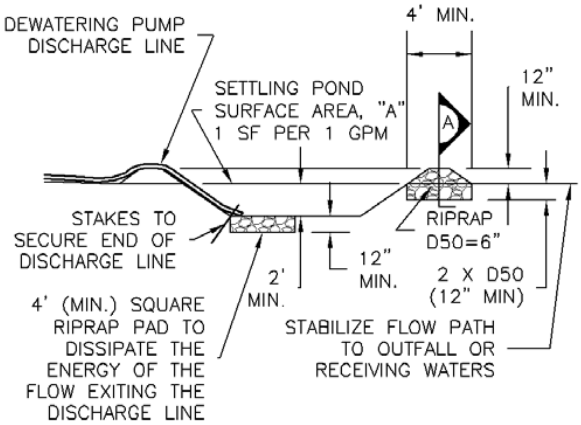
Properly dispose of used dewatering bags, as well as sediment removed from the dewatering BMPs. Depending on the size of the dewatering operation, it may also be necessary to revegetate or otherwise stabilize the area where the dewatering operation was occurring.



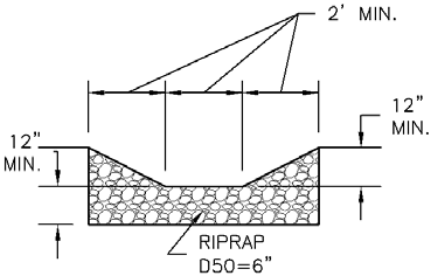
DW-1. DEWATERING POND ALREADY FILLED WITH WATER



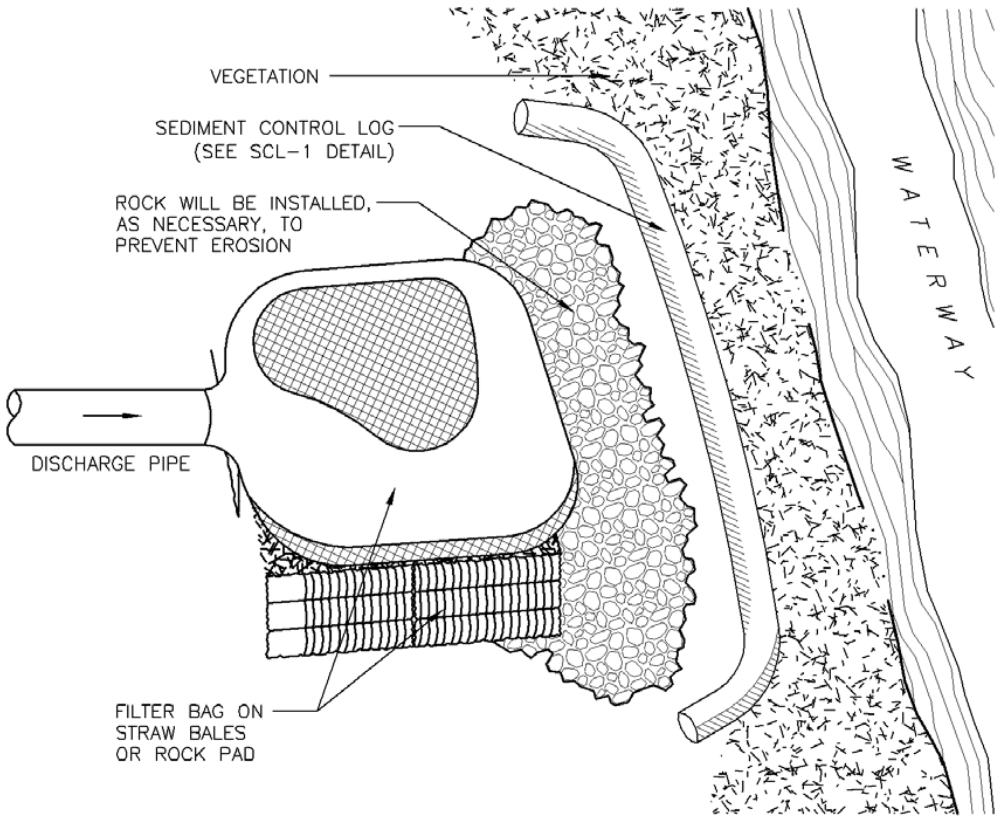
DW-2. DEWATERING SUMP FOR SUBMERSED PUMP



DW-3. SUMP DISCHARGE SETTLING BASIN



SETTLING BASIN SECTION A



DW-4. DEWATERING FILTER BAG

DEWATERING INSTALLATION NOTES

1. SEE PLAN VIEW FOR;
   -LOCATION OF DEWATERING EQUIPMENT.
   -TYPE OF DEWATERING OPERATION (DW-1 TO DW-4).

2. THE OWNER OR CONTRACTOR SHALL OBTAIN A CONSTRUCTION DISCHARGE (DEWATERING) PERMIT FROM THE STATE PRIOR TO ANY DEWATERING OPERATIONS DISCHARGING FROM THE SITE. ALL DEWATERING SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE PERMIT.

3. THE OWNER OR OPERATOR SHALL PROVIDE, OPERATE, AND MAINTAIN DEWATERING SYSTEMS OF SUFFICIENT SIZE AND CAPACITY TO PERMIT EXCAVATION AND SUBSEQUENT CONSTRUCTION IN DRY CONDITIONS AND TO LOWER AND MAINTAIN THE GROUNDWATER LEVEL A MINIMUM OF 2-FEET BELOW THE LOWEST POINT OF EXCAVATION AND CONTINUOUSLY MAINTAIN EXCAVATIONS FREE OF WATER UNTIL BACK-FILLED TO FINAL GRADE.

DEWATERING INSTALLATION NOTES

4. DEWATERING OPERATIONS SHALL USE ONE OR MORE OF THE DEWATERING SUMPS SHOWN ABOVE, WELL POINTS, OR OTHER MEANS APPROVED BY THE LOCAL JURISDICTION TO REDUCE THE PUMPING OF SEDIMENT, AND SHALL PROVIDE A TEMPORARY SEDIMENT BASIN OR FILTRATION BMP TO REDUCE SEDIMENT TO ALLOWABLE LEVELS PRIOR TO RELEASE OFF SITE OR TO A RECEIVING WATER. A SEDIMENT BASIN MAY BE USED IN LIEU OF SUMP DISCHARGE SETTLING BASIN SHOWN ABOVE IF A 4-FOOT-SQUARE RIPRAP PAD IS PLACED AT THE DISCHARGE POINT AND THE DISCHARGE END OF THE LINE IS STAKED IN PLACE TO PREVENT MOVEMENT OF THE LINE.

DEWATERING MAINTENANCE NOTES

1. INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

2. FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.

3. WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.

4. DEWATERING BMPs ARE REQUIRED IN ADDITION TO ALL OTHER PERMIT REQUIREMENTS.

5. TEMPORARY SETTLING BASINS SHALL BE REMOVED WHEN NO LONGER NEEDED FOR DEWATERING OPERATIONS. ANY DISTURBED AREA SHALL BE COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED IN A MANNER APPROVED BY THE LOCAL JURISDICTION.

NOTE: MANY JURISDICTIONS HAVE BMP DETAILS THAT VARY FROM UDFCD STANDARD DETAILS. CONSULT WITH LOCAL JURISDICTIONS AS TO WHICH DETAIL SHOULD BE USED WHEN DIFFERENCES ARE NOTED.

(DETAILS ADAPTED FROM DOUGLAS COUNTY, COLORADO, NOT AVAILABLE IN AUTOCAD)

BMP AK-9
Mulching

Objectives and Applications

Mulching is the application of a uniform protective layer of straw, wood fiber, wood chips, or other acceptable material on or incorporated into the soil surface of a seeded area to allow for the immediate protection of the seed bed.

The purpose of mulching is to protect the soil surface from the forces of raindrop impact and overland flow, foster the growth of vegetation, increase infiltration, reduce evaporation, insulate the soil, and suppress weed growth. Mulching also helps hold fertilizer, seed, and topsoil in place in the presence of wind, rain, and runoff, and reduces the need for watering. Mulching may be utilized in areas that have been seeded either for temporary or permanent cover.

Mulches include straw, hay, wood fiber, paper fiber, wood/ paper fiber blends, peat moss, wood chips, bark chips, shredded bark, manure, compost and corn stalks. This type of mulch is usually spread by hand or by machine (mulch blower) after seed, water, and fertilizer have been applied. Soil binders or tackifiers, composed of a variety of synthetic and organic materials, including emulsions or dispersions of vinyl compounds, rubber, asphalt, or plastics mixed with water are often added to commercial mulch products. Tackifiers aid in the stabilization process, and are not used as a mulch alone, except in cases where temporary dust and erosion control is required. Hydroseeding, sometimes referred to as hydromulching, consists of mixing a tackifier, specified organic mulch, seed, water, and fertilizer together in a hydroslurry and spraying a layer of the mixture onto a surface or slope with hydraulic application equipment. The choice of materials for mulching should be based on soil conditions, season, type of vegetation, and the size of the area.

Common Failures - Generally due to faulty installation or maintenance.

- Mulches are not properly watered after application, resulting in drying out and possible blowing or washing away of materials.
- Depth of mulching material is either insufficient or excessive, resulting in low seed germination rates.
- Hydroseeding slurry not applied uniformly, resulting in spotty germination and inadequate ground cover.

Other Considerations

- Mulch should be applied immediately after seeding to improve seed germination.
- Hydroseeding can be performed in one step, and is effective provided that materials are properly mixed and equipment is in good working order.
- Depth of the applied mulch should be not less than 1 in. and not more than 2 in.
- Chemical soil stabilizers or soil binders, when used alone, are less effective than other types of mulches. These products are primarily useful for tacking organic mulches.
- A tackifier should be used in conjunction with seeding, fertilizing, and mulching or hydro-seeding on any slopes steeper than 3:1.
- Check labels on chemical mulches and binders for environmental concerns. Take precautions to avoid damage to fish, wildlife, and water resources.
- Some materials such as wood chips may absorb nutrients necessary for plant growth.

Relationship to Other ESC Measures

Mulching may be performed in conjunction with seeding, fertilizing, surface roughening, and grading practices. Concentrated flows of runoff should be directed away from mulched areas.

Alternate Sediment Control Measures

Erosion Control Blankets; Sodding

Other Names

Hydromulching; Chemical Stabilization

Design

Design life: *1 season (6 months) or less*

Site applicability: *Areas which have been disturbed and require temporary or permanent cover*

Materials and application rates: *as per Section 619 and Section 727 of Alaska Standard Specifications for Highway Construction, and Special Provisions for project*

Materials

Most Commonly Specified Mulches – Wood Fiber, Paper Fiber, Wood/Paper Fiber Combination Blends, Peat Moss

Other Mulches – Straw, Hay, Wood Chips, Bark Chips, Shredded Bark, Corn Stalks, Compost, Manure

Tackifiers – Vinyl Compounds, Rubber, Asphalt, or Plastics mixed with water

Installation

Complete the required grading as shown on the plans and ensure that erosion control measures intended to minimize runoff over the area to be mulched are in place. Apply mulch at the rates specified in the special provisions either by hand or by machinery immediately after the seed and fertilizer have been applied (two step method), or as part of the hydroslurry incorporating seed, fertilizer, mulch, and water (one step method). Apply specified tackifier if not already incorporated into the mulch matrix or hydroslurry. Provide additional watering as specified to ensure optimal seed germination conditions.

Inspection

]

check for rill erosion, dislocation, or failure.

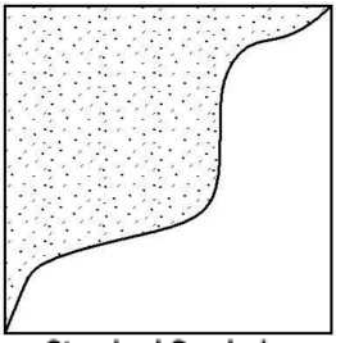
Maintenance

Replace mulch that has been loosened or dislodged. In addition, reseed areas if necessary. Water mulched areas periodically to ensure that moisture content will be maintained and seed germination and grass growth will continue.

Removal

Mulching is usually left in place to naturally decompose and become part of the soil structure.

EC-11 GEOTEXTILES, PLASTIC COVERS & EROSION CONTROL BLANKETS/MATS



Standard Symbol

BMP Objectives

- ☐ **Perimeter Control**
- ☒ **Slope Protection**
- ☒ **Borrow and Stockpiles**
- ☒ **Drainage Areas**
- ☐ **Sediment Trapping**
- ☐ **Stream Protection**
- ☒ **Temporary Stabilizing**
- ☒ **Permanent Stabilizing**

Definition and Purpose

This BMP involves the placement of geotextiles, mats, plastic covers, or erosion control blankets to temporarily stabilize disturbed soil areas and protect soils from erosion by wind or water.

Appropriate Applications

These measures are used when disturbed soils may be particularly difficult to stabilize, including the following situations:

- Steep slopes, generally steeper than 3:1
- Slopes with loose soils or non-cohesive sandy and/or silty material.
- Slopes and disturbed soils where mulch must be anchored.
- Disturbed areas where plants are slow to develop.
- Channels with flows exceeding 3.3 feet/second.
- Channels to be vegetated
- Stockpiles
- Slopes adjacent to water bodies of environmentally sensitive areas (ESAs).

Limitations

- Blankets and mats are more expensive than other erosion control measures, due to labor and material costs. This usually limits their application to areas inaccessible to hydraulic equipment or where other measures are not applicable, such as channels.

- Blankets and mats are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (because staples and netting can catch in mowers).
- Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
- Non-degradable fabrics must generally be removed when permanent stabilization measures are ready to be installed. Failure to move these materials creates trash that may be environmentally harmful and may result in littering fines.
- Plastic results in 100 percent runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- The use of plastic should be limited to covering stockpiles, or very small graded areas for short periods of time (such as through one imminent storm event), until alternative measures, such as seeding and mulching, may be installed.
- Geotextiles, mats, plastic covers, and erosion control covers have maximum flow rate limitations. The manufacturer shall be consulted for proper selection.

Material Selection

There are many types of erosion control blankets and mats, and selection of the appropriate type shall be based on the specific type of application and site conditions.

Geotextiles

- A wide variety of Geotextiles are available, dependent on their intended uses which range from separation of different materials (such as road bedding and underlying soils) to lining ponds and landfills. For temporary erosion control, geotextile fabrics typically consist of woven or non-woven fabrics that are used to line channels or slopes and are usually used in combination with rock or other mulches or riprap.
- Geomembrane is a more impervious type of geotextile and can be used to cover stockpiles or bare soil areas, where a more durable material (as compared to plastic sheeting) is desired. The use of geomembranes for this application will likely be very limited due to their higher costs.
- Geotextiles should be secured in place with wire staples or sandbags and by keying into tops of slopes and edges to prevent infiltration of surface waters under Geotextile. Staples shall be made of 0.12-inch steel wire and shall be U-shaped with 8-inch legs and 2-inch crown.
- Geotextiles may be reused if, in the opinion of the Engineer, they are suitable for the use intended.

Plastic Covers

- Plastic sheeting shall have a minimum thickness of 6 millimeters and shall be keyed in at the top of slope and firmly held in place with sandbags or other weights placed no more than 10 feet apart. Seams are typically taped or weighted down their entire length, and there shall be at least a 12 to 24 inches overlap of all seams. Edges shall be embedded a minimum of 6 inches in soil.

- Any sheeting failures shall be repaired immediately. If washout or breakages occur, the material shall be re-installed after repairing the damage to the slope.

Erosion Control Blankets/Mats (Rolled Erosion Control Products)

Degradable rolled erosion control products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. In order for an RECP to be considered 100 percent degradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together must also be degradable.

- **Jute** is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately 1 year. The material is supplied in rolled strips, which shall be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- **Excelsior (curled wood fiber)** blanket material shall consist of machine-produced mats of curled wood excelsior with 80 percent of the fiber 6 inches or longer. The excelsior blanket shall be of consistent thickness. The wood fiber shall be evenly distributed over the entire area of the blanket. The top surface of the blanket shall be covered with a photodegradable extruded plastic mesh. The blanket shall be smolder-resistant without the use of chemical additives and shall be non-toxic and non-injurious to plant and animal life. Excelsior blanket shall be furnished in rolled strips a minimum of 48 inches wide and shall have an average weight of 0.1 pound per square foot (±10 percent) at the time of manufacture. Excelsior blankets shall be secured in place with wire staples. Staples shall be made of 0.12-inch steel wire and shall be U-shaped with 8-inch legs and 2-inch crown.
- **Straw blanket** shall be machine-produced mats of straw with a lightweight degradable netting top layer. The straw shall be attached to the netting with degradable thread or glue strips. The straw blanket shall be of consistent thickness. The straw shall be evenly distributed over the entire area of the blanket. Straw blanket shall be furnished in rolled strips a minimum of 6.5-feet-wide, 82-feet-long, and 0.055 pound per square foot. Straw blankets shall be secured in place with wire staples. Staples shall be made of 0.12- inch steel wire and shall be U-shaped with 8-inch legs and 2-inch crown.
- **Wood fiber blanket** is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance revegetation. The material is furnished in rolled strips, which shall be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- **Coconut fiber blanket** shall be machine-produced mats of 100 percent coconut fiber with degradable netting on the top and bottom. The coconut fiber shall be attached to the netting with degradable thread or glue strips. The coconut fiber blanket shall be of consistent thickness. The coconut fiber shall be evenly distributed over the entire area of the blanket. Coconut fiber blanket shall be furnished in rolled strips with a minimum of 6.5-feet-wide, 82-feet-long, and 0.055 pound per square foot. Coconut fiber blankets shall be secured in place with wire staples. Staples shall be made of 0.12-inch steel wire and shall be U-shaped with 8-inch legs and 2-inch crown.

- **Coconut fiber mesh** is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a degradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which shall be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- **Straw coconut fiber blanket** shall be machine-produced mats of 70 percent straw and 30 percent coconut fiber with a degradable netting top layer and a degradable bottom net. The straw and coconut fiber shall be attached to the netting with degradable thread or glue strips. The straw coconut fiber blanket shall be of consistent thickness and shall be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket shall be furnished in rolled strips a minimum of 6.5-feet-wide, 82-feet-long, and 0.055 pound per square foot. Straw coconut fiber blankets shall be secured in place with wire staples. Staples shall be made of 0.12-inch steel wire and shall be U-shaped with 8-inch legs and 2-inch crown.

Non-degradable RECPs are typically composed of polyethylene, polypropylene, nylon, or other synthetic fibers. In some cases, a combination of degradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-degradable as well.

- **Plastic netting** is a lightweight biaxially-oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which shall be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- **Plastic mesh** is an open-weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than 2 inches. It is used with revegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which shall be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- **Synthetic fiber with netting** is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three-dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be revegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which shall be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- **Bonded synthetic fibers** consist of a three-dimensional geomatrix nylon (or other synthetic) matting. Typically, it has more than 90 percent open area, which facilitates root growth. Its tough root-reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that shall be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- **Combination synthetic and biodegradable RECPs** consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top

and a high-strength continuous-filament geomatrix or net stitched to the bottom. The material is designed to enhance revegetation. The material is furnished in rolled strips, which shall be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Site Preparation

- Prepare the site properly to ensure complete contact of the blanket or matting with the soil.
- Grade and shape the area of installation.
- Remove all rocks, clods, vegetation, or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil.
- Prepare seedbed by loosening 2 to 3 inches of topsoil. When using a fabric or mat that is designed to be used in conjunction with seeding or revegetation, follow the manufacturer's guidelines for proper seedbed preparation, seed application, and/or planting.

Seeding

Seed the area before blanket installation for erosion control and revegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all check slots and other areas disturbed during installation must be re-seeded. Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Anchoring

- U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats and blankets to the ground surface.
- Staples shall be made of 0.12-inch steel wire and shall be U-shaped with 8-inch legs and 2-inch crown. Wire staples shall be minimum of 11 gauge.
- Metal stake pins shall be 0.188-inch-diameter steel with a 1.5-inch steel washer at the head of the pin.
- Wire staples and metal stakes shall be driven flush to the soil surface.

- All anchors shall be a minimum of 6 inches long and have sufficient penetration to resist pullout. Longer anchors may be required for loose soils as determined by the responsible party or by manufacturer's installation guidelines.

Installation on Slopes

Installation shall be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Begin at the top of the slope and anchor the blanket in a 6-inch-deep by 6-inch-wide trench. Backfill trench and tamp earth firmly.
- Unroll blanket down slope in the direction of water flow.
- Overlap the edges of adjacent parallel rolls 6 inches and staple every 3 feet.
- When blankets must be spliced, place blankets end over end (shingle style) with 6 inches of overlap. Staple through overlapped area, approximately 12 inches apart.
- Lay blankets loosely and maintain direct contact with the soil. Do not stretch.
- Staple blankets sufficiently to anchor them and maintain contact with the soil. Staples shall be placed down the center and staggered with the staples placed along the edges.
    - Steep slopes (1:1 to 2:1) require a minimum of 2 staples/yd^2.
    - Moderate slopes (2:1 to 3:1) require a minimum of 1.5 staples/yd^2, placing 1 staple/yd on centers.
    - Gentle slopes require a minimum of 1 staple/yd^2.

Installation in Channels

Installation shall be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Dig initial anchor trench 12 inches deep and 6 inches wide across the channel at the lower end of the project area.
- Excavate intermittent check slots, 6 inches deep and 6 inches wide across the channel at 25- to 30-foot intervals along the channels.
- Cut longitudinal channel anchor slots 4 inches deep and 4 inches wide along each side of the installation to bury edges of matting. Whenever possible, extend matting 2 to 3 inches above the crest of the channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12-inch intervals. Note: matting will initially be upside down in anchor trench.
- In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 6 inches.
- Secure these initial ends of mats with anchors at 12-inch intervals, backfill, and compact soil.

- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 6-inch overlap.
- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot, then fold back against itself. Anchor through both layers of mat at 12-inch intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
- Alternate method for non-critical installations. Place two rows of anchors on 6-inch centers at 25- to 30-foot intervals in lieu of excavated check slots.
- Shingle lap ends by overlapping uphill on top of downhill fabric a minimum of 12 inches to prevent water from flowing underneath fabric at splice locations. See schematics at end of this BMP.
- Place edges of outside mats in previously excavated longitudinal slots. Anchor using prescribed staple pattern, backfill, and compact soil.
- Anchor, fill, and compact upstream end of mat in a 6-inch by 12-inch terminal trench.
- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.
- Seed and fill turf reinforcement matting with soil, if specified.

Soil Filling (if specified for turf reinforcement)

- Always consult the manufacturer's recommendations for installation.
- Do not drive tracked or heavy equipment over mat.
- Avoid any traffic over matting if loose or wet soil conditions exist.
- Use shovels, rakes, or brooms for fine grading and touch up.
- Smooth out soil filling, just exposing top netting of mat.

Blanket Removal

When no longer required for work, non-degradable temporary blankets shall be removed from the site and disposed.

Maintenance and Inspection

- Inspections shall be conducted as required by the APDES permit or contract specifications.
- Areas treated with temporary geotextiles, mats, blankets, and other covers shall be maintained to provide adequate erosion control. Temporary geotextiles, mats, blankets, and other covers shall be reapplied or replaced on exposed soils when greater than 10 percent of the previously treated area becomes exposed or exhibits visible erosion or as determined by the responsible party.
- Any failures shall be repaired immediately.

- If washout or breakage occurs, reinstall the material after repairing the damage to the slope or channel.

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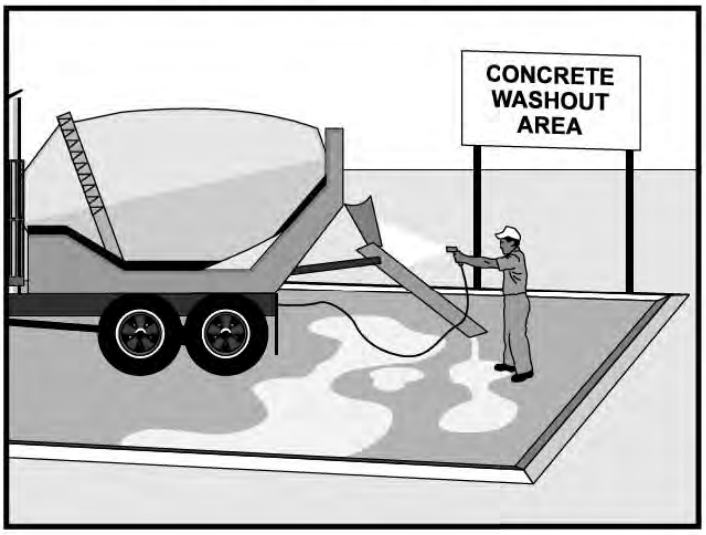

Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout offsite, performing onsite washout in a designated area, and training employee and subcontractors.

Suitable Applications

Concrete waste management procedures and practices are implemented on construction projects where:

- Concrete is used as a construction material or where concrete dust and debris result form demolition activities
- Slurries containing portland cement concrete (PCC) or asphalt concrete (AC) are generated, such as from saw cutting, coring, grinding, grooving, and hydro-concrete demolition
- Concrete trucks and other concrete-coated equipment are washed onsite
- Mortar-mixing stations exist

Limitations

- Offsite washout of concrete wastes may not always be possible.

WM-8 Concrete Waste Management

Implementation

The following steps will help reduce stormwater pollution from concrete wastes:

- Discuss the concrete management techniques described in this BMP (such as handling of concrete waste and washout) with the ready-mix concrete supplier before any deliveries are made.
- Incorporate requirements for concrete waste management into material supplier and subcontractor agreements.
- Store dry and wet materials under cover, away from drainage areas.
- Avoid mixing excess amounts of fresh concrete.
- Perform washout of concrete trucks offsite or in designated areas only.
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped onsite, except in designated areas.
- For onsite washout:
  - Locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste.
  - Wash out wastes into the temporary pit where the concrete can set, be broken up, and then disposed properly.
- Avoid creating runoff by draining water to a bermed or level area when washing concrete to remove fine particles and expose the aggregate.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile or dispose in the trash.

Education

- Educate employees, subcontractors, and suppliers on the concrete waste management techniques described herein.
- Arrange for contractor's superintendent or representative to oversee and enforce concrete waste management procedures.

Concrete Slurry Wastes

- PCC and AC waste should not be allowed to enter storm drains or watercourses.
- PCC and AC waste should be collected and disposed of or placed in a temporary concrete washout facility.
- A sign should be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.

Concrete Waste Management WM-8

- Below grade concrete washout facilities are typical. Above grade facilities are used if excavation is not practical.
- A foreman or construction supervisor should monitor onsite concrete working tasks, such as saw cutting, coring, grinding and grooving to ensure proper methods are implemented.
- Saw-cut PCC slurry should not be allowed to enter storm drains or watercourses. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine. Saw cutting residue should not be allowed to flow across the pavement and should not be left on the surface of the pavement.
- Slurry residue should be vacuumed and disposed in a temporary pit (as described in OnSite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below) and allowed to dry.

Onsite Temporary Concrete Washout Facility, Transit Truck Washout Procedures

- Temporary concrete washout facilities should be located a minimum of 50 ft from storm drain inlets, open drainage facilities, and watercourses. Each facility should be located away from construction traffic or access areas to prevent disturbance or tracking.
- A sign should be installed adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.
- Temporary concrete washout facilities should be constructed above grade or below grade at the option of the contractor. Temporary concrete washout facilities should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.
- Temporary washout facilities should have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.
- Washout of concrete trucks should be performed in designated areas only.
- Only concrete from mixer truck chutes should be washed into concrete wash out.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of offsite.
- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of according to local regulation Dispose of hardened concrete on a regular basis.

Remove hardened concrete waste when it has reached 1/2 the height of the container and dispose of it away from stormwater conveyance channels, storm drain inlets and waters of the U.S. Dispose of it in

- Temporary Concrete Washout Facility (Type Above Grade)
  - Temporary concrete washout facility (type above grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and

WM-8 Concrete Waste Management

minimum width of 10 ft, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.

- Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

- Temporary Concrete Washout Facility (Type Below Grade)
  - Temporary concrete washout facilities (type below grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations.
  - Lath and flagging should be commercial type.
  - Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete should be removed and disposed of. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and disposed of.
- Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Temporary concrete washout facilities should be maintained to provide adequate holding capacity with a minimum freeboard of 4 in. for above grade facilities and 12 in. for below grade facilities. Maintaining temporary concrete washout facilities should include removing and disposing of hardened concrete and returning the facilities to a functional condition. Hardened concrete materials should be removed and disposed of.
- Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 50 % full.

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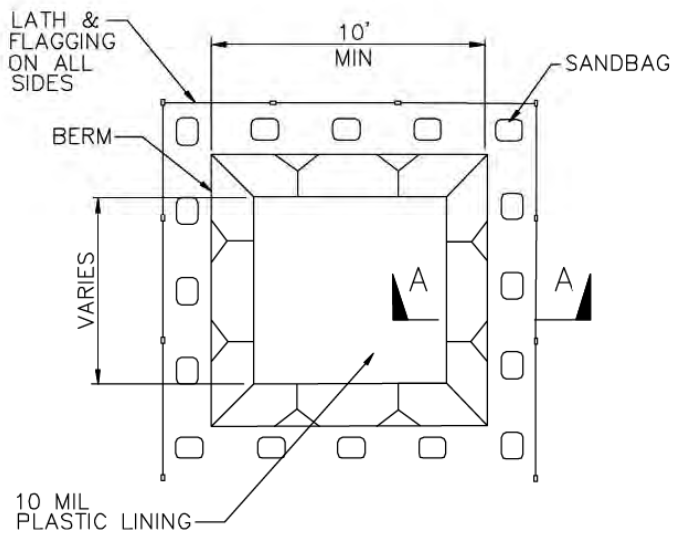
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

WM-8 Concrete Waste Management



PLAN
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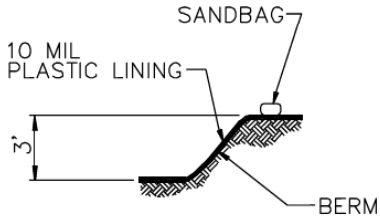
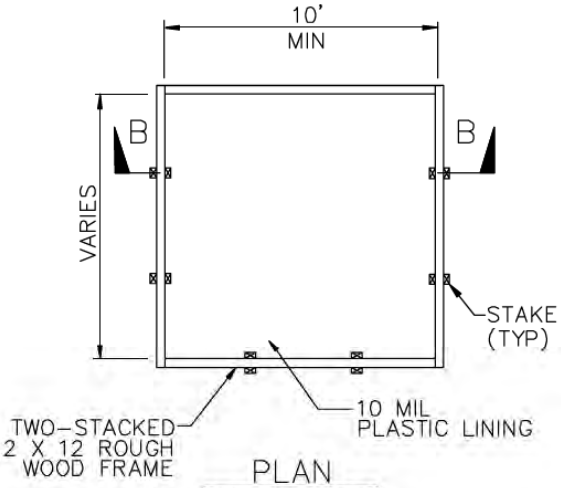
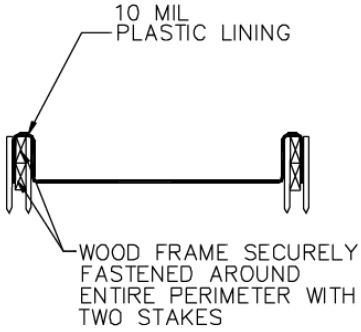


SECTION A–A
NOT TO SCALE



PLAN
NOT TO SCALE
TYPE "ABOVE GRADE"



SECTION B–B
NOT TO SCALE

NOTES

1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

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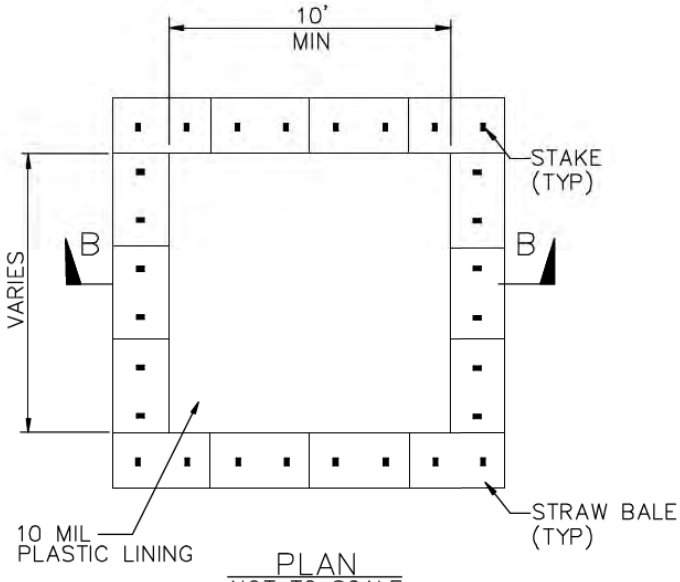
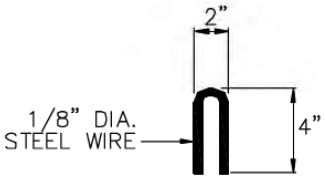
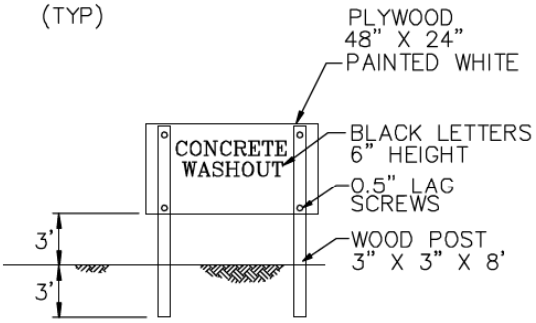


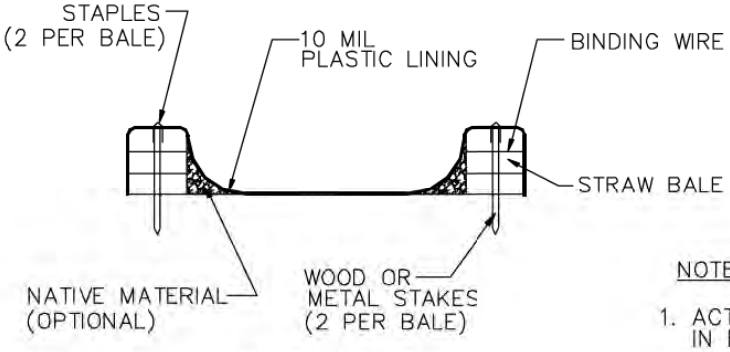
PLAN
NOT TO SCALE
TYPE "ABOVE GRADE"
WITH STRAW BALES



STAPLE DETAIL



CONCRETE WASHOUT
SIGN DETAIL
(OR EQUIVALENT)



SECTION B–B
NOT TO SCALE

NOTES

1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

General Plan of Operations
Appendix 06
Spill Prevention, Control, and Countermeasure Plan

January 2020

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Attachment A - Facility Diagrams

Attachment B - Container Storage Log

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Attachment G - Record of Containment Drainage

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1. INTRODUCTION

The Spill Prevention, Control, and Countermeasure (SPCC) Plan is the document required by the Code of Federal Regulations (CFR) Title 40, §112.3 that details the equipment, workforce, procedures, and steps to prevent, control, and provide adequate countermeasures to a discharge. As set forth at 40 CFR §112.1(e), the purpose of the Plan is to form a comprehensive Federal/State spill prevention program that minimizes the potential for discharges. This Plan addresses all relevant spill prevention, control, and countermeasures necessary for the facility and has been prepared to meet the applicable requirements of 40 CFR §112.7 and §112.8. Amendments, reviews, and evaluations of the Plan will be ongoing pursuant to §112.5. A copy of the plan will be maintained at the Environmental Office at Hawk Inlet. The official controlled document will be available to all personnel electronically via the Intelex system.

In addition to fulfilling the applicable requirements of 40 CFR part 112, this Plan is used as a reference for oil storage information, as a tool to communicate practices on preventing and responding to discharges with employees, as a guide to facility inspections, and as a resource during emergency response.

Hecla Greens Creek Mining Company (HGCMC) management has determined that this facility does pose a risk of substantial harm under 40 CFR part 112 (Attachment C), as recorded in the "Substantial Harm Determination" included in Attachment C of this Plan. This determination is based on the reasonable potential for discharge to the sensitive marine environment of Hawk Inlet during fuel deliveries, which involve the transfer of oil over water from the delivery barge to the bulk storage tank at Hawk Inlet. The oil storage capacity at Hawk Inlet is approximately 200,000 gallons. As a result, HGCMC has also prepared and maintains a Facility Response Plan to meet the applicable requirements of 40 CFR §112.20.

2. MANAGEMENT APPROVAL

This SPCC Plan has been prepared in accordance with good engineering practices and has the full approval of management at a level of authority to commit the necessary resources to fully implement the Plan. The plan follows the sequence specified in §112.7. The facility's conformance with the requirements listed in this part is detailed elsewhere in the Plan as required by this section.

3. PLAN DEVIATIONS AND EQUIVALENT ENVIRONMENTAL PROTECTION (40 CFR §112.7(A)(2))

Plan deviations from the requirements, if any, due to specific facility conditions, with the reasons for nonconformance, are described below along with the detail of the alternative methods to provide equivalent environmental protection of spill prevention, control, or countermeasure.

4. PROFESSIONAL ENGINEER CERTIFICATION

The undersigned licensed Professional Engineer is familiar with the requirements of Part 112 of Title 40 of the *Code of Federal Regulations* (40 CFR part 112) and has visited and examined the facility. The undersigned licensed Professional Engineer attests that this Spill Prevention, Control, and Countermeasure Plan has been prepared in accordance with good engineering practice, including consideration of applicable industry standards and the requirements of 40 CFR part 112; that procedures for required inspections and testing have been established; and that this Plan is adequate for the facility. [40 CFR §112.3(d)]

This certification in no way relieves HGCMC of their duty to prepare and fully implement this SPCC Plan in accordance with the requirements of 40 CFR part 112.

Signature

Name
Bruce N. Nelson

Company
EDE Consultants LLC

Professional Engineer Seal

Title Sr. Engineer / Principal

Date 2/5/20

5. FACILITY DESCRIPTION

The Greens Creek Mine is a precious and base metals (silver, gold, zinc and lead) underground mine with a production rate of a nominal 2,300+ tons per day. HGCMC employs approximately 430 people and operates continuously, 24 hours per day, 7 days per week. The major components of the facility include the:

- Mine/Mill site,
- Tailings site,
- Hawk Inlet site,
- Young Bay site, and
- 13.5 mile connecting Road System.

Since 2006 the facility has utilized hydroelectric power generated offsite as its primary power source. The facility also has the capability to produce enough power for normal operations using onsite diesel power generation. All vehicles and equipment are diesel powered (with few exceptions) and most buildings are heated with diesel fuel, used oil, or direct heat recovery. All petroleum storage tanks at the Greens Creek Mine facility are above ground. No underground tanks are located at this facility. All tanks are either within adequate sized secondary containment or double-walled containers.

5.1. Mine/Mill Site (920 Area)

Located at an elevation of 920 feet, 8.5 miles from the marine terminal at Hawk Inlet, this site is adjacent to Greens Creek and includes the mine, mill, power house, service complex, offices, warehouse, and a bulk diesel fuel storage tank yard (see Figure 1 in Attachment A). HGCMC transfers fuel from the Hawk Inlet bulk storage tank to the 920 Area bulk storage tanks via a 9,000 gallon tanker truck. Up to twelve fuel loads per week are necessary to support operations at full capacity. Approximately 4,000 gallons per month of lubricating oils and hydraulic oil are also transferred by truck from Hawk Inlet to the mine/mill site in portable tanks. Chemicals are delivered dry and wet in containers by truck, and stored at this location. The oil storage containers in this area are described in Attachment B.

5.2. Site 23 and 860

Located near the Mine/Mill site, this area is the site of several administrative buildings, a helipad for summer drill exploration, a storm water pond, and a mine development rock disposal pile. See Figure 2 in Attachment A for a layout diagram. The oil storage containers in this area are described in Attachment B.

5.3. Tailings Site

Located at the upper reaches of Tributary Creek drainage, this site includes a dry stacked (filter pressed) tailings pile, electrical substation, truck wash, large retention ponds for waste water storage prior to treatment, and a wastewater treatment plant (see Figure 3 in Attachment A). All mine/mill wastewater, and captured surface water runoff from the mine/mill, tailings, and Hawk Inlet sites are collected at the Tailings Site, treated, and discharged into Hawk Inlet in accordance with the Greens Creek Alaska Pollutant Discharge Elimination System (APDES) permit Number AK-0043206.

5.4. Hawk Inlet Site

This site includes the marine terminal where all supplies, materials, fuels, and ore concentrates are loaded and/or unloaded on a routine basis (see Figure 4 in Attachment A). Also included are a 200,000 gallon diesel fuel storage tank, associated fill piping from the fuel barge unloading dock, a fuel loading facility for vehicles and the tanker truck, an electrical generator building, and warehouse. Gasoline and Jet A fuel are also stored at the fuel loading facility. Assorted lubricating oils and used oil in portable tanks, totes, and drums are temporarily stored at this site's warehouse prior to their transport to the mine/mill site. A large ore concentrate storage building (maximum 40,000 tons capacity), temporary housing facilities, and ancillary support facilities are also located at the Hawk Inlet site. Chemicals are delivered dry and wet in containers by barge, and temporarily stored at the warehouse at this location. The oil storage containers in this area are described in Attachment B.

5.5. Young Bay Site

This site includes a docking facility for the crew ferry, which transports personnel to and from Juneau to the HGCMC island facilities twice per day. There is also a parking area for the buses used to transport personnel to and from the Hawk Inlet and mine/mill sites. A diesel powered electrical generator provides electricity for the site (see Figure 5 in Attachment A).

5.6. Road System

Greens Creek Mine roads, of variable width, link the Young Bay site, the Hawk Inlet site, and the mine/mill site. A 5 mile long road allows transport of personnel from the Young Bay dock to Hawk Inlet. An 8.5 mile long road allows transport of personnel, supplies, and ore concentrate between Hawk Inlet and the mine/mill site, as well as dry tailings from the mine/mill site to the tailings area. HGCMC policy for travel on these single-lane roads with turnouts requires that all drivers maintain radio contact during transit. Operators call over the in-vehicle radios on an assigned channel to note their position, direction of travel, and vehicle type at least once per mile. All vehicles are equipped with SAFEmine Collision Avoidance System GPS units.

6. OIL/FUEL STORAGE (40 CFR §112.7(A)(3)(I))

Attachment B contains a log of all bulk oil storage containers at the facility with a capacity of 55 gallons or more. Alpha-numeric identifications have been assigned to each fixed container and multi-use portable container. These can be cross-referenced to the appropriate figures in Attachment A to show the storage locations at each of the above referenced sites.

Oil storage at the facility can be grouped into the following categories:

Bulk Diesel Storage: Four field-erected, vertical AST's with one located at Hawk Inlet (200,000 gallon capacity) and three located at the 920 Area (1 @ 60,000 gallon and 2 @ 48,000 gallon capacity).

Fixed Container Storage: This category includes shop built, horizontal AST's, primarily of double-wall or integral closed top dike construction, at fixed locations near their point of use. Multiple tanks are located throughout the facility with capacities ranging from 60 gallons to 10,000 gallons. Contents include diesel, gasoline, hydraulic oil, motor oil and used oil.

Portable Container Storage: This category includes products stored in 55-gallon drums and 350-gallon totes as well as some larger containers that are routinely re-located throughout the site. Also included are towable equipment with on-board fuel tanks that exceed 55 gallons in capacity (e.g., compressors, pumps and generators). Contents include diesel, gasoline, Jet A fuel, hydraulic oil, lubricants, antifreeze, chemical reagents and used oil. The number of containers in each storage area varies and the total storage volume shown in Attachment B represents the likely maximum volume present at any given time.

Oil-Filled Operational Equipment: This category consists of oil filled electrical transformers and hydraulic systems.

Mobile Refuelers: This category includes the fuel truck, lube truck and fuel tanker, which move throughout the facility daily.

7. DISCHARGE PREVENTION MEASURES (40 CFR §112.7(A)(3)(II))

Discharge prevention is accomplished through proper storage and handling of oil products. Fuel and oil at the Greens Creek Mine is stored in appropriate containers and within secondary containment. Containers, appurtenances and containment systems are inspected on a routine basis and prior to transfer operations. Standard Operating Procedures have been developed for routine transfer operations. Product transfers are to be performed only by qualified personnel that have received appropriate task training. Spill response materials are stored at multiple locations throughout the facility where oil products are stored or handled on a routine basis. All HGCMC employees receive general awareness training in the SPCC Plan as part of their annual site-specific MSHA training. A more comprehensive annual SPCC training is also provided for oil-handling personnel. Specific details on secondary containment systems, routine inspections and employee training are provided in subsequent sections of this Plan.

8. DISCHARGE OR DRAINAGE CONTROLS (40 CFR §112.7(A)(3)(III))

Secondary containment is provided for all AST's and non-exempt storage containers. The oil storage container log in Attachment B lists the secondary containment provided for each container. Drainage from diked areas is only performed under direct supervision of HGCMC personnel. In addition to secondary containment, the area around the ASTs and loading/unloading areas have been graded to control drainage and contain oil in the event of a spill. The 920 Area has been sealed with a non-porous, concrete surface. All drainage from this area is directed by curbing to a lined ditch, which feeds to a concrete catchment basin and then into a lined retention pond. The Hawk Inlet port facility (beach area) is also graded to drain to a concrete catchment basin. All drainage collected at the 920 Area and Hawk Inlet is ultimately routed to the Tailings Facility/Pond 7 Water Treatment Plant. This method of containment is consistent with the requirements under §112.8(b)(3) to use ponds, lagoons, or catchment basins to retain oil at the facility.

9. SPILL RESPONSE (40 CFR §112.7(A)(3)(IV))

HGCMC maintains an active Facility Response Plan (FRP) in accordance with §112.20. The FRP describes the actions to be taken and the facility response capabilities for various discharge scenarios. The FRP

also describes the response actions and capabilities that might be required of a contractor. As a result, this SPCC Plan only addresses spill response in general concepts and the FRP should be reviewed for detailed information.

HGCMC personnel are on-site 24 hours per day, which ensures rapid discovery of any potential spills or leaks. Immediate action must be taken to control, contain, and recover discharged product. However, safety of all personnel is top priority.

In general, the following steps are taken:

- Evaluate and secure the scene; get help if needed,
- Eliminate potential spark/ignition sources;
- If possible and safe to do so, identify and shut down source of discharge to stop the flow;
- Don appropriate PPE and contain the discharge with sorbents, booms, or other material;
- Contact the Environmental Manager or his alternate;
- Contact regulatory authorities; and
- Collect and dispose of recovered products according to regulations

Spill response materials are stored at multiple locations throughout the facility where oil products are stored or handled on a routine basis. The locations of spill totes are shown on the figures in Attachment A. Spill kits containing absorbent materials are also carried on many of the site vehicles.

All spills regardless of the quantity, whether or not it is "reportable" by state and federal regulations, are reported to the Environmental Manager or other members of the HGCMC Environmental staff. A log of each event is maintained and kept on the company computer network.

10. WASTE DISPOSAL (40 CFR §112.7(A)(3)(V))

Wastes resulting from a discharge response will be containerized in impervious bags, drums, totes, or buckets and stored where direct contact of the materials, with either precipitation or runoff, will not occur. These wastes are to be kept segregated and managed separately from other solid waste streams. Recovered hydrocarbon product can be combined with used oil generated on-site, which is burned in waste oil heaters. On-site disposal or incineration of absorbent materials, contaminated soils, or any other waste resulting from a spill cleanup is strictly prohibited. The materials will be evaluated by the Environmental department to determine the proper disposal method to be used, in accordance with state and federal regulations.

Disposal of all small spill cleanup materials is handled by shipping materials to Chemical Waste Management located in Arlington, Oregon for incineration. Should the need arise from a spill response, they would be contracted to receive large volumes of absorbent or recovered product from a medium or large scale spill.

11. EMERGENCY CONTACTS (40 CFR §112.7(A)(3)(VI))

In the event of a spill to water or a spill greater than 10 gallons to land, the person discovering the spill shall immediately notify a qualified individual (i.e., Environmental Manager, Surface Operations General Foreman, or Surface Operations Manager) via telephone or radio Channel 6. The qualified individual will then determine the appropriate emergency response and/or agency notifications to be made based on the circumstances. Emergency contact information is provided in Attachment D.

12. DISCHARGE NOTIFICATION (40 CFR §112.7(A)(4))

Any size discharge (i.e., one that creates a sheen, emulsion, or sludge) to navigable waters or adjoining shorelines, or that may affect natural resources belonging to, appertaining to, or under the exclusive management authority of the United States (including resources under the Magnuson Fishery Conservation and Management Act), must be reported immediately to the National Response Center (1-800-424-8802). The Center is staffed 24 hours a day.

The Spill Response Notification Form used by HGCMC is shown in Attachment E. The sheet is used to facilitate reporting to both the National Response Center and the Alaska Department of Environmental Conservation (ADEC). This form is available on the ADEC website at the following address: http://dec.alaska.gov/spar/spillreport.htm.

In addition to the above reporting, 40 CFR §112.4 requires that information be submitted to the United States Environmental Protection Agency (EPA) Regional Administrator and the appropriate state agency in charge of oil pollution control activities (see contact information in Attachment D) whenever the facility discharges (as defined in 40 CFR §112.1(b)) *more than 1,000 gallons of oil in a single event,* or discharges (as defined in 40 CFR §112.1(b)) *more than 42 gallons of oil in each of two discharge incidents within a 12-month period.* The following information must be submitted to the EPA Regional Administrator and to ADEC within 60 days:

- Name of the facility;
- Name of the owner/operator;
- Location of the facility;
- Maximum storage or handling capacity and normal daily throughput;
- Corrective action and countermeasures taken, including a description of equipment repairs and replacements;
- Description of facility, including maps, flow diagrams, and topographical maps;
- Cause of the discharge(s) to navigable waters and adjoining shorelines, including a failure analysis of the system and subsystem in which the failure occurred;
- Additional preventive measures taken or contemplated to minimize possibility of recurrence; and
- Other pertinent information requested by the Regional Administrator.

13. POTENTIAL DISCHARGE VOLUMES AND DIRECTION OF FLOW (40 CFR §112.7(B))

Based on the engineering design, site drainage, containment features, equipment reliability, trained personnel and adherence to prescribed operating and maintenance procedures, the possibility of a major oil spill event at the Greens Creek Mine is very remote. From a contingency preparedness standpoint, the potential does exist for accident, equipment failure, and/or operator error.

13.1. Oil Storage Tanks

The most likely potential causes of a spill from the tanks listed in Attachment B would be from overfilling, leakage, or rupture. The available containment mechanisms for each tank are listed in the table (Attachment B). In a hypothetical worst-case scenario the maximum possible flow rates are assumed to be in the hundreds of gallons per minute, and the total quantity which could be discharged is assumed to be the tank's total capacity. The direction of oil flow in the event of a major spill event from these tanks can be predicted from the contour lines shown on the appropriate figure for each tank (Figures 1-5 in Attachment A). The bulk storage tanks pose the most serious threat of a major release. However, the combination of dikes and facility drainage controls provide adequate secondary containment for the volume of the largest tank plus precipitation from the modeled 10-year, 24-hour design storm event.

13.2. Fuel Barge Unloading

The greatest potential for oil spills reaching navigable waters comes during fuel barge unloading into the bulk tank at Hawk Inlet. The marine terminal bulk tank is filled through a 4-inch diameter, 870 feet long, steel pipeline originating at the marine headers at dockside (see Figure 4). Operator error could result in a poorly made hose connection, improper valve or pressure setting, and/or overfilling. In a hypothetical worst-case scenario of the line rupturing, the rate of flow could potentially be the maximum pumping rate of 30,000 gallons per hour, and the total quantity released could potentially be the total of the pumping rate times the anticipated worst-case response time of 10 minutes for a total spill volume of 5,000 gallons. The direction of oil flow in the event of a spill event can be predicted from the contour lines shown on Figure 4 in Attachment A. This operation is closely and continuously monitored by trained personnel during all fuel offloading operations, and inspection checklists are completed prior to each fuel transfer. Containment booms and other spill response equipment are stored in the SEAPRO vans located at the beach. Boom deployment drills and tabletop exercises are conducted by HGCMC personnel at least two times per year, as required by the FRP.

13.3. Fuel Tanker Truck Loading at Hawk Inlet

Diesel fuel is supplied to the mine/mill site via a 9,000-gallon tanker truck. The tanker may make as many as 12 trips per week when the facility is self-generating electricity, but normally makes two to three trips per week. The tanker is filled from the Hawk Inlet bulk storage facility, and offloaded at the 920 bulk storage facility. Overfilling and sloppy hose handling would be the most likely cause of a spill from this operation. In a worst-case scenario involving the line rupturing, the rate of flow could potentially be the maximum pumping rate of 15,000 gallons per hour at the Hawk Inlet facility. The maximum volume of oil released would be the volume discharged by the filling pump in the time period between the catastrophic fuel line rupture and the closing of valves by the fuel tanker operator. Fuel transfer protocols require that the operator be in constant attendance within 60 feet of the transfer operation. It is estimated that the shut-off valves would be closed within 45 seconds of the catastrophic

line failure. This would result in a spill of approximately 190 gallons to secondary containment. The tanker transfer area at the Hawk Inlet facility is concrete and graded to drain into the lined bulk fuel storage secondary containment.

13.4. Fuel Tanker Truck Unloading at 920 Bulk Storage Facility

Diesel fuel is supplied to the mine/mill site via a 9,000-gallon tanker truck. The tanker may make as many as 12 trips per week when the facility is self-generating electricity, but normally makes two to three trips per week. The tanker is filled from the Hawk Inlet bulk storage facility, and offloaded at the 920 bulk storage facility. Overfilling and sloppy hose handling would be the most likely cause of a spill from this operation. In a hypothetical worst-case scenario of the line rupturing, the rate of flow could potentially be the maximum pumping rate of 20,000 gallons per hour at the 920 bulk storage facility. The maximum volume of oil released would be the volume discharged by the filling pump in the time period between the catastrophic fuel line rupture and the closing of valves by the fuel tanker operator. Fuel transfer protocols require that the operator be in constant attendance within 60 feet of the transfer operation. It is estimated that the shut-off valves would be closed within 45 seconds of the catastrophic line failure. This would result in a spill of approximately 250 gallons. The tanker transfer area at the 920 Bulk Storage Facility is concrete and graded to drain to a lined collection ditch that is routed to a concrete catchment basin and into a lined retention pond. In the event of a large spill entering the retention pond, HGCMC has the ability to quickly isolate the pond from incoming flows to keep the spill contained until cleanup occurs.

13.5. Miscellaneous Hydrocarbon Storage

As shown in Attachment A, numerous smaller oil and fuel storage tanks are located throughout the facility. Overfilling and sloppy hose handling would be the most likely cause of a spill from these tanks. Another possible scenario is a piece of equipment running into a tank and piercing the tank wall. In both cases an operator would be present and take immediate steps to minimize the quantity of fuel spilled. The largest storage tank is 10,000 gallons, the remaining tanks are 5,000 gallons or smaller. The direction of flow in the event of a spill can be predicted from the contour lines shown in figures 1 through 5 in Attachment A. The likelihood of oil spilled from any of these tanks reaching navigable waters before cleanup occurs is very remote.

14. CONTAINMENT AND DIVERSIONARY STRUCTURES (40 CFR §112.7(C))

The primary objective of any and all containment and diversionary measures is to prevent oil spills from entering navigable waters or other sensitive areas, and/or creating a hazardous or dangerous environment. Methods of secondary containment and/or diversionary structures or equipment at this facility include the following:

Dikes, berms, or retaining walls. Concrete dike enclosures (as used in this Plan, “dike” is both a floor/base and curbing) are provided around the 920 bulk storage facility and for oil-filled transformers. Berms and plastic lined containment structures are provided around the Hawk Inlet bulk storage tanks, the 860 heli-pad tanks, and other portable containers. Several tanks are located inside buildings or beneath roof structures with concrete floor and curbing to provide containment.

Double-wall tank construction. With only a few exceptions, all tanks with a capacity of 10,000 gallons or less are shop-built, double-wall tanks with an outer shell designed to contain the

capacity of the inner tank. Other secondary containment measures are provided for the few single wall tanks that are in use.

Curbing or drip pans. A sloped concrete pad with curbing is located at the Hawk Inlet fuel transfer facility to direct any spills into lined secondary containment. Curbing is provided around the use tanks in the power house. A drip pan is located beneath the pipeline connection point at the fuel barge unloading dock. Drip pans are also used beneath flexible hose connections during oil/fuel transfer operations and beneath fuel dispensers when re-fueling vehicles.

Retention ponds. The 920 Area has a non-porous concrete surface that directs all drainage to a lined ditch that feeds into a concrete catchment basin and then to a lined retention pond with a capacity of approximately 1.2 million gallons. The Hawk Inlet port facility, including the area around the bulk storage secondary containment, is graded to drain to a concrete catchment basin with a capacity of approximately 46,000 gallons. All drainage from the 920 Area and Hawk Inlet port facility is ultimately routed to a lined retention pond (Pond 7) at the Tailings Facility Water Treatment Plant.

Steel containment vans. Small portable containers, including 55-gallon drums and totes, are stored in steel cargo containers with integral secondary containment.

Sorbent material. Spill response materials are stored at multiple locations throughout the facility where oil products are stored or handled on a routine basis. The locations of spill totes at the 920 Area are shown on Figure 1 in Attachment A. Spill kits containing absorbent materials are also carried on many of the site vehicles. See the Facility Response Plan for a full inventory of spill response materials maintained at the facility.

15. PRACTICABILITY OF SECONDARY CONTAINMENT (40 CFR §112.7(D))

HGCMC management has determined that the appropriate containment and/or diversionary structures or equipment listed in 40 CFR §112.7(c)(1) and (h)(1) are practicable at this facility.

16. INSPECTIONS, TESTS, AND RECORDS (40 CFR §112.7(E))

HGCMC personnel perform thorough visual inspections of all bulk storage containers, piping and containment systems on a monthly and annual basis, in accordance with the Steel Tank Institute (STI) SP001 – “Standard for the Inspection of Aboveground Storage Tanks”. The written procedure checklist provided in Attachment F is used for the inspections. The inspections cover the following key elements:

- Observing the exterior of aboveground storage tanks, pipes, and other equipment for signs of deterioration, leaks, and corrosion.
- Observing tank foundations and supports for signs of instability or excessive settlement.
- Observing the tank fill and discharge pipes for signs of poor connection that could cause a discharge, and tank vent for obstruction and proper operation.

All problems regarding tanks, piping, containment, or response equipment must immediately be reported to the Environmental Manager. Visible oil leaks from tank walls, piping, or other components

must be repaired as soon as possible to prevent a larger spill or a discharge to navigable waters or adjoining shorelines. Pooled oil is removed immediately upon discovery.

Written inspection records are signed by the inspector and maintained in the Environmental Office for a period of three years.

17. TRAINING (40 CFR §112.7(F))

All HGCMC personnel with oil-handling responsibilities receive annual training in the operation and maintenance of equipment to prevent discharges, discharge procedure protocols, applicable pollution control laws, rules and regulations, general facility operations, and the content of this SPCC Plan. Any new facility personnel with oil-handling responsibilities are provided with this same training prior to being involved in any oil-handling responsibilities. In addition, discharge prevention briefings will be scheduled and conducted to describe known discharges or failures, malfunctioning components, and any recently developed precautionary measures, if applicable. Records of the annual training are kept on the form shown in Attachment H and maintained with the SPCC files in the Environmental Office for a period of three years.

The Environmental Manager is the designated person who is accountable for discharge prevention.

18. SECURITY (40 CFR §112.7(G))

Because of the remote nature of the Greens Creek facility it is primarily only HGCMC personnel that are in a position to access the HGCMC storage facilities. All personnel are aware of the need to minimize environmental impacts and the consequences of a major oil or chemical spill. Therefore, no security fencing is provided for the bulk storage areas.

At the Hawk Inlet facility, valves and pump controls associated with the bulk storage tank, pipelines and containment system are kept locked at times of non-use. The 920 Area bulk storage tanks can be in use 24 hours per day, therefore valves and pumps are not locked. Both the Hawk Inlet and 920 Area bulk storage tanks are under video surveillance.

All pipelines not in service or on extended standby will be drained, capped and marked as to their status and origin.

Operation of the facility continues 24 hours per day. For this reason lighting systems have been installed in all critical areas to allow early discovery of spills or leaks and to allow sufficient visibility during darkness for security checks as well as ongoing operations.

HGCMC put a Security Plan for the Hawk Inlet port facility in place during 2004. This plan was reviewed and approved by the USGC. The USCG conducts routine facility inspections to audit compliance with the plan.

19. TANK TRUCK LOADING/UNLOADING RACK REQUIREMENTS (40 CFR §112.7(H))

HGCMC management is committed to ensuring the safe transfer of material to and from storage tanks. The facility does not have a loading rack as defined at §112.2 and thus the requirements of §112.7(h) are

not applicable. Nonetheless, secondary containment is provided in the tanker truck loading/unloading areas at both Hawk Inlet and the 920 area. The secondary containments are adequate to contain the full capacity of the fuel tanker.

Only trained Greens Creek Mine personnel conduct tanker transfer operations. Prior to every day's transfer operations, an inspection form is completed for both the tanker truck and the transfer facilities. These ensure all systems are in working order, and response materials are available in case of a spill. The truck driver or facility personnel remain with the vehicle at all times while fuel is being transferred. Prior to departure of the tanker truck, the lowermost drain and all outlets are inspected to prevent a discharge while in transit. It is also a HGCMC standard operating procedure that wheel chocks be placed as soon as the driver parks and exits any vehicle.

20. BRITTLE FRACTURE EVALUATION (40 CFR §112.7(I))

The Greens Creek Mine has four field-erected vertical AST's that were built to American Petroleum Institute (API) Standard 650. The thickness of each course of the tank shells is less than one-half inch. As discussed in the API Standard 653 *Tank Inspection, Repair, Alteration, and Reconstruction* (API-653), brittle fracture is not a concern for tanks that have a shell thickness of less than one-half inch. Further, site AST's have not undergone repairs, alterations, reconstruction or changes in service. This is the extent of the brittle fracture evaluation for site tanks.

21. OTHER APPLICABLE PART 112 REQUIREMENTS (40 CFR §112.7(J))

The only additional State rules to part 112 compliance pertain to reporting requirements for oil spills. The ADEC requires that oil spills greater than 10 gallons to land, or greater than 55 gallons to secondary containment, be reported within 48 hours. The spill reporting form is available on the ADEC website at http://dec.alaska.gov/spar/spillreport.htm.

22. QUALIFIED OIL-FILLED OPERATIONAL EQUIPMENT (40 CFR §112.7(K))

Oil-filled operational equipment at the Greens Creek Mine, regulated under part 112, is limited to transformers and hydraulic systems. A list of the transformers and their locations is provided in Attachment B. Although the qualification criteria of §112.7(k)(1) are met, secondary containment is already provided for this oil-filled operational equipment.

23. FACILITY DRAINAGE (40 CFR §112.8(B))

The diked storage areas at Hawk Inlet and the 920 Area are drained by manually activated pumps. The containment structures are visually inspected prior to activating the pumps to ensure no oil will be discharged. The drainage from these areas is combined with other facility drainage from the Hawk Inlet and 920 areas and ultimately routed to the Tailings Facility/Pond 7 water treatment plant. Secondary containment structures for the electrical transformers are equipped with manual operated ball valves.

24. BULK STORAGE CONTAINER CONSTRUCTION (40 CFR §112.8 (C)(1))

All bulk storage containers at the facility are constructed to either API 650 or UL 142 standards. The design and construction of all bulk storage containers are compatible with the characteristics of the oil product they contain, and with temperature and pressure conditions.

24.1. Secondary Containment (40 CFR §112.8(c)(2))

All bulk storage tank installations are required to be constructed to provide a secondary means of containment for the entire capacity of the largest single container and sufficient freeboard to contain precipitation. For this facility, sufficient freeboard for precipitation was determined to be 4.2 inches, which is the equivalent of a 10yr-24hr storm event for the 920 Area and the 25yr-24hr storm event for Hawk Inlet.

The concrete dike containment at the 920 bulk storage tanks has a net containment capacity of approximately 81,500 gallons, which accounts for the displacement volume of the smaller tanks. The rated capacity of the largest tank is approximately 54,000 gallons, which leaves an excess capacity of approximately 27,500 gallons for precipitation. This is equivalent to approximately 17 inches of freeboard in the containment, which greatly exceeds the 4.2 inches necessary for the 10-year, 24-hour storm event.

The secondary containment system for the Hawk Inlet bulk storage tank was modified in 2015. The modifications included raising the berm height to increase the containment volume, installing new 80-mil HDPE liner, and adding a lined containment pad for storage of portable containers. The bulk tank has a rated capacity of 186,000 gallons (shell capacity equals 200,000 gallons) and the total volume of the lined secondary containment system is 323,600 gallons. A spill of 200,000 gallons would fill the containment to elevation 33.0 feet, leaving 1.7 feet of freeboard to the top of berm elevation of 34.7 feet. Accounting for the displacement volume of the tank, the secondary containment has an excess volume of approximately 112,000 gallons for precipitation. Based on site survey data, the total drainage area reporting to the secondary containment is 20,600 square feet. The containment volume available for precipitation is equivalent to 8.7 inches of runoff over the drainage area. Therefore, the secondary containment system is adequately sized to contain the full contents of the fuel tank plus precipitation from in excess of a 25yr-24hr storm event.

24.2. Drainage of Diked Areas (40 CFR §112.8(c)(3))

Secondary containments are drained under direct supervision of facility personnel. The accumulated water is observed for signs of oil prior to draining. Dike drainage events are recorded on a form kept in a weather-proof enclosure at each containment structure. An example form is included in Attachment G of this Plan. Completed forms are routinely collected and maintained with the SPCC files at the Environmental Office for at least three years.

24.3. Inspections (40 CFR §112.8(c)(6))

Formal internal inspections of the field-erected, vertical AST's (tanks FT-01, FT-02, FT-04 and FT-05) were performed between 2010 and 2013 and are to be repeated on 10-year intervals. Formal external inspections of these tanks, to be repeated on 5-year intervals, were conducted between 2015 and 2017. Certified inspectors performed an API 653 inspection consisting of non-destructive evaluations including visual inspection, magnetic flux leakage evaluation, vacuum box weld examinations, magnetic particle testing, mechanical measurements and manual ultrasonic thickness inspection. Minor repairs were

made to each tank, none of which met the criteria to be classified as a major repair as defined in API standard 653. All four tanks were certified as suitable for continued service as a diesel storage tank. Inspection records will be maintained in the Environmental Office for as long as the tanks remain in service.

Formal external inspections of all shop-built, horizontal AST's at the facility were performed in 2011. Certified inspectors performed a STI-SP001 inspection consisting of non-destructive evaluations including visual inspection, mechanical measurements, and manual ultrasonic thickness inspections. The tanks were certified for continued service after all noted deficiencies have been repaired. The primary deficiency noted on many of the tanks was the condition of the exterior coating (i.e., paint) to prevent corrosion and inadequate labeling. This deficiency was promptly corrected by re-painting all tanks (excepting those located inside buildings), and included stenciling on a tank identification number, the contents, and capacity. Some of the tanks were also found to have inadequate or inoperable vents, either normal or emergency vents. These deficiencies have been corrected.

In addition to the monthly and annual visual inspections that are performed by HGCMC personnel, formal integrity testing of bulk storage containers will be performed following the schedule shown in Table 1 below.

Table 1. Tank Integrity Testing Schedule

	FT-01	FT-02	FT-04	FT-05	Other Small Tanks
Inspection Type	API-653	API-653	API-653	API-653	STI-SP001
Previous External Inspection	2015	2015	2017	2017	May 2011
Next External Inspection	2020	2020	2022	2022	May 2031
Previous Internal Inspection	2011	2010	2013	2012	NA
Next Internal Inspection	2021	2020	2023	2022	NA

24.4. Overfill Prevention Systems (40 CFR §112.8(c)(8))

The overfill prevention systems for each storage container are described in the storage container registry attached as Attachment B. The large vertical ASTs are equipped with dual (electronic and manual) level sensing devices, including alarms, to prevent overfilling. A few of the large shop-built tanks also have electronic level sensing gauges with high level alarms. The remaining fixed, non-portable tanks have direct vision gauges to monitor product level during filling. Tanks are also equipped with containment pans at the fill port to prevent discharges that could result from overfilling tanks (i.e., inadequate head space to allow for thermal expansion of the product). HGCMC protocol requires all fuel transfer operations to be attended at all times.

24.5. Effluent Treatment Facilities (40 CFR §112.8(c)(9))

The facility water treatment plants operate continuously. Holding ponds are observed during each shift by plant operators.

24.6. Visible Discharges (40 CFR §112.8(c)(10))

Visible discharges from any container or appurtenance – including seams, gaskets, piping, pumps, valves, rivets, and bolts – are quickly corrected upon discovery.

Oil is promptly removed from the diked area and disposed of according to the waste disposal method described in this Plan.

24.7. Mobile and Portable Containers (40 CFR §112.8(c)(11))

Small portable oil storage containers, such as 55-gallon containers, are stored in designated areas within secondary containment. Figures 6 and 7 in Attachment A show the locations at the 920 Area and Hawk Inlet Port Facility where portable containers are stored and used. Whenever possible, they are stored inside buildings or containment vans or under covered storage areas to prevent direct contact with precipitation. Any discharged material is quickly contained and cleaned up using sorbent pads and appropriate cleaning products.

Portable equipment (e.g., generators, pumps, compressors, etc.) with on-board fuel tanks in excess of 55 gallons are stored within lined secondary containment when in use, and when not in use are stored in designated staging areas with drainage controls.

25. TRANSFER OPERATIONS, PUMPING, AND FACILITY PROCESS (40 CFR §112.8(D))

The majority of all piping for facility transfer operations is located above ground. Buried piping is present in the 920 Area between the bulk fuel tanks and the powerhouse generator tanks, and also at Hawk Inlet between the dock and the bulk tank. All underground lines are coated and wrapped (AWW C203 "coal tar enamel coating or equivalent."). If at any time a portion of below grade pipe is exposed it will be inspected for corrosion and corrected if needed.

All fuel pipelines remain in service on a continual basis. The offloading supply line from the dock to the 200,000-gallon tank, which was replaced in 2011, is used the least of all lines. This line is used at least monthly for filling the bulk tank. Following each fuel transfer, this line is back-drained prior to its disconnection from the fuel barge. The line is then capped until its next use. A drip pan remains positioned beneath this connection point at all times during preparation and use. All pipe supports have been designed to allow for expansion and contraction of the line. Above ground portions of the pipe are inspected regularly. During these inspections, the overall condition of the expansion joints, valve glands and bodies, drip pans, pipeline supports and any other metal surfaces is assessed. In addition hydrostatic testing to 150% pressure is conducted once per year in those areas where drainage is such that pipe failure might lead to a spill event. Any pipeline not in service or in standby for an extended period of time will be capped and labeled as to its origin.

Most above ground pipelines are situated away from areas where vehicles are used on a regular basis. For locations such as the fuel truck loading facility and in areas where feeder lines supply generators etc., 4-inch steel posts filled with concrete extends 4 feet above grade to provide pipe protection from physical damage. All personnel are well aware of the dangers to exposed pipelines.

26. AMENDMENTS AND PLAN REVIEW (40 CFR §112.3 AND §112.5)

In accordance with 40 CFR §112.5(a), HGCMC will amend this SPCC Plan when there is a change in the facility design, construction, operation, or maintenance that materially affects the facility's potential for an oil discharge as described in 40 CFR §112.1(b). Amendments to the Plan made to address changes of this nature are referred to as technical amendments, and must be certified by a PE. Non-technical

updates can be done by HGCMC personnel. Non-technical updates include, but are not limited to, the following:

- change in the name or contact information (i.e., telephone numbers) of individuals responsible for the implementation of this Plan; or
- change in the name or contact information of spill response or cleanup contractors.

Any technical amendment to the Plan must be prepared within six months, and implemented as soon as possible, but not later than six months following preparation of the amendment. The Facility Manager is responsible for assuring amendment and amendment implementation of the Plan.

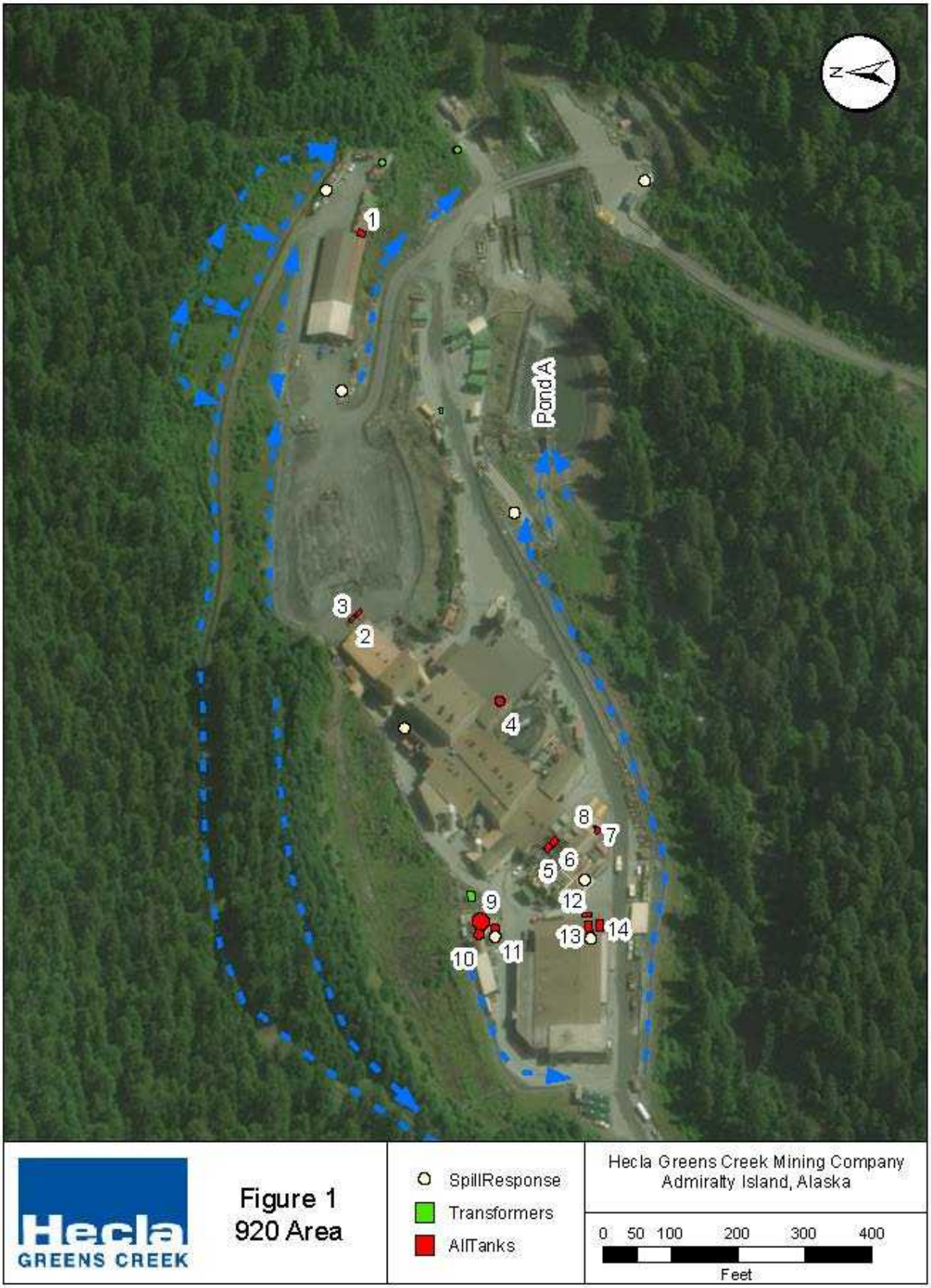
In accordance with 40 CFR §112.5(b) regulations, HGCMC will complete a review and evaluation of this SPCC Plan at least once every five years. As a result of this review and evaluation, the Plan will be amended to include more effective prevention and control technology if the technology has been field-proven at the time of the review and will significantly reduce the likelihood of a discharge, as described in 40 CFR §112.1(b), from the facility. Amendment(s) to the Plan, if needed, are made within six months of the five-year review and implemented as soon as possible, but no later than six months following preparation of any amendment. A licensed Professional Engineer certifies any technical amendment to the Plan, as described above, in accordance with 40 CFR §112.3(d) and §112.5(c).

Plan review and evaluations and subsequent Plan amendments, if any, are recorded in the "Plan Review Log" in Table 2. This log must be completed even if no amendment is made to the Plan as a result of the review and evaluation. Unless an administrative or technical change prompts an earlier review of this Plan, the next scheduled review must occur by 2025.

Table 2. Plan Review Log

By	Date	Activity	PE certification required?	Comments
	unknown			Initial SPCC Plan.
Bill Oelklaus	12/7/1994	Revise plan	No	-
Eric Sundberg	7/24/1997	Triennial review	Yes	-
Bill Oelklaus	5/18/2000	Plan amendment	Yes	Update format, facility information, storage areas, spill history
Gary Hayden	8/30/2005	Scheduled review	Yes	Regulatory review and revision, update spill response and oil storage inventory
Jim Akins	9/9/2006	update	No	-
David Landes	4/14/2015	Scheduled Review	Yes	Update format, facility information, and oil storage inventory
David Landes	11/23/2015	update	Yes	Hawk Inlet fuel farm containment upgraded October 2015. FT-47 removed from service
David Landes	2/15/2016	update	No	Correct deficiencies with small fixed tanks (level gauges, vents, containment pans at fill ports)
David Landes	12/31/2019	update	Yes	Update tank registry, New figures

GPO Appendix 06
Attachment A
Facility Diagrams


N
Pond A
1
2
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4
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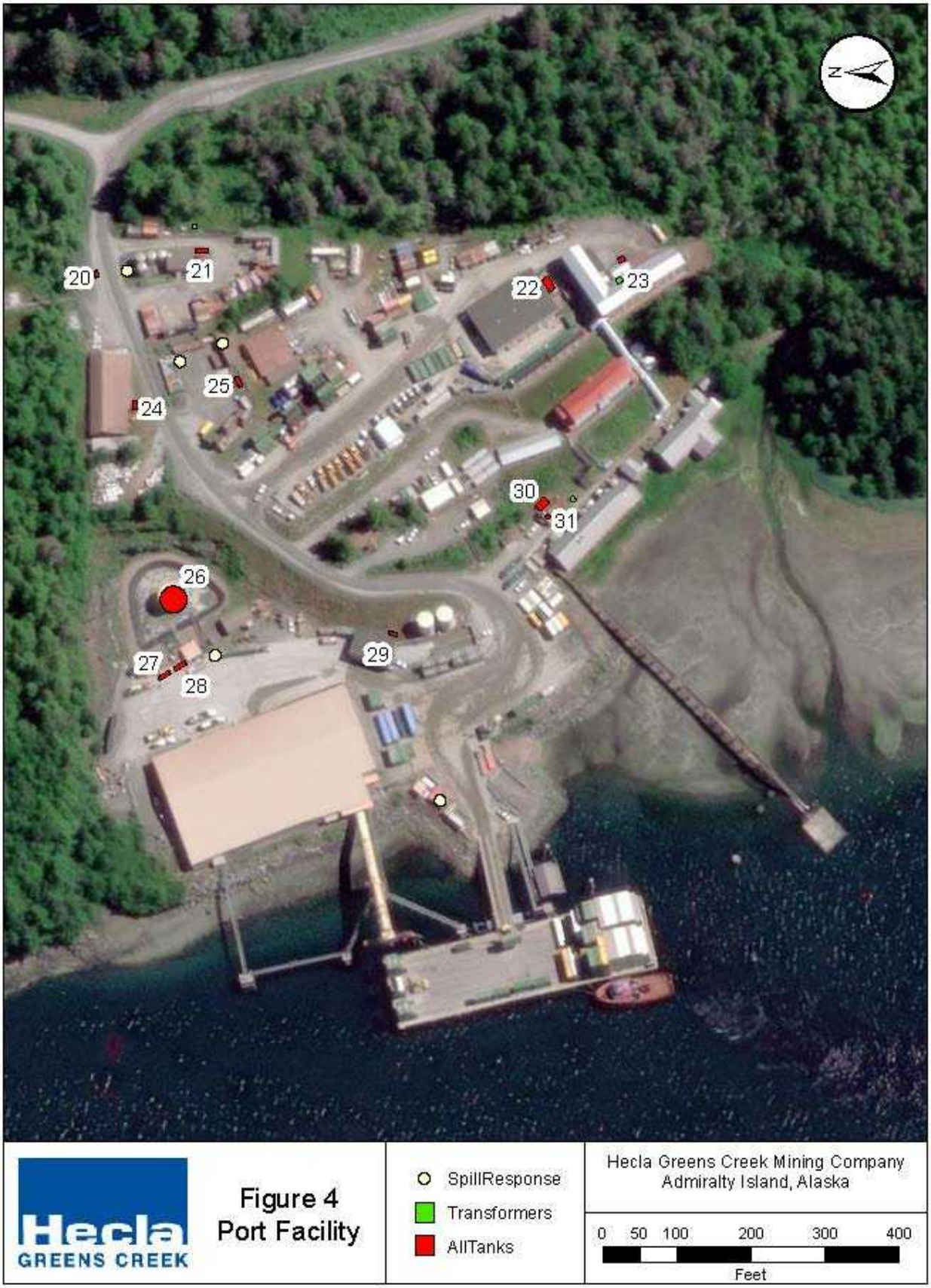
6
7
8
9
10
11
12
13
14
Hecla
GREENS CREEK
Figure 1
920 Area
SpillResponse
Transformers
AllTanks
Hecla Greens Creek Mining Company
Admiralty Island, Alaska
0 50 100 200 300 400
Feet

N
19
18
17
Pond C
16
Pond 23
15
Pond D
Hecla
GREENS CREEK
Figure 2
Site 23
SpillResponse
Transformers
AllTanks
Hecla Greens Creek Mining Company
Admiralty Island, Alaska
0 75 150 300 450 600
Feet

N
32
33
Hecla
GREENS CREEK
Figure 3
Tailings Disposal
Facility
SpillResponse
Transformers
AllTanks
Hecla Greens Creek Mining Company
Admiralty Island, Alaska
0 100 200 400 600 800
Feet


N
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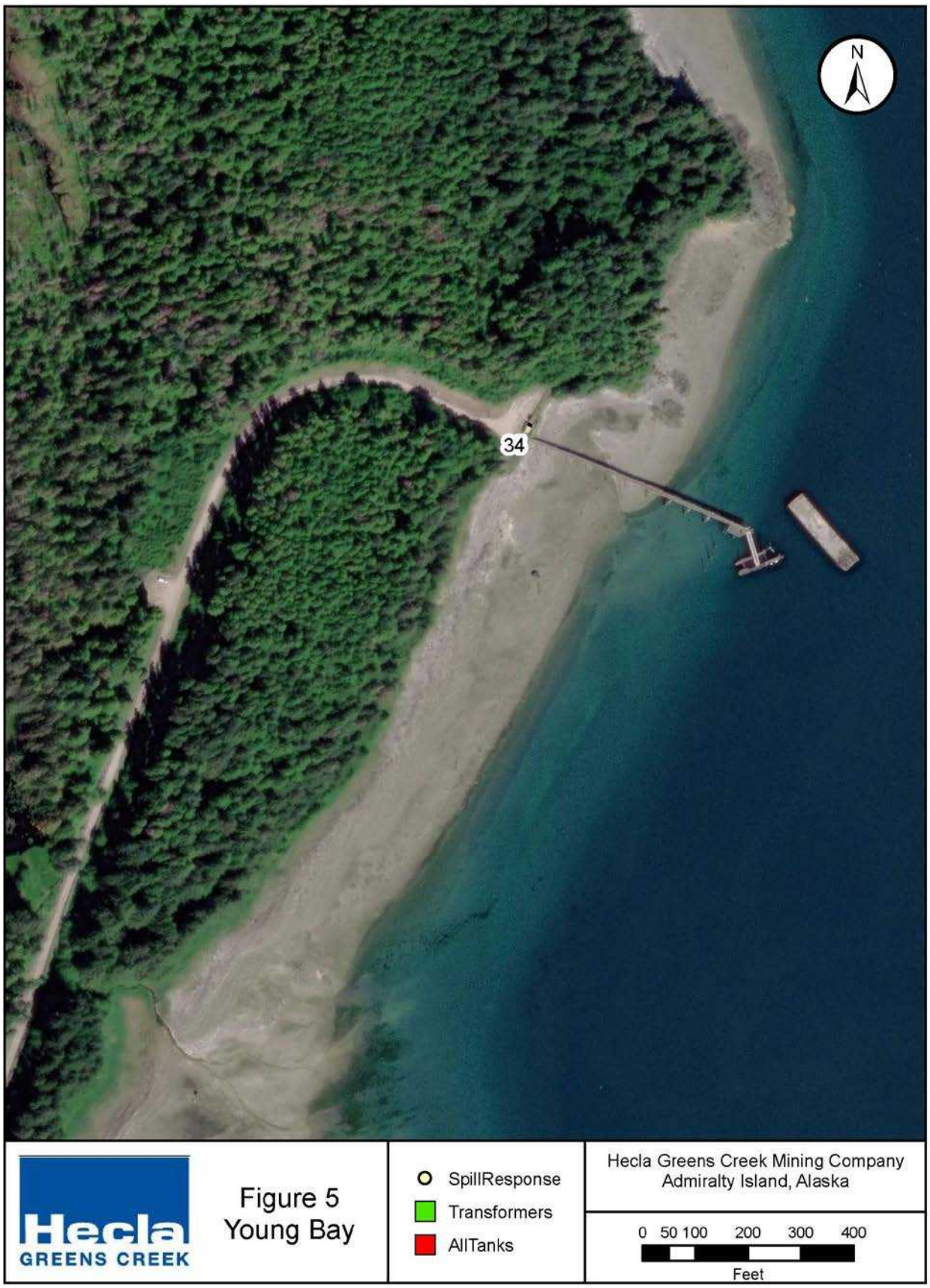
Hecla
GREENS CREEK
Figure 4
Port Facility
SpillResponse
Transformers
AllTanks
Hecla Greens Creek Mining Company
Admiralty Island, Alaska
0 50 100 200 300 400
Feet


N
34
Hecla
GREENS CREEK
Figure 5
Young Bay
SpillResponse
Transformers
AllTanks
Hecla Greens Creek Mining Company
Admiralty Island, Alaska
0 50 100 200 300 400
Feet

Hecla GREENS CREEK

Figure 6
920 Area
Portable Containers

Hecla Greens Creek Mining Company
Admiralty Island, Alaska

0 50 100 200 300 400
Feet

Hecla GREENS CREEK

Figure 7
Port Facility
Portable Containers

Hecla Greens Creek Mining Company
Admiralty Island, Alaska

0 50 100 200 300 400
Feet

GPO Appendix 06
Attachment B
Oil Storage Container Log

Oil Storage Tank Registry

Tank ID	Location / Map Desig.	Contents	Capacity	Condition	Tank Specification				Containment	Overfill Prevention	Comments
					Const. Date	Const. Mat.	Design	Type			
920 Area - Figure 1											
FT-01	920 Bulk Storage Area #9	Diesel	60,000	Good	1988	Carbon Steel	API 650	Single wall, Vert. AST	Concrete Dike	Dual gauges w/alarm	Secondary containment volume adequate for largest tank plus precipitation from 10 year storm event.
FT-04	920 Bulk Storage Area #11	Diesel	48,000	Excellent	2001	Carbon Steel	API 650	Single wall, Vert. AST	Concrete Dike	Dual gauges w/alarm	Secondary containment volume adequate for largest tank plus precipitation from 10 year storm event.
FT-05	920 Bulk Storage Area #10	Diesel	48,000	Excellent	2001	Carbon Steel	API 650	Single wall, Vert. AST	Concrete Dike	Dual gauges w/alarm	Secondary containment volume adequate for largest tank plus precipitation from 10 year storm event.
FT-10	920 Ore Pad Grizzly #3	Diesel	500	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank and within concrete containment	Direct vision gauge	Dual secondary containment provided. Stormwater system and Pond A provide tertiary containment
FT-17	920 Warehouse #1	Diesel	500	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Direct vision gauge	Large spill would likely drain to Pond A
FT-44	920 Powerhouse #5	Diesel	660	Excellent		Stainless St.	UL 142	Single wall, horiz., cylindrical AST	Drip pan and concrete floor inside powerhouse	Remote sensor, high level shut-off	If spill escaped building, would be contained in Pond A
FT-45	920 Powerhouse #6	Diesel	660	Excellent		Stainless St.	UL 142	Single wall, horiz., cylindrical AST	Drip pan and concrete floor inside powerhouse	Remote sensor, high level shut-off	If spill escaped building, would be contained in Pond A
FT-51	Mill Cleaner Building #2	Diesel	500	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank and within concrete containment	Direct vision gauge	Dual secondary containment provided. Stormwater system and Pond A provide tertiary containment
FT-52	Tails Press Heater #4	Diesel	440	Excellent	2014	Carbon Steel	UL 142	Dbl wall, vert., cylindrical AST	Double wall tank on concrete	Direct vision gauge	Large spill would likely drain to Pond A
TK-02	920 Powerhouse #7	Lube Oil	5,000	Good		Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank wihin concrete dike	Level sensor w/alarm	If spill escaped diked area, would be contained in Pond A
TK-03	920 Powerhouse #8	Used Oil	1,000	Good	1996	Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank wihin concrete dike	Level sensor w/alarm	If spill escaped diked area, would be contained in Pond A
TK-13	920 Maint. Shop #14	Engine Oil	5,000			Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Level sensor w/alarm	If spill escaped diked area, would be contained in Pond A
TK-14	920 Maint. Shop #13	Hyd. Oil	5,000			Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Level sensor w/alarm	If spill escaped diked area, would be contained in Pond A
TK-121	HI/920 (portable) #12	Used Oil	1,100	Good-Fair		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Manual dipstick	For transporting used oil from 920 to Hawk Inlet
TK-122	HI/920 (portable) #12	Used Oil	1,100	Good-Fair		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Manual dipstick	For transporting used oil from 920 to Hawk Inlet
860 Area - Figure 2											

Tank ID	Location / Map Desig.	Contents	Capacity	Condition	Tank Specification				Containment	Overfill Prevention	Comments
					Const. Date	Const. Mat.	Design	Type			
FT-03	860 Lab Building #19	Diesel	2,000	Good		Carbon Steel	STI Fireguard	Dbl wall, rectangular AST	Double wall tank	Direct vision gauge	Potential risk from vehicle traffic. Large spill would drain to Pond C
FT-16	860 Safety Building #18	Diesel	500	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Direct vision gauge	Potential risk from vehicle traffic. Large spill would drain to Pond C
FT-28	860 Core Shed #17	Diesel	550	Good	2006	Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank	Direct vision gauge	Potential risk from vehicle traffic. Large spill would drain to Greens Creek
FT-204	Pond 23 #15	Diesel	500	Excellent	2008	Carbon Steel	UL 142	Single wall, rectangular AST	Integral closed top dike secondary tank	Direct vision gauge	Large spill would drain to Greens Creek
	860 Helipad (summer) #16	Jet A	5,800			Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank in lined containment area	Not re-filled on site	Only present during exploration activity
Tailings Area - Figure 3											
	Tails Truck Wash #33	Diesel	500	Excellent	2017	Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank	Direct vision gauge	Large spill would drain to Pond 7
TK-127	Pond 7 WTP #32	Diesel	750	Excellent	2008	Carbon Steel	STI Fireguard	Dbl wall, rectangular AST	Double wall tank, inside bldg	Direct vision gauge	Large spill would drain to Pond 7
	Tails Misting System #TBD	Diesel	300	Excellent	2018	Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank inside steel containment van	Direct vision gauge	For tails water misting system, not in service yet
	Pond 7 WTP #TBD	Diesel	550	Excellent	2015	Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank inside steel containment van	Direct vision gauge	For portable generator, not in service yet
Hawk Inlet Area - Figure 4											
FT-02	HI Bulk Storage Area #26	Diesel	200,000	Good	1988	Carbon Steel	API 650	Single wall, Vert. AST	Earthen dike w/ syn. Liner	Dual gauges w/alarm	Secondary containment berm raised and re-lined in 2015.
FT-20	HI Core Shed #24	Diesel	500	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Direct vision gauge	Large spill would drain to DB-04
FT-21	HI Truck Fill Station #28	Diesel	1,000	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Direct vision gauge	Large spill would drain into bulk fuel containment
FT-22	HI Truck Fill Station #27	Gasoline	1,000	Good		Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank	Direct vision gauge	Large spill would drain into bulk fuel containment
FT-23	HI Truck Wheel Wash #29	Diesel	500	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Direct vision gauge	Large spill would drain to DB-04
FT-92	HI Water Bldg #21	Diesel	550	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Direct vision gauge	Potential risk from vehicle traffic. Large spill could potentially reach Cannery Creek.
FT-93	HI Boiler Bldg #30	Diesel	5,000	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Manual dipstick	Large spill would drain to Hawk Inlet. Piping susceptible to damage from sliding snow off roof.
TK-95	HI Hilton Boiler Bldg #23	Diesel	500	Excellent	2012	Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank	Direct vision gauge	Large spill would drain to Hawk Inlet
TK-97	HI Boiler Bldg #31	Diesel	100	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Inside Bldg w/sump	Direct vision gauge	If spill escaped bldg, would drain to Hawk Inlet

Tank ID	Location / Map Desig.	Contents	Capacity	Condition	Tank Specification				Containment	Overfill Prevention	Comments
					Const. Date	Const. Mat.	Design	Type			
TK-117	HI/920 (portable) #25	Used Oil	1,100	Good-Fair		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Manual dipstick	For transporting used oil from 920 to Hawk Inlet
TK-120	HI Warehouse #22	Used Oil	10,000	Excellent	2011	Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank	Direct vision gauge	Large spill would drain to Hawk Inlet
	HI Helipad (summer) #20	Jet A	5,800			Carbon Steel	UL 142	Dbl wall, horiz., cylindrical AST	Double wall tank in lined containment area	Not re-filled on site	Stored at Hawk Inlet fuel farm containment when not used for exploration
Youngs Bay - Figure 5											
FT-25	Young Bay #34	Diesel	275	Excellent		Carbon Steel	UL 142	Single wall, rectangular AST	Integral open top dike secondary tank	Direct vision gauge	Tank located inside connex
Mine - No Figure											
FT-18	Underground mine	Diesel	500	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Direct vision gauge	Tank was at batch plant in 2011, but has been moved underground
FT-19	Underground mine	Diesel	500	Good		Carbon Steel	UL 142	Single wall, horiz., cylindrical AST	Integral closed top dike secondary tank	Manual dipstick	Tank was at 920 Admin in 2011, but has been moved underground

Electrical Transformers

ID	Location	Type	Capacity	Containment / Diversion
EM01	Mill CV01	Electromagnet - Active	53	In bldg, curb, site runoff collection system
EM02	Mill CV01	Electromagnet – Stand-by	53	In bldg, curb, site runoff collection system
TO01	A – Pond	500 kVA Transformer	150	dike, site runoff collection sys
TO02	920 Pump House	50 kVA Transformer	<50	On pole, 920 pumphouse
TO03	920 Pump House	50 kVA Transformer	<50	On pole, 920 pumphouse
TO04	920 Pump House	50 kVA Transformer	<50	On pole, 920 pumphouse
TO05	920 Warehouse	50 kVA Transformer	<50	On pole, 920 warehouse
TO06	860 Assay Lab	500 kVA Transformer	198	Concrete containment structure
TO07	Site 23 Pump Stn	500 kVA Transformer	198	Concrete containment structure
TO09	860 Batch Plant	500 kVA Transformer	213	Concrete containment structure
TO11	Out of Service / Temporary Storage at H.I. Fuel Farm	500 kVA Transformer	213	HDPE Lined Pad drains to H.I. Fuel Farm
TO12	H.I. Water Utilities	500 kVA Transformer	193	Concrete containment structure
TO13	H.I. Boiler Bldg.	500 kVA Transformer	184	Concrete containment structure
TO14	B-Road Cannery Ck	112.5 kVA Transformer	>100	Concrete containment structure
TO15	Tailings Pond 7	500kVA	213	Concrete containment structure
TO16	H. I. Substation	2 MVA	1,260	Concrete containment structure
TO17	920 Substation	16MVA	4,070	Concrete containment structure
	new shift housing		128	Concrete containment structure

Hydraulic Systems

Description	Location	Capacity	Containment
Mill Filter Press (2)	Concentrates	~200 ea	Inside Mill building
Mill Filter Press (3)	Tails	~200 ea	Inside Mill building
Rock Breaker Grizzly	Ore Pad	~60	In bldg, curb, site runoff collection system

Portable Container Storage

ID	Location	Contents	Containers	Total Storage (gallons)	Containment
Zone 1	920 LV Maint. Shop (inside shop)	Lube Oil	55-gal drums	110	Concrete floor w/sump
Zone 2	920 Maintenance Shop (inside shop)	Lube Oil	55-gal drums	110	Concrete floor w/sump
Zone 3	920 Maintenance Shop (exterior covered)	Various Oils & Lubricants, Antifreeze, Used Oil & Filters	350-gal totes, 55-gal drums	1,700	Concrete floor, curbing and sump
Zone 4	Powerhouse Area connex & curtain vans	Used Oils	55-gal drums	1,200	Steel containment vans
Zone 5	Powerhouse exterior slab under awning	Used Oils	350-gal totes, 55-gal drums	1,000	Concrete floor w/ curbing
Zone 6	Connex van near tails load-out	Various Oils & Lubricants	55-gal drums, 5-gal pails	400	Steel containment van
Zone 7	920 Warehouse	Various Oils & Reagents	350-gal totes, 55-gal drums	4,000	Steel containment vans
Zone 8	Hawk Inlet Fuel Farm	Jet A, Gasoline	ISO containers totes	6,000	HDPE liner
Zone 9	Hawk Warehouse and Truck Pad	Various Oils, reagents and waste containers	Drums, totes, ISO containers	4,000	Steel containment vans, drainage controls

Portable Equipment

Description	Typical Storage Location	Contents	Quantity	Containment
Underground air compressor	Shed by Remuck Area	Diesel	>100 gallons	Shed w/Concrete floor
PP200 Godwin 6" Pump	Pond 7 WTP	Diesel	>55 gallons	Drainage control Pond 7
PP201 Godwin 6" Pump	Pond 7 WTP	Diesel	>55 gallons	Drainage control Pond 7
PP205 Godwin 8" Pump	Pond 7 WTP	Diesel	>55 gallons	Drainage control Pond 7

GPO Appendix 06
Attachment C
Substantial Harm Determination

Substantial Harm Determination

Facility Name: Hecla Greens Creek Mine
Facility Address: P.O. Box 32199
Juneau, AK 99803

1. Does the facility transfer oil over water to or from vessels and does the facility have a total oil storage capacity greater than or equal to 42,000 gallons?

Yes ● No ○

2. Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and does the facility lack secondary containment that is sufficiently large to contain the capacity of the largest aboveground oil storage tank plus sufficient freeboard to allow for precipitation within any aboveground storage tank area?

Yes ○ No ●

3. Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and is the facility located at a distance (as calculated using the appropriate formula in 40 CFR part 112 Appendix C, Attachment C-III or a comparable formula) such that a discharge from the facility could cause injury to fish and wildlife and sensitive environments?

Yes ○ No ●

4. Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and is the facility located at a distance (as calculated using the appropriate formula in 40 CFR part 112 Appendix C, Attachment C-III or a comparable formula) such that a discharge from the facility would shut down a public drinking water intake?

Yes ○ No ●

5. Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and has the facility experienced a reportable oil spill in an amount greater than or equal to 10,000 gallons within the last 5 years?

Yes ○ No ●

Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document, and that based on my inquiry of those individuals responsible for obtaining this information, I believe that the submitted information is true, accurate, and complete.

Signature

Title: Sr. Environmental Engineer

Name (type or print): David Landes

Date: 12/31/2019

GPO Appendix 06
Attachment D
Emergency Contacts

Notification procedures in the event of an emergency: one of the qualified individuals listed below must be notified. The qualified individual will then determine if additional notifications need to be made, including call out of the emergency response team, and/or agency contacts.

Qualified Individual Information

Christopher Wallace - Environmental Manager

Work: Greens Creek Mine,
Admiralty Island,
Work 907-790-8473 Cell 907-723-8681

Terry Maxwell - Surface Operations General Foreman

Work: Greens Creek Mine
Admiralty Island
907-790-8470/8495(eve)

Home: HGCMC Camp
Admiralty Island
Radio – Channel 6

Jeff Swanson - Surface Operations General Foreman

Work: Greens Creek Mine
Admiralty Island
907-790-8470/8495(eve)

Home: HGCMC Camp
Admiralty Island
Radio – Channel 6

Bryan Morgen – Surface Operations Manager

Work: Greens Creek Mine
Admiralty Island
907-789-8147 Cell 907-957-8997

Emergency Notification Phone List	**Phone Number**	
National Response Center	800-424-8802	
U.S. Coast Guard Sector Juneau (Federal OSC & Local Response Team)	907-463-2980	
Alaska Dept. Environmental Conservation (State OSC)	907-465-5340	800-478-9300
Helicopter Ambulance (Temsco)	907-789-9501	
Four Seasons Marine (boat)	907-790-6671	
Ward Air (airplane with floats)	907-789-9150	

Additional emergency telephone numbers and contact lists are provided in the HGCMC Emergency Response & Disaster Management and Recovery Plan (Red Book)

Public (if a spill presented an explosion or fire hazard): Mariners VHF Channel 16.

Contract Response Assistance (Offsite Spill Response Organization):

SEAPRO 907-225-7002 888-225-7676

Facility Response Team

Employee Name	Work Location	Response Time (minutes)	Work Phone	Radio Channel
Ahrens, David	Water Operations	5-20	8463	6
Benitz, Alan	Surface Operations	5-20	8470	6
Curtiss, Jason	Surface Operations	5-20	8470	6
Fagerstrom, Phil	Surface Operations	5-20	8470	6
Fredheim, Gunnar	Environmental	5-20	8461	6
Grande, Kim	Environmental	5-20	8472	6
Gross, David	Surface Operations	5-20	8470	6
Guenther, Neal	UG Safety Rep.	5-20	8447	3
Hamilton, Jeff	Surface Operations	5-20	8470	6
Hillman, Ernest	Surface Operations	5-20	8470	6
Hoffmann, Ted	Surface Operations	5-20	8470	6
Honea, Arthur	Warehouse	5-20	8182	6
Horne, Scott	Building Maintenance	5-20	6450	6
Jack III, Frank	Building Maintenance	5-20	8418	6
Katzeek, Tom	Surface Operations	5-20	8470	6
Kohuth, Daniel	Warehouse	5-20	8182	6
Landes, David	Environmental	5-20	8420	6
Larson, Doug	Surface Operations	5-20	8470	6
Lee, Jack	Surface Operations	5-20	8470	6
Londner, Elizabeth	Safety	5-20	8191	6
Maller, Doug	Environmental	5-20	8482	6
Maxwell, Terry	Surface Operations	5-20	8470	6
Morgan, Ira	Building Maintenance	5-20	8418	6
Parrish, Eric	Surface Operations	5-20	8470	6
Petrie, Mark	Building Maintenance	5-20	8418	6

Employee Name	Work Location	Response Time (minutes)	Work Phone	Radio Channel
Sage, James	Surface Operations	5-20	8470	6
Sell, Cameron	Environmental	5-20	8457	6
Swanson, Jeff	Surface Operations	5-20	8470	6
Tatlow, Brian	Surface Operations	5-20	8470	6
Tormey, Haynes	Surface Operations	5-20	8470	6
Ulin, Kelly	Surface Operations	5-20	8470	6
Wallace, Chris	Environmental	5-20	8473	6
Williams, Justin	Surface Operations	5-20	8470	6
Willis, Raymond	Surface Operations	5-20	8470	6

GPO Appendix 06
Attachment E
Discharge Notification Form

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

OIL & HAZARDOUS SUBSTANCES SPILL NOTIFICATION FORM

ADEC USE ONLY

ADEC SPILL #:	ADEC FILE #:	ADEC LC:

PERSON REPORTING:	PHONE NUMBER:	REPORTED HOW? (ADEC USE ONLY) ☐ Phone ☐ Fax ☐ PERS ☐ E-mail
DATE/TIME OF SPILL:	DATE/TIME DISCOVERED:	DATE/TIME REPORTED TO ADEC:
INCIDENT LOCATION/ADDRESS: Hecla Greens Creek Mine Admiralty Island 18 miles southwest of Juneau	DATUM: ☐ NAD27 ☐ NAD83 ☐ WGS84 ☐ Other _____ LAT. LONG.	PRODUCT SPILLED:

QUANTITY SPILLED:	QUANTITY CONTAINED:	QUANTITY RECOVERED:	QUANTITY DISPOSED:
☐ gallons ☐ pounds	☐ gallons ☐ pounds	☐ gallons ☐ pounds	☐ gallons ☐ pounds

	POTENTIAL RESPONSIBLE PARTY:	OTHER PRP, IF ANY:	VESSEL NAME:
Name/Business:	Hecla Greens Creek Mining Company		
Mailing Address:	P.O. Box 32199		VESSEL NUMBER:
	Juneau, AK 99803		
Contact Name:			>400 GROSS TON VESSEL:
Contact Number:			☐ Yes ☐ No

SOURCE OF SPILL:	CAUSE CLASSIFICATION: ☐ Accident ☐ Human Factors ☐ Structural/Mechanical ☐ Other
CAUSE OF SPILL: ☐ Under Investigation	
CLEANUP ACTIONS:	
DISPOSAL METHODS AND LOCATION:	

AFFECTED AREA SIZE:	SURFACE TYPE: *(gravel, asphalt, name of river etc.)*	RESOURCES AFFECTED/THREATENED: *(Water sources, wildlife, wells, etc.)*
COMMENTS:		

ADEC USE ONLY

SPILL NAME:	NAME OF DEC STAFF RESPONDING:	C-PLAN MGR NOTIFIED? ☐ Yes ☐ No
DEC RESPONSE: ☐ Phone follow-up ☐ Field visit ☐ Took Report	CASELOAD CODE: ☐ First and Final ☐ Open/No LC ☐ LC Assigned	CLEANUP CLOSURE ACTION: ☐ NFA ☐ Monitoring ☐ Transferred to CS or STP
COMMENTS:	Status of Case: ☐ Open ☐ Closed DATE CASE CLOSED:	
REPORT PREPARED BY:		DATE:

GPO Appendix 06
Attachment F
Inspection Checklists

Monthly SPCC Inspection of Hawk Inlet Fueling Facilities

Yes	No	
☐	☐	Are containment berm(s) and diversionary structure in place and operating correctly? If not explain:
☐	☐	Are main fuel transfer pump valves locked out in off position? If not explain:
☐	☐	Is fuel truck transfer hose capped when in non-operating status? If not explain:
☐	☐	Is fuel truck transfer area clean, clear of debris and in good working order? If not explain:
☐	☐	Are absorbent materials readily available to the fuel operator? If not explain:
☐	☐	Is containment berm dewatering pump locked in the off position? If not explain:
☐	☐	Is containment drainage log being maintained? If not explain:
☐	☐	Are master flow and drain valves and any other valves that permit direct outward flow of storage tanks contents securely locked in the closed position when in nonoperating status? If not explain:
☐	☐	Are valve glands and valve bodies free of leaks or seeps? If not explain:
☐	☐	Is the tank, FT02 (200,000 gal.) free of excessive rust, holes or leaks? If not explain:
☐	☐	Is the liner/tank seal free of defects? Banding tight, caulking sound? If not explain:
☐	☐	Are intermediate valves between master valve and fuel transfer pump in closed position when in nonoperating status? If not explain:
☐	☐	Is the the fuel filter system free of leaks? If not explain:
☐	☐	Are pipeline supports in place and undamaged? If not explain:
☐	☐	Are pipeline flanges in good working condition? (ie. rust, leaks, metal wear, bent flanges) If not explain:
☐	☐	Is pipeline in good working order and leak free? If not explain:
☐	☐	Does tank level indicator appear to be working properly? If not explain:
☐	☐	Is intermediate pipeline valve between concentrate building and loading dolphin locked out in open position? If not explain:
☐	☐	Is MARSEC security gate locked when in nonoperational status? If not explain:
☐	☐	Is dolphin fuel loading connection capped when in nonoperational status? If not explain:
☐	☐	Is dolphin fuel loading valve closed and locked out when in nonoperational status? If not explain:

Inspected By **Date**

Monthly SPCC Inspection of 920 Bulk Fueling Facilities

Yes	No	
☐	☐	Are containment berm(s) and diversionary structure in place and operating correctly? If not explain:
☐	☐	Is fuel truck transfer hose capped when in nonoperating status? If not explain:
☐	☐	Is fuel truck transfer area clean, clear of debris and in good working order? If not explain:
☐	☐	Are absorbent materials readily available to the fuel operator? If not explain:
☐	☐	Is containment berm dewatering pump locked in the off position? If not explain:
☐	☐	Is containment drainage log being maintained? If not explain:
☐	☐	Are valve glands and valve bodies free of leaks or seeps? If not explain:
☐	☐	Are the tanks, FT01 (60,000 gal.), FT04 (43,000 gal.) and FT05 (43,000 gal.) free of excessive rust, holes or leaks? If not explain:
☐	☐	Are pipeline supports in place and undamaged? If not explain:
☐	☐	Are flanges and expansion joint in good working condition? (ie. rust, leaks, metal wear, bent flanges) If not explain:
☐	☐	Is pipeline in good working order and free of leaks? If not explain:
☐	☐	Is the pipeline and tanks clearly marked and painted? If not explain:
☐	☐	Are product dispensing hoses undamaged and suitable for use? If not explain:
☐	☐	Are DEF tote, containment and dispensing system in good working order? If not explain:
☐	☐	Do tank level indicators appear to be working properly? If not explain:

Inspected By _____ **Date** _____

STI SP001 Monthly Inspection Checklist

Inspected by: _____

Hawk Inlet Area

Tank ID	Description	Capacity	Date	Liquid in 2nd Cont.?		Visible Leakage?		Level Gauge Readable?		Other Conditions?	
				Y*	N	Y*	N	Y	N*	Y*	N
FT-20	Core Shed, Diesel	500									
FT-21	Truck Fill, Diesel	1,000									
FT-22	Truck Fill, Gasoline	1,000									
FT-23	Truck Wash, Diesel	500									
FT-92	Water Bldg., Diesel	550									
FT-93	Boiler Bldg., Diesel	5,000									
FT-95	Shift House, Diesel	500									
TK-97	Boiler Bldg., Diesel	100									
TK-120	Warehouse, Used Oil	10,000									

(*) designates an item in a non-conformance status and that action is required to address a problem.

Other conditions includes: tank supports, paint, corrosion, dents, distortion, cracks, vents, piping, insulation and grounding strap.

Comments:

STI SP001 Monthly Inspection Checklist

Inspected by: _____

920/860 Area

Tank ID	Description	Capacity	Date	Liquid in 2nd Cont.?		Visible Leakage?		Level Gauge Readable?		Other Conditions?	
				Y*	N	Y*	N	Y	N*	Y*	N
FT-17	Warehouse, Diesel	500									
FT-10	Ore Pad, Diesel	500									
FT-51	Mill Cleaner, Diesel	500									
TK-02	Powerhouse, Used	5,000									
TK-03	Powerhouse, Used	1,000									
FT-44	PH Day Tank, Diesel	660									
FT-45	PH Day Tank, Diesel	660									
TK-13	Maint. Motor Oil	5,000									
TK-14	Maint. Hydraulic	5,000									
FT-03	860 Lab, Diesel	2,000									
FT-16	860 Safety, Diesel	500									
FT-28	860 Core, Diesel	500									
FT-52	Tails Loadout	440									

(*) designates an item in a non-conformance status and that action is required to address a problem.
Other conditions includes: tank supports, paint, corrosion, dents, distortion, cracks, vents, piping and grounding strap.

Comments:

STI SP001 Monthly Inspection Checklist

Inspected by: _____

Pond 23/Tailings/Young Bay/Portable

Tank ID	Description	Capacity	Date	Liquid in 2nd Cont.?		Visible Leakage?		Level Gauge Readable?		Other Conditions?	
				Y*	N	Y*	N	Y	N*	Y*	N
FT-204	Pond 23, Diesel	500									
FT-24	Tails TW (not in use)	550									
TK-127	P7 WTP, Diesel	750									
FT-25	Young's Bay, Diesel	275									
	New Truck Wash	500									
Portable Used Oil Tanks											
TK-117	HI Truck Pad/920 Area	1,100									
TK-121	HI Truck Pad/920 Area	1,100									
TK-122	HI Truck Pad/920 Area	1,100									

(*) designates an item in a non-conformance status and that action is required to address a problem.

Other conditions includes: tank supports, paint, corrosion, dents, distortion, cracks, vents, piping and grounding strap.

Comments:

GPO Appendix 06
Attachment G
Example Containment Drainage Log

Record of Containment Dike Drainage

920 Area Bulk Fuel Storage

This record must be completed when rainwater is pumped from diked area.

Drainage must be performed under responsible supervision.

Date (m/dd/yy)	Presence of Oil? (Y/N)	Decontamination Procedures (if applicable)	Initials

Record of Containment Dike Drainage

Hawk Inlet Bulk Fuel Storage

This record must be completed when rainwater is pumped from diked area.

Drainage must be performed under responsible supervision.

Date (m/dd/yy)	Presence of Oil? (Y/N)	Decontamination Procedures (if applicable)	Initials

GPO Appendix 06
Attachment H
Training Log

HECLA GREENS CREEK MINING COMPANY

Training Record

This training record should be used to record training that is not required by MSHA to be certified on a 5000-23 form.

Training Type: ❑ New Training ❑ Refresher Task Training

Specify Task: _____

Trainee's Full Name:_____ **Pay No:**_____

Department: ❑ Mill ❑ Mine ❑ Surface ❑ Maintenance ❑ Other: _____

Trainer (please print) :	Signature of trainer:	Date:

I verify that I have completed the above training	
Signature of person trained:	Date:

I Certify that the above training has been completed.		
Person responsible for training (please print) :	Signature of person responsible for training:	Date:

PLEASE ATTACH COMPLETED TRAINING CHECKSHEETS/ASSESSMENTS AND FORWARD COMPLETED DOCUMENT TO TRAINING COORDINATOR.

All sections of this form MUST be completed.
Incomplete forms will not be accepted.
Form must be completed in reproducible Blue or Black Ink.

Original – Employees Training File. Copy – Employee.

This is **not** a 5000-23 form. Equipment and Task training must be recorded on the Approved Alternate 5000-23 form or 5000-23 form.

General Plan of Operations
Appendix 07
Integrated Waste Management Disposal Plan

May 2020

Executive Summary

The Greens Creek Mine is owned and operated by Hecla Greens Creek Mining Company (HGCMC) a wholly owned subsidiary of Hecla Mining Company, Inc. The mine is an underground metals mine near Hawk Inlet on the northern end of Admiralty Island. It is located approximately 18 miles southwest of Juneau, Alaska. The mine is situated in the Greens Creek watershed in the Tongass National Forest. HGCMC has prepared this Integrated Waste Management and Disposal Plan to comply with the requirements of 18 AAC 60 Solid Waste Management Regulations of the Alaska Department of Environmental Conservation (ADEC) and the US Forest Service (USFS) General Plan of Operations (GPO) for the Greens Creek Mine.

This Integrated Waste Management and Disposal Plan (Plan) describes the required procedures for deposition of mill tailings, waste rock, and managing solid wastes and hazardous materials generated at the Greens Creek facilities. Specific management methods for the tailings placement and waste rock disposal within the mine as backfill and surface disposal are also included in this Plan, as are procedures for reusing and recycling materials. Methods for reusing and recycling materials are promoted and implemented whenever possible.

Decisions that may affect the generation of solid wastes are made with consideration to the following order of priorities: 1) potential to degrade waters of the State; 2) waste source reduction; 3) recycling of materials; 4) waste treatment; and 5) waste disposal. Appropriate management begins with geochemical characterization of excavated/mined material and at the procurement stage, before materials are purchased. Safety Data Sheets (SDS) of any new material proposed to be used at the Greens Creek Mine are reviewed prior to purchasing. The goal is to avoid materials that are considered hazardous or are classified as hazardous waste once the materials can no longer be used for their intended purposes, both for the protection of the workers handling these materials and for the benefit of the environment.

Methods to minimize the production of waste include proper handling and storage of hazardous materials to prevent accidental releases and cross-contamination of materials and providing appropriate secondary containment for hazardous materials to prevent releases, plus the associated generation of waste materials and spill residues, and the reuse and/or recycling of materials whenever possible.

Wastes are characterized to determine their appropriate management method. Non-liquid, non-hazardous wastes that cannot be recycled are disposed of at onsite disposal areas within the underground mine workings or the dry stack tailings disposal facility (TDF). Liquids, hazardous wastes and other materials that cannot be managed onsite are shipped offsite for recycling or disposal. This includes solvents, lamps, batteries, liquid paints, hydrocarbons, and mercury.

Solid waste disposal sites are constructed in underground workings of the mine (worked out stopes) for the disposal of mill tailings (as a cement/tailings mix backfill), waste rock and inert solid waste such as:

- Shipping containers, super sacks, general debris;
- Non-recyclable scrap metal;
- Tires;
- Settled solids from sumps, ditches and degritting basins;
- Construction items that include:
    - Scrap metal
    - Broken concrete slabs
    - Pipe

    - Other similar nonhazardous wastes
- Empty 5-gallon buckets and 55-gallon drums that cannot be recycled as scrap metal.

Ash from the incineration of camp wastes, sewage sludge, and sludge from the water treatment plant at the TDF are disposed of within the tailings dry stack.

Potentially reactive waste rock from the mine are kept underground, disposed of at the designated surface waste rock dump (Site 23), or hauled to the TDF for use on the internal roads or co-disposed with tailings.

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Acronyms

AAC	Alaska Administrative Code
ABA	Acid Based Accounting
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish & Game
ADNR	Alaska Department of Natural Resources
ANFO	Ammonium nitrate and fuel oil
APDES	Alaska Pollution Discharge Elimination System
ARD	Acid Rock Drainage
AS	Alaska Statute
CERCLA	Comprehensive Environmental Responsibility, Compensation & Liability Act
CESQG	Conditionally Exempt Small Quantity Generator
CFR	Code of Federal Regulations
CFATS	Chemical Facility Anti-Terrorism Standards
CWA	Clean Water Act
DHS	Department of Homeland Security
DRS	Development Rock Stockpile
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
FWS	Fish & Wildlife Service
GP	Graphitic Phyllite
GPO	General Plan of Operation
HazCom	Hazardous Communication
HDPE	High Density Polyethylene
IAEA	International Atomic Energy Agency
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IMDG	International Maritime Dangerous Goods
IUR	Inventory Update Reporting
LEPC	Local Emergency Planning Committee
LDR	Land Disposal Restriction
LQG	Large Quantity Generator
SDS	Safety Data Sheet
MSHA	US Department of Labor Mine Safety and Health Administration
MWMP	Meteoric Water Mobility Procedure
NiCad	Nickel Cadmium
NiMH	Nickel Metal Hydride
NNP	Net Neutralization Potential

NPDES	National Pollutant Discharge Elimination System
NRC	National Response Center
OSHA	US Department of Labor Occupational Safety & Health Administration
Plan	Integrated Waste Management and Disposal Plan
PPE	Personal Protective Equipment
RCRA	Resource Conservation and Recovery Act
SERC	State Emergency Response Commission
SQG	Small Quantity Generator
TDG	Transportation of Dangerous Goods
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TDF	Tailings Disposal Facility
USCG	US Coast Guard
USDOT	US Department of Transportation
USFS	US Forest Service
USGS	US Geological Survey
VOC	Volatile Organic Compounds
WTP	Water Treatment Plant

2. INTRODUCTION

This Integrated Waste Management and Disposal Plan (Plan) describes the required procedures for managing solid wastes and hazardous materials[1] generated at the Greens Creek Mine facilities, the temporary storage and final disposal of waste rock excavated during mining operations and deposition of mill tailings. Also included in this Plan are procedures for reusing and recycling materials, which are promoted and implemented wherever possible.

Hecla Greens Creek Mining Company (HGCMC) has prepared this Integrated Waste Management and Disposal Plan to comply with the requirements of 18 AAC 60 Solid Waste Management Regulations of the Alaska Department of Environmental Conservation (ADEC) and the US Forest Service (USFS) General Plan of Operations (GPO) for the Greens Creek Mine.

2.1. Project Location and Summary

The Greens Creek Mine is owned and operated by Hecla Greens Creek Mining Company (HGCMC) a wholly owned subsidiary of Hecla Mining Company, Inc. The Greens Creek Mine is located near Hawk Inlet on northern Admiralty Island, in the Tongass National Forest, approximately 18 miles southwest of Juneau, Alaska (Figure 1). The Mine site is situated partly within the Admiralty Island National Monument and completely within the municipal boundaries of the City and Borough of Juneau and is comprised of federal and patented mining claims. The Greens Creek mine facilities are located within the Greens Creek, Zinc Creek, Tributary Creek, and Cannery Creek watersheds.

The USFS has issued special use permits/leases for various aspects of the operations within the National Monument. In addition, HGCMC holds a number of patented mining and unpatented mining claims in the area, and 17 acres in Hawk Inlet under a warranty deed with Bristol Resources, Inc. The patented mining claims will be conveyed to the United States at the end of mine life or in 2095 at the latest.

The Greens Creek Mine has been in operation since 1989, with one temporary cessation of operations due to low metal prices from April 1993 until July 1996 and has been stable and constantly improving since recommissioning. HGCMC produces three concentrates containing four payable metals (silver, zinc, lead, and gold) for shipping to smelters around the world.

The mine processes approximately 2,300 tons of ore per day and employs over 400 full time employees to operate the mine and processing facilities.

The Greens Creek ore deposit consists of the following:

- Greens Creek is a Triassic age volcanogenic massive sulfide (VMS) deposit. The US Geological Survey (USGS) classifies the deposit as “Kuroko”-type, but mine personnel prefer “hybrid” because some of the features of the Kuroko-type model are not represented.

[1] As per 49 CFR Section § 105.5, *Hazardous material* means a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous under section 5103 of Federal hazardous materials transportation law (49 U.S.C. 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table (see 49 CFR § 172.101), and materials that meet the defining criteria for hazard classes and divisions in 49 CFR part 173 subchapter C

- The deposit occurs at the contact between black graphitic meta-argillite (structural footwall, geological hanging wall) and thinly laminated quartz-mica-carbonate phyllite (structural hanging wall, geological footwall).
- Both argillite and phyllite are mineralized with pyrite to varying degrees, but the phyllite is more mineralized.
- There are three main ore types present: massive, black and white. Massive ore is most common and is composed of pyrite, sphalerite and galena in a matrix of barite-bearing silica-carbonate rock. Chalcopyrite and arsenic, antimony and silver sulfosalts are present but less common. The black ore is similar but contains graphite. The white ore is pyrite poor and the gangue mineralogy is variable (barite, silicates or carbonates).

Figure 1: Project Location

3. WASTE MANAGEMENT

The following sections provide an overview of the regulatory requirements applicable to the management of solid wastes and the management procedures that are employed by the Greens Creek Mine to ensure wastes are handled safely and in accordance with all applicable regulations. The locations of the mine footprint and onsite facilities are shown on Figure 2. Key waste management facilities include the active waste rock dump (Site 23), the inactive waste rock sites (C, D, E and the 1350), the Tailings Disposal Facility (TDF), Hawk Inlet Port facilities, sewage treatment facilities, and water treatment plant are shown on Figure 2, 3, 4, and 5.

Management of wastes at the Greens Creek Mine begins before the materials are purchased by evaluating the potential environmental impacts of materials being considered for the project. In general, the Greens Creek Mine minimizes the overall generation of waste to the extent practical and minimizes the use of materials that are regulated as hazardous wastes when they no longer serve their intended purpose. Materials are reused and recycled whenever possible. Permitted solid waste disposal sites within the underground workings and at the designated areas within the TDF for the disposal of inert solid wastes are operated in accordance with the Integrated Waste Management Permit 0211-BA001 administered by the Alaska Department of Environmental Conservation (ADEC) and the regulations contained in 18 AAC 60. Contact water from waste management facilities are managed to ensure compliance with State of Alaska water quality standards.

Materials that cannot be managed onsite, such as liquid wastes, hazardous wastes, certain items to be recycled or reused, and wastes prohibited from disposal onsite, are shipped offsite for reuse, recycle or disposal at appropriate facilities.

The waste management methods discussed in these sections are based on the applicable regulations at the time this Plan was written. Changes to management methods may be required as regulations are modified. Additionally, the waste management permit may contain additional provisions that may necessitate changes to the methods discussed herein.

Figure 2: Mine Site Location Map

Figure 3: Hawk Inlet

Figure 4: Mill Site and 920 Portal

Figure 5: Tailings Disposal Facility

3.1. Regulatory Overview

Solid wastes are regulated in the State of Alaska under two main bodies of regulations:

- The Resource Conservation and Recovery Act (RCRA) federal regulations contained in 40 CFR 260 to 279; and
- The State of Alaska statutes and regulations contained in AS 46.03 and 18 AAC 60, Solid Waste Management respectively.

Hazardous wastes are regulated by the U.S. Environmental Protection Agency (EPA), Region 10 in Alaska, in accordance with the RCRA regulations. Alaska is one of the few states that does not have the authority to administer hazardous waste regulations and therefore defers to the federal regulations. Non-hazardous solid wastes, tailings and waste rock are mainly managed under the state regulations in 18 AAC 60, which includes permitted solid waste landfills and tailings disposal facilities.

When a material can no longer be used for its original purpose or otherwise meets the definition of *solid waste*, as defined in Section 2.1.1, a determination must be made as to whether or not the solid waste is a *hazardous waste*, as defined in Section 2.1.2. Waste determinations are discussed in Section 2.11.1. Once a waste determination has been made, the appropriate management method for the waste can be identified.

3.1.1. Definition of Solid Waste

The definition of solid waste can be found in AS 46.03.900(26); "solid waste" means garbage, refuse, abandoned, or other discarded solid or semi-solid material, regardless of whether subject to decomposition, originating from any source. Under the Federal definition, 40 CFR §261.2 a ***solid waste*** is any material, liquid or solid, except for materials excluded from the regulation that are a ***discarded material***, meaning a material that is:

1. *Abandoned:*
    - Disposed of; or
    - Burned or incinerated; or
    - Accumulated, stored, or treated (but not recycled) before or in lieu of being abandoned by being disposed of, burned, or incinerated.
2. *Recycled or accumulated, stored, or treated before recycling* if it is:
    - Used in a manner constituting disposal
    - Burned for energy recovery
    - Reclaimed; or
    - Accumulated speculatively.
3. Considered *inherently waste-like*; or
4. A *military munition* identified as a solid waste in 40 CFR §266.202.

There are several exclusions to the definition of solid wastes, as provided in 40 CFR § 261.4(a), such as domestic sewage and point source discharges subject to regulation under Section 402 of the Clean Water Act (CWA).

3.1.2. Definition of Hazardous Waste

As defined in 40 CFR § 261.3, a solid waste is ***hazardous*** if:

1. It is not *excluded* from regulation as a hazardous waste under 40 CFR §261.4(b);
2. It is a *characteristic hazardous* waste: it exhibits one of the characteristics of hazardous waste defined in Subpart C of 40 CFR 261:
    - Ignitability;
    - Corrosivity;
    - Reactivity; or
    - Toxicity.
3. It is a *listed hazardous waste*: a waste listed in Subpart D of 40 CFR 261 and has not been excluded in 40 CFR §260.20 or 260.22;
4. It is a *mixture* of solid waste and one or more listed hazardous waste and has not been excluded from regulation as a hazardous waste by an exemption to the regulations;
5. *Rebuttable presumption for used oil*: Used oil containing more than 1000 ppm total halogens is presumed to be a hazardous waste because it has been mixed with halogenated hazardous waste listed in Subpart D of 40 CFR 261. Persons may rebut this presumption by demonstrating that the used oil does not contain hazardous waste.

Solid wastes from beneficiation activities associated with mining operations (Bevill Exclusion to RCRA) that are exempt from being regulated as hazardous waste are listed under 40 CFR §261.4(b)(7):

> Beneficiation operations include crushing, grinding, washing, dissolution, crystallization, filtration, sorting, sizing, drying, sintering, pelletizing, briquetting, calcining, roasting in preparation for leaching (to produce a final or intermediate product that does not undergo further beneficiation or processing), gravity concentration, magnetic separation, electrostatic separation, flotation, ion exchange, solvent extraction, electrowinning, precipitation, amalgamation, and heap, dump, vat, tank, and in situ leaching.

Additionally, several exemptions are also listed in 40 CFR §261.3, which defines a hazardous waste. Some of the important exemptions that could be applied at the Greens Creek facilities include:

- Household waste (e.g. for products used for personal use at the camp facilities);
- Mine development rock returned to the mine site;
- Solid wastes from the extraction, beneficiation and processing of ores and minerals, also known as the Bevill Exemption (e.g. tailings);
- Non-tern plated used oil filters that are not mixed with a “listed hazardous waste” and have been gravity hot-drained; and
- Exemptions for mixtures which involve de minimis losses of certain hazardous wastes and laboratory wastewater discharged to water treatment systems regulated under an Alaska Pollutant Discharge Elimination System (APDES) permit.

It is important to note that intentionally mixing a hazardous waste with a non-hazardous solid waste can render the entire mixture a hazardous waste, subject to the full RCRA regulations. There are a few

exemptions to the mixture rule, however, they are only applicable under very specific circumstances and must be managed carefully to maintain compliance with RCRA.

3.2. Waste Management Priorities

In accordance with the State of Alaska Statute AS 46.06.021, in order to prevent and/or minimize the present and future generation of wastes, management decisions that may affect waste generation at the Greens Creek Mine are made by considering the following order of priority options: 1) potential of materials excavated, mined, or milled to adversely affect water quality; 2) waste source reduction; 3) recycling; 4) waste treatment; 5) and waste disposal, in accordance with applicable law. To accomplish this, the following is systematically performed:

- Geochemical characterization of materials to be excavated, mined, or milled;
- Operations that generate wastes are routinely reviewed to identify opportunities for reducing waste and these opportunities are implemented whenever possible;
- The properties of materials are reviewed prior to purchase and every effort is made to minimize the use of hazardous materials and those that would be classified as hazardous wastes once they can no longer be used for their intended purpose;
- Methods for reusing and recycling materials are promoted and implemented whenever possible to reduce waste;
- Non-hazardous solid wastes that are permitted for disposal onsite are disposed of at onsite within, permitted, solid waste sites, regulated by the Alaska Department of Environmental Conservation, in accordance with 18 AAC 60 or applicable state/federal permits;
- Materials that cannot be managed onsite are routinely shipped offsite for recycling, reuse, treatment and/or disposal to appropriate facilities.

3.3. Geochemical Characterization of Materials to be Excavated, Mined, or Milled

Materials to be excavated for construction, waste rock from the mine used for construction, and mill tailings that could potentially affect water quality are geochemically characterized and managed if necessary to prevent degradation of water resources. Material characterization is performed using one or more of the established analytical procedures; multi-element analysis, Acid Base Accounting (ABA) and kinetic testing (40-weeks). These analytical tools are used when appropriate to accurately classify the material and their potential to affect water quality.

Tailings solids are regularly collected for ABA analysis, and development rock samples are collected from the Waste Rock Facility (Site 23) from each of the waste rock type pile locations (i.e., #1, #2 and #3 waste rock types). ABA analysis is also performed on waste rock samples. If any changes are seen in the geochemical results of analysis for the development rock or tailings, additional sampling and analysis are conducted as determined necessary.

Other materials that are excavated at construction sites, mined from borrow pits, or imported to the site are appropriately characterized prior to use.

3.4. Purchasing of Materials

The following procedures are followed when purchasing materials for the Greens Creek Mine:

- Whenever possible, the Greens Creek Mine minimizes the generation of hazardous wastes by avoiding the purchase of materials that are regulated as hazardous wastes when the materials are no longer required for their intended purpose.

- To the extent practical, materials are purchased in containers (e.g. totes or drums) that can be returned to the vendor.
- The Safety Data Sheets (SDSs) for new materials to be purchased are reviewed by Environmental and Health and Safety departments to ascertain if the materials require special management under RCRA, Emergency Planning and Community Right to Know Act (EPCRA), Comprehensive Environmental Responsibility and Compensation Liability Act (CERCLA), Clean Air Act, and Toxic Substances Control Act (TSCA) (See EPA's "List of Lists").
- For materials requiring special handling and/or that are classified as a hazardous waste if disposed, HGCMC evaluates to determine if a suitable substitute is available that is considered "less hazardous". Less hazardous can include a waste that would not be classified as a hazardous waste if disposed, would not require special handling under the above-noted Acts, would generate less waste when disposed, can be reused or recycled or is generally considered to have less of an impact on the environment (e.g. a material with less discharges to the environment when treated and/or disposed).

3.5. Waste Minimization

Efforts to minimize waste begin at the purchasing phase, as discussed in the previous section, and continue on to the recycling and reuse of materials. Some examples of methods to minimize waste include:

- Use of primarily eco-friendly solvents in parts washers (e.g. Orange-Sol™ or SimpleGreen®):
    - Many solvents contain compounds that require that the solvent be managed as hazardous waste when disposed of and are harmful to the environment;
    - Parts washers reuse the same solvent repeatedly, thereby reducing the amount of waste solvent generated;
    - Use of eco-friendly solvents minimizes the volume of hazardous solvent generated (provided the solvent is not mixed with other wastes that would render the solvent mixture hazardous);
    - The use of eco-friendly solvents also minimizes the volume of other wastes that could be generated, such as rags. Rags used to wipe off chlorinated solvents must be managed as hazardous waste, just like the solvent.
- Use of low mercury, fluorescent lamps ("green end cap") and recycling of lamps and bulbs:
    - Many lamps must be regulated as hazardous waste once disposed of due to mercury and lead content. Recycling lamps prevents them from entering the waste stream;
    - Low mercury, fluorescent lamps are currently available. The mercury levels in these lamps are sufficiently low that they are not regulated as hazardous waste.
- Recycling or reuse of materials such as antifreeze, batteries, reusable light vehicle tires, scrap metal, and used oil, as discussed in Section 2.6 below;
- Returning containers to vendors or recycling them as scrap metal, which prevents the need for disposal of containers in landfills;
- Appropriate container management, including the provision of secondary containment and proper labeling:
    - Proper container management is key to reducing waste volumes;
    - Unlabeled containers holding unknown materials may require testing of the materials to determine the chemical constituents of the material, which can be costly;

  - Containers that are left uncovered and exposed to the elements may result in the material in the container becoming contaminated and unusable;
  - Containers without proper secondary containment that become damaged can result in the contamination of other materials, such as soil, and may cause harm to the environment or personnel.
- Prevention of mixing of hazardous wastes with non-hazardous wastes through waste segregation, established procedures and personnel training:
  - Mixing hazardous and non-hazardous wastes may result in the entire mixture being regulated as hazardous waste and should be avoided;
  - This is particularly important in the management of solvents and used oil.

3.6. Recycling and Reuse of Materials

The Greens Creek Mine recycles materials to the extent practical. Due to the logistics of shipping recycled materials from the mine site by air or barge and the costs associated with recycling materials, HGCMC re-evaluates the cost/benefit of their recycling program on a regular basis. Recycling opportunities vary based on the need for recycled materials, vendors available to handle recycled materials, costs, economic factors, etc. HGCMC adjusts its recycling practices to respond to these changes.

The alternative to recycling depends on the nature of the material. Materials that are considered hazardous (e.g. certain types of batteries) have a high priority for determining viable recycling alternatives since the only disposal alternative is offsite disposal in a hazardous waste disposal facility. Other materials that are not hazardous (e.g. scrap metal) may be disposed of onsite in an appropriate manner if recycling becomes impractical.

Some materials that may be recycled are discussed below. Due to the factors noted above, recycling of these materials may not always be possible or economically feasible, in which case the management methods are routinely reevaluated.

- Antifreeze (ethylene glycol) – recycled if possible or disposed of offsite;
- Cardboard and paper packaging material – bailed and shipped offsite for recycling;
- Hazardous batteries – returned to vendor for recycling or reclaimed offsite;
- Hazardous lamps – recycled offsite;
- Compressed gas cylinders – returned to vendor for reuse or recycled as scrap metal;
- Pallets – reused or burned on Site 23;
- Reusable Parts – sold/reused onsite or offsite where possible;
- Returnable/recyclable drums – returned to vendor for reuse and/or recycled as scrap metal;
- Scrap metal – recycled offsite;
- Used oil – burned for energy recovery in space heaters onsite (shipped offsite when not possible to burn for energy recovery onsite);

3.7. Waste Segregation

Waste management at the Greens Creek Mine includes appropriate segregation of wastes to ensure they are properly managed according to the applicable regulations and the specific waste handling procedures described in Section 4.0 as follows:

- All camp waste (e.g. putrescible food waste), is placed in a freezer van and shipped offsite for composting or disposal;

- Other camp waste (e.g. Household Municipal Waste) is shipped off site for disposal;
- Inert wastes destined for the TDF or disposal underground are either taken directly to these locations, or placed in specific areas such as the remuck bay for temporary storage prior to disposal;
- Hazardous wastes are placed in containers at Satellite Accumulation Areas (Section 2.11.3, for less than 55 gallons of waste) or placed in containers, appropriately labeled and brought directly to a Hazardous Waste Accumulation Area;
- Universal Wastes (lamps, batteries, mercury containing equipment) are placed in containers at Universal Waste Accumulation Areas according to the procedures outlined in Section 2.12;
- Electronics waste (e-waste) includes computer components, circuit boards, televisions, DVD players etc. are collected once deemed obsolete and are shipped offsite for recycling;
- Materials to be recycled are placed in segregated containers designated for the specific type of material and managed as outlined in Section 4.0;
- Mercury and mercury-containing materials are managed in compliance with all applicable regulations; and
- All containers are appropriately labeled and managed as described in Section 2.8 below.

3.8. Container Management

Containers are managed in accordance with all applicable regulations to ensure safety of personnel and the environment, and to prevent spills and contamination by the material contained as follows:

- All containers are appropriately labeled according to the US Department of Labor Occupational Safety & Health Administration (OSHA) or Mine Safety & Health Administration (MSHA) hazard communication standards (OSHA "HCS" at 29 CFR 1910.1200 or MSHA "HazCom" at 30 CFR 47), as described in Section 3.1;
- Hazardous wastes are labeled according to the requirements of RCRA:
    - Containers in Satellite Accumulation Areas must be labeled with words describing the contents of the container or the words "*Hazardous Waste*";
    - Containers in Hazardous Waste Accumulation Areas must be labeled with the words "*Hazardous Waste*" and the accumulation start date;
    - Containers holding Universal Waste must be labeled with the words "*Universal Waste – waste type*" "*Waste – waste type*" or "*Used – waste type*" where "*waste type*" is either batteries, lamps, thermostats or mercury containing equipment.
- Containers of used oil are labeled with the words "Used Oil";
- Hazardous materials are stored within appropriate secondary containment systems designed to contain at least 110% of the volume of the largest container within the containment. The containment are impermeable to the stored hazardous substances;
- Safety precautions listed in the SDS for each material stored are followed;
- Containers are kept closed except when adding or removing materials as required by RCRA for hazardous wastes or as needed to prevent contamination of the material, or harm to the environment or personnel;
- Inspections are conducted as required by the regulations and as needed to ensure containers are appropriately managed;
- Containers are emptied appropriately (see Section 2.8.1);
- Small containers of flammable materials are stored in flame resistant containers/cabinets;

- Incompatible materials are segregated;
- Appropriate firefighting and/or spill response equipment are available; and
- The applicable training, inspection, reporting, preparedness, prevention, contingency planning, and emergency procedures required by RCRA are implemented.

3.8.1. Procedures for Emptying Containers

An empty container is a non-hazardous waste provided it has been emptied according to the procedures described below. Residues from emptying the containers must be managed according to the hazard classification.

1. A container holding a *compressed gas* is considered empty when the pressure in the container approaches atmospheric pressure;
2. Containers that held an *acutely hazardous waste* (P-code wastes in 40 CFR §261.33), such as kepone, are considered empty when:
    a. The container or inner liner has been triple rinsed using a solvent capable of removing the material;
    b. The container or inner liner has been cleaned by another method that has been shown in the scientific literature, or by tests conducted by the generator, to achieve equivalent removal; or
    c. In the case of a container, the inner liner that prevented contact of the commercial chemical product or manufacturing chemical intermediate with the container has been removed.
3. Containers that held *hazardous waste* are considered empty when:
    a. All wastes have been removed that can be removed using the practices commonly employed to remove materials from that type of container, e.g., pouring, pumping, and aspirating, and
    b. No more than 1 inch (2.5 cm) of residue remain on the bottom of the container or inner liner, or
    c. No more than 3% by weight of the total capacity of the container remains in the container or inner liner if the container is less than or equal to 119 gallons in size; or
    d. No more than 0.3% by weight of the total capacity of the container remains in the container or inner liner if the container is greater than 119 gallons in size.
4. The Greens Creek Mine applies the standards for a container that held hazardous waste for all containers that held non-hazardous waste (other than compressed gas cylinder and aerosol cans), in addition to the following requirement:
    a. 55-gallon drums that are to be returned to the vendor are emptied to less than 1% residue.
5. Containers that have been appropriately emptied are labeled or tagged as “empty;”
6. All plugs or caps are replaced to ensure inlets/outlets are sealed from water or snow;

7. Marking, labeling or placarding required by the U.S. Department of Transportation's Hazardous Materials Regulations are retained until the packaging is sufficiently cleaned of residue and purged of vapors to remove any potential hazards; and
8. Until containers have been appropriately emptied and indicated as empty, they are kept in secondary containment where required and the labels, markings and placards are left in place.

3.9. Onsite Waste Management

Solid wastes management facilities at the Greens Creek Mine include inert solid waste underground disposal areas and the TDF. Potentially reactive materials (i.e. pyritic waste rock) are managed in waste rock Site 23, disposed of underground as backfill or used at the TDF.

These key waste management areas are regulated by ADEC under an Integrated Waste Management and Disposal Permit and are discussed in the following sections.

3.9.1. Solid Waste Disposal Sites

Surface and underground disposal sites are located within or on federal and patented mining claims meeting the approval or authorization as required by 18 AAC 60.20(b) (7) (B).

Solid waste disposal areas are located within the underground workings of the mine and at the TDF for the disposal of inert, non-hazardous solid waste and potentially reactive waste rock. These disposal areas are permitted by the ADEC in accordance with 18 AAC 60. The TDF site is located at mile 0.9 on the B access road between the Hawk Inlet Camp facilities and the 920-mine portal (Figure 3). Within the underground workings of the mine are designated areas to be backfilled as disposal sites considering options for structural backfill, disposal of inert waste materials, or final disposal of potentially reactive waste rock (i.e. pyritic waste rock).

In general, the TDF site is designed and operated to keep runoff from outside the facility area separate from the dry stack tailings, co-disposed waste rock, inert wastes, sewage sludge, etc. Visual monitoring inspections are conducted on the facilities to ensure compliance with the provisions of 18 AAC 60.

3.9.1.1. Underground Mine Disposal

Waste rock generated in the underground workings of the mine is disposed of in designated areas where mining activities have ceased, and the material is permanently entombed underground. Waste rock that is not disposed of within the mine is disposed of at Site 23. A yet to be determined amount of the waste rock from the temporary storage sites will be co-disposed of with tailings at the TDF.

A portion (up to 50%) of the mill tailings is mixed with cement (5-8%) and used as structural backfill within the underground working of the mine.

3.9.1.2. Mill and Hawk Inlet Facilities

Inert, general camp and mill refuse (e.g., no-recyclable packaging, non-recyclable empty containers, non-putrescible refuse, etc.) are placed in containers for disposal off site.

Cardboard is compressed, bailed and shipped off site for recycling, and wood scrap are burned at the TDF or Site 23. All tires are buried in designated areas underground.

3.9.2. Monitoring

The environmental monitoring implemented at the Greens Creek Mine is described in the "*Greens Creek Mine Integrated Waste Management Monitoring Plan*" This includes monitoring and characterization of

surface water, fish monitoring, benthic invertebrate monitoring, and aquatic plant monitoring. Surface and ground water monitoring and sampling in addition to other monitoring of facilities as required by ADEC under 18AAC 60.800-60.860.

3.9.3. Reporting and Record Keeping

Regular reporting is provided on waste management activities and results of environmental monitoring, as required by the waste management permit. Operating records are maintained onsite, as specified in 18 AAC 60.235.

3.10. Materials to be Managed Offsite

Certain materials are shipped offsite for recycling or disposal, including some of the recyclable materials listed in Section 2.6, in addition to liquid wastes and hazardous wastes. These materials are segregated, as described in Section 2.7 and ultimately delivered to the mine site Warehouse or Hawk Inlet facility for processing as described below. The 920 Warehouse is located approximately 200 feet east of the mill building (Figure 5).

- All materials received at the Warehouse are verified for appropriate labeling (e.g. type of material, date waste generated, etc.);
- Containers are assigned a unique container number and entered into an inventory;
- Testing is conducted, if required, to ensure materials are appropriately characterized;
- The material is placed in an appropriate accumulation area (e.g. Hazardous Waste Accumulation Area);
- Accumulated material designated to be shipped offsite are temporarily stored at Hawk Inlet (Figure 2);
- The material is shipped to an appropriate recycling and/or disposal facility depending on the type of material (e.g. solid or hazardous waste);
- All materials are shipped in accordance with the applicable regulations, including those mandated by the US Department of Transportation Pipeline and Hazardous Materials Safety Administration (Hazardous Materials Regulations), RCRA, International Civil Aviation Organization (ICAO), International Air Transport Association (IATA) and International Maritime Dangerous Goods (IMDG) code.

3.11. Hazardous Waste Management

The requirements for managing hazardous waste are found in the RCRA regulations, 40 CFR 260 to 282. The specific requirements that apply to a particular waste depend mainly on the classification of the waste generated and the generator status, which is based on the quantity of waste generated in a month and the total quantity of waste accumulated onsite at any one time. There are three categories of Generator Status:

- Very Small Quantity Generator (VSQG) – Generates 220 lb. (100 kg) or less of hazardous waste per month and the quantity of waste accumulated onsite does not exceed 2,204 lbs. (1,000 kg)[2];

[2] Additional storage limits for acute hazardous waste and residues or materials resulting from the spill of an acute hazardous waste are shown in Table 2-1.

- Small Quantity Generator (SQG) – Generates greater than 220 lb. (100 kg) but less than 2,204 lb. (1,000 kg) of hazardous waste in a calendar month and the quantity of waste accumulated onsite does not exceed 13,228 lbs. (6,000 kg);
- Large Quantity Generator (LQG) – Generates 2,204 lbs. (1,000 kg) or more of hazardous waste in a month.

The Greens Creek Mine maintains an inventory of the volumes of hazardous waste generated each month and the total volume of hazardous waste onsite to ascertain its generator status and complies with the applicable regulations. The regulations that apply to each generator status are outlined in Table 1.

Table 1. Applicable Regulations for Hazardous Waste Generators

	VSQG	SQG	LQG
Quantity Limits	≤ 220 lb. (100 kg) /month ≤ 2.2 lb. (1 kg) /month of acute hazardous waste ≤ 220 lb. (100 kg)/ month of acute spill residue or soil	Between 220 – 2,204 lb. (100 - 1,000 kg) /month	≥ 2,204 lb. (1,000 kg) /month > 2.2 lb. (1 kg) /month of acute hazardous waste > 220 lb. (100 kg) /month of acute spill residue or soil
EPA ID Number	Not required	Required	Required
On-Site Accumulation Quantity	≤ 2,204 lb. (1,000 kg) ≤ 2.2 lb. (1 kg) acute ≤ 220 lb. (100 kg) of acute spill residue or soil	≤ 13,228 lb. (6,000 kg)	No limit
Accumulation Time Limits	None	≤180 days or ≤270 days (if greater than 200 miles)	≤90 days
Storage Requirements	None	Basic requirements with technical standards for tanks or containers	Full compliance for management of tanks, containers, drip pads, or containment buildings
Waste Must be Shipped to	State approved or RCRA permitted/interim status facility	RCRA permitted/interim status facility	RCRA permitted/interim status facility
Manifest	Not required	Required	Required
Biennial Report	Not required	Not required	Required
Personnel Training	Not required	Basic training required	Required
Contingency Plan	Not required	Basic plan	Full plan required
Emergency Procedures	Not required	Required	Full plan required
USDOT Transport Requirements	Yes (if required by USDOT)	Yes	Yes

Source: EPA website - http://www.epa.gov/osw/hazard/generation/summary.htm

Hazardous Waste Determinations

As required by 40 CFR §262.11, hazardous waste determinations are made on all solid wastes generated. Determinations could be made by reviewing the regulations, testing the waste and/or applying generator knowledge.

3.11.1. Hazardous Waste Accumulation

The following procedures are followed while hazardous wastes are accumulated at the Greens Creek Mine project:

- In general, hazardous wastes are accumulated in Satellite Accumulation Areas. Once containers become full (55 gallons or less), they are delivered to a Hazardous Waste Accumulation Area within three days of becoming full;
- Wastes that are not accumulated in a Satellite Accumulation Area, such as wastes generated infrequently, are delivered to a Hazardous Waste Accumulation Area immediately;
- All wastes are shipped offsite within the required timeframe from their accumulation start date based on the generator status during the month the waste was generated;
- All containers are appropriately labeled as described in Section 2.8 and managed according to the applicable regulations (see Table 2-1).

3.11.2. Satellite Accumulation Areas

Up to 55 gallons of hazardous waste or one quart of acutely hazardous waste can be accumulated in Satellite Accumulation Areas provided the requirements of 40 CFR §262.34(c) are met. Containers must be at or near the point of generation of the wastes; under the control of the operator of the process generating the waste; in good condition; made of or lined with materials that are compatible with the waste; kept closed at all times (except when adding/removing waste); opened, handled and stored in a manner that prevents ruptures or leaks; and labeled with the words “Hazardous Waste” or a description of the contents (Appendix A). This allows the accumulation of waste without a time limit until a container becomes full. Once a container in a Satellite Accumulation Area becomes full, the date must be written on the label. Full containers will then be transferred to a Hazardous Waste Accumulation Area within three days of becoming full.

3.11.3. Shipments of Hazardous Waste

Hazardous wastes are shipped offsite to appropriate facilities in accordance with the applicable requirements of USDOT (see Section 3.6). Additional requirements apply depending on the mode of shipment, as mandated by the International Civil Aviation Organization (ICAO), International Air Transport Association (IATA) and International Maritime Dangerous Goods (IMDG) code. Shipments are accompanied by a Hazardous Waste Manifest and the appropriate Land Disposal Restriction (LDR) Notification and Certification forms where applicable.

3.12. Universal Waste Management

The Universal Waste regulations (40 CFR 273) are streamlined hazardous waste management regulations that can be applied to the management of the following hazardous wastes: batteries, pesticides, mercury-containing equipment and lamps. Generators of these wastes can choose to manage them as Universal Waste rather than under the more complex hazardous waste requirements. The intent of the Universal Waste regulations is to promote and facilitate the recycling and proper handling of these widely generated hazardous wastes.

The main types of Universal Wastes likely to be generated at the Greens Creek Mine include batteries, mercury-containing equipment and lamps. The Greens Creek Mine is a *Small Quantity Generator of Universal Waste*, meaning that *less than 11,000 lbs. (5,000 kg) of Universal Waste would be accumulated onsite at any time*.

Universal wastes are managed in accordance with the regulations in 40 CFR 273. This includes accumulation in appropriate containers that are labeled as specified in 40 CFR § 273.14, using a method that clearly demonstrates the length of time that the Universal Waste has been accumulated from the date it became a waste or was received.

The Greens Creek Mine trains all employees who handle or have responsibility for managing Universal Waste in the proper handling and emergency procedures appropriate to the type(s) of Universal Waste handled.

All releases of Universal Waste and other residues from Universal Wastes are immediately contained. A determination is made as to whether any material resulting from the release is hazardous waste, and if so, it is managed in compliance with all applicable requirements of 40 CFR parts 260 through 272.

Universal Waste materials are sent offsite to another Universal Waste Handler or a permitted destination facility[3] within one year of the accumulation start date. Universal Wastes meeting the definition of a hazardous material under the USDOT regulations are packaged, labeled, marked and placarded and appropriate shipping papers are prepared according to the applicable USDOT regulations under 49 CFR 171 through 180.

3.13. Used Oil Management

Used oil is defined as "any oil that has been refined from crude oil or any synthetic oil that has been used and as a result of such use is contaminated by physical or chemical impurities" and is regulated under RCRA, 40 CFR 279.

Mixing used oil with other hazardous wastes may render the mixture a hazardous waste, in which case the mixture could no longer be managed as used oil. Mixtures of used oil are regulated as follows:

- A mixture of used oil and a listed hazardous waste is regulated as *hazardous waste*;
- A mixture of used oil and a characteristic hazardous waste or a listed hazardous waste that is listed solely because it exhibits one or more hazardous waste characteristic is regulated as:
    - *Hazardous waste* if the mixture exhibits any characteristic of hazardous waste; and
    - *Used oil* if the mixture does not exhibit a characteristic of hazardous waste;
- Note that used oil containing more than *1,000 ppm of halogens* is presumed to be *hazardous waste* (referred to as the "rebuttable presumption for used oil"). This presumption can be rebutted if the generator can prove that the used oil was not mixed with hazardous waste.

Used oil generated at the Greens Creek Mine that meets the requirements to be regulated as used oil is burned for energy recovery in space heaters when possible. Used oil that must be regulated as hazardous waste is shipped offsite to an appropriate facility for handling.

[3] *Destination facility* means a facility that treats, disposes of, or recycles a particular category of Universal Waste, with the exception of the management activities described in 40 CFR § 273.13 (a) and (c) and 40 CFR § 273.33 (a) and (c).

The general requirements for managing used oil include:

- Records of used oil burned onsite and shipped offsite are prepared, as specified in 40 CFR 279;
- Containers are in good condition and labeled with the words "Used Oil";
- Any records produced as part of the management of used oil are kept on file for at least three years;
- Containers are provided with secondary containment as required under the applicable regulations (40 CFR 112 and 18 AAC 75).

3.14. Employee Training

Employees handling hazardous materials are trained in the appropriate and safe handling of these materials as required by MSHA, RCRA and/or USDOT based on the duties of the employees. This includes:

- Employees of Small and Large Quantity Generators of hazardous waste involved in handling hazardous wastes must be trained[4] on proper waste handling and emergency procedures relevant to their responsibilities during normal facility operations and emergencies;
- Employees of Small Quantity Handlers of Universal Waste are trained on proper handling and emergency response procedures appropriate for the type of Universal Waste handled;
- Personnel involved in shipping hazardous materials and wastes, including preparing packages, preparing/signing/reviewing manifests, loading/unloading materials, and transporting materials, have or will complete the appropriate USDOT Hazardous Materials (Hazmat) transportation training (49 CFR §172.704);
- Employees handling hazardous materials are trained according to the hazard communication standard under MSHA;
- Employees are required to complete the mandatory 40-hour new miner training and annual 8-hour refresher course required under MSHA.

Records of training are maintained on file according to the applicable regulations.

[4] The amount and/or type of training required for hazardous waste generators is dependent on the amount of hazardous waste generated by the facility in a calendar month. According to 40 CFR Section 262.34(a) (4), generators who generate more than 1,000 kg/month of hazardous waste (or more than 1 kg/month of acutely hazardous waste) (LQG) must comply with the emergency preparedness and personnel training requirements in Section 265.16. Generators who generate greater than 100 kg but less than 1,000 kg/month of hazardous waste (SQG), must comply with the emergency preparedness and personnel training requirements in Section 262.34(d)(5). The training requirements do not apply to generators of less than 100 kg/month (e.g., conditionally exempt small quantity generators)

4. HAZARDOUS MATERIALS MANAGEMENT

4.1. Handling and Storage of Hazardous Materials

Hazardous materials are handled and stored in the workplace according to the US Department of Labor and Mine Safety and Health Administration (MSHA) hazard communication standards, which require the following:

- The preparation and implementation of a written hazard communication program;
- Proper labeling of all hazardous materials, including the hazard classification;
- Retention of marking, labeling or placarding required by the USDOT's Hazardous Materials Regulations until the packaging is sufficiently cleaned of residue and purged of vapors to remove any potential hazards;
- Safety Data Sheets (SDS) readily available for all hazardous materials in the work place;
- Training of personnel handling hazardous materials; and
- Inspections to check for compliance with the standards.

All materials are stored based on the hazard classifications identified in their SDSs and in compliance with the applicable OSHA or MSHA regulations. Incompatible materials are segregated accordingly. Fuel and explosives are stored in separate, designated areas, segregated from other chemicals.

Additionally, secondary containment is provided as required by the federal Oil Pollution Prevention regulations in 40 CFR 112 and the State of Alaska Oil and Other Hazardous Substances Pollution Control regulations in 18 AAC 75. Hazardous wastes are handled and stored according to the Resource Conservation and Recovery Act (RCRA) regulations.

4.2. Specific Hazardous Materials Handling Procedures

Certain hazardous materials require special handling, including the key materials discussed below.

4.2.1. Explosives

Explosives are stored and handled according to the MSHA regulations contained in 30 CFR 56. Explosives are also handled and transported according to the regulations of the Bureau of Alcohol, Tobacco, Firearms and Explosives, US Department of Transportation Pipeline and Hazardous Materials Safety Administration and the US Coast Guard (USCG). All detonators and bagged products are stored in an explosives magazine meeting all applicable federal and state safety and security requirements.

Charges and detonators are shipped separately under the control of the explosives supplier. Transport companies that handle these cargoes have the appropriate certification and licenses. Although components used to produce the blasting require special handling, as detailed in 33 CFR § 126.28, they are shipped along with the rest of the general cargo destined for the mine site.

4.3. Inventory of Hazardous Materials

An inventory of all hazardous materials used and stored at the site is maintained for the Greens Creek Mine. This includes the quantities of materials used and stored annually, locations of storage, type of storage, etc.

Inventories of the locations of Hazardous Waste, Universal Waste and Satellite accumulation areas are also being maintained, in addition to the locations of lead acid battery accumulation areas.

4.4. Safety Data Sheets (SDS)

SDSs for each hazardous material are maintained online (Sitehawk) and are kept up-to-date and made readily available to employees and contractors employed at the Greens Creek Mine.

4.5. Inspections

Inspections of hazardous materials are conducted as required to ensure hazardous materials are being handled appropriately and in compliance with all applicable regulations and in accordance with the inspection requirements of applicable permits and/or plans.

4.6. Transportation of Hazardous Materials

Hazardous materials are transported in accordance with all applicable regulations, including, but not limited to, the following requirements:

- Containers are prepared for shipment according to the requirements of 49 CFR Part 172 for the preparation of shipping papers, marking, labeling and placarding;
- Materials are packaged according to 49 CFR Parts 173, 178 and 179;
- Emergency response information are provided and maintained according to 49 CFR 172 (Subpart G);
- Personnel involved in the transportation of hazardous materials are trained according to 49 CFR 172 (Subpart H);
- Where applicable, Safety and Security Plans are developed and implemented in accordance with 49 CFR 172 (Subpart I);
- Transportation of hazardous materials by aircraft are conducted in accordance with 49 CFR 175; and
- Transportation of hazardous materials by vessel are conducted in accordance with 33 CFR 126 and 49 CFR 176, which includes requirements for general handling, stowage, and segregation, port security, and the preparation of a Dangerous Cargo[5] Manifest, in addition to specific requirements for the various classes of hazardous materials.

Where applicable, international shipments of hazardous materials are shipped in accordance with the following regulations:

- International Civil Aviation Organization's Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO Technical Instructions);
- International Maritime Dangerous Goods Code (IMDG Code);
- Transport Canada's Transportation of Dangerous Goods (TDG) Regulations; or
- International Atomic Energy Agency Regulations for the Safe Transport of Radioactive Material (IAEA Regulations).

4.7. Employee Training

Employee training is discussed under Section 2.14.

4.8. Reporting Requirements

[5] Dangerous cargo is defined in 33 CFR §126.3 as all hazardous materials listed in 49 CFR parts 170 through 179, except those materials preceded by an “A” in the Hazardous materials Table in 49 CFR §172.101 and all cargo listed in 46 CFR part 148.

The purchase, use and release of certain hazardous substances require reporting under a variety of regulations, including:

- Releases of hazardous substances must be reported as outlined in Section 5.1, *Spill Reporting*.
- Emergency Planning & Community Right-To-Know Act (EPCRA) requirements of regulated facilities include:
    - Emergency planning and notification, including notification of releases of hazardous substances to the Local Emergency Planning Committee (LEPC) and State Emergency Response Commission (SERC);
    - Hazardous chemical reporting through the provision of SDSs and/or inventories of hazardous chemicals (e.g. Tier II inventory) to the LEPC, SERC and/or fire department having jurisdiction over the facility; and
    - Information on toxic chemical releases and waste management activities reported annually to the EPA through the Toxic Release Inventory (TRI) Program.
- Inventory Update Reporting (IUR) under the Toxic Substances Control Act (TSCA) requires reporting of manufacturing and/or importing of certain substances at or above a threshold quantity.
- The Department of Homeland Security (DHS) Chemical Facility Anti-Terrorism Standards (CFATS) require that facilities that possess any chemical on the CFATS (Appendix B): DHS Chemicals of Interest List complete a Top-Screen assessment to determine if they meet the CFATS criteria for high-risk chemical facilities.

5. SPECIFIC WASTE/MATERIAL HANDLING METHODS

The following sections describe the specific management methods that are followed for waste streams and other materials generated at the Greens Creek Mine. Adherence to these methods by employees and contractors is essential in order to ensure the project operates in compliance with all applicable regulations and permits, and to ensure the safety and protection of employees, contractors, and the environment.

This Plan will be kept updated as needed, for example, as new waste streams are added, due to changes in procedures or processes or in response to modifications to the applicable regulations.

5.1. Absorbents/Floor Dry

Absorbents, including absorbent pads, socks and booms, floor dry, and floor sweep are commonly used to collect spilled products. The disposal of absorbents is dictated by the material collected on the absorbent:

- Absorbents used to collect petroleum products are considered *non-hazardous waste once no free liquid can drain from the absorbent*. These absorbents are shipped offsite for energy recovery or disposal. The collected liquid is managed as used oil.
- Absorbents managed as *hazardous waste* are those contaminated with a material that is classified as hazardous waste if disposed of. These absorbents are shipped offsite to an appropriate facility (e.g. RCRA approved Treatment Storage and Disposal Facility). Any collected liquid that cannot be used for its original purpose is also shipped offsite to an appropriate facility.
- Absorbents managed as *non-hazardous waste* are those contaminated with a non-hazardous material. These absorbents collected and shipped offsite for energy recovery or final disposal. Collected liquid that cannot be reused or managed onsite are shipped offsite to an appropriate facility.

5.2. Antifreeze/Coolant

Ethylene glycol is commonly referred to as antifreeze or coolants. Ethylene glycol is typically used as a coolant in equipment such as vehicles and generators. Glycol is managed as follows:

- Used glycol is shipped offsite for recycling or disposal.
- Glycol that is found to be a hazardous waste is shipped offsite to an appropriate facility.

5.3. Asbestos

The presence of asbestos will be determined prior to any demolition or renovation activities. Certified and trained asbestos abatement contractors would be used for any required asbestos removal activities. It is not expected to encounter asbestos, but if the material is encountered, removal and disposal will follow 40 CFR 61, Subpart M. Any asbestos containing material purchased and brought to site is documented and tracked.

5.4. Assay Lab Waste

Wastes generated from the assay lab that contain lead are recycled through the mill. Other non-hazardous wastes are placed in containers for disposal off site.

Assay lab acid wastes are neutralized[6] and pumped into the process plant.

- Laboratory sample preparation wastes, crucibles, cupels, flux, and slag are returned to the process to recover any valuable minerals.
- Fire Assay baghouse filters are recycled through the mill to recover metals.
- Personnel Protective Equipment (PPE), i.e. gloves, masks, respirator cartridges, etc. are tested[7] to determine if they are hazardous. PPE found to be a *hazardous waste* are shipped offsite to an appropriate facility. *Non-hazardous waste* PPE are disposed of onsite.

5.5. Batteries

Batteries that are used onsite include alkaline, lithium, nickel cadmium, nickel metal hydride, and lead acid batteries. *Non-hazardous waste* batteries are shipped offsite for recycling or landfilled in designated underground areas. Hazardous batteries are managed as *Universal Waste* (40 CFR part 273) and shipped offsite for recycling. Lead-Acid batteries are shipped offsite for reclamation. A brief description of the battery types and management methods is provided below:

- Alkaline batteries are commonly used disposable batteries. Alkaline batteries are managed as *non-hazardous waste*;
- There are several types of lithium batteries, including rechargeable lithium-ion (Li-ion) and lithium-polymer (Li-poly) batteries and disposable lithium batteries such as lithium sulfur dioxide batteries (Li-SO_2). Lithium batteries are managed as *Universal Waste*;
- Nickel metal hydride (NiMH) batteries are commonly used rechargeable batteries. NiMH batteries are managed as *non-hazardous waste*;
- Nickel Cadmium batteries, also known as NiCad batteries are rechargeable batteries. NiCad batteries are managed as *Universal Waste*;
- Lead acid batteries are used in vehicles and equipment; smaller, sealed lead acid batteries are used in miner lights. Spent lead acid batteries are managed as *exempt* from the hazardous waste regulations *if reclaimed* (40 CFR §273.2).

5.6. Building Demolition Materials

A complete survey of any building or structure to be demolished are made prior to demolition to assess the potential environmental concerns and to determine appropriate management methods for any wastes or recyclable materials generated. If removal of asbestos is necessary, the procedures in Section 4.3 are followed.

5.7. Camp Waste

Household-type waste generated from employees and contractors at the project site camp facilities, including employee/contractor rooms, cafeteria and kitchen are shipped offsite for disposal. This is to ensure that no putrescible wastes are placed in the TDF and no wildlife are attracted to the area.

- Food scraps are frozen and sent to a landfill.

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[6] For materials meeting the characteristic of corrosivity (40 CFR §261.22), these activities are conducted according to the RCRA requirements for an elementary neutralization unit (40 CFR 260.10).

[7] Testing for the characteristic of toxicity is conducted according to the Toxicity Characteristic Procedure (TCLP), EPA test Method 1311in "*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*", EPA Publication SW-846.

- Cooking oil and grease from the kitchen are sent to a biodiesel company in Washington State;
- Other industrial-type wastes generated by maintenance and housekeeping activities are managed according to the procedures for the specific waste provided in this Plan;
- Aerosol cans are punctured at an aerosol can puncturing unit (see Section 4.9.3);

5.8. Chemicals / Reagents

The requirements for handling chemicals and reagents that have spilled or can no longer be used for their intended purpose varies depending on the type of chemical or reagent.

- The following materials used in the assay lab are considered non-hazardous waste and are reprocessed through the mill, ultimately ending up in with the tailings:
    - Borax
    - Silica Sand
    - Soda Ash
- The chemicals/reagents listed below require special handling. Every effort is made to return these chemicals to the process to be used for their original purpose. If this is not possible, the chemicals are shipped offsite to an appropriate facility.
    - Sodium Nitrate (refinery)
    - Isopropyl Xanthate
    - Methyl Isobutyl Carbinol (MIBC)
    - 2-Mercaptobenzothiazole and Dithiophosphinate (Aero 404 and Aerophine 3418A)
    - Muriatic Acid
    - Sulfuric Acid
    - Lime (calcium oxide)
    - Sodium Hydroxide (caustic soda)
    - Flocculents
    - Sodium Nitrate
    - Copper Sulfate
    - Zinc Sulfate
    - Ferric Chloride
    - Hydrogen Peroxide
    - Fluxes
    - Water Softening and Anti-Scalant Agents
    - Polyoxyparafins
    - Urea

5.9. Containers/Packaging

All containers and packaging must be emptied appropriately prior to disposal, reuse onsite or return to vendor, according to the requirements in Section 2.8.1. The application of “empty” label or tag is indication that containers have been appropriately emptied. *Until containers have been appropriately emptied and indicated as empty*, they are kept in secondary containment and the original labels, markings and placards are left in place.

5.9.1. Empty Drums

- Drums that contained acutely hazardous waste are emptied according to Item (2) in Section 2.8.1, which requires triple rinsing;
- Drums that contained all other materials are emptied according to Items (3) and (4) of Section 2.8.1, which requires emptying containers according to the RCRA requirements for hazardous waste;
- Additionally, as required by the vendor, 55-gallon drums that are returned to the vendor are emptied to less than 1% residue;
- All plugs or caps are replaced to ensure inlets/outlets are sealed from water or snow;
- Empty drums are recycled whenever possible by returning them to the vendor;
- Drums to be recycled as scrap metal are crushed prior to shipment offsite;
- All large, non-recyclable containers (over 5 gallons) are crushed prior to being shipped offsite or disposed of in the designated underground disposal area. The generators of the containers are responsible for ensuring containers are crushed prior to delivery for final disposal.

5.9.2. Compressed Gas Cylinders

Compressed gas cylinders include those containing oxygen, acetylene, propane, ether, carbon dioxide, argon and nitrogen:

- The majority of large cylinders are returned to the vendor and refilled;
- Cylinders are segregated by type and are managed according to safe handling procedures for compressed gas cylinders, which includes ensuring they are stored upright in a dry, cool, well-ventilated, secure area, protected from the weather, away from combustible materials and secured;
- Smaller cylinders such as those containing ether or propane, are purged of their contents using a cylinder recycling apparatus, such as the ProSolv® unit. The purged cylinders are recycled as scrap steel.

5.9.3. Aerosol Cans

- All aerosol cans other than the ones containing glue or spray foam are punctured and drained using onsite aerosol can puncturing units located at designated *Satellite Accumulation* areas throughout the property;
- Cans containing glue or spray foam are shipped offsite to an appropriate facility (e.g. RCRA approved Treatment Storage and Disposal Facility);
- A puncturing unit like the Aerosolv® brand or equivalent is used. The puncturing device is attached directly to the 2 inch-bung of a 30-gallon can. Cans are punctured with a non-sparking puncture pin and the liquid is collected in the drum. A filter is attached to the ¾ inch-bung on the drum to collect volatile organic compounds (VOCs);
- The punctured and drained aerosol cans are considered *non-hazardous waste* and recycled as scrap metal;
- Residues and filters from puncturing aerosol cans are either tested to determine if they are hazardous waste or just treated as such. Typically, these wastes must be managed as *hazardous wastes* and are shipped to an appropriate facility.

5.10. Contaminated Soil

The following sections describe procedures for handling specific types of contaminated soil.

5.10.1. Petroleum Contaminated Soil

- Petroleum contaminated soil is considered a *non-hazardous waste* and is collected and shipped offsite;
- The management of soil contaminated with petroleum products (e.g. oil) depends on whether the contaminated soil is inside or outside the underground operations, as described below:
    - Contaminated soil from the underground mine workings is removed and treated offsite or in some cases processed through the mill for recovery of any valuable minerals.
    - Soil samples for spills outside of the underground workings are collected depending on the size and location of the spill and based on regulatory guidance to verify that the spill area has been cleaned up appropriately according to the appropriate ADEC soil cleanup levels (18 AAC 75).

5.10.2. Caustic/Acid Releases outside the Mill and Secondary Containment

- Caustic compounds are also known as bases or alkaline compounds and have a pH greater than 7. Examples include potassium hydroxide, ammonia and sodium hydroxide.
- Acidic compounds have a pH of less than 7. Examples include sulfuric, hydrochloric and nitric acid (inorganic) or acetic and formic acid (organic).
- Where required, releases of caustic and acid are neutralized onsite and managed as *non-hazardous waste* either in situ or by removing the contaminated soil and subsequently neutralizing it as follows[8]:
    - Caustic spills – neutralize with a weak acid, preferably with a product specifically designed to neutralize caustic spills (e.g. Spill-X-C®);
    - Acid spills – neutralize with a weak base, preferably with a product specifically designed to neutralize acidic spills (e.g. Spill-X-A®);
    - Neutralizing caustic or acid spills can produce a violent reaction; therefore weak neutralizers must be used.
- Confirmation samples are collected when required. For in situ remediation, if the material has been appropriately neutralized, it is left in place. Otherwise, the material is removed and neutralized.
- Contaminated soil that has been neutralized is left in situ, placed in the designated underground disposal area, TDF, or used as fill where needed.

5.11. Filters

There are a number of filters, including those from vehicles, buildings, baghouses, aerosol can puncture devices, assay lab, etc. In general, filters classified as non-hazardous waste are shipped offsite or recycled as scrap metal. Filters classified as hazardous waste are shipped offsite to an appropriate facility (e.g. RCRA approved Treatment Storage and Disposal Facility);

The following sections describe procedures for managing filters collected throughout the facilities:

[8] For materials meeting the characteristic of corrosivity (40 CFR §261.22), these activities are conducted according to the RCRA requirements for an elementary neutralization unit (40 CFR 260.10)

- Filters from the fire assay baghouse may contain lead and are recycled through the mill to recover metals;
- Filters from aerosol can puncturing units are typically *hazardous waste* and are managed as described in Section 4.9.3;
- The majority of the filters from vehicles, equipment and buildings onsite are *non-hazardous waste* and are recycled as scrap metal. *Hazardous waste* filters are shipped offsite to an appropriate facility (e.g. RCRA approved Treatment Storage and Disposal Facility);
- Filter cloths from the milling process are disposed of in designated underground areas.
- Used oil filters include oil filters from vehicles or equipment and fuel filters from diesel equipment:
    - They are considered *exempt* from hazardous waste regulations if they are "non-terne-plated" and gravity hot-drained according to one of the methods described below:
        - Puncturing the filter anti-drain back valve or the filter dome end and hot-draining;
        - Hot-draining and crushing; or
        - Dismantling and hot-draining.
    - Note that hot-draining means the oil or diesel must be hot ($\geq$60ºF) and drained for a period of at least 12 hours;
    - Once appropriately gravity hot-drained, they are recycled as scrap metal;
    - Drained oil or diesel is collected and managed as used oil. Containers are be marked "Used Oil";
    - Used oil filters are managed as used oil until appropriate gravity hot-drained, with containers marked "Used Oil";
    - Used oil filters, once drained, are shipped offsite for recycling.

5.12. Food Waste (Putrescibles)

Food waste from the Hawk Inlet facilities are incinerated onsite:

- Food wastes from the kitchen and dining room are placed in designated trash cans and then transferred to a freezer van outside the Cannery. From there it is shipped offsite for composting or disposal;
- Non-putrescible waste from the kitchen, dining room and camp rooms, are compacted and shipped offsite for disposal;

Food waste collected at the mill and mine are placed in closed containers and shipped offsite for disposal. These waste management practices ensure that putrescibles are not disposed of onsite in order to prevent attraction of wildlife;

5.13. Light Bulbs/Lamps

Many used bulbs are considered hazardous waste when disposed of. They can be managed as *Universal Waste* if intact. Bulbs classified as hazardous waste that are intentionally broken or crushed must be managed as *hazardous waste*. HGCMC maintains a list of offsite facilities that recycle bulbs.

5.13.1. Hazardous Lamps

- Lamps containing mercury include fluorescent bulbs, high intensity discharge (HID) bulbs and neon/argon lamps. Examples of HID bulbs include mercury vapor, metal halide, and high-pressure sodium bulbs, as well as blue plasma vehicle headlights. The lamps may be classified as *hazardous waste* when disposed of;
- Many lamps contain lead in the solder, which cause them to be classified as *hazardous waste* when disposed of, including incandescent lamps;
- Used bulbs that are intact and classified as hazardous waste are managed as *Universal Waste* and shipped offsite;
- Used bulbs classified as hazardous waste that are intentionally broken or crushed are managed as *hazardous waste* and shipped offsite.

5.13.2. Non-Hazardous Lamps

- Environmentally friendly, low mercury, fluorescent lamps (“green end cap”) are currently available, which are classified as *non-hazardous waste* when disposed of. HGCMC purchases environmentally friendly fluorescent bulbs whenever possible;
- Halogen lamps are also typically *non-hazardous waste*;
- Non-hazardous lamps are shipped offsite intact for recycling.

5.14. Lubricants / Petroleum Products

5.14.1. Brake Fluid

- Brake fluid is managed as used oil and burned for energy recovery.

5.14.2. Grease

- Used grease that cannot be used onsite is shipped offsite for disposal;

- Grease buckets and other containers with less than 3% residue remaining in the container are considered empty and are crushed and disposed of within the designated underground disposal areas;
- Grease-contaminated trash is shipped offsite for disposal.

5.14.3. Used Oil

- Used oil generated at the Greens Creek Mine that meets the applicable RCRA regulatory requirements are burned in space heaters to recover energy (see Section 2.13 and for the used oil management requirements);
- Used oil that cannot be used onsite is shipped to an offsite facility;
- All used oil containers must be labeled "Used Oil" and contained in appropriate secondary containment;
- Quantities of used oil generated and burned for energy recovery or shipped offsite is logged.

5.15. Miscellaneous Materials

- Use of Styrofoam is discouraged at the site, but waste Styrofoam products are disposed of within the designated underground disposal areas. Styrofoam "peanuts" and other small pieces are placed in boxes or bags prior to disposal to ensure confinement prior to final disposal.
- Draeger test tubes may be *non-hazardous waste* or *hazardous waste* depending on the type. *Non-hazardous waste* tubes are disposed of onsite. *Hazardous waste* tubes are shipped offsite to an appropriate facility.
- Fiberglass insulation is disposed of onsite.
- Hoses are drained to the extent they will not drip any previous contents and disposed of within the designated underground disposal areas or shipped offsite.
- Plastic materials are placed within the designated underground disposal areas or shipped offsite.
- Rubber products are placed within the designated underground disposal areas or shipped offsite. If the rubber products are If contaminated, a waste determination need to be made, and the material handled accordingly.

5.16. Oily Waste

Oil or grease contaminated rags, pads, gloves or absorbents are considered *non-hazardous waste once no free liquid can drain from the absorbent*. These absorbents are collected, placed into shipping containers, and shipped offsite for disposal. The collected liquids are managed as used oil.

5.17. Paints

- Every effort is made to use paints for their intended purpose rather than dispose of them;
- Water-based, latex or acrylic paint – paint in solid form or painting materials (e.g. rags, brushes, rollers) are *non-hazardous waste* and are disposed of within the designated underground disposal areas or shipped offsite;
- Paint in liquid form is shipped offsite;

- Oil-based paints – paint in solid form[9] or painting materials are *non-hazardous waste* and are disposed of within the designated underground disposal areas or shipped offsite;
- Paint in liquid form is *hazardous waste* and is shipped offsite;
- Thinners and solvent-based or lead-based paint – paint in liquid or solid form or painting materials may be *hazardous waste* and are characterized and managed accordingly.

5.18. Radioactive Materials

Radioactive materials used onsite include analyzing equipment and potentially exit signs containing tritium. These materials are handled by the Radiation Safety Officer according to the applicable regulations of:

- The US Nuclear Regulatory Commission, which regulates the use of source, byproduct, and special nuclear material under the authority of the U.S. Atomic Energy Act (10 CFR Parts 1 - 171);
- The USDOT regulations, which establish criteria for the safe transport of radioactive materials in the United States (49 CFR Parts 171 through 178); and
- The EPA, which regulates the disposal of low level radioactive material mixed with hazardous waste (40 CFR Part 261).

5.19. Rags

The disposal of rags is dictated by the material on the rag:

- Rags contaminated with petroleum products, are considered *non-hazardous waste once no free liquid can drain from the rag* and are collected, placed into shipping containers and shipped offsite. Collected oil is managed as used oil;
- Rags contaminated with other materials are classified based on the classification of the material used on the rag if the materials were to become a waste:
    - Rags managed as *hazardous waste* are those contaminated with a material that is a hazardous waste if disposed of. These rags are shipped offsite to an appropriate facility;
    - Rags managed as *non-hazardous waste* are those contaminated with a non-hazardous material. Excess liquid is removed from these rags and then the rags placed into shipping containers and shipped offsite. Any collected liquid are managed according to the procedures described in this Plan for the particular liquid.

[9] Purposely leaving paint containers that contain hazardous waste paints open to dry to render them non-hazardous is not permitted.

5.20. Scrap Metal

Scrap metal includes building materials, empty drums, welding rod, compressed gas cylinders, grinding ball chips, mill liners, crusher liners, oil filters, punctured aerosol cans, and copper wire. To the extent practical, the project recycles any scrap metal generated at the site. If the material cannot be recycled, it is disposed of underground.

5.21. Solvents

Eco-friendly solvents are primarily used at the Greens Creek Mine. These solvents are non-hazardous. Provided they are appropriately managed and not mixed with other wastes or materials, they can be disposed of as *non-hazardous waste*. The main solvents generated are those from the parts washers. The solvent is reused and must be periodically replaced. Solvents from parts washers are sampled and characterized to determine if they are hazardous waste. Sludge from the parts washers is also sampled and characterized. Parts washer solvents and sludge are shipped offsite to an appropriate facility.

Used solvent can in some cases be mixed with used oil [40 CFR §261.3(b)(3)] and burned in space heaters to recover energy.

5.22. Tires

Tires are shipped offsite for recycling if feasible. If not recycled, they are disposed of within the designated underground disposal areas.

5.23. Tailings Disposal Facility (TDF)

Tailings produced by the flotation process at the Greens Creek mill are dewatered in a filter press. The tailings, consisting of between 66% and 86% by weight passing the No. 200 mesh. Tailings are permanently disposed of in two methods:

1. A portion (up to 50%) of the mill tailings are filter-pressed and mixed with cement (5-8%) and used as structural backfill in the underground working of the mine. In general, tailings backfilling to mined-out areas underground is the preferential disposal method. Tailings backfilling provides structural support of the underground workings and allows removal of more ore.

2. The remainder of the tailings is filter-pressed and strategically placed as dry tailings within the TDF. The tailings are placed into cells, spread and compacted (at just below the optimum standard Proctor moisture content of approximately 12%).

The TDF is situated near Hawk Inlet. Tailings are loaded at the Tailings load-out area into covered “maxhaul” tractor/trailers, each with a 45-ton capacity, and hauled down the B Road from the mill to the TDF. Approximately 20 round-trips per day are required, but this varies depending on the daily underground tailings backfill requirements.

The surface placement method involves depositing the tailings in discrete cells in the TDF, which allows better control over compaction, drainage and pore pressure dissipation. An access road is constructed, and the pile is divided into several cells. Prior to placing the tailings, any saturated tailings or snow accumulations on the placement surface are cleaned off. The tailings are placed in a small area and loads are recorded by cell. The tailings are spread in a sloped lift and compacted by several passes with a bulldozer followed by overlapping passes of a vibratory roller. During this placement, the grading and compaction-sealing of the surface allows surface water to run off, and, as best as possible, minimizes ruts or indentations so that infiltration into the placed tailings is minimized. Due to the limited placement area,

lifts are adjusted to maximize cell placement and slope consistency. Placement then progresses to another area.

5.23.1. Co-Disposal of Tailings and Waste Rock

The primary purpose of co-disposal is to reduce pyrite oxidation and metal leaching from waste rock by surrounding it with a matrix of fine-grained material (tailings), which will extend the duration over which the rock is able to neutralize acidity. Co-disposal of waste rock with tailings at the TDF has several benefits, including:

- Reduced waste rock oxidation rates and extended acid neutralization capacity;
- Improved tailings geotechnical characteristics, including lower permeability, higher friction angle, dilation during shear testing and good water retention capacity;
- Improved pore water chemistry relative to that of tailings and waste rock disposed of separately;
- Improved drainage quality at sites where waste rock is removed from temporary storage sites; and,
- Consolidation of sites requiring composite soil cover reclamation.

Effective mixing of the codisposed material is achieved by cutting and spreading a row of adjacent piles of tailings and waste rock into a short lift and then reworking the lift with an additional pass with the bulldozer. The lift is then compacted with a vibratory roller.

The tailings pile will receive Class 1 for outer surfaces, Class 2/3 for interim surfaces and roads and Class 4 for tailing co-disposal (special conditions apply). The pile will also receive weathered Class 2/3 waste rock for disposal within the TDF.

5.24. Waste Rock

Due to its variable geochemical properties (and acid generating potential), waste rock is managed based on the following classification system. The waste rock classification by an experienced geologist at the underground blast face or muck pile is based on visual characteristics as verified through testing identified in Section 2.4.

Waste Rock Types:

- Class 1: This material has a Net Neutralization Potential (NNP) > 100 tons Calcium carbonate ($CaCO_3$)/1000 tons. No special handling is required.
- Class 2: This material has a NNP value between 100 and -100 tons $CaCO_3$/1000 tons and is placed at Site 23.
- Class 3: This material has a NNP value between -100 and -300 tons $CaCO_3$/1000 tons. It is placed at Site 23.
- Class 4: This material has a NNP value less than -300 tons $CaCO_3$/1000 tons and is kept underground.

Waste rock at Greens Creek has two general conditions; fresh waste rock from the mine and weathered waste rock from older waste sites. Fresh rock is generally alkaline (pH 7-9). Weathered rock from older waste sites is either near neutral (pH 6-8) or acidic (pH <6).

5.24.1. Waste Rock Management for Disposal

Waste rock disposal management follows the following criteria:

- Mixing of Class 2 and Class 3 is allowed to avoid physical discontinuities in the waste rock dump;
- Priority use of Class 1 is of higher beneficial use at Site 23 and the TDF area as an the outer slope encapsulating layer;
- Place Class 1 as a outer layer at Site 23 and the TDF.

5.24.2. Site 23 Production Waste Rock Disposal Facility

Waste rock Classes 1 through 3 hauled from the underground mine is placed at Site 23, west of the mill site. Site 23 is the only active production rock disposal facility. The site is being developed with outer slopes acceptable for final closure (3H:1V) using the ascending ("bottom up") construction method. In addition, designated placement zones linked to the three classes of rock are marked on the active lift area prior to placement.

5.24.3. Site E Inactive Waste Rock Dump

Weathered waste rock from Site E is being relocated for permanent co-disposal at the TDF. Approximately 365,000 yd^3 of waste rock and glacial till were placed at the site from 1988 to 1994. Removal of the waste rock commenced in 2009 and will take several years to complete.

5.24.4. Underground

Underground stopes will receive tailings and all forms of waste rock. Class 4 waste rock will remain underground and weathered waste rock is limed prior to backfilling.

Potentially acid generating waste rock will not be backfilled above the 900-foot elevation. It is likely that workings above the 900-foot level will not be completely submerged after mine closure.

5.25. Water Treatment Plant (WTP) Wastes

- Analytical waste chemicals and reagents from the WTP are tested and disposed of according to hazard classification.
- Non-hazardous filter press sludge is disposed of in TDF.

5.26. Wood, Paper and Cardboard

There are two cardboard compactors; One at the 920 Warehouse and one at the Hawk Inlet Cannery. Most of the cardboard received on the island is compacted and shipped offsite for recycling

Wood and some cardboard products are still burned at the TDF or Site 23. Ashes from open burning are disposed of within the TDF or Site 23.

6. SPILL PREVENTION AND RESPONSE

The regulations governing spill response for the project involve the Alaska Department of Environmental Conservation (ADEC) and U.S. Environmental Protection Agency (EPA).

Table 5-1 provides a list of the required oil spill response plans, along with the areas where they apply and the federal or state agency with jurisdiction over the plans. In addition to oil spill response, the Greens Creek Mine response plan includes the use, storage, transport and disposal of other hazardous substances.

Table 2: Oil Spill Response Plans

Plan	Application	Jurisdiction	Reference
Marine Transportation Facility Response Plan	Bulk petroleum shipments to Hawk Inlet	USCG	33 CFR Part 154
State of Alaska Oil Discharge Prevention and Contingency Plan	Hawk Inlet fuel storage/ transfer facility Facility piping Vessels and barges Mine site oil/fuel storage	ADEC	18 AAC 75
SPCC Facility Response Plan	Containers of oil/fuel ≥ 55 gallons Mill site oil/fuel storage	EPA	40 CFR Part 112

6.1. Spill Reporting

Spill notification for the project involves several different agencies depending on the substance and quantity spilled, including the EPA, USCG, National Response Center (NRC) and ADEC, as described below. The following requirements are for oil and hazardous substances other than process solution spills. For spills of process water solution, the procedures outlined in Appendix B are followed.

- The requirements for reporting spills to ADEC are contained in 18 AAC 75, Article 3:
  - *Any release of a hazardous substance* must be reported as soon as the person has knowledge of the discharge;
  - *Any release of oil to water* must be reported as soon as the person has knowledge of the discharge;
  - *Any release of oil to land* in excess of 55 gallons must be reported as soon as the person has knowledge of the discharge;
  - *Any release of oil to land* in excess of 10 gallons but 55 gallons or less must be reported within 48 hours after the person has knowledge of the discharge;
  - A written report of any discharges of *oil from 1 to 10 gallons to land* shall be provided on a monthly basis;
  - *Any release of oil in excess of 55 gallons to secondary containment* must be reported within 48 hours after the person has knowledge of the discharge.
- Spills to water or wetlands or those that may affect wildlife or marine life are required to be reported to the Alaska Department of Fish and Game (ADF&G) and/or FWS.
- Spills occurring on state land must be reported to the Alaska Department of Natural Resources (ADNR).
- According to the EPCRA regulations in 40 CFR § 355.40, certain releases of a hazardous substance require immediate reporting to the community emergency coordinator for the LEPC of any area likely to be affected by the release and the SERC of any State likely to be affected by the release.

In the case of the Greens Creek Mine project, there is no LEPC currently active within the project area, in which case, reporting would be made to the Alaska SERC. Reporting is required for releases of a reportable quantity (RQ) of any Extremely Hazardous Substance (EHS) or Comprehensive Environmental Responsibility, CERCLA hazardous substance (See EPA's "List of Lists" for the reportable substances and associated RQs).

- Reporting to the EPA is required for any release (other than a federally permitted release or application of a pesticide) of a hazardous substance in a quantity equal to or exceeding the reportable quantity in a 24-hour period (see EPA's "List of Lists"). Reporting to the EPA can be accomplished by notifying the National Response Center (NRC).
- The EPA also requires reporting of discharges of oil in such quantities that the Administrator has determined may be harmful to the public health or welfare or the environment of the United States, which includes discharges of oil that violate applicable water quality standards, cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines, or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines. Reporting to the EPA can be accomplished by notifying the NRC.
- Spills to navigable waters must be reported to the US Coast Guard, which can be also made through reporting to the NRC (run by the USCG).
- Spills from a regulated pipeline are required to be reported to the USDOT.
- Spills to National Forest System lands should be to be reported to USFS.

Additional spill reporting notifications may be required depending on the area of the spill, substance spilled, and agreements made between agencies and/or stakeholders and HGCMC.

7. REFERENCES

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US Environmental Protection Agency, Solid Waste and Emergency Response, EPA530-R-06-002, *Mercury Lamp Drum-Top Crusher Study*, August 2006.

US Environmental Protection Agency, Solid Waste and Emergency Response, EPA530-K-05-010, *Introduction to Containers*, September 2005.

GPO Appendix 07
Attachment A
Requirements for Hazardous Waste Accumulation Areas

RCRA 40 CFR Reference	Description	SQG	LQG
262.34(a)(2)	Containers must be clearly marked with the accumulation start in a way that is visible for inspection	Yes	Yes
262.34(a)(3)	Containers must be clearly labeled with the words "Hazardous Waste"	Yes	Yes
265 Subpart C – Preparedness and Prevention			
265.31	Maintenance and Operation of Facility	Yes	Yes
235.32	Required Equipment	Yes	Yes
265.33	Testing and Maintenance of Equipment	Yes	Yes
265.34	Access to Communications or Alarm System	Yes	Yes
265.35	Required Aisle Space	Yes	Yes
265.37	Arrangements with Local Authorities	Yes	Yes
265 Subpart D – Contingency Plan and Emergency Procedures			
265.51	Purpose and Implementation of Contingency Plan	No	Yes
265.52	Content of Contingency Plan	No	Yes
265.53	Copies of Contingency Plan	No	Yes
265.54	Amendment of Contingency Plan	No	Yes
265.55	Emergency Coordinator	See 262.34(d)(5)	Yes
265.56	Emergency Procedures	See 262.34(d)(5)	Yes
265 Subpart I – Use and Management of Containers			
265.171	Condition of Containers	Yes	Yes
265.172	Compatibility of Waste With Container	Yes	Yes
265.173	Management of Containers	Yes	Yes
265.174	Inspections (at least weekly)	Yes	Yes
265.176	Special Requirements for Ignitable or Reactive Waste	*No*	Yes
265.177	Special Requirements for Incompatible Wastes	Yes	Yes
265.178	Air Emission Standards	*No*	Yes
265 Subpart AA – Air Emission Standards for Process Vents		*No*	Yes
265 Subpart BB – Air Emission Standards for Equipment Leaks		*No*	Yes
265 Subpart CC – Air Emission Standards for Tanks, Surface Impoundments and Containers		*No*	Yes

RCRA 40 CFR Reference	Description	SQG	LQG
265.111	Closure Performance Standard	*No*	Yes
265.114	Disposal or Decontamination of Equipment, Structures and Soils	*No*	Yes
265.16	Personnel Training (includes specific requirements, such as annual refresher and maintenance of training records)	See 262.34(d)(5)	Yes
262.34(d)(5)(i)	Emergency Coordinator on premises or on call responsible for coordinating emergency response measures	Yes	See Subpart D
262.34(d)(5)(ii)	Posting of Emergency Information	Yes	See Subpart D
262.34(d)(5)(iii)	Personnel Training	Yes	See 265.16
262.34(d)(5)(iv)	Emergency Response Procedures	Yes	See Subpart D

GPO Appendix 07
Attachment B
Reporting Criteria for Process Solutions

Greens Creek Mine Process Solution Discharge Response and Notification

Any spill resulting in process solution escaping from the secondary containment systems is responded to immediately as follows:

1) Notify the Mill Supervisor:
   a) The Mill Supervisor will ensure that immediate shutdown or repair of the system experiencing the upset.
   b) The Mill Supervisor would contact personnel from the environmental and safety department.
2) The Environmental Manager or their designee is responsible for notifying the appropriate agencies. Due to the liabilities associated with hazardous materials incidents, only personnel who are familiar with the facility components and reporting requirements should contact the regulatory agencies.
   a) **Spills at or over the Reportable Quantity (RQ)** (see EPA's "List of Lists") for the substance spilled would require immediate reporting to the Alaska Department of Environmental Conservation, Spill Prevention and Response **(ADEC SPAR) via telephone (907) 268-3063, fax (907) 269-7648, or outside business hours at 1-800-478-9300** and the National Response Center **(NRC) at 1-800-424-8802 or through their online reporting system**;
   b) Spills or releases below the RQ would require documentation that no surface or groundwater was impacted (through the Greens Creek Mine Spill Report Form);
   c) Spills to water or wetlands or those that may affect wildlife or marine life would also be reported to the ADF&G and/or FWS by ADEC;
   d) Spills occurring on state land are to be reported to the Alaska Department of Natural Resources (ADNR);
   e) Releases of a reportable quantity (RQ) of any Extremely Hazardous Substance (EHS) or Comprehensive Environmental Responsibility, CERCLA hazardous substance (See EPA's "List of Lists" for the reportable substances and associated RQs) require reporting to LEPC/SERC.
3) Once a release of process solution has been terminated and any required immediate agency reporting has been made, all pertinent information regarding the spill are recorded in the incident management system.
4) All liquid, in collectable volumes, remaining outside containment are pumped into a lined containment area, pond, or suitable vessel for temporary containment (portable tank).
5) Soil contaminated with other regulated material are decontaminated or disposed of according to Safety Data Sheet instructions for the product.
6) The incident report documenting the spill, response, and cleanup is to be submitted to the incident management system as soon as possible with all required information.

General Plan of Operations
Appendix 08
Road Operations and Maintenance

May 2020

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1. INTRODUCTION

Hecla Greens Creek Mining Company (HGCMC) is the owner and operator of a mine and concentrator facility located on the north end of Admiralty Island near Juneau, Alaska. Various materials and personnel are transported approximately 8.6 miles by truck to and from the "920" mine and mill area, and Port at Hawk Inlet, all of which are collectively referred to as the "mine site" in this document. This Plan describes the operations and maintenance of all surface roads operated and maintained by HGCMC.

The A-road provides access from Young Bay to Hawk Inlet and the junction with the B-road. The B-road is used for transporting ore concentrate and tailings from the mine to Hawk Inlet Port, transportation of waste rock, freight transportation, and crew transportation. The B-road extension, also known as the 1350 road, provides access to the original 1350 adit.

1.1. Public Access

The roads were developed for the following specific purposes; 1) transport employees, and 2) transport freight, tailings, and concentrates. For safety reasons, the use of the B-road by the public is strongly discouraged. Motorized vehicles, other than those used to support the mining operation, are prohibited on the A-road and B-road, and bicycles are prohibited on the B-road.

2. ROAD OPERATIONS

2.1. Bulk Concentrate and Tailings Transportation

HGCMC uses the B-road to transport concentrates to the Concentrate Storage Building at Hawk Inlet and mill tailings to the Tailings Disposal Facility (TDF). The trucks used to haul concentrates and tailings are capable of hauling 50-ton payloads. The trailer units are equipped with retractable lids and sealed tailgates.

The trailers are checked prior to use to assure covers are in place and secure, and that the tailgate is properly closed, latched, and secured against spillage.

2.2. Crew Transportation

Buses are used for transporting authorized personnel between Young Bay, Hawk Inlet, and the 920 for all shift changes. When not in use, buses may be parked in three locations: Young Bay, Hawk Inlet, or the 920.

2.3. Freight, Fuel, and Port Handling

Freight and fuel are transported from Hawk Inlet to the 920, or various other locations along the B-road as required. Freight is hauled using a tractor-trailer freight truck. Bulk fuel is hauled using a bulk fuel tanker.

2.4. General Safety Protocols

All vehicles traveling the road system use 2-way radios to announce their position and direction at least once per mile. The vehicles that routinely travel the road are also equipped with a "SafeMine" collision avoidance system. All vehicles are required to drive with headlights on and follow established speed limits. Speed limits are posted at 25 mph for the general road with sections reduced to speeds as slow as 5 mph as necessary.

The road has established right of way protocols. During normal operating conditions, production and maintenance vehicles have the right-of-way over light vehicles. Emergency vehicles always have right-of-way during upset conditions.

Tire chains are used by freight and haul trucks as required.

3. ROAD MAINTENANCE

HGCMC performs routine maintenance on all surface roads within the mine site. Road maintenance includes grading, watering for dust control, sanding, snow removal, culvert and ditch cleaning and maintenance, and other activities as required.

Other maintenance activities such as seeding, guardrail maintenance, repairs due to failure of the subsurface or road structure, major road resurfacing or repairing of damage due to slides, avalanches, washouts, or culvert collapse, is handled on a case-by-case basis and resolved at the time of their occurrence.

3.1. Routine Grading

Roads are routinely graded to ensure proper drainage, maintain a trafficable surface, and remove the accumulation of fines (sediment). Typically, a cross-slope is maintained between 4 and 7 percent. Berms are not used along the A-road and B-road system to allow free drainage of the road surface except as required by Mine Safety and Health Administration (MSHA) and/or special circumstances.

3.2. Sanding/Snow Removal

Snow is plowed and removed from the A-road and B-road, turnouts, and surface parking areas as required to maintain a safe and efficient safe road system. “Traction sand” consisting of 5/8” crushed rock is used as required for snowy and/or icy conditions. Snow berms are breached as required to allow snowmelt and/or rain to drain from the road surface.

The 1350 road is not typically maintained during winter months because routine access is not required, and the steep grades coupled with snowy/icy conditions make use and maintenance hazardous.

3.3. Dust Control

Fugitive dust may be generated by haul trucks, supply trucks, service vehicles, or personnel buses. HGCMC uses a water truck to spray the road with water and/or an approved mixture of water and dust control product as required to minimize dust generation.

Drivers noting dusting conditions are expected to notify their supervisor about dusting conditions so that appropriate resources can be redirected to mitigate the issue.

Dust control products approved by applicable regulatory agencies will be used on an as-needed basis.

3.4. Culverts and Ditches

Culverts and ditches are installed and maintained to assure good runoff from the road and nearby watersheds. It is critical for good road maintenance that functional culverts and ditches are maintained. Culverts and ditches will be examined at least twice each year for accumulated sediment.

Culverts and ditches more than half full of sediments will be scheduled for prompt cleaning. Areas behind sediment control features may achieve greater depositions without requiring clean-out. Sediment control

structures such as check dams, settling ponds, culvert inlet/outlet control, silt fences, and/or compost socks will be placed along the road system to reduce runoff velocities and associated erosive potential of flowing water, and to minimize sediment discharge to adjacent areas.

Sediment removal from road surfaces, ditches, and culverts will either be reused on the road, and/or disposed in the TDF, waste rock Site 23, and/or the Ore Pad.

Culverts and ditches are cleaned by vacuum truck, backhoe, or hand depending on the nature of the debris, and which method will give the best protection to adjacent infrastructure such as ditch lining, or adjacent pipelines. Plugged ditches, culverts, or other conveyance structures are cleaned as soon as possible. Debris cleaned from culverts and ditches will generally be disposed of within the TDF or waste rock Site 23 as outlined in the Erosion Control Plan.

3.5. Other Maintenance

Other maintenance such as seeding and revegetation, identification and removal of hazard trees are employed as part of normal operations. Maintenance such as guardrails repairs, rockfall or slide mitigation, or other nonroutine activities such as the following will be conducted as needed and as required:

- Guardrail repairs, replacement and/or installation,
- Rock highwall scaling,
- Installation of rockfall mitigation, and
- Excavate and reconstruction of damaged road sections.

3.6. Road Sediment

Excessive sediment generation is the primary environmental concern associated with the road system. Primary measures for controlling sediment generation include:

- Routine road maintenance and removal of accumulated sediment from the road surface and adjacent ditches,
- Installation of appropriate best management practices (BMPs) such as straw wattles, check dams, and settling ponds, and
- Reduced speed limits.

Sediment control measures are evaluated on a year-to-year basis, and as needed, and updated as required.

3.7. Timber Salvage

During the year trees along the Greens Creek road system may occasionally blow down, blocking the roadway, or creating a condition in which a blow down appears imminent, and presents a hazard. In these situations, Greens Creek will remove the hazard trees.

General Plan of Operations
Appendix 09a
USGC Operations Plan

June 2020

Greens Creek Mining Company

Hawk Inlet Marine Terminal

Admiralty Island, Alaska

Oil Transfer Operations Manual

To satisfy 33 CFR Part 154

Fuel Transfer and Storage Facility

Hawk Inlet, Alaska

June 2020

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Attachment A - Emergency Response Guide

Attachment B - ULSD Safety Data Sheet

1. 33 CFR 154.300 OIL TRANSFER OPERATIONS MANUAL REQUIRED CONTENTS

1) The geographic location of the facility;
2) A physical description of the facility including a plan and/or plans, maps, drawings, aerial photographs or diagrams, showing the boundaries of the facility subject to Coast Guard jurisdiction, mooring areas, transfer locations, control stations, wharfs, the extent and scope of the piping subject to the tests required by §156.170(c)(4) of this chapter, and the locations of safety equipment. For mobile facilities, a physical description of the facility;
3) The hours of operation of the facility;
4) The sizes, types, and number of vessels that the facility can transfer oil or hazardous material to or from simultaneously;
5) For each product transferred at the facility:
    a) Generic or chemical name; and
    b) The following cargo information:
        i) The name of the cargo;
        ii) A description of the appearance of the cargo;
        iii) A description of the odor of the cargo;
        iv) The hazards involved in handling the cargo;
        v) Instructions for safe handling of the cargo;
        vi) The procedures to be followed if the cargo spills or leaks, or if a person is exposed to the cargo; and
        vii) A list of fire fighting procedures and extinguishing agents effective with fires involving the cargo.
6) The minimum number of persons on duty during transfer operations and their duties;
7) The name and telephone number of the qualified individual identified under §154.1026 of this part and the title and/or position and telephone number of the Coast Guard, State, local, and other personnel who may be called by the employees of the facility in an emergency;
8) The duties of watchmen, required by §155.810 of this chapter and 46 CFR 35.05–15, for unmanned vessels moored at the facility;
9) A description of each communication system required by this part;
10) The location and facilities of each personnel shelter, if any;
11) A description and instructions for the use of drip and discharge collection and vessel slop reception facilities, if any;

12) A description and the location of each emergency shutdown system;

13) Quantity, types, locations, and instructions for use of monitoring devices if required by §154.525;

14) Quantity, type, location, instructions for use, and time limits for gaining access to the containment equipment required by §154.545;

15) Quantity, type, location, and instructions for use of fire extinguishing equipment required by §154.735(d) of this part;

16) The maximum allowable working pressure (MAWP) of each loading arm, transfer pipe system, and hose assembly required to be tested by §156.170 of this chapter, including the maximum relief valve setting (or maximum system pressure when relief valves are not provided) for each transfer system;

17) Procedures for:

    a) Operating each loading arm including the limitations of each loading arm;

    b) Transferring oil or hazardous material;

    c) Completion of pumping; and

    d) Emergencies;

18) Procedures for reporting and initial containment of oil or hazardous material discharges;

19) A brief summary of applicable Federal, state, and local oil or hazardous material pollution laws and regulations;

20) Procedures for shielding portable lighting authorized by the COTP under §154.570(c); and

21) A description of the training and qualification program for persons in charge.

22) Statements explaining that each hazardous materials transfer hose is marked with either the name of each product which may be transferred through the hose or with letters, numbers, symbols, color codes or other system acceptable to the COTP representing all such products and the location in the Operations Manual where a chart or list of symbols utilized is located and a list of the compatible products which may be transferred through the hose can be found for consultation before each transfer; and

    a) The facility operator shall incorporate a copy of each amendment to the operations manual under §154.320 in each copy of the manual with the related existing requirement, or add the amendment at the end of each manual if not related to an existing requirement.

    b) The operations manual must be written in the order specified in paragraph (a) of this section, or contain a cross-referenced index page in that order.

(Approved by the Office of Management and Budget under control number 1625–0093)

[CGD 75–124, 45 FR 7171, Jan. 31, 1980, as amended by CGD 88–102, 55 FR 25428, June 21, 1990; CGD 86–034, 55 FR 36253, Sept. 4, 1990; CGD 92–027, 58 FR 39662, July 26, 1993; CGD 93–056, 61 FR 41459, Aug. 8, 1996; USCG–2006–25150, 71 FR 39209, July 12, 2006]

2. GEOGRAPHIC LOCATION OF THE FACILITY:

The Greens Creek Mining Company Hawk Inlet Marine Terminal fuel transfer facility is located on the west side of Admiralty Island in Hawk Inlet about eighteen miles southwest of Juneau, Alaska. The facility coordinates are 134º45'15" W longitude and 58º07'30" N latitude.

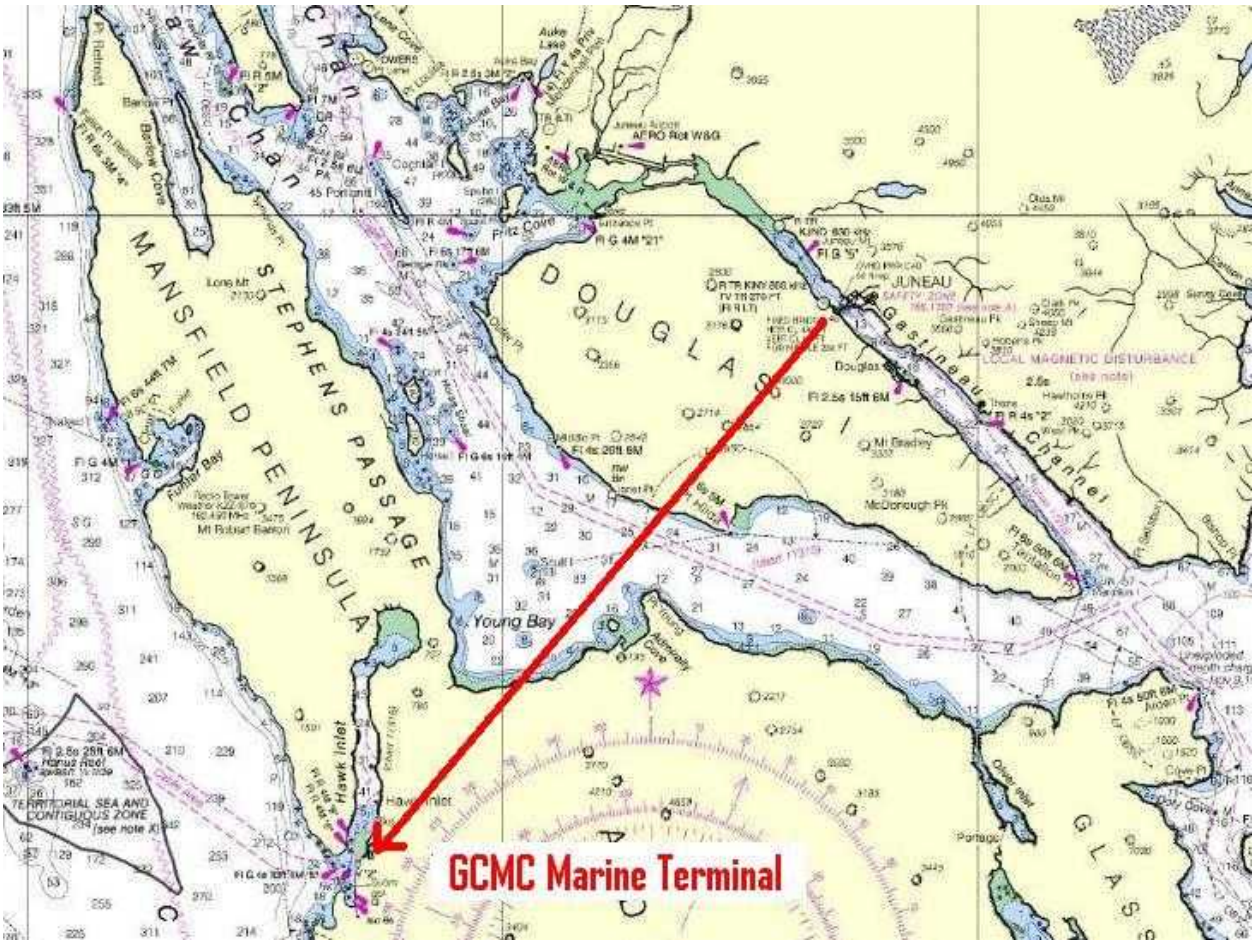


Figure 1. Location of Greens Creek Mining Company Hawk Inlet Marine Terminal

Figure 2. View of Hawk Inlet, looking northeast from the Chatham Strait entrance up the inlet. The Greens Creek Mining Company Marine Terminal is on the east side of the inlet

Figure 3. Aerial view of the Greens Creek Mining Company Marine Terminal, with bulk ore freighter alongside the loading conveyor

3. PHYSICAL DESCRIPTION OF THE FACILITY:

The Greens Creek Mining Company is a joint venture between two partners:

Greens Creek Mining Company P.O. Box 32199 Juneau, Alaska 99803-2199 (907) 789 8170	Hecla Mining Company 6500 Mineral Drive Coeur d' Alene, Idaho 83814-8788 (208) 769 4100

Greens Creek Mining Company has constructed a permanent fuel storage facility consisting of a single 200,000 gallon fuel tank. This fuel tank is the primary bulk receiving tank and fuel trucks will distribute fuel oil to the various mine locations. Also, there is a 10,000 gallon tank used to supply the generators at Hawk Inlet.

The Greens Creek Mining Company Marine Transfer facility consists of the fuel transfer system between Dolphin #4, the point of ship mooring, and the shutoff valve where the fuel transfer line enters the 200,000 gallon storage tank at the Hawk Inlet Terminal.

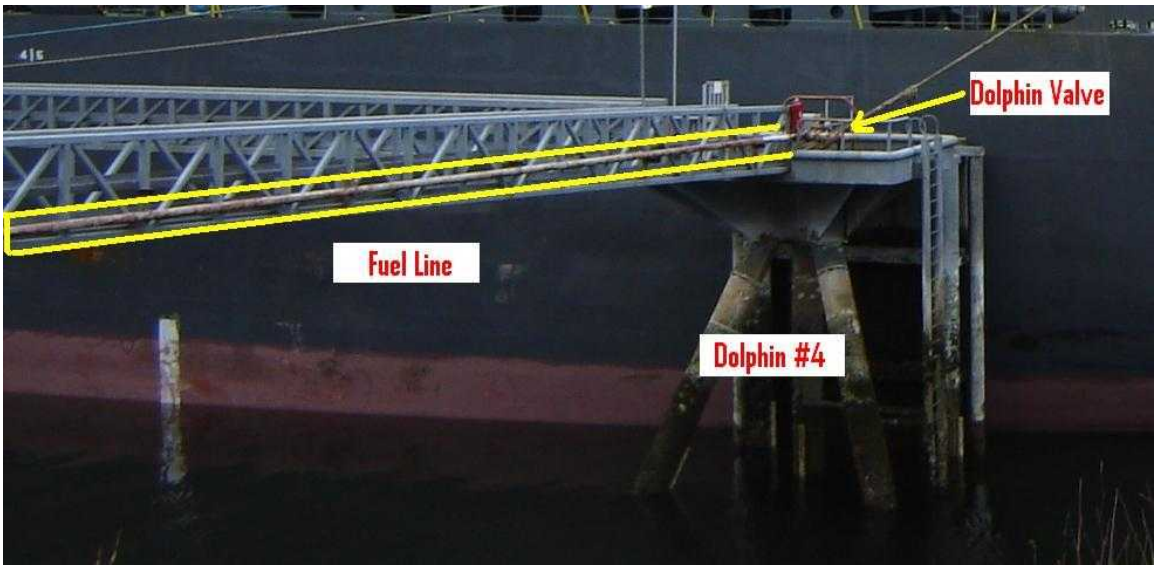


Figure 4. Fuel transfer system between fuel barge and shore

A four inch steel pipeline, shown outlined in yellow in Figure 4, has been continuously welded from the 200,000 gallon tank to the permanent barge connection at Dolphin #4. The pipeline has valves at the barge hose connection point on Dolphin #4 (the Header Valve), at the shore side end of the walkway to Dolphin #4 (the Mid-Valve), and at the inlet to the 200,000 gallon tank (the Tank valve). A schematic of the fuel transfer facility appears on the next page.

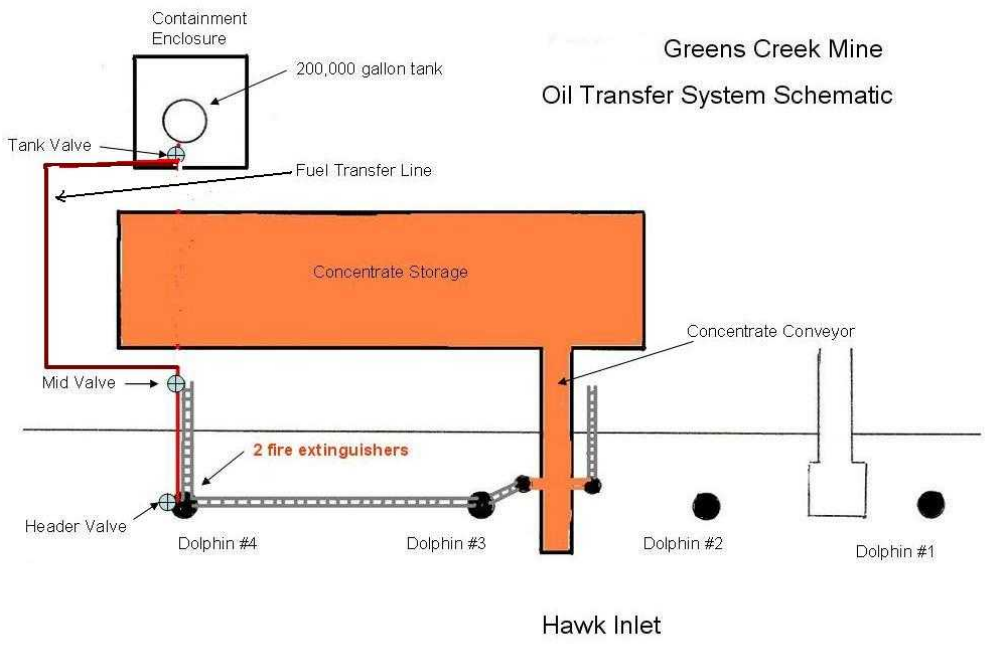


Figure 5. Schematic of fuel transfer facility

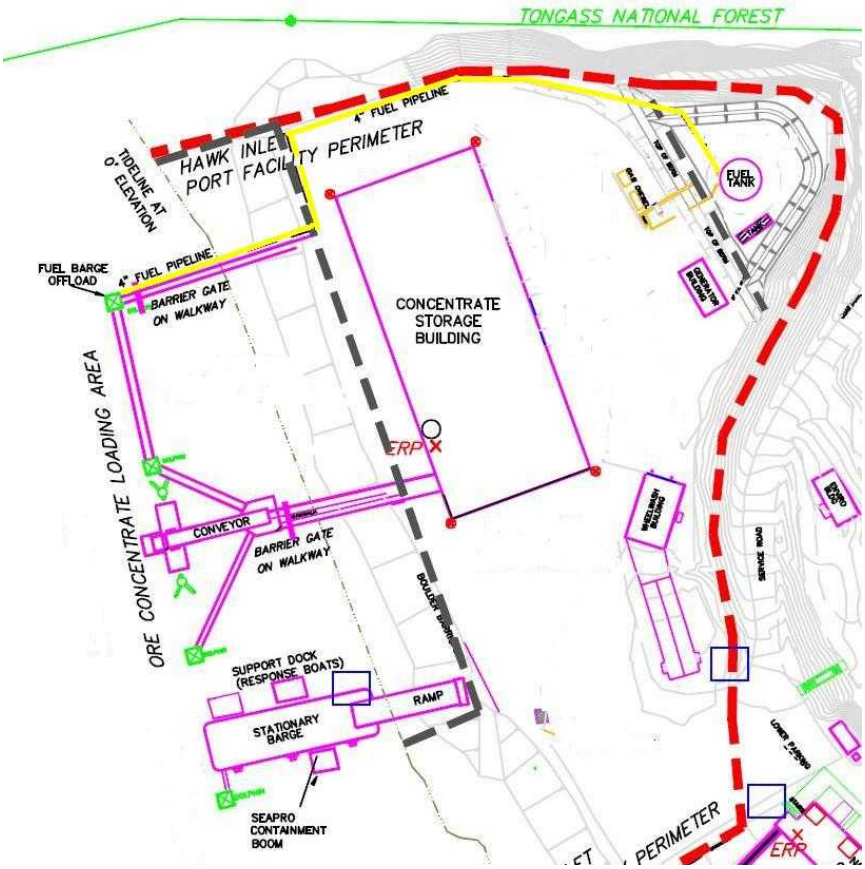


Figure 6. Oil Transfer Line under Coast Guard jurisdiction shown in yellow below

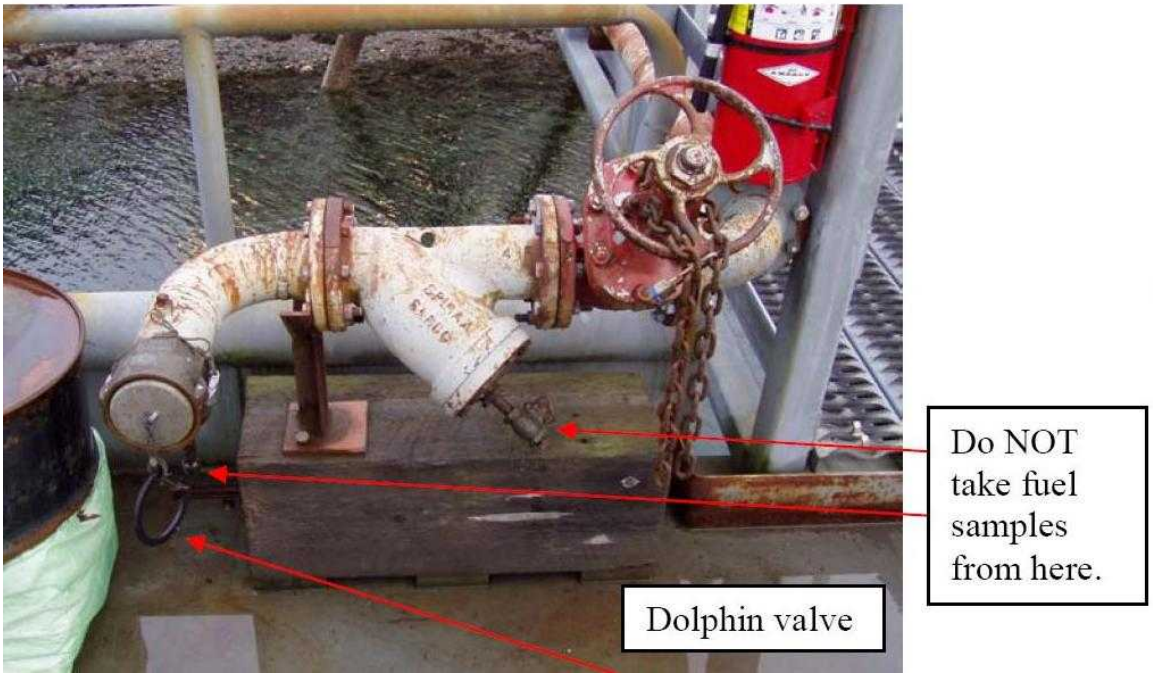


Figure 7. Header valve located on Dolphin #4

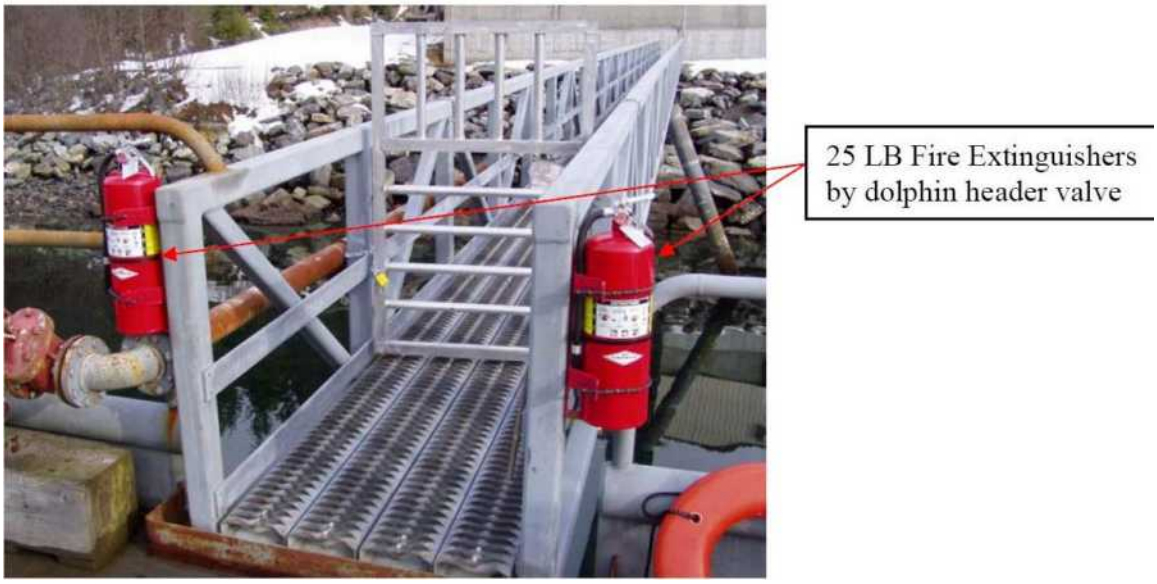


Figure 8. Location of fire extinguishers on Dolphin #4

Fire extinguishers are provided on Dolphin #4 (Figure 8) at the entrance to the catwalk leading back to the shore. Header Valve is out of sight on the left. Fueling area is secured from unauthorized entry by a locked gate.

The tank inlet is at the bottom of the tank and a pressure relief valve is at the tank on the inlet pipe to protect the pipeline from over pressure (Figure 9).

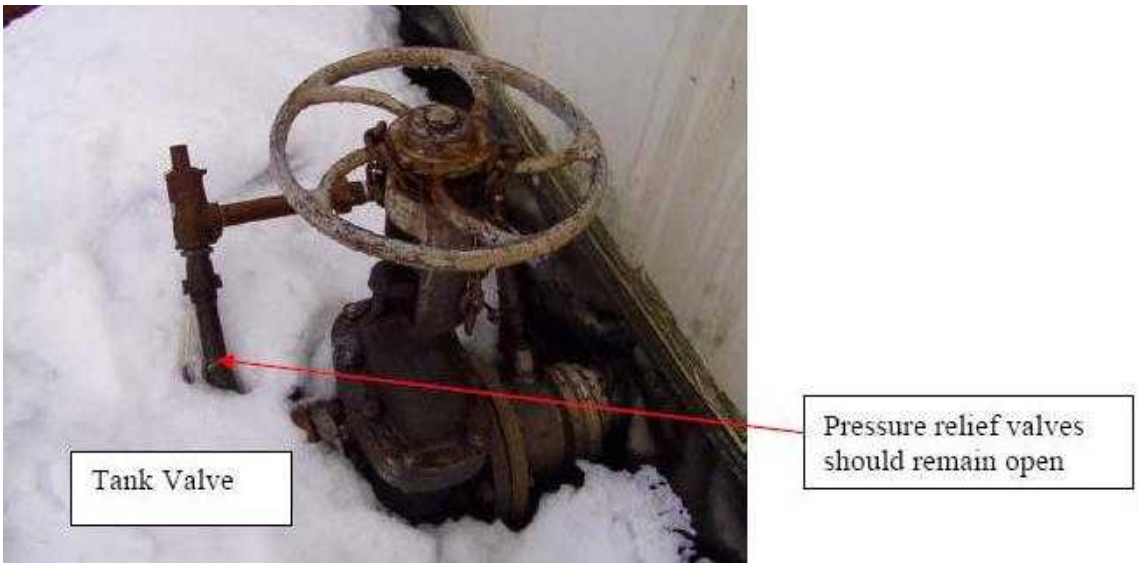


Figure 9. Tank inlet and pressure relief valve

Figure 10. Hawk Inlet fuel storage facility

The Greens Creek Mine Hawk Inlet Terminal consists of a 200,000 gallon diesel storage tank (Figure 10). Note fuel transfer line entering from left. The containment berm is lined with High Density Polyethylene (HDPE) which forms an impermeable barrier to prevent any leaks from the tank from breaching the containment barrier. The containment berm is sized to hold 110 percent of the tank volume.

At the mill site inland a 60,000 gallon fuel tank and two 34,000 gallon tanks have been constructed. These are supplied by truck transport from the storage tank at the marine terminal. The mill site fuel tank supplies the mill powerhouse by direct pipeline and also has a dispensing station for smaller vehicles and

mine equipment refueling. A concrete containment berm with HDPE liner surrounds the mill site fuel tank and additional safety and fuel absorbing equipment is kept near the vehicle fuel dispensing station and at the mine's warehouse near the mill site location.

4. HOURS OF OPERATION:

There are no "set" hours of operation. The facility is only considered to be "in operation" for the purposes of 33 CFR Part 154 when a tank barge is making a delivery to the storage facility. The fuel transfers between a tank barge and the storage facility can take place at any hour of the day or night. The fuel facilities will be used as a transferring, holding and tankage base only. Trucking fuel from the Marine Terminal to the mine site takes place with a frequency that varies seasonally and by the types of mining that is conducted. Fuel shipments are approximately biweekly when Greens Creek Mining Company is generating power, but drop to monthly when purchasing power from Alaska Electricity and Light (AEL&P).

5. SIZES, TYPES AND NUMBERS OF VESSELS TRANSFERRING OIL AT THE FACILITY:

The facility is served by the Petro Marine Barge PM-230. This is a 230' by 60' by 15' 1.05 million gallon capacity fuel barge certificated to carry 5 grades of petroleum products in 12 compartments. The barge is towed by the tug Pacific Patriot call sign WDB 6943. This is the only barge delivering product to this facility. The only use of the delivered fuel will be for use by the Greens Creek Mine and all delivered product will be utilized by diesel powered equipment inland. Small fishing vessels may tie up at the Greens Creek Mining Company dock, but will not be sold any fuel. Except in case of emergency, no fuel will be available for private or commercial craft.

6. CARGO INFORMATION:

Name of the Cargo:

Diesel Fuel

Appearance of the Cargo:

Colorless to yellow colored liquid

Odor of the Cargo:

Petroleum hydrocarbon odor

Hazards in Handling the Cargo:

Combustible liquid gives off invisible vapors which can explode; high hazard cargo. Liquid can release vapor at temperatures below ambient which readily forms flammable mixtures. Vapors settle to ground level and may reach, via drains, and other underground passages, ignition sources remote from the point of escape. Product can accumulate a static charge which may cause a fire or explosion.

Instructions for safe handling:

Avoid contact with the skin. Avoid inhalation of vapors or mists. Use in well ventilated area away from all ignition sources. This liquid is volatile and gives off invisible vapors. Either the liquid or vapor may settle in low areas or travel some distance along the ground or surface to ignition sources where they may ignite or explode.

Spill Procedures for Cargo:

Land Spill:

Evacuate nonessential personnel and eliminate sources of ignition. Consider wind direction; stay upwind and uphill if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact. Carefully contain and stop the source of the spill if safe to do so. Protect bodies of water by diking, absorbents or absorbent boom, if possible. Do not flush down sewer or drainage systems unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection. Take up with sand or other absorbing materials. Carefully shovel, scoop or sweep up into waste container for reclamation or disposal – caution flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment. See attached Material Safety Data Sheet.

Water Spill:

Eliminate sources of ignition. Advise occupants and boats in the vicinity in downwind areas of fire and explosion hazard and warn them to stay clear. Notify port and other relevant authorities. Attempt to confine in area of leakage. Utilize sorbent boom, pads or skimmers to clean from water surface and dispose of used sorbents in accordance with federal, state and local regulations. Allow liquid to evaporate from the surface. Do not use dispersants.

Personal Exposure Hazards:

If the eyes are exposed flush with clear water for fifteen minutes or until irritation subsides. If irritation persists, call physician. For exposure to the skin remove contaminated clothing and wash skin with soap and water. If product is injected into or under the skin, see a physician immediately. See attached Safety Data Sheet.

Fire Fighting Procedures and Extinguishing Agents:

Extinguishing Agents:

Carbon Dioxide, Foam, Dry Chemical, Water Fog

Special Fire Fighting Procedures:

Evacuate area. For large spills, fire fighting foam is the preferred agent and should be applied in sufficient quantities to blanket the product surface. Water may be ineffective, but water should be used to keep fire-exposed containers cool. Water spray may be used to flush spill away from exposures, but good judgment should be practiced to prevent spreading of the product into sewers, streams or drinking water supplies. If a leak or spill has not ignited, apply a foam blanket

to suppress the release of vapors. If foam is not available, a water spray curtain can be used to disperse vapors and to protect personnel attempting to stop the leak. See attached Safety Data Sheet.

7. MINIMUM NUMBER OF PERSONS DURING TRANSFER OPERATIONS AND THEIR DUTIES:

Greens Creek Mining Company will have two facility personnel on duty when receiving product from a petroleum barge. One person, generally the designated Person in Charge, will be at the dock headers, and the Hose Watch will function as a tank and pipeline watch. The Surface Operations Standard Operating Procedure 10007 – Bulk Fuel Offloading defines and addresses elements to the task of off-loading bulk fuel from vendor barges.

The person in charge will be on duty when receiving product and will compile and initial the pumping procedure and schedule along with the barge representative. The hose watch will witness the pre-transfer conference. The person in charge will inspect all lines, marine block and bleeder valves to assure all are closed. He will inspect the facility to see that all fire extinguishers, barricades, warning signs, non-sparking devices, drip pans and proper containment are on site and in place. The person in charge is the authority to start and stop the pumping operation, except in an emergency if he is not immediately available at the headers. He will schedule taking product samples and have the lines checked during pumping operations. He is responsible for all shore side operations including gauging tanks, scheduling line transfers, and topping off the tanks. During transfer operations he will generally remain present at the dock header location.

The hose watch will be in attendance at the dock header when the barge's hoses are coupled to the marine header. He will witness the pre-pumping meeting between the person in charge and the barge's tankerman and will assist the person in charge in inspection of the dock facilities including fire fighting equipment, barricades, warning signs, conditions of pipelines, closing of all dock headers, bleeders and block valves and securing of service lines that take off cargo lines. The person at the dock header will monitor cargo hoses in use during product transfer and will adjust same for changes in the level of the tide and movement of the barge and assure that no strain is on hoses from the hoist and ship's lines.

The Surface Operations Standard Operating Procedure 10007 – Bulk Fuel Offloading is more detailed step by step procedure for receiving the fuel and is included later in this manual.

A list of Designated Persons in Charge of Oil Transfer Operations is available in the security office in the bunkhouse building immediately inshore of the float plane dock and across the road from the port facilities.

8. QUALIFIED INDIVIDUALS IN ACCORDANCE WITH 33 CFR 1026:

These four persons are authorized by Greens Creek Mining Company to activate and engage in contracting with an oil spill removal organization, to act as a liaison with the pre-designated Federal On-Scene Coordinator and to obligate funds to carry out response activities

Table 1. Qualified Individuals

Name & Title	Work Contact Info	Home Contact Info
Bryan Morgen Surface Operations Manager	(907) 789-8147 Cell (907)	Admiralty Island (907)
Jeff Swanson Surface Operations General Foreman	(907) 790-8470 Cell (907)	Camp (907) 790-8495
Terry Maxwell Surface Operations General Foreman	(907) 790-8470 Cell (907) 723-3552	Camp (907) 790-8495
Christopher Wallace Environmental Compliance	(907) 790-8473 Cell (907) 723-8461	

Table 2. Other entities to be contacted in the event of a spill, fire, or other emergency

Organization	Phone Number
U.S. Coast Guard National Response Center (24 hrs)	(800) 424 8802
Coast Guard Sector Juneau	(907) 463 2980
Coast Guard Operations Center Juneau (24 hours)	(907) 463 2000
U.S. Environmental Protection Agency	(907) 586 7619
Alaska Department of Environmental Conservation	(907) 465 5357
ADEC (fax attached spill report form)	(907) 465 2237
ADEC after hours	(800) 478 9300
Southeast Alaska Petroleum Resource Organization	(888) 225 7676
SEAPRO	(907) 225 7002
SEAPRO FAX	(907) 247 1117
Hawk Inlet Marine Terminal	(907) 790 8418

9. DUTIES OF WATCHMAN FOR UNMANNED VESSELS MOORED AT THE FACILITY:

Anytime an oil barge is moored at the facility it will contain cargo and will not be gas free. In accordance with 33 CFR 155.810 and 46 CFR 35.05-15, tank barges moored in this condition must be kept under surveillance by crew members from the towing vessel. Since the barge used for supplying fuel to the Hawk Inlet Marine Terminal is constantly on the move supplying other facilities in Southeast Alaska, it rarely if ever remains moored at the Hawk Inlet facility any longer than it takes to make a fuel delivery. During fuel deliveries the barge deck is constantly manned and attended by the tankerman and other crew members. As such, no watchmen are utilized or necessary.

10. COMMUNICATION SYSTEMS:

Intrinsically safe portable VHF radios, arm signals and voice communication are used during fuel transfers at the facility to maintain contact between the tankerman on the barge and the Greens Creek Mine personnel at the marine header and at the tank.

11. PERSONNEL SHELTERS:

None are utilized.

12. DRIP AND DISCHARGE CONNECTIONS:

A portable container of approximately 20 gallons capacity is placed under the hose connection on Dolphin #4 beneath the vessel hose and the fixed 4-inch fuel transfer pipe prior to its coupling and uncoupling. Additionally, the dolphin top serves as a fixed three barrel containment structure when its drain valve is closed during fuel transfer operations. Unless spilled material is being emptied from the portable container, it is kept in position under the hose coupling during the entire transfer period to capture any minor drip or leakage. If leaked fuel accumulates in the portable container during the fuel transfer operation, following the hose connection uncoupling the spilled material is emptied into the Hawk Inlet used oil accumulation container within one hour of the completion of the transfer operation.

The top of Dolphin #4 provides three barrel fixed containment in addition to the portable containment described in the paragraph above. Prior to each fuel transfer the containment is inspected for integrity and it is drained of any accumulated rainwater so that its full capacity is available in the event of any spill.

Figure 11. Drain valve atop Dolphin #4

Drain Valve for three barrel fixed containment atop Dolphin #4, the valve is normally kept open to keep fixed containment drained of rainwater. The valve is closed when a fuel delivery is taking place.

There are no slop reception facilities at the Greens Creek Mine Hawk Inlet Marine Terminal fuel transfer facility.

13. EMERGENCY SHUTDOWN ARRANGEMENTS:

The fuel transfer line has a block valve at the marine header as well as a gate valve and a block valve on shore permitting closing off of the line if an emergency occurs during the receipt of product. The communications via VHF radio, hand signals or voice between the personnel on the shore and the tankerman on the barge serve as the trigger for any emergency shutdowns that would be required.

Figure 12. Boom shed and response boats at Hawk Inlet

Although not part of the Coast Guard regulated installation, the small boat moorage for the response boats and work boats at the facility is located on a floating dock between Dolphins 1 and 2. When fueling boats there is a shut off valve on each hose reel and the end of each hose is fitted with a back pressure shut off nozzle.

14. MONITORING DEVICES:

There are no monitoring devices required at the Greens Creek Mine Hawk Inlet fuel transfer facility.

15. CONTAINMENT EQUIPMENT:

Sorbent material and containment boom is in inventory at the plant. These first response materials are immediately available to the fuel off-loading process and located as noted below. Additional backup supplies are located in the Greens Creek Mine Company warehouses.

Immediately accessible material on hand

- 1000 feet of containment boom 8” x 12’ with ASTM end plates, located on the float on the north side of the Miss Rene barge, the deployment SEAPRO skiff is moored at the float on the north side of the Miss Rene barge which is secured to Dolphin #1.
- 400 feet of Sorb-Boom sorbent boom (10-foot long boom sections)
- 4 sweeps (22” x 100’) 3M Brand Type 126
- 8 bales of sorbent pads, 3M type 156
- All of this material is stored in the Conex boxes marked SEAPRO sitting on the beach adjacent to the head of the ramp leading onto the Miss Rene barge.

Use of absorbents and containment equipment

- Extract the containment boom from the float with the SEAPRO skiff.
- Secure the boom either with anchors or to fixed structures in the water or connected to shore to hold boom in place to prevent the spread of spilled petroleum products on the surface of the water.
- Sorbent materials are used to remove petroleum liquids from water or solid surfaces. They absorb "oily" material by being placed in contact with it. Spent sorbent materials are placed in provided containers for subsequent disposal in accordance with state and federal regulations.
- As a member of the Southeast Alaska Petroleum Resource Organization (SEAPRO), Greens Creek Mining Company has access to 18,000 feet of containment boom and numerous pieces of additional response equipment and additional response team personnel available from Juneau or other locations in Southeast Alaska. For more complete information on these response capabilities see the SEAPRO web site at http://www.seapro.org and the Alaska Regional Response Team Unified Response Plan for Southeast Alaska. The plan is available at http://www.akrrt.org

16. FIRE EXTINGUISHING EQUIPMENT:

The Greens Creek Hawk Inlet fuel transfer facility is equipped with fire fighting equipment as follows:

2 x 25 lb. multi-purpose dry chemical fire extinguishers are on Dolphin #4 adjacent to the Dolphin Valve and hose header connection (Figure 8)

1 x 150 lb. multi-purpose dry chemical nitrogen-propellant extinguisher is located near the stairway access to the tank farm secondary containment (Figure 13).

Figure 13. 150 pound fire extinguisher

The ABC type dry chemical fire extinguishers can be used for fighting small fires. The dry chemical extinguisher is carried and used upright. The flow of dry chemical is controlled with the squeeze-grip On-Off nozzle at the top of the bottle. The discharge is directed at the seat of the fire starting at the near edge. The stream should be moved from side to side with rapid motions, to sweep the fire off the fuel. Approach from the upwind side if possible. The initial discharge should not be directed onto the burning material from close range (3 to 8 feet). The velocity of the stream may scatter the burning material. The extinguisher must be recharged after each use or activation. However, the agent may be applied in short

bursts by opening and closing the nozzle with the squeeze grips. Dry chemical extinguishers extinguish class B (burning petroleum liquid) fires by chain breaking, with little or no cooling. Thus, a re-flash is possible if the surrounding surfaces are hot. Additional dry chemical or another appropriate extinguishing agent must be available as a backup until all sources of ignition are eliminated. Dry chemical extinguishing agents may be used along with water. Some dry chemical extinguishers are filled with an extinguishing agent that is compatible with foam.

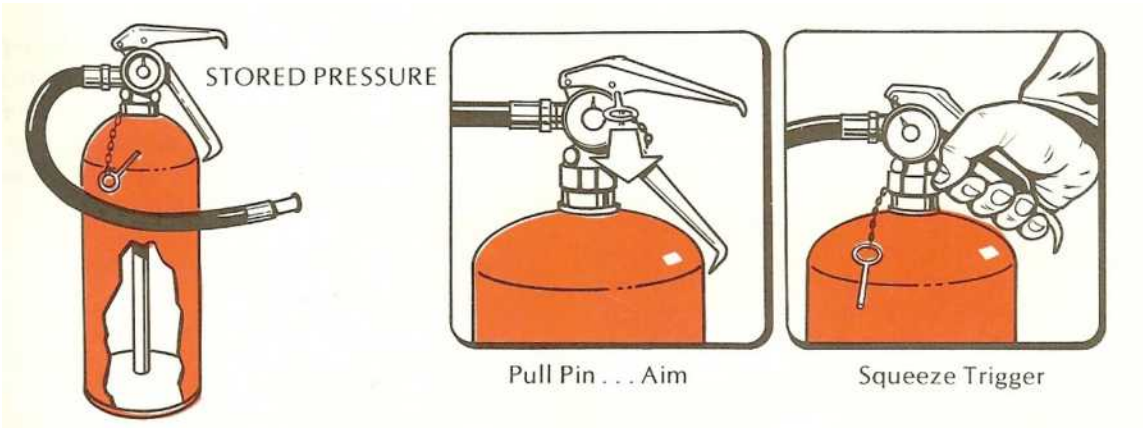


Figure 14. Procedure for using a dry chemical extinguisher

Stored-pressure dry chemical extinguishers are available in the same sizes as cartridge-operated types. They have the same ranges and durations of discharge and are used in the same way. The only difference is that the propellant gas is mixed in with the dry chemical in the stored-pressure type. And, the extinguisher is controlled with a squeeze-grip trigger on top of the container. A pressure gage indicates the condition of the charge.

17. MAXIMUM WORKING PRESSURE OF HOSES:

The hoses used for fuel transfers at the Greens Creek Hawk Inlet fuel transfer facility are all supplied by the barge. The hoses are properly marked and hydrostatically tested by the barge company. The fuel oil transfer line between the header valve on Dolphin #4 and the 200,000 gallon fuel tank has a maximum allowable working pressure of 150 psig. The transfer pipe system is pressure tested by certified testers annually. The maximum relief valve pressure setting on the barge pumps is 125 psig. There is a pressure relief valve on the fuel transfer line for bypassing pressure build-up in the pipeline into the fuel tank installation. (See photograph on page 9.)

18. PROCEDURES FOR TRANSFERRING OIL:

General Precautions

a) The transfer is considered to begin at the date and time when the Person in Charge of the Greens Creek Hawk Inlet fuel transfer facility and the vessel first meet to begin completing the Declaration of Inspection.

b) Actual transfer operations from the barge to the shore side are not to start until the Person in Charge of the shore side facility and the barge tankerman have first discussed the transfer pressure to ensure it will not exceed the maximum allowable working pressure (MAWP), and have received and signed an approved Declaration of Inspection.

c) Oil transfer operations are not permitted unless all requirements as specified on the Declaration of Inspection are met.

d) The Person in Charge of the terminal facility is not to start fuel transfer operations if the vessel is not properly moored.

e) When completing transfer operations, avoid excessive pressures by securing the pumping operation from the barge and closing the barge's valves first.

f) The Person in Charge should personally observe the topping off operations.

g) When transfer operations are completed, drain the transfer piping system and hoses into the barge's tank and secure all the piping to prevent spilling. Valves must be checked to ensure proper closure.

h) The transfer is considered to be complete when all the connections for the transfer have been uncoupled and secured with camlock caps and both the Person in Charge of the facility and the tankerman on the barge have completed the Declaration of Inspection including the date and time the transfer was completed.

Procedures for the Completion of Pumping

At the termination of a fuel transfer, the person in charge will personally monitor the topping off procedure. The barge ceases pumping fuel and its valves are closed first to eliminate the possibility of building up excessive pressure in the shore side line and causing a rupture. After the shore side valves are closed the fueling lines are carefully drained and then disconnected at the header and fuel is allowed to drain back into the barge. The main fuel transfer hose is then capped and returned to the barge and the Greens Creek Mining Company fuel transfer line is capped and locked shut. Throughout each fuel transfer operation the shore personnel are in constant communication with the tankerman on the barge and are on constant lookout for any leaks or spills from the hose or the tank or the fittings connecting them together.

Emergencies

At the Greens Creek Mining Company Hawk Inlet fuel transfer facility a list of all agencies to be contacted in an emergency is posted at the Security Office located in the north bunkhouse and in the Cannery Caretakers quarters. All persons involved with transfers must have previously read, understood and have initialed an outline of the established emergency procedures. In event of a product spill, fire, etc. procedures require personnel to secure pumping immediately, close tank and hose valves and make an immediate report to the appropriate local, federal and company personnel. Greens Creek Mining Company Emergency procedures are discussed with the barge tankerman prior to signing of the Declaration of Inspection and the beginning of any fuel transfer. See the facility response plan for more specific instructions.

19. PROCEDURES FOR REPORTING AND THE INITIAL CONTAINMENT OF OIL DISCHARGES:

Oil discharge detection at the Hawk Inlet Marine Terminal is usually by direct observation. The marine terminal and the mill site fuel tanks have mechanical level gauges, but no electronic or mechanical monitoring system for leaks. The storage tanks and associated fuel lines are visually inspected weekly. Once a spill has been detected, immediate action will be taken to determine the exact source of the spill and to confirm its magnitude. Contact will be made by radio to the trained response team members who will conduct cleanup and notify the appropriate agencies. If the spill can be easily stopped at the source and the discharge quickly contained or picked up, an immediate response will be made. Greens Creek Mining Company has a large stock of containment and absorbent boom which can be quickly placed by employees to contain any spills on land or water.

When reporting a spill to the National Response Center at 1-800-424-8802, as much of the information described below as possible should be provided:

- Name, address and telephone number of the reporting party.
- Description of the incident including date and time.
- Location of the incident e.g. Hawk Inlet Marine Terminal, Hawk Inlet on Admiralty Island, Southeast Alaska. The facility coordinates are 134°45'15" W longitude and 58°07'30" N latitude. The nearest city is Juneau, Alaska approximately 18 miles to the northeast.
- Details of the vessel involved or details concerning equipment failure at the facility (broken pipe, tank overflow etc.)
- Details of the material spilled including the amount released and whether released to the air, land or water.
- Weather conditions including wind direction and strength, water temperature, air temperature, state of the tide whether ebbing or flooding etc.
- Other information if applicable e.g. whether or not there have been any injuries, whether or not fire has resulted etc.
- Cleanup actions: advise whether or not cleanup is being performed.

The Alaska Department of Environmental Conservation must be notified as well. ADEC prefers that spills of oil and hazardous substances be reported by faxing the Oil and Hazardous Substance Spill Notification form to (907) 465 2237.

20. BRIEF SUMMARY OF APPLICABLE FEDERAL, STATE, AND LOCAL OIL POLLUTION LAWS AND REGULATIONS:

Federal Law

Greens Creek Mining Company is required to immediately report all spills and hazardous substance spills. The Federal Water Pollution Control Act Amendments of 1972 made it unlawful to discharge oil "into or

upon the navigable waters of the United States, adjoining shorelines or into or upon the waters of the contiguous zone", 33 USC 1321(b)(3).

Both the USCG and the EPA require immediate reporting of such discharges. The responsibility is established in the National Oil and Hazardous Substances Contingency Plan, 40 CFR 15410.36(b)(1)&(2).

Spills on inland waters are the responsibility of the EPA while the Coast Guard has jurisdiction for coastal water, ports and harbors. The Coast Guard National Response Center (NRC) will be notified in the event of a spill. The toll free number is 1-800-424-8802, 24 hours a day.

Alaska Law

The Alaska Department of Environmental Conservation (ADEC) requires that they be notified of any discharge of oil or hazardous substances in the following manner:

"For any discharge of oil to the water of the state which is in excess of 55 gallons, notification must be made as soon as the person in charge of the facility has knowledge of the discharge" 18 AAC 75.300.

For any discharge of oil solely to the land of the state in excess of 55 gallons, notification must be made within 5 hours of knowledge of the discharge" 18 AAC75.300.

Land spills of less than 55 gallons, but greater than 10 gallons, require notification within 24 hours and less than 10 gallons within 7 days.

ADEC regulations contained in 18 AAC 75.300 stipulate that the final report must include

- Date and time of discharge
- Location of the discharge
- Person or persons causing or responsible for the discharge

ADEC prefers that spills of oil and hazardous substances be reported by faxing the Oil and Hazardous Substance Spill Notification on the next page to (907) 465-2237.

Form 1. ADEC Spill Notification Form

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

OIL & HAZARDOUS SUBSTANCES SPILL NOTIFICATION FORM

CLEAR FORM

ADEC USE ONLY

ADEC SPILL #:	ADEC FILE #:	ADEC LC:

PERSON REPORTING:	**PHONE NUMBER:**	**REPORTED HOW? (ADEC USE ONLY)** ☐ Phone ☐ Fax ☐ Troopers
DATE/TIME OF SPILL:	**DATE/TIME DISCOVERED:**	**DATE/TIME REPORTED:**
INCIDENT LOCATION/ADDRESS:	**DATUM:** ☐ NAD27 ☐ NAD83 ☐ WGS84 ☐ Other _____ **LAT.** **LONG.**	**PRODUCT SPILLED:**

QUANTITY SPILLED:	**QUANTITY CONTAINED:**	**QUANTITY RECOVERED:**	**QUANTITY DISPOSED:**
☐ gallons ☐ pounds	☐ gallons ☐ pounds	☐ gallons ☐ pounds	☐ gallons ☐ pounds

	POTENTIAL RESPONSIBLE PARTY:	**OTHER PRP, IF ANY:**	**VESSEL NAME:**
Name/Business:			
Mailing Address:			**VESSEL NUMBER:**
Contact Name:			**> 400 GROSS TON VESSEL:**
Contact Number:			☐ Yes ☐ No

SOURCE OF SPILL:	**CAUSE CLASSIFICATION:** ☐ Accident ☐ Human Factors ☐ Structural/Mechanical ☐ Other
CAUSE OF SPILL: ☐ **Under Investigation**	

CLEANUP ACTIONS:

DISPOSAL METHODS AND LOCATION:

AFFECTED AREA SIZE:	**SURFACE TYPE:** *(gravel, asphalt, name of river etc.)*	**RESOURCES AFFECTED/THREATENED:** *(Water sources, wildlife, wells, etc.)*

COMMENTS:

ADEC USE ONLY

SPILL NAME:	**NAME OF DEC STAFF RESPONDING:**	**C-PLAN MGR NOTIFIED?** ☐ Yes ☐ No
DEC RESPONSE: ☐Phone follow-up ☐Field visit ☐Took Report	**CASELOAD CODE:** ☐First and Final ☐Open/No LC ☐LC Assigned	**CLEANUP CLOSURE ACTION:** ☐NFA ☐Monitoring ☐Transferred to CS or STP
COMMENTS:	**Status of Case:** ☐ **Open** ☐ **Closed**	**DATE CASE CLOSED:**
REPORT PREPARED BY:		**DATE:**

Revised 2/5/2008

21. PROCEDURES FOR SHIELDING PORTABLE LIGHTING:

This facility operates continuously year round. In the event a fuel transfer takes place during the hours of darkness, illumination is provided by intrinsically safe lighting located on the fuel barge and by a pole mounted light located 100 feet south of the fuel tank. The lights are oriented in such a way that they would not pose a confusion hazard for navigation to vessels operating offshore of the Greens Creek Mining Company fuel transfer facility in Hawk Inlet. Portable intrinsically safe flashlights can also be used to illuminate the camlock fittings and connections between the transfer hose and the header valve to observe the connections for drips or leaks or just for proper alignment between the valve connection and hose connection.

22. PERSONS IN CHARGE TRAINING AND QUALIFICATION PROGRAM:

To be trained as a Person-In-Charge (PIC) a person must have completed a training program conducted by an experienced PIC. This comprehensive program provides the prospective PIC with the knowledge and training necessary to properly operate the transfer equipment at the Greens Creek Mining Company's fuel transfer facility, perform the duties of a PIC, and follow the procedures and fulfill the duties of a PIC during an emergency. Prior to final certification as a PIC the person will have observed and participated with an authorized Person-In-Charge in a sufficient number of oil transfers to be completely familiar with the operations manual and the specific duties of a PIC and the assistant, Hose Watchman. Records certifying successful completion of PIC training and participation in the initial oil transfers for training will be kept by the Greens Creek Mining Company at the Surface Operations Security Office on the second floor of the Bunkroom Building at the shore end of the seaplane pier.

The designated person-in-charge for these operations is present at all fuel deliveries. The training to be conducted includes all handling procedures and general safety precautions for handling the products, the use of the Declaration of Inspection to establish readiness for transfer operations, the procedures for emergency shutdown that are followed on the barge, the preparation of fire fighting equipment for use in the event of any type of fire emergency and the procedures for ensuring that the shoreside containment is in place and functional and ready to contain any spillage that might occur. The designated person in charge will also be trained in topping off procedures and procedures for slowing pumping as the tank being filled is approaching its topped off level. These specific procedures coupled with study and familiarization with the Oil Transfer Operations Manual are sufficient to comply with the requirements of 33CFR Part 154.710(b).

In addition to the practical training in receiving fuel from the Petro Marine Barge detailed above, to comply with the requirements in 33 CFR 154.710 each designated person in charge of the transfer operations at the Greens Creek Mine Hawk Inlet Terminal is familiar with and has been trained on the hazards of the product to be transferred by virtue of being familiar with the descriptions of the products in this manual and in the Emergency Response Guide and in the Safety Data Sheet which is part of this manual. The facility operating procedures are described in the operating manual and the designated persons in charge also certify their familiarity with them by signing the Operations Plan Review Certifications and Training Record. Local discharge reporting procedures are all detailed in the Operations Manual and the designated persons in charge also certify their familiarity with them by signing the Operations Plan Review Certifications and Training Record. The facility's emergency response plans and response plans for discharge reporting and containment are covered in this manual and the designated

persons in charge also certify their familiarity with them by signing the Operations Plan Review Certifications and Training Record. The Hazard Communications requirements of the Occupational Safety and Health Administration (OSHA) and the Department of Labor in 29 CFR 1910.1200 are satisfied by the provision of the Safety Data Sheets in this manual.

Table 3. Approved Persons in Charge List

Name	Position
Ed Gilbert	Safety Specialist, Trainer
Kris Hildre	Crew Supervisor
Ernest Hillman	Relief Supervisor
Terry Maxwell	AFSO ,General Foreman
Jim Phillips	Relief Supervisor
Jeff Rideout	AFSO ,General Foreman
James Sage	Relief Supervisor
Michael Stocks	Relief Supervisor
Ken Stubbs	Crew Supervisor
Brian Tatlow	Crew Supervisor
Jeff Swanson	Crew Supervisor

OPERATIONS PLAN REVIEW CERTIFICATIONS

AND TRAINING RECORD

By my signature below I hereby certify that I have read and understand the Greens Creek Mine Hawk Inlet Marine Operations Terminal Fuel Oil Transfer Operations Manual with special emphasis on the relevant safety precautions for receiving fuel and responding to emergencies that may arise during fuel transfer operations and I have received training in general safety precautions to be taken in the event of any fuel spill, fire or other emergency on the Hawk Inlet Terminal fuel transfer facility.

Signature	Date

LETTER OF INTENT

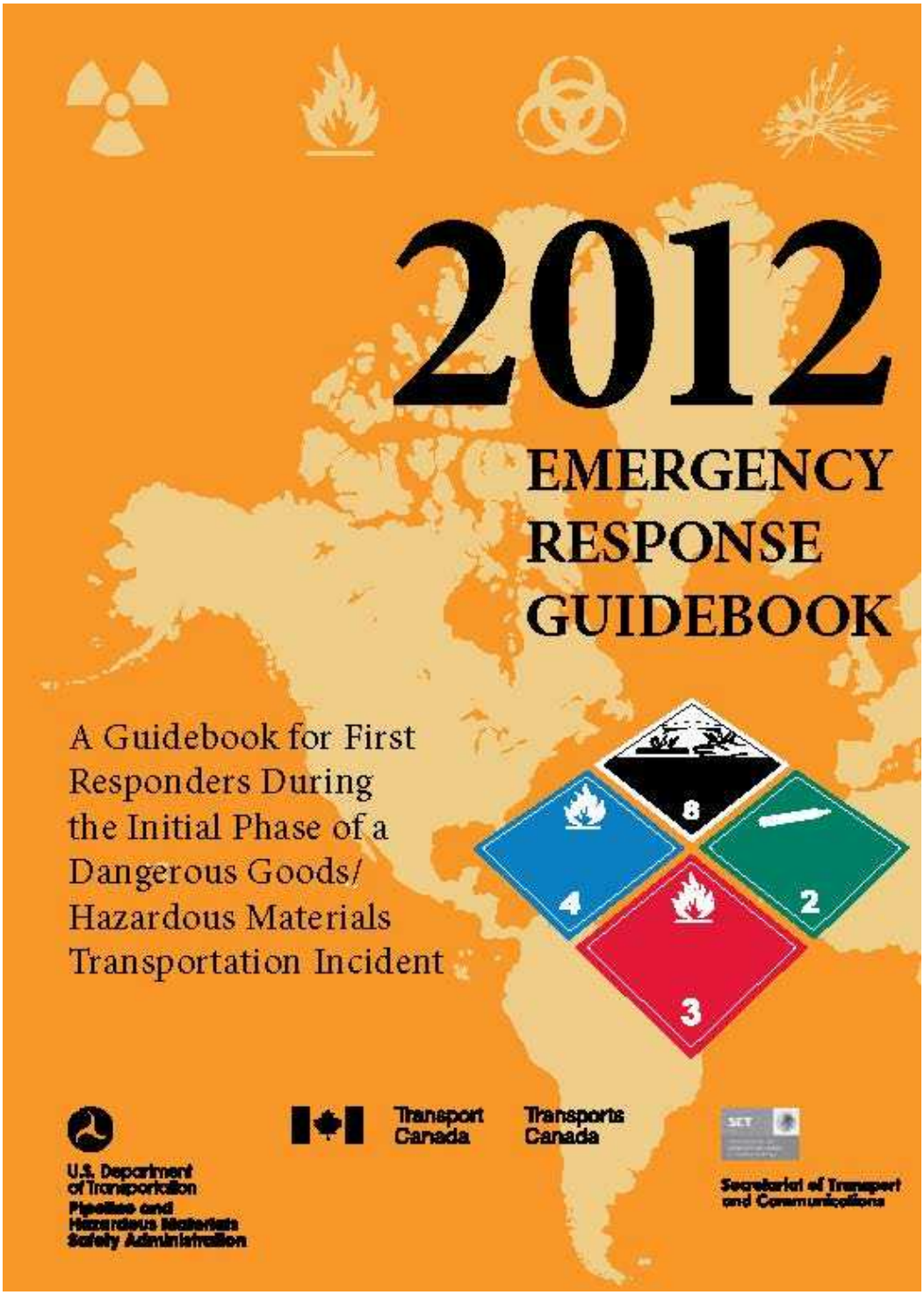
The Greens Creek Mining Company Hawk Inlet Terminal has been in operation in Hawk Inlet since 1989. During this time, several letters of intent have been filed with the Coast Guard Marine Safety Office in Juneau and Sector Juneau. All copies of previous letters of intent are on file in the Surface Operations Security Office in the north bunkhouse building immediately inshore of the float plane dock and across the road from the port facilities.

23. RECORD OF CHANGES

Table 4. Record of Changes and Amendments

Date	Who	Section(s) Changed or Amended
June 2020	Chris Wallace	Updated the format of the GPO and contact information.

GPO Appendix 09a
Attachment A
Emergency Response Guide


2012
EMERGENCY
RESPONSE
GUIDEBOOK
A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/ Hazardous Materials Transportation Incident
8
4
2
3
Transport Canada
Transports Canada
U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Secretariat of Transport and Communications

ID No.	Guide No.	Name of Material
1173	129	Ethyl acetate
1175	130	Ethylbenzene
1176	129	Ethyl borate
1177	130	2-Ethylbutyl acetate
1177	130	Ethylbutyl acetate
1178	130	2-Ethylbutyraldehyde
1179	127	Ethyl butyl ether
1180	130	Ethyl butyrate
1181	155	Ethyl chloroacetate
1182	155	Ethyl chloroformate
1183	139	Ethyldichlorosilane
1184	131	Ethylene dichloride
1185	131P	Ethyleneimine, stabilized
1188	127	Ethylene glycol monomethyl ether
1189	129	Ethylene glycol monomethyl ether acetate
1190	129	Ethyl formate
1191	129	Ethylhexaldehydes
1191	129	Octyl aldehydes
1192	129	Ethyl lactate
1193	127	Ethyl methyl ketone
1193	127	Methyl ethyl ketone
1194	131	Ethyl nitrite, solution
1195	129	Ethyl propionate
1196	155	Ethyltrichlorosilane
1197	127	Extracts, flavoring, liquid
1197	127	Extracts, flavouring, liquid
1198	132	Formaldehyde, solution, flammable
1198	132	Formaldehyde, solutions (Formalin)
1199	132P	Furaldehydes
1199	132P	Furfural
1199	132P	Furfuraldehydes
1201	127	Fusel oil
1202	128	Diesel fuel
1202	128	Fuel oil
1202	128	Fuel oil, no. 1,2,4,5,6
1202	128	Gas oil
1202	128	Heating oil, light
1203	128	Gasohol
1203	128	Gasoline
1203	128	Motor spirit
1203	128	Petrol
1204	127	Nitroglycerin, solution in alcohol, with not more than 1% Nitroglycerin
1206	128	Heptanes
1207	130	Hexaldehyde
1208	128	Hexanes
1208	128	Neohexane
1210	129	Ink, printer's, flammable
1210	129	Printing ink, flammable
1210	129	Printing ink related material
1212	129	Isobutanol
1212	129	Isobutyl alcohol
1213	129	Isobutyl acetate
1214	132	Isobutylamine
1216	128	Isooctenes
1218	130P	Isoprene, stabilized
1219	129	Isopropanol
1219	129	Isopropyl alcohol
1220	129	Isopropyl acetate
1221	132	Isopropylamine
1222	130	Isopropyl nitrate

GUIDE 128

FLAMMABLE LIQUIDS (NON-POLAR/WATER-IMMISCIBLE)

ERG2012

POTENTIAL HAZARDS

FIRE OR EXPLOSION

- **HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames.**
- Vapors may form explosive mixtures with air.
- Vapors may travel to source of ignition and flash back.
- Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Vapor explosion hazard indoors, outdoors or in sewers.
- Those substances designated with a **(P)** may polymerize explosively when heated or involved in a fire.
- Runoff to sewer may create fire or explosion hazard.
- Containers may explode when heated.
- Many liquids are lighter than water.
- Substance may be transported hot.
- For UN3166, if Lithium ion batteries are involved, also consult GUIDE 147.
- **If molten aluminum is involved, refer to GUIDE 169.**

HEALTH

- Inhalation or contact with material may irritate or burn skin and eyes.
- Fire may produce irritating, corrosive and/or toxic gases.
- Vapors may cause dizziness or suffocation.
- Runoff from fire control or dilution water may cause pollution.

PUBLIC SAFETY

- **CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind.
- Keep out of low areas.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters' protective clothing will only provide limited protection.

EVACUATION

Large Spill

- Consider initial downwind evacuation for at least 300 meters (1000 feet).

Fire

- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

FLAMMABLE LIQUIDS (NON-POLAR/WATER-IMMISCIBLE)

EMERGENCY RESPONSE

FIRE

CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.

CAUTION: For mixtures containing alcohol or polar solvent, alcohol-resistant foam may be more effective.

Small Fire

- Dry chemical, CO_2, water spray or regular foam.

Large Fire

- Water spray, fog or regular foam.
- **Do not use straight streams**.
- Move containers from fire area if you can do it without risk.

Fire involving Tanks or Car/Trailer Loads

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

SPILL OR LEAK

- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
- All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- A vapor suppressing foam may be used to reduce vapors.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
- Use clean non-sparking tools to collect absorbed material.

Large Spill

- Dike far ahead of liquid spill for later disposal.
- Water spray may reduce vapor; but may not prevent ignition in closed spaces.

FIRST AID

- Move victim to fresh air.
- Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Wash skin with soap and water.
- In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin.
- Keep victim warm and quiet.
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

GPO Appendix 09a
Attachment B
ULSD Safety Data Sheet

SAFETY DATA SHEET

SDS ID NO.: 0290MAR019
Revision Date 06/01/2016

1. IDENTIFICATION

Product Name: Marathon Petroleum No. 2 Ultra Low Sulfur Diesel

Synonym: #2 Diesel; No. 2 Ultra Low Sulfur Diesel 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 15 ppm Sulfur Max with Polar Plus; No. 2 Diesel, Motor Vehicle Use, Undyed; No. 2 Diesel, Motor Vehicle Use, Undyed, with Polar Plus; ULSD No. 2 Diesel 15 ppm Sulfur Max; ULSD No. 2 Diesel 15 ppm Sulfur Max with Polar Plus; No. 2 NR 15 Diesel; No. 2 NR 15 Diesel with Polar Plus; No. 2 Ultra Low Sulfur Diesel Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 Dyed 15 ppm Sulfur Max with Polar Plus; No. 2 Diesel, Tax Exempt-Motor Vehicle Use, Dyed; No. 2 Diesel, Tax Exempt-Motor Vehicle Use, Dyed, with Polar Plus; ULSD No. 2 Diesel Dyed 15 ppm Sulfur Max; ULSD No. 2 Diesel Dyed 15 ppm Sulfur Max, with Polar Plus; No. 2 NR 15 Diesel Dyed; No. 2 NR 15 Diesel Tx Le Dyed; #2 NR 15 CFI Diesel; #2 NR 15 CFI Diesel Dyed; No. 2 Low Sulfur Diesel (TxLED); No. 2 NR 15 Diesel Dyed, with Polar Plus; No. 2 NRLM 15 Diesel Dyed; No.2 NRLM Diesel Dyed; No.2 Low Emission Low Sulfur Diesel; No. 2 Heating Oil 5000 NMA Unmarked; NEMA No. 2 Heating Oil; Heating Oil, No. 2 Low Sulfur 5000 ppm; No. 2 Ultra Low Sulfur Diesel Dyed with <6% Renewable Diesel Fuel; Ultra Low Sulfur No. 2 Diesel Dyed with <6% Renewable Diesel Fuel; No. 2 Diesel Dyed with <6% Renewable Diesel Fuel 15 ppm Sulfur Max; No. 2 Ultra Low Sulfur Diesel with <6% Renewable Diesel Fuel; Ultra Low Sulfur No. 2 Diesel with <6% Renewable Diesel Fuel; No. 2 Diesel with <6% Renewable Diesel Fuel 15 ppm Sulfur Max; Garyville Export Diesel; Export Diesel, Garyville; Diesel Fuel, Export Garyville; #2 Motor Vehicle ULSD 15 ppm with 0-5% Renewable Diesel; Marathon No. 2 ULSD with 0-5% Renewable Fuel with R100; Marathon No. 2 ULSD with 0-5% Renewable Fuel with R99; No. 2 Heating Oil 2000 ppm Sulfur Max, Clear (Undyed) Unmarked;Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Clear (Undyed) Unmarked; ULS Heating Oil 15 ppm Clear (Undyed) Unmarked; ULS HO 15 ppm CLR; Ultra-Low Sulfur Heating Oil (<= 15ppm, Undyed); No. 2 Heating Oil 2000 ppm Sulfur Max, Dyed Unmarked; No. 2 Heating Oil 2000 ppm Sulfur Max, Dyed Marked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Dyed Unmarked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Dyed Marked;15 ppm Sulfur Heating Oil Grade 67; 15 PPM Heating Oil; 15 PPM Dyed Heating Oil; 0291MAR019; 0306MAR019; 0308MAR019; 0334MAR019; 0335MAR019; 0336MAR019; 0337MAR019; 0340MAR019;

Product Code: 0290MAR019
Chemical Family: Complex Hydrocarbon Substance

Recommended Use: Fuel.
Restrictions on Use: All others.

Manufacturer, Importer, or Responsible Party Name and Address:
MARATHON PETROLEUM COMPANY LP
539 South Main Street
Findlay, OH 45840

SDS information: 1-419-421-3070

Emergency Telephone: CHEMTREC: 1-800-424-9300

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 3
Acute toxicity - Inhalation (Dusts/Mists)	Category 4
Skin corrosion/irritation	Category 2
Carcinogenicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Specific target organ toxicity (repeated exposure)	Category 2
Aspiration toxicity	Category 1
Acute aquatic toxicity	Category 2
Chronic aquatic toxicity	Category 2

Hazards Not Otherwise Classified (HNOC)
Static accumulating flammable liquid

Label elements

EMERGENCY OVERVIEW

Danger

FLAMMABLE LIQUID AND VAPOR
May accumulate electrostatic charge and ignite or explode
May be fatal if swallowed and enters airways
Harmful if inhaled
Causes skin irritation
May cause respiratory irritation
May cause drowsiness or dizziness
Suspected of causing cancer
May cause damage to organs (thymus, liver, bone marrow) through prolonged or repeated exposure
Toxic to aquatic life with long lasting effects

Appearance Yellow to Red Liquid **Physical State** Liquid **Odor** Hydrocarbon

Precautionary Statements - Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use only non-sparking tools.
Use explosion-proof electrical/ventilating/lighting/equipment
Take precautionary measures against static discharge
Do not breathe mist/vapors/spray
Use only outdoors or in a well-ventilated area

Wear protective gloves/protective clothing/eye protection/face protection
Wash hands and any possibly exposed skin thoroughly after handling
Avoid release to the environment

Precautionary Statements - Response
IF exposed or concerned: Get medical attention
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
If skin irritation occurs: Get medical attention
Wash contaminated clothing before reuse
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor if you feel unwell
IF SWALLOWED: Immediately call a POISON CENTER or doctor
Do NOT induce vomiting
In case of fire: Use water spray, fog or regular foam for extinction
Collect spillage

Precautionary Statements - Storage
Store in a well-ventilated place. Keep container tightly closed
Keep cool
Store locked up

Precautionary Statements - Disposal
Dispose of contents/container at an approved waste disposal plant

3. COMPOSITION/INFORMATION ON INGREDIENTS

No. 2 Ultra Low Sulfur Diesel is a complex mixture of paraffins, cycloparaffins, olefins and aromatic hydrocarbon chain lengths predominantly in the range of eleven to twenty carbons. May contain up to 5% Renewable Diesel. May contain small amounts of dye and other additives (<0.15%) which are not considered hazardous at the concentration(s) used. May contain a trace amount of benzene (<0.01%). Contains a trace amount of sulfur (<0.0015%)

Composition Information:

Name	CAS Number	% Concentration
No. 2 Diesel Fuel	68476-34-6	50-100
Kerosine (petroleum)	8008-20-6	0-50
Alkanes, C10-C20 branched and linear	928771-01-1	0-5
Naphthalene	91-20-3	0.3-2.6

All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

4. FIRST AID MEASURES

First Aid Measures

General Advice: In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation: Remove to fresh air. If not breathing, institute rescue breathing. If breathing is difficult, ensure airway is clear, give oxygen and continue to monitor. If heart has stopped, immediately begin cardiopulmonary resuscitation (CPR). Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Skin Contact: Immediately wash exposed skin with plenty of soap and water while removing contaminated clothing and shoes. May be absorbed through the skin in harmful amounts. Get medical attention if irritation persists. Any injection injury from high pressure equipment should be evaluated immediately by a physician as potentially serious (See NOTES TO PHYSICIAN).

Place contaminated clothing in closed container until cleaned or discarded. If clothing is to be laundered, inform the person performing the operation of contaminant's hazardous

properties. Destroy contaminated, non-chemical resistant footwear.

Eye Contact: Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while flushing. Get medical attention if irritation persists.

Ingestion: Do not induce vomiting because of danger of aspirating liquid into lungs, causing serious damage and chemical pneumonitis. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects: Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking. Prolonged or repeated exposure may cause adverse effects to the thymus, liver, and bone marrow.

Indication of any immediate medical attention and special treatment needed

Notes To Physician: INHALATION: This material (or a component) sensitizes the myocardium to the effects of sympathomimetic amines. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in individuals exposed to this material. Administration of sympathomimetic drugs should be avoided.

SKIN: Leaks or accidents involving high-pressure equipment may inject a stream of material through the skin and initially produce an injury that may not appear serious. Only a small puncture wound may appear on the skin surface but, without proper treatment and depending on the nature, original pressure, volume, and location of the injected material, can compromise blood supply to an affected body part. Prompt surgical debridement of the wound may be necessary to prevent irreversible loss of function and/or the affected body part. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES.

INGESTION: This material represents a significant aspiration and chemical pneumonitis hazard. Induction of emesis is not recommended.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media
For small fires, Class B fire extinguishing media such as CO_2, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.

Unsuitable extinguishing media
Do not use straight water streams to avoid spreading fire.

Specific hazards arising from the chemical
This product has been determined to be a flammable liquid per the OSHA Hazard Communication Standard and should be handled accordingly. May accumulate electrostatic charge and ignite or explode. Vapors may travel along the ground or be moved by ventilation and ignited by many sources such as pilot lights, sparks, electric motors, static discharge, or other ignition sources at locations distant from material handling. Flashback can occur along vapor trail. For additional fire related information, see NFPA 30 or the Emergency Response Guidebook 128.

Hazardous combustion products
Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data

Sensitivity to Mechanical Impact No.
Sensitivity to Static Discharge Yes.

Special protective equipment and precautions for firefighters
Firefighters should wear full protective clothing and positive-pressure self-contained breathing apparatus (SCBA) with a full face-piece, as appropriate. Avoid using straight water streams. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Avoid excessive water spray application. Keep surrounding area cool with water spray from a distance and prevent further ignition of combustible material. Keep run-off water out of sewers and water sources.

Additional firefighting tactics
FIRES INVOLVING TANKS OR CAR/TRAILER LOADS: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after the fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles: if this is impossible, withdraw from area and let fire burn.

EVACUATION: Consider initial downwind evacuation for at least 1000 feet. If tank, rail car or tank truck is involved in a fire, ISOLATE for 5280 feet (1 mile) in all directions; also, consider initial evacuation of 5280 feet (1 mile) in all directions.

NFPA	Health 1	Flammability 2	Instability 0	Special Hazard -

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Eliminate all ignition sources. All contaminated surfaces will be slippery.
Protective equipment:	Use personal protection measures as recommended in Section 8.
Emergency procedures:	Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.
Environmental precautions:	Avoid release to the environment. Avoid subsoil penetration.
Methods and materials for containment:	Contain liquid with sand or soil. Prevent spilled material from entering storm drains, sewers, and open waterways.
Methods and materials for cleaning up:	Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids. Recover and return free product to proper containers. When recovering free liquids ensure all equipment is grounded and bonded. Use only non-sparking tools.

7. HANDLING AND STORAGE

Safe Handling Precautions:

NEVER SIPHON THIS PRODUCT BY MOUTH. Use appropriate grounding and bonding practices. Static accumulating flammable liquid. Bonding and grounding may be insufficient to eliminate the hazard from static electricity. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. Vapors may travel along the ground or be moved by ventilation. Flashback may occur along vapor trails. No smoking. Use only non-sparking tools. Avoid breathing fumes, gas, or vapors. Use only with adequate ventilation. Avoid repeated and prolonged skin contact. Use personal protection measures as recommended in Section 8. Exercise good personal hygiene including removal of soiled clothing and prompt washing with soap and water. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements.

Hydrocarbons are basically non-conductors of electricity and can become electrostatically charged during mixing, filtering, pumping at high flow rates or loading and transfer operations. If this charge reaches a sufficiently high level, sparks can form that may ignite

the vapors of flammable liquids. Sudden release of hot organic chemical vapors or mists from process equipment operating under elevated temperature and pressure, or sudden ingress of air into vacuum equipment may result in ignition of vapors or mists without the presence of obvious ignition sources. Nozzle spouts must be kept in contact with the containers or tank during the entire filling operation.

Portable containers should never be filled while in or on a motor vehicle or marine craft. Containers should be placed on the ground. Static electric discharge can ignite fuel vapors when filling non-grounded containers or vehicles on trailers. The nozzle spout must be kept in contact with the container before and during the entire filling operation. Use only approved containers.

A buildup of static electricity can occur upon re-entry into a vehicle during fueling especially in cold or dry climate conditions. The charge is generated by the action of dissimilar fabrics (i.e., clothing and upholstery) rubbing across each other as a person enters/exits the vehicle. A flash fire can result from this discharge if sufficient flammable vapors are present. Therefore, do not get back in your vehicle while refueling.

Cellular phones and other electronic devices may have the potential to emit electrical charges (sparks). Sparks in potentially explosive atmospheres (including fueling areas such as gas stations) could cause an explosion if sufficient flammable vapors are present. Therefore, turn off cellular phones and other electronic devices when working in potentially explosive atmospheres or keep devices inside your vehicle during refueling.

High-pressure injection of any material through the skin is a serious medical emergency even though the small entrance wound at the injection site may not initially appear serious. These injection injuries can occur from high-pressure equipment such as paint spray or grease or guns, fuel injectors, or pinhole leaks in hoses or hydraulic lines and should all be considered serious. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES (See First Aid Section 4).

Storage Conditions: Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area. Do not store near an open flame, heat or other sources of ignition.

Incompatible Materials Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	ACGIH TLV	OSHA PELS:	OSHA - Vacated PELs	NIOSH IDLH
No. 2 Diesel Fuel 68476-34-6	100 mg/m³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Kerosine (petroleum) 8008-20-6	200 mg/m³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	-	-
Naphthalene 91-20-3	10 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm TWA: 50 mg/m³	10 ppm TWA 50 mg/m³ TWA 15 ppm STEL 75 mg/m³ STEL	250 ppm

Notes: The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.

Engineering measures: Local or general exhaust required in an enclosed area or with inadequate ventilation. Use

mechanical ventilation equipment that is explosion-proof.

Personal protective equipment

Eye protection: Use goggles or face-shield if the potential for splashing exists.

Skin and body protection: Wear neoprene, nitrile or PVA gloves to prevent skin contact. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times.

Respiratory protection: Use a NIOSH approved organic vapor chemical cartridge or supplied air respirators when there is the potential for airborne exposures to exceed permissible exposure limits or if excessive vapors are generated. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.

Hygiene measures: Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical State	Liquid
Appearance	Yellow to Red Liquid
Color	Yellow to Red
Odor	Hydrocarbon
Odor Threshold	No data available.

Property	Values (Method)
Melting Point / Freezing Point	No data available.
Initial Boiling Point / Boiling Range	154-366 °C / 310-691 °F (ASTM D86)
Flash Point	58-76 °C / 136-168 °F (ASTM D93)
Evaporation Rate	No data available.
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%):	
Upper Flammability Limit:	No data available.
Lower Flammability Limit:	No data available.
Explosion limits:	No data available.
Vapor Pressure	No data available.
Vapor Density	No data available.
Specific Gravity / Relative Density	0.82-0.86
Water Solubility	No data available.
Solubility in other solvents	No data available.
Partition Coefficient	No data available.
Decomposition temperature	No data available.
pH:	Not applicable
Autoignition Temperature	No data available.
Kinematic Viscosity	1.90-3.32 cSt @ 40°C (ASTM D445)
Dynamic Viscosity	No data available.
Explosive Properties	No data available.
VOC Content (%)	No data available.
Density	No data available.
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

Reactivity The product is non-reactive under normal conditions.

Chemical stability The material is stable at 70°F (21°C), 760 mmHg pressure.

Possibility of hazardous reactions	None under normal processing.
Hazardous polymerization	Will not occur.
Conditions to avoid	Excessive heat, sources of ignition, open flame.
Incompatible Materials	Strong oxidizing agents.
Hazardous decomposition products	None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION

Potential short-term adverse effects from overexposures

Inhalation	Harmful if inhaled. May cause irritation of respiratory tract. May cause drowsiness or dizziness. Breathing high concentrations of this material in a confined space or by intentional abuse can cause irregular heartbeats which can cause death.
Eye contact	Exposure to vapor or contact with liquid may cause mild eye irritation, including tearing, stinging, and redness.
Skin contact	Irritating to skin. Effects may become more serious with repeated or prolonged contact. May be absorbed through the skin in harmful amounts.
Ingestion	May be fatal if swallowed or vomited and enters airways. May cause irritation of the mouth, throat and gastrointestinal tract.

Acute toxicological data

Name	Oral LD50	Dermal LD50	Inhalation LC50
No. 2 Diesel Fuel 68476-34-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	>1 - <5 mg/L (Rat) 4 h
Kerosine (petroleum) 8008-20-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.28 mg/L (Rat) 4 h
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	>1 - <5 mg/l (Rat) 4 h
Naphthalene 91-20-3	490 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 340 mg/m^3 (Rat) 1 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

MIDDLE DISTILLATES, PETROLEUM: Long-term repeated (lifetime) skin exposure to similar materials has been reported to result in an increase in skin tumors in laboratory rodents. The relevance of these findings to humans is not clear at this time. Altered mental state, drowsiness, peripheral motor neuropathy, irreversible brain damage (so-called Petrol Sniffer's Encephalopathy), delirium, seizures, and sudden death have been reported from repeated overexposure to some hydrocarbon solvents, naphthas, and gasoline.

MIDDLE DISTILLATES WITH CRACKED STOCKS: Light cracked distillates have been shown to be carcinogenic in animal tests and have tested positive with in vitro genotoxicity tests. Repeated dermal exposures to high concentrations in test animals resulted in reduced litter size and litter weight, and increased fetal resorptions at maternally toxic doses. Dermal exposure to high concentrations resulted in severe skin irritation with weight loss and some mortality. Inhalation exposure to high concentrations resulted in respiratory tract irritation, lung changes/infiltration/accumulation, and reduction in lung function.

ISOPARAFFINS: Studies in laboratory animals have shown that long-term exposure to similar materials (isoparaffins) can cause kidney damage and kidney cancer in male laboratory rats. However, in-depth research indicates that these findings are unique to the male rat, and that these effects are not relevant to humans.

NAPHTHALENE: Severe jaundice, neurotoxicity (kernicterus) and fatalities have been reported in young children and infants as a result of hemolytic anemia from overexposure to naphthalene. Persons with glucose 6-phosphate dehydrogenase (G6PD) deficiency are more prone to the hemolytic effects of naphthalene. Adverse effects on the kidney have been reported in persons overexposed to naphthalene but these effects are believed to be a consequence of hemolytic anemia, and not a direct effect. Hemolytic anemia has been observed in laboratory animals exposed to naphthalene. Laboratory rodents exposed to naphthalene vapor for 2 years (lifetime studies) developed non-neoplastic and neoplastic tumors and inflammatory lesions of the nasal and respiratory tract. Cataracts and other adverse effects on the eye have been observed in laboratory animals exposed to high levels of naphthalene. Findings from a large number of bacterial and mammalian cell mutation assays have been negative. A few studies have shown chromosomal effects (elevated levels of Sister Chromatid Exchange or chromosomal aberrations) in vitro. Naphthalene has been classified as Possibly Carcinogenic to Humans (2B) by IARC, based on findings from studies in laboratory animals.

DIESEL EXHAUST: The combustion of diesel fuels produces gases including carbon monoxide, carbon dioxide, oxides of nitrogen and/or sulfur, and hydrocarbons that can be irritating and hazardous with overexposure. Long-term occupational overexposure to diesel exhaust and diesel exhaust particulate matter has been associated with an increased risk of respiratory disease, including lung cancer, and is characterized as a "known human carcinogen" by the International Agency for Research on Cancer (IARC), as "a reasonably anticipated human carcinogen" by the National Toxicology Program, and as "likely to be carcinogenic to humans" by the EPA, based upon animal and occupational exposure studies. However, uncertainty exists with these classifications because of deficiencies in the supporting occupational exposure/epidemiology studies, including reliable exposure estimates. Lifetime animal inhalation studies with pulmonary overloading exposure concentrations of diesel exhaust emissions have produced tumors and other adverse health effects. However, in more recent long-term animal inhalation studies of diesel exhaust emissions, no increase in tumor incidence and in fact a substantial reduction in adverse health effects along with significant reductions in the levels of hazardous material emissions were observed and are associated with fuel composition alterations coupled with new technology diesel engines.

Adverse effects related to the physical, chemical and toxicological characteristics

Signs and Symptoms Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking. Prolonged or repeated exposure may cause damage to organs.

Skin corrosion/irritation Causes skin irritation.
Serious eye damage/eye irritation None known.
Sensitization None known.

Mutagenic effects None known.

Carcinogenicity Suspected of causing cancer.

Cancer designations are listed in the table below

Name	ACGIH (Class)	IARC (Class)	NTP	OSHA
No. 2 Diesel Fuel 68476-34-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Kerosine (petroleum) 8008-20-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Alkanes, C10-C20 branched and linear	Not Listed	Not Listed	Not Listed	Not Listed

928771-01-1				
Naphthalene 91-20-3	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Reasonably anticipated to be a human carcinogen	Not Listed

Reproductive toxicity None known.

Specific Target Organ Toxicity (STOT) - single exposure Respiratory system. Central nervous system.

Specific Target Organ Toxicity (STOT) - repeated exposure Thymus. Liver. Bone marrow.

Aspiration hazard May be fatal if swallowed or vomited and enters airways.

12. ECOLOGICAL INFORMATION

Ecotoxicity This product should be considered toxic to aquatic organisms, with the potential to cause long lasting adverse effects in the aquatic environment.

Name	Algae/aquatic plants	Fish	Toxicity to Microorganisms	Crustacea
No. 2 Diesel Fuel 68476-34-6	-	96-hr LC50 = 35 mg/l Fathead minnow (flow-through)	-	48-hr EL50 = 6.4 mg/l Daphnia magna
Kerosine (petroleum) 8008-20-6	72-hr EL50 = 5.0-11 mg/l Algae	96-hr LL50 = 18-25 mg/l Fish	-	48-hr EL50 = 1.4-21 mg/l Invertebrates
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	-	-
Naphthalene 91-20-3	-	96-hr LC50 = 0.91-2.82 mg/l Rainbow trout (static) 96-hr LC50 = 1.99 mg/l Fathead minnow (static)	-	48-hr LC50 = 1.6 mg/l Daphnia magna

Persistence and degradability Expected to be inherently biodegradable.

Bioaccumulation Has the potential to bioaccumulate.

Mobility in soil May partition into air, soil and water.

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues
This material may be a flammable liquid waste.

Safe Handling of Wastes
Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required. Use appropriate grounding and bonding practices. Use only non-sparking tools. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. No smoking.

Disposal of Wastes / Methods of Disposal
The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal
Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper Shipping Name:	Fuel Oil, No. 2
UN/Identification No:	NA 1993
Class:	3
Packing Group:	III

TDG (Canada):

UN Proper Shipping Name:	Diesel Fuel
UN/Identification No:	UN 1202
Transport Hazard Class(es):	3
Packing Group:	III

15. REGULATORY INFORMATION

US Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b): This product and/or its components are listed on the TSCA Chemical Inventory.

EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product does not contain any component(s) included on EPA's Extremely Hazardous Substance (EHS) List.

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
No. 2 Diesel Fuel	NA
Kerosine (petroleum)	NA
Alkanes, C10-C20 branched and linear	NA
Naphthalene	NA

SARA Section 304: This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	Hazardous Substances RQs
No. 2 Diesel Fuel	NA
Kerosine (petroleum)	NA
Alkanes, C10-C20 branched and linear	NA
Naphthalene	100 lb final RQ 45.4 kg final RQ

SARA Section 311/312: The following EPA hazard categories apply to this product:

Acute Health Hazard
Fire Hazard
Chronic Health Hazard

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

Name	CERCLA/SARA 313 Emission reporting:
No. 2 Diesel Fuel	None
Kerosine (petroleum)	None
Alkanes, C10-C20 branched and linear	None
Naphthalene	0.1 % de minimis concentration

State and Community Right-To-Know Regulations:
The following component(s) of this material are identified on the regulatory lists below:

No. 2 Diesel Fuel	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 2444
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 2444 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Kerosine (petroleum)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1091
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 1091 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Alkanes, C10-C20 branched and linear	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Naphthalene	
Louisiana Right-To-Know:	Not Listed

California Proposition 65:	Carcinogen, initial date 4/19/02
New Jersey Right-To-Know:	SN 1322 SN 3758
Pennsylvania Right-To-Know:	Environmental hazard Present (particulate)
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Carcinogen
New Jersey - Environmental Hazardous Substances List:	SN 1322 TPQ: 500 lb (Reportable at the de minimis quantity of >0.1%)
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	100 lb RQ (air); 1 lb RQ (land/water)

Canada DSL/NDSL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all of the information required by those regulations.

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
No. 2 Diesel Fuel	B3,D2A,D2B	0.1%
Kerosine (petroleum)	B3,D2B	1%
Alkanes, C10-C20 branched and linear	B3,D2A,D2B	0.1%
Naphthalene	B4,D2A	0.1%

Note: Not applicable.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety

Issue Date 10/31/2016

Revision Notes

Revision Date 06/01/2016

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

General Plan of Operations
Appendix 09b
Facility Response Plan
For
Oil Spill Prevention, Mitigation and Response

January 2020

1. RESPONSE PLAN COVER SHEET/INTRODUCTION

This section contains the requirements and information required in Section 2.0 of 40 CFR 112, Appendix F.

General Information

Owner/Operator of Facility: Hecla Greens Creek Mining Company (HGCMC)

1. Facility Name: Hecla Greens Creek Mine
2. Facility Address: P.O. Box 32199
   Juneau, AK 99803
3. Facility Phone: 907-789-8100 (24-hour contact phone for owner/operator)
4. Facility Location:

These HGCMC facilities are situated on the northeast side of Admiralty Island, some 18 air miles southwest of downtown Juneau, within the City and Borough of Juneau, Alaska

Hawk Inlet Marine Terminal:	Latitude 58° 07' N
	Longitude 134° 45' W
Mine/Mill Site:	Latitude 58° 05' 03" N
	Longitude 134° 37' 46" W

5. Largest Oil Storage Tank Capacity: 200,000 gallons
6. Maximum Oil Storage Capacity: 424,500 gallons
7. Number of Oil Storage Tanks: 58
8. Worst Case Discharge Amount: 200,000 gallons
9. Facility Distance to Navigable Waters: Adjacent

2. APPLICABILITY OF SUBSTANTIAL HARM CRITERIA

Does the facility transfer oil over water to or from vessels and does the facility have a total oil storage capacity greater than or equal to 42,000 gallons? .....**Yes**

Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and within any storage area, does the facility lack secondary containment that is sufficiently large to contain the capacity of the largest above ground oil storage tank plus sufficient free board to allow for precipitation? ..... No

Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and is the facility located at distance such that a discharge from the facility could cause injury to fish and wildlife and sensitive environments? ..... No

Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and is the facility located at a distance such that a discharge from the facility would shut down a public drinking water intake?..... No

Does the facility have a total oil storage capacity greater than 1 million gallons and has the facility experienced a reportable oil spill in an amount greater than or equal to 10,000 gallons within the last years? ..... No

2.1. Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document, and that based on my inquiry of those individuals responsible for obtaining information, I believe that the submitted information is true, accurate, and complete.

David Landes
Sr. Environmental Engineer
Hecla Greens Creek Mining Company

25 April 2019

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Attachment M – Geographic Response Strategies for Southeast Alaska Subarea, Zone 7

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5. RECORD OF CHANGES

This plan will be reviewed annually. It will be updated at least every 5 years, or as regulations change or if the facility experiences major changes. Also, the plan can be updated as a result of a compliance inspection if it is determined that the response plan does not meet the requirements, or as a result of inadequacies noted in the response plan during an actual incident at the facility.

Date	Person Responsible	Purpose of Change
4 Sept 1997	Oelklaus	Update plan to property re-opening
27 Feb 2001	Oelklaus	EPA Multi-Media Inspection Team review response
28 Feb 2002	Oelklaus	5-Year Update
20 June 2002	Oelklaus	Update for Interim Final Rule
18 Sept 2006	Oelklaus	Re-draft to new CFR 33 Part 154 requirements
30 July 2008	Oelklaus	Re-draft to new Hecla Mining Company ownership/name & include EPA-specific requirements
30 Mar 2009	Saran	Changes from EPA comments
25 June 2009	Saran	Changes from USCG comments
10 March 2014	Wallace	5-Year Update
25 April 2019	Landes	5-Year Update
21 Jan 2020	Landes	Changes from USCG comments
3 June 2020	Chris Wallace	Have been updating the format of the general plan of operations and the associated appendices.

5.1. Emergency Response Action Plan

The Hecla Greens Creek Mining Company (HGCMC) site utilizes a consolidated response effort to all significant issues at the property. The procedures are contained in an Emergency Response Plan document, pertinent sections of which have been placed in Attachment G of this plan document. In summary, the HGCMC approach utilizes an Incident Command Structure with roles assigned to positions rather than individuals to accommodate the HGCMC rotating shift schedules.

Notification procedures in the event of an emergency: one of the qualified individuals listed below must be notified. The qualified individual will then determine if additional notifications need to be made, including call out of the emergency response team, and/or agency contacts.

5.2. Qualified Individual

Table 1. Qualified Individual Information

Individual	Primary	Alternate
Chris Wallace Environmental Compliance	Office: (907) 790-8473 Cell: (907) 723-8681	

Bryan Morgen Surface Operations Manager	Office: (907) 789-8147 Cell: (907) 957-8997	
Terry Maxwell Surface Operations General Foreman	Office: (907) 790-8470 Room: (907) 790-8495 (evenings)	Radio: Channel 6
Jeff Swanson Surface Operations General Foreman	Office: (907) 790-8470 Room: (907) 790-8495 (evenings)	Radio: Channel 6

5.3. Emergency Notification

Table 2. Emergency Notification Phone List

Organization	Primary	Alternate
National Response Center	800-424-8802	
U.S. Coast Guard Sector Juneau (Federal OSC & Local Response Team)	907-463-2980	
Alaska Dept. Environmental Conservation (State OSC)	907-465-5340	800-478-9300
SEAPRO	907-225-7002 (24 hr.)	
Temsco Helicopters	907-789-9501	
Coastal Helicopters	907-789-5610	
Ward Air (float plane)	907-789-9150	

Additional emergency telephone numbers and contact lists are provided in the HGCMC Emergency Response & Disaster Management and Recovery Plan.

5.4. Facility Response Team

Table 3. HGCMC SPILL RESPONSE TEAM MEMBERS

Employee Name	Work Location	Response Time (minutes)	Work Phone	Radio Channel
Ahrens, David	Water Operations	5-20	8463	6
Benitz, Alan	Surface Operations	5-20	8470	6
Carlson, Beau	Electrical	5-20	9487	3
Curtiss, Jason	Surface Operations	5-20	8470	6
Fagerstrom, Phil	Surface Operations	5-20	8470	6
Fredheim, Gunnar	Surface Operations	5-20	8461	6
Grande, Kim	Safety	5-20	8472	6
Gross, David	Surface Operations	5-20	8470	6

Employee Name	Work Location	Response Time (minutes)	Work Phone	Radio Channel
Guenther, Neal	UG Safety Rep.	5-20	8447	3
Hamilton, Jeff	Surface Operations	5-20	8470	6
Hillman, Ernest	Surface Operations	5-20	8470	6
Hoffmann, Ted	Surface Operations	5-20	8470	6
Honea, Arthur	Warehouse	5-20	8182	6
Horne, Scott	Mill Maintenance	5-20	6409	6
Jack III, Frank	Building Maintenance	5-20	8418	6
Katzeek, Tom	Surface Operations	5-20	8470	6
Kohuth, Daniel	Warehouse	5-20	8182	6
Landes, David	Surface Operations	5-20	8420	6
Larson, Doug	Surface Operations	5-20	8470	6
Lee, Jack	Surface Operations	5-20	8470	6
Maller, Doug	Surface Operations	5-20	8482	6
Maxwell, Terry	Surface Operations	5-20	8470	6
Morgan, Ira	Building Maintenance	5-20	8418	6
Parrish, Eric	Surface Operations	5-20	8470	6
Petrie, Mark	Building Maintenance	5-20	8418	6
Sage, James	Surface Operations	5-20	8470	6
Sell, Cameron	Surface Operations	5-20	8457	6
Swanson, Jeff	Surface Operations	5-20	8470	6
Tatlow, Brian	Surface Operations	5-20	8470	6
Tormey, Haynes	Surface Operations	5-20	8470	6
Ulin, Kelly	Surface Operations	5-20	8470	6
Williams, Justin	Surface Operations	5-20	8470	6
Willis, Raymond	Surface Operations	5-20	8470	6

* All HGCMC Spill Response Team members receive annual 8-hour HAZWOPER training.

5.5. Organizational Assignments

Table 4. Organizational Assignments

Function	Greens Creek	SEAPRO
Command and Control	Primary	
Public Information	Primary	
Safety	Primary	Backup
Liaison with Agencies	Primary	Backup
Spill Operations	Primary	Backup
Planning	Primary	Backup
Logistics Support	Primary	Backup
Finance	Primary	Backup

5.6. Discharge Detection Systems

There are no automated discharge detection systems at HGCMC. Operating practices dictate that a person be stationed at each petroleum product loading/unloading/transport activity to ensure that there are no oil spills, or if necessary responses are timely and meet the need of the situation. These persons are also charged with monitoring for spills during these petroleum-related activities and activating the spill response plan if necessary. The AVAREC automatic fuel level indicator gauges on the bulk storage tanks serve to provide an indication of tank fuel level during the filling of these major tanks.

5.7. Spill Response Notification Form

The HGCMC Off-Site Notification Form based upon the Part 154.1035, example “Information on Discharge” appears on the following page:

5.8. Spill Notification Form

Form 1. Spill Response Off-Site Notification Form

(INITIAL NOTIFICATION MUST NOT BE DELAYED PENDING COLLECTION OF ALL INFORMATION)			
Reporter's Name			
Position			
Phone Numbers			
Company/Reporting Party			
Organization Type			
Address			
Were Materials Discharged? __(Y/N)		Confidential? _____(Y/N)	
Meeting Federal Obligations To Report		_____ (Y/N) Date Called:_____	
Calling For Responsible Party (If suspected responsible party is different from reporting party, a second form MUST be filled out with responsible party's information)		_____(Y/N) Time Called:_____	
Incident Description			
Source and/or Cause of Incident			
Date of Incident	Time of Incident:_____am/pm		
Incident Address/Location			
Nearest City:		State:	
Distance From City		Above/Below Ground Tanks:	
Direction From City		Section:	Township:
		Range:	Borough
Container Type			
Tank Oil Storage Capacity			
Facility Oil Storage Capacity			
Facility Latitude:	_____ Degrees	_____ Minutes	_____ Seconds
Facility Longitude	_____ Degrees	_____ Minutes	_____ Seconds
Material Spilled			
CHRIS Code	Discharged Quantity	Material Discharged In Water	Quantity
Response Actions:			
Were There Evacuations? _____(Y/N)		Number of Injuries_____	
Number Evacuated:_____		Number of Deaths: _____	Others:
Was there any damage? _____(Y/N)		Damage in Dollars (Approx.)	
Medium Affected:		Description:	
More Information About Medium:			
Caller Notification EPA_____		USCG_____	Other (Describe)_____
Forest Service _____		Ntnl. Rspns. Cntr._____	Incident Report #_____
State_____			
Additional Information (Not Recorded Elsewhere On This Form)			

5.9. HGCMC Discharge Scenarios

Small leaks confined to a limited area are responded to and cleaned up as part of normal operating procedures. Most historic spills have been small, generally less than 50 gallons, and confined to land where they can be quickly and easily cleaned up. The spills have resulted from accidents and equipment failure. The HGCMC Spill History is in Attachment K.

Spill scenarios have been developed for the Hawk Inlet marine terminal and the mine service area. The discharges would be oil group 1, non-persistent diesel. Spill volumes for each area are shown below and include the worst case discharge, maximum most probable discharge, and average most probable discharge. Worst case discharge volumes assume loss of the entire capacity of the largest tank at each area and does not account for secondary containment. The maximum most probable discharge is equal to 10% of the worst case discharge. The average most probable discharge is equal to 1% of the worst case discharge. These scenarios are reasonable considering the spill history and the containment and manpower available at the sites.

Table 5. Spill Scenarios

Facility	Worst Case (gallon)	Maximum Most Probable (gallon)	Avg. Most Probable (gallon)
Hawk Inlet Terminal	200,000	20,000	2,000
Mine/Mill Service Area	60,000	6,000	600

Table 6. HGCMC Spill Response Equipment

Amount	Description	Size	Vendor / Product
Hawk Inlet Port Facility (Vans)			
20 rolls	Sweep	100’ x 19”	3M-T126
10 bales	Mat Pad (acids, bases, corrosives and chemical spills)	15” x 20”	Pig MAT302
10 bales	Mat Pad (universal)	15” x 20”	Pig MAT204
20 bales	Mat Pad (oil)	15” x 20”	Pig MAT423
12 booms	Oil-Only Absorbent Boom	5” x 20’	Pig BOM413
8 booms	Oil-Only Spaghetti Boom	8” x10’	Pig BOM413
16 booms	Oil-Only Absorbent Boom	5” x 10'	Pig BOM405
18 socks	Sock (acids, bases, corrosives and chemical spills)	3” x10’	Pig PIG301
42 pillows	Pillow (oils, water, solvents, coolants; not recommended for acids, bases, or other corrosive liquids)	8” x 20” x 1.5”	Pig PIL205
96 pillows	Pillow (oils, water, solvents, coolants; not recommended for acids, bases, or other corrosive liquids)	17’ x 21” x 2”	Pig PIL201

Amount	Description	Size	Vendor / Product
40 rolls	Roll (oil)	36” x 150’	E150
32 rolls	Roll (oil)	15” x 150’	Pig MAT425
22 rolls	Roll (oil)	30” x 150’	Pig MAT401
4 each	Poly Drum	55 gallon	
3 each	Poly Film	48” x 100’	
4 each	Super Sacks	1 cu. Yd.	
20 each	Life vests		
Hawk Inlet Port Facility Area			
2 each	Boat	20-ft., with 150 hp outboard engine	
1,200 feet	Harbor boom (boom shed)	12” boom	Elastec
1 each	Drummer Skimmer	20 gpm	Elastec/American Marine

Table 7. Spill Response Absorbent Tote Locations (Site Wide)

Site	Tote	Absorbent Type
Hawk Inlet		
Beach Fuel Depot	Aluminum	Oil Only, Universal
Tailings Truck Wash		
Outside east wall, at the exit	Aluminum	Oil Only, Universal
860		
Outside Rear Lab Door (towards the 920)	Aluminum	Oil Only, Universal, Acids & Bases
920 Area		
920 Fuel Pump	Aluminum	Oil Only
Concrete ramp down from DB01	Wood	Oil Only 10” Boom for the 920 ditch & A Pond
920 Warehouse, front, uphill side	Aluminum	Oil Only, Universal
Site 23 & Site E	Aluminum	Oil Only

Table 8. Additional Equipment Site Wide

Equipment	Location
3000-gallon portable storage tank	920 mine site
Handheld VHF’s (Intrinsically Safe)	Operating Personnel

Equipment	Location
Base Station VHF	Throughout Facility
Fire Extinguishers	Throughout Facility
Front-End Loaders, multiple (CAT 924G, 926M, 966H, 980H, 980K; Volvo L70G, L180H)	Throughout Facility
Backhoe, CAT 420E	Throughout Facility
Dump Trucks, multiple (Volvo A35E, A35F; International 4400)	Throughout Facility
Road Grader, 2 (CAT 14H, 14M)	Throughout Facility
Fork-Lifts, multiple (3-Svetruck 45120-57; 2-Skyjack VR843D; Skyjack SJ1044; Hyster H40FT, W40ZC, H60FT, H80FT; CAT TL943)	Throughout Facility
Pick-up Trucks, multiple	Throughout Facility
Flat Bed Trucks, 3 (1 ton)	Throughout Facility
Buses, 4 (44 passenger) (Bluebird T3FE All American)	Throughout Facility
Dozers, multiple (2-CAT D6T; 2-CAT D8T; CAT D5K2 LGP)	Throughout Facility
Lowboy Trailer, 1 (Trail King 50 Ton)	Throughout Facility
Cranes, mobile, 2 (GROVE RT650E; National)	Throughout Facility

5.10. HGCMC Spill Mitigation Procedures:

Immediate Actions

In the event of an overfill, tank leak/failure, pipe rupture/leak, hose connection failure, explosion or fire, or other accident causing an oil spill, the following responses will take place.

5.11. Initial Response

Spill response sequence:

1. STOP – Don't rush in - Set safe distances
2. LOOK - Injury? What spilled? Source? Size? Continuing? Area Effected?
3. GET HELP – Call for the Greens Creek SEAPRO Emergency Response Team
4. SAFETY FIRST - Remove or control hazards.
5. IGNITION SOURCES – shut off motors, engines, electrical circuits, open flames
6. RESCUE injured parties.
7. CONTROL or stop spill source if possible.
8. CONTAIN spill to extent safe and possible.
9. NOTIFY company and authorities.

5.12. Qualified Individual's Duties

Qualified individuals must perform the following:

- Activate internal alarms and hazard communication systems.
- Notify response personnel.
- Identify the character, exact source, amount, extent of the release and other information needed for notification.
- Notify and provide necessary information to the appropriate Federal, State, and local authorities.
- Assess the interaction of the spilled substance with water and/or other substances stored at the facility and notify response personnel at the scene of that assessment.
- Assess the possible hazards to human health and the environment due to the release.
- Assess and implement prompt removal actions to contain and remove the substance released.
- Coordinate rescue and response actions as previously arranged with all response personnel.
- Use authority to immediately access company funding as necessary to initiate cleanup activities.
- Direct cleanup activities until properly relieved of this responsibility.

5.13. Spill Response Support Personnel Duty Descriptions

Support roles are spelled out in the HGCMC Emergency Response Plan document, pertinent sections of which are contained in Attachment G of this plan document. Duties for Command and Control, Public Coordination, Safety, Government Agency Liaison, Spill Operations, Planning, Logistics Support, and Finance are each described.

5.14. SEAPRO Spill Response Equipment

Hecla Greens Creek Mine maintains an active status within SEAPRO (see Attachment H). The U.S. Coast Guard classifies SEAPRO as an Oil Spill Removal Organization (OSRO) with the following classifications:

Captain of the Port Zone	Environment	Facility	Vessel
Southeast Alaska	River/Channel/Inland	MMPD, WCD1, WCD2, WCD3	MMPD, WCD1, WCD2, WCD3
	Offshore/Nearshore	MMPD, WCD1,WCD2	MMPD, WCD1, WCD2

SEAPRO currently maintains support and spill response equipment throughout Southeast Alaska meeting the requirements of 154.1045 and 154.1047. Equipment is maintained for both open water recovery and shore side recovery and clean-up efforts. SEAPRO Oil Response Barges sited at both Juneau and Gustavus could reasonably respond to a spill emergency at the Greens Creek Hawk Inlet shoreside facilities. SEAPRO spill Responder Teams are also located in Juneau, providing quick response support of trained people should they be needed to assist with a spill at the HGCMC facilities.

Skimmers are available via boat from SEAPRO in the Juneau area, meeting the two-hour accessibility requirement. Other resources available from SEAPRO are detailed on their website at http://www.seapro.org/equipment.cfm.

5.15. Aerial Support Providers

Aerial support may be needed during an oil spill response to provide oil tracking or to transport additional resources to the site. Helicopter support can be provided by Temsco Helicopters or Coastal Helicopters. Float plane support can be provided by Ward Air. All three companies would fly out of Juneau International Airport and could arrive at the site in less than one hour. HGCMC has service contracts with each company. The phone numbers are listed in the emergency notification phone list in this plan and the HGCMC Emergency Response Plan.

6. VULNERABILITY ANALYSIS

There are two general locations for bulk storage of petroleum products and response equipment at Hecla Greens Creek Mine - Hawk Inlet and the Mine/Mill site (see Facility Figures). Satellite storage sites for response materials (also shown on the Facility Figures) are strategically placed throughout the HGCMC facilities to assist with rapid response to smaller spills. Hawk Inlet is the HGCMC marine terminal where product is off loaded from barges into a storage tank.

The marine transfer area within Hawk Inlet is shown on Figure 3. If an incident occurs at this location, it would be non-persistent oil. The nearest navigable water is Hawk Inlet, which is a tidal influence area. The planning distance will therefore be assumed to be 5 miles.

The Mine/Mill site is located adjacent to Greens Creek (Figure 4). Greens Creek flows approximately seven miles from the Mine/Mill site to its mouth at Hawk Inlet. Since all of Greens Creek provides fish and wildlife habitat, the entire stretch of Greens Creek down gradient of the Mine/Mill site is considered as planning distance.

There are no residences in the planning area nor surface water drinking water sources downstream from the facility. Seven occasional-use “recreational” cabins in various stages of disrepair dot the shores of Hawk Inlet. These cabins receive intermittent use, generally to shelter hunters or fishermen for abbreviated stops. Three floating cabins are currently anchored in Hawk Inlet, north of the HGCMC shoreside facilities. These also are occasional-use “recreational” cabins which also generally shelter hunters or fishermen for abbreviated stops.

HGCMC employs approximately 430 people. At any one time approximately 225 personnel may be present on-island distributed throughout the facilities. None regularly work exclusively at the oil product storage locations, and only 1-3 staff work at these sites on an occasional basis. All HGCMC employees are refreshed annually on the site evacuation plan and procedures. Employees with emergency response responsibilities are provided additional training as appropriate to their responsibilities.

Vulnerability of each item of concern within the planning distances is summarized as follows:

Criteria	Hawk Inlet	Mill/Mine Site
Water Intakes	No	No
Schools	No	No
Medical Facilities	No	No
Residential Areas	No	No

Criteria	Hawk Inlet	Mill/Mine Site
Business	No	No
Wetlands/ Sensitive Environment	Yes	Yes
Fish and Wildlife	Yes	Yes
Lakes and Streams	No	Yes
Endangered Flora/Fauna	Yes	No
Recreational Areas	Yes	No
Transportation Areas	Yes	No
Utilities	No	No
Other Areas of Economic Importance	Yes	No
Wellhead Protection Area	No	No

Admiralty Island lies within the Tongass National Forest. The Greens Creek Mine facilities are located within and adjacent to the Admiralty National Monument, which encompasses the great majority of Admiralty Island, and adjacent to the wilderness area portion of the Monument. Greens Creek is an anadromous salmon stream. The island and adjacent marine environments are home to typical temperate rain forest fauna, including brown bear, Sitka black-tailed deer, bald eagles, waterfowl, shorebirds, furbearers and marine mammals.

Hawk Inlet contains bullwhip kelp beds, which shelter many other animals. Many species of fish inhabit Hawk Inlet. Hawk Inlet connects with Chatham Straight. Commercial and recreational fisherman use both Hawk Inlet and Chatham Straight. There is a commercial shrimp harvest area just within Hawk Inlet. Transportation activities, water and air craft, within Hawk Inlet are primarily to service the Hecla Greens Creek facilities.

Subsistence communities nearest to the Greens Creek project area are Angoon (44 miles south), Funter Bay (10 miles north) and Hoonah (28 miles west). There is no available published information regarding the amount and type of subsistence use of Hawk Inlet by Hoonah and Funter Bay residents, but there is some documented, continuing use of Hawk Inlet by Angoon residents. There are no known cultural resource sites within the mine service area at Greens Creek, although the marine terminal at Hawk Inlet was an old cannery operation. The Alaska State Preservation Office and Advisory Council of Historic Preservation approved mitigation plan for the Cannery area was completed and submitted to these Agencies April 1984, completing Section 106 compliance (National Historic Preservation Act).

A color map of the Hawk Inlet area (Figure1), depicting environmentally sensitive areas as identified by the Area Contingency Plan, augments the Attachment M Geographic Response Strategies for Southeast Alaska Subarea, Zone 7.

6.1. Spill Scenarios

6.1.1. Hawk Inlet Area

A spill during fuel barge unloading might occur due to failure of piping/tank or of manifold, mechanical loading arm, other transfer equipment, or hoses, tank overfill, pipe rupture, pipe leak, explosion and fire, pump or valve failure, or the like. Procedures have been put in place to minimize the potential for spills during unloading. For example, two facility personnel must be on duty at all times when receiving product from the petroleum barge. The person in charge will work the tanks while the other person will be stationed at the dock headers to watch the hose.

Hawk Inlet is entered on the east side of Chatham Strait 10 miles Southeast of Rocky Island Light. It has a northerly direction for five miles from its mouth and then contracts and changes to a northeast direction, ending in a basin about 1 mile in diameter. A foul area, marked by kelp, or bare at low water, extends about 0.35 mile south of Hawk Point. Both lighted and unlighted buoys mark the entrance to Hawk Inlet. Piledriver Cove, which completely drains during low tides, is on the south side of the inlet at the entrance (see Attachment M Hawk Inlet Environmental Sensitive Areas).

Two streams (Greens Creek & Zinc Creek) enter Hawk Inlet about 0.8 miles above the entrance, and form an extensive delta extending two-thirds of the way across the inlet; the west edge is marked by a light. The channel between the light and the west shore is about 100 yards wide with 6 fathoms in the middle. A north-south shoal with a least depth of 2 fathoms extends from about 0.25 to about 0.65 miles NNE of the light. The Hawk Inlet marine terminal is on the east side of Hawk Inlet some 1.4 miles north of the entrance light.

A large tidal variation, with a maximum of 26 feet, and the presence of the shallow Greens Creek delta strongly influence circulation patterns near the mouth of the inlet. The highest velocity currents of 2 to 3 feet per second occur at the Greens Creek sill, on flooding tides, in the surface waters of the narrow, 1000-foot wide channel. The maximum flood and ebb is at the light marking the flat, and is estimated to at least 4 knots. The Coast Guard has determined that deep-draft vessels should transit during slack water. The ebb current at the fuel pier has very little velocity; the flood is reported to set slightly toward the pier. A large eddy occurs in the broad central region of the Inlet, near the cannery site, with maximum currents about half those at the sill. The current patterns at Hawk Point and the entrance to Chatham Strait are complex, with tide rips and east/west and north/south currents of considerable speed reported in the entrance to Hawk Inlet, east and southeast of the entrance buoy.

The wind patterns for Southeast Alaska flow along with the orientation of the water channels. With low-pressure maritime weather influences, the wind generally blows north up Lynn Canal toward Haines. When high pressure dominates with dry interior weather, the wind blows out to sea. Wind-driven oil movement will generally follow the direction of the wind and travel at about four percent of the wind speed. The general movement of an oil spill from this facility will follow the combined results of wind-driven currents and tidal currents.

A <u>worst case discharge</u> at Hawk Inlet (calculated at 200,000 gallons (4,762 barrels) Attachment L) could likely involve drainage of oil product into Hawk Inlet, necessitating off shore response. For a worst case discharge, all onsite equipment would be deployed, and SEAPRO would be called in for backup support. Off-site response equipment and temporary storage capacity would be immediately arranged for response. Depending on the amount of oil in Hawk Inlet, Temsco Helicopters in Juneau may be called to provide aerial tracking. Immediate response actions as previously described would be implemented.

Containment would be the immediate priority, with booms placed strategically to minimize movement of the spilled oil and to protect shorelines or other sensitive areas. Cleanup material will likely be shipped to the port of Seattle to recycle or dispose of in an industrial landfill.

Initial actions:
Stop source, initiate ICS, develop and implement action plan to contain oil

Notification procedures:
All onsite personnel notified, Call SEAPRO for backup/support, notify all appropriate agencies (NRC, CG, State, etc.), notify personnel not on site to mobilize to take over next shift for current/initial responders

Mobilization of resources:
All onsite resources and personnel; SEAPRPO to mobilize its resources

SEAPRO off-site resources that would arrive within Tier 1 timeframe of 12 hours:

- 2 each - 249-barrel response barges – towable storage and response platform
    - 249 barrel storage capacity
    - LORI brush skimmer, rate of 2 knots
    - 2000' of 20" boom
- 1 each - Can-flex Bladder, 157-barrel storage
- 1 each - Vikoma 79-barrel storage bladder
- 3 each - skimmers
- 1 each - 5,700 feet of ACME boom

Additional SEAPRO equipment that would arrive within Tier 2 and 3 timeframes (36 hours and 60 hours, respectively) or sooner:

- 2 each - 249-barrel response barges – towable storage and response platform
    - 249 barrel storage capacity
    - LORI brush skimmer, rate of 2 knots
    - 2000' of 20" boom
- 1 each - Can-flex Bladder, 102-barrel storage
- 1 each - Can-flex 24 barrel tank

These resources would meet the required storage capacity necessary as calculated in Attachment L. These SEAPRO resources and their locations can be viewed in more detail at http://www.seapro.org/equipment.cfm.

On-site methods and equipment to:

1. Contain:
   boom, berms (if on land to be constructed from available materials with onsite equipment)

2. Recover:
   sorbents, skimmer

3. Store:
   on site mobile storage tank (3000 gallons); oily wastes (i.e., sorbents in plastic totes and/or 55-gallon drums)

4. Dispose of waste:
   free product and oily wastes shipped offsite for disposal

For a maximum most probable spill (calculated at 20,000 gallons (476 barrels) for Hawk Inlet), it is likely that some portion of the spilled material would be released on land. Immediate response would be to prevent further product flow from the tank or line and to prevent migration of spilled material toward Hawk Inlet. This should be readily accomplished for several reasons: ready access to the spill response equipment storage, immediate availability of front end loaders to construct temporary dikes, existing drainage control on site with collection sumps, and the relatively constant presence of operators in the vicinity. A maximum most probable spill to land would readily be discovered by on site personnel. Spills directly into Hawk Inlet would likely be immediately noticed because of the requirements for operator attendance when loading or unloading material from the tanks. Immediate response would be handled by Greens Creek personnel. If the qualified individual believes the spill to be beyond the capacity of onsite crews, especially in the case of direct spillage into Hawk Inlet, SEAPRO support will be called in. There are sufficient resources in Juneau to address a maximum most probable spill. Depending on the amount of oil in Hawk Inlet, Temsco Helicopters in Juneau may be called to provide aerial tracking. Containment would be the immediate priority, with booms placed strategically to minimize movement of the spilled oil and to protect shorelines or other sensitive areas. Cleanup material will likely be shipped to the port of Seattle to recycle or disposed of in an industrial landfill.

Initial actions:
Stop source, initiate ICS, develop and implement action plan to contain oil

Notification procedures:
all onsite personnel notified, Call SEAPRO for backup/support, notify all appropriate agencies (NRC, CG, State, etc.), notify personnel not on site to mobilize to take over next shift for current/initial responders

Mobilization of resources:
All onsite resources and personnel; SEAPRPO to mobilize its resources

Choose from available SEAPRO equipment listed above under Worst Case Discharge.

- Mobilize 2, 249 barrel response barge. The storage capacity on the barge is more than sufficient for this size of spill: the additional response equipment and platform work area would also be beneficial.

On-site methods and equipment to:

1. Contain:
   boom, berms (if on land to be constructed from available materials with onsite equipment)

2. Recover:
   sorbents, skimmer

3. Store:
   on site mobile storage tank (3000 gallons); oily wastes (i.e., sorbents in plastic totes and/or 55-gallon drums)

4. Dispose of waste:
   free product and oily wastes shipped offsite for disposal

For an average most probable spill (calculated at 2,000 gallons for Hawk Inlet), on site personnel and equipment should be capable of handling the initial containment. The qualified individual will likely call in SEAPRO to assist with recovery of oil on water. Containment capacity for an average most probable spill is available on site.

Initial actions:
Stop source, initiate ICS, develop and implement action plan to contain oil

Notification procedures:
all onsite personnel notified, Call SEAPRO for support, notify all appropriate agencies (NRC, CG, State, etc.), notify personnel not on site to mobilize to take over next shift for current/initial responders

Mobilization of resources:
All onsite resources and personnel; SEAPRPO to mobilize its resources

Choose from available SEAPRO equipment listed above under Worst Case Discharge.

- Mobilize skimmers, and boom if needed

On-site methods and equipment to:

1. Contain:
   boom, berms (if on land to be constructed from available materials with onsite equipment)

2. Recover:
   sorbents, skimmer

3. Store:
   on site mobile storage tank (3000 gallons); oily wastes (i.e., sorbents in plastic totes and/or 55-gallon drums)

4. Dispose of waste:
   free product and oily wastes shipped offsite for disposal

Gasoline is stored at the Hawk Inlet area. Although response volumes are different for non-persistent materials, with a worst case discharge volume of gasoline of 1,000 gallons, the response scenarios and equipment available for response are adequate to address gasoline or fuel oil spills.

6.1.2. Mine Service Area

Accident or operator error could result in small, medium or large spills of petroleum along the road or at the Mine/Mill site. Because of drainage controls, catch basins and surface grading, spills are unlikely to flow into Greens Creek or its tributaries. Accidents over bridges would be most likely to result in discharges to navigable waterways. In that instance, sensitive fisheries would immediately be affected, necessitating immediate HGCMC response.

The worst case spill for the mine service area is calculated to be 60,000 gallons (1,429 barrels) (Attachment L). This would occur at the fuel storage tank near the power plant. Fuel would run overland and would likely not enter Greens Creek. Besides the secondary containment, the site drainage leads to lined water collection ponds which would collect the spilled material. Water flow to the ponds would be stopped to assure that there is no overflow of collected oil.

Initial actions:
Stop source

Notification procedures:
all onsite personnel notified, Call SEAPRO for support, notify all appropriate agencies (NRC, CG, State, etc.), notify personnel not on site to mobilize to take over next shift for current/initial responders

Mobilization of resources:
All onsite resources and personnel; SEAPRPO to mobilize its resources

SEAPRO off-site resources that would arrive within Tier 1 timeframe of 12 hours:

- 1 each - Can-flex Bladder, 100 barrel storage
- 2 each - Can-flex 24 barrel tank
- 3 each - skimmers

Additional SEAPRO equipment that would arrive within Tier 2 and 3 timeframes (36 hours and 60 hours, respectively) or sooner:

- 1 each - Can-flex Bladder, 157 barrel storage
- 1 each - Can-flex 24 barrel tank

These resources, along with the onsite resources, would meet the required storage capacity necessary as calculated in Attachment L. Theses SEAPRO resources and their locations can be viewed in more detail at http://www.seapro.org/equipment.cfm.

On-site methods and equipment to:

1. Contain:
   boom, berms (if on land to be constructed from available materials with onsite equipment)
2. Recover:
   sorbents, skimmer
3. Store:
   on site mobile storage tank (3000 gallons); oily wastes (i.e., sorbents in plastic totes and/or 55-gallon drums)
4. Dispose of waste:
   free product and oily wastes shipped offsite for disposal

A maximum most probable discharge scenario is 6-8,000 gallons. The tanker truck, which transports material from Hawk Inlet to the mine service area, could spill up to 10,000 gallons. In general, most spills of this size would also be contained on land, because of the availability of catchment basins, and mobile

equipment working on site which would be immediately available to construct temporary containment berms.

Initial actions:
Stop source

Notification procedures:
all onsite personnel notified, Call SEAPRO for support, notify all appropriate agencies (NRC, CG, State, etc.), notify personnel not on site to mobilize to take over next shift for current/initial responders

Mobilization of resources:
All onsite resources and personnel; SEAPRPO to mobilize its resources

SEAPRO off-site resources that would arrive within Tier 1 timeframe of 12 hours:

- 1 each - Can-flex Bladder, 100 barrel storage
- 2 each - Can-flex 24 barrel tank
- 3 each - skimmers

Additional SEAPRO equipment that would arrive within Tier 2 and 3 timeframes (36 hours and 60 hours, respectively) or sooner:

- 1 each - Can-flex Bladder, 157 barrel storage
- 1 each - Can-flex 24 barrel tank

These resources, along with the onsite resources, would meet the required storage capacity necessary as calculated in Attachment L. Theses SEAPRO resources and their locations can be viewed in more detail at http://www.seapro.org/equipment.cfm.

On-site methods and equipment to:

1. Contain:
   boom, berms (if on land to be constructed from available materials with onsite equipment)
2. Recover:
   sorbents, skimmer
3. Store:
   on site mobile storage tank (3000 gallons); oily wastes (i.e., sorbents in plastic totes and/or 55-gallon drums)
4. Dispose of waste:
   free product and oily wastes shipped offsite for disposal

If any spilled material enters Greens Creek, immediate response is necessary. For a maximum most probable size discharge into Greens Creek, SEAPRO would likely be contacted immediately to provide spill response booms to supplement the supply available on site. First response following immediate containment, stoppage of flow and notifications, would be to deploy booms across Greens Creek at the nearest, easily accessible location such as a downstream bridge or sampling location. As booms are secured, additional booms would be placed progressively upstream to the spill entry until there is

sufficient capacity for collecting floating material. During the winter, consideration will be given to ice conditions as the booms are deployed.

An average most probable spill (600 gallon) at the mine service area is unlikely to migrate into Greens Creek unless the spill is over a bridge or directly adjacent to the creek. Booms in Greens Creek would be applied as previously described. Sufficient material is available on site to address spills of this volume. Initial actions and notification procedures would be similar to the maximum most probable spill listed above.

7. HGCMC DISPOSAL OF CLEANUP WASTES

For disposal, oil soaked pads and similar material should be placed in garbage bags. Garbage bags should be filled no more than HALF FULL sometimes less if the loads are heavy. Each bag should be double wrapped with a second bag. If possible, bags should be placed in watertight containers, such as dumpsters or fish totes.

Other oily waste materials from cleanup or decontamination should be kept in segregated storage areas. Various types of non-oily waste such as normal domestic or dockside garbage should NEVER BE MIXED with oily waste.

All dumpsters, fish totes, and other containers of waste should be labeled with the following information:

1. type of waste (oily pads, decontamination, etc.)
2. source of waste (boat, site, etc.)
3. amount of waste (number of bags, etc.)
4. name of person who transported waste to this site
5. date waste was transported

Before hauling oil cleanup waste to the next storage or disposal site, approval will be sought from the Federal On-Scene Coordinator or the State On-Scene Coordinator. Only state or federal approved disposal methods or facilities will be used. Open burning permits from ADEC are required for oily waste burning and may be approved on a case by case basis. Oily wastes and oil/water mixtures are not “hazardous wastes”, therefore no manifests would be required. Recycle would be first sought, with a secondary option of disposal as an industrial waste.

It is likely that shipment to the port of Seattle will be necessary for transport to permitted facilities in Washington for recycle. All off-island transportation of clean-up materials being sent for recycling or disposal will likely be carried by Alaska Marine Lines (907 586-3790), the company currently handling all material transportation to/from the HGCMC island facilities.

Spill cleanup material services from small spills have been discontinued by Capital Disposal, Juneau, Alaska (780-7801). Thus disposal of all such materials from HGCMC facilities are now shipped to the City of Spokane Waste-To-Energy plant in Spokane, Washington (509 625-7895), or through Waste Management facilities (713 512-6200) for contaminated materials not suitable for recycling or heat recovery at the Spokane facility. Should the need arise from a spill response, they would be contracted to receive large volumes of adsorbent material from a medium or large scale spill. Copies of the SDSs for fuel oil and gasoline are included in this plan in Attachment I.

8. HGCMC TRAINING

8.1. Training

Response personnel will be trained in safety and environmental requirements. HGCMC personnel are trained in the operation and maintenance of equipment to prevent the discharge of oil. The person in charge of overseeing all bulk tank loading operations had received 48 hours of training in oil transfer operations. Additional periodic training is provided for all employees involved in oil transfer operations. Included in the periodic training sessions will be briefings that highlight and describe past spill events or failures, malfunctioning equipment or newly developed precautionary measures. These and other discharge prevention meetings will be documented on safety meeting forms, or on the NPREP forms (see Attachment N). The National Preparedness for Response Exercise Program (NPREP) guidelines will be followed for drills (see next section for more details).

The Coast Guard licenses Dockmen and Tankermen responsible for fuel transfer and initial spill response. They have taken the required training to receive their licenses. Personnel engaged in post emergency response operations, such as shoreline cleanup, will receive a minimum of 4 hours training.

Employees will be trained on the following elements:

1. The Site Safety Plan including the names of personnel and alternates responsible for site safety and health.
2. Proper use of personal protective equipment, if required. Workers required to use respirators must have 40 hours of off-site training.
3. Work practices by which the employee can minimize risks from hazards.
4. The safe use of engineering controls and equipment on the site.
5. Medical surveillance requirements, including recognition of symptoms and signs which might indicate overexposure to hazards.

A record of training for each individual shall be maintained for three years with other training records. MSHA 5000-23 logs are often used to document training. Matters concerning occupational safety and health are communicated to employees by written documentation, staff meetings, formal training, informal training and posting. Communication from employees to supervisors and safety representatives about unsafe or unhealthy conditions is encouraged and may be verbal or written.

8.2. Facility Self Inspection

The HGCMC Spill Prevention, Control, and Countermeasure (SPCC) plan contains checklists used to document relevant inspections. Copies are included in this plan for reference (Attachment J).

A log of response equipment inventory/inspection is located in the spill response van. Inspections include: inventory (item and quantity), storage location, accessibility, security seals, operational status/condition, actual use/testing and shelf life.

9. HGCMC EXERCISE/DRILL PROGRAM

The HGCMC Exercise Program under this Facility Operating Plan includes the following:

- Quarterly Qualified Individual notification exercises

- Annual response team table top exercises; at least 1 of these table top exercises each 3 years will include a "worst case" scenario
- Equipment deployment exercises:
  - Semiannually for HGCMC response equipment
  - Annually for off-site response (e.g. SEAPRO) equipment
- Additional emergency procedure exercises will be held annually in satisfaction of other HGCMC emergency response programs (e.g. Fire Brigade, Mine Rescue, etc.)
- Annually, at least 1 of the above exercise scenarios will be unannounced.
- All components of the HGCMC Facility Response Plan will be included in the above exercises at least once every 3 years.
- Additional participation in USCG Captain of The Port-directed, or On-Scene Coordinator-directed Area exercises will occur as requested by those entities, but not necessarily more frequently than every 3 years, or every 6 years respectively.

A spill notification drill will involve notification of the qualified individual and potentially the facility personnel. Spill response equipment will be deployed in semi-annual drills. An unannounced annual drill, in which equipment is deployed, may be credited toward one of the semi-annual drills. The spill management team will also conduct a yearly tabletop drill. Drill logs are maintained by the HGCMC Environmental Department. HGCMC response equipment testing and deployment log summaries are in Attachment A.

The facility owner will plan an annual unannounced drill. During the drill, SEAPRO and the spill management team may be activated. Major response equipment at the facility or other appropriate staging area will be deployed. The facility owner shall conduct a drill that exercises the entire response plan at least once every three years.

Sufficient documentation of the drills will be made for facility personnel and the spill management team. These records shall be maintained for 3 years following completion of the drills. Attachment N contains a copy of the forms used to document the exercises and drills.

10. HGCMC EVACUATION PLAN

In the event of evacuation, all personnel will report to evacuation assembly locations per the following table. From these sites HGCMC will provide transportation as necessary to the pedestrian dock at Young Bay for transport to Juneau via boat (Figure 2). The full HGCMC Emergency Response Plan (The Red Book), as summarized in this Report Section, should be referred to for greater site evacuation detail.

EVACUATE FROM:	REPORT TO:
920 Offices & Shops	860 Safety Building
Mill, Powerhouse, and Warehouse	920 Office Dry
860 Safety Building	920 Office Dry
920 Warehouse	920 Office Dry
Mill 860 Wet Lab	920 Office Dry
860 Geology Trailer & Core Bldg.	920 Office Dry
Hilton and Grand	Building Maintenance Shop
North & South Cannery	Wheel Wash
Hawk Inlet Warehouse	Building Maintenance Shop
Pond 7 Water Treatment	Building Maintenance Shop
Hawk Inlet Environmental	Building Maintenance Shop
Concentrate Storage Building	Building Maintenance Shop
Hawk Inlet Geology	Building Maintenance Shop
Building Maintenance Shop	Wheel Wash

Employees will be notified of the need to evacuate an area by at least one of several means:

1. Mine site radio:
   - Channel 6 – Surface Locations;
   - Channel 2 – Mill Locations; or
   - Channel 3 – Underground Locations
2. Telephone (Surface & Mine “Leaky Feeder”)
3. Personal contact

Roll calls will be performed at designated assembly locations to document presence of personnel involved in evacuation

If evacuation beyond the designated assembly location is deemed necessary, or felt prudent, transportation via the HGCMC bus fleet, or alternatively trucks, will take place over the road system.

Due to the isolated island location of, and private access transportation for the HGCMC facilities on Admiralty Island and from these facilities to/from Juneau, there is no opportunity, purpose or need for coordination with other, local off-island evacuation plans.

HGCMC operates the only drinking water systems in this area; therefore, notification of the Emergency Response Personnel serves also to notify the “Local Water Supply System.”

Figure 1. Environmentally Sensitive Areas

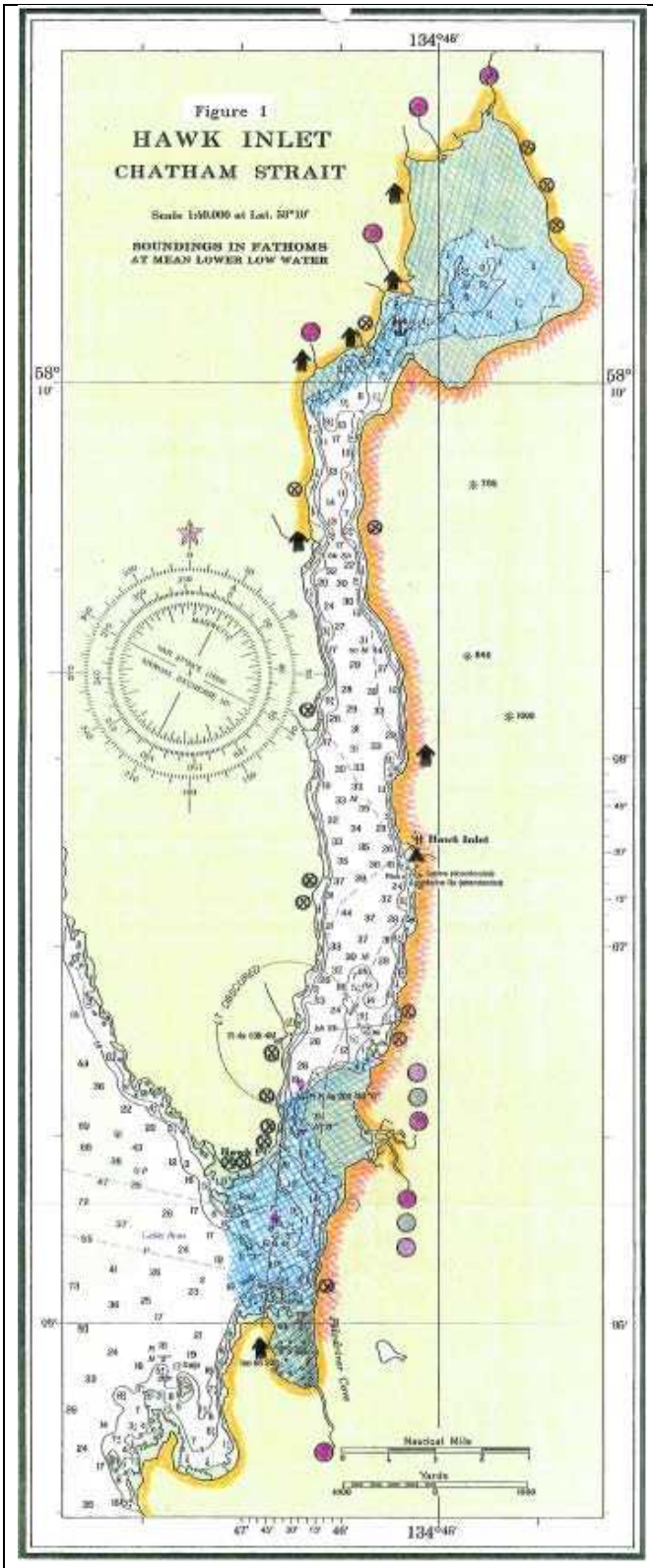

Figure 1: Environmentally Sensitive Areas

LEGEND

The areas listed below and shown on the following chart reflect spots of especially high sensitivity and unusually high concentrations of wildlife or resource use.

Map Code	Environmental Activity
●	Pink and Chum Salmon Spawning
●	Coho Salmon Spawning
●	Dolly Varden
⊗	Bald Eagle Nest
	Waterfowl Habitat
	Brown Bear Habitat
	Deer Winter Habitat
▲	Historic Site
⚓	Boat Moorage
⬆	Recreational Cabin

Figure 2. Mine Site Location Map

Figure 3. Hawk Inlet

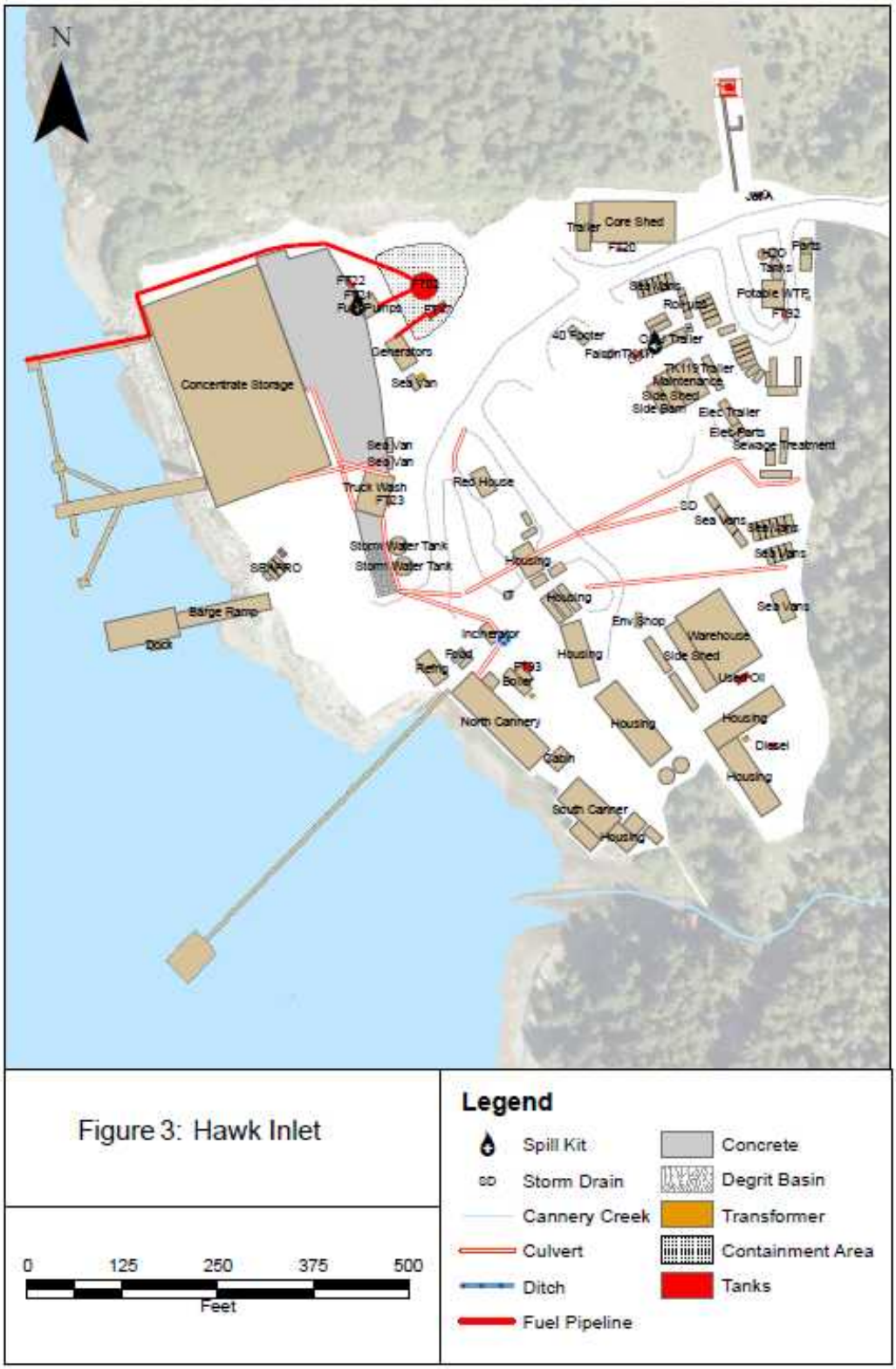

Figure 4. 920 Area

Figure 5. Hawk Inlet Fuel Farm

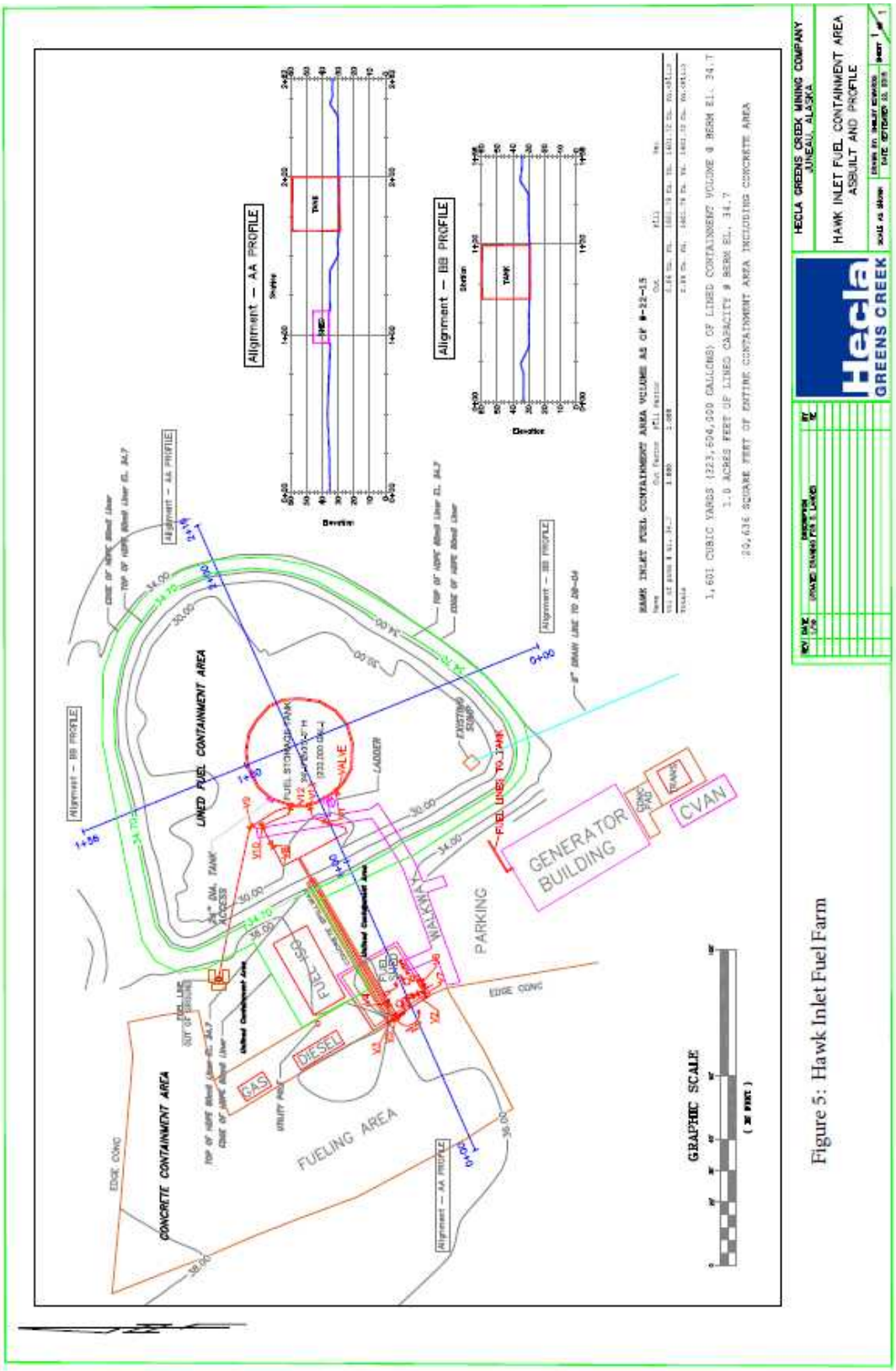

Figure 5: Hawk Inlet Fuel Farm

GPO Appendix 9b
Attachment A
Facility Specific Information

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1. FACILITY DETAILS AND LOCATION

Hecla Greens Creek Mine

P.O. Box 32199

Juneau, AK 99803

(907) 789-8100

The mine is located on the northwest side of Admiralty Island in Hawk Inlet, about 18 miles southwest of downtown Juneau, within the City and Borough of Juneau, Alaska.

Latitude and Longitude

Hawk Inlet Marine Terminal:

Latitude	58° 07' 30” N
Longitude	134° 45' 15” W

Mine/Mill Site:

Latitude	58° 05' 03" N
Longitude	134° 38' 05" W

Wellhead Protection Area

No

Date of Oil Storage Start-up

February 1989

1.1. Current Operation

Hecla Greens Creek Mining Company (HGCMC) is a zinc-lead-silver underground mine and surface mill operation. Operation began in February 1989, continuing until early 1993, when operations were temporarily suspended. The mine was placed on a standby mode from April 1993 to September 1995, with limited operation and staffing. At this time re-commissioning of the Mine/Mill infrastructure was begun preparatory to returning to an operational status. The mill began limited operation in July 1996, and progressively increased operating capacities through the end of the year. Since January 1997 the Hecla Greens Creek Mine has again been operating at full capacity. In April 2008 Hecla Mining Company purchased the complete Greens Creek Joint Venture, and assumed operational responsibility of the facility. This document addresses mine operating conditions, emergency spill procedures and equipment. The SIC codes for HGCMC are 1031 (lead and zinc ores), 1041 (gold ore), and 1044 (silver ore).

Major facilities include an underground mine; all other facilities are on the surface all connected by some 13.5 miles of single lane, gravel surfaced roadways (see facility maps). The surface facilities include a marine terminal, surface tailings impoundment, mine service area, mill, associated storage facilities, waste rock sites, and facilities to house workers during shift rotations. Beginning August 2006 hydroelectric power from Alaska Electric Light and Power became available to HGCMC. HGCMC will take

twenty five to one hundred percent of its needed power from AEL&P with availability dependent upon the Juneau power demand, and excess water in the lakes to drive the generator turbines.

1.1.1. Mine/Mill Site

Located at an elevation of 920 feet, 8.5 miles from the marine terminal at Hawk Inlet, this site is adjacent to Greens Creek and includes the mine, mill, power house, service complex, offices, warehouse, and a bulk diesel fuel storage tank yard adjacent to Greens Creek (see Figure 4). Fuel is delivered by a 10,000-gallon tanker truck from the bulk tank located at Hawk Inlet. An average of eight-to-twelve fuel loads per week is necessary to support operations at full capacity. Approximately 4,000 gallons per month of lubricating oils are also transferred by truck from Hawk Inlet to the mine/mill site in portable tanks. Chemicals are delivered dry and wet in containers by truck and stored at this location.

1.1.2. Tailings Site

Located at the upper reaches of Tributary Creek drainage, this site includes a dry stacked tailings impoundment, two retention/surge ponds and a wastewater treatment plant (see Figure 2). All mine/mill wastewater, and surface water runoff from the mine/mill, tailings, and Hawk Inlet sites are collected at the Tailings Site, treated, and discharged into Hawk Inlet in accordance with the Greens Creek National Pollutant Discharge Elimination System (NPDES) permit Number AK-004320-6.

1.1.3. Hawk Inlet Site

This site includes the marine terminal where all supplies, materials, fuels, and ore concentrates are loaded and/or unloaded on a routine basis (See Figure 3). Also included are a 200,000 gallon bulk diesel fuel storage tank, associated fill piping from the fuel barge unloading dock, a fuel loading facility for vehicles and the tanker truck, an electrical generator building, and warehouse. Less than 1,000 gallons of gasoline is also stored at the fuel loading facility. Assorted lubricating oils and used oils in portable tanks, totes, and drums are temporarily stored at this site's warehouse prior to their transport to the mine/mill site. A large ore concentrate storage building (maximum 40,000 tons capacity), temporary housing facilities, and ancillary support facilities are also located at the Hawk Inlet site. Chemicals are also delivered dry and wet in containers by barge, offloaded, and stored at the warehouse at this location.

1.1.4. Young Bay Site

This site includes a docking facility for the boat, which transports personnel to and from Juneau to the HGCMC island facilities twice per day. There is also a parking area for the buses used to transport personnel to and from the Hawk Inlet and mine/mill sites. A diesel powered electrical generator building provides electricity for the site (Figure 2).

1.1.5. Road System

Greens Creek Mine roads link the Young Bay site, the Hawk Inlet site, and the mine/mill site. A 5 mile long, 14 foot wide road allows transport of personnel from the Young Bay dock to Hawk Inlet. An 8.5 mile long, 16 foot wide road allows transport of personnel, supplies, and ore concentrate between Hawk Inlet and the mine/mill site, as well as dry tailings from the mine/mill site to the tailings area (see Figure 2). HGCMC policy for travel on these single-lane roads with turnouts requires that all drivers maintain radio contact during transit. Operators call over the in-vehicle radios on an assigned channel to note their position, direction of travel, and vehicle type at least once per mile.

2. DATES AND TYPE OF SUBSTANTIAL EXPANSION:

There has only been one substantial expansion of the oil storage capacity since start-up in 1989, which corresponded with increased mine production rates. The 920 bulk fuel storage area secondary containment was rebuilt and enhanced preparatory to the installation of two additional storage tanks during the summer of 2001. These tanks boosted the capacity of the 920 bulk fuel storage area from 60,000 gallons to 147,200 gallons with the addition of two 43,600-gallon tanks.

With the return to operational status in 1996, Hecla Greens Creek Mining Company has increased the size of our emergency response teams as well as the amount and kinds of response equipment onsite. As of 2019 there are 36 staff certified as SEAPRO spill responders.

3. MARINE VESSEL ACCESS TO HGCMC PORT FACILITIES

HGCMC receives three types of marine vessels at the port facilities in Hawk Inlet;

- Ocean-going ships up to 40,000 ton dead-weight, Handy sized vessels, are loaded with HGCMC metals concentrate products for delivery to ports around the world. HGCMC loads some 14 – 18 of these vessels annually. Petroleum products are not exchanged with these vessels and HGCMC.
- Supply barges originating in Seattle, Washington, and generally trans-shipped through Juneau shipping facilities, deliver the vast majority of equipment and supplies to the HGCMC Admiralty Island site. These supply barges generally are 3,537 or 5,524 gross tons. Among many other products, HGCMC receives lubricating and hydraulic oils in containers ranging from 250 to 4,000 gallons from these barges.
- These barges also return empty containers and waste products from HGCMC to Juneau and Seattle ports. HGCMC occasionally ships contaminated petroleum products off-site to recycling operations, generally in Washington State. These products are manifested (either Hazardous, or Non-Hazardous as appropriate) for each shipment. HGCMC utilizes most self-generated “used oil” on-site in space heaters, so such material seldom is shipped from the site.
- Fuel Supply barges carry bulk diesel to the HGCMC Hawk Inlet port facilities. These barges are typically 1,000,000 gallon capacity vessels. HGCMC facilities allow receipt of up to 200,000 gallons at any one time. HGCMC receives fuel barges under two differing fuel needs. When HGCMC is self-generating electricity on-site we receive fuel about every 7 – 10 days. When HGCMC is fully drawing electricity from the AEL&P power feed, we receive fuel shipments about every 2 - 3 weeks. Various combinations of self-generated and AEL&P electricity result in fuel deliveries somewhere in between these delivery rate schedules. Depending upon the season, HGCMC receives both #1 and #2 diesel fuel in these bulk deliveries.

HGCMC Hawk Inlet port facility has only one marine header. Therefore, it can only receive one fuel at a time (i.e., no simultaneous transfers occur for fuel.) On rare occasions, CDC transfers may occur simultaneously with bulk fuel transfers (i.e., freight barge and fuel barge may be offloading at the same time).

3.1. Transportation Related Portion of HGCMC Port Facilities

Bulk diesel is off-loaded from the fuel barges from Dolphin #4, the northern most dolphin at the HGCMC marine terminal. A welded 4" steel pipeline with flanged fittings runs from the shoreside 200,000-gallon tank to the regular barge connection point at Dolphin #4. The pipeline has valves at the Dolphin #4 (temporary barge) connection point, at the shoreline, and at the tank inlet. All tank valves are closed and locked when not in use. The valve at the tank inlet, within the secondary containment, constitutes the separation point of the Marine Transportation-Related port facility from the non-Marine Transportation-Related shoreside facility at the HGCMC Hawk Inlet site. The valve is labeled as V-9 in Figure 5.

3.2. Non- Transportation Related Portion of HGCMC Shoreside Facilities

The HGCMC Hawk Inlet shoreside facilities include a bulk fuel storage area and its associated fuel loading facility for vehicles and tank trucks. These Hawk Inlet tanks are located in the uplands adjacent to the terminal and include a 200,000-gallon bulk receiving tank. The tank inlet is on the bottom of the tank and a pressure relief valve on the inlet pipe protects the pipeline. A containment berm capable of holding greater than 110 percent of the volume of the tank (equivalent to full tank capacity plus precipitation from a 10-yr/24-hr storm event) surrounds it. Two double-walled tanks containing 1,000 gallons each of gasoline and diesel are located near the 200,000-gallon diesel tank. The concrete-lined degritting basin/pond at Hawk Inlet has a capacity of 49,618 gallons, and serves as tertiary containment for spills in the vicinity of the above described facilities.

4. HAZARD IDENTIFICATION

4.1. Storage Facilities

There are no surface impoundments containing petrochemicals at the facility. Some impoundments, by default, serve as tertiary containment facilities due to their positioning to capture and contain stormwater runoff from facility areas. All fuels are stored in above ground tanks, which are double-walled or protected by lined secondary containment. The HGCMC tank registry and figures showing their locations are provided in the current Spill Prevention, Control, and Countermeasure Plan.

The bulk storage tanks are all above ground and of steel construction in accordance with API 650 standards. All materials used are compatible with the stored petroleum products. The 200,000 and 60,000 gallon tanks are fail-safe engineered construction, providing additional assurance of tank integrity. Most original single-walled day tanks have been removed and replaced with double-walled tanks. The storage areas are constructed so drainage is away from tank bottoms to minimize corrosion from ponding water. For the large tanks, an AVAREC automatic fuel level indicator gauge is used during the filling of the tanks. Signaling between the fuel tankerman and the tank gauger include voice, hand signals and two-way radio.

The two bulk tanks are located in containment areas diked or impounded on all sides. The lined secondary containment is capable of holding 110% of the largest tank volume (an estimated 225,000 + gallon capacity at the Hawk Inlet and 66,000+ gallon capacity at the Mine/Mill site) plus additional freeboard for precipitation. The dikes at the Hawk Inlet facility are built on solid rock and are comprised of crushed gravel lined with an impermeable material. The 920 secondary containment structure was rebuilt in 2001 with concrete floor and walls overlaying a sealed impermeable material liner. An existing sub-base remains under, and isolated from the actual floor of the containment area by a layer of filter fabric, gravel and liner material. The subdrain flows to a catchment basin prior to discharge and due to the impermeable layer above it, is in no danger of collecting spilled oil.

The majority of the Mine/Mill facility area is covered with a concrete "paved" surface. Through control of surface flows, a series of drains and an impermeable lined collection ditch, all runoff fluids from this area are directed to A-Pond. This 3.7 acre/foot (1,225,000 gallon) capacity pond is also fitted with an impermeable liner. This structure provides tertiary containment for the main fuel storage tank, as well as secondary containment for spills onto the concrete paved surface of its adjacent fuel transfer area.

Assorted lubricating oils are stored in 250 – 350 gallon totes at both Hawk Inlet and Mine/Mill warehouses.

At the Mine/Mill service area 8.5 miles from the Hawk Inlet shore side facilities, adjacent to Greens Creek, #2 diesel is stored in one 60,000 gallon and two 43,600 gallon bulk tanks. Fuel for the mine service area is delivered by a 10,000-gallon tanker truck from the bulk tanks at the marine terminal or by portable tank delivered directly from the supply barge. A monthly transfer carries some 4,000 gallons of lube oils, which are stored in a portable tank at the mine service area within secondary containment.

The three Mine/Mill bulk storage fuel tanks primarily supply the mill powerhouse by direct pipeline, and have a dispensing station for mine equipment and smaller vehicles. A containment berm surrounds these tanks. A sump with an electric pump drains accumulated precipitation from each containment. The pump controls are locked out to prevent operation by unauthorized personnel.

Inspections of the containment areas are conducted once a month and more often during periods of high precipitation. Because the drainage from the bulk storage areas is not directed to an oily water treatment system, the impounded storm water is inspected and monitored for signs of contamination. Prior to release, any petroleum contamination is cleared from these impounded waters. Storm water drainage information will be noted on the monthly inspection form.

Water that collects in the containment areas of the smaller tanks will be emptied by pumping or siphoning after removal of any visible contamination. This water will then be treated in the mine's water treatment plant system prior to release. Because of the high rainfall in the area, a series of drainage ditches, culverts and settling ponds have been designed to intercept and treat the site storm water runoff. The runoff control systems at the mine/mill service area and at the marine terminal also provide an additional, secondary form of containment for the bulk fuel tanks.

The transport road is generally crowned to direct road runoff into an inside drainage ditch. The system would provide secondary containment for any spills that might occur in the roadway from the tanker truck. The individual drainage sections contain rock check dams or other BMPs to help treat the water prior to it reaching a series of culverts that direct the runoff to the adjacent forest floor.

4.2. Petroleum Product Transfer

Hecla Greens Creek Mining Company (HGCMC) receives some 24 barge shipments of diesel fuel annually. These consist primarily of #2 grade diesel fuel. However, a blend of #1/#2 diesel, and even some straight #1 diesel are also received, generally during the winter months. All of these fuels are delivered by ocean-going barge to the HGCMC shore-side facilities in Hawk Inlet (Figure 3). Annually these shipments could result in some 6,000,000 gallons of fuel being transferred from the barges to the HGCMC storage tanks. As previously mentioned fuel consumption is dependent upon the availability of line power form Juneau. Procedures for these transfers are discussed later in this document.

Intra-facility transfers occur in three ways, all by HGCMC employees: the 10,000 gallon tanker truck, the 3,500 gallon fuel truck, and the vehicle fuel pumps at both Hawk Inlet and the Mine/Mill facility area. Most fuel transferred on island is carried in the tanker truck from Hawk Inlet to the Mine/Mill service area.

On the average, when not on line power, this truck carries 12 to 14 loads a week between these facilities. The bulk storage tank capacity at the Mine/Mill service area allows some clustering of these trips, but some fuel is generally hauled each day.

The 3,500 gallon fuel truck services both small, fixed tanks throughout the facilities, as well as the less mobile equipment that does not have regular access to the vehicle fuel pumps. This truck is generally active daily.

The fixed vehicle fuel pump stations are located near to the bulk storage tanks: the 200,000 gallon tank at Hawk Inlet, and the 60,000 and two 43,600 gallon tanks at the Mine/Mill service area. Surfaces around both of these sites are paved with concrete. Secondary containment for the vehicle fuel pump stations is provided by the containment ponds at each of these facilities as described above.

5. ANALYSIS OF THE POTENTIAL FOR AN OIL SPILL

Based on the engineering design, equipment reliability, trained personnel, and adherence to prescribed operating and maintenance procedures, the possibility of a major oil spill at Hecla Greens Creek Mine is very remote. From a contingency preparedness standpoint, the potential does exist for accident, equipment failure and/or operator error.

As noted by the HGCMC Spill History (Attachment K) the great majority of spills at HGCMC have consisted of relatively small spills (<10-20 gallon), that were confined to land, and resulting from vehicle or equipment operations.

The bulk storage tanks pose the most serious threat of oil potentially reaching a drainage in the event of a major release. All tanks are enclosed within dikes sufficient to contain 110% of the storage volume capacity of the largest tank. The possibility of rupture of these tanks is remote.

The greatest potential for a large oil spill comes during fuel barge unloading into the bulk tanks, and during the filling and transporting of fuel by truck to the mine service area. The marine terminal bulk tanks are filled through a 4-inch steel pipeline originating at the marine headers at dockside. Operator error could result in a poorly made hose connection, improper valve or pressure setting and/or overfilling. A portable container of approximately 20 gallons is placed under this hose connection prior to its coupling and uncoupling and during fuel transfer operations. Unless residual material is being emptied from the container, it is kept in position under this coupling during the entire transfer period to capture every minor drip. If spilled fuel accumulates in the portable container during fuel transfer operations, it is emptied into the Hawk Inlet used oil accumulation container following the transfer completion. Following each fuel transfer this line is back-drained and capped. It therefore remains empty between transfer operations.

6. SPILL PLAN IMPLEMENTATION

Some general guidance on spill response follows. All spills entering Greens Creek or Hawk Inlet will be handled in the same manner, regardless of size.

6.1. Oil Spill Response Immediate Actions

1. Stop the product flow- Act quickly to secure pumps, close valves, etc.

2. Warn personnel- Enforce safety and security measures.
3. Shut off ignition sources- Motors, electrical circuits, open flames, etc.
4. Initiate containment- Around the tank and/or in the water with an oil boom.
5. Notify Environmental Department- 790-8473; after hours 723-8681
6. Notify NRC - 1-800-424-8802: ADEC - 465-5340

For GASOLINE spills to marine waters:

1. If a fire hazard, disperse gasoline and flush it away from docks, harbors, and boats.

For DIESEL spills to marine waters:

1. Use sorbent boom and pads to contain and collect as much diesel as soon as possible;
2. Use wind and tide information to predict where the escaped diesel will impact the closest environmentally sensitive area - at the HGCMC Hawk Inlet facilities, this would be the shoreline;
3. Alert boat and skiff crews for deployment of boom to protect those areas;
4. Deploy harbor boom for protection of sensitive areas.

At Hawk Inlet, initial spill response from fuel barge transfer operations will be done by the licensed crew members of the barges. Additional contractual assistance may be authorized as needed, depending on the size and duration of cleanup. HGCMC equipment and response teams will always be available to support or augment these fuel barge crew response efforts.

For spills along Greens Creek, its tributaries, or other surface streams, the response would be similar to that summarized above for marine water spill responses, but deployment would necessarily be manual, with booms placed cross-current to the creek. Several booms would be placed in succession downstream of a spill location.

6.2. Safety Considerations

Around the Hawk Inlet dock area, all fuel transfer and spill cleanup personnel are required to wear:

- rubber boots
- rubber rain gear
- rubber gloves
- eyeglasses
- life vests

If gasoline or diesel oil gets into clothing, the clothing must be removed and replaced with un-oiled clothing. If gasoline or diesel oil gets onto skin, the oil must be removed with soap and hot water.

Pertinent safety equipment on site:

- emergency eyewash kits
- first aid kits

- waterless hand cleaner
- paper towels

6.3. Oil Spill Removal and Management

The following resources are available and capable of responding to a spill. See the section of the FRP titled SPILL SCENARIOS for more specific information on resources and requirements for the three discharge scenarios.

Hecla Greens Creek Mining Company (HGCMC) has 36 SEAPRO certified spill response people on staff as of 2019. As a member of SEAPRO this facility has access to some additional 20,000 feet of containment boom in the Juneau area. This 20,000 feet of containment boom available through SEAPRO is sufficient to protect the environmentally sensitive areas identified within a 5-mile radius. Diversion and exclusion booming will be used to protect the identified sensitive areas. For locations of other SEAPRO member response equipment, see the SEAPRO "Technical Manual" at; http://www.seapro.org/TechnicalManual/SEAPRO_TechManHome.htm

A concrete containment structure encloses the mill site bulk fuel tanks and additional safety and fuel absorbing equipment is kept at the mine's warehouse, which is located at the mill site. Spill containment using soil berms to prevent discharge into the creek or Hawk Inlet will be constructed and used as needed. The onsite fuel storage tanks could be used to contain the recovered material if necessary.

HGCMC maintains two skiffs at Hawk Inlet for deployment in shallow waters. Skiffs will deploy the boom and sorbent material within one hour of detection of any spill occurring during a transfer procedure.

As a member of SEAPRO this facility is entitled to the services of the SEAPRO Response Team. As of March 2014, SEAPRO consisted of 63 member companies and some 90 facilities located or operating in Southeast Alaska. In addition to each member company's response equipment and staffs, SEAPRO has 195 trained responders for on-water response and shoreline cleanup. SEAPRO has segregated SE Alaska into 9 geographic zones, each with pre-positioned response equipment and responders. Juneau SEAPRO zone has 41 trained responders fully equipped and trained. SEAPRO has continued actively expanding this approach to provide even more comprehensive services throughout SE Alaska.

Sufficient numbers of trained personnel, firefighters, boats, aerial spotting aircraft, containment boom, sorbent materials, boom anchoring materials, and other supplies are available to sustain response operations to completion. Aerial support activities would be contracted with Temsco or Coastal for helicopter services, or Ward Air for float plane. All are located in Juneau and contact information is provided in Attachment B.

7. RESPONSE EQUIPMENT TESTING AND DEPLOYMENT

HGCMC conducts response equipment testing and deployment in accordance with 33 CFR Part 154.1050. Records of the drills are kept at the Environmental Office.

Last Inspection or Response Equipment Test Date: 8 July 2019

Last Deployment Drill Date: 8 July 2019

Deployment Frequency Required: Semi - Annually

7.1. Fire Control

The HGCMC Safety Supervisor will coordinate fire prevention/fighting activities. The HGCMC 7-member Fire Truck Brigade Team addresses fire-fighting actions. As with the other HGCMC Emergency Response teams (SEAPRO, HAZWOPPER, Mine Rescue), the Fire Truck Brigade members are specially trained volunteers dispersed throughout the HGCMC workforce.

In addition to the 10-pound chemical extinguishers positioned throughout all of the HGCMC facilities, larger (50, 100-pound) chemical extinguishers are located at specific hazard sites. Fire hose stations and fire hydrants are also situated throughout the HGCMC facility areas. A fire-fighting pumper truck is maintained by HGCMC at the on-island facilities, available to respond to any fire. Special foaming agents (AFFF) are stocked to address a petroleum based fire. Hand tools (shovels, rakes, buckets, saws) are kept ready in fire response containers at Hawk Inlet, the Mine/Mill service area, and at 4.6 mile of the B-Road.

GPO Appendix 9b
Attachment B
List of Contacts

7.5. Qualified Individual

Qualified Individual Information

Individual	Primary	Alternate
Chris Wallace Environmental Compliance	Office: (907) 790-8473 Cell: (907) 723-8681	
Bryan Morgen Surface Operations Manager	Office: (907) 789-8147 Cell: (907) 957-8997	
Terry Maxwell Surface Operations General Foreman	Office: (907) 790-8470 Room: (907) 790-8495 (evenings)	Radio: Channel 6
Jeff Swanson Surface Operations General Foreman	Office: (907) 790-8470 Room: (907) 790-8495 (evenings)	Radio: Channel 6

7.6. Emergency Notification

Emergency Notification Phone List

Organization	Primary	Alternate
National Response Center	800-424-8802	
U.S. Coast Guard Sector Juneau (Federal OSC & Local Response Team)	907-463-2980	
Alaska Dept. Environmental Conservation (State OSC)	907-465-5340	800-478-9300
SEAPRO	907-225-7002 (24 hr.)	
Temsco Helicopters	907-789-9501	
Coastal Helicopters	907-789-5610	
Ward Air (float plane)	907-789-9150	

Additional emergency telephone numbers and contact lists are provided in the HGCMC Emergency Response & Disaster Management and Recovery Plan.

7.7. Facility Response Team

HGCMC SPILL RESPONSE TEAM MEMBERS

Employee Name	Work Location	Response Time (minutes)	Work Phone	Radio Channel
Ahrens, David	Water Operations	5-20	8463	6
Benitz, Alan	Surface Operations	5-20	8470	6
Carlson, Beau	Electrical	5-20	9487	3

Employee Name	Work Location	Response Time (minutes)	Work Phone	Radio Channel
Curtiss, Jason	Surface Operations	5-20	8470	6
Fagerstrom, Phil	Surface Operations	5-20	8470	6
Fredheim, Gunnar	Surface Operations	5-20	8461	6
Grande, Kim	Safety	5-20	8472	6
Gross, David	Surface Operations	5-20	8470	6
Guenther, Neal	UG Safety Rep.	5-20	8447	3
Hamilton, Jeff	Surface Operations	5-20	8470	6
Hillman, Ernest	Surface Operations	5-20	8470	6
Hoffmann, Ted	Surface Operations	5-20	8470	6
Honea, Arthur	Warehouse	5-20	8182	6
Horne, Scott	Mill Maintenance	5-20	6409	6
Jack III, Frank	Building Maintenance	5-20	8418	6
Katzeek, Tom	Surface Operations	5-20	8470	6
Kohuth, Daniel	Warehouse	5-20	8182	6
Landes, David	Surface Operations	5-20	8420	6
Larson, Doug	Surface Operations	5-20	8470	6
Lee, Jack	Surface Operations	5-20	8470	6
Maller, Doug	Surface Operations	5-20	8482	6
Maxwell, Terry	Surface Operations	5-20	8470	6
Morgan, Ira	Building Maintenance	5-20	8418	6
Parrish, Eric	Surface Operations	5-20	8470	6
Petrie, Mark	Building Maintenance	5-20	8418	6
Sage, James	Surface Operations	5-20	8470	6
Sell, Cameron	Surface Operations	5-20	8457	6
Swanson, Jeff	Surface Operations	5-20	8470	6
Tatlow, Brian	Surface Operations	5-20	8470	6
Tormey, Haynes	Surface Operations	5-20	8470	6
Ulin, Kelly	Surface Operations	5-20	8470	6
Williams, Justin	Surface Operations	5-20	8470	6
Willis, Raymond	Surface Operations	5-20	8470	6

***** All HGCMC Spill Response Team members receive annual 8-hour HAZWOPER training.

GPO Appendix 9b
Attachment C
Equipment List and Records

Table 9. HGCMC Spill Response Equipment

Amount	Description	Size	Vendor / Product
Hawk Inlet Port Facility (Vans)			
20 rolls	Sweep	100’ x 19”	3M-T126
10 bales	Mat Pad (acids, bases, corrosives and chemical spills)	15” x 20”	Pig MAT302
10 bales	Mat Pad (universal)	15” x 20”	Pig MAT204
20 bales	Mat Pad (oil)	15” x 20”	Pig MAT423
12 booms	Oil-Only Absorbent Boom	5” x 20’	Pig BOM413
8 booms	Oil-Only Spaghetti Boom	8” x10’	Pig BOM413
16 booms	Oil-Only Absorbent Boom	5” x 10'	Pig BOM405
18 socks	Sock (acids, bases, corrosives and chemical spills)	3” x10’	Pig PIG301
42 pillows	Pillow (oils, water, solvents, coolants; not recommended for acids, bases, or other corrosive liquids)	8” x 20” x 1.5”	Pig PIL205
96 pillows	Pillow (oils, water, solvents, coolants; not recommended for acids, bases, or other corrosive liquids)	17’ x 21” x 2”	Pig PIL201
40 rolls	Roll (oil)	36” x 150’	E150
32 rolls	Roll (oil)	15” x 150’	Pig MAT425
22 rolls	Roll (oil)	30” x 150’	Pig MAT401
4 each	Poly Drum	55 gallon	
3 each	Poly Film	48” x 100’	
4 each	Super Sacks	1 cu. Yd.	
20 each	Life vests		
Hawk Inlet Port Facility Area			
2 each	Boat	20-ft., with 150 hp outboard engine	
1,200 feet	Harbor boom (boom shed)	12” boom	Elastec
1 each	Drummer Skimmer	20 gpm	Elastec/American Marine

Table 10. Spill Response Absorbent Tote Locations (Site Wide)

Site	Tote	Absorbent Type
Hawk Inlet		
Beach Fuel Depot	Aluminum	Oil Only, Universal
Tailings Truck Wash		
Outside east wall, at the exit	Aluminum	Oil Only, Universal
860		
Outside Rear Lab Door (towards the 920)	Aluminum	Oil Only, Universal, Acids & Bases
920 Area		
920 Fuel Pump	Aluminum	Oil Only
Concrete ramp down from DB01	Wood	Oil Only 10" Boom for the 920 ditch & A Pond
920 Warehouse, front, uphill side	Aluminum	Oil Only, Universal
Site 23 & Site E	Aluminum	Oil Only

Table 11. Additional Equipment Site Wide

Equipment	Location
3000-gallon portable storage tank	920 mine site
Handheld VHF's (Intrinsically Safe)	Operating Personnel
Base Station VHF	Throughout Facility
Fire Extinguishers	Throughout Facility
Front-End Loaders, multiple (CAT 924G, 926M, 966H, 980H, 980K; Volvo L70G, L180H)	Throughout Facility
Backhoe, CAT 420E	Throughout Facility
Dump Trucks, multiple (Volvo A35E, A35F; International 4400)	Throughout Facility
Road Grader, 2 (CAT 14H, 14M)	Throughout Facility
Fork-Lifts, multiple (3-Svetruck 45120-57; 2-Skyjack VR843D; Skyjack SJ1044; Hyster H40FT, W40ZC, H60FT, H80FT; CAT TL943)	Throughout Facility
Pick-up Trucks, multiple	Throughout Facility
Flat Bed Trucks, 3 (1 ton)	Throughout Facility
Buses, 4 (44 passenger) (Bluebird T3FE All American)	Throughout Facility
Dozers, multiple	Throughout Facility

Equipment	Location
(2-CAT D6T; 2-CAT D8T; CAT D5K2 LGP)	
Lowboy Trailer, 1 (Trail King 50 Ton)	Throughout Facility
Cranes, mobile, 2 (GROVE RT650E; National)	Throughout Facility

GPO Appendix 9b
Attachment D
Communication Plan

Hecla Greens Creek Mining Company Emergency Communication Plan

Hecla Greens Creek Mining Company maintains several medium to facilitate communications during both operations and during an emergency response.

Telephone System

The HGCMC telephone system flows through a local area network microwave repeater system to the land connection at Lena Point. Repeaters at the 920 and Hawk Inlet facility areas feed to the repeater on the ridge above Site E on the southerly ridge of the Greens Creek drainage. In the event the normal system is compromised:

- Medical Office at the 920 has a satellite phone available.

  The satellite phone number is 1 254 381-7323

- Surface Exploration Office at Hawk Inlet has two satellite phones available

  These phone numbers are; 1 254 460-2043, and 1 254 460-2044

  Detailed instructions for these portable phones can be found within their Pelican carrying cases.

Radio Equipment

HGCMC radio systems are regularly used for ongoing operations. All mobile road vehicles contain a two-way radio. Additionally, some 50 hand-held two-way radios are in use throughout the HGCMC operation. In the event of an emergency the following channels directly access the referenced work areas:

- Surface Operations, Channel 6, with Channel 5 used for extended conversations;
- Mill Operations, Channel 2;
- Mine Operations, Channel 3.

There are also Marine Radios available throughout the HGCMC facilities. Use channel 16 or 25. The HGCMC site is identified as #WRV305: GREENS CREEK MINE. These units can be found at:

- Hawk Inlet Cannery — Marine Base Unit
- Ship Loader Control Room — Marine Base Unit
- Bobby Hicks cabin — Base Station
- Hawk Inlet Warehouse — Base Station
- Geology Office Trailer — Base Station
- Mill Operations 1 — Base Station
- 920 Medical Office — Base Station
- 860 Safety Office — Base Station
- H&S Superintendent Office — Base Station

- Surface Repair Shop Base Station
- Mine underground repair shop Base Station
- Mine underground electrical shop Base Station

Additionally, the mine leaky-feeder system connects to units in the underground workings. The surface access to this system is in the 920 Dry, 920 Medical Room, and 920 Office complex.

Appendix 9b
Attachment E
Safety and Health Plan

Hecla Greens Creek Mining Company Safety and Health Plan

In a spill response the safety of personnel is the top priority. If a spill were to happen that was beyond the capabilities of HGCMC and SEAPRO was called in assist, it would be necessary to have a site specific safety and health plan for all parties to follow. A site specific safety and health plan template is available on the SEAPRO website (hyper link below) that allows a plan to be generated quickly.

http://www.seapro.org/ssshp.html

While every spill is unique and presents different physical and chemical hazards, some fundamental safety practices are to be followed in all situations.

Hazard Analysis / Risk Assessment

The chemical hazards associated with the spilled product must be evaluated prior to initiating a response. This includes the routes and limits of exposure, the signs and symptoms of over exposure, and the appropriate personal protective equipment. This information can be found in Section 8 of the Safety Data Sheet (SDS) for the chemical. Attachment I of this Plan contains the SDSs for the oil products handled at HGCMC that could be involved in a large spill. The primary exposure hazard for these chemicals is through contact with the skin or eyes. The SEAPRO response vans contain an adequate inventory of chemical resistant gloves, rubber boot covers, and Tyvek suits for the initial response teams. Additional PPE is available onsite through the warehouse.

Physical hazards present the greatest risk to personnel performing spill response at Greens Creek. Some examples include hazards associated with: boating; boom deployment and anchoring; slips, trips and falls; weather conditions; heat or cold stress; darkness; and wildlife. Experienced boat captains are required for the skiffs. A minimum of three people is needed on each boat and four people in the boom shed for effective boom deployment and for safety. It is possible that response activities could be delayed or curtailed due to physical hazards.

Communications

Effective communications are critical in any response. Attachment D of this Plan describes the radio communications on site. HGCMC also has hand-held radios capable of communicating with Temsco Helicopters, if necessary. Hand signals should be reviewed with personnel, as appropriate for the operations.

Site Control

One of the immediate responses to an incident is to secure the scene. This is done to protect the safety of personnel who may be unaware of the risks. Site control also limits the spread of contamination by establishing the hot zone, the contamination reduction zone (decon area), and access corridors where personnel and equipment travel back and forth.

Medical Plan

HGCMC has trained medics and EMT's on site. The HGCMC Emergency Response Plan (Red Book) contains the pertinent contact numbers and information for handling medical emergencies.

Appendix 9b
Attachment F
Acronym List & Definitions

Acronyms

CFR	U.S. Code of Federal Regulations
Chan.	Channel, as on the HGCMC two-way radio system
dba	Doing Business As
DB-01	Degritting Basin #1
Eve.	Evening
EPA	United States Environmental Protection Agency
Etc.	Et cetera and so forth
HAZWOPER	Hazardous Waste Operations and Emergency Response
ICS	Incident Command System
Hawk Inlet	The HGCMC beach-side facilities alternately referred to as The Cannery
HGCMC	Hecla Greens Creek Mining Company
Min.	Minute
SDS	Safety Data Sheet
MSHA	U.S. Mine Safety and Health Administration
NPREP	National Preparedness for Response Exercise Program
OSRO	Oil Spill Removal Organization, in this case SEAPRO
Poly	Polypropylene
SEAPRO	Southeast Alaska Petroleum Resource Organization
SIC	U.S. Standard Industrial Code
SPCC	Spill Prevention, Control, and Containment Plan
Tote(s)	Containers, generally in the 200 - 500 gallon range (poly, various metals, or wood)
U.S.	United States of America
VAN	C-Van, Connex shipping container
VHF	Very High Frequency, radios
Yd	Yard (yd = linear; yd^3 = cubic)
860	The HGCMC Safety and Wet Laboratory facilities area (860’ elevation)
920	The HGCMC mine, mill, shop, and office surface facilities (920’ elevation)

Appendix 9b
Attachment G
Incident Command System

1. INITIAL EMERGENCY RESPONSE

This procedure outlines the format for reacting to any emergency situation, keeping in mind that although every emergency is different, the basic steps in responding to emergency and the order of priority are always the same.

- Ensure medical aid and protect personnel – Supervisors and First Responders must immediately assess the situation and take care to ensure the safety and well being of the injured. Notify medical emergency services that assistance is required. Be specific to help get prompt response.
- Take control – Unless a senior manager is there, Supervisors and/or First Responders need to take charge and control of the situation. The first priority is always the protection and rescue of people. The second is the environment, followed by our property and then production.
- Maintain control – Do not try to do too much. Know your "span of control" capabilities. Maintain your response efforts to directing 1 to 6 people or actions. Recognize when you need help.
- Control potential secondary events - Secondary accidents are possible at a scene because normal controls have been critically weakened by the incident. Positive temporary actions to secure the scene need to be taken after quick, but careful, thought of the consequences.
- Preserve evidence - When there is significant loss, good investigation is more important than getting back to work. Preserve the site until the investigation is complete and the proper authorities have been notified.
- Maintain control – Secure, sign or rope off to prevent further access to a scene.

2. INCIDENT COMMAND SYSTEM STRUCTURE

Emergency Plan organization consists of the Incident Command System (ICS). ICS is a tool used to manage emergencies of any type. It structures the organization of an entire emergency incident. It will assist in organizing emergencies that will include inter-agency responses with Central Mine Rescue, US Coast Guard, Juneau Fire & Rescue, State Troopers, HAZWOPER, SEADOGS, SEAPRO, etc.

Greens Creek ICS consists of three groups containing ten specific sections of responsibility. The groups are:

- ICS Staff,
- ICS Operations,
- ICS Support.

For each section, individuals are assigned to ensure the plan is current and maintained to a ready state of preparedness.

The ICS system identifies positions that are tied to functions that must be performed in response to an incident. The structure is designed to be modular; use only those elements that are needed.

Determine level of response based on span of control.

All personnel that participate in the ICS response must be trained in the specifics of the system as it is applied at Greens Creek.

The Greens Creek Incident Command System template is based on Management organization. Trained Supervisors and First Responders must be familiar with the structure and its roles and accountabilities in case they must assume and maintain command of an incident until command is properly transferred to the appropriate individual or organization.

2.1. INCIDENT COMMANDER:

The General Manager is the Incident Commander and is responsible to ensure the plan is current as operations dictate. The Incident Commander will review and approve the plan at the desired standard.

2.1.1. Duties:

- Provide continuing and overall command to Emergency Response actions.
- Review and evaluate response and attack efforts and revise as needed.
- Ensure the incident is secured.
- Release assets and resources in an orderly manner.
- Transfer Command to subordinate when incident has de-escalated.
- Ensure proper notification is made to all relevant corporate and regulatory agencies.

2.2. SAFETY OFFICERS – ICS COORDINATORS:

The Safety Supervisor & Staff are the Safety Officers responsible to oversee and review ICS structures and activities in response to any emergencies. Safety Officers are responsible to review the ERP at least on a quarterly basis OR as changes to the operation dictate. Safety Officers ensure distribution of revised documentation, and provide necessary training to all participants as required.

2.2.1. Duties:

- Manage special situations that expose responders to hazards.
- Highly mobile position that monitors entire emergency response organization and efforts.
- Maintain emergency response resource status and accountability.
- Evaluate organization and span of control.
- Coordinate EMS, Mine Rescue, Fire Response, SEAPRO or HAZWOPER team response preparedness. Initiate appropriate Call Out Procedures and assist in preparation in getting Team(s) and relevant equipment ready for emergency service.
- Arrange for suitable transportation for team members and responders to attend emergency service at the mine site.
- Brief team and responder personnel to carry out the tasks assigned by Incident Command.
- Liaise with the Incident Commander to recommend additional trained team or responder support from outside and mutual aid sources.

2.3. PUBLIC RELATIONS OFFICER:

The Human Resources Manager is responsible for managing all public relations and liaison information.

2.3.1. Duties:

- Under the direction of the IC, the PRO shall release appropriate information to the media while acting as the liaison between the Media and Command.
- Allows the IC to concentrate maximum efforts on incident at hand.
- Meets all arriving outside agencies and passes on instructions from Command relative to the situation on their requested assistance.
- Acts as liaison between outside agency and COMMAND.
- Immediately notify the families of employees injured or effected. If the injured are taken to hospital, arrange for family transportation if necessary. In no case should the names of injured or effected employees be released to the press or public until families have been properly notified.

2.4. ENVIRONMENTAL OFFICER:

The Environmental Manager, or other Environmental Department staff as assigned by the Incident Commander, is responsible for both Environmental protection and liaison within the ICS structure as well as with Environmental Agencies.

2.4.1. Duties:

- Review ICS structures to ensure environmental impact is minimized.
- Act as liaison between environmental agencies and Command.

3. INCIDENT COMMAND SYSTEM OPERATIONS

3.1. MASS CASUALTY INCIDENT COMMAND CONTROL GROUP:

The Medical Technician on duty is the Incident Commander and is responsible to establish the Casualty ICS Group. The participants shall include all certified Emergency Medical System Responders, Department Managers, and Safety Department.

3.2. UNDERGROUND INCIDENT COMMAND CONTROL GROUP:

The Mine Production Manager is the Operations Commander and is responsible to establish the Mine ICS Group. The participants shall include the Department Operations Manager, Mine Coordinator, Mine Supervisors, Senior Engineer, Senior Geologist, Safety Department, Medical Technician, and trained Mine Rescue and EMS personnel.

3.3. MILL INCIDENT COMMAND CONTROL GROUP:

The Mill Department Manager is the Operations Commander and is responsible to establish the Mill ICS Group. Participants shall include the Mill Operations Superintendent, Maintenance Superintendent, Chief Metallurgist, Mill Supervisors, Maintenance & Electrical Supervisors, Safety Department, Medical Technician, and trained HAZWOPER, Fire Brigade, Mine Rescue and EMS personnel

3.4. SURFACE INCIDENT COMMAND CONTROL GROUP:

The Surface Department Manager is the Operations Commander and is responsible to establish the Surface ICS group. Participants shall include the Surface Operations Coordinator, Surface Supervisors, Environmental Manager, Maintenance & Electrical Supervisors, Safety Department, Medical Technician, and trained HAZWOPER, Fire Brigade, Mine Rescue and EMS personnel.

3.5. DUTIES:

The department OC is in charge of the Control Group and Incident Control Center. With assistance from the Group, the OC will:

- Develop Operations portion of the Incident Action Plan.
- Provide direct management of all incident tactical priorities and activities including safety of all personnel in the Operations section.
- Take control and gather information to make an assessment of the Emergency.
- Establish Incident Command and Communication Logbook.
- Establish and maintain communication with the effected area(s).
- Organize and appropriate Rescue or Response Operation for the type and extent of the Emergency or Disaster.
- Appoint a Check-Out Coordinator to account for all employees and assemble employees at a safe designated assembly point.
- Take appropriate steps with Maintenance to ensure continuous power and utility supply and distribution, telephone and radio services.
- Ensure notifications are made to the appropriate parties. Keep Advisory Group informed of the Rescue/Response operations.
- Develop a remedial action plan for the restoration of operations.
- Conduct a Team Investigation into the causes of the Emergency or Disaster, recommend corrective measures and prepare a full report to the Incident Commander.
- Establish confirmed means of communication with teams from the emergency control center to the emergency site.
- Report all update information and status receive from teams to the Incident Commander immediately.

4. INCIDENT COMMAND SYSTEM SUPPORT

4.1. PLANNING CONTROL GROUP:

The Incident Commander will appoint an Operations Commander of the Planning Group to lend assistance to Operations Groups as required. The participants shall include: Senior Engineer, Senior Geologist, Environmental Manager, Environmental Coordinator, Maintenance & Electrical Supervisors and Safety Department.

4.1.1. DUTIES:

- Obtain and utilize technical assistance.
- Maintain incident records.
- Collect, evaluate, and disseminate information about the incident.
- Meet all arriving support units and direct to a staging area.
- Advise IC of current situation and predict probable course of incident.
- Prepare primary and alternate strategies for the IC.

4.2. LOGISTICS & FINANCE CONTROL GROUP:

The Incident Commander will appoint an Operations Commander of the Logistics and Finance Group to lend assistance to Operations Groups as required. The participants shall include: Controller, Chief Accountant, Chief Buyer, and Purchasing Agents.

4.2.1. DUTIES:

- Arrange service and support systems including, facilities, transportation, supplies, equipment, fueling, maintenance and food.
- Arrange for all necessary emergency equipment and supplies shipment and transportation.

Ensure financial resources are identified and available for emergency response and rehabilitation activities.

5. EMERGENCY RESPONSE TEAMS

5.1. RESPONSE TEAM PROCEDURES:

EMERGENCY RESPONSE TEAM PROCEDURES APPLY TO ALL TRAINED DISCIPLINES

- EMERGENCY MEDICAL PERSONNEL (EMS).
- MINE RESCUE TEAMS.
- FIRE TRUCK BRIGADE.
- SEAPRO / HAZWOPER BRIGADE.

5.2. NOTIFICATION:

- Upon receiving notification of a mine emergency, Team personnel will report to the designated Incident Command Center without delay.

  920 MINE SITE MEDICAL OFFICE

  HAWK INLET SURFACE OFFICE – N. CANNERY

- Personnel notified off-island will travel to the mine site via designated transportation.

5.3. TEAM STRUCTURE:

- ICS Coordinators will determine team structures. Teams will be established depending on the emergency type, specialized team member skills, and the ICS response plan.
- Prior to any team embarking on an Emergency Response Task, a fully prepared backup team will be standing by. A backup team will be established and prepared prior to each succeeding team

5.4. TEAM BRIEFING:

- Team briefing will be carried out by the ICS Coordinators only after all decisions in connection with the operation have been made by the Incident Commander and Operations Group.
- Briefing will be done with the entire team, where questions may be answered, and the tasks are explained and fully understood by the teams.
- All pertinent instructions will be issued to Team Captains (in writing if necessary), including communication procedures from established phone or radio communications. Time limits of the trip or task will be completely understood and synchronized.
- Briefing will include that if team is overdue in returning, reporting, or establishing communications, the backup team will be dispatched to assist, even at the cost of delaying operations.

5.5. TEAM CAPTAINS OR LEADERS:

Team Captains and Leaders will take charge of and be responsible for team discipline, general safety, and for the task or objective performed by the team. Captains and Leaders will take orders only from and communicate with the ICS Coordinators.

Appendix 9b
Attachment H
SEAPRO Certification

SEAPRO

Southeast Alaska Petroleum Response Organization, Inc.
540 Water Street Suite 201 Ketchikan, Alaska 99901
(907) 225-7002 Office || (907) 247-1117 Fax
www.seapro.org

12/12/2019

Chris Wallace
P.O. Box 32199
Juneau, AK 99803

Dear Chris,

Please find enclosed the SEAPRO Membership Certificate for 2020. We encourage you to copy and distribute your membership certificate to any facilities, vessels, or other offices in your company.

Should you need further assistance, please contact us at (907) 225-7002.

Sincerely,

David Owings
General Manager

Enclosure

Certificate of Membership

This is to certify that

Hecla Green's Creek Mining Company

is a member in good standing of the

SOUTHEAST ALASKA PETROLEUM
RESPONSE ORGANIZATION

An Alaska Not For Profit Corporation
SEAPRO's mission is to mitigate oil spills, at the direction of its membership, in the Southeast Alaska Captain of the Port Zone.

Hecla Green's Creek Mining Company
is entitled to refer to the resources at SEAPRO's disposal in their Oil Pollution Prevention and Response Contingency Plans, and to represent to governmental agencies and to others that these capabilities and resources are available to the Member when needed to contain, control, or clean up any oil spill.

This membership is effective from
January 1 to December 31, **2020**

Dave Owings
General Manager

Appendix 9b
Attachment I
Safety Data Sheets

SAFETY DATA SHEET

SDS ID NO.: 0290MAR019
Revision Date 06/01/2016

1. IDENTIFICATION

Product Name: Marathon Petroleum No. 2 Ultra Low Sulfur Diesel

Synonym: #2 Diesel; No. 2 Ultra Low Sulfur Diesel 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 15 ppm Sulfur Max with Polar Plus; No. 2 Diesel, Motor Vehicle Use, Undyed; No. 2 Diesel, Motor Vehicle Use, Undyed, with Polar Plus; ULSD No. 2 Diesel 15 ppm Sulfur Max; ULSD No. 2 Diesel 15 ppm Sulfur Max with Polar Plus; No. 2 NR 15 Diesel; No. 2 NR 15 Diesel with Polar Plus; No. 2 Ultra Low Sulfur Diesel Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 Dyed 15 ppm Sulfur Max with Polar Plus; No. 2 Diesel, Tax Exempt-Motor Vehicle Use, Dyed; No. 2 Diesel, Tax Exempt-Motor Vehicle Use, Dyed, with Polar Plus; ULSD No. 2 Diesel Dyed 15 ppm Sulfur Max; ULSD No. 2 Diesel Dyed 15 ppm Sulfur Max, with Polar Plus; No. 2 NR 15 Diesel Dyed; No. 2 NR 15 Diesel Tx Le Dyed; #2 NR 15 CFI Diesel; #2 NR 15 CFI Diesel Dyed; No. 2 Low Sulfur Diesel (TxLED); No. 2 NR 15 Diesel Dyed, with Polar Plus; No. 2 NRLM 15 Diesel Dyed; No.2 NRLM Diesel Dyed; No.2 Low Emission Low Sulfur Diesel; No. 2 Heating Oil 5000 NMA Unmarked; NEMA No. 2 Heating Oil; Heating Oil, No. 2 Low Sulfur 5000 ppm; No. 2 Ultra Low Sulfur Diesel Dyed with <6% Renewable Diesel Fuel; Ultra Low Sulfur No. 2 Diesel Dyed with <6% Renewable Diesel Fuel; No. 2 Diesel Dyed with <6% Renewable Diesel Fuel 15 ppm Sulfur Max; No. 2 Ultra Low Sulfur Diesel with <6% Renewable Diesel Fuel; Ultra Low Sulfur No. 2 Diesel with <6% Renewable Diesel Fuel; No. 2 Diesel with <6% Renewable Diesel Fuel 15 ppm Sulfur Max; Garyville Export Diesel; Export Diesel, Garyville; Diesel Fuel, Export Garyville; #2 Motor Vehicle ULSD 15 ppm with 0-5% Renewable Diesel; Marathon No. 2 ULSD with 0-5% Renewable Fuel with R100; Marathon No. 2 ULSD with 0-5% Renewable Fuel with R99; No. 2 Heating Oil 2000 ppm Sulfur Max, Clear (Undyed) Unmarked;Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Clear (Undyed) Unmarked; ULS Heating Oil 15 ppm Clear (Undyed) Unmarked; ULS HO 15 ppm CLR; Ultra-Low Sulfur Heating Oil (<= 15ppm, Undyed); No. 2 Heating Oil 2000 ppm Sulfur Max, Dyed Unmarked; No. 2 Heating Oil 2000 ppm Sulfur Max, Dyed Marked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Dyed Unmarked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Dyed Marked;15 ppm Sulfur Heating Oil Grade 67; 15 PPM Heating Oil; 15 PPM Dyed Heating Oil; 0291MAR019; 0306MAR019; 0308MAR019; 0334MAR019; 0335MAR019; 0336MAR019; 0337MAR019; 0340MAR019;

Product Code: 0290MAR019
Chemical Family: Complex Hydrocarbon Substance

Recommended Use: Fuel.
Restrictions on Use: All others.

Manufacturer, Importer, or Responsible Party Name and Address:
MARATHON PETROLEUM COMPANY LP
539 South Main Street
Findlay, OH 45840

SDS information: 1-419-421-3070

Emergency Telephone: CHEMTREC: 1-800-424-9300

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 3
Acute toxicity - Inhalation (Dusts/Mists)	Category 4
Skin corrosion/irritation	Category 2
Carcinogenicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Specific target organ toxicity (repeated exposure)	Category 2
Aspiration toxicity	Category 1
Acute aquatic toxicity	Category 2
Chronic aquatic toxicity	Category 2

Hazards Not Otherwise Classified (HNOC)
Static accumulating flammable liquid

Label elements

EMERGENCY OVERVIEW

Danger

FLAMMABLE LIQUID AND VAPOR
May accumulate electrostatic charge and ignite or explode
May be fatal if swallowed and enters airways
Harmful if inhaled
Causes skin irritation
May cause respiratory irritation
May cause drowsiness or dizziness
Suspected of causing cancer
May cause damage to organs (thymus, liver, bone marrow) through prolonged or repeated exposure
Toxic to aquatic life with long lasting effects

Appearance Yellow to Red Liquid **Physical State** Liquid **Odor** Hydrocarbon

Precautionary Statements - Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use only non-sparking tools.
Use explosion-proof electrical/ventilating/lighting/equipment
Take precautionary measures against static discharge
Do not breathe mist/vapors/spray
Use only outdoors or in a well-ventilated area

Wear protective gloves/protective clothing/eye protection/face protection
Wash hands and any possibly exposed skin thoroughly after handling
Avoid release to the environment

Precautionary Statements - Response
IF exposed or concerned: Get medical attention
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
If skin irritation occurs: Get medical attention
Wash contaminated clothing before reuse
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor if you feel unwell
IF SWALLOWED: Immediately call a POISON CENTER or doctor
Do NOT induce vomiting
In case of fire: Use water spray, fog or regular foam for extinction
Collect spillage

Precautionary Statements - Storage
Store in a well-ventilated place. Keep container tightly closed
Keep cool
Store locked up

Precautionary Statements - Disposal
Dispose of contents/container at an approved waste disposal plant

3. COMPOSITION/INFORMATION ON INGREDIENTS

No. 2 Ultra Low Sulfur Diesel is a complex mixture of paraffins, cycloparaffins, olefins and aromatic hydrocarbon chain lengths predominantly in the range of eleven to twenty carbons. May contain up to 5% Renewable Diesel. May contain small amounts of dye and other additives (<0.15%) which are not considered hazardous at the concentration(s) used. May contain a trace amount of benzene (<0.01%). Contains a trace amount of sulfur (<0.0015%)

Composition Information:

Name	CAS Number	% Concentration
No. 2 Diesel Fuel	68476-34-6	50-100
Kerosine (petroleum)	8008-20-6	0-50
Alkanes, C10-C20 branched and linear	928771-01-1	0-5
Naphthalene	91-20-3	0.3-2.6

All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

4. FIRST AID MEASURES

First Aid Measures

General Advice: In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation: Remove to fresh air. If not breathing, institute rescue breathing. If breathing is difficult, ensure airway is clear, give oxygen and continue to monitor. If heart has stopped, immediately begin cardiopulmonary resuscitation (CPR). Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Skin Contact: Immediately wash exposed skin with plenty of soap and water while removing contaminated clothing and shoes. May be absorbed through the skin in harmful amounts. Get medical attention if irritation persists. Any injection injury from high pressure equipment should be evaluated immediately by a physician as potentially serious (See NOTES TO PHYSICIAN).

Place contaminated clothing in closed container until cleaned or discarded. If clothing is to be laundered, inform the person performing the operation of contaminant's hazardous

properties. Destroy contaminated, non-chemical resistant footwear.

Eye Contact: Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while flushing. Get medical attention if irritation persists.

Ingestion: Do not induce vomiting because of danger of aspirating liquid into lungs, causing serious damage and chemical pneumonitis. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects: Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking. Prolonged or repeated exposure may cause adverse effects to the thymus, liver, and bone marrow.

Indication of any immediate medical attention and special treatment needed

Notes To Physician: INHALATION: This material (or a component) sensitizes the myocardium to the effects of sympathomimetic amines. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in individuals exposed to this material. Administration of sympathomimetic drugs should be avoided.

SKIN: Leaks or accidents involving high-pressure equipment may inject a stream of material through the skin and initially produce an injury that may not appear serious. Only a small puncture wound may appear on the skin surface but, without proper treatment and depending on the nature, original pressure, volume, and location of the injected material, can compromise blood supply to an affected body part. Prompt surgical debridement of the wound may be necessary to prevent irreversible loss of function and/or the affected body part. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES.

INGESTION: This material represents a significant aspiration and chemical pneumonitis hazard. Induction of emesis is not recommended.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media
For small fires, Class B fire extinguishing media such as CO_2, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.

Unsuitable extinguishing media
Do not use straight water streams to avoid spreading fire.

Specific hazards arising from the chemical
This product has been determined to be a flammable liquid per the OSHA Hazard Communication Standard and should be handled accordingly. May accumulate electrostatic charge and ignite or explode. Vapors may travel along the ground or be moved by ventilation and ignited by many sources such as pilot lights, sparks, electric motors, static discharge, or other ignition sources at locations distant from material handling. Flashback can occur along vapor trail. For additional fire related information, see NFPA 30 or the Emergency Response Guidebook 128.

Hazardous combustion products
Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data

Sensitivity to Mechanical Impact No.
Sensitivity to Static Discharge Yes.

Special protective equipment and precautions for firefighters
Firefighters should wear full protective clothing and positive-pressure self-contained breathing apparatus (SCBA) with a full face-piece, as appropriate. Avoid using straight water streams. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Avoid excessive water spray application. Keep surrounding area cool with water spray from a distance and prevent further ignition of combustible material. Keep run-off water out of sewers and water sources.

Additional firefighting tactics
FIRES INVOLVING TANKS OR CAR/TRAILER LOADS: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after the fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles: if this is impossible, withdraw from area and let fire burn.

EVACUATION: Consider initial downwind evacuation for at least 1000 feet. If tank, rail car or tank truck is involved in a fire, ISOLATE for 5280 feet (1 mile) in all directions; also, consider initial evacuation of 5280 feet (1 mile) in all directions.

NFPA	Health 1	Flammability 2	Instability 0	Special Hazard -

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Eliminate all ignition sources. All contaminated surfaces will be slippery.
Protective equipment:	Use personal protection measures as recommended in Section 8.
Emergency procedures:	Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.
Environmental precautions:	Avoid release to the environment. Avoid subsoil penetration.
Methods and materials for containment:	Contain liquid with sand or soil. Prevent spilled material from entering storm drains, sewers, and open waterways.
Methods and materials for cleaning up:	Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids. Recover and return free product to proper containers. When recovering free liquids ensure all equipment is grounded and bonded. Use only non-sparking tools.

7. HANDLING AND STORAGE

Safe Handling Precautions:

NEVER SIPHON THIS PRODUCT BY MOUTH. Use appropriate grounding and bonding practices. Static accumulating flammable liquid. Bonding and grounding may be insufficient to eliminate the hazard from static electricity. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. Vapors may travel along the ground or be moved by ventilation. Flashback may occur along vapor trails. No smoking. Use only non-sparking tools. Avoid breathing fumes, gas, or vapors. Use only with adequate ventilation. Avoid repeated and prolonged skin contact. Use personal protection measures as recommended in Section 8. Exercise good personal hygiene including removal of soiled clothing and prompt washing with soap and water. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements.

Hydrocarbons are basically non-conductors of electricity and can become electrostatically charged during mixing, filtering, pumping at high flow rates or loading and transfer operations. If this charge reaches a sufficiently high level, sparks can form that may ignite

the vapors of flammable liquids. Sudden release of hot organic chemical vapors or mists from process equipment operating under elevated temperature and pressure, or sudden ingress of air into vacuum equipment may result in ignition of vapors or mists without the presence of obvious ignition sources. Nozzle spouts must be kept in contact with the containers or tank during the entire filling operation.

Portable containers should never be filled while in or on a motor vehicle or marine craft. Containers should be placed on the ground. Static electric discharge can ignite fuel vapors when filling non-grounded containers or vehicles on trailers. The nozzle spout must be kept in contact with the container before and during the entire filling operation. Use only approved containers.

A buildup of static electricity can occur upon re-entry into a vehicle during fueling especially in cold or dry climate conditions. The charge is generated by the action of dissimilar fabrics (i.e., clothing and upholstery) rubbing across each other as a person enters/exits the vehicle. A flash fire can result from this discharge if sufficient flammable vapors are present. Therefore, do not get back in your vehicle while refueling.

Cellular phones and other electronic devices may have the potential to emit electrical charges (sparks). Sparks in potentially explosive atmospheres (including fueling areas such as gas stations) could cause an explosion if sufficient flammable vapors are present. Therefore, turn off cellular phones and other electronic devices when working in potentially explosive atmospheres or keep devices inside your vehicle during refueling.

High-pressure injection of any material through the skin is a serious medical emergency even though the small entrance wound at the injection site may not initially appear serious. These injection injuries can occur from high-pressure equipment such as paint spray or grease or guns, fuel injectors, or pinhole leaks in hoses or hydraulic lines and should all be considered serious. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES (See First Aid Section 4).

Storage Conditions: Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area. Do not store near an open flame, heat or other sources of ignition.

Incompatible Materials Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	ACGIH TLV	OSHA PELS:	OSHA - Vacated PELs	NIOSH IDLH
No. 2 Diesel Fuel 68476-34-6	100 mg/m³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Kerosine (petroleum) 8008-20-6	200 mg/m³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	-	-
Naphthalene 91-20-3	10 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm TWA: 50 mg/m³	10 ppm TWA 50 mg/m³ TWA 15 ppm STEL 75 mg/m³ STEL	250 ppm

Notes: The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.

Engineering measures: Local or general exhaust required in an enclosed area or with inadequate ventilation. Use

mechanical ventilation equipment that is explosion-proof.

Personal protective equipment

Eye protection: Use goggles or face-shield if the potential for splashing exists.

Skin and body protection: Wear neoprene, nitrile or PVA gloves to prevent skin contact. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times.

Respiratory protection: Use a NIOSH approved organic vapor chemical cartridge or supplied air respirators when there is the potential for airborne exposures to exceed permissible exposure limits or if excessive vapors are generated. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.

Hygiene measures: Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical State	Liquid
Appearance	Yellow to Red Liquid
Color	Yellow to Red
Odor	Hydrocarbon
Odor Threshold	No data available.

Property	Values (Method)
Melting Point / Freezing Point	No data available.
Initial Boiling Point / Boiling Range	154-366 °C / 310-691 °F (ASTM D86)
Flash Point	58-76 °C / 136-168 °F (ASTM D93)
Evaporation Rate	No data available.
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%):	
Upper Flammability Limit:	No data available.
Lower Flammability Limit:	No data available.
Explosion limits:	No data available.
Vapor Pressure	No data available.
Vapor Density	No data available.
Specific Gravity / Relative Density	0.82-0.86
Water Solubility	No data available.
Solubility in other solvents	No data available.
Partition Coefficient	No data available.
Decomposition temperature	No data available.
pH:	Not applicable
Autoignition Temperature	No data available.
Kinematic Viscosity	1.90-3.32 cSt @ 40°C (ASTM D445)
Dynamic Viscosity	No data available.
Explosive Properties	No data available.
VOC Content (%)	No data available.
Density	No data available.
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

Reactivity The product is non-reactive under normal conditions.

Chemical stability The material is stable at 70°F (21°C), 760 mmHg pressure.

Possibility of hazardous reactions	None under normal processing.
Hazardous polymerization	Will not occur.
Conditions to avoid	Excessive heat, sources of ignition, open flame.
Incompatible Materials	Strong oxidizing agents.
Hazardous decomposition products	None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION

Potential short-term adverse effects from overexposures

Inhalation	Harmful if inhaled. May cause irritation of respiratory tract. May cause drowsiness or dizziness. Breathing high concentrations of this material in a confined space or by intentional abuse can cause irregular heartbeats which can cause death.
Eye contact	Exposure to vapor or contact with liquid may cause mild eye irritation, including tearing, stinging, and redness.
Skin contact	Irritating to skin. Effects may become more serious with repeated or prolonged contact. May be absorbed through the skin in harmful amounts.
Ingestion	May be fatal if swallowed or vomited and enters airways. May cause irritation of the mouth, throat and gastrointestinal tract.

Acute toxicological data

Name	Oral LD50	Dermal LD50	Inhalation LC50
No. 2 Diesel Fuel 68476-34-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	>1 - <5 mg/L (Rat) 4 h
Kerosine (petroleum) 8008-20-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.28 mg/L (Rat) 4 h
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	>1 - <5 mg/l (Rat) 4 h
Naphthalene 91-20-3	490 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 340 mg/m^3 (Rat) 1 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

MIDDLE DISTILLATES, PETROLEUM: Long-term repeated (lifetime) skin exposure to similar materials has been reported to result in an increase in skin tumors in laboratory rodents. The relevance of these findings to humans is not clear at this time. Altered mental state, drowsiness, peripheral motor neuropathy, irreversible brain damage (so-called Petrol Sniffer's Encephalopathy), delirium, seizures, and sudden death have been reported from repeated overexposure to some hydrocarbon solvents, naphthas, and gasoline.

MIDDLE DISTILLATES WITH CRACKED STOCKS: Light cracked distillates have been shown to be carcinogenic in animal tests and have tested positive with in vitro genotoxicity tests. Repeated dermal exposures to high concentrations in test animals resulted in reduced litter size and litter weight, and increased fetal resorptions at maternally toxic doses. Dermal exposure to high concentrations resulted in severe skin irritation with weight loss and some mortality. Inhalation exposure to high concentrations resulted in respiratory tract irritation, lung changes/infiltration/accumulation, and reduction in lung function.

ISOPARAFFINS: Studies in laboratory animals have shown that long-term exposure to similar materials (isoparaffins) can cause kidney damage and kidney cancer in male laboratory rats. However, in-depth research indicates that these findings are unique to the male rat, and that these effects are not relevant to humans.

NAPHTHALENE: Severe jaundice, neurotoxicity (kernicterus) and fatalities have been reported in young children and infants as a result of hemolytic anemia from overexposure to naphthalene. Persons with glucose 6-phosphate dehydrogenase (G6PD) deficiency are more prone to the hemolytic effects of naphthalene. Adverse effects on the kidney have been reported in persons overexposed to naphthalene but these effects are believed to be a consequence of hemolytic anemia, and not a direct effect. Hemolytic anemia has been observed in laboratory animals exposed to naphthalene. Laboratory rodents exposed to naphthalene vapor for 2 years (lifetime studies) developed non-neoplastic and neoplastic tumors and inflammatory lesions of the nasal and respiratory tract. Cataracts and other adverse effects on the eye have been observed in laboratory animals exposed to high levels of naphthalene. Findings from a large number of bacterial and mammalian cell mutation assays have been negative. A few studies have shown chromosomal effects (elevated levels of Sister Chromatid Exchange or chromosomal aberrations) in vitro. Naphthalene has been classified as Possibly Carcinogenic to Humans (2B) by IARC, based on findings from studies in laboratory animals.

DIESEL EXHAUST: The combustion of diesel fuels produces gases including carbon monoxide, carbon dioxide, oxides of nitrogen and/or sulfur, and hydrocarbons that can be irritating and hazardous with overexposure. Long-term occupational overexposure to diesel exhaust and diesel exhaust particulate matter has been associated with an increased risk of respiratory disease, including lung cancer, and is characterized as a "known human carcinogen" by the International Agency for Research on Cancer (IARC), as "a reasonably anticipated human carcinogen" by the National Toxicology Program, and as "likely to be carcinogenic to humans" by the EPA, based upon animal and occupational exposure studies. However, uncertainty exists with these classifications because of deficiencies in the supporting occupational exposure/epidemiology studies, including reliable exposure estimates. Lifetime animal inhalation studies with pulmonary overloading exposure concentrations of diesel exhaust emissions have produced tumors and other adverse health effects. However, in more recent long-term animal inhalation studies of diesel exhaust emissions, no increase in tumor incidence and in fact a substantial reduction in adverse health effects along with significant reductions in the levels of hazardous material emissions were observed and are associated with fuel composition alterations coupled with new technology diesel engines.

Adverse effects related to the physical, chemical and toxicological characteristics

Signs and Symptoms Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking. Prolonged or repeated exposure may cause damage to organs.

Skin corrosion/irritation Causes skin irritation.
Serious eye damage/eye irritation None known.
Sensitization None known.

Mutagenic effects None known.

Carcinogenicity Suspected of causing cancer.

Cancer designations are listed in the table below

Name	ACGIH (Class)	IARC (Class)	NTP	OSHA
No. 2 Diesel Fuel 68476-34-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Kerosine (petroleum) 8008-20-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Alkanes, C10-C20 branched and linear	Not Listed	Not Listed	Not Listed	Not Listed

928771-01-1				
Naphthalene 91-20-3	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Reasonably anticipated to be a human carcinogen	Not Listed

Reproductive toxicity None known.

Specific Target Organ Toxicity (STOT) - single exposure Respiratory system. Central nervous system.

Specific Target Organ Toxicity (STOT) - repeated exposure Thymus. Liver. Bone marrow.

Aspiration hazard May be fatal if swallowed or vomited and enters airways.

12. ECOLOGICAL INFORMATION

Ecotoxicity This product should be considered toxic to aquatic organisms, with the potential to cause long lasting adverse effects in the aquatic environment.

Name	Algae/aquatic plants	Fish	Toxicity to Microorganisms	Crustacea
No. 2 Diesel Fuel 68476-34-6	-	96-hr LC50 = 35 mg/l Fathead minnow (flow-through)	-	48-hr EL50 = 6.4 mg/l Daphnia magna
Kerosine (petroleum) 8008-20-6	72-hr EL50 = 5.0-11 mg/l Algae	96-hr LL50 = 18-25 mg/l Fish	-	48-hr EL50 = 1.4-21 mg/l Invertebrates
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	-	-
Naphthalene 91-20-3	-	96-hr LC50 = 0.91-2.82 mg/l Rainbow trout (static) 96-hr LC50 = 1.99 mg/l Fathead minnow (static)	-	48-hr LC50 = 1.6 mg/l Daphnia magna

Persistence and degradability Expected to be inherently biodegradable.

Bioaccumulation Has the potential to bioaccumulate.

Mobility in soil May partition into air, soil and water.

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues
This material may be a flammable liquid waste.

Safe Handling of Wastes
Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required. Use appropriate grounding and bonding practices. Use only non-sparking tools. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. No smoking.

Disposal of Wastes / Methods of Disposal
The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal
Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper Shipping Name:	Fuel Oil, No. 2
UN/Identification No:	NA 1993
Class:	3
Packing Group:	III

TDG (Canada):

UN Proper Shipping Name:	Diesel Fuel
UN/Identification No:	UN 1202
Transport Hazard Class(es):	3
Packing Group:	III

15. REGULATORY INFORMATION

US Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b): This product and/or its components are listed on the TSCA Chemical Inventory.

EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product does not contain any component(s) included on EPA's Extremely Hazardous Substance (EHS) List.

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
No. 2 Diesel Fuel	NA
Kerosine (petroleum)	NA
Alkanes, C10-C20 branched and linear	NA
Naphthalene	NA

SARA Section 304: This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	Hazardous Substances RQs
No. 2 Diesel Fuel	NA
Kerosine (petroleum)	NA
Alkanes, C10-C20 branched and linear	NA
Naphthalene	100 lb final RQ 45.4 kg final RQ

SARA Section 311/312: The following EPA hazard categories apply to this product:

Acute Health Hazard
Fire Hazard
Chronic Health Hazard

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

Name	CERCLA/SARA 313 Emission reporting:
No. 2 Diesel Fuel	None
Kerosine (petroleum)	None
Alkanes, C10-C20 branched and linear	None
Naphthalene	0.1 % de minimis concentration

State and Community Right-To-Know Regulations:
The following component(s) of this material are identified on the regulatory lists below:

No. 2 Diesel Fuel	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 2444
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 2444 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Kerosine (petroleum)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1091
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 1091 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Alkanes, C10-C20 branched and linear	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Naphthalene	
Louisiana Right-To-Know:	Not Listed

California Proposition 65:	Carcinogen, initial date 4/19/02
New Jersey Right-To-Know:	SN 1322 SN 3758
Pennsylvania Right-To-Know:	Environmental hazard Present (particulate)
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Carcinogen
New Jersey - Environmental Hazardous Substances List:	SN 1322 TPQ: 500 lb (Reportable at the de minimis quantity of >0.1%)
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	100 lb RQ (air); 1 lb RQ (land/water)

Canada DSL/NDSL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all of the information required by those regulations.

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
No. 2 Diesel Fuel	B3,D2A,D2B	0.1%
Kerosine (petroleum)	B3,D2B	1%
Alkanes, C10-C20 branched and linear	B3,D2A,D2B	0.1%
Naphthalene	B4,D2A	0.1%

Note: Not applicable.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety

Issue Date 10/31/2016

Revision Notes

Revision Date 06/01/2016

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

SAFETY DATA SHEET

SDS ID NO.: 0289MAR019
Revision Date 06/01/2016

1. IDENTIFICATION

Product Name: Marathon Petroleum No. 1 Ultra Low Sulfur Diesel

Synonym: Kerosene; Diesel, Motor Vehicle Use, Undyed; ULSD No. 1 Diesel 15 ppm Sulfur Max; No. 1 MV 15 Diesel; No. 1 Ultra Low Sulfur Diesel Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 1 Dyed 15 ppm Sulfur Max; No. 1 Diesel, Tax Exempt-Motor Vehicle Use, Dyed; ULSD No. 1 Diesel Dyed 15 ppm Sulfur Max; No. 1 MV 15 Diesel Dyed; 0273MAR019; Kerosine

Product Code: 0289MAR019
Chemical Family: Complex Hydrocarbon Substance

Recommended Use: Fuel.
Restrictions on Use: All others.

Manufacturer, Importer, or Responsible Party Name and Address:
MARATHON PETROLEUM COMPANY LP
539 South Main Street
Findlay, OH 45840

SDS information: 1-419-421-3070

Emergency Telephone: 1-877-627-5463

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 3
Skin corrosion/irritation	Category 2
Carcinogenicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Aspiration toxicity	Category 1
Acute aquatic toxicity	Category 2
Chronic aquatic toxicity	Category 2

Hazards Not Otherwise Classified (HNOC)
Static accumulating flammable liquid

Label elements

EMERGENCY OVERVIEW

Danger

FLAMMABLE LIQUID AND VAPOR

May accumulate electrostatic charge and ignite or explode
May be fatal if swallowed and enters airways
Causes skin irritation
May cause respiratory irritation
May cause drowsiness or dizziness
Suspected of causing cancer
Toxic to aquatic life with long lasting effects

Appearance Clear or Colored Liquid **Physical State** Liquid **Odor** Slight Hydrocarbon

Precautionary Statements - Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use explosion-proof electrical/ventilating/lighting/equipment
Use only non-sparking tools.
Take precautionary measures against static discharge
Avoid breathing mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection
Wash hands and any possibly exposed skin thoroughly after handling
Avoid release to the environment

Precautionary Statements - Response
IF exposed or concerned: Get medical attention
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
If skin irritation occurs: Get medical attention
Wash contaminated clothing before reuse
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor if you feel unwell
IF SWALLOWED: Immediately call a POISON CENTER or doctor
Do NOT induce vomiting
In case of fire: Use water spray, fog or regular foam for extinction
Collect spillage

Precautionary Statements - Storage
Store in a well-ventilated place. Keep container tightly closed
Keep cool
Store locked up

Precautionary Statements - Disposal
Dispose of contents/container at an approved waste disposal plant

3. COMPOSITION/INFORMATION ON INGREDIENTS

No. 1 Ultra Low Sulfur Diesel is a complex mixture of paraffins, cycloparaffins, olefins and aromatic hydrocarbons having hydrocarbon chain lengths predominantly in the range of nine to sixteen carbons. May contain small amounts of red dye and additives (<0.15%) which are not considered hazardous at the concentrations used.

Composition Information:

Name	CAS Number	% Concentration
Kerosine (petroleum)	8008-20-6	100
Naphthalene	91-20-3	0.3-2.6

All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

4. FIRST AID MEASURES

First Aid Measures

General Advice: In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation: Remove to fresh air. If not breathing, institute rescue breathing. If breathing is difficult, ensure airway is clear, give oxygen and continue to monitor. If heart has stopped, immediately begin cardiopulmonary resuscitation (CPR). Keep affected person warm and at rest. If symptoms occur get medical attention.

Skin Contact: Immediately wash exposed skin with plenty of soap and water while removing contaminated clothing and shoes. May be absorbed through the skin in harmful amounts. Get medical attention if irritation occurs. Any injection injury from high pressure equipment should be evaluated immediately by a physician as potentially serious (See NOTES TO PHYSICIAN).

Place contaminated clothing in closed container until cleaned or discarded. If clothing is to be laundered, inform the person performing the operation of contaminant's hazardous properties. Destroy contaminated, non-chemical resistant footwear.

Eye Contact: Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while flushing. Get medical attention if irritation persists.

Ingestion: Do not induce vomiting because of danger of aspirating liquid into lungs, causing serious damage and chemical pneumonitis. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects: Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Additional effects may include skin sensitization. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking.

Indication of any immediate medical attention and special treatment needed

Notes To Physician: INHALATION: This material (or a component) sensitizes the myocardium to the effects of sympathomimetic amines. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in individuals exposed to this material. Administration of sympathomimetic drugs should be avoided.

SKIN: Leaks or accidents involving high-pressure equipment may inject a stream of material through the skin and initially produce an injury that may not appear serious. Only a small puncture wound may appear on the skin surface but, without proper treatment and depending on the nature, original pressure, volume, and location of the injected material,

can compromise blood supply to an affected body part. Prompt surgical debridement of the wound may be necessary to prevent irreversible loss of function and/or the affected body part. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES.

INGESTION: This material represents a significant aspiration and chemical pneumonitis hazard. Induction of emesis is not recommended. The metabolism of fatty acid methyl ester may release free methanol in the body that could induce metabolic acidosis with delayed effects. If a large amount of product is ingested, i.e. several ounces, consider the use of ethanol or fomepizole (Antizol) and hemodialysis. Consult standard literature or contact a poison control center for treatment details.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media
For small fires, Class B fire extinguishing media such as CO_2, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.

Unsuitable extinguishing media
Do not use straight water streams to avoid spreading fire.

Specific hazards arising from the chemical
This product has been determined to be a flammable liquid per the OSHA Hazard Communication Standard and should be handled accordingly. May accumulate electrostatic charge and ignite or explode. Vapors may travel along the ground or be moved by ventilation and ignited by many sources such as pilot lights, sparks, electric motors, static discharge, or other ignition sources at locations distant from material handling. Flashback can occur along vapor trail. For additional fire related information, see NFPA 30 or the Emergency Response Guidebook 128.

Hazardous combustion products
Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data
Sensitivity to Mechanical Impact No.
Sensitivity to Static Discharge Yes.

Special protective equipment and precautions for firefighters
Firefighters should wear full protective clothing and positive-pressure self-contained breathing apparatus (SCBA) with a full face-piece, as appropriate. Avoid using straight water streams. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Avoid excessive water spray application. Keep surrounding area cool with water spray from a distance and prevent further ignition of combustible material. Keep run-off water out of sewers and water sources.

Additional firefighting tactics
FIRES INVOLVING TANKS OR CAR/TRAILER LOADS: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after the fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles: if this is impossible, withdraw from area and let fire burn.

EVACUATION: Consider initial downwind evacuation for at least 1000 feet. If tank, rail car or tank truck is involved in a fire, ISOLATE for 5280 feet (1 mile) in all directions; also, consider initial evacuation of 5280 feet (1 mile) in all directions.

NFPA	Health 1	Flammability 2	Instability 0	Special Hazard -

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Eliminate all ignition sources. All contaminated surfaces will be slippery.

Protective equipment:	Use personal protection measures as recommended in Section 8.
Emergency procedures:	Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.
Environmental precautions:	Avoid release to the environment. Avoid subsoil penetration.
Methods and materials for containment:	Contain liquid with sand or soil. Prevent spilled material from entering storm drains, sewers, and open waterways.
Methods and materials for cleaning up:	Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids. Recover and return free product to proper containers. When recovering free liquids ensure all equipment is grounded and bonded. Use only non-sparking tools.

7. HANDLING AND STORAGE

Safe Handling Precautions:

NEVER SIPHON THIS PRODUCT BY MOUTH. Use appropriate grounding and bonding practices. Static accumulating flammable liquid. Bonding and grounding may be insufficient to eliminate the hazard from static electricity. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. Vapors may travel along the ground or be moved by ventilation. Flashback may occur along vapor trails. No smoking. Use only non-sparking tools. Avoid repeated and prolonged skin contact. Avoid breathing vapors or mists. Use only with adequate ventilation. Use personal protection measures as recommended in Section 8. Exercise good personal hygiene including removal of soiled clothing and prompt washing with soap and water. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements.

Hydrocarbons are basically non-conductors of electricity and can become electrostatically charged during mixing, filtering, pumping at high flow rates or loading and transfer operations. If this charge reaches a sufficiently high level, sparks can form that may ignite the vapors of flammable liquids. Sudden release of hot organic chemical vapors or mists from process equipment operating under elevated temperature and pressure, or sudden ingress of air into vacuum equipment may result in ignition of vapors or mists without the presence of obvious ignition sources. Nozzle spouts must be kept in contact with the containers or tank during the entire filling operation.

Portable containers should never be filled while in or on a motor vehicle or marine craft. Containers should be placed on the ground. Static electric discharge can ignite fuel vapors when filling non-grounded containers or vehicles on trailers. The nozzle spout must be kept in contact with the container before and during the entire filling operation. Use only approved containers.

A buildup of static electricity can occur upon re-entry into a vehicle during fueling especially in cold or dry climate conditions. The charge is generated by the action of dissimilar fabrics (i.e., clothing and upholstery) rubbing across each other as a person enters/exits the vehicle. A flash fire can result from this discharge if sufficient flammable vapors are present. Therefore, do not get back in your vehicle while refueling.

Cellular phones and other electronic devices may have the potential to emit electrical charges (sparks). Sparks in potentially explosive atmospheres (including fueling areas such as gas stations) could cause an explosion if sufficient flammable vapors are present. Therefore, turn off cellular phones and other electronic devices when working in potentially explosive atmospheres or keep devices inside your vehicle during refueling.

High-pressure injection of any material through the skin is a serious medical emergency even though the small entrance wound at the injection site may not initially appear serious. These injection injuries can occur from high-pressure equipment such as paint spray or grease or guns, fuel injectors, or pinhole leaks in hoses or hydraulic lines and should all be

considered serious. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES (See First Aid Section 4).

Storage Conditions: Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area. Do not store near an open flame, heat or other sources of ignition.

Incompatible Materials Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	ACGIH TLV	OSHA PELS:	OSHA - Vacated PELs	NIOSH IDLH
Kerosine (petroleum) 8008-20-6	200 mg/m³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Naphthalene 91-20-3	10 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm TWA: 50 mg/m³	10 ppm TWA 50 mg/m³ TWA 15 ppm STEL 75 mg/m³ STEL	250 ppm

Notes: The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.

Engineering measures: Local or general exhaust required in an enclosed area or with inadequate ventilation. Use mechanical ventilation equipment that is explosion-proof.

Personal protective equipment

Eye protection: Use goggles or face-shield if the potential for splashing exists.

Skin and body protection: Wear neoprene, nitrile or PVA gloves to prevent skin contact. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times.

Respiratory protection: Use a NIOSH approved organic vapor chemical cartridge or supplied air respirators when there is the potential for airborne exposures to exceed permissible exposure limits or if excessive vapors are generated. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.

Hygiene measures: Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical State	Liquid
Appearance	Clear or Colored Liquid
Color	Yellow to Red
Odor	Slight Hydrocarbon
Odor Threshold	No data available.

Property	Values (Method)
Melting Point / Freezing Point	-55 to -39 °C -68 to -39 °F (ASTM D5949)
Initial Boiling Point / Boiling Range	134-294 °C / 274-562 °F (ASTM D86)
Flash Point	46-71 °C / 116-159 °F (ASTM D93)
Evaporation Rate	No data available.
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%):	

Upper Flammability Limit:	5.0
Lower Flammability Limit:	0.4
Explosion limits:	No data available.
Vapor Pressure	No data available.
Vapor Density	No data available.
Specific Gravity / Relative Density	0.70-0.82
Water Solubility	No data available.
Solubility in other solvents	Negligible
Partition Coefficient	No data available.
Decomposition temperature	No data available.
pH:	Not applicable
Autoignition Temperature	210 °C / 410 °F
Kinematic Viscosity	1.37-1.72 cSt @ 40°C (ASTM D445)
Dynamic Viscosity	No data available.
Explosive Properties	No data available.
VOC Content (%)	No data available.
Density	No data available.
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

Reactivity	The product is non-reactive under normal conditions.
Chemical stability	The material is stable at 70°F (21°C), 760 mmHg pressure.
Possibility of hazardous reactions	None under normal processing.
Hazardous polymerization	Will not occur.
Conditions to avoid	Excessive heat, sources of ignition, open flame.
Incompatible Materials	Strong oxidizing agents.
Hazardous decomposition products	None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION

Potential short-term adverse effects from overexposures

Inhalation	May cause irritation of respiratory tract. May cause drowsiness or dizziness. Breathing high concentrations of this material, for example, in a confined space or by intentional abuse, can cause irregular heartbeats which can cause death.
Eye contact	Exposure to vapor or contact with liquid may cause mild eye irritation, including tearing, stinging, and redness.
Skin contact	Causes skin irritation. Effects may become more serious with repeated or prolonged contact. May be absorbed through the skin in harmful amounts.
Ingestion	May be fatal if swallowed or vomited and enters airways. May cause irritation of the mouth, throat and gastrointestinal tract.

Acute toxicological data

Name	Oral LD50	Dermal LD50	Inhalation LC50
Kerosine (petroleum) 8008-20-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.28 mg/L (Rat) 4 h
Naphthalene 91-20-3	490 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 340 mg/m^3 (Rat) 1 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

MIDDLE DISTILLATES, PETROLEUM: Long-term repeated (lifetime) skin exposure to similar materials has been reported to result in an increase in skin tumors in laboratory rodents. The relevance of these findings to humans is not clear at this time. Altered mental state, drowsiness, peripheral motor neuropathy, irreversible brain damage (so-called Petrol Sniffer's Encephalopathy), delirium, seizures, and sudden death have been reported from repeated overexposure to some hydrocarbon solvents, naphthas, and gasoline.

ISOPARAFFINS: Studies in laboratory animals have shown that long-term exposure to similar materials (isoparaffins) can cause kidney damage and kidney cancer in male laboratory rats. However, in-depth research indicates that these findings are unique to the male rat, and that these effects are not relevant to humans.

NAPHTHALENE: Severe jaundice, neurotoxicity (kernicterus) and fatalities have been reported in young children and infants as a result of hemolytic anemia from overexposure to naphthalene. Persons with glucose 6-phosphate dehydrogenase (G6PD) deficiency are more prone to the hemolytic effects of naphthalene. Adverse effects on the kidney have been reported in persons overexposed to naphthalene but these effects are believed to be a consequence of hemolytic anemia, and not a direct effect. Hemolytic anemia has been observed in laboratory animals exposed to naphthalene. Laboratory rodents exposed to naphthalene vapor for 2 years (lifetime studies) developed non-neoplastic and neoplastic tumors and inflammatory lesions of the nasal and respiratory tract. Cataracts and other adverse effects on the eye have been observed in laboratory animals exposed to high levels of naphthalene. Findings from a large number of bacterial and mammalian cell mutation assays have been negative. A few studies have shown chromosomal effects (elevated levels of Sister Chromatid Exchange or chromosomal aberrations) in vitro. Naphthalene has been classified as Possibly Carcinogenic to Humans (2B) by IARC, based on findings from studies in laboratory animals.

DIESEL EXHAUST: The combustion of diesel fuels produces gases including carbon monoxide, carbon dioxide, oxides of nitrogen and/or sulfur, and hydrocarbons that can be irritating and hazardous with overexposure. Long-term occupational overexposure to diesel exhaust and diesel exhaust particulate matter has been associated with an increased risk of respiratory disease, including lung cancer, and is characterized as a "known human carcinogen" by the International Agency for Research on Cancer (IARC), as "a reasonably anticipated human carcinogen" by the National Toxicology Program, and as "likely to be carcinogenic to humans" by the EPA, based upon animal and occupational exposure studies. However, uncertainty exists with these classifications because of deficiencies in the supporting occupational exposure/epidemiology studies, including reliable exposure estimates. Lifetime animal inhalation studies with pulmonary overloading exposure concentrations of diesel exhaust emissions have produced tumors and other adverse health effects. However, in more recent long-term animal inhalation studies of diesel exhaust emissions, no increase in tumor incidence and in fact a substantial reduction in adverse health effects along with significant reductions in the levels of hazardous material emissions were observed and are associated with fuel composition alterations coupled with new technology diesel engines.

Adverse effects related to the physical, chemical and toxicological characteristics

Signs and Symptoms	Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Additional effects may include skin sensitization. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking.
Sensitization	Not expected to be a skin or respiratory sensitizer.
Mutagenic effects	None known.

Carcinogenicity Suspected of causing cancer.

Cancer designations are listed in the table below

Name	ACGIH (Class)	IARC (Class)	NTP	OSHA
Kerosine (petroleum) 8008-20-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Naphthalene 91-20-3	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Reasonably anticipated to be a human carcinogen	Not Listed

Reproductive toxicity None known.

Specific Target Organ Toxicity (STOT) - single exposure Respiratory system. Central nervous system.

Specific Target Organ Toxicity (STOT) - repeated exposure Not classified.

Aspiration hazard May be fatal if swallowed or vomited and enters airways.

12. ECOLOGICAL INFORMATION

Ecotoxicity This product should be considered toxic to aquatic organisms, with the potential to cause long lasting adverse effects in the aquatic environment.

Name	Algae/aquatic plants	Fish	Toxicity to Microorganisms	Crustacea
Kerosine (petroleum) 8008-20-6	72-hr EL50 = 5.0-11 mg/l Algae	96-hr LL50 = 18-25 mg/l Fish	-	48-hr EL50 = 1.4-21 mg/l Invertebrates
Naphthalene 91-20-3	-	96-hr LC50 = 0.91-2.82 mg/l Rainbow trout (static) 96-hr LC50 = 1.99 mg/l Fathead minnow (static)	-	48-hr LC50 = 1.6 mg/l Daphnia magna

Persistence and degradability Expected to be inherently biodegradable.

Bioaccumulation Has the potential to bioaccumulate.

Mobility in soil May partition into air, soil and water.

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues
This material may be a flammable liquid waste.

Safe Handling of Wastes
Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required. Use appropriate grounding and bonding practices. Use only non-sparking tools. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. No smoking.

Disposal of Wastes / Methods of Disposal
The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal
Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper Shipping Name:	Fuel Oil, No. 1
UN/Identification No:	NA 1993
Class:	3
Packing Group:	III

TDG (Canada):

UN Proper Shipping Name:	Fuel Oil
UN/Identification No:	UN 1202
Transport Hazard Class(es):	3
Packing Group:	III

15. REGULATORY INFORMATION

US Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b): This product and/or its components are listed on the TSCA Chemical Inventory.

EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product does not contain any component(s) included on EPA's Extremely Hazardous Substance (EHS) List.

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
Kerosine (petroleum)	NA
Naphthalene	NA

SARA Section 304: This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	Hazardous Substances RQs
Kerosine (petroleum)	NA
Naphthalene	100 lb final RQ 45.4 kg final RQ

SARA Section 311/312: The following EPA hazard categories apply to this product:

Acute Health Hazard
Fire Hazard
Chronic Health Hazard

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

Name	CERCLA/SARA 313 Emission reporting:
Kerosine (petroleum)	None
Naphthalene	0.1 % de minimis concentration

State and Community Right-To-Know Regulations:
The following component(s) of this material are identified on the regulatory lists below:

Kerosine (petroleum)

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1091
Pennsylvania Right-To-Know:	Present

Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 1091 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Naphthalene

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Carcinogen, initial date 4/19/02
New Jersey Right-To-Know:	SN 1322 SN 3758
Pennsylvania Right-To-Know:	Environmental hazard Present (particulate)
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Carcinogen
New Jersey - Environmental Hazardous Substances List:	SN 1322 TPQ: 500 lb (Reportable at the de minimis quantity of >0.1%)
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	100 lb RQ (air); 1 lb RQ (land/water)

Canada DSL/NDSL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all of the information required by those regulations.

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
Kerosine (petroleum)	B3,D2B	1%
Naphthalene	B4,D2A	0.1%

Note: Not applicable.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety

Revision Notes

Revision Date 06/01/2016

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Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

SAFETY DATA SHEET

SDS ID NO.: 0127MAR019
Revision Date 03/19/2018

1. IDENTIFICATION

Product Name: Marathon Petroleum Gasoline - All Grades

Synonym: Gasoline; Regular Unleaded Gasoline; Conventional Regular Unleaded Gasoline; Mid Grade Unleaded Gasoline; Conventional Mid Grade Unleaded Gasoline; Premium Unleaded Gasoline; Conventional Premium Unleaded Gasoline; Sub-Octane Gasoline; Regular RBOB; Super RBOB; Premium RBOB; RBOB; Reformulated Blend Stock For Oxygenated Blending; 84 Octane Gasoline; CBOB; Premium CBOB; Conventional Blend Stock for Oxygenate Blending; Recreational Gasoline; Recreational Gasoline; Recreational Unleaded Gasoline; 89 Recreational Gasoline; Brand 89 Recreational Gasoline; 7.0 Max RVP 89 Recreational Gasoline; BR 7.0 Max RVP 89 Recreational Gasoline; 90 Recreational Gasoline; 90 Marina Gasoline; Brand EX 90 UL Recrtnl Gasoline; Brand 91 Recreational Gasoline; 91 Recreational Gasoline; 91 Marina Gasoline; 90 Octane Midgrade Gasoline with No Ethanol; 7.8# New York CBOB Gasoline Blend Grade; Non-Summer New York CBOB Gasoline Blend Grade 0125MAR019; 0126MAR019; 0134MAR019; 0313MAR019; 0314MAR019

Product Code: 0127MAR019
Chemical Family: Complex Hydrocarbon Substance

Recommended Use: Fuel.
Restrictions on Use: All others.

Manufacturer, Importer, or Responsible Party Name and Address:
MARATHON PETROLEUM COMPANY LP
539 South Main Street
Findlay, OH 45840

SDS information (M-F, 8-5 EST): 1-419-421-3070

Emergency Telephone (24/7): CHEMTREC: 1-800-424-9300 CCN#: 13740

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 1
Skin corrosion/irritation	Category 2
Germ cell mutagenicity	Category 1B
Carcinogenicity	Category 1A
Reproductive toxicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Specific target organ toxicity (repeated exposure)	Category 1
Aspiration toxicity	Category 1

Acute aquatic toxicity	Category 2
Chronic aquatic toxicity	Category 2

Hazards Not Otherwise Classified (HNOC)
Static accumulating flammable liquid

Label elements

EMERGENCY OVERVIEW

Danger

EXTREMELY FLAMMABLE LIQUID AND VAPOR
May accumulate electrostatic charge and ignite or explode
May be fatal if swallowed and enters airways
Causes skin irritation
May cause respiratory irritation
May cause drowsiness or dizziness
May cause genetic defects
May cause cancer
Suspected of damaging fertility or the unborn child
Causes damage to organs (blood, blood-forming organs, immune system) through prolonged or repeated exposure
Toxic to aquatic life with long lasting effects

Appearance Clear yellow liquid **Physical State** Liquid **Odor** Hydrocarbon

Precautionary Statements - Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use explosion-proof electrical/ventilating/lighting/equipment
Use only non-sparking tools.
Take action to prevent static discharges
Do not eat, drink or smoke when using this product
Do not breathe mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection
Wash hands and any possibly exposed skin thoroughly after handling
Avoid release to the environment

Precautionary Statements - Response
IF exposed, concerned or you feel unwell: Get medical attention
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
If skin irritation occurs: Get medical attention
Wash contaminated clothing before reuse
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor if you feel unwell
IF SWALLOWED: Immediately call a POISON CENTER or doctor
Do NOT induce vomiting
In case of fire: Use water spray, fog or regular foam for extinction
Collect spillage

Precautionary Statements - Storage
Store in a well-ventilated place. Keep container tightly closed
Keep cool
Store locked up

Precautionary Statements - Disposal
Dispose of contents/container at an approved waste disposal plant

3. COMPOSITION/INFORMATION ON INGREDIENTS

Gasoline is a complex combination of hydrocarbons consisting of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons having molecular chains ranging in length from four to ten carbons. May contain small amounts of dye and other additives (>0.02%) which are not considered hazardous at the concentrations used.

Composition Information:

Name	CAS Number	% Concentration
Gasoline	86290-81-5	100
Heptane (mixed isomers)	142-82-5	2.5-26
Butane (mixed isomers)	106-97-8	0.5-19
Pentane (mixed isomers)	78-78-4	6.5-19
Hexane Isomers (other than n-Hexane)	107-83-5	2-12
Toluene	108-88-3	3-9.5
Xylene (mixed isomers)	1330-20-7	3.5-9.5
Benzene	71-43-2	0.1-4.9
n-Hexane	110-54-3	0.1-4.5
Cumene	98-82-8	0-4
1,2,4 Trimethylbenzene	95-63-6	1-4
Ethylbenzene	100-41-4	0.5-2.5
Cyclohexane	110-82-7	0-1.5
Octane	111-65-9	0-1.5
1,2,3-Trimethylbenzene	526-73-8	0-1
Naphthalene	91-20-3	0.1-0.5

Benzene concentration is percent by volume. All other concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

4. FIRST AID MEASURES

First Aid Measures

General Advice: In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation: Remove to fresh air. If not breathing, institute rescue breathing. If breathing is difficult, ensure airway is clear, give oxygen and continue to monitor. If heart has stopped, immediately begin cardiopulmonary resuscitation (CPR). Keep affected person warm and at rest. If symptoms occur get medical attention.

Skin Contact: Immediately wash exposed skin with plenty of soap and water while removing contaminated clothing and shoes. May be absorbed through the skin in harmful amounts. Get medical attention if irritation persists. Any injection injury from high pressure equipment should be evaluated immediately by a physician as potentially serious (See NOTES TO PHYSICIAN).

Place contaminated clothing in closed container until cleaned or discarded. If clothing is to be laundered, inform the person performing the operation of contaminant's hazardous properties. Destroy contaminated, non-chemical resistant footwear.

Eye Contact: Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while

flushing. Get medical attention if irritation persists.

Ingestion: Do not induce vomiting because of danger of aspirating liquid into lungs, causing serious damage and chemical pneumonitis. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects: Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Prolonged or repeated exposure may cause adverse effects on blood, blood-forming organs, and immune system. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking.

Indication of any immediate medical attention and special treatment needed

Notes To Physician: INHALATION: This material (or a component) sensitizes the myocardium to the effects of sympathomimetic amines. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in individuals exposed to this material. Administration of sympathomimetic drugs should be avoided.

SKIN: Leaks or accidents involving high-pressure equipment may inject a stream of material through the skin and initially produce an injury that may not appear serious. Only a small puncture wound may appear on the skin surface but, without proper treatment and depending on the nature, original pressure, volume, and location of the injected material, can compromise blood supply to an affected body part. Prompt surgical debridement of the wound may be necessary to prevent irreversible loss of function and/or the affected body part. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES.

INGESTION: This material represents a significant aspiration and chemical pneumonitis hazard. Induction of emesis is not recommended.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media
For small fires, Class B fire extinguishing media such as CO_2, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.

Unsuitable extinguishing media
Do not use straight water streams to avoid spreading fire.

Specific hazards arising from the chemical
This product has been determined to be an extremely flammable liquid per the OSHA Hazard Communication Standard and should be handled accordingly. May accumulate electrostatic charge and ignite or explode. Vapors may travel along the ground or be moved by ventilation and ignited by many sources such as pilot lights, sparks, electric motors, static discharge, or other ignition sources at locations distant from material handling. Flashback can occur along vapor trail. For additional fire related information, see NFPA 30 or the Emergency Response Guidebook 128.

Hazardous combustion products
Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data
Sensitivity to Mechanical Impact No.
Sensitivity to Static Discharge Yes.

Special protective equipment and precautions for firefighters

Firefighters should wear full protective clothing and positive-pressure self-contained breathing apparatus (SCBA) with a full face-piece, as appropriate. Avoid using straight water streams. Water may be ineffective in extinguishing low flash point fires, but can be used to cool exposed surfaces. Avoid excessive water spray application. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Keep run-off water out of sewers and water sources.

Additional firefighting tactics
FIRES INVOLVING TANKS OR CAR/TRAILER LOADS: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after the fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles: if this is impossible, withdraw from area and let fire burn.

EVACUATION: Consider initial downwind evacuation for at least 1000 feet. If tank, rail car or tank truck is involved in a fire, ISOLATE for 5280 feet (1 mile) in all directions; also, consider initial evacuation of 5280 feet (1 mile) in all directions.

NFPA	Health 1	Flammability 3	Instability 0	Special Hazard -

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Eliminate all ignition sources.
Protective equipment:	Use personal protection measures as recommended in Section 8.
Emergency procedures:	Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.
Environmental precautions:	Avoid release to the environment. Avoid subsoil penetration. Ethanol in gasoline phase seperates in contact with water. Monitor downstream for dissolved ethanol or other appropriate indicators.
Methods and materials for containment:	Contain liquid with sand or soil. Prevent spilled material from entering storm drains, sewers, and open waterways.
Methods and materials for cleaning up:	Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids. Recover and return free product to proper containers. When recovering free liquids ensure all equipment is grounded and bonded. Use only non-sparking tools.

7. HANDLING AND STORAGE

Safe Handling Precautions:

NEVER SIPHON THIS PRODUCT BY MOUTH. Use appropriate grounding and bonding practices. Static accumulating flammable liquid. Bonding and grounding may be insufficient to eliminate the hazard from static electricity. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. Vapors may travel along the ground or be moved by ventilation. Flashback may occur along vapor trails. No smoking. Use only non-sparking tools. Avoid contact with skin, eyes and clothing. Avoid breathing fumes, gas, or vapors. Use only with adequate ventilation. Avoid repeated and prolonged skin contact. Use personal protection measures as recommended in Section 8. Exercise good personal hygiene including removal of soiled clothing and prompt washing with soap and water. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements.

Hydrocarbons are basically non-conductors of electricity and can become electrostatically charged during mixing, filtering, pumping at high flow rates or loading and transfer operations. If this charge reaches a sufficiently high level, sparks can form that may ignite the vapors of flammable liquids. Sudden release of hot organic chemical vapors or mists from process equipment operating under elevated temperature and pressure, or sudden ingress of air into vacuum equipment may result in ignition of vapors or mists without the

presence of obvious ignition sources. Nozzle spouts must be kept in contact with the containers or tank during the entire filling operation.

Portable containers should never be filled while in or on a motor vehicle or marine craft. Containers should be placed on the ground. Static electric discharge can ignite fuel vapors when filling non-grounded containers or vehicles on trailers. The nozzle spout must be kept in contact with the container before and during the entire filling operation. Use only approved containers.

A buildup of static electricity can occur upon re-entry into a vehicle during fueling especially in cold or dry climate conditions. The charge is generated by the action of dissimilar fabrics (i.e., clothing and upholstery) rubbing across each other as a person enters/exits the vehicle. A flash fire can result from this discharge if sufficient flammable vapors are present. Therefore, do not get back in your vehicle while refueling.

Cellular phones and other electronic devices may have the potential to emit electrical charges (sparks). Sparks in potentially explosive atmospheres (including fueling areas such as gas stations) could cause an explosion if sufficient flammable vapors are present. Therefore, turn off cellular phones and other electronic devices when working in potentially explosive atmospheres or keep devices inside your vehicle during refueling.

High-pressure injection of any material through the skin is a serious medical emergency even though the small entrance wound at the injection site may not initially appear serious. These injection injuries can occur from high-pressure equipment such as paint spray or grease or guns, fuel injectors, or pinhole leaks in hoses or hydraulic lines and should all be considered serious. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES (See First Aid Section 4).

Storage Conditions: Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area. Do not store near an open flame, heat or other sources of ignition.

Incompatible Materials Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	ACGIH TLV	OSHA PELS:	OSHA - Vacated PELs	NIOSH IDLH
Gasoline 86290-81-5	300 ppm TWA 500 ppm STEL	-	300 ppm TWA 900 mg/m³ TWA 500 ppm STEL 1500 mg/m³ STEL	-
Heptane (mixed isomers) 142-82-5	400 ppm TWA 500 ppm STEL	TWA: 500 ppm TWA: 2000 mg/m³	400 ppm TWA 1600 mg/m³ TWA 500 ppm STEL 2000 mg/m³ STEL	750 ppm
Butane (mixed isomers) 106-97-8	1000 ppm STEL	-	800 ppm TWA 1900 mg/m³ TWA	-
Pentane (mixed isomers) 78-78-4	1000 ppm TWA	-	-	-
Hexane Isomers (other than n-Hexane) 107-83-5	500 ppm TWA 1000 ppm STEL	-	500 ppm TWA 1800 mg/m³ TWA 1000 ppm STEL 3600 mg/m³ STEL	-
Toluene 108-88-3	20 ppm TWA	TWA: 200 ppm Ceiling: 300 ppm	100 ppm TWA 375 mg/m³ TWA 150 ppm STEL 560 mg/m³ STEL	500 ppm
Xylene (mixed isomers) 1330-20-7	100 ppm TWA 150 ppm STEL	TWA: 100 ppm TWA: 435 mg/m³	100 ppm TWA 435 mg/m³ TWA 150 ppm STEL 655 mg/m³ STEL	900 ppm
Benzene	0.5 ppm TWA	TWA: 10 ppm (applies to	25 ppm Ceiling	500 ppm

71-43-2	2.5 ppm STEL Skin - potential significant contribution to overall exposure by the cutaneous route	industry segments exempt from the benzene standard) TWA: 1 ppm STEL: 5 ppm (see 29 CFR 1910.1028)	1 ppm TWA 5 ppm STEL	
n-Hexane 110-54-3	50 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 500 ppm TWA: 1800 mg/m^3	50 ppm TWA 180 mg/m^3 TWA	1100 ppm
Cumene 98-82-8	50 ppm TWA	TWA: 50 ppm TWA: 245 mg/m^3 Skin	50 ppm TWA 245 mg/m^3 TWA Limit applies to skin	900 ppm
1,2,4 Trimethylbenzene 95-63-6	25 ppm TWA	-	25 ppm TWA 125 mg/m^3 TWA	-
Ethylbenzene 100-41-4	20 ppm TWA	TWA: 100 ppm TWA: 435 mg/m^3	100 ppm TWA 435 mg/m^3 TWA 125 ppm STEL 545 mg/m^3 STEL	800 ppm
Cyclohexane 110-82-7	100 ppm TWA	TWA: 300 ppm TWA: 1050 mg/m^3	300 ppm TWA 1050 mg/m^3 TWA	1300 ppm
Octane 111-65-9	300 ppm TWA	TWA: 500 ppm TWA: 2350 mg/m^3	300 ppm TWA 1450 mg/m^3 TWA 375 ppm STEL 1800 mg/m^3 STEL	1000 ppm
1,2,3-Trimethylbenzene 526-73-8	25 ppm TWA	-	25 ppm TWA 125 mg/m^3 TWA	-
Naphthalene 91-20-3	10 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm TWA: 50 mg/m^3	10 ppm TWA 50 mg/m^3 TWA 15 ppm STEL 75 mg/m^3 STEL	250 ppm

Notes: The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.

Engineering measures: Local or general exhaust required in an enclosed area or when there is inadequate ventilation. Use mechanical ventilation equipment that is explosion-proof.

Personal protective equipment

Eye protection: Use goggles or face-shield if the potential for splashing exists.

Skin and body protection: Use nitrile rubber, Viton® or PVA gloves for repeated or prolonged skin exposure. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times.

Respiratory protection: Use a NIOSH approved organic vapor chemical cartridge or supplied air respirators when there is the potential for airborne exposures to exceed permissible exposure limits or if excessive vapors are generated. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.

Hygiene measures: Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical State Liquid
Appearance Clear yellow liquid

Color	Yellow
Odor	Hydrocarbon
Odor Threshold	No data available.

Property	Values (Method)
Melting Point / Freezing Point	No data available.
Initial Boiling Point / Boiling Range	24-210 °C / 75-410 °F (ASTM D86)
Flash Point	-43 °C / -45 °F
Evaporation Rate	No data available.
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%):	
Upper Flammability Limit:	7.6
Lower Flammability Limit:	1.4
Explosion limits:	No data available.
Vapor Pressure	5.5-15 psi (ASTM D4814)
Vapor Density	3-4
Specific Gravity / Relative Density	0.70-0.76
Water Solubility	No data available.
Solubility in other solvents	No data available.
Partition Coefficient	2.13-4.5
Decomposition temperature	No data available.
pH:	Not applicable
Autoignition Temperature	280 °C / 536 °F
Kinematic Viscosity	No data available.
Dynamic Viscosity	No data available.
Explosive Properties	No data available.
VOC Content (%)	100%
Density	No data available.
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

Reactivity	The product is non-reactive under normal conditions.
Chemical stability	The material is stable at 70°F (21°C), 760 mmHg pressure.
Possibility of hazardous reactions	None under normal processing.
Hazardous polymerization	Will not occur.
Conditions to avoid	Excessive heat, sources of ignition, open flame.
Incompatible Materials	Strong oxidizing agents.
Hazardous decomposition products	None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION

Potential short-term adverse effects from overexposures

Inhalation	May cause irritation of respiratory tract. May cause drowsiness or dizziness. Breathing high concentrations of this material in a confined space or by intentional abuse can cause irregular heartbeats which can cause death.
Eye contact	Exposure to vapor or contact with liquid may cause mild eye irritation, including tearing, stinging, and redness.
Skin contact	Irritating to skin. Effects may become more serious with repeated or prolonged contact. May be absorbed through the skin in harmful amounts.

Ingestion May be fatal if swallowed or vomited and enters airways. May cause irritation of the mouth, throat and gastrointestinal tract.

Acute toxicological data

Name	Oral LD50	Dermal LD50	Inhalation LC50
Gasoline 86290-81-5	14000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.2 mg/L (Rat) 4 h
Heptane (mixed isomers) 142-82-5	-	3000 mg/kg (Rabbit)	103 g/m³ (Rat) 4 h
Butane (mixed isomers) 106-97-8	-	-	658 mg/L (Rat) 4 h
Pentane (mixed isomers) 78-78-4	-	-	450 mg/L (Mouse) 2 h
Hexane Isomers (other than n-Hexane) 107-83-5	> 5000 mg/kg (Rat)	-	-
Toluene 108-88-3	> 2000 mg/kg (Rat)	8390 mg/kg (Rabbit)	12.5 mg/L (Rat) 4 h
Xylene (mixed isomers) 1330-20-7	> 2000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.04 mg/L (Rat) 4 h
Benzene 71-43-2	> 2000 mg/kg (Rat)	> 5000 mg/kg (Rabbit)	> 20 mg/l (Rat) 4 h
n-Hexane 110-54-3	15000 mg/kg (Rat)	3000 mg/kg (Rabbit)	48000 ppm (Rat) 4 h
Cumene 98-82-8	> 2000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 20 mg/L (Rat) 6 h
1,2,4 Trimethylbenzene 95-63-6	3280 mg/kg (Rat)	> 3160 mg/kg (Rabbit)	18,000 mg/m³ (Rat) 4 h
Ethylbenzene 100-41-4	> 2000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	17.2 mg/L (Rat) 4 h
Cyclohexane 110-82-7	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	13.9 mg/L (Rat) 4 h
Octane 111-65-9	-	-	118 g/m³ (Rat) 4 h
1,2,3-Trimethylbenzene 526-73-8	-	-	-
Naphthalene 91-20-3	490 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 340 mg/m³ (Rat) 1 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

NAPHTHAS: In a large epidemiological study on over 15,000 employees at several petroleum refineries and amongst residents located near these refineries, no increased risk of kidney cancer was observed in association with gasoline exposures (a similar material). In a similar study, no increased risk of kidney cancer was observed among petroleum refinery workers, but there was a slight trend in the incidence of kidney cancers among service station employees, especially after a 30-year latency period. Altered mental state, drowsiness, peripheral motor neuropathy, irreversible brain damage (so-called Petrol Sniffer's Encephalopathy), delirium, seizures, and sudden death have been reported from repeated overexposure to some hydrocarbon solvents, naphthas, and gasoline.

ISOPARAFFINS: Studies in laboratory animals have shown that long-term exposure to similar materials (isoparaffins) can cause kidney damage and kidney cancer in male laboratory rats. However, in-depth research indicates that these findings are unique to the male rat, and that these effects are not relevant to humans.

C9 AROMATIC HYDROCARBONS: A developmental inhalation study was conducted in laboratory mice. Increased implantation losses, reduced fetal weights, delayed ossification and an increased incidence of cleft palate were observed at the highest exposure level (1,500 ppm). This exposure level was extremely toxic to pregnant female mice (44% mortality). Reduced fetal body weights were also observed at 500 ppm. A multi-generation reproduction inhalation study was conducted in laboratory rats.

Reductions in pup weights, pup weight gain, litter size, and pup survival were observed at 1,500 ppm, an exposure level at which significant maternal toxicity was observed. Reduced pup weight gain was also observed at 500 ppm.

BUTANES: Studies in laboratory animals indicate exposure to extremely high levels of butanes (1-10 or higher vol.% in air) may cause cardiac arrhythmias (irregular heartbeats) which may be serious or fatal.

PENTANES: Studies of pentane isomers in laboratory animals indicate exposure to extremely high levels (roughly 10 vol.%) may induce cardiac arrhythmias (irregular heartbeats) which may be serious or fatal.

TOLUENE: Case studies of persons abusing toluene suggest isolated incidences of adverse effects on the fetus including birth defects. Abuse of toluene at high concentrations (e.g., glue sniffing and solvent abuse) has been associated with adverse effects on the liver, kidney and nervous system, and can cause CNS depression, cardiac arrhythmias, and death. Studies of workers indicate longterm exposure may be related to impaired color vision and hearing. Some studies of workers suggest longterm exposure may be related to neurobehavioral and cognitive changes. Some of these effects have been observed in laboratory animals following repeated exposure to high levels of toluene. Several studies of workers suggest longterm exposure may be related to small increases in spontaneous abortions and changes in some gonadotropic hormones. However, the weight of evidence does not indicate toluene is a reproductive hazard to humans. Studies in laboratory animals indicate some changes in reproductive organs following high levels of exposure, but no significant effects on mating performance or reproduction were observed. Case studies of persons abusing toluene suggest isolated incidences of adverse effects on the fetus including birth defects. Findings in laboratory animals have been largely negative. Positive findings include small increases in minor skeletal and visceral malformations and developmental delays following very high levels of maternal exposure. Studies of workers indicate long-term exposure may be related to effects on the liver, kidney and blood, but these appear to be limited to changes in serum enzymes and decreased leukocyte counts. Adverse effects on the liver, kidney, thymus and nervous system were observed in animal studies following very high levels of exposure. The relevance of these findings to humans is not clear at this time.

XYLENES, ALL ISOMERS: Overexposure to xylene may cause upper respiratory tract irritation, headache, cyanosis, blood serum changes, nervous system damage and narcosis. Effects may be increased by the use of alcoholic beverages. Evidence of liver and kidney impairment were reported in workers recovering from a gross overexposure. Effects from Prolonged or Repeated Exposure: Impaired neurological function was reported in workers exposed to solvents including xylene. Studies in laboratory animals have shown evidence of impaired hearing following high levels of exposure. Studies in laboratory animals suggest some changes in reproductive organs following high levels of exposure but no significant effects on reproduction were observed. Studies in laboratory animals indicate skeletal and visceral malformations, developmental delays, and increased fetal resorptions following extremely high levels of maternal exposure with evidence of maternal toxicity. The relevance of these observations to humans is not clear at this time. Adverse effects on the liver, kidney, bone marrow (changes in blood cell parameters) were observed in laboratory animals following high levels of exposure. The relevance of these observations to humans is not clear at this time.

BENZENE: Studies of workers exposed to benzene show clear evidence that overexposure can cause cancer and other diseases of the blood forming organs including Acute Myelogenous Leukemia (AML), and Aplastic Anemia (AA), an often fatal disease. Some studies suggest overexposure to benzene may also be associated with Myelodysplastic Syndrome (MDS). Findings from a case control study of workers exposed to benzene was reported during the 2009 Benzene Symposium in Munich included an increase in Acute Myeloid Leukemias and Non-Hodgkins Lymphoid Neoplasms (NHLN) of the subtype follicular lymphoma (FL) in some occupational categories. Some studies of workers exposed to benzene have shown an association with increased rates of chromosome aberrations in circulating lymphocytes. One study of women workers exposed to benzene

suggested a weak association with irregular menstruation. However, other studies of workers exposed to benzene have not demonstrated clear evidence of an effect on fertility or reproductive outcome in humans. Benzene can cross the placenta and affect the developing fetus. Cases of AA have been reported in the offspring of persons severely overexposed to benzene. Studies in laboratory animals indicate that prolonged, repeated exposure to high levels of benzene vapor can cause bone marrow suppression and cancer in multiple organ systems. Studies in laboratory animals show evidence of adverse effects on male reproductive organs following high levels of exposure but no significant effects on reproduction have been observed. Embryotoxicity has been reported in studies of laboratory animals but effects were limited to reduced fetal weight and minor skeletal variations. Benzene has been classified as a proven human carcinogen by OSHA and a Group 1 (Carcinogenic to Humans) material by IARC. The current proposed IARC classification for benzene is summarized as follows: Sufficient evidence for Acute Myeloid Leukemia; limited evidence for Acute Lymphatic Leukemia, Chronic Lymphatic Leukemia, Non-Hodgkin Lymphoma, and Multiple Myeloma.

N-HEXANE: Long-term or repeated exposure to n-hexane can cause peripheral nerve damage. Initial symptoms are numbness of the fingers and toes. Also, motor weakness can occur in the digits, but may also involve muscles of the arms, thighs and forearms. The onset of these symptoms may be delayed for several months to a year after the beginning of exposure. Testicular atrophy and partial to full loss of the germ cell line were observed in sub-chronic high-dose inhalation studies of laboratory rodents. These effects appeared irreversible. Rodent reproduction studies have shown evidence of reduced fetal weight but no frank malformations.

CUMENE: Overexposure to cumene may cause upper respiratory tract irritation and CNS depression. Studies in laboratory animals indicate evidence of respiratory tract hyperplasia, and adverse effects on the liver, kidney and adrenal glands following high level exposure. The relevance of these findings to humans is not clear at this time. Findings from lifetime laboratory rodent inhalation studies were as follows: In F344/N rats: an increased incidence of renal carcinomas and adenomas, respiratory epithelial adenomas, and interstitial cell adenomas of the testes. In B6C3F1 mice: an increased incidence of carcinomas and adenomas of the bronchi and lung, liver neoplasms, hemangiosarcomas of the spleen, and adenomas of the thyroid.

1,2,4-TRIMETHYLBENZENE: The following information pertains to a mixture of C9 aromatic hydrocarbons, over 40% of which was composed of 1,2,4-trimethylbenzene. A developmental inhalation study was conducted in laboratory mice. Increased implantation losses, reduced fetal weights, delayed ossification and an increased incidence of cleft palate were observed at the highest exposure level (1,500 ppm). This exposure level was extremely toxic to pregnant female mice (44% mortality). Reduced fetal body weights were also observed at 500 ppm. A multi-generation reproduction inhalation study was conducted in laboratory rats. Reductions in pup weights, pup weight gain, litter size, and pup survival were observed at 1,500 ppm, an exposure level at which significant maternal toxicity was observed. Reduced pup weight gain was also observed at 500 ppm. Embryotoxicity has been reported in studies of laboratory animals. Adverse effects included increased implantation losses, reduced fetal weights, delayed ossification and an increased incidence of cleft palate.<n><n>

ETHYLBENZENE: Findings from a 2-year inhalation study in rodents conducted by NTP were as follows: Effects were observed only at the highest exposure level (750 ppm). At this level the incidence of renal tumors was elevated in male rats (tubular carcinomas) and female rats (tubular adenomas). The incidence of tumors was also elevated in male mice (alveolar and bronchiolar carcinomas) and female mice (hepatocellular carcinomas). IARC has classified ethyl benzene as "possibly carcinogenic to humans" (Group 2B). Studies in laboratory animals indicate some evidence of post-implantation deaths following high levels of maternal exposure. The relevance of these findings to humans is not clear at this time. Studies in laboratory animals indicate limited evidence of renal malformations, resorptions, and developmental delays following high levels of maternal exposure with evidence of maternal toxicity. The relevance of these findings to humans is not clear at this time. Studies in laboratory animals have demonstrated evidence of ototoxicity (hearing loss)

following exposure levels as low as 300 ppm for 5 days. Studies in laboratory animals indicate some evidence of adverse effects on the liver, kidney, thyroid, and pituitary gland.

NAPHTHALENE: Severe jaundice, neurotoxicity (kernicterus) and fatalities have been reported in young children and infants as a result of hemolytic anemia from overexposure to naphthalene. Persons with glucose 6-phosphate dehydrogenase (G6PD) deficiency are more prone to the hemolytic effects of naphthalene. Adverse effects on the kidney have been reported in persons overexposed to naphthalene but these effects are believed to be a consequence of hemolytic anemia, and not a direct effect. Hemolytic anemia has been observed in laboratory animals exposed to naphthalene. Laboratory rodents exposed to naphthalene vapor for 2 years (lifetime studies) developed non-neoplastic and neoplastic tumors and inflammatory lesions of the nasal and respiratory tract. Cataracts and other adverse effects on the eye have been observed in laboratory animals exposed to high levels of naphthalene. Findings from a large number of bacterial and mammalian cell mutation assays have been negative. A few studies have shown chromosomal effects (elevated levels of Sister Chromatid Exchange or chromosomal aberrations) in vitro. Naphthalene has been classified as Possibly Carcinogenic to Humans (2B) by IARC, based on findings from studies in laboratory animals.

CARBON MONOXIDE: is a chemical asphyxiant with no warning properties (such as odor). At 400-500 ppm for 1 hour headache and dyspnea may occur. If activity is increased, symptoms of overexposure may include nausea, irritability, increased respiration, tinnitus, sweating, chest pain, confusion, impaired judgement, dizziness, weakness, drowsiness, ataxia, irregular heart beat, cyanosis and pallor. Levels in excess of 1000 ppm can result in collapse, loss of conciousness, respiratory failure and death. Extremely high concentrations (12,800 ppm) can cause immediate unconsciousness and death in 1-3 minutes. Repeated anoxia can lead to central nervous system damage and peripheral neuropathy, with loss of sensation in the fingers, amnesia, and mental deterioration and possible congestive heart failure. Damage may also occur to the fetus, lung, liver, kidney, spleen, cardiovascular system and other organs.

WHOLLY-VAPORIZED UNLEADED GASOLINE: Lifetime exposure to wholly vaporized unleaded gasoline produced an increased incidence of liver tumors in female mice exposed to the highest exposure concentration (2056 ppm) and α-2 urinary globulin-mediated kidney tumors in male rats. No exposure-related tumors were observed in male mice or female rats. The male-specific rat kidney tumors are not considered relevant to human health. Mice receiving lifetime repeated skin application of various petroleum naphthas exhibited an irritation-dependent increased incidence of skin tumors. Additional studies suggest that these tumors occur through a mechanism that may not be relevant to human health. Epidemiological data from over 18,000 petroleum marketing and distribution workers showed no increased risk of leukemia, multiple myeloma, or kidney cancer resulting from gasoline exposure. Unleaded gasoline has been identified as possibly carcinogenic to humans (2B) by the International Agency for Research on Cancer (IARC).

COMBUSTION ENGINE EXHAUST: Chronic inhalation studies of gasoline engine exhaust in mice, rats and hamsters did not produce any carcinogenic effects. Condensates/extracts of gasoline engine exhaust produced an increase in tumors compared to controls when testing by skin painting, subcutaneous injection, intratracheal instillation or implantation into the lungs. Gasoline exhaust has been classified as possibly carcinogenic to humans (2B) by the International Agency for Research on Cancer (IARC).

Adverse effects related to the physical, chemical and toxicological characteristics

Signs and Symptoms

Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Prolonged or repeated exposure may cause damage to organs. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking.

Sensitization Not expected to be a skin or respiratory sensitizer.

Mutagenic effects May cause genetic defects.

Carcinogenicity May cause cancer.

Cancer designations are listed in the table below

Name	ACGIH (Class)	IARC (Class)	NTP	OSHA
Gasoline 86290-81-5	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Not Listed	Not Listed
Heptane (mixed isomers) 142-82-5	Not Listed	Not Listed	Not Listed	Not Listed
Butane (mixed isomers) 106-97-8	Not Listed	Not Listed	Not Listed	Not Listed
Pentane (mixed isomers) 78-78-4	Not Listed	Not Listed	Not Listed	Not Listed
Hexane Isomers (other than n-Hexane) 107-83-5	Not Listed	Not Listed	Not Listed	Not Listed
Toluene 108-88-3	Not Classifiable (A4)	Not Classifiable (3)	Not Listed	Not Listed
Xylene (mixed isomers) 1330-20-7	Not classifiable (A4)	Not classifiable (3)	Not Listed	Not Listed
Benzene 71-43-2	Confirmed human carcinogen (A1)	Carcinogenic to humans (1)	Known to be human carcinogen	Known carcinogen
n-Hexane 110-54-3	Not Listed	Not Listed	Not Listed	Not Listed
Cumene 98-82-8	Not listed	Possible human carcinogen (2B)	Reasonably anticipated to be a human carcinogen	Not listed
1,2,4 Trimethylbenzene 95-63-6	Not Listed	Not Listed	Not Listed	Not Listed
Ethylbenzene 100-41-4	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Not Listed	Not Listed
Cyclohexane 110-82-7	Not Listed	Not Listed	Not Listed	Not Listed
Octane 111-65-9	Not Listed	Not Listed	Not Listed	Not Listed
1,2,3-Trimethylbenzene 526-73-8	Not Listed	Not Listed	Not Listed	Not Listed
Naphthalene 91-20-3	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Reasonably anticipated to be a human carcinogen	Not Listed

Reproductive toxicity Suspected of damaging fertility or the unborn child.

Specific Target Organ Toxicity (STOT) - single exposure Respiratory system. Central nervous system.

Specific Target Organ Toxicity (STOT) - repeated exposure Blood. Blood-forming organs. Immune system.

Aspiration hazard May be fatal if swallowed or vomited and enters airways.

12. ECOLOGICAL INFORMATION

Ecotoxicity This product should be considered toxic to aquatic organisms, with the potential to cause long lasting adverse effects in the aquatic environment.

Name	Algae/aquatic plants	Fish	Toxicity to Microorganisms	Crustacea
Gasoline 86290-81-5	72-hr EC50 = 56 mg/l Algae	96-hr LC50 = 11 mg/l Rainbow trout (static)	-	48-hr LC50 = 7.6 mg/l Daphnia magna
Heptane (mixed isomers)	-	96-hr LC50 = 375 mg/L	-	-

142-82-5		Tilapia		
Butane (mixed isomers) 106-97-8	-	-	-	-
Pentane (mixed isomers) 78-78-4	-	96-hr LC50 = 3.1 mg/L Rainbow trout	-	48-hr EC50 = >1 - <10 mg/L Daphnia magna
Hexane Isomers (other than n-Hexane) 107-83-5	-	-	-	-
Toluene 108-88-3	72-hr EC50 = 12.5 mg/l Algae	96-hr LC50 <= 10 mg/l Rainbow trout	-	48-hr EC50 = 5.46-9.83 mg/l Daphnia magna 48-hr EC50 = 11.5 mg/l Daphnia magna (Static)
Xylene (mixed isomers) 1330-20-7	72-hr EC50 = 11 mg/l Algae	96-hr LC50 = 8 mg/l Rainbow trout	-	48-hr LC50 = 3.82 mg/l Daphnia magna
Benzene 71-43-2	72-hr EC50 = 29 mg/l Algae	96-hr LC50 = 5.3 mg/l Rainbow trout (flow-through)	-	48-hr EC50 = 8.76-15.6 mg/l Daphnia magna (Static)
n-Hexane 110-54-3	-	96-hr LC50 = 2.5 mg/l Fathead minnow	-	-
Cumene 98-82-8	72-hr EC50 = 2.6 mg/l Algae	96-hr LC50 = 6.04-6.61 mg/l Fathead minnow (Flow-through) 96-hr LC50 = 2.7 mg/l Rainbow trout (semi-static)	-	48-hr EC50 = 7.9-14.1 mg/l Daphnia magna (static)
1,2,4 Trimethylbenzene 95-63-6	-	96-hr LC50 = 7.19-8.28 mg/l Fathead minnow (flow-through)	-	48-hr EC50 = 6.14 mg/L Daphnia magna
Ethylbenzene 100-41-4	72-hr EC50 = 1.7-7.6 mg/l Algae	96-hr LC50 = 4 mg/L Rainbow trout	-	48-hr EC50 = 1-4 mg/L Daphnia magna
Cyclohexane 110-82-7	72-hr EC50 = 500 mg/l Algae	96-hr LC50 = 3.96-5.18 mg/l Fathead minnow	-	48-hr EC50 = 1.7-3.5 mg/L Bay shrimp
Octane 111-65-9	-	-	-	48-hr LC50 = 0.38 mg/l Daphnia magna
1,2,3-Trimethylbenzene 526-73-8	-	96-hr LC50 = 7.72 mg/l Fathead Minnow (flow-through)	-	-
Naphthalene 91-20-3	-	96-hr LC50 = 0.91-2.82 mg/l Rainbow trout (static) 96-hr LC50 = 1.99 mg/l Fathead minnow (static)	-	48-hr LC50 = 1.6 mg/l Daphnia magna

Persistence and degradability Expected to be inherently biodegradable. The presence of ethanol in this product may impede the biodegradation of benzene, toluene, ethylbenzene and xylene in groundwater, resulting in elongated plumes of these constituents.

Bioaccumulation Has the potential to bioaccumulate.

Mobility in soil May partition into air, soil and water.

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues
This material may be a flammable liquid waste.

Safe Handling of Wastes
Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required. Use appropriate grounding and bonding practices. Use only non-sparking tools. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. No smoking.

Disposal of Wastes / Methods of Disposal
The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal
Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper Shipping Name:	Gasoline
UN/Identification No:	UN 1203
Class:	3
Packing Group:	II

TDG (Canada):

UN Proper Shipping Name:	Gasoline
UN/Identification No:	UN 1203
Transport Hazard Class(es):	3
Packing Group:	II

15. REGULATORY INFORMATION

US Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b): This product and/or its components are listed on the TSCA Chemical Inventory.

EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product does not contain any component(s) included on EPA's Extremely Hazardous Substance (EHS) List.

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
Gasoline	NA
Heptane (mixed isomers)	NA
Butane (mixed isomers)	NA
Pentane (mixed isomers)	NA
Hexane Isomers (other than n-Hexane)	NA
Toluene	NA
Xylene (mixed isomers)	NA
Benzene	NA
n-Hexane	NA
Cumene	NA
1,2,4 Trimethylbenzene	NA
Ethylbenzene	NA
Cyclohexane	NA
Octane	NA
1,2,3-Trimethylbenzene	NA
Naphthalene	NA

SARA Section 304: This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	Hazardous Substances RQs
Gasoline	NA
Heptane (mixed isomers)	NA
Butane (mixed isomers)	NA
Pentane (mixed isomers)	NA
Hexane Isomers (other than n-Hexane)	NA

Toluene	1000 lb final RQ 454 kg final RQ
Xylene (mixed isomers)	100
Benzene	10
n-Hexane	5000
Cumene	5000
1,2,4 Trimethylbenzene	NA
Ethylbenzene	1000
Cyclohexane	1000
Octane	NA
1,2,3-Trimethylbenzene	NA
Naphthalene	100 lb final RQ 45.4 kg final RQ

SARA Section 311/312: The following EPA hazard categories apply to this product:

Acute Health Hazard
Chronic Health Hazard
Fire Hazard

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

Name	CERCLA/SARA 313 Emission reporting:
Gasoline	None
Heptane (mixed isomers)	None
Butane (mixed isomers)	None
Pentane (mixed isomers)	None
Hexane Isomers (other than n-Hexane)	None
Toluene	1.0 % de minimis concentration
Xylene (mixed isomers)	1.0 % de minimis concentration
Benzene	0.1 % de minimis concentration
n-Hexane	1.0 % de minimis concentration
Cumene	1.0 % de minimis concentration
1,2,4 Trimethylbenzene	1.0 % de minimis concentration
Ethylbenzene	0.1 % de minimis concentration
Cyclohexane	1.0 % de minimis concentration
Octane	None
1,2,3-Trimethylbenzene	None
Naphthalene	0.1 % de minimis concentration

State and Community Right-To-Know Regulations:
The following component(s) of this material are identified on the regulatory lists below:

Gasoline

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 0957
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Carcinogen; Flammable - third degree
New Jersey - Environmental Hazardous	SN 0957 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental

Substances List:	hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Heptane (mixed isomers)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1339
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Butane (mixed isomers)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 0273
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - fourth degree
New Jersey - Environmental Hazardous Substances List:	SN 0273 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Pentane (mixed isomers)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1064
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - fourth degree
New Jersey - Environmental Hazardous Substances List:	SN 1064 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 -	Not Listed

List of Hazardous Substances:	
Hexane Isomers (other than n-Hexane)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1285
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Toluene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Developmental toxicity, initial date 1/1/91 Female reproductive toxicity, initial date 8/7/09
New Jersey Right-To-Know:	SN 1866
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic (skin); Flammable (skin)
Michigan Critical Materials Register List:	100 lb Annual usage threshold
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree; Teratogen
New Jersey - Environmental Hazardous Substances List:	SN 1866 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1000 lb RQ (air); 1 lb RQ (land/water)
Xylene (mixed isomers)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 2014
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic (skin); Flammable (skin)
Michigan Critical Materials Register List:	100 lb Annual usage threshold all isomers
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 2014 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1000 lb RQ (air); 1 lb RQ (land/water)
Benzene	
Louisiana Right-To-Know:	Not Listed

California Proposition 65:	Carcinogen, initial date 2/27/87 Developmental toxicity, initial date 12/26/97 Male reproductive toxicity, initial date 12/26/97
New Jersey Right-To-Know:	SN 0197
Pennsylvania Right-To-Know:	Environmental hazard; Special hazardous substance
Massachusetts Right-To Know:	Carcinogen; Extraordinarily hazardous
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic (skin); Flammable (skin); Carcinogen (skin)
Michigan Critical Materials Register List:	100 lb Annual usage threshold
Massachusetts Extraordinarily Hazardous Substances:	Carcinogen; Extraordinarily hazardous
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Present
New Jersey - Special Hazardous Substances:	Carcinogen; Flammable - third degree; Mutagen
New Jersey - Environmental Hazardous Substances List:	SN 0197 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	10 lb RQ (air); 1 lb RQ (land/water)

n-Hexane

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1340
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 1340 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1 lb RQ (air); 1 lb RQ (land/water)

Cumene

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Carcinogen, initial date 4/6/10
New Jersey Right-To-Know:	SN 0542
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic (skin); Flammable (skin)
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 0542 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	5000 lb RQ (air); 1 lb RQ (land/water)

1,2,4 Trimethylbenzene

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1929

Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Ethylbenzene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Carcinogen, initial date 6/11/04
New Jersey Right-To-Know:	SN 0851
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Carcinogen; flammable - Third degree
New Jersey - Environmental Hazardous Substances List:	SN 0851 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1000 lb RQ (air); 1 lb RQ (land/water)
Cyclohexane	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 0565
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 0565 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1000 lb RQ (air); 1 lb RQ (land/water)
Octane	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1434
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable

Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
1,2,3-Trimethylbenzene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1929
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Naphthalene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Carcinogen, initial date 4/19/02
New Jersey Right-To-Know:	SN 1322 SN 3758
Pennsylvania Right-To-Know:	Environmental hazard Present (particulate)
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Carcinogen
New Jersey - Environmental Hazardous Substances List:	SN 1322 TPQ: 500 lb (Reportable at the de minimis quantity of >0.1%)
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	100 lb RQ (air); 1 lb RQ (land/water)

Canada DSL/NDSL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all of the information required by those regulations.

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
Gasoline	B2,D2A,D2B	0.1%
Heptane (mixed isomers)	B2,D2B	1%

Butane (mixed isomers)	A,B1	1%
Pentane (mixed isomers)	B2	1%
Hexane Isomers (other than n-Hexane)	B2	1%
Toluene	B2,D2A,D2B	0.1%
Xylene (mixed isomers)	B2,D2A,D2B	m-, o-isomers 1.0%; p-isomer 0.1%
Benzene	B2,D2A,D2B	0.1%
n-Hexane	B2,D2A,D2B	1%
Cumene	B2,D2A	0.1%
1,2,4 Trimethylbenzene	B3,D2B	1%
Ethylbenzene	B2,D2A,D2B	0.1%
Cyclohexane	B2,D2B	1%
Octane	B2,D2B	1%
1,2,3-Trimethylbenzene	B3	1%
Naphthalene	B4,D2A	0.1%

Note: Not applicable.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety

Revision Notes

Revision Date 03/19/2018
Previous Publish Date 11/06/2017
Revised Sections The following sections (§) have been updated:
2. HAZARD IDENTIFICATION
3. COMPOSITION/INFORMATION ON INGREDIENTS
4. FIRST AID MEASURES
11. TOXICOLOGICAL INFORMATION

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

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29 CFR 1910.1200 (OSHA HazCom 2012)

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product identifier

Trade name : Valvoline™ SAE 30 NON-DETERGENT MOTOR OIL

Details of the supplier of the safety data sheet Valvoline LLC 100 Valvoline Way Lexington, KY 40509 United States of America (USA) 1-800-TEAMVAL (1-800-832-6825) SDS@valvoline.com	**Emergency telephone number** 1-800-VALVOLINE (1-800-825-8654) **Regulatory Information Number** 1-800-TEAMVAL (1-800-832-6825) **Product Information** 1-800-TEAMVAL (1-800-832-6825)

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Not a hazardous substance or mixture.

GHS label elements

Not a hazardous substance or mixture.

Other hazards

None known.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Mixture

Hazardous components

Chemical name	CAS-No.	Classification	Concentration (%)
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC	64742-54-7	Not a hazardous substance or mixture.	>=80.00 - < 90.00

SECTION 4. FIRST AID MEASURES

General advice : No hazards which require special first aid measures.

If inhaled	:	If breathed in, move person into fresh air. If unconscious, place in recovery position and seek medical advice. If symptoms persist, call a physician.
In case of skin contact	:	First aid is not normally required. However, it is recommended that exposed areas be cleaned by washing with soap and water.
In case of eye contact	:	Remove contact lenses. Protect unharmed eye.
If swallowed	:	Do not give milk or alcoholic beverages. Never give anything by mouth to an unconscious person. If symptoms persist, call a physician.
Most important symptoms and effects, both acute and delayed	:	No symptoms known or expected.
Notes to physician	:	No hazards which require special first aid measures.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media	:	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Water spray Foam Carbon dioxide (CO2) Dry chemical
Specific hazards during firefighting	:	Do not allow run-off from fire fighting to enter drains or water courses.
Hazardous combustion products	:	carbon dioxide and carbon monoxide Hydrocarbons
Specific extinguishing methods	:	
		Product is compatible with standard fire-fighting agents.
Further information	:	Standard procedure for chemical fires.
Special protective equipment for firefighters	:	In the event of fire, wear self-contained breathing apparatus.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Persons not wearing protective equipment should be excluded from area of spill until clean-up has been completed.
Environmental precautions	:	Prevent further leakage or spillage if safe to do so.
Methods and materials for containment and cleaning up	:	Soak up with inert absorbent material (e.g. sand, silica gel, acid binder, universal binder, sawdust). Keep in suitable, closed containers for disposal.
Other information	:	Comply with all applicable federal, state, and local regulations.

SECTION 7. HANDLING AND STORAGE

Advice on safe handling	:	Smoking, eating and drinking should be prohibited in the application area. For personal protection see section 8.
Materials to avoid	:	No materials to be especially mentioned.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC	64742-54-7	TWA	5 mg/m3 Mist	OSHA Z-1
		TWA	5 mg/m3 Inhalable fraction	ACGIH
		TWA	5 mg/m3 Mist	OSHA P0
		TWA	5 mg/m3 Mist	NIOSH REL
		ST	10 mg/m3 Mist	NIOSH REL
		PEL	5 mg/m3 particulate	CAL PEL

Engineering measures	:	General room ventilation should be adequate for normal conditions of use. However, if unusual operating conditions exist, provide sufficient mechanical (general and/or local

exhaust) ventilation to maintain exposure below exposure guidelines (if applicable) or below levels that cause known, suspected or apparent adverse effects.

Personal protective equipment

Respiratory protection	:	No personal respiratory protective equipment normally required.
Eye protection	:	Not required under normal conditions of use. Wear splash-proof safety goggles if material could be misted or splashed into eyes.
Skin and body protection	:	Wear as appropriate: Safety shoes Wear resistant gloves (consult your safety equipment supplier).
Hygiene measures	:	General industrial hygiene practice.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	liquid
Colour	:	amber
Odour	:	No data available
Odour Threshold	:	No data available
pH	:	No data available
Melting point/freezing point	:	No data available
Boiling point/boiling range	:	No data available
Flash point	:	> 390 °F / > 199 °C Method: Cleveland open cup
Evaporation rate	:	No data available
Flammability (solid, gas)	:	No data available
Self-ignition	:	No data available
Upper explosion limit / Upper flammability limit	:	No data available

Lower explosion limit / Lower flammability limit	:	No data available
Vapour pressure	:	1.3333333 hPa (68 °F / 20 °C) Calculated Vapor Pressure
Relative vapour density	:	No data available
Relative density	:	0.888 (60.1 °F / 15.6 °C)
Density	:	0.8890 g/cm3 (60.01 °F / 15.56 °C)
Solubility(ies)		
Water solubility	:	negligible
Solubility in other solvents	:	No data available
Partition coefficient: n-octanol/water	:	No data available
Decomposition temperature	:	No data available
Viscosity		
Viscosity, dynamic	:	No data available
Viscosity, kinematic	:	No data available
Oxidizing properties	:	No data available

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	No decomposition if stored and applied as directed.
Chemical stability	:	Stable under recommended storage conditions.
Possibility of hazardous reactions	:	Product will not undergo hazardous polymerization.
Conditions to avoid	:	None known.
Incompatible materials	:	Strong acids Strong oxidizing agents
Hazardous decomposition products		No hazardous decomposition products are known.

SECTION 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure
Inhalation
Skin contact
Eye Contact
Ingestion
Acute toxicity
Not classified based on available information.
Product:
Acute dermal toxicity : Acute toxicity estimate: > 5,000 mg/kg
Method: Calculation method

Components:
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC:
Acute oral toxicity : LD50 (Rat): > 15 g/kg

Acute dermal toxicity : LD50 (Rabbit): > 5 g/kg

Skin corrosion/irritation
Not classified based on available information.
Components:
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC:
Assessment : Slight, transient irritation
Result : Slight, transient irritation

Serious eye damage/eye irritation
Not classified based on available information.
Product:
Remarks : Unlikely to cause eye irritation or injury.

Components:
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC:
Result : No eye irritation
Assessment : No eye irritation

Respiratory or skin sensitisation
Skin sensitisation
Not classified based on available information.
Respiratory sensitisation
Not classified based on available information.
Germ cell mutagenicity
Not classified based on available information.
Carcinogenicity
Not classified based on available information.
Components:
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC:
Carcinogenicity - Assessment : Classified based on DMSO extract content < 3% (Regulation (EC) 1272/2008, Annex VI, Part 3, Note L)

IARC No component of this product present at levels greater than or equal to 0.1% is

identified as probable, possible or confirmed human carcinogen by IARC.

OSHA No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

NTP No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive toxicity
Not classified based on available information.
STOT - single exposure
Not classified based on available information.
STOT - repeated exposure
Not classified based on available information.
Aspiration toxicity
Not classified based on available information.

Components:
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC:
No aspiration toxicity classification

Further information
Product:
Remarks : No data available

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity
Product:
Ecotoxicology Assessment
Short-term (acute) aquatic hazard : Not classified based on available information.

Long-term (chronic) aquatic hazard : Not classified based on available information.

Components:
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC:
Toxicity to fish : LL50 (Fish): > 100 mg/l
Exposure time: 96 h

Toxicity to daphnia and other aquatic invertebrates : EL50 (Aquatic invertebrates): > 10,000 mg/l
Exposure time: 48 h

Toxicity to algae : EL50 (Algae, algal mat (Algae)): > 100 mg/l
Exposure time: 72 h

Toxicity to fish (Chronic toxicity) : NOEC (Fish): 10 mg/l

Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity) : NOEC (Aquatic invertebrates): 10 mg/l

Ecotoxicology Assessment
Short-term (acute) aquatic hazard : Not classified based on available information.

Long-term (chronic) aquatic hazard : Not classified based on available information.

Persistence and degradability
Components:
No data available
Bioaccumulative potential
Components:
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC:
Partition coefficient: n-octanol/water : log Pow: Expected > 7

No data available
Mobility in soil
Components:
No data available
Other adverse effects
No data available
Product:
Additional ecological information : No data available

Components:

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

General advice : Dispose of in accordance with all applicable local, state and federal regulations.

Contaminated packaging : Empty remaining contents.

SECTION 14. TRANSPORT INFORMATION

International transport regulations

REGULATION

ID NUMBER	PROPER SHIPPING NAME	*HAZARD CLASS	SUBSIDIARY HAZARDS	PACKING GROUP	MARINE POLLUTANT / LTD. QTY.

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U.S. DOT - ROAD

Not dangerous goods

CFR_RAIL_C

Not dangerous goods

U.S. DOT - INLAND WATERWAYS

Not dangerous goods

TDG_ROAD_C

Not dangerous goods

TDG_RAIL_C

Not dangerous goods

TDG_INWT_C

Not dangerous goods

INTERNATIONAL MARITIME DANGEROUS GOODS

Not dangerous goods

INTERNATIONAL AIR TRANSPORT ASSOCIATION - CARGO

Not dangerous goods

INTERNATIONAL AIR TRANSPORT ASSOCIATION - PASSENGER

Not dangerous goods

MX_DG

Not dangerous goods

***ORM = ORM-D, CBL = COMBUSTIBLE LIQUID**

Marine pollutant	no

Dangerous goods descriptions (if indicated above) may not reflect quantity, end-use or region-specific exceptions that can be applied. Consult shipping documents for descriptions that are specific to the shipment.

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know Act

CERCLA Reportable Quantity

Components	CAS-No.	Component RQ (lbs)	Calculated product RQ (lbs)
TOLUENE	108-88-3	1000	*

*: Calculated RQ exceeds reasonably attainable upper limit.

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 311/312 Hazards : Hazard not otherwise classified (physical hazards)

California Prop. 65

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

The components of this product are reported in the following inventories:

DSL : All components of this product are on the Canadian DSL

AICS : On the inventory, or in compliance with the inventory

ENCS : On the inventory, or in compliance with the inventory

KECI : On the inventory, or in compliance with the inventory

PICCS : On the inventory, or in compliance with the inventory

IECSC : On the inventory, or in compliance with the inventory

TCSI : On the inventory, or in compliance with the inventory

TSCA : On TSCA Inventory

TSCA list

No substances are subject to TSCA 12(b) export notification requirements.

SECTION 16. OTHER INFORMATION

Further information
Revision Date: 10/23/2018

NFPA:	HMIS III:

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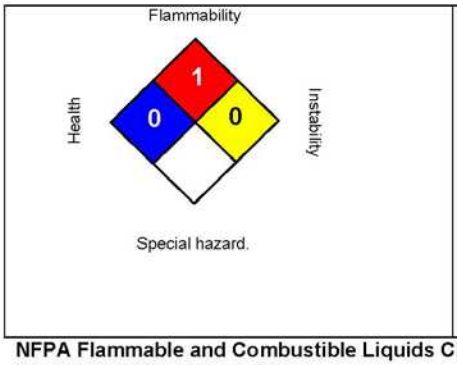


HEALTH	0
FLAMMABILITY	1
PHYSICAL HAZARD	0

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 = Extreme, * = Chronic

NFPA Flammable and Combustible Liquids Classification
Combustible Liquid Class IIIB

Full text of H-Statements

Sources of key data used to compile the Safety Data Sheet
Valvoline internal data including own and sponsored test reports
The UNECE administers regional agreements implementing harmonised classification for labelling (GHS) and transport.

The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. This SDS has been prepared by Valvoline's Environmental Health and Safety Department (1-800-VALVOLINE).

List of abbreviations and acronyms that could be, but not necessarily are, used in this safety data sheet :
ACGIH : American Conference of Industrial Hygienists
BEI : Biological Exposure Index
CAS : Chemical Abstracts Service (Division of the American Chemical Society).
CMR : Carcinogenic, Mutagenic or Toxic for Reproduction
FG : Food grade
GHS : Globally Harmonized System of Classification and Labeling of Chemicals.
H-statement : Hazard Statement
IATA : International Air Transport Association.
IATA-DGR : Dangerous Goods Regulation by the "International Air Transport Association" (IATA).

ICAO : International Civil Aviation Organization
ICAO-TI (ICAO) : Technical Instructions by the "International Civil Aviation Organization"
IMDG : International Maritime Code for Dangerous Goods

ISO : International Organization for Standardization
logPow : octanol-water partition coefficient
LCxx : Lethal Concentration, for xx percent of test population
LDxx : Lethal Dose, for xx percent of test population.
ICxx : Inhibitory Concentration for xx of a substance
Ecxx : Effective Concentration of xx
N.O.S.: Not Otherwise Specified
OECD : Organization for Economic Co-operation and Development
OEL : Occupational Exposure Limit
P-Statement : Precautionary Statement
PBT : Persistent , Bioaccumulative and Toxic
PPE : Personal Protective Equipment
STEL : Short-term exposure limit
STOT : Specific Target Organ Toxicity
TLV : Threshold Limit Value
TWA : Time-weighted average
vPvB : Very Persistent and Very Bioaccumulative
WEL : Workplace Exposure Level

CERCLA : Comprehensive Environmental Response, Compensation, and Liability Act
DOT : Department of Transportation
FIFRA : Federal Insecticide, Fungicide, and Rodenticide Act
HMIRC : Hazardous Materials Information Review Commission
HMIS : Hazardous Materials Identification System
NFPA : National Fire Protection Association
NIOSH : National Institute for Occupational Safety and Health
OSHA : Occupational Safety and Health Administration
PMRA : Health Canada Pest Management Regulatory Agency
RTK : Right to Know
WHMIS : Workplace Hazardous Materials Information System

Appendix 9b
Attachment J
SPCC Site Inspection Checklists

Monthly SPCC Inspection of 920 Bulk Oil & Fluids Facilities

Yes	No	
☐	☐	Does the maintenance building oil containment appear sound, i.e., cracks, holes , broken curbs, ect? If not explain:
☐	☐	Is the containment area free of standing water? If not explain:
☐	☐	Is the containment area free of spilled oil, glycol or other fluids? If not explain:
☐	☐	Do bulk oil tanks appear sound, i.e., no excessive rust, missing plugs, leaking hose connections, ect If not explain:
☐	☐	Do ICB tanks appear sound, i.e., excessive rust, missing caps, damaged shut-off valves, leaking hose connections, ect? If not explain:
☐	☐	Are drip pans in place under ICB hose connections? If not explain:
☐	☐	Is the area free of excessive non-hazordous waste accumulation, i.e., used acid batteries, crushed filters, used glycol, used grease, punched aerosol cans? If not explain:
☐	☐	Are all drums properly marked and labeled? If not explain:
☐	☐	Are absorbents readily available? If not explain:
☐	☐	Is containment area reasonably free of trash? If not explain:
☐	☐	Are all general observations within specifications? If not explain:

Inspected By **Date**

Revised 02-11-14 GF

Monthly SPCC Inspection of Hawk Inlet Fueling Facilities

Yes	No	
☐	☐	Are containment berm(s) and diversionary structure in place and operating correctly? If not explain:
☐	☐	Are main fuel transfer pump valves locked out in off position? If not explain:
☐	☐	Is fuel truck transfer hose capped when in non-operating status? If not explain:
☐	☐	Is fuel truck transfer area clean, clear of debris and in good working order? If not explain:
☐	☐	Are absorbent materials readily available to the fuel operator? If not explain:
☐	☐	Is containment berm dewatering pump locked in the off position? If not explain:
☐	☐	Is containment drainage log being maintained? If not explain:
☐	☐	Are master flow and drain valves and any other valves that permit direct outward flow of storage tanks contents securely locked in the closed position when in nonoperating status? If not explain:
☐	☐	Are valve glands and valve bodies free of leaks or seeps? If not explain:
☐	☐	Is the tank, FT02 (200,000 gal.) free of excessive rust, holes or leaks? If not explain:
☐	☐	Is the liner/tank seal free of defects? Banding tight, caulking sound? If not explain:
☐	☐	Are intermediate valves between master valve and fuel transfer pump in closed position when in nonoperating status? If not explain:
☐	☐	Is the the fuel filter system free of leaks? If not explain:
☐	☐	Are pipeline supports in place and undamaged? If not explain:
☐	☐	Are pipeline flanges in good working condition? (ie. rust, leaks, metal wear, bent flanges) If not explain:
☐	☐	Is pipeline in good working order and leak free? If not explain:
☐	☐	Does tank level indicator appear to be working properly? If not explain:
☐	☐	Is intermediate pipeline valve between concentrate building and loading dolphin locked out in open position? If not explain:
☐	☐	Is MARSEC security gate locked when in nonoperational status? If not explain:
☐	☐	Is dolphin fuel loading connection capped when in nonoperational status? If not explain:
☐	☐	Is dolphin fuel loading valve closed and locked out when in nonoperational status? If not explain:

Inspected By **Date**

Revised 01-22-18 DL

Monthly SPCC Inspection of 920 Bulk Fueling Facilities

Yes	No	
☐	☐	Are containment berm(s) and diversionary structure in place and operating correctly? If not explain:
☐	☐	Is fuel truck transfer hose capped when in nonoperating status? If not explain:
☐	☐	Is fuel truck transfer area clean, clear of debris and in good working order? If not explain:
☐	☐	Are absorbent materials readily available to the fuel operator? If not explain:
☐	☐	Is containment berm dewatering pump locked in the off position? If not explain:
☐	☐	Is containment drainage log being maintained? If not explain:
☐	☐	Are valve glands and valve bodies free of leaks or seeps? If not explain:
☐	☐	Are the tanks, FT01 (60,000 gal.), FT04 (43,000 gal.) and FT05 (43,000 gal.) free of excessive rust, holes or leaks? If not explain:
☐	☐	Are pipeline supports in place and undamaged? If not explain:
☐	☐	Are flanges and expansion joint in good working condition? (ie. rust, leaks, metal wear, bent flanges) If not explain:
☐	☐	Is pipeline in good working order and free of leaks? If not explain:
☐	☐	Is the pipeline and tanks clearly marked and painted? If not explain:
☐	☐	Are product dispensing hoses undamaged and suitable for use? If not explain:
☐	☐	Are DEF tote, containment and dispensing system in good working order? If not explain:
☐	☐	Do tank level indicators appear to be working properly? If not explain:

Inspected By _____ **Date** _____

Appendix 9b
Attachment K
Oil Spill History

Spill Register : 1989

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	4/1/1989	diesel fuel	3,300	Generator day tank	Solenoid valve	valve failure during auto refill, <50 gal to water	ground/water	no

Spill Register : 1990

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	10/24/1990	diesel fuel	< 1			faulty D-ring released fuel	ground	no
2	11/26/1990	diesel fuel	1	920 Area	Haul truck	truck struck power pole	ground	no

Spill Register : 1991

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	1/3/1991	hydraulic oil	60	920-storage	forklift	punched hole in full barrel	ground	no
2	1/21/1991	hydraulic oil	60	Hawk Inlet	ship loader	blown seal released hydraulic oil	gravel	no
3	9/11/1991	hydraulic oil	<10	Hawk Inlet	fuel system	line leak, sheen on water	ground/water	no

Spill Register : 1992

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	1/20/1992	hydraulic oil	60		hydraulic system	seal failure, 5 gal to water	ground/water	no
2	9/28/1992	diesel fuel	8	1350 Area	55-gallon drum	overfilled drum/tank	ground	no
3	9/30/1992	hydraulic oil	40	920 Area - concrete apron	hydraulic system	hydraulic line failure	ground	no
4	10/31/1992	hydraulic oil	20		hydraulic system	hydraulic line failure	ground	no

Spill Register : 1993

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
	no reportable spills							

Spill Register : 1994

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	2/24/1994	hydraulic oil	7		hydraulic system	hydraulic line failure	ground	no
2	3/14/1994	diesel fuel	50	Hawk Inlet Core Shed	heater day tank	tank shifted	ground	no

Spill Register : 1995

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	1/21/1995	diesel fuel	>50 (estimate)	920-power house	DG-03 generator engine	fire; diesel spray onto exhaust	concrete	no
2	1/30/1995	hydraulic oil	20	B-Road	haul trailer	hydraulic line failure	ground	no
3	2/8/1995	diesel fuel	<5	920 Area	front-end loader	fuel line leak	ground	no
4	3/16/1995	diesel fuel	15	920 Area	ambulance	fuel line crack	concrete	no
5	5/15/1995	hydraulic oil	40		hydraulic line	hydraulic line burst	ground	no
6	8/14/1995	hydraulic oil	50		hydraulic cylinder	hydraulic cylinder burst	ground	no
7	10/25/1995	hydraulic oil	5		hydraulic hose	hydraulic hose burst	ground	no
8	11/21/1995	hydraulic oil	15-20		hydraulic line	hydraulic line rupture	ground	no
9	12/2/1995	diesel fuel	10	920 Area	fuel pump	nozzle failed to fully shutoff	concrete	yes
10	12/18/1995	diesel fuel	<10	Hawk Inlet	fuel haulage trailer	dry-lock hose fitting leak	concrete	yes

Spill Register : 1996

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	3/3/1996	diesel fuel	12	Hawk Inlet	fuel haulage trailer	over-filled trailer tank, operator error	concrete	yes
2	3/5/1996	diesel fuel	10	920 Batch Plant	batch plant day tank	over-filled tank, operator error	ground	no
3	4/5/1996	diesel fuel	<50	Hawk Inlet	fuel truck	faulty automatic shut-off valve, tank overfill	ground	no
4	5/11/1996	diesel fuel	5	Hawk Inlet	fuel barge (USCG $250 fine)	fuel off-load spill <2 gallons into Hawk Inlet	contain/ water	no
5	7/17/1996	hydraulic oil	10		hydraulic system	hydraulic hose fitting blown	ground	no
6	8/8/1996	diesel fuel	<10	920 Area	UG haul truck	faulty automatic shut-off valve, tank overfill	concrete	yes
7	12/31/1996	diesel fuel	<10	920 Area	fuel pump	fuel refill valve left slightly open	concrete	yes

Spill Register : 1997

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	1/20/1997	hydraulic oil	100-150	920-surface shop	lube tank hose valve	tank valve not fully closed	concrete	yes
2	3/9/1997	hydraulic oil	12		hydraulic system	blown hydraulic hose	ground	no
3	5/27/1997	water/used oil	500 estimate	Hawk Inlet warehouse pad	buried waste disposal site	inadvertent breaching of closed waste site	ground	no
4	7/7/1997	diesel fuel	200	920 fuel farm	60,000 gallon fuel tank	level gauge failure allowed tank overfill	concrete	yes
5	9/20/1997	hydraulic oil	30		hydraulic system	hydraulic line broke	ground	no
6	11/19/1997	diesel fuel	50-55	Hawk Inlet	buried historic fuel tanks	construction breached buried tanks	ground	no

Spill Register : 1998

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	3/25/1998	hydraulic oil	150	920-UG shop	hydraulic fluids system	line maintenance began without tank isolation	concrete	yes

Spill Register : 1999

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	1/22/1999	diesel fuel	100	920 fuel pump	UG haul truck	filling truck left unattended	concrete	yes
2	5/5/1999	hydraulic oil	15	920 Area	surface haul truck	hydraulic filter broken	concrete	yes
3	7/21/1999	diesel fuel	300	Hawk Inlet	fuel distribution sys.for 200,000 gal tank	system in repair, left unattended/unsecured	HDPE liner	yes
4	7/29/1999	hydraulic oil	25	920 - surface shop	shop hydraulic oil distribution line	broken hydraulic filter	concrete	yes
5	8/20/1999	hydraulic oil	15	920 Area	hydraulic system	blown hydraulic hose	concrete	yes
6	8/24/1999	used oil	30	Hawk Inlet warehouse	used oil tank	overfill holding tank during transfer	ground	no
7	8/28/1999	hydraulic oil	50		hydraulic system	blown hydraulic hose	ground	yes
8	11/18/1999	hydraulic oil	25-30		hydraulic system	hydraulic line rupture	ground	yes
9	12/27/1999	used oil	150	920 Area	used oil accumulation tank	full tank dropped during handling	concrete	yes

Spill Register : 2000

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	1/17/2000	lubricating oil	200	920-surface shop	lubricating oil holding tank	valve left partially open following transfer	concrete	yes
2	2/24/2000	diesel fuel	20-40			tank overfilled	concrete	yes
3	4/19/2000	hydraulic oil	200	Hawk Inlet truck pad	hydraulic system	blown hydraulic hose	ground	no
4	6/19/2000	hydraulic oil	20		hydraulic system	blown hydraulic line	ground	no
5	7/12/2000	40-weight oil	80	920-surface shop	lubricating oil holding tank	valve left partially open following transfer	concrete	yes
6	7/16/2000	hydraulic oil	20		hydraulic system	blown hydraulic hose	ground	no
7	7/26/2000	diesel fuel	40	Tailings area	surface fuel truck	pressure gauge failure during delivery	ground	yes
8	9/18/2000	hydraulic oil	50		surface haul truck	blown hydraulic hose	ground	yes
9	9/21/2000	hydraulic oil	25		UG haul truck	dump valve failure	ground	no
10	10/18/2000	hydraulic oil	80	Concentrate storage building	hydraulic system	incorrect line installed, failed	ground	no
11	10/24/2000	hydraulic oil	20		hydraulic system	blown hydraulic line	ground	no
12	11/7/2000	hydraulic oil	10		hydraulic system	filter gasket failure	ground	no

Spill Register : 2001

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	1/17/2001	Hydraulic Oil	10	Hawk Inlet Truck Pad	Fork Lift	Hydraulic Hose Failure		No
2	2/1/2001	Diesel	3	Pit 5		Diesel Nozzle Auto-Stop failure		Yes
3	2/2/2001	Diesel	2	Tailings		Diesel Nozzle Auto-Stop failure		Yes
4	3/8/2001	Diesel	20	Greens Creek Pump House	New Mobile Compressor	Fuel Tank Received Cracked		No
5	3/29/2001	Diesel	170	Hawk Inlet Fuel Storage	Fuel Line Vent	Leak		Yes
6	5/6/2001	Lube Oil & Glycol	100 & 70	920 Power House	DG-05 GenSet	Catastrophic Engine Failure		Yes
7	5/10/2001	Diesel	40	Hawk Inlet; pad and barge	Front-end Loader	Fuel tank puncture		Yes
8	6/14/2001	Hydraulic Oil	20	Mill Pad area	Power Washer	Hydraulic Line Rupture		Yes
9	6/30/2001	Diesel Fuel	20	Hawk Inlet Truck Pad	Service Truck	Faulty Solenoid Valve		Yes
10	8/24/2001	Oil	45	Mill Compressor Room	AC-21 Air Compressor	Loose Pipe Flange Fitting		Yes
11	10/7/2001	Hydraulic Oil	50	Ore Pad	Rock Breaker Arm	Burst Hydraulic Hose		Yes

Spill Register : 2002

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	9/29/2002	Hydraulic Oil	50	Beach to 1-Mile B-Road	MT-03	Blown Hydraulic Filter		No
2	11/22/2002	90-Weight Lube Oil	200	Underground Shop	Storage Tote	Slipped Off Of FEL & Split Open		Yes
3	11/27/2002	Diesel/Used Oil	50	Outside of Power House	Used Oil Tank	Over Filled Used Oil Tank		Yes

Spill Register : 2003

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	6/5/2003	Aviation Fuel	40	860 Helipad	Helicopter	Spilled refueling drum		yes
2	9/29/2003	Diesel Fuel	40	920 Fuel Pump	Fuel Pump	Large Spill Found @ Pump		yes

Spill Register : 2004

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	6/29/2004	Diesel Fuel	2	Upper Zinc Creek	Exploration Drill Rig	Hand Pump Tipped Over		No
2	8/2/2004	Hydraulic Oil	50	1.8-Mile B-Road	MaxHaul Rock Trailer MM11	Trailer Rollover		No
3	8/26/2004	Diesel Fuel	<5	Upper Zinc Creek	Exploration Drill Rig	Leak From Uncontained Tank		No
4	10/5/2004	Hydraulic Oil	60	Underground 2950- 613 Drift	Underground Loader	Blown Hose Tank Drained		Yes

Spill Register : 2005

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	6/16/2005	Diesel Fuel	350	Underground Lube Bay 653	Lube Truck LT-14	Nozzle Stripped/Tank Drained		Yes
2	12/1/2005	Hydraulic Oil	75	Underground Main Haulage	Haul Truck HT-40	Broken Hydraulic Fitting		No
3	12/11/2005	Hydraulic Oil	25	920 Ore Pad	Underground Haul Truck	Blown Hydraulic Hose		No

Spill Register : 2006

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	6/27/2006	Diesel Fuel	1,500	Hawk Inlet Fuel Farm Contai	Day-Tank Overfilled	Valving Incorrectly Set Filling Haul Truck		Yes
2	9/30/2006	Diesel Fuel	480	920 Fuel Farm	Diesel Tanks FT-01, FT-04, FT-05	Tank Overflow Into Secondary Containment		Yes

Spill Register : 2007

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
	no reportable spills							

Spill Register : 2008

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	2/20/2008	glycol	50	Mill regrind building	glycol heater	FEL fork rack struck heater feed pipes	concrete	yes
2	2/27/2008	jet fuel	25-50	Hawk Inlet helicopter pad	helicopter fuel tank	valve left partially open at last use	ground	no
3	3/19/2008	hydraulic oil	350	Underground maintenance sh	shipping/storage tote	valve broke off in moving	concrete	yes
4	9/28/2008	ATF	45	920 warehouse	drum and forklift	drum was compromised while moving it out of a connex	packed dirt pad	no
5	12/30/2008	glycol	305	920 near powerplant	forklift and chemical tote	forklift tire slipped on ice and tote fell off of forklift - top broke off	frozen gnd/snow	no

Spill Register : 2009

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	1/13/2009	hydraulic oil	60	Site 23	haul truck	hydraulic oil filter loose and leaked	snow/waste rock	no
2	3/8/2009	diesel	200	920 powerhouse	generator	high pressure fuel line ruptured and leaked	concrete	yes
3	5/2/2009	glycol	70	920 powerhouse	pipeline	breach in pipeline	dirt	yes
4	5/3/2009	hydraulic oil	30	mill	filter press	flange blew off end of hydraulic ram	concrete	yes
5	5/11/2009	hydraulic oil	44	920 near shop	haul truck	hydraulic oil filter loose and leaked	concrete and rock	no
6	5/21/2009	hydraulic oil	60	underground	haul truck	ruptured hydraulic hose	concrete and rock	yes
7	6/28/2009	hydraulic oil	75	underground	valve	valve fitting worked loose	cement	yes
8	8/5/2009	DS200	15	mill	drum	drum spilled	concrete	yes
9	9/14/2009	glycol	200	powerhouse	pump	pump motor failure	concrete	yes

Spill Register : 2010

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	4/11/2010	hydraulic oil	20	surface shop	tank	overfilled tank	concrete	yes
2	6/21/2010	hydraulic oil	20	tailings facility	haul truck	blown hose	tailings	no
3	8/22/2010	hydraulic oil	20	ore pad	haul truck	blew o ring	ore	no
4	10/18/2010	hydraulic oil	60	underground	haul truck	blown hose	ground	yes

Spill Register : 2011

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	11/3/2011	Jet A Fuel	30	860 helipad	fuel station	Fuel leaked from hose connection	gravel	no

Spill Register : 2012

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	3/4/2012	hydraulic oil	50	ore pad hill	HT 48	hydraulic line failure	ground	no
2	4/7/2012	hydraulic oil	20	site 23	haul truck	filter came loose on the truck while working at the site	ground	no
3	4/12/2012	diesel	2000	920 Fuel farm	PLC	The PLC failed allowing the day tank to overfill.	concrete	yes

Spill Register : 2013

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	2/17/2013	Diesel	60	920 Fuel Farm	Fuel transfer nozzle	The transfer nozzle was left partially open	concrete	yes
2	4/7/2013	Diesel	250	Port Facility	Lube Truck	The transfer line rupture, while the truck was idling	gravel	no
3	5/28/2013	Hydraulic Oil	55	Underground	Underground haul truck	Failure of a hydraulic line	gravel	no
4	10/23/2013	Hydraulic Oil	60	Underground	LR-49	Failure of a hydraulic line	gravel	no

Spill Register : 2014

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	3/3/2014	Hydraulic Oil	30	Tailings	Excavator BH-29	Failure of a hydraulic line	tailings	no
2	3/9/2014	Diesel	1	0.8-mile B Road	Portable air compressor	Loose fuel filter	gravel frozen	no
3	6/24/2014	Diesel and 50-Wt Oil	300	Underground	Underground lube truck	Drive line failure broke tank fittings	gravel	yes
4	6/28/2014	Hydraulic Oil	250	920 Shop	TK-14 suction line	Hose/pipe connection failure	concrete	yes
5	7/6/2014	Diesel	50	Camp potable water bldg	TK-92	Truck hit tank causing line to crack	gravel	no
6	12/13/2014	Hydraulic Oil	80	Underground	HT-47	Leaking seal on drive system	gravel	yes

Spill Register : 2015

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	1/1/2015	Hydraulic Oil	50	Underground	LR-46	Pump failure resulted in leak	gravel	yes
2	7/7/2015	Hydraulic Oil	200	920 Shop	TK-14	tank overfilled during transfer	concrete	yes
3	9/23/2015	Hydraulic Oil	25	860 Batch Plant	UT-23	Failure of a hydraulic line	sand	no
4	12/25/2015	Diesel	400	Underground	Fuel tank	Hose failure on pressurized system	gravel	yes

Spill Register : 2016

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	1/3/2016	Hydraulic Oil	32	Tailings	BH-32	Failure of a hydraulic line	tailings	no
2	1/14/2016	Hydraulic Oil	2.5	Port facility	Transfer bridge hydraulic cylinder	While extending bridge, nylon sling caught on fitting and snapped it off. Oil spilled on rip-rap beneath bridge and washed out on high tide.	Rip-rap/ sea water	no
3	3/14/2016	Diesel	150	Underground-653 lube bay	Underground lube truck	Leak from broken fitting on pressurized system	concrete	yes
4	4/6/2016	Hydraulic Oil	20	860 Heli-pad	BH-29	Failure of a hydraulic line	gravel	no
5	6/9/2016	Hydraulic Oil	15	920 Batch Plant	Haul truck	Failure of a hydraulic line	concrete	no
6	7/1/2016	Hydraulic Oil	45	Tailings	KT-19	Failure of a hydraulic line while dumping tails	tailings	no

Spill Register : 2017

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	4/5/2017	Hydraulic Oil	15	920 Batch Plant	Haul truck	Failure of a hydraulic line	concrete	no
2	4/5/2017	Hydraulic Oil	20	Tails Load-Out	Max Haul truck	Hydraulic filter blew apart	concrete	no
3	4/27/2017	Hydraulic Oil	20	Tailings	KT-27	Failure of a hydraulic line while dumping tails	tailings	no
4	9/25/2017	Hydraulic Oil	30	Tailings	Max Haul truck	Failure of a hydraulic line while dumping tails	tailings	no
5	10/18/2017	Hydraulic Oil	20	Tailings	KT-28	Failure of a hydraulic line while dumping tails	tailings	no
6	11/14/2017	Engine Oil	620	920 Shop	TK-13	Human error resulted in over-filling tank	concrete	yes
7	12/14/2017	Hydraulic Oil	0.01	Wetland at 0.8-Mile	Drill rig	Sheen observed on water, but no obvious source of oil	wetland	no

Spill Register : 2018

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	2/27/2018	Glycol	15	2.8-Mile B-Road	MT-17	Loose hose clamp allowed line to disconnect	snow-ice	no
2	6/5/2018	Hydraulic Oil	38	920 road	HT-60	Failure of a hydraulic line	concrete	no
3	6/11/2018	Hydraulic Oil	15	Ore Pad	HT-58	Failure of a hydraulic line	ore	no
4	6/25/2018	Hydraulic Oil	60	Tailings	MT-23	Broken filter housing	tailings	no

Spill Register : 2019

No.	Date	Spilled Material	Quantity (gal)	Location	Equipment	Incident	Spilled Onto	Contained
1	2/2/2019	Hydraulic Oil	50	Tailings	MT-23	Leak from broken filter housing	tailings	no
2	2/4/2019	Hydraulic Oil	30	Tailings	MT-23	Leak from broken filter housing	tailings	no
3	2/6/2019	Hydraulic Oil	20	Tailings	KT-20	Failure of a hydraulic line while dumping tails	tailings	no
4	3/23/2019	Hydraulic Oil	0.03	Hawk Inlet ship loader	Hydraulic cylinder	Hydraulic cylinder came apart in ship loader winch house	sea water	no

Appendix 9b
Attachment L
Worst Case Discharge Calculation

Hawk Inlet

PART I Background Information

worst case discharge (gallons)	200,000 gallons
worst case discharge (barrels)	4,762 gallons
oil group	1 (nonpersistent, diesel)
operating area	nearshore
Percentages of oil (from table for oil group 1)	
dissipation	80%
recovered floating	20%
oil onshore	10%
on water oil recovery (barrels × % float recovery)/100	952 barrels
shoreline recovery (barrels × % float recovery) / 100	476 barrels
Emulsification factor (1.0 for group 1 oil)	1.0
On water oil recovery resource mobilization factors (from table)	0.15 TIER 1
	0.25 TIER 2
	0.40 TIER 3

PART II On Water Oil Recovery Capacity

calculate for each TIER from Part I	143 barrels, TIER 1
(on water oil recovery × emulsion factor × mobil factor)	238 barrels, TIER 2
	318 barrels, TIER 3

PART III Is Recovery Capacity Larger than on Water Response Capacity?

Shoreline cleanup volume	476 barrels
(shoreline recovery × emulsion factor)	
On water response capacity by operating area	12,500 barrels/day, TIER 1
(from table)	25,000 barrels/day, TIER 2
	50,000 barrels/day, TIER 3
Quantity needed to be identified, but not contracted for in advance	
(Is any Part II TIER 1,2, or 3 > Part III TIER 1, 2, or 3)	**NONE**

920 Mine Service Area

PART I Background Information

worst case discharge (gallons)	60,000 gallons
worst case discharge (barrels)	1,429 gallons
oil group	1 (nonpersistent, diesel)
operating area	inland
Percentages of oil (from table for oil group 1)	
dissipation	80%
recovered floating	20%
oil onshore	10%
on water oil recovery (barrels × % float recovery)/100	286 barrels
shoreline recovery (barrels × % float recovery) / 100	143 barrels
Emulsification factor (1.0 for group 1 oil)	1.0
On water oil recovery resource mobilization factors (from table)	0.15 TIER 1
	0.25 TIER 2
	0.40 TIER 3

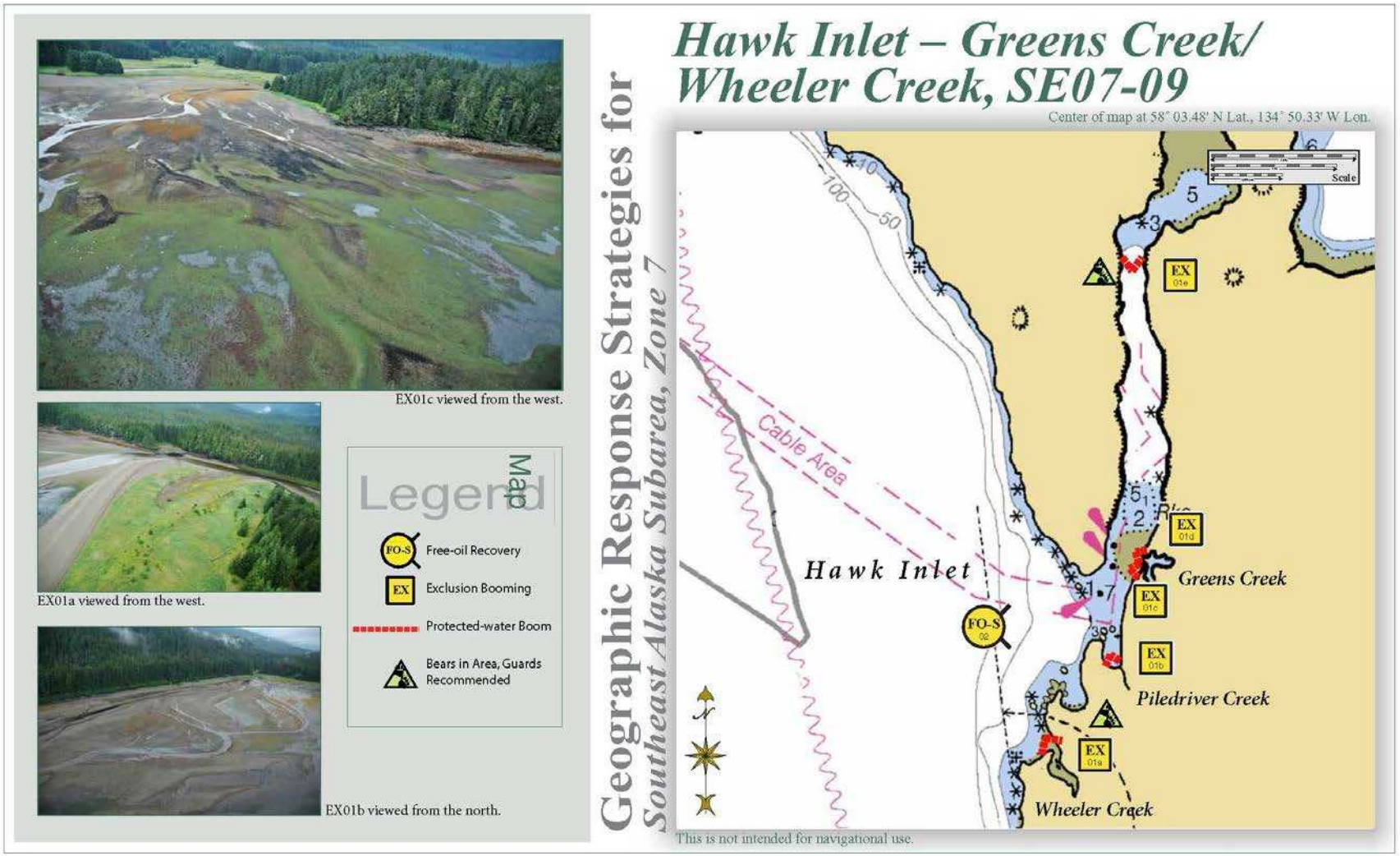
PART II On Water Oil Recovery Capacity

calculate for each TIER from Part I	43 barrels, TIER 1
(on water oil recovery × emulsion factor × mobil factor)	71 barrels, TIER 2
	114 barrels, TIER 3

PART III Is Recovery Capacity Larger than on Water Response Capacity?

Shoreline cleanup volume	143 barrels
(shoreline recovery × emulsion factor)	
On water response capacity by operating area	12,500 barrels/day, TIER 1
(from table)	25,000 barrels/day, TIER 2
	50,000 barrels/day, TIER 3
Quantity needed to be identified, but not contracted for in advance	
(Is any Part II TIER 1,2, or 3 > Part III TIER 1, 2, or 3)	**NONE**

Appendix 9b
Attachment M
Geographic Response Strategies for Southeast Alaska Subarea, Zone 7



May 2014

DRAFT This tactic map is a working draft being used to develop a Geographic Response Strategy at this location. The tactics represented here have not been approved by the Subarea Committee and should not be considered final. If you have questions or comments please contact us by email at contact@nukaresearch.com.

NUKA Research & Planning Group, LLC.

Site Information for *Southeast Alaska, SE07-09*

ID	Location and Description	Response Strategy	Implementation	Response Resources	Staging Area	Site Access	Resources Protected	Special Considerations
SE07-09-01 EX	**Hawk Inlet Greens Creek / Wheeler Creek** **Wheeler Creek** a. Lat. 58° 03.48'N Lon. 134°47.50'W **Piledriver Creek** b. Lat. 58° 04.43'N Lon. 134°46.15'W **Greens Creek** c. Lat. 58° 05.55'N Lon. 134°45.46'W d. Lat. 58° 06.08'N Lon. 134°45.54'W e. Lat. 58° 09.11'N Lon. 134°45.59'W	**Exclusion** Exclude oil from entering the Hawk Inlet Greens Creek / Wheeler Creek	Deploy anchors and boom with skiffs (class 6). Place protected-water boom in a chevron pattern in front of the entrance to designated creeks/rivers. Tend throughout the tide. Boom Lengths: a. 500 ft. b. 350 ft. c. 350 ft. d. 350 ft. e. 1300 ft.	**Deployment** **Equipment** 2850 ft. protected-water boom 18 ea. anchor systems 20 ea. anchor stakes **Vessels** 1 ea. class 3 3 ea. class 6 **Personnel/Shift** 5 ea. vessel crew **Tending** **Vessels** 1 ea. class 6 1 ea. class 3 **Personnel/Shift** 5 ea. vessel crew	Vessel Platform	Via marine waters Chart 17312	Fish: coho, sockeye, cutthroat, dolly varden, steelhead Birds: seabird nesting Habitat: marsh, exposed tidal flats Human Use: high recreational use, subsistence	Vessel master should have local knowledge. Bears are present in the area. Bear guard required. Facilities at Greens Creek Mine may provide support. Consult with Incident Command to ensure ADFG-Title 16 and ADNR-Title 41 permits have been obtained. Consult the Site Selection Matrix for cultural resources designation. Consult the ADEC "Spill Tactics for Alaska Responders" manual for additional information on the deployment of these tactics. Survey: not yet Tested: not yet
SE07-09-02 FO-S	**Hawk Inlet Greens Creek / Wheeler Creek** Nearshore waters in the general area of: Lat. 58° 05.22'N Lon. 134°47.03'W	**Free-oil Recovery** Maximize free-oil recovery in the offshore & nearshore environment of Hawk Inlet Greens Creek / Wheeler Creek depending on spill location and trajectory.	Deploy free-oil recovery strike teams upwind and up current of Hawk Inlet Greens Creek / Wheeler Creek. Use aerial surveillance to locate incoming slicks.	Deploy multiple free-oil recovery strike teams as required to maximize interception of oil before it impacts sensitive areas.	Hoonah- 26nm-via marine access	Via marine waters Chart 17360	Same as SE07-09-01	Vessel master should have local knowledge. Use extreme caution, shoal waters with numerous reefs and rocks, shallow mud flats and channels.

NOTE: Sensitive resource information can be found on other maps which can be accessed through the sensitive area section of the SEAK Sub-Area Contingency Plan: http://www.dec.state.ak.us/spar/perp/plans/scp_se.htm.

Appendix 9b
Attachment N
Exercise/Drill Program Forms and Logs

SEAPRO ANNUAL REQUIREMENTS DOCUMENTATION

Greens Creek Internal Documentation

Directions:
Fill out one of these forms for each year
Fill out the date conducted column for all drills conducted
Fill out a separate form documenting the details of each drill (each drill type has a separate form)

DRILL TYPE	REQUIRED FREQUENCY	DATE CONDUCTED
Qualified Individual Notification[1]	JAN - MAR	
	APR - JUN	
	JUL - SEP	
	OCT - DEC	
Equipment Deployment[2]	JAN - JUN	
	JUL - DEC	
Tabletop[3]	JAN - DEC	
Equipment Inspection[4]	JAN - DEC	
	DESCRIPTION	**DATE CONDUCTED**
Emergency Procedures[5]		

****At least one exercise each year must be unannounced****
****One Qualified Individual Notification each year should be conducted during non-business hours****

[1] The Qualified Individual Notification exercise must be conducted by all EPA and Coast Guard regulated facilities. This exercise may not count towards the unannounced exercise requirement.

[2] The Equipment Deployment exercise must be conducted by all EPA and Coast Guard regulated facilities. This exercise may count towards the unannounced exercise requirement.

[3] The Tabletop exercise must be conducted by all EPA and Coast Guard regulated facilities. This exercise may count towards the unannounced exercise requirement, and at least one exercise over the triennial cycle must evaluate the worst case discharge.

[4] The Equipment Inspection must be conducted annually, including a containment boom inspection.

[5] The Emergency Procedures exercise is optional for EPA and Coast Guard regulated facilities. It may count towards the annual unannounced exercise requirement.

Retain this form for a minimum of 5 years as per EPA requirements.

QUALIFIED INDIVIDUAL NOTIFICATION
Greens Creek Internal Documentation

Location: _____

Date performed: _____

Exercise/drill or response: _____

Organization initiating exercise: _____

Person notified: _____

Time drill was initiated: _____

Time designee responded: _____

Method of contact: ( ) Phone ( ) Pager ( ) Fax ( ) Radio
( ) Other: _____

Description of notification:

_____
_____
_____
_____

Which core components of response plan were exercised:

_____
_____
_____
_____
_____
_____

Signature of site representative _____

Signature of OSRO representative (SEAPRO rep., if present) _____

Signature of agency representative (if present) _____

Retain this form for a minimum of 5 years as per EPA requirements.

EQUIPMENT DEPLOYMENT EXERCISE

Greens Creek Internal Documentation

Exercise/drill or response: _____

Announced or unannounced: _____

Organization initiating exercise: _____

Time drill was initiated: _____ Time completed: _____

Spill/scenario discharge volume: _____

( ) Average most probable discharge
( ) Maximum most probable discharge
( ) Worst case discharge

Equipment was: ( ) Facility owned ( )OSRO/SEAPRO ( ) Both

List equipment deployed, location and number of support personnel involved:

_____
_____

Describe objectives of exercise: _____
_____

Describe lessons learned in exercise:

_____

Was all equipment deployed operational? If not, Why?

_____
_____
_____

Equipment deployed in intended operating environment? (Yes/No): _____

Which core components of the response plan were initiated:

_____
_____
_____

Signature of site representative _____

Signature of OSRO representative _____
Signature of agency representative _____

Retain this form for a minimum of 5 years as per EPA requirements.

TABLETOP EXERCISE
Greens Creek Internal Documentation

Date(s) performed: _____

Exercise or actual response: _____

If an exercise, announced or unannounced? _____

Location of tabletop: _____

Time started: ___ Time completed: ___

Response plan scenario used:

( ) Average most probable discharge
( ) Maximum most probable discharge
( ) Worst case discharge

Size of simulated spill: _____

Describe how the following objectives were exercised:

- spill management team's knowledge of oil-spill response plan:

- proper notifications:

- communications system:

- spill management team's ability to access contracted oil spill removal organizations (SEAPRO):

- spill management team's ability to coordinate spill response with On Scene Coordinator & agencies:

- spill management team's ability to access sensitive site & resource info in Area Contingency Plan:

Which core components of the response plan were exercised:

_____
_____
_____
_____

Attach description of lesson(s) learned and person(s) responsible for follow up of corrective measures.

Signature of site representative _____

Retain this form for a minimum of 5 years as per EPA requirements.

ANNUAL EQUIPMENT INSPECTION
Greens Creek Internal Documentation

NOTE: Monthly inspections and pressure test records are kept separately

Date of Inspection: _____

Equipment Inspected: _____ Condition: _____
(booms, anchors, boats, etc.)

Describe any necessary maintenance/replacement:

Signature of site representative

Retain this form for a minimum of 5 years as per EPA requirements.

EMERGENCY PROCEDURES EXERCISE

Greens Creek Internal Documentation

Location: _____

Exercise/drill or response: _____

Announced or unannounced: _____

Organization initiating exercise: _____

Time drill was initiated: _____

Time completed: _____

Spill or scenario exercised: _____

Describe objectives and how they were exercised: _____

Describe lessons learned in exercise:
(NOTE: revise response plan, if necessary) _____

Which core components of the response plan were initiated: _____

Signature of site representative _____

Signature of OSRO representative (SEAPRO rep., if present) _____

Signature of agency representative (if present) _____

Retain this form for a minimum of 5 years as per EPA requirements.

General Plan of Operations
Appendix 10
Pond 7/10 Dam System Operations and Maintenance Manual

February 2020

Pond 7/10 Dam System Operations and Maintenance Manual

FEBRUARY 2020

Version Log

Version No.	Description of Change	Prepared By	Date
2020-01	Initial Release	M. Butikofer / G. Hayden	February 28, 2020

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1. Introduction

The purpose of this manual is to instruct the operations groups at Hecla Greens Creek Mining Company (HGCMC) on how the Pond 7/10 Dam System is to be operated and maintained. It is a living document that will be updated as conditions change around the site.

The Pond 7/10 Dam System includes Pond 7 and Pond 10 and appurtenant works of the dams which divert, capture, contain, collect and transfer water to Pond 7 and 10 including all respective, integrated components at the Tailings Disposal Facility (TDF), Site 920, Site 23, Hawk Inlet and other areas of the Site.

The items described in the previous paragraph are summarized in section 7 of this document. Flow diagrams, component profiles, site as-builts, and labeled photographs are included in the appendices to go along with section 7.

2. Definitions

Catch Basin: a vault used to collect stormwater from precipitation. Water is discharged from the catch basin by gravity through a pipeline to another structure.

Caisson: a large diameter buried pipe, installed vertically with the top open to the ground surface, used to collect water, and may or may not contain a pump or pumps. Also referred to as a "wet well."

Clarifier: settling tank built with mechanical means for continuous removal of solids being deposited by sedimentation. Removes suspended solids from water.

Contact Water: water that has touched a disturbed or operational area such as the 920, Site 23, TDF, Hawk Inlet, the road system, or the mine and is usually from precipitation. Also referred to as stormwater.

Degrit Basin: large, concrete structure used to collect and settle out sediment. Usually has an access ramp to allow loaders to enter and exit for cleaning. Stormwater often, but not always, is routed to a degrit basin.

Effluent: treated water from a water, industrial wastewater or sewer treatment plant. Effluent from the sewer treatment plants and the 920 industrial wastewater plants is sent to Pond 7/10. Effluent from the Pond 7 WTP is discharged to Hawk Inlet.

Gabion or Gabion Basket: a wirework (chain-link) container filled with rock used for erosion protection and/or energy dissipation in a water channel. Gabions are used at the Pond 7 and Pond 10 inlet channels.

Influent: water flowing into a water, industrial wastewater, or sewer treatment plant.

Lag Pump: in a wet well with more than one pump, the lag pump turns on after the lead pump.

Lead Pump: in a wet well with more than one pump, the lead pump turns on first.

Lift Station: used to pump wastewater or sewage from a low level to a higher level. It usually includes pumps, instruments, and a wet well or caisson.

SCADA: computerized system used to monitor and control plant equipment around the Greens Creek Site including the Pond 7/10 Dam System. Also used for gathering and analyzing real time data such as flow rates and caisson and tank levels.

Spillway: a structure used to provide the controlled release of water from a dam into a downstream area.

Stormwater: both direct rainfall onto the mine footprint and limited run-on into the mine footprint. Storm water is also referred to as contact water.

Sump: small pipe or pit used to collect water.

Surge protection: storage space available in the ponds site wide for a storm event. i.e. – The volume available in a pond to take on large amounts of stormwater during a large rainstorm.

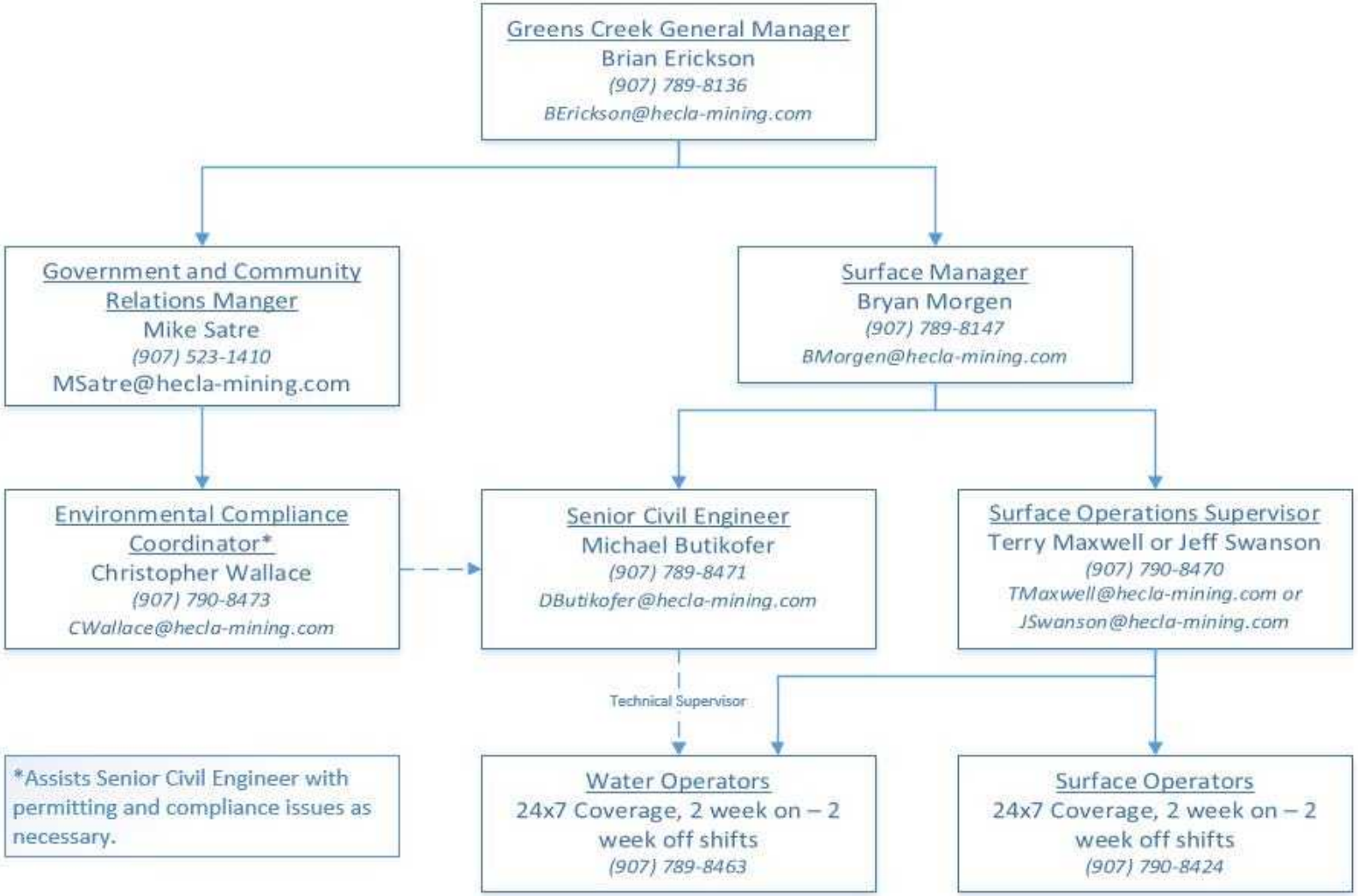
Weir: a barrier across the width of a channel that alters the flow characteristics of the water and can be used to calculate flows. The weirs across Greens Creek and Cannery Creek act as small dams. The Greens Creek weir is used to calculate creek flow, the Cannery Creek weir is not.

Wet Well: a caisson used to collect water. Generally, it will have a pump and acts as a lift station.

3. Acronyms

ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
ARV	Air Relief Valve
BMP	Best Management Practices
DB	Degrit Basin
FCS	Flow Control Structure
FCV	Flow Control Valve
GPM	Gallons Per Minute
HDPE	High Density Polyethylene
HGCMC	Hecla Greens Creek Mining Company
MCP	Motor Control Panel
MCC	Motor Control Center
N.C.	Normally Closed
N.O.	Normally Open
RPP	Reinforced Polypropylene
PLC	Program Logic Control
SDADA	Supervisory Control and Data Acquisition
TDF	Tailings Disposal Facility
TK	Tank
VFD	Variable Frequency Drive
WTP	Water Treatment Plant
WW	Wet Well

4. Pond 7/10 Dam System Hierarchy



5. Pond 7/10 Dam System Summary

Hecla Greens Creek Mining Company (HGCMC) operates a water management program intended to discharge all water impacted by mine operations in a manner compliant with governmental agency regulations, applicable governmental permits, and industry best practices.

HGCMC manages water from three sources:

1. Stormwater: both direct rainfall onto the mine footprint and limited run-on into the mine footprint. Storm water is also referred to as contact water.
2. Groundwater: withdrawn by drain systems beneath portions of the mine footprint and from dewatering operations within the underground mine.
3. Surface water (fresh water withdrawals): water withdrawn from creeks for operational uses, including Greens Creek, Cannery Creek, and various other small streams within and adjacent to the mine footprint.

The water management program at Greens Creek Mine can be broadly subdivided into two programs based on the point of discharge to the environment. All discharges to the environment are regulated by HGCMC's individual Alaska Pollutant Discharge Elimination System (APDES) permit number AK0043206.

1. The collection, storage, treatment, and discharge of all stormwater, groundwater, and surface water impacted by mining operations not managed by the stormwater discharge system described above. All water managed by this system is discharged to the environment at a discharge point within Hawk Inlet, designated as APDES Outfall 002.
2. Stormwater and surface water managed along the road system using stormwater Best Management Practices (BMPs), resulting in the discharge of stormwater to the environment near the source of origin. These discharge locations are designated as APDES outfall numbers 003 through 009.

The Pond 7/10 O&M Manual addresses only the first program described above. The stormwater management program along the road system is described by the HGCMC General Plan of Operations (GPO) Appendix 5 BMP Plan.

Pond 7 is a 31.5 acre-ft water retention structure, and Pond 10 is a 35.2 acre-ft water retention structure. The two structures are hydraulically connected via a series of large culverts, and effectively function together as a single water retention structure referred to as Pond 7/10.

Water is conveyed to Pond 7/10 from three independent areas:

1. Tailings Disposal Facility (TDF) Area: Stormwater and groundwater collected from within the TDF footprint and conveyed to Pond 7/10 via a system of ditches, gravity pipelines, and pumped pipelines.
2. 920 Area: Stormwater, groundwater, and surface water collected from within the underground mine, mill and administrative office area footprint, Greens Creek, and the footprint of the waste rock storage sites adjacent to the mine site. This water is conveyed to Pond 7/10 via three pipelines referred to as the '920 pipelines'.

3. Hawk Inlet: Stormwater, groundwater, and surface water collected from the Hawk Inlet port and camp facility footprint and Cannery Creek. This water is conveyed to Pond 7/10 via a pumped pipeline discharging to the West Ditch within the TDF.

6. Summary of Relevant Permits

The following permits are relevant to the Pond 7/10 Dam System.

6.1. Certificate of Approval to Operate a Dam

The Certificate of Approval to Operate a Dam (Certificate No. FY2018-18-AK00316) authorizes HGCMC to operate the following jurisdictional dams:

- Pond 7 Dam (NID ID#AK00307)
- Pond 10 Dam (NID ID#AK00316)

This certificate applies to the Pond 7 Dam, the Pond 10 Dam, and to the appurtenant works of the dams which divert, capture, contain, collect and transfer water to Pond 7 and Pond 10 including all respective, integrated components at the tailing disposal facility (TDF), 920 Site, Site 23, Hawk Inlet and other areas of the site. Collectively, these features are referred to as the Pond 7/10 Dam System.

6.2. Waste Management Permit

The Waste Management Permit (Permit No. 2014DB0003) covers the disposal of waste and defines monitoring requirements at the following sites:

- TDF,
- Site 23,
- Underground Mine Workings,
- Inactive Waste Rock Disposal Sites (Sites 1350, C, D, and E),
- Pond 7/10, and
- Numerous other Fresh Water Monitoring Sites throughout the mine footprint.

The waste management permit requires HGCMC to control and treat onsite surface water, groundwater and seepage as necessary to prevent offsite water quality exceedances except as authorized by APDES permit.

6.3. Alaska Pollutant Discharge Elimination System (APDES)

The Alaska Pollutant Discharge Elimination System (APDES) (Permit No. AK003206) authorizes HGCMC to discharge water at Outfalls 002 through 009. It defines the following:

- Effluent limitations of all outfalls,
- Sampling requirements, and
- Mixing zone in Hawk Inlet for Outfall 002.

7. Detailed System Description and Operating Parameters

The following areas report to Pond 7 and/or Pond 10, collectively referred to as Pond 7/10. Each area is broken down into sections that correspond with the flow diagrams included in Appendix 2. Profiles of all major caissons are included in Appendix 3. As-built drawings in plan view are included in Appendix 4. Labeled photographs of each major component are included in Appendix 5.

Tailings Disposal Facility (TDF):

1. Pond 7 and 10 (Pond 7/10)
2. Pond 7 Pumphouse
3. Pond 10 Pumphouse
4. Pond 7 Inlet
5. Pond 7 Water Treatment Plant and APDES Outfall 002
6. South Embankment Wet Wells
7. West Ditch
8. Flow Control Structure
9. Wheel Wash 05

920 Area:

1. Pond A and 920 Area
2. 920 Fresh Water System
3. 920 Lined Ditch
4. Pond C
5. Site 23 Lined Ditch
6. Pond 23
7. Site D
8. 920 Pipelines
9. Site E

Hawk Inlet Area:

1. Hawk Inlet
2. Hawk Inlet Tanks
3. Cannery Creek

The Pond 7/10 Dam System is controlled by a series of PLCs (Program Logic Controller) spread throughout the property. In general, these PLCs are controlled by a SCADA (Supervisory Control and Data Acquisition) system managed by the HGCMC Maintenance Department. The SCADA system collects data from instruments throughout the system including level sensors, flow meters, and pumps. The data collected from SCADA is stored in a SQL database maintained by the HGCMC IT group.

Several screens and trends for the water systems site wide are presented in the SCADA system allowing operators and engineers to determine if components of the Pond 7 Dam System are functioning as detailed in this O&M Manual.

The reader is reminded that this is a living document. Changes should be noted, submitted and added as needed.

7.1.Tailings Disposal Facility

The tailings disposal facility (TDF) is approximately 82.6 acres. Filtered tailings and other waste materials are disposed of in the TDF. All stormwater runoff originating within the TDF area is collected via a series of ditches internal to the disposal area and along the inside perimeter of the disposal area. Above and below liner subsurface drains are present in all lined areas of the TDF. A slurry wall surrounds the unlined areas of the TDF. These areas also contain subsurface drains. The subsurface drains report to wet wells and ditches throughout the facility by gravity.

The following water management features exist in the TDF area:

7.1.1. Ponds 7 and 10 (Pond 7/10)

Pond 7 is the primary collection point for all contact water from the TDF, 920, and Hawk Inlet Areas. Water reports to Pond 7 via the Pond 7 Inlet and Pond 7/10 Flow Control Structure (FCS). Pond 10 is a backup pond used to provide additional surge protection in case of a large storm event. Most flows around the site report directly to Pond 7. The 8 and 18-inch pipelines from the 920 can be directed to either pond through the FCS.

The ponds are connected by four 36-inch culverts at elevation 137 feet and share a common spillway at the north end of Pond 7 at elevation 140 feet. The pond 7/10 dam crest is at elevation 144 feet.

The combined capacity of Pond 7/10 is 66.7 acre-feet or 21,700,556 gallons. See Table 7-4 and Figure 7-3 below. Ponds 7 and 10 are described in further detail below.

7.1.1.1. Pond 7

- Primary retention pond at the TDF with 31.5 acre-ft or 10,250,896 gallons of capacity (see Table 7-1 and Figure 7-1). Collects water from around the Greens Creek site before treatment in Pond 7 Water Treatment Plant (WTP).
- Pond level is maintained at 130 feet (Operating Level).
    - ✓ The operating level is maintained just above the sediment level in the pond. It is only to exceed 130 feet during a storm event. Discharge to Outfall 002 will be maximized until the pond returns to 130 feet to maximize pond capacity (surge capacity)
- Lined with one layer of 80-mil (1 mil = 0.001 inch) HDPE Liner.
- An underdrain system and vibrating wire piezometers are contained in the sand layer under the liner.
    - ✓ Underdrains drain the sand layer to keep pressures low beneath the liner. In addition, water samples are pulled from the underdrain flow to show the liner is sound.
    - ✓ Vibrating wire piezometers are used to determine water level below the liner.
- Provides stormwater surge protection for the TDF.
- Sediment trap for stormwater off the TDF.
- Receives water from the following sources through the inlet channel on the east side of the pond:
    - ✓ TDF area surface runoff
    - ✓ Water from Hawk Inlet (reports from DB-04 to the West Ditch)
    - ✓ Wheel Wash 05
    - ✓ Wet Well (WW)-14

- ✓ WW-3 via the West Ditch
- ✓ Subsurface drains (above and below-liner) reporting to the West Ditch

- Receives water from the 920 via the FCS

Table 7-1 – Pond 7 Capacity

Elevation (ft AMSL)	Area (acres)	Incremental Capacity (ac-ft)	Capacity (ac-ft)	Capacity (cu. ft.)	Capacity (gallons)	Notes
121	0.001	0.000	0.000	0	0	
122	0.011	0.006	0.006	248	1,857	
123	0.022	0.016	0.022	952	7,119	
124	0.329	0.176	0.197	8,601	64,335	
125	0.911	0.620	0.817	35,608	266,349	
126	1.188	1.049	1.867	81,305	608,159	
127	1.415	0.018	3.168	137,983	1,032,115	
127.5	1.495	0.728	3.895	169,675	1,269,172	
128	1.575	0.767	4.663	203,102	1,519,205	
129	1.772	1.673	6.336	275,998	2,064,463	
130	**1.870**	**1.821**	**8.157**	**355,334**	**2,657,895**	**Operating Capacity**
131	1.965	1.918	10.075	438,860	3,282,672	
132	2.056	2.011	12.085	526,442	3,937,783	
133	2.147	2.102	14.187	617,994	4,622,594	
134	2.237	2.192	16.379	713,471	5,336,762	
135	2.327	2.282	18.661	812,857	6,080,173	
136	2.418	2.372	21.033	916,190	6,853,104	
136.5	2.464	1.221	22.253	969,356	7,250,782	
137	**2.511**	**1.244**	**23.497**	**1,023,533**	**7,656,028**	Pond 10 Connector El.
138	2.606	2.558	26.055	1,134,966	8,489,547	
139	2.702	2.654	28.709	1,250,563	9,354,215	
***140**	**2.802**	**2.752**	**31.461**	**1,370,441**	**10,250,896**	Spillway Invert
141	2.911	2.857	34.318	1,494,872	11,181,642	
142	3.092	3.002	37.319	1,625,624	12,159,666	
143	3.236	3.164	40.483	1,763,452	13,190,621	
144	3.415	3.326	43.809	1,908,313	14,274,181	Embankment Top

Total Capacity = 31.46 ac-ft

Operating Capacity = 8.16 ac-ft

Total Surge Capacity = 23.30 ac-ft

Surge Capacity to 137 ft. AMSL = 15.34 ac-ft

*Note: When water exceeds 140 feet, it is discharged directly to the wetlands west of Pond 7

Table 7-2- Rating Table for Weir at Pond 7 Inlet

Eleveation (ft)	STAGE (ft)	VAVG (ft/s)	Q (cfs)	Q (gpm)	Q (ac-ft/hr)
141.0	0.0	0.00	0.00	0	0.00
141.1	0.1	0.12	0.17	76	0.01
141.2	0.2	0.24	0.69	310	0.06
141.3	0.3	0.37	1.59	714	0.13
141.4	0.4	0.50	2.89	1,297	0.24
141.5	0.5	0.64	4.61	2,069	0.38
141.6	0.6	0.78	6.76	3,034	0.56
141.7	0.7	0.92	9.35	4,197	0.77
141.8	0.8	1.07	12.38	5,557	1.02
141.9	0.9	1.22	15.87	7,123	1.31
142.0	1.0	1.37	19.80	8,887	1.64
142.1	1.1	1.52	24.20	10,862	2.00
142.2	1.2	1.67	29.05	13,039	2.40
142.3	1.3	1.83	34.38	15,431	2.84
142.4	1.4	1.98	40.17	18,030	3.32
142.5	1.5	2.14	46.43	20,839	3.84
142.6	1.6	2.30	53.17	23,864	4.39
142.7	1.7	2.46	60.38	27,100	4.99
142.8	1.8	2.61	68.07	30,552	5.63
142.9	1.9	2.77	76.25	34,223	6.30
143.2	2.0	2.93	84.91	38,110	7.02
143.1	2.1	3.10	94.05	42,212	7.77
143.2	2.2	3.26	103.69	46,539	8.57
143.3	2.3	3.42	113.81	51,081	9.41
143.4	2.4	3.58	124.43	55,848	10.28
143.5	2.5	3.75	135.55	60,839	11.20
143.6	2.6	3.91	147.17	66,054	12.16
143.7	2.7	4.08	159.29	71,494	13.17
143.8	2.8	4.24	171.92	77,163	14.21
143.9	2.9	4.41	185.06	83,060	15.30
144.0	3.0	4.58	198.70	89,183	16.42
144.1	3.1	4.75	212.87	95,542	17.59
144.2	3.2	4.92	227.55	102,131	18.81
144.3	3.3	5.09	242.75	108,953	20.06
144.4	3.4	5.26	258.48	116,014	21.36
144.5	3.5	5.43	274.74	123,312	22.71
144.6	3.6	5.60	291.53	130,847	24.10
144.7	3.7	5.77	308.85	138,621	25.53
144.8	3.8	5.94	326.72	146,642	27.00
144.9	3.9	6.12	345.13	154,905	28.53
145.0	4.0	6.29	364.09	163,415	30.09

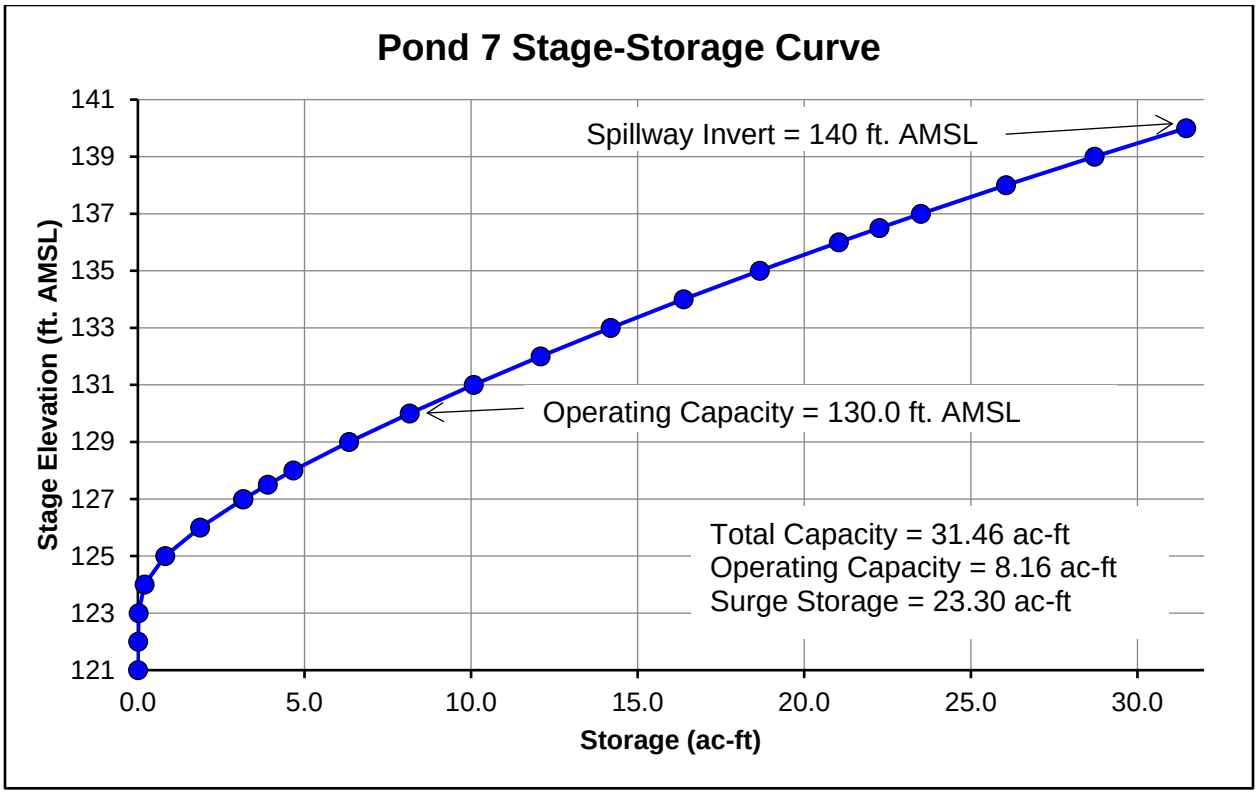


Figure 7-1 – Pond 7 Stage-Storage Curve

7.1.1.2. Pond 10

- Secondary retention pond at the TDF with 35.2 acre-ft or 11,469,174 gallons of capacity (see *Table* 7-3 and Figure 7-2). Not normally used.
- Typical inflows to Pond 10 include direct precipitation and Pond 10 underdrain flows.
- Pond 10 is maintained empty.
- Water from the 920 and the south end of the TDF can be sent directly to Pond 10 as needed via the FCS.
- Water flows from Pond 7 to Pond 10 at elevation 137 feet through four 36-inch connector culverts.
- Water overflows to the environment at elevation 140 feet via the Pond 7/10 Emergency Spillway at the north end of Pond 7.
- Lined with two layers of 80-mil HDPE liner.
- Vibrating Wire Piezometers and drains are installed in the sand layer below the bottom liner.
- A drainage layer is placed in-between HDPE liners and drains to a sump at the low point of the pond then to an 8-inch standpipe inside WW-11, designated WW-11A (see Appendix 2, Figure 2-4 and Appendix 3, Figure 3-4). This system is used to determine if a leak is present in the liner system. Small flows (less than 200 gallons per day (GPD)) have been collected through the bottom liner. More flow is captured in this system during wet periods.

Table 7-3 – Pond 10 Capacity

Elevation (ft AMSL)	Area (acres)	Incremental Capacity (ac-ft)	Capacity (ac-ft)	Capacity (cu. ft.)	Capacity (gallons)	Notes
123	0.080	0.00	0.00	0	0	
123.44	**0.160**	**0.05**	**0.05**	**2,178**	**16,291**	Operating Capacity
124	0.260	0.17	0.17	7,405	55,391	
125	0.695	0.48	0.65	28,205	210,974	
126	1.130	0.91	1.56	67,954	508,293	
127	1.495	1.31	2.87	125,126	935,943	
128	1.860	1.68	4.55	198,198	1,482,521	
129	1.990	1.93	6.48	282,051	2,109,741	
130	2.120	2.06	8.53	371,567	2,779,320	
131	2.235	2.18	10.71	466,419	3,488,812	
132	2.350	2.29	13.00	566,280	4,235,774	
133	2.450	2.40	15.40	670,824	5,017,764	
134	2.550	2.50	17.90	779,724	5,832,336	
135	2.655	2.60	20.50	893,089	6,680,305	
136	2.760	2.71	23.21	1,011,028	7,562,486	
137	**2.870**	**2.82**	**26.03**	**1,133,649**	**8,479,695**	Pond 7 Connector El.
138	2.980	2.93	28.95	1,261,062	9,432,744	
139	3.095	3.04	31.99	1,393,376	10,422,449	
***140**	**3.210**	**3.15**	**35.20**	**1,533,312**	**11,469,174**	Spillway Invert
141	3.325	3.27	38.47	1,675,644	12,533,819	
142	3.440	3.38	41.85	1,822,986	13,635,935	
143	3.540	3.49	45.34	1,975,010	14,773,078	
144	3.640	3.59	48.93	2,131,391	15,942,803	Embankment Top

Total Capacity = 35.20 ac-ft

Operating Capacity = 0.05 ac-ft

Total Surge Capacity = 35.15 ac-ft

Surge Capacity to 137 ft. AMSL = 25.98 ac-ft

*Note: When water exceeds 140 feet, it is discharged directly to the wetlands west of Pond 7

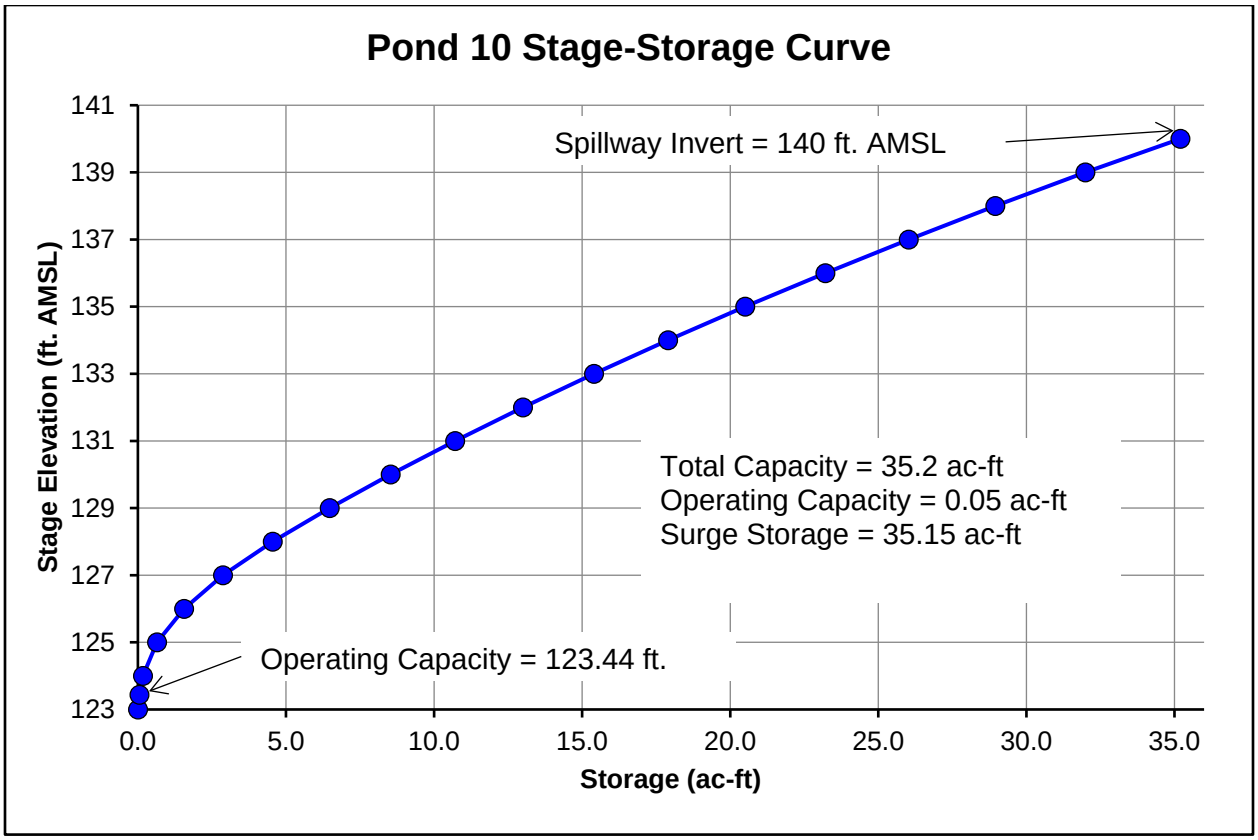


Figure 7-2 – Pond 10 Stage-Storage Curve

Table 7-4 – Pond 7-10 Capacity above 137 feet

Elevation (ft AMSL)	Area (acres)	Incremental Capacity (ac-ft)	Capacity (ac-ft)	Total Capacity (ac-ft)	Capacity (cu. ft.)	Capacity (gallons)	Notes
137	**5.381**	**0.00**	**0.00**	**49.52**	**2,157,182**	**16,135,722**	Pond 7 to 10 Connector El.
138	5.586	5.48	5.48	55.01	2,396,028	17,922,290	
139	5.797	5.69	11.17	60.70	2,643,939	19,776,663	
140	**6.012**	**5.78**	**17.08**	**66.60**	**2,901,139**	**21,700,520**	Spillway Invert
141	6.236	6.12	23.20	72.73	3,167,903	23,695,911	
142	6.532	6.38	29.59	79.11	3,445,996	25,776,051	
143	6.776	6.65	36.24	85.76	3,735,849	27,944,149	
144	7.055	6.92	43.16	92.68	4,037,090	30,197,434	Embankment Top

Total Capacity = 66.60 ac-ft

Total Operating Capacity = 8.21 ac-ft

Total Surge Capacity = 58.39 ac-ft

Surge Capacity 137 to 140 ft. AMSL = 17.08 ac-ft

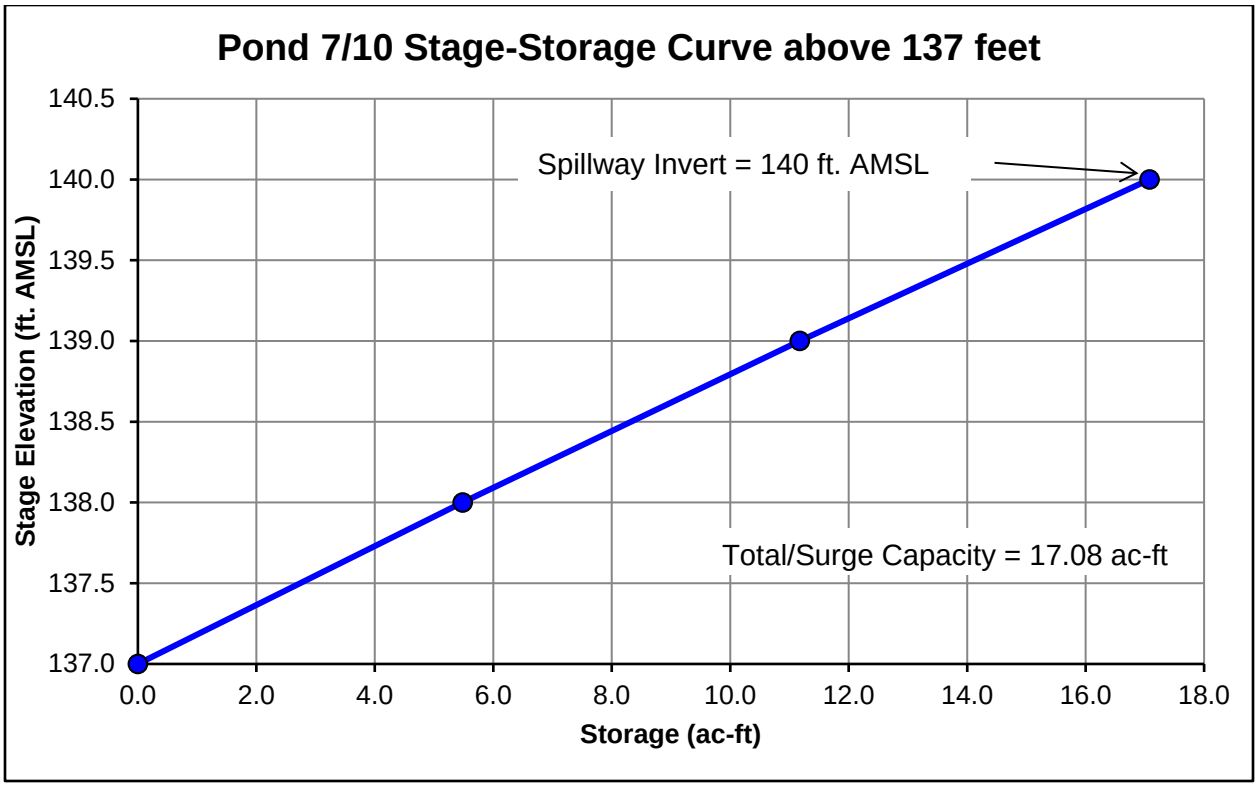


Figure 7-3 – Pond 7/10 Stage-Storage Curve above 137 feet

Table 7-5 - Pond 7/10 Emergency Spillway Rating Table

Elevation (ft)	Stage (ft)o	Velocity (ft/s)	Flow (cfs)
140.0	0	0.00	0.00
140.1	0.1	2.51	4.77
140.2	0.2	3.96	15.04
140.3	0.3	5.16	29.37
140.4	0.4	6.21	47.12
140.5	0.5	7.16	67.88
140.6	0.6	8.03	91.38
140.7	0.7	8.84	117.37
140.8	0.8	9.60	145.68
140.9	0.9	10.31	176.14
141.0	1.0	10.99	208.61
141.1	1.1	11.64	242.98
141.2	1.2	12.26	279.15
141.3	1.3	12.85	317.01
141.4	1.4	13.42	356.49
141.5	1.5	13.97	397.50
141.6	1.6	14.49	439.97
141.7	1.7	15.00	483.85
141.8	1.8	15.49	529.06
141.9	1.9	15.96	575.55
142.0	2.0	16.42	623.28
142.1	2.1	16.87	672.18
142.2	2.2	17.30	722.22
142.3	2.3	17.72	773.36
142.4	2.4	18.13	825.54
142.5	2.5	18.52	878.74
142.6	2.6	18.91	932.92
142.7	2.7	19.29	988.05
142.8	2.8	19.65	1,044.08
142.9	2.9	20.01	1,101.00
143.0	3.0	20.36	1,158.77
143.1	3.1	20.70	1,217.37
143.2	3.2	21.03	1,276.77
143.3	3.3	21.35	1,336.94
143.4	3.4	21.67	1,397.86
143.5	3.5	21.98	1,459.52
143.6	3.6	22.28	1,521.87
143.7	3.7	22.57	1,584.92
143.8	3.8	22.86	1,648.63
143.9	3.9	23.15	1,712.98
144.0	4.0	23.43	1,777.97

7.1.2. Pond 7 Pumphouse

The Pond 7 Pumphouse is located at the southwest corner of Pond 7 and houses WW-7. A Program Logic Controller (PLC) in the Pond 7 Pumphouse controls the pumps and instrumentation associated with WW-7 and WW-7A.

WW-7A is contained in a second pumphouse at the base of the Pond 7 dam.

7.1.2.1. WW-7

Lift station in Pond 7 Pump House used to convey water from Pond 7 to the Pond 7 WTP.

- PP-131&132:
  - ✓ 70 HP submersible electric pumps are controlled with the PLC in the Pond 7 Pump House and powered through variable frequency drives (VFD).
  - ✓ Both pumps are on a rail system.
  - ✓ The flow set point on the "Pond 7 Plant Overview" SCADA screen is used to determine speed of pumps. Both pumps typically run 24/7. The minimum flow rate is 1300 gpm.
  - ✓ The four pumps in WW-7 and WW-10 are tied together in the program logic for the Pond 7 WTP. If one pump is running, then one pump pumps all flow; if two pumps are running, the flow is split evenly between the two pumps; if three pumps are running, the flow is split evenly between the three pumps; etc.
- Flow meter FIT-6020: located in the Pond 7 WTP in a common pipeline receiving flow from WW-7 and 10.
- Pressure sensor LIT-6090: pressure transducer used to detect level of water in WW-7 and therefore Pond 7. Pump draw-down in the caisson is accounted for in the reading displayed in SCADA.

7.1.2.2. WW-7A (Pond 7 Underdrain Return)

Perforated caisson that collects underdrain water from Pond 7 and ground water at the toe of the Pond 7 Dam.

- Reports to WW-7 by pumping.
- Flow Meter FIT-WW-7A: measures flow from WW-7A.
- PP-134: 10 HP submersible electric pump controlled with the PLC in the Pond 7 Pump House. Pump is on a rail system. Pump is controlled by caisson level and does not have a VFD.
- Pressure sensor LT-WW-7A: Pressure transducer used to detect the level of the water in WW-7A.
  - ✓ PP-134 on at elevation 103.1 feet (2.8 feet)
  - ✓ PP-134 off at elevation 101.5 feet (1.2 feet)

7.1.3. Pond 10 Pumphouse

The Pond 10 Pumphouse is located at the north end of Pond 10 on the west side of the pond and houses the structures and instruments described below. It contains a Motor Control Panel (MCP) with a PLC that controls the pumps and instruments associated with WW-10, 11, and 11A.

7.1.3.1. WW-10

Lift station in Pond 10 Pump House used to convey water from Pond 10 to the Pond 7 WTP.

- PP-162 and 163:
  - ✓ 70 HP submersible electric pumps controlled with the PLC in the Pond 10 Pump House and powered through VFD's.
  - ✓ Both pumps are on a rail system.
  - ✓ Pumps are turned on and off via the Pond 10 Pumphouse screen in SCADA.
  - ✓ In "Auto" mode PP-162 turns on at elevation 121.5 feet (13.4 feet); off at 114.7 feet (6.6 feet)
  - ✓ In "Auto" mode PP-163 turns on at elevation 125.2 feet(17.1 feet); off at 116.2 feet (8.1 feet)
  - ✓ PP-162 and 163 are left in "Auto" when the influent flow to Pond 7 WTP is 1300 gpm. If influent flow is increased, then pumps are turned to "Manual" until the flow rate is returned to 1300 gpm.
  - ✓ The influent flow set point found on the "Pond 7 Plant Overview" SCADA screen is used to determine speed of pumps. The minimum flow rate is 1300 gpm.
  - ✓ The four pumps in WW-7 and WW-10 are tied together in the program logic. If one pump is running, then one pump pumps all flow until pump is maxed out; if two pumps are running, the flow is split evenly between the two pumps; if three pumps are running, the flow is split evenly between the three pumps; etc.
- Flow meter FIT-6020: located in the Pond 7 WTP in a common pipeline receiving flow from WW-7 and 10.
- Pressure sensor LT-WW-10: pressure transducer used to detect level of water in WW-10 and therefore Pond 10.

7.1.3.2. WW-11

Lift station in Pond 10 Pump House used to collect flow from Pond 10 underdrain and convey water to WW-10.

- PP-160: 3.8-HP submersible electric pump controlled with the PLC in the Pond 10 Pump House. Has no VFD.
- Pressure sensor LT-WW-11: pressure transducer used to detect level of water in WW-11:
  - ✓ Pump on at elevation at elevation 113.8 feet (6 feet); off at 109.8 feet (2 feet)
  - ✓ High alarm at elevation 115.8 feet (8.0 feet); High-High alarm at 119.8 feet (10.0 feet)
- Flow meter FIT-PP-160: magnetic flow meter in the 3-inch pipeline between WW-11 and WW-10 used to measure underdrain flows.

7.1.3.3. WW-11A (leak detection system)

8-inch standpipe connected to a sump in the low point of the bottom liner in Pond 10.

- PP-161: ½ HP submersible electric well pump controlled with the PLC in the Pond 10 Pump House. Has no VFD.
- Pressure sensor LT-WW-11A: pressure transducer used to detect level of water in WW-11A
  - ✓ PP-161 on at elevation 118.4 feet (5.9 feet); off at 115.5 feet (3 feet)
  - ✓ High alarm at elevation 113.8 feet (6.0 feet); High-High alarm at 114.8 feet (7.0 feet)
- Flow meter FIT-PP-161: magnetic flow meter in 1-inch pipeline between WW-11A and WW-10 to measure flows from leak detection system.

7.1.4. Pond 7 Inlet

The Pond 7 Inlet is the channel were most of the flow from the TDF and Hawk Inlet reports to. The treated water from the 920 also reports here via the 10-inch pipeline from the 920.

- Several pipes report to the Pond 7 inlet channel (See Appendix 5, Figure 5-7)
  - ✓ (3) 18-inch pipelines from the South Embankment ditch.
  - ✓ (1) 18-inch pipeline from Wheel Wash 05.
  - ✓ (4) 24-inch culverts from the West Ditch
  - ✓ (1) 18-inch pipeline from WW-14, TK-07 overflow/emergency discharge, and 10-inch pipeline from the 920.
  - ✓ (1) 24-inch pipeline from the reclaim tank in the Pond 7 WTP.
  - ✓ (1) 12-inch pipeline from the 12-inch three-way valves between the reclaim tank and TK-07
  - ✓ (1) 8-inch pipeline from sump at east door of Pond 7 WTP.
  - ✓ (5) Miscellaneous pipelines from the TDF subsurface beneath the RPP liner in the at the Pond 7 Inlet. Very little contributing flow.

The pond 7 inlet channel is designed for the 500yr-24hr event. See Table 7-2.

7.1.4.1. WW-14

Collects water from WW-A which collects water from most of the underdrains in the central portion of the TDF.

- Reports to Pond 7 inlet through common overflow pipeline.
- MCP with PLC stationed at WW-14 that controls the following:
  - ✓ Pressure sensor LT-WW-14: Detects water level in WW-14
  - ✓ PP-172: 10 HP lag pump that turns on at elevation 116.7 feet (6 feet) and off at 112.7 feet (2 feet).
  - ✓ PP-173: 4 HP lead pump that turns on at elevation 115.7 feet (5 feet) and off at 112.7 feet (2 feet).
  - ✓ Flow meter FIT-WW-14: magnetic flow meter that measures flow in discharge pipeline.

7.1.5. Pond 7 Water Treatment Plant and APDES Outfall 002

The Pond 7 Water Treatment Plant (WTP) treats all water that reports to Ponds 7 and 10. 1300 to 2500 GPM is pumped into the WTP as influent flow Ponds 7 and/or 10. Ferric chloride, hydrated lime, and an anionic flocculant are added during the process. Once treated, the water is discharged from the clarifier to the reclaim tank.

The Pond 7 Water treatment plant is controlled by a Motor Control Center (MCC) with a PLC. This PLC controls the valves, pumps, level sensors, and flow meters within and immediately adjacent to the Water Treatment Plant building.

7.1.5.1. Reclaim Tank

Tank water flows from the WTP clarifier to the reclaim tank. The reclaim tank is connected to the TK-07 head tank via two 12-inch pipelines. At the top of the reclaim tank is an overflow pipeline. This pipeline flows back to the Pond 7 Inlet (see Appendix 5, Figure 5-9).

7.1.5.2. Head tank TK-07

Head Tank TK-07 is a 12-foot diameter 36-foot tall tank. As the water level rises in the tank, more water is discharged through the 14-inch pipeline to Hawk Inlet referred to as APDES Outfall 002. The 14-inch pipeline is an HDPE pipeline that exits the head tank five feet above the bottom of tank (see Appendix 5, Figure 5-9). The pumps and valves between the reclaim tank and TK-07 are monitored and controlled on the "Pond 7 WTP" screen in SCADA.

- 1300 GPM is the minimum amount of water that can be treated in the Pond 7 WTP. During dry periods base flows are less than 1300 GPM. Therefore, not all 1300 GPM is discharged to Hawk Inlet. About 550 GPM is discharged to Hawk Inlet during dry periods and the remaining is recirculated to Pond 7 from the reclaim tank.
  - ✓ Treated water from the Pond 7 WTP is discharged to the reclaim tank. From the reclaim tank it is sent to the head tank (TK-07).
- (2) 12-inch pipelines leave the reclaim tank to TK-07. Each pipeline has a 3-way valve (FCV-6042 and 6044) and a pump (PP-30 and 31).
- From the reclaim tank water is directed to TK-07 or back to Pond 7. The 3-way valves are controlled via the SCADA system with the following positions:
  - ✓ Valve open, water is discharged from reclaim tank to TK-07.
  - ✓ Valve closed, water is discharged from reclaim tank to Pond 7 via overflow pipeline.
- FCV-6040: Automated emergency dump valve at the bottom of TK-07. The valve opens automatically if the effluent leaving the Pond 7 WTP is out of compliance. When open, water is sent back to Pond 7; when closed water is discharged to Outfall 002.
- The 12-inch valves and associated pumps are adjusted to control discharge through Outfall 002, generally using the following combinations:
  - ✓ Pumps off with one valve open and one valve closed: flow to Hawk Inlet is approximately 550 GPM.
  - ✓ Pumps off and two valves open: flow to Hawk Inlet is approximately 1200 GPM.
  - ✓ Pumps on and both valves open: flow to Hawk Inlet is varies form 1300 GPM to 2400 GPM dependent on influent flow. The VFDs controlling PP-30 and 31 automatically ramp up and down dependent on the influent flow. In other words, at influent flows between 1300 and 2400 GPM influent flow is equal to effluent flow.

7.1.5.3. 14-inch Discharge Pipeline and APDES Outfall 002

The 14-inch HDPE pipeline from TK-07 to APDES Outfall 002 is 8,920 feet long.

- 1,660 feet overland form TK-07 to the shore of Hawk Inlet
- 7,260 feet along the seabed and intertidal zone to the discharge point which consists of 15 diffusers.
- An inline magnetic flow meter (FIT-6092) is located approximately 200 feet downstream of TK-07.
- Three combination air relief valves (ARV) are installed at grade breaks and high points along the 14-inch pipeline.
  - ✓ 3-inch ARV 200 feet downstream of TK-07.
  - ✓ 3-inch ARV 1,000 feet downstream of TK-07.
  - ✓ 2-inch ARV 6,540 feet downstream of TK-07.

- A 14-inch butterfly valve is located at the discharge point at TK-07 and is adjusted to regulate the water level in the tank. The water level in the tank must be above 156.1 feet to keep flows monitored by the in-line flow meter stable.

7.1.6. South Embankment Wet Wells

The South Embankment Wet Wells are located on the south end of the TDF and were constructed in 2017 as part of the Stage 3 Phase 1 TDF Expansion Project. An MCP containing a PLC is installed at these wet wells for controlling the pumps and instruments associated with each wet well. All pumps are submersible electric pumps installed on a rail system.

7.1.6.1. WW 12

Lift station south of TDF that collects above liner drainage from the south end of the TDF (S3P1 Expansion) and conveys drainage to the Pond 7/10 FCS through a shared discharge line.

- PP-167: 3.8 HP lead pump.
- PP-168: 10 HP lag pump.
- Pressure Sensor LT-WW-12: pressure transducer used to detect level of water in WW-12.
  - ✓ PP-167 on at elevation 117.0 feet (4.5 feet), off at 113.5 feet (1.0 feet)
  - ✓ PP-168 on at elevation 119.0 feet (6.5 feet), off at 113.5 feet (1.0 feet)
  - ✓ High alarm at elevation 117.75 feet (5.25 feet), High-high alarm at 118.5 feet (6.0 feet)

7.1.6.2. WW 13

Lift station south of TDF that collects below liner drainage for the south end of the TDF and conveys drainage to TK-08 at Wheel Wash 05.

- PP-169: 3.8 HP lead pump.
- PP-170: 15 HP lag pump.
- Pressure Sensor LT-WW-13: pressure transducer used to detect level of water in WW-13.
  - ✓ PP-169 on at elevation 116.5 feet (4 feet), off at 114.5 feet (2 feet)
  - ✓ PP-170 on at elevation 118.0 feet (5.5 feet), off at 114.5 feet (2 feet)
  - ✓ High alarm at elevation 118.1 feet (5.6 feet), High-high alarm at 119.0 feet (6.5 feet)f

7.1.6.3. WW 15

Lift station on the south side of the TDF that collects water from to toe ditch from the wetlands to the south of the S3P1 Expansion through an 18-inch culvert. This caisson is not normally used, and the 18-inch culvert is capped. Flows from WW 15 would report to the FCS.

- PP-171: 3.2 HP Pump. Pump disconnected.
- Pressure Sensor LT-WW-15: pressure transducer
  - ✓ High alarm at elevation 117.75 feet (5.25 feet), High-high alarm at elevation 118.5 feet (6 feet).

7.1.6.4. WW 16

Lift station on the south side of the TDF that collects water from the ditch running along the toe of the South Embankment that reports to WW-16 through a 30-inch culvert. These flows are pumped to the FCS. If this lift station does not function properly, the toe ditch will overflow to the wetlands south of the TDF during a storm event.

- PP-165: 5 HP lead pump.
- PP-166: 15 HP lag pump.
- Pressure Sensor LT-WW-16: pressure transducer
  - ✓ PP-165 on at elevation 116.5 feet (4.0 feet), off at 114.5 feet (2.0 feet).
  - ✓ PP-166 on at elevation 118.5 feet (6.0 feet), off at 114.5 feet (2.0 feet).
  - ✓ High Alarm at elevation 119.75 feet (7.25 feet), High-high alarm at 120.5 feet (8.0 feet).
  - ✓ Water flows to the environment at elevation 125.8 feet (13.3 feet)

7.1.7. West Ditch

The west ditch collects surface water from most of the north and west sides of the TDF. It also collects subsurface flows from a portion of the TDF and water from DB-04 at Hawk Inlet.

7.1.7.1. Pond 9

Pond 9 is a small HDPE-lined pond on the north end of the TDF.

- Provides limited surge protection for the north end of the TDF.
- Lined with 80-mil HDPE
- Water and sediment collection point for north ditches.
- WW-9 is a catch basin on the west end of Pond 9 and reports to the West Ditch by gravity via an 18-inch pipeline

7.1.7.2. WW-3

WW-3a lift station that collects subsurface water from the West Buttress Area

- PP-107: 10 HP Pump
- A float switch actuates pump PP-107. Flows report to West Ditch.

7.1.8. Pond 7/10 Flow Control Structure

The flow control structure (FCS) is used to route water to either Pond 7 or Pond 10 and is located between the ponds.

- The 8 and 18-inch 920 pipelines terminate at the FCS
- Discharge pipelines from WW-12, 15, and 16 terminate at the FCS
- Water from sources described above are discharged to either Pond 7 or Pond 10 from the FCS. Sluice gates within the FCS are adjusted as needed to route flows to either Pond 7 or Pond 10 or combination of both. Normal position is for all flows to report to Pond 7.
- The following in-line magnetic flow meters are at the FCS:
  - ✓ FIT-SD2: 8-inch pipeline from 920
  - ✓ FIT-SD1: 18-inch pipeline from 920 (pipeline and flow meter reduce to 16 inches at FCS)
  - ✓ FIT-WW-16: 6-inch discharge pipeline from WW-16
  - ✓ FIT-WW-15: 3-inch discharge pipeline form WW-15
  - ✓ FIT-WW-12: 6-inch discharge pipeline from WW-12
- Four 36-inch pipelines connect Ponds 7 and 10 at elevation 137 feet.

7.1.8.1. Pond 7/10 Connector Culverts and Emergency Spillway

Pond 7 and 10 are connected at 137 feet, and water spills to the wetland northwest of Pond 7 at elevation 140 feet.

- (4) 36-inch corrugated polyethylene pipelines are installed at elevation 137 feet between Ponds 7 and 10. They are referred to as the Pond 7/10 Connector Culverts.
- Pond 7/10 Emergency Spillway is located on the north end of Pond 7. The spillway crest has an elevation of 140 feet. See Table 7-5 - Pond 7/10 Emergency Spillway Rating Table. The spillway is designed to pass the 500-year, 24-hour storm event.

7.1.9. Wheel Wash 05

All mobile equipment that goes into the TDF must exit through the wheel wash before entering the B-Road at 1.3-mile. There are several components of the wheel wash including (5) 20 HP pumps used to recirculate recycled water, one 40 HP pump used to pump water from TK-08 through the final rinse cycle, and a 25 HP hose reel pump used to wash equipment.

7.1.9.1. Tank 8 (TK-08)

- Fresh water supply for the rinse cycle in wheel wash and Pond 7 WTP
- An additional 3-inch outlet is attached to the tank to fill water trucks for watering roads for dust abatement.
- Receives pumped water via PP-164 on demand from WW-18 (Cannery Creek). Pump on at tank level 15.2 feet (elevation 188.7 feet); pump off at 16.6 feet (elevation 190.1 feet) and
- Water from WW-13 reports to TK-08.
- Tank overflows at 19.5 feet (elevation 193 feet) and reports to DB-08.
- Flow meters for discharge line from WW-18 and WW-13 located at TK-08
  - ✓ FIT-9050: Flow from WW-18 to TK-08
  - ✓ FIT-WW-13: Flow from WW-13 to TK-08
- Bottom of tank = elevation 173.5 feet
- Low level alarm at 7 feet (elevation 180.5 feet)
- Pressure sensor LT-TK-08 measures tank level.

7.1.9.2. DB-08

DB-08 is the degrit basin within the wheel wash building used to settle out sediment from the wash water. It includes a sump on one end that contains the five recycle pumps to feed the initial wash down stage with recycled water.

7.2.920 Area

The 920 area generically refers to the footprint of the infrastructure adjacent to the underground mine portal. Within this footprint are the milling facilities, administrative buildings, maintenance and freight management facilities, water management structures, Site 23, Site C and 860 Area, and Site D. All stormwater runoff originating within the 920 area is routed to a system of retention ponds via a system of surface ditches, culverts, and lift stations. Stormwater runoff external but adjacent to the 920 area is routed around the facility via a system of diversion ditches. Groundwater is extracted from the 920 area rockfill and waste rock storage sites via a system of underground perforated collection pipes all ultimately reporting to the 920 area retention pond system. Additionally, groundwater extracted from within the underground mine as a part of operational dewatering practices is discharged to the 920 area retention pond system and ultimately conveyed to Pond 7/10.

The 920 area retention pond system is comprised of Pond A, Pond C, Pond D, and Pond 23. Surface water at the 920 area is withdrawn from Greens Creek for use in the milling process, potable water, and fire protection water. Additionally, the milling process uses water from both Pond A and Pond D.

The following water management components exist at the 920 area:

7.2.1. Pond A and 920 Area

7.2.1.1. Pond A

Pond A is a 3.6-acre-ft pond and serves as the primary water retention pond for the upper 920 area including the administration building, mine dry and change house, maintenance buildings, mill buildings, and warehouse building. Water within Pond A is contained by a single layer 80mil HDPE liner. See Table 7-6 and Figure 7-4 for capacity information. The pumps and instruments at Pond A are controlled with a PLC located at in the area.

- The following report to Pond A:
  - ✓ Overflow from mill.
  - ✓ Overflow from screen plant with contributing flows from DB-01, DB-02, and the mine workings.
  - ✓ Surface Ditches from 920 area via DB-01 and DB-02.
  - ✓ An underdrain below the Pond A 80 mil liner discharges to Pond A.
  - ✓ Pond B Caisson from the west side of Pond A.
- PP-29 – 30 HP submersible pump on a barge in Pond A that pumps to the mill.
  - ✓ FIT-9029: monitors flow form Pond A to the Mill.
- Pond A Caisson: Concrete caisson in Pond A
  - ✓ LIT-9029: Pressure sensor in Pond A Caisson that monitors Pond A Level.
    - Pond overflows at elevation 906.5 feet (12.7 feet).
  - ✓ PP-09 and 10: 150 HP multi-stage pumps
    - Lead and lag pump are interchangeable.
    - Lead pump on at 902 feet (9.2 feet), off at elevation 901 feet (8.2 feet)
    - Lag pump on at 903 feet (10.2 feet), off at elevation 902 feet (9.2 feet)
  - ✓ Water normally reports to DB-03
    - option to send directly to Pond 7/10
    - option to send to the mill
- Pond B Caisson: Local area stormwater runoff to the west of Pond A and below the 920 lined ditch is collected at the Pond B Caisson. A curtain drain also reports to the caisson.
  - ✓ Water pumped to Pond A using a Ready 8 pump (PP-65) controlled by a float switch. There is no flow meter in the discharge line.
- Pond A Underdrain: 18-inch culvert connected to French drains below the Pond A liner
  - ✓ PP-12: Ready 8 pump
  - ✓ LIT-9031: Pressure sensor that monitors level of underdrain caisson
    - PP-12 on at elevation 896.2 feet (2.0 feet), off at elevation 894.7 feet (0.5 feet)
  - ✓ High level alarm at elevation 899.2 feet (5 feet)

7.2.1.2. DB-09

Degrit basin on the ore pad. Runoff on the ore pad is directed to DB-09. Captured sediment is cleaned out by mill ops as needed and returned to the ore pile. Water overflowing the degrit basin reports to the ditch below the ore pad and then to DB-01.

7.2.1.3. Backslope French Drain

Collects flows from along the back slope of the warehouse and ore pad. The water collected reports to the ditch below the ore pad then to DB-01.

7.2.1.4. DB-01

Degrit basin east of Pond A. Collects surface water from the warehouse and ore pad area, and much of the area north of Greens Creek and east of the mill. Used as a dumping point for sediment collected around the 920 area as well. DB-01 overflows to Pond A.

- SU-29: 40 HP submersible agitator pump used to pump solids to screen plant SN-15.

7.2.1.5. DB-02

Degrit basin west of Pond A used to collect water from the 920 lined ditch. DB-02 overflows to Pond A.

- SU-28: 30 HP submersible agitator pump used to pump solids to screen plan SN-15.

7.2.1.6. Screen Plant SN-15

Water is pumped from the mine workings, DB-01, and DB-02 to SN-15. SN-15 is used to separate oversized particles from this sediment laden water before routing it to the tailings thickener in the mill. The Screen Plant has an MCP with a PLC that controls the screen plant, the pumps in DB-01 and 02, and the associated instruments.

Table 7-6 – Pond A Capacity

Elevation (ft AMSL)	Area (acres)	Incremental Capacity (ac-ft)	Capacity (ac-ft)	Capacity (cu. ft.)	Capacity (gallons)	Notes
892	0.00	0.00	0.00	0	0	
894	0.01	0.01	0.01	395	2,954	
896	0.21	0.22	0.23	9,903	74,073	
898	0.26	0.47	0.70	30,507	228,194	
899.65	0.29	0.87	1.10	47,838	357,825	30% Operating Capacity
900	0.30	0.17	1.27	55,185	412,785	
902	0.34	0.65	1.91	83,336	623,355	
904	0.38	0.73	2.64	114,951	859,835	
906	0.42	0.81	3.45	150,104	1,122,780	
906.5	0.43	0.21	3.66	159,453	1,192,708	Spillway Invert

Total Capacity = 3.66 ac-ft

30% Operating Capacity = 1.10 ac-ft

Surge Capacity = 2.56 ac-ft

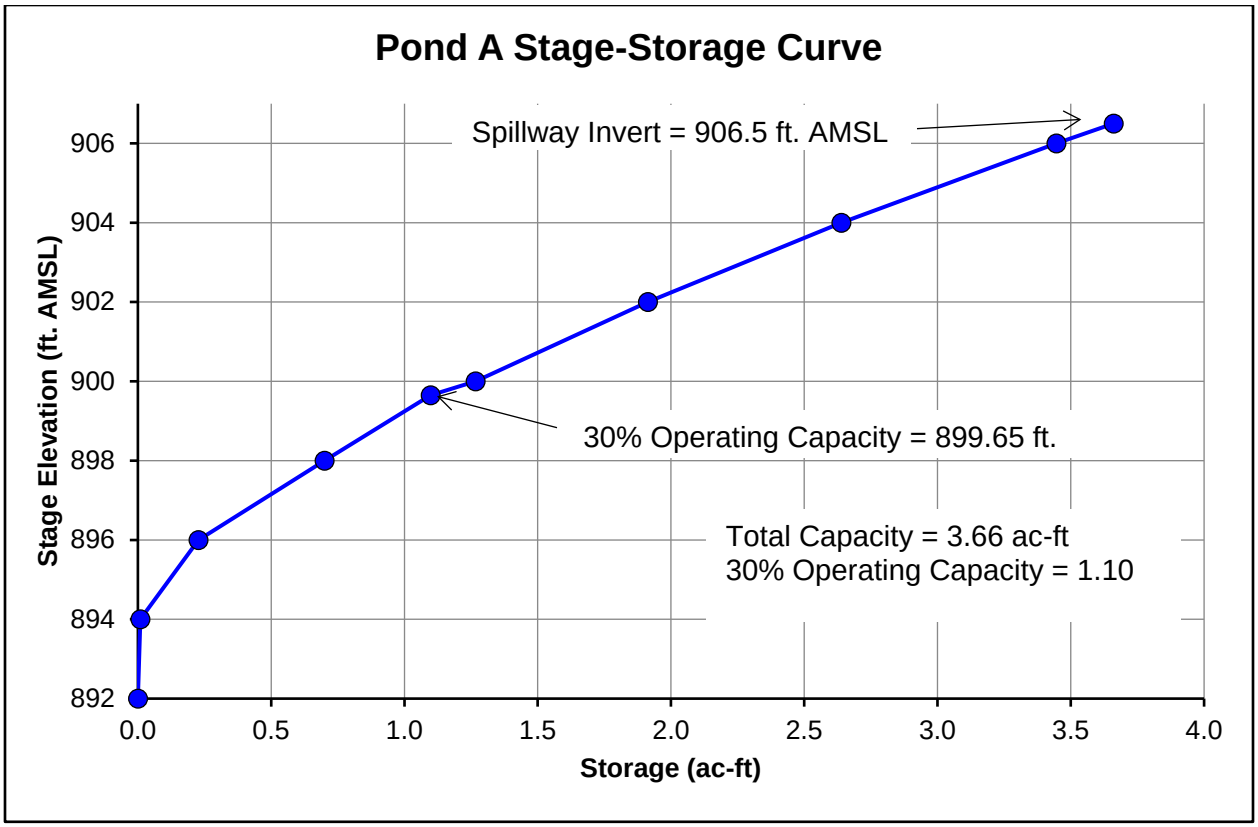


Figure 7-4 – Pond A Stage-Storage Curve

7.2.2. 920 Fresh Water System

Up to 700 GPM is pumped from Greens Creek just north of the Portal Bridge. This water is used in:

- the milling process,
- the mine,
- for fire water, and
- for potable water at the 920.

An MCP is located within the 920 Fresh Water Pumphouse and contains a PLC that controls the pumps and instruments in the pump house.

7.2.2.1. 920 Fresh Water Pumphouse at Greens Creek

Generally, two of three pumps are in operation at a time to pump up to 700 GPM.

- Three intake screens: in the sand bed of Greens Creek and connected to the 920 Fresh Water Caisson
- WP-42, 43, and 44: 40 HP multistage pumps.
- Flow meter Fit-9002: tracks pumped flows
- Greens Creek Fresh Water Caisson level is monitored by a level transmitter.
- Screens are blown down with air as needed to free screens of fine sediment and organics.

7.2.2.2. 1160 Head Tank

Head tank used to store fire water and fresh water for the 920 area and mine. Tank is 34 feet in diameter and 24 feet tall. The bottom 15 feet (100,000 gallons) of the tank is used for firewater reserve. The top 9 feet (60,0000 gallons) is for freshwater reserve.

- Fire water is pulled from the bottom of the tank.
- Fresh water is pulled from 15 feet up from the bottom of the tank.
  - ✓ Water is fed into the tank through the same pipe as it is drawn.
- Level sensor LIT-9000: monitors level of the tank.

7.2.2.3. Fire Water System

The fire water system at the 920 is pressurized by the 1160 head tank. 100,000 gallons is always held in reserve to ensure that water is available for a fire.

- The fire loop fed from the 1160 head tank through a 10-inch HDPE pipeline and feeds the fire hydrants and sprinkler system in the buildings around the 920.

7.2.2.4. Fresh Water System

The fresh water system is fed from the 1160 head tank through an 8-inch HDPE Pipeline and from the pumps in the fresh water caisson. The pipeline between the 1160 head tank and the Fresh Water pump house moves water both ways. Water to the mill comes from the fresh water pump house or the head tank.

- All fresh water goes through the mill and is monitored by FIT-9024.
- A portion to the fresh water goes to the mine workings underground and is monitored by FIT-9003.

7.2.2.5. 920 Potable Water System

Up to 10 GPM is pulled from the fresh water system to feed the potable water system. A microfiltration system is used to filter all potable water after which it is Chlorinated. The microfiltration system is controlled by its own PLC.

- About 28,000 gallons of water is stored in three tanks for potable water usage at the 920. While being stored in the tank, the potable water gets “contact time” with the chlorine before entering the distribution system.
- The distribution system for the drinking water consists of a 4-inch main that feeds the mill, the 920 admin building, and the safety and lab buildings at the 860.
- Pressure sensor LIT-9008: monitors the level to the storage tanks. All three are connected and are at the same level.
- Flow meter FIT- 9008: magnetic flow meter monitoring the flow exiting the potable water storage tanks.

7.2.3. 920 Lined Ditch

The 920 lined ditch reports to DB-02. The ditch collects water from the west end of the 920 site and includes the following flows:

- 920 area surface runoff from the concrete pad around the site
- 920 Dry showers and laundry from facilities built in 2012

- Sewer treatment plant effluent
- Mill backslope horizontal drains
- Mill spray water tank overflow
- Mill reclaim tank overflow

7.2.4. Pond C

Pond C consists of two small ponds referred to as Upper and Lower Pond C. A control cabinet with a PLC is located at Pond C to control the pumps and instruments associated with Pond C.

7.2.4.1. Upper Pond C

Upper Pond C is a 0.10 acre-foot pond use to capture surface water from the 860 area including the B-Road. It is lined with 45-mil RPP liner. See Table 7-7 – Upper Pond C Capacity and Figure 7-5 – Upper Pond C Stage-Storage Curve for capacity info.

- Perforated Caisson with heater to keep caisson thawed during winter months.
- Pressure sensor LIT-CPOND: measures pond level.
- PP-138 and 139: rail pumps in the upper caisson. The lead and lag pumps are interchangeable. The pumps are both 6.5 HP.
  - ✓ Lead pump on at elevation 875 feet (5.5 feet)
  - ✓ Lag pump on at elevation 875.5 feet (6.0 feet)
  - ✓ Lead pump off at elevation 872.5 feet (3.0 feet)
  - ✓ Lag pump off at elevation 873 feet (3.5 feet)
- Upper Pond C spillway reports to lower Pond C
- Upper Pond C underdrain reports to lower Pond C

7.2.4.2. Lower Pond C

Lower Pond C is a 0.19 acre-foot pond used to capture seeps off of the Site C back slope. The outer slope is lined with 80-mil HDPE liner and is covered with fill. See Table 7-8 – Lower Pond C Capacityand Figure 7-6 – Lower Pond C State-Storage Curvefor capacity info.

- Lower Pond C Caisson: perforated caisson collection water from the pond.
- PP-140: 7.5 HP submersible electric pump will be used to move water form lower to upper Pond C. Ready 8 pump currently installed.
- Pressure sensor to be installed to measure pond level
- Flow meter to be installed to monitor flows from lower to upper Pond C
- Overflows to greens creek through 18-inch culvert
- A heater is installed in the caisson to keep it thawed in below freezing conditions

Table 7-7 – Upper Pond C Capacity

Elevation (ft AMSL)	Area (acres)	Incremental Capacity (ac-ft)	Capacity (ac-ft)	Capacity (cu. ft.)	Capacity (gallons)	Notes
872.5	0.01	0.00	0.00	0	0	
873.4	0.01	0.01	0.01	455	3,400	Operating Capacity
874.0	0.02	0.01	0.02	821	6,142	
876.0	0.02	0.04	0.05	2,389	17,870	
878.0	0.03	0.05	0.10	4,560	34,110	Spillway Invert
Total Capacity = 0.10 ac-ft						
Operating Capacity = 0.01 ac-ft						
Surge Capacity = 0.09 ac-ft						

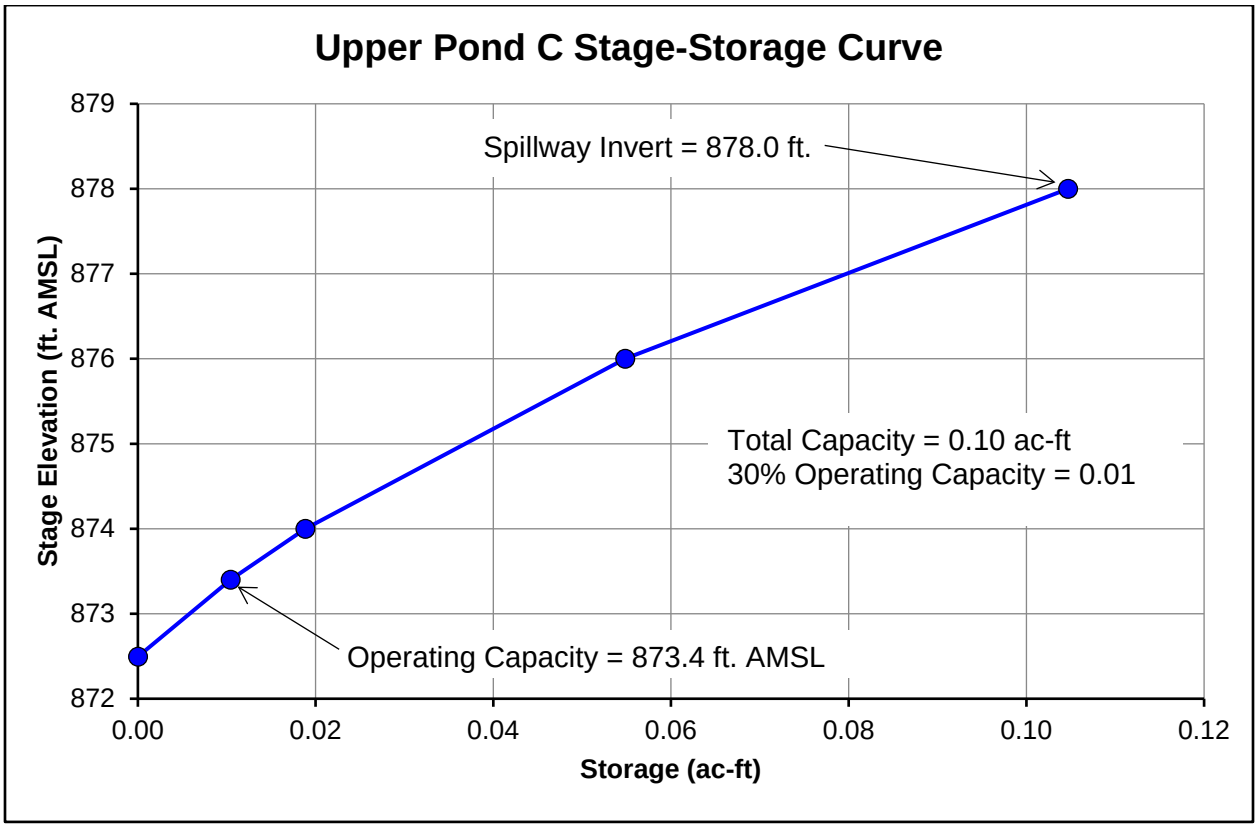


Figure 7-5 – Upper Pond C Stage-Storage Curve

Table 7-8 – Lower Pond C Capacity

Elevation (ft AMSL)	Area (acres)	Incremental Capacity (ac-ft)	Capacity (ac-ft)	Capacity (cu. ft.)	Capacity (gallons)	Notes
853.2	0.00	0.00	0.00	0	0	Bottom of Caisson
854.0	0.00	0.00	0.00	44	332	
856.0	0.01	0.01	0.01	548	4,099	
858.0	0.02	0.03	0.04	1,744	13,041	
860.0	0.03	0.05	0.09	3,856	28,846	
860.3	0.03	0.01	0.10	4,277	31,989	Top of Caisson Perforations
862.0	0.05	0.07	0.17	7,480	55,952	
862.4	0.06	0.02	0.19	8,447	63,182	Overflow Culvert Invert
864.0	0.08	0.11	0.30	13,277	99,310	
865.0	0.10	0.09	0.39	17,159	128,347	
865.1	0.10	0.01	0.40	17,589	131,564	Top of Liner
865.2	0.10	0.01	0.42	18,159	135,832	Top of Caisson
865.8	0.11	0.06	0.48	20,813	155,681	Spillway Invert

Total Capacity = 0.19 ac-ft

Operating Capacity = 0.00 ac-ft

Surge Capacity = 0.19 ac-ft

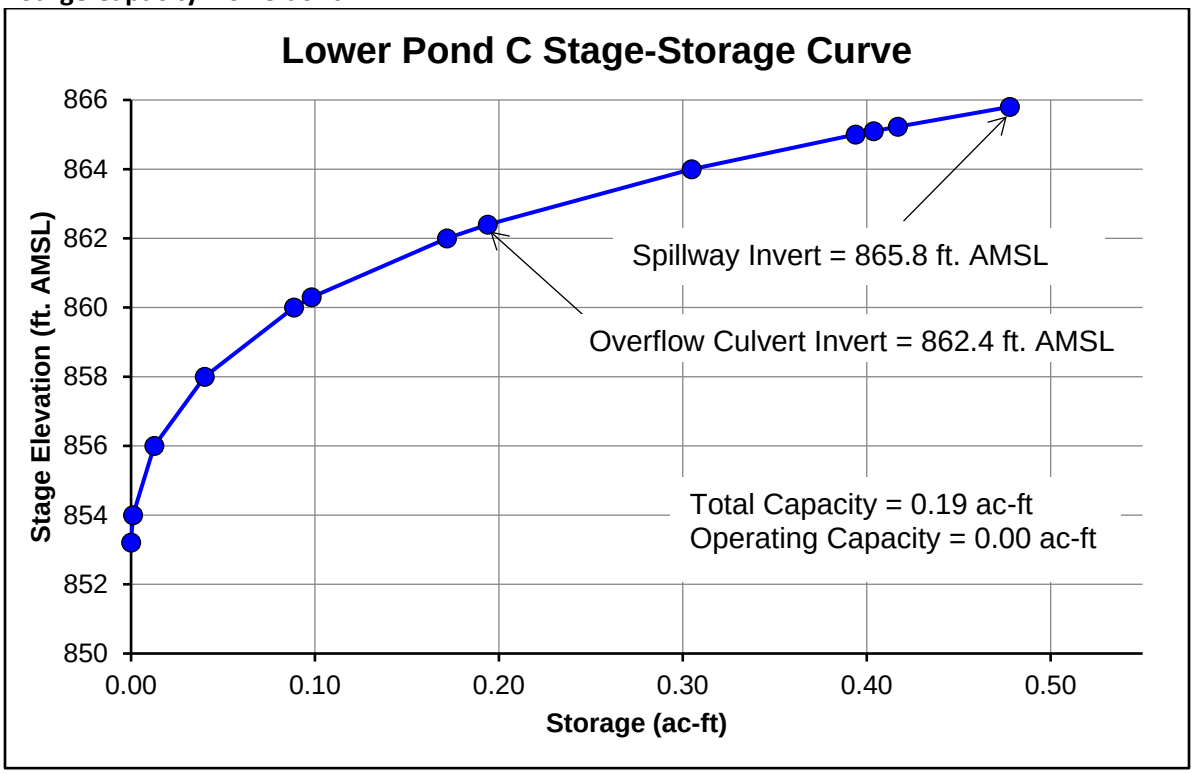


Figure 7-6 – Lower Pond C State-Storage Curve

7.2.5. Site 23 Lined Ditch

The Site 23 Lined Ditch Runs along the base of Site 23 along the B-Road and reports to DB-03. It is lined with 45-mil RPP liner. Water is collected from the following sources:

- Site 23 surface runoff
- Site 23 horizontal drains
- Shotcrete Plant Sump
- Pond C

7.2.6. Pond 23

Pond 23 is a 4.5-acre-foot pond. It is lined with 80-mill HDPE Liner. and is located on the east end of Site 23. See Table 7-9 and Figure 7-7 for capacity information. A control cabinet with a PLC is in Pumphouse 23 to control the pumps and instruments associated with Pond 23 and Pond D.

7.2.6.1. DB-03

DB-03 is the degrit basin at the east end of Pond 23. The Site 23 lined ditch reports here.

- 8-inch pipeline from Pond A normally reports to DB-03.
- 10-inch pipeline can be directed to DB-03. During winter time operations, a small portion of the flow from the 10-inch line diverted to DB-03 to keep Pond 23 from freezing.
- DB-03 is cleaned with a loader and dump truck or the vac truck and is dumped at DB-01 or Site 23.

7.2.6.2. Pond 23 Caisson

Connected to Pond 23 with two multistage pumps via a 12-inch pipeline.

- Level sensor LIT-9033: measures the level in the caisson.
- PP-24 and 25: 75HP multistage pumps used to move water from Pond 23 to Pond 7/10 via the 8-inch 920 pipeline.
  - ✓ Lead and lag pump are interchangeable
  - ✓ Summer mode (normal setting) is as follows:
    - Lead pump on at elevation 883.5 feet (12.5 feet), off at elevation 881.5 feet (10.5 feet).
    - Lag pump on at 885 feet (14.0 feet), off at elevation 883 feet (12.0 feet).
  - ✓ Winter mode is as follows:
    - Lead pump on at elevation 885 feet (14.0 feet), off at elevation 883 feet (12.0 feet).
    - Lag pump on at 886.5 feet (15.5 feet), off at elevation 885 feet (14.0 feet).
  - ✓ Storm mode is as follows:
    - Lead pump runs at full speed until elevation 882 feet (11.0 feet) is achieved
    - If the lead pump cannot keep up, then the lag pump runs at full speed until elevation 882 feet (11.0 feet) is achieved.

“Winter mode” is normally not used. “Storm mode” is used when the pumps cannot keep up with runoff to Pond 23 in “Summer mode”.

7.2.6.3. Pond D Caisson 2

The Pond D Caisson 2 receives water via the six-inch discharge line form Pond D. It acts as a lift station to pump Pond D water to the mill. Components of the caisson are as follows:

- FIT-9033: Flow meter measuring flows from Pond D via six-inch pipeline.
- FIT-9032: Flow meter measuring flows form the Pond D Caisson to the Mill.
- LIT-9033: Level sensor measuring caisson level.
- PP-37: 25-HP multistage pump used to pump water to the mill.
- Overflow to Pond 23.

7.2.6.4. PP-204 – 18-inch Diesel Pump

Back up pump 300- HP diesel pump that can pump up to 6000 GPM to evacuate water from Pond 23. The components are as follows:

- 18-inch intake strainer staged in the pond during summer months and removed during winter months.
- Flow meter for 18-inch pipeline located at the FCS at Pond 7/10.

Table 7-9 – Pond 23 Capacity

Elevation (ft AMSL)	Area (acres)	Incremental Capacity (ac-ft)	Capacity (ac-ft)	Capacity (cu. ft.)	Capacity (gallons)	Notes
877	0.00	0.00	0.00	0	0	
878	0.04	0.02	0.02	1,008	7,543	
879	0.10	0.07	0.09	4,036	30,188	
880	0.14	0.12	0.21	9,132	68,310	
881	0.18	0.16	0.37	16,102	120,443	
882	0.22	0.20	0.57	24,923	186,423	
883	0.26	0.24	0.82	35,551	265,925	
884	0.30	0.28	1.10	47,901	358,298	
884.78	0.33	0.25	1.35	58,806	439,869	30% Operating Capacity
885	0.34	0.07	1.42	61,927	463,215	
886	0.38	0.36	1.78	77,543	580,024	
887	0.41	0.39	2.17	94,641	707,912	
888	0.44	0.43	2.60	113,175	846,552	
889	0.48	0.46	3.06	133,148	995,945	
890	0.51	0.49	3.55	154,557	1,156,089	
891	0.61	0.56	4.10	178,799	1,337,413	
891.5	0.63	0.31	4.50	196,020	1,466,230	Spillway Invert

Total Capacity = 4.50 ac-ft
30% Operating Capacity = 1.35 ac-ft
Surge Capacity = 3.15 ac-ft

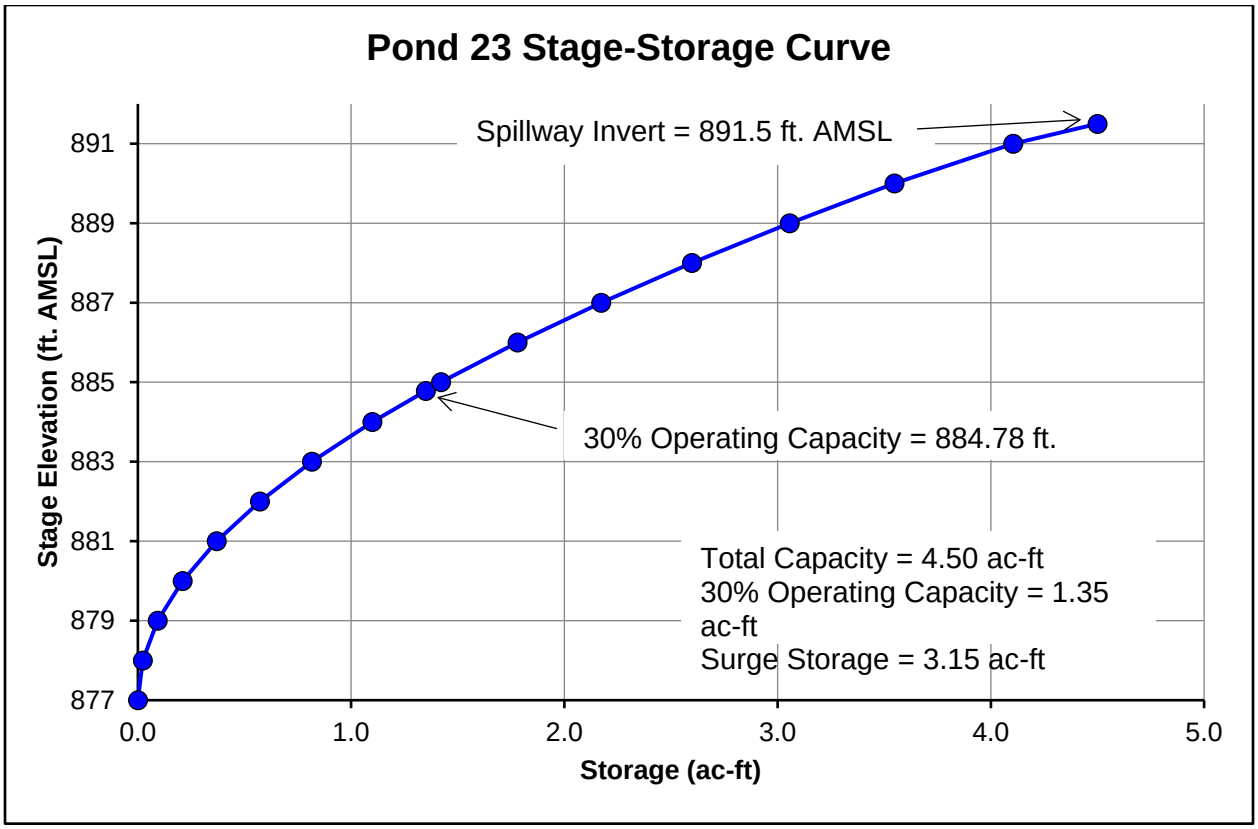


Figure 7-7 – Pond 23 Stage-Storage Curve

7.2.7. Pond D

Unlined pond at the base of Site D adjacent to Green Creek. The Pond D pumps and instruments are controlled by the PLC at Pond 23 Pumphouse. Collects water from the following sources:

- Site 23 Curtain drain
- Site D Sumps
- Site D Surface Runoff

See Table 7-10 and Figure 7-8 for capacity information.

7.2.7.1. Pond D Caisson 1

Caisson in the east end of Pond D with two submersible pumps.

- Level sensor LIT-9033
- PP-21: 15 HP lead Pond D pump discharging water through a 6-inch pipeline to Pond D Caisson 2.
- PP22: 110 HP lag Pond D pump discharge water through a 12-inch pipeline to Pond 23 with the option to send directly down-hill via the 18-inch pipeline.

7.2.7.2. PP-205-8-inch Diesel Pump

Backup 99 HP diesel pump adjacent to Pond D Caisson 1.

- Tied into 12-inch discharge pipeline from PP-22.

- Barge strainer staged at Pond D. Deployed when pump is used. Requires more than one person to install.

Table 7-10 – Pond D Capacity

Elevation (ft AMSL)	Area (acres)	Incremental Capacity (ac-ft)	Capacity (ac-ft)	Capacity (cu. ft.)	Capacity (gallons)	Notes
812	0.05	0.00	0.00	0	0	
813	0.08	0.07	0.07	2,831	21,179	
814	0.09	0.09	0.15	6,534	48,874	
814.2	0.09	0.02	0.17	7,579	56,694	30% Operating Capacity
815	0.10	0.08	0.25	10,672	79,828	
816	0.12	0.11	0.35	15,246	114,040	
817	0.34	0.23	0.58	25,265	188,981	Spillway Invert

Total Capacity = 0.58 ac-ft

30% Operating Capacity = 0.17 ac-ft

Surge Capacity = 0.41 ac-ft

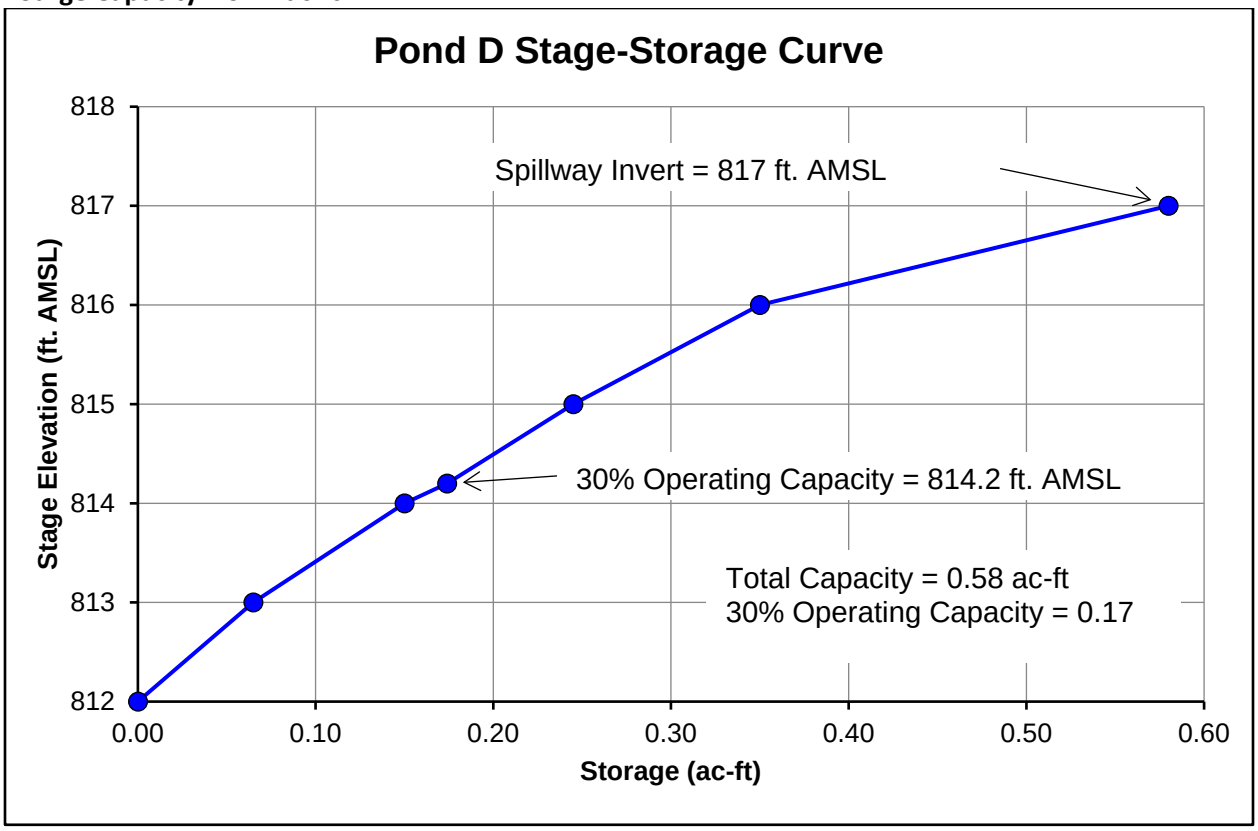


Figure 7-8 – Pond D Stage-Storage Curve

7.2.8. 920 Pipelines

Three pipelines are used to convey water from the 920 to Pond 7/10 and include an 8-inch, 10-inch, and 18-inch pipeline. Air relief valve stations (ARV) are positioned at the following location for all three pipelines unless otherwise noted:

- 10-inch pipeline only: two near DB-03
- 8 and 18-inch pipelines: 8-mile behind Pump House 23
- 7.8-mile
- 7.2-mile
- 6.6-mile
- 6.1-mile
- 4.6-mile
- 4.1-mile
- 2.8-mile
- 2.3-mile

7.2.8.1. 8-inch Pipeline

The 8-inch HDPE pipeline conveys stormwater to Pond 7/10 from Pond 23 or directly from Pond A.

The following operating parameters exist:

- Three-way valve between 8 and 18-inch pipelines at 7.9-mile B-Road with the following options:
  - ✓ 8-inch only position sending water to Pond 7/10
  - ✓ 18-inch only position sending water to Pond 7/10: **Normal Position**
  - ✓ Split water between the 8 and 18-inch pipelines

7.2.8.2. 10-inch Pipeline

The 10-inch HDPE pipeline conveys treated water from the 800 GPM Water Treatment Plant at the Mill to Pond 7. The following options exist in the 10-inch pipeline:

- Two gate valves at DB-03 allowing water to be diverted to DB-03. A small flow is sent to DB-03 in the wintertime to keep Pond 23 from freezing.
- Three-way valve at 7.9-mile with the following options:
  - ✓ 10-inch only position sending water to Pond 7: **Normal Position**
  - ✓ 18-inch only position sending water to Pond 7/10
  - ✓ Split water between 10 and 18-inch pipelines

7.2.8.3. 18-inch Pipeline

The 18-inch HDPE pipeline can convey water in the following ways to Pond 7/10:

- Water diverted from the 8 or 10-inch pipelines via three-way valves to Pond 7/10.
- 12-inch Pipeline from Pond D directly to the 18-inch pipeline and then to Pond 7/10.
- PP-204: 18-inch Diesel Pump can be engaged to pump directly out of the west end of Pond 23.

7.2.9. Site E

A 45-mil RPP-lined drainage pond exists at Site E (4.7-mile B-Road) and is pumped into the 8-inch pipeline at 4.6-mile ARV station as needed throughout the summer months. The pond is not maintained in winter months. The following components exist:

- PP-200 or 201 (interchangeable) 6-inch diesel with barge strainer.
- 6-inch discharge pipeline between pond and 4.6-mile.
- 6-inch check valve at the 8-inch pipeline tie-in point used to prevent backflow to the pond.

7.3. Hawk Inlet Area

The Hawk Inlet port and camp facility is located approximately one mile away from Ponds 7 and 10. This port serves to store the milled concentrate products, load bulk container ships for concentrate shipment, and manage freight, fuel, and rock aggregate shipments to the mine site. All Greens Creek Mine employees not commuting to and from Juneau daily reside in a camp facility adjacent to the port.

There are no retention ponds at Hawk Inlet, but water is collected to a central location know as DB-04 which also acts as a sediment catch for the equipment washdown area adjacent to the concentrate storage facility.

The following water management features exist at Hawk Inlet:

7.3.1. DB-04

DB-04 is a double-chambered degrit basin at Hawk Inlet. It is the primary retention basin for all water collected at Hawk Inlet that is required to be treated at the Pond 7 WTP.

A PCC with a PLC is located at DB-04 in the wheel wash building that controls the pumps and instruments in the area.

Most of the “beach” area runoff reports directly to DB-04 during rain events.

7.3.1.1. WW-20 and Concentrate Building Sump

WW20 collects water from the portion of the beach that slopes toward the ocean at transfer bridge (barge ramp). A sump is located inside the concentrate building.

- PP-174 is a 3 HP pump controlled by a float switch. Water is discharged to WW 27 in the truck wash.
- A submersible pump on a float switch is located inside the concentrate building. This water is discharged to DB-04.

7.3.1.2. Herman’s Gulch Sump

Herman’s Gulch is where all water reports to from above the beach. A control cabinet in the Boot Wash contains a PLC that controls WW-21 at Herman’s Gulch.

- WW-21 or the Herman’s Gulch Sump: level is monitored with a pressure sensor.
- PP-175: 6 HP pump and moves water from WW21 to the primary cannery catch basin.
- A Ready 8 is used as a backup pump.

7.3.1.3. Primary Cannery Catch Basin

Catch basin at the base of the hill north of the cannery buildings. It is connected to DB-04 with an 18-inch culvert by gravity. The following reports to the catch basin:

- WW-26 from the boot wash.
- WW-21 or Herman's Gulch Sump
- Truck pad and road surface runoff.

7.3.1.4. Miscellaneous Flows

Other flows reporting to DB-04 include the following:

- Hawk Inlet Truck Wash: Water from the truck wash reports to DB-04 via surface flow.
- Core shed saw discharge: Small amounts of water from the core shed in summertime only.
- Fuel farm sump water pumped with a Ready 8 pump to DB-01 form the FT-01 fuel farm.
- Hawk Inlet Sewer Plant Effluent: Treated water from the sewer plant at Hawk Inlet is discharged to DB-04 via an HDPE pipeline.

7.3.1.5. Cannery Sumps

There are several small sumps that exist around the toe of the slope at the North and South Cannery Buildings. A PLC contained in a control panel in the boot wash controls the pumps in this area.

- WW-22: South Cannery Dry Sump – Collects small seep at base of the slope under the South Cannery Dry.
    - ✓ PP-176: Chemical resistant 0.4 HP pump operated with a float switch.
- WW-23: Utilador Sump – Sump located at the south end of the Hawk Inlet Utilidor used to collect small amounts of rainwater making it in.
    - ✓ PP-177: Ready 8 pump controlled with a float switch.
- WW-24: South Cannery Sump – Collects a small seep at the base of the slope under the north end of the South Cannery.
    - ✓ PP-178: Chemical resistant 0.4 HP pump operated with a float switch.
- WW-24: South Cannery Sump – Collects a small seep at the base of the slope under the north end of the South Cannery.
    - ✓ PP-178: Chemical resistant 0.4 HP pump operated with a float switch.
- WW-25: Mayor's Office Sump – Collects a small seep at the base of the slope east of the boardwalk near the "Mayor's Office".
    - ✓ PP-179: Chemical resistant 0.4 HP pump operated with a float switch.
- WW-26: Boot Wash Sump – Collects water from the sumps along the cannery sumps and the boot wash.
    - ✓ PP-180: Ready 8 Pump sending water to the cannery catch basin.

7.3.1.6. WW 27

Water from DB-04 is pumped to the TDF West Ditch using two pumps in series (PP-44 & PP-43).

- PP-44 is a submersible pump located in WW-27, and PP-43 is mounted on the concrete slab within the Hawk Inlet truck wash.
    - ✓ Pumps turn on at elevation 22 feet (7.5 feet) and off at elevation 18.6 feet (4.1 feet).
    - ✓ Level monitored by sonic head.

- Water from WW-27 reports to the West Ditch at the TDF.
- Storm drains from the concentrate shed storage area report to WW-27.

7.3.1.7. TK-132 and 133

Each tank is 32 feet high and 22 feet in diameter with a capacity of 90,000 gallons. The tanks are connected with a common pipeline to fill and empty them. They are used to add additional surge capacity in the Hawk Inlet area during a storm event.

- PP-206 is an 8-inch diesel pump used to fill the tanks as needed. A strainer is on standby to insert into DB-04 as needed.

During storm events in which PP-44 & PP-43 can't maintain water levels within DB-04 below the top of concrete elevation these tanks can be filled using PP-206, and drained back to DB-04 when conditions allow.

7.3.2. Fresh Water System

Raw water at Hawk Inlet is supplied from Cannery Creek. There is an MCC in the Hawk Inlet Water Utility with a PLC that controls the pumps and instruments in the building.

- TK-96, 97, & 98: 20,000 Gallon storage tanks at the junction. Provide water for Hawk Inlet Truck Wash and fire water system
    - ✓ FCV-8110: Automated valve at TK-96, 97, & 98 in 2-inch HDPE pipeline from Cannery Creek.
    - ✓ Valve opens when tanks are at 22 feet; closes when tanks are at 23 feet.
- Fresh water is withdrawn from the raw water storage tanks and used at the Hawk Inlet Truck Wash, the Hawk Inlet Sewer Treatment Plant (STP-01), the concentrate building, and the Hawk Inlet fire protection system.
    - ✓ Water tanks must be kept 17.25 feet for adequate fire protection at Hawk Inlet.
- Potable water treatment
    - ✓ Fresh water is withdrawn from the raw water storage tanks, treated, and stored in TK-95.
    - ✓ Potable water is used in the Hawk Inlet camp facilities.

7.3.3. Cannery Creek

A small wooden weir structure is in place at Cannery Creek that holds back the water. Boards are inserted and removed as necessary when flow changes. An MCP containing a PLC is in the air compressor building at Cannery Creek. The PLC controls the air compressor, pumps, and instruments at Cannery Creek.

- Provides fresh water to Hawk Inlet and the TDF Wheel Wash 05
- Fresh water is withdrawn from Cannery Creek via two wet wells (Wet Wells 18 & 19) hydraulically connected to the small pond formed by the weir.
    - ✓ WW-19 is connected by a well casing installed horizontally in the sand bed
    - ✓ WW-18 is connected by a screen in the water above the sand bed.
- An air compressor, air reservoir and manifold are in place to direct air as needed to the well casing and screen. Compressed air is used blow down the screens when clogged with organic particles.

- WW-18 pumped to TK-08 at TDF Wheel Wash 05
    - ✓ PP-164: 23 HP pump.
    - ✓ LT-WW-18: Pressure sensor in WW-18.
- WW-19 pumped to Hawk Inlet raw water storage tanks TK-96, 97, & 98.
    - ✓ PP-112: Ready 8 Pump.
    - ✓ LT-Caisson 1: Pressure sensor in the WW-19.

8. Monitoring Requirements and Thresholds

8.1. Reporting

A daily log of activities and observations including pond levels, pipeline flows, water treatment plant activities and any equipment or facility operating issues. Also, as previously noted, most of instrumentation data are logged by SCADA and stored in a SQL server database on a continuous basis.

Inspections are conducted by Water Operations technicians on a weekly basis. They follow a check list. Monthly inspections are also conducted by the Surface Engineer over Pond 7/10 dam system. A similar checklist is followed. See Appendix 1.

Technicians and engineers are looking for items that are unusual or out of place.

8.2. Thresholds

Thresholds are established to allow engineers at Greens Creek to determine if the dams and ponds are stable and functioning as expected.

8.2.1. Pond 7

Survey monuments are installed along the Pond 7 Dam to determine if settlement is within acceptable limits. Vibrating wire piezometers are installed beneath the liner to determine the pressures in the foundation of the pond. See Figure 4-2 in Appendix 4 for locations of monuments and piezometers. Thresholds are presented in the Tables 8-1 and 8-2. The Engineer of Record is contacted if these thresholds are exceeded.

Table 8-1 - Pond 7 Below Liner Vibrating Wire Piezometers

Instrument ID	Coordinates (Mine Grid Datum)		Instrument Tip El. (ft)	Liner El. (ft)	Threshold El. (ft)
	Northing (ft)	Easting (ft)			
PZ-P7-05-01	51,887	39,727	121.3	123.0	127.0
PZ-P7-05-02	52,160	39,534	122.5	124.3	126.3
PZ-P7-05-03	51,967	39,589	120.0	122.5	124.5
PZ-P7-05-04	51,868	39,488	119.1	121.3	123.3

Table 8-2 - Pond 7 Surface Survey Monuments

Instrument ID	Coordinates (Mine Grid Datum)			Threshold Movement Rates
	Northing (ft)	Easting (ft)	El. (ft)	
P7-1	51752.35	39394.57	146.054	Horizontal > 3 in/year Vertical > 6 in/year Cumulative Settlement > 12 in
P7-2	51733.81	39389.79	135.108	
P7-4	51782.08	39373.92	146.937	
P7-5	51781.63	39327.09	130.145	
P7-6	51779.59	39309.41	118.222	
P7-7	51954.84	39395.44	148.333	
P7-8	51956.41	39375.29	137.391	
P7-9	51957.49	39352.94	126.386	

8.2.2. Pond 10

Survey monuments are also installed along the Pond 10 Dam and there are vibrating wire piezometers installed in the bedding sand below the liners. See Figure 4-3 in Appendix 4 for locations of monuments and piezometers. Thresholds are presented in Tables 8-3 and 8-4. The Engineer of Record is notified if these thresholds are exceeded.

Table 8-3 - Pond 10 Below Liner Vibrating Wire Piezometers

Instrument ID	Coordinates (Mine Grid Datum)		Instrument Tip El. (ft)	Liner El. (ft)	Threshold El. (ft)
	Northing (ft)	Easting (ft)			
IP15	51,287	39,563	124.1	124.5	128.5
IP16	51,288	39,644	124.3	124.5	127.5
IP17	51,499	39,626	122.3	122.4	127.5
IP18	51,618	39,633	120.1	121.3	126.0
IP18A	51,620	39,646	120.2	121.3	126.0
IP18B	51,621	39,657	120.1	121.2	126.0
IP18C	51,621	39,668	120.1	121.3	126.0
IP19	51,485	39,542	122.1	122.5	127.5

Table 8-4 - Pond 10 Surface Survey Monuments

Instrument ID	Coordinates (Mine Grid Datum)			Threshold Movement Rates
	Northing (ft)	Easting (ft)	El. (ft)	
P10-1	51688.95	39477.01	148.507	Horizontal > 3 in/year Vertical > 6 in/year Cumulative Settlement > 12 in
P10-2	51680.73	39435.91	132.249	
P10-3	51693.24	39373.59	125.137	
P10-4	51602.83	39421.34	139.519	
P10-5	51583.68	39457.85	148.312	
P10-6	51470.51	39419.06	148.624	
P10-7	51163.90	39471.45	148.397	
P10-8	51141.13	39538.59	148.665	

Pond 10 has a leak detection system. Daily flow rates are collected in the SDADA system. If the flow rate exceeds 200 GPD, the Engineer of Record will be notified.

8.2.3. Pond A

To be developed.

8.2.4. Pond 23

To be developed.

9. Maintenance Requirements

A fully staffed maintenance department is in place that handles routine and breakdown maintenance needs around the site including the mechanical and electrical components of the Pond 7/10 Dam System. A computer program is used to maintain a database of mechanical and electrical assets site wide. Work orders are generated with this program for routine and breakdown maintenance needs. The work orders are tracked and saved providing a maintenance history of components.

The Maintenance Department is broken down into the following groups:

- Fixed Maintenance: Responsible for non-mobile equipment such as pumps, air compressors, filter presses, etc.
    - ✓ Building Maintenance: Responsible for maintaining structures site wide.
- Fixed Electrical: Responsible for maintaining electrical components of the Pond 7/10 Dam system site wide. Components include instruments and electric motors on pumps.
    - ✓ Process Control Group: Responsible for maintaining SCADA and PLCs around the site.
- Mobile Maintenance: Responsible for maintaining mobile equipment including the diesel motors on the mobile pumps site wide.

Additional detail will be added to this section in subsequent versions of the O&M Manual.

10. Operator Training Program

10.1. New Employees

New HGCMC Water Operations technicians will do the following to learn how to operate the operation of the Pond 7/10 Dam System:

- Thoroughly review this document and the associated appendices.
- Examine all components of the Pond 7/10 Dam System in the field with an experienced operator and the surface engineer responsible for the system.
- Shadow an experienced water operator for a minimum of three two-week rotations or until comfortable with the operation of the system.

The surface operations manager will be responsible for determining if a new technician is ready to operate the Pond 7/10 Dam System.

10.2. Operator Refresher Training

The Water Operations group will have at minimum an annual meeting with all operators attending. The purpose of the meeting is to review the Pond 7/10 System focusing on system changes that have occurred within the previous year. Discussions will cover system performance and problems. Review of and updates to this document will be a part of the meeting.

10.3. Safety

The HGCMC Water Operations personnel must attend at least three safety meetings per month as per company safety standards. HGCMC regards safety aspects of the water systems as a high priority and addresses key critical or hazardous tasks with risk assessments and safe work procedures such as; energy isolation, working around water hazards, chemical handling, confined space entry, excavation permits, and vehicle and driving standards.

Each HGCMC employee must attend an annual 8-hour MSHA refresher course in the spring to meet MSHA regulations

11. Emergency Action Plan

11.1. HGCMC Emergency Response Plan and Incident Command System

Current copies of the Emergency Response Plan (ERP) (often referred to as the red book) kept at critical locations throughout the mine property including the Pond 7 WTP. The ERP contains phone lists to notify critical personnel and departments when an emergency or disaster occurs. The ERP defines an emergency versus disaster situation and outlines the initials steps of the response. The ERP has guidelines for establishing and operating an Incident Command (IC) system and the organization of response teams.

The Disaster Recovery Management Plan is activated when an emergency response has ended. The disaster recovery plan is used to implement the necessary steps to get HGCMC back into full operation following an emergency or disaster.

11.2. Potential Hazards

The following potential exposures exist in the operation of the Pond 7/10 Dam System (not all inclusive):

- Bear interactions
- Electrical energy
- Mechanical energy
- Slick liners at ponds and ditches
- Gases such as Hydrogen Sulfide
- Suspended loads
- Exposure to lead

Training programs and standards are in place to protect employees from potential exposures to prevent injuries and fatalities.

The primary failure hazard of the ponds is environmental damage from a release. There are no dwellings or other facilities down slope of the dams.

Pond 10 is a double-lined facility. If the top or primary liner is compromised, then the bottom or secondary liner will contain the water.

11.3. Equipment Failure

Equipment failure (i.e. a pump) during a major storm event can lead to discharge of storm water to the environment. To prevent a release, redundant systems are in place were possible. An example is the 18-inch 920 pipeline. A database of equipment and instrumentation is maintained electronically. Work orders are created when maintenance is required. Work orders are tracked to maintain a history of performance.

An inventory of critical spare equipment and parts is maintained including the following (not all inclusive):

- Electric pumps and motors
- Generators
- Portable Diesel pumps
- Pipe including HDPE
- Pipe fittings and couplings
- RPP and HDPE Liner
- Fusion equipment for HDPE Pipe and Liner

HGCMC has an experienced workforce that works together to respond to equipment or facility failures.

11.4. Major Hydrologic Events

During a storm event the following will be monitored:

- Weather forecasts at Hawk Inlet and the 920:
  - ✓ https://forecast.weather.gov/MapClick.php?lat=58.117802193238425&lon=-134.74738115905762#.XlaWaKhKjcs
  - ✓ https://forecast.weather.gov/MapClick.php?lon=-134.64485202575685&lat=58.080732795376605#.XlaWfKhKjct
- Current precipitation intensities:
  - ✓ http://gc-920env-w1/Dataloggers2/index.html
    - Click on the “Met” tab for real time weather data
- Pond levels:
  - ✓ See “Water Levels Overview” screen in SCADA

If any of the ponds overflow to the environment the following will occur:

- Notify the environmental department and/or surface operations immediately
- The HGCMC incident command structure is initiated
- Monitor flow leaving the structure:
  - ✓ Record start and end times that pond was spilling to the environment
  - ✓ Estimated flow rates during that time

        - Record level on the staff gauge at the Pond 7/10 emergency spillway every 15 minutes
- Sampling of the flows leaving the structure per the environmental compliance coordinator's instruction.

If more that 2-inches of precipitation is observed at Hawk Inlet, the TDF, or the 920 in a 24-hour period, the following will occur:

- Manually measure the flow rate from the Pond 7 Underdrain pipe (see figure 5-5 in appendix 5)
- Conduct a visual inspection of the Pond 7/10 dam system per the monthly inspection checklist
- Review trends of pond levels and flow rates for all systems and include summary in inspection report.

11.5. Seismic Events

If a seismic event of a magnitude 5 or greater occurs within 100 miles of the Greens Creek Mine the following will occur:

- Visual inspection of the Pond 7/10 dam system per the monthly inspection checklist.
- Survey surface monuments at Ponds 7, 10 and the TDF.
- Notify ADNR Dam Safety and Environmental Compliance Coordinator of any damage discovered.
- The HGCMC incident command structure is initiated if damage affects the ability of operate any of the ponds.

12. Closing

The following personnel are responsible for knowing the contents of this manual in order of priority:

1. Water Operations Technicians
2. Surface engineer responsible for maintaining the facility
3. Environmental Compliance Coordinator
4. Surface Operations Manager
5. Surface Operations Foreman and Supervisors
6. Maintenance personnel responsible for maintaining electrical instrumentation mechanical components of the Pond 7/10 Dam System.

The following personnel are responsible for keeping this manual current in order of priority:

1. Surface engineer responsible for the Pond 7/10 Dam System
2. Water Operations Technicians

This manual is a living document and will be updated as infrastructure and components of the system are updated.

13. References

Alaska Department of Natural Resources (ADNR). 2017. Draft Revision - Guidelines for Cooperation with the Alaska Dam Safety Program. Prepared by the Dam Safety Construction Unit, Water Resources Section, Division of Mining, Land and Water, Alaska Department of Natural Resources

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Department of Environmental Conservation (DEC). 2015. Alaska Pollutant Discharge Elimination System. Individual Permit AK0043206. August 20, 2015.

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Environmental Design Engineering Consultants (EDE). 2018. Hecla Greens Creek Mine 2018 Water Balance. June. Project No. GCM1706

Hecla Greens Creek Mining Company (HGCMC). 2020. Greens Creek Mine Emergency Response & Disaster Management and Recovery Plan. January, 2020.

Klohn Crippen Berger (KCB). 2020. 2019 Pond 7/10 Annual Instrumentation Summary. February, 2020

APPENDIX 1

Weekly and Monthly Inspection Templates

POND 7/10 DAM SYSTEM SITEWIDE WEEKLY INSPECTION

Name of Dam: POND 7/10 (AK00307; AK00316)		***Date:***	
Weather:			
Pool Elevation Pond 7:	*ft-msl*	***Inflow to Pond 7 WTP:***	*gpm*
Pool Elevation Pond 10:	*ft-msl*	***14-inch Outfall Discharge:***	*gpm*
Inspector:		***Initial after inspection completion:***	
Supervisor:		***Supervisor signature:***	

Sample Point	Date	Dissolved Zn	Total Zn	Dissolved Cu	Total Cu	Dissolved Pb	Total Pb	TSS	pH
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
WTP Influent									
Pond 7 Underdrain									
Pond 10 Underdrain									

1. Pond 7 Main Embankment	**OK**	**NOT OK**
Is the crest free of cracks? Is settlement or erosion occurring on the slopes of the embankment? Is the pond liner intact and free of holes? Is the access ramp free of vegetation and other obstructions?	☐	☐
2. Wet Well 7		
Is water from Pond 7 flowing freely into WW 7? Is the cover of WW7 intact and sturdy? Is the fall protection structure intact and sturdy? Is there signs of caisson deformation? Are the pumps functioning appropriately? Are the pump rails free and clear of obstructions?	☐	☐
3. Pond 7 Inlet		
Is the concrete structure free of cracks? Is the weir inlet clean and clear of obstructions including sediment? Are staff gauges intact and readable? Are the gabion baskets intact? Is the energy dissipater intact?	☐	☐
4. Pond 7 Emergency Spillway		
Is the weir inlet and stilling basin clear and free of obstructions? Is the concrete structure free of cracks? Are the staff gauges intact? Is the rip rap in place?	☐	☐
5. Pond 7 Underdrain System		
Is water running into the caisson from the inlet pipe? Is the caisson deformed? Is the submersible pump functioning? Is the caisson level within specified limits?	☐	☐

POND 7/10 DAM SYSTEM SITEWIDE WEEKLY INSPECTION

6. Pond 7/10 Flow Control Structure	**OK**	**NOT OK**
Discharge basin clear and free of obstructions? Are the slide gates free moving and intact? Is the pipe insulation intact around the pipes and flowmeters in the vault? Are the flowmeters functioning? Is the wiring intact? Is the liner below the inlet culvert from the FCS free of wear? Is the concrete free of cracks?	☐	☐
7. Pond 7/10 Connector Culverts		
Are culverts free of obstructions? Are the pipe boots intact?	☐	☐
8. Pond 10 Main Embankment		
Is the crest free of cracks? Is settlement or erosion occurring on the slopes of the embankment? Is the pond liner intact and free of holes?	☐	☐
9. Pond 10 Inlet Structure and Access Ramp		
Are there obstructions present? Are the gabions intact? Is the access ramp free of vegetation and other obstructions?	☐	☐
10. Wet Wells 10 & 11		
Is water from Pond 10 flowing freely into WW 10? Is water flowing into WW11 from the underdrains? Is there signs of caisson deformation WW 10 or 11? Are the pumps functioning appropriately? Are the pump rails free and clear of obstructions? Are the trends as would be expected?	☐	☐
11. WW 3		
Is the caisson showing signs of deformation? Is the pump functioning? Is there water entering the caisson through the inlet pipe?	☐	☐
12. Wet Well 14		
Is the caisson showing signs of deformation? Are the pumps functioning? Is there water entering the caisson through the inlet pipe? Do the trends look as you would expect?	☐	☐
13. Wet Wells 12, 13, 15 and 16 at South Embankment		
Are the caissons showing signs of deformation? Are the pumps functioning? Is there water entering the caisson through the inlet pipes for WW 12and 13? Is the culvert entering WW16 intact and clear? Do the trends look as you would expect?	☐	☐
14. Pond 9		
Is the pond outlet clear of obstructions?	☐	☐
15. DB-04 and Sump		
Water flowing from DB-04 to sump in building? Pumps functioning?	☐	☐
16. Pond A and Caisson B		
Is the crest free of cracks? Is there settlement occurring? Is settlement or erosion occurring on the slopes of the embankment? Is the pond liner intact and free of holes? Is the underdrain pump functioning properly? Is the pump in Caisson B functioning?	☐	☐

17. Pond C	**OK**	**NOT OK**
Are embankments free of settlement or erosion? Are caissons showing signs of deformation? Are the pumps function normally? Are the caisson heaters on? Is access free and clear? Is the Upper Pond C liner free of holes or tares? Is Upper Pond C discharge pipeline draining?	☐	☐
18. Pond D		
Is the embankment free of settlement or erosion? Is the caisson showing signs of deformation? Are the pumps functioning properly? Is the fuel tank intact? Are the inlet and discharge lines intact?	☐	☐
19. Pond 23		
Is the embankment free of settlement or erosion? Are the pumps functioning? Is the underdrain functioning? Is the liner intact and free of holes? Do the trends look as they should?	☐	☐
20. 8”, 10” and 18” wastewater pipelines from Pond 23 to Pond 7/10		
Are the pipelines intact? Are the AVRs functioning as they should?	☐	☐

Describe noted deficiencies (items checked “not OK”):

Describe immediate actions taken to remedy deficiencies:

Describe marginal items that are still functioning but need attention:

Other remarks:

POND 7/10 DAM SYSTEM SITEWIDE MONTHLY INSPECTION

Name of Dam: POND 7/10 (AK00307; AK00316)		***Date:***	
Weather:			
Pool Elevation Pond 7:	*ft-msl*	***Inflow to Pond 7 WTP:***	*gpm*
Pool Elevation Pond 10:	*ft-msl*	***14-inch Outfall Discharge:***	*gpm*
Inspector:		***Inspector signature:***	
Supervisor:		***Supervisor signature:***	

1. Pond 7 Main Embankment	**OK**	**NOT OK**
Is the crest free of cracks? Is settlement or erosion occurring on the slopes of the embankment? Is the pond liner intact and free of holes? Is the access ramp free of vegetation and other obstructions?	☐	☐
2. Wet Well 7		
Is water from Pond 7 flowing freely into WW 7? Is the cover of WW7 intact and sturdy? Is the fall protection structure intact and sturdy? Is there signs of caisson deformation? Are the pumps functioning appropriately? Are the pump rails free and clear of obstructions?	☐	☐
3. Pond 7 Inlet		
Is the concrete structure free of cracks? Is the weir inlet clean and clear of obstructions including sediment? Are staff gauges intact and readable? Are the gabion baskets intact? Is the energy dissipater intact?	☐	☐
4. Pond 7 Emergency Spillway		
Is the weir inlet and stilling basin clear and free of obstructions? Is the concrete structure free of cracks? Are the staff gauges intact? Is the rip rap in place?	☐	☐
5. Pond 7 Underdrain System		
Is water running into the caisson from the inlet pipe? Is the caisson deformed? Is the submersible pump functioning? Is the caisson level within specified limits?	☐	☐
6. Pond 7/10 Flow Control Structure		
Discharge basin clear and free of obstructions? Are the slide gates free moving and intact? Is the pipe insulation intact around the pipes and flowmeters in the vault? Are the flowmeters functioning? Is the wiring intact? Is the liner below the inlet culvert from the FCS free of wear? Is the concrete free of cracks?	☐	☐
7. Pond 7/10 Connector Culverts		
Are culverts free of obstructions? Are the pipe boots intact?	☐	☐
8. Pond 10 Main Embankment		
Is the crest free of cracks? Is settlement or erosion occurring on the slopes of the embankment? Is the pond liner intact and free of holes?	☐	☐

POND 7/10 DAM SYSTEM SITEWIDE MONTHLY INSPECTION

9. Pond 10 Inlet Structure and Access Ramp	**OK**	**NOT OK**
Are there obstructions present? Are the gabions intact? Is the access ramp free of vegetation and other obstructions?	☐	☐
10. Wet Wells 10 & 11		
Is water from Pond 10 flowing freely into WW 10? Is water flowing into WW11 from the underdrains? Is there signs of caisson deformation WW 10 or 11? Are the pumps functioning appropriately? Are the pump rails free and clear of obstructions? Are the trends as would be expected?	☐	☐
11. WW 3		
Is the caisson showing signs of deformation? Is the pump functioning? Is there water entering the caisson through the inlet pipe?	☐	☐
12. Wet Well 14		
Is the caisson showing signs of deformation? Are the pumps functioning? Is there water entering the caisson through the inlet pipe? Do the trends look as you would expect?	☐	☐
13. Wet Wells 12, 13, 15 and 16 at South Embankment		
Are the caissons showing signs of deformation? Are the pumps functioning? Is there water entering the caisson through the inlet pipes for WW 12and 13? Is the culvert entering WW16 intact and clear? Do the trends look as you would expect?	☐	☐
14. Pond 9		
Is the pond outlet clear of obstructions?	☐	☐
15. DB-04 and Sump		
Water flowing from DB-04 to sump in building? Pumps functioning?	☐	☐
16. Pond A and Caisson B		
Is the crest free of cracks? Is there settlement occurring? Is settlement or erosion occurring on the slopes of the embankment? Is the pond liner intact and free of holes? Is the underdrain pump functioning properly? Is the pump in Caisson B functioning?	☐	☐
17. Pond C		
Are embankments free of settlement or erosion? Are caissons showing signs of deformation? Are the pumps function normally? Are the caisson heaters on? Is access free and clear? Is the Upper Pond C liner free of holes or tares? Is Upper Pond C discharge pipeline draining?	☐	☐
18. Pond D		
Is the embankment free of settlement or erosion? Is the caisson showing signs of deformation? Are the pumps functioning properly? Is the fuel tank intact? Are the inlet and discharge lines intact?	☐	☐

POND 7/10 DAM SYSTEM SITEWIDE MONTHLY INSPECTION

19. Pond 23	**OK**	**NOT OK**
Is the embankment free of settlement or erosion? Are the pumps functioning? Is the underdrain functioning? Is the liner intact and free of holes? Do the trends look as they should?	☐	☐
20. 8", 10" and 18" wastewater pipelines from Pond 23 to Pond 7/10		
Are the pipelines intact? Are the AVRs functioning as they should?	☐	☐

Describe noted deficiencies (items checked "not OK"):

Describe immediate actions taken to remedy deficiencies:

Describe marginal items that are still functioning but need attention:

Other remarks:

APPENDIX 2

Flow Diagrams

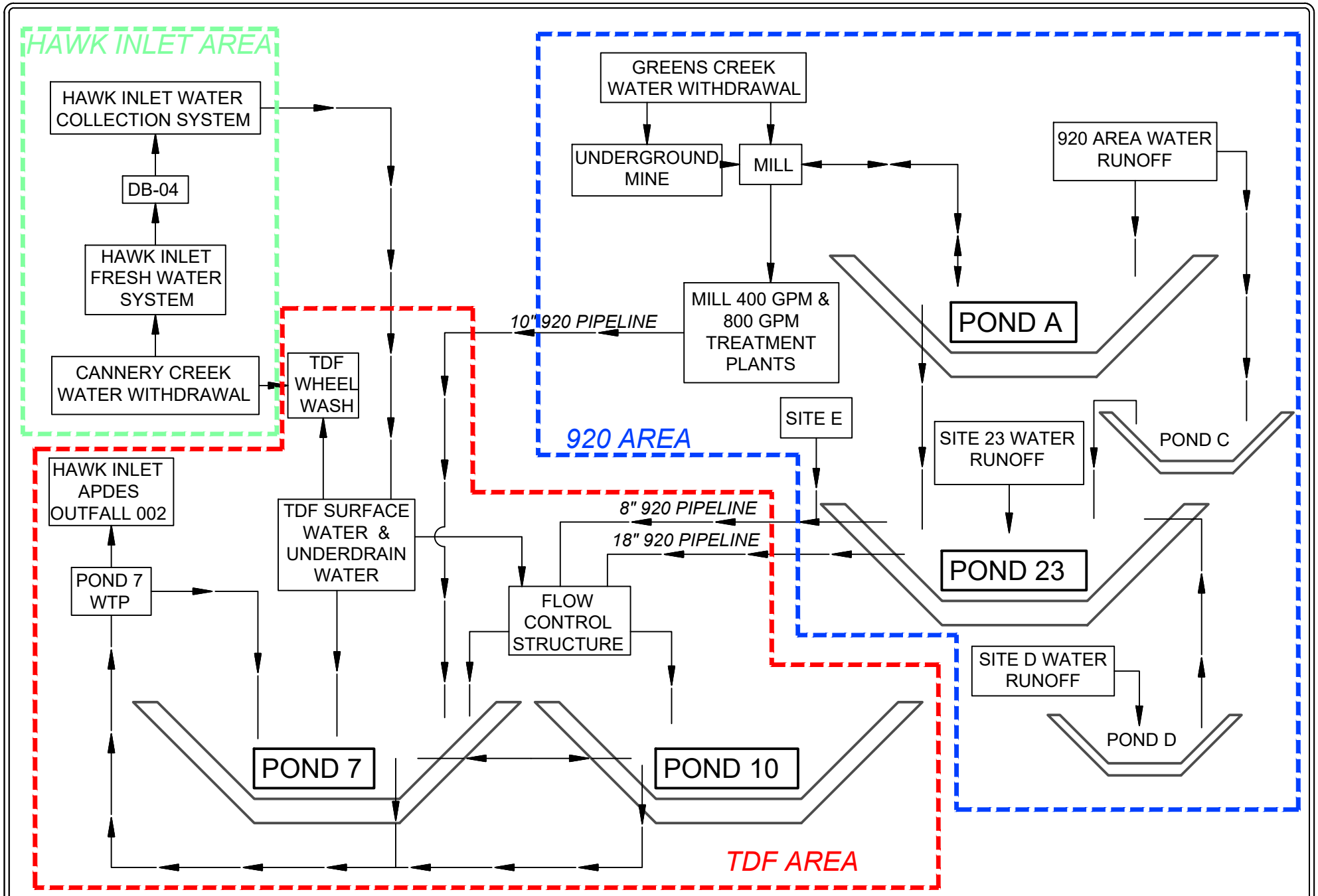


FIGURE 2-1
SIMPLIFIED SITE OVERVIEW FLOW DIAGRAM

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

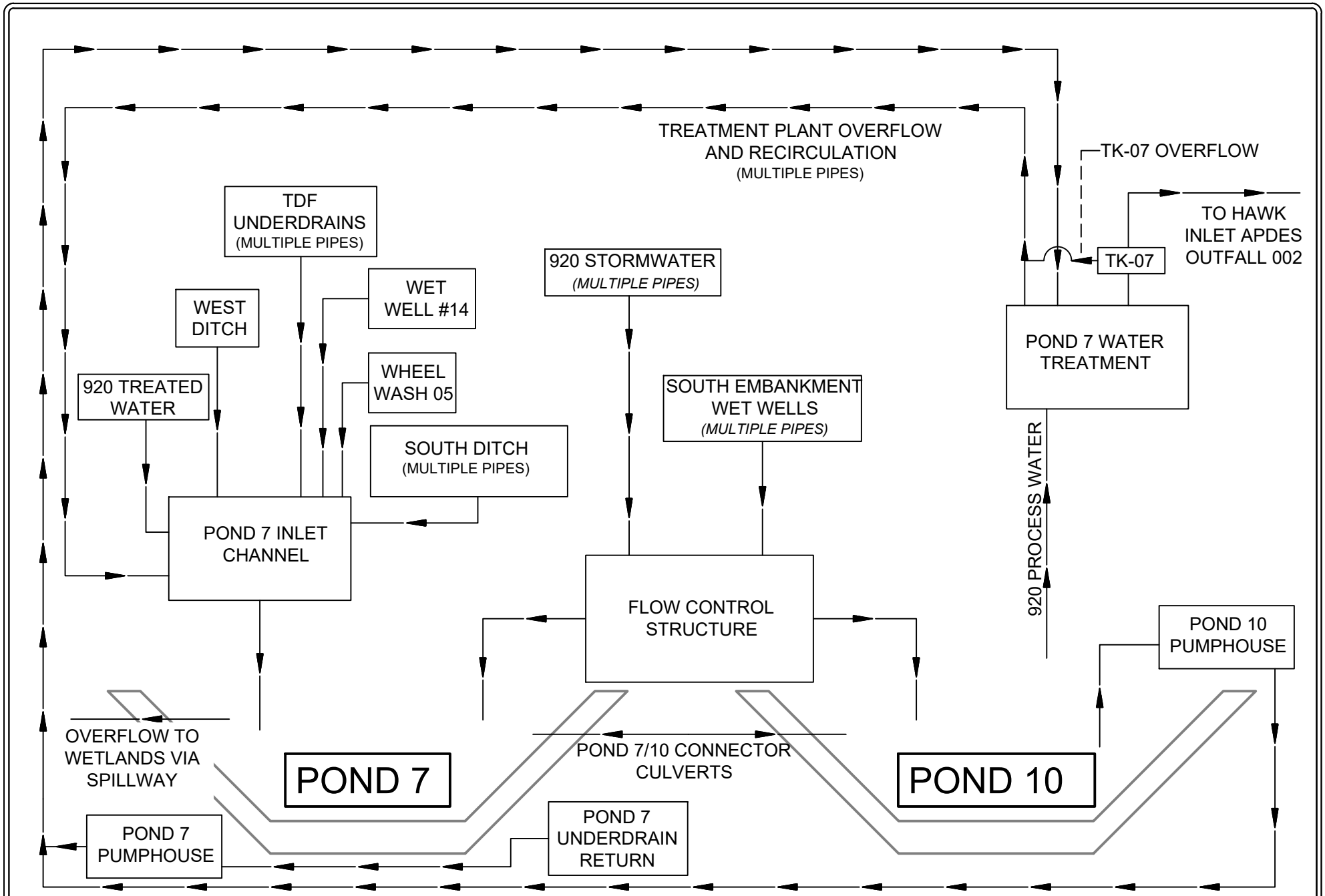


FIGURE 2-2 POND 7 AND 10 FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

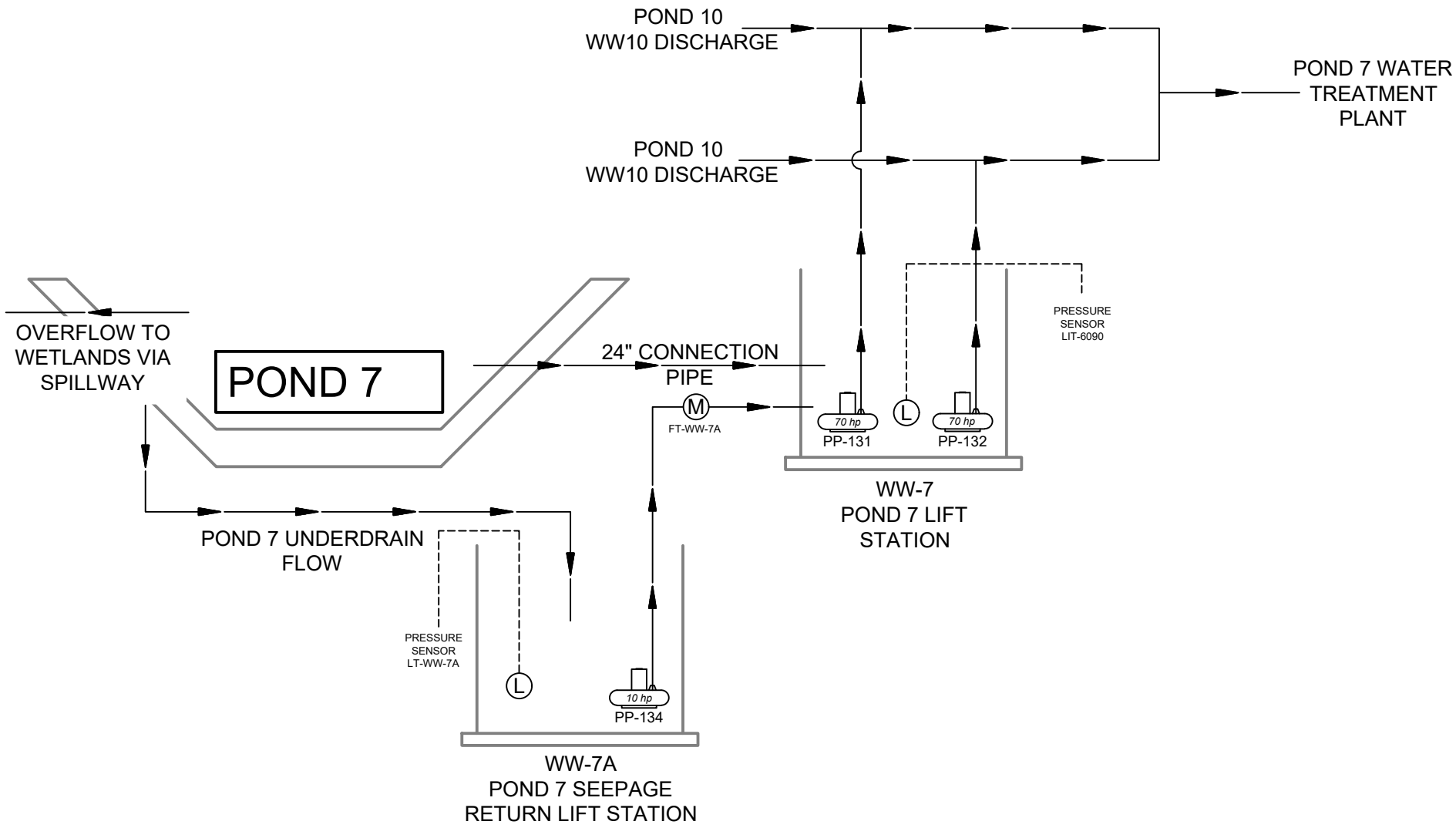


FIGURE 2-3 POND 7 PUMPHOUSE FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

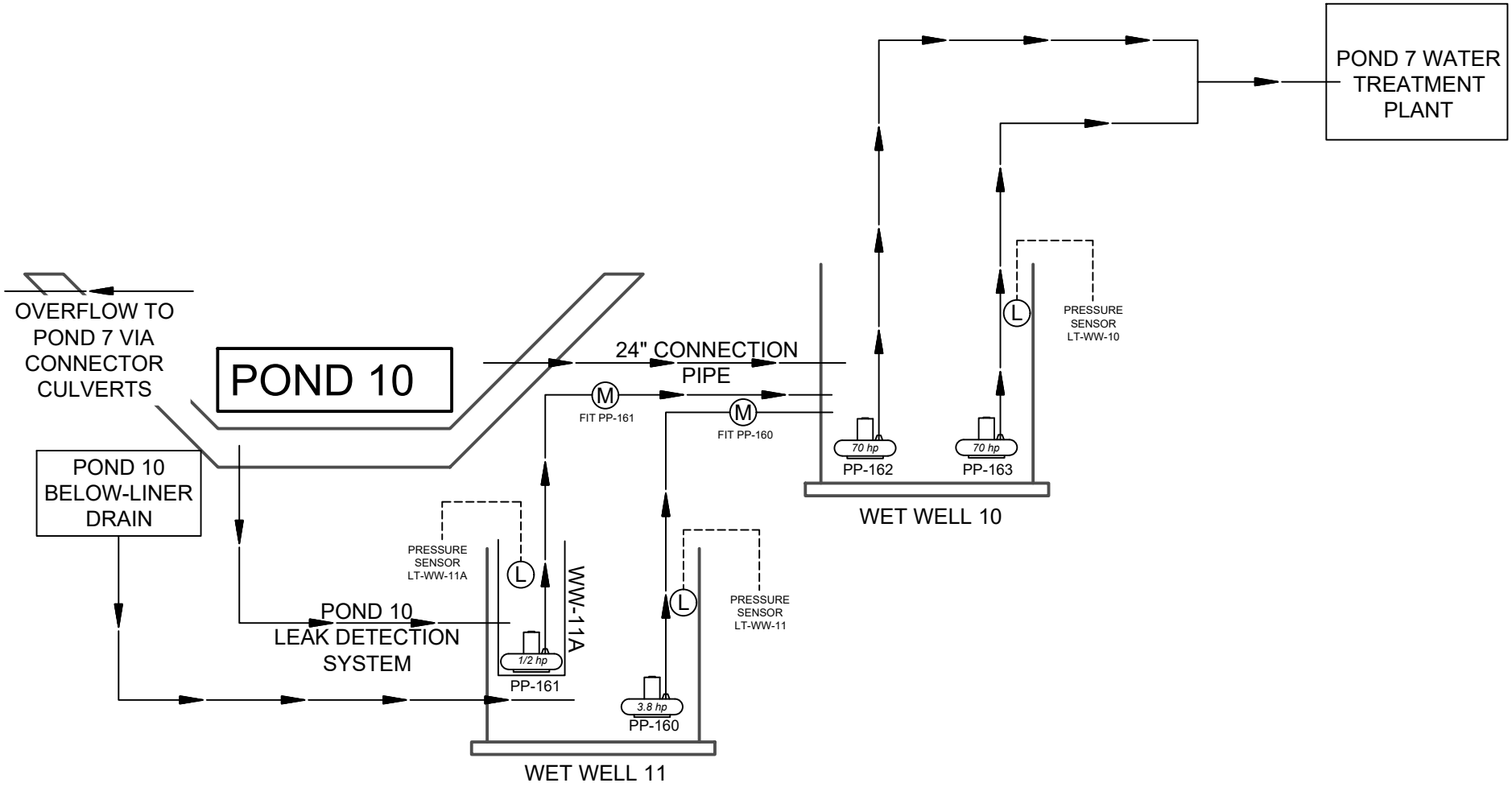


FIGURE 2-4
POND 10 PUMPHOUSE FLOW DIAGRAM

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

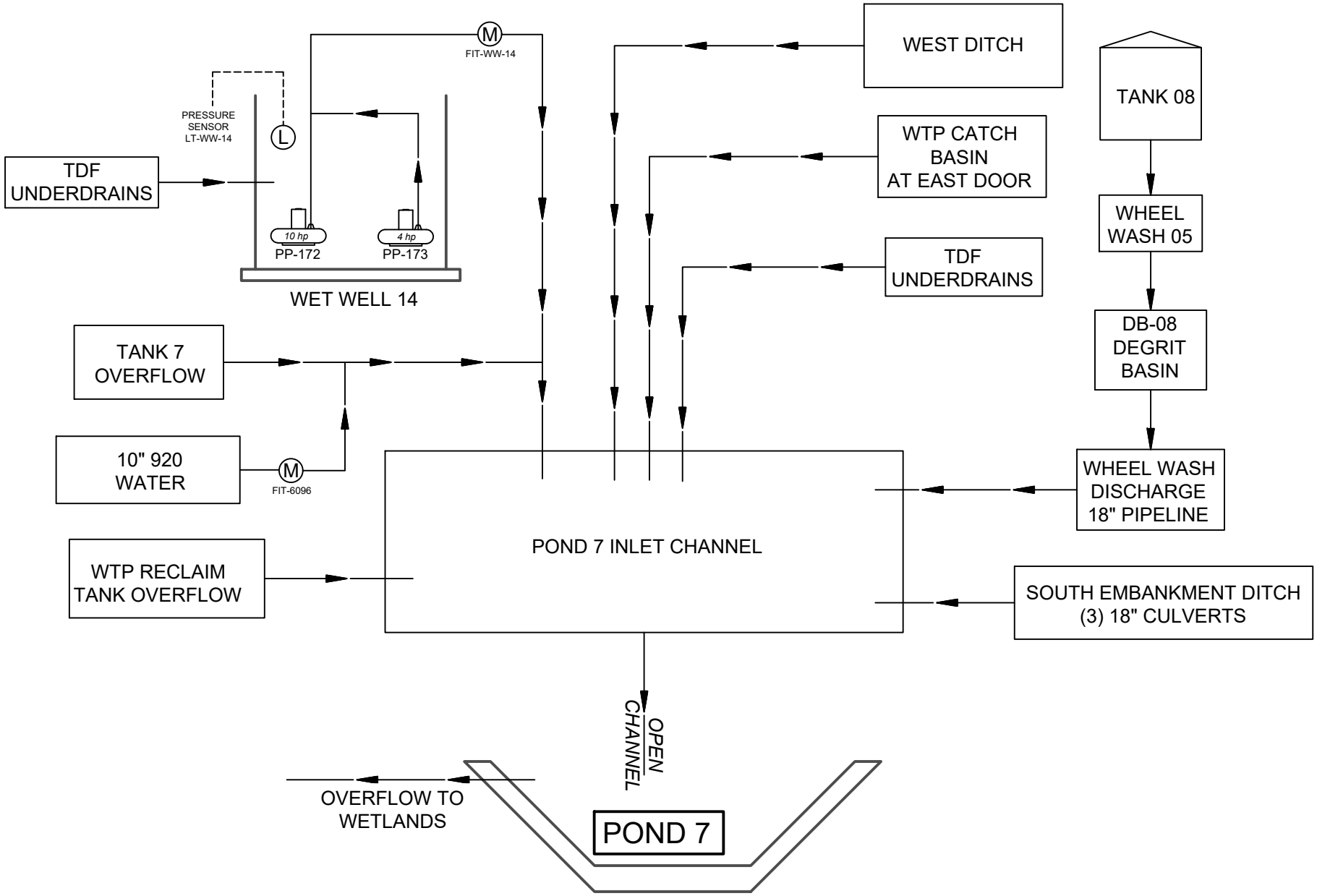


FIGURE 2-5 POND 7 INLET FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

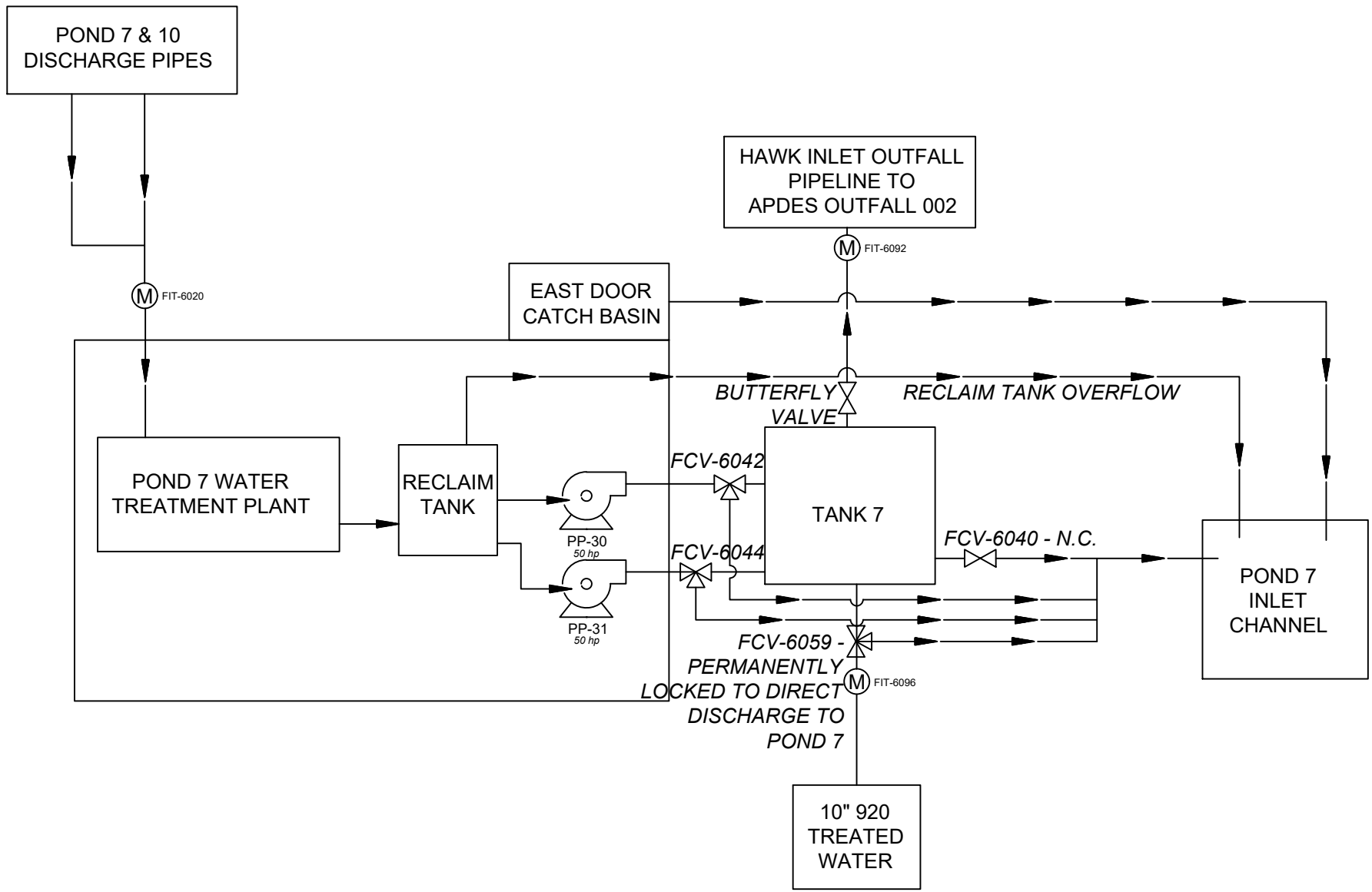


FIGURE 2-6
POND 7 WATER TREATMENT PLANT FLOW DIAGRAM

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla
MINING COMPANY

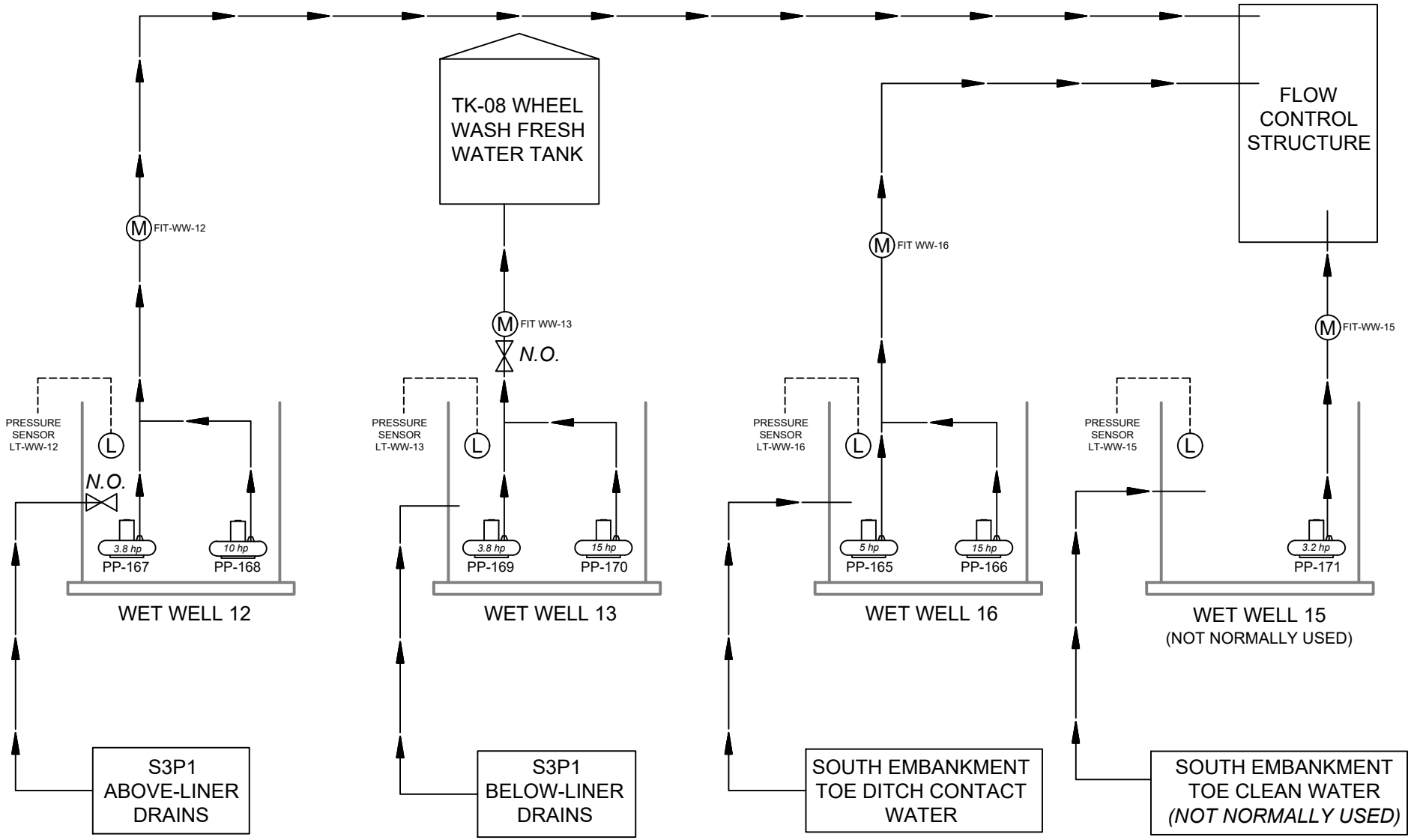


FIGURE 2-7 SOUTH EMBANKMENT WET WELLS FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

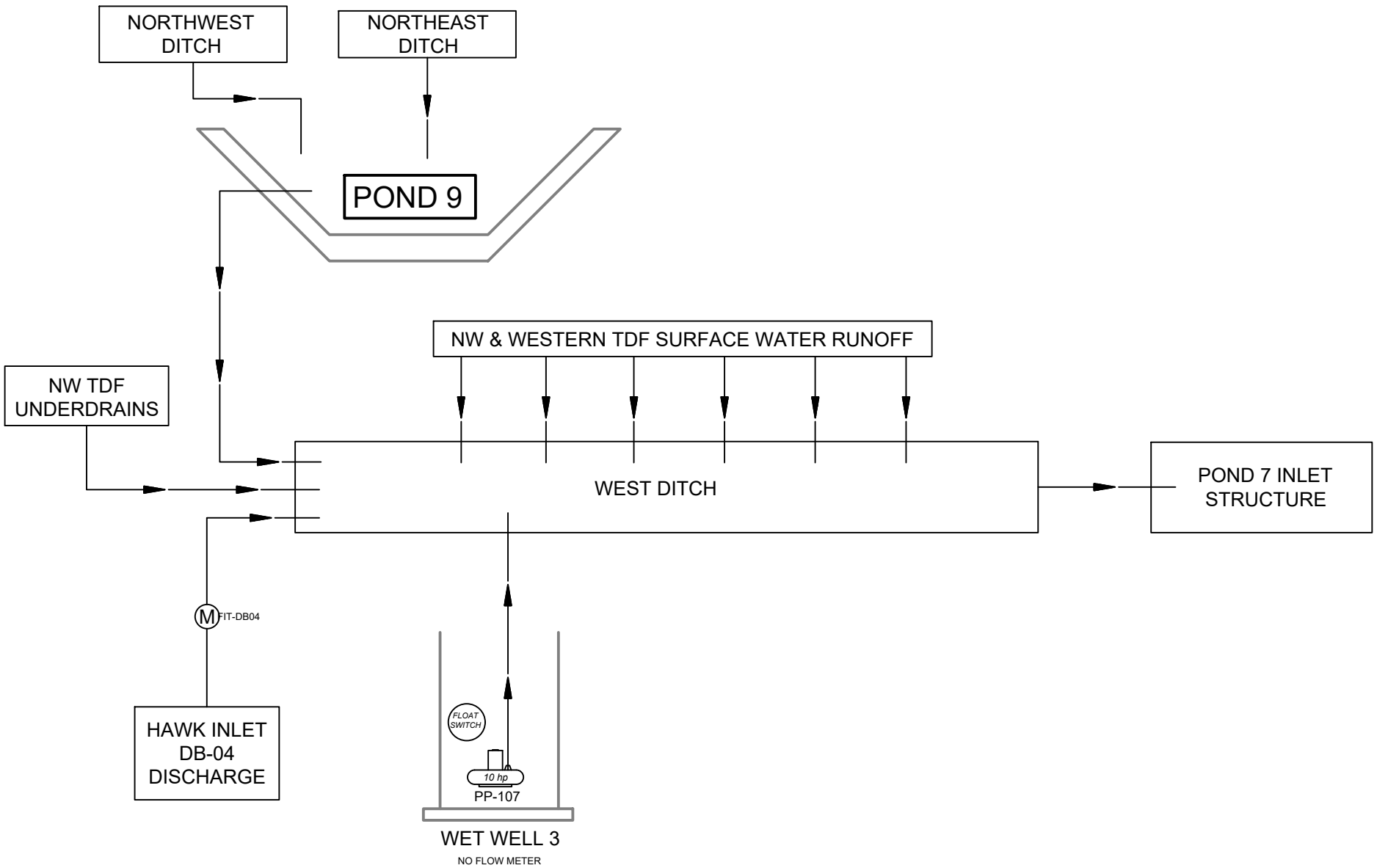


FIGURE 2-8 WEST DITCH FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

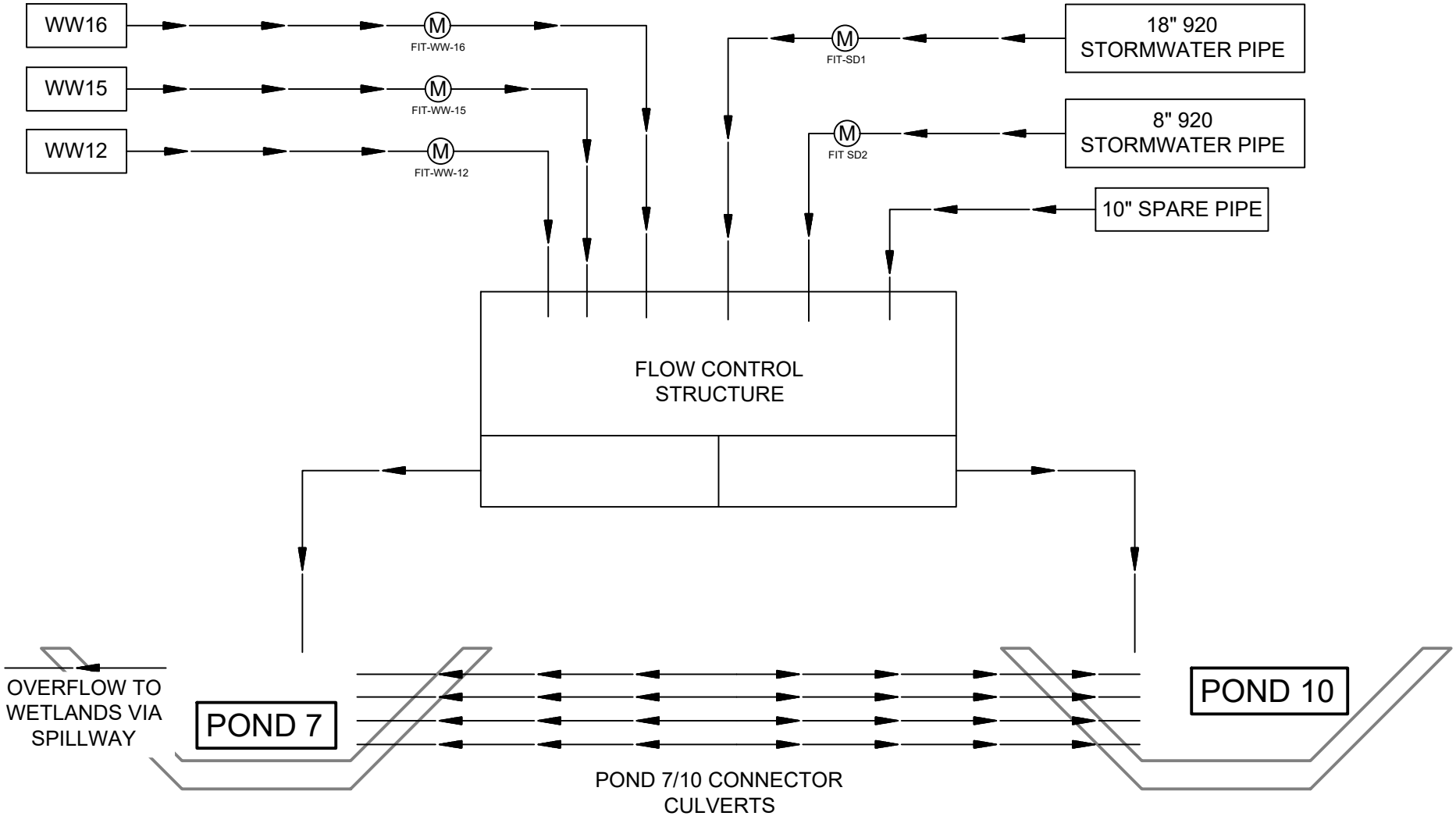


FIGURE 2-9 POND 7/10 FLOW CONTROL STRUCTURE FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

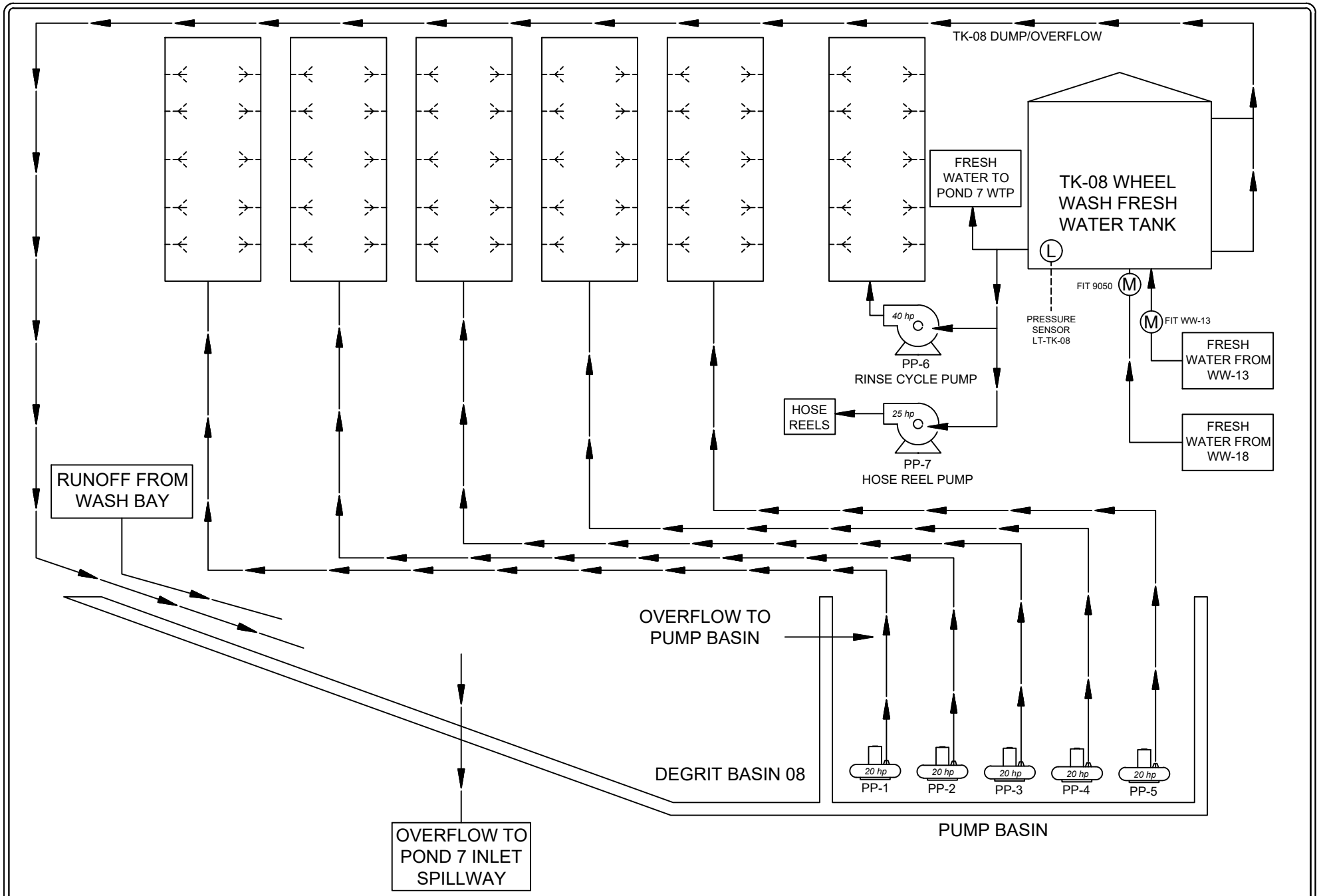


FIGURE 2-10
WHEEL WASH 05 FLOW DIAGRAM

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

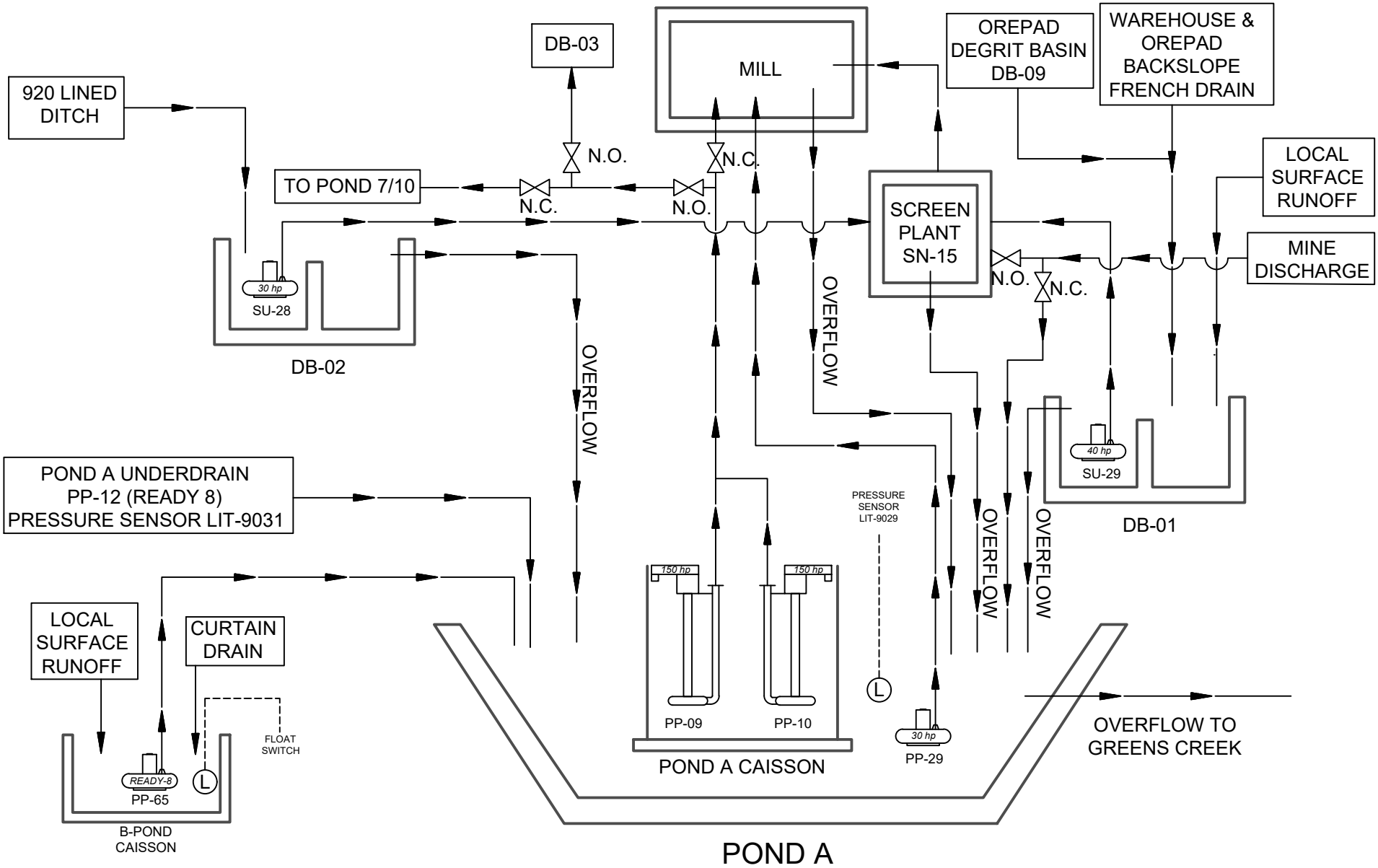


FIGURE 2-11 POND A AND 920 AREA FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

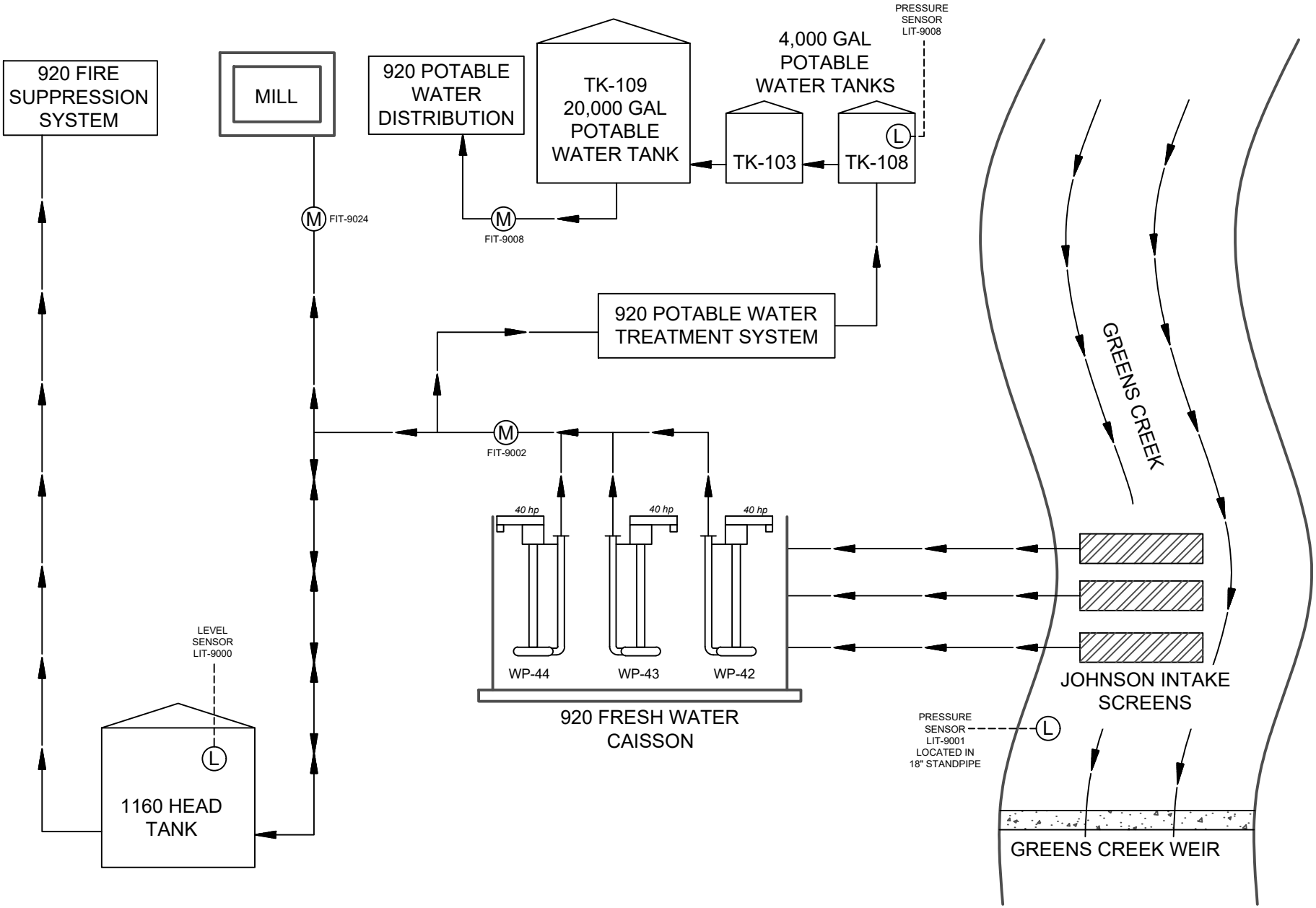


FIGURE 2-12
920 FRESH WATER SYSTEM FLOW DIAGRAM

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

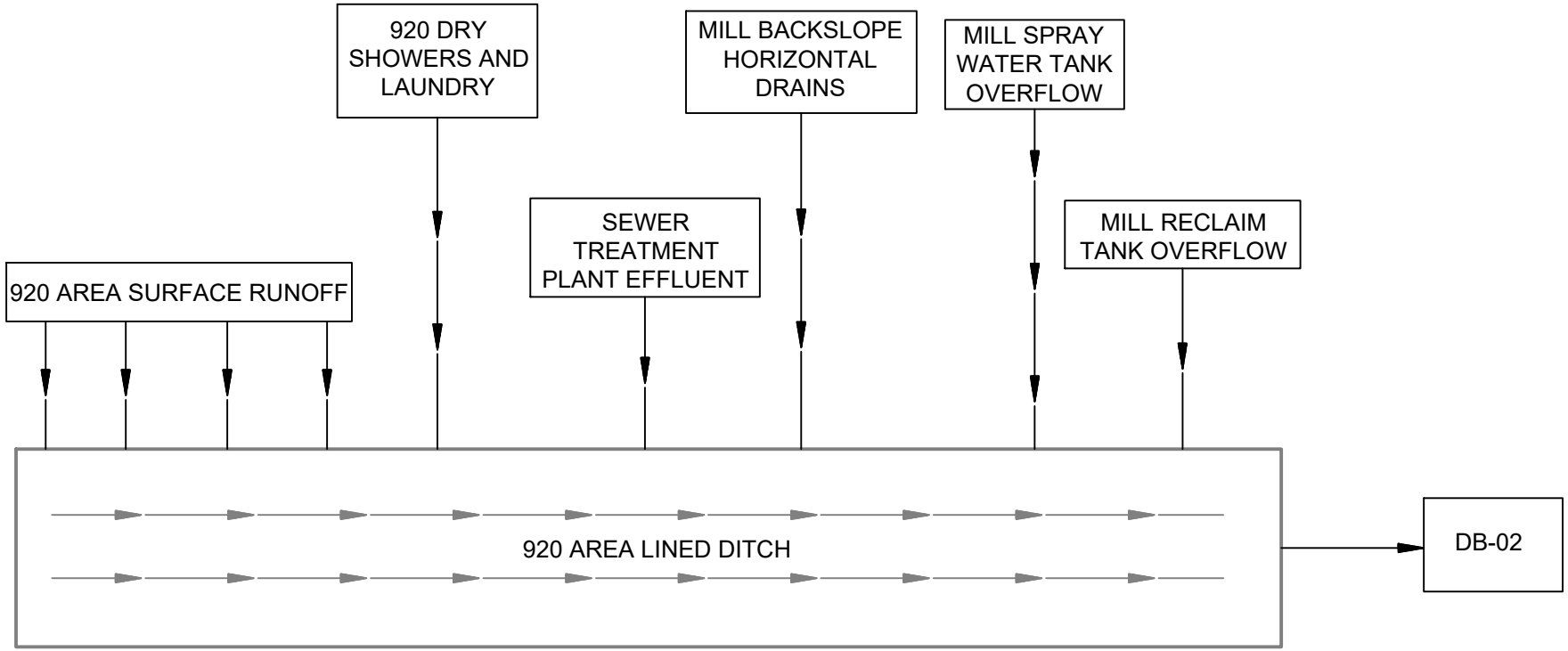


FIGURE 2-13 920 LINED DITCH FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

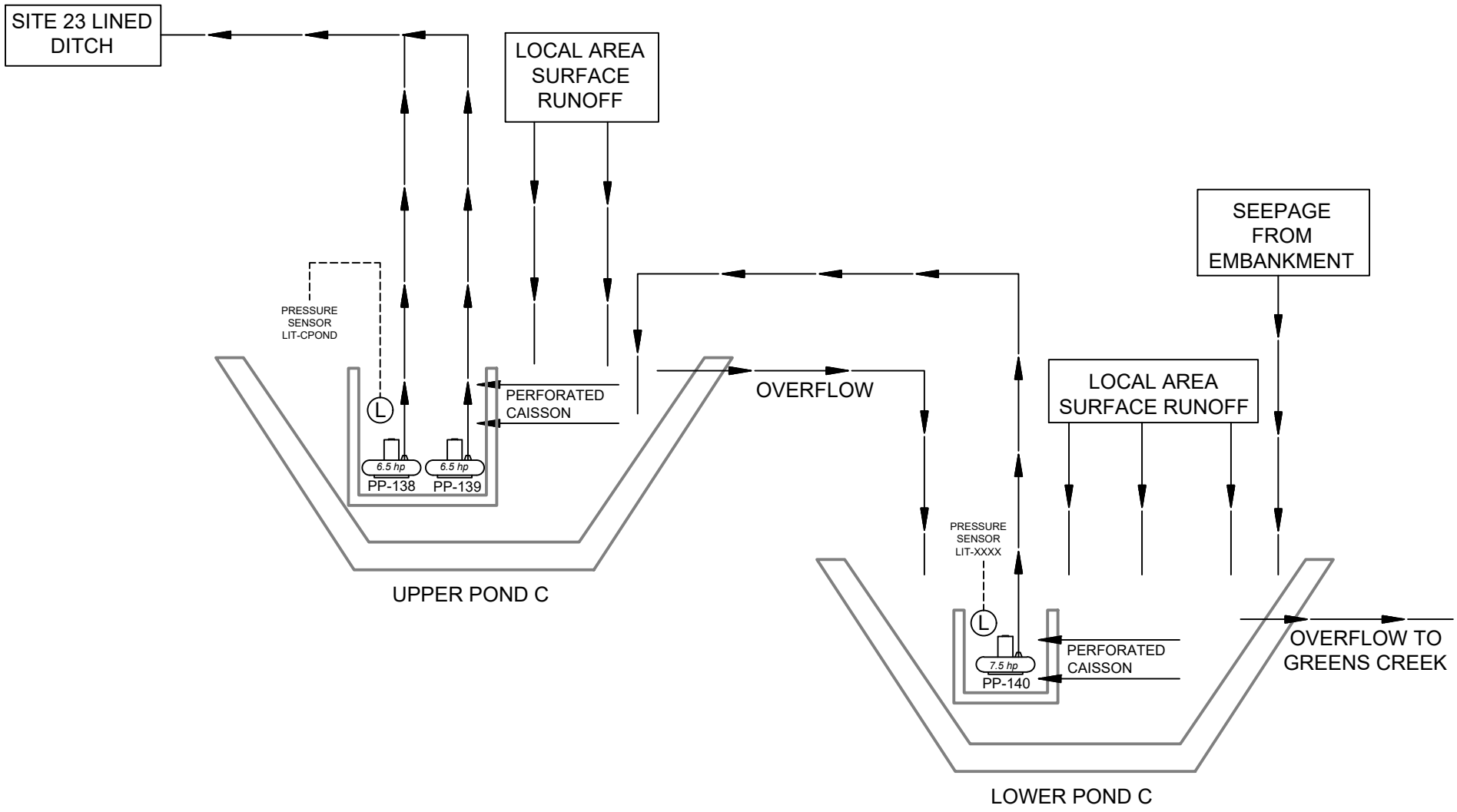


FIGURE 2-14 POND C FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

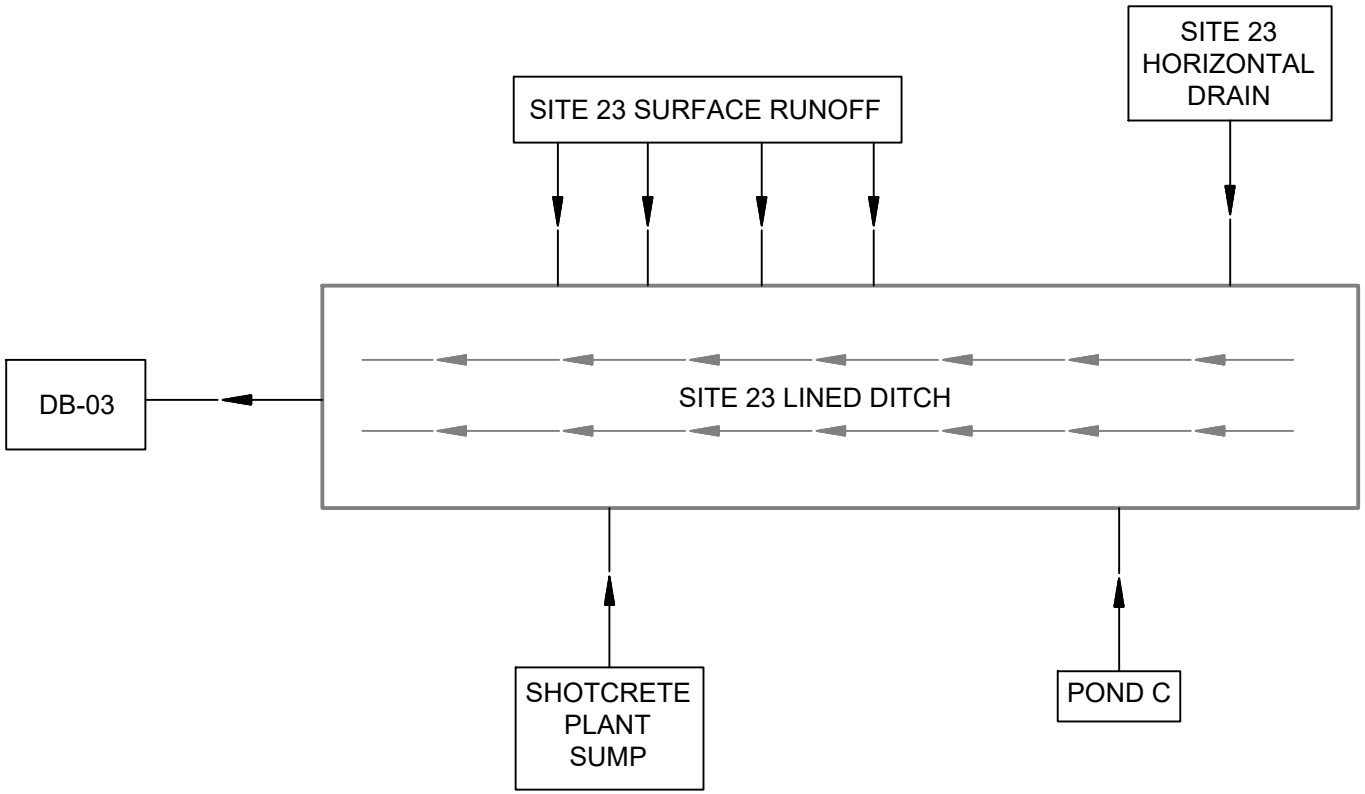


FIGURE 2-15 SITE 23 LINED DITCH FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

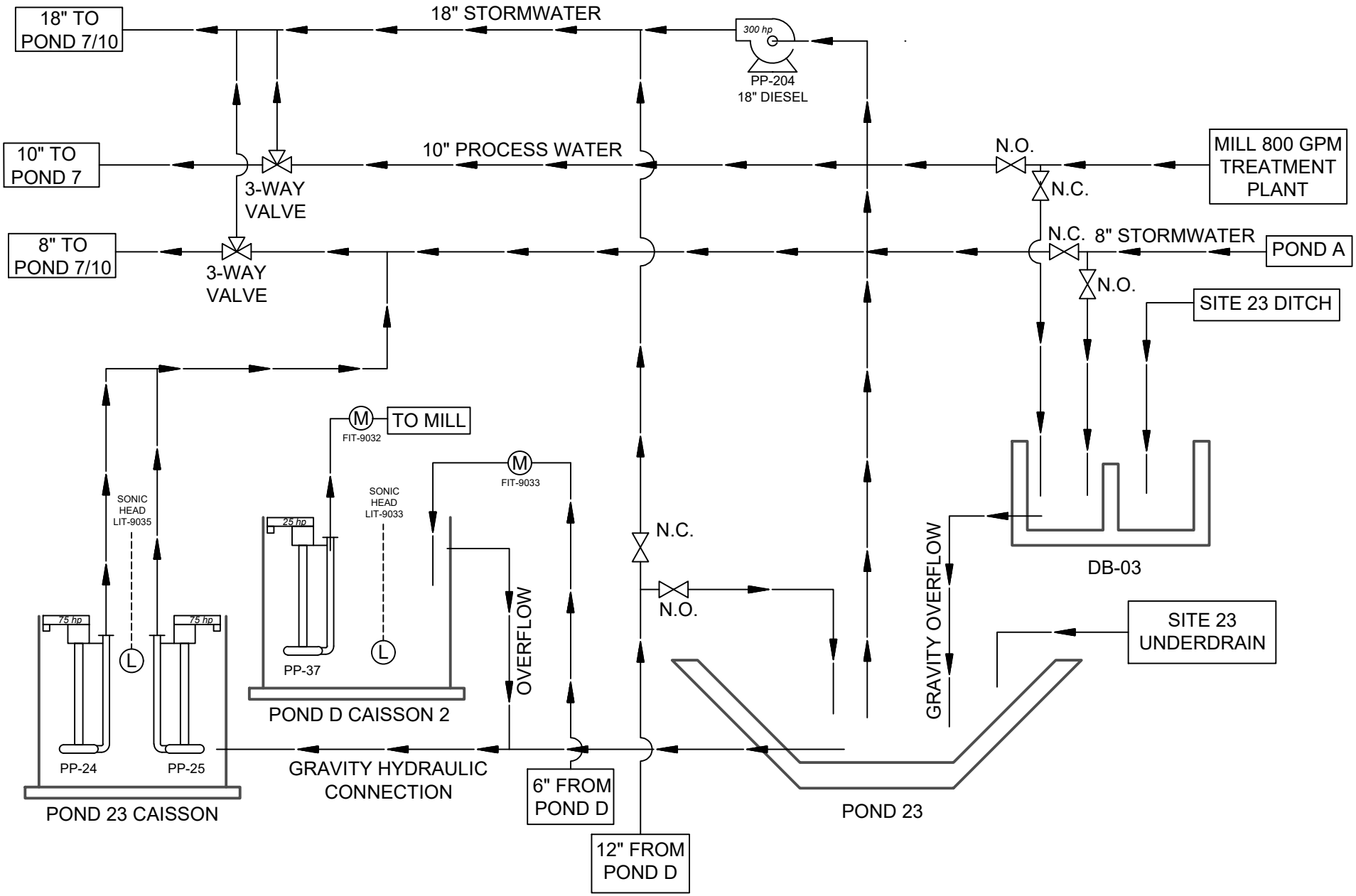


FIGURE 2-16 POND 23 FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

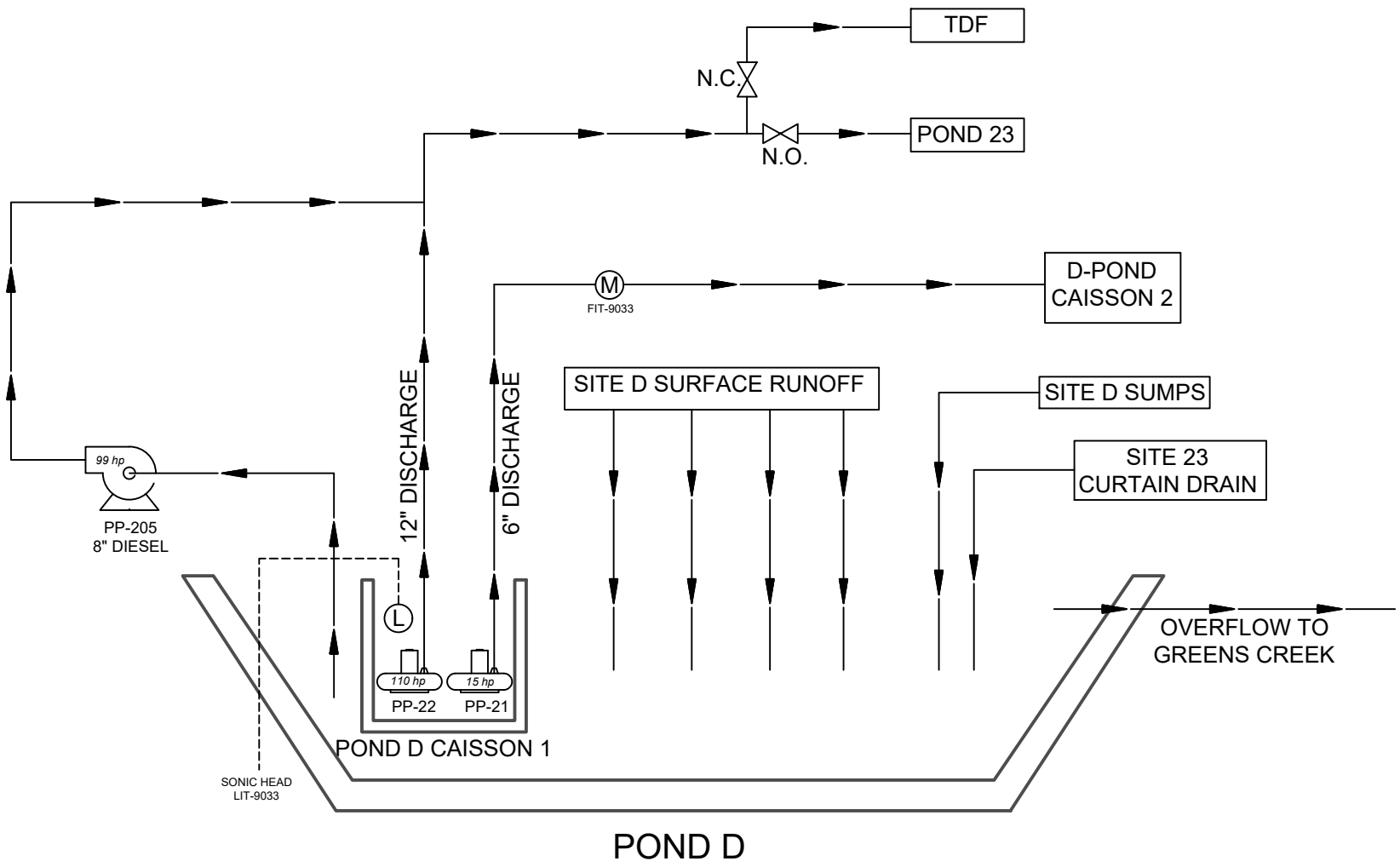


FIGURE 2-17 SITE D FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

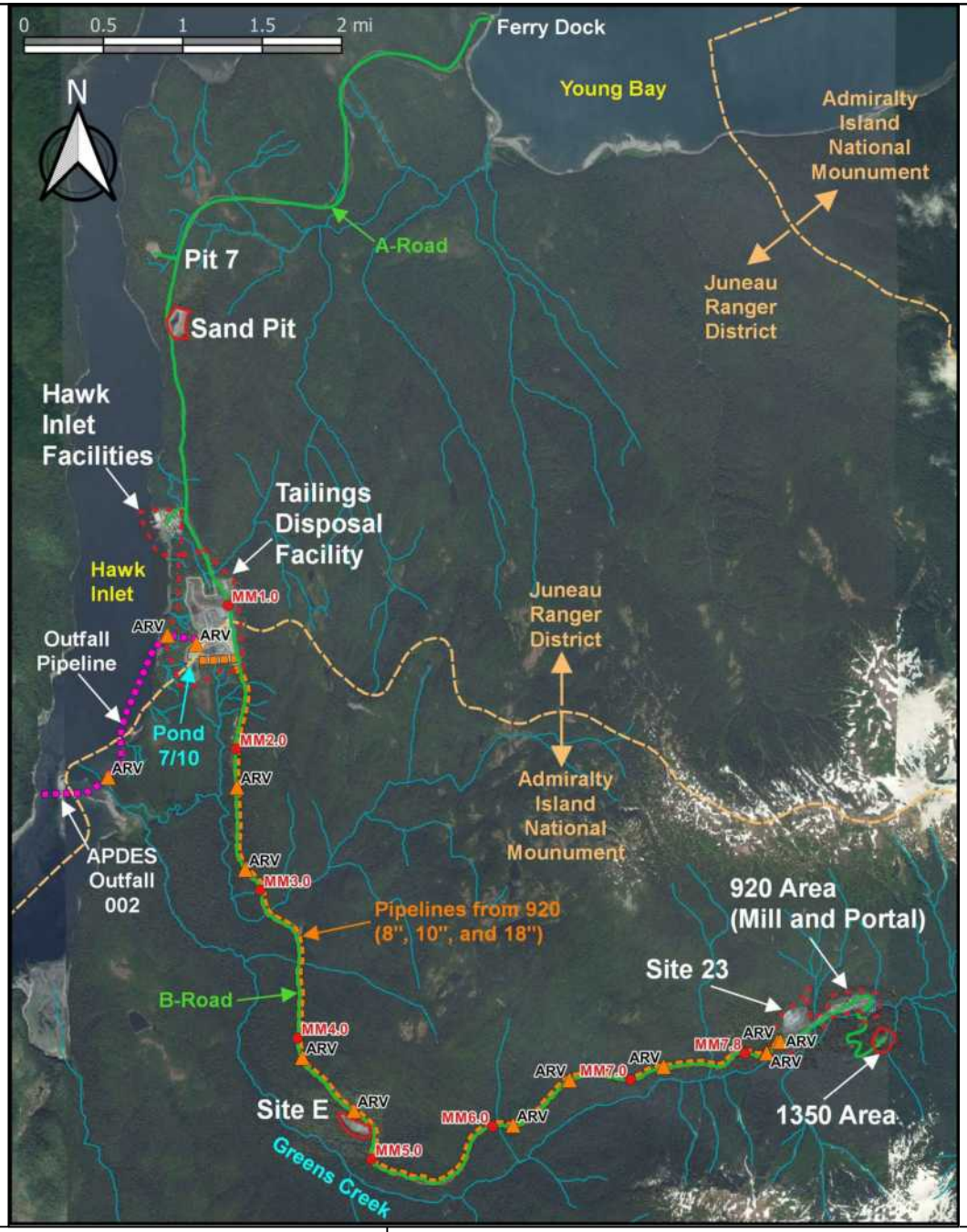


FIGURE 2-18
920 PIPELINE LAYOUT AND SITEWIDE ARV LOCATIONS

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

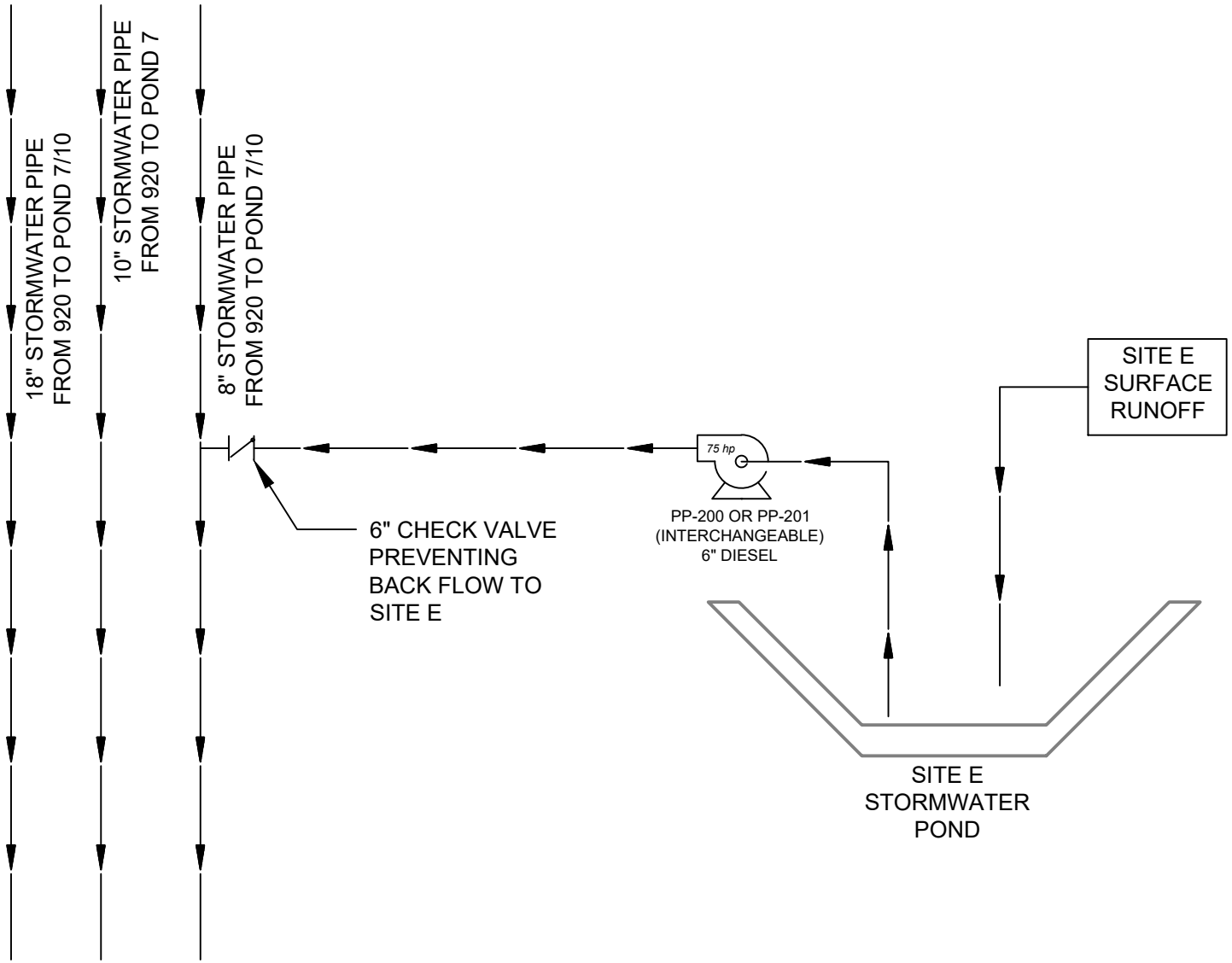


FIGURE 2-19 SITE E FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

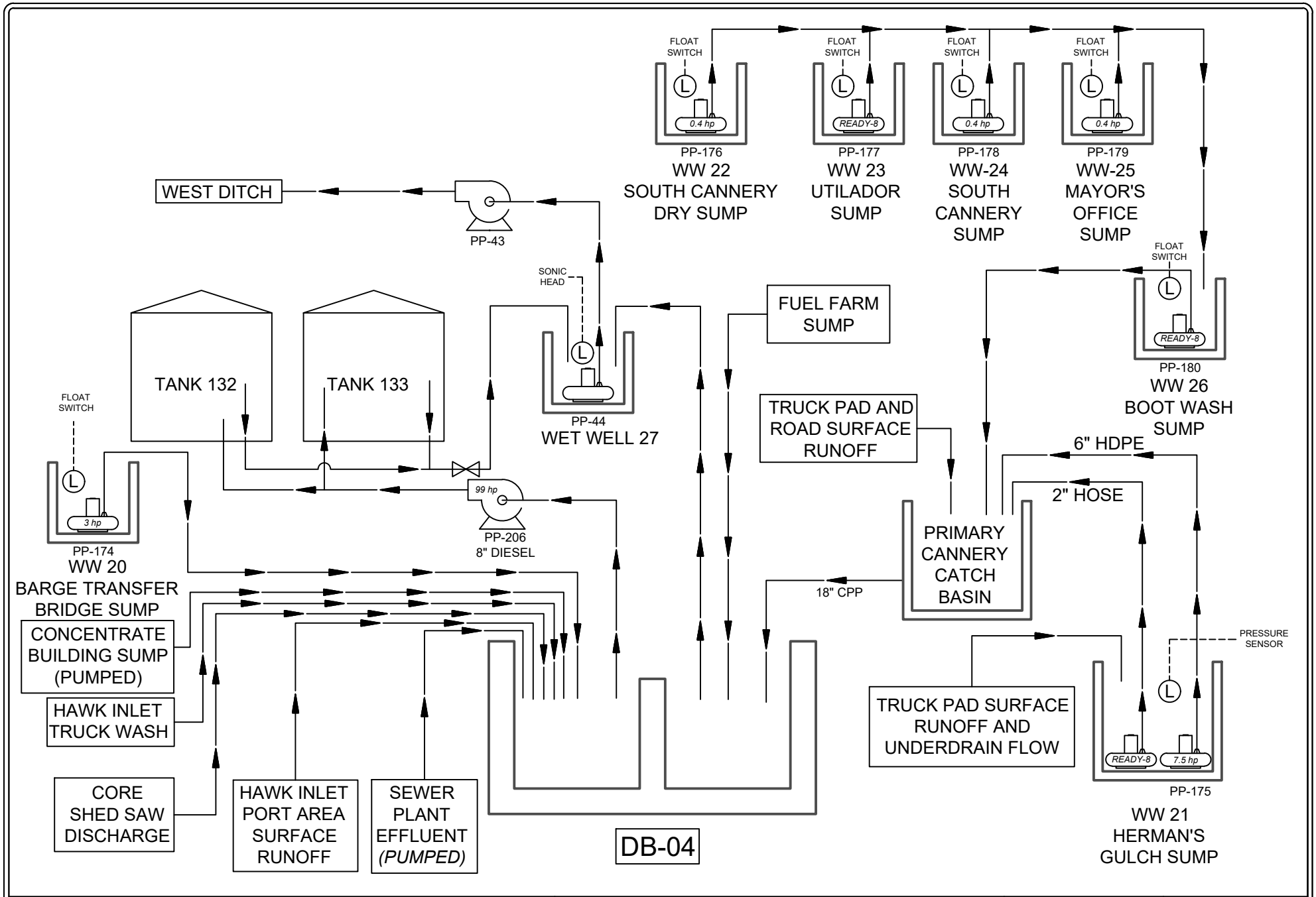


FIGURE 2-20
HAWK INLET FLOW DIAGRAM

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

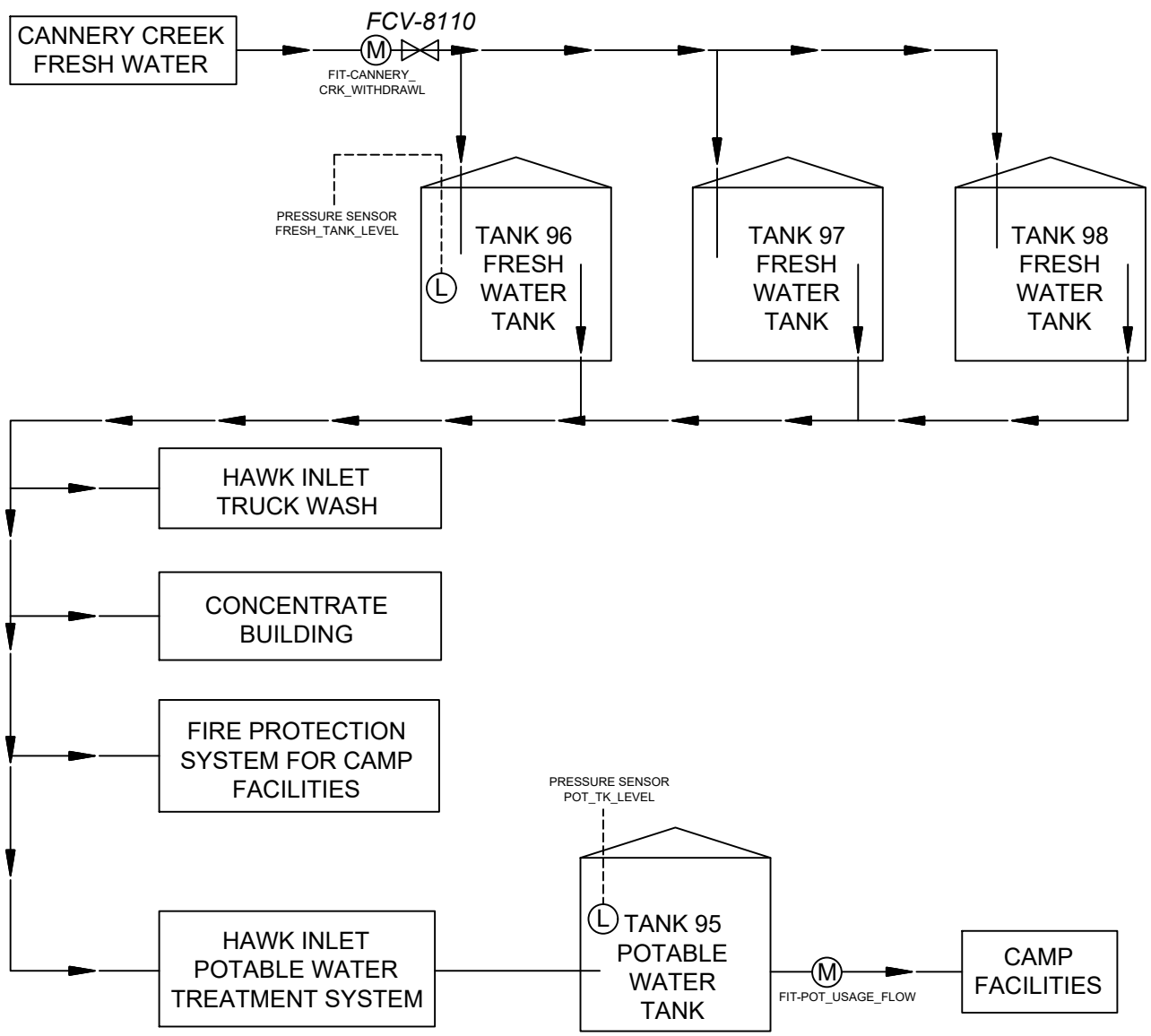


FIGURE 2-21 HAWK INLET FRESH WATER SYSTEM FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

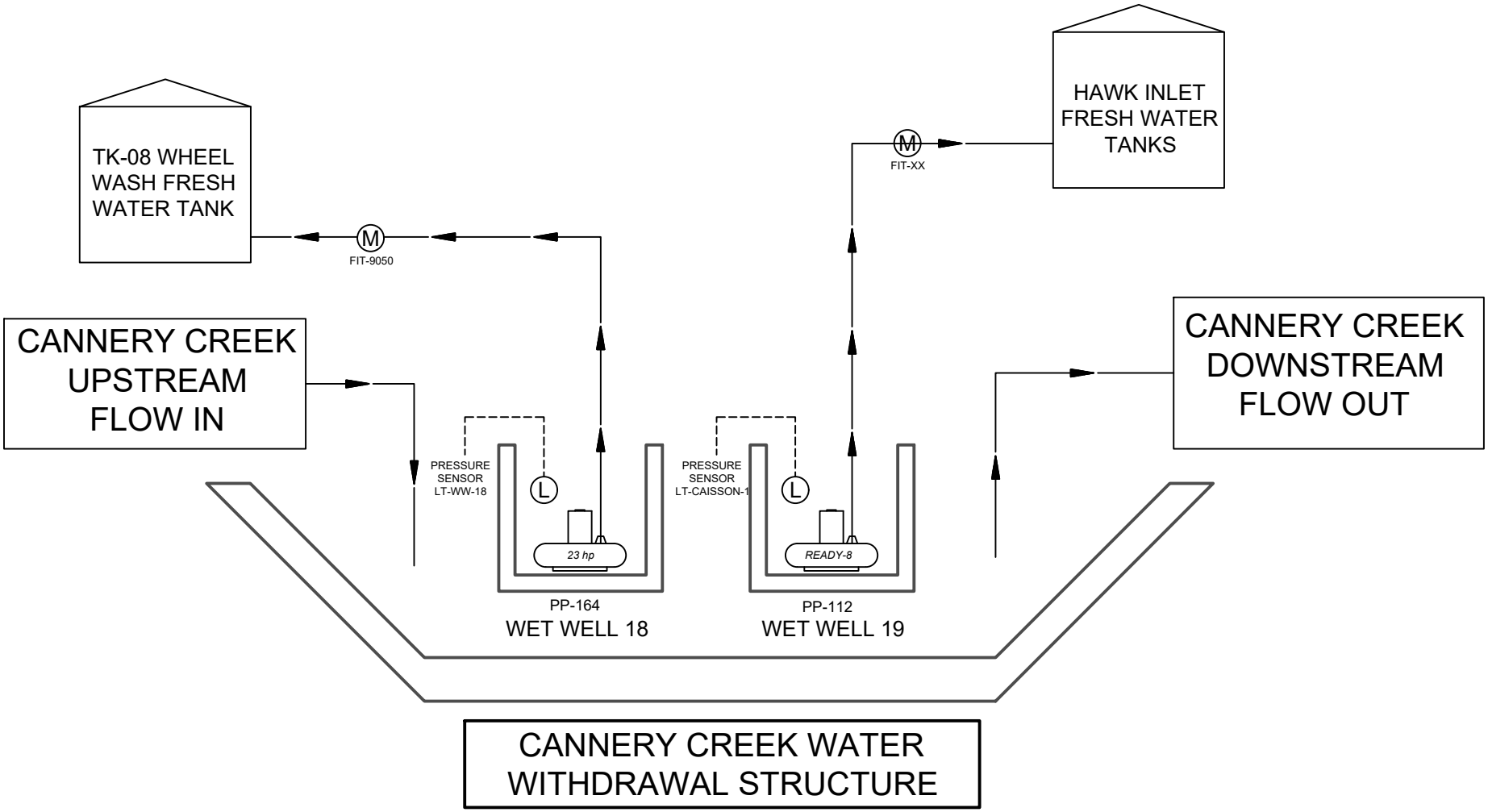


FIGURE 2-22 CANNERY CREEK FLOW DIAGRAM	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

APPENDIX 3

Caisson and Tank Profiles

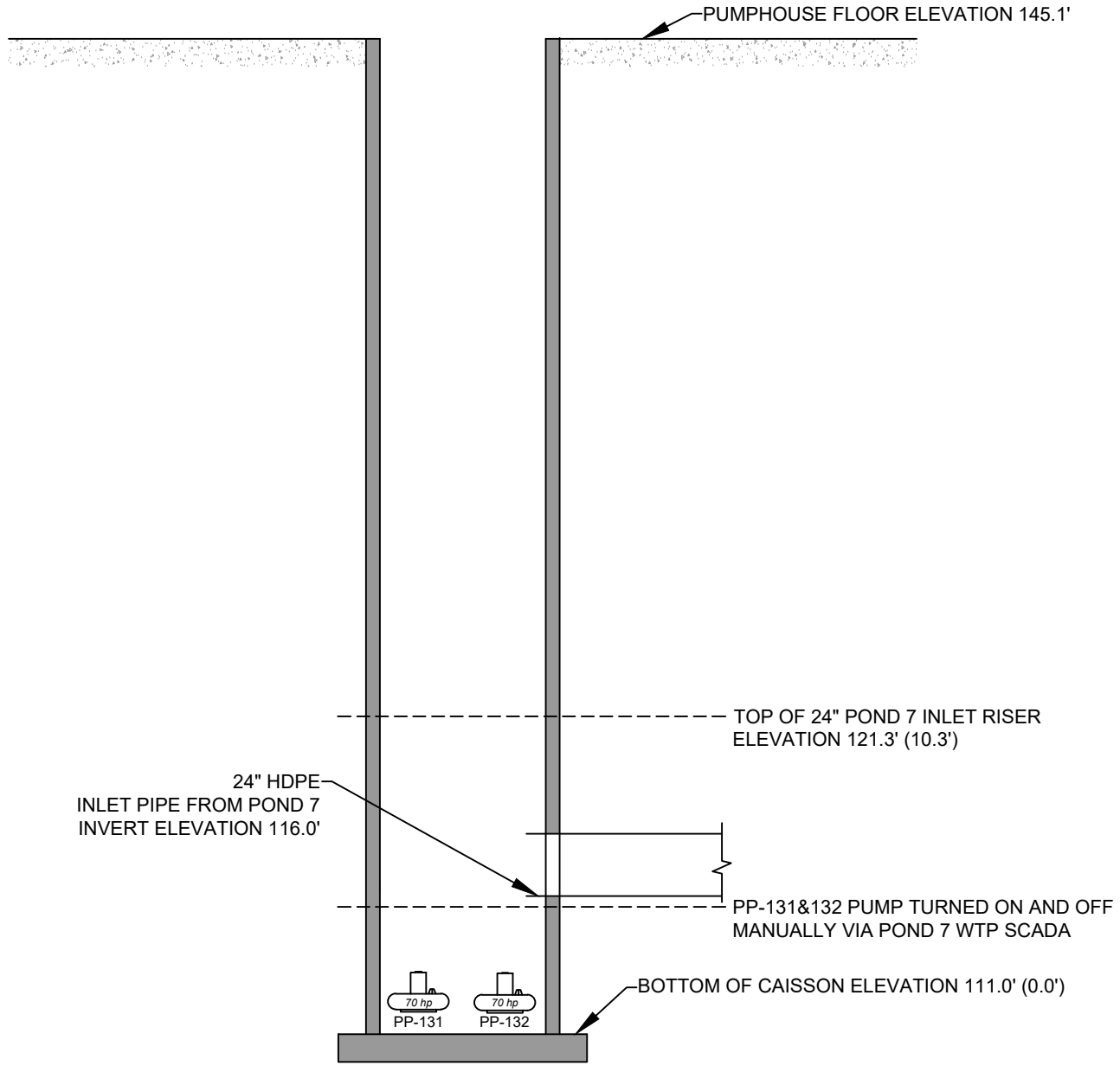


FIGURE 3-1 WET WELL 7 PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

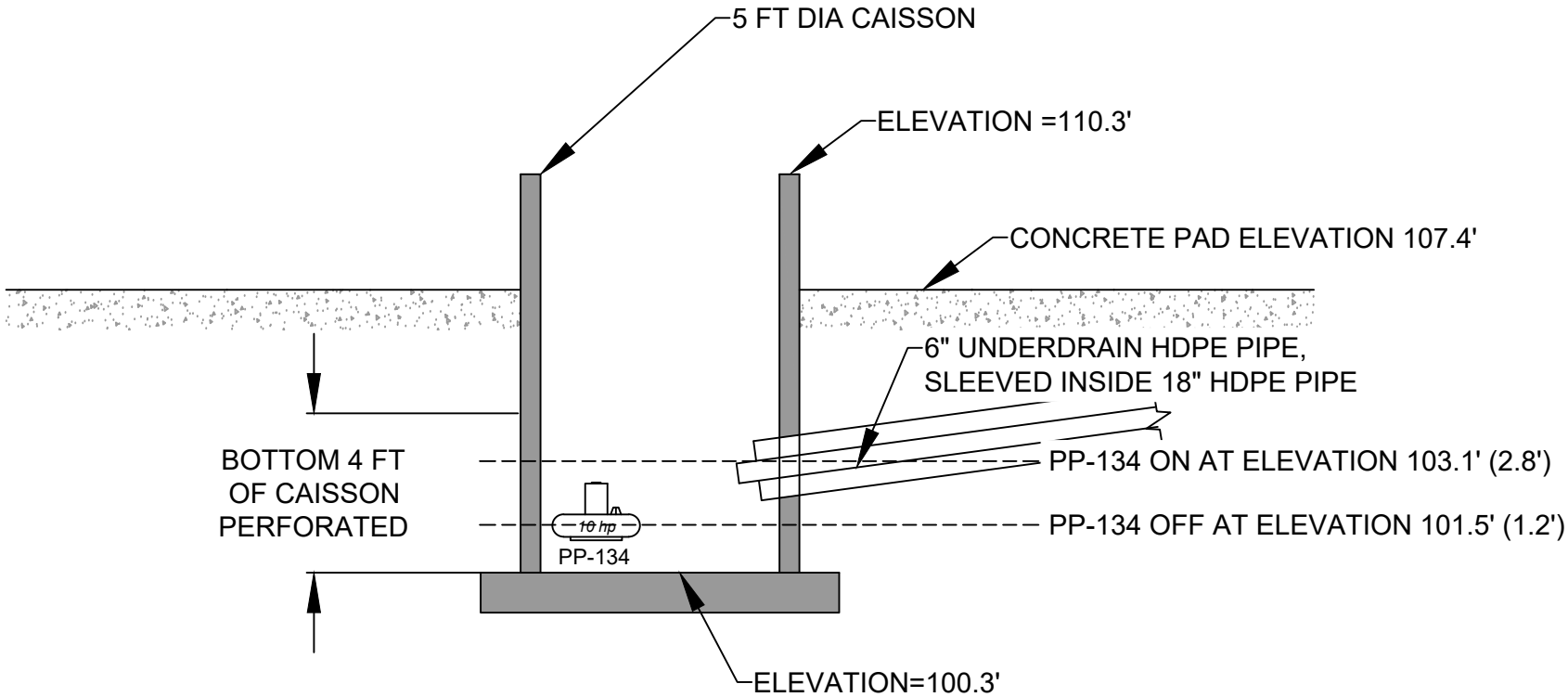


FIGURE 3-2 WET WELL 7A PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

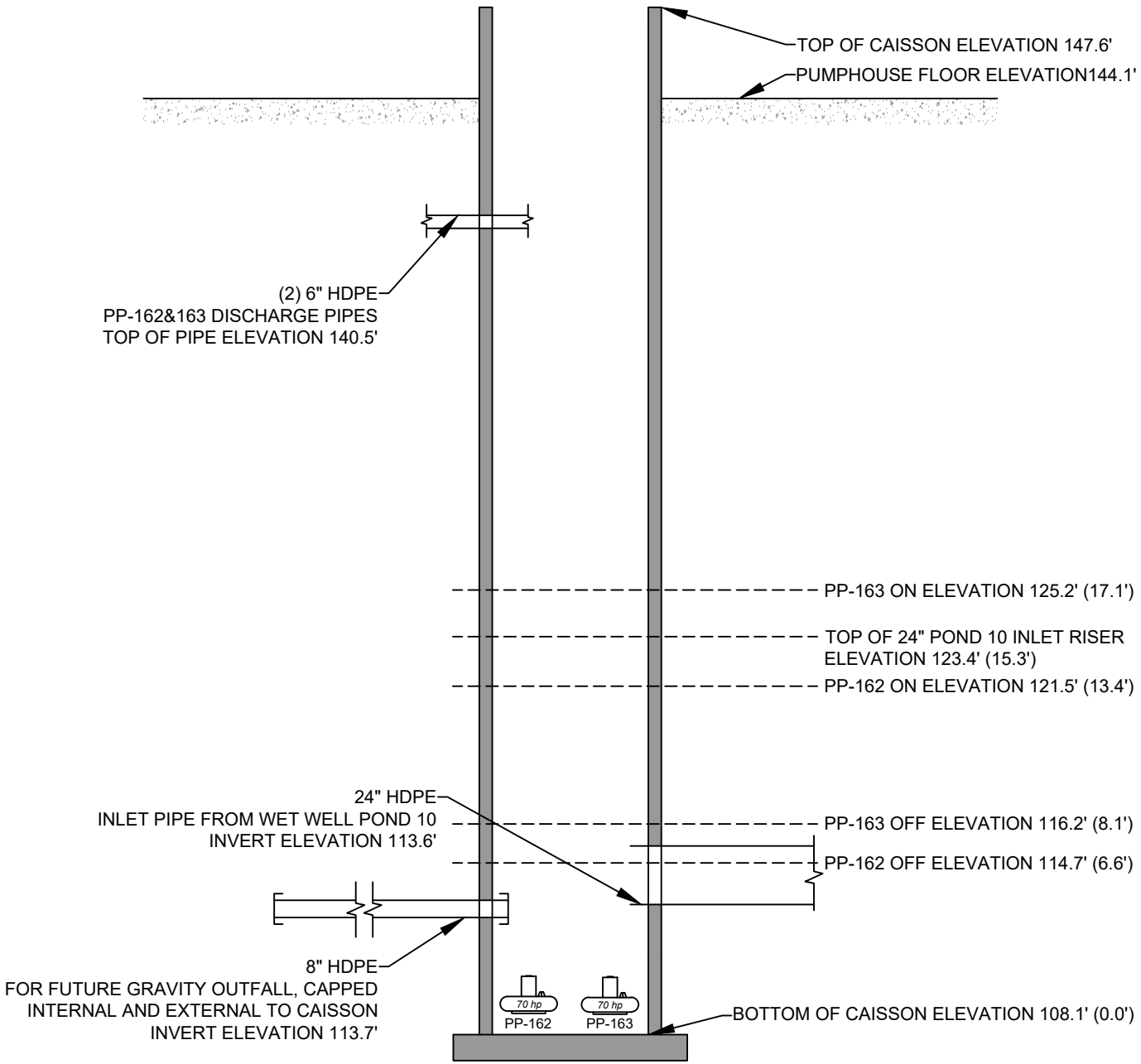


FIGURE 3-3 WET WELL 10 PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

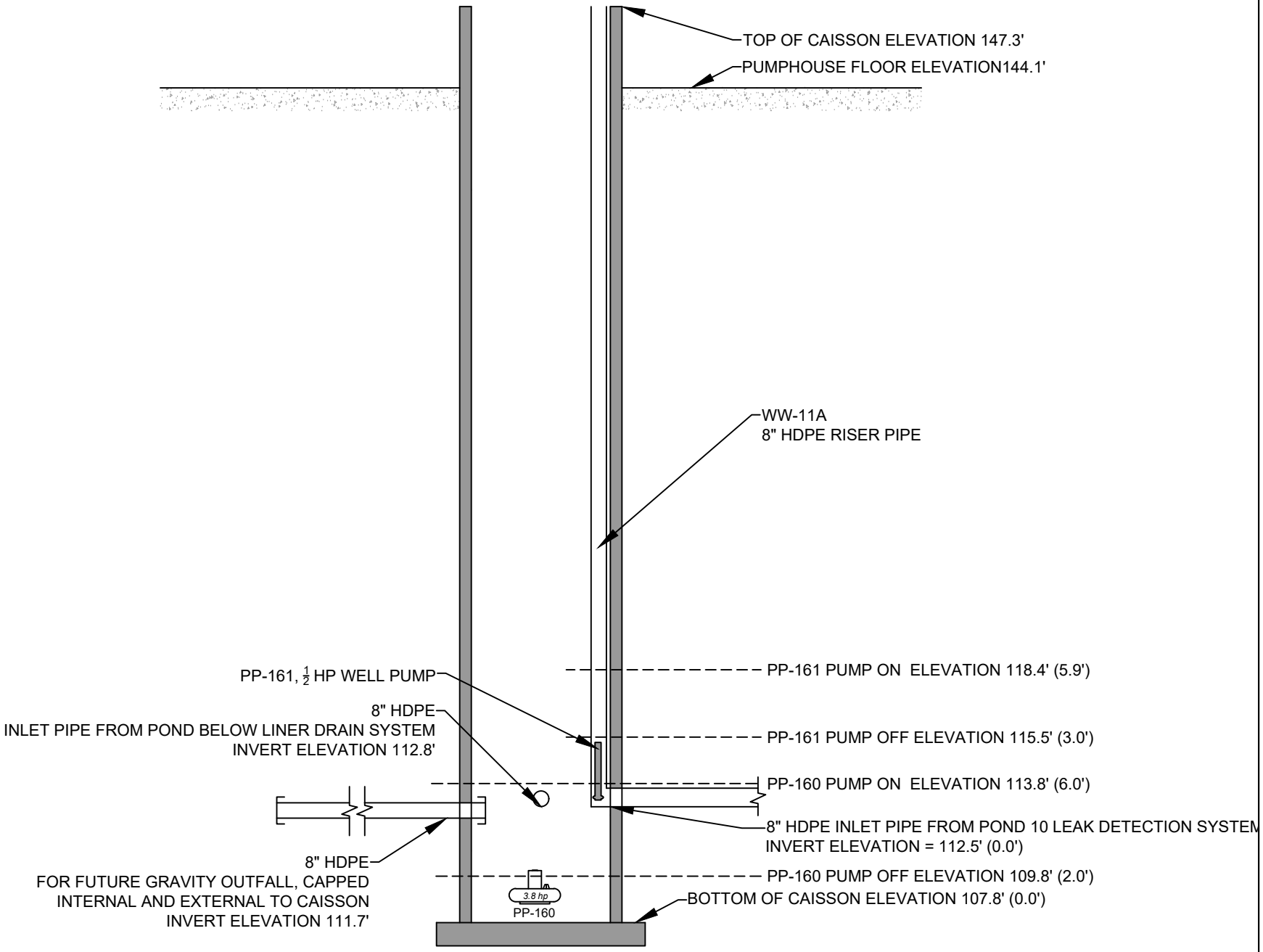


FIGURE 3-4 WET WELL II PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

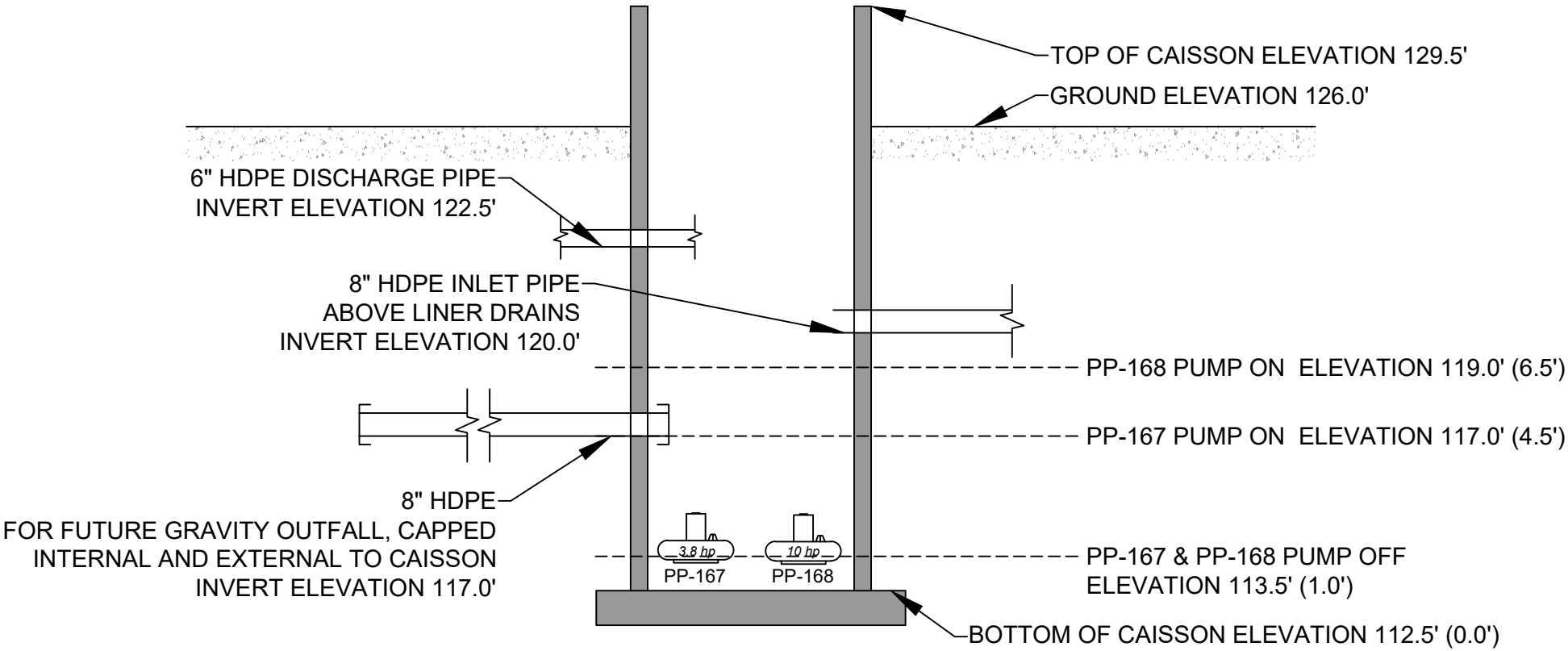


FIGURE 3-5 WET WELL 12 PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

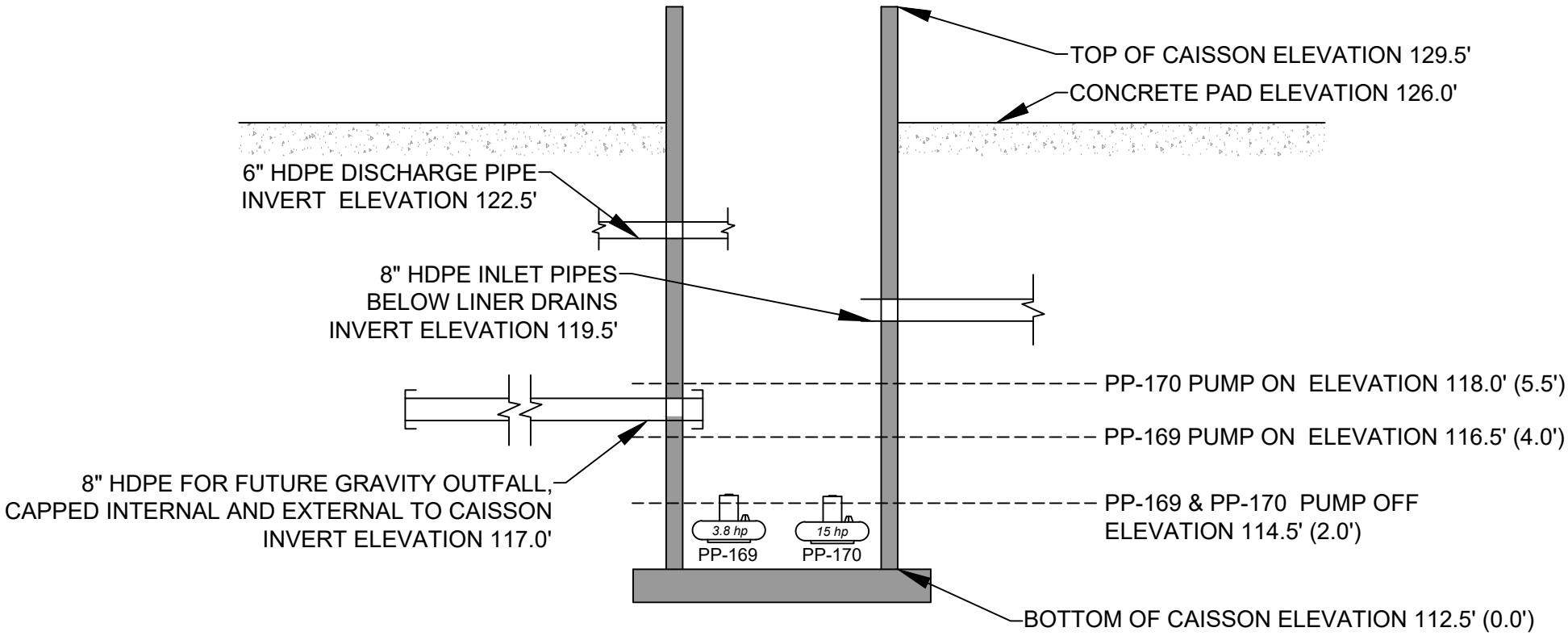


FIGURE 3-6 WET WELL 13 PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

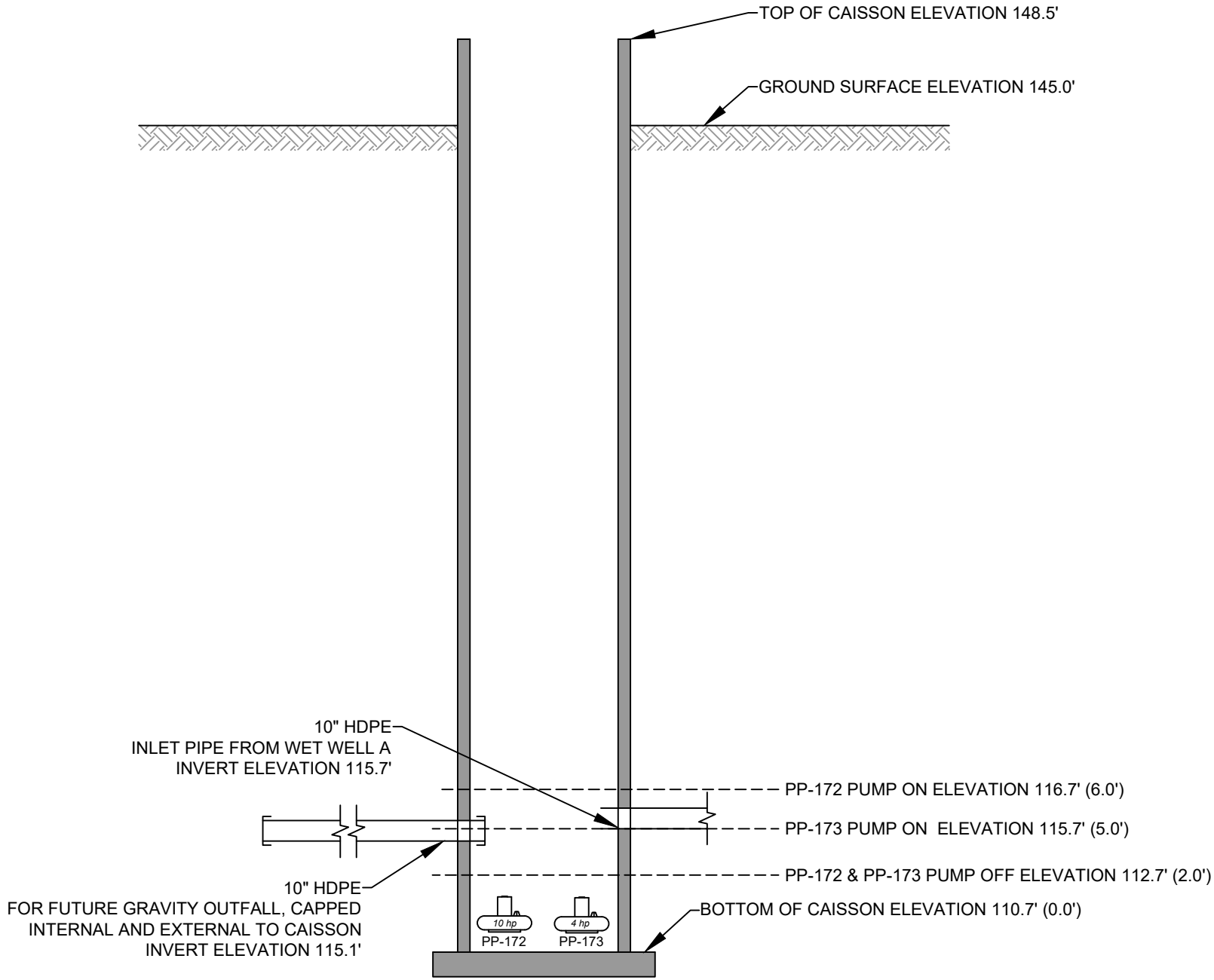


FIGURE 3-7 WET WELL 14 PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

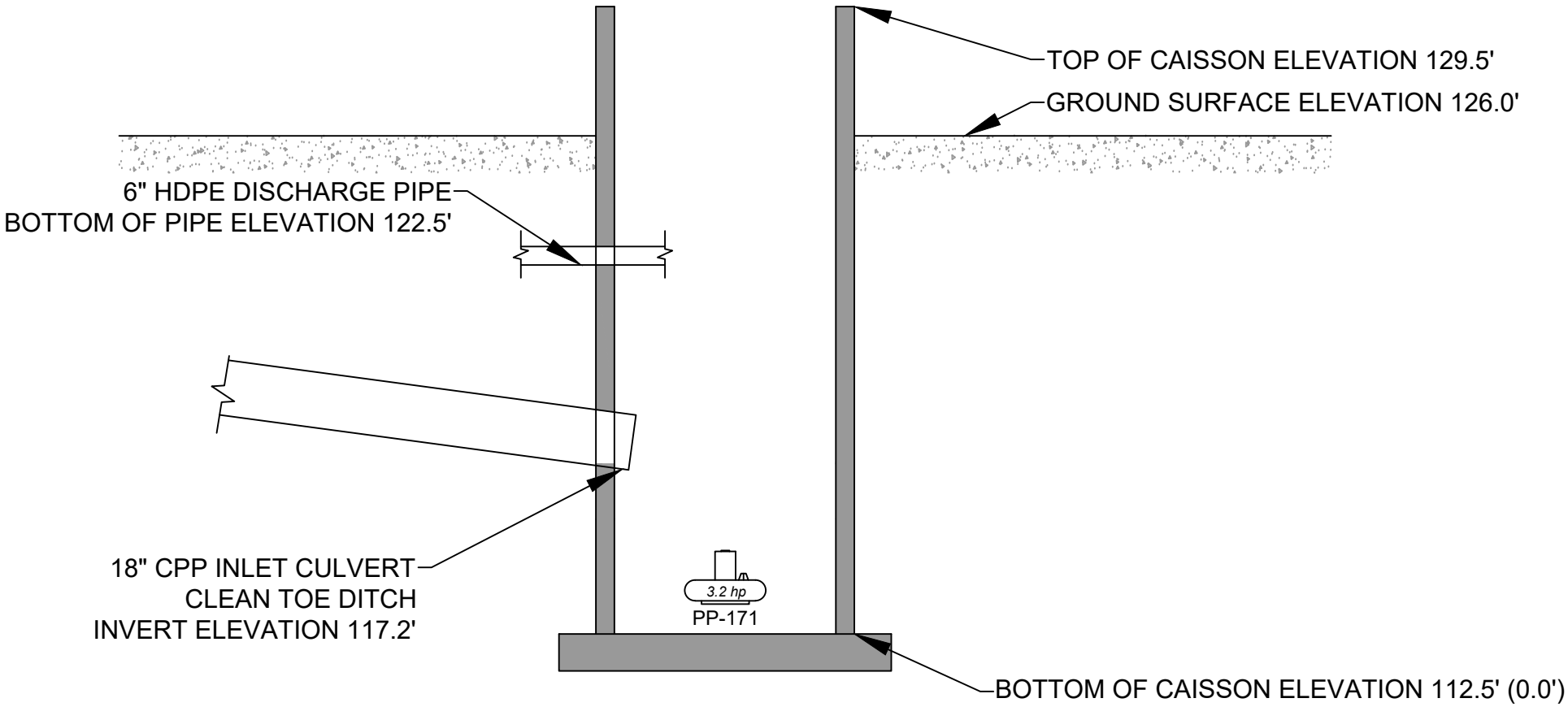


FIGURE 3-8 WET WELL 15 PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

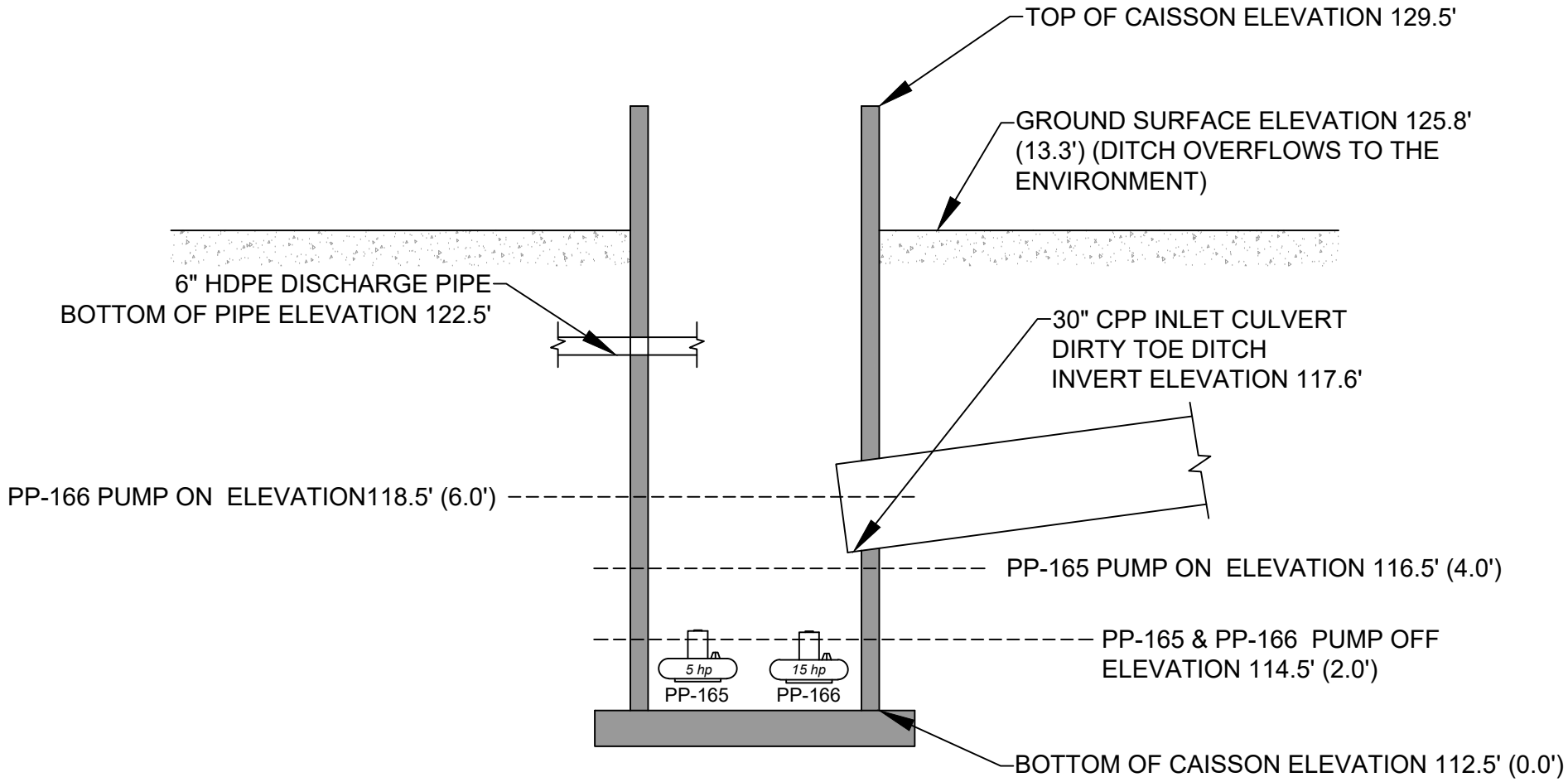


FIGURE 3-9 WET WELL 16 PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

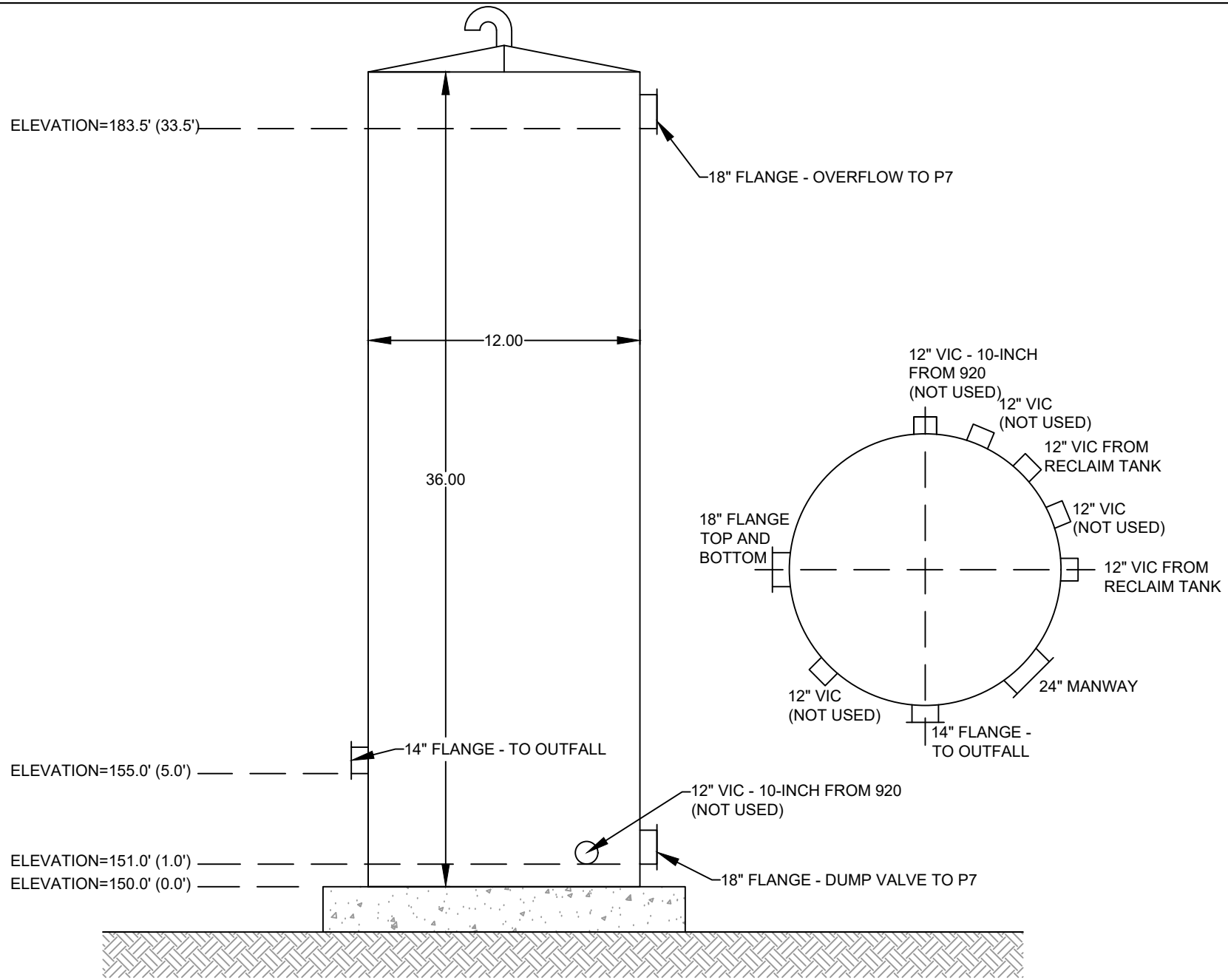


FIGURE 3-10 TANK 7 PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

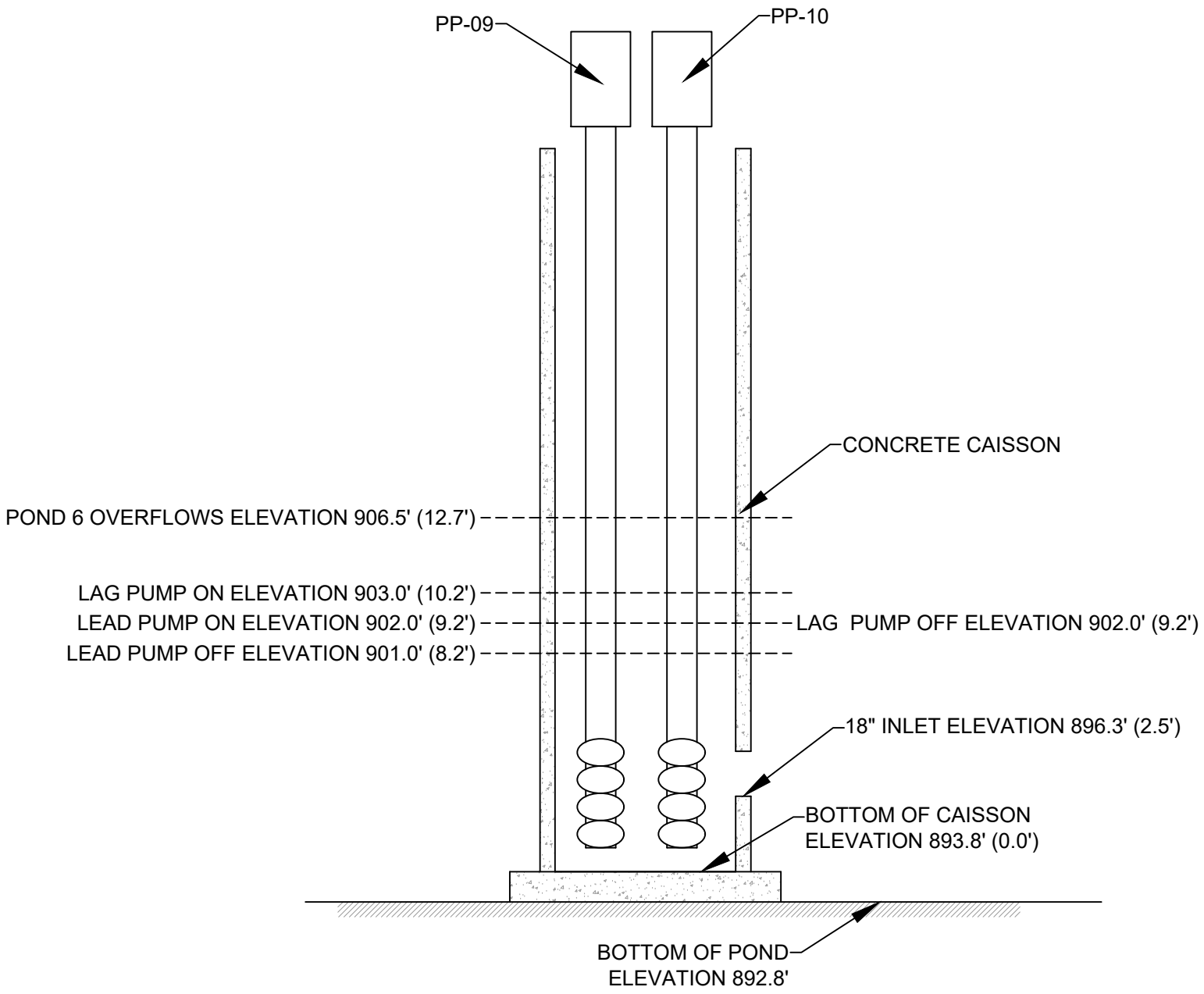


FIGURE 3-11 POND A CAISSON PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

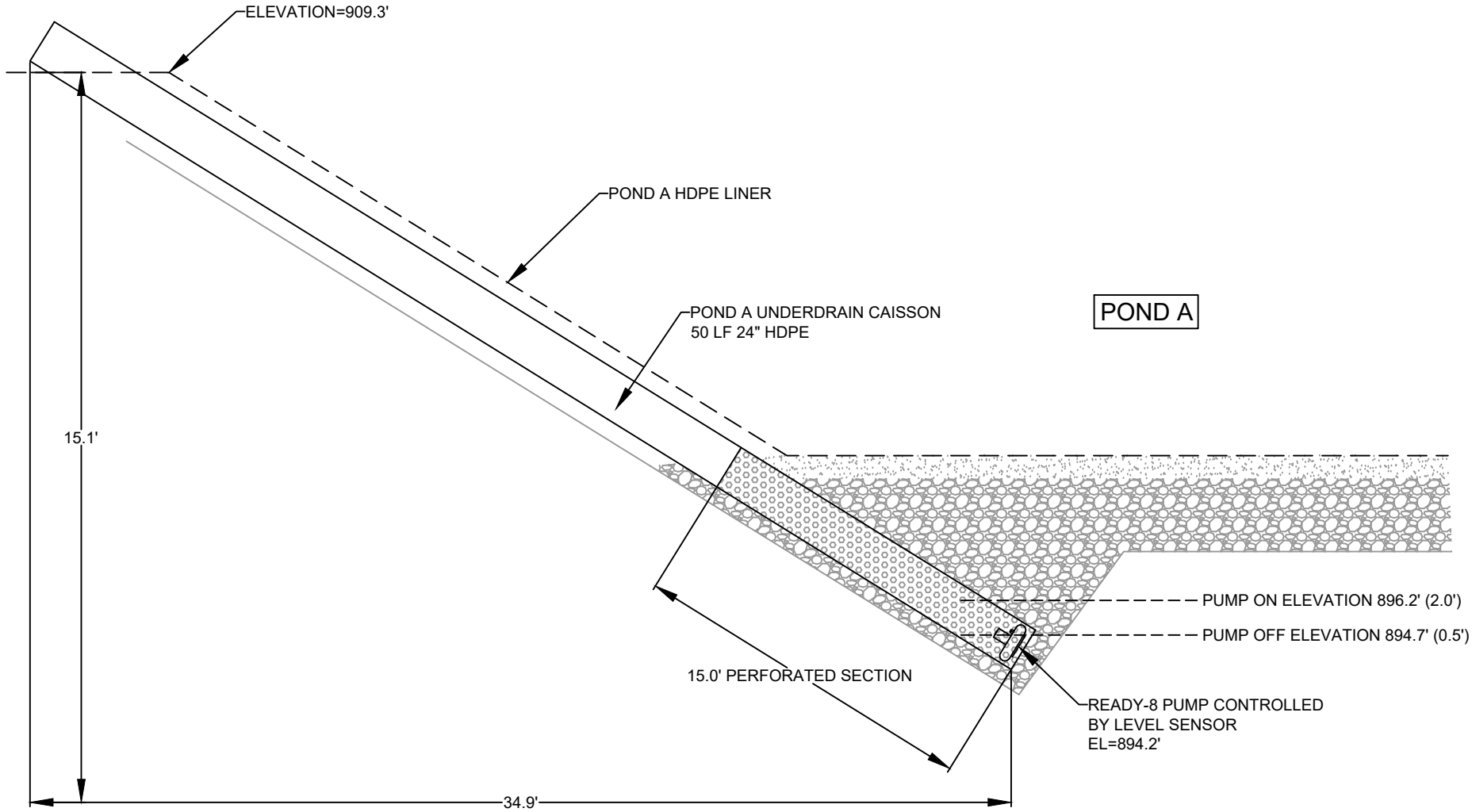


FIGURE 3-12 POND A UNDERDRAIN PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

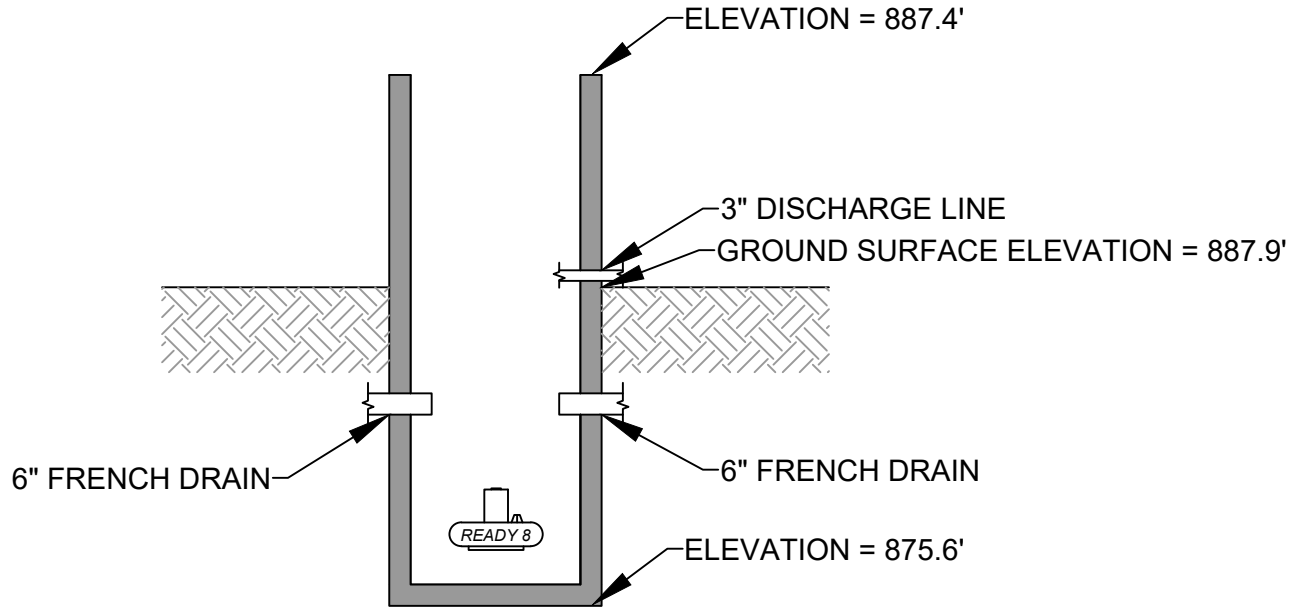


FIGURE 3-13 POND 13 CAISSON PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

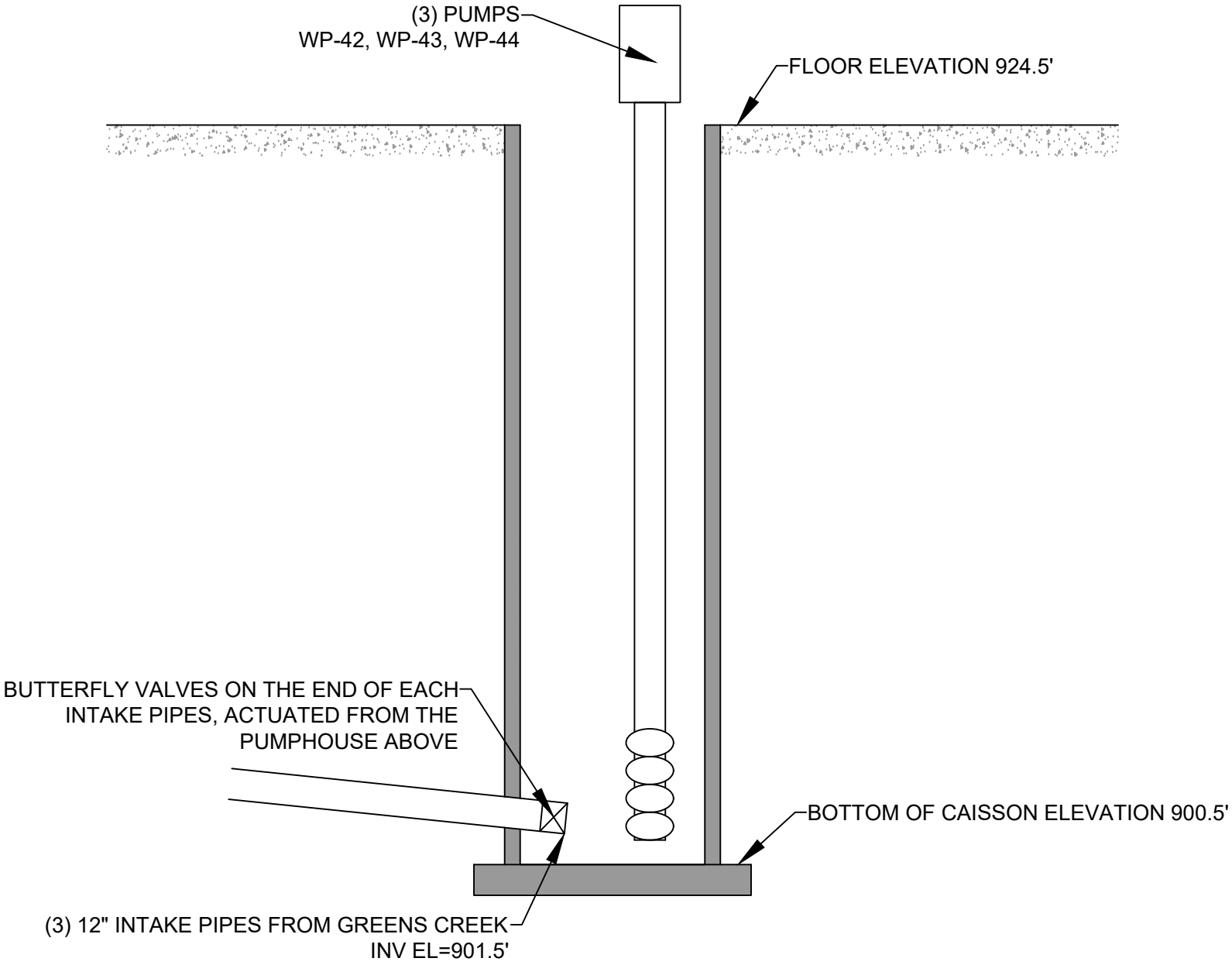


FIGURE 3-14 920 FRESH WATER CAISSON PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

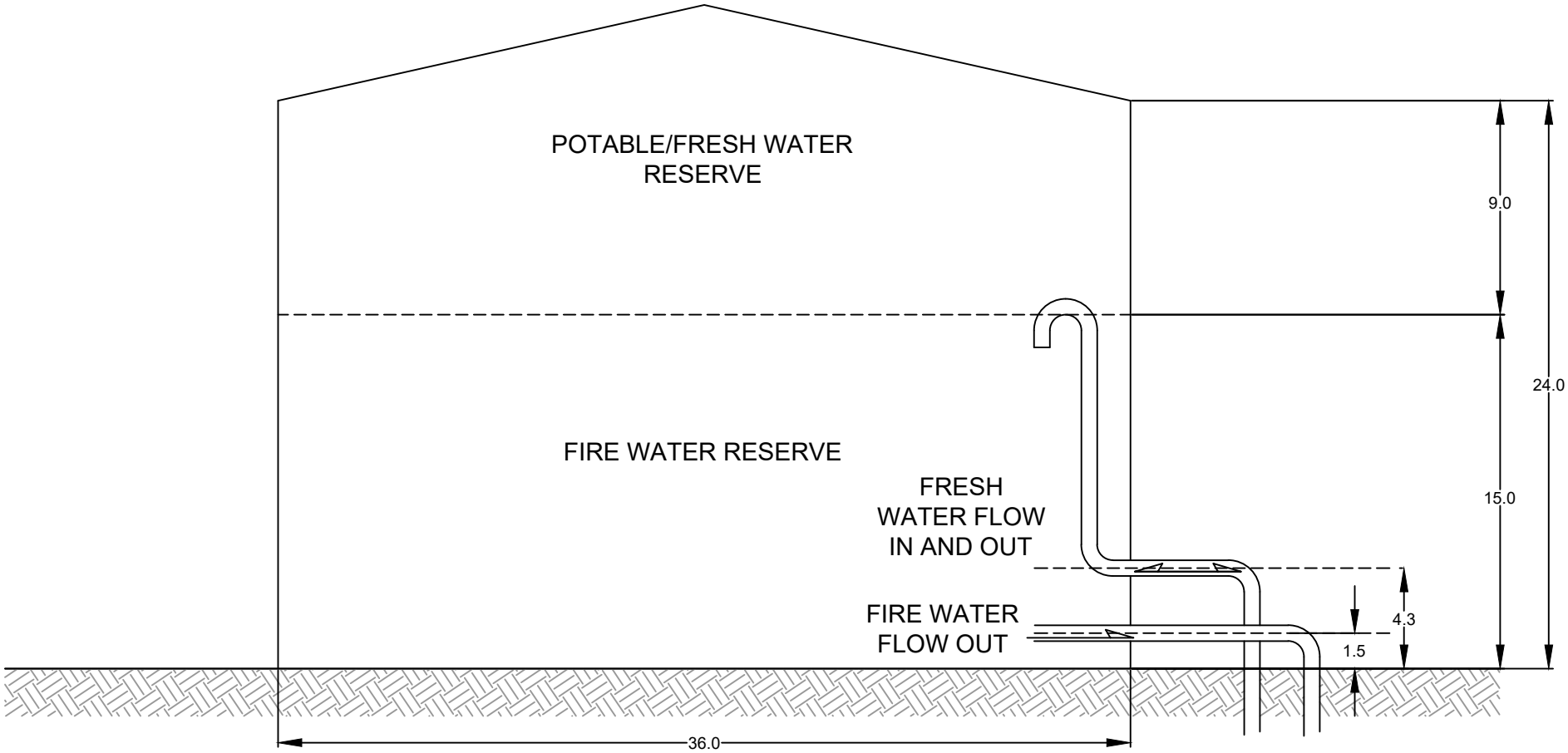
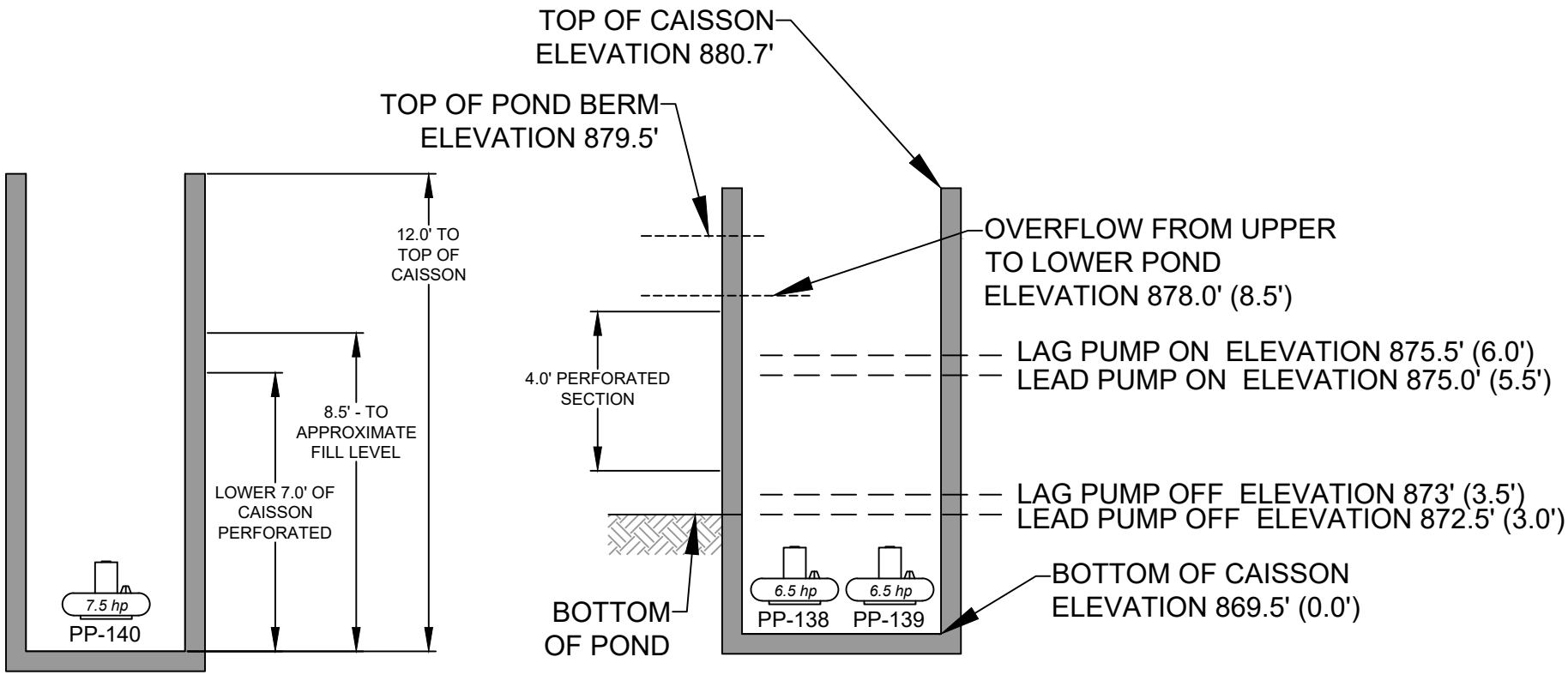


FIGURE 3-15 1160 HEAD TANK	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY



LOWER POND C
CAISSON

UPPER POND C
CAISSON

FIGURE 3-16 POND C PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

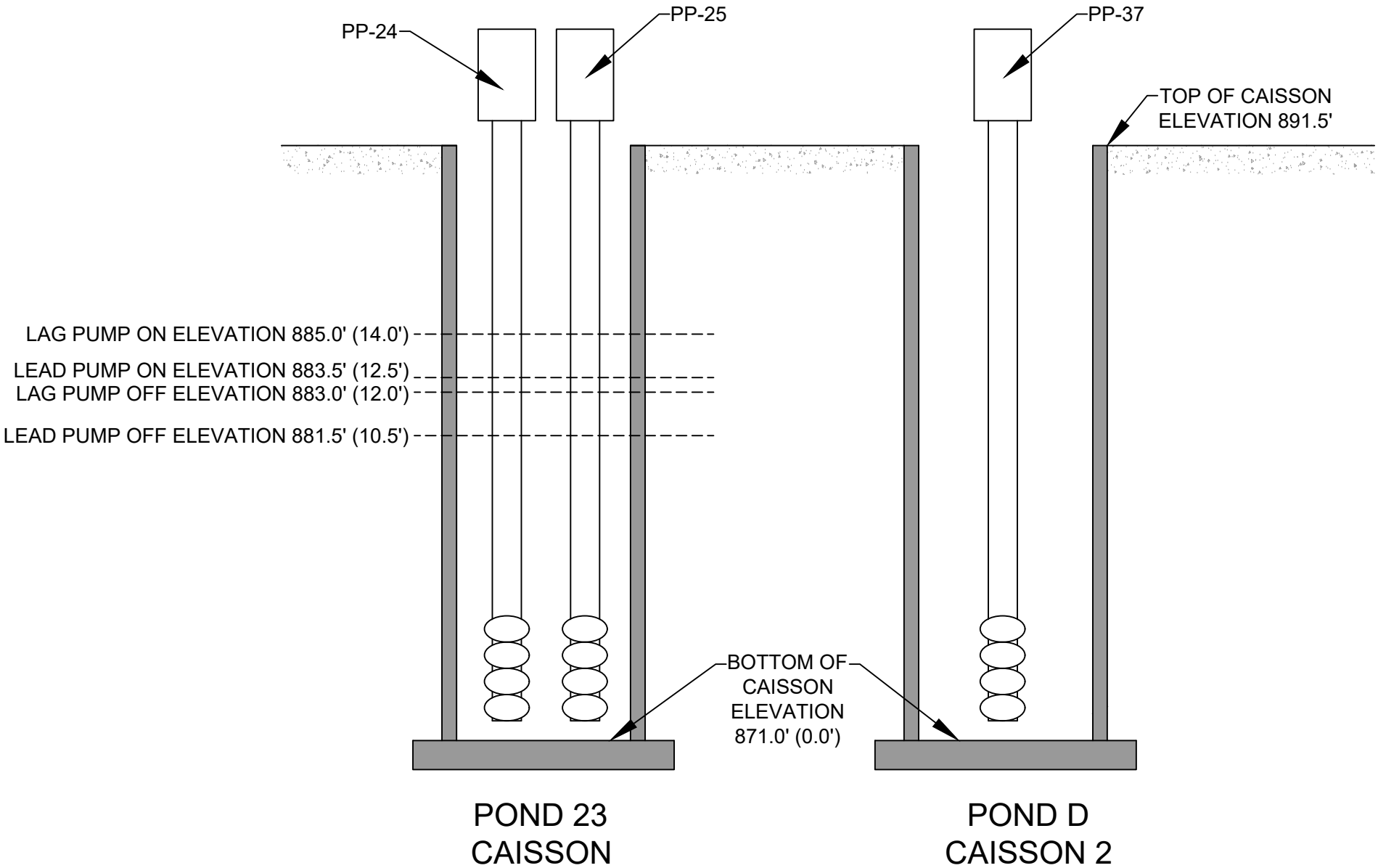


FIGURE 3-17 POND 23 PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

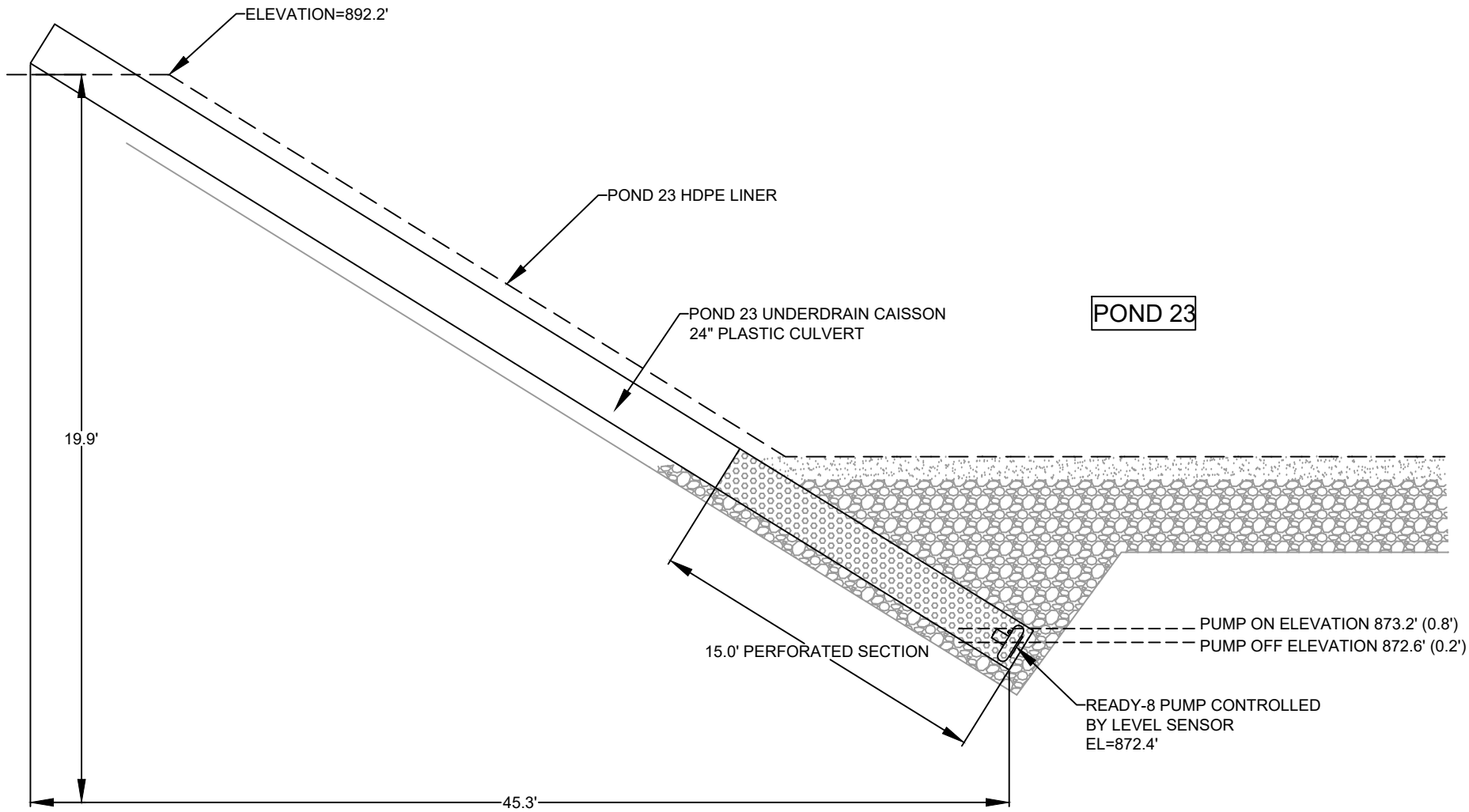
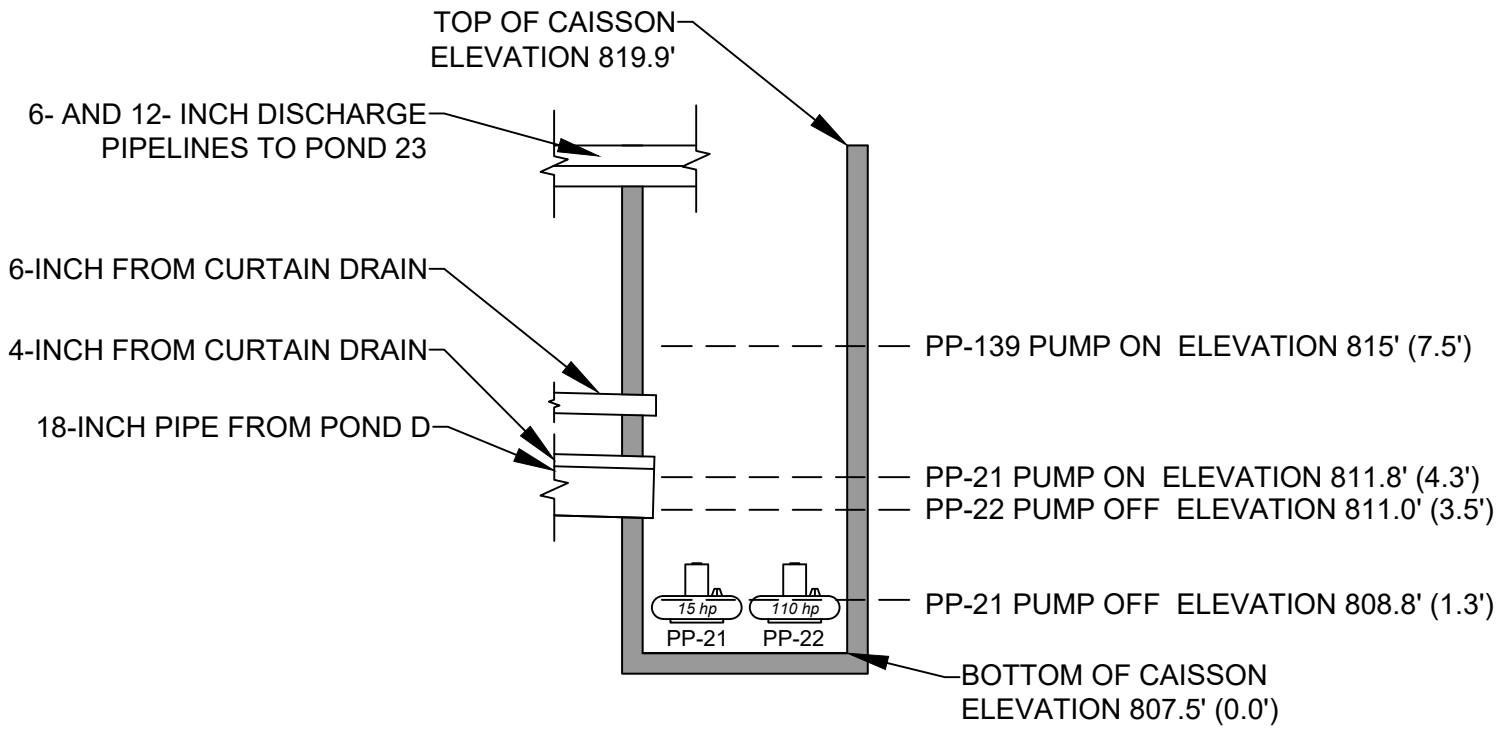


FIGURE 3-18 POND 23 UNDERDRAIN PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY



POND D
CAISSON 1

FIGURE 3-19 POND D PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

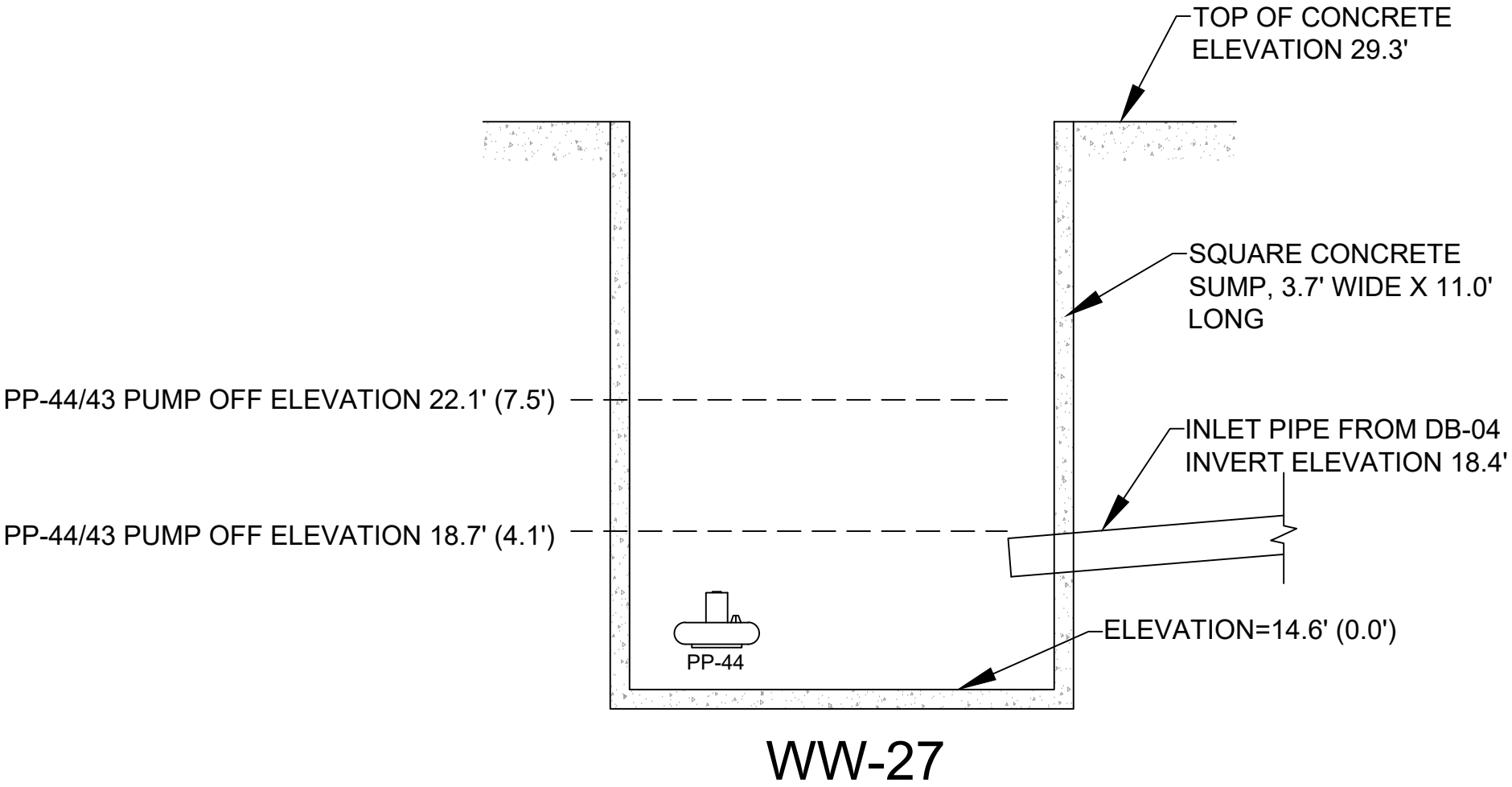


FIGURE 3- 20 HAWK INLET TRUCK WASH PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

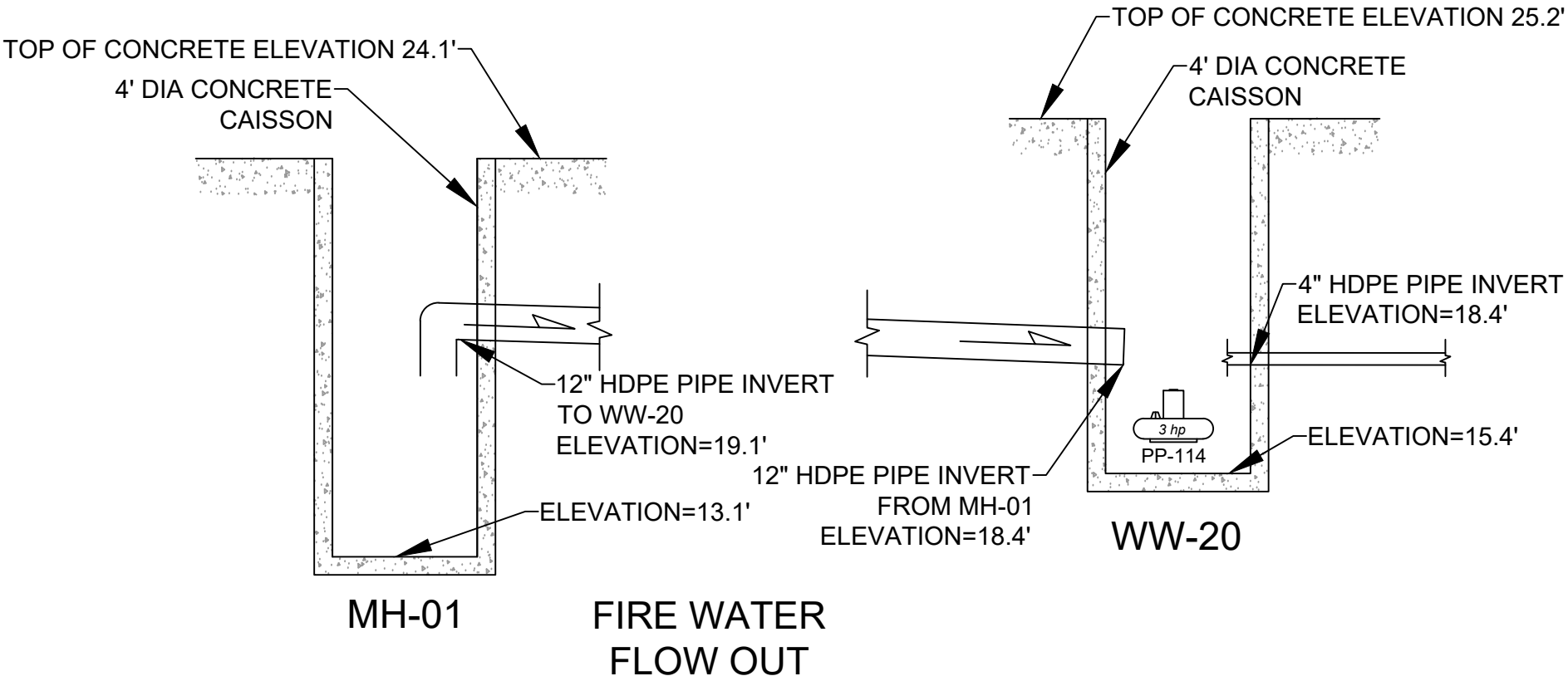


FIGURE 3-21 BARGE RAMP PROFILE	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

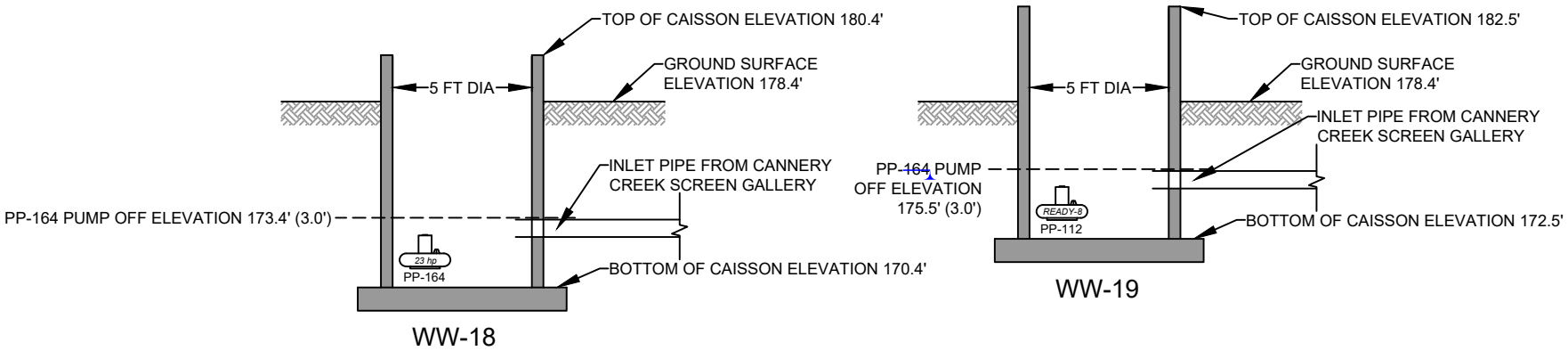


FIGURE 3-22
CANNERY CREEK WET WELL 18 & 19 PROFILE

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

APPENDIX 4

Site Asbuilds

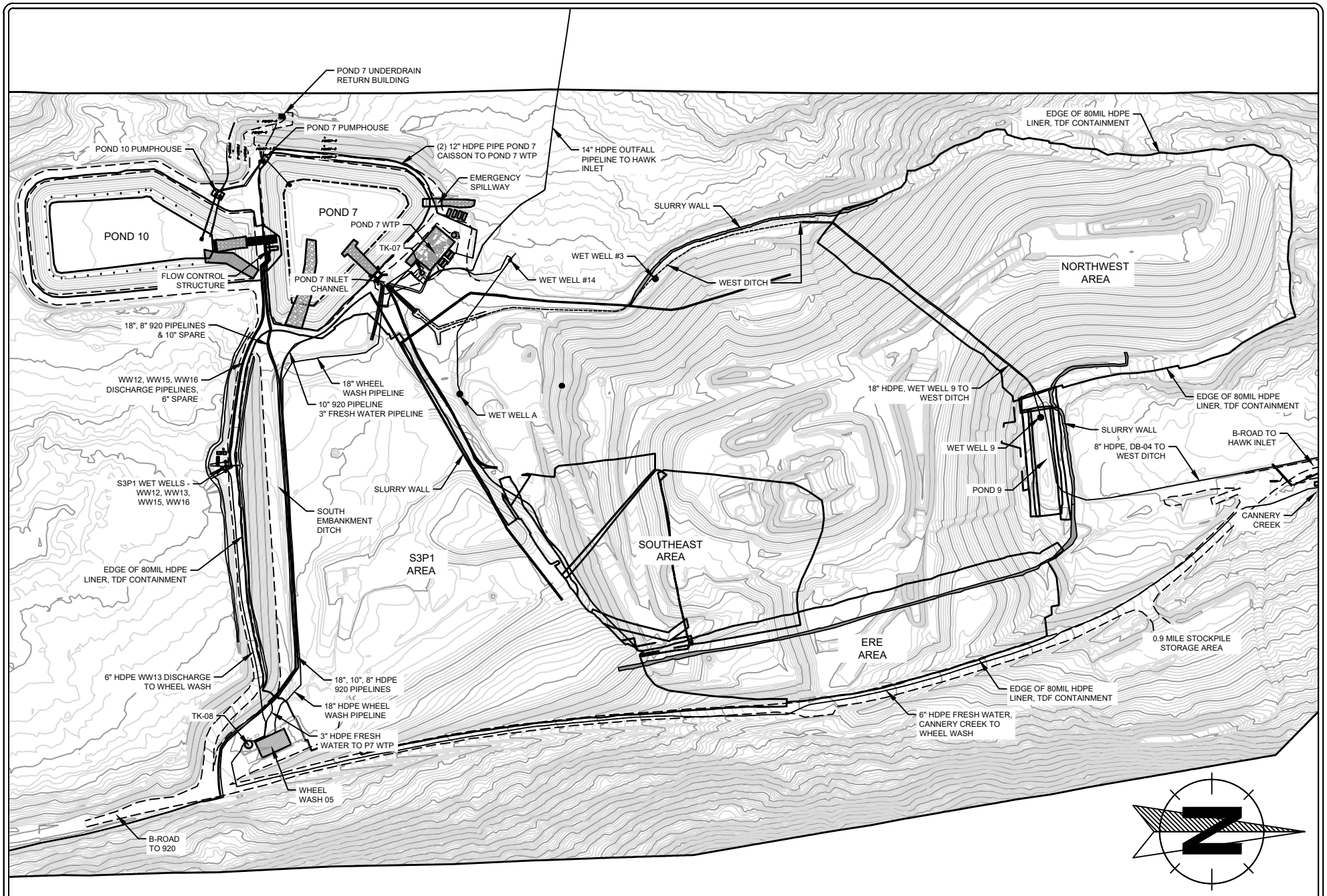


FIGURE 4-1
TAILINGS DISPOSAL AREA SITE MAP

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

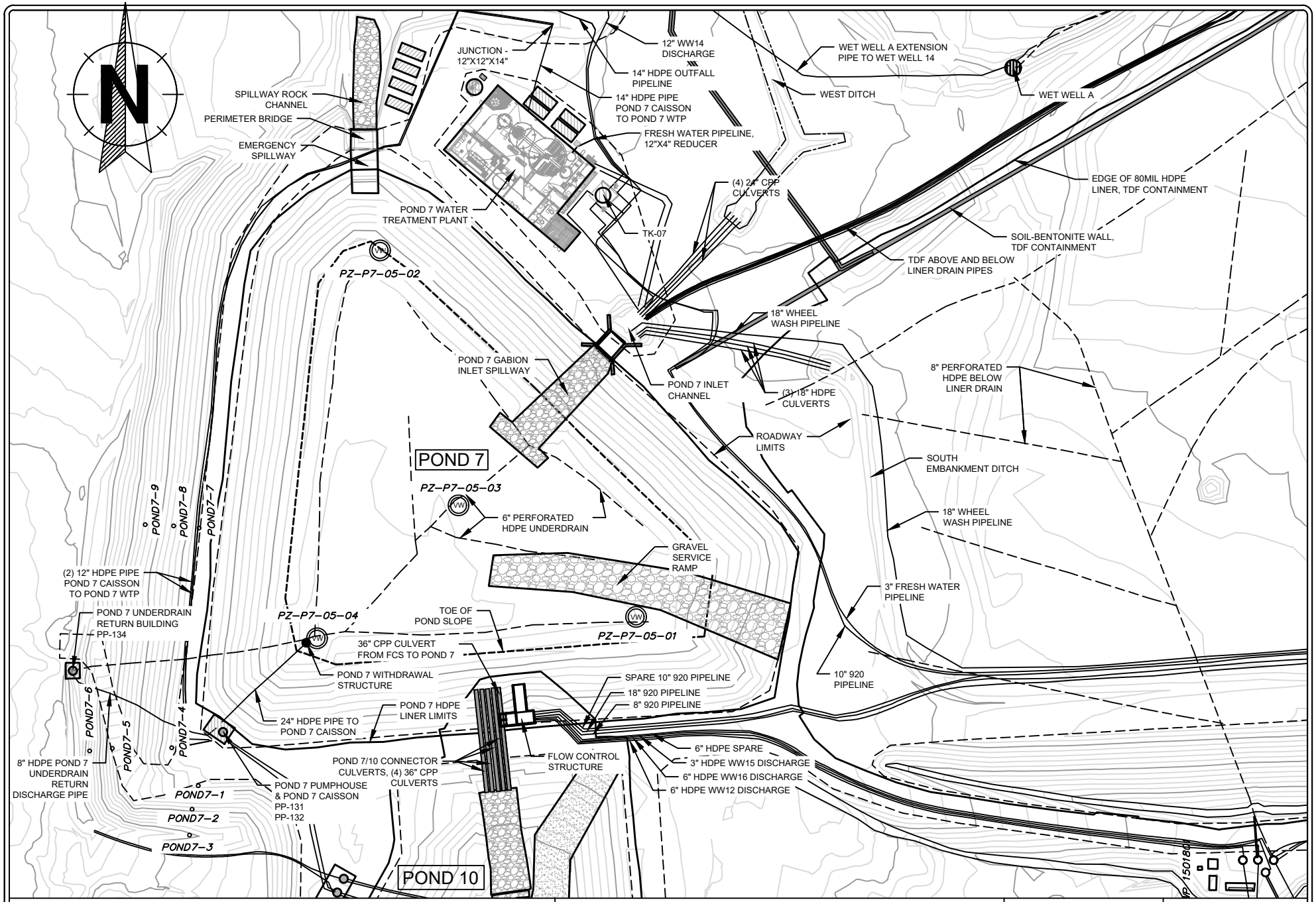


FIGURE 4-2
POND 7 SITE MAP

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

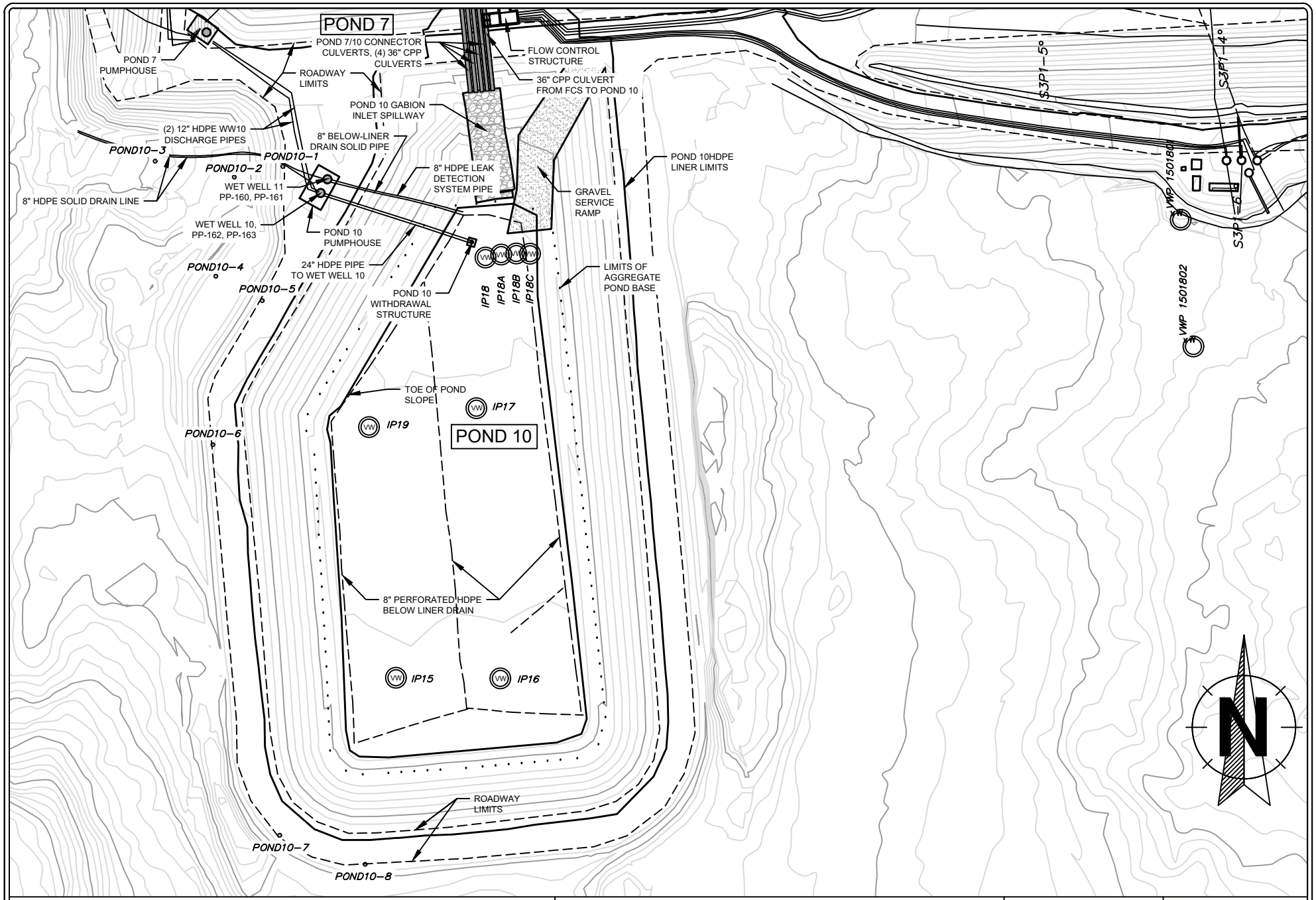


FIGURE 4-3
POND 10 SITE MAP

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

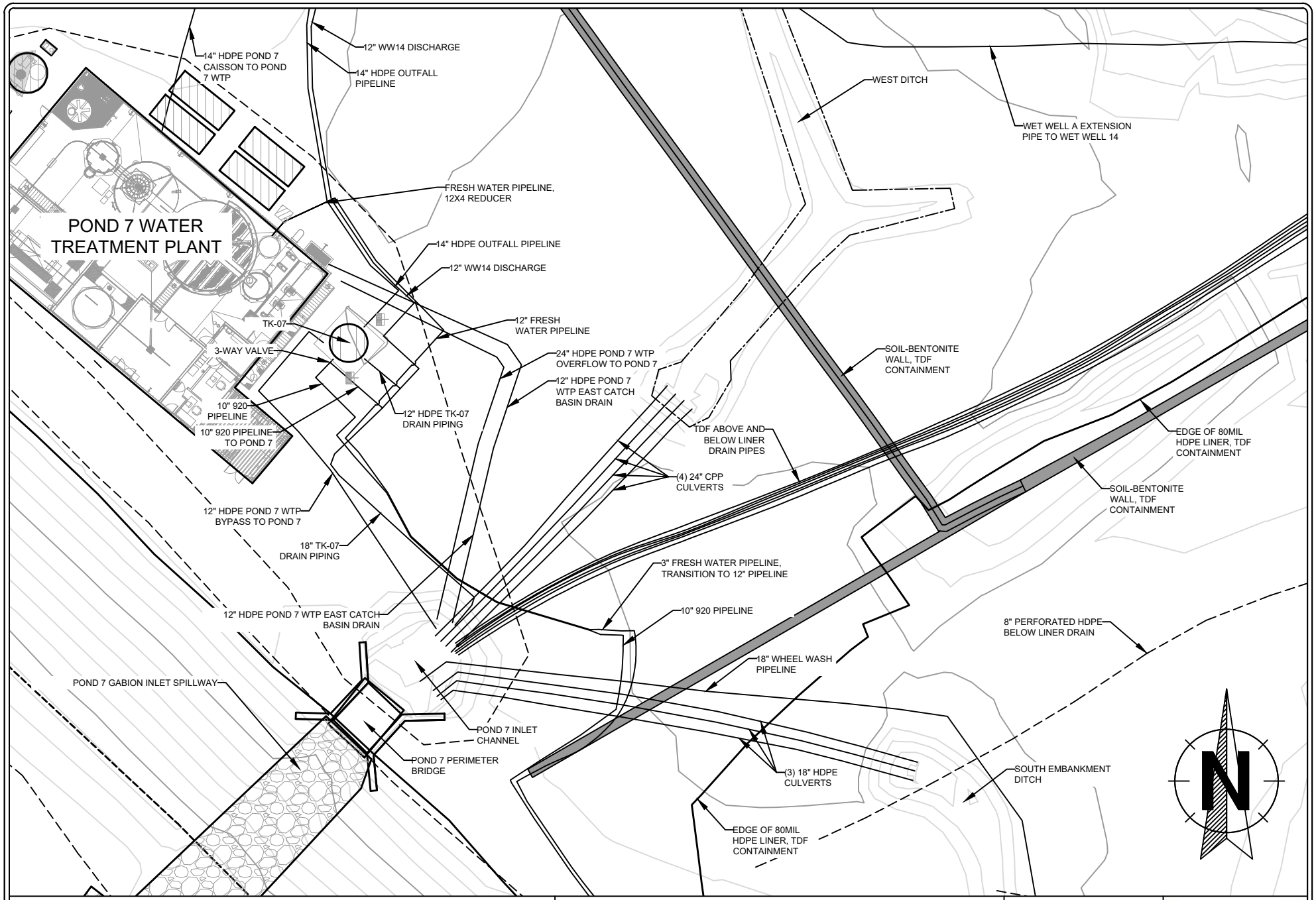


FIGURE 4-4
POND 7 WATER TREATMENT PLANT SITE MAP

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

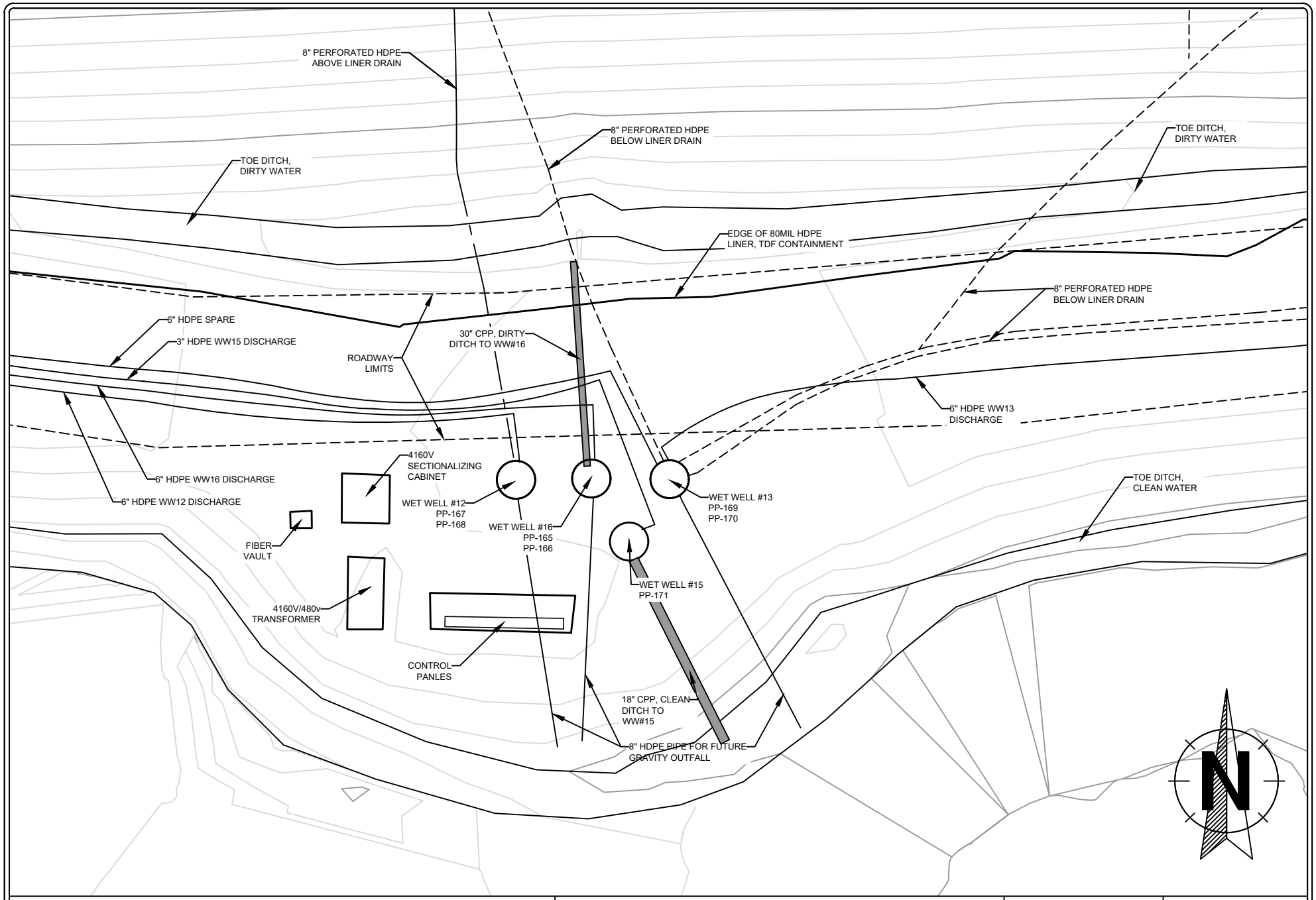


FIGURE 4-5 SOUTH EMBANKMENT WET WELLS SITE MAP	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

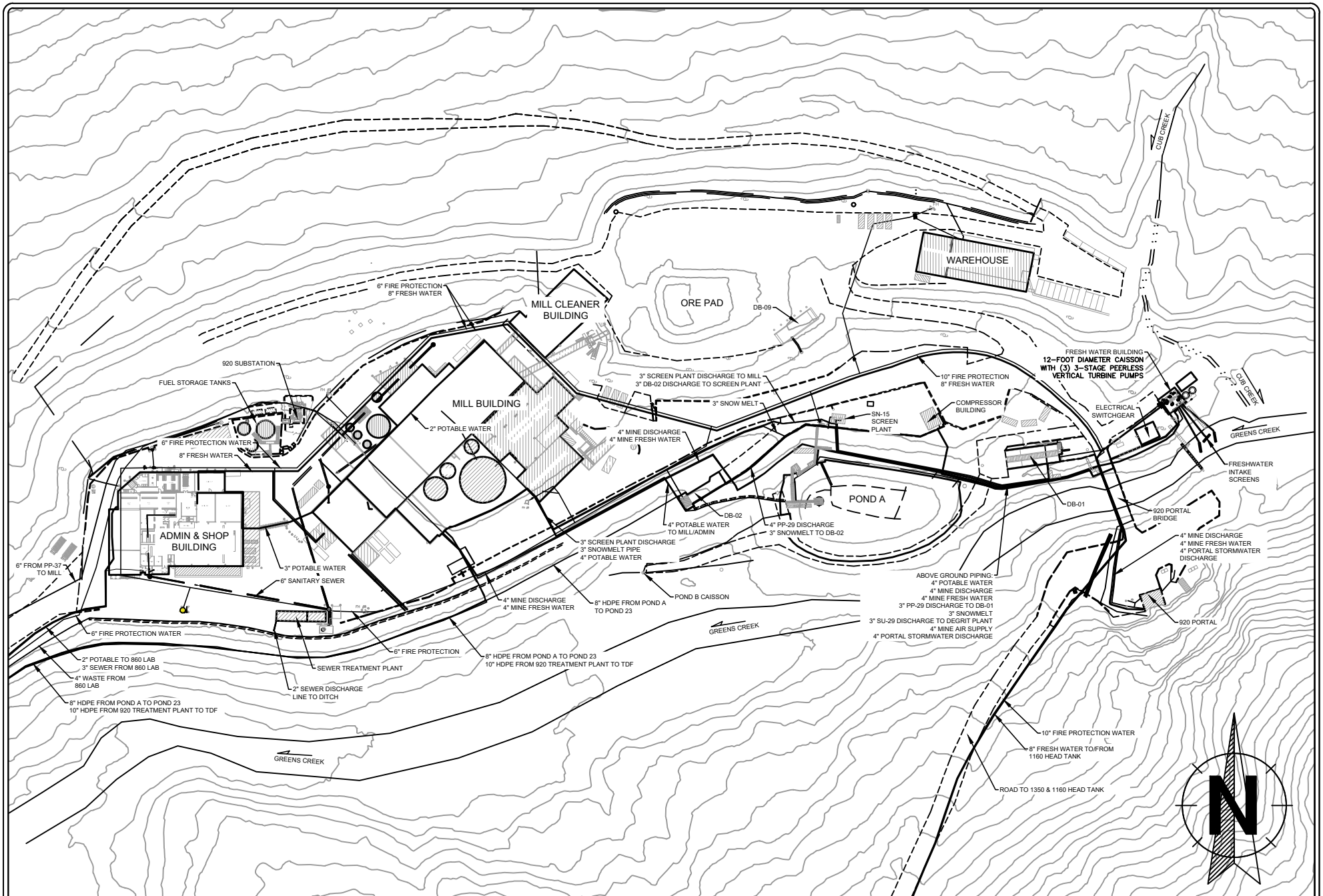


FIGURE 4-6
920 AREA SITE MAP

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

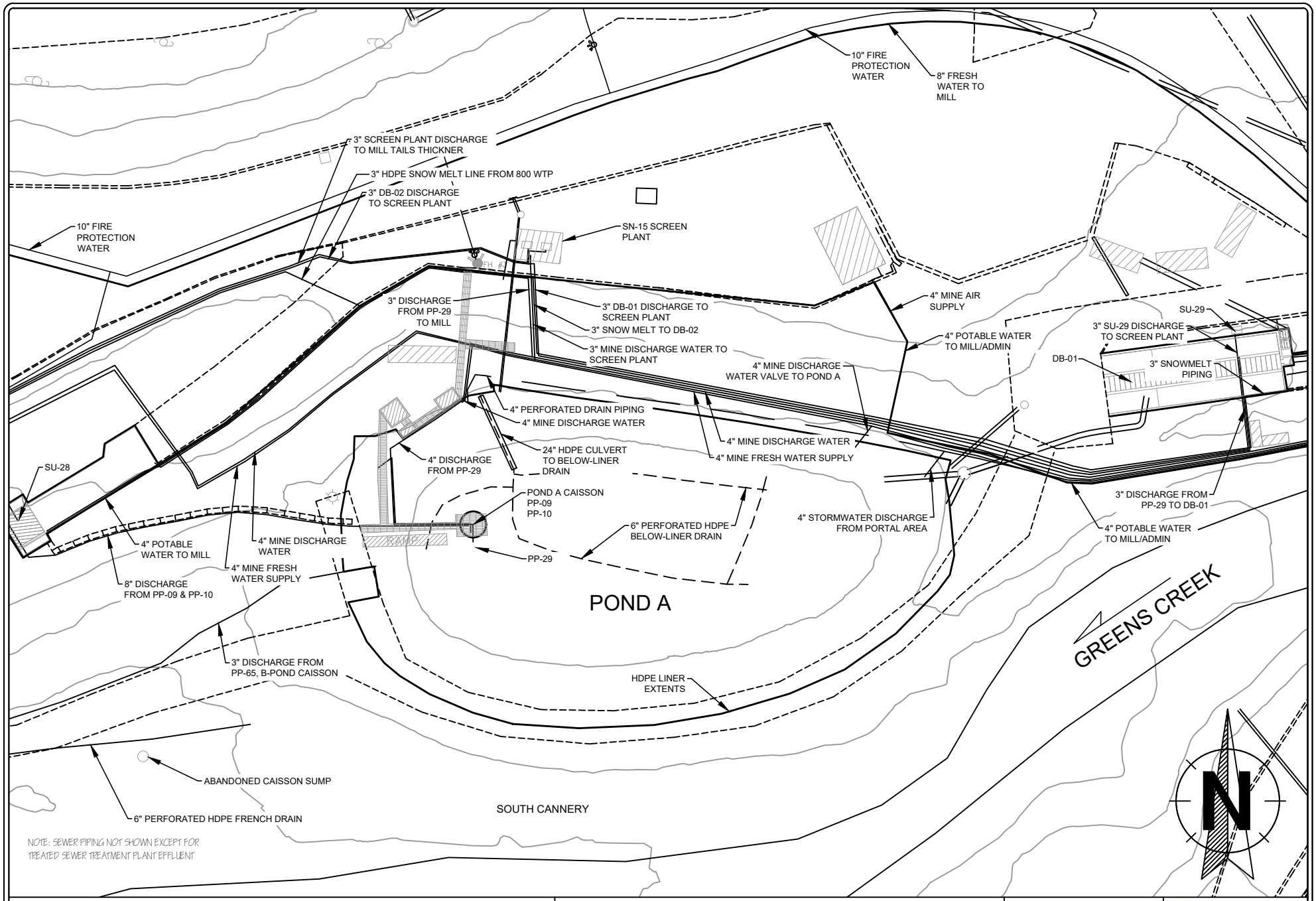


FIGURE 4-7 POND A SITE MAP	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

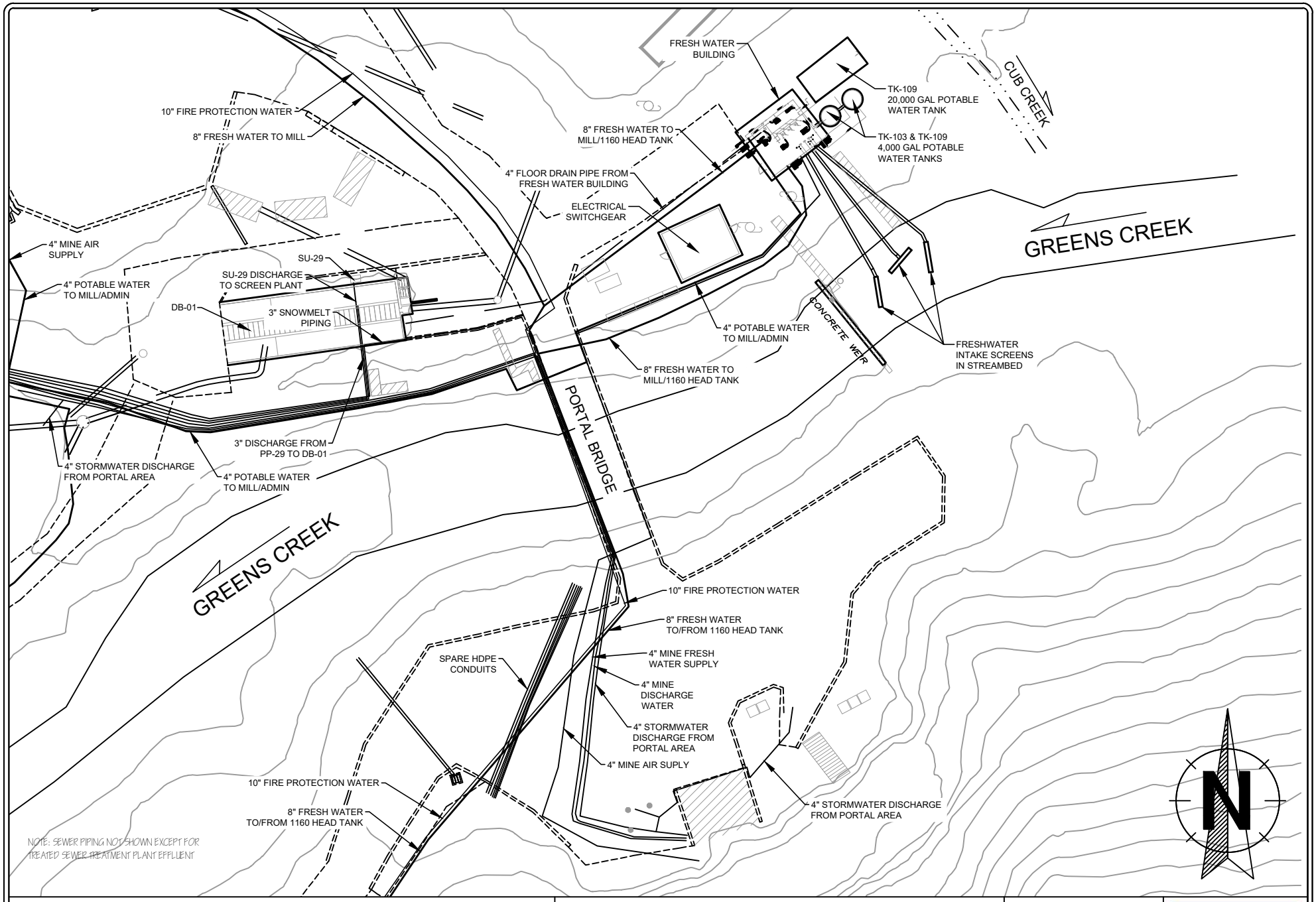


FIGURE 4-8 920 FRESH WATER SITE MAP	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE

Hecla MINING COMPANY

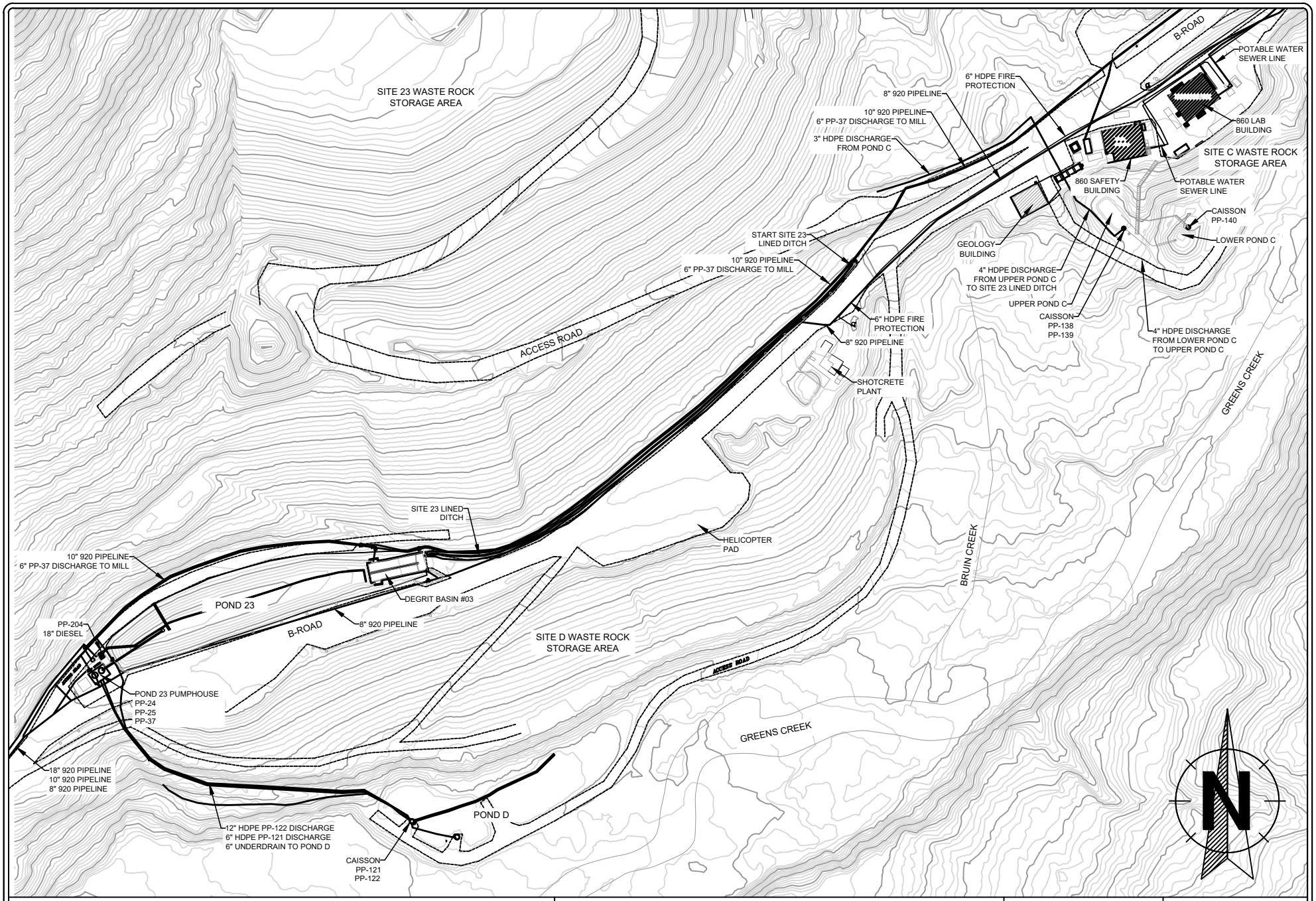


FIGURE 4-9
SITE 23 SITE MAP

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

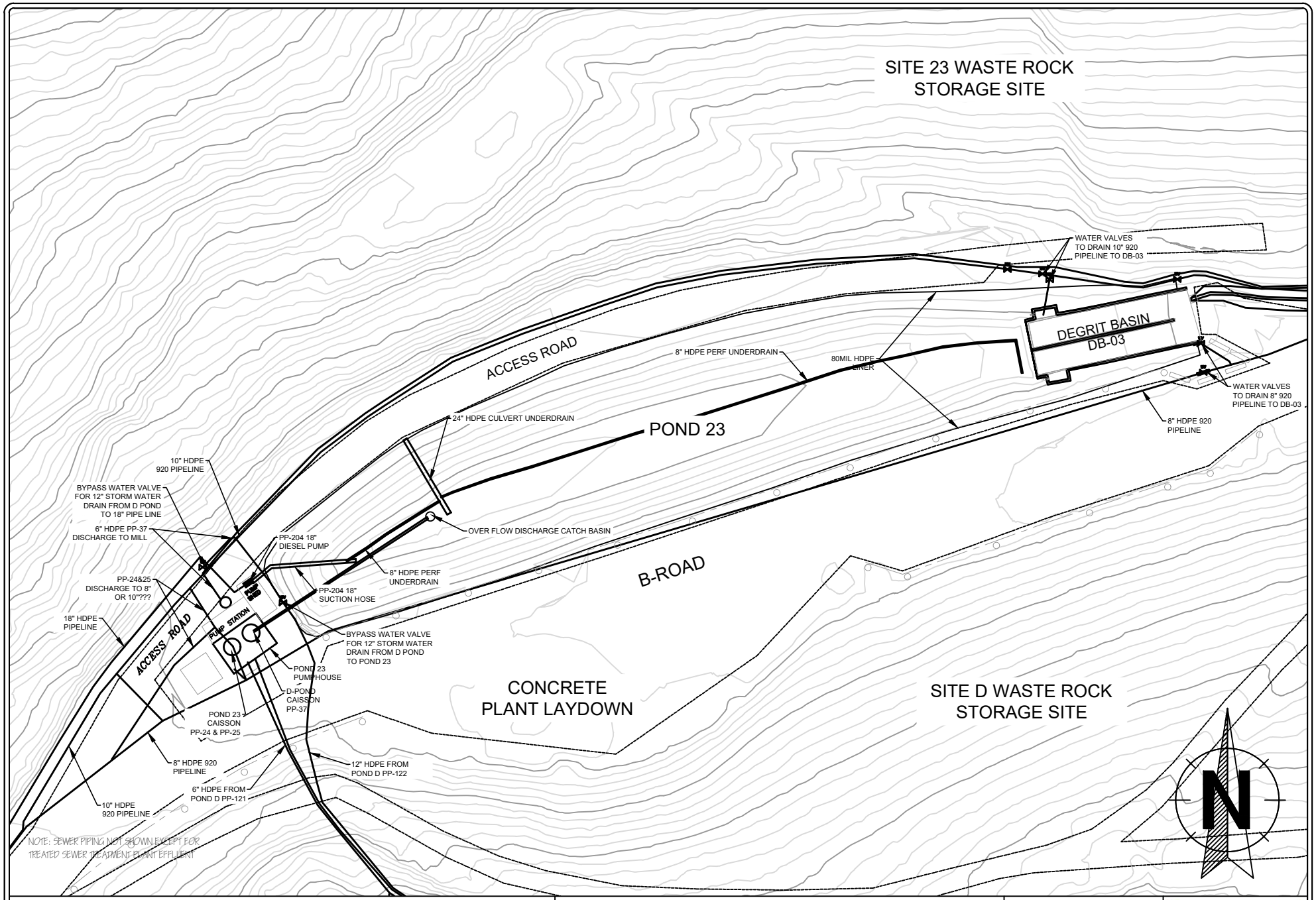


FIGURE 4-10
POND 23 SITE MAP

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla
MINING COMPANY

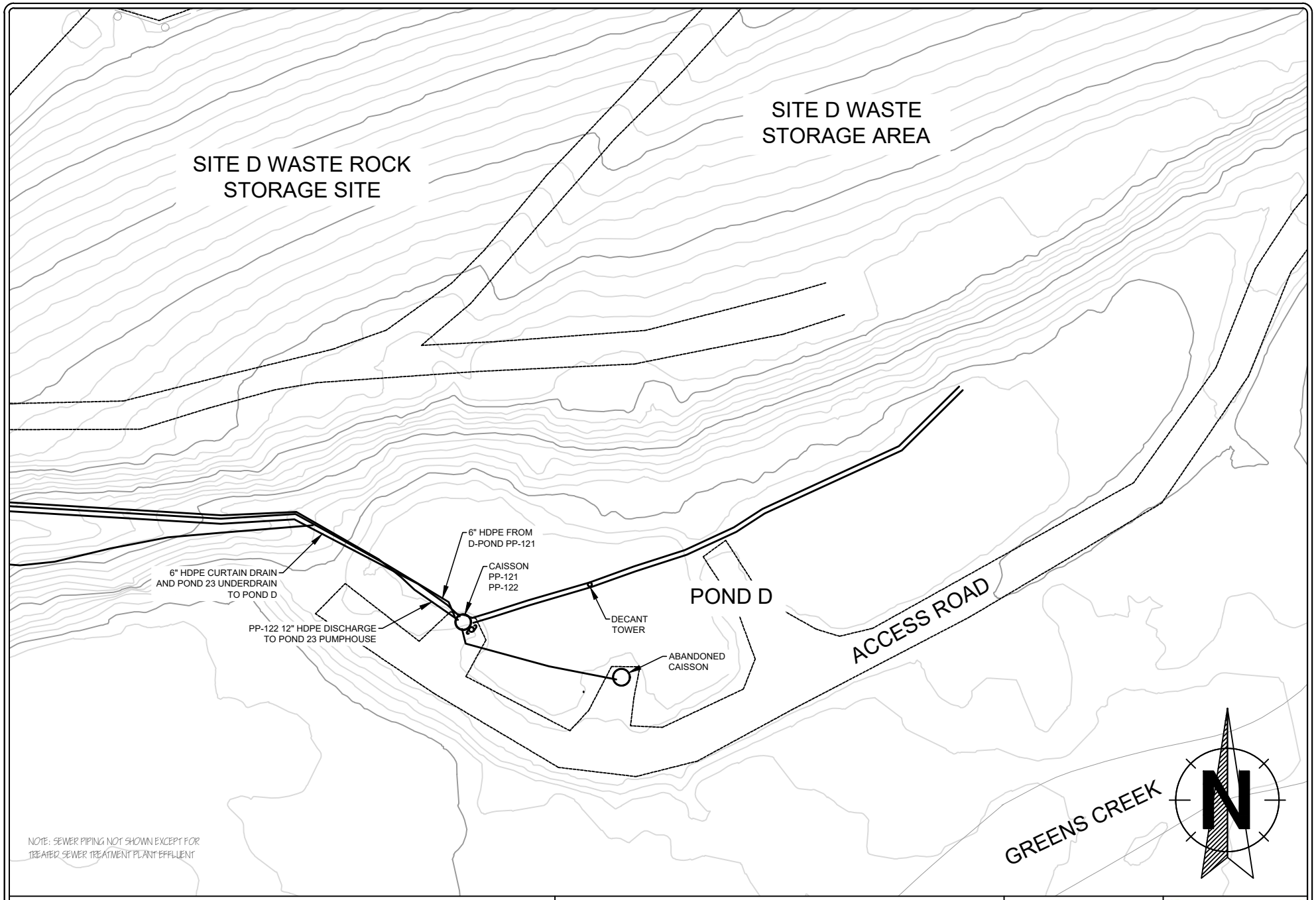


FIGURE 4-11 SITE D SITE MAP	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

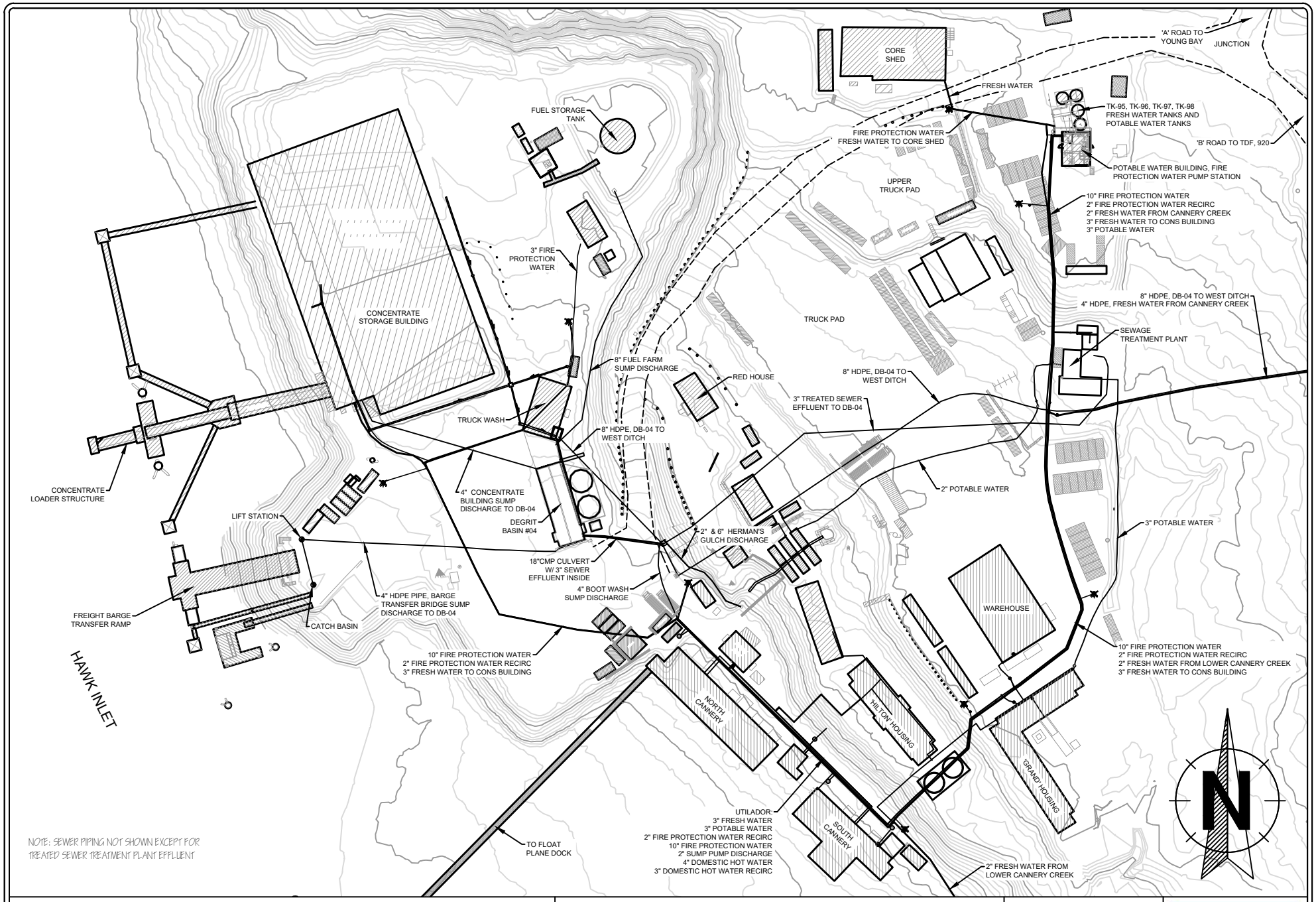


FIGURE 4-12
HAWK INLET AREA SITE MAP

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

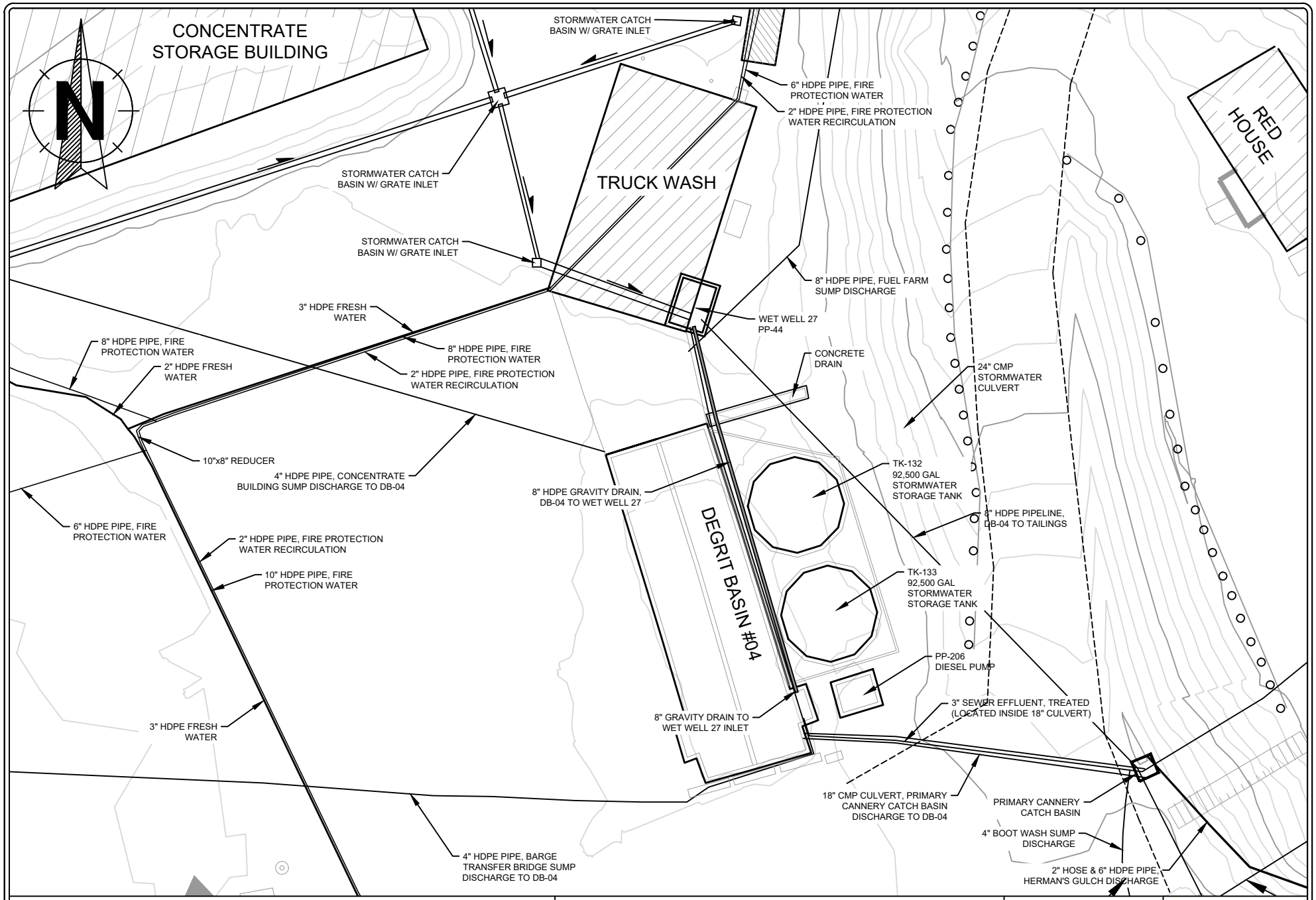


FIGURE 4-13 DB-04 AREA SITE MAP	POND 7/10 DAM SYSTEM O&M MANUAL	2019 UPDATE	Hecla MINING COMPANY

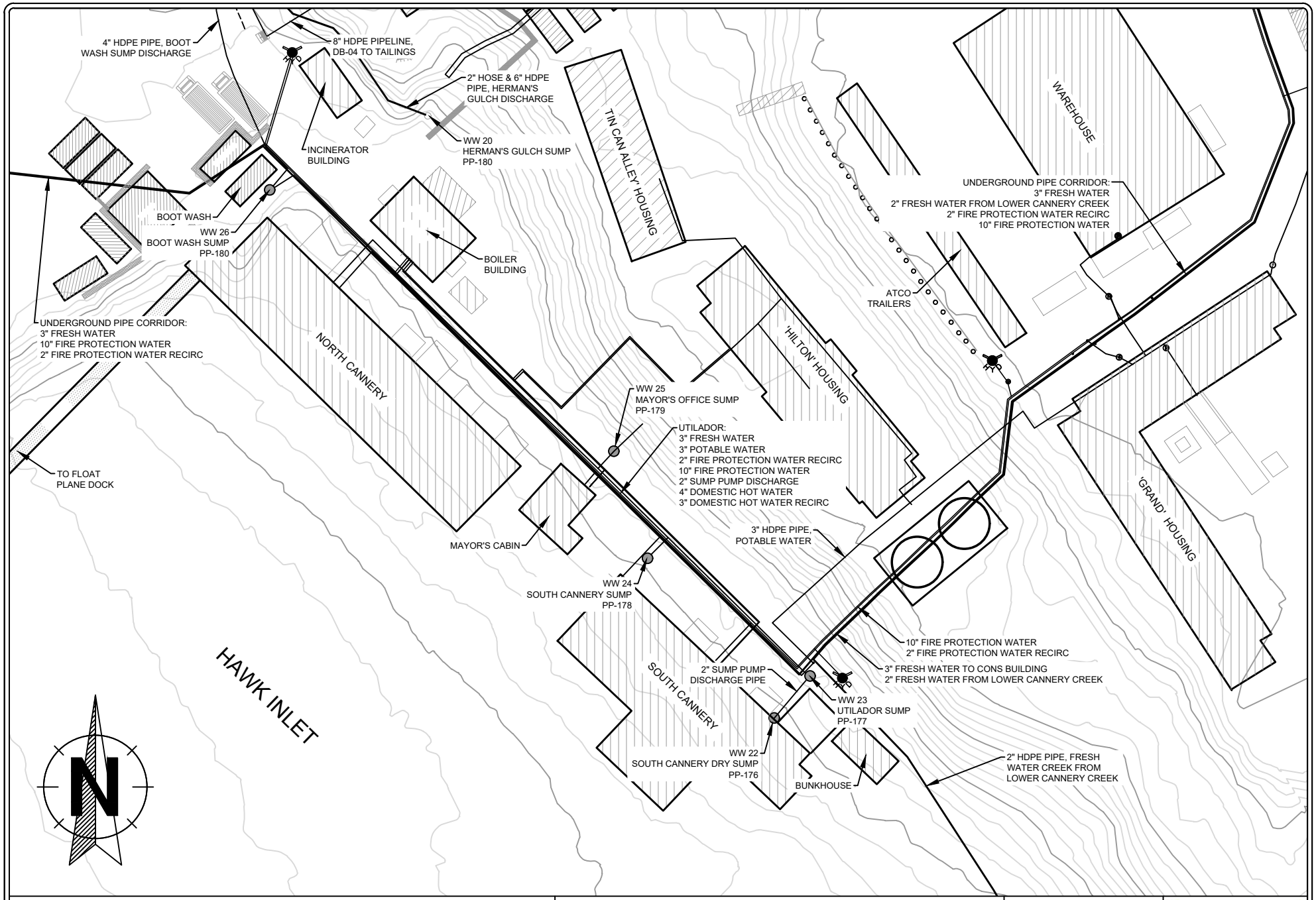


FIGURE 4-14
HAWK INLET CANNERY AREA SITE MAP

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

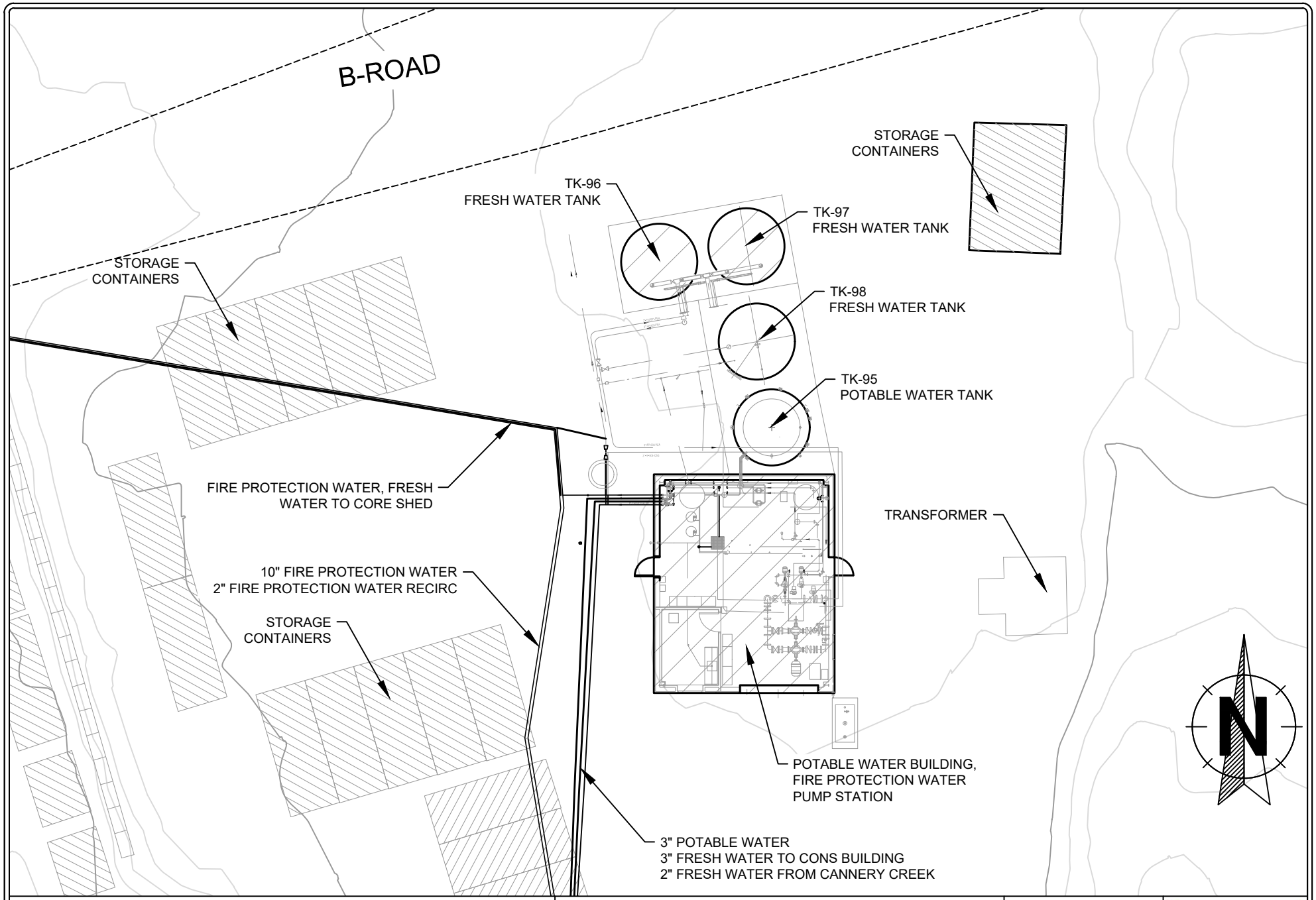


FIGURE 4-15
HAWK INLET FRESH WATER TANKS SITE MAP

POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla MINING COMPANY

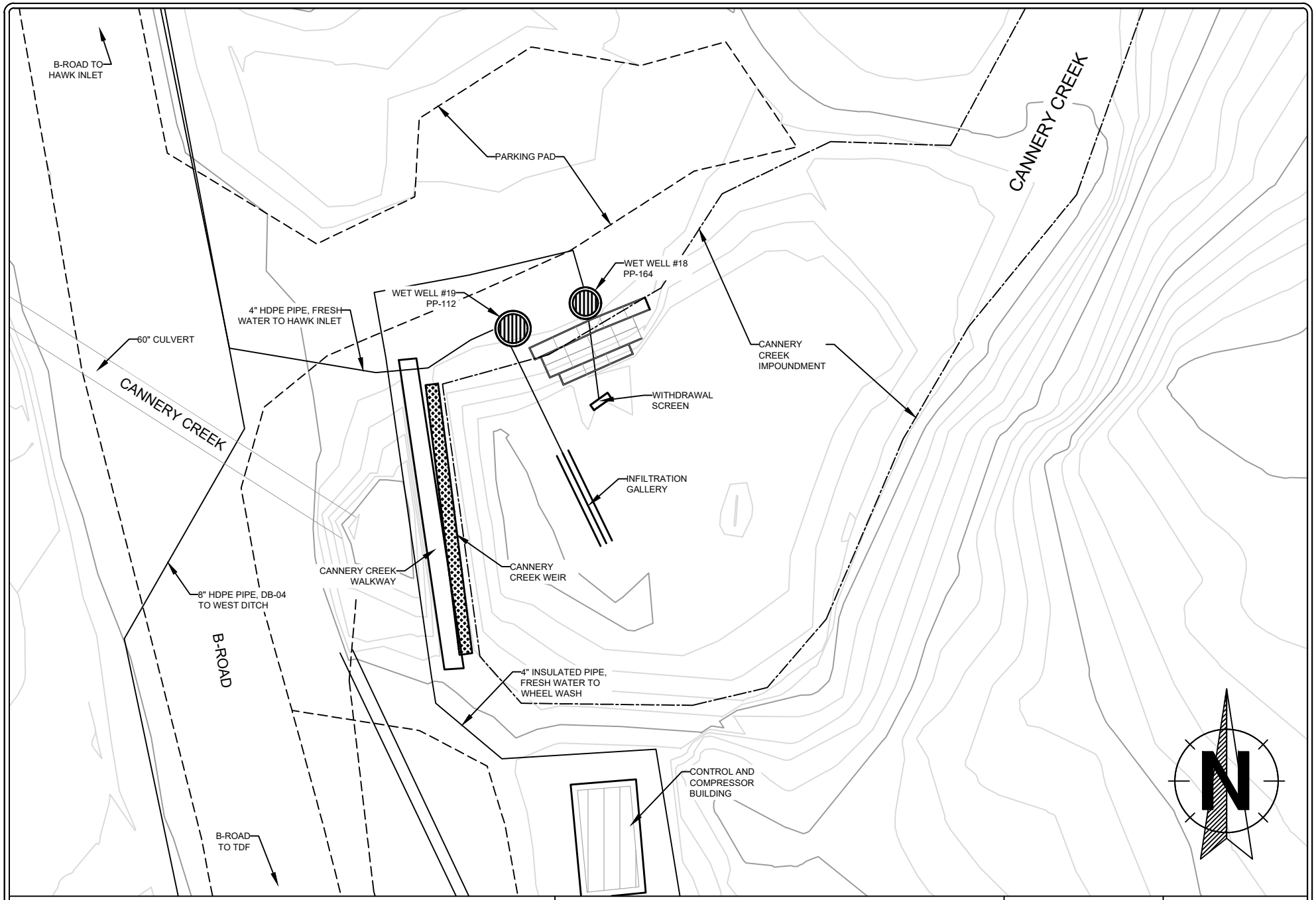


FIGURE 4-16
CANNERY CREEK SITE MAP

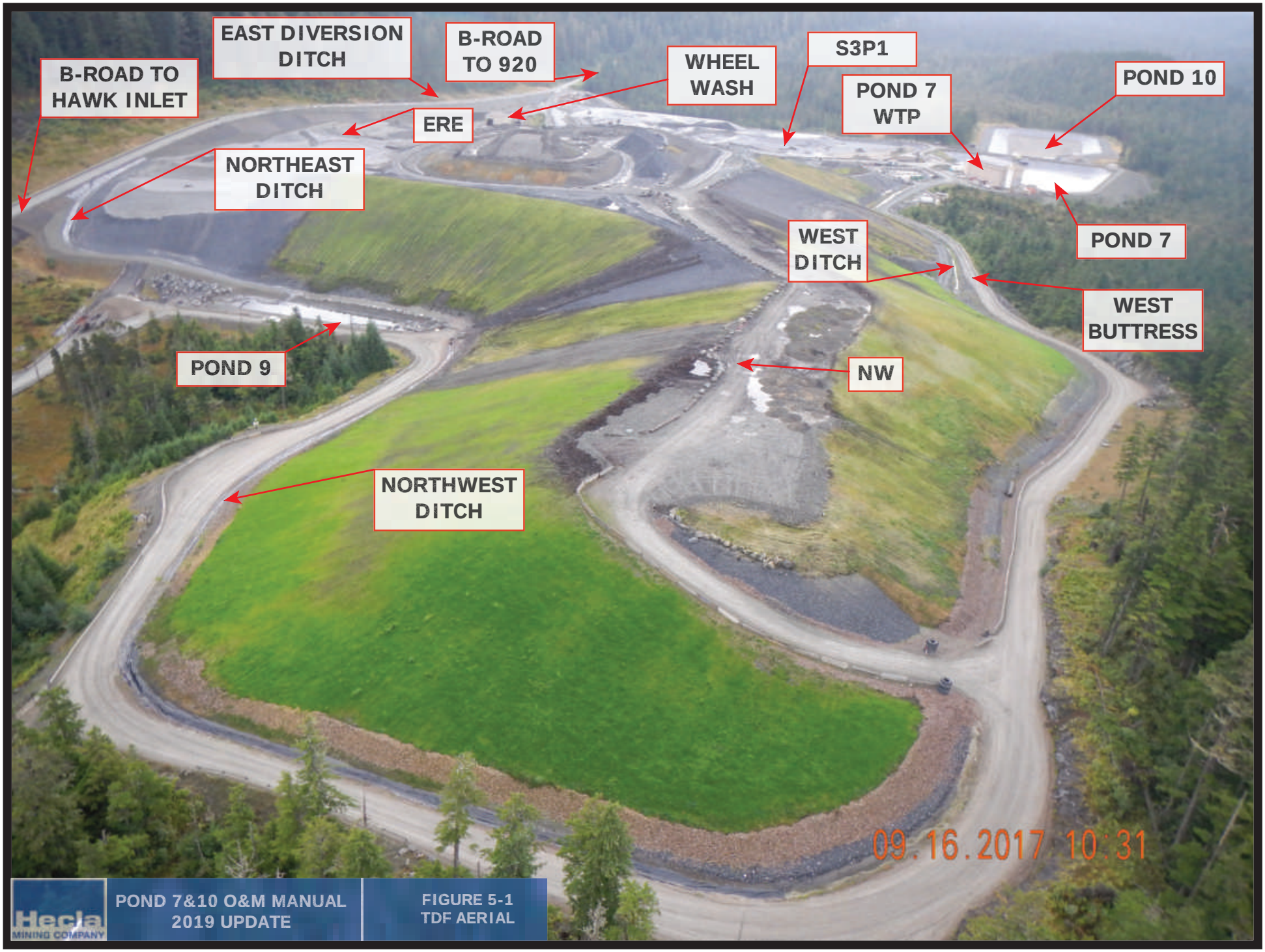
POND 7/10 DAM
SYSTEM O&M MANUAL

2019 UPDATE

Hecla
MINING COMPANY

APPENDIX 5

Labelled Photographs



Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-1
TDF AERIAL

POND 7
WTP
POND 7 INLET
CHANNEL
POND 7/10
EMERGENCY
SPILLWAY
FLOW CONTROL
STRUCTURE
POND 7
POND 7/10
CONNECTOR
CULVERTS
POND 7 DAM
CREST
POND 7 DAM
POND 7
PUMPHOUSE
POND 10
POND 7 UNDERDRAIN
RETURN BUILDING
POND 10
PUMPHOUSE
Hecla
MINING COMPANY
POND 7&10 O&M MANUAL
2019 UPDATE
FIGURE 5-2
POND 7

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

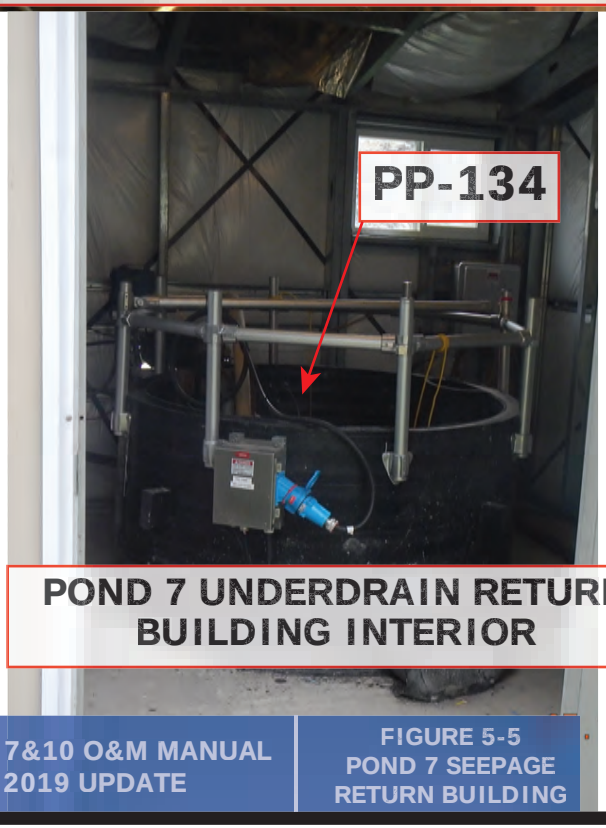
FIGURE 5-3
POND 10

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-4
POND 7
PUMPHOUSE

POND 7 UNDERDRAIN CAISSON

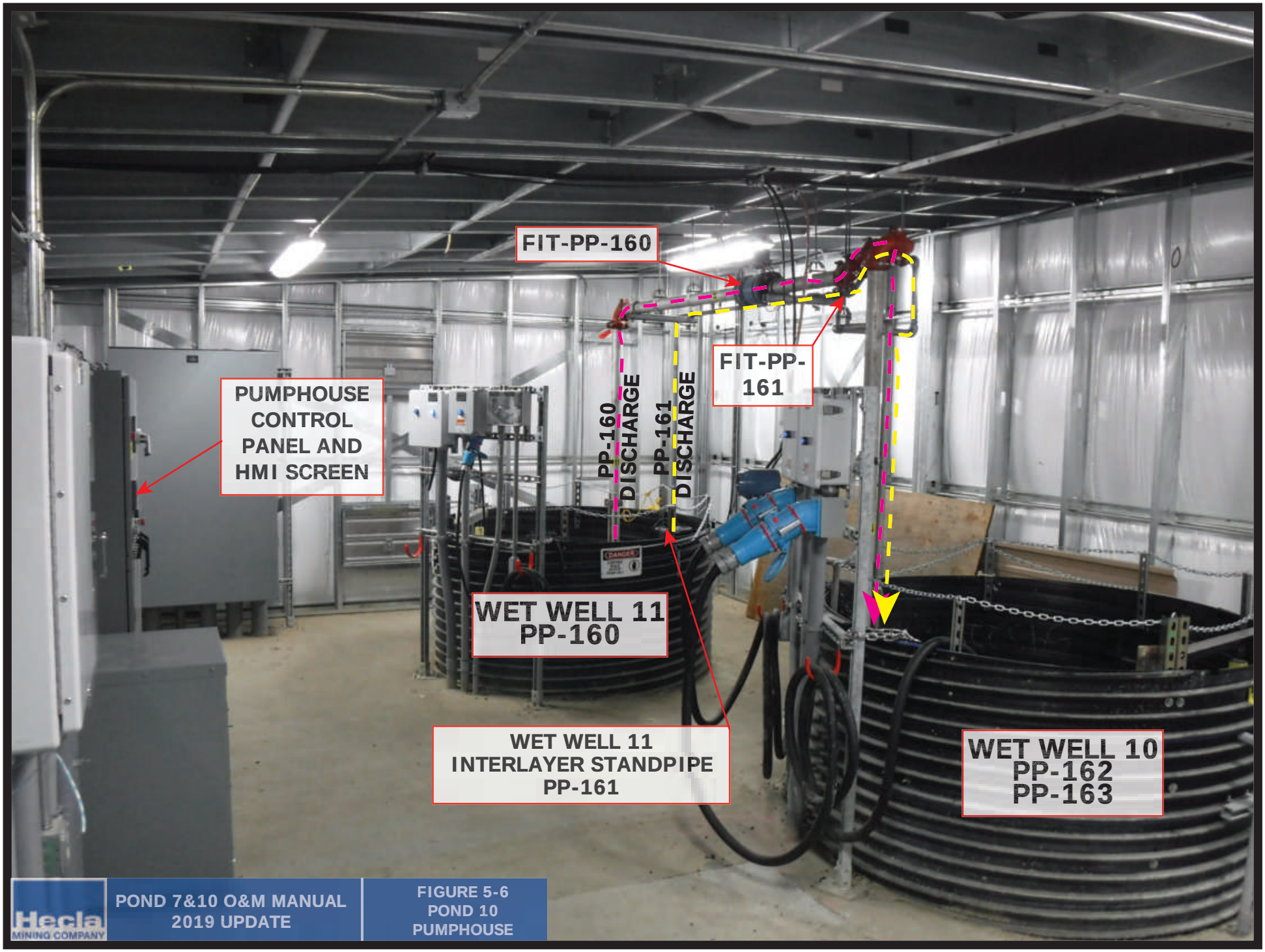


POND 7 UNDERDRAIN RETURN BUILDING INTERIOR

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-5
POND 7 SEEPAGE
RETURN BUILDING



Hecla MINING COMPANY

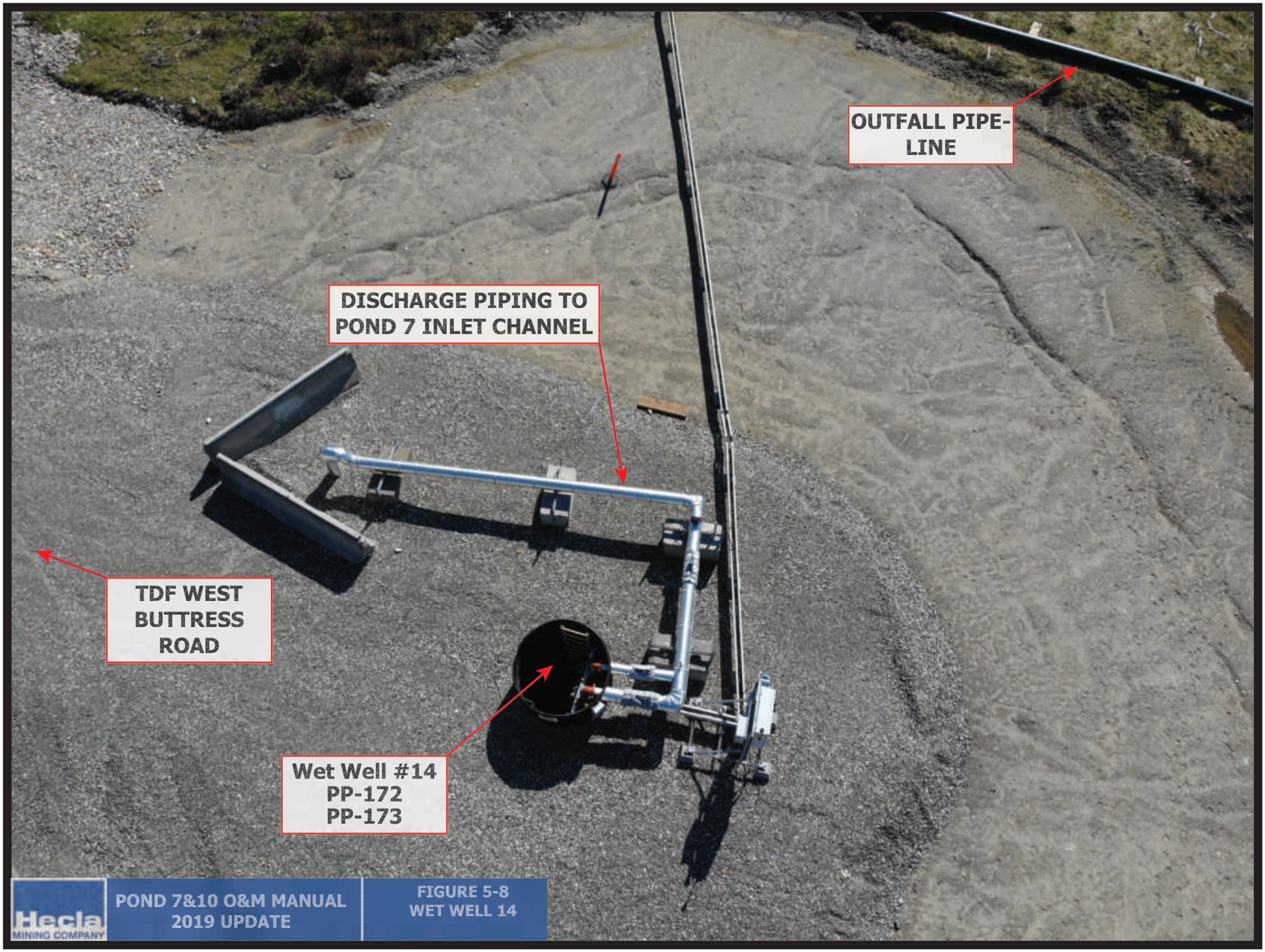
POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-6
POND 10
PUMPHOUSE

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

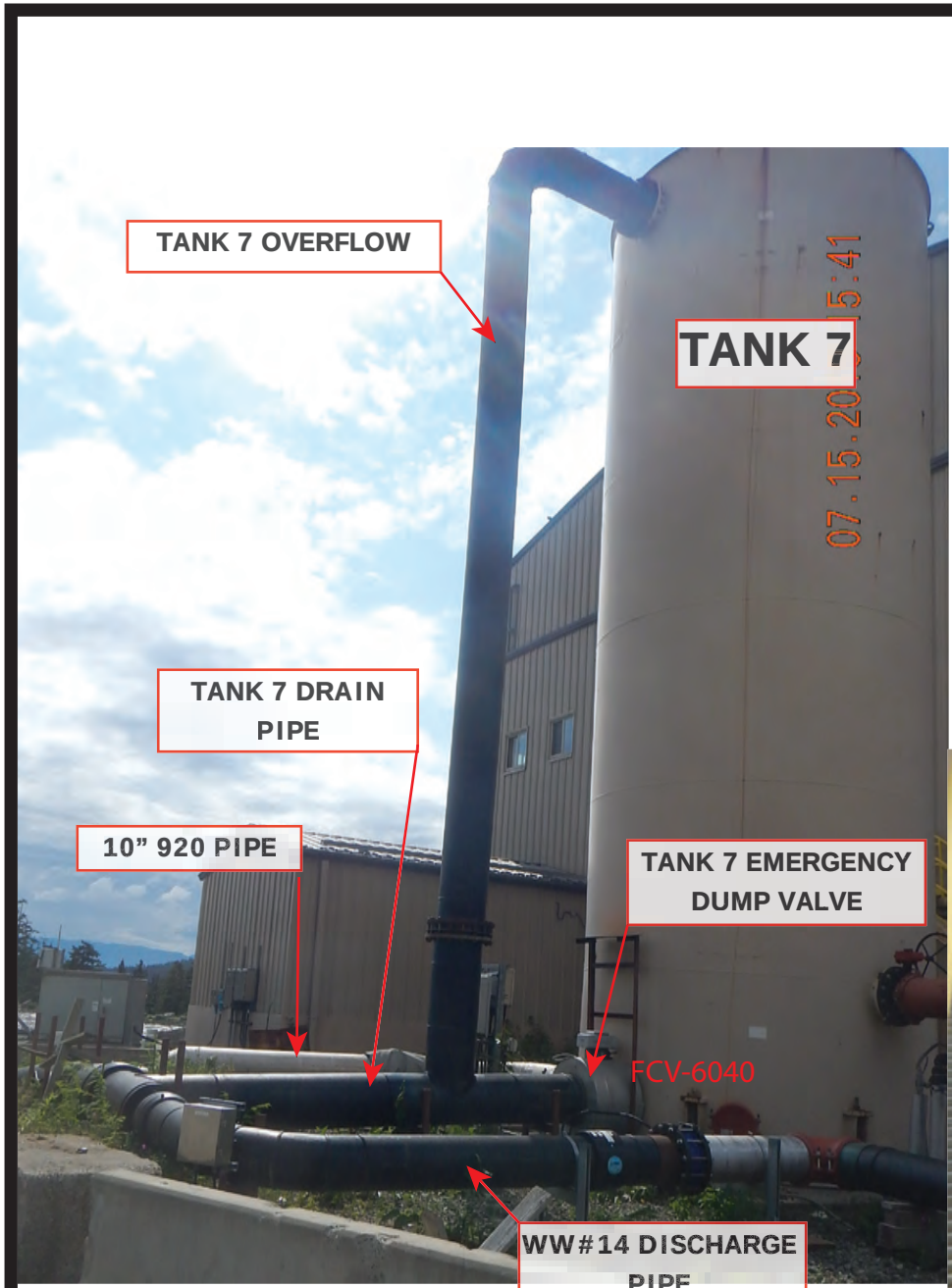
FIGURE 5-7
POND 7 INLET CHANNEL

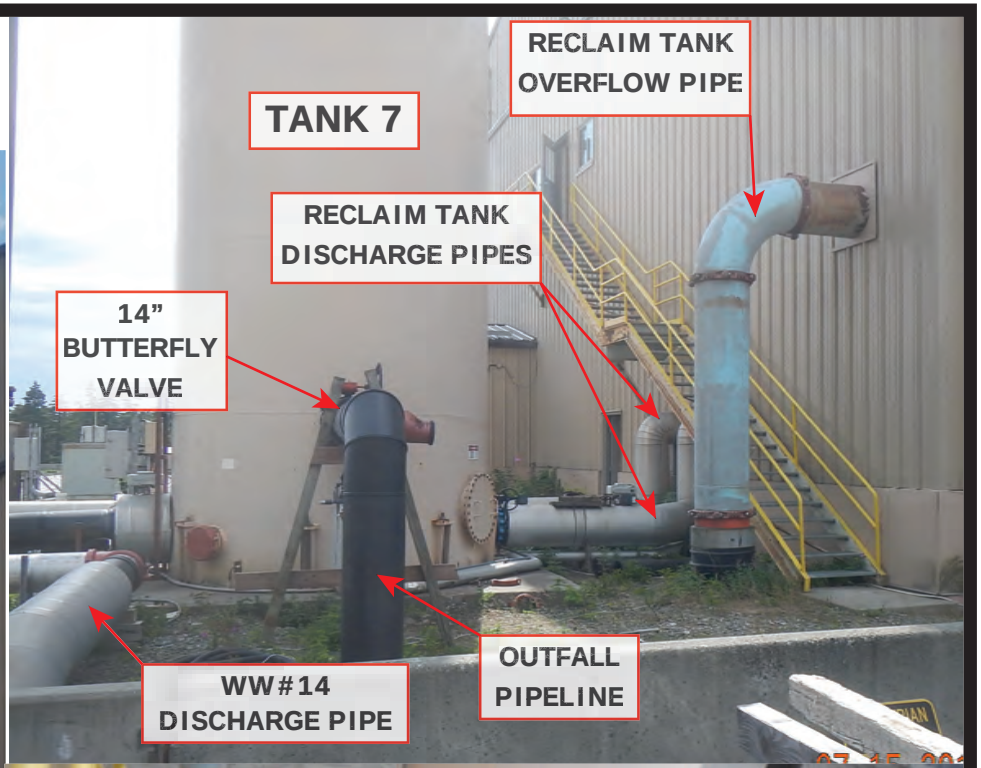


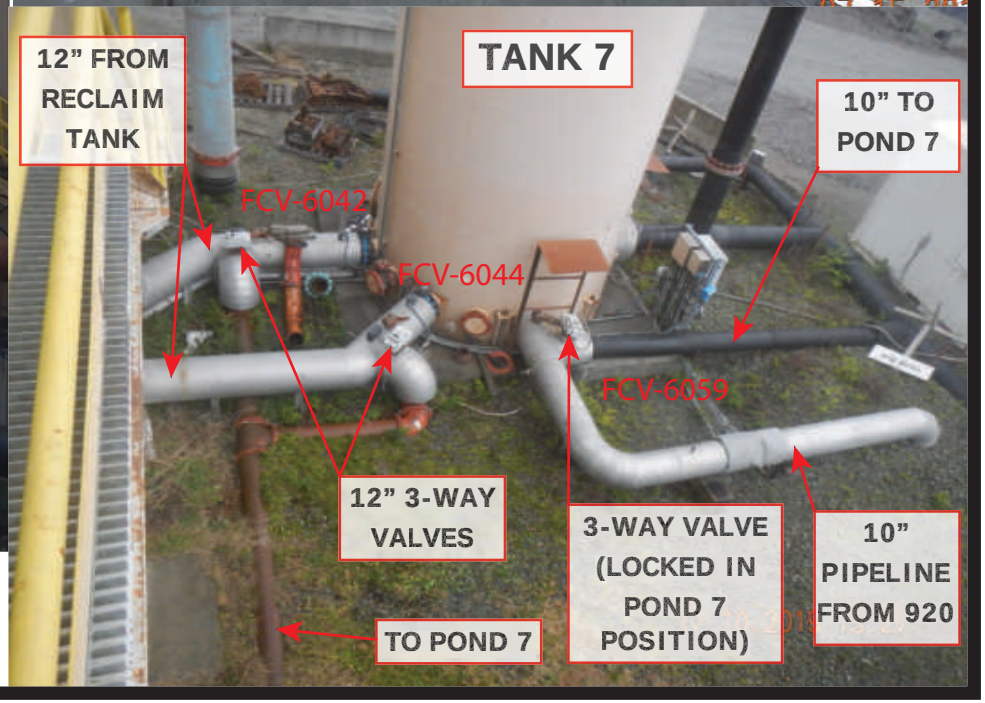
Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-8
WET WELL 14







Hecla MINING COMPANY

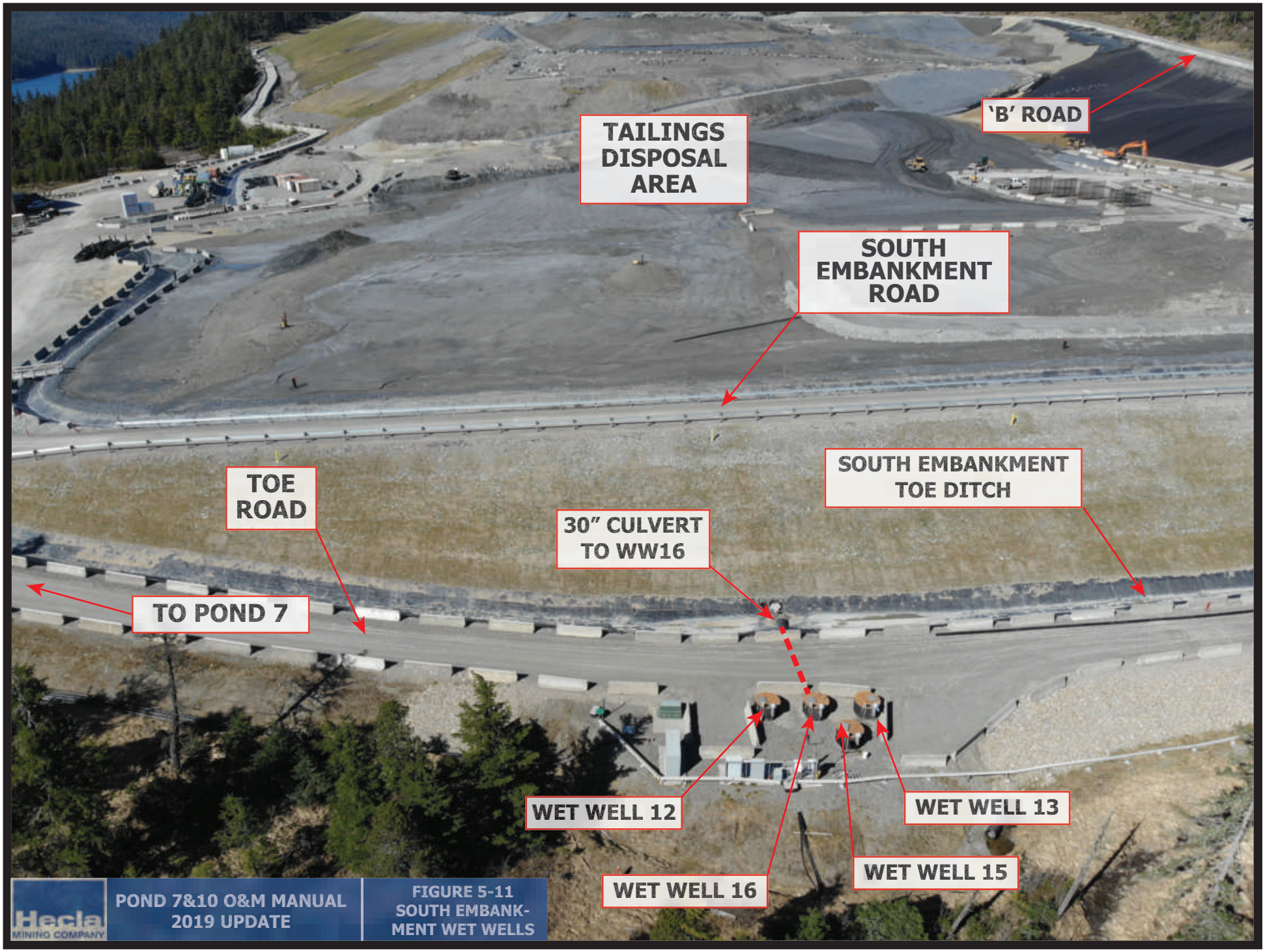
POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-9
TANK 7

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

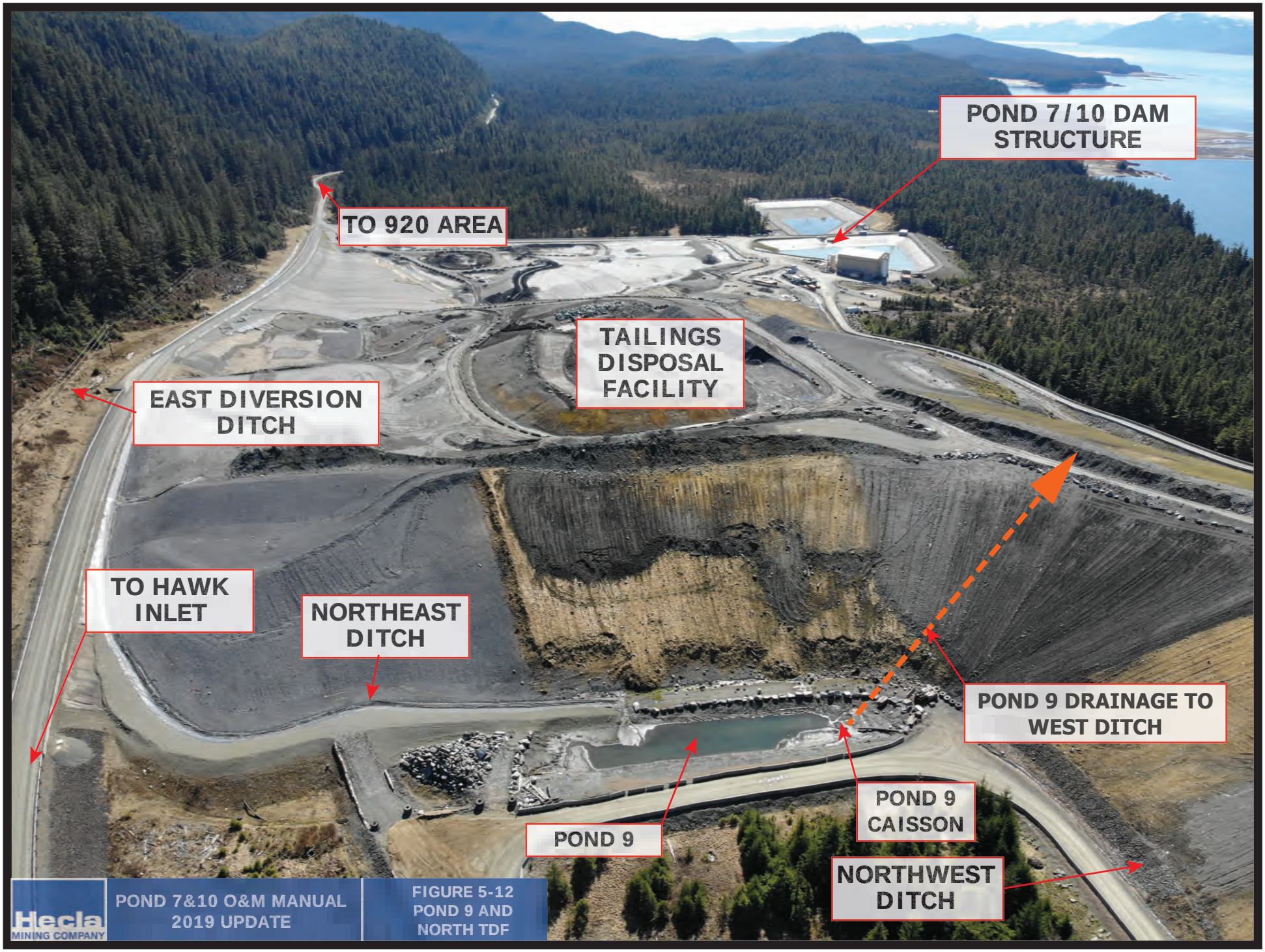
FIGURE 5-10
OUTFALL PIPELINE
FLOW METER



Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-11
SOUTH EMBANKMENT WET WELLS



Hecla MINING COMPANY

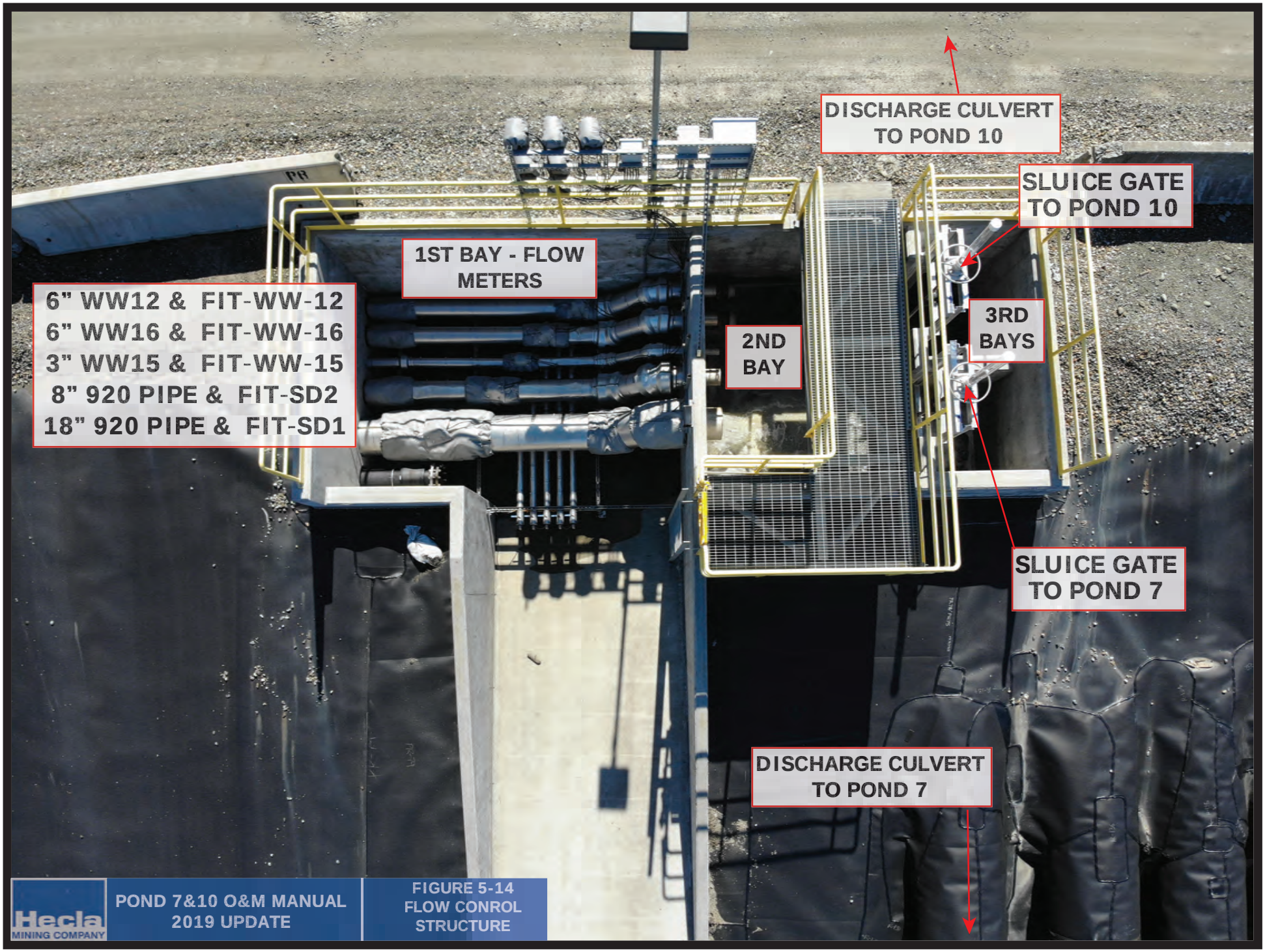
POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-12
POND 9 AND
NORTH TDF

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

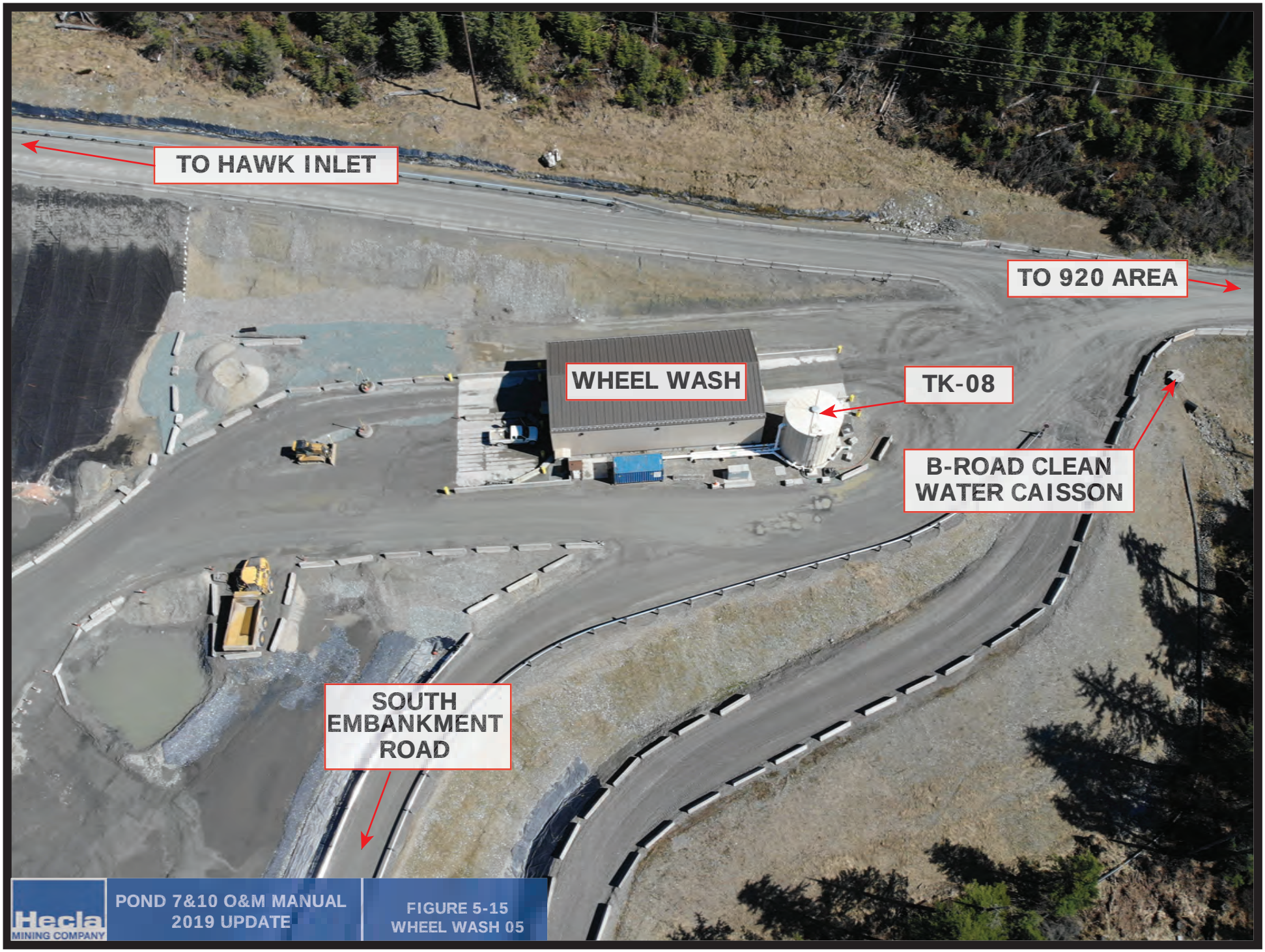
FIGURE 5-13
WET WELL #3



Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-14
FLOW CONROL STRUCTURE



Hecla MINING COMPANY

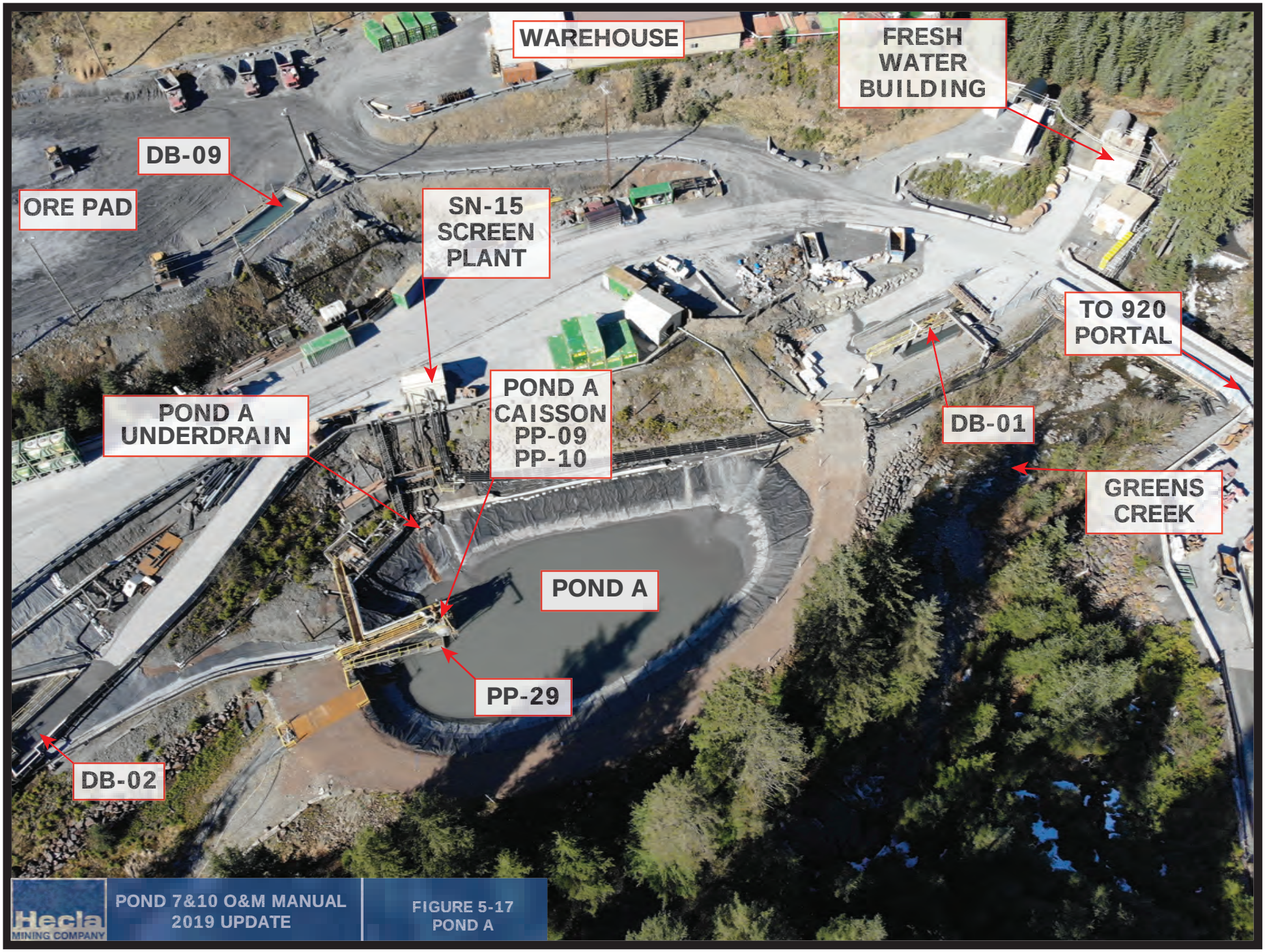
POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-15
WHEEL WASH 05

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

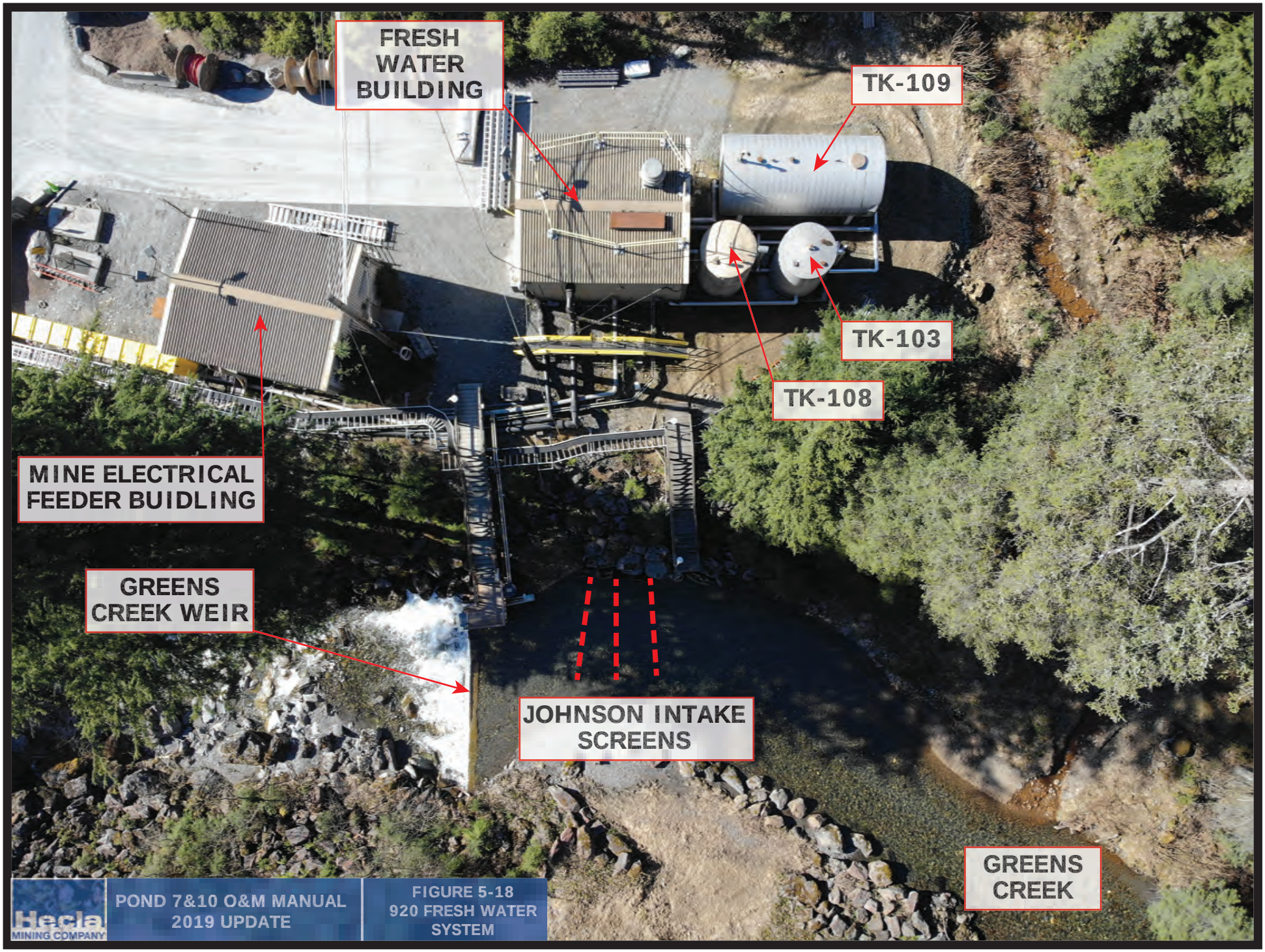
FIGURE 5-16
POND A



Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-17
POND A



Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-18
920 FRESH WATER SYSTEM

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-19
920 FRESH WATER BUILDING

Hecla MINING COMPANY

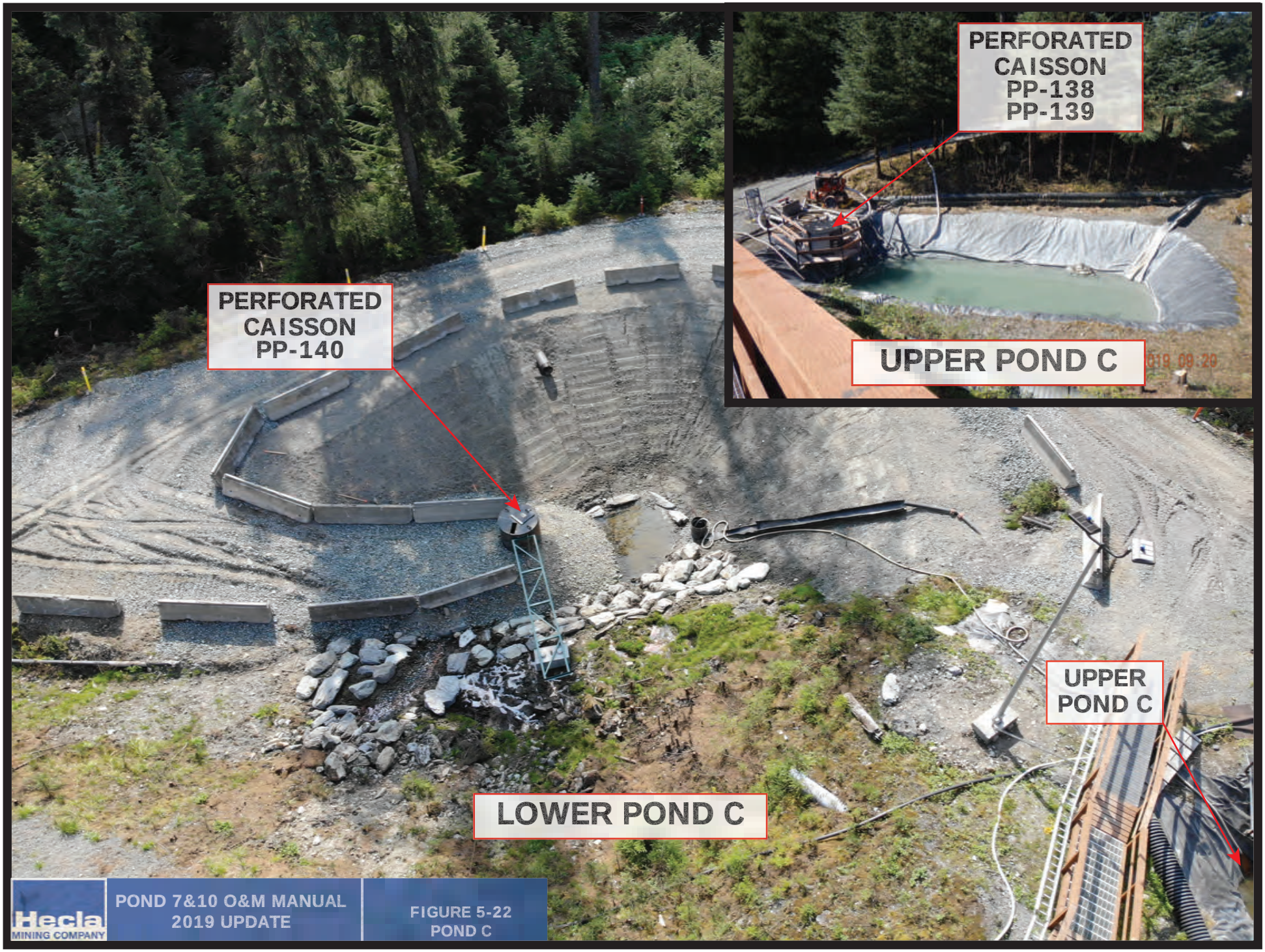
POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-20
1160 HEAD TANK

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-21
920 LINED DITCH



Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-22
POND C

Hecla MINING COMPANY

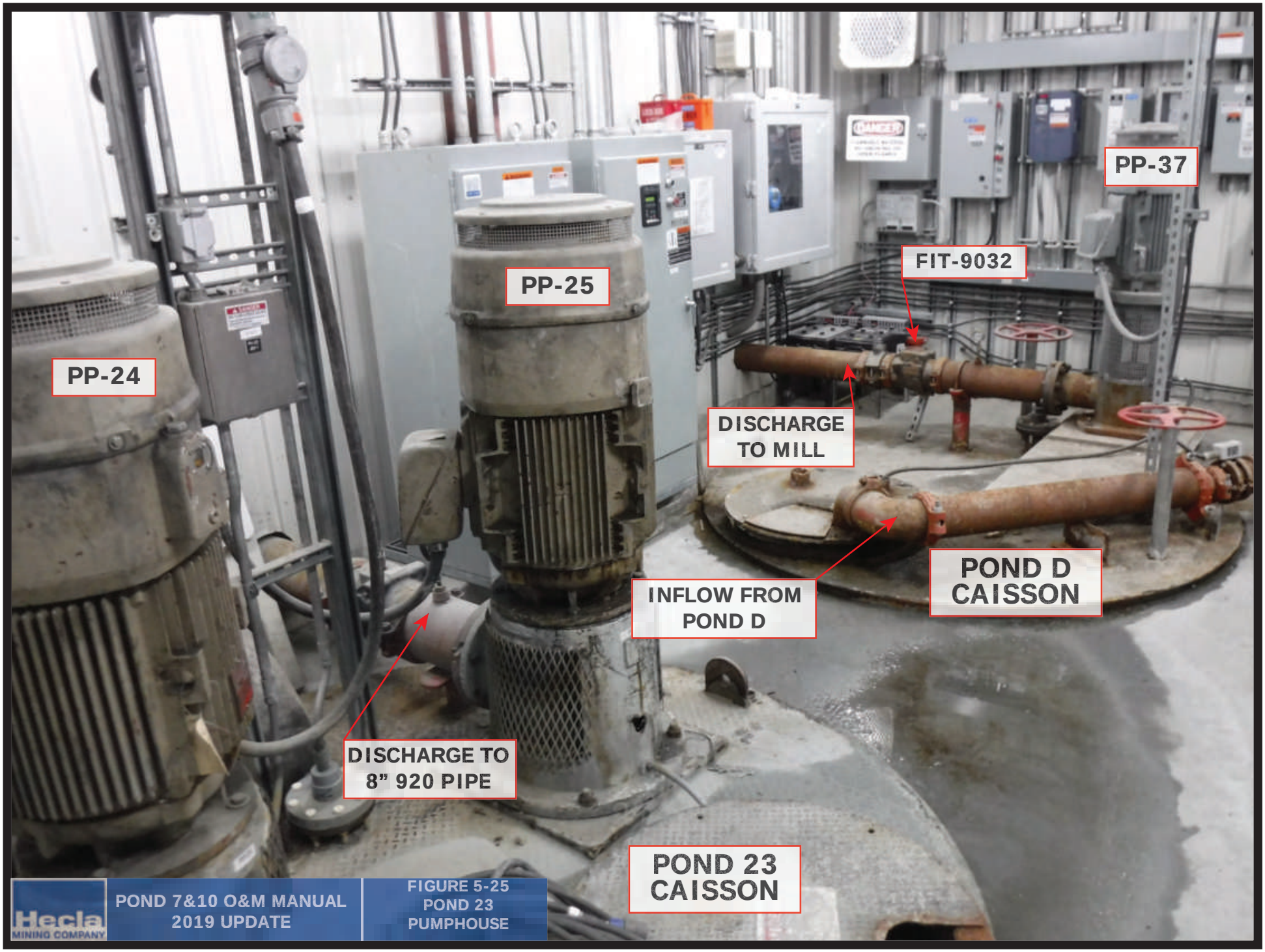
POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-23
SITE 23

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-24
POND 23



Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-25
POND 23
PUMPHOUSE

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-26
POND D

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-27
POND D CAISSON

Hecla MINING COMPANY

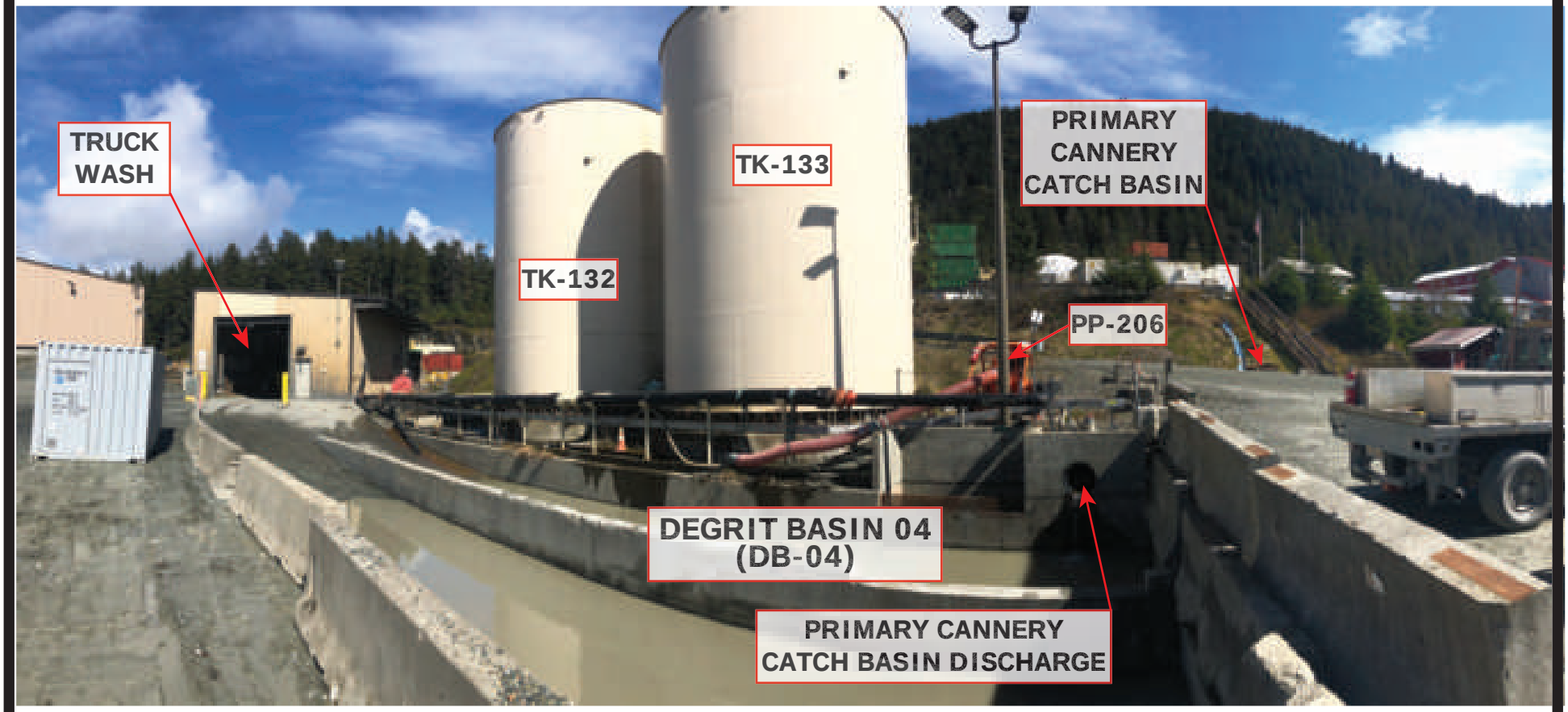
POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-28
920 PIPELINE VALVE
STATION

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-29
SITE E



Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-30
DEGRIT BASIN #04

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-31
DB-04
AERIAL

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POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-32
HAWK INLET TRUCK
WASH

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 3-33
HERMAN'S GULCH SUMP

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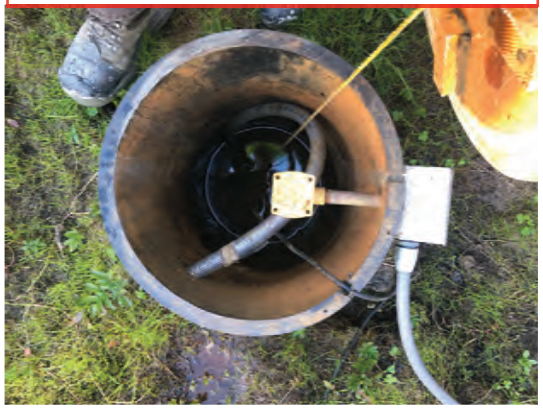
POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-34
CANNERY SUMPS
AERIAL

MAYOR'S OFFICE SUMP

SOUTH CANNERY SUMP



UTILADOR SUMP

SOUTH CANNERY DRY SUMP

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-35
Cannery Sumps

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-36
Cannery Boot Wash Sump

Hecla MINING COMPANY

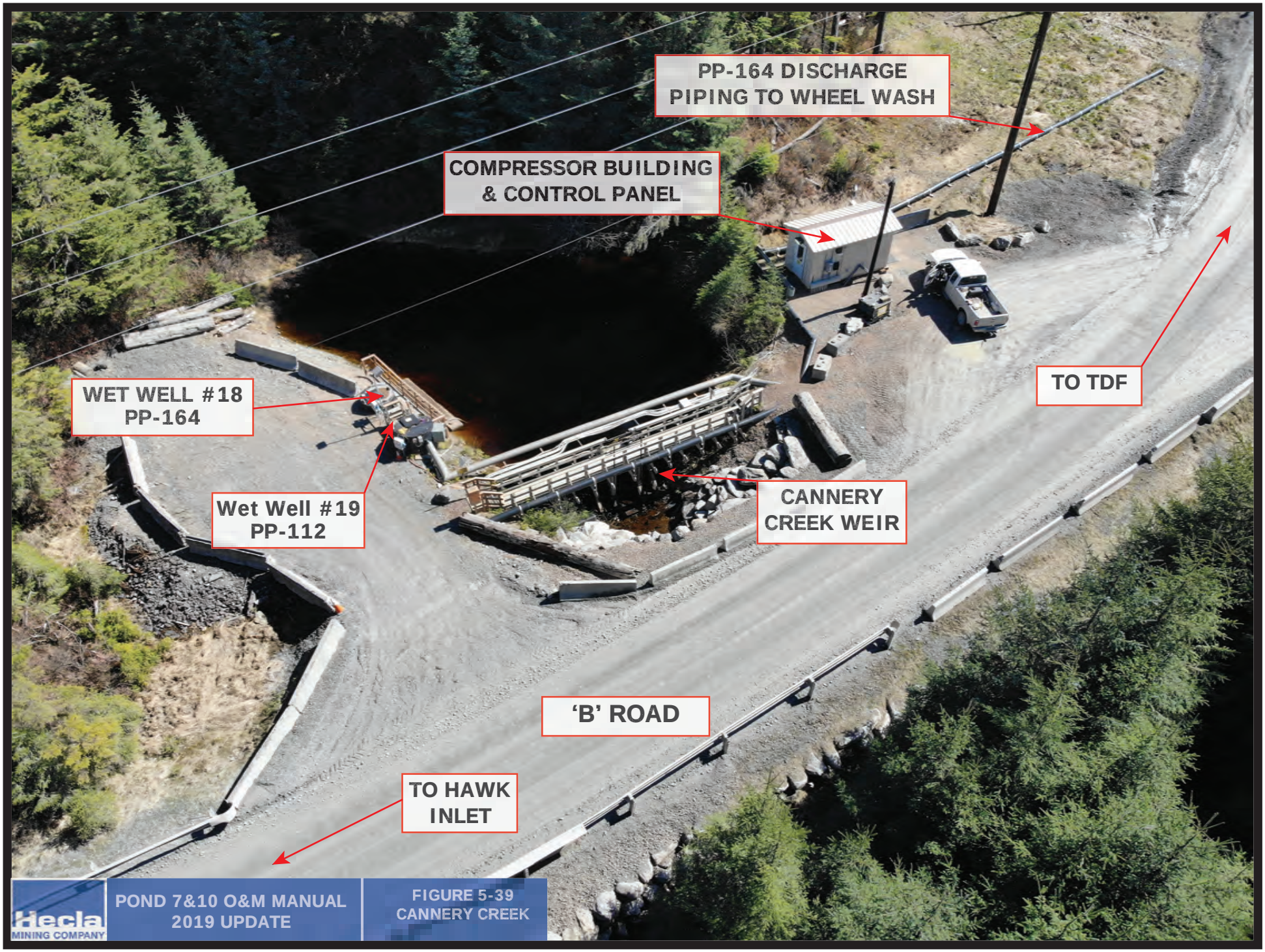
POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-37
HAWK INLET
SEWAGE TREATMENT

Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-38
HAWK INLET FRESH WATER SYSTEM



Hecla MINING COMPANY

POND 7&10 O&M MANUAL
2019 UPDATE

FIGURE 5-39
CANNERY CREEK

Appendix 6

Project Data Sheets

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

NID No. AK00307

A. GENERAL

Dam Name	Greens Creek Containment Pond 7	
NID Number	AK 00307	
Hazard Potential Class	Class II (Significant)	
Purpose	Off-channel water impoundment	
Year Built	2005	
Year Modified	2017	
Location	N58 6'50.4" W134 44'58.8"	lat/long (GPS)
Reservoir Name	Pond 7	
River or Creek Name	N/A (off channel)	
Owner	Hecla Greens Creek Mining Company	
Contact Name	Michael Butikofer	
Address	P.O. Box 32199	
City, State, Zip	Juneau, Alaska 99803-2199	
Phone	(907) 790-8471	
Email	mbutikofer@hecla-mining.com	

B. DAM

Type	Rockfill and earthfill	
Primary Seepage Control	HDPE-upstream lining	
Crest Length	700 total length	feet
Crest Width	Varies (min. 18 ft. to max. 24 ft.)	feet
Crest Elevation	El. 144 above mean sea level (amsl)	feet
Crest Height (from d/s toe)	38 (max.)	feet
Hydraulic Height at Normal Pool	130 (day of PSI site inspection)	feet

C. PRIMARY SPILLWAY

Type	Open pipes	
Location	FCS through south embankment crest	
Spillway Invert Elevation	137	feet
Top Width	5x 36 in diameter HDPE pipes	feet
Bottom Width	n/a	feet
Length	75	feet
Discharge Capacity at Dam Crest		
Elevation or Maximum Flood Pool	131 cfs at pond El. 139.9 ft	cubic feet/second (cfs)

D. EMERGENCY SPILLWAY

Type	Broad-crested concrete weir, discharges to cobble lined channel	
Location	North corner of Pond 7	
Spillway Invert Elevation	140	feet
Top Width	19	feet
Bottom Width	19	feet
Length	1 (weir crest)	feet
Discharge Capacity at Dam Crest		
Elevation or Maximum Flood Pool	135.4 cfs at pond El. 140.8 ft	cfs

Note: Assumes Pond 10 is present.

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET
(continued)

E. OUTLET WORKS

Type	Wet well, fed by 24-inch diameter pipe	
Location	Southwest corner of pond	
Inlet Invert Elevation	121	feet
Outlet Invert Elevation	115	feet
Diameter	20 in ID HDPE pipe	inches
Length	95	feet
Outlet Type	Collection caisson with pump (Flygt 3127.181) 2x70Hp	
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool	5.35 cfs (2400 gpm outfall discharge capacity)	cfs

F. RESERVOIR

Normal Storage Capacity at Spillway Invert Elevation	31.5	acre-feet
Surface Area at Spillway Invert Elevation	2.80	acres
Maximum Storage Capacity at Dam Crest or Maximum Flood Pool	34	acre-feet
Maximum Surface Area at Dam Crest or Maximum Flood Pool	2.9	acres

G. HYDROLOGY

Drainage Basin Area	86 acres direct; 107 indirect	sq. miles
Average Annual Precipitation	55.8	inches
100 Year/24 Hour Precipitation	6.28	inches
100 Year Flood	97.8	cfs
Probable Maximum Precipitation	n/a	inches
Probable Maximum Flood	n/a	cfs
Flood of Record	n/a	cfs
Inflow Design Flood	116.2	cfs

H. DATA REFERENCES
(use endnotes)

NID No. AK00316

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

A. GENERAL

Dam Name	Greens Creek Containment Pond 10	
NID Number	AK 00316	
Hazard Potential Class	Class II (Significant)	
Purpose	Off-channel water impoundment	
Year Built	2017	
Year Modified	N/A	
Location	N58 6'50.4" W134 44'58.8"	lat/long (GPS)
Reservoir Name	Pond 10	
River or Creek Name	N/A (off channel)	
Owner	Hecla Greens Creek Mining Company	
Contact Name	Michael Butikofer	
Address	P.O. Box 32199	
City, State, Zip	Juneau, Alaska 99803-2199	
Phone	(907) 790-8471	
Email	mbutikofer@hecla-mining.com	

B. DAM

Type	Earthfill	
Primary Seepage Control	HDPE-upstream lining	
Crest Length	535 total length	feet
Crest Width	Varies (min. 25 ft to max. 90 ft)	feet
Crest Elevation	El. 144 above mean sea level (amsl)	feet
Crest Height (from d/s toe)	35.2 (max.)	feet
Hydraulic Height at Normal Pool	Empty	feet

C. PRIMARY SPILLWAY

Type	Open pipes	
Location	FCS through south embankment crest	
Spillway Invert Elevation	137	feet
Top Width	5x 36 in diameter HDPE pipes	feet
Bottom Width	n/a	feet
Length	75	feet
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool	131 cfs at pond El. 139.9 ft	cubic feet/second (cfs)

D. EMERGENCY SPILLWAY

Type	Broad-crested concrete weir, discharges to cobble lined channel	
Location	North corner of Pond 7	
Spillway Invert Elevation	140	feet
Top Width	19	feet
Bottom Width	19	feet
Length	1 (weir crest)	feet
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool	135.4 cfs at pond El. 140.8 ft	cfs

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

(continued)

E. OUTLET WORKS

Type	Wet well, fed by 24-inch diameter pipe	
Location	Southwest corner of pond	
Inlet Invert Elevation	121	feet
Outlet Invert Elevation	115	feet
Diameter	20 in ID HDPE pipe	inches
Length		feet
Outlet Type	Collection caisson with pump (Flygt 3127.181) 2x70Hp	
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool	5.35 cfs (2400 gpm outfall discharge capacity)	cfs

F. RESERVOIR

Normal Storage Capacity at Spillway Invert Elevation	35.2	acre-feet
Surface Area at Spillway Invert Elevation	3.21	acres
Maximum Storage Capacity at Dam Crest or Maximum Flood Pool	48.93	acre-feet
Maximum Surface Area at Dam Crest or Maximum Flood Pool	3.64	acres

G. HYDROLOGY

Drainage Basin Area	86 acres direct; 107 indirect	sq. miles
Average Annual Precipitation	55.8	inches
100 Year/24 Hour Precipitation	6.28	inches
100 Year Flood	97.8	cfs
Probable Maximum Precipitation	n/a	inches
Probable Maximum Flood	n/a	cfs
Flood of Record	n/a	cfs
Inflow Design Flood	116.2	cfs

H. DATA REFERENCES

(use endnotes)

NID No. None

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

A. GENERAL

Dam Name	Greens Creek Containment Pond A	
NID Number	None	
Hazard Potential Class	Class II (Significant)	
Purpose	Off-channel water impoundment	
Year Built	1986	
Year Modified	2014	
Location	58.0826 N, 134.6245 W	lat/long (GPS)
Reservoir Name	Pond A	
River or Creek Name	N/A (off channel)	
Owner	Hecla Greens Creek Mining Company	
Contact Name	Michael Butikofer	
Address	P.O. Box 32199	
City, State, Zip	Juneau, Alaska 99803-2199	
Phone	(907) 790-8471	
Email	mbutikofer@hecla-mining.com	

B. DAM

Type	Rockfill and earthfill	
Primary Seepage Control	HDPE-upstream lining	
Crest Length	380	feet
Crest Width	20	feet
Crest Elevation	908.0	feet
Crest Height (from d/s toe)	18	feet
Hydraulic Height at Normal Pool	7.7 (Normal elevation 899.7)	feet

C. PRIMARY SPILLWAY

Type	None	
Location		
Spillway Invert Elevation		feet
Top Width		
Bottom Width		feet
Length		
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool		cubic feet/second (cfs)

D. EMERGENCY SPILLWAY

Type	HDPE Lined	
Location	West End of Pond	
Spillway Invert Elevation	906.1	feet
Top Width	8.2	
Bottom Width	8.2	feet
Length	36	feet
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool		cfs

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

NID No. None

(continued)

E. OUTLET WORKS

Type	Wet well,	
Location	West end of pond	
Inlet Invert Elevation	896.3	feet
Outlet Invert Elevation	N/A	feet
Diameter	1 8	inches
Length	N/A	feet
Outlet Type	Wet Well and pumping system	
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool	3.34	cfs

F. RESERVOIR

Normal Storage Capacity at Spillway Invert Elevation	3.66	acre-feet
Surface Area at Spillway Invert Elevation	0.43	acres
Maximum Storage Capacity at Dam Crest or Maximum Flood Pool		acre-feet
Maximum Surface Area at Dam Crest or Maximum Flood Pool		acres

G. HYDROLOGY

Drainage Basin Area	19.1 acres	sq. miles
Average Annual Precipitation	69.01	inches
100 Year/24 Hour Precipitation	9.6	inches
100 Year Flood	22.1	cfs
Probable Maximum Precipitation	n/a	inches
Probable Maximum Flood	n/a	cfs
Flood of Record	n/a	cfs
Inflow Design Flood	16.8 (25-yr, 24-hr)	cfs

H. DATA REFERENCES

(use endnotes)

NID No. None

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

A. GENERAL

Dam Name	Greens Creek Containment Pond C	
NID Number	None	
Hazard Potential Class	Class II (Significant)	
Purpose	Off-channel water impoundment	
Year Built	1987	
Year Modified	2018	
Location	58.0810 N, 134.6415 W	lat/long (GPS)
Reservoir Name	Pond C	
River or Creek Name	N/A (off channel)	
Owner	Hecla Greens Creek Mining Company	
Contact Name	Michael Butikofer	
Address	P.O. Box 32199	
City, State, Zip	Juneau, Alaska 99803-2199	
Phone	(907) 790-8471	
Email	mbutikofer@hecla-mining.com	

B. DAM

Type	Rockfill and earthfill	
Primary Seepage Control	HDPE-upstream lining	
Crest Length	180	feet
Crest Width	15	feet
Crest Elevation	866	feet
Crest Height (from d/s toe)	8	feet
Hydraulic Height at Normal Pool	0	feet

C. PRIMARY SPILLWAY

Type	None	
Location		
Spillway Invert Elevation		feet
Top Width		
Bottom Width		feet
Length		
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool		cubic feet/second (cfs)

D. EMERGENCY SPILLWAY

Type	18-inch Culvert	
Location	South East side	
Spillway Invert Elevation	864.2	feet
Top Width	N/A	
Bottom Width	N/A	feet
Length	37.6	feet
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool	25	cfs

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

(continued)

E. OUTLET WORKS

Type	Wet well,	
Location	North Side of Pond	
Inlet Invert Elevation	853.2	feet
Outlet Invert Elevation	N/A	feet
Diameter	N/A	
Length	N/A	feet
Outlet Type	Wet Well and pumping system	
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool	1.0 (pumped)	cfs

F. RESERVOIR

Normal Storage Capacity at Spillway Invert Elevation	0.29	acre-feet
Surface Area at Spillway Invert Elevation	0.14	acres
Maximum Storage Capacity at Dam Crest or Maximum Flood Pool		acre-feet
Maximum Surface Area at Dam Crest or Maximum Flood Pool		acres

G. HYDROLOGY

Drainage Basin Area	2.9 acres	sq. miles
Average Annual Precipitation	65.01	inches
100 Year/24 Hour Precipitation	9.6	inches
100 Year Flood	3.0	cfs
Probable Maximum Precipitation	N/A	inches
Probable Maximum Flood	N/A	cfs
Flood of Record	N/A	cfs
Inflow Design Flood	2.4 (25-yr, 24-hr)	cfs

H. DATA REFERENCES

(use endnotes)

NID No. None

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

A. GENERAL

Dam Name	Greens Creek Containment Pond D	
NID Number	None	
Hazard Potential Class	Class II (Significant)	
Purpose	Off-channel water impoundment	
Year Built	1987	
Year Modified	2009	
Location	58.0788 N, 134.6463 W	lat/long (GPS)
Reservoir Name	Pond D	
River or Creek Name	N/A (off channel)	
Owner	Hecla Greens Creek Mining Company	
Contact Name	Michael Butikofer	
Address	P.O. Box 32199	
City, State, Zip	Juneau, Alaska 99803-2199	
Phone	(907) 790-8471	
Email	mbutikofer@hecla-mining.com	

B. DAM

Type	Rockfill and earthfill	
Primary Seepage Control	None	
Crest Length	435	feet
Crest Width	14	feet
Crest Elevation	818	feet
Crest Height	(from d/s toe) 8	feet
Hydraulic Height	at Normal Pool 5	feet

C. PRIMARY SPILLWAY

Type	None	
Location		
Spillway Invert Elevation		feet
Top Width		
Bottom Width		feet
Length		
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool		cubic feet/second (cfs)

D. EMERGENCY SPILLWAY

Type	18-inch Culvert	
Location	West end of pond near wet well	
Spillway Invert Elevation	816.6	feet
Top Width	N/A	
Bottom Width	N/A	feet
Length	33	feet
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool	15	cfs

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

NID No. None

(continued)

E. OUTLET WORKS

Type	Wet well,	
Location	West end of pond	
Inlet Invert Elevation	812	feet
Outlet Invert Elevation	N/A	feet
Diameter	N/A	
Length	N/A	feet
Outlet Type	Wet Well and pumping system	
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool	5.12	cfs

F. RESERVOIR

Normal Storage Capacity at Spillway Invert Elevation	0.58	acre-feet
Surface Area at Spillway Invert Elevation	0.34	acres
Maximum Storage Capacity at Dam Crest or Maximum Flood Pool		acre-feet
Maximum Surface Area at Dam Crest or Maximum Flood Pool		acres

G. HYDROLOGY

Drainage Basin Area	7.5 acres	sq. miles
Average Annual Precipitation	65.01	inches
100 Year/24 Hour Precipitation	9.6	inches
100 Year Flood	7.5	cfs
Probable Maximum Precipitation	N/A	inches
Probable Maximum Flood	N/A	cfs
Flood of Record	N/A	cfs
Inflow Design Flood	5.4 (25-yr, 24-hr)	cfs

H. DATA REFERENCES

(use endnotes)

NID No. None

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

A. GENERAL

Dam Name	Greens Creek Containment Pond 23	
NID Number	None	
Hazard Potential Class	Class II (Significant)	
Purpose	Off-channel water impoundment	
Year Built	1995	
Year Modified	2016	
Location	58.0796 N, 134.6482 W	lat/long (GPS)
Reservoir Name	Pond 23	
River or Creek Name	N/A (off channel)	
Owner	Hecla Greens Creek Mining Company	
Contact Name	Michael Butikofer	
Address	P.O. Box 32199	
City, State, Zip	Juneau, Alaska 99803-2199	
Phone	(907) 790-8471	
Email	mbutikofer@hecla-mining.com	

B. DAM

Type	Rockfill and earthfill	
Primary Seepage Control	HDPE Liner	
Crest Length	1000	feet
Crest Width	50	
Crest Elevation	892	feet
Crest Height (from d/s toe)	45 (15 feet u/s)	feet
Hydraulic Height at Normal Pool	6.0	feet

C. PRIMARY SPILLWAY

Type	None	
Location		
Spillway Invert Elevation		feet
Top Width		
Bottom Width		feet
Length		
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool		cubic feet/second (cfs)

D. EMERGENCY SPILLWAY

Type	(2) 6-inch HDPE Culverts	
Location	West end of Pond	
Spillway Invert Elevation	891.5	feet
Top Width	N/A	
Bottom Width	N/A	feet
Length	24.3	feet
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool	7.45	cfs

ALASKA DAM SAFETY PROGRAM
PROJECT DATA SHEET

NID No. None

(continued)

E. OUTLET WORKS

Type	Wet well,	
Location	West End of the Pond	
Inlet Invert Elevation	877.0	feet
Outlet Invert Elevation	N/A	feet
Diameter	N/A	
Length	N/A	feet
Outlet Type	Wet Well and pumping system	
Discharge Capacity at Dam Crest Elevation or Maximum Flood Pool:	15.15	cfs

F. RESERVOIR

Normal Storage Capacity at Spillway Invert Elevation	4.50	acre-feet
Surface Area at Spillway Invert Elevation	0.63	acres
Maximum Storage Capacity at Dam Crest or Maximum Flood Pool		acre-feet
Maximum Surface Area at Dam Crest or Maximum Flood Pool		acres

G. HYDROLOGY

Drainage Basin Area	63.3 Acres	sq. miles
Average Annual Precipitation	65.01	inches
100 Year/24 Hour Precipitation	9.6	inches
100 Year Flood	58	cfs
Probable Maximum Precipitation	n/a	inches
Probable Maximum Flood	n/a	cfs
Flood of Record	n/a	cfs
Inflow Design Flood	42.4 (25-yr, 24-hr)	cfs

H. DATA REFERENCES

(use endnotes)

General Plan of Operations
Appendix 11
Waste Rock Management Plan

April 2019

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Attachments

Attachment A - Waste Rock Management Standard Operating Procedure

Attachment B - Waste Rock Management Plan Figures

Attachment C - Waste Rock Management Plan Inspection Form

Acronyms

AAC	Alaska Administrative Code
ABA	Acid-Base Accounting
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
APDES	Alaska Pollutant Discharge Elimination System
ARD	acid rock drainage
EA	Environmental Assessment
FEIS	Final Environmental Impact Statement
GPO	General Plan of Operations
HGCMC	Hecla Greens Creek Mining Company
KGCMC	Kennecott Greens Creek Mining Company
IMP	Integrated Monitoring Plan
KCB	Klohn Crippen Berger, Ltd.
MSHA	Mine Safety and Health Administration
NEPA	National Environmental Policy Act
NNP	Net Neutralization Potential
QA	quality assurance
QC	quality control
SOP	Standard Operating Procedure
TDF	Tailings Disposal Facility
USDA	United States Department of Agriculture
USFS	United States Forest Service
WMP	Waste Management Permit

1. INTRODUCTION

Operation of the Greens Creek Mine is carried out by Hecla Greens Creek Mining Company (HGCMC) in accordance with the General Plan of Operations (GPO) approved by the United States Forest Service (USFS), hereafter referred to as the Forest Service. The GPO describes the management activities which are conducted at Greens Creek Mine, the location and timing of those activities, and how the environment and resources in the area are protected through compliance with federal and state requirements. This document, GPO Appendix 11 Waste Rock Management, defines management objectives and provides general information on the background, operations, maintenance, and monitoring for Greens Creek Mine waste rock sites.

Table 1. Record of Changes and Amendments

Date	Section(s) Changed or Amended
August 2000	Submittal by Kennecott Greens Creek Mining Company
February 2014	Submittal by Hecla Greens Creek Mining Company. Revisions associated with specifying separate operating procedures for active and inactive waste sites, including waste rock removal efforts, and incorporation of ADEC solid waste permit requirements (2003 and 2008). Also updated for stability monitoring requirements associated with active waste rock disposal site, Site 23.
November 2014	Submittal by Hecla Greens Creek Mining Company. Revisions to incorporate reference to ADEC Waste Management Permit 2014DB0003, issued August 11, 2014.
April 2019	Reviewed plan prior to submittal to the ADEC as part of the Waste Management Permit renewal.

Certain areas of the mine's operation are also subject to federal and state permits and approvals issued by other federal and state agencies. State of Alaska Department of Environmental Conservation (ADEC) regulates mill tailings and waste rock disposal facilities at the Greens Creek mine as well as other aspects of the operation primarily through Title 18 of the Alaska Administrative Code (AAC), Chapters 50, 60, 70, 72 and 80. The Waste Management Permit, issued by the ADEC, authorizes tailings and waste rock disposal and prescribes monitoring, reporting, closure, post-closure and financial responsibility requirements. The Forest Service has issued special use permits and leases for various aspects of the operations.

Closure requirements for the Greens Creek Mine, including temporary and permanent closure, are described in more detail in GPO Appendix 14. The Alaska Department of Natural Resources (ADNR) is the lead state agency (Alaska Statute 27.05.010) and regulates the reclamation, by issuing the Reclamation Plan approval for the entire site, including the tailings and waste rock disposal sites Title 11 AAC 97.310. The Forest Service also sets requirements for reclamation. Permits and authorizations are further discussed in Section 2.1.

Management objectives associated with waste rock sites consider acid rock drainage (ARD) and metals leaching, which can potentially create adverse environmental conditions. These risks are evaluated with respect to local hydrology, climate and geochemistry to ensure the employment of practices best matched to site-specific conditions while providing the operational flexibility to incorporate systems improvement. Specific aspects of the practices used to achieve management objectives outlined in this document are presented in the standard operating procedure (SOP) for waste rock provided in Attachment A. The SOP format allows flexibility for regular updates as site conditions and needs change. Modifications to the SOP are summarized in the annual report. This appendix is updated through coordination with the USFS, the ADEC, and the ADNR. If there is a conflict between the terms established in the GPO, applicable regulations, or the WMP, then the terms with the most recent written approval from the ADEC, the USFS, and the ADNR govern.

2. BACKGROUND

This section summarizes permits and authorizations, waste rock characterization and weathering characteristics, and active and inactive waste rock sites. The understanding of the Greens Creek Mine waste rock geochemistry and potential influences on water quality has developed over the life of the project.

2.1. Permits and Authorizations

The Forest Service and the ADEC regulate waste rock placement, monitoring, and reclamation. The ADNR Mining Section also regulates the reclamation and closure of the waste rock facilities. For a complete summary of federal, state, and local agencies involved in the permitting approval processes for Greens Creek Mine, refer to the 2013 Final Environmental Impact Statement (FEIS) (USFS 2013).

Regulatory references pertaining to site-specific waste rock management are included in the 1983 FEIS (USFS 1983), 1988 Environmental Assessment (EA) for *Proposed Changes to the General Plan of Operation for the Development and Operation of the Greens Creek Mine*. (USFS 1988), and 1992 *EA for Additional Waste Rock Disposal Capacity at Greens Creek Mine* (USFS 1992).

The 1992 EA Decision Notice approved the use of ten acres in addition to the 43 acres approved by the 1983 FEIS Record of Decision for waste rock disposal. The Decision Notice incorporates all aspects of the operations and maintenance, required improvements, mitigation, monitoring, and reclamation components identified in the Components Common to all Alternatives section of the EA.

The EA concluded that the potential for short or long-term generation of acid drainage from waste rock was small and required an ongoing assessment of field conditions to verify these conclusions from laboratory studies. The EA Decision Notice required that mitigation measures defined from the ongoing assessment be incorporated into the General Plan of Operations, if necessary. Subsequent findings during these assessments indicate that there is a potential for acid rock drainage development and/or metal(oid)s leaching from Greens Creek waste rock.

Mining wastes are categorically exempt from regulation under the ADEC Solid Waste Program unless they pose a potential "welfare threat or environmental problem associated with the management of the waste". The ADEC made the determination that waste rock placed in Site 23, the only active production waste rock site at Greens Creek Mine, is subject to Chapter 60 solid waste requirements, which include the need to acquire a permit. Mining waste is regulated under the monofill standards 18 AAC 60.455

which allows the department discretion to incorporate applicable provisions of 18 AAC 60 into the waste management permit. Waste Management Permit (WMP #0211-BA001) was issued to Kennecott Greens Creek Mining Company in November 2003 (ADEC 2003). Refer to GPO 3 for further discussion of ADEC WMP requirements associated with waste disposal sites.

In 2004, correspondence between the ADEC and KGCMC, ADEC and the Forest Service authorized modification to WMP #0211-BA001 and GPO Appendix 11 for Site 23 waste rock placement methodology and changes to final cover design. Modification to the Site 23 placement design was with regards to details of the rock type (no longer segregating class 2 and class 3 waste rock) and shell thickness. The Waste Rock Management SOP provided in Attachment A incorporates these modifications.

There were further permit modifications approved for Site 23 in 2008 (ADEC 2008) to include authorized construction of a temporary lined storage pad at Site 23 to be used for interim waste storage (waste rock relocation) from inactive waste rock sites pending transport to underground (ADEC 2008). This interim facility was removed after all the waste rock was moved into the underground.

In 2009, the *Site E Removal and Waste Rock\ Tailings Co-Disposal Plan* (HGCMC 2009) was approved by agencies for co-disposal of waste rock at the TDF. Co-disposal refers to the placement of a mixture of waste rock and tailings. The primary purpose of co-disposal is to reduce pyrite oxidation and metal leaching from waste rock by surrounding it with a matrix of fine-grained material (tailings). The geotechnical, geochemical and operational aspects of co-disposal have been studied, and the results demonstrate that co-disposal of waste rock and tailings will significantly improve the drainage quality at uncontained inactive waste rock sites by relocating this material to the TDF, without negatively impacting tailings drainage compositions, and can be done in a manner that minimizes effects on the environment.

Procedures for waste rock co-disposal with tailings at the tailings disposal facility (TDF) are also included in the SOP provided in Attachment A.

The Waste Management Permit (WMP #2014DB0003) issued to Hecla Greens Creek Mining Company was renewed in August 2014. The renewed permit incorporates the previous permit revisions approved in 2004, 2008 and 2009.

2.2. Waste Rock Characterization

The geochemical characterization programs for the Greens Creek Mine waste rock are well established. Classification and segregation of waste rock provides the basis for ongoing management at active and inactive sites. Waste rock at Greens Creek has two general conditions; fresh waste rock from the mine and weathered waste rock from inactive waste rock sites.

The objective of waste rock characterization is to define the materials and determine how they behave under weathering conditions. Limiting metal(oid)s mobility and the potential for development of acid rock drainage are primary objectives.

Waste rock from the mine generally consists of two varieties, argillite and phyllite. Argillite consists primarily of near-equal amounts of quartz and dolomite with minor pyrite and graphite, which gives it a dark grey to black color. Argillite exhibits both slatey and massive textures, with the slatey variety having concentrations of pyrite and graphite along slatey cleavage planes. Argillite is not acid generating but does pose a metal(oid)s and sulfate leaching risk despite producing neutral to alkaline drainage.

Phyllite consists primarily of quartz, sericite, dolomite, pyrite and chlorite. Sericite and chlorite give phyllites their grey and green coloration, respectively. The carbonate content in phyllite is lower than argillite (typically 10 to 20 wt% versus 30 to 50 wt% for argillite) and pyrite content is typically higher. Phyllites are well-foliated and pyrite often occurs along foliation planes, making it readily available to exposure as the rock weathers. Most of the phyllite produced by the mine is potentially acid generating and poses a metal(oid)s and sulfate leaching risk.

Further description of the mineralogy and weathering characteristics of Greens Creek Mine rock types are provided in several assessment reports (Vos 1993, Vos 1994, KGCMC 1995, SMI 2000) and annual reports from 1995 to present.

2.3. Weathering Characteristics and Acid Rock Drainage

Several variables, including pH, control the solubility (stability) of minerals under weathering conditions. In general, minerals are more soluble under acidic (low pH) conditions. As a result, drainage from acidic environments tends to carry a considerably larger dissolved load than drainage from neutral to alkaline environments. However, some metals, such as zinc, may be released under neutral pH conditions. Some sulfide minerals, predominantly pyrite (FeS_2), react with oxygen and water in the weathering environment to produce sulfuric acid. If the acid is not neutralized by dissolution of neutralizing minerals within the rock, acid rock drainage (ARD) can result.

Because of its acidity, ARD is able to dissolve minerals with which it is in contact. Although this tends to neutralize the acidity, it also depletes the rock of neutralizing potential and liberates dissolved metals.

The relative amounts of oxygen, water and pyrite that can chemically interact dictate the rate and volume of ARD production. ARD unchecked may increase exponentially. Therefore, limiting the supply of any one of these variables will help to decrease the severity of ARD.

Given the above considerations, it is clear that interaction between many complex variables influences water quality associated with waste rock removal and storage. Knowledge of the dynamics is important to meet water quality objectives. Timely evaluation of significant variables at existing locations is necessary for effective planning and action.

Static tests (acid-base accounting [ABA]) and past kinetic tests (column or humidity cells) allow identification of the potential for acid generation and determination of how materials behave under controlled weathering conditions. These tests are then used in conjunction with physical and mineralogical characterization to determine best management practices for waste rock disposal.

In 1994 GCMC drilled and sampled several inactive waste rock sites to better define site specific material composition and weathering characteristics (KGCMC 1994). The results indicate a moderate net acid generation potential of surface materials sampled. Distribution of potentially acid generating material was not homogeneous and there was a considerable range in net neutralization potential (NNP) values for each site. Local waste rock acidification was encountered in areas where significant surface water infiltration into potentially acid generating material had occurred. The amount of readily soluble metals in surface samples was determined via shake flask extraction tests. The results indicated that samples that had undergone acidification produce metals, sulfate, and acidity significantly higher than samples that have not undergone acidification.

Monitoring of Site 23 and older, inactive waste rock sites can be viewed as simplified field kinetic tests. Results of drainage monitoring and visual observations during removal of several inactive sites

supports the findings of the laboratory test work. The historic piles were comprised of a mixture of rock types, and highly pyritic phyllite placed near the surface had begun to locally generate acidic drainage (15-20 years of exposure). Most of the waste rock below a depth of five feet retains its grey/green color and has not depleted its available carbonate. Drainage from the larger, historic piles and Site 23 remains near neutral and produces sulfate, zinc and other metals at elevated levels. Lower sulfide contents and smaller surface areas yield a lower flux of oxidation products from quarries compared to waste rock sites. Refer to annual reports for a summary of the latest monitoring and interpretations for the sites.

Characterization of Greens Creek Mine argillite and phyllite using ABA and other field observations indicate that argillite is clearly not acid generating and that most samples of phyllite are potentially acid generating. Due to these characteristics, management objectives have been established for management of waste rock materials and monitoring and control of water quality effluent from waste rock disposal sites.

Specific assessment of material weathering characteristics, classification of acid generating and/or neutralization potential of waste rock, and test methods and sampling frequency are discussed in GPO Appendix 1, Integrated Monitoring Plan (IMP).

2.4. Active and Inactive Waste Rock Sites

HGCMC currently operates one active production waste rock site, identified as Site 23. The rest of the waste rock sites used in the past are termed inactive, used to refer to not receiving further waste rock from on-going mine production. Table 2 summarizes inactive production waste rock sites and a borrow area associated with Greens Creek Mine (refer to Attachment B). The borrow area is because it has been utilized as a storage sites for waste rock materials.

Table 2. Inactive Waste Rock Areas and Borrow Areas

Site	Description
Site E (4.7 B-road)	Site E is located at mile marker 4.6 along the B Road, about halfway between the port facility and the mine service area. Waste placement began during 1988 and continued through 1994. During placement activities a total of approximately 365,000 cubic yards of material were placed over an area of about 9 acres. Concurrent reclamation to relocate this material to the TDF initiated in 2009 and is on-going. Removal activity from Site E slowed while the TDF was being expanded. This is an estimated 220,000 cubic yards of waste rock needing to be reclaimed.
Site D (8.0 B-road)	Waste rock Disposal Site D is located downslope from the B Road between mile markers 8.0 and 8.2. Site D was approved for active waste rock placement during 1987. Waste placement, on an intermittent basis, began during October of 1987 and continued through 1989. During placement activities a total of 300,000 cubic yards of material were placed over approximately 7 acres.
Site C/920 Area	Waste rock and fill were placed in the 920 portal, mill site, and Site C from 1987 to 1989 as part of mine site construction. During mill development, a large amount of clayey till was removed for geotechnical reasons and was placed in the lower portion of Site E (prior to waste rock placement at that site), with a smaller amount placed in Site D. Approximately 48.500 cubic yards of waste rock and fill have been placed in Site C over a combined area of 2 acres. Some of this waste rock was relocated to Site 23 initially in 2006 and more recently in 2011 as part of storm water management pond modifications.
960 Area	A small quantity of waste rock from the 920 portal was placed along the 1350 access road just uphill from the portal. Approximately 10,000 cubic yards of rock have been placed in the 960, which covers about 1 acre. A majority of this waste rock (excluding 1350 access road prism/subgrade) was removed as part of concurrent reclamation activities in 2005.
Site 1350	Site 1350 is located approximately 1.5 road miles above the main (920) mine entrance. Waste was placed intermittently between 1978 and 1985. Approximately 100,000 cubic yards were placed over an area of 5 acres. Concurrent reclamation removal activities initiated in 2005 and are periodically on-going. Waste rock was relocated to the Site 23 temporary storage pad for pending eventual transport to underground. Most of the waste rock has been removed from Site 1350, an estimated 9,000-10,000 cubic yards remains near the 1350 Portal. This material will be removed during final reclamation of the mine site.
Pit 405 (7.6 B-road)	Borrow area located on the B road near Site 23. This former borrow area has been backfilled with waste rock and the upper level received till materials from the main mine site excavation. The till materials will be used as part of reclamation and the waste rock will eventually be relocated.

3. WASTE ROCK MANAGEMENT

HGCMC Surface Operations department manages the active waste rock facility, with delivery of the rock conducted by the Mine Department. The Surface Operations Department also manages removal of waste rock from inactive waste sites as part of concurrent reclamation efforts. Management responsibility will transfer to the Environmental Department upon completion of closure activities.

Management of waste rock from active mining applies to waste rock placement at Site 23, the TDF, and underground workings, where appropriate. Management of inactive waste rock sites that are independent of other mine infrastructure require ensuring integrity of the sites are maintained until materials can be removed and consolidated at the TDF, underground, or Site 23.

3.1. Management Objectives

HGCMC manages its waste rock facilities to safely receive material during production, maintain pile stability, reduce impacts to the receiving environment and ultimately return the land to natural use. Practices consistent with industry standard are employed to achieve management objectives. Objectives applicable to surface waste rock site management include the following:

- Segregate waste rock for disposal based on the Greens Creek Mine defined classification scheme (e.g., class 1 – 4).
- Maintain surface water controls by using best management practices.
- Reduce potential for water quality issues caused by air and water entry into the waste rock mass.
- Place and maintain interim argillite cover over the disposal site.
- Construct and maintain waste rock sites in a manner that ensures operational stability.

3.2. Underground Waste Rock Classification

Management and routing of waste rock initiates in the underground mine. Waste rock classification is based on rock type and pyrite content. Interpretation of development and exploration drilling information allows mine geologists and engineers to estimate the quantities of argillite and phyllite anticipated during mining. Where practical the mine plan tries to minimize development in high pyritic rock, although mining potentially acid generating rock is unavoidable. Production geologists visually inspect the active mining face and muck piles to determine the waste rock lithology and pyrite content, estimate the NNP value and assign the heading a class. The classification system was not based on the distribution of NNP values or specific geochemical groups. Despite this, it is well-integrated in the mining process and sufficient to meet management objectives. It is as follows:

- Class 1 - NNP greater than 100 tons $CaCO_3$/kt (surplus of approximately 10% carbonate)
- Class 2 - NNP between 100 and -100 tons $CaCO_3$/kt
- Class 3 - NNP between -100 and -300 tons $CaCO_3$/kt
- Class 4 - NNP less than -300 tons $CaCO_3$/kt (deficit of approximately 30% carbonate)

Production geologists communicate the class of the heading to the mine department as conditions change and it is posted in the mine office/dry to notify truck drivers. Verbal communication and paint markings in the workings are also used. Class 4 waste rock is retained underground. Class 1, Class 2 and Class 3 waste rock is brought to the surface if not needed underground for backfill. Tonnage estimates are calculated from a polygonal estimate made from a surveyed plan as-built and these tonnage

estimates are reconciled with hauled tonnages. Tonnage records are maintained by the Mine Department and reported in annual reports.

Chip samples of the headings are collected and sent to a laboratory for ABA analysis. The ABA results help document the types of material produced and validates the visual classification system.

3.3. Surface Operations

Surface operations for active and inactive waste rock site management are in this subsection.

3.3.1.1. *Active Waste Rock Site Management (Site 23)*

Per the 2003 WMP, a minimum slope of 3H:1V shall be used to ensure slopes are stable and do not erode or slough. This requirement is waived for the slope at Site 23 during construction. The slope is designed and constructed to a 2.85(H):1(V).

Waste rock is brought to the active waste rock site (Site 23) by underground haul trucks and placed in stockpiles, which are signed according to their waste rock class (Class 1 or Class 2/3). Some waste rock is hauled from the stockpiles to the TDF to armor slopes and construct access roads on the tailings pile.

Site 23 is constructed from the bottom-up in less than two-foot, compacted lifts. This minimizes air entry into the pile by preventing size sorting and maximizing compacted density. Minimizing air entry minimizes pyrite oxidation. Bottom-up placement also allows construction at 3H:1V side slope.

Class 1 material is placed on at least the outer two feet of the pile. This provides a barrier between the atmosphere and the potentially acid generating, Class 2 and Class 3 rock. The outer layer of Class 1 rock is also an oxygen sink. Pyrite contained in the Class 1 rock consumes oxygen and the abundance of carbonate neutralizes acidity generated by the pyrite oxidation.

Class 2 and Class 3 rock is placed in sub-horizontal to modestly-inclined, homogeneous lifts at least two feet from outer pile surfaces. Segregation of Class 2 and Class 3 was discontinued in 2004/2005 because it was creating physical discontinuities in the pile, which were promoting water and air entry. The classification system was not changed because it is well integrated into the mine operation and still provides useful production information. The primary objective of waste rock placement is to create a well-compacted, physically homogeneous surface that is buried quickly, minimizing exposure to air and water. The placement practices described above meets this objective. As available, additional Class 1 rock may be placed within the Site 23 pile along with Class 2/3 rock.

In 2008, construction of a temporary lined storage pad at Site 23 was authorized to be used for interim waste storage (waste rock relocation) from inactive waste rock sites pending transport to underground (ADEC 2008). The lined pad was constructed and used through 2013, with deconstruction initiating late in 2013 upon construction of a second pad at a higher elevation. Once the reclamation work was completed at Site 1350 and the waste rock hauled into the underground the second pad was removed.

Surface water runoff from Site 23 is routed through a network of diversion tubes and ditches to the Site 23 water management pond located near 8-mile B road. Refer to GPO Appendix 10 – Water Operations and Maintenance Manual for more details on water management.

Attachment B, Figure 2 includes the Site 23 as-built for reference; refer to HGCMC annual reports for the most recent facility as-built.

3.3.1.2. *Inactive Waste Rock Site Management*

Management of inactive waste rock sites (refer to Section 2.4) includes adhering to BMP's for surface water controls and monitoring for potential adverse impacts. All inactive waste rock sites are vegetated for erosion control either with grasses or small trees that have naturally grown in, with the exception of Site E. Concurrent reclamation of Site E initiated in 2009 with waste rock being relocated to the TDF for co-disposal with tailings. This waste rock removal is on-going over multiple years and dependent on space availability for these materials at the TDF. Active water collection systems exist at both Site E and Site D. Site E surface water runoff is routed to a collection pond which is pumped to the storm water line located along the B Road for routing to the water treatment plan at the TDF; pumping is by manual operation and only during summer months. The Site D collection pond receives water runoff from the B Road and Site D. This collection pond is on automated pump control and pumps water to the Site 23 water management system for eventual routing to the water treatment plant.

3.4. Monitoring and Inspection Active Waste Rock Site 23

All monitoring shall be conducted in accordance with the WMP, 18 AAC 60.820-860 (surface water and groundwater), and GPO Appendix 1, IMP. GPO Appendix 1 contains information regarding water quality compliance monitoring, including monitoring requirements, test procedures, frequency, parameters, field procedures, and QA/QC plans.

Inspections, survey data and material sampling are used to ensure that construction of the active waste site is according to approved construction plans. Monitoring hub, inclinometer, piezometer and topographic survey data are used in conjunction with engineering assessments to determine site stability. Visual observations and routine maintenance ensure that the water management system is functioning as designed. Routine water quality, flow and level monitoring, material sampling and data collection from site meteorological stations are used to define geochemical and hydrologic processes occurring at the site. This information is evaluated with respect to design expectations, and modifications are made, if necessary, to minimize effects on the receiving environment in the short and long term.

Monthly inspections of the facility will be performed when operations are in process, using an inspection checklist, in addition to any daily or weekly visual inspections made routinely as part of operation for which an inspection checklist is not used. A person who is familiar with the waste management permit requirements shall conduct the monthly inspection. Visual monitoring shall be conducted on routine facility operations, leachate collection and diversion systems, leachate pumping systems, the engineered cover and the facility perimeter. Structural changes or leakage noted during the inspections shall be documented. Inspections shall include but may not be limited to the following:

- signs of damage or potential damage to any component of the facility from settlement, ponding, leakage, thermal instability, frost action, erosion, slip failure, thawing of the waste, or operations that contribute to a problem;
- exceptions to conditions of the waste management permit;
- unauthorized waste disposal;
- damage to the structural integrity of a monitoring device, containment or drain structure; retaining wall, erosion control or diversion structure; and,
- evidence of death or stress to fish, wildlife, or vegetation caused by the facility.

Surface stability monitoring is performed at Site 23. Based on review of regional topography in the mid-2000's, concern arose that the site may have been constructed on an ancient landslide. A vertical inclinometer was installed in the central portion of the pile in 2006. Monitoring of that inclinometer identified a slow creep movement subsurface to the waste rock pile at the interface with the till (less than 3 mm/year at approximately 80-ft bgs). In 2010, three additional inclinometers were installed proximate to the site (north and west of Site 23, and south at the toe of Site D). The movement rate is generally constant at three of the inclinometers, and the fourth inclinometer located at the toe of slope indicates no movement. All associated site stability data was assessed by a geotechnical engineer in 2011 (KCB 2012). As part of this data assessment, procedures were identified to be followed if changes in site movement rates are identified as part of future monitoring. Monitoring is performed and summarized in annual reports.

If any structural change in or damage to the facility, or any exception to the WMP conditions are observed during the visual monitoring program, it shall be reported to the ADEC by the end of the next working day and appropriate action will be taken to correct the exception or damage, prevent the escape of waste or leachate, and clean up any improper waste disposal. The Forest Service will be notified.

HGCMC submits reports on waste rock sites to the ADEC per WMP requirements, and the Forest Service in consideration of the GPO. These reports include:

- an as-built topographic survey (in plan and cross section) of active sites;
- a running total of waste rock placed on active sites and a current remaining volume estimate;
- a summary of piezometer readings;
- a summary of key activities, observations, problems and corrective actions;
- a status report for inactive sites;
- a summary of water and waste rock monitoring, including a description of the geochemical and hydrological processes occurring at the site; and
- a summary of pertinent reclamation/closure activities and studies.

Refer to the reporting requirements section of the WMP for additional details on reporting items.

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GPO Appendix 11
Attachment A
Waste Rock Management
Standard Operating Procedure

Waste Rock Management Standard Operating Procedure

Hecla Greens Creek Mining Company (HGCMC) uses the following operational procedures for waste rock management at active and inactive sites.

1. GENERAL

- Waste rock disposal sites are permitted under the Waste Management (WMP); the requirements of that permit must be adhered to.
- Best management practices (BMPs) shall be utilized with regards to storm water and sediment management; refer to GPO Appendix 5, BMPs.
- Site reclamation shall be per approved GPO Appendix 14, Reclamation Plan.

Safety

- Conduct operations per HGCMC and MSHA safety standards. This includes:
- Install safety berms per MSHA standards.
- Awareness around highwalls
- Adequate lighting for night operations.
- Maintaining site access grade and road surfaces.
- Radio or visual contact with site operator.
- Awareness of uneven surfaces, slips trips and falls awareness

Site Access

- Proper signage shall be placed at site entrances for site access authorizations, and as appropriate, traffic patterns and active placement areas.
- Site access may be restricted with locked gates, chains, or cables. Secured accesses shall be maintained, if required by site-specific policy.

Water Management

- Divert surface runoff from undisturbed areas around the site.
- Ensure ditches are in place to prevent surface waters from running into placement or disturbed areas.
- Ensure site runoff is conveyed via designed and properly sized diversion ditches or conveyance tubes to retention ponds or discharge points to minimize erosion and sediment loss.
- Minimize surface water ponding and flow down site access roads.

Fugitive Dust Control

- Apply water as needed, particularly on traffic areas and during screening and crushing.
- Maintain roads properly.
- Hydroseed exposed inactive areas or cover with granular rock or soils.
- Use dust suppression aids where approved/appropriate.

Sediment Control

- Maintain access roads in a manner that minimizes sediment production.

- Construct and maintain rock check dams and settling basins to reduce sediment loading in site drainage.
- Use flocculent aids where approved/appropriate.

2. WASTE ROCK SITE 23 SPECIFIC

Ground Preparation

- Remove reclamation materials in accordance with approved site design plans, adhering to lease boundaries.
- Keep useful reclamation materials separated where practical.
- Place overburden in approved stockpile areas with appropriate drainage control.
- Avoid creating stockpiles with mixed organic material and oxide soil horizons (these generate iron and manganese water quality issues); drainage containment may be necessary.
- Burn large woody debris per Forest Service guidelines.
- Leave excavated ground in stable condition.
- Prepare foundation and install foundation drainage per design plans.

Water Management

- Maintain water controls as designed and constructed.
- Protect the installed foundation drain system which discharges via pipe to the ditch along the upgradient side of the B Road. This includes monitoring and repair of any erosion at discharge points from piping.

Waste Rock Placement

A slope of 3H:1V is generally used to ensure slopes are stable and do not erode or slough. Constructed slope during operations is established for some pile areas at a 2.85(H):1(V).

- Place waste rock in sub-horizontal to modestly inclined, less than 2-foot lifts.
- Spread with bulldozer and compact with four passes of the vibratory roller.
- Place Class 2/Class 3 at least two feet from outer pile surfaces.
- Avoid physical discontinuities in lifts that would allow water and air entry.
- Place Class 1 on at least two feet of outer final slopes to encapsulate Class 2/Class 3 rock.
- Encapsulate foundation drains with at least two feet of Class 1 rock.
- Place lifts in a manner that minimizes exposure of Class 2/Class 3 rock (continual burial).
- Avoid constructing access roads in valleys or depressions.

Temporary Storage Pad

- Temporary storage pads for interim concurrent reclamation waste rock storage shall be designed and constructed with adequate containment and drainage controls, per ADEC approval requirements.
- Protect containment liner.
- Maintain surface runoff drainage collection piping which routes surface water runoff from the waste pile to a retention swale and is then piped to the Site 23 water management pond degrit basin.

- Only store approved waste rock materials on the pad.
- If required by the source area, blend with lime for temporary geochemical stabilization until waste rock can be transported to underground or another approved disposal area.

Burn Pile

- Burn pile shall be located, operated, and maintained at adequate distance from surface water routing piping and environmental monitoring instrumentation.

Snow Removal

- Do not place waste rock on snow.
- Remove snow to outer slope of pile or stockpile it away from active placement zones.
- Avoid mixing waste rock with snow during snow removal.

3. INTERIM RECLAMATION

- Conform to stipulations in the ADEC waste management permit.
- Conduct operations in a manner that minimizes closure/reclamation liability.
- Manage materials to maximize availability for reclamation use.

4. EMERGENCY ACTION PLAN

- Issues identified during inspections shall be addressed in a timely manner before an emergency arises. In the event of unforeseen facility slope movement and/or water control issues, the following procedure will be followed:
- Remove non-critical personnel from the area and mark off the area with flagging.
- For slope movement issues, assess the site condition with input from a geotechnical engineer. Prepare an action plan as appropriate for the identified site condition and proceed with implementation.
- For water control issues, work with the surface operations and/or water treatment personnel to prepare an action plan appropriate for the identified site condition and proceed with implementation.

5. MONITORING

Monitoring includes visual inspections, environmental, and water quality monitoring. Inspections and environmental monitoring shall be performed per the current *Integrated Monitoring Plan* (IMP) (refer to GPO Appendix 1). This includes the following activities:

- Inspections
- Surface water, groundwater, drains, and lysimeter water quality monitoring
- Lysimeters sampled for field parameters, major ions and trace elements
- Acid base accounting and geochemical analysis
- Water levels (wells and piezometers)
- Geo-technical stability (survey hubs and inclinometers)
- Meteorological conditions

GPO Appendix 04
Attachment B
Waste Rock Management Plan Figures

Figure 1. Greens Creek Mine Site Map

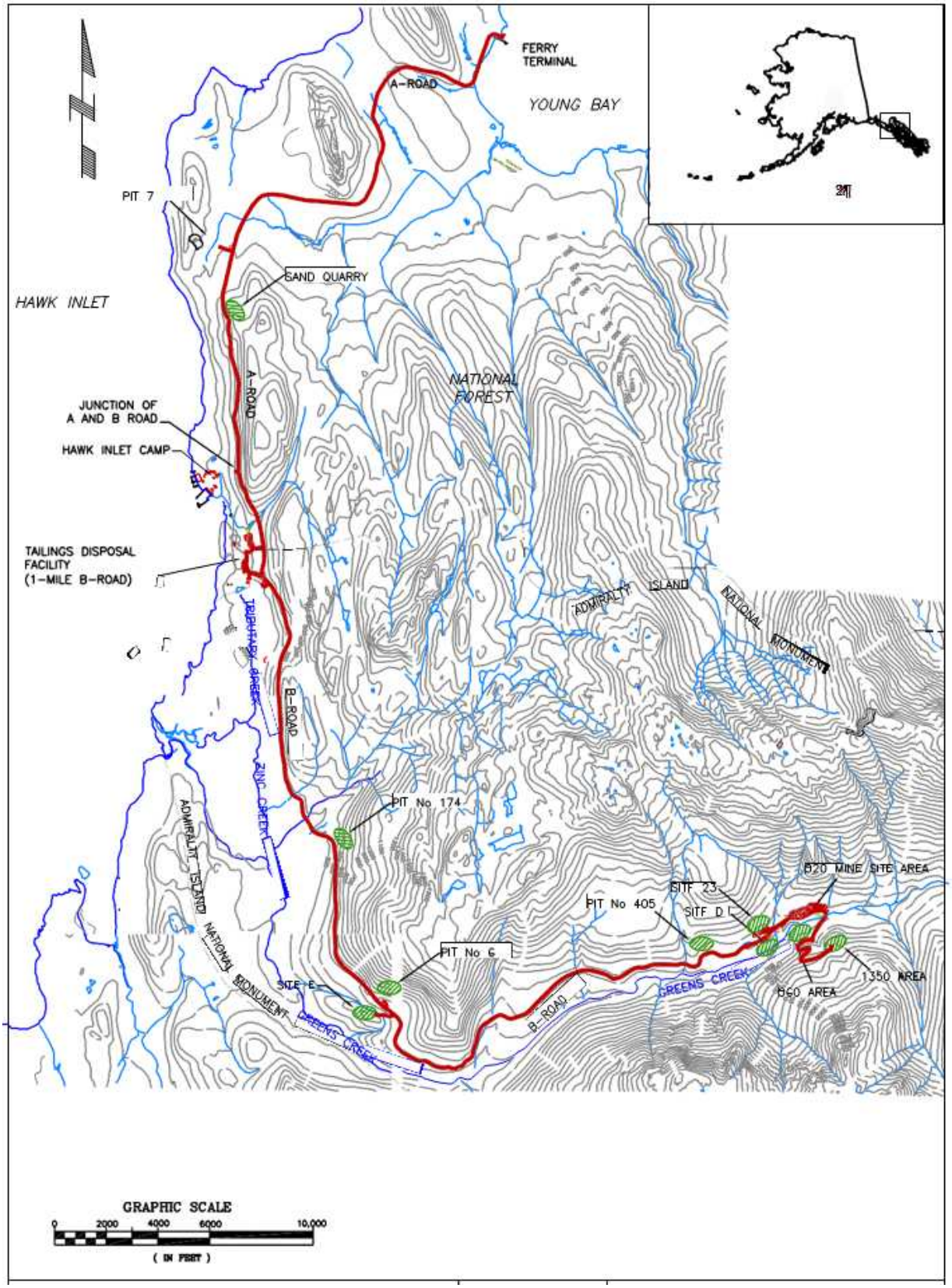
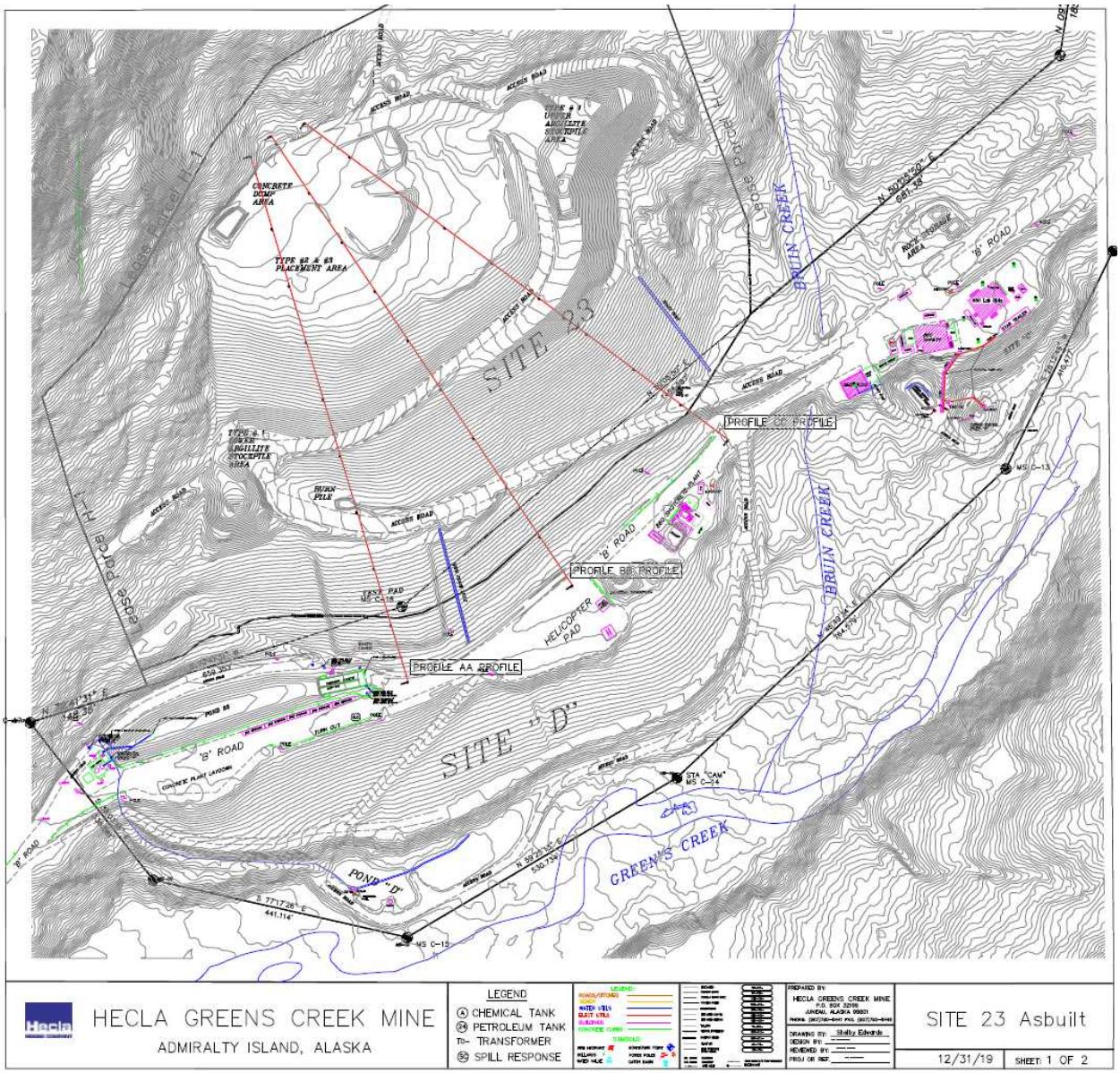


Figure 2. Waste Rock Site 23 As-Built



GPO Appendix 04
Attachment C
Waste Rock Management Plan
Inspection Form

Form 1. Example Site Inspection Form

Waste rock Site 23 Inspection

Yes	No	N/A	
			Are diversion ditches clear and unblocked?
			Are collection ditches clear and unblocked?
			Are the step channels clear and unblocked?
			Is placement according to plan? Grade and compaction according to plan?
			Is the backslope free of slides or cracks?
			Is the piping O.K.?
			Is snow removal being done properly?
			Are the survey hubs and the inclinometer in good condition?
			Are the wells, piezometers and lysimeters intact and in good condition?
			Is the area free of trash and scrap?
			Is the burn pile in good condition?
			Is the 23 pond and ditch liner in good condition?
			Are revegetation efforts successful? Please make any needed comments.
			Are all environmental concerns addressed?

Comments:

Inspected By: Date:

General Plan of Operations
Appendix 12
Air Quality Plan

May 2020

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6. REPORTING 1

Acronyms

AAC	Alaska Administrative Code
ABA	Acid-Base Accounting
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
APDES	Alaska Pollutant Discharge Elimination System
ARD	acid rock drainage
EA	Environmental Assessment
FEIS	Final Environmental Impact Statement
GPO	General Plan of Operations
HGCMC	Hecla Greens Creek Mining Company
KGCMC	Kennecott Greens Creek Mining Company
IMP	Integrated Monitoring Plan
KCB	Klohn Crippen Berger, Ltd.
MSHA	Mine Safety and Health Administration
NEPA	National Environmental Policy Act
NNP	Net Neutralization Potential
QA	quality assurance
QC	quality control
SOP	Standard Operating Procedure
TDF	Tailings Disposal Facility
USDA	United States Department of Agriculture
USFS	United States Forest Service
WMP	Waste Management Permit

1. INTRODUCTION

Greens Creek Mining Company (HGCMC) operates the Greens Creek underground hard rock mine, located on Admiralty Island, Alaska. The mine produces ore concentrates composed of silver, lead, zinc, and gold.

The Alaska Department of Environmental Conservation (ADEC) Division of Air Quality (DAQ) has issued HGCMC air quality permits for the operations. The Hawk Inlet port facility and the tailings disposal facility (TDF) are covered under the Owner Requested Limit permit number AQ0853ORL03, and the mine and mill sites are managed under the Title V Permit number AQ0302TVP03.

2. CLIMATE

The west side of Admiralty Island is located in the climactic maritime zone of Southeast Alaska. The following weather parameters characterize this region:

Mean Annual Precipitation	45–80 inches/year
Wet Days Per Year	125
Mean Annual Snowfall	90 inches/year
Mean January Minimum Temperature	24°F
Mean January Maximum Temperature	32°F
Mean July Minimum Temperature	48°F
Mean July Maximum Temperature	62°F
Mean Annual Temperature	42°F
Seasonal Temperature Variation	14°F
Diurnal Temperature Variation	11°F
Mean Sea Level Pressure	759 mm

3. SOURCES

Potential emissions are expected to derive from power generation, milling operations, hauling activities, conveyor operation, material transfer, burning, and tailings disposal.

4. MONITORING

HGCMC conducts the visible emission, fuel sulfur content, and source monitoring as required through the ADEC DAQ permits. Furthermore, HGCMC is required to monitor and mitigate visible dust emissions from mine activities and trafficked areas of the project. For additional information, refer to the *GPO Appendix* 1 *Integrated Monitoring Plan.*

5. MITIGATION

HGCMC utilizes a number of measures to reduce or eliminate air pollutants, including transporting tailings and concentrates in covered trailers and conveyors, utilizing hydropower supplied from Alaska Electric

Light and Power (AEL&P), eliminating an on-site incinerator used for kitchen food waste, and recycling cardboard, as described below.

Finished concentrates and tailings are transported in covered trailers to minimize the liberation of fugitive dust along the road system. An enclosed conveyor system with a telescoping snorkel is used to transfer concentrates to bulk cargo ships.

HGCMC began to receive power, over 60% on average, from the Alaska Electric Light and Power (AEL&P) company starting in 2006. Because AEL&P generates primarily via renewable resources (hydro), air emissions from the mine have been significantly reduced. However, when self-generating, HGCMC takes measures to minimize sulfur dioxide (SO_2) emissions by purchasing ultra-low sulfur (15ppm) fuel

In anticipation of changes to the Commercial and Industrial Solid Waste Incineration Units (CISWI) regulations implemented in 2018, in 2017 HGCMC phased out the small remote incinerator operated for kitchen food waste management. Furthermore, though approved to burn clean cardboard and wood, HGCMC implemented cardboard recycling diverting over 30 tons annually from the burn pile.

Mitigation measures for fugitive dust from the TDF and road system are detailed in *GPO Appendix 3 Tailings Facility* and *GPO Appendix 8 Road Operations,* respectively.

6. REPORTING

Results from the air monitoring program are reported to the ADEC and the Environmental Protection Agency as required. Biannually, facility operating reports are prepared and submitted.

Annually, an assessable emissions estimate, an annual compliance certification report, and an owner requested limit report are submitted. Triennially emissions inventories are compiled and submitted. Finally, every five years, the results from the source testing are provided.

General Plan of Operations
Appendix 13
Fire Plan

June 2020

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1. INTRODUCTION

This plan will identify Permitted Burns, Fire Prevention, Training and Fire Response.

2. FACILITIES PLAN

Greens Creek Mine has conducted a facility hazard analysis on the following areas:

- Mine
- Mill
- Powerhouse
- Administrative Complex
- Warehouse
- Hawk Inlet
- Road System

2.1. Mine

The mine is located approximately 18 miles southwest of Juneau, Alaska, and is situated in the northern portion of Admiralty Island. The mine is eight miles by road from Hawk Inlet on the Northwestern coast of the island. Access to Hawk Inlet is via air or coastal marine transportation. Young Bay is located five miles from the Hawk Inlet junction then 8.4 miles to the mine for a total of 13.4 miles. Greens Creek's Mine Fire and Emergency Response Plan are within the regulatory requirements set forth by Mine Safety and Health Administration (MSHA).

The mine is comprised of an ore body that is classified by MSHA as being non-gassy. The classification of non-gassy refers to the inability to either liberate methane or have the potential to liberate methane based on the history of the mine or the geological area in which the mine is located.

Combustible liquids used underground are maintained on an as needed basis. When not in use these liquids are kept in approved containers.

Waste rags containing flammable or combustible liquids are disposed of properly in covered metal containers.

Machinery and equipment is maintained regularly as per a scheduled maintenance program and inspections are conducted prior to operation of any piece of mobile equipment and every shift for other machinery and equipment to eliminate the possibility of a fire resulting from equipment failure. Explosives used underground are stored and shipped in accordance with ATF, MSHA and Department of Transportation (DOT) regulations.

The mine's fire suppression system includes a four inch main water lines which are fed from a 150,000 gallon water tank. The tank is located directly above the portal at an elevation of 1,160 feet, and ABC fire extinguishers are strategically placed throughout the mine.

Inspections are conducted and documented daily to include such items as ground conditions, equipment maintenance, housekeeping, etc.

Fire extinguishers are checked monthly and receive an annual service every 12-months.

Fire evacuation drills are used to assess the ability of all persons underground to reach the surface or other designated points of safety within time limits of the self-rescue devices that would be used during an actual emergency.

2.1.1. Situation Plan/Steps

Go to the nearest mine phone or radio and report nature and location of the emergency, and remain on the mine phone or radio until all information has been received.

If access to the portal is cut off or if evacuation routes are questionable, all personnel underground shall report to a predetermined assembly point or nearest refuge chamber and follow instructions from the highest-ranking underground supervisor.

Whoever receives the emergency call outside shall immediately notify GCMC supervision and document the information on an emergency information sheet.

Outside personnel will be responsible for initiating the stench system immediately after notification has been received.

All personnel underground shall stop work immediately, shut down equipment and close all valves on compressed gas cylinders, and evacuate to the portal, refuge chamber, or assembly point.

Upon confirmation of a fire underground or if personnel feel that it is necessary, they shall don their self-rescuers immediately.

Upon confirmation of a fire, the highest-ranking underground supervisor shall notify outside as to the location and level of emergency.

The ventilation system shall be left in its normal operating conditions until all information is received as to its effects of the entire underground operation. The General Manager or his/her designated representative such as mine superintendent and/or mine foreman are the only individuals authorized to modify the ventilation system during emergency.

2.1.2. Fire Fighting - Small Fires

A small fire is one that does not create enough smoke, flame and heat to prevent fighting the fire using a hand-held fire extinguisher or a small water hose. Special attention shall be given to the type of fire: Extinguishers can be used on all A-B-C fires while water should only be used on Class A fires.

Small fires are readily fought by the use of hand-held extinguishers so personnel should make a reasonable effort to extinguisher the fire. If two or more people are present, one should fight the fire while one reports the size, type and location in the event the fire grows out of control. Under no circumstances do personnel fight fires after donning of their self-rescuers.

Small fires as aforementioned are referred as fires in the incipient stage.

Personnel will not directly engage any fire which is beyond the incipient stage, i.e., a fire which has progressed to the point it has substantially inundated the structure/equipment or one that involves explosives.

2.1.3. Fire Fighting - Large Fires

A large fire is one that creates enough smoke, flame and heat that will not allow personnel to fight the fire using normal firefighting equipment.

To extinguish this size fire will require the use of trained mine rescue personnel using self-contained breathing apparatuses, and other firefighting equipment, or by means of bulkheading.

The responsibility to fight the fire or to bulkhead will be directed from the incident command center, usually directed by the mine manager or his/her designated representative.

The highest-ranking supervisor or his/her designated representative outside will be responsible for coordinating the following tasks:

- Portal security
- Restricting entrance(s) of personnel underground
- Posting guards at electrical & ventilation controls to prevent accidental power disconnect or reversal without proper authority.
- Notification of off duty mine rescue personnel and equipment call-out list.
- All local, state and federal officials (MSHA, , Paramedics, National Mine Service, etc.)
- Housing and feeding arrangements etc.

Water for firefighting underground as on the surface is fed from a 150,000-gallon tank on located above the portal at the 1160 level.

2.1.4. Escape Plan

If transportation is not available from underground, it will be dispatched from the surface, if possible, and report to assembly points.

If transportation is not available at all, the highest-ranking mining supervisor will instruct personnel as to the evacuation route to take. A person will be assigned to the rear to ensure all personnel are accounted for.

All personnel exiting the portal shall ensure that they report and sign out at the dry.

Underground Emergency Barricade:

If fire or any other emergency dictates evacuation to a refuge chamber, the highest-ranking mining supervisor will ensure that the refuge chamber is safe to access.

Prior to closing and sealing of the refuge chamber door, a sign shall be posted outside on the door indicating the number of personnel inside, date and time entered, and any medical conditions known.

All personnel once inside refuge chamber shall sit down and remain silent with only one cap lamp on to conserve batteries. Once inside the refuge chamber, the instructions for refuge chamber utilization shall be followed, including use of the CO and CO_2 scrubbing unit, air conditioner, and gas testing system. The instructions are posted in each refuge chamber.

All penetrations into the refuge chamber shall be sealed shut by means of closing valves or sealing (predetermined means of effectively sealing) openings closed.

If voice communication can be maintained with the surface, names of personnel, their conditions, and any other information to aid rescuers shall be given.

If piped compressed air is available into the refuge chamber, it shall be utilized as breathing air and to create a slight positive pressure.

If piped compressed air is not available, the stored oxygen cylinders shall be opened and adjusted to the appropriate flow rate as per the number of personnel in the refuge chamber (see chart in refuge chamber) to provide the same result.

The possibility of being confined for a lengthy period is a real possibility. In this case all food shall be stored in a central location for rationing purposes. Again, only one light shall remain on at a time to conserve batteries. Personnel shall take turns walking through the chamber to prevent the stratification of foul air.

Once the refuge chamber doors are closed and sealed, the door shall remain closed until mine rescue personnel state that all is clear.

2.2. Mill

The concentrator building (mill) includes both ground level and upper floor working areas. The mill is constructed of concrete floors and structural steel perimeter walls with steel panels outside. Inside office walls are covered with minimum one hour fire rated gypsum board.

The concentrator (mill) is powered by means of 4160 volts, which is purchased or generated from the power house located on Admiralty Island. The 4160 volts is fed into two feeders which split into 480 volts, still allowing the mill to utilize 4160 volts. All electrical wiring meets or exceeds the requirements set forth by MSHA and National Electric Code (NEC).

The mill's fire suppression system consists of a water supply from a 150,000 gallon tank with 90,000 gallons dedicated for fire protection. The tank is at an elevation of 1,160 feet and feeds a 10 inch HDPE pipe that connects to a 6 inch HDPE loop producing 260 feet of static head at the mill site.

The main gate valve will be chained and locked in the open position.

Standpipes are hydraulically designed to supply 100 GPM at 65 PSI at the most remote valve (EL.1001'-6"). The system demand - 100 GPM @ 92.26 PSI residual pressure at base of riser-1000 GPM at 97.5 PSI.

ABC (monoammonium phosphate) fire extinguishers are strategically placed within the mill.

There are approximately 18 separate chemicals used at the mill, of which two are flammable. The two chemicals, Sodium Isopropyl Xanthate, and Methyl Isobutyl Carbinol, are stored in proper approved containers. With proper storage, placement and handling, these chemicals do not pose a fire threat.

If a situation (fire) is observed by any person, they should go to the nearest phone or radio and report the nature and location of the emergency, remain on the phone or radio if possible until all information has been received.

Whoever receives the call shall immediately notify emergency response crews and document information on an emergency information sheet.

2.2.1. Escape Plan

Personnel not directly involved with firefighting will evacuate the building by way of one of the exits, north, south, east and west. Personnel have been instructed to report to the 920 Administration office as to account for all personnel assigned to the mill.

2.3. Powerhouse

The powerhouse building is approximately 6,600 square feet in size, constructed of steel structural members and steel siding.

The powerhouse is designed to produce electricity for the entire Greens Creek Mine operation, underground, 920 and Mill complex, Tailings Disposal Facility, and Hawk Inlet. Generation of electricity is accomplished from three Ruston generators, a diesel turbine, and two Caterpillar (CAT) generators (CAT's are housed outside of powerhouse building).

The powerhouse generates from a range of 0 megawatt to a full operational load of ~ 9.5 megawatt. The fixed plant capacity of all generators is ~14 megawatt.

Generators are fueled continuously from a 60,000 gallon fuel tank which is located approximately 125 feet northwest of the powerhouse. The amount of fuel used during an average 24 hour operational period of self generation is approximately 12,000 gallons.

Inside the powerhouse confines are located the day fuel tanks.

Fire suppression system for the power house consists of overhead fire sprinklers and ABC fire extinguishers in the form of hand-held and wheeled. The sprinkler system is activated by heat sensors which are located near the exhaust fans on the ceiling. Sprinkler system is fed from a water supply tank containing 150,000 gallons, of which 90,000 gallons is dedicated to firefighting. The main gate valve is chained and locked in the open position. Fire extinguishers are strategically located throughout the building. The turbine has a CO_2 fire suppression system.

2.3.1. Escape Plan

In the event of a fire, personnel have been directed to evacuate through one of exits, located on the west, east, north, and south sides of the building. Personnel have been instructed to report to the 920 Administration building for accountability.

2.4. 920 Administrative Complex

The building materials used in construction include non-combustible structural members, including walls, columns, beams, floors, and roofs.

The electrical power for the entire complex is received from the powerhouse in the form of 480 volts. Power enters the building through the shop area into a 400 amp disconnect, then proceeds through a 75 KVA transformer and distributed throughout the entire complex.

The Administrative portion of the building is designated for engineering, management, and general administrative functions, none of which either harbor or manufacture any hazardous or flammable products.

Fire suppression system for the entire complex is comprised of standpipes and fire extinguishers (ABC) placed strategically throughout the complex. One standpipe in the shop area, one in the dry area, and one on the upper floor. Fire extinguishers are placed strategically throughout the shop, dry and upper floor.

The fire suppression standpipe is supplied with water from the 150,000 gallon tank, of which 90,000 gallons is dedicated for mine water and firefighting. The standpipe will have the main gate valve chained and locked in the open position.

2.4.1. Escape Plan Administrative Complex

There are two stair well exits from the upper floor, one on the southeast, and the other on the southwest side of the building, both of which are marked by illuminated signs.

Personnel have been instructed to report to the 860 area to account for all personnel.

2.5. Shop

The shop area is designated for major repair and fabrication of equipment and associated components.

The shop area maintains many combustibles and compressed gases, all of which are stored and used in accordance with MSHA and NFPA regulatory guidelines. When not in use, flammables are stored in approved flammable storage cabinets and compressed gas bottles are shut off with lines bled off, and valves are protected.

Outside on the east side of the building, liquids are stored. There are approximately seven separate containers, which store approximately:

- 3,800 gallons of hydraulic oil
- 3,800 gallons of 15/40 motor oil
- 440 gallons of hydraulic oil
- 440 gallons of ATF transmission oil
- 440 gallons of TDH (rock drill oil) oil
- 500 gallons of anti-freeze
- 1,000 gallons of waste oil

Liquids mentioned above are stored in inside a containment area.

The shop's fire suppression system consists of one standpipe and numerous fire extinguishers placed throughout the shop in potential fire areas.

Used oily rags and empty aerosol cans are disposed in accordance with Environmental Protection Agency (EPA), NFPA, and MSHA regulatory standards.

2.5.1. Escape Plan Shop

In the unlikely event of a fire, personnel are directed to exit through one of the nine exits, two to the west, three in the north, and four through the east side of the building.

Exits are illuminated by means of battery back-up emergency lighting and illuminated exit signs.

Personnel have been instructed to report to the 860 area to account for all personnel.

2.6. Dry

The dry house facility's main purpose is for personnel to change clothes and shower. There is also have office space provided in the east side of the building.

The cleaning products used in maintaining the dry are stored in metal cabinets within the building and do not pose a fire, safety or environmental hazard. Used cleaning product containers are disposed of according to EPA regulations and in a proper and safe manner as not to pose a potential fire hazard.

2.6.1. Escape Plan Dry

In the unlikely event of a fire in the dry or any other part of the complex, personnel that are not directly involved in firefighting have been instructed to report to the 860 area to account for all personnel.

2.7. Warehouse

The 960 Warehouse is approximately 6,000 square feet of storage facility and office space. The building materials used in construction include combustible materials which include the structural members, columns, beams, and roof.

The electrical power is received from the powerhouse to the warehouse on the east wall, which feeds into a 125 amp breaker, 120/208 3-phase. Total connected load equals 3.9 KVA/15.8 amp.

The main function of the warehouse is to procure and distribute a constant supply of materials, to enable the mine and surface to operate daily.

The warehouse receives and will continue to receive an increasing amount of combustible materials. These materials are stored for a period of time before being distributed to various work locations across the operation.

Fire suppression system for the warehouse incorporates the use of ABC fire extinguishers and an overhead sprinkler system.

Fire extinguishers are placed strategically throughout the warehouse and the sprinkler system is fed from the 150,000 gallon water tank with a supply of 100 GPM at 65 PSI and the system demand at an average working pressure - 100 GPM at 120 PSI residual pressure.

With proper storage and handling of combustibles and adequate fire protection the warehouse does not pose a fire threat.

2.7.1. Escape Plan

In the unlikely event of a fire at the warehouse, all personnel have been instructed to report to the Administration building to account for all personnel.

3.6 Hawk Inlet

Hawk Inlet consists of multiple buildings., The buildings of interest will be the concentrate storage building, north and south bunkhouse/kitchen, Hilton, Grand, and the Hawk Inlet Warehouse.

3.6.1 Concentrate Storage

The concentrate building is approximately 60,000 square feet of storage area. The concentrate building is constructed of concrete floors, and structural steel perimeter walls with steel panels outside.

The electrical for the concentrate building is located on the east side of the building in a separate 12X10 steel shed. Electrical lines are fed 200 feet east underground to the concentrate building where a 480 volt panel box is located.

The main electrical source for Hawk Inlet is purchased power. Backup power can be provided by either the 920 power house or the Hawk Inlet power house.

A 200,000-gallon diesel fuel tank is located approximately 150 feet east of the concentrate building. The tank is bermed to hold 110% of capacity in the event of a leak.

The concentrate building fire suppression system consists of fire extinguishers located throughout the building.

2.7.2. Escape Plan

In the unlikely event of a fire personnel have been instructed to evacuate through one of exits, one east, one south, and one west.

2.8. Cannery/Kitchen

Cannery/kitchen is approximately 26,000 square feet of living quarters and kitchen facilities, which encompasses ground floor and a second floor. The Cannery's/kitchen's exterior walls, bearing walls, and floors and roofs and their supports are wholly or partly of wood.

Smoke/fire alarms are located throughout the entire complex, with fire extinguishers (ABC) located strategically in hallways and other areas of assembly. There is a sprinkler system located throughout the complex.

Located in the kitchen are smoke/fire alarms and above the grill and fryers are a fire suppression system that can be actuated in two separate locations within the kitchen.

The Cannery/kitchen houses no hazardous or flammable products within the facility.

Municipal solid waste generated at Hawk Inlet and the mine complex is collected and disposed of off-site.

A 1000-gallon double-walled fuel tank is located approximately 60 feet east of the Cannery/kitchen. This fuel is consumed for heating. A 300-pound wheeled extinguisher and handheld fire extinguishers are located near the tank in the unlikely event of an incident.

2.8.1. Escape Plan

In the event of a fire, personnel are notified through the fire alarm system and instructed to exit through one of the five exits on the ground floor, three east, one south and one north. On the second floor personnel can exit directly through one of two exterior stairway exits, one north or one south, personnel can also exit through the stairway inside the building then exit through the ground floor exit.

2.9. Hawk Inlet Warehouse

The Hawk Inlet Warehouse is approximately 7200 square feet, located approximately 330 feet east of the Cannery/kitchen. The building is constructed of steel structural members including walls, columns, beams, floors, roof, and siding which is approved noncombustible or limited-combustible materials

The Hawk Inlet Warehouse electrical power is primarily purchased with backup provided by Greens Creek. Power is cabled underground to a panel box (main disconnect) on the east side of the storage facility.

The warehouse facility is utilized mainly for bulk items such as, engines, wheels and other large items that have been barged in and received at Hawk Inlet. Materials are then distributed either from there, or, taken to the 960 warehouse for distribution.

The heating system for the building is a waste oil heating system.

Storage building does not possess a fire suppression system, but there are fire extinguishers placed strategically throughout the building.

2.10. Hilton Housing Facility

2.11. Grand Housing Facility

2.12. Road System

The road system consists of approximately 13.4 miles of gravel road, starting from Young Bay leading north to Hawk Inlet junction which encompasses five miles, then proceeding to the mine complex at another 8.4 miles encompassing 13.4 miles.

Any work that is related to widening, tree removal, guard railing, etc., must have prior Forest Service approval.

Forest Service Phone Numbers

Admiralty National Monument:	(907) 586-8790
Dispatch (Sitka)	(907) 747-5611

In the event of wildfires, GCMC will:

- Immediately fight the fire with the necessary personnel to keep fire(s) under control.
- Greens Creek will keep a watchperson on the Island during night and weekend hours to check on live fires.
- Notify the Forest Service as soon as possible.
- Continue fighting the fire until it is out or until released by the Forest Service.

When the Forest Service arrives on scene, Forest Service will assume responsibilities as incident commander and GCMC will respond accordingly.

Forest Service will:

- Dispatch additional manpower and equipment needed.
- Take charge for the direction of firefighting if Forest service resources are committed to the fire.

- Ensure that a 12-foot wide radius fire line has been constructed around the pile prior to burning.

Greens Creek will have equipment available and in good serviceable condition, which will be maintained at a location that is accessible to operations. Equipment will be tested periodically as may be required by the Forest Officer in charge.

Any gasoline powered saw will be provided with a muffler in good working condition. Greens Creek will ensure that the approved spark arrester is in the muffler, and the saw operator will inspect the spark arrestor during dry conditions. ABC fire extinguisher no less than 20 pounds will be located strategically in the unlikely event of a fire.

If work is to be scheduled during critical dry season additional precautions will be taken, such as larger amounts of extinguishing agents, shovels and possibly a fire watch.

Any surface refueling will be tasked in clear areas, if gasoline powered saws are refueled, they shall be moved at least 50 feet prior to restarting.

Disposal of slash and debris by burning will require a tank truck or trailer of not less than 300 gallons be present during burning unless weather conditions suffice as ample protection.

Tank trucks will be equipped with various tools and equipment to aid in firefighting.

Post a copy of this plan in a conspicuous place so that Greens Creek and contract employees are aware of the provisions and their responsibilities stated within.

General Plan of Operations
Appendix 14
Reclamation and Closure Plan

November 2019

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Acronyms

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish & Game
ADNR	Alaska Department of Natural Resources
APDES	Alaska Pollutant Discharge Elimination System
AWQS	Alaska Water Quality Standards
AS	Alaska Statute
BMP	Best Management Practices
COE	U.S. Army Corps of Engineers
FEIS	Final Environmental Impact Statement
GPO	General Plan of Operation
HGCMC	Hecla Greens Creek Mining Company
HMC	Hecla Mining Company
ML/ARD	Metal Leaching and Acid Rock Drainage
MOU	Memorandum of Understanding
MSHA	U.S. Department of Labor Mine Safety and Health Administration
NEPA	National Environmental Policy Act
Plan	Reclamation and Closure Plan Record of Decision
SAG	semi-autogenous
SRCE	Standard Reclamation Estimate Model
TDF	Tailings Disposal Facility
USFS	U.S. Forest Service
WDF	Waste Disposal Facility
WMP	Waste Management Permit
WRD	Waste Rock Disposal
WTP	Water Treatment Plant

Units of Measure

amsl	above mean sea level
°F	Fahrenheit
ft	feet/foot
H:V	ratio of horizontal to vertical distance
kg/ha	kilograms per acre
lbs.	pounds
tpd	tons per day
yd^3	cubic yards

1. INTRODUCTION

1.1. Purpose

Hecla Greens Creek Mining Company (HGCMC) a wholly owned subsidiary of Hecla Mining Company (HMC), has prepared this Reclamation and Closure Plan (Plan) to address interim, concurrent, final reclamation and post-mining land use of the Greens Creek Mine. These reclamation plan and closure cost estimates are being submitted to the U.S. Forest Service (USFS) as required under 36 CFR 228.1 et. seq. and 36 CFR 228A (Training Guide for Reclamation Bond Estimation and Administration 2004). Concurrently, the plan and cost estimate are being submitted to the Alaska Departments of Natural Resources, Division of Mining, Land and Water (ADNR) and Environmental Conservation, Division of Water (ADEC) in accordance with AS 27.19, 11 AAC 97, 11 AAC 93, AS 46.03.100, and 18 AAC 60.265.

The Plan sets performance goals applicable to interim, concurrent, and final reclamation, and addresses post-closure monitoring requirements. It also sets scheduling and other standards for reclamation and for final closure planning requirements, and it explains how detailed, regularly-updated reclamation task planning will be used for purposes of calculating a reclamation bond.

Prior to closure of the mine facilities, this Plan provides performance goals and general information on how HGCMC anticipates the facilities will be reclaimed. The Basis of Cost Estimate, which is included in Appendix B of this Plan, serves as a surrogate for the final closure condition and provides detailed assumptions necessary to develop a cost estimate for bonding purposes. Prior to actual closure, the Basis of Cost Estimate also assumes a default condition where the regulatory agencies are responsible for closure of the facilities. At closure, this Plan and the Basis of Cost Estimate will be updated based on the actual conditions that exist at the time and will become the final Plan and Basis of Cost Estimate.

HGCMC will reclaim exploration, development, mining and process-related disturbances at the Greens Creek Mine in a manner compatible with the land use selected and discussed herein. Reclamation practices will utilize best practicable established and accepted technologies and methodologies suitable for the southeast Alaska environment.

As generally discussed in the previous reclamation plan submittals, reclamation philosophies, technologies, and methodologies are, and will continue to be, subject to change. Reclamation practices are under constant scrutiny by government, industry, and the public. Therefore, reclamation plans must be, within the context of existing regulations, dynamic and capable of changing with the input of new information, ideas, and techniques (11 AAC 97.330 Amendment of Reclamation Plan).

When practical, final reclamation will be initiated immediately and completed within three years of permanent cessation of mining and milling operations where affected land cannot practicably be reclaimed concurrently. There may be circumstances where a holding period (care and maintenance with no active work) is necessary or where more than three years will be required to perform the work. Notification, in writing, of final closure will be given to the USFS, ADEC, and ADNR within 90 days prior to cessation of mining and milling operations.

Access by Federal and State regulatory personnel to the Greens Creek Mine facilities for the purpose of inspecting for reclamation or other appropriate compliance areas are statutory/regulatory mandates and will be honored by HGCMC.

1.2. Project Summary

The Greens Creek Mine has been in operation since 1989, with one temporary cessation of operations due to low metal prices from April 1993 until July 1996. HGCMC produces three concentrates containing four payable metals (silver, zinc, lead, and gold) for shipping to smelters around the world.

The mine has an estimated remaining mine life of over 10 years at a current processing rate of approximately 2,250 tons of ore per day. The project employs over 400 360 full time employees to operate the mine and processing facilities.

1.3. General Environmental Information

The Greens Creek Mine facilities are located from sea level to 1,350 ft (amsl) above the main mine portal and mill complex. The area is characterized as a temperate rain forest considering annual precipitation and temperature. The regional annual precipitation at sites near sea level is between 40 inches (Angoon) and 225 inches (Port Walter). The air temperature at the project site is heavily influenced by the coastal marine environment, which has a moderating effect on temperature extremes. The annual average temperature at the project site is generally in the low forties degrees Fahrenheit, with daily maximum and minimum one-hour average temperatures occasionally exceeding 80°F and 0°F, respectively.

The Greens Creek Mine facilities are located within the Greens Creek, Zinc Creek, Tributary Creek, Cannery Creek and Fowler Creek watersheds.

There is no known regional aquifer system in the area, but groundwater resources occur under a wide range of conditions. The many small drainages and irregular topography and geology make for numerous small-scale aquifers and groundwater flow systems. Groundwater can be found in manmade fill, peat, sand, gravel, till, and fractured bedrock aquifers. Confining materials include silt and clay.

Groundwater flow systems at the project area are complex. Flow systems are driven by local precipitation and snowmelt and the local terrain. With average annual precipitation at the site of approximately 53 inches, a surplus of water is frequently available for groundwater recharge. Much of the annual precipitation runs off from saturated or low-permeability surfaces in the area.

Air quality in the vicinity is good. Sites are generally classified as to whether they attain or fail to attain air quality standards. The project site area has been designated as having attained such standards, based on available ambient data for all criteria pollutants.

1.4. Location and Land Status

The Greens Creek Mine is located near Hawk Inlet on northern Admiralty Island, in the Tongass National Forest, approximately 18 miles southwest of Juneau, Alaska (Figure 1). The Mine site is situated partly within the Admiralty Island National Monument, completely within the municipal boundaries of the City and Borough of Juneau and comprised of federal and patented mining claims.

The USFS has issued special use permits/leases for various aspects of the operations. In addition, HGCMC holds18 patented and 498 unpatented mining claims plus fee simple lands consisting of approximately 17 acres of uplands and 21 acres of tidelands in Hawk Inlet under a warranty deed with Bristol Resources, Inc. The patented mining claims will be conveyed to the United States at the end of mine life or in 2095 at the latest. In addition to patented and unpatented claims HGCMC also holds the mineral rights on 7,301 acres of federal land acquired through a land exchange with the United States Forest Service. The total land package encompasses approximately 16,000 acres.

1.5. Agency Requirements

1.5.1. United States Forest Service (USFS)

The USFS has numerous reclamation requirements for the Greens Creek Mine. These requirements can be categorized as general USFS mining rules, Forest and Monument specific rules, and decisions reached through the National Environmental Policy Act (NEPA) review process.

General Forest Service Mine Reclamation Requirements

- CFR 36 Part 228 Minerals, Subpart A Locatable Minerals; Sec. 228.8 f, g, h; Sec. 228.10, Sec.228.13
- Forest Service Manual 2800 (FSM 2800) Minerals and Geology (selected provisions) 2841, 2842, 2843, 2844, 2846

Monument Specific Forest Service Reclamation Requirements

- Subpart D – Miscellaneous Minerals Provisions, Sec. 228.80

Tongass National Forest Reclamation Requirements

- 2016 Forest Plan

NEPA Reclamation Stipulations

- Greens Creek Final Environmental Impact Statement (1983)
- Environmental Assessment for Proposed Changes to the General Plan of Operation (GPO) for the Development and Operation of the Greens Creek Mine Admiralty Island National Monument, Alaska (1988)
- Environmental Assessment for Additional Waste Rock Disposal Capacity at Greens Creek Mine Admiralty Island National Monument, Alaska (1992)
- Greens Creek Tailings Disposal Final Environmental Impact Statement (2003)
- Greens Creek Mine Tailings Disposal Facility Expansion Final Environmental Impact Statement and Record of Decision (2013)

The 1983 Final Environmental Impact Statement (FEIS) Record of Decision (ROD) states that reclamation performed within the monument will intend to return the land to a natural condition. This includes sealing mine openings, restoring original surface drainage, removing structures, reestablishing natural contours where possible, and stabilizing the soils. Stabilizing the soils includes revegetating all disturbed areas, where necessary, and ensuring and maintaining healthy growth.

The ROD states that detailed mitigation, monitoring, and reclamation plans will be included in the GPO. The reclamation plan includes all areas on national forest land disturbed by the project. The plan includes both lands administered by the Admiralty National Monument and Juneau Ranger District. The reclamation of the privately-owned Hawk Inlet facility is also covered in this reclamation plan. The privately-owned surface facility is under the jurisdiction of the City and Borough of Juneau and ADNR.

Figure 1: Project Location and Site Map

1.5.2. Alaska Department of Environmental Conservation (ADEC)

The State of Alaska made the determination that tailings and waste rock placed in the dry tailings stack and Site 23/D are subject to the Chapter 60 solid waste requirements, which include the need to acquire a permit. Mining waste is regulated under the monofill standards 18 Alaska Administrative Code (AAC) section 60.455 which allows ADEC discretion to incorporate applicable provisions of 18 AAC 60 into a waste management permit (WMP). A waste that is not specifically addressed in Article 4 (i.e. tailings) will be classified by the ADEC and assigned the most applicable waste category.

The waste management permit contains applicable provisions of Article 1 and 2 (60.010 to 60.265) that have to do with general standards, limitations, prohibitions and administrative procedures to be followed by every disposal facility regulated under the chapter. Additionally, the waste management permit will apply relevant locational, operational, and design related requirements from the monofill standards in Article 4 (18 AAC 60.400 to 60.495). The monofill requirements also include closure and post-closure plans, notifications, monitoring and reporting.

Furthermore, the Greens Creek facilities are subject to Article 6 (18 AAC 60.700 to 60.730) which have to do with user fees and Article 7 monitoring and corrective action requirements (18 AAC 60.800 to 60.865). In Article 7, monitoring requirements specify visual, surface water and groundwater requirements. Detection monitoring is also required under Article 7. Specific inspection and monitoring requirements are detailed in Section 3.0 of this document. Lastly, the facilities at Greens Creek are open to waivers to any provision of the chapter under 18 AAC 60.900 upon adequate demonstration and ADEC discretion.

ADEC has statutory authority to require proof of financial responsibility under AS 46.03.100(f).

See the Waste Management Permit for Greens Creek for more details on ADEC requirements regarding bonding, temporary closure, permanent closure, post closure care, and post closure monitoring.

1.5.3. Alaska Department of Natural Resources (ADNR)

Alaska Statute (AS) 27.19, the Reclamation Act, applies to state, federal, municipal, and private land and water subject to mining operations. This statute is administered by the commissioner of ADNR. The Reclamation Act states that "a mining operation shall be conducted in a manner that prevents unnecessary and undue degradation of land and water resources and the mining operation shall be reclaimed as contemporaneously as practicable with the mining operation to leave the site in a stable condition" and 11 AAC 97.240 further states "a miner shall reclaim a mined area that has potential to generate acid rock drainage (acid mine drainage) in a manner that prevents the generation of acid rock drainage or prevents the offsite discharge of acid rock drainage." An approved reclamation plan and a performance bond are required prior to approval of a mining operation with the exception of certain small operations. The bond amount shall be set at a level not more than an amount reasonably necessary to ensure the faithful performance of the requirements of the reclamation plan. Alaska Administrative Code (11 AAC 97 Mining Reclamation) applies to the approval of reclamation plans, reclamation bonding, and enforcement of reclamation requirements under AS 27.19 for locatable mineral, leasable mineral, and material mining operations on state, federal, municipal, and private land. Nothing in the Reclamation Act precludes a federal or state agency (including the ADNR), acting under its own regulatory or proprietary authority, from establishing and enforcing additional requirements or higher standards for reclamation. The Reclamation Performance Standards are defined in 11 AAC 97.200.

ADNR's Dam Safety Program jurisdictional requirements are an ongoing part of the operation, closure, and post-closure planning of the Greens Creek Mine. The Pond 7/10 dam system at the Greens Creek

Mine is regulated under the Alaska dam safety statutes and regulations. HGCMC recognizes the authority the ADNR has for requiring that the operation, abandonment or removal of the Pond 7/10 dam system (11 AAC 93.151 to 93.201) be included in each revision of the detailed mine reclamation plan. Sufficient funds for these requirements will be included in the financial assurance or any revisions thereof. A copy of associated sections of the Reclamation Plan and financial assurance instrument will be submitted to the Dam Safety and Construction Unit of the ADNR during each review and revision cycle.

2. APPLICANT INFORMATION

Date:	April 2019
Location:	(Mine Portal) Latitude 58° 04’58” North Longitude 134° 37’57” West
Name of Facility:	Hecla Greens Creek Mining Company – Greens Creek Mine
Type of Facility:	Underground Silver, Lead, Zinc, and Gold Mine and Milling Operation
Business Name:	Hecla Greens Creek Mining Company PO Box 32199 Juneau, Alaska 99803
Telephone:	(907) 789-8100

2.1. Corporate Information

General Manager: Brian Erickson

Hecla Greens Creek Mining Company is a Delaware Corporation, Incorporated May 19, 1986 (formerly known as) Kennecott Greens Creek Mining Company)

2.2. Alaska Registered Agent

Name:	Hecla Greens Creek Mining Company #38561F
Address:	c/o CT Corporation System (Agent) 9360 Glacier Hwy, Suite 202 Juneau, Alaska 99801

2.3. Designated Contact Person for Regulatory Issues

Name:	Christopher Wallace
Title:	Permitting and Environmental Compliance Coordinator
Telephone:	(907) 790-8473

3. APPLICANT STATEMENT OF RESPONSIBILITY

HGCMC recognizes its responsibility in the use of public (Federal) lands and accepts that responsibility in agreeing to reclaim the Greens Creek Mine site. HGCMC will meet the requirements of its reclamation plan and return the site to a safe and stable condition consistent with the approved post-mining land use. HGCMC will meet required local, state, and federal regulations regarding reclamation of any surface area affected by the mining and processing operations. Reclamation activities and post-reclamation maintenance of remaining structures are HGCMC's responsibility.

In the event a new operator/land owner assumes control of the Greens Creek Mine, at that time, the new operator/land owner will agree to assume responsibility for the reclamation and maintenance of any affected land and structures that are the subject of this plan or existing permits. The new operator/land owner will request transfer of all applicable state and federal permits. The new operator/land owner will provide evidence that a surety is filed with USFS, ADEC, and ADNR that would cover reclamation of disturbed lands, including privately owned, as well as post-reclamation maintenance of remaining structures.

4. PROJECT DESCRIPTION

4.1. General

The mine, located on the south side of Greens Creek, has a main access portal at an elevation of 920 feet. Personnel and supplies are brought into the mine at the 920 portal and distributed throughout the mine with rubber-tired vehicles. Underground mining methods incorporate rubber-tired diesel-powered equipment. Drift and fill is the primary mining method used to extract the ore. Long-hole stoping is also utilized in select ore zones conducive to this bulk mining method. Cemented tailings and waste rock generated by the mining operations are used as backfill in mined out areas to support vehicles and equipment and to provide structural ground support, allowing subsequent mining of adjacent ore.

HGCMC mines an average of 2,300 tons of ore each day. A comparable milling rate is processed daily, producing approximately 500 tons per day (tpd) of concentrate and 1,800 tpd of tailings. On average 300 tons of waste rock daily is disposed of at the Site 23/TDF facilities.

The mill site is located on the north side of Greens Creek approximately 800 feet from the mine. Access to the mine site from the mill site is via a bridge that crosses Greens Creek. The mill site consists of the mill buildings, fuel storage tanks, an office/shop complex, a coarse ore stockpile, water supply pump house, switch gear building, and a warehouse and storage area.

A selective flotation milling process is used to concentrate valuable minerals from the raw ore following grinding. The flotation process consists of size reduction, mineral concentration, and moisture reduction of the concentrate. Size reduction involves grinding the ore in semi-autogenous (SAG) and ball mills. Ore enters the SAG mill at a size of 15 inches or smaller and leaves in the 0.05-inch (-16 mesh) size range. The ore then enters the ball mill to be further reduced in size to 80% at minus 74 microns (minus 200 mesh) this material is then slurried. Further size reduction of select flotation material in tower mills assists with the concentration of target metals.

The slurry flows to flotation cells, where carbonaceous wastes, then valuable minerals, are separated from gangue materials in a series of froth flotation processes. The ore minerals in this case are sulfides of lead, zinc, copper, silver, and free gold. Waste includes various silicate, carbonate, and sulfide minerals. The valuable minerals adhere to air bubbles that rise to the surface of the tank and are removed. Small quantities of metallic gold and silver are also recovered on site using a gravity process for shipment to off-site refineries.

Following separation of ore minerals from tailings, the concentrate slurries are piped to separate thickener tanks, where the water content is reduced. The thickened slurries are then compression-filtered to remove most of the remaining water. Concentrate products are reduced to some 8% by weight moisture. Tailings material moisture content is reduced to approximately 12%, the optimum moisture level to achieve maximum compaction when placed as mine backfill or at the surface Tailings Disposal Facility (TDF).

In general, tailings are preferentially placed back into the mine as structural backfill, with the remaining material placed at the TDF. Tailings reporting to the TDF are loaded at the concentrator load-out area into covered Maxhaul tractor/trailers, each with a 45-ton capacity, and hauled down the B Road to the TDF (Figure 1). Approximately 20 round-trips per day are required, but this varies depending on the daily underground tailings backfill requirements.

Supplies, such as fuels and reagents, are transported by barge to the Hawk Inlet dock facility and unloaded at the marine terminal complex. The cargo dock is located at the same site as the old cannery dock structure. HGCMC receives a yearly average of 80 barges bringing goods, road rock, and fuel to these Hawk Inlet facilities. Chemicals and containers are unloaded from barges by forklifts and transported to the process site by truck. HGCMC wastes and return materials shipping containers are placed back onto these barges by forklifts.

Hawk Inlet infrastructure also includes a 200,000 gallon bulk diesel fuel storage tanks, associated fill piping from the fuel barge unloading dock, a fuel loading facility for vehicles and the tanker truck, an electrical generator building, and warehouse. Less than 1,000 gallons of gasoline is also stored at the fuel loading facility. Assorted lubricating oils and used oils in portable tanks, totes, and drums are temporarily stored at this site's warehouse prior to their transport to the mine/mill site. A large ore concentrate storage building (maximum 40,000 tons capacity), temporary housing facilities, and ancillary support facilities are also located at the Hawk Inlet site. Chemicals are delivered in dry and wet form in containers by barge, offloaded, and stored at the warehouse at this location.

Concentrates are transported from the mill to Hawk Inlet dock facility by covered haul truck. An enclosed telescoping boom conveyor and drop chute are used to transport concentrates from within the shore storage area directly into the holds of bulk cargo ships. Twelve to eighteen concentrate ships are loaded by HGCMC annually in Hawk Inlet.

In 2006, the installation of infrastructure to augment the mine's use of diesel-generated power with less expensive hydroelectric power was completed. Although the Snettisham/Lake Dorothy hydroelectric link has the ability to provide cheaper power when available. The Greens Creek operation relies on on-site power generation when hydroelectric power is not available.

4.2. Surface Disturbance

Operations procedures have been implemented to support closure strategies with the use of tailings and waste rock for backfilling to minimize surface area used for final disposal. The primary surface operation consists of the mine portal, mill/warehouse/administration facilities, Site 23/D Waste Rock Disposal (WRD), TDF, Hawk Inlet, material sites, reclamation stockpiles, and Young Bay terminal all connected with 13 miles of access roads (Figure 1). The A and B access roads are single lane with vehicle turnouts to minimize disturbed acreage.

4.2.1. Areas and Acreage of Disturbance

The disturbances listed in Table 1 are for disturbed areas within the lease boundary on both public and private lands over the life-of-mine of Greens Creek Mine operations. The listed acres are a more refined updated estimate of areas that may be disturbed over the life of mine.

Table 1: Areas and Acreage of Disturbance

Project Components	Acres
920 Mill and Portal area	24
Waste Rock Site 23	20
Waste Rock Site D	8
Waste Rock Site 1350 and Portal area	3.5
1350 Road	4
1160 Tank	1
960 Waste Rock Area	1
Waste Rock Site C and 860 area	3
Waste Rock Site E	10
Tailing Disposal Facility	102
Hawk Inlet and Marine load out area	14.5
Young Bay Dock Facility	1
Access A Road	24
Access B Road	41
Power Line Right-of-way	32
Topsoil stockpiles & borrow sites	31
Total	**320**

5. RECLAMATION / CLOSURE PLANNING

5.1. General

HGCMC's long-term goals of reclamation during and after mining and milling operations are to shape, stabilize, revegetate, or otherwise treat the land in order to return it to a safe and stable condition consistent with the establishment of productive post-mining uses of the land. The current designated post-mining uses for the Greens Creek Mine area is for wildlife habitat and recreation as prescribed by AS 27.19.020 and is consistent with the USFS Tongass Land and Resource Management Plan that includes the Admiralty Island National Monument. HGCMC is currently incorporating practices that include contouring and stabilizing disturbed areas using best engineering practices to create seed beds which invite and promote early seral colonization, and using commercially available native plant species, if available, and soil amendments with proven on-site track records.

HGCMC considers reclamation to be a progressive process tied directly to the design, construction, operation, and closure of the mining operation. Reclamation and reclamation planning will or has occurred to meet the following objectives, with some overlap:

1. Satisfy all regulatory requirements;
2. Protect water quality, and public health;
3. Return the site to a near-natural conditions to the extent practical;
4. Support lands uses consistent with the Forest Plan;
5. Minimize or eliminate long-term management requirements;
6. Ensure long-term stability; and
7. Provide a cost estimate for reclamation and post-closure obligations.

HGCMC will continue to adhere to the above general objectives in developing and implementing this reclamation plan at the Greens Creek site. Therefore, the “on-the-ground” implementation of the plan will work to ensure:

1. Stabilization and protection of surficial soil materials from wind and water erosion;
2. Stabilization of steep slopes through contouring and leveling to provide rounded land forms and suitable seedbeds;
3. Management of contact water associated with the mine, TDF, material sites, and waste disposal facility (WDF);
4. Removal and reclamation of material sites and WDF (Site 23/D) to minimize contact water and post-closure water treatment;
5. Establishment of long-term, self-sustaining vegetative communities through reseeding and/or promotion of natural invasion and succession; and
6. Establish water storage ponds and batch water treatment plant for long-term water treatment and management to meet closure water effluent discharge limits.

HGCMC will continue working with the USFS, ADNR, and Alaska Department of Fish & Game (ADF&G) with the implementation and evaluation of both concurrent and long-term reclamation activities.

The physical reclamation of the Greens Creek site will utilize best practicable proven and documented technology. Specific technologies that will be employed to satisfy these performance goals are the

responsibility of HGCMC. The details and procedures for area specific reclamation such as the mine, millsite, waste rock facilities, tailing disposal facility, etc. are discussed in Section 6.0.

5.1.1. Land Use

Land Use Prior to Green Creek

Historically fishing and the canning industry have been the primary industrial users of the Admiralty Island coastal area with canneries once located at Angoon, Gambier Bay, Hood Bay, Port Gardner, Pybus Bay, and Hawk Inlet. There are no longer any active seafood processing canneries located on Admiralty Island.

Large-scale logging in several bays occurred in the 1950's and 1960's. With the reduction of timber sales, changing market conditions, and designation in 1978 by President Jimmy Carter declaring Admiralty Island a National Monument for the protection of its ecological, cultural, geological, historic, prehistoric and scientific values, logging activities have been minimized. In 1980, Congress designated most of the island as Wilderness and this has resulted in it being the only large island in Southeast Alaska not to have been extensively logged or developed.

Subsistence and recreational hunting, fishing, and wildlife viewing are historic uses and remain the primary attraction due to the high populations of game animals (i.e., Alaska brown bear, and Sitka Black-tailed deer). Wildlife viewing along the shoreline and estuaries in the early mornings and at twilight often provides a glimpse of either eagles or brown bears.

Coal and mineral extraction activities have been intermittent on Admiralty Island since 1895. Some hardrock lode mining occurred during the 1920's and 1930's. Modern mineral exploration and mining activities saw resurgence in the 1970's that ultimately resulted in development of the Greens Creek Mine and associated infrastructure.

Land Use during Greens Creek Operations

Subsistence and recreational hunting, fishing, and wildlife viewing are the main activities island-wide. Federal authorizations allow access for hunting along the roads but limits access to the general public in some areas due to the inherent hazards associated with the operation of large mine equipment and process components. Compliance with requirements of MSHA regulations limit access to personnel trained to recognize hazards and observe safety rules to insure the health and safety of employees and visitors.

Proposed Post-Mining Land Uses

The land comprising the Greens Creek Mine, inclusive of all Admiralty Island facilities, consists of both publicly and privately-owned uplands and tidelands. Greens Creek leases parcels from the United States on both the Monument and non-monument lands. HGCMC uses other public lands pursuant to special use permits issued by the USFS and leases issued by the State of Alaska. It owns land on Admiralty Island both as a result of patenting mining and millsite claims and through transfer of private lands in the historic cannery area from its predecessor. Additionally, Greens Creek holds subsurface and restricted surface use rights to approximately 7,300 acres of public lands as a result of a land exchange made pursuant to the Greens Creek Land Exchange Act of 1995 (Pub. L. 104-123 April 1, 1996).

Under the land exchange agreement, certain private lands (e.g. patented claims) owned by HGCMC ultimately will be transferred to the United States and the 7,300 acres of subsurface and restricted-use surface lands patented to Greens Creek in 1999 will revert to the United States. The land exchange agreement does not impose special reclamation requirements on these lands. It requires that they must be reclaimed in accordance with applicable laws and the approved reclamation plan.

Final reclamation of the mine facilities will take into account anticipated post-mining land uses. Since such uses likely will be limited primarily to monument-related activities, returning the surface to a near-natural condition should satisfy post-mining land use needs. Private lands that will retain their private status after mining were developed for non- monument uses prior to creation of the Admiralty Island National Monument. After closure, HGCMC will consult with the ultimate landowners, as well as any agencies having regulatory authority over reclamation of such lands, to determine the final disposition of structures and facilities.

Post-closure water treatment facilities and associated ancillary facilities will remain until all water associated with process component meet applicable discharge standards.

5.1.2. Interim Reclamation

Interim reclamation includes all actions taken to stabilize disturbed areas during operation of the mine. Generally, the focus of interim reclamation is to reduce erosion and sedimentation of waterways, and to protect water quality.

Techniques used to protect slopes from erosion and to reduce sediment delivery into water courses include various Best Management Practices (BMPs) that are described in more detail in Appendix 5 of the General Plan of Operations (GPO). Management actions used to protect water quality include surface water diversion, groundwater diversion, and collection and treatment of contact water. These water management actions are also described in more detail in Section 8.1.4.

HGCMC routinely performs interim reclamation throughout the site. Interim reclamation has included hydroseeding, as well as construction of berms, slope drains, rock check dams, silt fences, and settling ponds, all of which minimize erosion, reduce sediment production in disturbed areas, and stabilize previously disturbed areas.

5.1.3. Concurrent Reclamation

Reclamation that is completed while the mine is still in production is termed concurrent reclamation. Concurrent reclamation differs from interim reclamation in that concurrent reclamation is designed to provide permanent, low maintenance achievement of reclamation goals.

Concurrent reclamation is encouraged for many reasons. First, it allows the mine and agencies to measure the performance of specific reclamation technologies before mine closure and to refine the techniques for site-specific conditions. Next, concurrent reclamation could potentially reduce bonding requirements, following agency sign off. Additionally, concurrent reclamation facilitates the determination of more accurate closure costs. Finally, evaluation of the performance of concurrently reclaimed areas allows for a more accurate assessment of the likelihood that specific reclamation technologies will achieve desired performance goals.

Generally, for areas in which metal leaching and acid rock drainage (ML/ARD) risk may exist, HGCMC will initiate concurrent reclamation based on a site-wide risk assessment, addressing the higher risk sites first, when possible.

Areas that have undergone concurrent reclamation during operations since 1989 are listed in the Annual Reports applicable to the year the reclamation occurred.

5.1.4. Temporary Closure

Temporary Closure means the cessation of the mining and milling operations for a period of not more than three years. If conditions require temporary closure to extend beyond three years, final reclamation will begin, unless an extension is requested by the company and approved by USFS, ADNR, and ADEC. Temporary closure scenarios, which require modifications to the plan of operation, reclamation plan, solid waste, or 404 Permit, will be coordinated with and submitted to the appropriate Federal and State agencies for approval.

Temporary closure may include planned and unplanned cessation of the mining and milling processes. Planned temporary closures which have specific conditions defining their beginning and end include, but are not limited to the following:

1. Interruptions in the active beneficiation processes to provide planned periods of quiescence for metallurgical or operating reasons;
2. Any other planned condition, which will interrupt the active beneficiation process including modification to process components or suppressed metal market conditions; and
3. Change in ownership requiring the temporary cessation of operations while operating permits are transferred to the new owner/operator.

Unplanned temporary closures may include, but are not limited to the following:

1. Closure because of unforeseen weather events;
2. A failure in a major system component or a process failure which causes the fluid management system or a portion thereof to shut down; or

The cessation of operations as a result of litigation.

HGCMC will notify the Agencies within ten days of the first day of the temporary closure of any unanticipated suspension or cessation of operations that is expected to last more than ninety days or more. The notice will state the nature and reason for the temporary closure, the anticipated duration of the temporary closure and any event that would reasonably be anticipated to result in either the resumption or abandonment of operations. Project operations must resume for not less than ninety consecutive days in order to terminate the temporary closure status. HGCMC will maintain the project area in a safe and secure condition during a temporary closure and HGCMC will not allow the project area to be degraded or eroded during or as a result of the temporary closure. HGCMC will continue, in full force, all water collection and treatment, monitoring and reporting required by the reclamation plan unless otherwise agreed to by the agencies.

While the mine operation is inactive, environmental monitoring programs described in the GPO will continue to be implemented. The need for implementation of interim reclamation activities or final reclamation on components of the mine will be addressed on the basis of environmental monitoring results and consultation with the appropriate agencies.

5.1.5. Final Reclamation

After HGCMC has completed operations at Greens Creek, or at any individual facility or mine unit, final reclamation can be initiated. When a facility is no longer needed for mine operation or when it has

reached its design capacity, then reclamation will be initiated as soon as practical. It is assumed that at the final stage of operations, a significant amount of site-specific reclamation experience and performance data will have been incorporated into periodic reclamation plan updates. The final reclamation plan will be submitted for approval two-years prior to planned, final reclamation of the facility. Unlike the periodic updates, which make assumptions about the anticipated closure conditions (i.e., Basis of Cost Estimate); the final plan will be based on the actual conditions that exist at closure.

5.1.6. Post-Closure Care and Maintenance

Achievement of many reclamation goals can be expected over a number of years. Following final reclamation, the site will be inspected, monitored, and maintained in a fashion that helps achieve the long-term goals set out in this Plan. HGCMC has determined long-term post-closure water treatment (active) may be required for mine drainage and TDF seepage. Specific water management practices such as batch treatment will be estimated based on closure assumptions prior to final closure, will be defined more clearly when actual closure conditions exist and may be further refined based on information obtained during post-closure monitoring. Appendix B provides more details on assumptions regarding post-closure care and maintenance.

5.2. Reclamation Plan Submission and Approval

HGCMC will continue to submit an updated Reclamation Plan as required to keep current with operations, regulatory changes, and issues identified during the regular third-party Environmental Compliance Audits. Each updated and revised Plan will contain sufficient detail to allow for calculation of estimated closure costs including post-closure maintenance and monitoring. The Plan will identify how the reclaimed facilities will conform to relevant performance standards.

More frequent Plan revisions may be required by the agencies if substantial increases in the disturbed area have occurred since the last update, or if specific portions of the Plan are shown to be inconsistent with performance goals.

The Plan shall contain cost calculations and a tabulation of material quantities required to complete the reclamation. The Annual Report contains a description concurrent reclamation that has occurred and anticipated reclamation projects for the following year.

The Reclamation Plan and other relevant GPO appendices will be maintained in accordance with agency monitoring requirements. These documents describe the sites monitored, the data collected, and the monitoring frequency and duration.

5.3. Reclamation Cost Calculation and Bond Release

The regulatory agencies have coordinated their financial assurance authority through a Memorandum of Understanding (MOU) to require financial assurance for performance of reclamation and facility closure and post-closure monitoring activities at Greens Creek. Proof of financial assurance, which may take any form mutually agreed upon by the agencies and HGCMC, is referred to as a “bond” in this section. Unless otherwise agreed between the agencies and HGCMC, the bond amount will be calculated on the basis of the Reclamation Plan and use of the Standard Reclamation Cost Estimate Model (SRCE) Version 1.4.1 Build 16. The bond will address all costs that would be incurred by the agencies in taking over reclamation activities in the event of Operator default (Appendix B).

5.3.1. Incremental Bond Release

A site or area will be eligible for release or partial release of the bond amount directly attributable to that site or area when all pertinent aspects of final reclamation activities are complete. This includes but is not limited to removing any facility and necessary materials, grading the surface, applying cover-soils as necessary, applying the approved final seed mix, and the area exhibits vegetative cover meeting the specific plant community goals as specified in Section 6.2.2. Bond release can be sought for areas reclaimed concurrently (during operation) or after final reclamation.

For a site or area subject to overlapping jurisdiction of the agencies, concurrence from all agencies having jurisdiction over the site or area will be sought as to the completeness of the reclamation. HGCMC will apply for incremental bond release by submitting a letter to the appropriate agencies requesting release of the specific site or area(s). The letter will summarize the conducted reclamation activities, the reclamation activity schedule, and the final revegetation completion date.

The agencies will approve incremental bond release through a process upon which they have agreed. The agencies may require a joint agency/HGCMC site visit to confirm that HGCMC has completed pertinent reclamation activities at the site or area(s). These reclamation requirements will be described in the final reclamation plan, in the waste management permit, and in other applicable permits. If required, HGCMC will continue monitoring the site or area(s) in compliance with applicable permits or approval until the agencies release the entire bond.

5.3.2. Bonding and Management during Post-Closure

After mining activities are completed in a particular area, HGCMC will return the area to a near-natural condition using the pertinent procedures described in this Reclamation Plan. After closure, a portion of the site's total bond will be retained for a period to be determined in consultation with the agencies, in light of the applicable post-closure care requirements, to provide for personnel, materials, equipment, and repairs necessary for monitoring, maintenance, and post-closure water management (active and passive water treatment).

If monitoring shows that a site or area is not satisfactorily progressing toward meeting performance goals, HGCMC, will within 60 days of problem identification propose for the agencies' concurrence a written corrective action plan which may require either or both:

- Continued monitoring, with continued retention of the remaining bond amount, over an extended period until progress is made toward satisfaction of the performance goals
- Implementation of additional remedial measures to correct the situation delaying or preventing attainment of those goals

If remedial measures are implemented, HGCMC will, at the discretion of appropriate agencies, restart the monitoring period, which will delay bond release. The agency holding the bond, in accordance with the agreement among the agencies, may proceed with final bond release if the problems being addressed through remedial measures represent an insignificant proportion of the disturbed area compared to the overall success of the reclamation closure.

5.3.3. Bond Release

Final release of the bond for the physical reclamation and closure of facilities will occur when monitoring demonstrates that performance goals/objectives described in Section 5.0 have been met and any post-closure monitoring required by an applicable permit or approval has been satisfactorily completed.

Application for and final bond release will follow the same protocol as described above for incremental bond release. Removal of monitoring equipment and abandonment of monitoring wells (according to ADEC regulations) will follow the joint agency/HGCMC site visit for confirmation of final bond release.

Long-term post closure water treatment, monitoring, and periodic dam safety inspections will have specific financial assurance to provide funding for potential in perpetuity operation of the designated post-closure facilities.

5.3.4. Reporting

Annual reports required under the WMP are submitted by HGCMC to the USFS, ADEC, and ADNR. Additionally, performance monitoring of reclaimed areas, and post-closure monitoring results will be reported.

6. RECLAMATION GOALS AND PROCEDURES

General procedures for physical stabilization and revegetation of mined land disturbances are well documented and proven. Additionally, the procedures discussed herein for the development and management of reclaimed process components, contact water, and storm water runoff associated with the Greens Creek Mine and infrastructure. These proven techniques are incorporated throughout the Plan and, in coordination with the agencies will be continuously used during the implementation phase of final reclamation.

The ultimate goal of final reclamation of the site is to blend into the natural landscape features of Admiralty Island, minimize or eliminate long-term management requirements, and meet applicable AWQS for surface and groundwater, which is consistent with the Tongass Land and Resource Management Plan.

6.1. Aesthetics

The final reclamation plan will be reviewed by a designated professional staff from USFS, ADNR, and ADEC to assess the degree to which the reclamation plan meets the aesthetic goals of the plan. Examples of aesthetic considerations in a reclamation plan may include but are not limited to:

- reduction in the extent of long uninterrupted slope crests with the same elevation;
- design of contours on reclaimed facilities that have crenulations in plain view (e.g. having an irregularly wavy or serrate outline) that approximate those found in surrounding landforms;
- creation of slopes that have a similar profile to those found in surrounding landforms (e.g. concave or convex profiles); and
- integration of natural drainage networks into reclaimed slopes.

Aesthetic considerations may conflict with other performance goals such as stability or environmental performance of engineered covers. Where such conflicts exist, environmental protection shall take precedence over aesthetics.

6.2. Earthwork and Revegetation

Reclamation will require extensive earthwork. The mill/administration/warehouse complex will require removal of potentially acid generating rock (see SRCE User Sheet 1), grading, contouring, and possible growth media application. The TDF will require final cover construction. Generally, slopes will be constructed to 3H:1V, shallower where feasible, or match surrounding topography. Figure 2 and Figure 4 depict typical post-reclamation topography (i.e., end of operations) of the Greens Creek reclaimed access roads and the TDF once final regrading of surfaces has occurred. Potentially acid generating rock encountered in the access roads will be hauled to the TDF or underground (See SRCE User Sheet 1).

Growth media is generally described as material that will support vegetation following reclamation. It may contain organic matter, but HGCMC experience indicates that “topsoil” is not necessary for successful revegetation of disturbed areas at the site. HGCMC will use growth media salvaged from construction of access roads, material sites, TDF, and TDF ponds for reclamation and construction of covers on the TDF. Table 2 lists volumes of stockpiled reclamation material and the location of the major stock piles are shown in Figure 1. Additional growth media needed to complete reclamation will be imported from off-island sources as needed for cover construction and revegetation. There is an additional 199,874 cu. yd. of material in the 1.4 A road sand pit that could be used for reclamation. However, this material is not being used in this Plan. Reclamation materials, such as topsoil, till, and marine sediments are salvaged

when practical and stockpiled in a manner that keeps them separate from other materials. HGCMC keeps an inventory of reclamation material stockpiles that documents their location and content so they can be located and utilized during mine closure (Table 2). Sites D and E have material that is suitable for the barrier layer of the cover. This silt/clay/gravel till was excavated from the mill site during construction of the mill and is currently overlain by waste rock at sites D and E. Reclamation of these sites will entail removing the waste rock in a manner that prevents comingling with the till material. Once the waste rock is removed, the till will be available for use in construction of the cover at the tailings facility. The clay matrix of the till has inhibited downward flow of drainage from the waste rock through the till.

Earthwork will utilize industry standard heavy equipment. It is anticipated that the equipment list will include dozers (track and rubber tired), water truck, motor graders, hydroseeder, grid compactor, broadcast seeder, straw blower, and disk harrow. Other equipment such as (but not limited to) front-end loaders, track and tire mounted backhoes, and haul trucks may be substituted for or included with this general equipment list. Equipment needs, and use must and will remain dynamic, as specific conditions require during implementation of the plan.

Table 2: Total Volumes of Stored Reclamation Material

Material	Location	Reclamation Soils Subtotal by Volume (yd^3)
Till	0.9 mile A Road	4,458
Till	1.9 mile B Road	100
Peat/Organics	2.8 mile B Road	664
Till	3.2 mile B Road	5,300
Till	4.6 mile B Road	7,640
Mill Site	4.9 mile B Road	29,262
Till	5.9 mile B Road	1,165
Till	6.2 mile B Road	14,402
Till/Organics	6.3 mile B Road	672
Till/Organics	6.4 mile B Road	720
Till	7.3 mile B Road	3,810
Till	7.4 mile B Road	1,746
Till	7.5 mile B Road	647
Till	7.6 mile B Road	4,056
Till	Pit 405	10,895
Till	Pit 174	10,375
Till	Pit 6	18,418
Till/Organics	Site 23	5,000
Till/Organics	Pit 7	163,280
Approximate	**Total**	**262,028***

*as of March 2019

6.2.1. Revegetation

Disturbed areas at Greens Creek will be reclaimed to one of three vegetation types including upland meadows, upland forest, or wetlands (A Revegetation Manual for Alaska, 2008). Specific seed mixtures, woody seedling density, and maps showing each vegetation type will be submitted with the final reclamation plan and subsequent reports.

Following final reclamation, revegetation success will be monitored for three years following seedbed preparation, fertilization, and seeding, mulching, and temporary erosion control measures. Monitoring reports will include information regarding condition, ground cover, and species present.

Upland Meadow Areas

Areas reclaimed with grass and forbs on Admiralty Island have shown significant use by a wide range of wildlife species i.e., deer, bear, rodents, raptors, and songbirds. HGCMC will generally limit open meadow areas to 10 contiguous acres to enhance edge-effect, benefit wildlife, improve aesthetics, and advance the rate of succession to the next seral stage. Forbs will propagate as natural volunteers and will not be planted or included in the seed mix.

Upland Forest Areas

Forest stands will be developed using a combination of natural regeneration and reseeding or transplanting if necessary. Natural regeneration is preferred over planting as a means of establishing a coniferous overstory in small areas where seed sources are available. Natural regeneration will ensure re-establishment of Admiralty Island genotype species, follow natural successional stages, and provide unique wildlife habitat during stand development. Naturally-regenerated plants are well adapted to growing on site. The seeds either migrate from surrounding native plants or, in many instances, are already in the soil. Natural regeneration benefits the environment by ensuring the succession of naturally occurring, site adapted genotype species.

According to an Alaska Forest Management Education Alliance pamphlet on Forest Regeneration, Alaska has some unique regeneration opportunities that relate to the type of trees and cold soils in Southeast Alaska. The coastal forests of Southeast Alaska regenerate very quickly and profusely. Approximately 95% of disturbed areas seed-in naturally from surrounding stands. Western hemlock and Sitka spruce grow rapidly in this area. Natural regeneration of these climax species is evident throughout areas previously disturbed by HGCMC activities and in areas without any reclamation preparation.

HGCMC will utilize natural regeneration as the primary method of woody plant restoration in areas seeded as upland forest and in smaller disturbed areas where adequate seed trees are present. Accelerated regeneration through seeding will be implemented if necessary in more expansive reclaimed areas (several acres), or in areas that require stabilization (*Alaska Coastal Revegetation & Erosion Control Guide. 2010*). Accelerated regeneration would consist of planting more of the climax species to minimize large open areas and accelerate succession.

In areas where the trees propagate either from natural regeneration or from planted seedlings, HGCMC may thin the subsequent growth to allow the remaining trees to grow more quickly and achieve climax forest conditions. As determined by the generally accepted Silvicultural Prescription for coastal forests of Southeast Alaska.

Wetland Areas

Wetlands provide food, protection from predators, and other vital habitat factors for many fish and wildlife species. Wetland systems have economic value associated with recreational, commercial, and subsistence use of fish and wildlife resources. In addition, wetlands remove sediment from overland flows before they reach lakes, rivers, and bays. Wetlands intercept storm runoff and release floodwaters gradually to downstream surface and groundwater systems. A significant portion of the Greens Creek temperate rain forest setting supports wetlands. Riparian, muskeg, and forested wetland communities all occur in the area (*Streambank Revegetation and Protection – A Guide for Alaska. 2005*).

Seed Mixtures:

The following specific seed mix is used for interim erosion control at the Greens Creek Mine.

Common Name	Scientific Name	% of Mix
Annual ryegrass	*Lolium perenne* ssp. *multiflorum*	40%
'Boreal' Red fescue	Festuca rubra	40%
'Arctared' Red fescue	Festuca rubra	20%

If either boreal red fescue or arctared fescue is unavailable, then the amounts of the available two may be adjusted to total 100%.

The application for hydric or wetlands seeding using the seed mix would be 15 lbs. of pure live seed (PLS) per acre. Approximately 15 to 30 lbs. of PLS per acre would be applied for mesic or upland areas depending on surface contours, grade, aspect, and rockiness of the specific site.

Approved Concurrent and Final Reclamation Seed Mix for Mesic (Upland) and Hydric (Wetland) Areas

Upland

Common Name	Scientific Name	% of Mix
'Nortran' Tufted hairgrass	*Deschampsia caespitosa*	60%
'Boreal' Red fescue	Festuca rubra	20%
'Arctared' Red fescue	Festuca rubra	10%
'Gruening' Alpine bluegrass	Poa alpina	10%

The ADNR, Plant Material Center (ADNR 2014) recommends a broadcast seed at a rate of 43 pounds per acre for areas completely devoid of vegetation or when native species may be inhibited from moving into the site. For other areas the application rate for the Upland seed mix would be approximately 15-30 lbs. of PLS per acre depending on surface contours, grade, aspect, rockiness of the specific site. A lower seeding rate also allows for species to move in by natural reinvasion.

Wetland

Common Name	Scientific Name	% of Mix
'Egan' American sloughgrass	*Beckmannia syzigachne*	45%
'Notan' Tuftedhairgrass	*Deschampsia caespitosa beringensis*	45%

'Sourdough' Bluejoint reedgrass	*Calamagrostis canadensis*	10%

Broadcast seed at a rate of 30 lbs. per acre for areas completely devoid of vegetation and when native species may be inhibited from moving into the site. For other areas the application rate for the presently proposed seed mix would be 15 lbs. of PLS per acre.

Fertilizer:

Chemical fertilizers will continue to be used with the following chemical analysis and application rate (depending on availability):

- 10-20-10 (10% nitrogen, 20% phosphorus, and 10% potassium): 200 lbs./acre (225 kg/ha) or
- 22-13-6-7S-1Mg (22% nitrogen, 13% phosphorus, 6% potassium, 7% sulfur, and 1% magnesium; 200 lbs./acre (225 kg/ha) and
- 46-0-0 (nitrogen urea): 100 lbs./acre (110 kg/ha)

The specific fertilizer used will be based on availability and with prior agency notification.

Mulch:

Disturbed areas within the Greens Creek site vary in the amount of organic matter in the growth media placed prior to seeding and fertilizing. The rate of mulch (organic materials) added has varied from 100 lbs./acre (110 kg/ha) to 1,800 lbs./acre (2,018 kg/ha). For planning purposes and closure cost estimating, the higher application rate will be used, but actual field application rates may vary depending on site specific conditions.

6.2.2. Specific Plant Community Goals

Vegetation on concurrent and final reclaimed areas at Greens Creek will be subject to monitoring requirements and performance standards that will be derived in consultation with appropriate regulatory agencies following revegetation and considering site-specific conditions. Roads used for permanent access and other areas where buildings are maintained for post-mining use, will not be subject to vegetation standards.

6.3. Wildlife Use

If stipulated by the agencies involved, HGCMC will conduct qualitative wildlife species counts to monitor wildlife habitat utilization and wildlife habitat potential of the reclaimed areas.

6.4. Fish and Fish Passage

The infiltration gallery and weir in upper Greens Creek adjacent to the 920 portal will be removed at final closure. HGCMC will collaborate with ADF&G, Habitat Division on the final stream bed substrate and gradient.

The constructed Fish Pass, located near river mile 3.5 on Greens Creek, will be maintained after final closure to meet the long-term fish passage goals set by the ADF&G, Habitat Division, and the 2013 USFS ROD. Alternatives to maintaining constructed weirs may include excavation of material or blasting to create a stable long-term natural gradient that provides fish passage.

6.5. Roads and Site Access

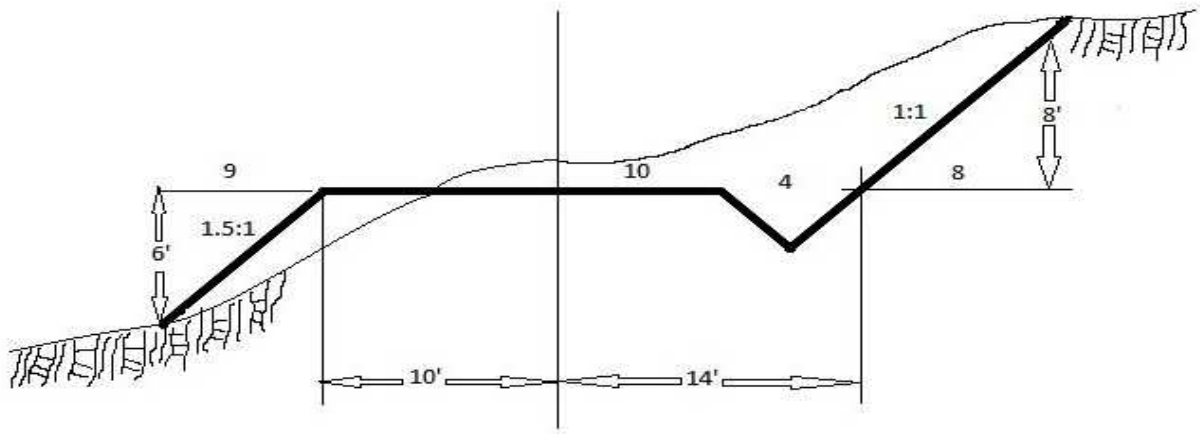
The primary access roads from Young Bay to Hawk Inlet and from the TDF to the mill area and portal will be removed at closure. Access from Hawk Inlet to the Water Treatment Plant (WTP) located at the TDF

site (Figure 1) will be maintained because the continued collection and treatment of contact water (Section 7.1.4) will require access to maintain and replace equipment (i.e., pipe, tanks, pumps, etc.), deliver reagents, and monitor operations of WTP facilities.

6.5.1. Bridges and Culverts

Bridge components on the B Road and over Greens Creek that are necessary to provide pipeline crossings will be retained. Nonessential bridge components (e.g. wood decking, deck supports and splash guards) will be removed. Access to these structures will be via helicopter. Other structures (e.g. road ditch culverts) will be removed during reclamation of the road.

Figure 2: Typical Road Cut / Reclaimed Slope



6.6. Waste Rock Disposal and Tailings Disposal Facilities

Material from WDF (Site 23/D) will be transported to the TDF or underground for final disposal. The original ground surface will be recontoured and growth media placed for revegetation. The TDF will be contoured and reclaimed with an engineered cover. The cover will be designed to include a low permeability layer or oxygen excluding layer consisting of a mixture of silt and clay covered with growth medium to promote revegetation of the areas (Figure 4). HGCMC has commissioned studies by the Oregon State University on vegetative cover growth, including conifer reinvasion and windblown trees, on integrity of the cover that indicate the cover will meet the objectives of the design (OSU 2010). Drain layers consisting of sand and/or gravel may also be incorporated into the cover to promote lateral drainage within the cover profile and act as a capillary break between cover layers and the tailing pile. Pond 7 and Pond 10 at the TDF (Figure 3), will remain to provide adequate storage for seepage, underdrain, and storm water collected at the TDF. Furthermore, eventual mine drainage will report to this pond system. In addition to Pond 7/10, if any additional ponds are defined a dam as specified by ADNR, requirements for operation, abandonment or removal will be included in the appropriate revision of the Plan. Assumptions regarding the operation and maintenance costs for ponds are included in Appendix B and SRCE. Once vegetation is established and surface water runoff meets the applicable AWQS, only TDF seepage and underdrain water, mine drainage, and precipitation (directly into the ponds) will be collected and stored for batch water treatment.

Figure 3: Tailings Disposal Facility

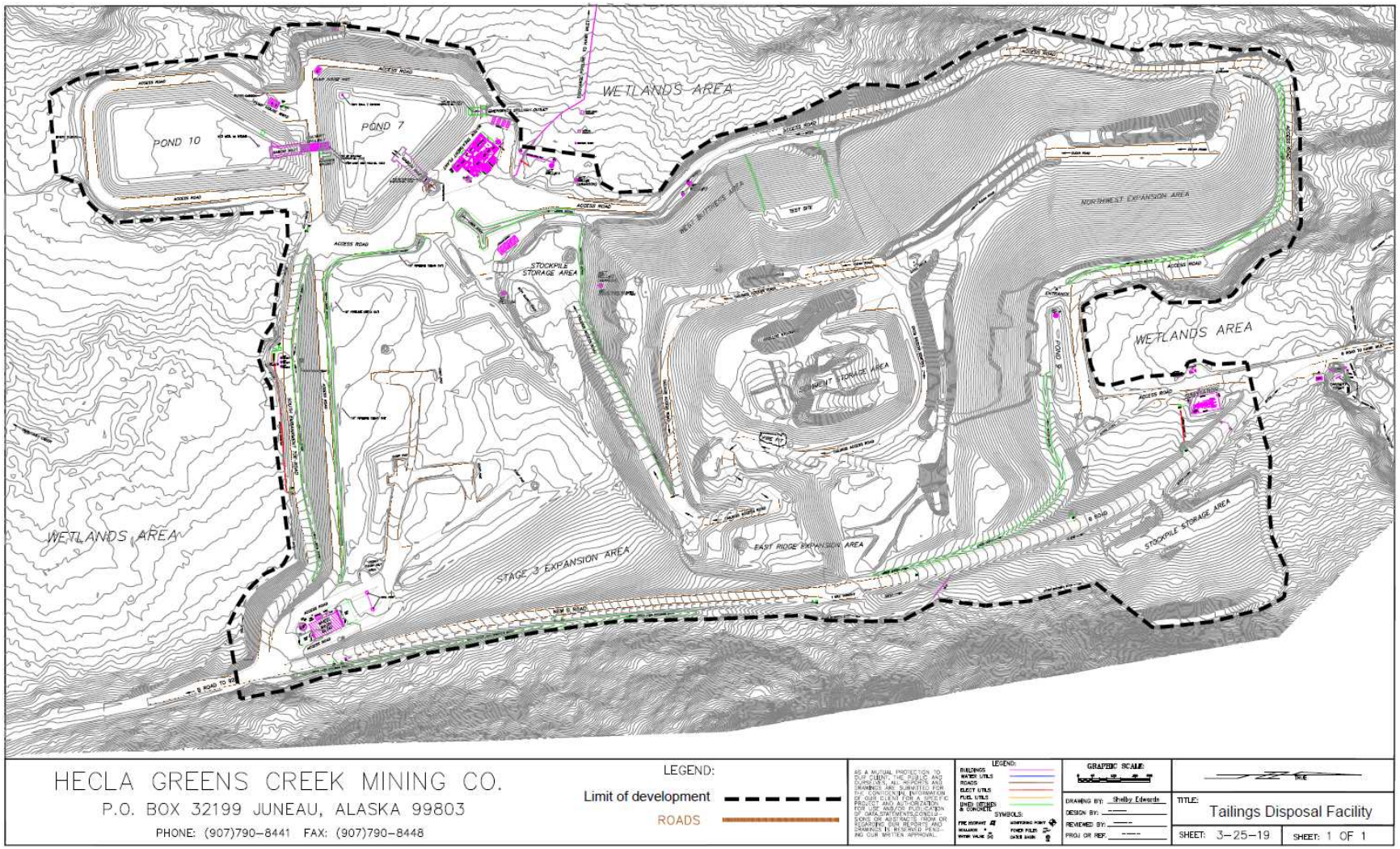
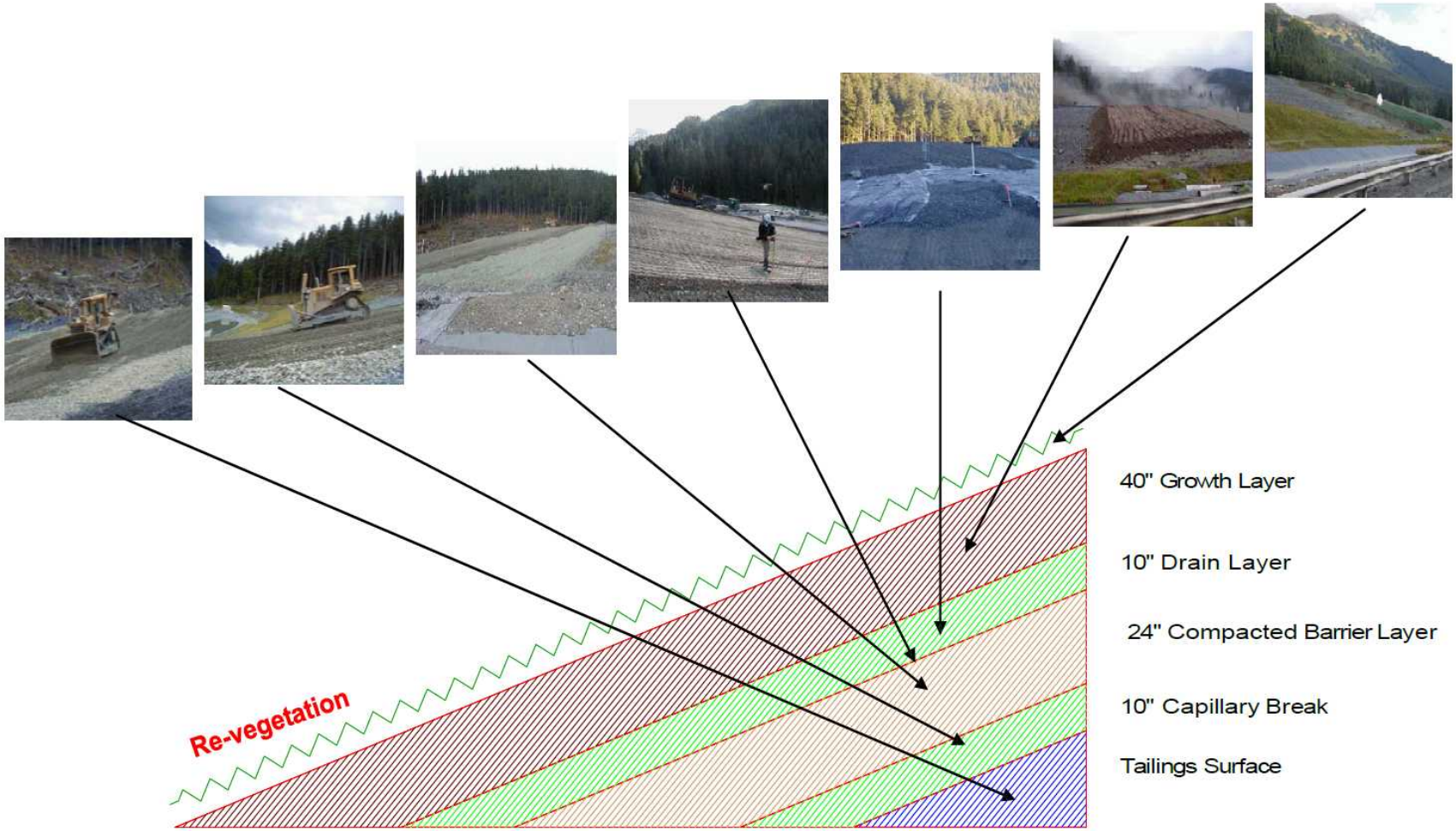


Figure 4: Engineered Cover - Typical 4-layer installation on a 3:1 slope



6.7. Demolition of Structures and Equipment

6.7.1. Mine Portals

The 1350 Portal and two surface ventilation shafts will be sealed and the area recontoured to promote runoff away from the sealed portal, vent shafts, and reclaimed 1350 waste rock site. The access road from the 920 Portal to the water tank and 1350 Portal will be reclaimed after the upper portal and ventilation shafts are sealed, and water tank removed (Figure 1).

Four exploration drill holes (2.15-inch diameter) from the 1,350 elevation will be grouted and three internal mine ventilation shafts (8.0 ft. diameter) between levels will be plugged with concrete. A bulkhead will be constructed at the 920 Portal and the workings will be allowed to flood naturally. When the flooded underground water level reaches the 920 Portal bulkhead it will flow via gravity pipeline to the TDF water treatment plant or a passive system if it is determined that adequate treatment is provided to meet Alaska Water Quality Standards (AWQS).

6.7.2. Hawk Inlet Facilities

The facilities at Hawk Inlet will be partially reclaimed to leave only the historic cannery buildings (Figure 1). The concentrate storage and load out facility will be decontaminated (with power washer), demolished, and material recycled or disposed of in the TDF, or underground workings of the mine. Fuel storage tanks will be dismantled and removed from the site as scrap steel. The warehouse, shipping containers, shift housing, tanks, core shed, maintenance building, and assorted trailers will be dismantled, demolished, or recycled as appropriate for the structure.

HGCMC will defer a final decision on the demolition and reclamation of the drinking water and sewage treatment facilities until a final post-mining use of the Hawk Inlet historic buildings is determined.

6.7.3. Young Bay

The A Road east of the tailings pile to Young Bay and dock facility lies outside of the National Monument in an area with a Land Use Designation of “Semi Remote Recreation”; as such, the two areas are treated slightly different within the Forest Plan in regards to minerals development and reclamation. For cost estimating purposes HGCMC assumes the A Road will be reclaimed during the closure period (Years 1-3) and the electrical transmission line will remain until Year 10. Access to the electrical transmission line by the third-party owner of the line (Kwaan) following road removal will be by helicopter as in other remote areas within their distribution network. Maintenance and removal of the power line is the responsibility of the third-party owner. The existing barge, pier facilities, and pilings will be removed at final closure. Pilings that cannot be pulled out will be cut at base level.

6.7.4. Solid Waste

Structures that have been constructed on Forest Service administered lands, plant site, and other structures not identified to remain for post-mining use will be demolished. All material and equipment will be salvaged and recycled when cost effective. All hazardous materials will be removed as described in Section 6.7.5 below. Materials that cannot be salvaged will be disposed of in designated areas of the underground workings as approved under the Waste Management Permit issued by ADEC, removed from the site for disposal, or disposed on-site in an appropriate manner. If applicable, a solid waste permit will be obtained for on-site disposal of demolition debris.

HGCMC will recover and remove all salvageable equipment, instrumentation, furniture, unused chemicals and fuels, and other salvageable or waste material following permanent closure of the operation. Removal

will consist of loading at the site, transporting to the HGCMC Hawk Inlet facility and offloading to a barge. These materials will either be shipped to buyers, recyclers, or to an approved waste disposal area.

6.7.5. Hazardous Materials

Hazardous materials that remain on-site at the time of final reclamation, whether in the form of unused process reagents, fuels or lubricants, or as residue from demolition of the site (contaminated soil, etc.) will be removed from Admiralty Island and will be properly recycled or disposed under applicable State and Federal law.

6.7.6. Miscellaneous Sites and Equipment

Wells and Well Closure

Once monitoring of the TDF and other process components indicates component stability, the applicable monitoring wells for those facilities would be abandoned by plugging the well and removing the surface casing. Well abandonment will be conducted in accordance with ADEC regulations (18 AAC 80.015). Abandonment procedures generally include removal and disposal of pumps and piping, removal of the casing where possible, perforating the screened portion of the well, plugging of the well with an approved sealing material at total depth, removal of the collar, minor grading around the well site, and revegetating the area as appropriate (i.e., seeding, mulching, etc.).

At Greens Creek, bentonite or cement grout would be forced into the perforated screened interval and into the remainder of the well casing to decommission the well in a way that protects the groundwater resources.

After mining and milling ceases, additional wells not needed for post-closure monitoring will require abandonment. This procedure will be revisited on a periodic basis as additional operating data become available and during development of final process component closure plans.

Fence Removal

The use of fences as a post-mining reclamation structure would be minimized in favor of more permanent structures, such as earthen berms, to restrict access. The use of fencing during closure will be limited to reagent areas for the WTP or until such time that all reagents and chemicals (including, but not limited to petroleum products) are removed from the site. During final site closure, all manufactured fencing will be removed except in those area previously noted.

Mobile Equipment

For the purposes of this plan, no salvage value will be assigned to the mobile equipment. Mobile equipment and other equipment not needed for future potential uses of the site will be salvaged and removed from the site. Mobile equipment not designated for removal will be buried in designated area of the underground workings at closure. To prevent degradation of water resources or other contaminant mobilization, batteries will be removed and all fluids will be drained from all mobile vehicles prior to final disposal underground. The equipment burial locations would be surveyed and reported to the ADEC in the final closure report for the site.

7. STABILITY AND WATER MANAGEMENT

7.1. Mass Instability

Semi-annual inspections of all reclaimed areas for evidence of slope instability shall be made in year 1. Annual inspections will be made in years 2, 3 and 5 following completion of reclamation activities. Additionally, the TDF reclaimed with an engineered cover will be monitored for the duration of the post-closure mandatory period specified in the waste disposal permit. HGCMC will submit slope-stability reports to the appropriate agencies, summarizing the findings of the periodic inspections.

- Underground Mine: The portal area and areas where stopes are within 50 ft of land surface will be monitored from the surface for signs of geotechnical instability. The final reclamation plan will include a map of these stope areas.
- TDF: The slopes of the tailings pile will be monitored to verify the TDF remains in a stable condition.
- Other Reclaimed Areas: The slopes of other areas throughout the permit area, including the mill area, material sites, access roads, and other support facilities will be monitored to confirm the areas remain in a stable condition.

Mass instability, including slope failure and subsidence in the above areas, will be subject to the contingency requirements described below.

Underground Mine: If crown pillar failure occurs over any stopes, or if development headings collapse near the portal, HGCMC will notify the appropriate agencies within two business days of problem discovery, will conduct a geotechnical investigation to determine the cause of such failure and will propose a corrective action plan for review. After review and approval of the plan by the appropriate agencies, HGCMC will implement the approved plan in a timely manner.

TDF: If slope movement, subsidence, erosion or other mass instability is observed in the tailings pile, HGCMC will notify the appropriate agencies within two business days of problem discovery. A geotechnical investigation will be conducted to ascertain the extent of the problem, and a report describing the situation as identified, including estimates of the volume affected by the instability and potential consequences of the instability with respect to its effect on the integrity of the cover system and drainage features. Investigation report will be developed by HGCMC and submitted to the appropriate agencies within 30 days of the date of problem identification. A corrective action plan will be submitted by HGCMC to the agencies for review and approval within 75 days of the date of problem identification. Any remedial measures undertaken in conjunction with the corrective action plan will be completed in a timely manner, which minimizes disturbance to reclaimed areas and meets all original design criteria for the tailings pile.

Other Reclaimed Areas (i.e., material sites, reclaimed roads, etc.): If slope movement, subsidence or other failure which threatens the integrity of any other reclaimed area occurs, HGCMC will notify the appropriate agencies within 30 days of problem discovery and will repair any damage that could affect other reclaimed facilities in a timely manner.

7.1.1. Permanent Channels and Channel Inspection

Surface water flows will be managed in most cases by establishing vegetative cover and constructing moderate slopes. Most slopes will be constructed with a 3H: 1V slope. Constructing slopes at 3H:1V

reduces the erosive effects of water. In areas with minor flow concentrations, brush berms, silt fences, and swales will be used to reduce the velocity of the water and reduce erosion while vegetation becomes established. Also, hydroseeding of these areas will stabilize the soils.

If natural stream channels enter reclaimed areas the water will be diverted, diffused, or channeled through the reclaimed area using designed and constructed non-erosive channels. If necessary, stream channels will be stabilized with degradable fiber mat to establish vegetation. Riprap will be used to stabilize the constructed channels in areas that are subject to highly erosive stream flows.

Drainage channels and diversion structures are incorporated into the design and construction of the site facilities.

Modifications to the drainage channels will be accommodated as necessary in the design and construction of the cover at the TDF. All drainage channels and diversion structures that will be retained after closure are designed to handle flows from at least a 24 hour/25-year storm event, with minimal maintenance. These structures will be subject to the routine inspection and maintenance requirements described below.

In order to ensure that the drainage channels and diversion structures are functioning properly, they will be inspected semi-annually by site staff for signs of excessive erosion for five years following completion of reclamation activities. After the first two years of monitoring, HGCMC may propose to the appropriate agencies that inspection be conducted less frequently if appropriate. During the five-year period, drainage channels and diversion structures will be inspected within 24 hours following any 24-hour storm event in excess of two inches of rainfall for signs of deterioration and erosional damage as well as excessive sedimentation.

During the remainder of the post-closure monitoring period required under the waste disposal permit, drainage channels and diversion structures will be inspected after each storm event that exceeds the largest prior storm that has occurred since completion of reclamation. The appropriate agencies may require more frequent inspection by HGCMC during the post-closure monitoring period if the drainage channels and diversion structures are shown to require frequent maintenance or repair.

Routine inspections and inspections completed after major storm events will be subject to the following requirements:

- physical damage, trash build-up, and sedimentation will be recorded on field inspection sheets
- diversion intake and outflow areas will be inspected for evidence of scouring or bypass
- any areas needing maintenance or repair will be reported on the field inspection sheets

If damage is noted, appropriate repairs will be completed by HGCMC in a timely manner. A summary of all observed damage requiring repair will be submitted annually to the appropriate agency, including as-built reports verifying the completion of the required repair.

If significant damage or overflow is caused by storms that are smaller than the structure's design storm, HGCMC will conduct an investigation to identify the cause of significant damage or overflow of diversions. A report will be prepared by HGCMC identifying the extent of the problem and the probable causes. The report will be submitted to the appropriate agencies within 30 days of the date of problem identification. A corrective action plan will also be submitted to the appropriate agencies for review and approval within 75 days of the date of problem identification. The corrective actions to be taken may include, but need

not be limited to, regrading, armoring of drainage features, redesign and re-construction of channel cross-section and alignment, replacement of topsoil, reseeding, and replanting of trees and shrubs. After approval by the appropriate agencies, HGCMC will implement the plan in a timely manner.

7.1.2. Drainage

The surface of the reclaimed facilities will be maintained in a free-draining condition, which allows water to egress the facility without ponding or causing erosion, to the extent practical.

If significant ponding of water occurs on the surface of any non-wetland reclaimed facility, HGCMC will notify agencies within two business days of the date of problem identification. In addition, the extent of such ponding will be ascertained and a report describing the situation as identified, including probable causes, will be developed by HGCMC and submitted to the agencies within 30 days of the date of problem identification. A corrective action plan will be submitted by HGCMC to the agencies for review and approval within 75 days of the date of problem identification. Following approval of the corrective action plan by the agencies, HGCMC will implement the plan in a timely manner. The corrective actions to be taken may include, but need not be limited to, the following steps:

- Placement of additional fill that meets original design criteria
- Re-grading of placed fill to original design criteria
- Placement of growth medium to original design thickness

Any such remedial measures will be undertaken in a manner that minimizes disturbance to adjacent reclaimed areas.

7.1.3. Cover Performance and Inspection

Performance monitoring of an engineered cover test plot commenced at Site 23 in 2000. Construction and monitoring of a new test plot on the tailings pile will begin after sufficient final slope area is available and information from the Site 23 test plot monitoring is incorporated into a design update. Performance data from these test plots will help guide construction of the final cover at the tailings facility. Climate data, soil suction, temperature, moisture content, and soil gas compositions will be monitored initially to verify that the cover is performing as designed. Long term cover performance will be evaluated based on visual observation of the cover surface and facility water quality monitoring.

Cover Inspection

In order to ensure that the cover systems are functioning properly, they will be inspected semi-annually for five years following completion of reclamation activities for signs of excessive erosion, damage due to blow-down of trees or damage by animals. Long-term post-closure inspections will continue annually.

The cover is designed to minimize erosion and monitoring of the cover surface by site staff during batch treatment campaigns will allow for rapid identification and remediation if a problem develops. After the first two years of inspection, HGCMC may propose to the appropriate agencies that inspection be conducted less frequently, if appropriate. During the five-year period, the cover system, diversion structures, and drainage channels will also be inspected by HGCMC within 24 hours following any 24-hour storm event in excess of two inches of rainfall for signs of deterioration and erosional damage as well as sedimentation. Any necessary repairs will be completed by HGCMC in a timely manner.

If levels of erosion, which are potentially destructive to the cover, are identified, HGCMC will notify the appropriate agencies within two business days of the date of problem identification. In addition, the

extent of the problem will be ascertained and a report describing the situation as identified, including probable causes, will be developed by HGCMC and submitted to the agencies within 30 days. A corrective action plan will be submitted to the agencies for review and approval within 75 days of the date of problem identification. Following approval of the corrective action plan, HGCMC will implement the corrective action plan in a timely manner. If the cover system is breached by rodents and/or other digging wildlife, the extent of the problem will be ascertained and a report describing the situation as identified, including probable causes will be developed by HGCMC and submitted to the appropriate agencies within 30 days of the date of problem identification. A corrective action plan will be submitted to the agencies for review and approval within 75 days of the date of problem identification. Following approval of the corrective action plan, HGCMC will implement the plan in a timely manner. If removal and/or relocation of animals are required, State of Alaska and Forest Service biologists will be consulted regarding the removal/relocation process. In the event of an emergency need to remove or relocate animals when no biologist is available for consultation, HGCMC will consult with qualified wildlife biologists and submit a summary report of the actions taken to the agencies.

Repair of the low permeability layer will include, but need not be limited to, the following steps:

1. Removal of growth medium from the affected and immediately adjacent area and stockpiling
2. Removal of the damaged areas of the low permeability layer or oxygen-excluding layer
3. Re-installation of the cover components in affected areas to the design performance criteria under the same QA/QC procedures as the original installation. The edges of the re-installed layers will overlap with the adjacent undisturbed layers to assure adequate joining of the layers.
4. Replacement of overlying cover layers to their original design thickness
5. Reseeding/planting as per original design specifications

All such repairs will be undertaken in a manner that minimizes the disturbance to the surrounding reclaimed area. HGCMC will submit an as-built report of the work performed under the corrective action plan to the agencies.

7.1.4. Erosion

All reclaimed areas will be inspected following completion of reclamation activities for signs of excessive erosion. After the first two years of monitoring, HGCMC may propose to the appropriate agencies that inspection be conducted less frequently if appropriate. Routine monitoring will include a visual assessment of rills and gullies.

Monitoring of the constructed TDF cover for erosion will be routinely conducted to determine that there is not significant exposure of contiguous areas of low permeability or oxygen excluding layers. This monitoring will verify that there would not be a significant decrease in the performance of the reclaimed soil cover in minimizing infiltration into the pile.

Erosion of applied soil covers and growth media on reclaimed roads, material sites, the 920 area, and other reclaimed areas will be monitored to verify that there is not a significant decrease in the performance of the reclaimed soil cover in supporting vegetation and stabilizing the area. If potentially destructive levels of erosion are identified, HGCMC will notify the appropriate agencies within two business days. In addition, HGCMC will determine the extent of erosion and will submit a report describing the situation identified and probable causes to the appropriate agencies within 30 days of the date of problem identification. A corrective action plan will be submitted by HGCMC to the appropriate agencies for review and approval within 75 days of the date of problem identification. Following approval of the

corrective action plan, HGCMC will implement the plan in a timely manner. This work may include, but need not be limited to, regarding, armoring of drainage features, re- establishment of topsoil thickness, reseeding, and replanting of trees and shrubs.

8. PERFORMANCE GOALS

8.1. Water Quality

8.1.1. Monitoring Requirements

GPO Appendices 1 has the necessary methods, procedures, analysis, data management, and information to fulfill the water quality monitoring requirements. After closure HGCMC will continue to:

- sample and analyze groundwater monitoring wells per the appropriate schedule
- sample and analyze surface water monitoring sites per the appropriate schedule
- sample and analyze sediment and marine organisms, as well as marine receiving waters as long as wastewater discharges continue under the Alaska Pollutant Discharge Elimination System (APDES) permit

If practical, remaining monitoring sites that were used in internal monitoring programs at the TDF will also continue to be monitored during the post-closure monitoring period.

8.1.2. Waiver or Modification

Water quality monitoring will be conducted for not less than five years after completion of reclamation activities and not less than three years after cessation of collection and treatment of contact water (see Section 7.1.4). HGCMC may, however, request modification of the water quality monitoring requirements at any or all monitoring sites. Modifications may include removal of water quality monitoring stations, reduction in monitoring frequency, or changes in constituents monitored. Request for changes in the monitoring requirements at a facility will be contained in a report that demonstrates that all downgradient monitoring stations have been in compliance with AWQS for at least three consecutive years. Additionally, results of monitoring at internal sites must corroborate the finding that water quality downgradient of the facility will not change in the foreseeable future. The report will be submitted by HGCMC to the appropriate agencies for their review and approval prior to changing water quality monitoring practices.

This waiver section should be interpreted jointly with provisions contained in the GPO. Where the waiver provisions contained in this document conflict with the GPO, these provisions supersede until the documents are reconciled.

If a point source discharge permit remains in effect for the components of the mine affected by the request for modification, then HGCMC will also obtain approval for any modifications of the point source discharge permit from ADEC.

8.1.3. Performance Standards and Point of Compliance

The facilities will be in compliance if:

1. all relevant AWQS are met at the downgradient monitoring points specified in the GPO; or
2. accepted detection monitoring statistical analysis, as set out in Section D of the HECLA Greens Creek Quality Assurance Project Plan, as applied to the upgradient and downgradient stations fail to show a statistically significant increase in the constituents; or
3. observed exceedance or increase in constituents is due to natural conditions which have been documented and have been accepted by the regulatory agencies.

These provisions for the reclaimed condition of a facility would supersede the compliance provisions of the GPO that apply to operating conditions once the facility is reclaimed.

8.1.4. Contact Water Management and Post Closure Water Management

During operation of the Greens Creek Mine, water collected from the underground workings, seepage collected beneath WDF (Site 23) and the TDF, and storm water runoff of WDF (Site 23/D), the mill area and the TDF are collected and treated. Collectively, these waters, known as "contact water," are collected and treated prior to discharge under an APDES permit (Petros GeoConsulting September 2012).

HGCMC plans to phase out collection and conventional treatment of surface storm water (contact water) from some of these sources as areas are reclaimed, the engineered cover is constructed on the TDF, vegetation established, and water monitoring demonstrates the applicable AWQS are met. In order to ensure that water quality will be protected after HGCMC ceases to collect and treat contact water from these sources, the following requirements will be satisfied.

Before HGCMC will be allowed to cease collection and conventional treatment of contact water, a report will be developed by HGCMC for submission to the appropriate agencies. The report will utilize results of analysis from collected samples and a water quality predictive model of the TDF to determine whether AWQS are or will be met at downgradient stations and will include identification of effective treatment methods. Achievement of applicable AWQS at the compliance point can be by any of the following processes alone or in combination: batch treatment using conventional WTP (High Density Sludge Process), reduction in ARD or metals loads due to reclamation practices, deployment of demonstrated biological or other non-conventional treatment techniques, or reliance on natural attenuation mechanisms.

Monitoring described in the GPO will ensure that appropriate water quality standards are met at relevant points of compliance prior to ceasing collection and conventional treatment of the drainage from a particular site following successful reclamation.

Relevant points of compliance will be monitored for a minimum of three years after cessation of collection and treatment of contact water. If violation of the AWQS occurs at the compliance points, then HGCMC will notify the agencies and take corrective actions as required by the GPO and WMP. The corrective actions to be taken may include, but need not be limited to, changes in the passive treatment system, modification of the water management system, re- establishment of conventional treatment, or improvements to the facility reclamation.

Long-term Water Treatment: Long-term water treatment may be required for some components of the contact water through active water treatment facilities. The WTP has the capacity to discharge 2250 gpm via gravity (more if pumped) and has adequate capacity to efficiently treat identified sources from the mine drainage, and seepage from the TDF at closure. The facility will have additional capacity to treat surface water runoff until AWQS are met.

In order to meet the Alaska APDES effluent limits for copper, lead, mercury, and zinc a High-Density Sludge Process WTP is in use during operations, will continue operating after closure, and during post-closure. The use of conventional chemical precipitation technology continues to effectively reduce constituent concentrations to effluent discharge limits.

In order to minimize pumping and post-closure WTP operations, two new storage ponds located at or below the level of Pond 7 will provide adequate storage of accumulated contact water. Construction of the two ponds will allow full time gravity flow (no pumping) from TDF Wet Well A, Stage 3 above liner

drains and the Pond 7 below liner drain. The stored contact water will be batch-treated (pumped to treatment plant when ponds approach capacity).

Water Treatment Plant Sludge Disposal: Sludge from the water treatment plant will be pumped to one or more of the water storage ponds until enough sludge accumulates to warrant batch dewatering and placement at the TDF or an approved solid waste disposal site. Because of the low flow rates and small sludge volume produced, HGCMC estimates that excess storage in Ponds 7 and 10 will allow for many decades of sludge storage. If removal from the pond(s) is warranted, and disposal at the TDF is the preferred option, a small area with drainage containment will be used to accept the sludge. Due to the oxidized character of the sludge, oxygen exclusion will not be necessary and a simple water limiting cover that promotes vegetation will be sufficient to reclaim the area that receives the sludge.

9. ESTIMATE OF RECLAMATION COSTS

The estimated reclamation costs for the various components of the Greens Creek Mine represent general mining industry accepted reclamation and closure methods. An updated version of the Standard Reclamation Cost Estimator (SRCE) Version 1.4.1 Build 16 was used to prepare this cost estimate. Assumptions used to develop the cost estimate are discussed in detail in Appendix B.

9.1. Closure Cost Rates

Mobile equipment costs were based on other operating underground, open pit mines and contractor costs in Alaska, and include:

- equipment rental costs
- consumables
- ground-engaging tools
- preventative maintenance

In determining the prevailing labor rates, the Alaska Department of Labor and Workforces Development, Division of Labor Standards and Safety's Laborers' & Mechanics' Minimum Rates of Pay (Pamphlet 600) (Alaska "Little Davis- Bacon") was used and will be updated as the Pamphlet is updated.

Material costs for fuel, concrete, etc., were provided by Alaska vendors. Information provided in the 2018 RS Means Heavy Construction Cost Data, Western Edition, was used where equipment, labor, or material rates were unavailable from other sources.

9.1.1. Closure Cost Productivities

Productivity data and calculations were based on:

- Caterpillar Handbook, Edition 36, for productivity calculations as incorporated into the SRCE.
- Means Heavy Construction Cost Data for productivities/crews for demolition. A large excavator with shears and a medium excavator with grapples were added to the building demolition fleet, but no productivity increase was included because of unfamiliarity with this methodology.
- Use of best estimates and available data to populate the SRCE cost model.

9.1.2. Key Cost Assumptions

The following closure cost assumptions were made:

- Mobile equipment will be rented.
- All structures and infrastructure will be removed.
- No salvage value is assumed for scrap, equipment, or mobile fleet.

9.1.3. Conclusions

Acknowledging the social and environmental responsibility associated with modern mining operations, HGCMC recognizes and commits to the comprehensive closure and reclamation of the Greens Creek Mine site and ancillary facilities. All reclamation activities and post-reclamation maintenance of remaining structures (TDF, mine drainage pipeline, and access road) are the responsibility of HGCMC, unless and until a subsequent landowner assumes responsibility. A modification to the designated post-mining land use may require further changes to the closure and reclamation plan, along with the timelines for implementing and finalizing closure.

The reclamation cost estimate, as discussed herein and included in Appendix B (see SRCE Cost Summary tab for grand total amount) is sufficient to fund the following:

- all elements of reclamation discussed in this Plan;
- capital to construct future replacements for the WTP for water treatment (100 years);
- reagent and operating costs for the WTP; and
- associated facility and access maintenance.

10. ACKNOWLEDGEMENTS

1. It is understood that should the nature of the operation change that a modified or supplemental plan of operations and reclamation plan may be required.
2. It is understood that approval of this reclamation plan does not constitute:
    a. Certification of ownership to any person named herein; and
    b. Recognition of the validity of any mining claims herein.
3. It is understood that a bond equivalent to the estimated cost of performing the agreed upon reclamation measures would be required before this plan can be approved. Bonding and any bond reduction amounts would be set on a site-specific basis by USFS in coordination with the cooperating agencies (ADEC, and ADNR).
4. It is understood that any information provided with this plan or provided in the future, that is marked “Confidential” would be treated by the agency in accordance with that agency's laws, rules, and regulations.

HGCMC has reviewed and agrees to comply with all conditions in the plan of reclamation. HGCMC understands that the bond would not be released until USFS, ADEC, and ADNR give written approval of the reclamation work.

11. REFERENCES

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GPO Appendix 14
Attachment A
Land Status, Legal Description & Landowner Authorization

April 2019

Figure 1: Project and Regional Land Holdings Layout Plan

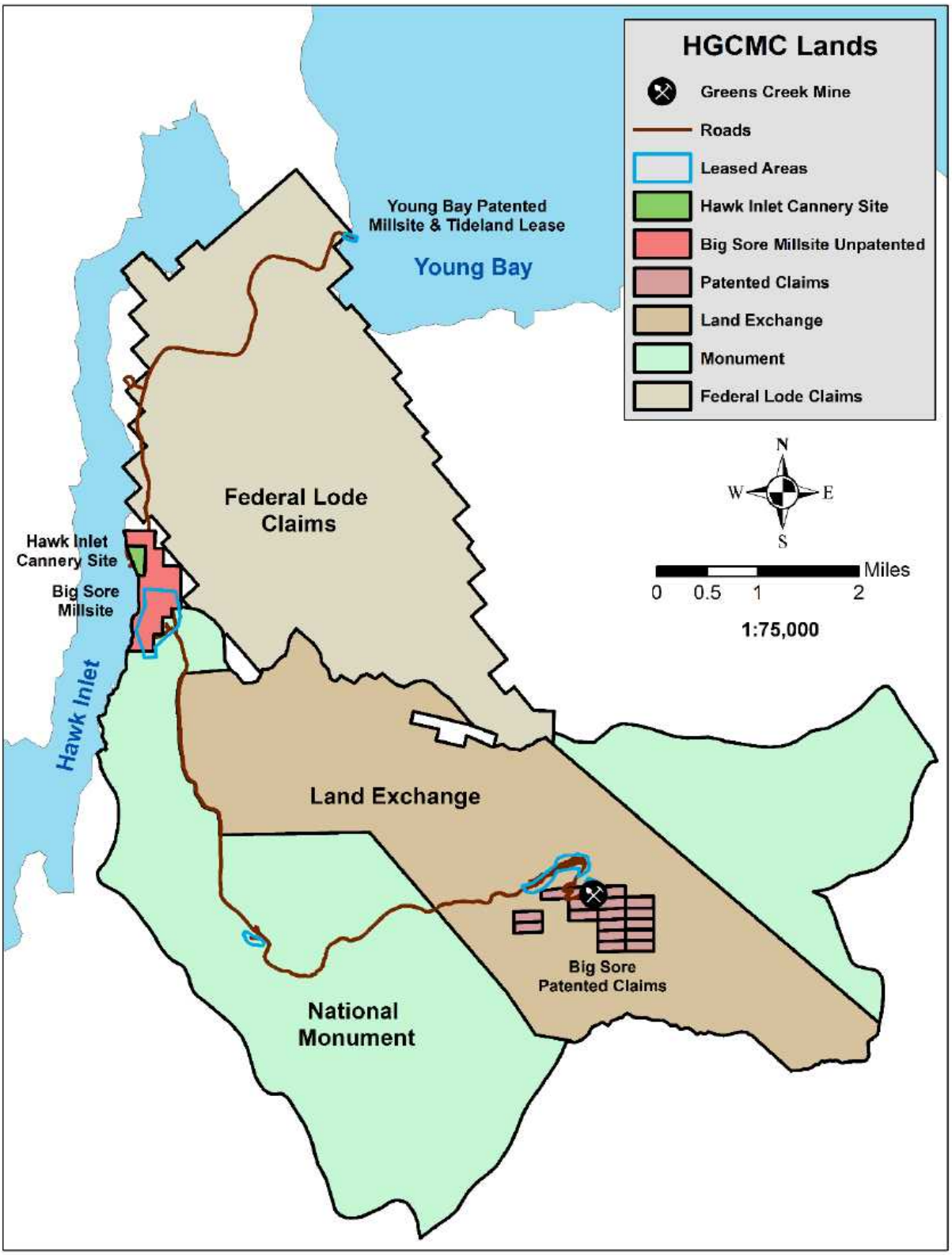


Table 1: Summary – Patented Claims and Mill Sites

Claim Names	Number	BLM Serial No. or Survey No. or ADL No.	Type	Acreage
Patented Claims				
Big Sore #s 902, 903, 904, 905, 906, 1006, 1007 and Big Sore #1305	8	Mineral patent Surveys: MS2402, MS2515	Patented surface and subsurface ("fee simple") lode mining claims	155.366 (62.874 ha)
Big Sore #s 1002, 1003, 1004, 1005, 1106, 1107; Big Sore #1105, 1207; and Big Sore #1304	9	Mineral Patent Surveys: MS2402, MS2515, MS2516	Patented lode	171.825 (69.535 ha)
Patented Millsite				
Young No. 1 millsite	1	Mineral Patent Survey: MS2514	Patented millsite, patented (surface) in Dec. 1992	0.6151 (0.2489 ha)

Table 2: Summary – Land Exchange and Other Fee Properties

Property Name	Number	BLM Serial No. or Survey No. or ADL No.	Type	Acreage
Exchange lands (Greens Creek Land Exchange Act of 1995)	N/A	Pat. No. 50-98-0434; U.S. Survey No. 11840, Alaska	Sub-surface mineral estate, surface considered AINM non-wilderness for mining development purposes	7,301.48 acres (2,954.80 ha)
Hawk Inlet Cannery site	1	U.S. Survey No. 793		16.83 acres (6.81 ha)
Hawk Inlet Cannery site tidelands	1	Alaska Tidelands Survey No. 57/ Serial No. 63-1523		21.019 acres (8.5 ha)
Exchange lands (Greens Creek Land Exchange Act of 1995)	N/A	Pat. No. 50-98-0434; U.S. Survey No. 11840, Alaska	Sub-surface mineral estate, surface considered AINM non-wilderness for mining development purposes	7,301.48 acres (2,954.80 ha)
Hawk Inlet Cannery site	1	U.S. Survey No. 793		16.83 acres (6.81 ha)
Hawk Inlet Cannery site tidelands	1	Alaska Tidelands Survey No. 57/ Serial No. 63-1523		21.019 acres (8.5 ha)

Table 3: Summary – Claims Holdings Obligations

Names	Number	Type	Acreage	Holding Costs	Royalties	Comments
Big Sore #'s 902, 903, 904, 905, 906, 1006, 1007 (MS 2402) and Big Sore # 1305 (MS 2515)	8	patented surface and sub-surface ('fee simple') Federal lode mining claims	155.366 (62.874 ha)	property taxes	none	within Exchange Lands; represents so-called "perfected" claims in the immediate mine area (core claims with valid discoveries **as of** 12/1/78)
Big Sore #'s 1002, 1003, 1004, 1005, 1106, 1107 (MS 2402); Big Sore # 1105, 1207 (MS 2516); and Big Sore # 1304 (MS 2515)	9	patented sub-surface Federal lode mining claims	171.825 (69.535 ha)	property taxes	none	within Exchange Lands; represent so-called "unperfected" claims in the immediate mine area (core claims with valid discoveries made **after** 12/1/78)
Young No. 1 Millsite	1	Federal millsite claim, fully patented (surface) in Dec. 1992	0.6151 (0.2489 ha)	property taxes	none	outside of AINM within standard Tongass National Forest lands; claim provides a site for Young Bay dock and parking facility
Big Sore 1321-1324, 1421-1424, 1521-1524, 1623-1627, 1723-1728, 1824-1827	27	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 540 acres (219 ha); valid acreage is **much less**	$125/year/claim BLM rental fees, plus filing/recording fees	none	Mariposite Ridge area (abutting the Mammoth claims) within Tongass National Forest lands but overlapping **into** AINM; a portion of this claim block is invalid
Mariposite 1-77, 79-87, 100-114	101	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 2,020 acres (817 ha); because of overlaps actual valid acreage will be **less**	$125/year/claim BLM rental fees, plus filing/recording fees	none	multiple groups staked in 80's; on Tongass Nat'l Forest lands; portions may be invalid due to overlaps, especially with Lil Sore block
West Mariposite 115-123, 128-156, 159-165, 168-171	49	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 980 acres (397 ha); because of overlaps actual valid acreage will be **less**	$125/year/claim BLM rental fees, plus filing/recording fees	none	staked in 1996; on Tongass Nat'l Forest land:

Names	Number	Type	Acreage	Holding Costs	Royalties	Comments
Lil Sore 41-48	8	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 160 acres (65 ha); because of overlaps actual valid acreage will be **less**	$125/year/claim BLM rental fees, plus filing/recording fees	none	staked in 1996; on Tongass Nat'l Forest land; borders Lil' Sore block to W, Fowler block to N, Young Bay Experimental Forest to E
Fowler 543-558, 643-658, 743-758, 843-858, 943-958, 1043-1047, 1143-1147	90	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 1,800 acres (728 ha); because of overlaps actual valid acreage will be **less**	$125/year/claim BLM rental fees, plus filing/recording fees	none	staked in 1985; on Tongass Nat'l Forest land; bordered by West Fowler, North Fowler, & East Fowler; Lil Sore and Mariposite blocks to S
North Fowler 41, 141-144, 226-246, 250-251, 336-358, 363, 436-461	75	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 1,660 acres (672 ha); because of overlaps actual valid acreage will be **less**	$125/year/claim BLM rental fees, plus filing/recording fees	none	93 claims staked in 1996; on Tongass Nat'l Forest land; 10 claims were declared Null and Void Ab Initio (and portions of 12 others) by BLM in February 1997 (State Selected Land)
West Fowler 559-561, 659-664, 759-767, 859-865, 959-966	33	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 660 acres (267 ha); because of overlaps actual valid acreage will be **less**	$125/year/claim BLM rental fees, plus filing/recording fees	none	staked in 1996; on Tongass Nat'l Forest land; 7 claims abandoned in April 1997 that overlapped new mill sites claims, 1 declared Null and Void Ab Initio (and portions of 10 others) by BLM in February 1997 (State Selected Land)
East Fowler 538-542, 641-642, 741-742, 841-842, 941-942, 1042	14	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 280 acres (113 ha); because of overlaps actual valid acreage will be **less**	$125/year/claim BLM rental fees, plus filing/recording fees	none	41 claims staked in 1996; on Tongass Nat'l Forest land;
Big Sore Mill Site Nos. 798, 802-803, 899-902, 904-907, 996, 1001-1010, 1096-1097, 1103-1108, 1202-1205, 1505-1508, 1509-1511, 1514, 1516-1517,	58	unpatented Federal mill site mining claims	claimed acreage, @ 5 acres/claim, is 290 acres (117 ha)	$125/year/claim BLM rental fees, plus filing/recording fees	none	25 were re-staked in Fall 1993; on Tongass Nat'l Forest land; covers main tailings area; 33 sites to the north and east were re-staked in May 2002 (originally staked in Fall 1996)

Names	Number	Type	Acreage	Holding Costs	Royalties	Comments
1610-1614, 1710-1718						
HIP 010, 020, 030, 040, and 050	5	Alaska State Prospecting Sites	claimed acreage is 800 acres (324 ha) (1/4 section, 160 acres, per pros. site), 'valid' acreage is roughly 1/2 that due to shoreline	no rentals, no fees, no filings required **until land tentatively approved,** costs thereafter would be same as the state tideland claims	3% net income production royalty	staked in Feb 1996; on State selected lands along E side of Hawk Inlet, **status in limbo**; no development allowed until state selections are tentatively approved (has not happened as of Sept, 2005)
Hawk Inlet Cannery site	1	fee simple land (US survey 783)	16.83 acres (6.81 ha)	property taxes	NA	acquired from Bristol Resources, Inc.
Hawk Inlet Cannery site tidelands	1	Alaska Tidelands Survey No. 57	21.019 acres (8.50 ha)	property taxes	NA	acquired from Bristol Resources, Inc.
Exchange Lands (Greens Creek Land Exchange Act of 1996)	NA	sub-surface mineral estate, surface remains AINM non-wilderness	7,301 acres (2,955 ha)	none	3% net island receipts (NIR) production royalty; 3/4% NIR when NIR value is less than $120/ton ore	Completed in 1998; no surface mining allowed; 100-year expiration of conveyance
East Ridge #'s 1011-1015, 1111-1115, 1210-1215, 1310-1315, 1408-1417, 1510-1515, 1611-1615,	43	unpatented Federal lode mining claims	claimed acreage, @ 20 acres/claim, is 860 acres (348 ha); because of overlaps actual valid acreage will be less	$125/year/claim BLM rental fees, plus filing/recording fees	none	
The total unpatented and patented claims and mill sites, state prospecting sites and tideland claims; including Exch. Lands, **approximately 16,410 acres** (6,530 ha) encompassed			approximate total direct holding costs, excluding property taxes, are **$87,750 plus approx. $1720** in recording costs			* excluding Forest Service leases and State tideland leases (approx. 113 acres (46 ha) total) ** AINM is Admiralty Island National Monument

Auth ID: ADM230
Contact ID: HECLA GREENS CREEK MINING CO
Use Code: 342, 922, 914

FS-2700-23 (v. 10/09)
OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
AMENDMENT
FOR
SPECIAL-USE AUTHORIZATION
Amendment#: 1

This amendment is attached to and made a part of the special use authorization for the (1):Tailings Basin consisting of a dry tailings disposal area and a Wastewater Sedimentation Pond (2): Wastewater Pipeline with a Right of Way, and (3): outfall Pipeline Right of Way which is a part of the Tongass National Forest issued to HECLA GREENS CREEK MINING CO on 06/15/2009 which is hereby amended as follows:

Per the Record of Decision dtd August 30, 2013, and certified Plat # Juneau 2014-34 dtd August 18, 2014, the expanded lease area totaling 193.2 for Tailings Disposal has been authorized. See Exhibit A dtd August 18, 2014 for detailed Meets & Bounds description and Monument Accessory Table.

This Amendment is accepted subject to the conditions set forth herein, and to conditions attached hereto and made a part of this Amendment.

Digitally signed by Brian Erickson
Date: 2014.09.22 08:44:54 -08'00'

Holder

Authorized Office

Forest Supervisor, Tongass National Forest

Title

Title

9.23.2014

Date

Date

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average one (1) hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

Authorization ID: ADM405010 Contact ID: KGC Use Code: 342, 914, 922	FS-2700-23 (03/06) OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
AMENDMENT
FOR
Lease For Mining Purposes
AMENDMENT NUMBER: 2

This amendment is attached to and made a part of the lease for mining purposes (identified above) issued to Greens Creek Mining Co. on 09/01/1988 which is hereby amended as follows:

The lease is amended to reflect the Name Change from Kennecott Greens Creek Mining Company to Hecla Greens Creek Mining Company. The Authorization ID changes from ADM405010 to ADM230 with use codes 342, 914 and 922. The Contact ID changes from KGC to HGC. Authorized under ADM230 are a (1):Tailings Basin consisting of a dry tailings disposal area and a Wastewater Sedimentation Pond consisting of 123 acres(68 acres within the Admiralty National Monument and 55 acres outside the Monument on Tongass National Forest lands administered by the Juneau Ranger District); (2):a Wastewater Pipeline with a Right of Way of 4 ft wide by 32,059 feet long where it parallels the mine haul road, and 30 ft wide by 420 ft. long where it is not within the haul road corridor, for a total Wastewater Pipeline Right of Way of 5.46 acres, and (3): a outfall Pipeline Right of Way of 30 ft wide by approximately 420 ft. long for a total Outfall Right of Way of 0.29 acres. Total acreage covered by this amendment is 128.75 acres.

This Amendment is accepted subject to the conditions set forth herein, and to conditions N/A to N/A attached hereto and made a part of this Amendment.

(Holder Signature)	(Authorized Officer Signature)
Scott N. Hartman V.P. General Manager (Name and Title)	Forrest Cole Trust Superviser (Name and Title)
Date: 1 June 2009	Date: 6.15.09

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

Authorization ID: ADM405008 Contact ID: KGC Use Code: 522	FS-2700-23 (03/06) OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
AMENDMENT
FOR
LEASE FOR MINING PURPOSES
AMENDMENT NUMBER: 3

This amendment is attached to and made a part of the special use authorization (identified above) issued to Kennecott Greens Creek Mining Co. on 10/27/1987 which is hereby amended as follows:

The lease is amended to reflect the name change from Kennecott Greens Greek Mining Company to Hecla Greens Creek Mining company. The Authorization ID changes from ADM405008 to ADM229. The Contact ID changes from KGC to HGC. Authorized under ADM229 is Waste Area E which is used for storage of overburden and excavated material. Total acres covered by this amendment: 10.8 acres.

This Amendment is accepted subject to the conditions set forth herein, and to conditions N/A to N/A attached hereto and made a part of this Amendment.

(Holder Signature)	(Authorized Officer Signature)
Scott N. Hartman V.P. General Manager (Name and Title)	Forrest Cole District Silviculturist (Name and Title)
Date: 1 June 2009	Date: 6.15.09

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

A L A S K A

2008-003387-0

Recording Dist: 101 - Juneau
5/8/2008 3:14 PM Pages: 1 of 2

CC

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND AND WATER
400 WILLOUGHBY, PO BOX 111020
JUNEAU, ALASKA 99811-1020
(907) 465-3400

AMENDMENT # 1 TO LEASE AGREEMENT
ADL 106488

In accordance with the Amended Certificate of Authority issued by the State of Alaska Department of Commerce, Community, and Economic Development on April 22, 2008, the Lessee Kennecott Greens Creek Mining Company is altered to read Hecla Greens Creek Mining Company and ceases to read as originally written.

All other terms and conditions of the Lease Agreement remain unchanged.

Ronald W. Clayton, Vice President — 5/1/08 Date
Hecla Greens Creek Mining Company

Southeast Region Manager — 5/8/08 Date
Division of Mining, Land and Water

STATE OF IDAHO)
) ss.
County of Kootenai)

THIS IS TO CERTIFY that on this 1st day of May, 2008, before me personally appeared Ronald W. Clayton, known to me to be the Vice President of the Hecla Greens Creek Mining Company, which executed the foregoing Lease Agreement Amendment, and acknowledged to me that he executed the same for and on behalf of said corporation, and that he is fully authorized by said corporation so to do; Ronald W. Clayton acknowledged to me that he signed and executed the same freely and voluntarily, for the uses and purposes therein stated.

TRISHA JIMMERSON NOTARY PUBLIC STATE OF IDAHO

Trisha Jimmerson
Notary Public in and for the State of Idaho
My Commission Expires: 9/20/2013

STATE OF ALASKA)
1st)ss.
Judicial District)

THIS IS TO CERTIFY that on this 8th day of May, 2008 before me personally appeared Ed Collazzi, Southeast Region Manager, of the Division of Mining, Land and Water of the Department of Natural Resources of the State of Alaska, who executed the foregoing Right-of-Way Permit Amendment and acknowledged voluntarily signing the same.

Douglas T. Sanvik
Notary Public in and for the State of Alaska
My Commission Expires: w/office

STATE OF ALASKA
OFFICIAL SEAL
Douglas T. Sanvik
NOTARY PUBLIC
My Commission Expires: w/office.

Lease Agreement ADL 106488 is recorded in the Book 535, Pages 776-789 in the Juneau Recording District, First Judicial District, State of Alaska.

After recording in the Juneau Recording District, for official state business, no charge, return this document to: State of Alaska, DNR - Division of Mining, Land & Water, Southeast Region, 400 Willoughby Avenue, PO Box 111020, Juneau, AK 99811-1020.

2 of 2
2008-003387-0

ALASKA

2016 – 004609 – 0

Recording District 101 Juneau

09/20/2016 10:45 AM Page 1 of 11

THIS COVER SHEET HAS BEEN ADDED TO THIS DOCUMENT TO PROVIDE SPACE FOR THE RECORDING DATA. THIS COVER SHEET APPEARS AS THE FIRST PAGE OF THE DOCUMENT IN THE OFFICIAL PUBLIC RECORD.

DO NOT DETACH

August 23, 2001

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND AND WATER

ADL 105124
Hecla Greens Creek Mining Company
Private Non-exclusive Easement

THIS EASEMENT is granted this 19th day of September, 2016 by the STATE OF ALASKA, acting by and through the **Department of Natural Resources, Division of Mining, Land and Water**, Southeast Regional Office hereinafter referred to as the Grantor, whose address is 400 Willoughby Avenue, Juneau, Alaska 99811. **Hecla Greens Creek Mining Company**, whose address is P.O. Box 32199 Juneau, AK 99803, is hereinafter referred to as the Grantee.

WHEREAS, it is understood and agreed that, as a condition to the granting of said easement, this easement shall be used for no purpose other than a marine outfall line and mixing area above and across portions of the following described state lands:

As depicted on **Attachment A**, within the **Copper River Meridian, Township 43 South, Range 65 East, Sections 22, 27, & 34**, a parcel of submerged lands approximately 8024.57 feet in length, with a variable width and containing approximately 3.04 acres, more or less.

IN accordance with the provisions of AS 38.05.850, and the rules and regulations promulgated thereunder, the grantor hereby reserves a Private Non-exclusive Easement over and across the above described state land within the **Juneau Recording District** as shown on the survey identified as Attachment A.

This easement shall terminate at the end of the stated term, 25 years, or when the Grantor determines that the easement is abandoned, is no longer necessary, is no longer in use for the purpose(s) authorized, or is revoked as a result of violations of the terms, conditions and stipulations of this easement.

The Grantee and entry persons who may exercise the rights and privileges granted by this document shall comply with all regulations now in effect or as hereafter established by the Division of Mining, Land & Water, all other federal, state or local laws, regulations or ordinances applicable to the area herein granted. In addition, the Grantee shall maintain the premise in a neat and orderly manner and shall adopt and apply such safety measures as shall be necessary, proper and prudent with respect to the use to which the land is subjected.

In the event that the easement granted shall in any manner conflict with or overlap a previously granted easement the Grantor recognizes that the easement granted herein shall be used in such a manner as not to interfere with the peaceful use and enjoyment of the previously issued easement or right-of-way.

The State of Alaska shall be forever wholly absolved from any liability for damages which might result from any claims, suits, loss, liability and expense for injury to or death of persons and damage to or loss of property arising out of or in connection with this easement.

NOW THEREFORE, in accordance with the provisions of AS 38.05.850 and the rules and regulations promulgated thereunder and in accordance with the conditions and stipulations of this easement including all documents that are incorporated by reference, the Grantee is authorized to operate and maintain said easement.

IN WITNESS WHEREOF, the Grantor has signed this easement on the day and year first above written.

[Signature Page Follows]

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
GRANTOR

Robert H. Edwardson

Southeast Regional Office Manager
Division of Mining, Land and Water

STATE OF ALASKA)
) ss.
_____ Judicial District)

THIS IS TO CERTIFY THAT ON THIS 19th day of September, 2016 before me personally appeared Robert H. Edwardson known by me to be the person named in and who executed said document and acknowledged voluntarily signing the same.

Douglas T. Sanvik

Notary Public in and for the State of Alaska

My Commission expires: w/office

STATE OF ALASKA
OFFICIAL SEAL
Douglas T. Sanvik
NOTARY PUBLIC
My Commission Expires with office.

HECLA GREENS CREEK MINING COMPANY
GRANTEE

STATE OF ALASKA)
) ss.
1st Judicial District)

THIS IS TO CERTIFY THAT ON THIS 13th day of September, 2016, before me personally appeared Scott N. Hartman, known by me to be the person named in and who executed said document and acknowledged voluntarily signing the same.

Tina Clum

Notary Public in and for the State of Alaska

My Commission expires: April 13, 2019

TINA CLUM
Notary Public
State of Alaska
My Commission Expires
April 13, 2019

FEE: THIS IS OFFICIAL STATE BUSINESS, NO CHARGE

RETURN TO: Lands Section, DMLW, DNR
PO Box 111020
Juneau, AK 99811

Easement Stipulations
ADL 105124

1. Authorized Officer. The Authorized Officer ("AO") for the Department of Natural Resources (DNR), Division of Mining, Land & Water ("DMLW"), Southeast Region Office is the Regional Manager or designee. The AO may be contacted at the address on the front of the authorization or at (907) 465-3400.

2. Assignment. This authorization may be transferred or assigned only with prior written approval from the AO.

3. Change of Address. The Grantee shall maintain current contact information with the DMLW. Any change of address must be submitted in writing to the AO.

4. Term. This easement is issued for a period of 25 years and shall expire on June 30, 2041, or sooner should the land not be required for the purpose this easement was issued. This easement is subject to revocation for cause, or if the State has a higher and better use for the land. The cost of relocating any improvements shall be borne by the Grantee.

5. Annual Fee. The use fee for this Private Non-exclusive Easement is $400 per year as established in regulation under 11 AAC 05.010(e)(11)(A). The annual use fee is due on or before July 1st each year. This fee is subject to adjustment by Grantor at the commencement of the sixth year of the term and every fifth year thereafter (the "adjustment date"). The adjustment shall be based on the Division's fee schedule. The compensation adjustment takes effect on the applicable adjustment date, regardless of whether the adjustment determination occurs before or after that date.

6. Penalty Charges. The Grantee shall pay a fee for any late payment or returned check issued by the Grantee as follows:

> **a. Late Payment Penalty:** The greater of either the fee specified in 11 AAC 05.010 or interest at the rate set by AS 45.45.010(a) will be assessed on a past-due account until payment is received by the State.
>
> **b. Returned Check Penalty:** A returned check fee as provided in 11 AAC 05.010 will be assessed for any check on which the bank refuses payment.

7. Development Plan/Plan of Operations. Authorized improvements must be sited in a manner which impacts the least amount of ground consistent with the purpose of the facility. Only those uses and improvements depicted on **Attachment A** are allowed, unless prior approval is obtained from the AO for additional improvements. The Grantee is responsible for accurately siting development and operations within this area.

8. Amendment or Modification. To amend or modify the uses allowed under this authorization, the Grantee shall submit a request in writing to the AO. Any amendment or modification must be approved by the AO and may require additional fees. Any purported amendment or modification has no legal effect until placed in writing and signed by both parties.

9. Removal of Improvements and Site Restoration. Upon termination of this authorization, whether by abandonment, revocation or any other means, the Grantee shall within 30 days remove all improvements and chattels from the area herein granted, except those owned by the State, and the site shall be restored to a condition acceptable to the AO. Should the Grantee fail or refuse to remove said improvements or chattels within the time allotted, they may be seized by the State; however, the Grantee shall not be relieved of the cost of the removal of the improvements and chattels and/or the cost of restoring the area.

10. Destruction of Markers. All survey monuments, witness corners, reference monuments, mining claim posts, bearing trees, National Register of Historic Places plaques, interpretive panels and unsurveyed lease corner posts shall be protected against damage, destruction, or obliteration. The Grantee shall notify the AO of any damaged, destroyed, or obliterated markers and shall reestablish the markers at the Grantee's expense in accordance with accepted survey practices of the DMLW.

11. Alaska Historic Preservation Act. The Alaska Historic Preservation Act (AS 41.35.200) prohibits the appropriation, excavation, removal, injury, or destruction of any state-owned historic, prehistoric (paleontological) or archaeological site without a permit from the commissioner. Should any sites be discovered within the authorization area, activities that may damage the site will cease and the Office of History and Archaeology in the Division of Parks and Outdoor Recreation shall be notified immediately at (907)269-8721.

12. Public Trust Doctrine. This easement is subject to the principles of the Public Trust Doctrine as specifically, the right of the public to use navigable waterways and the land beneath them for: navigation, commerce, fishing, hunting, protection of areas for ecological studies, and other purposes. These rights must be protected. The DMLW Regional Manager reserves the right to grant other interests to the subject area consistent with the public trust doctrine. The operation, use, and maintenance of the facility shall not interfere with the free public use of public roads, trails, waters, or public access easements in the area of their activities.

13. Fuel and Hazardous Substances. Storage, use, and discharge of fuel or hazardous substances must satisfy the requirements of the Department of Environmental Conservation ("DEC").

14. Spill Notification. The Grantee shall immediately notify DEC by telephone, and immediately afterwards send DEC a written notice by facsimile, hand delivery, or first class mail, informing DEC of: any unauthorized discharges of oil to water, any discharge of hazardous substances other than oil; and any discharge or cumulative discharge of oil greater than 55 gallons solely to land and outside an impermeable containment area. If a discharge, including a cumulative discharge, of oil is greater than 10 gallons but less than 55 gallons, or a discharge of oil greater than 55 gallons is made to an impermeable secondary containment area, the Grantee shall report the discharge within 48 hours, and immediately afterwards send DEC a written notice by facsimile, hand delivery, or first class mail. Any discharge of oil, including a cumulative discharge, solely to land greater than one gallon up to 10 gallons must be reported in writing on a monthly basis. The posting of information requirements of 18 AAC 75.305 shall be met. Scope and Duration of Initial Response Actions (18 AAC 75.310) and reporting requirements of 18 AAC 75, Article 3 also apply. The Grantee shall supply DEC with all follow-up incident reports. Notification of a discharge must be made to the nearest DEC Area Response Team during working hours: Anchorage (907) 269-3063, fax (907) 269-7648; Fairbanks (907) 451-2121, fax (907) 451-2362; Juneau (907) 465-5340, fax (907) 465-2237. The DEC oil spill report number outside normal business hours is (800) 478-9300.

15. In-Water Work. Prior to any in-water work that may use, divert, obstruct, pollute, or utilize waters of the State, the Grantee shall must obtain approval from the Alaska Department of Fish and Game and file an image copy with the AO.

16. Compliance with Governmental Requirements; Recovery of Costs. The Grantee shall, at its expense, comply with all applicable laws, regulations, rules and orders, and the requirements and stipulations included in this authorization. The Grantee shall ensure compliance by its employees, agents, contractors, subcontractors, licensees, or invitees.

Discharge from the outfall is regulated by the Alaska Department of Conservation (DEC). If significant loss of fish or wildlife habitat occurs as a result from failure to comply with the DEC's requirements, the loss must be rectified, to the extent feasible and prudent, by repairing, rehabilitating, or restoring the affected area to a functional state. The Grantee may be required replace or enhance fish and wildlife habitat when significant or irreversible loss has occurred.

17. Other Authorizations. The issuance of this authorization does not alleviate the necessity of the Grantee to obtain authorizations required by other agencies for this activity. Failure to obtain said authorizations shall constitute grounds for termination of this authorization.

18. Valid Existing Rights. This authorization is subject to all valid existing rights in and to the land under this authorization. The State of Alaska makes no representations or warranties whatsoever, either expressed or implied, as to the existence, number or nature of such valid existing rights.

19. Reservation of Rights. The DMLW reserves the right to grant additional authorizations to third parties for compatible uses on or adjacent to the land under this authorization. Authorized concurrent users of State land, their agents, employees, contractors, subcontractors, and licensees shall not interfere with the operation or maintenance activities of each user.

The DMLW may require authorized concurrent users of State land to enter into an equitable agreement regarding concurrent use.

The AO reserves the right to modify these stipulations or use additional stipulations as deemed necessary. The Grantee will be notified in writing prior to the implementation of any change in the terms or conditions exercised by the AO under this provision. The Grantee will be afforded the opportunity to review and comment regarding the effect of any proposed change to this authorization. Failure of the Grantee to notify the AO of any change to current officers or addresses shall not be sufficient grounds to invalidate the AO's compliance with this notification process.

20. Inspections. Authorized representatives of the State of Alaska shall have reasonable access to the subject parcel for purposes of inspection. The Grantee may be charged fees under 11 AAC 05.010(a)(7)(M) for routine inspections of the subject parcel, inspections concerning non-compliance, and a final close-out.

21. Performance Guaranty. The Grantee shall provide a surety bond or other form of security acceptable to the AO in the amount of $40,728 payable solely to the State of Alaska, DNR. Such performance guaranty shall remain in effect for the term of this authorization and any subsequent authorizations under ADL 105124 to secure performance of the Grantee's obligations hereunder. The amount of the performance guaranty may be adjusted by the AO upon approval of amendments to this authorization,

changes in the development plan or changes in the activities conducted on the premises. The guaranty may be utilized by the Division of Mining, Land and Water, at the discretion of the AO, to cover costs incurred by the State of Alaska to pay for any necessary corrective actions in the event the Grantee does not comply with site utilization and restoration guidelines. The provisions of this authorization shall not prejudice the State's right to obtain remedy under any law or regulation. The performance guaranty may only be released in writing by the AO.

22. Insurance. Pursuant to 11 AAC 96.065 the Grantee shall secure or purchase at its own expense, and maintain in force at all times during the term of this authorization, the following policies of insurance to protect both the Grantee and the Grantor (the State, its officers, agents and employees). If the Grantee's policy contains higher limits, the State shall be entitled to coverage to the extent of such higher limits. Certificates of Insurance must be furnished to the AO prior to the issuance of this authorization and must provide for a notice of cancellation, non-renewal, or material change of conditions in accordance with policy provisions. The Grantee must provide for a 60-day prior notice to the State before they cancel, not renew or make material changes to conditions to the policy. Failure to furnish satisfactory evidence of insurance, or lapse of the policy, are material breaches of this authorization and shall be grounds, at the option of the State, for termination of the authorization. All insurance policies shall comply with, and be issued by, insurers licensed to transact the business of insurance under Alaska Statute, Title 21. The policy shall be written on an "occurrence" form and shall not be written as a "claims-made" form unless specifically reviewed and agreed to by the Division of Risk Management, Department of Administration. The State must be named as an additional named insured on the policy with respect to the operations of the Grantee on or in conjunction with the authorized premises, referred to as ADL 105124.

In the event the Grantee becomes aware of a claim against any of its liability coverage, the Grantee shall notify, and provide documentation and full disclosure of the claim to the AO within 20 days.

> **a. Commercial General Liability Insurance:** Such policy shall have minimum coverage limits of $1,000,000 combined single limit per occurrence.

23. Indemnification. The Grantee assumes all responsibility, risk and liability for its activities and those of its employees, agents, contractors, subcontractors, licensees, or invitees, directly or indirectly related to this authorization, including environmental and hazardous substance risk and liability, whether accruing during or after the term of this authorization. Grantee shall defend, indemnify, and hold harmless the State of Alaska, its agents and employees, from and against any and all suits, claims, actions, losses, costs, penalties, and damages of whatever kind or nature, including all attorney's fees and litigation costs, arising out of , in connection with, or incident to any act or omission by the Grantee, its employees, agents, contractors, subcontractors, licensees, or invitees, unless the proximate cause of the injury or damage is the sole negligence or willful misconduct of the State or a person acting on the State's behalf. Within 15 days, the Grantee shall accept any such cause, action or proceeding upon tender by the State. This indemnification shall survive the termination of the authorization.

24. Violations. The AO reserves the right to rescind this authorization for adequate cause and/or violation of the stipulations included within this easement.

ADL 105124 Private Non-exclusive Easement
Hecla Greens Creek Mining Company
Attachment A
Page 1 of 3

SURVEYOR'S CERTIFICATE:

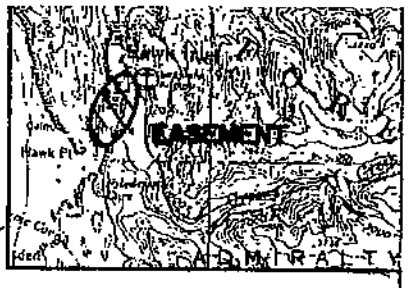
I HEREBY CERTIFY THAT I AM PROPERLY REGESTERED AND LICENSED TO P LAND SURVEYING IN THE STATE OF ALASKA, THAT THIS PLAT REPRESENTS A SURVEY MADE BY ME OR UNDER MY DIRECT SUPERVISION, THAT THE MONUMENTS SHOWN HEREON ACTUALLY EXIST AS DESCRIBED AND THAT ALL DIMENSIONS AND OTHER DETAILS ARE CORRECT.

Thomas M. Kirchner

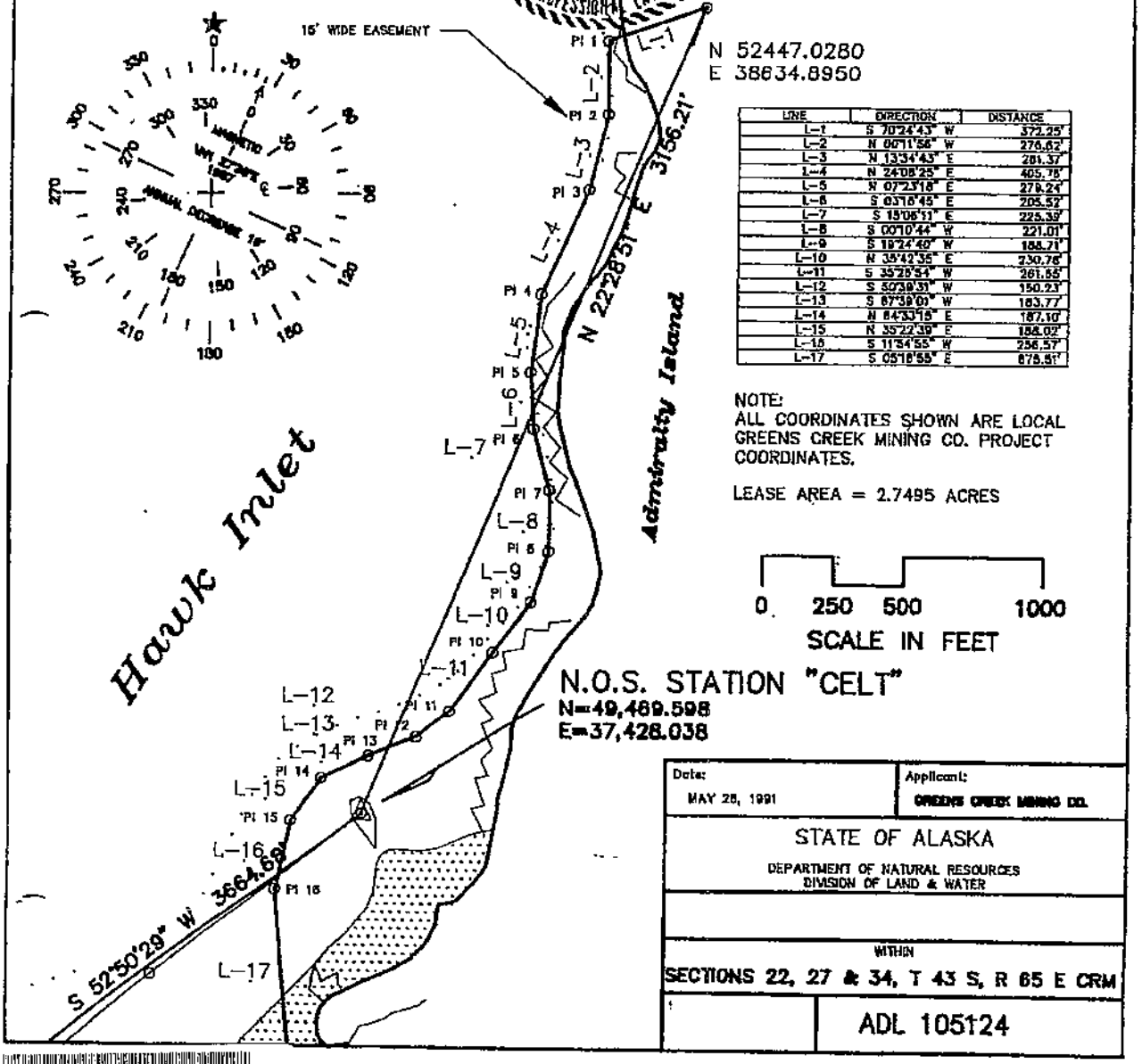
THOMAS M. KIRCHNER,
REGISTERED LAND SURVEYOR, No. 5713

DATE: MAY 28, 1991

STATE OF ALASKA 49TH Thomas M. Kirchner LS-5713 REGISTERED PROFESSIONAL LAND SURVEYOR



VICINITY MAP



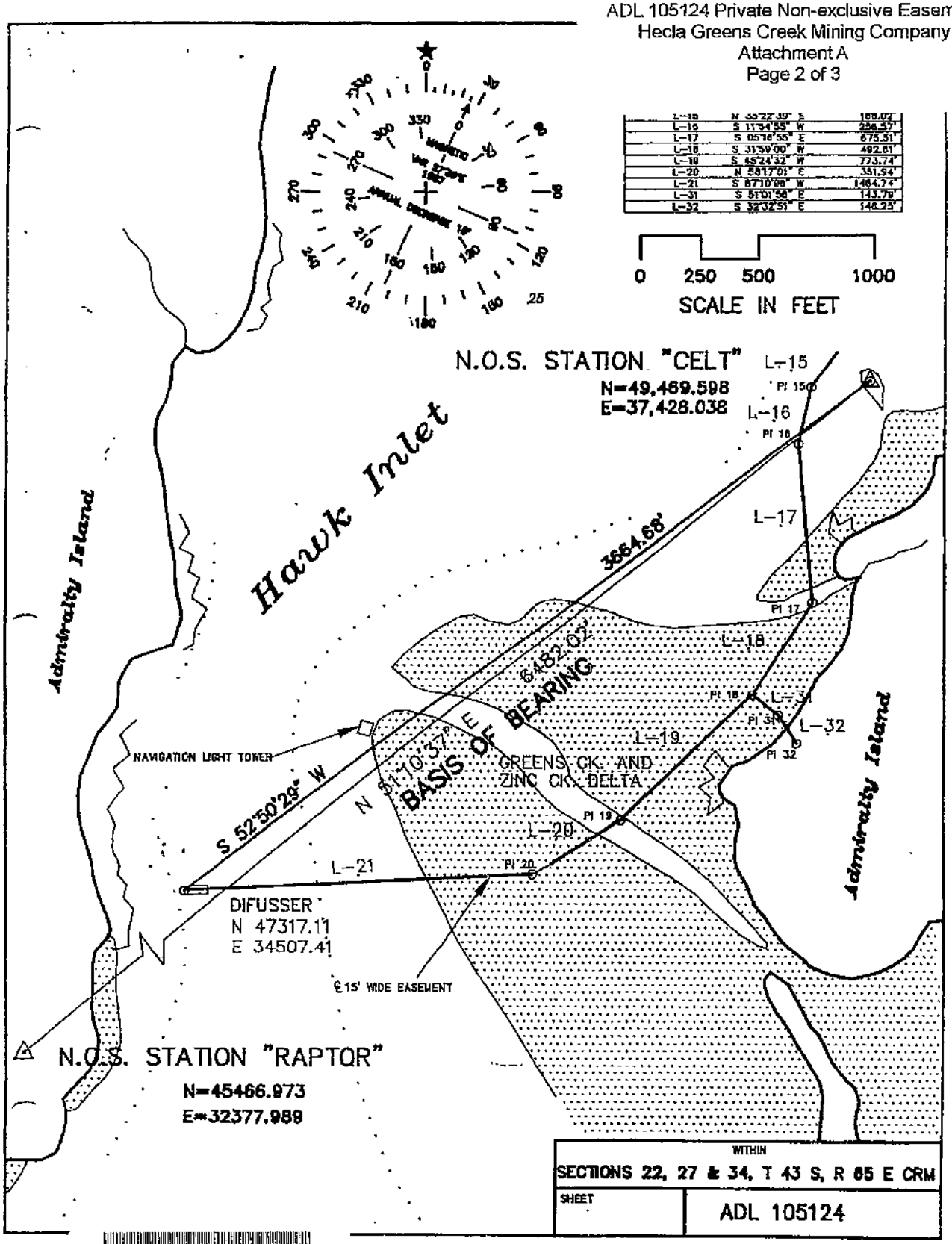
LINE	DIRECTION	DISTANCE
L-1	S 70°24'43" W	372.25'
L-2	N 00°11'56" W	276.62'
L-3	N 13°34'43" E	281.37'
L-4	N 24°08'25" E	405.78'
L-5	N 07°23'18" E	279.24'
L-6	S 03°16'45" E	205.52'
L-7	S 15°06'11" E	225.39'
L-8	S 00°10'44" W	221.01'
L-9	S 19°24'40" W	188.71'
L-10	N 35°42'35" E	230.76'
L-11	S 35°25'54" W	261.55'
L-12	S 50°39'31" W	150.23'
L-13	S 87°39'00" W	183.77'
L-14	N 84°33'15" E	187.10'
L-15	N 35°22'39" E	188.02'
L-16	S 11°34'55" W	256.57'
L-17	S 05°18'55" E	675.51'

NOTE:
ALL COORDINATES SHOWN ARE LOCAL GREENS CREEK MINING CO. PROJECT COORDINATES.

LEASE AREA = 2.7495 ACRES

ADL 105124 Private Non-exclusive Easement
Hecla Greens Creek Mining Company
Attachment A
Page 2 of 3

L-15	N 35°22'39" E	169.02'
L-16	S 11°34'55" W	256.57'
L-17	S 05°16'55" E	675.51'
L-18	S 31°59'00" W	492.61'
L-19	S 45°24'32" W	773.74'
L-20	N 58°17'01" E	351.94'
L-21	S 87°10'08" W	1464.74'
L-31	S 51°01'56" E	143.79'
L-32	S 32°32'51" E	146.25'



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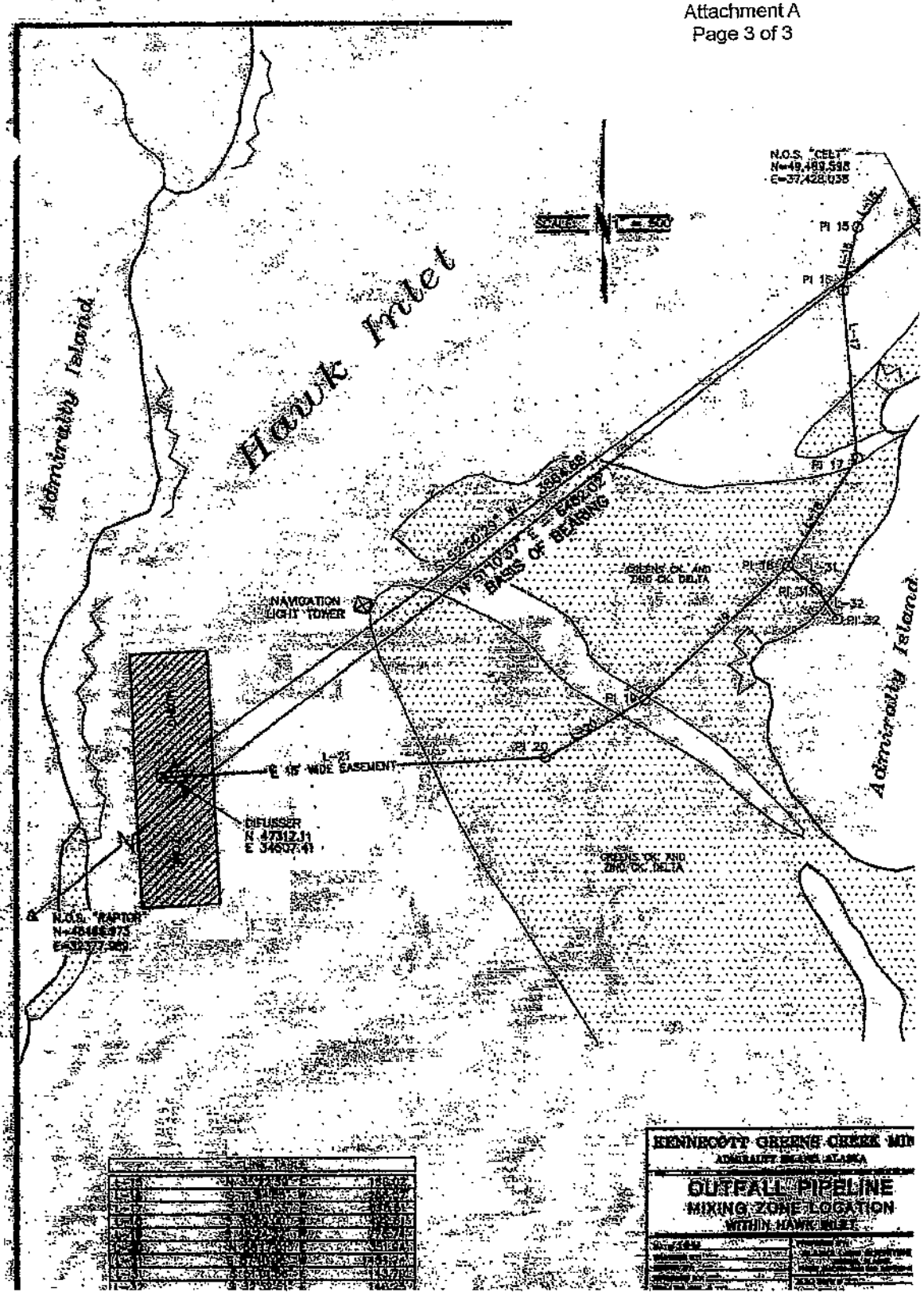
2016-004609-0

ADL 105124 Private Non-exclusive Easement
Hecla Greens Creek Mining Company
Attachment A
Page 3 of 3



Page 11 of 11
2016 – 004609 – 0

THE STATE of ALASKA

GOVERNOR BILL WALKER

Department of Natural Resources

DIVISION OF MINING, LAND & WATER
Southeast Regional Office

P. O. Box 111020
Juneau, Alaska 99811-1020
Main: 907.465.3400
TDD: 907.269.8411
Fax: 907.465.3886

April 28, 2015

Hecla Greens Creek Mining Company
Attn: Chris Wallace
PO Box 32199
Juneau, AK 99803

Re: Original Recorded Amendment #2 to Lease Agreement ADL 106488

Dear Mr. Wallace:

I have attached the original recorded document referenced above. Please file it in a safe place. Let me know if you have any questions.

Sincerely,

Doug Sanvik

Doug Sanvik
Natural Resource Specialist
(907) 465-3513

CC

A L A S K A

2015-001267-0

Recording District 101 Juneau

03/25/2015 11:51 AM Page 1 of 5

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND AND WATER
400 WILLOUGHBY, PO BOX 111020
JUNEAU, ALASKA 99811-1020
(907) 465-3400

AMENDMENT # 2 TO LEASE AGREEMENT
ADL 106488 (ATS 1333)

Tideland lease ADL 106488, currently in the name of Hecla Greens Creek Mining Company, is hereby amended to include the following:

Updated Development Plan Drawing and List of Improvements on the leasehold, Attachment "B", attached hereto and made a part hereof, which supersedes all previous development plans for this lease agreement.

All other terms and conditions of the Lease Agreement remain unchanged.

13 March 2015

Scott Hartman, General Manager
Hecla Greens Creek Mining Company

Date

Robert H Edwardson

25 March 2015

Southeast Region Manager
Division of Mining, Land and Water

Date

Amendment #2 to Lease Agreement ADL 106488 Page 1 of 2

STATE OF ALASKA)
) **ss.**
Juneau **Judicial District**)

THIS IS TO CERTIFY that on this 13th day of March, 2015, before me personally appeared Scott Hartman, known to me to be the General Manager of the Hecla Greens Creek Mining Company, which executed the foregoing Lease Agreement Amendment, and acknowledged to me that he executed the same for and on behalf of said corporation, and that he is fully authorized by said corporation so to do; Scott Hartman acknowledged to me that he signed and executed the same freely and voluntarily, for the uses and purposes therein stated.

STATE OF ALASKA
OFFICIAL SEAL
Cari L. Atkinson
NOTARY PUBLIC
My Commission Expires 03/11/2017

Cari L. Atkinson
Notary Public in and for the State of Alaska
My Commission Expires: 3-11-17

STATE OF ALASKA)
)**ss.**
1st **Judicial District**)

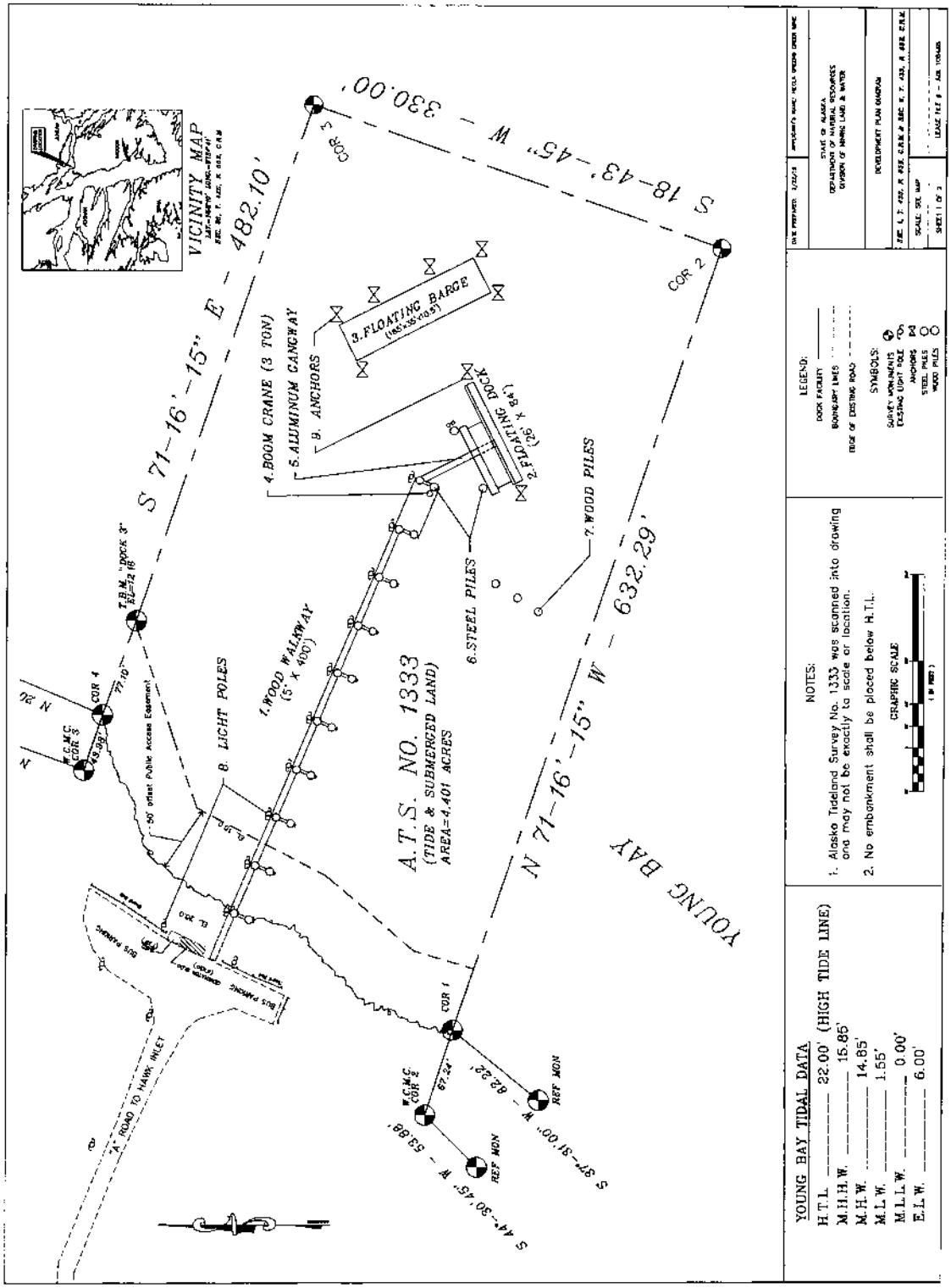
THIS IS TO CERTIFY that on this 25th day of March, 2015 before me personally appeared Robert H. Edwardson, Southeast Region Manager, of the Division of Mining, Land and Water of the Department of Natural Resources of the State of Alaska, who executed the foregoing Right-of-Way Permit Amendment and acknowledged voluntarily signing the same.

STATE OF ALASKA
OFFICIAL SEAL
Douglas T. Sanvik
NOTARY PUBLIC
My Commission Expires with office.

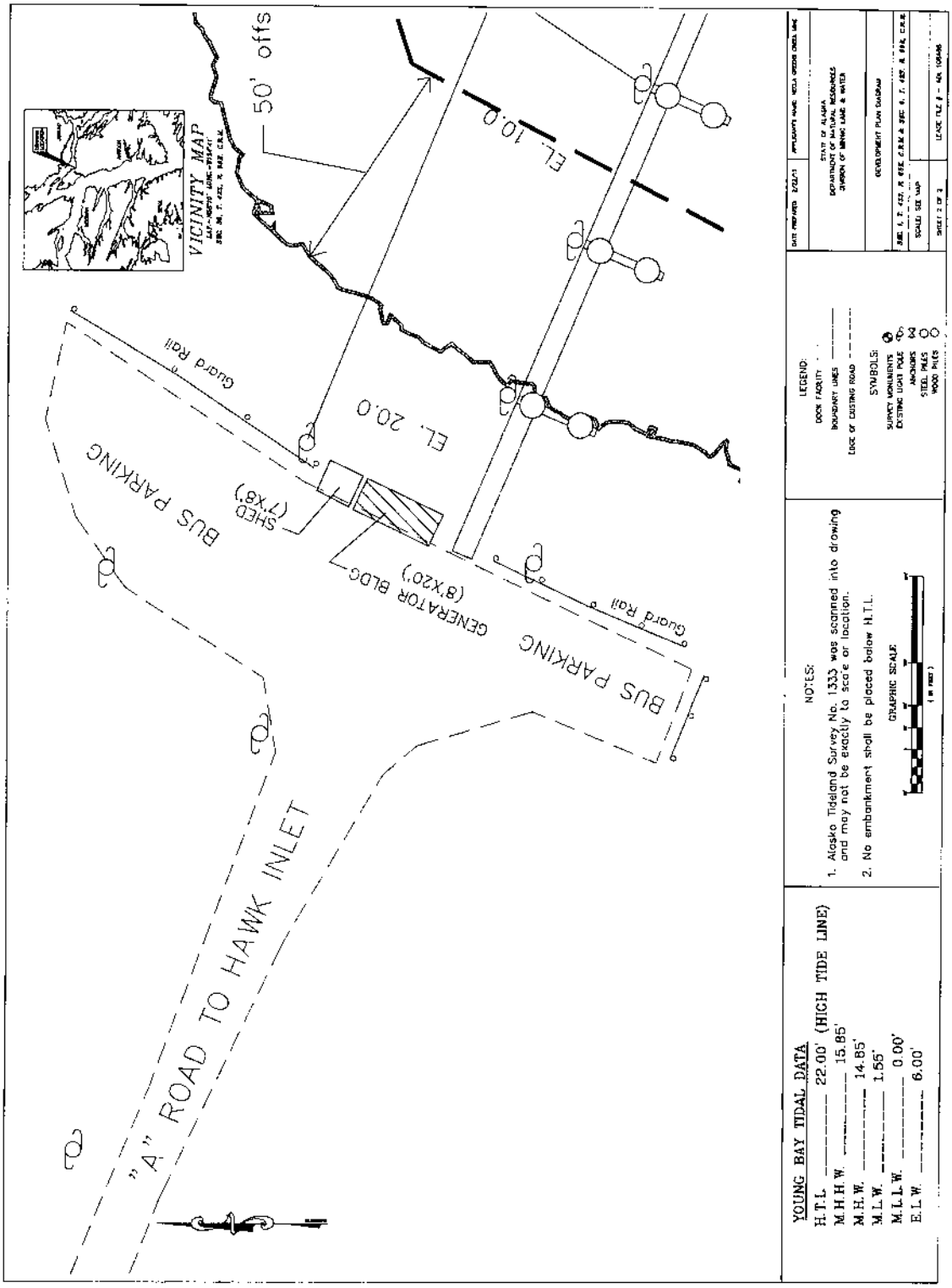
Douglas T. Sanvik
Notary Public in and for the State of Alaska
My Commission Expires: w/office

Lease Agreement ADL 106488 is recorded in the Book 535, Pages 776-789 in the Juneau Recording District, First Judicial District, State of Alaska. Amendment #1 to lease is recorded in the Juneau Recording District as document number 2008-003387-0.

After recording in the Juneau Recording District, for official state business, no charge, return this document to: State of Alaska, DNR - Division of Mining, Land & Water, Southeast Region, 400 Willoughby Avenue, PO Box 111020, Juneau, AK 99811-1020.



Attachment "B" Page 1 of 3



Attachment "B" Page 2 of 3

LIST OF IMPROVEMENTS WITHIN DEVELOPMENT PLAN DIAGRAM AREA
ADL 106488

1. Wood Walkway
2. Floating Dock
3. Floating Barge
4. Boom Crane
5. Aluminum Gangway
6. Steel Piles (24)
7. Wood Piles (3)
8. Light Poles (10)
9. Anchors (8)

Page 5 of 5
2015-001267-0

Attachment "B" Page 3 of 3

THE STATE of ALASKA

GOVERNOR BILL WALKER

Department of Natural Resources

Division of Mining Land & Water
Southeast Regional Land Office

400 Willoughby Avenue
PO Box 111020
Juneau, Alaska 99811-1020
Main: (907) 465-3400
Fax: (907) 465-3886

LAND USE PERMIT
AS 38.05.850

PERMIT # LAS 19928

HECLA GREENS CREEK MINING COMPANY, herein known as the Permittee, is issued this permit authorizing the use of State land within:

Legal Description: SW¼ NE¼ Section 22, Township 43 South, Range 65 East, Copper River Meridian; .3 ac., more or less

This permit is issued for the purpose of authorizing the following: year-round placement and use of a mooring buoy.

This permit is effective beginning **October 6, 2015** and ending **October 5, 2020** unless sooner terminated at the State's discretion. This permit does not convey an interest in State land and as such is revocable, with or without cause. The department will give 30 days' notice before revoking a permit at will. A revocation for cause is effective immediately. No preference right for use or conveyance of the land is granted or implied by this authorization.

This permit is issued subject to the following:

- Payment of the annual use fee in the amount of $250 due on or before the annual anniversary date and any additional fees identified in the stipulations below.
- Payment of the annual fee for use occurring from October 6, 2015 to October 5, 2016.
- Proof of insurance as described in stipulations below.

The non-receipt of a courtesy billing notice does not relieve the Permittee from the responsibility of paying fees on or before the due date.

All activities shall be conducted in accordance with the following stipulations:

1. **Authorized Officer:** The Authorized Officer (AO) for the Department of Natural Resources is the Regional Manager or designee. The AO may be contacted at the address and phone number on the front of the authorization. The AO reserves the right to modify these stipulations or use additional stipulations as deemed necessary. The Permittee will be advised before any such modifications or additions are finalized.
2. **Development Plan/Plan of Operations:** The development of the site authorized by this permit shall be limited to the area and improvements specified in the attached development plan/plan of operations dated September 7, 2000 or subsequent modifications approved by the AO. The Permittee is responsible for accurately siting development and operations within this area. Any proposed revisions to the development plan/plan of operations must be approved in writing by the AO before the change in use or development occurs.

LAS 19928

a. Any improvements/structures authorized under this permit must be constructed in a manner that will allow for removal from the permitted site within 48 hours of receiving a notice to vacate. The establishment of permanent foundations and structures is prohibited under this permit.
b. Authorized temporary improvements must be sited in a manner which impacts the least amount of ground consistent with the purpose of the facility.

3. **Anchoring and Shore-ties:** Anchoring methods including shore-ties shall not preclude reasonable public access nor interfere with the ability to safely navigate within and adjacent to the permit area. Use of shore-ties connected to uplands is prohibited unless written permission is first obtained from the upland owner.
4. **Amendments:** To conduct activities other than that in the approved plan of operations or development plan, the Permittee must have prior authorization from the AO. A map of the new location or an amended plan of operations or development plan is required and a $100 amendment fee, per 11 AAC05.010(a)(5)(B).
5. **Use Fees:** The Permittee shall pay to the Division an annual use fee of $250. The use fee is due on or before the annual anniversary of the effective date of this permit without the necessity of any billing by the Division. The annual land use fee is subject to adjustments in the fee schedule as set forth in 11 AAC 05.010.
6. **Failure to Pay:** Failure to pay either the annual permit fee and/or Visitor Day fees when due is a default of the terms and condition of this permit. Failure to pay fees subjects this permit to termination.
7. **Late Payment Penalty Charges:** The Permittee shall pay a fee for any late payment. The amount is the greater of either the fee specified in 11 AAC 05.010 or interest at the rate set by AS 45.45.010(a) and will be assessed on a past-due account until payment is received by the State.
8. **Returned Check Penalty:** A returned check fee as provided in 11 AAC 05.010 will be assessed for any check on which the bank refuses payment. Late payment penalties shall continue to accumulate.
9. **Alaska Historic Preservation Act:** The Alaska Historic Preservation Act (AS 41.35.200) prohibits the appropriation, excavation, removal, injury, or destruction of any State-owned historic, prehistoric (paleontological) or archaeological site without a permit from the commissioner. Should any sites be discovered during the course of field operations, activities that may damage the site will cease and the Office of History and Archaeology in the Division of Parks and Outdoor Recreation (907) 269-8721 and shall be notified immediately.
10. **Public Trust Doctrine:** This authorization is issued subject to the Public Trust Doctrine, which guarantees public access to, and the public's right to use, all navigable and public waters and the land beneath them for navigation, commerce, fishing, and other purposes. The Permittee may not preclude or restrict public access on and through the permitted area. The Division of Mining, Land and Water reserves the right to grant other interests consistent with the Public Trust Doctrine.
11. **Valid Existing Rights:** This authorization is subject to all valid existing rights in and to the land. The State of Alaska makes no representations or warranties whatsoever, either expressed or implied, as to the existence, number, or nature of such valid existing rights.
12. **Reservation of Rights:** The Division reserves the right to grant additional authorizations to third parties for compatible uses on or adjacent to the land under this authorization. The Division may require authorized concurrent users of State land to enter into an equitable operation or maintenance agreement. Authorized concurrent users of State land, their agents, employees, contractors, subcontractors, and licensees, shall not interfere with the operation or maintenance activities of each user.
13. **Inspections:** Authorized representatives of the State of Alaska shall have reasonable access to the subject parcel for purposes of inspection and may inspect the permitted area at any time without notice. The Permittee may be charged fees under 11 AAC 05.010(a)(7)(M) for routine inspections of the subject parcel, inspections concerning non-compliance, and a final close-out inspection.

LAS 19928

14. **Indemnification:** The Permittee assumes all responsibility, risk and liability for its activities and those of its employees, agents, contractors, subcontractors, licensees, or invitees, directly or indirectly related to this permit, including environmental and hazardous substance risk and liability, whether accruing during or after the term of this permit. The Permittee shall defend, indemnify, and hold harmless the State of Alaska, its agents and employees, from and against any and all suits, claims, actions, losses, costs, penalties, and damages of whatever kind or nature, including all attorney's fees and litigation costs, arising out of , in connection with, or incident to any act or omission by the Permittee, its employees, agents, contractors, subcontractors, licensees, or invitees, unless the proximate cause of the injury or damage is the sole negligence or willful misconduct of the State or a person acting on the State's behalf. Within 15 days, the Permittee shall accept any such cause, action or proceeding upon tender by the State. This indemnification shall survive the termination of the permit.
15. **Performance Guaranty:** Pursuant to 11 AAC 96.060, the Permittee shall provide a surety bond or other form of security acceptable to the Division in the amount of $1000 payable to the State of Alaska. Such performance guaranty shall remain in effect for the term of this authorization and shall secure performance of the Permittee's obligations hereunder. The amount of the performance guaranty may be adjusted by the AO in the event of approved amendments to this authorization, changes in the development plan, or any change in the activities or operations conducted on the premises.

    The guaranty may be utilized by the DMLW to cover actual costs incurred by the State of Alaska to pay for any necessary corrective actions in the event the Permittee does not comply with the site utilization, restoration requirements and other stipulations contained in this permit agreement. If the Permittee fails to perform the obligations under this permit within a reasonable timeframe, the State may perform the Permittee's obligations at the Permittee's expense. The Permittee agrees to pay within 20 days following demand, all costs and expenses incurred by the State of Alaska as a result of the failure of the Permittee to comply with the terms and conditions of this permit. Failure to do so may result in the termination of an authorization and/or forfeiture of the performance guaranty.

    The provisions of this permit shall not prejudice the State's right to obtain a remedy under any law or regulation. If the Regional Manager determines that the Permittee has satisfied the terms and conditions of this authorization, the performance guaranty will be subject to release. The performance guaranty may only be released in writing by the AO.
16. **Insurance:** Pursuant to 11 AAC 96.065, the Permittee shall secure or purchase at its own expense, and maintain in force at all times during the term of this permit, the following policies of insurance to protect both the Permittee and the permittor (the State, its officers, agents and employees). If the Permittee's policy contains higher limits, the State shall be entitled to coverage to the extent of such higher limits. Certificates of Insurance must be furnished to the AO prior to the issuance of this permit and must provide for a notice of cancellation, non-renewal, or material change of conditions in accordance with policy provisions. The Permittee must provide for a 60-day prior notice to the State before they cancel, not renew or make material changes to conditions to the policy. Failure to furnish satisfactory evidence of insurance, or lapse of the policy, are material breaches of this permit and shall be grounds, at the option of the State, for termination of the permit. All insurance policies shall comply with, and be issued by, insurers licensed to transact the business of insurance under Alaska Statute, Title 21. The policy shall be written on an "occurrence" form and shall not be written as a "claims-made" form unless specifically reviewed and agreed to by the Division of Risk Management, Department of Administration. The State must be named as an additional named insured on the policy with respect to the operations of the Permittee on or in conjunction with the permitted premises, referred to as LAS 19928 (Case Number).

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a. Insurance: Commercial General Liability Insurance: Such policy shall have minimum coverage limits of $1,000,000 combined single limit per occurrence.

b. In the event the Permittee becomes aware of a claim against any of its liability coverage, the Permittee shall notify, and provide documentation and full disclosure of the claim to the AO within 20 days.

17. **Notification of Discharge:** Pursuant to 18 AAC 75.300 the Permittee shall immediately notify The DNR and Alaska Department of Environmental Conservation (DEC) by phone of any discharge of hazardous substances (other than oil), any unauthorized discharge of oil to water, and any discharge of oil greater than 55 gallons on land. All fires and explosions must also be reported. The DNR 24-hour spill report number is (907) 451-2678 and the fax number is (907) 451-2751. The DEC spill report number is (800) 478-9300. The DNR and the DEC shall be supplied with all follow-up incident reports as outlined in 18 AAC 75.300.
18. **Compliance with Governmental Requirements; Recovery of Costs:** The Permittee shall, at its expense, comply with all applicable laws, regulations, rules and orders, and the requirements and stipulations included in this authorization. The Permittee shall ensure compliance by its employees, agents, contractors, subcontractors, licensees, or invitees.
19. **Violations:** This authorization is revocable immediately upon violation of any of its terms, conditions, stipulations, nonpayment of fees, or upon failure to comply with any other applicable laws, statutes and regulations (federal and state). Should any unlawful discharge, leakage, spillage, emission, or pollution of any type occur due to the Permittee's, or its employees', agents', contractors', subcontractors', licensees', or invitees' act or omission, the Permittee, at its expense shall be obligated to clean the area to the reasonable satisfaction of the State of Alaska.
20. **Change of Address:** The Permittee shall maintain current contact information with the Division of Mining, Land and Water. Any change of address must be submitted in writing to the AO.
21. **Other Authorizations:** The issuance of this authorization does not alleviate the necessity of the Permittee to obtain authorizations required by other agencies for this activity.
22. **Assignment:** This permit may not be transferred or assigned.
23. **Revocable at Will:** This permit does not convey an interest in State land and as such is revocable, with or without cause. The department will give 30 days' notice before revoking a permit at will. A revocation for cause is effective immediately.
24. **Permit Extensions/Renewal:** Any request for permit extension or renewal should be submitted at least 90 days prior to the end of the authorized term. A one-year extension may be granted upon remittance of a written request explaining the need for an extension and a $100 non-refundable filing fee. A new Land Use Permit application and $100 non-refundable filing fee is required for renewals of up to 5 years or for modifications to the approved development/operations plan on file with the DMLW.
25. **Site Restoration:** On or before permit expiration, or termination of this authorization by the Permittee, the site shall be vacated and all improvements, personal property, and other chattels shall be removed. In the event the Permittee fails to comply with this requirement, the State, at its discretion, may remove and dispose of improvements and restore the site at the expense of the Permittee.
26. **Site Restoration Documentation:** Prior to or upon termination of this permit by the Permittee or within the thirty (30) day period following permit expiration (if a renewal application has not been submitted), the Permittee must complete and submit "A Relinquishment Form and Environmental Hazard Evaluation Affidavit" along with a comprehensive set of photographs verifying the site has been vacated and restored to a clean, safe condition. The performance guaranty will not be subject to release until the Permittee provides the required documentation verifying site restoration. All such remittances are subject to the approval of the AO.

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The Authorized Officer reserves the right to modify these stipulations or use additional stipulations as deemed necessary. The Permittee will be advised before any such modifications or additions are finalized. DNR has the authority to implement and enforce these conditions under AS 38.05.850. Any correspondence on this permit may be directed to the Department of Natural Resources, Division of Mining, Land and Water, Southeast Regional Land Office, 400 Willoughby Avenue/PO Box 111020, Juneau, AK 99811-1020, (907) 465-3400.

I have read and understand all of the foregoing and attached stipulations. By signing this permit, I agree to conduct the authorized activity in accordance with the terms and conditions of this permit.

Christopher Wallace Environmental Manager 26 January 2017

Signature of Permittee or Authorized Representative | Title | Date

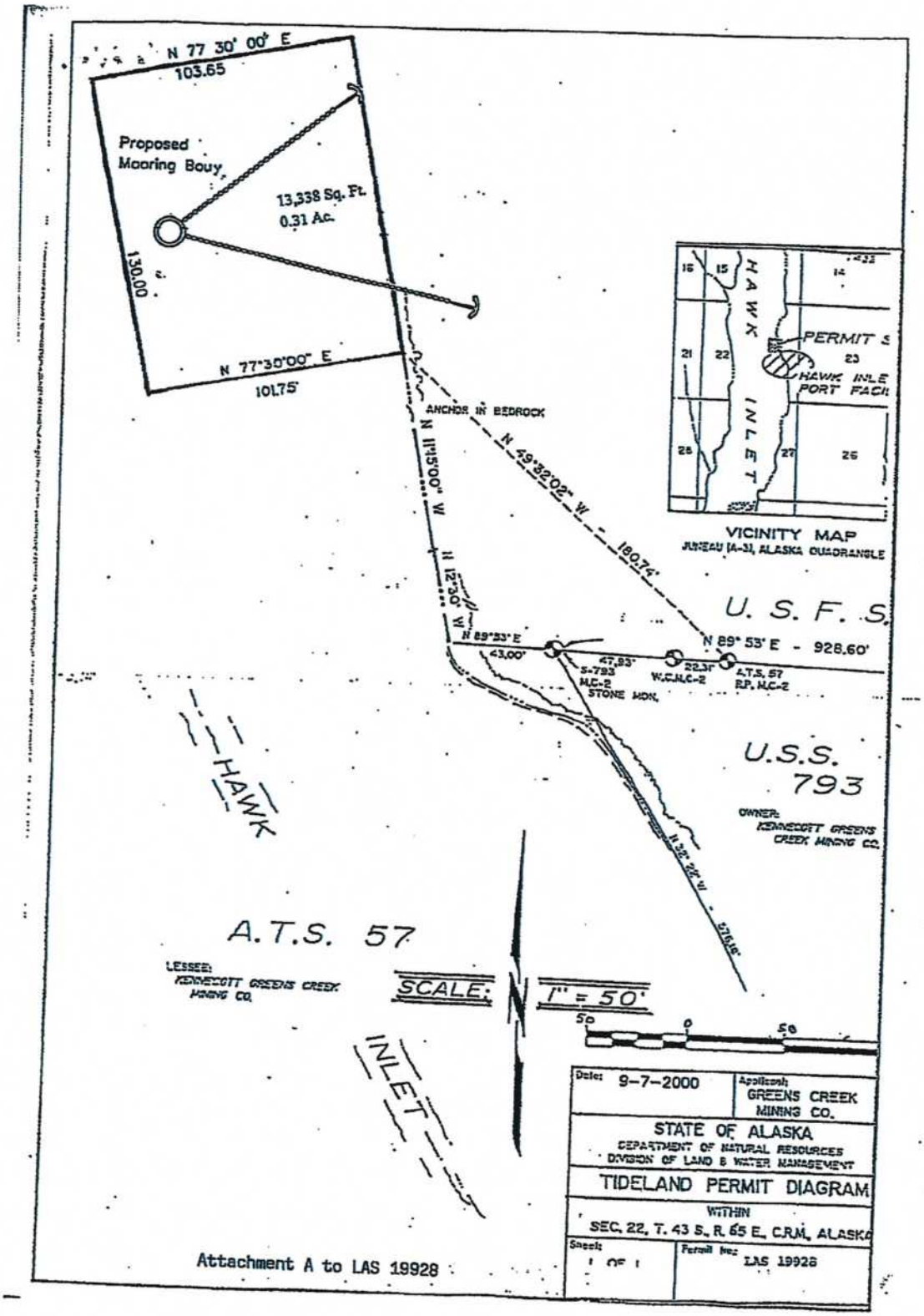
P.O. Box 32199 | Juneau | AK | 99803

Permittee's Address | City | State | Zip

Christopher Walllace | (907) 790-8473

Contact Person | Home Phone | Work Phone

Signature of Authorized State Representative | Title | Date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JUNEAU (A-3), ALASKA QUADRANGLE
Date: 9-7-2000
Applicant: GREENS CREEK MINING CO.
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF LAND & WATER MANAGEMENT
TIDELAND PERMIT DIAGRAM
WITHIN
SEC. 22, T. 43 S., R. 65 E., C.R.M., ALASKA
Sheet: 1 OF 1
Parcel No.: LAS 19928
Attachment A to LAS 19928

GPO Appendix 14
Attachment B
Basis of Cost Estimate

November 2019

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1. INTRODUCTION AND SCOPE OF REPORT

Hecla Greens Creek Mining Company (HGCMC) has prepared an estimate of the costs to be incurred should the Greens Creek Mine (site) be closed under a default scenario. This report outlines the methods and assumptions used to prepare this closure cost estimate. The closure costs addressed in this report include direct and indirect costs for physical closure and long-term water treatment, monitoring and maintenance over a 100-year period of closure and post-closure. The closure period (Year 0 to Year 3) includes a holding year where only care and maintenance occurs and three years of active reclamation. The post-closure period (Year 4 to Year 100) includes long term water treatment and care, maintenance and monitoring. The 100-year term of this estimate is a proxy for in perpetuity. The costs are provided in un-discounted form and include indirect costs such as contingency, contractor overhead and profit, and agency administration.

2. BACKGROUND AND BRIEF

This cost estimate (2019) was prepared by HGCMC and is based upon the approved 2014 cost estimate associated with Waste Management Permit No. 2014DB0003. HGCMC hired SRK to prepare the 2014 cost estimate as an update to the bond cost estimate submitted in 2008 for the WMP renewal.

This estimate also incorporates updates to the operating mine as described in the Reclamation and Closure Plan, GPO-14 (of which this report is an attachment). HGCMC reviewed and updated the Standardized Reclamation Cost Estimate (SRCE), approved in 2018, to prepare the estimate. The SRCE provides a standardized approach to common closure activities encountered at mining operations. The scope of the update included the following:

- updated unit rates for labor, equipment and materials
- updated closure cost estimate including the closure of the mine as described in the Reclamation and Closure Plan
- reviewed this report outlining the methodologies used to prepare the cost estimate

Christopher Wallace (Environmental Manager at HGCMC) and Pete Condon (Petros GeoConsulting Inc.) provided information and assisted with the completion of this work.

3. PURPOSE OF THE REPORT

The purpose of this report is to describe the methodologies and data sources used to complete the closure cost estimate. This closure cost estimate is being submitted to the U.S. Forest Service (USFS) as required under 36 CFR 228.1 et. seq. and 36 CFR 228A (Training Guide for Reclamation Bond Estimation and Administration 2004). Concurrently, the cost estimate is being submitted to the Alaska Departments of Natural Resources, Division of Mining (ADNR) and Environmental Conservation, (ADEC) in accordance with AS 27.19, 11 AAC 97, 11 AAC 93, AS 46.03.100, and 18 AAC 60.265.

4. METHODOLOGY

4.1. Introduction

The closure cost estimate was prepared using the SRCE model version 1.4.1 build 16. The SRCE was originally developed for the State of Nevada to provide a standardized approach to calculating bond costs for closure. Version 1.4 was developed using the Nevada model as a basis but was modified to be more generic and applicable for use in other jurisdictions and to include the option to use metric inputs.

The purpose of the SRCE is to provide a systematic approach to the development of a closure cost with modules included for the most common closure elements encountered at mining operations. The SRCE does not include closure tasks that are not commonly found at mining operations and provides blank worksheets for the development of custom calculations which can be linked into the model.

The model inputs required are the physical dimensions of the various facilities and calculations are based upon first principles. These calculations and assumptions are demonstrated on each worksheet with diagrams and examples of the calculations performed by the model.

Equipment used in the model is standardized upon Caterpillar because they have the most extensive line of equipment and the most comprehensive technical specifications and productivities available. Equipment productivities are derived from the Caterpillar Performance Handbook (2004). Productivity for other types of equipment is derived from technical specifications where available or on field experience at Nevada mine closure sites.

Crews for various tasks are derived from the RS Means Heavy Construction Data. Crew productivities are also derived from RS Means and used to calculate project specific unit rates utilizing the labor, equipment and material rates as defined for the project.

4.2. Data Requirements

Data required for SRCE consists of project data and cost data. Project data are dimensions, areas, distances, etc., that are specific to the project facilities. For this project, data consisted of dimensions of the roads, tailings facility, and buildings. A discussion is provided below under the relevant headings.

4.2.1. Project Data

Project data is input into the spreadsheet under tabs with the following headings:

- Exploration
- Exploration Roads & Pads
- Waste Rock Dumps
- Heap Leach Pads
- Tailings
- Roads
- Pits
- Quarries & Borrow Pits
- Underground Openings
- Material Hauling
- Foundations and Buildings
- Other Demo & Equipment Removal

- Sediment & Drainage Control
- Process Ponds
- Landfills
- Yards, Etc.
- Waste Disposal
- Well Abandonment
- Miscellaneous Costs
- Monitoring
- Construction Management
- Solution Management
- Closure Planning
- General & Administration
- Human Resources
- Other User

Custom calculations are prepared using the "User Sheets" in the back of the model. Wherever possible these calculations are linked back to the model such that the calculations are updated whenever unit rates are updated. Cost totals from the User Sheets are linked into the Other User worksheet.

4.2.2. Cost Data

The SRCE utilizes cost data which is input into a separate file ("Cost Data File") where the user can define up to 15 different cost bases. Once loaded into the SRCE the cost bases can be selected by the user to quickly switch between cost bases. The data input in the Cost Data File include the following:

- labor rates
- equipment rates
- material costs
- miscellaneous unit costs

Some costs were derived from previous estimates provided by contractors or from other sources. In these cases, the costs were updated to reflect inflation using the annual Consumer Price Index for All Urban Consumers (CPI-U) available at DLWD (2019). This inflation rates (included in User Sheet 1) are only used to update costs from previous estimates. Inflation adjustment for the five-year term of this Plan will be determined prior to the renewal of the permit. Included on User Sheet 20 is a bond estimate calculation modeled after the calculation used for WMP No. 2014DB0003. It is only an estimate and is subject to change pending approval of this Plan, however it allows for direct comparison to the current permit.

4.2.3. Model Results

The model results are reflected in the Cost Summary, Cost Schedule, and Reclamation Quantities sheets of the SRCE. The cost summary sheet provides a breakdown of inputs by labor, equipment, and material categories per the headings below to provide the total direct costs per heading:

A. Earthwork/Recontouring
B. Revegetation/Stabilization
C. Detoxification/Water Treatment/Disposal of Wastes
D. Structure, Equipment and Facility Removal, and Misc.
E. Monitoring

F. Construction Management & Support
G. Closure Planning, G&A, Human Resources

These headings and their respective items' costs are furthermore reflected in the Cost Schedule sheet where scheduling by year can be carried out manually.

The Reclamation Quantities sheet sums total earthworks costs and total earthworks amounts (volumes and areas). These data are then used to calculate project-specific unit costs. This sheet can also be used to easily link calculations to the rest of the SRCE where sums of earthworks-related quantities are utilized.

5. DATA INPUT

This section provides a discussion of the particular data input into the model to calculate a closure cost. Much of the data for SRCE model came from the previous bond calculations submitted in 2008 and 2014. There have been minor facility changes since the 2014 update that have been incorporated into this model. The SRCE files are shown in Attachment A and the Cost data file are shown in Attachment B.

5.1. Built-In Sheets

The below headings discuss the activities and assumptions used in estimating the closure costs in the order they appear in the SRCE spreadsheet.

5.1.1. General and Administration (G&A)

Costs of air transportation (plane and helicopter), camp support, power, and water treatment were provided for by updating costs with available rates or adjusting for inflation and considering the closure and post-closure activity schedules in User Sheet 5. Calculations have been included in User Sheet 5 and entered in the G&A worksheet. Details are provided in the sections below.

5.1.1.1. Air Transportation

Helicopters and planes are utilized depending on whether they transport passengers and/or equipment. Copies of quotes or information are included in Attachment C.

5.1.1.2. Camp Support

Daily camp costs were estimated by use of quotes by ESS Support Services. These costs are presented in Table 1. It has been assumed that the camp would be maintained until the end of the closure period, by which time all buildings will have been removed. The price quote is a per man per day cost associated with camp occupancy based on population bands for a four-year period. These rates include all wages, burden, transportation, and benefit costs, as well as all food, paper, chemical, and other associated direct and indirect cost. The average of the costs has been taken and utilized for the closure duration.

Table 1. Camp Costs

MIN	MAX	Cost
5	5	$380.99
6	10	$319.25
11	15	$207.06
16	20	$155.36
21	25	$127.51

5.1.1.3. Power

The power requirements of the closure phase will be based on the following demands in Table 2:

Table 2: Closure Period Power Requirements

Item	Calculated/Supported In	Reflected In
Water treatment	User Sheet 4	Solution Management sheet
Ventilation	User Sheet 5	G&A sheet
Camp	User Sheet 5	G&A sheet

Supporting information for ventilation and camp energy consumption is provided in Section 5.2.5.

5.1.2. Solution Management

HGCMC proposes to collect and store the drainage from the principal resources (underground workings and the tailings facility) in Pond 7 and Pond 10 which respectively contain 27.6 acre-ft and 35.2 acre-ft of water, for a combined capacity of 20.1 million gallons. The stored water will be actively treated in the water treatment facility existing on site. Water treatment from the Holding Year through to Year 3 after operations will be treated continuously. After Year 3 the expected flow of water will decrease, and the water will accumulate in the storage ponds and be treated in batches (campaigns). For Years 4-10 both ponds will be utilized for water storage. In Year 11 expected flow will again decrease, after which only Pond 7 will be used for storage. It is assumed the water treatment campaign will continue through year 100. Water treatment costs are included in the Solution Management sheet. Changes to the water treatment plant and pipe configurations changes are included in the "Other User" sheet.

The Solution Management sheet includes the cost of pumping water for treatment. Electrical costs for Holding Year through Year 3 and Years 4-10 assume the use of grid power and diesel-generated power for batch treatment in the following years (11-100). Following the removal of Site 23 and the decreased flows, crews would be mobilized to the site and the water treatment plant would be started up for discrete campaign runs. The water treatment plant would be operated for the duration it would take to treat the accumulated inventory. Once the accumulated water is treated the plant would be deactivated until the next campaign and the crews mobilized out of the site.

The expenditures in active water treatment are reagents and power. Consumable (reagent) expenditure is provided in User Sheet 4. The currently observed power consumption of the water treatment plant operating at 2,500 gallons per minute (gpm) is 150 kilowatts (kW) energy. Electrical consumption is calculated as follows:

150 kW/2,500 gpm = 150 kW/(2,500 gal/min × 60 min/hr)

= 0.001 kilowatt hours (kWh)/gal

For grid power, the cost per gallon becomes the following:

$0.15/kWh x 0.001 kWh/gal = $0.00015/gallon

For diesel-generated power (discussed in Section 6.4.2), the cost is calculated below:

$0.32/kWh x 0.001kWh/gal = $0.00032/gallon

The treatment crew is assumed to consist of one foreman and one laborer. The duration and frequency of the campaigns are calculated on User Sheet 4 and linked to the Solution Management sheet heading "Treatment." Pond 10 will be decommissioned in Year 11, the water treatment plant will be replaced in Year 50, and Pond 7 will be relined in Year 50 provision for these costs are provided in "Process Ponds" and "Other User."

5.1.3. Human Resources

The size of the average active reclamation crew is estimated to be 25 persons. Most of these (such as equipment operators and laborers) are captured as the labor elements of reclamation activities in the various cost calculations by task. The rest consist of administrative and other technical personnel and are entered in the Human Resources worksheet. Human resources costs over the course of the closure period

are calculated for the holding crew (2 skilled laborers), technical and administrative support over the active closure period, and the monitoring crew for Holding Year through Year 100.

This sheet also includes the cost of employing a crew for batch water treatment. This sheet was used instead of entering the crew in the Solution Management sheet because extra time was required for travel, startup and shutdown of the plant past the active closure years. These labor costs are derived from the numbers of days per year as calculated in User Sheet 4 (described in Section 5.2.4).

5.1.4. Other User

The Other User worksheets have been used to include costs for items not covered under other built in worksheets in the SRCE model. Calculations from User Sheet tabs are linked and referenced here. Costs linked from the User Sheets are discussed under their respective headings and are annotated in the "Comment" column.

The items listed in the Other User Sheet include the following and can be referenced through the comments column in the SRCE:

1. Lime purchase for short-lag disposal
2. Internal mill infrastructure demolition
3. Post-closure cover maintenance - Tailings
4. Outfall pipeline and facilities maintenance
5. Various waste disposal
6. Bridge Demolition
7. Monitoring
8. Marine demo
9. Decontamination
10. Removal of miscellaneous linear items (1 backhoe+2 laborers)
11. Utilization of underground equipment for disposal
12. Small crossings over Zinc and Greens Creek bridge locations
13. Excavator for residual and short-lag material
14. Reconfiguration pumps and pipes
15. Demolish WTP
16. Material deficit
17. Drain Material
18. Mob-demob
19. Pipe for water collection from Pond D
20. WTP replacement - every 50 years
21. Pond cleaning - every 50 years
22. Pond relining - every 50 years

The cost of lime purchase has been estimated through User Sheet 1 by using a quote and the rate of 1% by weight of lime addition to the short-lag material, as discussed in User Sheet 1 (Section 5.2.1). User Sheet 1 also provides a calculation of underground haulage for material disposed of underground. The cost of surface haulage to the portal for materials disposed of underground and the materials disposed of in the tailings storage facility are calculated in the Haul Materials sheet. The accompanying excavator time is calculated in the Other User sheet by dividing the total volume of material to be handled by dividing with the corrected productivity of the excavator.

The mill demolition cost estimate is discussed in Section 5.2.6.

The 2014 plan had a provision for post-closure cover maintenance for engineered covers. The SRCE can also be made to provide an estimate of post-closure maintenance of revegetation and erosion; however, given the engineered cover maintenance is a specialized item, it has been further carried into this cost estimate to account for engineered cover-specific activities.

The maintenance of the outfall pipeline was an assumption in the 2014 estimate which has been incorporated through User Sheet 5 with the assumption of maintenance once every three years after active reclamation. User Sheet 6 includes a calculation for demolition of the water treatment plant for eventual demolition. A provision for capital cost of ~$106,000 in reconfiguring pumps and pipe systems during water treatment has been assumed. The required labor is assumed to span a month with support from a backhoe, and a welder is assumed for a quarter of that time. A crew is defined in the "Fleets (Crews)" sheet as User Crew 3 with the welder and associated equipment number at 0.25 (rounded and displayed as "0") and linked to the Other User sheet for direct multiplication of the crew cost with hours.

The disposal of production rock material, demolition of marine structures, monitoring, bridge demolition, waste disposal and decontamination, and monitoring are discussed in Sections 5.2.1, 5.2.3, 5.2.7, 5.2.9, and 5.2.11, respectively.

Existing growth media stockpiles will be used for cover construction on the TDF. The deficit will be purchased.

Most of the surface pipes will be removed with the potentially acid generating (PAG) material at the various locations. Two weeks of time for a crew of a backhoe with operator and two laborers (User Crew #1 in the Fleets/Crews sheet) has been used to estimate a cost to remove and dispose of any remaining surface pipes as well as culvert crossings.

The removal of materials and disposal to the underground will require double handling. These are calculated under User Sheet 1 (discussed in 5.2.1). An extra excavator is assumed to be required to excavate the material for the haulage fleet.

Periodic safety inspections of the dam system are included through calculations in User 8. Mobilization-demobilization is included through calculations in User 2.

Pond cleaning costs assume that sludge from water treatment will be removed from Pond 7, prior to relining the pond. The timing will coincide with the replacement of the water treatment plant in Year 50.

5.1.5. Tailings

The tailings pile will be capped with a four-layer system including (from bottom to top) a capillary break, a compacted barrier layer, a drain layer and growth media (Attachment D). Costs for haulage and placement of site-derived growth media, the capillary break and drain layers and the barrier layer are calculated in the Haul Material worksheet. The costs for importing any cover material deficit is calculated in the Other User worksheet.

The tailings facility is designed with final slopes at 3H:1V. Input values are obtained from the AutoCAD file "HGCMC Stage 3 phase 1 full buildout design 11-14-13_final revised_MidbenchLengths_mth ACAD14_ ft.dwg.dwg" and are shown on Figure 1. For this Plan HGCMC verified the model inputs from 2013. Acreage calculations were slightly less in 2019, however HGCMC decided to maintain the (now conservative) 2013 values for this plan. The inputs are summarized in Table 3. Given an assumption of

hydroseeding, it is assumed that the application of the hydroseed will include ripping/scarifying and this is not further selected in the SRCE.

Table 3: Tailings Storage Facility Input Values

Sub-division	Mid-bench length (ft)	Height (ft)	Area (acres)
Area 1 - North East	447	120	4.93
Area 2 - North	709	190	7.18
Area 3 - Far North	876	90	6.14
Area 4 - North West	574	120	7.26
Area 5 - West	1,371	220	19.63
Area 6 - South	511	190	7.89
Area 7 - East	852	170	8.34
		Total	61.37

5.1.6. Roads

Both A Road and B Road will be reclaimed. The roads include some PAG material which will need to be removed for disposal. This calls for reclamation and closure of roads by the end of the closure period. These quantities are covered under the Haul Material sheet (surface haulage) and User Sheet 1 (underground haulage). The reclamation of roads will be one of the last activities on site before the completion of the closure period in order to service the reclamation activities. It has been assumed that during the post-closure period, in the absence of roads, the crews necessary for monitoring, maintenance, and water treatment would be mobilized to site by helicopter. There will be a section of the road from Hawk Inlet to the tailings storage facility that will be left (approximately 1 mile) to allow for mobilized crews to operate past the active closure years. This section of the road will be reclaimed last.

HGCMC proposes that during the post-closure period, with the reclamation of the roads, the crews necessary for monitoring, maintenance, and water treatment would be mobilized to site by helicopter. This is provided under Section 5.2.5 (User Sheet 5).

5.1.7. Underground Openings

The Underground Openings sheet includes the cost to close adits and shafts. Portals will be closed with concrete bulkheads. The 920 portal bulkhead will be constructed to allow gravity drainage to the water treatment plant via a pipeline. Ventilation raises (two reaching the surface and three underground, between levels) will be closed with concrete caps. The dimensions for adits are required as height and width and those for the shafts are required in diameters. Given the ventilation raises in this mine are typically square-shaped, the 10 ft×10 ft dimensions were converted into diameters:

Diameter = (A/π)^0.5×2 = (H×W/π)^0.5×2 = (10×10/3.14)^0.5×2 = 11.3 ft

5.1.8. Haul Materials

The Haul Material worksheet is used to calculate the costs to haul, screen (if applicable), and compact (if applicable). Items included here are the engineered cover materials, Pit 174 glacial till wedge, the concrete foundation debris (from the Foundations and Buildings sheet), and hauling materials to the tailings storage facility and to the underground mine. The list consists of the potentially acid generating (PAG) materials (“residual” or “short-lag”) stored on the surface according to the summation of incremental distances. Furthermore, for conservative costing it has been assumed that all of Site 23 (Figure 3) will be

hauled to the tailings storage facility. For this estimate, it has been assumed that material disposed of underground will be double-handled by first transporting to the portal and then loading the material to underground trucks for transportation to the underground dump site where a dozer will stack the material. The Haul Material sheet therefore includes the initial transportation to the portal. The underground haulage is calculated in User Sheet 1 and discussed in Section 5.2.1.

The Haul Material sheet has an over-ride for the number of equipment utilized. This has been used to make the model calculate the maximum number of trucks that can haul across the roads on site without compromising efficiency (8 trucks) where the model calculates greater numbers of trucks with increasing haulage distance. Truck numbers for haulage items for which fewer trucks are estimated by the model have not been over-ridden.

5.1.9. Foundations and Buildings

Building structures and flat areas (paved or otherwise) were originally obtained for the 2014 Plan from the following files:

- 920_asbuilt.dwg
- 2011920-1350-Site23Disturbanceareas.dwg
- 2011HAWKINLETDISTURBANCEAREA.dwg
- HI1015.dwg
- 9201010.dwg

The 2019 Plan includes the additional buildings built over the past 5 years. The SRCE utilizes the dimensions of the buildings as well as the construction material and demolition method in calculating the cost of demolition. Eve heights were assumed for most buildings based upon discussions with site personnel.

The Foundations and Buildings worksheet calculates the cost to demolish buildings, load building debris onto dump trucks and haul for 20 miles by default. To reflect the cost of double handling debris material by transporting from site to portal and double handling from portal to a location in the underground mine, the concrete slab volume calculated in this sheet and an assumed 10% of the building volume to reflect other building debris, the “Fleets (Crews)” sheet B-8 crew for large building demolition has been adjusted by setting truck and loader costs to zero, leaving only a crane. Then the aforementioned volumes are used in the “Haul Materials” sheet to estimate the cost of hauling the debris materials underground.

5.1.10. Ponds

The ponds at the site are provided in Table 4 and Figures 4, 5, and 6. During closure activities, some of these ponds will be removed along with the PAG material to be disposed of underground or in the tailings storage facility.

Table 4: Pond Input Values

Pond/Basin	Length (ft)	Width (ft)	Depth (ft)	Remarks
Pond 7	327	327	24.0	Reclaimed in Year 100
Pond 10	355	355	24	Reclaimed in Year 11
Pond 9	115	115	5.0	Reclaimed in Year 11
Pond C lower	74	74	2.0	Reclaimed during closure of other
Pond C upper	38	38	2.0	Reclaimed during closure of other

Pond/Basin	Length (ft)	Width (ft)	Depth (ft)	Remarks
Pond A	140	140	6.0	Reclaimed during closure of other
Pond 23	140	140	2.0	Reclaimed during closure of other
Pond D	90	90	4.0	Reclaimed during closure of other

Where pond shapes are not rectangular, assumed dimensions are used to accurately estimate the area.

5.1.11. Yards

The Yards worksheet is used to calculate miscellaneous surface disturbance where little or no grading is required. This includes building areas and any perimeter disturbance around other facilities. A summary of the disturbed acreage is provided in Table 1 of the Reclamation and Closure Plan.

Disturbance areas with Reclamation Plan acreages decreased by SRCE worksheet area calculations are the following:

- 920 mill and portal area (decreased by "Foundations and Buildings" sheet total footprint area which covers both the 920 area and Hawk Inlet)
- tailings disposal facility (decreased by "Tailings" sheet total footprint area)

5.1.12. Well Abandonment

170 monitoring wells site-wide are assumed to require closure. Of these, 144 monitoring wells will be closed immediately, leaving 26 for closure and post-closure monitoring as per the set of locations in 5.2.7. Two production wells (mill backslope) are also included in the worksheet for abandonment during closure.

5.1.13. Miscellaneous Costs

It is assumed that one of the two substations and the power line are the responsibility of another party. Therefore, one substation will be removed, and demolition costs are entered here and calculated based upon RS Means crew assumptions. The remaining substation will be removed at Year 10, at which time all surface water will gravity flow to the treatment pond and generator sets will be used to provide power for water management and treatment.

5.1.14. Monitoring

The Monitoring worksheet calculates the cost to repair vegetation (re-seed), repair erosion of covers and collect soil and groundwater samples. It has been utilized to estimate revegetation maintenance and erosion maintenance costs assuming that 10% will need to be repaired. The framework of monitoring of soil and groundwater is presented in User Sheet 8.

Further monitoring activities for post-closure maintenance of the engineered tailings cover (period of 5 years, cost-per-acre of utilization of a dozer, an excavator, and a compactor as well as materials maintenance) are included in the Other User sheet. The cost for Outfall pipeline maintenance is provided in the Other User sheet (through User Sheet 5).

5.1.15. Construction Management

The Construction Management sheet is used to estimate road maintenance costs. A provision has been made for road maintenance over this period. This will consist of the use of a small water truck and small grader. The number of months is calculated by the multiplication of years of active closure times the number of months in an operating season.

5.2. User Sheets

5.2.1. User Sheet 1 – Rock Removal

This sheet contains a summary table of the amounts of short-lag and residual material (to be disposed of underground or at the tailings storage facility). The amounts in the Plan have been updated to reflect current reclamation activities (e.g., Site 1350 and Site E) and increased volumes (e.g., Site 23). These volumes and changes are discussed in HGCMC's annual reports for active and inactive sites. These quantities are reflected in the Haul Materials sheet for calculation of haulage costs to the portal or the tailings storage facility. This sheet is further used to estimate the cost the surface haulage of the short-lag material double-handling (prior to haulage from the portal to the underground stacking location). "Short-lag" refers to potentially acid generating (PAG) material that is assumed to be at or near the point of acidification. "Residual" refers to PAG material that is not short-lag.

An estimate of the amount of lime to be used has also been made based on the total quantities. The amount of lime to be used is estimated as 1% by weight of short-lag material to be hauled. The total amount of lime estimated has been linked to the "Other User" sheet. The cost for lime has been obtained from HGCMC.

5.2.2. User Sheet 2 – Mobilization/Demobilization

The estimation of equipment mobilization/demobilization costs is determined by the number and types of equipment to be mobilized and the number of mobilizations and demobilizations to site (equal to the number of years each piece of equipment would be used for closure).

For this exercise, the SRCE file has been evaluated as a whole. The hours calculated by the standard SRCE sheets (Tailings, Roads, Haul Material, Foundations and Buildings, Yards, and Process Ponds as well as some miscellaneous items used in Well Abandonment and Construction Management sheets) have been considered. Also taken into consideration is the underground equipment utilized in the user sheets. This exercise goes hand in hand with the task of scheduling the costs in the Cost Schedule sheet (discussed in Section 5.3).

5.2.3. User Sheet 3 – Marine Demo Summary

This sheet has been used to calculate the cost of demolition of marine structures as provided for in the 2008 estimate. The details for these items have been gathered from the individual sheets used in the 2008 plan. Costs specific to marine demolition were adjusted for inflation and an additional ~$530,000 added. These costs have been linked into the Other User sheet.

5.2.4. User Sheet 4 – Water Treatment Summary

This sheet provides a summary of water treatment quantities by intervals as provided by Petros GeoConsulting Inc. (2014). The values in the 2014 SRCE model were vetted by Petros GeoConsulting Inc. against the 2018 sitewide water balance (EDE 2018). Water modeling data used for the 2014 model was more conservative as compared to the 2018 water balance. HGCMC decided to maintain the use of the conservative values from 2014 for this Plan. Currently, HGCMC is working on remodeling the sitewide water balance, the results of which will be used to update the future SRCE models. The pressure heads and pumping and treatment quantities and routine maintenance costs from this sheet are linked to the Solution Management sheet.

The quantity of surface water requiring treatment will vary over the closure and post closure period. This sheet provides an estimated production quantity (in gallons per minute) for each interval. The annual number of days required to treat the accumulated water is also estimated and used to calculate a labor cost in the Human Resources worksheet.

5.2.5. User Sheet 5 – Administration

General and administration (G&A) and human resources have been itemized and reflected under the SRCE sheets for G&A and Human Resources, respectively. Costs for long-term water treatment support elements (landing craft and meals) are included. For the purposes of this estimate, general and administration includes the following items:

- Camp support
- Power costs - camp
- Power costs - ventilation
- Transportation
- Landing craft for materials/equip costs
- Meals for WTP crew

Transportation to the site will be required for personnel, monitoring, and batch treatment of water. It is assumed that during the closure period, airplanes will be used. It is estimated that about five aircraft would be used to transport staff. These numbers and the fact that staff and operational personnel will be transported to site five months of the year are taken into consideration when estimating the number of trips in a year when monitoring and batch treating water are combined. These costs are then reflected in the SRCE sheet G&A. During post- closure, helicopters will be used to transport personnel and some items after the roads have been closed.

Power costs other than the power to treat water consist of underground ventilation and power for the camp. Power requirements for one main and two auxiliary fans for air flow rate of 205,000 cfm is estimated at 290 kW/hour. Peak power requirements for the camp are estimated at between 125 kW/hour and 188kW/hour. The average of these values was (157kW/hour) multiplied by a factor of 0.75, to adjust for the reduced power consumption at night and during the workday. For modeling purposes, it was assumed the camp is in use continuously from the Holding Year through Year 3. These numbers are used to estimate the underground ventilation and camp energy consumption costs. Camp support costs are calculated here based on a quote from ESS Support Services.

5.2.6. User Sheet 6 – Mill Demolition

This worksheet provides a summary of the various mill demolition tasks calculated elsewhere and includes a cost item to dismantle and remove the interior infrastructure prior to demolition of the buildings. This cost item is being calculated because the SRCE Buildings and Foundations demolition costs are based upon RS Means. RS Means assumes a standard industrial building with a standard amount of interior infrastructure. This is applicable to most buildings at a mine site except for a mill which has more complicated infrastructure.

There is no published data on the time required for this task. For the 2014 Plan SRK assumed a value based upon their experience with other demolition cost estimates. It is assumed two B-8 work crews would take three months to accomplish the work. Because the mill infrastructure has not changed HGCMC will continue to use this assumption.

Only Task 2 'Remove all internal mill parts, cut into pieces for transport underground' found on User 6, is entered in the Other User worksheet as the other tasks are calculated elsewhere (Foundations and Buildings and User 14 sheets) and only provided here to illustrate the total mill demolition costs.

5.2.7. User Sheet 8 - Monitoring

Cost items in this sheet comprise the following:

- Underground Care and Maintenance
- Suite Q
- QA/QC
- Stormwater
- APDES
- Marine water sampling
- Marine sediment and organism
- Site-wide vegetation
- Dam stability monitoring
- Dam PSI reporting

Table 5 provides surface and ground water monitoring locations with three additional locations to be monitored during the reclamation and post closure period. In the case of the three additional monitoring locations, they were assumed to be monitored at the same frequency as Site 54. These numbers may be reduced depending on monitoring results. The costs are linked to the "Other User" sheet.

In addition to the above monitoring discharged waters to the environment will also be monitored under the regulatory structure of the Alaska Pollutant Discharge Elimination System (APDES) permit. This will include monitoring of the 002 Outfall, stormwater discharges, marine waters, marine sediments, and marine organisms. Costs for stability monitoring and periodic safety inspections of the dams are included on User Sheet 8.

Table 5: Surface and Ground Water Monitoring Locations

Site	Name
6	Greens Creek Middle
9	Tributary Creek Lower
13	1350 East
27	Tailings Downgradient South Shallow
29	Tailings Downgradient West Shallow
32	Tailings Downgradient West Shallow 2
46	Bruin Creek Upper
48	Greens Creek Upper
49	Bruin Creek Lower
54	Greens Creek Lower 1
56	Site 23 Downgradient*
57	Site 23 Upgradient*
60	Tailings Stormwater Pond Downgradient 1
61	Greens Creek Flood Plain
62	Greens Creek Lower 2
609	Further Creek Lower
711	Greens Creek Above Site E
712	Greens Creek Below Site E
New site	Mine Drainage
New site	Tailings Drainage
New site	Site 23 Drainage

5.2.8. User Sheet 10 – Summary of RS Means Cost Calculations

RS Means costs were used in earlier versions of the reclamation and closure model. A few calculations remain that that reference RS Means, in calculations they are manipulated to provide unit costs based upon the labor, equipment and materials costs used in the SRCE. The crew makeup and productivity is used from the RS Means database as a basis for this new calculation. This worksheet provides a summary of the RS Means calculations and is linked to allow updates to automatically occur should the input cost data be changed.

5.2.9. User Sheet 11 – Bridge Demolition

Bridge demolition costs have been updated with available labor and equipment costs and adjusted material costs. These costs have been entered in the "Other User" sheet. The related decontamination costs have been calculated in User Sheet 14. During reclamation the bridges will be modified to support the pipelines. Demolition will consist of removing bridge components that will not be needed to support the pipeline (e.g. decking, guard rails and splash guards).

5.2.10. User Sheet 12 – Surface Disturbance Summary

This sheet summarizes the surface disturbances cited in the referenced sources for use elsewhere in the spreadsheet, particularly the "Yards" sheet which aims to include the areas that are not included in the various SRCE sheets calculations.

5.2.11. User Sheet 14 – Waste Disposal and Decontamination

Decontamination and disposal of various wastes are calculated in this worksheet. The tasks are summarized in Table 6. Cost calculations were carried forward from previous models and updated or inflated for current unit costs.

Table 6: Waste Disposal

Item	Activities
Waste Disposal	Industrial Waste Disposal
	Waste Material Disposal
	Scrap Shipping and Specialty Equipment for Cleanup
	Radiation Source Disposal
Decontamination	Prep of Demo Scrap
	Prep of Re-Bar Scrap
	Stockpiling Scrap
	Loading of Scrap
	Miscellaneous Demo

5.2.12. User Sheet 20 – Bond Calculation

This sheet uses the data from the cost schedule to calculate the surety. It follows the model that was used for the surety calculation in Waste Management Permit No. 2014BD0003. The calculation is based upon 200 years of data, derived from the cost schedule. The first four years (Holding Year – Year 3), commonly referred to as active reclamation, are funded directly from the surety. Long-term care, maintenance, and water treatment costs (Year 4 – Year 200+) are funded from a trust fund. It is assumed that the trust will be started by the end of the Holding Year from surety funds. The rate of return (3.97%) for the trust fund was established by the US Forest Service and accepted by the ADEC and the ADNR. Monies derived from the trust fund in Years 1-3 will be reinvested into the trust, resulting in the trust being fully funded by Year

4. The rate of inflation was calculated from the Anchorage Consumer Price Index over the past 5 years. This rate will need to be verified and possibly updated when the renewal is issued.

This calculation uses the same indirect cost percentages as in the current approved Plan. Indirect cost percentages are applied against all the direct costs, however when they are received in the estimate varies Table 7.

Table 7: Indirect Cost Percentages

Indirect Cost	Rate	Received in Year
Engineering, Design and Construction Plan	2.75%	HY
Contingency	13.00%	HY - In perpetuity
Performance Bond	3.00%	HY - Year 3
Contractor Profit	15.50%	HY - In perpetuity
Contract Administration	7.00%	HY - In perpetuity
TOTAL	41.25%	

5.3. Cost Schedule

Cost calculated in the various worksheets are entered into the schedule by task and according to the year they will be completed. Included below are the assumptions used to build the schedule:

- The closure costs and active water treatment costs are scheduled out to 100 years to represent water treatment in perpetuity.
- There will be one “holding year” before the closure period begins.
- The closure period is scheduled to last three years.
- Reclamation activities during the closure period will be seasonal and scheduled for five and a half months per year.
- Water treatment activities during the reclamation phase will be continuous and scheduled for twelve months per year.
- Equipment will be mobilized for each summer construction season and at year 10 and year 100 for subsequently scheduled activities.
- The removal of Site 23 to the tailings storage facility will require 2 years. Following removal of Site 23, the removal of other waste rock sites and other material moving activities will be completed.
- Prior to Year 10, pumping of water from the base of Site D to the TDF pipeline (or underground) may be required and the cost of power for this purpose is included in the estimate. After Year 10, the substation providing line power for pumping will be removed, after which water collection in ponds will occur via gravity flow and power for pumping water to the ponds and from the ponds will be provided by diesel generators.
- Zinc Creek, Falls Creek, Killer Creek and Greens Creek bridges will be modified to serve as pipeline crossings for long term water management.
- Most wells will be abandoned during the active closure period. Some will remain for long term monitoring and will be abandoned in year 100.
- Post-closure activities during Years 11-99 will consist of monitoring, water treatment plant batch operations, and water treatment plant replacement in Year 50.

At the end of the active closure period, the remaining roads will be reclaimed, except for the section of B Road that leads from Hawk Inlet to the water treatment plant and ponds. The section of B Road not reclaimed at the end of active closure will be reclaimed in Year 100 when equipment will be mobilized for closure of the water treatment plant, the ponds providing for batch treatment, and the last remaining bridges.

6. UNIT COST DATA DEVELOPMENT

6.1. Project Cost Bases

The SRCE works by importing user cost data from a file ("user cost data file") with different "bases". Once these data are imported, they are reproduced in the following sheets of the SRCE and used within the spreadsheet:

- labor rates
- equipment rates
- material costs
- miscellaneous unit costs

A discussion is provided below for how these rates have been fed to the user cost data file.

6.2. Labor

Labor rates have been acquired from the Alaska Pamphlet 600 effective September 2018. Taxes and fringes have been added to base rates and then adjusted for shifts of 112 hours consisting of 96 hours "straight" time and 16 hours overtime.

Table 8 provides an overview of the basic hourly rate and subtotal of fringes, it also illustrates how these rates are adjusted from the base rate and fringes. Base rate and fringes are paid for straight time. For overtime,

1.5 times the base rate is paid, and fringes are also included for overtime hours worked (Alaska.gov, 2013).

Table 8: Alaska Pamphlet 600 Basic Hourly Rate and Fringes by Groups Used

Group	BHR	H&W	PEN	TRN	Other Benefits		THR	Straight Hourly Fringe	Straight Hourly Rate	Overtime Hourly Fringe	Overtime Hourly Rate	Total Straight Time Hourly Rate	Total Overtime Hourly Rate	Total Average Hourly Rate
A0301	38.34	10.08	14.63	0.95	0.10	0.10	64.20	25.86	36.59	0.20	57.51	62.45	57.71	61.77
A1601	40.28	9.80	12.25	1.00	0.10	0.00	63.43	23.15	37.59	0.10	60.42	60.74	60.52	60.71
A1602	42.04	9.80	12.25	1.00	0.10	0.00	65.19	23.15	38.59	0.10	63.06	61.74	63.16	61.94
A1604	38.79	9.80	12.25	1.00	0.10	0.00	61.94	23.15	39.59	0.10	58.19	62.74	58.29	62.10
A2101	39.59	10.58	11.89	1.15	0.10	0.00	63.31	23.72	40.59	0.10	59.39	64.31	59.49	63.62
A2102	40.86	10.58	11.89	1.15	0.10	0.00	64.58	23.72	41.59	0.10	61.29	65.31	61.39	64.75
A2105	36.93	10.58	11.89	1.15	0.10	0.00	60.65	23.72	42.59	0.10	55.40	66.31	55.50	64.77
S0401	37.63	8.21	11.80	1.18	0.10	0.00	58.92	21.29	43.59	0.10	56.45	64.88	56.55	63.69
S1201	30.26	8.70	17.06	1.25	0.20	0.20	57.67	27.41	44.59	0.40	45.39	72.00	45.79	68.26
S1203	32.16	8.70	17.06	1.25	0.20	0.20	59.57	27.41	45.59	0.40	48.24	73.00	48.64	69.52
S2204	38.98	8.70	17.06	1.25	0.20	0.20	66.39	27.41	46.59	0.40	58.47	74.00	58.87	71.84

BHR Basic hourly Rate
H&W Health and Welfare (Not applied to overtime)
PEN Pension (Not applied to overtime)
TRN Training (Not applied to overtime)
THR Total Hourly Rate

Total Average Hourly Rage = (Straight Time + Straight Fringe) x 96 hours) + (Overtime + Overtime Fringe) x 16 hours)/112 hours per shift

6.3. Equipment

The SRCE has a set list of equipment for which monthly rates can be input through the user cost data file. The monthly equipment rates are converted to hourly rates and add-ons such as fuel, lube, wear, etc., are added for total rates. The source data for equipment costs is provided in the cost data file (Attachment B). Equipment rental rates and fuel consumption rates for underground mining equipment were obtained from a contractor.

The SRCE calculates a "wet" hourly rate (hourly rate including fuel) for equipment. For equipment not included in the Cost Data file, wet equipment rates were estimated. These fuel consumption rates are summarized in Table 9.

Table 9: Fuel Consumption Rates

Equipment	gal/hr
Track Hoe with Shear*	6
Lowboy Trailer*	8
8,000 lbs. Grade All*	3
MT2010**	5.8
MT436B**	7.3
ST2G**	3.75
ST2D**	3.75

* Source: 2008 Reclamation Plan
** Source: CMI Alaska, July 2, 2012

6.4. Materials

The following are the principal materials utilized in the model:

- off-road diesel
- electrical power
- diesel power
- hydroseed mix
- cement
- monitoring costs
- other miscellaneous unit costs

Each element is discussed separately below.

6.4.1. Diesel

The diesel fuel cost utilized for this cost estimate were not adjusted from the 2014. In 2014 costs were provided by Taku Fuel with an additional fuel surcharge of 19% added. The national 5-year (2009-2014) average of a gallon of diesel in 2014 was $3.44, at the end of 2018 the national 5-year (2014-2018) average was $2.93 (U.S. EIA). HGCMC has chosen to maintain the fuel rate from the 2014 Plan and not adjust to reflect the national decrease in fuel prices.

Diesel: $4.14/gallon

6.4.2. Electricity and Diesel Generated Power

Electrical power at the site is assumed to be that currently used at the site ($0.10/kWh).

The cost of diesel-generated power in $/kWh has been calculated from the cost of fuel as per the assumptions below. It is furthermore assumed that grid power would be utilized until the end of Year 10 when the closure period is over. After this, power requirements for activities such as water treatment would be supplied by generators. This generated power cost is calculated by the following formula and utilized as a user over-ride in the SRCE in the Solution Management sheet.

Fuel burn rate: 0.078 gallons/kWh

Generator repairs, maintenance, etc.: 0.062 ¢/kWh Cost per generated kWh:

$4.14/gallon×0.078 gallons/kWh+$0.00062/kWh

≈ $0.32/kWh

6.4.3. Seed

Costs for seeding assumed using the highest cost seed mix for all areas with the maximum amount of mulch and fertilizer applied. Since the SRCE requires a cost per acre input these were converted as shown in Table 10.

Table 10: Seed Costs

Item	Cost per bag ($)	Unit (lb. bag)	Application Rate (lb/ac)	Cost per Acre ($)
Seed	21.30	1	25	532.50
Mulch	9.50	50	100	342.00
Fertilizer	21.66	50	300	129.96
			Total	**1,004.46**

Source: Quote from FMI Sales, 03/04/2019

The labor cost per acre for hydroseeding has been calculated by assuming a daily output of 15 acres. ($68.26 {General Laborer} / hour × 11 hours/day) / (15 acres/day) = $50.06/acre

For the equipment cost, a rental quote was obtained from Yukon Equipment (2014 inflation adjusted to 2019) and used to calculate hydroseeding equipment rates in $/acre.

($6,900 / month × 1 month / 334 hrs + 2 gal / hr × $4.14/gal) × (11 hours/day) / (15 acres/day)

=$21.22/acre

These data have been entered in the cost data file under “Seeding - Broadcast Mechanical” in the “Misc. Unit Costs” sheet and the revegetation method in the sheet “Material Costs” has been set to “Seeding - Broadcast Mechanical”.

6.4.4. Cement

The cost of concrete in the 2008 cost estimate was $205/yd^3. This has been adjusted by inflation to obtain

$249/yd^3. The SRCE typically requires the cost of cement in 50-lb. bags for calculation of costs related to concrete usage, such as underground working plugging. Therefore, with the default SRCE assumption that

one 50-lb bag mixes with water to make 0.21 yd3 or 0.16 m3 of grout/cement slurry, the $249/yd3 concrete cost has been converted to $44.73/bag cement.

Cement: ($249/yd3) × (0.21 yd^3/bag) = $52.29/50-lb bag

The cost for a 50-lb bag of bentonite was inflation adjusted from the 2014 cost estimate.

Bentonite: $13.69/50-lb bag

6.4.5. Other Miscellaneous Material Costs

Other Material costs are included in the following sheets:

- User Sheet 8 – Monitoring (discussed in Section 5.2.8)
- User Sheet 14 – Waste Disposal and Decontamination (discussed in Section 5.2.11)

6.5. Indirect Costs

Indirect costs consist of the following at the indicated rates and are valid for all cost bases provided in a cost data file:

1. Engineering and redesign 2.75%
2. Contractor profit and overhead 15%
3. Contract administration 3.5%
4. Government administration 3.5%
5. Performance bond 1.5%
6. Payment bond 1.5%
7. Insurance 0.5%
8. Scope contingency 6.5%
9. Bid contingency 6.5%

In the cost data file, insurance has been included together with the contractor overhead for a total of 15.5%. Scope contingency and bid contingency are also provided together for a total of 13%. Contract administration and government administration are provided together as a total of 7%.

7. CONCLUSIONS

The SRCE model calculation for the direct closure cost is estimated at $90,112,711. Together with indirect costs including engineering, design and construction plan, contingency, insurance, contractor overhead, performance bond, contractor profit, contract administration, and government indirect costs at a total of 41.25% of direct costs, or $37,171,493, the grand total is estimated at $127,284,204.

As with the current bond, required under WMP 2014DB0003, HGCMC intends to fund this bond with a surety. The surety will cover both the active reclamation phase and the long-term water treatment and maintenance costs. Long-term costs will be funded from a trust started with surety monies. HGCMC estimates, using the calculation logic from section 4 “Financial Responsibility” of WMP 2014DB0003, that the financial responsibility for the life of the renewed permit, unless modified, will be $91,718,196.

8. REFERENCES

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Kennecott Minerals, 2008. General Plan of Operations, Appendix 14, Attachment A. Kennecott Greens Creek Mining Company, April 1, 2008.

NVBond.org (2012). Standardized Reclamation Cost Model User Manual, Public Domain Version. http://nvbond.org/downloads/SRCE_User_Manual_1_3.pdf [Last accessed 5/10/2012]

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GPO Appendix 14
Attachment C
Standardized Reclamation Cost Estimator

November 2019

Closure Cost Estimate
Property Information

Enter Data Below in Green and Blue Spaces

STANDARDIZED RECLAMATION COST ESTIMATOR

Version 1.4.1
Build 016
NOT YET VALIDATED FOR REGULATORY USE IN NEVADA

COST DATA FILE INFORMATION

File Name:	20191120 HGCMC SRCE Model V1.xlsm
Cost Data File:	2019 SRCE Cost Data File Version 7.xlsm
Cost Data Date:	November 11, 2019
Cost Data Basis:	User Data — Data Cost Units: Imperial
Author/Source:	SRK Consulting/Greens Creek

PROJECT INFORMATION

Property/Mine Name:	Greens Creek — Property Code:
Project Name:	Reclamation Plan Update 2019
Date of Submittal:	April 2019 — Average Altitude: 600 ft.
Units of Measure:	○ Metric (m, km, ha, etc.) ◉ Imperial (ft, mi, acres, etc.)
Select One:	○ Notice or Sm Exploration Plan ○ Lg Exploration Plan ◉ Mine Operation
Select One:	○ Private Land ◉ Public or Public/Private
Cost Estimate Type:	Surety
Cost Basis Category:	Greens Creek 2019 - November 2019
Cost Basis Description:	**Equipment rental inflation adjusted from 2014 estimate. Cost(2019) = Cost(2014) * 1.0656 (Anchorage CPI 2014-2019)**

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Project Name: Reclamation Plan Update 2019
Project Date: April 2019
20191120 HGCMC SRCE Model V1.xlsm
Reclamation Plan

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Closure Cost Estimate
Cost Summary

Project Name: Reclamation Plan Update 2019
Project Date: April 2019
Model Version: Version 1.4.1
File Name: 20191120 HGCMC SRCE Model V1.xlsm

A. Earthwork/Recontouring	Labor (1)	Equipment (2)	Materials	Total
Exploration	$0	$0	$0	$0
Exploration Roads & Drill Pads	$0	$0	$0	$0
Roads	$101,317	$218,353	$0	$319,670
Well Abandonment	$101,734	$26,221	$2,088	$130,043
Pits	$0	$0	N/A	$0
Quarries & Borrow Areas	$0	$0	$0	$0
Underground Openings	$46,969	$4,581	$14,671	$66,222
Process Ponds	$69,684	$137,498	$0	$207,182
Heaps	$0	$0	$0	$0
Waste Rock Dumps	$0	$0	$0	$0
Landfills	$0	$0	$0	$0
Tailings	$0	$0	$0	$0
Foundation & Buildings Areas	$0	$0	$0	$0
Yards, Etc.	$162,170	$225,906	$0	$388,076
Drainage & Sediment Control	$0	$0	$0	$0
Generic Material Hauling	$6,101,676	$12,285,342	$0	$18,387,018
Other User Costs (from Other User sheet)	$798,471	$1,340,883	$10,870,083	$13,009,438
Other**				$0
Subtotal	**$7,382,021**	**$14,238,785**	**$10,886,842**	**$32,507,649**
Mob/Demob if included in Other User sheet	$0	$689,610	$0	$689,610
Mob/Demob				$0
Subtotal "A"	**$7,382,021**	**$14,928,395**	**$10,886,842**	**$33,197,259**

B. Revegetation/Stabilization	Labor (1)	Equipment (2)	Materials	Total
Exploration	$0	$0	$0	$0
Exploration Roads & Drill Pads	$0	$0	$0	$0
Roads	$2,733	$1,496	$69,308	$73,537
Well Abandonment				N/A
Pits	$0	$0	$0	$0
Quarries & Borrow Areas	$0	$0	$0	$0
Underground Openings				N/A
Process Ponds	$345	$189	$7,232	$7,767
Heaps	$0	$0	$0	$0
Waste Rock Dumps	$2,769	$1,515	$70,180	$74,464
Landfills	$0	$0	$0	$0
Tailings	$0	$0	$0	$0
Foundation & Buildings Areas	$0	$0	$0	$0
Yards, Etc.	$7,845	$4,292	$198,883	$211,020
Drainage & Sediment Control	$0	$0	$0	$0
Generic Material Hauling	$0	$0	$0	$0
Other User Costs (from Other User sheet)	$0	$0	$0	$0
Other**				$0
Subtotal "B"	**$13,692**	**$7,492**	**$345,603**	**$366,788**

C. Detoxification/Water Treatment/Disposal of Wastes**	Labor (1)	Equipment (2)	Materials	Total
Process Ponds/Sludge				$0
Heaps				$0
Dumps (Waste & Landfill)				$0
Tailings				$0
Surplus Water Disposal				$0
Monitoring				$0
Miscellaneous				$0
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$0
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
Pumping (from Solution Mgmt sheet)	$0	$416,796	N/A	$416,796
Evaporation (from Solution Mgmt sheet)	$0	$0	$0	$0
Treatment (from Solution Mgmt sheet)	$0	$10,966,818	$1,178,083	$12,144,901
Decontamination (from Solution Mgmt sheet)	$0	$0	$0	$0
Other User Costs (from Other User sheet)	$880,455	$1,085,218	$7,713,286	$9,678,959
Other**				$0
Subtotal "C"	**$880,455**	**$12,468,833**	**$8,891,369**	**$22,240,656**

D. Structure, Equipment and Facility Removal, and Misc.	Labor (1)	Equipment (2)	Materials	Total
Foundation & Buildings Areas	$948,186	$233,658	$0	$1,181,844
Other Demolition	$0	$0	$0	$0
Equipment Removal	$0	$0	$0	$0
Fence Removal	$0	$0		$0
Fence Installation	$0	$0	$0	$0
Culvert Removal	$0	$0	N/A	$0
Pipe Removal	$0	$0	N/A	$0
Powerline Removal	$0			$0
Transformer Removal	$29,001			$29,001
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Misc. Costs	$0	$0	$0	$0
Other User Costs (from Other User sheet)	$1,867,604	$967,784	$363,269	$3,198,656
Other**				$0
Subtotal "D"	**$2,844,791**	**$1,201,442**	**$363,269**	**$4,409,501**

E. Monitoring	Labor (1)	Equipment (2)	Materials	Total
Reclamation Monitoring and Maintenance	$8,979	$23,341	$37,162	$69,482
Ground and Surface Water Monitoring	$0	$0	$0	$0
Other User Costs (from Other User sheet)	$101,855	$646,824	$6,774,694	$7,523,372
Subtotal "E"	**$110,834**	**$670,165**	**$6,811,856**	**$7,592,854**

F. Construction Management & Support	Labor	Equipment (2)	Materials	Total
Construction Management	$0	$0	N/A	$0
Construction Support	$0	$0	$0	$0
Road Maintenance	$180,263	$139,892	$0	$320,155
Other User Costs (from Other User sheet)	$12,390	$1,614	$7,086	$21,090
Other**				$0
Subtotal "F"	**$192,653**	**$141,506**	**$7,086**	**$341,245**

G. Closure Planning, G&A, Human Resources			Include?	Total
Closure Planning				$0
General & Administration				$10,128,539
Human Resources				$11,951,540
Other User Costs (from Other User sheet)	$0	$0	$0	$0
Other**				$0
Subtotal "G"	**$0**	**$0**	**$0**	**$22,080,079**

Subtotal Operational & Maintenance Costs	Labor (1)	Equipment (2)	Materials (3)	Total
Subtotal A through G	**$11,424,445**	**$29,417,833**	**$27,306,024**	**$90,228,382**

** Other Operator supplied costs - additional documentation required.

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Closure Cost Estimate
Cost Summary

Project Name: Reclamation Plan Update 2019
Project Date: April 2019
Model Version: Version 1.4.1
File Name: 20191120 HGCMC SRCE Model V1.xlsm

Indirect Costs				Include?	Total
1. Engineering, Design and Construction (ED&C) Plan (7)					$2,481,281
2. Contingency (8)					$11,729,690
3. Insurance (9)		$0			$0
4. Performance Bond (10)					$2,706,851
5. Contractor Profit (11)					$13,985,399
6. Contract Administration (12)					$6,315,987
7. Government Indirect Cost (13)					$0
Subtotal Add-On Costs					**$37,219,208**
Total Indirect Costs as % of Direct Cost					41%
GRAND TOTAL					**$127,447,590**

Administrative Cost Rates (%)					
	Cost Ranges for Indirect Cost Percentages				
	<=	<=	<=	>	
1. Engineering, Design and Construction (ED&C) Plan	$500,000	$2,500,000	$25,000,000	$25,000,000	Small Plan
Variable Rate	3%	3%	0.0275	3%	3%
	<=	<=	<=	>	
2. Contingency (6.5% bid, 6.5% scope)	$500,000	$5,000,000	$50,000,000	$50,000,000	Small Plan
Variable Rate	13%	13%	13%	13%	13%
3. Insurance	0.0%	of labor costs			
4. Bond (payment and performance)	3.0%	of the O&M costs if O&M costs are >$100,000			
5. Contractor overhead and profit+insurance (@0.5%)	16%	of the O&M costs			
	<=	<=	<=	>	
6. Contract Admin and Government Admin (ea. 3.5%)	$1,000,000	$15,000,000	$25,000,000	$25,000,000	
Variable Rate	7%	7%	0.07	7%	7%
0	0%	$0			

RECLAMATION COST ESTIMATION SUMMARY SHEET FOOTNOTES

NOTE :
As per WMP 2014DB0003

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Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Clear Schedule

Cost Schedule and Financial Analysis

Budget Year:	2020	
First Year of Operation	1989	
Operating Period		years
Closure Year 1:	2020	
Closure Period:	4	years
Post Closure Period	99	years

Inflation Rate (r) (%):	0.0%
Market Risk (MR)(%):	0.0%
Discount Rate (i)(%):	0.0%

Closure Period:	
Post Closure Period:	

Engineering, Design and Construction Plan (%)	3%
Contingency (%)	13.0%
Contractor OH and Profit (CP)(%):	16%
Contract Administration (%)	7%

Show how many years in schedule (10 to 100) 100 Set Years <<< Set years and click "Set Years" button

	Term (t)(years):	Total From Cost Summary	0	1	2	3	4	5	6	7	8	9	10	11	12	13
	Schedule Variance		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
A. Earthwork/Recontouring																
Exploration	$ -	$ -														
Exploration Roads & Drill Pads	$ -	$ -														
Roads	$ -	$ 319,670				$ 319,670										
Well Abandonment	$ -	$ 130,043		$ 111,302												
Pits	$ -	$ -														
Quarries & Borrow Areas	$ -	$ -														
Underground Openings	$ -	$ 66,222				$ 66,222										
Process Ponds	$ -	$ 207,182		$ 109,510												
Heaps	$ -	$ -														
Waste Rock Dumps	$ -	$ -														
Landfills	$ -	$ -														
Tailings	$ -	$ -														
Foundation & Buildings Areas	$ -	$ -														
Yards, Etc.	$ -	$ 388,076		$ 129,359	$ 129,359	$ 129,359										
Drainage & Sediment Control	$ -	$ -														
Generic Material Hauling	$ -	$ 18,387,018		$ 6,129,006	$ 6,129,006	$ 6,129,006										
Other User Costs (from Other User sheet)	$ -	$ 13,009,438		$ 4,336,479	$ 4,336,479	$ 4,336,479										
Other**	$ -	$ -														
Mob/Demob if included in Other User sheet	$ -	$ 689,610		$ 263,952	$ 165,848	$ 172,445	$ 21,420	$ 21,420					$ -			
Mob/Demob	$ -	$ -														
Subtotal "A"	$ -	$ 33,197,259	$ -	$ 11,079,608	$ 10,760,692	$ 11,153,181	$ 21,420	$ 21,420	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
B. Revegetation/Stabilization																
Exploration	$ -	$ -														
Exploration Roads & Drill Pads	$ -	$ -														
Roads	$ -	$ 73,537				$ 73,537										
Well Abandonment		N/A														
Pits	$ -	$ -														
Quarries & Borrow Areas	$ -	$ -														
Underground Openings		N/A														
Process Ponds	$ -	$ 7,767			$ 7,767											
Heaps	$ -	$ -														
Waste Rock Dumps	$ -	$ 74,464			$ 74,464											
Landfills	$ -	$ -														
Tailings	$ -	$ -				$ -										
Foundation & Buildings Areas	$ -	$ -			$ -											
Yards, Etc.	$ -	$ 211,020		$ 70,340	$ 70,340	$ 70,340										
Drainage & Sediment Control	$ -	$ -														
Generic Material Hauling	$ -	$ -														
Other User Costs (from Other User sheet)	$ -	$ -				$ -										
Other**	$ -	$ -														
Subtotal "B"	$ -	$ 366,788	$ -	$ 70,340	$ 152,571	$ 143,877	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C. Detoxification/Water Treatment/Disposal of Wastes**																
Process Ponds/Sludge	$ -	$ -														
Heaps	$ -	$ -														
Dumps (Waste & Landfill)	$ -	$ -														
Tailings	$ -	$ -														
Surplus Water Disposal	$ -	$ -														
Monitoring	$ -	$ -														
Miscellaneous	$ -	$ -														
Solid Waste - On Site	$ -	$ -														
Solid Waste - Off Site	$ -	$ -														
Hazardous Materials	$ -	$ -														
Hydrocarbon Contaminated Soils	$ -	$ -														
Pumping (from Solution Mgmt sheet)	$ -	$ 416,796	$ 25,518	$ 20,148	$ 21,492	$ 21,492	$ 5,196	$ 5,196	$ 5,196	$ 5,196	$ 5,196	$ 5,196	$ 5,196	$ 2,363	$ 2,363	$ 2,363
Evaporation (from Solution Mgmt sheet)	$ -	$ -														
Treatment (from Solution Mgmt sheet)	$ -	$ 12,144,901	$ 177,398	$ 180,843	$ 180,843	$ 180,843	$ 127,045	$ 127,045	$ 127,045	$ 127,045	$ 127,045	$ 127,045	$ 127,045	$ 115,561	$ 115,561	$ 115,561

Decontamination (from Solution Mgmt sheet)	$ -	$ -																
Other User Costs (from Other User sheet)	$ -	$ 9,678,959	$ 225,381	$ 416,929	$ 261,427	$ 672,095												
Other**	$ -	$ -																
Subtotal "C"	$ -	$ 22,240,656	$ 428,296	$ 617,921	$ 463,762	$ 874,430	$ 132,241	$ 132,241	$ 132,241	$ 132,241	$ 132,241	$ 132,241	$ 132,241	$ 117,924	$ 117,924	$ 117,924		
D. Structure, Equipment and Facility Removal, and Misc.																		
Foundation & Buildings Areas	$ -	$ 1,181,844		$1,180,438														
Other Demolition	$ -	$ -																
Equipment Removal	$ -	$ -																
Fence Removal	$ -	$ -																
Fence Installation	$ -	$ -																
Culvert Removal	$ -	$ -																
Pipe Removal	$ -	$ -																
Powerline Removal	$ -	$ -																
Transformer Removal	$ -	$ 29,001												$29,001				
Rip-rap, rock lining, gabions	$ -	$ -																
Other Misc. Costs	$ -	$ -																
Other User Costs (from Other User sheet)	$ -	$ 3,198,656		$1,554,648	$1,554,648	$89,361												
Other**	$ -	$ -																
Subtotal "D"	$ -	$ 4,409,501	$ -	$ 2,735,086	$ 1,554,648	$ 89,361	$ -	$ -	$ -	$ -	$ -	$ -	$ 29,001	$ -	$ -	$ -		
E. Monitoring																		
Reclamation Monitoring and Maintenance	$ -	$ 69,482					$13,896	$13,896	$13,896	$13,896	$13,896							
Ground and Surface Water Monitoring (calculated from user input in Monitoring Sheet)	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Other User Costs (from Other User sheet)	$ -	$ 7,523,372	$333,170	$309,872	$259,872	$259,872	$418,565	$386,877	$230,911	$280,911	$249,224	$113,166	$163,166	$104,614	$86,302	$86,302		
Subtotal "E"	$ -	$ 7,592,854	$ 333,170	$ 309,872	$ 259,872	$ 259,872	$ 432,461	$ 400,774	$ 244,808	$ 294,808	$ 263,120	$ 113,166	$ 163,166	$ 104,614	$ 86,302	$ 86,302		
F. Construction Management & Support																		
Construction Management	$ -	$ -																
Construction Support	$ -	$ -																
Road Maintenance	$ -	$ 320,155		$106,718	$106,718	$106,718												
Other User Costs (from Other User sheet)	$ -	$ 21,090				$21,090												
Other**	$ -	$ -																
Subtotal "F"	$ -	$ 341,245	$ -	$ 106,718	$ 106,718	$ 127,808	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
G. Closure Planning, G&A, Human Resources																		
Closure Planning	$ -	$ -																
General & Administration	$ -	$ 10,128,539	$742,388	$1,085,948	$999,818	$999,818	$73,056	$73,056	$59,928	$59,928	$59,928	$59,928	$59,928	$56,328	$56,328	$56,328		
Human Resources	$ -	$ 11,951,540	$1,387,685	$998,917	$998,917	$998,917	$395,690	$395,690	$135,665	$135,665	$135,665	$135,665	$135,665	$56,527	$56,527	$56,527		
Other User Costs (from Other User sheet)	$ -	$ -																
Other**	$ -	$ -																
Subtotal "G"	$ -	$ 22,080,079	$ 2,130,073	$ 2,084,864	$ 1,998,734	$ 1,998,734	$ 468,746	$ 468,746	$ 195,593	$ 195,593	$ 195,593	$ 195,593	$ 195,593	$ 112,855	$ 112,855	$ 112,855		
Subtotal Operational & Maintenance Costs																		
Subtotal A through G	$ -	$ 90,228,382	$ 2,891,540	$ 17,004,408	$ 15,296,997	$ 14,647,263	$ 1,054,868	$ 1,023,181	$ 572,642	$ 622,642	$ 590,954	$ 441,000	$ 520,001	$ 335,393	$ 317,080	$ 317,080		
Indirect Costs																		
1. Engineering, Design and Construction (ED&C) Plan (7)	$ -	$ 2,481,281	$2,481,281															
2. Contingency (8)		$ 11,729,690	$ 375,900	$ 2,210,573	$ 1,988,610	$ 1,904,144	$ 137,133	$ 133,013	$ 74,443	$ 80,943	$ 76,824	$ 57,330	$ 67,600	$ 43,601	$ 41,220	$ 41,220		
3. Insurance (9)	$ -	$ -																
4. Performance Bond (10)	$ -	$ 2,706,851	$676,713	$676,713	$676,713	$676,713												
5. Contractor Profit (11)		$ 13,985,399	$ 448,189	$ 2,635,683	$ 2,371,034	$ 2,270,326	$ 163,505	$ 158,593	$ 88,759	$ 96,509	$ 91,598	$ 68,355	$ 80,600	$ 51,986	$ 49,147	$ 49,147		
6. Contract Administration (12)		$ 6,315,987	$ 202,408	$ 1,190,309	$ 1,070,790	$ 1,025,308	$ 73,841	$ 71,623	$ 40,085	$ 43,585	$ 41,367	$ 30,870	$ 36,400	$ 23,477	$ 22,196	$ 22,196		
7. Government Indirect Cost (13)	$ -	$ -																
Subtotal Add-On Costs	$ (103,688)	$ 37,219,208	$ 4,184,490	$ 6,713,278	$ 6,107,147	$ 5,876,491	$ 374,478	$ 363,229	$ 203,288	$ 221,038	$ 209,789	$ 156,555	$ 184,600	$ 119,064	$ 112,564	$ 112,564		
Grand Total (Undiscounted)	$ (103,688)	$ 127,447,590	$ 7,076,031	$ 23,717,686	$ 21,404,143	$ 20,523,755	$ 1,429,346	$ 1,386,410	$ 775,930	$ 843,680	$ 800,743	$ 597,555	$ 704,602	$ 454,457	$ 429,644	$ 429,644		

Inflation Adjustment (Future Value = FV)	**FV = $Se^{(rt)}$**		$ 7,076,031	$ 23,717,686	$ 21,404,143	$ 20,523,755	$ 1,429,346	$ 1,386,410	$ 775,930	$ 843,680	$ 800,743	$ 597,555	$ 704,602	$ 454,457	$ 429,644	$ 429,644
Market Risk Adjustment	**(MR x FV)**		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Future Value (Fv_{adj})	**Fv_{adj} = (FV + MR)**		$ 7,076,031	$ 23,717,686	$ 21,404,143	$ 20,523,755	$ 1,429,346	$ 1,386,410	$ 775,930	$ 843,680	$ 800,743	$ 597,555	$ 704,602	$ 454,457	$ 429,644	$ 429,644
Net Present Value (PV)	**PV = $FV_{adj}/(1+i)^t$**	$ 127,051,827	$ 7,076,031	$ 23,717,686	$ 21,404,143	$ 20,523,755	$ 1,429,346	$ 1,386,410	$ 775,930	$ 843,680	$ 800,743	$ 597,555	$ 704,602	$ 454,457	$ 429,644	$ 429,644

Grand Total (Undiscounted)		$ 127,051,827
Grand Total (Inflation Adjusted) (FV)		$ 127,051,827
Grand Total Market Risk Adjusted (Fv_{adj})		$ 127,051,827
Grand Total Net Present Value (NPV)		$ 127,051,827

Source: This worksheet was prepared and contributed by Patric Lassiter, SRK Consulting

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363
$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561

$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$101,379	$139,144	$31,676	$49,989	$34,911	$31,676	$106,067	$31,676	$31,676	$54,032	$31,676	$87,754	$49,989	$31,676	$31,676	$49,989	$87,754	$29,250	$47,562	$33,294	$29,250	$103,640
$ 101,379	$ 139,144	$ 31,676	$ 49,989	$ 34,911	$ 31,676	$ 106,067	$ 31,676	$ 31,676	$ 54,032	$ 31,676	$ 87,754	$ 49,989	$ 31,676	$ 31,676	$ 49,989	$ 87,754	$ 29,250	$ 47,562	$ 33,294	$ 29,250	$ 103,640
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328
	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527
$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855
$ 332,158	$ 369,923	$ 262,455	$ 280,767	$ 265,690	$ 262,455	$ 336,845	$ 262,455	$ 262,455	$ 284,811	$ 262,455	$ 318,533	$ 280,767	$ 262,455	$ 262,455	$ 280,767	$ 318,533	$ 260,029	$ 278,341	$ 264,072	$ 260,029	$ 334,419
$ 43,181	$ 48,090	$ 34,119	$ 36,500	$ 34,540	$ 34,119	$ 43,790	$ 34,119	$ 34,119	$ 37,025	$ 34,119	$ 41,409	$ 36,500	$ 34,119	$ 34,119	$ 36,500	$ 41,409	$ 33,804	$ 36,184	$ 34,329	$ 33,804	$ 43,474
$ 51,484	$ 57,338	$ 40,681	$ 43,519	$ 41,182	$ 40,681	$ 52,211	$ 40,681	$ 40,681	$ 44,146	$ 40,681	$ 49,373	$ 43,519	$ 40,681	$ 40,681	$ 43,519	$ 49,373	$ 40,304	$ 43,143	$ 40,931	$ 40,304	$ 51,835
$ 23,251	$ 25,895	$ 18,372	$ 19,654	$ 18,598	$ 18,372	$ 23,579	$ 18,372	$ 18,372	$ 19,937	$ 18,372	$ 22,297	$ 19,654	$ 18,372	$ 18,372	$ 19,654	$ 22,297	$ 18,202	$ 19,484	$ 18,485	$ 18,202	$ 23,409
$ 117,916	$ 131,323	$ 93,171	$ 99,672	$ 94,320	$ 93,171	$ 119,580	$ 93,171	$ 93,171	$ 101,108	$ 93,171	$ 113,079	$ 99,672	$ 93,171	$ 93,171	$ 99,672	$ 113,079	$ 92,310	$ 98,811	$ 93,746	$ 92,310	$ 118,719
$ 450,074	$ 501,246	$ 355,626	$ 380,440	$ 360,010	$ 355,626	$ 456,426	$ 355,626	$ 355,626	$ 385,919	$ 355,626	$ 431,612	$ 380,440	$ 355,626	$ 355,626	$ 380,440	$ 431,612	$ 352,339	$ 377,152	$ 357,818	$ 352,339	$ 453,138
$ 450,074	$ 501,246	$ 355,626	$ 380,440	$ 360,010	$ 355,626	$ 456,426	$ 355,626	$ 355,626	$ 385,919	$ 355,626	$ 431,612	$ 380,440	$ 355,626	$ 355,626	$ 380,440	$ 431,612	$ 352,339	$ 377,152	$ 357,818	$ 352,339	$ 453,138
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 450,074	$ 501,246	$ 355,626	$ 380,440	$ 360,010	$ 355,626	$ 456,426	$ 355,626	$ 355,626	$ 385,919	$ 355,626	$ 431,612	$ 380,440	$ 355,626	$ 355,626	$ 380,440	$ 431,612	$ 352,339	$ 377,152	$ 357,818	$ 352,339	$ 453,138
$ 450,074	$ 501,246	$ 355,626	$ 380,440	$ 360,010	$ 355,626	$ 456,426	$ 355,626	$ 355,626	$ 385,919	$ 355,626	$ 431,612	$ 380,440	$ 355,626	$ 355,626	$ 380,440	$ 431,612	$ 352,339	$ 377,152	$ 357,818	$ 352,339	$ 453,138

36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 2,363	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026
$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 115,561	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211

														$ 8,103,128							
$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 117,924	$ 8,223,702	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$29,250	$29,250	$47,562	$29,250	$85,328	$47,562	$29,250	$29,250	$47,562	$85,328	$29,250	$47,562	$29,250	$29,250	$103,640	$29,250	$29,250	$47,562	$29,250	$85,328	$47,562	$29,250
$ 29,250	$ 29,250	$ 47,562	$ 29,250	$ 85,328	$ 47,562	$ 29,250	$ 29,250	$ 47,562	$ 85,328	$ 29,250	$ 47,562	$ 29,250	$ 29,250	$ 103,640	$ 29,250	$ 29,250	$ 47,562	$ 29,250	$ 85,328	$ 47,562	$ 29,250
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$56,328	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504
$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$56,527	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370
$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 112,855	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874
$ 260,029	$ 260,029	$ 278,341	$ 260,029	$ 316,107	$ 278,341	$ 260,029	$ 260,029	$ 278,341	$ 316,107	$ 260,029	$ 278,341	$ 260,029	$ 260,029	$ 8,440,197	$ 300,361	$ 300,361	$ 318,673	$ 300,361	$ 356,439	$ 318,673	$ 300,361
$ 33,804	$ 33,804	$ 36,184	$ 33,804	$ 41,094	$ 36,184	$ 33,804	$ 33,804	$ 36,184	$ 41,094	$ 33,804	$ 36,184	$ 33,804	$ 33,804	$ 1,097,226	$ 39,047	$ 39,047	$ 41,428	$ 39,047	$ 46,337	$ 41,428	$ 39,047
$ 40,304	$ 40,304	$ 43,143	$ 40,304	$ 48,997	$ 43,143	$ 40,304	$ 40,304	$ 43,143	$ 48,997	$ 40,304	$ 43,143	$ 40,304	$ 40,304	$ 1,308,231	$ 46,556	$ 46,556	$ 49,394	$ 46,556	$ 55,248	$ 49,394	$ 46,556
$ 18,202	$ 18,202	$ 19,484	$ 18,202	$ 22,127	$ 19,484	$ 18,202	$ 18,202	$ 19,484	$ 22,127	$ 18,202	$ 19,484	$ 18,202	$ 18,202	$ 590,814	$ 21,025	$ 21,025	$ 22,307	$ 21,025	$ 24,951	$ 22,307	$ 21,025
$ 92,310	$ 92,310	$ 98,811	$ 92,310	$ 112,218	$ 98,811	$ 92,310	$ 92,310	$ 98,811	$ 112,218	$ 92,310	$ 98,811	$ 92,310	$ 92,310	$ 2,996,270	$ 106,628	$ 106,628	$ 113,129	$ 106,628	$ 126,536	$ 113,129	$ 106,628
$ 352,339	$ 352,339	$ 377,152	$ 352,339	$ 428,324	$ 377,152	$ 352,339	$ 352,339	$ 377,152	$ 428,324	$ 352,339	$ 377,152	$ 352,339	$ 352,339	$ 11,436,467	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989
$ 352,339	$ 352,339	$ 377,152	$ 352,339	$ 428,324	$ 377,152	$ 352,339	$ 352,339	$ 377,152	$ 428,324	$ 352,339	$ 377,152	$ 352,339	$ 352,339	$ 11,436,467	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 352,339	$ 352,339	$ 377,152	$ 352,339	$ 428,324	$ 377,152	$ 352,339	$ 352,339	$ 377,152	$ 428,324	$ 352,339	$ 377,152	$ 352,339	$ 352,339	$ 11,436,467	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989
$ 352,339	$ 352,339	$ 377,152	$ 352,339	$ 428,324	$ 377,152	$ 352,339	$ 352,339	$ 377,152	$ 428,324	$ 352,339	$ 377,152	$ 352,339	$ 352,339	$ 11,436,467	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989

58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026
$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211

$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$29,250	$47,562	$85,328	$29,250	$47,562	$29,250	$29,250	$103,640	$29,250	$29,250	$47,562	$29,250	$85,328	$47,562	$29,250	$29,250	$47,562	$85,328	$29,250	$47,562	$29,250	$29,250
$ 29,250	$ 47,562	$ 85,328	$ 29,250	$ 47,562	$ 29,250	$ 29,250	$ 103,640	$ 29,250	$ 29,250	$ 47,562	$ 29,250	$ 85,328	$ 47,562	$ 29,250	$ 29,250	$ 47,562	$ 85,328	$ 29,250	$ 47,562	$ 29,250	$ 29,250
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504
$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370
$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874
$ 300,361	$ 318,673	$ 356,439	$ 300,361	$ 318,673	$ 300,361	$ 300,361	$ 374,751	$ 300,361	$ 300,361	$ 318,673	$ 300,361	$ 356,439	$ 318,673	$ 300,361	$ 300,361	$ 318,673	$ 356,439	$ 300,361	$ 318,673	$ 300,361	$ 300,361
$ 39,047	$ 41,428	$ 46,337	$ 39,047	$ 41,428	$ 39,047	$ 39,047	$ 48,718	$ 39,047	$ 39,047	$ 41,428	$ 39,047	$ 46,337	$ 41,428	$ 39,047	$ 39,047	$ 41,428	$ 46,337	$ 39,047	$ 41,428	$ 39,047	$ 39,047
$ 46,556	$ 49,394	$ 55,248	$ 46,556	$ 49,394	$ 46,556	$ 46,556	$ 58,086	$ 46,556	$ 46,556	$ 49,394	$ 46,556	$ 55,248	$ 49,394	$ 46,556	$ 46,556	$ 49,394	$ 55,248	$ 46,556	$ 49,394	$ 46,556	$ 46,556
$ 21,025	$ 22,307	$ 24,951	$ 21,025	$ 22,307	$ 21,025	$ 21,025	$ 26,233	$ 21,025	$ 21,025	$ 22,307	$ 21,025	$ 24,951	$ 22,307	$ 21,025	$ 21,025	$ 22,307	$ 24,951	$ 21,025	$ 22,307	$ 21,025	$ 21,025
$ 106,628	$ 113,129	$ 126,536	$ 106,628	$ 113,129	$ 106,628	$ 106,628	$ 133,037	$ 106,628	$ 106,628	$ 113,129	$ 106,628	$ 126,536	$ 113,129	$ 106,628	$ 106,628	$ 113,129	$ 126,536	$ 106,628	$ 113,129	$ 106,628	$ 106,628
$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989
$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989
$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989

80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	TOTAL
2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	
																					$ -
																					$ -
																					$ 319,670
																			$ 18,741		$ 130,043
																					$ -
																					$ -
																					$ 66,222
																			$ 97,672		$ 207,182
																					$ -
																					$ -
																					$ -
																					$ -
																					$ -
																					$ 388,076
																					$ -
																					$ 18,387,018
																					$ 13,009,438
																					$ -
																			$ 44,525		$ 689,610
																					$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 160,938	$ -	$ 33,197,259
																					$ -
																					$ -
																					$ 73,537
																					$ -
																					$ -
																					$ -
																					$ -
																					$ 7,767
																					$ -
																					$ 74,464
																					$ -
																					$ -
																					$ -
																					$ 211,020
																					$ -
																					$ -
																					$ -
																					$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 366,788
																					$ -
																					$ -
																					$ -
																					$ -
																					$ -
																					$ -
																					$ -
																					$ -
																					$ -
																					$ -
																					$ -
$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026	$ 4,026		$ 416,796
																					$ -
$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 118,211	$ 236,423		$ 12,144,901

																					$ -
																					$ 9,678,959
																					$ -
$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 122,237	$ 240,449	$ -	$ 22,240,656

																			$1,406		$ 1,181,844
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																					$ 69,482
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$103,640	$29,250	$29,250	$47,562	$29,250	$85,328	$47,562	$29,250	$29,250	$47,562	$85,328	$29,250	$47,562	$29,250	$29,250	$103,640	$29,250	$29,250	$47,562	$114,578		$ 7,523,372
$ 103,640	$ 29,250	$ 29,250	$ 47,562	$ 29,250	$ 85,328	$ 47,562	$ 29,250	$ 29,250	$ 47,562	$ 85,328	$ 29,250	$ 47,562	$ 29,250	$ 29,250	$ 103,640	$ 29,250	$ 29,250	$ 47,562	$ 114,578	$ -	$ 7,592,854

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																					$ -
$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504	$73,504		$ 10,128,539
$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$75,370	$218,571		$ 11,951,540
																					$ -
																					$ -
$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ 148,874	$ -	$ 22,080,079

$ 374,751	$ 300,361	$ 300,361	$ 318,673	$ 300,361	$ 356,439	$ 318,673	$ 300,361	$ 300,361	$ 318,673	$ 356,439	$ 300,361	$ 318,673	$ 300,361	$ 300,361	$ 374,751	$ 300,361	$ 300,361	$ 318,673	$ 517,370	$ -	$ 90,228,382

																					$ 2,481,281
$ 48,718	$ 39,047	$ 39,047	$ 41,428	$ 39,047	$ 46,337	$ 41,428	$ 39,047	$ 39,047	$ 41,428	$ 46,337	$ 39,047	$ 41,428	$ 39,047	$ 39,047	$ 48,718	$ 39,047	$ 39,047	$ 41,428	$ 67,258	$ -	$ 11,691,720
																					$ -
																					$ 2,706,851
$ 58,086	$ 46,556	$ 46,556	$ 49,394	$ 46,556	$ 55,248	$ 49,394	$ 46,556	$ 46,556	$ 49,394	$ 55,248	$ 46,556	$ 49,394	$ 46,556	$ 46,556	$ 58,086	$ 46,556	$ 46,556	$ 49,394	$ 80,192	$ -	$ 13,940,127
$ 26,233	$ 21,025	$ 21,025	$ 22,307	$ 21,025	$ 24,951	$ 22,307	$ 21,025	$ 21,025	$ 22,307	$ 24,951	$ 21,025	$ 22,307	$ 21,025	$ 21,025	$ 26,233	$ 21,025	$ 21,025	$ 22,307	$ 36,216	$ -	$ 6,295,541
																					$ -
$ 133,037	$ 106,628	$ 106,628	$ 113,129	$ 106,628	$ 126,536	$ 113,129	$ 106,628	$ 106,628	$ 113,129	$ 126,536	$ 106,628	$ 113,129	$ 106,628	$ 106,628	$ 133,037	$ 106,628	$ 106,628	$ 113,129	$ 183,666	$ -	$ 37,115,520

$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 701,036	$ -	$ 127,343,902

$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 701,036	$ -	$ 127,051,827
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 701,036	$ -	$ 127,051,827
$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 701,036	$ -	$ 127,051,827

Comments

Closure Cost Estimate
Solution Mgmt

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

Color Code Key

User Input - Direct Input	**Direct Input**
User Input - Pull Down List	**Pull Down Selection**
Program Constant (can override)	**Alternate Input**
Program Calculated Value	**Locked Cell - Formula or Reference**

Standard Power Cost 0.15 $/kWh
User Override Power Cost $/kWh (used if costs for pumping differ from standard rates (e.g. use of diesel powered generator or pump)

Solution/Water Management - User Input - Pumping

	Description (required)	ID Code	Water Type (select)	Management Type (select)	Capital Cost $	Flow (Q) gpm	Pipeline Length ft	Static Head ft	Pipe Diameter (ID) in	Pipe Material (select)	Pump Efficiency %	Total Concentated Losses [1]	Operating Period: Hrs/Day	Operating Period: Days/ Month	Operating Period: Number of Months	User Overrides: Crew Size	User Overrides: Power Cost ($/kWh)
1	Holding Year (Year 0) - From Main Sump (el 950'/890'?) to A Pond		Contact Water	Active		30.00	260	10.0	4	HDPE	88	0	24.0	30.0	12	0	
2	Holding Year (Year 0) - From A Pond (el 900'/838', crest 846) to Pond 7		Contact Water	Active		169.00	3,580	10.0	8	HDPE	88	0	24.0	30.0	12	0	
3	Holding Year (Year 0) - From B Pond Sump (el 890'/826') to A Pond		Contact Water	Active		100.00	100	20.0	4	HDPE	88	0	24.0	30.0	12	0	
4	Holding Year (Year 0) - From C Pond (el 850'/796') to 23 Pond		Contact Water	Active		7.00	480	96.0	6	HDPE	88	0	24.0	30.0	12	0	
5	Holding Year (Year 0) - From D Pond (el 810'/752') to 23 Pond PS		Contact Water	Active		129.00	350	70.0	12	HDPE	88	0	24.0	30.0	12	0	
6	Holding Year (Year 0) - From 23 Pond (el 878'/822') to 23 Pond PS		Contact Water	Active		138.00	0	0.0	8	HDPE	88	0	24.0	30.0	12	0	
7	Holding Year (Year 0) - From 23 Pond Pump Station (el 878'/822') to Pond 7		Contact Water	Active		267.00	3,500	10.0	8	HDPE	88	0	24.0	30.0	12	0	
8	Holding Year (Year 0) - From Cannery Creek Potable (el 174') to Hawk Inlet Water Bldg		Contact Water	Active		1.00	270	10.0	6	HDPE	88	0	24.0	30.0	12	0	
9	Holding Year (Year 0) - From Hawk Inlet Water Bldg (el 120') to Hawk Inlet Various		Contact Water	Active		1.00	450	10.0	4	HDPE	88	0	24.0	30.0	12	0	
10	Holding Year (Year 0) - From Hawk Inlet Lift Station (el 18') to Sewage Treatment Plant		Contact Water	Active		1.00	310	62.0	4	HDPE	88	0	24.0	30.0	12	0	
11	Holding Year (Year 0) - From Sewage Treatment Plant (el 80') to DB-04		Contact Water	Active		1.00	280	10.0	4	HDPE	88	0	24.0	30.0	12	0	
12	Holding Year (Year 0) - From Seeps (4) (el 18') to DB-04		Contact Water	Active		1.00	100	20.0	2	HDPE	88	0	24.0	30.0	12	0	
13	Holding Year (Year 0) - From Herman's Gulch Sump (el 24') to DB-04		Contact Water	Active		2.00	75	15.0	6	HDPE	88	0	24.0	30.0	12	0	
14	Holding Year (Year 0) - From DB-04 (el' 24') to Pond 7 via west ditch		Contact Water	Active		14.00	800	160.0	8	HDPE	88	0	24.0	30.0	12	0	
15	Holding Year (Year 0) - From Pond 10 (bottom el 120') (including runoff) to Pond 7		Contact Water	Active		28.00	125	25.0	8	HDPE	88	0	24.0	30.0	12	0	
16	Holding Year (Year 0) - From Pond 10 Underdrain WW 11 (el 115') to Pond 10		Contact Water	Active		15.00	155	31.0	8	HDPE	88	0	24.0	30.0	12	0	
17	Holding Year (Year 0) - From WW A (el 132') to Pond 7		Contact Water	Active		17.00	40	8.0	8	HDPE	88	0	24.0	30.0	12	0	
18	Holding Year (Year 0) - From WW 5 (170') to Pond 9		Contact Water	Active		8.00	80	16.0	8	HDPE	88	0	24.0	30.0	12	0	
19	Holding Year (Year 0) - From WW 3 (150') to Pond 7 via west ditch		Contact Water	Active		2.00	50	10.0	6	HDPE	88	0	24.0	30.0	12	0	
20	Holding Year (Year 0) - From WW 12 S3P1 above liner (110') to Pond 7 via east ditch		Contact Water	Active		8.00	150	30.0	8	HDPE	88	0	24.0	30.0	12	0	
21	Holding Year (Year 0) - From WW 13 S3P1 below liner (110') to Pond 7 via east ditch		Contact Water	Active		70.00	150	30.0	8	HDPE	88	0	24.0	30.0	12	0	
22	Holding Year (Year 0) - From WW 15 S3P1 toe pumpback (113') to Pond 7 via east ditch		Contact Water	Active		19.00	135	27.0	8	HDPE	88	0	24.0	30.0	12	0	
23	Holding Year (Year 0) - From Pond 7 (bottom el 122') including runoff to 2500 GPM WTP		Contact Water	Active		809.00	240	48.0	12	HDPE	88	0	24.0	30.0	12	0	
24	Holding Year (Year 0) - From Pond 7 Underdrain pumpback(el 110') to Pond 7		Contact Water	Active		19.00	180	36.0	6	HDPE	88	0	24.0	30.0	12	0	
25	Holding Year (Year 0) - From 2500 GPM WTP (el 170') to APDES Outfall		Contact Water	Active		809.00	850	10.0	14	HDPE	88	0	24.0	30.0	12	0	
26	Holding Year (Year 0) - From APDES Outfall (el 0') to Hawk Inlet		Contact Water	Active		809.00	0	0.0	14	HDPE	88	0	24.0	30.0	12	0	
27	Years 1-3 - From A Pond (el 900'/838', crest 846) to Pond 7		Contact Water	Active		139.00	3,580	10.0	8	HDPE	88	0	24.0	30.0	36	0	
28	Years 1-3 - From B Pond Sump (el 890'/826') to A Pond		Contact Water	Active		100.00	100	20.0	4	HDPE	88	0	24.0	30.0	36	0	
29	Years 1-3 - From C Pond (el 850'/796') to 23 Pond		Contact Water	Active		7.00	480	96.0	6	HDPE	88	0	24.0	30.0	36	0	
30	Years 1-3 - From D Pond (el 810'/752') to 23 Pond PS		Contact Water	Active		129.00	350	70.0	12	HDPE	88	0	24.0	30.0	36	0	
31	Years 1-3 - From 23 Pond (el 878'/822') to 23 Pond PS		Contact Water	Active		138.00	0	0.0	8	HDPE	88	0	24.0	30.0	36	0	
32	Years 1-3 - From 23 Pond Pump Station (el 878'/822') to Pond 7		Contact Water	Active		267.00	3,500	10.0	8	HDPE	88	0	24.0	30.0	36	0	
33	Years 1-3 - From Cannery Creek Potable (el 174') to Hawk Inlet Water Bldg		Contact Water	Active		5.00	270	10.0	6	HDPE	88	0	24.0	30.0	36	0	
34	Years 1-3 - From Hawk Inlet Water Bldg (el 120') to Hawk Inlet Various		Contact Water	Active		5.00	450	10.0	4	HDPE	88	0	24.0	30.0	36	0	
35	Years 1-3 - From Hawk Inlet Lift Station (el 18') to Sewage Treatment Plant		Contact Water	Active		5.00	310	62.0	4	HDPE	88	0	24.0	30.0	36	0	
36	Years 1-3 - From Sewage Treatment Plant (el 80') to DB-04		Contact Water	Active		1.00	280	10.0	4	HDPE	88	0	24.0	30.0	36	0	
37	Years 1-3 - From Seeps (4) (el 18') to DB-04		Contact Water	Active		1.00	100	20.0	2	HDPE	88	0	24.0	30.0	36	0	
38	Years 1-3 - From Herman's Gulch Sump (el 24') to DB-04		Contact Water	Active		2.00	75	15.0	6	HDPE	88	0	24.0	30.0	36	0	
39	Years 1-3 - From DB-04 (el' 24') to Pond 7 via west ditch		Contact Water	Active		18.00	800	160.0	8	HDPE	88	0	24.0	30.0	36	0	
40	Years 1-3 - From Cannery Creek Withdrawal (el 174') to Truckwash		Contact Water	Active		35.00	550	110.0	4	HDPE	88	0	24.0	30.0	36	0	
41	Years 1-3 - From Pond 10 (bottom el 120') (including runoff) to Pond 7		Contact Water	Active		28.00	125	25.0	8	HDPE	88	0	24.0	30.0	36	0	
42	Years 1-3 - From Pond 10 Underdrain WW 11 (el 115') to Pond 10		Contact Water	Active		15.00	155	31.0	8	HDPE	88	0	24.0	30.0	36	0	
43	Years 1-3 - From WW A (el 132') to Pond 7 - via WW 14		Contact Water	Active		17.00	40	8.0	8	HDPE	88	0	24.0	30.0	36	0	
44	Years 1-3 - From WW 5 (170') to Pond 9		Contact Water	Active		8.00	80	16.0	8	HDPE	88	0	24.0	30.0	36	0	
45	Years 1-3 - From WW 3 (150') to Pond 7 via west ditch		Contact Water	Active		2.00	50	10.0	6	HDPE	88	0	24.0	30.0	36	0	
46	Years 1-3 - From WW 12 S3P1 above liner (110') to Pond 7 via east ditch		Contact Water	Active		8.00	150	30.0	8	HDPE	88	0	24.0	30.0	36	0	
47	Years 1-3 - From WW 13 S3P1 below liner (110') to Pond 7 via east ditch		Contact Water	Active		70.00	150	30.0	8	HDPE	88	0	24.0	30.0	36	0	
48	Years 1-3 - From WW 15 S3P1 toe pumpback (113') to Pond 7 via east ditch		Contact Water	Active		19.00	135	27.0	8	HDPE	88	0	24.0	30.0	36	0	
49	Years 1-3 - From Pond 7 (including runoff) to TDF WTP		Contact Water	Active		818.00	240	48.0	12	HDPE	88	0	24.0	30.0	36	0	
50	Years 1-3 - From Pond 7 Underdrain pumpback(el 110') to Pond 7		Contact Water	Active		19.00	180	36.0	6	HDPE	88	0	24.0	30.0	36	0	
51	Years 1-3 - From 2500 GPM WTP (el 170') to APDES Outfall		Contact Water	Active		818.00	850	10.0	14	HDPE	88	0	24.0	30.0	36	0	
52	Years 1-3 - From APDES Outfall (el 0') to Hawk Inlet		Contact Water	Active		818.00	0	0.0	14	HDPE	88	0	24.0	30.0	36	0	
53	Years 4-10 - From D Pond (el 810'/752') to Pond 7		Contact Water	Active		120.00	350	70.0	10	HDPE	88	0	24.0	30.0	84	0	
54	Years 4-10 - From Pond 10 to TDF WTP Batched		Contact Water	Active		13.00	240	48.0	8	HDPE	88	0	24.0	30.0	84	0	
55	Years 4-10 - From Pond 7 (including runoff) to TDF WTP Batched		Contact Water	Active		150.00	240	48.0	12	HDPE	88	0	24.0	30.0	84	0	
56	Years 4-10 - From Pond 7 Underdrain to Pond 7/10		Contact Water	Active		19.00	180	36.0	6	HDPE	88	0	24.0	30.0	84	0	
57	Years 4-10 - From WW 14 (WW A + WW 3) to Pond 7/10		Contact Water	Active		19.00	350	70.0	8	HDPE	88	0	24.0	30.0	84	0	
58	Years 4-10 - From WW 12 to Pond 7/10		Contact Water	Active		8.00	350	70.0	8	HDPE	88	0	24.0	30.0	84	0	
59	Years 11-50 - From Pond 10 to TDF WTP Batched		Contact Water	Active		39.50	65	13.0	8	HDPE	88	0	24.0	30.0	480	0	0.320
60	Years 11-50 - From Pond 7 (including runoff) to TDF WTP Batched		Contact Water	Active		39.50	240	48.0	12	HDPE	88	0	24.0	30.0	480	0	0.320
61	Years 11-50 - From Pond 7 Underdrain to Pond 7/10		Contact Water	Active		14.00	180	36.0	6	HDPE	88	0	24.0	30.0	36	0	0.320
62	Years 11-50 - From WW 14 (WW A + WW 3) to Pond 7/10		Contact Water	Active		14.00	350	70.0	8	HDPE	88	0	24.0	30.0	480	0	0.320
63	Years 11-50 - From WW 12 to Pond 7/10		Contact Water	Active		8.00	350	70.0	8	HDPE	88	0	24.0	30.0	480	0	0.320

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Closure Cost Estimate
Solution Mgmt

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

64	**Years 50-100 - From Pond 10 (including runoff) to TDF WTP Batched**	**Contact Water**	**Active**		**54.50**	**240**	**48.0**	**8**	**HDPE**	**88**	**0**	**24.0**	**30.0**	**600**	**0**	**0.320**
65	**Years 50-100 - From Pond 7 (including runoff) to TDF WTP Batched**	**Contact Water**	**Active**		**54.50**	**240**	**48.0**	**12**	**HDPE**	**88**	**0**	**24.0**	**30.0**	**600**	**0**	**0.320**
66	**Years 50-100 - From Pond 7 Underdrain to Pond 7/10**	**Contact Water**	**Active**		**14.00**	**180**	**36.0**	**6**	**HDPE**	**88**	**0**	**24.0**	**30.0**	**36**	**0**	**0.320**
67	**Years 50-100 - From WW 14 (WW A + WW 3) to Pond 7/10**	**Contact Water**	**Active**		**14.00**	**350**	**70.0**	**8**	**HDPE**	**88**	**0**	**24.0**	**30.0**	**600**	**0**	**0.320**
68	**Years 50-100 - From WW 12 to Pond 7/10**	**Contact Water**	**Active**		**8.00**	**350**	**70.0**	**8**	**HDPE**	**88**	**0**	**24.0**	**30.0**	**600**	**0**	**0.320**

Notes: 1. k (total of all losses related to valves, restrictions, etc.). Typically 8 -20. Not significant for longer pipes.
2. Default crew assumes crew of two laborers required during pumping hours

Assumed crew same as for water treatment
Assumed use of grid power until end of Year 10.

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Closure Cost Estimate
Solution Mgmt

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

Solution/Water Management - User Input - Forced Evaporation

															Operating Period			User Overrides	
	Description (required)	ID Code	Water Type (select)	Management Type (select)	Forced Evaporation Method (select)	Capital Cost $	Flow (Q) gpm	Pipeline Length ft	Static Head ft	Pipe Diameter (ID) in	Pipe Material (select)	Pump Efficiency %	Total Concentated Losses (1)	Required Pressure at Outlet psi	Hrs/Day	Days/Month	Number of Months	Crew Size	Power Cost ($/kWh)

Notes: 1. Default crew assumes crew of two laborers required during pumping hours
3. Assumes 1-1.5 ton truck for every 2 laborers

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Closure Cost Estimate
Solution Mgmt

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

Solution/Water Management - Water Treatment

	Description (required)	ID Code	Water Type (select)	Treatment Type (select)	Treatment Method	Montly Quantity gal	Treatment Labor Crew Size per Shift	Capital Cost $	Consumable Cost/ gal $	Treatment Operating Cost/gal $	Operating Period: Number of Months	Operating Period: Hour per Day
1	**Year 0**		**Other Water**	**Active**		**35,434,200**	**0**	**$76,696**	**$0.00**		**12.0**	**12.0**
2	**Year 1**		**Other Water**	**Active**		**35,828,400**	**0**	**$76,696**	**$0.00**		**12.0**	**12.0**
3	**Year 2**		**Other Water**	**Active**		**35,828,400**	**0**	**$76,696**	**$0.00**		**12.0**	**12.0**
4	**Year 3**		**Other Water**	**Active**		**35,828,400**	**0**	**$76,696**	**$0.00**		**12.0**	**12.0**
5	**Years 4-10**		**Other Water**	**Active**		**9,154,200**	**0**	**$536,872**	**$0.00**		**84.0**	**3.6**
6	**Years 11-50**		**Other Water**	**Active**		**3,460,200**	**0**	**$3,067,838**	**$0.00**		**480.0**	**2.0**
7	**Years 51-100**		**Other Water**	**Active**		**4,774,200**	**0**	**$3,834,798**	**$0.00**		**600.0**	**2.6**

Notes:
1. Use pumping section (above) to calculate pumping costs (including groundwater pumping).
2. Include initial materials (e.g. chemicals, organic substrate, etc.) in capital cost.
3. Treatment crew includes 1 foreman (crew defined by user above), 1 light truck if crew size > 0
4. Assumes active treatement crew works 8 hr/day, 365 days/year.
5. Assumes 1 truck per each two employees per shift

Treatment reagent cost $ per gal (not rounded to two decimals): **0.000168072**
Backup calculations in User 4.

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Closure Cost Estimate
Solution Mgmt

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

Solution/Water Management - User Input - Decontamination

	Description (required)	ID Code	Management Type (select)	Type	Disposal Location	Capital Cost $	Pumping Flow (Q) gpm	Pipeline Length ft	Static Head ft	Pipe Diameter (ID) in	Pipe Material (select)	Pump Efficiency %	Total Concentated Losses (1)	Operating Period: Number of Work Days days	Operating Period: Pumping Hrs/Day	User Overrides: Crew Size	User Overrides: Power Cost ($/kWh)

Notes:
1. Assumes triple rinse of all piping, tanks and vessels requiring decontamination
2. Standard crew includes 2 laborers and 1 foreman
3. Assumes 1-1.5 ton truck for every 2 laborers
4. Assumes crew works 8 hr/day

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Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

Water Management - Assumptions & Calculations

Manning's Roughness Coefficient

Pipe material	Manning n
HDPE	
ID < 4" (100 mm)	0.011
ID ≥ 4 in (100 mm) < 10 in (250 mm)	0.01
ID ≥ 10 in (250 mm)	0.009
PVC	
ID < 4" (100 mm)	0.011
ID ≥ 4 in (100 mm) < 10 in (250 mm)	0.01
ID ≥ 10 in (250 mm)	0.009
Brass	0.011
Cast Iron	0.013
Smooth Steel	0.012
Asbestos Cement	0.011

Water Treatment Costs

Water treatment cost = CapEx + Labor Cost + Equipment Cost (includes Operating Cost)

CapEx = User Entered Value
Consumable costs = cost of treatment chemicals or materials based quantity treated
Labor Cost = No. Months x Days/mo. x [(Supervisor Cost x 8 hrs) + (Laborer Cost x Crew Size x Hours/day)]
Operating Cost = Fuel, power, maintenance or other costs calculated based on quantity treated
Equipment Cost = No. Months x Days/mo. x [(Supervisor Truck Cost x 8 hrs) + (Labor Truck Cost x No. Crew Trucks x Hours/day)]
No. Crew Trucks = 1 per each two laborers per shift

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Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

Solution/Water Management - Pumping

	Description (required)	Flow gpm	Manning n (see above)	Losses k	Velocity ft/sec	Friction Head ft	Total Dynamic Head ft	Pump Efficiency %	Power Required kW	Horsepower Required HP	Monthly Operating Hours hrs	Pump Capital Cost $	Total Operating Cost $	Total Labor Cost $	Total Crew Equipment Cost $	Total Cost $	Cost/ m3 $
1	Holding Year (Year 0) - From Main Sump (el 950'/890'?)	30.00	0.010	0	0.008	0	10	88	0.06	1	720	$0	$72	$0	$0	$72	$0.00
2	Holding Year (Year 0) - From A Pond (el 900'/838', crest	169.00	0.010	0	0.012	2	12	88	0.43	1	720	$0	$552	$0	$0	$552	$0.00
3	Holding Year (Year 0) - From B Pond Sump (el 890'/826'	100.00	0.010	0	0.027	1	21	88	0.45	1	720	$0	$588	$0	$0	$588	$0.00
4	Holding Year (Year 0) - From C Pond (el 850'/796') to 23	7.00	0.010	0	0.001	0	96	88	0.14	1	720	$0	$180	$0	$0	$180	$0.01
5	Holding Year (Year 0) - From D Pond (el 810'/752') to 23	129.00	0.009	0	0.004	0	70	88	1.93	3	720	$0	$2,496	$0	$0	$2,496	$0.01
6	Holding Year (Year 0) - From 23 Pond (el 878'/822') to 2	138.00	0.010	0	0.010	0	0	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
7	Holding Year (Year 0) - From 23 Pond Pump Station (el	267.00	0.010	0	0.018	5	15	88	0.85	2	720	$0	$1,104	$0	$0	$1,104	$0.00
8	Holding Year (Year 0) - From Cannery Creek Potable (el	1.00	0.010	0	0.000	0	10	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
9	Holding Year (Year 0) - From Hawk Inlet Water Bldg (el	1.00	0.010	0	0.000	0	10	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
10	Holding Year (Year 0) - From Hawk Inlet Lift Station (el	1.00	0.010	0	0.000	0	62	88	0.01	1	720	$0	$12	$0	$0	$12	$0.01
11	Holding Year (Year 0) - From Sewage Treatment Plant (	1.00	0.010	0	0.000	0	10	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
12	Holding Year (Year 0) - From Seeps (4) (el 18') to DB-04	1.00	0.011	0	0.001	0	20	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
13	Holding Year (Year 0) - From Herman's Gulch Sump (el	2.00	0.010	0	0.000	0	15	88	0.01	1	720	$0	$12	$0	$0	$12	$0.00
14	Holding Year (Year 0) - From DB-04 (el' 24') to Pond 7 v	14.00	0.010	0	0.001	0	160	88	0.48	1	720	$0	$624	$0	$0	$624	$0.02
15	Holding Year (Year 0) - From Pond 10 (bottom el 120') (	28.00	0.010	0	0.002	0	25	88	0.15	1	720	$0	$192	$0	$0	$192	$0.00
16	Holding Year (Year 0) - From Pond 10 Underdrain WW	15.00	0.010	0	0.001	0	31	88	0.10	1	720	$0	$132	$0	$0	$132	$0.00
17	Holding Year (Year 0) - From WW A (el 132') to Pond 7	17.00	0.010	0	0.001	0	8	88	0.03	1	720	$0	$36	$0	$0	$36	$0.00
18	Holding Year (Year 0) - From WW 5 (170') to Pond 9	8.00	0.010	0	0.001	0	16	88	0.03	1	720	$0	$36	$0	$0	$36	$0.00
19	Holding Year (Year 0) - From WW 3 (150') to Pond 7 via	2.00	0.010	0	0.000	0	10	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
20	Holding Year (Year 0) - From WW 12 S3P1 above liner (	8.00	0.010	0	0.001	0	30	88	0.05	1	720	$0	$60	$0	$0	$60	$0.00
21	Holding Year (Year 0) - From WW 13 S3P1 below liner (	70.00	0.010	0	0.005	0	30	88	0.45	1	720	$0	$588	$0	$0	$588	$0.00
22	Holding Year (Year 0) - From WW 15 S3P1 toe pumpbac	19.00	0.010	0	0.001	0	27	88	0.11	1	720	$0	$144	$0	$0	$144	$0.00
23	Holding Year (Year 0) - From Pond 7 (bottom el 122') in	809.00	0.009	0	0.025	0	48	88	8.35	12	720	$0	$10,824	$0	$0	$10,824	$0.01
24	Holding Year (Year 0) - From Pond 7 Underdrain pumpt	19.00	0.010	0	0.002	0	36	88	0.15	1	720	$0	$192	$0	$0	$192	$0.01
25	Holding Year (Year 0) - From 2500 GPM WTP (el 170') to	809.00	0.009	0	0.018	0	10	88	1.78	3	720	$0	$2,304	$0	$0	$2,304	$0.00
26	Holding Year (Year 0) - From APDES Outfall (el 0') to Ha	809.00	0.009	0	0.018	0	0	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
27	Years 1-3 - From A Pond (el 900'/838', crest 846) to Pon	139.00	0.010	0	0.010	1	11	88	0.33	1	720	$0	$1,296	$0	$0	$1,296	$0.00
28	Years 1-3 - From B Pond Sump (el 890'/826') to A Pond	100.00	0.010	0	0.027	1	21	88	0.45	1	720	$0	$1,764	$0	$0	$1,764	$0.00
29	Years 1-3 - From C Pond (el 850'/796') to 23 Pond	7.00	0.010	0	0.001	0	96	88	0.14	1	720	$0	$540	$0	$0	$540	$0.01
30	Years 1-3 - From D Pond (el 810'/752') to 23 Pond PS	129.00	0.009	0	0.004	0	70	88	1.93	3	720	$0	$7,488	$0	$0	$7,488	$0.01
31	Years 1-3 - From 23 Pond (el 878'/822') to 23 Pond PS	138.00	0.010	0	0.010	0	0	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
32	Years 1-3 - From 23 Pond Pump Station (el 878'/822') to	267.00	0.010	0	0.018	5	15	88	0.85	2	720	$0	$3,312	$0	$0	$3,312	$0.00
33	Years 1-3 - From Cannery Creek Potable (el 174') to Ha	5.00	0.010	0	0.001	0	10	88	0.01	1	720	$0	$36	$0	$0	$36	$0.00
34	Years 1-3 - From Hawk Inlet Water Bldg (el 120') to Haw	5.00	0.010	0	0.001	0	10	88	0.01	1	720	$0	$36	$0	$0	$36	$0.00
35	Years 1-3 - From Hawk Inlet Lift Station (el 18') to Sewa	5.00	0.010	0	0.001	0	62	88	0.07	1	720	$0	$288	$0	$0	$288	$0.01
36	Years 1-3 - From Sewage Treatment Plant (el 80') to DB	1.00	0.010	0	0.000	0	10	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
37	Years 1-3 - From Seeps (4) (el 18') to DB-04	1.00	0.011	0	0.001	0	20	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
38	Years 1-3 - From Herman's Gulch Sump (el 24') to DB-0	2.00	0.010	0	0.000	0	15	88	0.01	1	720	$0	$36	$0	$0	$36	$0.00
39	Years 1-3 - From DB-04 (el' 24') to Pond 7 via west ditch	18.00	0.010	0	0.001	0	160	88	0.62	1	720	$0	$2,412	$0	$0	$2,412	$0.02
40	Years 1-3 - From Cannery Creek Withdrawal (el 174') to	35.00	0.010	0	0.010	1	110	88	0.83	2	720	$0	$3,240	$0	$0	$3,240	$0.02
41	Years 1-3 - From Pond 10 (bottom el 120') (including ru	28.00	0.010	0	0.002	0	25	88	0.15	1	720	$0	$576	$0	$0	$576	$0.00
42	Years 1-3 - From Pond 10 Underdrain WW 11 (el 115') t	15.00	0.010	0	0.001	0	31	88	0.10	1	720	$0	$396	$0	$0	$396	$0.00
43	Years 1-3 - From WW A (el 132') to Pond 7 - via WW 14	17.00	0.010	0	0.001	0	8	88	0.03	1	720	$0	$108	$0	$0	$108	$0.00
44	Years 1-3 - From WW 5 (170') to Pond 9	8.00	0.010	0	0.001	0	16	88	0.03	1	720	$0	$108	$0	$0	$108	$0.00
45	Years 1-3 - From WW 3 (150') to Pond 7 via west ditch	2.00	0.010	0	0.000	0	10	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
46	Years 1-3 - From WW 12 S3P1 above liner (110') to Pon	8.00	0.010	0	0.001	0	30	88	0.05	1	720	$0	$180	$0	$0	$180	$0.00
47	Years 1-3 - From WW 13 S3P1 below liner (110') to Pon	70.00	0.010	0	0.005	0	30	88	0.45	1	720	$0	$1,764	$0	$0	$1,764	$0.00
48	Years 1-3 - From WW 15 S3P1 toe pumpback (113') to P	19.00	0.010	0	0.001	0	27	88	0.11	1	720	$0	$432	$0	$0	$432	$0.00
49	Years 1-3 - From Pond 7 (including runoff) to TDF WTP	818.00	0.009	0	0.025	0	48	88	8.45	12	720	$0	$32,868	$0	$0	$32,868	$0.01
50	Years 1-3 - From Pond 7 Underdrain pumpback(el 110')	19.00	0.010	0	0.002	0	36	88	0.15	1	720	$0	$576	$0	$0	$576	$0.01
51	Years 1-3 - From 2500 GPM WTP (el 170') to APDES Ou	818.00	0.009	0	0.018	0	10	88	1.81	3	720	$0	$7,020	$0	$0	$7,020	$0.00
52	Years 1-3 - From APDES Outfall (el 0') to Hawk Inlet	818.00	0.009	0	0.018	0	0	88	0.00	0	720	$0	$0	$0	$0	$0	$0.00
53	Years 4-10 - From D Pond (el 810'/752') to Pond 7	120.00	0.009	0	0.005	0	70	88	1.80	3	720	$0	$16,296	$0	$0	$16,296	$0.01
54	Years 4-10 - From Pond 10 to TDF WTP Batched	13.00	0.010	0	0.001	0	48	88	0.13	1	720	$0	$1,176	$0	$0	$1,176	$0.01
55	Years 4-10 - From Pond 7 (including runoff) to TDF WT	150.00	0.009	0	0.005	0	48	88	1.54	3	720	$0	$13,944	$0	$0	$13,944	$0.01
56	Years 4-10 - From Pond 7 Underdrain to Pond 7/10	19.00	0.010	0	0.002	0	36	88	0.15	1	720	$0	$1,344	$0	$0	$1,344	$0.01
57	Years 4-10 - From WW 14 (WW A + WW 3) to Pond 7/10	19.00	0.010	0	0.001	0	70	88	0.28	1	720	$0	$2,520	$0	$0	$2,520	$0.01
58	Years 4-10 - From WW 12 to Pond 7/10	8.00	0.010	0	0.001	0	70	88	0.12	1	720	$0	$1,092	$0	$0	$1,092	$0.01
59	Years 11-50 - From Pond 10 to TDF WTP Batched	39.50	0.010	0	0.003	0	13	88	0.11	1	720	$0	$12,000	$0	$0	$12,000	$0.00
60	Years 11-50 - From Pond 7 (including runoff) to TDF W	39.50	0.009	0	0.001	0	48	88	0.41	1	720	$0	$45,120	$0	$0	$45,120	$0.01
61	Years 11-50 - From Pond 7 Underdrain to Pond 7/10	14.00	0.010	0	0.002	0	36	88	0.11	1	720	$0	$900	$0	$0	$900	$0.01
62	Years 11-50 - From WW 14 (WW A + WW 3) to Pond 7/1	14.00	0.010	0	0.001	0	70	88	0.21	1	720	$0	$23,040	$0	$0	$23,040	$0.02
63	Years 11-50 - From WW 12 to Pond 7/10	8.00	0.010	0	0.001	0	70	88	0.12	1	720	$0	$13,440	$0	$0	$13,440	$0.02
64	Years 50-100 - From Pond 10 (including runoff) to TDF	54.50	0.010	0	0.004	0	48	88	0.56	1	720	$0	$77,400	$0	$0	$77,400	$0.01
65	Years 50-100 - From Pond 7 (including runoff) to TDF W	54.50	0.009	0	0.002	0	48	88	0.56	1	720	$0	$77,400	$0	$0	$77,400	$0.01
66	Years 50-100 - From Pond 7 Underdrain to Pond 7/10	14.00	0.010	0	0.002	0	36	88	0.11	1	720	$0	$900	$0	$0	$900	$0.01
67	Years 50-100 - From WW 14 (WW A + WW 3) to Pond 7/	14.00	0.010	0	0.001	0	70	88	0.21	1	720	$0	$28,800	$0	$0	$28,800	$0.02
68	Years 50-100 - From WW 12 to Pond 7/10	8.00	0.010	0	0.001	0	70	88	0.12	1	720	$0	$16,800	$0	$0	$16,800	$0.02

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Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

48,960	**$0**	**$416,796**	**$0**	**$0**	**$416,796**

Notes:
1. Assumes 2 man labor crew unless user overrides default.

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Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

Solution/Water Management - Forced Evaporation

	Description (required)	Flow gpm	Manning n (see above)	Losses k	Velocity ft/sec	Friction Head ft	Total Dynamic Head ft	Pump Efficiency %	Power Required kW	Horsepower Required HP	Annual Operating Hours hrs	Evaporator/ Pump Capital Cost $	Total Labor Cost $	Total Equipment Cost $	Total Power Cost $	Total Cost $	Cost/ m3 $
												$0	**$0**	**$0**	**$0**	**$0**	

Notes:
1. Assumes 2 man labor crew unless user overrides default.

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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

Solution/Water Management - Water Treatment

	Description (required)	Total Quantity Treated gal	Capital Cost $	Total Consumables Cost $	Total Labor Cost $	Total Equipment + Operating Cost $	Total Treatment Cost $	Cost/ m3 $
1	**Year 0**	425,210,400	$76,696	$71,466	$0	$31,886	$180,048	$0.000
2	**Year 1**	429,940,800	$76,696	$72,261	$0	$31,886	$180,843	$0.000
3	**Year 2**	429,940,800	$76,696	$72,261	$0	$31,886	$180,843	$0.000
4	**Year 3**	429,940,800	$76,696	$72,261	$0	$31,886	$180,843	$0.000
5	**Years 4-10**	768,952,800	$536,872	$129,239	$0	$223,205	$889,316	$0.000
6	**Years 11-50**	1,660,896,000	$3,067,838	$279,150	$0	$1,275,456	$4,622,444	$0.001
7	**Years 51-100**	2,864,520,000	$3,834,798	$481,445	$0	$1,594,320	$5,910,563	$0.001
		7,009,401,600	**$7,746,292**	**$1,178,083**	**$0**	**$3,220,526**	**$12,144,901**	

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Closure Cost Estimate
Solution Mgmt

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Solution/Water Management - Cost Summary

	Labor	Equipment + Operating + Power	Materials	Capital	Totals
Pumping	$0	$416,796	N/A	$0	$416,796
Forced Evaporation	$0	$0		$0	$0
Water Treatment	$0	$3,220,526	$1,178,083	$7,746,292	$12,144,901
Decontamination	$0	$0		$0	$0
TOTALS	**$0**	**$3,637,322**	**$1,178,083**	**$7,746,292**	**$12,561,697**

Solution/Water Management - Decontamination

	Description (required)	Flow gpm	Manning n (see above)	Losses k	Velocity ft/sec	Friction Head ft	Total Dynamic Head ft	Pump Efficiency %	Power Required kW	Horsepower Required HP	Total Operating Hours hrs	Pump Capital Cost $	Total Operating Cost $	Total Labor Cost $	Total Equipment Cost $	Total Cost $
												$0	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Other User

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Other Cost Items Calculated Elsewhere

	Description (required)	ID Code	Facility Type	Quantity	Units	Total Capital Cost $	Material Unit Cost $	Labor Unit Cost $	Equipment/ Operating Unit Cost $	Cost Type (select)	Total Cost $	Comments
1	Lime purchase for short-lag disposal		Waste Mgmt & Disposal	5,205	tons		$300.00			A. Earthwork	$1,561,500	User 1 (quantity proportioned from total shortlag; lime cost adjusted for inflation)
2	Internal mill infrastructure demolition		Equipment Removal	2,916	hrs		$0.00	$477.47	$178.90	D. Facility & Equipment	$1,913,975	User 6 (mill demolition in Foundations and Buildings sheet)
3	Post-closure cover maintenance - Tailings		Tailings Impoundments	349	acres*yrs		$1,219.54	$291.56	$174.11	E. Monitoring	$588,725	2008 plan page 45: hydroseeding materials; operators; equipment
4	Outfall pipeline and facilities maintenance		Water Treatment - Other	1	ls				$586,000.00	E. Monitoring	$586,000	User 5
5	Various waste disposal		Waste Mgmt & Disposal	1	ls				$784,279.58	C. Water Management	$784,280	2008 waste disposal costs adjusted for 2012; User Sheet 14
6	Bridge Demolition		Site Facilities - Structures	1	ls		$0.00	$113,640.25	$74,475.97	D. Facility & Equipment	$188,116	User 11
7	Monitoring		Monitoring/Regulatory Re	1	LS		$6,348,646.67			E. Monitoring	$6,348,647	See user 8
8	Marine demo		Equipment Removal	1	LS		$363,268.75	$291,310.90	$345,477.99	D. Facility & Equipment	$1,000,058	From Marine Demo 2008.xls; see User Sheet 3
9	Decontamination		Equipment Removal	1	LS		$0.00	$373,545.05	$37,123.20	C. Water Management	$410,668	User 14
10	Removal of miscellaneous linear items (1 backhoe+2 laborers)		Equipment Removal	243	hrs			$198.46	$46.14	D. Facility & Equipment	$59,438	Assume two weeks.
11	Utilization of underground equipment for disposal		UG Mine	1	LS			$529,661.43	$877,252.61	A. Earthwork	$1,406,914	User 1
12	Small crossings over Zinc and Greens Creek bridge locations		Other Facilities	100	sf		$70.86	$123.90	$16.14	F. Construction Mgmt	$21,090	User 10
13	Excavator for residual and short-lag material		Waste Rock Dump	4,428	hrs			$60.71	$104.71	A. Earthwork	$732,440	Total CY divided by corrected productivity for 345B on Productivity sheet
14	Reconfiguration pumps and pipes		H2O Treat Sys Constr - Ad	486	hrs	$106,556		$212.41	$32.09	C. Water Management	$225,381	Utilizes User Crew 3: two laborers, 1 backhoe, and 1 pipewelder for a quarter of the time
15	Demolish WTP		H2O Treat Sys Constr - Ad	1	ls			$22,124.08	$14,945.66	D. Facility & Equipment	$37,070	User Sheet 6
16	Material deficit		Stockpile	92,235	cy		$50.00			A. Earthwork	$4,611,767	Channel Construction Quote of $22/yd from 8/13/13; tailings area times growth media thickness minu
17	Drain Material		Off Site Facilities	93,936	cy		$50.00			A. Earthwork	$4,696,817	
18	Mob-demob		Access Road	1	LS				$689,609.76	Mob/Demob	$689,610	User 2
19	Pipe for water collection from Pond D		Other Facilities	10,560	ft		$3.67	$7.79	$3.27	C. Water Management	$155,503	2 miles of piping e-mail January 20, 2014 Chris Wallace
20	WTP replacement - every 50 years		Water Treatment - Contac	1	LS	$7,458,927				C. Water Management	$7,458,927	
21	Pond cleaning - every 50 years		Ponds	33,272	sf				$4.85	C. Water Management	$161,311	Cost from Brian Erickson email February 03, 2014; timing assumed to coincide with WTP removal
22	Pond relining - every 50 years		Ponds	238,087	sf		$0.46	$1.35	$0.22	C. Water Management	$482,890	Relining ponds; area from User 4; 3skwk crew
						$7,565,483	$18,162,934	$3,660,774	$4,731,933		$34,121,125	

Notes: Capital cost is lump sum (i.e. not multiplied by the quantity).
Material, Labor and Equipment/Operating costs are unit costs (i.e. multiplied by the quantity).
Transporting pipes to Hawk Inlet: 8 miles of pipe divided into 40 ft pieces, 6 pieces hauled at a time = 176 trips; 1 trip takes approximately 1 hr
Assumed construction of two pedestrian crossings at 4'W and 80'L in place of the two bridges demolished.

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Closure Cost Estimate
Closure Planning

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Closure Plan Management	
	Totals
Technical Studies	$0
Engineering	$0
Permitting	$0
TOTALS	**$0**

Closure Plan Studies and Reporting

	Description (required)	ID Code	Type (select type)	Total Cost $	Comments
				$0	

Notes:

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Closure Cost Estimate
Closure Planning

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Closure Plan Management	
	Totals
Technical Studies	$0
Engineering	$0
Permitting	$0
TOTALS	**$0**

Closure Plan Engineering

	Description (required)	ID Code	Type (select type)	Total Cost $	Comments
				$0	

Notes:

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Closure Cost Estimate
Closure Planning

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Closure Plan Management	
	Totals
Technical Studies	$0
Engineering	$0
Permitting	$0
TOTALS	**$0**

Closure Plan Permitting

	Description (required)	ID Code	Type (select type)	Total Cost $	Comments
				$0	

Notes:

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Closure Cost Estimate
G & A

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

General & Administration	Totals
Property Holding Costs	$0
Security & Maintenance	$0
Administration	$10,128,539
TOTALS	**$10,128,539**

Color Code Key	
User Input - Direct Input	**Direct Input**
User Input - Pull Down List	**Pull Down Selection**
Program Constant (can override)	**Alternate Input**
Program Calculated Value	**Locked Cell - Formula or Reference**

Property Holding Costs

	Description (required)	ID Code	Type (select type)	Frequency (select type)	Cost/ Payment $	Number of Payments	Total Cost $	Comments
							$0	

Notes:

Security and Maintenance

	Description (required)	ID Code	Type (select type)	Frequency (select type)	Cost/ Payment $	Number of Payments	Total Cost $	Comments
1							$0	
							$0	

Notes:

Administration

	Description (required)	ID Code	Type (select type)	Frequency (select type)	Cost/ Payment $	Number of Payments	Total Cost $	Comments
1	**Camp support**		**Camp Lodging**	**Other**	**$1,734,639**	**1**	$1,734,639	**User 5**
2	**Power costs - camp**		**Electric power**	**Other**	**$616,923**	**1**	$616,923	**User 5**
3	**Power costs - ventilation**		**Electric power**	**Other**	**$143,550**	**1**	$143,550	**User 5**
4	**Transportation**		**Material/Goods Transport**		**$1,234,127**	**1**	$1,234,127	**User 5**
5	**Landing craft for materials/equip costs**		**Material/Goods Transport**		**$4,716,000**	**1**	$4,716,000	**User 5**
6	**Meals for WTP, Montioring, and Laborer crews**		**Material/Goods Transport**		**$1,683,300**	**1**	$1,683,300	**User 5**
							$10,128,539	

Notes:

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Closure Cost Estimate
Human Resources

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Human Resources	Totals
Salaries & Benefits	$11,951,540
Severance & Relocation	$0
TOTALS	$11,951,540

Human Resources - Salary & Benefits

	Job Description (required)	Avg. Annual Salary (incl. benefits) $	Type	Closure Year 1 #	Closure Year 2 #	Closure Year 3 #	Closure Year 4 #	Closure Year 5 #	Closure Year 6 #	Closure Year 7 #	Closure Year 8 #	Closure Year 9 #	Closure Year 10 #	Closure Year 11 #	Closure Year 12 #	Closure Year 13 #	Closure Year 14 #	Closure Year 15 #	Closure Year 16 #	Closure Year 17 #	Closure Year 18 #	Closure Year 19 #	Closure Year 20 #	Closure Year 21 #	Closure Year 22 #	Closure Year 23 #	Closure Year 24 #	Closure Year 25 #	Closure Year 26 #	Closure Year 27 #	Closure Year 28 #	Closure Year 29 #	Closure Year 30 #	Closure Year 31 #	Closure Year 32 #	Closure Year 33 #	Closure Year 34 #	Closure Year 35 #	Closure Year 36 #	Closure Year 37 #	Closure Year 38 #	Closure Year 39 #	Closure Year 40 #	Closure Year 41 #	Closure Year 42 #
1	Holding crew	$202,998	Closure G & A	2																																								
2	Hourly - Tech 5	$202,998	Closure G & A		2	2	2																																					
3	Crew for monit sched A	$293,941	Closure G & A	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Crew for monit sched B	$33,916	Closure G & A	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Y0 crew - foreman	$388,769	Water Treatment - Other	1																																								
6	Y0 crew - laborer	$298,979	Water Treatment - Other	1																																								
7	Y1-3 crew - laborer	$298,979	Water Treatment - Other		1	1	1																																					
8	Y4-10 WTP crew - foreman	$37,516	Water Treatment - Other					1	1	1	1	1	1	1																														
9	Y4-10 WTP crew - laborer	$44,232	Water Treatment - Other					1	1	1	1	1	1	1																														
10	Y11-15 WTP crew - foreman	$31,954	Water Treatment - Other												1	1	1	1	1																									
11	Y11-15 WTP crew - laborer	$24,574	Water Treatment - Other												1	1	1	1	1																									
12	Y16-50 WTP crew - foreman	$31,954	Water Treatment - Other																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	Y16-50 WTP crew - laborer	$24,574	Water Treatment - Other																	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	Y51-100 WTP crew - foreman	$42,605	Water Treatment - Other																																									
15	Y51-100 WTP crew - laborer	$32,765	Water Treatment - Other																																									
	SUBTOTAL			$ 1,387,685	$ 998,917	$ 998,917	$ 998,917	$ 395,690	$ 395,690	$ 135,665	$ 135,665	$ 135,665	$ 135,665	$ 135,665	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527	$ 56,527

Notes:
Closure Year 1 is the Holding Year
Costs for water treatment crew are for contracting to start up, batch operate, and shut down the water treatment plant at frequencies required in the years in corresponding interval.
Costs for monitorino crew ischedules A and BI include one field tech and one laborer contracted time to travel to site and samole.
Batching days: See User 4 for calculation.

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Closure Cost Estimate
Human Resources

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Human Resources	Totals
Salaries & Benefits	$11,951,540
Severance & Relocation	$0
TOTALS	$11,951,540

Human Resources - Severance & Outplacement Benefits

	Job Description	Severance & Outplacement Cost $		Closure Year 1 #	Closure Year 2 #	Closure Year 3 #	Closure Year 4 #	Closure Year 5 #	Closure Year 6 #	Closure Year 7 #	Closure Year 8 #	Closure Year 9 #	Closure Year 10 #	Closure Year 11 #	Closure Year 12 #	Closure Year 13 #	Closure Year 14 #	Closure Year 15 #	Closure Year 16 #	Closure Year 17 #	Closure Year 18 #	Closure Year 19 #	Closure Year 20 #	Closure Year 21 #	Closure Year 22 #	Closure Year 23 #	Closure Year 24 #	Closure Year 25 #	Closure Year 26 #	Closure Year 27 #	Closure Year 28 #	Closure Year 29 #	Closure Year 30 #	Closure Year 31 #	Closure Year 32 #	Closure Year 33 #	Closure Year 34 #	Closure Year 35 #	Closure Year 36 #	Closure Year 37 #	Closure Year 38 #	Closure Year 39 #	Closure Year 40 #	Closure Year 41 #	Closure Year 42 #
1	Holding crew			2.0																																								
2	Hourly - Tech 5						2.0																																					
3	Crew for monit sched A								1.0																																			
4	Crew for monit sched B													1.0																														
5	Y0 crew - foreman			1.0																																								
6	Y0 crew - laborer			1.0																																								
7	Y1-3 crew - laborer						1.0																																					
8	Y4-10 WTP crew - foreman													1.0																														
9	Y4-10 WTP crew - laborer													1.0																														
10	Y11-15 WTP crew - foreman																		1.0																									
11	Y11-15 WTP crew - laborer																		1.0																									
12	Y16-50 WTP crew - foreman																																								1.0			
13	Y16-50 WTP crew - laborer																																								1.0			
14	Y51-100 WTP crew - foreman																																											
15	Y51-100 WTP crew - laborer																																											
			SUBTOTAL	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Notes:
1. Assumes Severance + Outplacement

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Closure Cost Estimate
Reclamation Quantities

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Data Cost File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Reclamation Quantity Summary

												Unit Costs					
	Description	Total Regrade or Haul Volume cy	Total Regrade or Haul Cost $	Total Cover Volume cy	Cover Placement Cost $	Total Growth Media Volume cy	Growth Media Placement Cost $	Total Surface Area acres	Total Scarify Cost $	Total Revetation Cost $	TOTALS $	Regrade Unit Cost $/CY	Material Haul or Backfill Unit Cost $/CY	Cover Unit Cost $/CY	Growth Media Unit Cost $/CY	Scarify Unit Cost $/CY	Area Unit Cost $/acre
1	Waste Rock Dumps		$ -		$ -		$ -	69.87	$ -	$ 74,464	$ 74,464		N/A			$0.00	$1,065.75
2	Tailings Impoundments		$ -		$ -		$ -		$ -	$ -	$ -		N/A				
3	Heap Leach Pads		$ -		$ -		$ -		$ -	$ -	$ -		N/A				
5	Open Pits		$ -							$ -	$ -		N/A				
4	Quarries & Borrow Pits		$ -		$ -		$ -		$ -	$ -	$ -		N/A				
6	Roads	154,871	$ 124,504			111,315	$ 195,166	69	$ -	$ 73,537	$ 393,207	$0.80	N/A		$1.75	$0.00	$5,698.65
7	Landfills		$ -		$ -		$ -		$ -	$ -	$ -		N/A				
8	Buildings				$ -		$ -	21.6	$ -	$ -	$ -		N/A			$0.00	$0.00
9	Yards	108,000	$ 298,491		$ -	63,726	$ 89,585	198	$ -	$ 211,020	$ 599,096	$2.76	N/A		$1.41	$0.00	$3,025.74
10	Ponds	133,928	$ 181,567			11,616	$ 15,975	7.9		$ 7,767	$ 205,309	N/A	$1.36		$1.38		$25,988.43
11	Exploration Roads		$ -				$ -		$ -	$ -	$ -		N/A				
12	Exploration Trenches		$ -							$ -	$ -		N/A				
13	Diversion Ditches		$ -							$ -	$ -		N/A				
14	Sediment Ponds		$ -				$ -		$ -	$ -	$ -						
15	Generic Haulage/Backfill	2,872,074	$ 18,387,018		$ -		$ -	3.6	$ -	$ -	$ 18,387,018	N/A	$6.40			$0.00	#########
16	Adit/Decline Backfilling1		$ -								$ -	N/A					
17	Shaft Backfilling	220	$ 3,900								$ 3,900	N/A	$17.73				
	TOTALS	3,269,093	$ 18,995,480	-	$ -	186,657	$ 300,726	369.97	$ -	$ 366,788	$ 19,662,993						
	Average Costs	per CY	$5.81	per CY		per CY	$1.61	per acre	$0.00		$53,148	per acre					

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Closure Cost Estimate
Exploration

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration - Cost Summary	Labor	Equipment	Materials	Totals
Hole Abandonment Costs	$0	$0	$0	$0
Trench Backfilling Costs	$0	$0		$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Trench Revegetation Costs	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Drillhole Abandonment - User Input

Facility Description			Hole Plugging							
	Description (required)	ID Code	Hole Type (select)	Diameter in	Total Number of Holes	Max Holes Open at One Time	Casing to Remove ft	Average Depth of Hole[1] ft bgs	Depth to Water ft bgs	Hole Plug Method (select)

Notes:
1. If core holes are pre-drilled, use length of hole below pre-drilled length
2. If Top Plug is selected, assumes maximum 1/2hr laborer time to place plug and backfill with cuttings/soil (including move-to/set up time).

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Closure Cost Estimate
Exploration

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration - Cost Summary	Labor	Equipment	Materials	Totals
Hole Abandonment Costs	$0	$0	$0	$0
Trench Backfilling Costs	$0	$0		$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Trench Revegetation Costs	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Trenches - User Input

Facility Description			Trench Parameters					Backfill			Revegetation		
	Description (required)	ID Code	Trench Length ft	Trench Depth ft	Trench Bottom Width ft	Trench Sideslope Angle degrees	Additional Hrs for Walk-in (1) hr	Backfill Material (select)	Cut Material Type (select)	Backfilling Fleet (select)	Seed Mix (select)	Mulch (select)	Fertilizer (select)

Notes:
1. Include one-way hours necessary to walk equipment in from drop-off point to work area
2. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Figure 1 - Trench Volume

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Closure Cost Estimate
Exploration

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration - Cost Summary	Labor	Equipment	Materials	Totals
Hole Abandonment Costs	$0	$0	$0	$0
Trench Backfilling Costs	$0	$0		$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Trench Revegetation Costs	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Drillhole Abandonment

Description (required)	Vol/foot of depth ft3	Hole Plugging Material (1)	Total Grout Volume (2) cy	Total Cuttings Volume cy	Total Top Seal Volume (3,4) cy	Total Drillhole Abandon. Hours (6,7) hrs	Casing Removal Labor Cost (5) $	Casing Removal Equipment Cost $	Plugging Labor Cost $	Plugging Equipment Cost $	Plugging Material Cost $	Top Seal Material Cost (2,3) $	Total Cost (6,7) $
							$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Notes:

1. Assumes grout backfill from bottom of hole to 50' (15.24m) above static water level, up to 10' (3m) from top of hole
2. Assumes 25% loss to formation for grout backfill
3. If "Top Plug" hole plug method is used, assumes physical plug installed without backfill, grout or cement. Not available option for Nevada projects
4. Assumes top 10' (3 m) of hole is plugged with cement if "Grout Only", "Backfill + Grout", or "Cement Plug" hole plug method are chosen.
5. Assumes that a) casing is not cemented entire length, b) does not include temporary surface casing
6. Assumes minimum 1 hr per hole for abandonment (excluding move-to and casing removal)
7. Assumes fixed hours per hole for setup & tear-down and moving between holes (see Productivty Sheet) per drill hole (includes rig time if grouting required, labor crew only if cuttings backfill only)

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Closure Cost Estimate
Exploration

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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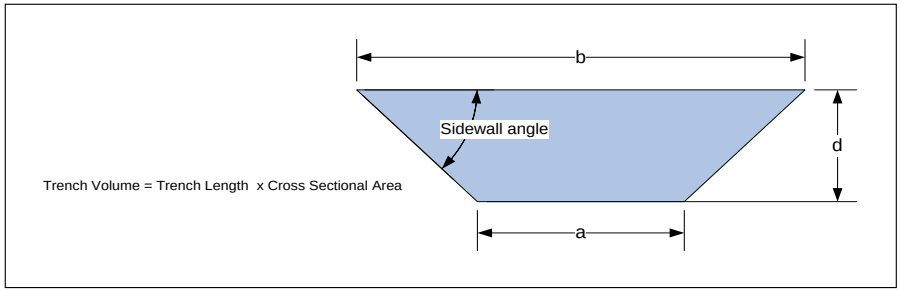
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration - Cost Summary	Labor	Equipment	Materials	Totals
Hole Abandonment Costs	$0	$0	$0	$0
Trench Backfilling Costs	$0	$0		$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Trench Revegetation Costs	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Trenches - Calculations

Exploration Trench Volume Calculation



Dozing & Ripping/Scarifying Calculations

Dozing: Dozing distance = 1/2 trench length or 400 ft (max push) whichever is less
Assumes flat push (grade correction factor = 1)

Revegetation: 10 ft added to trench width to account for revegetation under spoil pile

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Closure Cost Estimate
Exploration

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration - Cost Summary	Labor	Equipment	Materials	Totals
Hole Abandonment Costs	$0	$0	$0	$0
Trench Backfilling Costs	$0	$0		$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Trench Revegetation Costs	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Trenches - Backfill/Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83)

	Description (required)	Trench Backfill Volume	Dozer Push Distance	Equipment Productivity	Dozing Material	Density Correction	Backfilling Fleet	Corrected Hourly Productivity	Total Dozer Hours	Trench Backfill Labor Cost	Trench Backfill Equipment Cost	Total Trench Backfill Cost
		LCY (BCY+30%)	ft	yd3/hr				yd3/hr	hr	$	$	$
										$0	**$0**	**$0**

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Closure Cost Estimate
Exploration

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration - Cost Summary	Labor	Equipment	Materials	Totals
Hole Abandonment Costs	$0	$0	$0	$0
Trench Backfilling Costs	$0	$0		$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Trench Revegetation Costs	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Trenches - Revegetation Costs

Description (required)	Surface Area acres	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
		$0	**$0**	**$0**	**$0**

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Closure Cost Estimate
Expl. Roads & Pads

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration Roads & Pads - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Roads & Pads - User Input — **You must fill in ALL green cells and relevant blue cells in this section for each road**

Facility Description			Physical (1) - MANDATORY										User Overrides		Growth Media		
	Description (required)	ID Code	Underlying Ground Slope % grade	Ungraded Slope _H:1V	Cut Slope degrees	Road + Drill Pad Length ft	Road Width ft	Number of Drill Pads	Individual Sump Volume cy	Drill Pad Width ft	Drill Pad Length ft	Slope Replacement Percent %	Regrade Volume (if calculated elsewhere) cy	Disturbed Area (if calculated elsewhere) acres	Growth Media Thickness in	Distance to Growth Media Stockpile ft	Slope from Road to Stockpile % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. Slope replacement refers to the percentage of cut volumn replaced during regrading.
3. If Slope from facility to Cut/Fill Source is < -20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
4. Sump volume will be applied to all roads on slopes <20%. On slopes >20% pad width (i.e. cut volume) should be adequate to account for sump volume.

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Closure Cost Estimate
Expl. Roads & Pads

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration Roads & Pads - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Roads & Pads - User Input (cont.) **You must fill in ALL green cells and relevant blue cells in this section for each road**

		Grading				Growth Media				Revegetation				
	Description (required)	**Regrade Material Condition** (select)	**Cut Material Type** (select)	**Recontouring Equipment Fleet** (select)	**Additional Hrs for Walk-in** (1)	**Growth Media Material Type** (select)	**Growth Media Placement Equipment Fleet** (select)	**Maximum Fleet Size** (user override)	**Additional Hrs for Walk-in** (1)	**Seed Mix** (select)	**Mulch** (select)	**Fertilizer** (select)	**Scarifying/ Ripping?** (select)	**Ripping Fleet** (select)

Notes:
1. Include one-way hours necessary to walk equipment in from drop-off point to work area
2. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Expl. Roads & Pads

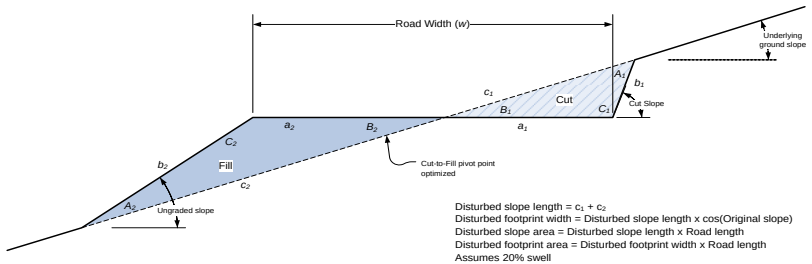
Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration Roads & Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Roads & Pads - Calculations

Regrading Volume and Footprint Volume



Disturbed slope length = $c_1 + c_2$
Disturbed footprint width = Disturbed slope length x cos(Original slope)
Disturbed slope area = Disturbed slope length x Road length
Disturbed footprint area = Disturbed footprint width x Road length
Assumes 20% swell

Will not allow dozer for slopes greater than 30%
For dozer regrading push distance = road width
Assumes dozer push is uphill
Assumes minimum push distance of 100 ft

Swell Factor: 1.2

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per area
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Road length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
For dozer regrading assumes push distance = 3 x road width

Revegetation Calculations

Minimum of 1 acre crew time per area

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Closure Cost Estimate
Expl. Roads & Pads

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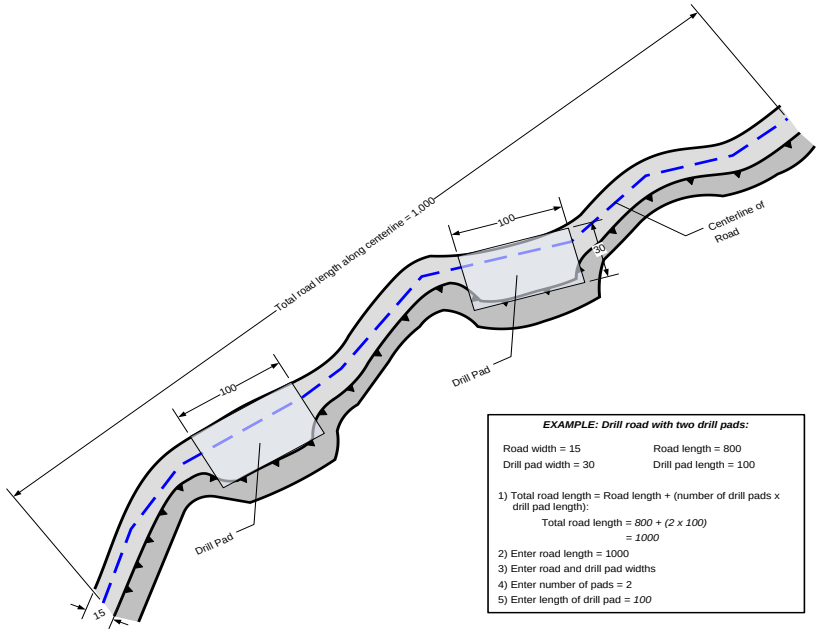
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration Roads & Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Inputting Exploration Roads and Drill Pads



EXAMPLE: Drill road with two drill pads:

Road width = 15 Road length = 800
Drill pad width = 30 Drill pad length = 100

1) Total road length = Road length + (number of drill pads x drill pad length):
Total road length = *800 + (2 x 100)*
= *1000*
2) Enter road length = 1000
3) Enter road and drill pad widths
4) Enter number of pads = 2
5) Enter length of drill pad = *100*

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Closure Cost Estimate
Expl. Roads & Pads

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration Roads & Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Roads & Pads - Regrading Costs

Description (required)	Total Road Length ft	Total Drill Pad Length ft	Regrading Volume cy	Recontouring Fleet	Equipment Productivity cy/hr	Total Equipment Hours (1) hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
							$0	**$0**	**$0**

(1) Includes walk-in time based on distance and travel speed (see Productivity sheet for speeds)

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Closure Cost Estimate
Expl. Roads & Pads

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration Roads & Pads - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Roads & Pads - Growth Media Costs

	Description (required)	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
							$0	**$0**	**$0**

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Closure Cost Estimate
Expl. Roads & Pads

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Exploration Roads & Pads - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Roads & Pads - Scarifying/Revegetation Costs

	Description (required)	Surface Area acres	Ripping Hours hrs	Ripping Labor Costs $	Ripping Equipment Cost $	Total Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
				$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Waste Rock Dumps

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$2,769	$1,515	$70,180	$74,464
TOTALS	**$2,769**	**$1,515**	**$70,180**	**$74,464**

Waste Rock Dumps - User Input

You must fill in ALL green cells in this section for each dump, lift or dump category

	Facility Description			Physical - MANDATORY									Cover				Growth Media			
	Description (required)	ID Code	Type	Underlying Ground Slope % Grade	Ungraded Slope _H:1V	Final Slope _H:1V	Final Top Slope % Grade	Lift (dump) Height ft	Mid-Bench Length ft	Average Flat Area Long Dimension (ripping distance) ft	Final (Regraded) Dump Footprint acres	Regrade Volume (1) (if calculated elsewhere) cy	Cover Thickness Slopes in	Cover Thickness Flat Areas in	Distance from Cover Borrow ft	Slope from Dump to Cover Borrow % grade	Slope Growth Media Thickness in	Flat Area Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Dump to Stockpile % grade
1	**Area 1 - North East**		**Waste Rock Dur**	**0.0**	**3.0**	**3.0**	**0.0**	**120**	**447**	**500**	**4.93**									
2	**Area 2 - North**		**Waste Rock Dur**	**0.0**	**3.0**	**3.0**	**0.0**	**190**	**709**	**600**	**7.18**									
3	**Area 3 - Far North**		**Waste Rock Dur**	**0.0**	**3.0**	**3.0**	**0.0**	**90**	**876**	**500**	**6.14**									
4	**Area 4 - North West**		**Waste Rock Dur**	**0.0**	**3.0**	**3.0**	**0.0**	**120**	**574**	**600**	**7.26**									
5	**Area 5 - West**		**Waste Rock Dur**	**0.0**	**3.0**	**3.0**	**0.0**	**220**	**1,371**	**900**	**19.63**									
6	**Area 6 - South**		**Waste Rock Dur**	**0.0**	**3.0**	**3.0**	**0.0**	**190**	**511**	**600**	**7.89**									
7	**Area 7 - East**		**Waste Rock Dur**	**0.0**	**3.0**	**3.0**	**0.0**	**170**	**852**	**600**	**8.34**									

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

HGCMC Stage 3 phase 1 full buildout design 11-14-13_final revised_MidbenchLengths_mth ACAD14_ft.dwg
GreenCreekPOO_MidbenchLengths_311400.010_mth_ft.xlsx

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Closure Cost Estimate
Waste Rock Dumps

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$2,769	$1,515	$70,180	$74,464
TOTALS	**$2,769**	**$1,515**	**$70,180**	**$74,464**

Waste Rock Dumps - User Input (cont.)

You must fill in ALL green cells and relevant blue cells in this section for each dump, lift or dump category

		Grading				Cover		Growth Media		Revegetation								
	Description (required)	Dozing Material Condition (select)	Dump Material Type (select)	Grading Equipment Fleet (select)	Slot/Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Seed Mix Slopes (select)	Seed Mix Flat Areas (select)	Mulch Slopes (select)	Mulch Flat Areas (select)	Fertilizer Slopes (select)	Fertilizer Flat Areas (select)	Slope Scarify/ Rip? (select)	Flat Area Scarify/ Rip? (select)	Scarify/ Ripping Fleet (select)
1	**Area 1 - North East**	**1**	**Alluvium**	**Small**	**No**					**Mix 1**	**Mix 1**							
2	**Area 2 - North**	**1**	**Alluvium**	**Small**	**No**					**Mix 1**	**Mix 1**							
3	**Area 3 - Far North**	**1**	**Alluvium**	**Small**	**No**					**Mix 1**	**Mix 1**							
4	**Area 4 - North West**	**1**	**Alluvium**	**Small**	**No**					**Mix 1**	**Mix 1**							
5	**Area 5 - West**	**1**	**Alluvium**	**Small**	**No**					**Mix 1**	**Mix 1**							
6	**Area 6 - South**	**1**	**Alluvium**	**Small**	**No**					**Mix 1**	**Mix 1**							
7	**Area 7 - East**	**1**	**Alluvium**	**Small**	**No**					**Mix 1**	**Mix 1**							

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Waste Rock Dumps

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Model Version: Version 1.4.1
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Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$2,769	$1,515	$70,180	$74,464
TOTALS	**$2,769**	**$1,515**	**$70,180**	**$74,464**

Waste

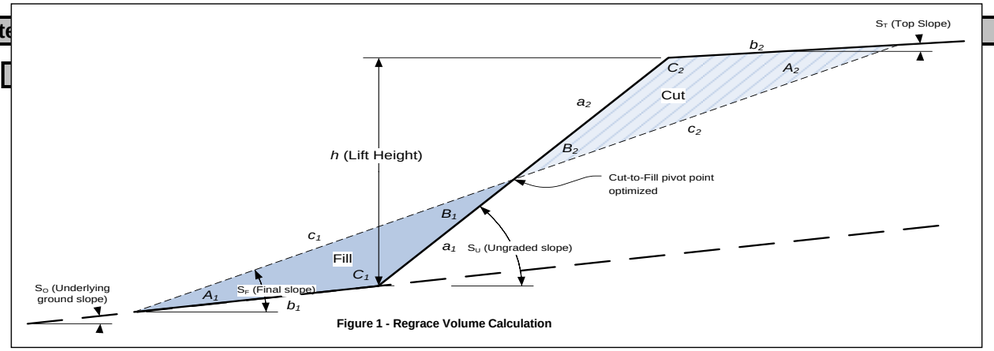

Figure 1 - Regrace Volume Calculation

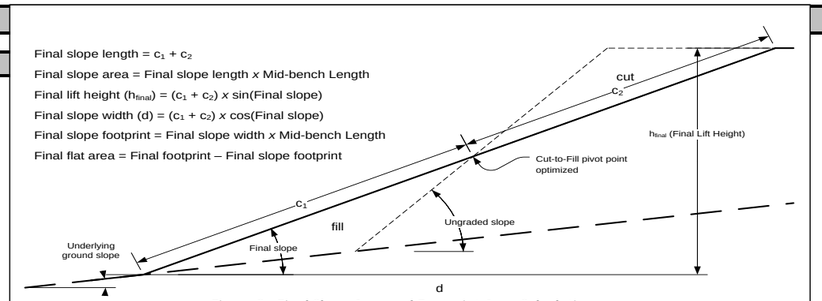

Figure 3 - Final Slope Area and Footprint Area Calculation

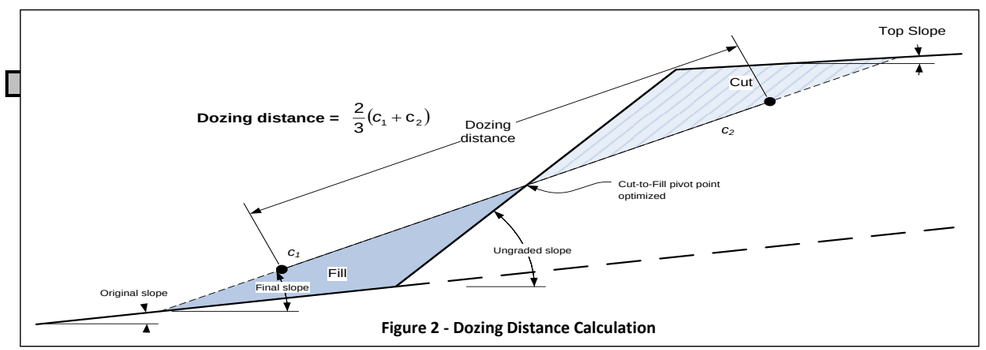

Figure 2 - Dozing Distance Calculation

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per dump

Slopes:
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Mid-bench length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
Minimum 1 hr

Flat Areas:
Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Revegetation: Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Waste Rock Dumps

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$2,769	$1,515	$70,180	$74,464
TOTALS	**$2,769**	**$1,515**	**$70,180**	**$74,464**

Waste Rock Dumps - Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1	**Area 1 - North East**	0		D6R								$0	$0	$0
2	**Area 2 - North**	0		D6R								$0	$0	$0
3	**Area 3 - Far North**	0		D6R								$0	$0	$0
4	**Area 4 - North West**	0		D6R								$0	$0	$0
5	**Area 5 - West**	0		D6R								$0	$0	$0
6	**Area 6 - South**	0		D6R								$0	$0	$0
7	**Area 7 - East**	0		D6R								$0	$0	$0
												$0	**$0**	**$0**

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Closure Cost Estimate
Waste Rock Dumps

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Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$2,769	$1,515	$70,180	$74,464
TOTALS	**$2,769**	**$1,515**	**$70,180**	**$74,464**

Waste Rock Dumps - Cover and Growth Media Costs

		Cover (lower layer)								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Cover Labor Cost $	Cover Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity BCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Topsoiling Cost $
1	**Area 1 - North East**						$0	$0	$0						$0	$0	$0
2	**Area 2 - North**						$0	$0	$0						$0	$0	$0
3	**Area 3 - Far North**						$0	$0	$0						$0	$0	$0
4	**Area 4 - North West**						$0	$0	$0						$0	$0	$0
5	**Area 5 - West**						$0	$0	$0						$0	$0	$0
6	**Area 6 - South**						$0	$0	$0						$0	$0	$0
7	**Area 7 - East**						$0	$0	$0						$0	$0	$0
							$0	**$0**	**$0**						**$0**	**$0**	**$0**

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Closure Cost Estimate
Waste Rock Dumps

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Cost Data: User Data
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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$2,769	$1,515	$70,180	$74,464
TOTALS	**$2,769**	**$1,515**	**$70,180**	**$74,464**

Waste Rock Dumps - Scarifying/Revegetation Costs

	Description (required)	Slope Area acres	Flat Area acres	Total Surface Area acres	Final Slope Length ft	Flat Area Long Dimension ft	Ripping/ Scarifying Fleet	Slope Scarifying/ Ripping Hours hrs	Flat Area Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Area 1 - North East**	3.89	1.00	4.89	379					$0	$0	$0	$194	$106	$4,911	$5,211
2	**Area 2 - North**	9.78		9.78	601					$0	$0	$0	$387	$212	$9,824	$10,423
3	**Area 3 - Far North**	5.73	1.00	6.73	285					$0	$0	$0	$267	$146	$6,760	$7,173
4	**Area 4 - North West**	4.99	3.00	7.99	379					$0	$0	$0	$317	$173	$8,025	$8,515
5	**Area 5 - West**	21.91		21.91	696					$0	$0	$0	$868	$475	$22,008	$23,351
6	**Area 6 - South**	7.05	1.00	8.05	601					$0	$0	$0	$319	$175	$8,085	$8,579
7	**Area 7 - East**	10.52		10.52	538					$0	$0	$0	$417	$228	$10,567	$11,212
		63.87	6.00	69.87							**$0**	**$0**	**$2,769**	**$1,515**	**$70,180**	**$74,464**

Notes: 1) Minimum total ripping hours = 1 (i.e. If total ripping hrs (slope + flat) < 1, then one hour of fleet time is assumed, regardless of acres shown in in scarifying table.)

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Closure Cost Estimate
Heap Leach

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Heap Leach Pads - Cost Summary	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pads - User Input — You must fill in ALL green cells and relevant blue cells in this section for each heap, lift or heap category

Facility Description				Physical (1) - MANDATORY									Cover				Growth Media			
	Description (required)	ID Code	Type	Underlying Ground Slope % grade	Ungraded Slope _H:1V	Final Slope _H:1V	Final Top Slope % grade	Lift (heap) Height ft	Mid-Bench Length ft	Average Flat Area Long Dimension (ripping distance) ft	Final (Regraded) Heap Footprint acres	Regrade Volume (if calculated elsewhere) cy	Cover Thickness Slopes in	Cover Thickness Flat Areas in	Distance from Cover Borrow ft	Slope from Heap to Cover Borrow % grade	Slope Growth Media Thickness in	Flat Area Growth Media Thickness in	Distance from Growth Material Stockpile ft	Slope from Heap to Stockpile % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Figure 1 - Regrading Volume Calculation

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Closure Cost Estimate
Heap Leach

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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Heap Leach Pads - Cost Summary	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pads - User Input (cont.) — **You must fill in ALL green cells and relevant blue cells in this section for each heap, lift or heap category**

		Grading				Cover		Growth Media		Revegetation								
	Description (required)	Dozing Material Condition (select)	Heap Material Type (select)	Grading Equipment Fleet (select)	Slot/ Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Seed Mix Slopes (select)	Seed Mix Flat Areas (select)	Mulch Slopes (select)	Mulch Flat Areas (select)	Fertilizer Slopes (select)	Fertilizer Flat Areas (select)	Slope Scarify/ Rip? (select)	Flat Area Scarify/ Rip? (select)	Scarifying/ Ripping Fleet (select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Heap Leach

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Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Heap Leach Pads - Cost Summary	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pads - User Input (cont.)		Solution Collection Ditch Fill							Piping			
	Description (required)	Collection Ditch Length ft	Collection Ditch Top Width ft	Collection Ditch Depth ft	Volume (if calculated elsewhere) cy	Distance from Borrow ft	Slope to Borrow % grade	Drain Rock Equipment Fleet (select)	Solid Pipe Length ft	Solid Pipe Type (select)	Drainage Pipe Length ft	Drainage Pipe Type (select)

Notes:

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Closure Cost Estimate
Heap Leach

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Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
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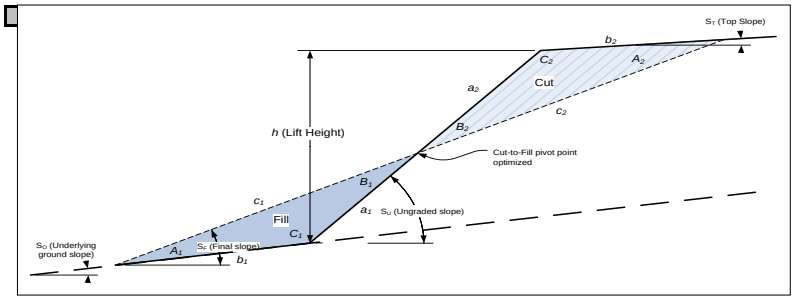
Heap Leach Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pads - Calculations



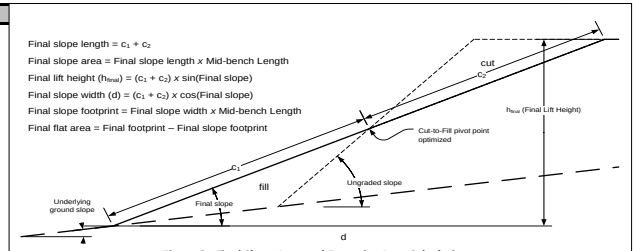


Figure 3 - Final Slope Area and Footprint Area Calculation

Dozing Push Distance Calculation

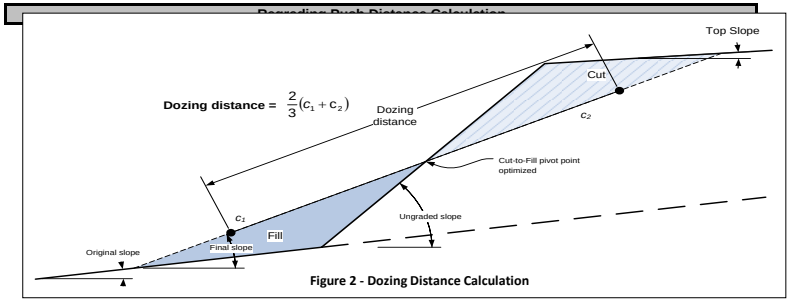


Figure 2 - Dozing Distance Calculation

Solution Collection Ditch Calculations

Use when existing heap material is not suitable drain rock
Assume t
Assume 2
Drain roc

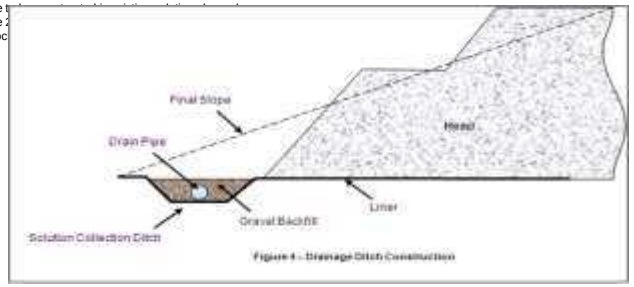


Figure 4 - Drainage Ditch Construction

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying per area

Slopes:
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Mid-bench length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Flat Areas:
Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Revegetation: Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Heap Leach

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Heap Leach Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pad - Drainage Channel Fill & Drainage Pipe Installation

		Drain Rock Placement								Drainpipe Installation				
	Description (required)	Drain Rock Volume cy	Drain Rock Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours hrs	Drainage Labor Cost $	Drainage Equipment Cost $	Total Drainage Cost $	Piping Crew Hours hrs	Piping Labor Cost $	Piping Equipment Cost $	Piping Material Cost $	Total Pipe Installation Cost $
						0	**$0**	**$0**	**$0**		**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Heap Leach

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Heap Leach Pads - Cost Summary	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pad - Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
												$0	**$0**	**$0**

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Closure Cost Estimate
Heap Leach

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Heap Leach Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pad - Cover and Growth Media Costs

		Cover (lower layer)								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Cover Labor Cost $	Cover Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity BCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Topsoiling Cost $
							$0	$0	$0						$0	$0	$0

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Closure Cost Estimate
Heap Leach

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Heap Leach Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pad - Scarifying/Revegetation Costs

Description (required)	Slope Area acres	Flat Area acres	Total Surface Area acres	Final Slope Length ft	Flat Area Long Dimension ft	Ripping/ Scarifying Fleet	Slope Scarifying/ Ripping Hours hrs	Flat Area Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
									$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

1) Minimum total ripping hours = 1 (i.e. If total ripping hrs (slope + flat) < 1, then one hour of fleet time is assumed, regardless of acres shown in in scarifying table.)

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Bond Calculation
Tailings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Tailings - Cost Summary	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$0	$0	N/A	$0
Tailings Surface Grading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Tailings - User Input — You must fill in ALL green cells and relevant blue cells in this section for each tailings impoundment

Facility Description			Physical - MANDATORY								Cover				Growth Media		
	Description (required)	ID Code	Underlying Ground Slope % Grade	Ungraded Slope _H:1V	Final (Regraded) Embankment Slope _H:1V	Final Embankment Height ft	Final Tailings Surface Area acres	Mid-Embankment or Ripping Length ft	Embankment Regrade Volume (if calculated elsewhere) cy	Surface Regrade Volume (calculated elsewhere) cy	Embankment Cover Thickness in	Tailings Surface Cover Thickness in	Distance from Cover Borrow ft	Slope from Tailings to Borrow % grade	Embankment Growth Media Thickness in	Tailings Surface Growth Media Thickness in	Distance from Growth Material Stockpile ft

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

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Bond Calculation
Tailings

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Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Tailings - Cost Summary	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$0	$0	N/A	$0
Tailings Surface Grading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Tailings - User Input (cont.) **You must fill in ALL green cells and relevant blue cells in this section for each tailings impoundment**

		Grading				Cover		Growth Media		Revegetation							
	Description (required)	Dozing Material Condition (select)	Embankment Material Type (select)	Grading Equipment Fleet (select)	Slot/Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Seed Mix Embankment Slope (select)	Seed Mix Tailings Surface (select)	Mulch Embankment Slopes (select)	Mulch Tailings Surface (select)	Fertilizer Embankment Slopes (select)	Fertilizer Tailing Surface (select)	Embankment Slope Scarify/ Rip? (select)	Tailings Surface Scarify/ Rip? (select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Bond Calculation
Tailings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Tailings - Cost Summary

	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$0	$0	N/A	$0
Tailings Surface Grading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Tailings - Calculations

Surface Area Calculations

Top Surface Area provided by user

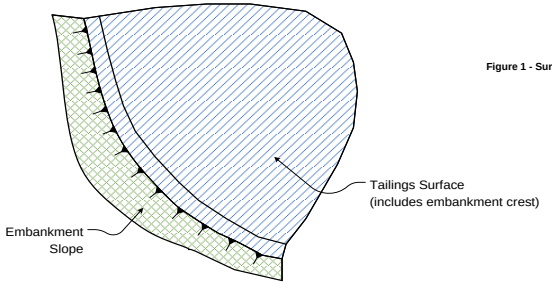

Figure 1 - Surface Areas

Final Slope Area and Footprint Area Calculations

$$\text{Overall slope length (c)} = \frac{\text{Embankment height}}{\cos(\text{Overall slope angle})}$$

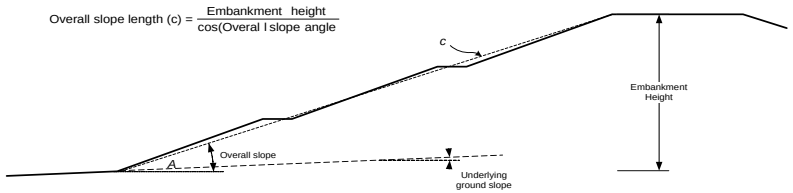

Figure 2 - Final Slope Area and Footprint Area Calculation

Grading Calculations

Grading assumed on impoundment surface only, not embankment
Average push distance assumed to be 2/3 of the 600 feet maximum from Catepillar Handbook or 400 feet
Material assumed to be loose stockile (1.2 productivity factor)
Dozing density correction based on dry sand = 2300/2400 = 0.96
Slope assumed to be 0 to 5% (1.0 productivity factor)

Ripping/Scarifying/Revegetation Calculation

Minimum 1 hr ripping/scarifying per area
Minimum 1 acre revegetation crew time per area

Regrading Volume Calculation

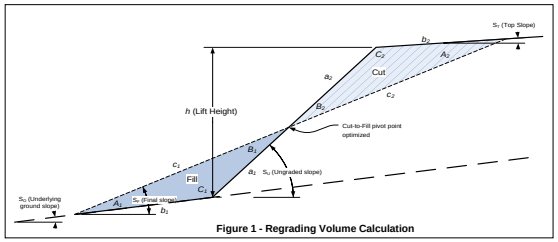

Figure 1 - Regrading Volume Calculation

Regrading Push Distance Calculation

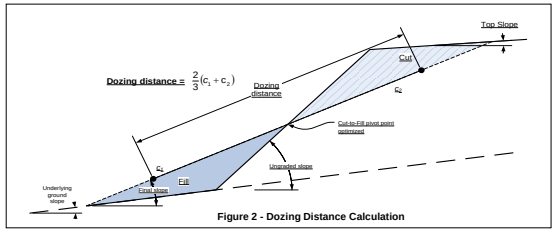

Figure 2 - Dozing Distance Calculation

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Bond Calculation
Tailings

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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Tailings - Cost Summary

	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$0	$0	N/A	$0
Tailings Surface Grading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Tailings - Embankment Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material Condition	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
												$0	**$0**	**$0**

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Bond Calculation
Tailings

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Tailings - Cost Summary

	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$0	$0	N/A	$0
Tailings Surface Grading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Tailings - Surface Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Density Correction	Dozing Material	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
												$0	**$0**	**$0**

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Bond Calculation
Tailings

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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Tailings - Cost Summary

	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$0	$0	N/A	$0
Tailings Surface Grading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Tailings - Cover and Growth Media Costs

		Cover Placement								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Placement Fleet	Cover Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Placement Cost $	Growth Media Volume cy	Growth Media Placement Fleet	Growth Media Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Topsoil Placement Cost $
							$0	**$0**	**$0**						**$0**	**$0**	**$0**

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Bond Calculation
Tailings

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Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Tailings - Cost Summary

	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$0	$0	N/A	$0
Tailings Surface Grading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Tailings - Scarifying/Revegetation Costs

	Description (required)	Embankment Slope Area acres	Tailings Surface Area acres	Total Surface Area acres	Final Slope Length ft	Ripping/ Scarifying Fleet	Slope Scarifying/ Ripping Hours hrs	Flat Area Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Cost $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Cost $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
									$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Bond Calculation
Tailings

Slope from Tailings to Stockpile % grade

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Bond Calculation
Tailings

Scarifying/ Ripping Fleet
(select)

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Bond Calculation
Tailings

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Bond Calculation
Tailings

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Closure Cost Estimate
Roads

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Roads - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$39,493	$85,011	N/A	$124,504
Cover Placement Cost	$61,824	$133,342	N/A	$195,166
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$101,317**	**$218,353**		**$319,670**
Revegetation Cost	$2,733	$1,496	$69,308	$73,537
TOTALS	**$104,050**	**$219,849**	**$69,308**	**$393,207**

Roads - User Input — **You must fill in ALL green cells and relevant blue cells in this section for each road**

	Facility Description			Physical (1) - MANDATORY						User Overrides		Growth Media		
	Description (required)	ID Code	Type	Underlying Ground Slope % grade	Ungraded Slope _H:1V	Cut Slope degrees	Road Width ft	Road Length ft	Slope Replacement Percent %	Regrade Volume (if calculated elsewhere) cy	Disturbed Area (if calculated elsewhere) acres	Growth Media Thickness in	Haul Distance from Growth Media Stockpile ft	Slope from Road to Stockpile % grade
1	**B-road**		**Project Road**	**20.0**	**1.5**	**60.0**	**41.5**	**43,085**	**100%**		**41.00**	**12.0**	**2,000**	**0%**
2	**A-road**		**Project Road**	**20.0**	**1.5**	**60.0**	**37.1**	**28,215**	**100%**		**24.00**	**12.0**	**2,000**	**0%**
3	**1350 road**		**Project Road**	**20.0**	**1.5**	**60.0**	**41.5**	**4,198**	**100%**		**4.00**	**12.0**	**2,000**	**0%**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Because the work required for building roads with a dozer is similar to that required to regrade a road with a dozer, this sheet could be used to provide a rough estimate of road construction costs if a dozer is selected as the grading fleet.

Total disturbance for the roads A and B is 102 acres in rec plan. The parameters of the road inputs (except for road length) have been adjusted to reflect this acreage of disturbance.

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Closure Cost Estimate
Roads

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Grading Costs	$39,493	$85,011	N/A	$124,504
Cover Placement Cost	$61,824	$133,342	N/A	$195,166
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$101,317**	**$218,353**		**$319,670**
Revegetation Cost	$2,733	$1,496	$69,308	$73,537
TOTALS	**$104,050**	**$219,849**	**$69,308**	**$393,207**

Roads - User Input (cont.)

		Haul Road Safety Berms				
	Description (required)	Berm Length ft	Berm Height ft	Berm Base Width ft	Berm Sideslope Angle _H:1V	Number of Berms (2) (1 or 2 sides)
1	**B-road**					
2	**A-road**					
3	**1350 road**					

(2) Enter 1 if berm on only one side of road, 2 if both sides of road are bermed.

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Closure Cost Estimate
Roads

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TOTALS	**$104,050**	**$219,849**	**$69,308**	**$393,207**

Roads - User Input (cont.) You must fill in ALL green cells and relevant blue cells in this section for each road

		Grading				Growth Media			Revegetation				
	Description (required)	Dozing Material Condition (select)	Cut Material Type (select)	Recontouring Equipment Fleet[2] (select)	No. of Excavators if grade >30% (select)	Growth Media Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarifying/ Ripping? (select)	Ripping Fleet (select)
1	**B-road**	**1**	**Alluvium**	**Med Excavator**		**Alluvium**	**Med Truck**		**Mix 1**	**None**		**No**	
2	**A-road**	**1**	**Alluvium**	**Med Excavator**		**Alluvium**	**Med Truck**		**Mix 1**	**None**		**No**	
3	**1350 road**	**1**	**Alluvium**	**Med Excavator**		**Alluvium**	**Med Truck**		**Mix 1**	**None**		**No**	

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table
2. If original slope >30% only excavators are allowed

Figure 1 - Regrading Volume

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Closure Cost Estimate
Roads

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Roads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$39,493	$85,011	N/A	$124,504
Cover Placement Cost	$61,824	$133,342	N/A	$195,166
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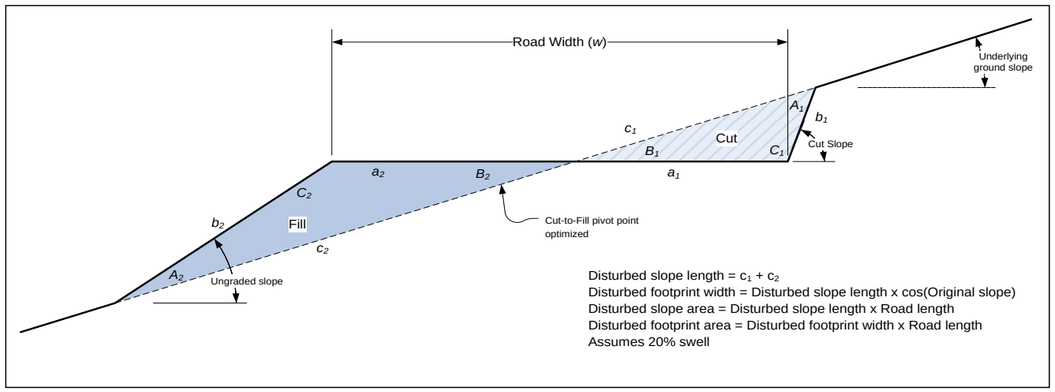
Revegetation Cost	$2,733	$1,496	$69,308	$73,537
TOTALS	**$104,050**	**$219,849**	**$69,308**	**$393,207**

Roads - Calculations

Regrading Volume and Footprint Volume

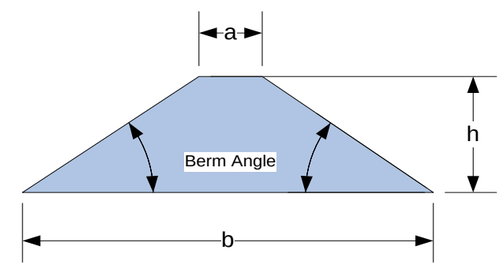


Will not allow dozer for slopes greater than 30%
For dozer regrading push distance = road width
Assumes dozer push is uphill
Assumes minimum push distance of 100 ft

Safety Berm Volume Calculation

Cross Sectional Area = $\frac{(a+b)}{2} \times h$

Berm Volume = Berm Length x Cross Sectional Area x No. Sides



Total berm volume doubled if both sides of road are bermed.
If length of berm on each side of road is different, input total length of both berms and input 1 for number of sides

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per area
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Road length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
For dozer regrading assumes push distance = 3 x road width

Revegetation Calculations

Minimum of 1 acre crew time per area

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Closure Cost Estimate
Roads

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Cover Placement Cost	$61,824	$133,342	N/A	$195,166
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$101,317**	**$218,353**		**$319,670**
Revegetation Cost	$2,733	$1,496	$69,308	$73,537
TOTALS	**$104,050**	**$219,849**	**$69,308**	**$393,207**

Roads - Regrading Costs

	Description (required)	Regrading Volume cy	Recontouring Fleet	Fleet Productivity cy/hr	Total Fleet Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1	**B-road**	95,628	345B	480	199	$24,407	$52,538	$76,945
2	**A-road**	49,925	345B	480	104	$12,756	$27,457	$40,213
3	**1350 road**	9,318	345B	480	19	$2,330	$5,016	$7,346
		154,871			322	**$39,493**	**$85,011**	**$124,504**

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Closure Cost Estimate
Roads

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Cover Placement Cost	$61,824	$133,342	N/A	$195,166
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$101,317**	**$218,353**		**$319,670**
Revegetation Cost	$2,733	$1,496	$69,308	$73,537
TOTALS	**$104,050**	**$219,849**	**$69,308**	**$393,207**

Roads - Growth Media Costs

	Description (required)	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Topsoiling Cost $
1	**B-road**	66,143	740/988G	455	2	145	$36,740	$79,240	$115,980
2	**A-road**	38,718	740/988G	455	2	85	$21,537	$46,451	$67,988
3	**1350 road**	6,454	740/988G	455	2	14	$3,547	$7,651	$11,198
		111,315				244	**$61,824**	**$133,342**	**$195,166**

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Closure Cost Estimate
Roads

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Roads - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$39,493	$85,011	N/A	$124,504
Cover Placement Cost	$61,824	$133,342	N/A	$195,166
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$101,317**	**$218,353**		**$319,670**
Revegetation Cost	$2,733	$1,496	$69,308	$73,537
TOTALS	**$104,050**	**$219,849**	**$69,308**	**$393,207**

Roads - Scarifying/Revegetation Costs

	Description (required)	Total Surface Area acres	Final Slope Length ft	Ripping Hours hrs	Ripping Labor Costs $	Ripping Equipment Cost $	Total Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**B-road**	41.00	41.0		$0	$0	$0	$1,624	$889	$41,183	$43,696
2	**A-road**	24.00	37.0		$0	$0	$0	$951	$520	$24,107	$25,578
3	**1350 road**	4.00	42.0		$0	$0	$0	$158	$87	$4,018	$4,263
		69.00			**$0**	**$0**	**$0**	**$2,733**	**$1,496**	**$69,308**	**$73,537**

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Closure Cost Estimate
Pits

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Pits - Cost Summary

	Labor	Equipment	Materials	Totals
Safety Berm Construction Cost	$0	$0	N/A	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Pits - User Input

Facility Description				Pit Berms					Berm Construction		Excavate or Doze	Hauling (if selected method)				Revegetation		
	Description (required)	ID Code	Type	Berm (or Highwall) Length ft	Berm Height ft	Berm Base Width ft	Berm Sideslope Angle _H:1V	Volume (if calculated elsewhere) cy	Construction Method (select)	Berm Material Type (select)	Berm Construction Equipment Fleet (select)	Berm Hauling Fleet (select)	Distance to Borrow Source ft	Slope to Borrow Source % grade	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Pits

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Pits - Cost Summary

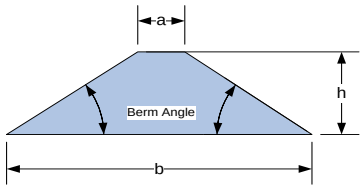
	Labor	Equipment	Materials	Totals
Safety Berm Construction Cost	$0	$0	N/A	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Pits - Calculations

Safety Berm Volume Calculation

Cross Sectional Area = $\frac{(a+b)}{2} \times h$

Berm Volume = Berm Length x Cross Sectional Area



Dozer productivity assumes push distance of:
100 feet

Dozer:
Length x (Berm Base Width + Dozer Push Distance) - accounts for disturbance created in borrow area

Excavator:
Length x (Berm Base Width + (2 x Excavator Track Width) - accounts for disturbance created in borrow area

Haul & Place:
Length x Berm Base Width - if necessary use Yards sheet to account for disturbance created in borrow area

Revegetation Calculations

Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Pits

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Pits - Cost Summary

	Labor	Equipment	Materials	Totals
Safety Berm Construction Cost	$0	$0	N/A	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Pits - Safety Berm Construction Costs

		Safety Berm							
	Description (required)	Safety Berm Volume cy	Selected Fleet	Number of Trucks/ Scrapers	Corrected Fleet Productivity cy/hr	Total Hours	Safety Berm Labor Cost $	Safety Berm Equipment Cost $	Total Safety Berm Cost $
							$0	**$0**	**$0**

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Closure Cost Estimate
Pits

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Pits - Cost Summary

	Labor	Equipment	Materials	Totals
Safety Berm Construction Cost	$0	$0	N/A	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Pits - Safety Berms - Revegetation Costs

	Description (required)	Flat Area acres	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
			$0	**$0**	**$0**	**$0**

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Closure Cost Estimate
Quarries & Borrow Pits

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Quarries and Borrow Areas - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Safety Berm Construction Cost	$0	$0	N/A	$0
Subtotal Earthwork	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
	$0	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Quarries & Borrow Pits - User Input — **You must fill in ALL green cells in this section for each dump, lift or dump category**

Facility Description				Physical - MANDATORY									Cover				Growth Media			
	Description (required)	ID Code	Type	Underlying Ground Slope % Grade	Ungraded Slope _H:1V	Final Slope _H:1V	Final Top Slope % Grade	Bench or Highwall Height ft	Mid-Bench Length ft	Average Flat Area Long Dimension (ripping distance) ft	Final (Regraded) Footprint acres	Regrade Volume (1) (if calculated elsewhere) cy	Cover Thickness Slopes in	Cover Thickness Flat Areas in	Distance from Cover Borrow ft	Slope from Dump to Cover Borrow % grade	Slope Growth Media Thickness in	Flat Area Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Dump to Stockpile % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

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Closure Cost Estimate
Quarries & Borrow Pits

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Quarries and Borrow Areas - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Safety Berm Construction Cost	$0	$0	N/A	$0
Subtotal Earthwork	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
	$0	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Quarries & Borrow Pits - User Input (cont.) You must fill in ALL green cells and relevant blue cells in this section for each dump, lift or dump category

		Grading				Cover		Growth Media		Revegetation								
	Description (required)	Dozing Material Condition (select)	Highwall Material Type (select)	Grading Equipment Fleet (select)	Slot/Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Seed Mix Slopes (select)	Seed Mix Flat Areas (select)	Mulch Slopes (select)	Mulch Flat Areas (select)	Fertilizer Slopes (select)	Fertilizer Flat Areas (select)	Slope Scarify/ Rip? (select)	Flat Area Scarify/ Rip? (select)	Scarify/ Ripping Fleet (select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Quarries & Borrow Pits

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Quarries and Borrow Areas - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Safety Berm Construction Cost	$0	$0	N/A	$0
Subtotal Earthwork	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
	$0	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Quarries & Borrow Pits - User Input (cont.)

Facility Description	Highwall Berms					Berm Construction		Excavate or Doze	Hauling (if selected method)				Revegetation		
Description (required)	Berm (or Highwall) Length ft	Berm Height ft	Berm Base Width ft	Berm Sideslope Angle _H:1V	Volume (if calculated elsewhere) cy	Construction Method (select)	Berm Material Type (select)	Berm Construction Equipment Fleet (select)	Berm Hauling Fleet (select)	Distance to Borrow Source ft	Slope to Borrow Source % grade	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Quarries & Borrow Pits - Calculations

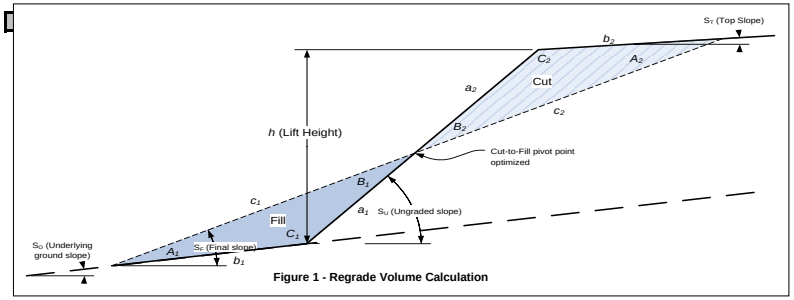

Figure 1 - Regrade Volume Calculation

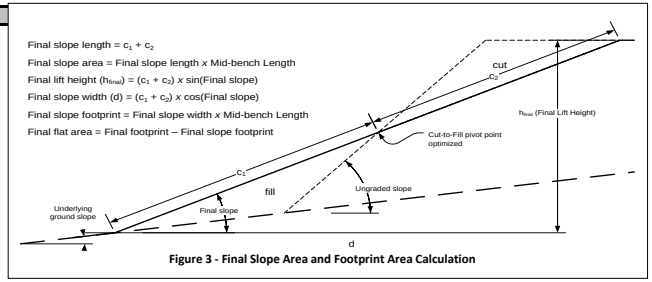

Figure 3 - Final Slope Area and Footprint Area Calculation

Regrading Push Distance Calculation

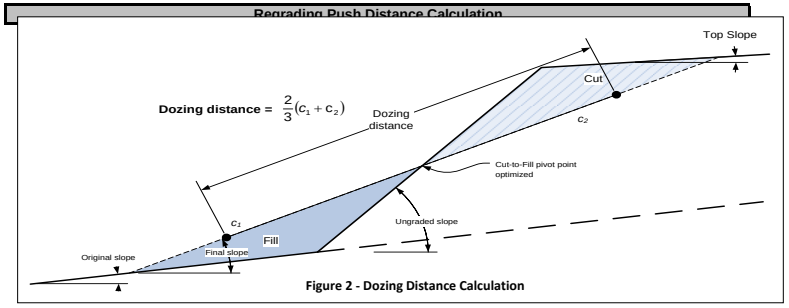

Figure 2 - Dozing Distance Calculation

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per dump

Slopes:
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Mid-bench length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
Minimum 1 hr

Flat Areas:
Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Revegetation: Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Quarries & Borrow Pits

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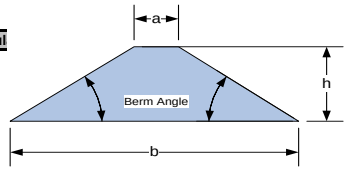
Quarries and Borrow Areas - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Safety Berm Construction Cost	$0	$0	N/A	$0
Subtotal Earthwork	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
	$0	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Cross Sectional Area = $\frac{(a+b)}{2} \times h$ **Safety Berm Volume Calcul**

Berm Volume = Berm Length x Cross Sectional Area



Dozer productivity assumes push distance of:
100 feet

Dozer:
Length x (Berm Base Width + Dozer Push Distance) - accounts for disturbance created in borrow area

Excavator:
Length x (Berm Base Width + (2 x Excavator Track Width) - accounts for disturbance created in borrow area

Haul & Place:
Length x Berm Base Width - if necessary use Yards sheet to account for disturbance created in borrow area

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Closure Cost Estimate
Quarries & Borrow Pits

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Quarries and Borrow Areas - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Safety Berm Construction Cost	$0	$0	N/A	$0
Subtotal Earthwork	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
	$0	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Quarries & Borrow Pits - Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
												$0	$0	$0

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Closure Cost Estimate
Quarries & Borrow Pits

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Quarries and Borrow Areas - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Safety Berm Construction Cost	$0	$0	N/A	$0
Subtotal Earthwork	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
	$0	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Quarries & Borrow Pits - Cover and Growth Media Costs

		Cover (lower layer)								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Cover Labor Cost $	Cover Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity BCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Topsoiling Cost $
							$0	$0	$0						$0	$0	$0

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Closure Cost Estimate
Quarries & Borrow Pits

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Quarries and Borrow Areas - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Safety Berm Construction Cost	$0	$0	N/A	$0
Subtotal Earthwork	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
	$0	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Quarries & Borrow Pits - Scarifying/Revegetation Costs

Description (required)	Slope Area acres	Flat Area acres	Total Surface Area acres	Final Slope Length ft	Flat Area Long Dimension ft	Ripping/ Scarifying Fleet	Slope Scarifying/ Ripping Hours hrs	Flat Area Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
										$0	**$0**	**$0**	**$0**	**$0**	**$0**

Notes: 1) Minimum total ripping hours = 1 (i.e. If total ripping hrs (slope + flat) < 1, then one hour of fleet time is assumed, regardless of acres shown in in scarifying table.)

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Closure Cost Estimate
Underground Openings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Underground Openings Cost Summary	Labor	Equipment	Materials	Totals
Adits, Portals & Declines Plugging	$25,689	$1,113	$7,446	$34,248
Shaft Backfill/Cover	$1,265	$2,635	N/A	$3,900
Shaft Capping	$20,015	$833	$7,225	$28,074
TOTALS	**$46,969**	**$4,581**	**$14,671**	**$66,222**

Color Code Key	
User Input - Direct Input	**Direct Input**
User Input - Pull Down List	**Pull Down Selection**
Program Constant (can override)	**Alternate Input**
Program Calculated Value	**Locked Cell - Formula or Reference**

Adits, Portals & Declines - User Input

	Facility Description		Physical Characteristics				Backfill Material			
	Description (required)	ID Code	Height ft	Width ft	Backfill/ Plug Type	Distance to Bulkhead ft	Backfill Material Condition (select)	Backfill Material Type (select)	Distance to Backfill Borrow ft	Slope from Adit to Borrow Area % grade
1	**1350 portal**		**15.0**	**20.0**	**Concrete Bul**	**30**				
2	**920 portal**		**15.0**	**20.0**	**Concrete Bul**	**30**				
3	**Secondary escapeway**		**15.0**	**20.0**	**Concrete Bul**	**30**				

Notes: 1) Foam (adit) option is for smaller openings that can be plugged with simple forms and a 5 ft thick plug.
2) Foam (production) option is for larger production openings (declines, etc.) and requires larger form construction and minimum 10 ft thick plug.
3) All foam plugs include minimum 15ft of backfill from opening to plug.
4) Bat gate option is for small openings and the material cost is the same for any size opening.
5) Backfilling assumes that small dozer will push material from nearby stockpile or dump
6) Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Shaft Openings - User Input

You must fill in ALL green cells and relevant blue cells in this section for each shaft

	Facility Description		Physical Characteristics			Backfill or Foundation Cover					
	Description (required)	ID Code	Diameter ft	Shaft Depth (for backfill method) ft	Backfill/ Plug Type (select)	Backfill Material Type (select)	Cover/ Backfill Fleet (select)	Thickness (if not complete backfill) ft	Distance to Backfill Borrow ft	Slope from Shaft to Borrow Area % grade	Maximum Fleet Size (user override)
1	**Ventilation raise - 1**		**11.3**		**Concrete Cap**	**Alluvium**	**Small Truck**	**12.0**	**500**	**-5.0**	
2	**Ventilation raise - 2**		**11.3**		**Concrete Cap**	**Alluvium**	**Small Truck**	**12.0**	**500**	**-5.0**	
3	**Ventilation raise - 3**		**11.3**		**Concrete Cap**	**Alluvium**	**Small Truck**	**12.0**	**500**	**-5.0**	
4	**Ventilation raise - 4**		**11.3**		**Concrete Cap**	**Alluvium**	**Small Truck**	**12.0**	**500**	**-5.0**	
5	**Ventilation raise - 5**		**11.3**		**Concrete Cap**	**Alluvium**	**Small Truck**	**12.0**	**500**	**-5.0**	

Notes:
1. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
2. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Underground Openings

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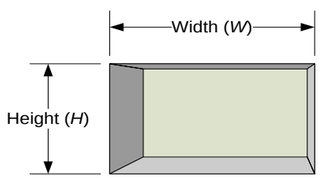
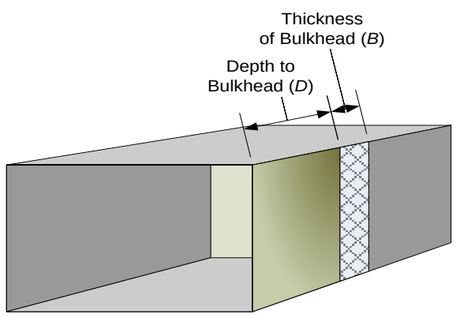
Underground Openings Cost Summary

	Labor	Equipment	Materials	Totals
Adits, Portals & Declines Plugging	$25,689	$1,113	$7,446	$34,248
Shaft Backfill/Cover	$1,265	$2,635	N/A	$3,900
Shaft Capping	$20,015	$833	$7,225	$28,074
TOTALS	**$46,969**	**$4,581**	**$14,671**	**$66,222**

Underground Openings - Calculations

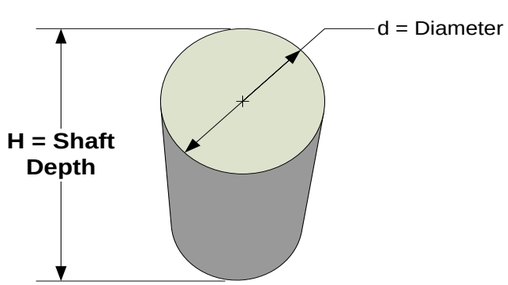
Adits, Declines and Portals - Volume Calculations





Cross-Sectional Area (A) = W x H
Volume of Concrete Bulkhead = A x B
Volume of Backfill = A x D

Shaft Volume Calculations



Radius (r) = ½d
Cross-Sectional Area (A) = πr^2
Volume = A x H

Concrete Cover/Bulkhead Volume Calculation

Using Means Heavy Construction Cost Data (2004)
- Estimage cover/bulkhead thickness
- Assumes that all concrete works are reinforced
- Productivity for crew from Means Heavy Construction Cost Data (2004) adjusted for supervision (addressed in Misc. Costs) and Davis-Bacon Wage Rates
- Assumes 18 in thick slab

Backfill Calculations

Uses 1 large and 1 small dozer for adit backfill
- Assumes max 400 foot push
- Assumes average operator and 50 min/hr availability

Uses truck & loader load, haul place fleets for shafts
- Concrete cap will be 1.5 feet thick, reinforced, structually supported.
- If concrete cap is used, assume 10 feet of rock backfill on top of cap.
- Assumes that all concrete works are reinforced
- If backfill is used, assume overfill by 5 feet

Carpenter rate incl Fringe: 0 per hour

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Closure Cost Estimate
Underground Openings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Underground Openings Cost Summary	Labor	Equipment	Materials	Totals
Adits, Portals & Declines Plugging	$25,689	$1,113	$7,446	$34,248
Shaft Backfill/Cover	$1,265	$2,635	N/A	$3,900
Shaft Capping	$20,015	$833	$7,225	$28,074
TOTALS	**$46,969**	**$4,581**	**$14,671**	**$66,222**

Adits, Portals & Declines Plugging

Uses RS Means Heavy Construction Cost Data for bulkhead production rate, material costs and crews

				Bulkhead Construction				Backfill or Foam (1)				Bat Gate or Culvert (2,3,4)				Total Costs			
	Description (required)	Bulkhead Volume cy	Backfill (rock) Volume cy	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Bulkhead Cost $	Total Labor Cost $	Total Equipment Cost $	Material (Foam) Cost $	Total Backfill Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Bat Gate Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Plugging Costs $
1	**1350 portal**	17		$8,563	$371	$2,482	$11,416	$0	$0	$0	$0	$0	$0	$0	$0	$8,563	$371	$2,482	**$11,416**
2	**920 portal**	17		$8,563	$371	$2,482	$11,416	$0	$0	$0	$0	$0	$0	$0	$0	$8,563	$371	$2,482	**$11,416**
3	**Secondary escapeway**	17		$8,563	$371	$2,482	$11,416	$0	$0	$0	$0	$0	$0	$0	$0	$8,563	$371	$2,482	**$11,416**
		51		**$25,689**	**$1,113**	**$7,446**	**$34,248**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$25,689**	**$1,113**	**$7,446**	**$34,248**

Notes:
1) Foam costs include 1 hour move to and setup + 1 hr. minimum crew time
2) Assumes 1 hr walk-in/walk-out time for equipment
3) Batgate assumes 8 hr install time each
4) Bat culvert backfill costs based on one 8-hr day (i.e. backfilling hours = 8 hrs).

Shaft Plugging

		Cover/Cap						Backfill/Cover		
	Description (required)	Cover Area ft2	Backfill or Cover Volume cy	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Shaft Cap Cost $	Total Labor Cost $	Total Equipment Cost $	Total Backfill Cost $
1	**Ventilation raise - 1**	100	44	$4,003	$167	$1,445	$5,615	$253	$527	**$780**
2	**Ventilation raise - 2**	100	44	$4,003	$167	$1,445	$5,615	$253	$527	**$780**
3	**Ventilation raise - 3**	100	44	$4,003	$167	$1,445	$5,615	$253	$527	**$780**
4	**Ventilation raise - 4**	100	44	$4,003	$167	$1,445	$5,615	$253	$527	**$780**
5	**Ventilation raise - 5**	100	44	$4,003	$167	$1,445	$5,615	$253	$527	**$780**
		500	220	**$20,015**	**$833**	**$7,225**	**$28,074**	**$1,265**	**$2,635**	**$3,900**

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Closure Cost Estimate
Haul Material

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Generic Material Hauling - Cost Summary

	Labor	Equipment	Materials	Totals
Hauling/Crush/Screen/Compact	$6,101,676	$12,285,342	N/A	$18,387,018
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$6,101,676**	**$12,285,342**	**$0**	**$18,387,018**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$6,101,676**	**$12,285,342**	**$0**	**$18,387,018**

Generic Material Hauling - User Input

	Facility Description			Physical		Hauled Material			Crushing & Screening					Cover			Growth Media		
	Description (required)	ID Code	Type	Final Surface Area acres	Average Ripping Distance ft	Material Volume Required cy	Distance from Borrow Source (1) ft	Slope to Borrow Source % grade	Crush Material	Screen Material	Loss to Crushing/ Screening %	Distance to Placement Location (2) ft	Slope to Placement % grade	Cover Thickness in	Distance to Cover Borrow ft	Slope to Borrow % grade	Growth Media Thickness in	Distance to Growth Material Stockpile ft	Slope to Stockpile % grade
1	Tailings - 10 in. Drain Layer		Tailings Impoundments			93,936	5,280	5.0		No	25%	5,000	-5.0						
2	Tailings - 24 in. compacted till from Site E and Site D		Tailings Impoundments			225,447	31,100	5.0											
3	Tailings - Growth Media (from existing stockpiles)		Tailings Impoundments			283,510	17,100	-5.0											
4	Tailings - 10-in Lower Capillary Break		Tailings Impoundments			93,936	500	0.0		Yes	25%	500	5.0						
5	Pit 174 glacial till wedge		Quarry			18,500	500	-5.0											
6	920 Foundations and buildings concrete to portal		Structures			7,573	5,333	-5.0											
7	Hawk Inlet Foundations and buildings concrete to portal		Structures			649	41,026	-5.0											
8	920 building debris to portal		Structures			19,530	5,333	-5.0											
9	Hawk Inlet building debris to portal		Structures			3,668	41,026	-5.0											
10	5.0 mile A-Road to tailings		Waste Rock Dump			1,000	28,934	-5.0											
11	3.9 mile A-Road to tailings		Waste Rock Dump			15,000	23,126	-5.0											
12	3.2 mile A-Road to tailings		Waste Rock Dump			600	19,430	-5.0											
13	0.9 mile A-Road to tailings		Waste Rock Dump			1,500	7,286	-5.0											
14	1.8 mile B-Road to tailings		Waste Rock Dump			5,000	4,224	-5.0											
15	2.5 mile B-Road to tailings		Waste Rock Dump			60,000	7,920	-5.0											
16	Zinc Creek Bridge to tailings		Waste Rock Dump			5,000	16,896	-5.0											
17	Pit 174 to tailings		Waste Rock Dump			4,000	12,144	-5.0											
18	7.3 mile B-Road to tailings		Waste Rock Dump			500	33,264	-5.0											
19	1350 Road to tailings		Waste Rock Dump			8,000	42,240	-5.0											
20	Core Shed to tailings		Waste Rock Dump			2,000	5,280	-5.0											
21	Truck Pad to tailings		Waste Rock Dump			30,000	5,280	-5.0											
22	Con Storage to tailings		Waste Rock Dump			10,000	5,280	-5.0											
23	Site E to tailings		Waste Rock Dump			163,400	19,008	-5.0											
24	Pit 405 to tailings		Waste Rock Dump			20,000	34,848	-5.0											
25	D Pile to tailings		Waste Rock Dump			120,000	36,960	-5.0											
26	Pond 23 Bedding to tailings		Waste Rock Dump			6,000	36,960	-5.0											
27	Site C to portal		Waste Rock Dump			50,000	1,908	-5.0											
28	Mill Backslope to portal		Waste Rock Dump			25,000	946	-5.0											
29	Mill/Admin Fill to portal		Waste Rock Dump			100,000	946	-5.0											
30	Ore Pad to portal		Waste Rock Dump			18,000	946	-5.0											
31	Warehouse Pad to portal		Waste Rock Dump			13,000	946	-5.0											
32	Water Building to portal		Waste Rock Dump			3,500	946	-5.0											
33	Mine Portal to portal		Waste Rock Dump			4,000	681	-5.0											
34	960 Site to portal		Waste Rock Dump			100	681	-5.0											
35	1350 Site to portal		Waste Rock Dump			10,000	500	-5.0											
36	Site 23 to tailings		Waste Rock Dump			1,449,725	36,200	-5.0											

Notes:
1. Input distance to crusher if material to be crushed
2. Input distance from crusher to placement if material to be crushed
3. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

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Closure Cost Estimate
Haul Material

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Generic Material Hauling - Cost Summary

	Labor	Equipment	Materials	Totals
Hauling/Crush/Screen/Compact	$6,101,676	$12,285,342	N/A	$18,387,018
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$6,101,676**	**$12,285,342**	**$0**	**$18,387,018**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$6,101,676**	**$12,285,342**	**$0**	**$18,387,018**

Generic Material Hauling - User Input (cont.)

		Hauling Material				Cover			Growth Media			Revegetation				
	Description (required)	Haul Material Type (select)	Material Hauling Fleet (select)	Each Fleet Size (from/to crusher) (user override)	Compact After Placement?	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch Type (select)	Fertilizer Type (select)	Scarify/ Rip? (select)	Scarifying/ Ripping Fleet (select)
1	Tailings - 10 in. Drain Layer	LS - broken	Med Truck	4												
2	Tailings - 24 in. compacted till from Site E and Site D	LS - broken	Med Truck	8	Yes											
3	Tailings - Growth Media (from existing stockpiles)	LS - broken	Med Truck	8												
4	Tailings - 10-in Lower Capillary Break	LS - broken	Med Truck	4												
5	Pit 174 glacial till wedge	LS - broken	Med Truck													
6	920 Foundations and buildings concrete to portal	LS - broken	Small Truck													
7	Hawk Inlet Foundations and buildings concrete to portal	LS - broken	Small Truck	8												
8	920 building debris to portal	LS - broken	Small Truck													
9	Hawk Inlet building debris to portal	LS - broken	Small Truck	8												
10	5.0 mile A-Road to tailings	LS - broken	Med Truck	8												
11	3.9 mile A-Road to tailings	LS - broken	Med Truck	8												
12	3.2 mile A-Road to tailings	LS - broken	Med Truck													
13	0.9 mile A-Road to tailings	LS - broken	Med Truck													
14	1.8 mile B-Road to tailings	LS - broken	Med Truck													
15	2.5 mile B-Road to tailings	LS - broken	Med Truck													
16	Zinc Creek Bridge to tailings	LS - broken	Med Truck	8												
17	Pit 174 to tailings	LS - broken	Med Truck													
18	7.3 mile B-Road to tailings	LS - broken	Med Truck	8												
19	1350 Road to tailings	LS - broken	Med Truck	8												
20	Core Shed to tailings	LS - broken	Med Truck													
21	Truck Pad to tailings	LS - broken	Med Truck													
22	Con Storage to tailings	LS - broken	Med Truck													
23	Site E to tailings	LS - broken	Med Truck	8												
24	Pit 405 to tailings	LS - broken	Med Truck	8												
25	D Pile to tailings	LS - broken	Med Truck	8												
26	Pond 23 Bedding to tailings	LS - broken	Med Truck	8												
27	Site C to portal	LS - broken	Small Truck													
28	Mill Backslope to portal	LS - broken	Small Truck													
29	Mill/Admin Fill to portal	LS - broken	Small Truck													
30	Ore Pad to portal	LS - broken	Small Truck													
31	Warehouse Pad to portal	LS - broken	Small Truck													
32	Water Building to portal	LS - broken	Small Truck													
33	Mine Portal to portal	LS - broken	Small Truck													
34	960 Site to portal	LS - broken	Small Truck													
35	1350 Site to portal	LS - broken	Small Truck													
36	Site 23 to tailings	LS - broken	Med Truck	8												

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Haul Material

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Generic Material Hauling - Cost Summary

	Labor	Equipment	Materials	Totals
Hauling/Crush/Screen/Compact	$6,101,676	$12,285,342	N/A	$18,387,018
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$6,101,676**	**$12,285,342**	**$0**	**$18,387,018**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$6,101,676**	**$12,285,342**	**$0**	**$18,387,018**

Generic Material Hauling - Load, Haul, Place and Grade

		Material Haulage								Crush and/or Compact			
	Description (required)	Material Volume to Crusher cy	Final Material Volume cy	Material Haulage Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Hauling Labor Cost $	Hauling Equipment Cost $	Total Crush/ Screen Cost $	Compact Labor Cost $	Compact Equipment Cost $	Total Load/Haul/ Place Cost $
1	**Tailings - 10 in. Drain Layer**	93,936	93,936	740/988G	637	8	147	$56,283	$117,080	$0	$0	$0	$173,363
2	**Tailings - 24 in. compacted till from Site E and Site D**	225,447	225,447	740/988G	412	8	547	$351,108	$709,142	$0	$90,179	$24,799	$1,175,228
3	**Tailings - Growth Media (from existing stockpiles)**	283,510	283,510	740/988G	432	8	656	$421,073	$850,452	$0	$0	$0	$1,271,525
4	**Tailings - 10-in Lower Capillary Break**	125,248	93,936	740/988G	1,189	8	105	$70,832	$147,345	$100,099	$0	$0	$318,276
5	**Pit 174 glacial till wedge**	18,500	18,500	740/988G	571	2	32	$8,108	$17,487	$0	$0	$0	$25,595
6	**920 Foundations and buildings concrete to portal**	7,573	7,573	740/988G	501	4	15	$5,743	$11,653	$0	$0	$0	$17,396
7	**Hawk Inlet Foundations and buildings concrete to portal**	649	649	740/988G	206	8	3	$1,926	$3,830	$0	$0	$0	$5,756
8	**920 building debris to portal**	19,530	19,530	740/988G	501	4	39	$14,932	$30,297	$0	$0	$0	$45,229
9	**Hawk Inlet building debris to portal**	3,668	3,668	740/988G	206	8	18	$11,554	$22,982	$0	$0	$0	$34,536
10	**5.0 mile A-Road to tailings**	1,000	1,000	740/988G	279	8	4	$2,568	$5,186	$0	$0	$0	$7,754
11	**3.9 mile A-Road to tailings**	15,000	15,000	740/988G	339	8	44	$28,243	$57,042	$0	$0	$0	$85,285
12	**3.2 mile A-Road to tailings**	600	600	740/988G	588	12	1	$901	$1,796	$0	$0	$0	$2,697
13	**0.9 mile A-Road to tailings**	1,500	1,500	740/988G	515	5	3	$1,343	$2,764	$0	$0	$0	$4,107
14	**1.8 mile B-Road to tailings**	5,000	5,000	740/988G	574	4	9	$3,446	$7,168	$0	$0	$0	$10,614
15	**2.5 mile B-Road to tailings**	60,000	60,000	740/988G	583	6	103	$52,775	$107,783	$0	$0	$0	$160,558
16	**Zinc Creek Bridge to tailings**	5,000	5,000	740/988G	438	8	11	$7,061	$14,261	$0	$0	$0	$21,322
17	**Pit 174 to tailings**	4,000	4,000	740/988G	571	8	7	$4,493	$9,075	$0	$0	$0	$13,568
18	**7.3 mile B-Road to tailings**	500	500	740/988G	246	8	2	$1,284	$2,593	$0	$0	$0	$3,877
19	**1350 Road to tailings**	8,000	8,000	740/988G	199	8	40	$25,675	$51,857	$0	$0	$0	$77,532
20	**Core Shed to tailings**	2,000	2,000	740/988G	505	4	4	$1,532	$3,186	$0	$0	$0	$4,718
21	**Truck Pad to tailings**	30,000	30,000	740/988G	505	4	59	$22,590	$46,991	$0	$0	$0	$69,581
22	**Con Storage to tailings**	10,000	10,000	740/988G	505	4	20	$7,658	$15,929	$0	$0	$0	$23,587
23	**Site E to tailings**	163,400	163,400	740/988G	398	8	411	$263,813	$532,829	$0	$0	$0	$796,642
24	**Pit 405 to tailings**	20,000	20,000	740/988G	239	8	84	$53,918	$108,899	$0	$0	$0	$162,817
25	**D Pile to tailings**	120,000	120,000	740/988G	226	8	531	$340,838	$688,399	$0	$0	$0	$1,029,237
26	**Pond 23 Bedding to tailings**	6,000	6,000	740/988G	226	8	27	$17,331	$35,003	$0	$0	$0	$52,334
27	**Site C to portal**	50,000	50,000	740/988G	413	2	121	$30,659	$63,750	$0	$0	$0	$94,409
28	**Mill Backslope to portal**	25,000	25,000	740/988G	508	2	49	$12,416	$25,816	$0	$0	$0	$38,232
29	**Mill/Admin Fill to portal**	100,000	100,000	740/988G	508	2	197	$49,916	$103,791	$0	$0	$0	$153,707
30	**Ore Pad to portal**	18,000	18,000	740/988G	508	2	35	$8,868	$18,440	$0	$0	$0	$27,308
31	**Warehouse Pad to portal**	13,000	13,000	740/988G	508	2	26	$6,588	$13,698	$0	$0	$0	$20,286
32	**Water Building to portal**	3,500	3,500	740/988G	508	2	7	$1,774	$3,688	$0	$0	$0	$5,462
33	**Mine Portal to portal**	4,000	4,000	740/988G	544	2	7	$1,774	$3,688	$0	$0	$0	$5,462
34	**960 Site to portal**	100	100	740/988G	544	2	1	$253	$527	$0	$0	$0	$780
35	**1350 Site to portal**	10,000	10,000	740/988G	571	2	18	$4,561	$9,483	$0	$0	$0	$14,044
36	**Site 23 to tailings**	1,449,725	1,449,725	740/988G	226	8	6,415	$4,117,660	$8,316,534	$0	$0	$0	$12,434,194
		2,903,387	2,872,074				9,798	**$6,011,497**	**$12,160,444**	**$100,099**	**$90,179**	**$24,799**	**$18,387,018**

Notes: Final Material Volume includes allowance for additional material hauled to crushing/screening plant based on Loss to Crushing/Screening input above.

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Closure Cost Estimate
Haul Material

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Generic Material Hauling - Cost Summary	Labor	Equipment	Materials	Totals
Hauling/Crush/Screen/Compact	$6,101,676	$12,285,342	N/A	$18,387,018
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$6,101,676**	**$12,285,342**	**$0**	**$18,387,018**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$6,101,676**	**$12,285,342**	**$0**	**$18,387,018**

Generic Material Hauling - Cover and Growth Media Costs

		Cover Placement								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Placement Fleet	Cover Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Placement Cost $	Growth Media Volume cy	Growth Media Placement Fleet	Growth Media Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Topsoil Placement Cost $
1	**Tailings - 10 in. Drain Layer**						$0	$0	$0	0					$0	$0	$0
2	**Tailings - 24 in. compacted till from Site E and Site D**						$0	$0	$0	0					$0	$0	$0
3	**Tailings - Growth Media (from existing stockpiles)**						$0	$0	$0	0					$0	$0	$0
4	**Tailings - 10-in Lower Capillary Break**						$0	$0	$0	0					$0	$0	$0
5	**Pit 174 glacial till wedge**						$0	$0	$0	0					$0	$0	$0
6	**920 Foundations and buildings concrete to portal**						$0	$0	$0	0					$0	$0	$0
7	**Hawk Inlet Foundations and buildings concrete to portal**						$0	$0	$0	0					$0	$0	$0
8	**920 building debris to portal**						$0	$0	$0	0					$0	$0	$0
9	**Hawk Inlet building debris to portal**						$0	$0	$0	0					$0	$0	$0
10	**5.0 mile A-Road to tailings**						$0	$0	$0	0					$0	$0	$0
11	**3.9 mile A-Road to tailings**						$0	$0	$0	0					$0	$0	$0
12	**3.2 mile A-Road to tailings**						$0	$0	$0	0					$0	$0	$0
13	**0.9 mile A-Road to tailings**						$0	$0	$0	0					$0	$0	$0
14	**1.8 mile B-Road to tailings**						$0	$0	$0	0					$0	$0	$0
15	**2.5 mile B-Road to tailings**						$0	$0	$0	0					$0	$0	$0
16	**Zinc Creek Bridge to tailings**						$0	$0	$0	0					$0	$0	$0
17	**Pit 174 to tailings**						$0	$0	$0	0					$0	$0	$0
18	**7.3 mile B-Road to tailings**						$0	$0	$0	0					$0	$0	$0
19	**1350 Road to tailings**						$0	$0	$0	0					$0	$0	$0
20	**Core Shed to tailings**						$0	$0	$0	0					$0	$0	$0
21	**Truck Pad to tailings**						$0	$0	$0	0					$0	$0	$0
22	**Con Storage to tailings**						$0	$0	$0	0					$0	$0	$0
23	**Site E to tailings**						$0	$0	$0	0					$0	$0	$0
24	**Pit 405 to tailings**						$0	$0	$0	0					$0	$0	$0
25	**D Pile to tailings**						$0	$0	$0	0					$0	$0	$0
26	**Pond 23 Bedding to tailings**						$0	$0	$0	0					$0	$0	$0
27	**Site C to portal**						$0	$0	$0	0					$0	$0	$0
28	**Mill Backslope to portal**						$0	$0	$0	0					$0	$0	$0
29	**Mill/Admin Fill to portal**						$0	$0	$0	0					$0	$0	$0
30	**Ore Pad to portal**						$0	$0	$0	0					$0	$0	$0
31	**Warehouse Pad to portal**						$0	$0	$0	0					$0	$0	$0
32	**Water Building to portal**						$0	$0	$0	0					$0	$0	$0
33	**Mine Portal to portal**						$0	$0	$0	0					$0	$0	$0
34	**960 Site to portal**						$0	$0	$0	0					$0	$0	$0
35	**1350 Site to portal**						$0	$0	$0	0					$0	$0	$0
36	**Site 23 to tailings**						$0	$0	$0	0					$0	$0	$0
							$0	**$0**	**$0**						**$0**	**$0**	**$0**

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Closure Cost Estimate
Haul Material

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Generic Material Hauling - Cost Summary

	Labor	Equipment	Materials	Totals
Hauling/Crush/Screen/Compact	$6,101,676	$12,285,342	N/A	$18,387,018
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$6,101,676**	**$12,285,342**	**$0**	**$18,387,018**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$6,101,676**	**$12,285,342**	**$0**	**$18,387,018**

Generic Material Hauling - Scarifying/Revegetation Costs

	Description (required)	Total Surface Area acres	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Cost $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Cost $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Tailings - 10 in. Drain Layer**	0.10		$0	$0	$0	$0	$0	$0	$0
2	**Tailings - 24 in. compacted till from Site E and Site D**	0.10		$0	$0	$0	$0	$0	$0	$0
3	**Tailings - Growth Media (from existing stockpiles)**	0.10		$0	$0	$0	$0	$0	$0	$0
4	**Tailings - 10-in Lower Capillary Break**	0.10		$0	$0	$0	$0	$0	$0	$0
5	**Pit 174 glacial till wedge**	0.10		$0	$0	$0	$0	$0	$0	$0
6	**920 Foundations and buildings concrete to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
7	**Hawk Inlet Foundations and buildings concrete to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
8	**920 building debris to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
9	**Hawk Inlet building debris to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
10	**5.0 mile A-Road to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
11	**3.9 mile A-Road to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
12	**3.2 mile A-Road to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
13	**0.9 mile A-Road to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
14	**1.8 mile B-Road to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
15	**2.5 mile B-Road to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
16	**Zinc Creek Bridge to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
17	**Pit 174 to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
18	**7.3 mile B-Road to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
19	**1350 Road to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
20	**Core Shed to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
21	**Truck Pad to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
22	**Con Storage to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
23	**Site E to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
24	**Pit 405 to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
25	**D Pile to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
26	**Pond 23 Bedding to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
27	**Site C to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
28	**Mill Backslope to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
29	**Mill/Admin Fill to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
30	**Ore Pad to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
31	**Warehouse Pad to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
32	**Water Building to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
33	**Mine Portal to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
34	**960 Site to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
35	**1350 Site to portal**	0.10		$0	$0	$0	$0	$0	$0	$0
36	**Site 23 to tailings**	0.10		$0	$0	$0	$0	$0	$0	$0
		3.60		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary

	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

Buildings & Foundation - User Input

You must fill in ALL green cells and relevant blue cells in this section for each building or facility

	Facility Description			Physical - MANDATORY								Foundation Cover (1)			Growth Media (1) (entire footprint)		
	Description (required)	ID Code	Type	Length ft	Width ft	Eve Height ft	Slab Thickness in	Foundation Wall Thickness in	Foundation Wall Height ft	Average Flat Area Long Dimension (ripping distance) ft	Building Area Footprint (including surrounding facilities) acres	Foundation Cover Thickness in	Distance from Foundation Cover Borrow Area ft	Slope from Facility to Borrow Area % grade	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Facility to Stockpile % grade
1	860 - Exploration Trailer I		Process - Other	31	8	12	0	0	0	32	0.01						
2	860 - Exploration Trailer II		Process - Other	12	12	12	6	12	2	17	0.00						
3	860 - Geology Building		Process - Other	42	32	12	6	12	2	53	0.03						
4	860 - Laboratory Building		Process - Other	56	44	12	6	12	2	71	0.06						
5	860 - Safety Building		Process - Other	55	33	12	6	12	2	64	0.04						
6	860 - Test Cover Building		Process - Other	40	21	12	0	0	0	45	0.02						
7	860 - Training Trailer		Process - Other	58.75	15	12	0	0	0	0	0.02						
8	860 - Concrete containment		Process - Other	12.5	13	4	6	6	2	18	0.00						
9	860 - Sewer lift station		Process - Other	7	7	6	6	6	0	10	0.00						
10	860 - Shipping Container		Process - Other	20	32	8	0	0	0	86	0.01						
11	920 - Admin/Shop Building		Process - Other	134.5	100	22	6	12	2	168	0.31						
12	920 - Admin/Shop Building Entrance		Process - Other	22	10	12	6	12	2	24	0.01						
13	920 - Batch Plant		Process - Other	54	16	22	6	12	2	56	0.02						
14	920 - Batch Plant Feed Hopper		Process - Other	40	20	12	6	12	2	45	0.02						
15	920 - Batch Plant MCC		Process - Other	10.5	7	12	12	12	2	13	0.00						
16	920 - Electrical Shop		Process - Other	41	32	22	6	12	2	52	0.03						
17	920 - Light Vehicle Shop		Process - Other	53	41	22	6	12	2	67	0.05						
18	920 - Mill cleaner building		Process - Other	114	60	24	6	12	2	129	0.16						
19	920 - Mill Concentrate loadout		Process - Other	82	78	32	12	12	2	113	0.15						
20	920 - Mill Concentrator		Process - Other	178	113	70	6	12	2	211	0.46						
21	920 - Mill E&I Shop		Process - Other	49.5	14	12	6	12	2	51	0.02						
22	920 - Mill Maintenance Shop		Process - Other	58	33	22	6	12	2	67	0.04						
23	920 - Mill Tails Loadout I		Process - Other	30	18	22	12	0	0	35	0.01						
24	920 - Mill Tails Loadout II		Process - Other	115	43	32	12	0	0	123	0.11						
25	920 - Mill Tails Loadout III		Process - Other	81	21	32	12	0	0	84	0.04						
26	920 - Mill WTP 400 gpm		Process - Other	62	25	32	6	12	2	62	0.04						
27	920 - Mill WTP 800 gpm		Process - Other	65.75	30	32	12	12	2	72	0.05						
28	920 - Mine switch gear building		Process - Other	26.5	22	12	6	12	2	34	0.01						
29	920 - Ore Pad Shack		Process - Other	16.5	8	12	6	12	2	18	0.00						
30	920 - Potable building		Process - Other	26	22	12	6	12	2	34	0.01						
31	920 - Powerhouse Generator Cat I		Process - Other	30	10	12	6	12	2	32	0.01						
32	920 - Powerhouse Generator Cat II		Process - Other	30	10	12	6	12	2	32	0.01						
33	920 - Powerhouse I		Process - Other	78.5	64	22	6	12	2	101	0.12						
34	920 - Powerhouse II		Process - Other	27.25	22	12	6	0	0	35	0.01						
35	920 - Powerhouse Turbine		Process - Other	32.25	8	12	6	12	2	33	0.01						
36	920 - Shop bulk oil storage		Process - Other	49.5	25	12	6	0	0	55	0.03						
37	920 - Shop covered bays		Process - Other	86.5	12	22	0	0	0	87	0.02						
38	920 - Shop Tire Storage I		Process - Other	49.5	25	12	12	0	0	55	0.03						
39	920 - Shop Tire Storage II		Process - Other	92.25	16	12	6	0	0	94	0.03						
40	920 - Warehouse		Process - Other	150	52	22	6	12	2	150	0.18						
41	920 - Caisson		Process - Other	5	5	12	0	0	0	7	0.00						
42	920 - Concrete containment		Process - Other	7	6	0	6	12	2	9	0.00						
43	920 - Concrete road surface		Process - Other	30	2,900	0	12	0	0	410	2.00						
44	920 - DB-01		Process - Other	70	12	0	12	6	12	71	0.02						
45	920 - DB-01'		Process - Other	70	12	0	12	6	12	71	0.02						
46	920 - DB-02		Process - Other	64	20	0	12	6	6	67	0.03						
47	920 - DB-03 - Pond 23		Process - Other	80	12	0	12	6	6	81	0.02						
48	920 - DB-03' - Pond 23		Process - Other	80	12	0	12	6	6	81	0.02						
49	920 - DB-09 - Ore Pad		Process - Other	70	18	0	12	12	6	71	0.03						
50	920 - Fuel Farm Containment		Process - Other	80	50	0	6	12	4	80	0.09						
51	920 - Main substation		Process - Other	50	40	12	6	12	2	64	0.05						
52	920 - Mill thickeners concrete pad		Process - Other	110	75	0	12	0	0	62	0.19						
53	920 - Powerhouse fuel containment pad		Process - Other	70	56	0	6	12	2	90	0.09						
54	920 - Sediment trap I		Process - Other	10	6	6	6	6	0	11	0.00						

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
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Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

55	920 - Sediment trap II		Process - Other	12	6	6	6	6	0	13	0.00						
56	920 - Sewer lift station		Process - Other	18	10	8	6	6	8	21	0.00						
57	920 - Utility vault I		Process - Other	9.5	6	6	6	0	6	11	0.00						
58	920 - Utility vault II		Process - Other	9	5	6	6	0	6	10	0.00						
59	920 - Utility vault III		Process - Other	6	4	6	6	0	6	7	0.00						
60	920 - Utility vault IV		Process - Other	13	7	6	6	0	6	15	0.00						
61	920 - Warehouse microwave tower		Process - Other	15	10	12	12	0	0	18	0.00						
62	920 - Portal Transformer I		Process - Other	9	5	4	6	0	0	10	0.00						
63	920 - Portal Transformer II		Process - Other	13	8	4	6	0	0	15	0.00						
64	920 - Containers		Process - Other	20	8	8	0	0	0	23	0.00						
65	920 - Containers		Process - Other	20	8	8	6	0	0	22	0.00						
66	920 - Containers		Process - Other	52	20	12	0	0	0	56	0.02						
67	920 - Containers		Process - Other	80	32	12	0	0	0	86	0.06						
68	920 - Containers		Process - Other	80	32	12	0	0	0	86	0.06						
69	920 - Containers		Process - Other	20	8	12	0	0	0	20	0.00						
70	920 - Containers		Process - Other	20	8	12	0	0	0	20	0.00						
71	920 - Containers		Process - Other	20	8	12	0	0	0	20	0.00						
72	920 - Batch plant hopper		Process - Other	36	17	12	12	0	0	40	0.01						
73	920 - Fuel tank FT-01, 24'D x 18'H		Process - Other	21	21	18	0	0	0	0	0.01						
74	920 - Fuel tank FT-04, 16'D x 32'H		Process - Other	14	14	32	0	0	0	0	0.00						
75	920 - Fuel tank FT-05, 16'D x 32'H		Process - Other	14	14	32	0	0	0	0	0.00						
76	920 - Mill bulk thickener		Process - Other	31	31	12	12	0	0	44	0.02						
77	920 - Mill cleaner building tube		Process - Other	40	8	12	0	0	0	0	0.01						
78	920 - Mill conveyor		Process - Other	114	9	5	0	0	0	114	0.02						
79	920 - Mill lead thickener		Process - Other	20.5	21	12	12	0	0	29	0.01						
80	920 - Mill tailings thickener		Process - Other	61	61	12	6	0	0	86	0.09						
81	920 - Mill tails stk		Process - Other	19	19	12	6	0	0	27	0.01						
82	920 - Mill zinc thickener		Process - Other	31	31	12	6	0	0	44	0.02						
83	920 - Ore pad crusher		Process - Other	21	18	12	6	12	2	28	0.01						
84	920 - Sewer treatment plant		Process - Other	60	16	12	0	0	0	62	0.02						
85	920 - Mill ferric chloride tank		Process - Other	13	13	12	6	0	0	18	0.00						
86	920 - Mill sulfuric acid tank		Process - Other	13	13	12	6	0	0	18	0.00						
87	23 Pond - Diesel pump		Process - Other	17	10	12	6	0	0	20	0.00						
88	23 Pond - Pump house		Process - Other	26	25	12	6	12	2	36	0.01						
89	23 Pond - Vault		Process - Other	4	4	6	6	0	6	6	0.00						
90	860 - 860 Shotcrete - Eco-block walls		Process - Other	15	2	12	0	24	12	15	0.00						
91	860 - 860 Shotcrete - Eco-block walls		Process - Other	40	2	12	0	24	12	40	0.00						
92	860 - 860 Shotcrete - Shotcrete Plant		Process - Other	40	40	12	12	0	0	47	0.04						
93	Hawk Inlet - Bathroom		Process - Other	20	8	8	0	0	0	0	0.00						
94	Hawk Inlet - Bathroom		Process - Other	20	8	8	0	0	0	0	0.00						
95	Hawk Inlet - Boat house/boom shed		Process - Other	41	24	12	0	0	0	0	0.02						
96	Hawk Inlet - Boiler building		Process - Other	34	24	12	6	12	2	42	0.02						
97	Hawk Inlet - Building maintenance shed II		Process - Other	46.75	17	12	6	12	2	50	0.02						
98	Hawk Inlet - Building maintenance shed I		Process - Other	49	17	12	6	12	2	52	0.02						
99	Hawk Inlet - Cardboard		Process - Other	25	12	12	6	12	2	28	0.01						
100	Hawk Inlet - Concentrate storage building		Process - Other	281	162	24	6	12	2	324	1.04						
101	Hawk Inlet - Conveyor, headhouse etc.		Process - Other	71	56	12	0	0	0	90	0.09						
102	Hawk Inlet - Core shed		Process - Other	103.5	52	12	6	12	2	116	0.12						
103	Hawk Inlet - Exploration Trailer		Process - Other	60.75	14	12	0	0	0	62	0.02						
104	Hawk Inlet - Generator building		Process - Other	42	23	12	6	12	2	48	0.02						
105	Hawk Inlet - Housing		Process - Other	20	8	12	0	0	0	0	0.00						
106	Hawk Inlet - Housing		Process - Other	20	8	12	0	0	0	0	0.00						
107	Hawk Inlet - Housing		Process - Other	20	8	12	0	0	0	0	0.00						
108	Hawk Inlet - Housing		Process - Other	20	8	12	0	0	0	0	0.00						
109	Hawk Inlet - Housing		Process - Other	20	8	12	0	0	0	0	0.00						
110	Hawk Inlet - Housing		Process - Other	20	8	12	0	0	0	0	0.00						
111	Hawk Inlet - Housing		Process - Other	80	23	12	0	0	0	0	0.04						
112	Hawk Inlet - Housing		Process - Other	38	24	12	0	0	0	0	0.02						
113	Hawk Inlet - Housing (Grand Boiler Building)		Process - Other	25	10	12	6	12	2	26	0.01						
114	Hawk Inlet - Housing (Grand I)		Process - Other	124	75	40	6	0	0	145	0.21						
115	Hawk Inlet - Housing (Grand II)		Process - Other	91	25	40	6	0	0	94	0.05						
116	Hawk Inlet - Housing (Hilton)		Process - Other	115	30	32	6	12	2	119	0.08						
117	Hawk Inlet - Laundry		Process - Other	20	8	12	0	0	0	0	0.00						

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

118	**Hawk Inlet - Maintenance building**		Process - Other	50.75	34	12	6	12	2	61	0.04						
119	**Hawk Inlet - Pump house on pilings**		Process - Other	5	4	12	0	0	0	0	0.00						
120	**Hawk Inlet - Pump house on pilings**		Process - Other	45.75	43	12	6	12	2	62	0.04						
121	**Hawk Inlet - Trailer**		Process - Other	61	14	10	0	0	0	0	0.02						
122	**Hawk Inlet - Trailer**		Process - Other	60.75	14	10	0	0	0	0	0.02						
123	**Hawk Inlet - Trailer**		Process - Other	42	12	10	0	0	0	0	0.01						
124	**Hawk Inlet - Trailer**		Process - Other	40	10	10	0	0	0	0	0.01						
125	**Hawk Inlet - Trailer**		Process - Other	40	10	10	0	0	0	0	0.01						
126	**Hawk Inlet - Trailer**		Process - Other	31.75	10	10	0	0	0	0	0.01						
127	**Hawk Inlet - Warehouse**		Process - Other	94	60	22	6	12	2	112	0.13						
128	**Hawk Inlet - Warehouse Storage I**		Process - Other	94	10	12	6	12	2	95	0.02						
129	**Hawk Inlet - Warehouse Storage II**		Process - Other	94	20	12	6	0	0	96	0.04						
130	**Hawk Inlet - Water treatment building**		Process - Other	34.5	29	22	6	12	2	45	0.02						
131	**Hawk Inlet - Wheel wash building**		Process - Other	55	34	22	6	12	2	65	0.04						
132	**Hawk Inlet - 22' tank's Pad**		Process - Other	67	27	0	12	0	0	72	0.04						
133	**Hawk Inlet - Concrete pad in front of warehouse**		Process - Other	77	20	0	6	0	0	80	0.04						
134	**Hawk Inlet - Concrete pad west side of warehouse**		Process - Other	22	20	0	6	0	0	30	0.01						
135	**Hawk Inlet - DB-04**		Process - Other	80	12	0	12	6	6	81	0.02						
136	**Hawk Inlet - DB-04'**		Process - Other	80	12	0	12	6	6	81	0.02						
137	**Hawk Inlet - DB-04 Concrete drain**		Process - Other	24.5	3	0	6	0	0	25	0.00						
138	**Hawk Inlet - Oil containment**		Process - Other	37	2	2	6	6	2	37	0.00						
139	**Hawk Inlet - Pump containment pad**		Process - Other	10	8	0	6	0	1	13	0.00						
140	**Hawk Inlet - Sewer lift station**		Process - Other	5	5	0	6	6	6	7	0.00						
141	**Hawk Inlet - Sump from DB-04**		Process - Other	12.5	10	12	6	12	2	16	0.00						
142	**Hawk Inlet - Transformer**		Process - Other	12	12	4	6	12	2	13	0.00						
143	**Hawk Inlet - Transformer (Grand)**		Process - Other	12	12	4	6	12	2	13	0.00						
144	**Hawk Inlet - Transformer and containment**		Process - Other	12.5	9	0	6	12	2	15	0.00						
145	**Hawk Inlet - Above ground cable tray**		Process - Other	51.5	2	0	0	0	0	0	0.00						
146	**Hawk Inlet - Poles**		Process - Other	2	2	60	0	0	0	6	0.00						
147	**Hawk Inlet - Pump station**		Process - Other	10	7	12	6	0	0	12	0.00						
148	**Hawk Inlet - Ramp**		Process - Other	120	20	0	6	12	2	92	0.06						
149	**Hawk Inlet - switch gear next to generator building**		Process - Other	24	12	8	6	0	0	27	0.01						
150	**Hawk Inlet - Transformer-dry**		Process - Other	6	4	6	0	0	0	0	0.00						
151	**Hawk Inlet - Containers**		Process - Other	180	72	12	0	0	0	194	0.30						
152	**Hawk Inlet - Containers**		Process - Other	160	64	12	0	0	0	172	0.24						
153	**Hawk Inlet - Containers**		Process - Other	20	8	12	0	0	0	22	0.00						
154	**Hawk Inlet - Containers**		Process - Other	200	80	12	0	0	0	215	0.37						
155	**Hawk Inlet - Containers**		Process - Other	126	56	12	0	0	0	138	0.16						
156	**Hawk Inlet - Containers**		Process - Other	100	40	12	0	0	0	108	0.09						
157	**Hawk Inlet - 5000 gallon FT-93**		Process - Other	20	10	8	0	0	0	22	0.00						
158	**Hawk Inlet - DB-04 surge tank**		Process - Other	25	25	0	12	0	0	35	0.01						
159	**Hawk Inlet - DB-04 surge tank**		Process - Other	25	25	0	12	0	0	35	0.01						
160	**Hawk Inlet - diesel FT-21**		Process - Other	15.25	6	6	6	0	0	16	0.00						
161	**Hawk Inlet - Filter skid**		Process - Other	11.5	10	6	6	0	0	15	0.00						
162	**Hawk Inlet - Fuel tank**		Process - Other	36	36	30	0	0	0	51	0.03						
163	**Hawk Inlet - Fuel tank**		Process - Other	8	4	4	6	0	0	9	0.00						
164	**Hawk Inlet - Gas FT-22**		Process - Other	12	8	4	6	0	0	14	0.00						
165	**Hawk Inlet - Oil tank FT-20**		Process - Other	8	4	4	0	0	0	0	0.00						
166	**Hawk Inlet - Tank FT-23**		Process - Other	8	4	4	6	0	0	9	0.00						
167	**Hawk Inlet - Tanks next to water treatment building**		Process - Other	12	12	18	6	0	0	17	0.00						
168	**Hawk Inlet - Used oil tank**		Process - Other	25	8	12	0	0	0	0	0.00						
169	**Hawk Inlet - Water tank at core shed**		Process - Other	16	8	6	0	0	0	0	0.00						
170	**Pond D - Wet well**		Process - Other	6	6	12	6	12	2	8	0.00						
171	**Tails - 1.3 wheel wash**		Process - Other	84	46	22	12	12	4	85	0.09						

Notes:
1. Foundation cover only calculated to cover slab. Growth media estimated over entire footprint area
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Conc road from 920_asbuilt_ft.dwg (layer 311400 010 Concrete surface); **Growth media and revegetation under Yards**
Source:
920_asbuilt.dwg
2011920-1350-Site23Disturbanceareas.dwg
2011HAWKINLETDISTURBANCEAREA.dwg

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

All acres and reseeding/reveg/ripping calculations are in the Yards sheet
Cost to haul the broken concrete underground is included in the Haul Material sheet
Concentrator height from 30010210.DWG

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Buildings & Foundation Demolition Cost Summary

	Labor	Equipment	Materials	Totals
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Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

Buildings & Foundation - User Input (cont.) You must fill in ALL green cells and relevant blue cells in this section for each building or facility

		Construction Materials		Slab Demolition		Foundation Cover			Growth Media			Revegetation				
	Description (required)	Building Type (select)	Foundation Wall Type (select)	Slab Demo Method (select)	Slab Breaking Equipment Fleet (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarify/ Rip? (select)	Ripping Fleet (select)
1	860 - Exploration Trailer I	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
2	860 - Exploration Trailer II	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
3	860 - Geology Building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
4	860 - Laboratory Building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
5	860 - Safety Building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
6	860 - Test Cover Building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
7	860 - Training Trailer	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
8	860 - Concrete containment	Sm. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
9	860 - Sewer lift station	Sm. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
10	860 - Shipping Container	Lg. steel		Break & bury	Med Excavator			Containers								
11	920 - Admin/Shop Building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
12	920 - Admin/Shop Building Entrance	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
13	920 - Batch Plant	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
14	920 - Batch Plant Feed Hopper	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
15	920 - Batch Plant MCC	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
16	920 - Electrical Shop	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
17	920 - Light Vehicle Shop	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
18	920 - Mill cleaner building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
19	920 - Mill Concentrate loadout	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
20	920 - Mill Concentrator	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
21	920 - Mill E&I Shop	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
22	920 - Mill Maintenance Shop	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
23	920 - Mill Tails Loadout I	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
24	920 - Mill Tails Loadout II	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
25	920 - Mill Tails Loadout III	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
26	920 - Mill WTP 400 gpm	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
27	920 - Mill WTP 800 gpm	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
28	920 - Mine switch gear building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
29	920 - Ore Pad Shack	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
30	920 - Potable building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
31	920 - Powerhouse Generator Cat I	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
32	920 - Powerhouse Generator Cat II	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
33	920 - Powerhouse I	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
34	920 - Powerhouse II	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
35	920 - Powerhouse Turbine	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
36	920 - Shop bulk oil storage	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
37	920 - Shop covered bays	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
38	920 - Shop Tire Storage I	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
39	920 - Shop Tire Storage II	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
40	920 - Warehouse	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
41	920 - Caisson	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
42	920 - Concrete containment	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
43	920 - Concrete road surface	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
44	920 - DB-01	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
45	920 - DB-01'	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
46	920 - DB-02	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
47	920 - DB-03 - Pond 23	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
48	920 - DB-03' - Pond 23	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
49	920 - DB-09 - Ore Pad	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
50	920 - Fuel Farm Containment	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
51	920 - Main substation	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
52	920 - Mill thickeners concrete pad	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
53	920 - Powerhouse fuel containment pad	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
54	920 - Sediment trap I	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
55	920 - Sediment trap II	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								

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Closure Cost Estimate
Foundations & Buildings

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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

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Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

56	920 - Sewer lift station	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
57	920 - Utility vault I	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
58	920 - Utility vault II	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
59	920 - Utility vault III	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
60	920 - Utility vault IV	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
61	920 - Warehouse microwave tower	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
62	920 - Portal Transformer I	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Dry Transformer								
63	920 - Portal Transformer II	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Dry Transformer								
64	920 - Containers	Sm. steel		Break & bury	Med Excavator			Sea Vans								
65	920 - Containers	Sm. steel		Break & bury	Med Excavator			Sea Vans								
66	920 - Containers	Sm. steel		Break & bury	Med Excavator			Sea Vans								
67	920 - Containers	Sm. steel		Break & bury	Med Excavator			Sea Vans								
68	920 - Containers	Sm. steel		Break & bury	Med Excavator			Sea Vans								
69	920 - Containers	Sm. steel		Break & bury	Med Excavator			Sea Vans								
70	920 - Containers	Sm. steel		Break & bury	Med Excavator			Sea Vans								
71	920 - Containers	Sm. steel		Break & bury	Med Excavator			Sea Vans								
72	920 - Batch plant hopper	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
73	920 - Fuel tank FT-01, 24'D x 18'H	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
74	920 - Fuel tank FT-04, 16'D x 32'H	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
75	920 - Fuel tank FT-05, 16'D x 32'H	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
76	920 - Mill bulk thickener	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
77	920 - Mill cleaner building tube	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
78	920 - Mill conveyor	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
79	920 - Mill lead thickener	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
80	920 - Mill tailings thickener	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
81	920 - Mill tails stk	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
82	920 - Mill zinc thickener	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
83	920 - Ore pad crusher	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
84	920 - Sewer treatment plant	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
85	920 - Mill ferric chloride tank	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Tank								
86	920 - Mill sulfuric acid tank	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Tank								
87	23 Pond - Diesel pump	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
88	23 Pond - Pump house	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
89	23 Pond - Vault	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
90	860 - 860 Shotcrete - Eco-block walls	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
91	860 - 860 Shotcrete - Eco-block walls	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Concrete								
92	860 - 860 Shotcrete - Shotcrete Plant	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Steel								
93	Hawk Inlet - Bathroom	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
94	Hawk Inlet - Bathroom	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
95	Hawk Inlet - Boat house/boom shed	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
96	Hawk Inlet - Boiler building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
97	Hawk Inlet - Building maintenance shed II	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
98	Hawk Inlet - Building maintenance shed I	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
99	Hawk Inlet - Cardboard	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
100	Hawk Inlet - Concentrate storage building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
101	Hawk Inlet - Conveyor, headhouse etc.	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
102	Hawk Inlet - Core shed	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
103	Hawk Inlet - Exploration Trailer	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
104	Hawk Inlet - Generator building	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
105	Hawk Inlet - Housing	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
106	Hawk Inlet - Housing	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
107	Hawk Inlet - Housing	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
108	Hawk Inlet - Housing	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
109	Hawk Inlet - Housing	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
110	Hawk Inlet - Housing	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
111	Hawk Inlet - Housing	Lg. steel	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
112	Hawk Inlet - Housing	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
113	Hawk Inlet - Housing (Grand Boiler Building)	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
114	Hawk Inlet - Housing (Grand I)	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
115	Hawk Inlet - Housing (Grand II)	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
116	Hawk Inlet - Housing (Hilton)	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
117	Hawk Inlet - Laundry	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								
118	Hawk Inlet - Maintenance building	Lg. concrete	Block 4 in (100 mm) thick	Break & bury	Med Excavator			Building								

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

119	**Hawk Inlet - Pump house on pilings**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
120	**Hawk Inlet - Pump house on pilings**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
121	**Hawk Inlet - Trailer**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
122	**Hawk Inlet - Trailer**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
123	**Hawk Inlet - Trailer**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
124	**Hawk Inlet - Trailer**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
125	**Hawk Inlet - Trailer**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
126	**Hawk Inlet - Trailer**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
127	**Hawk Inlet - Warehouse**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
128	**Hawk Inlet - Warehouse Storage I**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
129	**Hawk Inlet - Warehouse Storage II**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
130	**Hawk Inlet - Water treatment building**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
131	**Hawk Inlet - Wheel wash building**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
132	**Hawk Inlet - 22' tank's Pad**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
133	**Hawk Inlet - Concrete pad in front of warehouse**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
134	**Hawk Inlet - Concrete pad west side of warehouse**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
135	**Hawk Inlet - DB-04**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
136	**Hawk Inlet - DB-04'**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
137	**Hawk Inlet - DB-04 Concrete drain**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
138	**Hawk Inlet - Oil containment**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
139	**Hawk Inlet - Pump containment pad**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
140	**Hawk Inlet - Sewer lift station**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
141	**Hawk Inlet - Sump from DB-04**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
142	**Hawk Inlet - Transformer**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
143	**Hawk Inlet - Transformer (Grand)**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
144	**Hawk Inlet - Transformer and containment**	**Lg. concrete**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Concrete**								
145	**Hawk Inlet - Above ground cable tray**	**Sm. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Misc.**								
146	**Hawk Inlet - Poles**	**Sm. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Misc.**								
147	**Hawk Inlet - Pump station**	**Sm. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Misc.**								
148	**Hawk Inlet - Ramp**	**Sm. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Misc.**								
149	**Hawk Inlet - switch gear next to generator building**	**Sm. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Misc.**								
150	**Hawk Inlet - Transformer-dry**	**Sm. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Misc.**								
151	**Hawk Inlet - Containers**	**Sm. steel**		**Break & bury**	**Med Excavator**			**Sea Vans**								
152	**Hawk Inlet - Containers**	**Sm. steel**		**Break & bury**	**Med Excavator**			**Sea Vans**								
153	**Hawk Inlet - Containers**	**Sm. steel**		**Break & bury**	**Med Excavator**			**Sea Vans**								
154	**Hawk Inlet - Containers**	**Sm. steel**		**Break & bury**	**Med Excavator**			**Sea Vans**								
155	**Hawk Inlet - Containers**	**Sm. steel**		**Break & bury**	**Med Excavator**			**Sea Vans**								
156	**Hawk Inlet - Containers**	**Sm. steel**		**Break & bury**	**Med Excavator**			**Sea Vans**								
157	**Hawk Inlet - 5000 gallon FT-93**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
158	**Hawk Inlet - DB-04 surge tank**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
159	**Hawk Inlet - DB-04 surge tank**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
160	**Hawk Inlet - diesel FT-21**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
161	**Hawk Inlet - Filter skid**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
162	**Hawk Inlet - Fuel tank**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
163	**Hawk Inlet - Fuel tank**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
164	**Hawk Inlet - Gas FT-22**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
165	**Hawk Inlet - Oil tank FT-20**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
166	**Hawk Inlet - Tank FT-23**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
167	**Hawk Inlet - Tanks next to water treatment building**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
168	**Hawk Inlet - Used oil tank**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
169	**Hawk Inlet - Water tank at core shed**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Steel**								
170	**Pond D - Wet well**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								
171	**Tails - 1.3 wheel wash**	**Lg. steel**	**Block 4 in (100 mm) thick**	**Break & bury**	**Med Excavator**			**Building**								

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary

	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

Buildings & Foundation - Calculations

Building Volume Calculations

Using Means Heavy Construction Cost Data (2004) calculates cubic feet from building dimensions
Estimage slab thickness and wall thickness if not known
Assumes that all concrete slabs are reinforced
Productivity for crew from Means Heavy Construction Cost Data (2004) adjusted for supervision
(addressed in Misc. Costs) and Davis-Bacon Wage Rates
Demolition costs do not include hauling or disposing if debris - Use Waste Disposal module

Slab Demolition Calculations

Minimum 1 hr excavator time for slab demolition

Cover Volume Calculation

Foundation area x cover thickness
If "Bury in Place" is selected as slab demolition method, cover thickness is adjusted such that
total cover (cover + growth media) equals value entered in "Minimum thickness of cover over unbroken slab" cell above

Ripping/Scarifying Calculations

Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Revegetation

Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Foundations & Buildings

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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
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Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

Building & Foundation Demolition Costs

Uses RS Means Heavy Construction Cost Data for building and wall demolition cost calculations. Uses CAT Handbook for slab breaking production.

								Building Demolition			Wall Demolition			Slab Demolition			Total Costs		
	Description (required)	Building Footprint (slab area) sqft	Building Volume cu ft	Wall Length ft	Wall Area sq ft	Slab Demolition Fleet	Slab Volume cy	Total Labor Cost $	Total Equipment Cost $	Total Building Demolition Cost $	Total Labor Cost $	Total Equipment Cost $	Total Wall Demolition Cost $	Total Labor Cost $	Total Equipment Cost $	Total Slab Breaking Cost $	Total Labor Cost $	Total Equipment Cost $	Total Demolition Costs $
1	**860 - Exploration Trailer I**	248	2,976	78	0	345B	0	$327	$60	$387	$0	$0	$0	$0	$0	$0	$327	$60	$387
2	**860 - Exploration Trailer II**	144	1,728	48	96	345B	3	$190	$35	$225	$349	$0	$349	$123	$328	$451	$662	$363	$1,025
3	**860 - Geology Building**	1,344	16,128	148	296	345B	25	$1,774	$323	$2,097	$1,077	$0	$1,077	$123	$328	$451	$2,974	$651	$3,625
4	**860 - Laboratory Building**	2,464	29,568	200	400	345B	46	$3,252	$591	$3,843	$1,456	$0	$1,456	$123	$328	$451	$4,831	$919	$5,750
5	**860 - Safety Building**	1,788	21,450	175	350	345B	33	$2,360	$429	$2,789	$1,274	$0	$1,274	$123	$328	$451	$3,757	$757	$4,514
6	**860 - Test Cover Building**	820	9,840	121	0	345B	0	$1,082	$197	$1,279	$0	$0	$0	$0	$0	$0	$1,082	$197	$1,279
7	**860 - Training Trailer**	881	10,575	148	0	345B	0	$1,163	$212	$1,375	$0	$0	$0	$0	$0	$0	$1,163	$212	$1,375
8	**860 - Concrete containment**	156	625	50	100	345B	3	$188	$56	$244	$364	$0	$364	$123	$328	$451	$675	$384	$1,059
9	**860 - Sewer lift station**	49	294	28	0	345B	1	$88	$26	$114	$0	$0	$0	$123	$328	$451	$211	$354	$565
10	**860 - Shipping Container**	640	5,120	104	0	345B	0	$563	$102	$665	$0	$0	$0	$0	$0	$0	$563	$102	$665
11	**920 - Admin/Shop Building**	13,450	295,900	469	938	345B	249	$32,549	$5,918	$38,467	$3,414	$0	$3,414	$515	$1,380	$1,895	$36,478	$7,298	$43,776
12	**920 - Admin/Shop Building Entrance**	220	2,640	64	128	345B	4	$290	$53	$343	$466	$0	$466	$123	$328	$451	$879	$381	$1,260
13	**920 - Batch Plant**	864	19,008	140	280	345B	16	$2,091	$380	$2,471	$1,019	$0	$1,019	$123	$328	$451	$3,233	$708	$3,941
14	**920 - Batch Plant Feed Hopper**	800	9,600	120	240	345B	15	$1,056	$192	$1,248	$874	$0	$874	$123	$328	$451	$2,053	$520	$2,573
15	**920 - Batch Plant MCC**	74	882	35	70	345B	3	$97	$18	$115	$255	$0	$255	$123	$328	$451	$475	$346	$821
16	**920 - Electrical Shop**	1,312	28,864	146	292	345B	24	$3,175	$577	$3,752	$1,063	$0	$1,063	$123	$328	$451	$4,361	$905	$5,266
17	**920 - Light Vehicle Shop**	2,173	47,806	188	376	345B	40	$5,259	$956	$6,215	$1,369	$0	$1,369	$123	$328	$451	$6,751	$1,284	$8,035
18	**920 - Mill cleaner building**	6,840	164,160	348	696	345B	127	$18,058	$3,283	$21,341	$2,533	$0	$2,533	$258	$690	$948	$20,849	$3,973	$24,822
19	**920 - Mill Concentrate loadout**	6,396	204,672	320	640	345B	237	$22,514	$4,093	$26,607	$2,330	$0	$2,330	$491	$1,314	$1,805	$25,335	$5,407	$30,742
20	**920 - Mill Concentrator**	20,114	1,407,980	582	1,164	345B	372	$154,878	$28,160	$183,038	$4,237	$0	$4,237	$760	$2,037	$2,797	$159,875	$30,197	$190,072
21	**920 - Mill E&I Shop**	668	8,019	126	252	345B	12	$882	$160	$1,042	$917	$0	$917	$123	$328	$451	$1,922	$488	$2,410
22	**920 - Mill Maintenance Shop**	1,914	42,108	182	364	345B	35	$4,632	$842	$5,474	$1,325	$0	$1,325	$123	$328	$451	$6,080	$1,170	$7,250
23	**920 - Mill Tails Loadout I**	540	11,880	96	0	345B	20	$1,307	$238	$1,545	$0	$0	$0	$123	$328	$451	$1,430	$566	$1,996
24	**920 - Mill Tails Loadout II**	4,945	158,240	316	0	345B	183	$17,406	$3,165	$20,571	$0	$0	$0	$380	$1,018	$1,398	$17,786	$4,183	$21,969
25	**920 - Mill Tails Loadout III**	1,701	54,432	204	0	345B	63	$5,988	$1,089	$7,077	$0	$0	$0	$135	$361	$496	$6,123	$1,450	$7,573
26	**920 - Mill WTP 400 gpm**	1,550	49,600	174	348	345B	29	$5,456	$992	$6,448	$1,267	$0	$1,267	$123	$328	$451	$6,846	$1,320	$8,166
27	**920 - Mill WTP 800 gpm**	1,973	63,120	192	384	345B	73	$6,943	$1,262	$8,205	$1,398	$0	$1,398	$147	$394	$541	$8,488	$1,656	$10,144
28	**920 - Mine switch gear building**	583	6,996	97	194	345B	11	$770	$140	$910	$706	$0	$706	$123	$328	$451	$1,599	$468	$2,067
29	**920 - Ore Pad Shack**	124	1,485	48	96	345B	2	$163	$30	$193	$349	$0	$349	$123	$328	$451	$635	$358	$993
30	**920 - Potable building**	572	6,864	96	192	345B	11	$755	$137	$892	$699	$0	$699	$123	$328	$451	$1,577	$465	$2,042
31	**920 - Powerhouse Generator Cat I**	300	3,600	80	160	345B	6	$396	$72	$468	$582	$0	$582	$123	$328	$451	$1,101	$400	$1,501
32	**920 - Powerhouse Generator Cat II**	300	3,600	80	160	345B	6	$396	$72	$468	$582	$0	$582	$123	$328	$451	$1,101	$400	$1,501
33	**920 - Powerhouse I**	5,024	110,528	285	570	345B	93	$12,158	$2,211	$14,369	$2,075	$0	$2,075	$196	$526	$722	$14,429	$2,737	$17,166
34	**920 - Powerhouse II**	600	7,194	99	0	345B	11	$791	$144	$935	$0	$0	$0	$123	$328	$451	$914	$472	$1,386
35	**920 - Powerhouse Turbine**	258	3,096	81	162	345B	5	$341	$62	$403	$590	$0	$590	$123	$328	$451	$1,054	$390	$1,444
36	**920 - Shop bulk oil storage**	1,213	14,553	148	0	345B	22	$1,601	$291	$1,892	$0	$0	$0	$123	$328	$451	$1,724	$619	$2,343
37	**920 - Shop covered bays**	1,038	22,836	197	0	345B	0	$2,512	$457	$2,969	$0	$0	$0	$0	$0	$0	$2,512	$457	$2,969
38	**920 - Shop Tire Storage I**	1,213	14,553	148	0	345B	45	$1,601	$291	$1,892	$0	$0	$0	$123	$328	$451	$1,724	$619	$2,343
39	**920 - Shop Tire Storage II**	1,430	17,159	216	0	345B	26	$1,887	$343	$2,230	$0	$0	$0	$123	$328	$451	$2,010	$671	$2,681
40	**920 - Warehouse**	7,800	171,600	404	808	345B	144	$18,876	$3,432	$22,308	$2,941	$0	$2,941	$294	$788	$1,082	$22,111	$4,220	$26,331
41	**920 - Caisson**	25	300	20	0	345B	0	$45	$9	$54	$0	$0	$0	$0	$0	$0	$45	$9	$54
42	**920 - Concrete containment**	42	0	26	52	345B	1	$0	$0	$0	$189	$0	$189	$123	$328	$451	$312	$328	$640
43	**920 - Concrete road surface**	87,000	0	5,860	0	345B	3,222	$0	$0	$0	$0	$0	$0	$6,586	$17,640	$24,226	$6,586	$17,640	$24,226
44	**920 - DB-01**	840	0	164	1,968	345B	31	$0	$0	$0	$7,164	$0	$7,164	$123	$328	$451	$7,287	$328	$7,615
45	**920 - DB-01'**	840	0	164	1,968	345B	31	$0	$0	$0	$7,164	$0	$7,164	$123	$328	$451	$7,287	$328	$7,615
46	**920 - DB-02**	1,280	0	168	1,008	345B	47	$0	$0	$0	$3,669	$0	$3,669	$123	$328	$451	$3,792	$328	$4,120
47	**920 - DB-03 - Pond 23**	960	0	184	1,104	345B	36	$0	$0	$0	$4,019	$0	$4,019	$123	$328	$451	$4,142	$328	$4,470
48	**920 - DB-03' - Pond 23**	960	0	184	1,104	345B	36	$0	$0	$0	$4,019	$0	$4,019	$123	$328	$451	$4,142	$328	$4,470
49	**920 - DB-09 - Ore Pad**	1,260	0	176	1,056	345B	47	$0	$0	$0	$3,844	$0	$3,844	$123	$328	$451	$3,967	$328	$4,295
50	**920 - Fuel Farm Containment**	4,000	0	260	1,040	345B	74	$0	$0	$0	$3,786	$0	$3,786	$147	$394	$541	$3,933	$394	$4,327
51	**920 - Main substation**	2,000	24,000	180	360	345B	37	$3,600	$720	$4,320	$1,310	$0	$1,310	$123	$328	$451	$5,033	$1,048	$6,081
52	**920 - Mill thickeners concrete pad**	8,250	0	370	0	345B	306	$0	$0	$0	$0	$0	$0	$626	$1,675	$2,301	$626	$1,675	$2,301
53	**920 - Powerhouse fuel containment pad**	3,920	0	252	504	345B	73	$0	$0	$0	$1,835	$0	$1,835	$147	$394	$541	$1,982	$394	$2,376
54	**920 - Sediment trap I**	55	330	31	0	345B	1	$50	$10	$60	$0	$0	$0	$123	$328	$451	$173	$338	$511
55	**920 - Sediment trap II**	66	396	35	0	345B	1	$59	$12	$71	$0	$0	$0	$123	$328	$451	$182	$340	$522

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

56	**920 - Sewer lift station**	180	1,440	56	448	345B	3	$216	$43	$259	$1,631	$0	$1,631	$123	$328	$451	$1,970	$371	$2,341
57	**920 - Utility vault I**	52	314	30	180	345B	1	$47	$9	$56	$655	$0	$655	$123	$328	$451	$825	$337	$1,162
58	**920 - Utility vault II**	45	270	28	168	345B	1	$41	$8	$49	$612	$0	$612	$123	$328	$451	$776	$336	$1,112
59	**920 - Utility vault III**	21	126	19	114	345B	0	$19	$4	$23	$415	$0	$415	$0	$0	$0	$434	$4	$438
60	**920 - Utility vault IV**	91	546	40	240	345B	2	$82	$16	$98	$874	$0	$874	$123	$328	$451	$1,079	$344	$1,423
61	**920 - Warehouse microwave tower**	150	1,800	50	0	345B	6	$270	$54	$324	$0	$0	$0	$123	$328	$451	$393	$382	$775
62	**920 - Portal Transformer I**	45	180	28	0	345B	1	$20	$4	$24	$0	$0	$0	$123	$328	$451	$143	$332	$475
63	**920 - Portal Transformer II**	104	416	42	0	345B	2	$46	$8	$54	$0	$0	$0	$123	$328	$451	$169	$336	$505
64	**920 - Containers**	160	1,280	56	0	345B	0	$294	$90	$384	$0	$0	$0	$0	$0	$0	$294	$90	$384
65	**920 - Containers**	160	1,280	56	0	345B	3	$294	$90	$384	$0	$0	$0	$123	$328	$451	$417	$418	$835
66	**920 - Containers**	1,040	12,480	144	0	345B	0	$2,870	$874	$3,744	$0	$0	$0	$0	$0	$0	$2,870	$874	$3,744
67	**920 - Containers**	2,560	30,720	224	0	345B	0	$7,066	$2,150	$9,216	$0	$0	$0	$0	$0	$0	$7,066	$2,150	$9,216
68	**920 - Containers**	2,560	30,720	224	0	345B	0	$7,066	$2,150	$9,216	$0	$0	$0	$0	$0	$0	$7,066	$2,150	$9,216
69	**920 - Containers**	160	1,920	56	0	345B	0	$442	$134	$576	$0	$0	$0	$0	$0	$0	$442	$134	$576
70	**920 - Containers**	160	1,920	56	0	345B	0	$442	$134	$576	$0	$0	$0	$0	$0	$0	$442	$134	$576
71	**920 - Containers**	160	1,920	56	0	345B	0	$442	$134	$576	$0	$0	$0	$0	$0	$0	$442	$134	$576
72	**920 - Batch plant hopper**	612	7,344	106	0	345B	23	$808	$147	$955	$0	$0	$0	$123	$328	$451	$931	$475	$1,406
73	**920 - Fuel tank FT-01, 24'D x 18'H**	441	7,938	84	0	345B	0	$873	$159	$1,032	$0	$0	$0	$0	$0	$0	$873	$159	$1,032
74	**920 - Fuel tank FT-04, 16'D x 32'H**	196	6,272	56	0	345B	0	$690	$125	$815	$0	$0	$0	$0	$0	$0	$690	$125	$815
75	**920 - Fuel tank FT-05, 16'D x 32'H**	196	6,272	56	0	345B	0	$690	$125	$815	$0	$0	$0	$0	$0	$0	$690	$125	$815
76	**920 - Mill bulk thickener**	961	11,532	124	0	345B	36	$1,269	$231	$1,500	$0	$0	$0	$123	$328	$451	$1,392	$559	$1,951
77	**920 - Mill cleaner building tube**	320	3,840	96	0	345B	0	$422	$77	$499	$0	$0	$0	$0	$0	$0	$422	$77	$499
78	**920 - Mill conveyor**	1,026	5,130	246	0	345B	0	$564	$103	$667	$0	$0	$0	$0	$0	$0	$564	$103	$667
79	**920 - Mill lead thickener**	420	5,043	82	0	345B	16	$555	$101	$656	$0	$0	$0	$123	$328	$451	$678	$429	$1,107
80	**920 - Mill tailings thickener**	3,721	44,652	244	0	345B	69	$4,912	$893	$5,805	$0	$0	$0	$147	$394	$541	$5,059	$1,287	$6,346
81	**920 - Mill tails stk**	361	4,332	76	0	345B	7	$477	$87	$564	$0	$0	$0	$123	$328	$451	$600	$415	$1,015
82	**920 - Mill zinc thickener**	961	11,532	124	0	345B	18	$1,269	$231	$1,500	$0	$0	$0	$123	$328	$451	$1,392	$559	$1,951
83	**920 - Ore pad crusher**	378	4,536	78	156	345B	7	$499	$91	$590	$568	$0	$568	$123	$328	$451	$1,190	$419	$1,609
84	**920 - Sewer treatment plant**	960	11,520	152	0	345B	0	$1,267	$230	$1,497	$0	$0	$0	$0	$0	$0	$1,267	$230	$1,497
85	**920 - Mill ferric chloride tank**	169	2,028	52	0	345B	3	$223	$41	$264	$0	$0	$0	$123	$328	$451	$346	$369	$715
86	**920 - Mill sulfuric acid tank**	169	2,028	52	0	345B	3	$223	$41	$264	$0	$0	$0	$123	$328	$451	$346	$369	$715
87	**23 Pond - Diesel pump**	174	2,091	55	0	345B	3	$230	$42	$272	$0	$0	$0	$123	$328	$451	$353	$370	$723
88	**23 Pond - Pump house**	650	7,800	102	204	345B	12	$858	$156	$1,014	$743	$0	$743	$123	$328	$451	$1,724	$484	$2,208
89	**23 Pond - Vault**	16	96	16	96	345B	0	$14	$3	$17	$349	$0	$349	$0	$0	$0	$363	$3	$366
90	**860 - 860 Shotcrete - Eco-block walls**	30	360	34	408	345B	0	$54	$11	$65	$1,485	$0	$1,485	$0	$0	$0	$1,539	$11	$1,550
91	**860 - 860 Shotcrete - Eco-block walls**	80	960	84	1,008	345B	0	$144	$29	$173	$3,669	$0	$3,669	$0	$0	$0	$3,813	$29	$3,842
92	**860 - 860 Shotcrete - Shotcrete Plant**	1,600	19,200	160	0	345B	59	$2,112	$384	$2,496	$0	$0	$0	$123	$328	$451	$2,235	$712	$2,947
93	**Hawk Inlet - Bathroom**	160	1,280	56	0	345B	0	$141	$26	$167	$0	$0	$0	$0	$0	$0	$141	$26	$167
94	**Hawk Inlet - Bathroom**	160	1,280	56	0	345B	0	$141	$26	$167	$0	$0	$0	$0	$0	$0	$141	$26	$167
95	**Hawk Inlet - Boat house/boom shed**	984	11,808	130	0	345B	0	$1,299	$236	$1,535	$0	$0	$0	$0	$0	$0	$1,299	$236	$1,535
96	**Hawk Inlet - Boiler building**	816	9,792	116	232	345B	15	$1,077	$196	$1,273	$844	$0	$844	$123	$328	$451	$2,044	$524	$2,568
97	**Hawk Inlet - Building maintenance shed II**	783	9,397	127	254	345B	15	$1,034	$188	$1,222	$925	$0	$925	$123	$328	$451	$2,082	$516	$2,598
98	**Hawk Inlet - Building maintenance shed I**	821	9,849	132	264	345B	15	$1,083	$197	$1,280	$961	$0	$961	$123	$328	$451	$2,167	$525	$2,692
99	**Hawk Inlet - Cardboard**	300	3,600	74	148	345B	6	$396	$72	$468	$539	$0	$539	$123	$328	$451	$1,058	$400	$1,458
100	**Hawk Inlet - Concentrate storage building**	45,382	1,089,156	885	1,770	345B	840	$119,807	$21,783	$141,590	$6,443	$0	$6,443	$1,717	$4,599	$6,316	$127,967	$26,382	$154,349
101	**Hawk Inlet - Conveyor, headhouse etc.**	3,941	47,286	253	0	345B	0	$5,201	$946	$6,147	$0	$0	$0	$0	$0	$0	$5,201	$946	$6,147
102	**Hawk Inlet - Core shed**	5,408	64,895	312	624	345B	100	$7,138	$1,298	$8,436	$2,271	$0	$2,271	$209	$558	$767	$9,618	$1,856	$11,474
103	**Hawk Inlet - Exploration Trailer**	851	10,206	150	0	345B	0	$1,123	$204	$1,327	$0	$0	$0	$0	$0	$0	$1,123	$204	$1,327
104	**Hawk Inlet - Generator building**	945	11,340	129	258	345B	18	$1,247	$227	$1,474	$939	$0	$939	$123	$328	$451	$2,309	$555	$2,864
105	**Hawk Inlet - Housing**	160	1,920	56	0	345B	0	$211	$38	$249	$0	$0	$0	$0	$0	$0	$211	$38	$249
106	**Hawk Inlet - Housing**	160	1,920	56	0	345B	0	$211	$38	$249	$0	$0	$0	$0	$0	$0	$211	$38	$249
107	**Hawk Inlet - Housing**	160	1,920	56	0	345B	0	$211	$38	$249	$0	$0	$0	$0	$0	$0	$211	$38	$249
108	**Hawk Inlet - Housing**	160	1,920	56	0	345B	0	$211	$38	$249	$0	$0	$0	$0	$0	$0	$211	$38	$249
109	**Hawk Inlet - Housing**	160	1,920	56	0	345B	0	$211	$38	$249	$0	$0	$0	$0	$0	$0	$211	$38	$249
110	**Hawk Inlet - Housing**	160	1,920	56	0	345B	0	$211	$38	$249	$0	$0	$0	$0	$0	$0	$211	$38	$249
111	**Hawk Inlet - Housing**	1,800	21,600	205	0	345B	0	$2,376	$432	$2,808	$0	$0	$0	$0	$0	$0	$2,376	$432	$2,808
112	**Hawk Inlet - Housing**	912	10,944	124	0	345B	0	$1,642	$328	$1,970	$0	$0	$0	$0	$0	$0	$1,642	$328	$1,970
113	**Hawk Inlet - Housing (Grand Boiler Building)**	250	3,000	70	140	345B	5	$450	$90	$540	$510	$0	$510	$123	$328	$451	$1,083	$418	$1,501
114	**Hawk Inlet - Housing (Grand I)**	9,300	372,000	398	0	345B	172	$55,800	$11,160	$66,960	$0	$0	$0	$356	$953	$1,309	$56,156	$12,113	$68,269
115	**Hawk Inlet - Housing (Grand II)**	2,275	91,000	232	0	345B	42	$13,650	$2,730	$16,380	$0	$0	$0	$123	$328	$451	$13,773	$3,058	$16,831
116	**Hawk Inlet - Housing (Hilton)**	3,450	110,400	290	580	345B	64	$16,560	$3,312	$19,872	$2,111	$0	$2,111	$135	$361	$496	$18,806	$3,673	$22,479
117	**Hawk Inlet - Laundry**	160	1,920	56	0	345B	0	$288	$58	$346	$0	$0	$0	$0	$0	$0	$288	$58	$346
118	**Hawk Inlet - Maintenance building**	1,713	20,554	169	338	345B	32	$3,083	$617	$3,700	$1,230	$0	$1,230	$123	$328	$451	$4,436	$945	$5,381

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

119	**Hawk Inlet - Pump house on pilings**	20	240	18	0	345B	0	$36	$7	$43	$0	$0	$0	$0	$0	$0	$36	$7	$43
120	**Hawk Inlet - Pump house on pilings**	1,944	23,333	177	354	345B	36	$3,500	$700	$4,200	$1,289	$0	$1,289	$123	$328	$451	$4,912	$1,028	$5,940
121	**Hawk Inlet - Trailer**	854	8,540	150	0	345B	0	$1,281	$256	$1,537	$0	$0	$0	$0	$0	$0	$1,281	$256	$1,537
122	**Hawk Inlet - Trailer**	851	8,505	150	0	345B	0	$936	$170	$1,106	$0	$0	$0	$0	$0	$0	$936	$170	$1,106
123	**Hawk Inlet - Trailer**	504	5,040	108	0	345B	0	$554	$101	$655	$0	$0	$0	$0	$0	$0	$554	$101	$655
124	**Hawk Inlet - Trailer**	400	4,000	100	0	345B	0	$440	$80	$520	$0	$0	$0	$0	$0	$0	$440	$80	$520
125	**Hawk Inlet - Trailer**	400	4,000	100	0	345B	0	$440	$80	$520	$0	$0	$0	$0	$0	$0	$440	$80	$520
126	**Hawk Inlet - Trailer**	310	3,096	83	0	345B	0	$341	$62	$403	$0	$0	$0	$0	$0	$0	$341	$62	$403
127	**Hawk Inlet - Warehouse**	5,640	124,080	308	616	345B	104	$13,649	$2,482	$16,131	$2,242	$0	$2,242	$209	$558	$767	$16,100	$3,040	$19,140
128	**Hawk Inlet - Warehouse Storage I**	940	11,280	208	416	345B	17	$1,241	$226	$1,467	$1,514	$0	$1,514	$123	$328	$451	$2,878	$554	$3,432
129	**Hawk Inlet - Warehouse Storage II**	1,880	22,560	228	0	345B	35	$2,482	$451	$2,933	$0	$0	$0	$123	$328	$451	$2,605	$779	$3,384
130	**Hawk Inlet - Water treatment building**	983	21,632	126	252	345B	18	$2,380	$433	$2,813	$917	$0	$917	$123	$328	$451	$3,420	$761	$4,181
131	**Hawk Inlet - Wheel wash building**	1,870	41,140	178	356	345B	35	$4,525	$823	$5,348	$1,296	$0	$1,296	$123	$328	$451	$5,944	$1,151	$7,095
132	**Hawk Inlet - 22' tank's Pad**	1,809	0	188	0	345B	67	$0	$0	$0	$0	$0	$0	$135	$361	$496	$135	$361	$496
133	**Hawk Inlet - Concrete pad in front of warehouse**	1,540	0	194	0	345B	29	$0	$0	$0	$0	$0	$0	$123	$328	$451	$123	$328	$451
134	**Hawk Inlet - Concrete pad west side of warehouse**	440	0	84	0	345B	8	$0	$0	$0	$0	$0	$0	$123	$328	$451	$123	$328	$451
135	**Hawk Inlet - DB-04**	960	0	184	1,104	345B	36	$0	$0	$0	$4,019	$0	$4,019	$123	$328	$451	$4,142	$328	$4,470
136	**Hawk Inlet - DB-04'**	960	0	184	1,104	345B	36	$0	$0	$0	$4,019	$0	$4,019	$123	$328	$451	$4,142	$328	$4,470
137	**Hawk Inlet - DB-04 Concrete drain**	74	0	55	0	345B	1	$0	$0	$0	$0	$0	$0	$123	$328	$451	$123	$328	$451
138	**Hawk Inlet - Oil containment**	74	148	78	156	345B	1	$22	$4	$26	$568	$0	$568	$123	$328	$451	$713	$332	$1,045
139	**Hawk Inlet - Pump containment pad**	80	0	36	36	345B	1	$0	$0	$0	$131	$0	$131	$123	$328	$451	$254	$328	$582
140	**Hawk Inlet - Sewer lift station**	25	0	20	120	345B	0	$0	$0	$0	$437	$0	$437	$0	$0	$0	$437	$0	$437
141	**Hawk Inlet - Sump from DB-04**	125	1,500	45	90	345B	2	$225	$45	$270	$328	$0	$328	$123	$328	$451	$676	$373	$1,049
142	**Hawk Inlet - Transformer**	144	576	48	96	345B	3	$86	$17	$103	$349	$0	$349	$123	$328	$451	$558	$345	$903
143	**Hawk Inlet - Transformer (Grand)**	144	576	48	96	345B	3	$86	$17	$103	$349	$0	$349	$123	$328	$451	$558	$345	$903
144	**Hawk Inlet - Transformer and containment**	113	0	43	86	345B	2	$0	$0	$0	$313	$0	$313	$123	$328	$451	$436	$328	$764
145	**Hawk Inlet - Above ground cable tray**	103	0	107	0	345B	0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
146	**Hawk Inlet - Poles**	4	240	8	0	345B	0	$55	$17	$72	$0	$0	$0	$0	$0	$0	$55	$17	$72
147	**Hawk Inlet - Pump station**	65	780	33	0	345B	1	$179	$55	$234	$0	$0	$0	$123	$328	$451	$302	$383	$685
148	**Hawk Inlet - Ramp**	2,400	0	280	560	345B	44	$0	$0	$0	$2,038	$0	$2,038	$123	$328	$451	$2,161	$328	$2,489
149	**Hawk Inlet - switch gear next to generator building**	288	2,304	72	0	345B	5	$530	$161	$691	$0	$0	$0	$123	$328	$451	$653	$489	$1,142
150	**Hawk Inlet - Transformer-dry**	24	144	20	0	345B	0	$33	$10	$43	$0	$0	$0	$0	$0	$0	$33	$10	$43
151	**Hawk Inlet - Containers**	12,960	155,520	504	0	345B	0	$35,770	$10,886	$46,656	$0	$0	$0	$0	$0	$0	$35,770	$10,886	$46,656
152	**Hawk Inlet - Containers**	10,240	122,880	448	0	345B	0	$28,262	$8,602	$36,864	$0	$0	$0	$0	$0	$0	$28,262	$8,602	$36,864
153	**Hawk Inlet - Containers**	160	1,920	56	0	345B	0	$442	$134	$576	$0	$0	$0	$0	$0	$0	$442	$134	$576
154	**Hawk Inlet - Containers**	16,000	192,000	560	0	345B	0	$44,160	$13,440	$57,600	$0	$0	$0	$0	$0	$0	$44,160	$13,440	$57,600
155	**Hawk Inlet - Containers**	7,056	84,672	364	0	345B	0	$19,475	$5,927	$25,402	$0	$0	$0	$0	$0	$0	$19,475	$5,927	$25,402
156	**Hawk Inlet - Containers**	4,000	48,000	280	0	345B	0	$11,040	$3,360	$14,400	$0	$0	$0	$0	$0	$0	$11,040	$3,360	$14,400
157	**Hawk Inlet - 5000 gallon FT-93**	200	1,600	60	0	345B	0	$176	$32	$208	$0	$0	$0	$0	$0	$0	$176	$32	$208
158	**Hawk Inlet - DB-04 surge tank**	625	0	100	0	345B	23	$0	$0	$0	$0	$0	$0	$123	$328	$451	$123	$328	$451
159	**Hawk Inlet - DB-04 surge tank**	625	0	100	0	345B	23	$0	$0	$0	$0	$0	$0	$123	$328	$451	$123	$328	$451
160	**Hawk Inlet - diesel FT-21**	88	526	42	0	345B	2	$58	$11	$69	$0	$0	$0	$123	$328	$451	$181	$339	$520
161	**Hawk Inlet - Filter skid**	115	690	43	0	345B	2	$76	$14	$90	$0	$0	$0	$123	$328	$451	$199	$342	$541
162	**Hawk Inlet - Fuel tank**	1,296	38,880	144	0	345B	0	$4,277	$778	$5,055	$0	$0	$0	$0	$0	$0	$4,277	$778	$5,055
163	**Hawk Inlet - Fuel tank**	32	128	24	0	345B	1	$14	$3	$17	$0	$0	$0	$123	$328	$451	$137	$331	$468
164	**Hawk Inlet - Gas FT-22**	90	360	39	0	345B	2	$40	$7	$47	$0	$0	$0	$123	$328	$451	$163	$335	$498
165	**Hawk Inlet - Oil tank FT-20**	32	128	24	0	345B	0	$14	$3	$17	$0	$0	$0	$0	$0	$0	$14	$3	$17
166	**Hawk Inlet - Tank FT-23**	32	128	24	0	345B	1	$14	$3	$17	$0	$0	$0	$123	$328	$451	$137	$331	$468
167	**Hawk Inlet - Tanks next to water treatment building**	144	2,592	48	0	345B	3	$285	$52	$337	$0	$0	$0	$123	$328	$451	$408	$380	$788
168	**Hawk Inlet - Used oil tank**	200	2,400	66	0	345B	0	$264	$48	$312	$0	$0	$0	$0	$0	$0	$264	$48	$312
169	**Hawk Inlet - Water tank at core shed**	132	792	49	0	345B	0	$87	$16	$103	$0	$0	$0	$0	$0	$0	$87	$16	$103
170	**Pond D - Wet well**	36	432	24	48	345B	1	$48	$9	$57	$175	$0	$175	$123	$328	$451	$346	$337	$683
171	**Tails - 1.3 wheel wash**	3,864	85,008	260	1,040	345B	143	$9,351	$1,700	$11,051	$3,786	$0	$3,786	$294	$788	$1,082	$13,431	$2,488	$15,919
			6,263,340				8,222	**$799,055**	**$166,627**	**$965,682**	**$124,054**	**$0**	**$124,054**	**$25,077**	**$67,031**	**$92,108**	**$948,186**	**$233,658**	**$1,181,844**

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

Building & Foundation - Foundation Cover and Growth Media Costs

		Foundation Cover								Growth Media								Total Cover & Growth Media Costs		
	Description (required)	Cover Volume cy	Cover Repacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Repacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $	Total Labor Cost $	Total Equipment Cost $	Total Costs $
1	860 - Exploration Trailer I						$0	$0	$0						$0	$0	$0	$0	$0	$0
2	860 - Exploration Trailer II						$0	$0	$0						$0	$0	$0	$0	$0	$0
3	860 - Geology Building						$0	$0	$0						$0	$0	$0	$0	$0	$0
4	860 - Laboratory Building						$0	$0	$0						$0	$0	$0	$0	$0	$0
5	860 - Safety Building						$0	$0	$0						$0	$0	$0	$0	$0	$0
6	860 - Test Cover Building						$0	$0	$0						$0	$0	$0	$0	$0	$0
7	860 - Training Trailer						$0	$0	$0						$0	$0	$0	$0	$0	$0
8	860 - Concrete containment						$0	$0	$0						$0	$0	$0	$0	$0	$0
9	860 - Sewer lift station						$0	$0	$0						$0	$0	$0	$0	$0	$0
10	860 - Shipping Container						$0	$0	$0						$0	$0	$0	$0	$0	$0
11	920 - Admin/Shop Building						$0	$0	$0						$0	$0	$0	$0	$0	$0
12	920 - Admin/Shop Building Entrance						$0	$0	$0						$0	$0	$0	$0	$0	$0
13	920 - Batch Plant						$0	$0	$0						$0	$0	$0	$0	$0	$0
14	920 - Batch Plant Feed Hopper						$0	$0	$0						$0	$0	$0	$0	$0	$0
15	920 - Batch Plant MCC						$0	$0	$0						$0	$0	$0	$0	$0	$0
16	920 - Electrical Shop						$0	$0	$0						$0	$0	$0	$0	$0	$0
17	920 - Light Vehicle Shop						$0	$0	$0						$0	$0	$0	$0	$0	$0
18	920 - Mill cleaner building						$0	$0	$0						$0	$0	$0	$0	$0	$0
19	920 - Mill Concentrate loadout						$0	$0	$0						$0	$0	$0	$0	$0	$0
20	920 - Mill Concentrator						$0	$0	$0						$0	$0	$0	$0	$0	$0
21	920 - Mill E&I Shop						$0	$0	$0						$0	$0	$0	$0	$0	$0
22	920 - Mill Maintenance Shop						$0	$0	$0						$0	$0	$0	$0	$0	$0
23	920 - Mill Tails Loadout I						$0	$0	$0						$0	$0	$0	$0	$0	$0
24	920 - Mill Tails Loadout II						$0	$0	$0						$0	$0	$0	$0	$0	$0
25	920 - Mill Tails Loadout III						$0	$0	$0						$0	$0	$0	$0	$0	$0
26	920 - Mill WTP 400 gpm						$0	$0	$0						$0	$0	$0	$0	$0	$0
27	920 - Mill WTP 800 gpm						$0	$0	$0						$0	$0	$0	$0	$0	$0
28	920 - Mine switch gear building						$0	$0	$0						$0	$0	$0	$0	$0	$0
29	920 - Ore Pad Shack						$0	$0	$0						$0	$0	$0	$0	$0	$0
30	920 - Potable building						$0	$0	$0						$0	$0	$0	$0	$0	$0
31	920 - Powerhouse Generator Cat I						$0	$0	$0						$0	$0	$0	$0	$0	$0
32	920 - Powerhouse Generator Cat II						$0	$0	$0						$0	$0	$0	$0	$0	$0
33	920 - Powerhouse I						$0	$0	$0						$0	$0	$0	$0	$0	$0
34	920 - Powerhouse II						$0	$0	$0						$0	$0	$0	$0	$0	$0
35	920 - Powerhouse Turbine						$0	$0	$0						$0	$0	$0	$0	$0	$0
36	920 - Shop bulk oil storage						$0	$0	$0						$0	$0	$0	$0	$0	$0
37	920 - Shop covered bays						$0	$0	$0						$0	$0	$0	$0	$0	$0
38	920 - Shop Tire Storage I						$0	$0	$0						$0	$0	$0	$0	$0	$0
39	920 - Shop Tire Storage II						$0	$0	$0						$0	$0	$0	$0	$0	$0
40	920 - Warehouse						$0	$0	$0						$0	$0	$0	$0	$0	$0
41	920 - Caisson						$0	$0	$0						$0	$0	$0	$0	$0	$0
42	920 - Concrete containment						$0	$0	$0						$0	$0	$0	$0	$0	$0
43	920 - Concrete road surface						$0	$0	$0						$0	$0	$0	$0	$0	$0
44	920 - DB-01						$0	$0	$0						$0	$0	$0	$0	$0	$0
45	920 - DB-01'						$0	$0	$0						$0	$0	$0	$0	$0	$0
46	920 - DB-02						$0	$0	$0						$0	$0	$0	$0	$0	$0
47	920 - DB-03 - Pond 23						$0	$0	$0						$0	$0	$0	$0	$0	$0
48	920 - DB-03' - Pond 23						$0	$0	$0						$0	$0	$0	$0	$0	$0
49	920 - DB-09 - Ore Pad						$0	$0	$0						$0	$0	$0	$0	$0	$0
50	920 - Fuel Farm Containment						$0	$0	$0						$0	$0	$0	$0	$0	$0
51	920 - Main substation						$0	$0	$0						$0	$0	$0	$0	$0	$0
52	920 - Mill thickeners concrete pad						$0	$0	$0						$0	$0	$0	$0	$0	$0
53	920 - Powerhouse fuel containment pad						$0	$0	$0						$0	$0	$0	$0	$0	$0
54	920 - Sediment trap I						$0	$0	$0						$0	$0	$0	$0	$0	$0
55	920 - Sediment trap II						$0	$0	$0						$0	$0	$0	$0	$0	$0

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Closure Cost Estimate
Foundations & Buildings

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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

56	**920 - Sewer lift station**						$0	$0	$0					$0	$0	$0	$0	$0	$0
57	**920 - Utility vault I**						$0	$0	$0					$0	$0	$0	$0	$0	$0
58	**920 - Utility vault II**						$0	$0	$0					$0	$0	$0	$0	$0	$0
59	**920 - Utility vault III**						$0	$0	$0					$0	$0	$0	$0	$0	$0
60	**920 - Utility vault IV**						$0	$0	$0					$0	$0	$0	$0	$0	$0
61	**920 - Warehouse microwave tower**						$0	$0	$0					$0	$0	$0	$0	$0	$0
62	**920 - Portal Transformer I**						$0	$0	$0					$0	$0	$0	$0	$0	$0
63	**920 - Portal Transformer II**						$0	$0	$0					$0	$0	$0	$0	$0	$0
64	**920 - Containers**						$0	$0	$0					$0	$0	$0	$0	$0	$0
65	**920 - Containers**						$0	$0	$0					$0	$0	$0	$0	$0	$0
66	**920 - Containers**						$0	$0	$0					$0	$0	$0	$0	$0	$0
67	**920 - Containers**						$0	$0	$0					$0	$0	$0	$0	$0	$0
68	**920 - Containers**						$0	$0	$0					$0	$0	$0	$0	$0	$0
69	**920 - Containers**						$0	$0	$0					$0	$0	$0	$0	$0	$0
70	**920 - Containers**						$0	$0	$0					$0	$0	$0	$0	$0	$0
71	**920 - Containers**						$0	$0	$0					$0	$0	$0	$0	$0	$0
72	**920 - Batch plant hopper**						$0	$0	$0					$0	$0	$0	$0	$0	$0
73	**920 - Fuel tank FT-01, 24'D x 18'H**						$0	$0	$0					$0	$0	$0	$0	$0	$0
74	**920 - Fuel tank FT-04, 16'D x 32'H**						$0	$0	$0					$0	$0	$0	$0	$0	$0
75	**920 - Fuel tank FT-05, 16'D x 32'H**						$0	$0	$0					$0	$0	$0	$0	$0	$0
76	**920 - Mill bulk thickener**						$0	$0	$0					$0	$0	$0	$0	$0	$0
77	**920 - Mill cleaner building tube**						$0	$0	$0					$0	$0	$0	$0	$0	$0
78	**920 - Mill conveyor**						$0	$0	$0					$0	$0	$0	$0	$0	$0
79	**920 - Mill lead thickener**						$0	$0	$0					$0	$0	$0	$0	$0	$0
80	**920 - Mill tailings thickener**						$0	$0	$0					$0	$0	$0	$0	$0	$0
81	**920 - Mill tails stk**						$0	$0	$0					$0	$0	$0	$0	$0	$0
82	**920 - Mill zinc thickener**						$0	$0	$0					$0	$0	$0	$0	$0	$0
83	**920 - Ore pad crusher**						$0	$0	$0					$0	$0	$0	$0	$0	$0
84	**920 - Sewer treatment plant**						$0	$0	$0					$0	$0	$0	$0	$0	$0
85	**920 - Mill ferric chloride tank**						$0	$0	$0					$0	$0	$0	$0	$0	$0
86	**920 - Mill sulfuric acid tank**						$0	$0	$0					$0	$0	$0	$0	$0	$0
87	**23 Pond - Diesel pump**						$0	$0	$0					$0	$0	$0	$0	$0	$0
88	**23 Pond - Pump house**						$0	$0	$0					$0	$0	$0	$0	$0	$0
89	**23 Pond - Vault**						$0	$0	$0					$0	$0	$0	$0	$0	$0
90	**860 - 860 Shotcrete - Eco-block walls**						$0	$0	$0					$0	$0	$0	$0	$0	$0
91	**860 - 860 Shotcrete - Eco-block walls**						$0	$0	$0					$0	$0	$0	$0	$0	$0
92	**860 - 860 Shotcrete - Shotcrete Plant**						$0	$0	$0					$0	$0	$0	$0	$0	$0
93	**Hawk Inlet - Bathroom**						$0	$0	$0					$0	$0	$0	$0	$0	$0
94	**Hawk Inlet - Bathroom**						$0	$0	$0					$0	$0	$0	$0	$0	$0
95	**Hawk Inlet - Boat house/boom shed**						$0	$0	$0					$0	$0	$0	$0	$0	$0
96	**Hawk Inlet - Boiler building**						$0	$0	$0					$0	$0	$0	$0	$0	$0
97	**Hawk Inlet - Building maintenance shed II**						$0	$0	$0					$0	$0	$0	$0	$0	$0
98	**Hawk Inlet - Building maintenance shed I**						$0	$0	$0					$0	$0	$0	$0	$0	$0
99	**Hawk Inlet - Cardboard**						$0	$0	$0					$0	$0	$0	$0	$0	$0
100	**Hawk Inlet - Concentrate storage building**						$0	$0	$0					$0	$0	$0	$0	$0	$0
101	**Hawk Inlet - Conveyor, headhouse etc.**						$0	$0	$0					$0	$0	$0	$0	$0	$0
102	**Hawk Inlet - Core shed**						$0	$0	$0					$0	$0	$0	$0	$0	$0
103	**Hawk Inlet - Exploration Trailer**						$0	$0	$0					$0	$0	$0	$0	$0	$0
104	**Hawk Inlet - Generator building**						$0	$0	$0					$0	$0	$0	$0	$0	$0
105	**Hawk Inlet - Housing**						$0	$0	$0					$0	$0	$0	$0	$0	$0
106	**Hawk Inlet - Housing**						$0	$0	$0					$0	$0	$0	$0	$0	$0
107	**Hawk Inlet - Housing**						$0	$0	$0					$0	$0	$0	$0	$0	$0
108	**Hawk Inlet - Housing**						$0	$0	$0					$0	$0	$0	$0	$0	$0
109	**Hawk Inlet - Housing**						$0	$0	$0					$0	$0	$0	$0	$0	$0
110	**Hawk Inlet - Housing**						$0	$0	$0					$0	$0	$0	$0	$0	$0
111	**Hawk Inlet - Housing**						$0	$0	$0					$0	$0	$0	$0	$0	$0
112	**Hawk Inlet - Housing**						$0	$0	$0					$0	$0	$0	$0	$0	$0
113	**Hawk Inlet - Housing (Grand Boiler Building)**						$0	$0	$0					$0	$0	$0	$0	$0	$0
114	**Hawk Inlet - Housing (Grand I)**						$0	$0	$0					$0	$0	$0	$0	$0	$0
115	**Hawk Inlet - Housing (Grand II)**						$0	$0	$0					$0	$0	$0	$0	$0	$0
116	**Hawk Inlet - Housing (Hilton)**						$0	$0	$0					$0	$0	$0	$0	$0	$0
117	**Hawk Inlet - Laundry**						$0	$0	$0					$0	$0	$0	$0	$0	$0
118	**Hawk Inlet - Maintenance building**						$0	$0	$0					$0	$0	$0	$0	$0	$0

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Foundations & Buildings

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Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

119	**Hawk Inlet - Pump house on pilings**						$0	$0	$0						$0	$0	$0	$0	$0	$0
120	**Hawk Inlet - Pump house on pilings**						$0	$0	$0						$0	$0	$0	$0	$0	$0
121	**Hawk Inlet - Trailer**						$0	$0	$0						$0	$0	$0	$0	$0	$0
122	**Hawk Inlet - Trailer**						$0	$0	$0						$0	$0	$0	$0	$0	$0
123	**Hawk Inlet - Trailer**						$0	$0	$0						$0	$0	$0	$0	$0	$0
124	**Hawk Inlet - Trailer**						$0	$0	$0						$0	$0	$0	$0	$0	$0
125	**Hawk Inlet - Trailer**						$0	$0	$0						$0	$0	$0	$0	$0	$0
126	**Hawk Inlet - Trailer**						$0	$0	$0						$0	$0	$0	$0	$0	$0
127	**Hawk Inlet - Warehouse**						$0	$0	$0						$0	$0	$0	$0	$0	$0
128	**Hawk Inlet - Warehouse Storage I**						$0	$0	$0						$0	$0	$0	$0	$0	$0
129	**Hawk Inlet - Warehouse Storage II**						$0	$0	$0						$0	$0	$0	$0	$0	$0
130	**Hawk Inlet - Water treatment building**						$0	$0	$0						$0	$0	$0	$0	$0	$0
131	**Hawk Inlet - Wheel wash building**						$0	$0	$0						$0	$0	$0	$0	$0	$0
132	**Hawk Inlet - 22' tank's Pad**						$0	$0	$0						$0	$0	$0	$0	$0	$0
133	**Hawk Inlet - Concrete pad in front of warehouse**						$0	$0	$0						$0	$0	$0	$0	$0	$0
134	**Hawk Inlet - Concrete pad west side of warehouse**						$0	$0	$0						$0	$0	$0	$0	$0	$0
135	**Hawk Inlet - DB-04**						$0	$0	$0						$0	$0	$0	$0	$0	$0
136	**Hawk Inlet - DB-04'**						$0	$0	$0						$0	$0	$0	$0	$0	$0
137	**Hawk Inlet - DB-04 Concrete drain**						$0	$0	$0						$0	$0	$0	$0	$0	$0
138	**Hawk Inlet - Oil containment**						$0	$0	$0						$0	$0	$0	$0	$0	$0
139	**Hawk Inlet - Pump containment pad**						$0	$0	$0						$0	$0	$0	$0	$0	$0
140	**Hawk Inlet - Sewer lift station**						$0	$0	$0						$0	$0	$0	$0	$0	$0
141	**Hawk Inlet - Sump from DB-04**						$0	$0	$0						$0	$0	$0	$0	$0	$0
142	**Hawk Inlet - Transformer**						$0	$0	$0						$0	$0	$0	$0	$0	$0
143	**Hawk Inlet - Transformer (Grand)**						$0	$0	$0						$0	$0	$0	$0	$0	$0
144	**Hawk Inlet - Transformer and containment**						$0	$0	$0						$0	$0	$0	$0	$0	$0
145	**Hawk Inlet - Above ground cable tray**						$0	$0	$0						$0	$0	$0	$0	$0	$0
146	**Hawk Inlet - Poles**						$0	$0	$0						$0	$0	$0	$0	$0	$0
147	**Hawk Inlet - Pump station**						$0	$0	$0						$0	$0	$0	$0	$0	$0
148	**Hawk Inlet - Ramp**						$0	$0	$0						$0	$0	$0	$0	$0	$0
149	**Hawk Inlet - switch gear next to generator building**						$0	$0	$0						$0	$0	$0	$0	$0	$0
150	**Hawk Inlet - Transformer-dry**						$0	$0	$0						$0	$0	$0	$0	$0	$0
151	**Hawk Inlet - Containers**						$0	$0	$0						$0	$0	$0	$0	$0	$0
152	**Hawk Inlet - Containers**						$0	$0	$0						$0	$0	$0	$0	$0	$0
153	**Hawk Inlet - Containers**						$0	$0	$0						$0	$0	$0	$0	$0	$0
154	**Hawk Inlet - Containers**						$0	$0	$0						$0	$0	$0	$0	$0	$0
155	**Hawk Inlet - Containers**						$0	$0	$0						$0	$0	$0	$0	$0	$0
156	**Hawk Inlet - Containers**						$0	$0	$0						$0	$0	$0	$0	$0	$0
157	**Hawk Inlet - 5000 gallon FT-93**						$0	$0	$0						$0	$0	$0	$0	$0	$0
158	**Hawk Inlet - DB-04 surge tank**						$0	$0	$0						$0	$0	$0	$0	$0	$0
159	**Hawk Inlet - DB-04 surge tank**						$0	$0	$0						$0	$0	$0	$0	$0	$0
160	**Hawk Inlet - diesel FT-21**						$0	$0	$0						$0	$0	$0	$0	$0	$0
161	**Hawk Inlet - Filter skid**						$0	$0	$0						$0	$0	$0	$0	$0	$0
162	**Hawk Inlet - Fuel tank**						$0	$0	$0						$0	$0	$0	$0	$0	$0
163	**Hawk Inlet - Fuel tank**						$0	$0	$0						$0	$0	$0	$0	$0	$0
164	**Hawk Inlet - Gas FT-22**						$0	$0	$0						$0	$0	$0	$0	$0	$0
165	**Hawk Inlet - Oil tank FT-20**						$0	$0	$0						$0	$0	$0	$0	$0	$0
166	**Hawk Inlet - Tank FT-23**						$0	$0	$0						$0	$0	$0	$0	$0	$0
167	**Hawk Inlet - Tanks next to water treatment building**						$0	$0	$0						$0	$0	$0	$0	$0	$0
168	**Hawk Inlet - Used oil tank**						$0	$0	$0						$0	$0	$0	$0	$0	$0
169	**Hawk Inlet - Water tank at core shed**						$0	$0	$0						$0	$0	$0	$0	$0	$0
170	**Pond D - Wet well**						$0	$0	$0						$0	$0	$0	$0	$0	$0
171	**Tails - 1.3 wheel wash**						$0	$0	$0						$0	$0	$0	$0	$0	$0
							$0	**$0**	**$0**						**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary

	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

Building & Foundation - Scarifying/Revegetation Costs

					Scarifying/Ripping			Revegetation				Total Scarify & Revegation Costs			
	Description (required)	Flat Area acres	Area Long Dimension ft	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Costs $
1	**860 - Exploration Trailer I**	0.10	32		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2	**860 - Exploration Trailer II**	0.10	17		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3	**860 - Geology Building**	0.10	53		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4	**860 - Laboratory Building**	0.10	71		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
5	**860 - Safety Building**	0.10	64		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
6	**860 - Test Cover Building**	0.10	45		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
7	**860 - Training Trailer**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
8	**860 - Concrete containment**	0.10	18		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
9	**860 - Sewer lift station**	0.10	10		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
10	**860 - Shipping Container**	0.10	86		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
11	**920 - Admin/Shop Building**	0.30	168		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
12	**920 - Admin/Shop Building Entrance**	0.10	24		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
13	**920 - Batch Plant**	0.10	56		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
14	**920 - Batch Plant Feed Hopper**	0.10	45		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
15	**920 - Batch Plant MCC**	0.10	13		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
16	**920 - Electrical Shop**	0.10	52		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
17	**920 - Light Vehicle Shop**	0.10	67		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
18	**920 - Mill cleaner building**	0.20	129		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
19	**920 - Mill Concentrate loadout**	0.10	113		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
20	**920 - Mill Concentrator**	0.50	211		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
21	**920 - Mill E&I Shop**	0.10	51		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
22	**920 - Mill Maintenance Shop**	0.10	67		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
23	**920 - Mill Tails Loadout I**	0.10	35		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
24	**920 - Mill Tails Loadout II**	0.10	123		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
25	**920 - Mill Tails Loadout III**	0.10	84		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
26	**920 - Mill WTP 400 gpm**	0.10	62		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
27	**920 - Mill WTP 800 gpm**	0.10	72		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
28	**920 - Mine switch gear building**	0.10	34		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
29	**920 - Ore Pad Shack**	0.10	18		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
30	**920 - Potable building**	0.10	34		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
31	**920 - Powerhouse Generator Cat I**	0.10	32		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
32	**920 - Powerhouse Generator Cat II**	0.10	32		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
33	**920 - Powerhouse I**	0.10	101		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
34	**920 - Powerhouse II**	0.10	35		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
35	**920 - Powerhouse Turbine**	0.10	33		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
36	**920 - Shop bulk oil storage**	0.10	55		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
37	**920 - Shop covered bays**	0.10	87		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
38	**920 - Shop Tire Storage I**	0.10	55		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
39	**920 - Shop Tire Storage II**	0.10	94		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
40	**920 - Warehouse**	0.20	150		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
41	**920 - Caisson**	0.10	7		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
42	**920 - Concrete containment**	0.10	9		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
43	**920 - Concrete road surface**	2.00	410		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
44	**920 - DB-01**	0.10	71		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
45	**920 - DB-01'**	0.10	71		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
46	**920 - DB-02**	0.10	67		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
47	**920 - DB-03 - Pond 23**	0.10	81		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
48	**920 - DB-03' - Pond 23**	0.10	81		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
49	**920 - DB-09 - Ore Pad**	0.10	71		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
50	**920 - Fuel Farm Containment**	0.10	80		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
51	**920 - Main substation**	0.10	64		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
52	**920 - Mill thickeners concrete pad**	0.20	62		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
53	**920 - Powerhouse fuel containment pad**	0.10	90		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
54	**920 - Sediment trap I**	0.10	11		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
55	**920 - Sediment trap II**	0.10	13		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

56	**920 - Sewer lift station**	0.10	21		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
57	**920 - Utility vault I**	0.10	11		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
58	**920 - Utility vault II**	0.10	10		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
59	**920 - Utility vault III**	0.10	7		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
60	**920 - Utility vault IV**	0.10	15		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
61	**920 - Warehouse microwave tower**	0.10	18		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
62	**920 - Portal Transformer I**	0.10	10		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
63	**920 - Portal Transformer II**	0.10	15		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
64	**920 - Containers**	0.10	23		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
65	**920 - Containers**	0.10	22		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
66	**920 - Containers**	0.10	56		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
67	**920 - Containers**	0.10	86		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
68	**920 - Containers**	0.10	86		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
69	**920 - Containers**	0.10	20		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
70	**920 - Containers**	0.10	20		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
71	**920 - Containers**	0.10	20		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
72	**920 - Batch plant hopper**	0.10	40		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
73	**920 - Fuel tank FT-01, 24'D x 18'H**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
74	**920 - Fuel tank FT-04, 16'D x 32'H**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
75	**920 - Fuel tank FT-05, 16'D x 32'H**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
76	**920 - Mill bulk thickener**	0.10	44		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
77	**920 - Mill cleaner building tube**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
78	**920 - Mill conveyor**	0.10	114		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
79	**920 - Mill lead thickener**	0.10	29		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
80	**920 - Mill tailings thickener**	0.10	86		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
81	**920 - Mill tails stk**	0.10	27		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
82	**920 - Mill zinc thickener**	0.10	44		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
83	**920 - Ore pad crusher**	0.10	28		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
84	**920 - Sewer treatment plant**	0.10	62		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
85	**920 - Mill ferric chloride tank**	0.10	18		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
86	**920 - Mill sulfuric acid tank**	0.10	18		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
87	**23 Pond - Diesel pump**	0.10	20		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
88	**23 Pond - Pump house**	0.10	36		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
89	**23 Pond - Vault**	0.10	6		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
90	**860 - 860 Shotcrete - Eco-block walls**	0.10	15		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
91	**860 - 860 Shotcrete - Eco-block walls**	0.10	40		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
92	**860 - 860 Shotcrete - Shotcrete Plant**	0.10	47		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
93	**Hawk Inlet - Bathroom**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
94	**Hawk Inlet - Bathroom**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
95	**Hawk Inlet - Boat house/boom shed**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
96	**Hawk Inlet - Boiler building**	0.10	42		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
97	**Hawk Inlet - Building maintenance shed II**	0.10	50		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
98	**Hawk Inlet - Building maintenance shed I**	0.10	52		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
99	**Hawk Inlet - Cardboard**	0.10	28		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
100	**Hawk Inlet - Concentrate storage building**	1.00	324		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
101	**Hawk Inlet - Conveyor, headhouse etc.**	0.10	90		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
102	**Hawk Inlet - Core shed**	0.10	116		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
103	**Hawk Inlet - Exploration Trailer**	0.10	62		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
104	**Hawk Inlet - Generator building**	0.10	48		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
105	**Hawk Inlet - Housing**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
106	**Hawk Inlet - Housing**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
107	**Hawk Inlet - Housing**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
108	**Hawk Inlet - Housing**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
109	**Hawk Inlet - Housing**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
110	**Hawk Inlet - Housing**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
111	**Hawk Inlet - Housing**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
112	**Hawk Inlet - Housing**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
113	**Hawk Inlet - Housing (Grand Boiler Building)**	0.10	26		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
114	**Hawk Inlet - Housing (Grand I)**	0.20	145		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
115	**Hawk Inlet - Housing (Grand II)**	0.10	94		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
116	**Hawk Inlet - Housing (Hilton)**	0.10	119		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
117	**Hawk Inlet - Laundry**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
118	**Hawk Inlet - Maintenance building**	0.10	61		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

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Closure Cost Estimate
Foundations & Buildings

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Buildings & Foundation Demolition Cost Summary	Labor	Equipment	Materials	Totals
Building Demolition Cost	$799,055	$166,627	N/A	$965,682
Wall Demolition Cost	$124,054	$0	N/A	$124,054
Slab Demolition	$25,077	$67,031	N/A	$92,108
Subtotal Demolition	**$948,186**	**$233,658**	**$0**	**$1,181,844**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$948,186**	**$233,658**	**$0**	**$1,181,844**

119	**Hawk Inlet - Pump house on pilings**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
120	**Hawk Inlet - Pump house on pilings**	0.10	62		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
121	**Hawk Inlet - Trailer**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
122	**Hawk Inlet - Trailer**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
123	**Hawk Inlet - Trailer**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
124	**Hawk Inlet - Trailer**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
125	**Hawk Inlet - Trailer**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
126	**Hawk Inlet - Trailer**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
127	**Hawk Inlet - Warehouse**	0.10	112		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
128	**Hawk Inlet - Warehouse Storage I**	0.10	95		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
129	**Hawk Inlet - Warehouse Storage II**	0.10	96		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
130	**Hawk Inlet - Water treatment building**	0.10	45		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
131	**Hawk Inlet - Wheel wash building**	0.10	65		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
132	**Hawk Inlet - 22' tank's Pad**	0.10	72		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
133	**Hawk Inlet - Concrete pad in front of warehouse**	0.10	80		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
134	**Hawk Inlet - Concrete pad west side of warehouse**	0.10	30		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
135	**Hawk Inlet - DB-04**	0.10	81		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
136	**Hawk Inlet - DB-04'**	0.10	81		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
137	**Hawk Inlet - DB-04 Concrete drain**	0.10	25		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
138	**Hawk Inlet - Oil containment**	0.10	37		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
139	**Hawk Inlet - Pump containment pad**	0.10	13		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
140	**Hawk Inlet - Sewer lift station**	0.10	7		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
141	**Hawk Inlet - Sump from DB-04**	0.10	16		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
142	**Hawk Inlet - Transformer**	0.10	13		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
143	**Hawk Inlet - Transformer (Grand)**	0.10	13		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
144	**Hawk Inlet - Transformer and containment**	0.10	15		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
145	**Hawk Inlet - Above ground cable tray**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
146	**Hawk Inlet - Poles**	0.10	6		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
147	**Hawk Inlet - Pump station**	0.10	12		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
148	**Hawk Inlet - Ramp**	0.10	92		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
149	**Hawk Inlet - switch gear next to generator building**	0.10	27		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
150	**Hawk Inlet - Transformer-dry**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
151	**Hawk Inlet - Containers**	0.30	194		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
152	**Hawk Inlet - Containers**	0.20	172		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
153	**Hawk Inlet - Containers**	0.10	22		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
154	**Hawk Inlet - Containers**	0.40	215		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
155	**Hawk Inlet - Containers**	0.20	138		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
156	**Hawk Inlet - Containers**	0.10	108		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
157	**Hawk Inlet - 5000 gallon FT-93**	0.10	22		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
158	**Hawk Inlet - DB-04 surge tank**	0.10	35		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
159	**Hawk Inlet - DB-04 surge tank**	0.10	35		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
160	**Hawk Inlet - diesel FT-21**	0.10	16		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
161	**Hawk Inlet - Filter skid**	0.10	15		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
162	**Hawk Inlet - Fuel tank**	0.10	51		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
163	**Hawk Inlet - Fuel tank**	0.10	9		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
164	**Hawk Inlet - Gas FT-22**	0.10	14		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
165	**Hawk Inlet - Oil tank FT-20**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
166	**Hawk Inlet - Tank FT-23**	0.10	9		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
167	**Hawk Inlet - Tanks next to water treatment building**	0.10	17		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
168	**Hawk Inlet - Used oil tank**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
169	**Hawk Inlet - Water tank at core shed**	0.10	0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
170	**Pond D - Wet well**	0.10	8		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
171	**Tails - 1.3 wheel wash**	0.10	85		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
		21.60			**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Other Demo & Equip Removal

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Other Demoltion and Equipment Removal - Cost Summary	Labor	Equipment	Materials	Totals
Other Demolition	$0	$0	$0	$0
Equipment Removal	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Other Demolition

Facility Description							
	Description (required)	ID Code	Type	Quantity	Units	Labor Unit Cost $	Equipment Unit Cost $
						$0	**$0**

Notes:

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Closure Cost Estimate
Other Demo & Equip Removal

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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Other Demoltion and Equipment Removal - Cost Summary	Labor	Equipment	Materials	Totals
Other Demolition	$0	$0	$0	$0
Equipment Removal	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Equipment & Material Removal

Facility Description							
	Description (required)	ID Code	Type	Quantity	Units	Labor Unit Cost ($)	Equipment Unit Cost ($)
						$0	**$0**

Notes:

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Closure Cost Estimate
Other Demo & Equip Removal

Material Unit Cost $
$0

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Closure Cost Estimate
Other Demo & Equip Removal

Material Unit Cost ($)
$0

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Closure Cost Estimate
Sediment & Drainage Control

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Diversion Ditches - User Input

		Diversions Ditches							Revegetation			Liner and Rip-Rap Installation			
Description (required)	**ID Code**	**Diversion Length** ft	**Diversion Depth** ft	**Ditch Bottom Width** ft	**Ditch Sideslope Angle** _H:1V	**Excavate Volume (if calculated elsewhere)** cy	**Excavating Material Condition** (select)	**Excavating Equipment Fleet** (select)	**Seed Mix** (select)	**Mulch** (select)	**Fertilizer** (select)	**Liner Area** S.Y.	**Liner Type** (select)	**Rip-Rap Area** S.Y.	**Rip-Rap Type** (select type)

Notes:

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Closure Cost Estimate
Sediment & Drainage Control

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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Sediment/Evaporation Pond Construction/Removal - User Input

		Sediment Ponds								Growth Media		
Description (required)	ID Code	Pond Width ft	Pond/Berm Length ft	Berm Height ft	Crest Width ft	Sideslope Angle _H:1V	Final Area (if calculated elsewhere) acres	Regrade Volume (if calculated elsewhere) cy	Cover Volume (if calculated elsewhere) cy	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Pond to Borrow % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Sediment & Drainage Control

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Sediment/Evaporation Pond Construction/Removal - User Input (cont.)

	Sediment Ponds				Growth Media			Revegetation			Ripping/Scarifying	
Description (required)	Excavating Material Condition (select)	Material Type (select)	Excavating Equipment Fleet (select)	Liner Type (select)	Growth Media Material Type (select)	Growth Media Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarify/ Rip? (select)	Scarify/ Ripping Fleet (select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Sediment & Drainage Control

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Drainage Control - Calculations

Diversion Ditch Volume Calculation

Cross Sectional Area = $\frac{(a+b)}{2} \times d$

Ditch Volume = Ditch Length x Cross Sectional Area

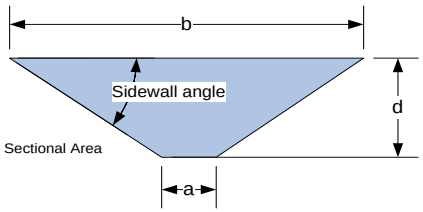
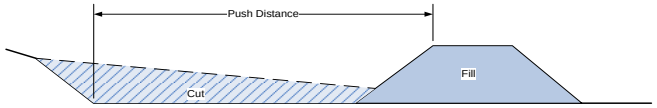


Figure 1 - Ditch Volume Calculation

1) Assume 20% swell for excavations
2) Assumes heavy duty trenching bucket is used

Sediment/Evaporation Pond Construction Calculation



Cut = Fill
Push distance = pond width up to 2/3 max push distance (400 ft)

Figure 2 - Sediment Ponds

1) Assume balanced cut-to-fill for berm construction
2) Include cost for liner, if required.
3) Include line items for removal, if necessary.
4) Assume 20% swell for excavations
5) Minimum 1 hr ripping/scarifying per area
6) Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Sediment & Drainage Control

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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Diversion Ditches - Excavation Costs

								Liner Installation				Rip-Rap Installation			
Description (required)	Diversion Ditch Volume LCY	Diversion Ditch Equipment	Corrected Excavator Productivity LCY/hr	Total Hours	Diversion Ditch Labor Cost $	Diversion Ditch Equipment Cost $	Total Diversion Ditch Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Liner Cost $	Labor Cost $	Equipment Cost $	Material Cost $	Total Cost $
					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Notes: LCM assumes 20% swell from ditch volume

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Closure Cost Estimate
Sediment & Drainage Control

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Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Diversion Ditches - Revegetation Costs

Description (required)	Surface Area acres	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
		$0	**$0**	**$0**	**$0**

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Closure Cost Estimate
Sediment & Drainage Control

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Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Sediment/Evaporation Ponds - Construction/Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83)

											Earthwork			Liner		
	Description (required)	Regrading Volume cy	Sed/Evap Pond Equipment	Dozing Distance (see above) ft	Uncorrected Dozer Productivity LCY/hr	Grade Correction	Density Correction	Excavating Material	Corrected Productivity LCY/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Constr/ Regrading Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $
											$0	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Sediment & Drainage Control

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Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Sediment/Evaporation Ponds - Growth Media Costs

	Growth Media							
Description (required)	Growth Media Volume cy	Growth Media Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Placement Cost $
						$0	**$0**	**$0**

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Closure Cost Estimate
Sediment & Drainage Control

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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$0	$0	N/A	$0
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Sediment/Evaporation Ponds - Revegetation Costs

Description (required)	Surface Area acres	Long Ripping Distance ft	Area Width ft	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
				0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Process Ponds

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Process Ponds - Cost Summary

	Labor	Equipment	Materials	Totals
Backfilling Costs	$57,517	$124,050	N/A	$181,567
Growth Media Placement Costs	$5,066	$10,909	N/A	$15,975
Liner Cutting & Folding Costs	$7,101	$2,539	N/A	$9,640
Subtotal Earthworks	**$69,684**	**$137,498**	**$0**	**$207,182**
Revegetation Costs	$345	$189	$7,232	$7,767
TOTALS	**$70,029**	**$137,687**	**$7,232**	**$214,949**

Process Ponds - User Input

You must fill in ALL green cells and relevant blue cells in this section for each pond

	Facility Description		Pond Dimensions (1)					Backfill - (If trucks are used) (1)				Growth Media		
	Description (required)	ID Code	Pond Length ft	Pond Width ft	Pond Depth ft	Pond Sideslope Angle _H:1V	Disturbed Area (if calculated elsewhere) acres	Percent Backfill (100% if blank)	Distance from Backfill Borrow ft	Slope from Facility to Borrow Area % grade	Pond Volume (if calculated elsewhere) cy	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Facility to Stockpile % grade
1	**Pond C lower (reclaimed during closure of other facility)**		**74**	**74**	**2.0**	**3.0**	**0.10**	**0%**						
2	**Pond C upper (lined) (reclaimed during closure of other facility)**		**38**	**38**	**2.0**	**3.0**	**0.10**	**0%**						
3	**Pond A (reclaimed during closure of other facility)**		**140**	**140**	**6.0**	**3.0**	**0.40**	**0%**						
4	**Pond 23 (reclaimed during closure of other facility)**		**140**	**140**	**2.0**	**3.0**	**0.10**	**0%**						
5	**Pond D**		**90**	**90**	**4.0**	**3.0**	**0.20**	**0%**	**500**	**-5%**		**12**	**500**	**-5%**
6	**Pond 7**		**327**	**327**	**24.0**	**3.0**	**3.40**	**100%**	**500**	**-5%**		**12**	**500**	**-5%**
7	**Pond 9**		**115**	**115**	**5.0**	**3.0**	**0.30**	**100%**	**500**	**-5%**		**12**	**500**	**-5%**
8	**Pond 10**		**355**	**355**	**24.0**	**3.0**	**3.30**	**100%**	**500**	**-5%**		**12**	**500**	**-5%**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Except for Pond 7 and Pond 9, the ponds will be removed during closure of other facilities. D-pond will be backfilled in Y10.
New storage pond liner in Other User sheet.

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Closure Cost Estimate
Process Ponds

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Process Ponds - Cost Summary

	Labor	Equipment	Materials	Totals
Backfilling Costs	$57,517	$124,050	N/A	$181,567
Growth Media Placement Costs	$5,066	$10,909	N/A	$15,975
Liner Cutting & Folding Costs	$7,101	$2,539	N/A	$9,640
Subtotal Earthworks	**$69,684**	**$137,498**	**$0**	**$207,182**
Revegetation Costs	$345	$189	$7,232	$7,767
TOTALS	**$70,029**	**$137,687**	**$7,232**	**$214,949**

Process Ponds - User Input (cont.)

		Liner	Backfill			Growth Media			Revegetation		
	Description (required)	Crew Cut & Fold Time (2) hrs	Backfill Material Type (select)	Backfill Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)
1	Pond C lower (reclaimed during closure of other facility)										
2	Pond C upper (lined) (reclaimed during closure of other fa	12.0									
3	Pond A (reclaimed during closure of other facility)										
4	Pond 23 (reclaimed during closure of other facility)										
5	Pond D		Alluvium	Small Truck		Alluvium	Small Truck		Mix 1	None	
6	Pond 7 Figure 1 - Pond Volume		Alluvium	Med Truck		Alluvium	Med Truck		Mix 1	None	
7	Pond 9		Alluvium	Med Truck		Alluvium	Med Truck		Mix 1	None	
8	Pond 10	24.0	Alluvium	Med Truck		Alluvium	Med Truck		Mix 1	None	

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table
(2) Pond liner removal crew (2Clab + excavator) = 2 General Laborers + 325C Excavator

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Closure Cost Estimate
Process Ponds

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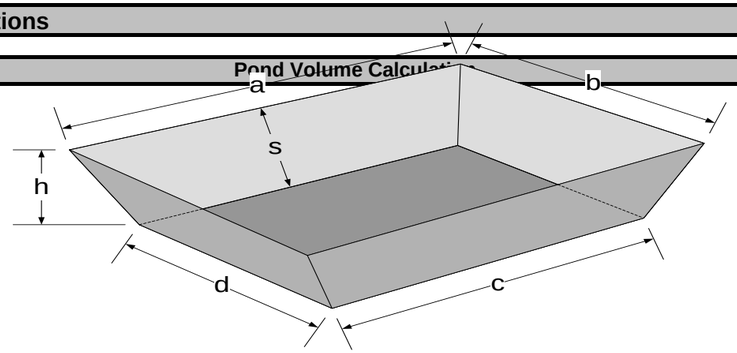
Process Ponds - Cost Summary

	Labor	Equipment	Materials	Totals
Backfilling Costs	$57,517	$124,050	N/A	$181,567
Growth Media Placement Costs	$5,066	$10,909	N/A	$15,975
Liner Cutting & Folding Costs	$7,101	$2,539	N/A	$9,640
Subtotal Earthworks	**$69,684**	**$137,498**	**$0**	**$207,182**
Revegetation Costs	$345	$189	$7,232	$7,767
TOTALS	**$70,029**	**$137,687**	**$7,232**	**$214,949**

Process Ponds - Calculations

Pond Volume Calculations



Area and Volume of the Frustrum of a Pyramid

$$\text{Surface Area} = ab + cd + (a+b+c+d) \times \frac{s}{2}$$

$$\text{Volume} = \frac{h\,(ab + cd + \sqrt{abcd}\,)}{3}$$

Revegetation Calculations

Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Process Ponds

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Process Ponds - Cost Summary	Labor	Equipment	Materials	Totals
Backfilling Costs	$57,517	$124,050	N/A	$181,567
Growth Media Placement Costs	$5,066	$10,909	N/A	$15,975
Liner Cutting & Folding Costs	$7,101	$2,539	N/A	$9,640
Subtotal Earthworks	**$69,684**	**$137,498**	**$0**	**$207,182**
Revegetation Costs	$345	$189	$7,232	$7,767
TOTALS	**$70,029**	**$137,687**	**$7,232**	**$214,949**

Process Ponds - Liner Cutting and Folding

	Description (required)	Crew Hours hrs	Total Labor Cost $	Total Equipment Cost $	Total Cover Cost $
1	**Pond C lower (reclaimed during closure of other facility)**		$0	$0	$0
2	**Pond C upper (lined) (reclaimed during closure of other fa**	12	$2,367	$846	$3,213
3	**Pond A (reclaimed during closure of other facility)**		$0	$0	$0
4	**Pond 23 (reclaimed during closure of other facility)**		$0	$0	$0
5	**Pond D**		$0	$0	$0
6	**Pond 7**		$0	$0	$0
7	**Pond 9**		$0	$0	$0
8	**Pond 10**	24	$4,734	$1,693	$6,427
		36	**$7,101**	**$2,539**	**$9,640**

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Closure Cost Estimate
Process Ponds

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Process Ponds - Cost Summary

	Labor	Equipment	Materials	Totals
Backfilling Costs	$57,517	$124,050	N/A	$181,567
Growth Media Placement Costs	$5,066	$10,909	N/A	$15,975
Liner Cutting & Folding Costs	$7,101	$2,539	N/A	$9,640
Subtotal Earthworks	**$69,684**	**$137,498**	**$0**	**$207,182**
Revegetation Costs	$345	$189	$7,232	$7,767
TOTALS	**$70,029**	**$137,687**	**$7,232**	**$214,949**

Process Ponds - Backfill and Growth Media Costs

		Pond Backfill								Growth Media							
	Description (required)	Backfill Volume cy	Backfill Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours hrs	Total Labor Cost $	Total Equipment Cost $	Total Backfill Cost $	Growth Media Volume cy	Growth Media Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Topsoiling Cost $
1	**Pond C lower (reclaimed during closure of other facility)**	0					$0	$0	$0						$0	$0	$0
2	**Pond C upper (lined) (reclaimed during closure of other fa**	0					$0	$0	$0						$0	$0	$0
3	**Pond A (reclaimed during closure of other facility)**	0					$0	$0	$0						$0	$0	$0
4	**Pond 23 (reclaimed during closure of other facility)**	0					$0	$0	$0						$0	$0	$0
5	**Pond D**	0					$0	$0	$0	323	740/988G	589	2	1	$253	$527	$780
6	**Pond 7**	59,336	740/988G	589	2	101	$25,591	$55,194	$80,785	5,485	740/988G	589	2	9	$2,280	$4,918	$7,198
7	**Pond 9**	1,866	740/988G	589	2	3	$760	$1,639	$2,399	484	740/988G	589	2	1	$253	$546	$799
8	**Pond 10**	72,726	740/988G	589	2	123	$31,166	$67,217	$98,383	5,324	740/988G	589	2	9	$2,280	$4,918	$7,198
		133,928				227	**$57,517**	**$124,050**	**$181,567**	11,616				20	**$5,066**	**$10,909**	**$15,975**

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Closure Cost Estimate
Process Ponds

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Process Ponds - Cost Summary	Labor	Equipment	Materials	Totals
Backfilling Costs	$57,517	$124,050	N/A	$181,567
Growth Media Placement Costs	$5,066	$10,909	N/A	$15,975
Liner Cutting & Folding Costs	$7,101	$2,539	N/A	$9,640
Subtotal Earthworks	**$69,684**	**$137,498**	**$0**	**$207,182**
Revegetation Costs	$345	$189	$7,232	$7,767
TOTALS	**$70,029**	**$137,687**	**$7,232**	**$214,949**

Process Ponds - Revegetation Costs

	Description (required)	Surface Area acres	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Pond C lower (reclaimed during closure of other facility)**	0.10	$0	$0	$0	$0
2	**Pond C upper (lined) (reclaimed during closure of other fa**	0.10	$0	$0	$0	$0
3	**Pond A (reclaimed during closure of other facility)**	0.40	$0	$0	$0	$0
4	**Pond 23 (reclaimed during closure of other facility)**	0.10	$0	$0	$0	$0
5	**Pond D**	0.20	$40	$22	$201	$262
6	**Pond 7**	3.40	$135	$74	$3,415	$3,624
7	**Pond 9**	0.30	$40	$22	$301	$362
8	**Pond 10**	3.30	$131	$72	$3,315	$3,518
		7.90	**$345**	**$189**	**$7,232**	**$7,767**

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Closure Cost Estimate
Landfills

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Landfills - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Landfills - User Input — You must fill in ALL green cells and relevant blue cells in this section for each landfill

Facility Description			Physical (1)			Cover			Growth Media		
	Description (required)	ID Code	Final Landfill Footprint acres	Average Long Dimension (ripping distance) ft	Regrade Volume (calculated elsewhere) cy	Cover Thickness in	Distance from Cover Borrow ft	Slope from Landfill to Cover Borrow % grade	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Landfill to Stockpile % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

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Closure Cost Estimate
Landfills

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Landfills - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Landfills - User Input (cont.) You must fill in ALL green cells and relevant blue cells in this section for each landfill

		Grading				Cover			Growth Media			Revegetation				
	Description (required)	Dozing Material Condition	Landfill Material Type	Grading Equipment Fleet	Slot/ Side-by-Side	Cover Material Type	Cover Placement Equipment Fleet	Maximum Fleet Size	Growth Media Material Type	Growth Media Equipment Fleet	Maximum Fleet Size	Seed Mix	Mulch Type	Fertilizer	Scarify/ Rip?	Scarifying/ Ripping Fleet
		(select)	(select)	(select)	(select)	(select)	(select)	(user override)	(select)	(select)	(user override)	(select)	(select)	(select)	(select)	(select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Landfills

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Landfills - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Landfills - Calculations

Dozing, Ripping/Scarifying & Revegetation Calculations

Dozing: Dozing distance = 2/3 of the 600 feet maximum from Catepillar Handbook or 400 feet
Assumes flat push (grade correction factor = 1)
Minimum 1 hr per area

Ripping: Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
Minimum 1 hr per area

Revegetation: Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Landfills

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Landfills - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Landfills - Regrading Costs

Productivity = Dozer Productivity x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Uncorrected Dozer Productivity cy/hr	Dozing Material	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity LCY/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
										$0	**$0**	**$0**

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Closure Cost Estimate
Landfills

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Landfills - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Landfills - Cover and Growth Media Costs

		Cover Placement								Growth Media Placement						
	Description (required)	Cover Volume ft	Cover Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Cover Labor Cost $	Cover Equipment Cost $	Total Cover Cost $	Growth Media Volume ft	Growth Media Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $
							$0	$0	$0						$0	$0

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Closure Cost Estimate
Landfills

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Landfills - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Landfills - Scarifying/Revegetation Costs

	Description (required)	Surface Area acres	Long Dimension ft	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
					$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Landfills

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Total Topsoiling Cost $
$0

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Closure Cost Estimate
Landfills

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Closure Cost Estimate
Yards, Etc.

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Yards, Etc. - Cost Summary	Labor	Equipment	Materials	Totals
Regrading Cost	$133,791	$164,700	N/A	$298,491
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$28,379	$61,206	N/A	$89,585
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$162,170**	**$225,906**		**$388,076**
Revegetation Cost	$7,845	$4,292	$198,883	$211,020
TOTALS	**$170,015**	**$230,198**	**$198,883**	**$599,096**

Yards, Etc. - User Input — **You must fill in ALL green cells and relevant blue cells in this section for each building or facility**

	Facility Description			Physical			Cover			Growth Media		
	Description (required)	ID Code	Type	Area acres	Average Flat Area Long Dimension (ripping distance) ft	Regrade Volume (calculated elsewhere) cy	Cover Thickness in	Distance from Cover Borrow Area ft	Slope from Facility to Borrow Area % grade	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Facility to Stockpile % grade
1	**920 mill and portal area**		Yard	**24.00**	**1,000**	**39,000**				**12**	**500**	**-5.0**
2	**Waste rock site D**		Yard	**8.00**	**600**	**13,000**						
3	**Waste rock site 1350 and portal area**		Yard	**3.50**	**400**	**6,000**						
4	**1160 tank**		Yard	**1.00**	**200**	**2,000**						
5	**960 waste rock area**		Yard	**1.00**	**200**	**2,000**						
6	**Waste rock site C and 860 area**		Yard	**3.00**	**400**	**5,000**						
7	**Waste rock site E**		Yard	**10.00**	**700**	**16,000**						
8	**Hawk inlet and marine load out area**		Yard	**14.50**	**800**	**23,000**				**12**	**500**	**-5.0**
9	**Young Bay Dock facility**		Yard	**1.00**	**200**	**2,000**				**12**	**500**	**-5.0**
10	**Topsoil stockpiles and borrow areas**		Yard	**31.00**	**1,200**							
11	**Tailings (disturbance area minus design footprint)**		Yard	**49.00**	**1,500**							
12	**Power Line Right-of-way**		Yard	**32.00**								
13	**Waste rock site 23**		Yard	**20.00**	**100**							

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Acreages from 2012 reclamation plan

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Closure Cost Estimate
Yards, Etc.

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Yards, Etc. - Cost Summary	Labor	Equipment	Materials	Totals
Regrading Cost	$133,791	$164,700	N/A	$298,491
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$28,379	$61,206	N/A	$89,585
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$162,170**	**$225,906**		**$388,076**
Revegetation Cost	$7,845	$4,292	$198,883	$211,020
TOTALS	**$170,015**	**$230,198**	**$198,883**	**$599,096**

Yards, Etc. - User Input (cont.) You must fill in ALL green cells and relevant blue cells in this section for each building or facility

		Grading			Cover			Growth Media			Revegetation				
	Description (required)	Dozing Material Condition (select)	Dozing Material Type (select)	Grading Equipment Fleet (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarify/ Rip? (select)	Ripping Fleet (select)
1	920 mill and portal area	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
2	Waste rock site D	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
3	Waste rock site 1350 and portal area	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
4	1160 tank	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
5	960 waste rock area	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
6	Waste rock site C and 860 area	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
7	Waste rock site E	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
8	Hawk inlet and marine load out area	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
9	Young Bay Dock facility	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
10	Topsoil stockpiles and borrow areas	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
11	Tailings (disturbance area minus design footprint)	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
12	Power Line Right-of-way	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	
13	Waste rock site 23	1	Alluvium	Small				Alluvium	Med Truck		Mix 1	None		No	

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Yards, Etc.

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Yards, Etc. - Cost Summary

	Labor	Equipment	Materials	Totals
Regrading Cost	$133,791	$164,700	N/A	$298,491
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$28,379	$61,206	N/A	$89,585
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$162,170**	**$225,906**		**$388,076**
Revegetation Cost	$7,845	$4,292	$198,883	$211,020
TOTALS	**$170,015**	**$230,198**	**$198,883**	**$599,096**

Yards, Etc. - Calculations

Grading Calculations

Average push distance assumed to be 2/3 of the 600 feet maximum from Catepillar Handbook or 400 feet
Material assumed to be loose stockile (1.2 productivity factor)
Slope assumed to be 0 to 5% (1.0 productivity factor)

Cover Volume Calculation

Yard area x cover thickness

Ripping/Scarifying Calculations

Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
Minimum 1 hr ripping/scarifying per area

Revegetation

Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Yards, Etc.

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Yards, Etc. - Cost Summary	Labor	Equipment	Materials	Totals
Regrading Cost	$133,791	$164,700	N/A	$298,491
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$28,379	$61,206	N/A	$89,585
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$162,170**	**$225,906**		**$388,076**
Revegetation Cost	$7,845	$4,292	$198,883	$211,020
TOTALS	**$170,015**	**$230,198**	**$198,883**	**$599,096**

Yards, Etc. - Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material	Density Correction	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1	**920 mill and portal area**	39,000	400	102	1.0	1.0	0.79	50	780	$48,313	$59,475	$107,788
2	**Waste rock site D**	13,000	400	102	1.0	1.0	0.79	50	260	$16,104	$19,825	$35,929
3	**Waste rock site 1350 and portal area**	6,000	400	102	1.0	1.0	0.79	50	120	$7,433	$9,150	$16,583
4	**1160 tank**	2,000	400	102	1.0	1.0	0.79	50	40	$2,478	$3,050	$5,528
5	**960 waste rock area**	2,000	400	102	1.0	1.0	0.79	50	40	$2,478	$3,050	$5,528
6	**Waste rock site C and 860 area**	5,000	400	102	1.0	1.0	0.79	50	100	$6,194	$7,625	$13,819
7	**Waste rock site E**	16,000	400	102	1.0	1.0	0.79	50	320	$19,821	$24,400	$44,221
8	**Hawk inlet and marine load out area**	23,000	400	102	1.0	1.0	0.79	50	460	$28,492	$35,075	$63,567
9	**Young Bay Dock facility**	2,000	400	102	1.0	1.0	0.79	50	40	$2,478	$3,050	$5,528
10	**Topsoil stockpiles and borrow areas**									$0	$0	$0
11	**Tailings (disturbance area minus design footprint)**									$0	$0	$0
12	**Power Line Right-of-way**									$0	$0	$0
13	**Waste rock site 23**									$0	$0	$0
		108,000							2,160	**$133,791**	**$164,700**	**$298,491**

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Closure Cost Estimate
Yards, Etc.

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Yards, Etc. - Cost Summary	Labor	Equipment	Materials	Totals
Regrading Cost	$133,791	$164,700	N/A	$298,491
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$28,379	$61,206	N/A	$89,585
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$162,170**	**$225,906**		**$388,076**
Revegetation Cost	$7,845	$4,292	$198,883	$211,020
TOTALS	**$170,015**	**$230,198**	**$198,883**	**$599,096**

Yards, Etc. - Cover and Growth Media Costs

		Cover								Growth Media							
	Description (required)	Cover Volume cy	Topsoil Repacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Topsoiling Cost $
1	**920 mill and portal area**						$0	$0	$0	38,720	740/988G	571	2	68	$17,230	$37,161	$54,391
2	**Waste rock site D**						$0	$0	$0						$0	$0	$0
3	**Waste rock site 1350 and portal area**						$0	$0	$0						$0	$0	$0
4	**1160 tank**						$0	$0	$0						$0	$0	$0
5	**960 waste rock area**						$0	$0	$0						$0	$0	$0
6	**Waste rock site C and 860 area**						$0	$0	$0						$0	$0	$0
7	**Waste rock site E**						$0	$0	$0						$0	$0	$0
8	**Hawk inlet and marine load out area**						$0	$0	$0	23,393	740/988G	571	2	41	$10,389	$22,406	$32,795
9	**Young Bay Dock facility**						$0	$0	$0	1,613	740/988G	571	2	3	$760	$1,639	$2,399
10	**Topsoil stockpiles and borrow areas**						$0	$0	$0						$0	$0	$0
11	**Tailings (disturbance area minus design footprint)**						$0	$0	$0						$0	$0	$0
12	**Power Line Right-of-way**						$0	$0	$0						$0	$0	$0
13	**Waste rock site 23**						$0	$0	$0						$0	$0	$0
							$0	**$0**	**$0**	63,726				112	**$28,379**	**$61,206**	**$89,585**

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Closure Cost Estimate
Yards, Etc.

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Yards, Etc. - Cost Summary	Labor	Equipment	Materials	Totals
Regrading Cost	$133,791	$164,700	N/A	$298,491
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$28,379	$61,206	N/A	$89,585
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$162,170**	**$225,906**		**$388,076**
Revegetation Cost	$7,845	$4,292	$198,883	$211,020
TOTALS	**$170,015**	**$230,198**	**$198,883**	**$599,096**

Yards, Etc. - Scarifying/Revegetation Costs

	Description (required)	Surface Area acres	Area Long Dimension ft	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**920 mill and portal area**	24.00			$0	$0	$0	$951	$520	$24,107	$25,578
2	**Waste rock site D**	8.00			$0	$0	$0	$317	$173	$8,036	$8,526
3	**Waste rock site 1350 and portal area**	3.50			$0	$0	$0	$139	$76	$3,516	$3,731
4	**1160 tank**	1.00			$0	$0	$0	$40	$22	$1,004	$1,066
5	**960 waste rock area**	1.00			$0	$0	$0	$40	$22	$1,004	$1,066
6	**Waste rock site C and 860 area**	3.00			$0	$0	$0	$119	$65	$3,013	$3,197
7	**Waste rock site E**	10.00			$0	$0	$0	$396	$217	$10,045	$10,658
8	**Hawk inlet and marine load out area**	14.50			$0	$0	$0	$574	$314	$14,565	$15,453
9	**Young Bay Dock facility**	1.00			$0	$0	$0	$40	$22	$1,004	$1,066
10	**Topsoil stockpiles and borrow areas**	31.00			$0	$0	$0	$1,228	$672	$31,138	$33,038
11	**Tailings (disturbance area minus design footprint)**	49.00			$0	$0	$0	$1,941	$1,062	$49,219	$52,222
12	**Power Line Right-of-way**	32.00			$0	$0	$0	$1,268	$694	$32,143	$34,105
13	**Waste rock site 23**	20.00			$0	$0	$0	$792	$433	$20,089	$21,314
		198.00			**$0**	**$0**	**$0**	**$7,845**	**$4,292**	**$198,883**	**$211,020**

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Closure Cost Estimate
Waste Disposal

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Waste Disposal - Cost Summary	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$0
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Waste Disposal - User Input - Solid Waste						Landfill (Bulk) Disposal			Dumpster
	Description (required)	ID Code	Waste Type (select)	Disposal Method (select)	Quantity cy	Distance to Landfill ft	Slope to Landfill % grade	Number of Trucks (user override)	Months Dumpster Rental months
1									

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Waste disposal provided under "Other User Costs"

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Closure Cost Estimate
Waste Disposal

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Waste Disposal - Cost Summary	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$0
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Waste Disposal - User Input - Hazardous Materials

	Description (required)	ID Code	Waste Type (select)	Container Type (select)	Vacuum Truck Size (select)	Liquid Quantity gallons	Soild Quantity cy	One Way Travel Distance to Disposal Site mi	One Way Travel Time to Disposal Site hr
1									

Notes:
1. Use Other Demo & Equip Removal Sheet for tank removal

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Closure Cost Estimate
Waste Disposal

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
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Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Waste Disposal - Cost Summary	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$0
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Waste Disposal - User Input - Hydrocarbon Contaminated Soils

	Description (required)	ID Code	Waste Type (select)	Disposal Method (select)	Quantity cy	Travel Distance to Offsite Disposal mi

Notes:
1. Use Yards or Landfills Sheets for bioremediation facility reclamation

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Closure Cost Estimate
Waste Disposal

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Waste Disposal - Cost Summary

	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$0
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Waste Disposal - Assumptions & Calculations

Solid Waste Disposal

Off site disposal assumes use of average rolloff dumpster [30 cy (m3), 10 ton (tonne)]
On site disposal assumes use of small loader/truck fleet for haulage
Average density for on site disposal = 2,600 lb/cy (1,540 kg/m3)
For on site disposal only 1 truck is required unless total truck hours > 8, only 2 trucks unless total truck hours are > 16

Hazardous Materials Disposal

Assumes all hazardous materials are known
Enter EITHER solid or liquid quantity each line.
If container type = 55 gallon (200 liter) drum then solid waste hauling costs apply
Average density for solids assumed to be 2,600 lb/cy (1,540 kg/m3)
Vacuum truck sizes: small = 2,200 gal (~8,300 litres), large = 5,000 gal (~19,000 litres)
Vacuum truck on site for 4 hours for each load

Hydrocarbon Contaminated Soils Disposal

Assumes all hazardous materials are known
On site disposal assumes biopad treatment
Exavation productivity =45 cy./hr (35 m3/hr) (Means Heavy Construction, 2006: 02315-424-0360)

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Closure Cost Estimate
Waste Disposal

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Waste Disposal - Cost Summary

	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$0
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Waste Disposal - Solid Waste Disposal

	Description (required)	Waste Volume cy	Number of Off Site Dumpster Loads	Landfill Fleet Equipment	Landfill Fleet Productivity LCY/hr	Number of Trucks	Total Fleet Hours	Total Dumpster Cost $	Total Labor Cost $	Total Equipment Cost $
1								$0	$0	$0
								$0	**$0**	**$0**

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Closure Cost Estimate
Waste Disposal

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Waste Disposal - Cost Summary

	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$0
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Waste Disposal - Hazardous Materials Disposal

	Description (required)	Liquid Waste Volume gallons	Solid Waste Volume cy	Number of Truck Loads	Tons of Waste Tons	Pick-up Fees $	Transport Fees $	Disposal Fees $	Total Hazardous Material Cost $
1						$0	$0	$0	$0
						$0	**$0**	**$0**	**$0**

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Closure Cost Estimate
Waste Disposal

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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Waste Disposal - Cost Summary	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$0
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Waste Disposal - Hydrocarbon Contaminated Soils

	Description (required)	Quantity cy	Total Fleet Hours	Treatment Cost $	Transport Fees $	Disposal Fees $	Total Labor Cost $	Total Equipment Cost $	Total Waste Disposal Cost $
				$0	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Well Abandonment

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Well Abandonment	Labor	Equipment	Materials	Totals
Production, Dewatering, Infiltration Wells	$3,620	$2,694	$204	$6,518
Monitoring Wells	$98,114	$23,527	$1,884	$123,525
TOTALS	**$101,734**	**$26,221**	**$2,088**	**$130,043**

Production, Dewatering and Infiltration Well Closure

	Description (required)	ID Code	Number of Holes	Casing Diam in	Average Depth(1) ft bgs	Depth to First Water ft bgs	Original Static Water Level ft bgs	Top of Slotted Casing(2) ft bgs	Blank Casing Below Top of Screen(2) ft	Type of Pump (if any) (select)	Depth to Pump ft bgs	Hole Plug Method (select)	Casing Volume per ft cf	Perforation Length (3,4) ft	Grout Volume per Hole(4,5) cy	Cement Volume per Hole(6) cy	Inert Media Volume per Hole(7) cy	Pump Removal Labor Cost $	Pump Removal Equip Cost $	Perf Labor Cost $	Perf Equip Cost (8) $	Grout + Cement Labor Cost(9) $	Grout + Cement Equip Cost(9) $	Grout + Cement Material Cost $	Inert Media Labor Cost(10) $	Inert Media Equip Cost(9) $
1	**DW-3**		**1**	**6.0**	**73**	**70**	**20**	**38**	**36**	**Submersil**	**70**	**Grout Only**	0.200	36	0.79	0.10		$178	$387	$588	$435	$608	$358	$77	$387	$89
2	**DW-4**		**1**	**6.0**	**125**	**70**	**20**	**78**	**48**	**Submersil**	**70**	**Grout Only**	0.200	75	1.56	0.10		$178	$387	$647	$569	$647	$381	$127	$387	$89
																		$356	**$774**	**$1,235**	**$1,004**	**$1,255**	**$739**	**$204**	**$774**	**$177**

(1) For previously abandoned holes enter "0" for depth
(2) Wells abandoned per Nevada Administrative Code (NAC 534.420). Hole grouted and perforated from bottom to 50 feet (15.24m) above the top of the screen, or first water encountered or original static water level, depending on vertical hydraulic gradient and well construction parameters. Inert media (cuttings or alluvium) used from top of grout to top seal.
(3) Perforation length = amount of blank casing below first water (for confined aquifers) or predicted recovered water table (unconfined aquifers) + 50 feet (15.24m) of blank casing above water table
(4) Assumes 50' (15.24m) sanitary seal at top of hole. Therefore, perforation and grouting only required to bottom of sanitary seal.
(5) Assumes 100% loss to formation for grout (abandonite) for screened and perforated sections.
(6) Assumes 10' (3m) top seal of cement in casing only. See note 4.
(7) Inert material is cuttings or alluvium sourced locally.
(8) Includes perforation tool wear cost/ft of perforation (see Productivty Sheet).
(9) See Productivity Sheet for hourly production. Minimum 1 hr per hole + fixed hours per hole for move and setup. If no perforation required, use standard drill rig.
(10) See Productivity Sheet for hourly production. Minimum 1 hr per hole.

Notes:

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Closure Cost Estimate
Well Abandonment

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Well Abandonment	Labor	Equipment	Materials	Totals
Production, Dewatering, Infiltration Wells	$3,620	$2,694	$204	$6,518
Monitoring Wells	$98,114	$23,527	$1,884	$123,525
TOTALS	**$101,734**	**$26,221**	**$2,088**	**$130,043**

Monitoring Well Closure

	Description (required)	ID Code	Number of Holes	Casing Diam in	Average Depth ft bgs	Top of Screen(1) ft bgs	Hole Plug Method (select)	Casing Volume per ft ft3	Grout Volume/ Well(2,3) cy	Cement Volume per Hole(4) cy	Inert Backfill Volume per Hole(5) cy	Total Grouting Hours/ Hole hr	Total Inert Media Hours/ Hole hr	Grout + Cement Labor Cost(6) $	Grout + Cement Equip Cost(6) $	Grout + Cement Material Cost $	Inert Material Labor Cost(7) $	Inert Material Equip Cost(7) $
1	**Monitoring wells - closure period**		**140**	**2.2**	**50**	**40**	**Grout Onl**	0.030	0.04	0.03		3.1		$80,251	$19,244	$1,416	$0	$0
2	**Monitoring wells - post-closure period**		**26**	**2.2**	**50**	**40**	**Grout Onl**	0.030	0.04	0.03		3.1		$14,904	$3,574	$263	$0	$0
3	**Underground boreholes (Three holes approximately 500'**		**4**	**2.2**	**500**	**490**	**Grout Onl**	0.030	0.67	0.03		4.0		$2,959	$709	$205	$0	$0
														$98,114	**$23,527**	**$1,884**	**$0**	**$0**

Wells abandoned per NAC 534.420 with bentonite grout placed to 50 feet above the top of the screen (see note 1).
(1) Assumes top of screen is at or above the static water level (in unconfined aquifers) or the depth of first water encountered (in confined aquifers).
(2) Assumes 25% loss to formation for grouting
(3) Grouting only required to 50' (15.24m) above the top of screen because monitor wells are constructed with a seal in the annular space.
(4) Assumes top 10' (3m) plugged with cement.
(5) Assumes hole plugged with inert material (cuttings or alluvium) above grout up to cement surface plug.
(6) See Productivity Sheet for hourly production. Minimum 1 hr per hole + fixed hours per hole for move and setup (see Productivty Sheet).
(7) See Productivity Sheet for hourly production. Minimum 1 hr per hole.

Notes:

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Closure Cost Estimate
Well Abandonment

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Well Abandonment				
	Labor	Equipment	Materials	Totals
Production, Dewatering, Infiltration Wells	$3,620	$2,694	$204	$6,518
Monitoring Wells	$98,114	$23,527	$1,884	$123,525
TOTALS	**$101,734**	**$26,221**	**$2,088**	**$130,043**

Well Construction

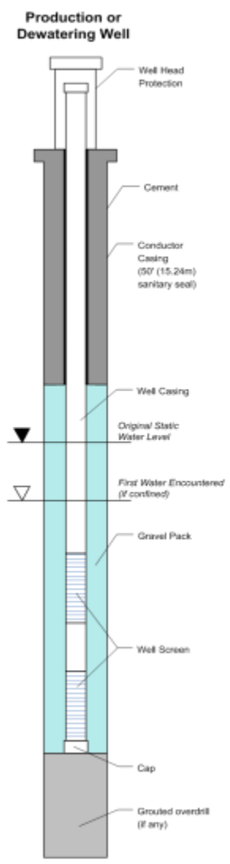

Figure 1 - Production Well

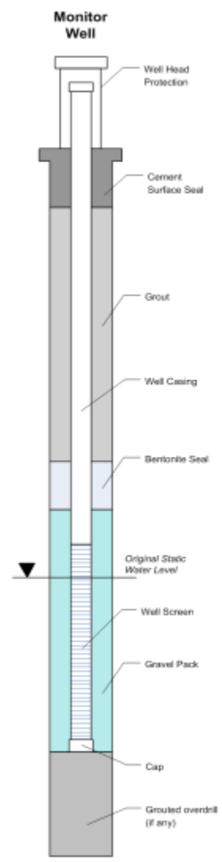

Figure 2 - Monitor Well

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Closure Cost Estimate
Misc. Costs

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Miscellaneous Cost Summary

	Labor	Equipment	Materials	Totals
Fence Removal	$0	$0	N/A	$0
Fence Installation	$0	$0	$0	$0
Culvert & Buried Pipe Removal	$0	$0	N/A	$0
Surface Pipe Removal	$0	$0	N/A	$0
Power Lines	$0	N/A	N/A	$0
Substations/Transformers	$29,001	N/A	N/A	$29,001
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0
TOTALS	**$29,001**	**$0**	**$0**	**$29,001**

Fence Removal — You must fill in ALL green and blue cells

	Description (required)	ID Code	Length ft	Type (select type)	Labor Cost $	Equipment Cost $	Total Cost $
					$0	**$0**	**$0**

Notes:

Fence Installation — You must fill in ALL green and blue cells

	Description (required)	ID Code	Input: Length ft	Input: Type (select type)	Costs: Labor Cost $	Costs: Equipment Cost $	Costs: Material Cost ($)
1							
					$0	**$0**	**$0**

Notes:

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Closure Cost Estimate
Misc. Costs

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Miscellaneous Cost Summary

	Labor	Equipment	Materials	Totals
Fence Removal	$0	$0	N/A	$0
Fence Installation	$0	$0	$0	$0
Culvert & Buried Pipe Removal	$0	$0	N/A	$0
Surface Pipe Removal	$0	$0	N/A	$0
Power Lines	$0	N/A	N/A	$0
Substations/Transformers	$29,001	N/A	N/A	$29,001
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0
TOTALS	**$29,001**	**$0**	**$0**	**$29,001**

Culvert & Buried Pipe Removal — You must fill in ALL green and blue cells

	Input					Costs	
	Description (required)	ID Code	Length ft	Type (select type)	Location (select)	Labor Cost $	Equipment Cost $
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
						$0	**$0**

Notes:

Surface Pipe Removal — You must fill in ALL green and blue cells

	Input					Costs	
	Description (required)	ID Code	Length ft	Type (select type)	Location (select)	Labor Cost $	Equipment Cost $
1							
2							
						$0	**$0**

Notes:

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Closure Cost Estimate
Misc. Costs

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Model Version: Version 1.4.1
Cost Data: User Data
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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Miscellaneous Cost Summary

	Labor	Equipment	Materials	Totals
Fence Removal	$0	$0	N/A	$0
Fence Installation	$0	$0	$0	$0
Culvert & Buried Pipe Removal	$0	$0	N/A	$0
Surface Pipe Removal	$0	$0	N/A	$0
Power Lines	$0	N/A	N/A	$0
Substations/Transformers	$29,001	N/A	N/A	$29,001
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0
TOTALS	**$29,001**	**$0**	**$0**	**$29,001**

Power Line and Substation Removal — **You must fill in ALL green and blue cells**

	Description (required)	ID Code	Input: Power Line Length miles	Power Line Type (select)	Number of Substations #	Location (select)	Power Line Removal $
1	**Removal of one substation Year 10**			**Double Pole**	**1**	**On-site**	$0
							$0

Notes: If substation owned by operator, use Other Demo & Equipment Removal sheet
User may need to add line items in Foundations & Buildings for substation slab demolition and fence removal
Labor/Equipment costs assume approximately 80% of cost are equipment and 20% are labor related costs
920_asbuilt_ft.dwg\utilities-power and 1350-power
1 substation stays to service the water treatment

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Closure Cost Estimate
Misc. Costs

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Miscellaneous Cost Summary

	Labor	Equipment	Materials	Totals
Fence Removal	$0	$0	N/A	$0
Fence Installation	$0	$0	$0	$0
Culvert & Buried Pipe Removal	$0	$0	N/A	$0
Surface Pipe Removal	$0	$0	N/A	$0
Power Lines	$0	N/A	N/A	$0
Substations/Transformers	$29,001	N/A	N/A	$29,001
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0
TOTALS	**$29,001**	**$0**	**$0**	**$29,001**

Rip-Rap & Rock Lining — **You must fill in ALL green and blue cells**

			Input		Costs		
	Description (required)	ID Code	Area S.Y.	Type (select type)	Labor Cost $	Equipment Cost $	Material Cost $
1							
					$0	**$0**	**$0**

Notes:

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Closure Cost Estimate
Misc. Costs

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Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Miscellaneous Cost Summary				
	Labor	Equipment	Materials	Totals
Fence Removal	$0	$0	N/A	$0
Fence Installation	$0	$0	$0	$0
Culvert & Buried Pipe Removal	$0	$0	N/A	$0
Surface Pipe Removal	$0	$0	N/A	$0
Power Lines	$0	N/A	N/A	$0
Substations/Transformers	$29,001	N/A	N/A	$29,001
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0
TOTALS	**$29,001**	**$0**	**$0**	**$29,001**

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Closure Cost Estimate
Monitoring

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Reclamation Monitoring & Maintenance - Cost Summary

	Labor	Equipment	Lab & Materials	Totals
Revegetation Maintenance	$1,466	$802	$37,162	$39,430
Erosion Maintenance	$7,513	$22,539	N/A	$30,052
Reclamation Monitoring	$0	$0	N/A	$0
Subtotal Reclamation Monitoring	**$8,979**	**$23,341**	**$37,162**	**$69,482**
Water Quality Monitoring	$0	$0	$0	$0
TOTAL MONITORING	**$8,979**	**$23,341**	**$37,162**	**$69,482**

Clear Sheet

Reclamation Maintenance

Description	Total Revegetation Surface Area (1,2) acres	% Area Requiring Reseeding	Seed Mix (select)	Area Requiring Reseeding acres	Seed $/acres	Labor $/acres	Equipment $/acres	Totals $
Revegetation Maintenance	370	**10%**	**Mix 1**	37.0	$1,004.46	$39.61	$21.67	
Labor								$1,466
Equipment								$802
Materials								$37,162
Cost/Acre								$1,066
							Subtotal	**$39,430**

Notes: 1) Surface area is NOT the same as footprint disturbance area typically used for permitting purposes.
2) If BRCE model, revegetation surface area determined by area included in PER, LOM or Surety estimate

	Total Volume Growth Media cy	% Volume Requiring Maintenance	Average Growth Media Placement Cost $/CY	Volume Requiring Replacement cy		Labor (assume: 25%) $/acres	Equipment (assume: 75%) $/acres	Total $
Erosion Maintenance	186,657	**10%**	$1.61	18,666		$7,513.00	$22,539.00	$30,052

Notes:

Reclamation Monitoring

Description	Hrs/Day	Days/Year	Number of Years	Rate $/hr		
Field Work						
Field Geologist/Engineer						$0
Range Scientist						$0
Reporting						
Field Geologist/Engineer						$0
Range Scientist						$0
					Subtotal	**$0**
Travel						
	Hrs/Trip hr	**Trips/Year**	**Years**	**Truck Cost** $/hr		
Travel				$11.05		$0
					Subtotal	**$0**
					Total Reclamation Monitoring	**$0**

Notes:

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Closure Cost Estimate
Monitoring

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Reclamation Monitoring & Maintenance - Cost Summary

	Labor	Equipment	Lab & Materials	Totals
Revegetation Maintenance	$1,466	$802	$37,162	$39,430
Erosion Maintenance	$7,513	$22,539	N/A	$30,052
Reclamation Monitoring	$0	$0	N/A	$0
Subtotal Reclamation Monitoring	**$8,979**	**$23,341**	**$37,162**	**$69,482**
Water Quality Monitoring	$0	$0	$0	$0
TOTAL MONITORING	**$8,979**	**$23,341**	**$37,162**	**$69,482**

Clear Sheet

Water and Rock Sample Analysis

Description	Samples #	Events/Year	No. Years	First Sample Year closure year (1-100)	No. of Samplers	Days/Event	Hrs/Day	Analysis Cost $/sample	Supplies $/sample	Lab Cost $
										$0.00

Notes: Sampling labor cost = No. Samplers x Years x Events/year x Days/event x Hour/Day x Labor Rate
Sampling equipment costs include 1 pickup truck for every two samplers

Ground & Surface Water Monitoring

Pump Costs

Description	No. of units		Years		Cost $
Pump (purchased)		Replacement period (yrs):			$0
				Subtotal Field Work	**$0**

Notes: Replacement period = frequency of pump replacement

Reporting

Description	Hrs/Event	Rate $/hr	Cost $
Field Geologist/Engineer			
		Subtotal Reporting	

Notes:

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Closure Cost Estimate
Constr. Mgmt

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Clear Sheet

Construction Management & Road Maintenance - Cost Summary	Labor	Equipment	Materials	Totals
Construction Management	$0	$0	N/A	$0
Construction Support		$0		$0
Road Maintenance	$180,263	$139,892	$0	$320,155
TOTAL CONSTRUCTION MANAGEMENT	**$180,263**	**$139,892**	**$0**	**$320,155**

Construction Management

Construction Management Staff

Description	Duration mo.	Hours/ Month hr.	Number of Supervisors	Supervisor Rate $/hr	Labor Cost $	Equipment Cost(1) $	Totals $
Active Reclamation					$0	$0	$0
Monitoring & Maintenance					$0	$0	$0
				Total Staff	**$0**	**$0**	**$0**

Construction Management Support

Description	Duration mo.	Number of Units		Rental Rate $/mo	Generator Cost $/mo	Equipment Cost(1) $	Totals $
Temporary Office Rental						$0	$0
Temporary Toilets						$0	$0
					Total Support	**$0**	**$0**

Notes: Office rental assumes only 1 generator required for every 4 trailers

Total Construction Management **$0**

Road Maintenance

Description	Fleet Size (select)	Number	Duration mo.	Hours/ Month hr.	Labor Cost $	Equipment Cost $	Totals $
Active Reclamation							
Water Truck	**Small**	**1**	**17**	**72**	$76,947	$60,612	$137,559
Grader	**Small**	**1**	**17**	**72**	$73,585	$56,466	$130,051
Monitoring & Maintenance							
Water Truck	**Small**				$0	$0	$0
Grader	**Small**	**1**	**3**	**160**	$29,731	$22,814	$52,545
Description	**Gallons/ Day**	**Days/ Month**	**Duration mo.**	**Cost/ Gallon $**			**Totals $**
Water Fees							
Water Fees							$0
				Total Project Maintenance	**$180,263**	**$139,892**	**$320,155**

Notes: 1) Supervisor equipment = pickup truck
Duration: 3 years * 5.5 months/year.
2) Road Maintenance Hawk Inlet to WTP
Duration: 12 hours * 40 days (Frequency: grade the road once every 2.5 years)

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Closure Cost Estimate
Labor Rates

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Color Code Key	
User Input - Direct Input	Direct Input
User Input - Pull Down List	Pull Down Selection
Program Constant (can override)	Alternate Input
Program Calculated Value	Locked Cell - Formula or Reference

ZONE ADJUSTMENTS			
Cost Basis/Project Region	Greens Creek 2019 - November 2019		Equipment rental inflation adjusted from 2014 estimate. Cost(2019) = Cost(2014) * 1.0656 (Anchorage CPI 2014-2019)
Power Equipment Operators	none	$0.00	
Truck Drivers	none	$0.00	
Laborers	none	$0.00	
INDIRECT COSTS			
Unemployment (%)			
Retirement/SS/Medicare (%)			
Workman's Compensation (%)			
Other Indirects			
State Payroll Tax (13),(15),(17),(			
Total Other Indirects	**0.00%**		

HOURLY LABOR RATE TABLE

EQUIPMENT TYPE (1) OR JOB DESCRIPTION	Labor Group	Base Rate ($/hr)	Zone Adjustment ($/hr)	Hourly Wage ($/hr)	Fringe ($/hr)	Retirement/ Medicare ($/hr)	Unemployment Insurance ($/hr)	Workman's Compensation ($/hr)	Other Indirect Costs ($/hr)	Additional User Markups to Base Rate† ($/hr)	%	($/hr)	Total ($/hr)
Equipment Operators ($/hr) (2)													
Bulldozers													
D6R	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
D6R w/ Winch	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
D7R	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
D8R	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
D9R	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
D10R	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
D11R	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
Wheeled Dozers													
824G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
834G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
844	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
854G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
Motor Graders													
120H	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
14G/H	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
16G/H	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
24M	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
Track Excavators													
312C	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
320C	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
325C	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
330C	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
345B	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
365BL	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
385BL	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
Scrapers													
631G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
637G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
Wheeled Loaders													
924G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
928G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
950G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
966G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
972G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
980G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
988G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
990	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
992G	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
994D	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
L2350	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
Shovels													
PC2000	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
PC3000	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
PC4000	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
PC5500	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
PC8000	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
Hydraulic Hammers													
H-120 (fits 325)													
H-160 (fits 345)													
H-180 (fits 365/385)													
Demolition Shears													
S340 (fits 322/325/330)													
S365 (fits 330/345)													
S390 (fits 365/385)													
Demolition Grapples													
G315 (fits 322/325)													
G320 (fits 325/330)													
G330 (fits 345/365)													

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Closure Cost Estimate
Labor Rates

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Color Code Key	
User Input - Direct Input	Direct Input
User Input - Pull Down List	Pull Down Selection
Program Constant (can override)	Alternate Input
Program Calculated Value	Locked Cell - Formula or Reference

ZONE ADJUSTMENTS

Cost Basis/Project Region	Greens Creek 2019 - November 2019	Equipment rental inflation adjusted from 2014 estimate. Cost(2019) = Cost(2014) * 1.0656 (Anchorage CPI 2014-2019)
Power Equipment Operators	none	$0.00
Truck Drivers	none	$0.00
Laborers	none	$0.00

INDIRECT COSTS

Unemployment (%)	
Retirement/SS/Medicare (%)	
Workman's Compensation (%)	

Other Indirects

State Payroll Tax (13),(15),(17),(	
Total Other Indirects	**0.00%**

HOURLY LABOR RATE TABLE

Other Equipment													
420D 4WD Backhoe	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
428D 4WD Backhoe	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
CS533E Vibratory Roller	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
CS633E Vibratory Roller	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
CP533E Sheepsfoot Compactor	A2105	$64.77	$0.00	$64.77	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.77
CP633E Sheepsfoot Compactor	A2105	$64.77	$0.00	$64.77	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.77
Light Truck - 1.5 Ton	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
Supervisor's Truck	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
Flatbed Truck	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
Air Compressor + tools	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
Welding Equipment	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
Heavy Duty Drill Rig	S2204	$71.84	$0.00	$71.84	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$71.84
Pump (plugging) Drill Rig	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
Concrete Pump					$0.00							$0	
Gas Engine Vibrator	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
Generator 5KW					$0.00							$0	
HDEP Welder (pipe or liner)					$0.00							$0	
5 Ton Crane	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
20 Ton Crane	A1601	$60.71	$0.00	$60.71	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$60.71
50 Ton Crane	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94
120 Ton Crane	A1602	$61.94	$0.00	$61.94	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$61.94

NOTES:

(1) Equipment Type:	Catepillar model or equivalent, LeTourneau
(2) Equipment Operator Source:	
(3) Zone Basis:	

Truck Drivers ($/hr) (4)

725	A2101	$63.62	$0.00	$63.62	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$63.62
730	A2101	$63.62	$0.00	$63.62	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$63.62
735	A2101	$63.62	$0.00	$63.62	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$63.62
740	A2102	$64.75	$0.00	$64.75	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.75
769D	A2102	$64.75	$0.00	$64.75	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.75
773E	A2102	$64.75	$0.00	$64.75	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.75
777D	A2102	$64.75	$0.00	$64.75	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.75
785C	A2102	$64.75	$0.00	$64.75	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.75
793C	A2102	$64.75	$0.00	$64.75	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.75
797B	A2102	$64.75	$0.00	$64.75	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.75
613E (5,000 gal) Water Wagon	A2105	$64.77	$0.00	$64.77	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.77
621E (8,000 gal) Water Wagon	A2105	$64.77	$0.00	$64.77	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.77
777D Water Truck	A2105	$64.77	$0.00	$64.77	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.77
785C Water Truck	A2105	$64.77	$0.00	$64.77	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.77
Dump Truck (10-12 yd3)	A2105	$64.77	$0.00	$64.77	$0.00	$0.00	$0.00	$0.00	$0.00			$0	$64.77

NOTES:

(4) Truck Driver Source:	
(5) Zone Basis:	

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Closure Cost Estimate
Labor Rates

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Color Code Key	
User Input - Direct Input	Direct Input
User Input - Pull Down List	Pull Down Selection
Program Constant (can override)	Alternate Input
Program Calculated Value	Locked Cell - Formula or Reference

ZONE ADJUSTMENTS

Cost Basis/Project Region	Greens Creek 2019 - November 2019	Equipment rental inflation adjusted from 2014 estimate. Cost(2019) = Cost(2014) * 1.0656 (Anchorage CPI 2014-2019)
Power Equipment Operators	none	$0.00
Truck Drivers	none	$0.00
Laborers	none	$0.00

INDIRECT COSTS

Unemployment (%)	
Retirement/SS/Medicare (%)	
Workman's Compensation (%)	

Other Indirects

State Payroll Tax (13),(15),(17),(	
Total Other Indirects	**0.00%**

HOURLY LABOR RATE TABLE

Laborers ($/hr) (6,7)

General Laborer	S1201	$68.26	$0.00	$68.26		$0.00	$0.00	$0.00	$0.00			$0	$68.26
Skilled Laborer	S1203	$69.52	$0.00	$69.52		$0.00	$0.00	$0.00	$0.00			$0	$69.52
Driller's Helper	A1604	$62.10	$0.00	$62.10		$0.00	$0.00	$0.00	$0.00			$0	$62.10
Rodmen (reinforcing concrete)	S0401	$63.69	$0.00	$63.69		$0.00	$0.00	$0.00	$0.00			$0	$63.69
Cement finisher	S0401	$63.69	$0.00	$63.69		$0.00	$0.00	$0.00	$0.00			$0	$63.69
Carpenter	A0301	$61.77	$0.00	$61.77		$0.00	$0.00	$0.00	$0.00			$0	$61.77

NOTES:

(6) Laborer Source:	Alaska DB 2018
(7) Carpenter Source:	Alaska DB 2018
(8) Zone Basis:	

Project Management and Technical Labor ($/hr) (9)

Project Manager												$0	
Foreman		$88.76	$0.00	$88.76		$0.00	$0.00	$0.00	$0.00			$0	$88.76
Field Geologist/Engineer													
Field Tech/Sampler		$88.76	$0.00	$88.76		$0.00	$0.00	$0.00	$0.00			$0	$88.76
Range Scientist													
Senior Planning Engineer													
Project Engineer													
Mechanic/Fitter													

NOTES:

(9) Project Manager:	
(9) Foreman Source:	
(9) Techical Labor Source:	
Other Labor Source:	
Other Labor Source:	
†Additional User Markups	
(These are added by the user to the	
base rate to account for site-specific	
conditions or corporate requirements)	

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Closure Cost Estimate
Equipment Costs

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Monthly Rental Basis: 486 hrs month

EQUIPMENT RENTAL RATE TABLE

EQUIPMENT TYPE (1)	Monthly Owner/Rental Rate	Equipment Hourly Rate	Fuel/Lube/ Wear	Total Rate
Bulldozers				
D6R	$18,805.00	$38.69	$37.56	$76.25
D6R w/ Winch	$22,566.00	$46.43	$37.56	$83.99
D7R	$27,267.25	$56.11	$44.90	$101.00
D8R	$31,028.25	$63.84	$56.78	$120.62
D9R	$37,610.00	$77.39	$81.92	$159.30
D10R			$104.07	$104.07
D11R			$150.64	$150.64
Wheeled Dozers				
824G			$44.55	$44.55
834G			$52.21	$52.21
844			$62.16	$62.16
854G			$78.73	$78.73
Motor Graders				
120H	$15,044.00	$30.95	$16.58	$47.53
14G/H	$26,327.00	$54.17	$56.97	$111.14
16G/H	$36,669.75	$75.45	$68.29	$143.74
24M			$64.23	$64.23
Track Excavators				
312C	$9,026.40	$18.57	$7.79	$26.36
320C	$13,915.70	$28.63	$29.43	$58.06
325C	$15,984.25	$32.89	$37.65	$70.54
330C	$22,566.00	$46.43	$33.98	$80.41
345B	$26,327.00	$54.17	$50.54	$104.71
365BL	$43,251.50	$88.99	$61.20	$150.19
385BL			$91.99	$91.99
Scrapers				
631G			$87.50	$87.50
637G			$125.68	$125.68
Wheeled Loaders				
924G	$6,957.85	$14.32	$16.62	$30.93
928G	$8,462.25	$17.41	$28.73	$46.14
950G	$14,103.75	$29.02	$23.60	$52.62
966G	$19,745.25	$40.63	$50.28	$90.91
972G	$22,566.00	$46.43	$55.00	$101.44
980G	$26,327.00	$54.17	$45.05	$99.22
988G	$41,371.00	$85.13	$90.76	$175.88
990	$65,817.49	$135.43	$70.44	$205.87
992G	$122,232.49	$251.51	$176.07	$427.58
994D			$149.18	$149.18
L2350			$273.49	$273.49
Shovels				
PC2000			$153.32	$153.32
PC3000			$207.19	$207.19
PC4000			$290.07	$290.07
PC5500			$493.11	$493.11
PC8000			$617.43	$617.43
Hydraulic Hammers				
H-120 (fits 325)	$15,984.25	$32.89	$5.29	$38.17
H-160 (fits 345)	$26,327.00	$54.17	$10.30	$64.48
H-180 (fits 365/385)	$32,908.75	$67.71	$12.21	$79.93
Demolition Shears				
S340 (fits 322/325/330)				$0.00
S365 (fits 330/345)				$0.00
S390 (fits 365/385)				$0.00
Demolition Grapples				
G315 (fits 322/325)				$0.00
G320 (fits 325/330)				$0.00
G330 (fits 345/365)				$0.00
Other Equipment				
420D 4WD Backhoe	$5,077.35	$10.45	$19.13	$29.58
428D 4WD Backhoe	$6,205.65	$12.77	$19.13	$31.90
CS533E Vibratory Roller	$9,402.50	$19.35	$15.54	$34.89
CS633E Vibratory Roller	$14,103.75	$29.02	$19.68	$48.70
CP533E Sheepsfoot Compactor	$9,402.50	$19.35	$15.54	$34.89
CP633E Sheepsfoot Compactor	$141,037.49	$290.20	$19.68	$309.88
Light Truck - 1.5 Ton	$2,350.62	$4.84	$6.22	$11.05
Supervisor's Truck	$3,290.87	$6.77	$4.14	$10.92
Flatbed Truck	$3,290.87	$6.77	$19.48	$26.25
Air Compressor + tools	$1,598.42	$3.29	$4.14	$7.43
Welding Equipment	$846.22	$1.74	$8.29	$10.03
Heavy Duty Drill Rig	$31,968.50	$65.78	$49.73	$115.50
Pump (plugging) Drill Rig	$1,410.37	$2.90	$41.44	$44.34
Concrete Pump	$6,111.62	$12.58	$41.44	$54.01
Gas Engine Vibrator	$1,175.31	$2.42	$4.14	$6.56
Generator 5KW	$713.42	$1.47	$6.22	$7.68
HDEP Welder (pipe or liner)	$2,820.75	$5.80	$8.29	$14.09
5 Ton Crane	$8,462.25	$17.41	$12.43	$29.84
20 Ton Crane	$16,924.50	$34.82	$16.58	$51.40
50 Ton Crane	$26,327.00	$54.17	$19.48	$73.65
120 Ton Crane	$47,012.50	$96.73	$21.55	$118.28
Trucks				
725	$22,566.00	$46.43	$35.49	$81.92
730	$24,446.49	$50.30	$37.95	$88.25
735	$30,087.99	$61.91	$53.56	$115.47
740	$33,849.00	$69.65	$55.34	$124.99
769D			$38.33	$38.33
773E			$48.69	$48.69
777D			$69.41	$69.41
785C			$100.49	$100.49
793C			$173.00	$173.00
797B			$243.45	$243.45
613E (5,000 gal) Water Wagon	$8,462.25	$17.41	$33.61	$51.02
621E (8,000 gal) Water Wagon			$44.55	$44.55
777D Water Truck			$69.41	$69.41
785C Water Truck			$100.49	$100.49
Dump Truck (10-12 yd^3)	$8,462.25	$17.41	$23.27	$40.68

NOTES:

(1) Power Equipment Source:	
(2) Power Equipment Type:	Catepillar model or equivalent, LeTourneau loader, Komatsu shovels
(3) Drilliing Equipment Source:	
(4) Other Equipment Source:	
(5) Drill rig includes support (pipe) truck	

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Closure Cost Estimate
Equipment Costs

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm

FUEL, LUBE AND WEAR CALCULATIONS

EQUIPMENT TYPE	PM Cost Per Hour (1)	Under carriage or Tires (2)	G.E.T Consumption (3)	Fuel Use Rate gal/hr (4)	Cost@ 4.14/gal	Total Hourly Equipment Cost
Bulldozers						
D6R	$7.08		$4.58	6.25	$25.90	$37.56
D6R w/ Winch	$7.08		$4.58	6.25	$25.90	$37.56
D7R	$7.02		$6.80	7.50	$31.08	$44.90
D8R	$7.60		$8.78	9.75	$40.40	$56.78
D9R	$9.22		$13.65	14.25	$59.05	$81.92
D10R	$10.38		$19.11	18.00	$74.59	$104.07
D11R	$12.44		$28.40	26.50	$109.81	$150.64
Wheeled Dozers						
824G		$0.00		10.75	$44.55	$44.55
834G		$0.00		12.60	$52.21	$52.21
844		$0.00		15.00	$62.16	$62.16
854G		$0.00		19.00	$78.73	$78.73
Motor Graders						
120H				4.00	$16.58	$16.58
14G/H	$6.16	$11.26	$13.65	6.25	$25.90	$56.97
16G/H	$5.00	$13.55	$18.66	7.50	$31.08	$68.29
24M				15.50	$64.23	$64.23
Track Excavators						
312C				1.88	$7.79	$7.79
320C	$4.97		$4.16	4.90	$20.30	$29.43
325C	$5.07		$5.23	6.60	$27.35	$37.65
330C				8.20	$33.98	$33.98
345B			$6.62	10.60	$43.92	$50.54
365BL	$6.50			13.20	$54.70	$61.20
385BL	$7.41		$12.06	17.50	$72.52	$91.99
Scrapers						
631G		$17.83	$7.51	15.00	$62.16	$87.50
637G		$17.83	$9.44	23.75	$98.42	$125.68
Wheeled Loaders						
924G		$5.22		2.75	$11.40	$16.62
928G	$4.92	$5.22	$4.08	3.50	$14.50	$28.73
950G		$7.03		4.00	$16.58	$23.60
966G	$5.91	$11.01	$9.53	5.75	$23.83	$50.28
972G	$6.04	$11.01	$12.05	6.25	$25.90	$55.00
980G		$13.97		7.50	$31.08	$45.05
988G	$9.07	$18.65	$12.89	12.10	$50.14	$90.76
990				17.00	$70.44	$70.44
992G	$12.96	$37.27	$30.54	23.00	$95.31	$176.07
994D				36.00	$149.18	$149.18
L2350				66.00	$273.49	$273.49
Shovels						
PC2000				37.00	$153.32	$153.32
PC3000				50.00	$207.19	$207.19
PC4000				70.00	$290.07	$290.07
PC5500				119.00	$493.11	$493.11
PC8000				149.00	$617.43	$617.43
Hydraulic Hammers						
H-120 (fits 325)	N/A		$5.29			$5.29
H-160 (fits 345)	N/A		$10.30			$10.30
H-180 (fits 365/385)	N/A		$12.21			$12.21
Demolition Shears						
S340 (fits 322/325/330)	N/A					$0.00
S365 (fits 330/345)	N/A					$0.00
S390 (fits 365/385)	N/A					$0.00
Demolition Grapples						
G315 (fits 322/325)	N/A					$0.00
G320 (fits 325/330)	N/A					$0.00
G330 (fits 345/365)	N/A					$0.00
Other Equipment						
420D 4WD Backhoe	$3.51		$3.20	3.00	$12.43	$19.13
428D 4WD Backhoe	$3.51		$3.20	3.00	$12.43	$19.13
CS533E Vibratory Roller				3.75	$15.54	$15.54
CS633E Vibratory Roller				4.75	$19.68	$19.68
CP533E Sheepsfoot Compactor				3.75	$15.54	$15.54
CP633E Sheepsfoot Compactor				4.75	$19.68	$19.68
Light Truck - 1.5 Ton				1.50	$6.22	$6.22
Supervisor's Truck				1.00	$4.14	$4.14
Flatbed Truck				4.70	$19.48	$19.48
Air Compressor + tools			N/A	1.00	$4.14	$4.14
Welding Equipment			N/A	2.00	$8.29	$8.29
Heavy Duty Drill Rig				12.00	$49.73	$49.73
Pump (plugging) Drill Rig				10.00	$41.44	$41.44
Concrete Pump			N/A	10.00	$41.44	$41.44
Gas Engine Vibrator			N/A	1.00	$4.14	$4.14
Generator 5KW			N/A	1.50	$6.22	$6.22
HDEP Welder (pipe or liner)			N/A	2.00	$8.29	$8.29
5 Ton Crane				3.00	$12.43	$12.43
20 Ton Crane				4.00	$16.58	$16.58
50 Ton Crane				4.70	$19.48	$19.48
120 Ton Crane				5.20	$21.55	$21.55
Trucks						
725	$16.02			4.70	$19.48	$35.49
730	$16.40			5.20	$21.55	$37.95
735	$23.10			7.35	$30.46	$53.56
740	$24.88			7.35	$30.46	$55.34
769D				9.25	$38.33	$38.33
773E				11.75	$48.69	$48.69
777D				16.75	$69.41	$69.41
785C				24.25	$100.49	$100.49
793C				41.75	$173.00	$173.00
797B				58.75	$243.45	$243.45
613E (5,000 gal) Water Wagon	$7.71	$1.03		6.00	$24.86	$33.61
621E (8,000 gal) Water Wagon				10.75	$44.55	$44.55
777D Water Truck				16.75	$69.41	$69.41
785C Water Truck				24.25	$100.49	$100.49
Dump Truck (10-12 yd3) (5)	N/A	$1.72	N/A	5.20	$21.55	$23.27

Notes:

(1) PM Source:	
(2) Undercarriage Source:	
(3) G.E.T. Source:	
(4) Fuel Use Source:	Caterpillar Handbook, Edition 35, Ch. 20; or estimated average for smaller vehicles
(5) Dump Truck Oper. Cost Source:	Means Heavy Construction (2008)

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Closure Cost Estimate
Equipment Costs

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm

TIRE COST TABLES

Equipment	Tire Size	# of Tires Per Piece of Equipment	Cost Per Tire	Tire Cost (1)(2)	Life Expectency Hours (Low/Zone A) (3)	Tire Cost per Hour
Bulldozers						
D6R			N/A			
D6R w/ Winch			N/A			
D7R			N/A			
D8R			N/A			
D9R			N/A			
D10R			N/A			
D11R			N/A			
Wheeled Dozers						
824G	29.5R25	4		$0.00	3,500	$0.00
834G	35/65-R33	4		$0.00	3,500	$0.00
844	45/65-R39	4		$0.00	3,500	$0.00
854G	45/65-R45	4		$0.00	3,500	$0.00
Motor Graders						
120H	13PR24	6		$0.00	3,500	
14G/H	20.5R25	6	$6,570.29	$39,421.72	3,500	$11.26
16G/H	23.5R25	6	$7,905.72	$47,434.31	3,500	$13.55
24M	23.5R25	6		$0.00	3,500	
Track Excavators						
312C			N/A			
320C			N/A			
325C			N/A			
330C			N/A			
345B			N/A			
365BL			N/A			
385BL			N/A			
Scrapers						
631G	37.25R35	4	$17,826.54	$71,306.16	4,000	$17.83
637G	37.25R35	4	$17,826.54	$71,306.16	4,000	$17.83
Wheeled Loaders						
924G	17.5R25	4	$5,872.19	$23,488.77	4,500	$5.22
928G	17.5R25	4	$5,872.19	$23,488.77	4,500	$5.22
950G	26.5R25	4	$7,905.72	$31,622.87	4,500	$7.03
966G	26.5R25	4	$12,387.22	$49,548.87	4,500	$11.01
972G	26.5R25	4	$12,387.22	$49,548.87	4,500	$11.01
980G	29.5R25	4	$15,721.18	$62,884.72	4,500	$13.97
988G	35/65-33	4	$20,985.51	$83,942.04	4,500	$18.65
990	41.25/70-39	4		$0.00	4,500	
992G	45/65R45	4	$41,926.82	$167,707.28	4,500	$37.27
994D	55/85R57	4		$0.00	4,500	
L2350	55/85R57	4		$0.00	4,500	
Shovels						
PC2000			N/A			
PC3000			N/A			
PC4000			N/A			
PC5500			N/A			
PC8000			N/A			
Hydraulic Hammers						
H-120 (fits 325)			N/A			
H-160 (fits 345)			N/A			
H-180 (fits 365/385)			N/A			
Demolition Shears						
S340 (fits 322/325/330)			N/A			
S365 (fits 330/345)			N/A			
S390 (fits 365/385)			N/A			
Demolition Grapples						
G315 (fits 322/325)			N/A			
G320 (fits 325/330)			N/A			
G330 (fits 345/365)			N/A			
Other Equipment						
420D 4WD Backhoe	340/80R18-19.5LR24	2		$0.00	3,000	
428D 4WD Backhoe	340/80R18-16.9R28	2		$0.00	3,000	
CS533E Vibratory Roller			N/A			
CS633E Vibratory Roller			N/A			
CP533E Sheepsfoot Compactor			N/A			
CP633E Sheepsfoot Compactor			N/A			
Light Truck - 1.5 Ton		4		$0.00	3,000	
Supervisor's Truck		4		$0.00	3,000	
Flatbed Truck		22		$0.00	3,000	
Air Compressor + tools			N/A			
Welding Equipment			N/A			
Heavy Duty Drill Rig		4		$0.00	3,000	
Pump (plugging) Drill Rig		4		$0.00	3,000	
Concrete Pump			N/A			
Gas Engine Vibrator			N/A			
Generator 5KW			N/A			
HDEP Welder (pipe or liner)			N/A			
5 Ton Crane		4		$0.00	3,000	
20 Ton Crane		4		$0.00	3,000	
50 Ton Crane		6		$0.00	3,000	
120 Ton Crane		6		$0.00	3,000	
Trucks						
725	23.5R25	6		$0.00	2,000	
730	23.5R25	6		$0.00	2,000	
735	26.5R25	6		$0.00	2,000	
740	29.5R25	6		$0.00	2,000	
769D	18.00R33	6		$0.00	6,000	
773E	24.00R35	6		$0.00	5,000	
777D	27.00R49	6		$0.00	5,000	
785C	33.00R51	6		$0.00	4,000	
793C	40.00R57	6		$0.00	4,000	
797B	40.00R57	6		$0.00	4,000	
613E (5,000 gal) Water Wagon	23.5R25	6	$1,031.50	$6,189.00	6,000	$1.03
621E (8,000 gal) Water Wagon	33.25R29	6		$0.00	8,000	
777D Water Truck	27.00R49	6		$0.00	5,000	
785C Water Truck	33.00R51	6		$0.00	4,000	
Dump Truck (10-12 yd3)		10	$1,031.50	$10,315.01	6,000	$1.72

Notes:

(1) Unit Cost Basis:	
(2) Cost Basis:	
(3) Tire Cost Source:	
(4) Tire Wear Source:	

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Closure Cost Estimate
Material Costs

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Color Code Key	
User Input - Direct Input	**Direct Input**
User Input - Pull Down List	**Pull Down Selection**
Program Constant (can override)	**Alternate Input**
Program Calculated Value	**Locked Cell - Formula or Reference**

Revegetation Materials

Seed Mixes

Seed Mix	Description		Cost/Acre
None			
Mix 1	Basins		$1,004.46
Mix 2	Low Hills		
Mix 3	Uplands		
Mix 4	Riparian or Custom		
User Mix 1			
User Mix 2			
User Mix 3			
User Mix 4			
	Cost/lb	**lbs/Acre**	**Cost/Acre**
User Mix 5 (from Seed Mix shee	#DIV/0!	$0.00	$0.00
Notes:			

Mulch

Item	Cost/lb	lbs/Acre	Cost/Acre
None			
Straw Mulch		10	
Hydro Mulch		10	
Timber Mulch		10	
		10	
Notes:			

Revegetation Method

Slopes

Disturbance Type	Seed Application Method	Labor Cost/Acre	Equipment Cost/Acre	Total Cost/Acre
Waste Rock Dumps	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Heap Leach	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Tailings	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Quarries & Borrow Pits	**Mechanical Broadcast**	$39.61	$21.67	$61.29

Flat Areas and Undifferentiated

Disturbance Type	Seed Application Method	Labor Cost/Acre	Equipment Cost/Acre	Total Cost/Acre
Exploration Trenches	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Exploration Roads	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Waste Rock Dumps	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Heap Leach	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Tailings	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Quarries & Borrow Pits	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Roads	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Pits	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Haul Material	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Foundations & Buildings	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Sediment & Drainge Control	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Process Ponds	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Landfills	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Yards, Etc.	**Mechanical Broadcast**	$39.61	$21.67	$61.29
Revegetation Maintenance	**Mechanical Broadcast**	$39.61	$21.67	$61.29

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Closure Cost Estimate
Material Costs

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Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Amendments			
Item	Cost/lb	lbs/Acre	Cost/Acre
None			
Organic Matter		10	
Treated Sludge		10	
Chemical		10	
		10	
Notes:			

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Closure Cost Estimate
Material Costs

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Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Well Abandonment Materials

Description	Cost/50lb bag	Units	Cost/unit*
Cement	$52.49	cy	$249.97
Grout (Low Grade Bentonite)	$13.74	cy	$65.44
Inert Material/Cuttings		cy	
		cy	
		cy	

* Assumes 1 bag mixes with water to make 0.21 y3 or 0.16 m3 of grout/cement slurry.

Monitoring Costs

Description	Units	Cost/unit
Monitor Well Pump	ea.	$2,291.04
Sampling Supplies	ea.	$0.00
Underground Care and Maintenanc	ea.	$68,198.40
Suite Q	ea.	$625.00
QA/QC	ea.	$625.00
Stormwater - sites	ea.	$156.00
APDES - discharge	ea.	$113.45
Hawk Inlet seawater sampling	ea.	$3,175.00
Hawk Inlet sediment and organism	ea.	$25,104.00
Site-wide vegetation	ea.	$512.31
Shipping	ea.	$83.33
PSI Report	ea.	$50,000.00
IMP Sulfate	ea.	$17.11
	ea.	
	ea.	
	ea.	
	ea.	

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Fuel, Etc.

Description	Units	Cost/unit	User Overrides
Off-road Diesel - delivered (1)	$/gal	$4.144	
Pickup Truck Mileage	$/mi		
Electical Power	$/kWh	$0.150	
Diesel power	$/kWh	$0.320	
Water treatment reagents	$/gal		

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Closure Cost Estimate
Misc. Unit Costs

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Revegetation

	Means Number	Unit	Crew	Daily Output	Daily Output User	Materials	Labor	Equipment	Total	Notes
Seeding - Broadcast Hand (1)		acres					$0.00	$0.00	$0.00	
Seeding - Broadcast Mechanical (1)		acres					$39.61	$21.67	$61.29	
Seeding - Drill (1)		acres		365			$39.61	$21.67	$61.29	
Seeding - Hydroseeding (1)				365			$39.61	$21.67	$61.29	
Shrub Planting - bare root 6-10 in (150- 250mm) (2)	02910-400-0561	ea.	1 Clab	365			$1.50	$0.00	$1.50	
Tree Planting - bare root 11-16 in (270- 400mm) (3)	02910-400-0562	ea.	1 Clab	260			$2.10	$0.00	$2.10	
Cactus Planting (4)		ea.	1 Clab						$0.00	
NOTES:										
(1) Seeding Source:										
(2) Shrub Source:										
(3) Tree Source:										
(4) Cactus Source:										

Building and Wall Demolition

Hourly productivity rates and crew composition from Means Heavy Construction 2005 Edition by permission of R.S.Means/Reed Construction Data .
All equipment, labor and material unit costs are from Labor Costs, Equipment Costs and Material Costs spreadsheets

	Means Number	Unit	Crew	Daily Output	Daily Output User	Labor	Equipment	Premium	Total	Notes
Building Demolition										
Lg. steel	02220-110-0012	C.F.	B-8	21500		$0.11	$0.02		$0.13	
Lg. concrete	02220-110-0050	C.F.	B-8	15300		$0.15	$0.03		$0.18	
Lg. masonry	02220-110-0080	C.F.	B-8	20100		$0.11	$0.02		$0.13	
Lg. mixed	02220-110-0100	C.F.	B-8	20100		$0.11	$0.02		$0.13	
Sm. steel	02220-110-0500	C.F.	B-3	14800		$0.23	$0.07		$0.30	
Sm. concrete	02220-110-0600	C.F.	B-3	11300		$0.30	$0.09		$0.39	
Sm. masonry	02220-110-0650	C.F.	B-3	14800		$0.23	$0.07		$0.30	
Sm. wood	02220-110-0700	C.F.	B-3	14800		$0.23	$0.07		$0.30	
Wall Demolition										
Block 4 in (100 mm) thick	02220-130-2000	S.F.	1 Clab	180		$3.03	$0.00	20%	$3.64	
Block 6 in (150 mm) thick	02220-130-2040	S.F.	1 Clab	170		$3.21	$0.00	20%	$3.85	
Block 8 in (200 mm) thick	02220-130-2080	S.F.	1 Clab	150		$3.64	$0.00	20%	$4.37	
Block 12 in (300 mm) thick	02220-130-2100	S.F.	1 Clab	150		$3.64	$0.00	20%	$4.37	
Conc 6 in (150 mm) thick	02220-130-2400	S.F.	B-9	160		$21.13	$0.37	10%	$23.65	
Conc 8 in (200 mm) thick	02220-130-2420	S.F.	B-9	140		$24.14	$0.42	10%	$27.02	
Conc 10 in (250 mm) thick	02220-130-2440	S.F.	B-9	120		$28.17	$0.50	10%	$31.54	
Conc 12 in (300 mm) thick	02220-130-2500	S.F.	B-9	100		$33.80	$0.59	10%	$37.83	

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Closure Cost Estimate
Misc. Unit Costs

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Waste Disposal

Unit rates from Means Heavy Construction 2006 Edition by permission of R.S.Means/Reed Construction Data .

	Means Number	Unit	Crew	Daily Output	Materials	Labor	Equipment		Total	Notes
Rubbish Handling										
Dumpster delivery (average for all sizes)	02220-350-0910	ea.							$0.00	
Haul (average for all sizes)	02220-350-0920	ea.							$0.00	
Rent per month (average for all sizes)	02220-350-0940	ea.							$0.00	
Disposal fee per ton (tonne) (average for all sizes)	02220-350-0950	ton							$0.00	
NOTES:										
Dumpster Cost Source										
Dumpster Disposal Fee Source:										
Hazardous Material Handling - Solids (+ Liquids in drums)										
Pickup fees 55 gal (200 L). drums	02110-300-1100	ea.			$245.09				$245.09	
Bulk material (average)	02110-300-1220/1230	ton			$404.93				$404.93	
Transport - truck load (80 drums, 25 cy (m3), 18 tons)	02110-300-1260/1270	mile			$5.57				$5.57	
Dump site solid disposal fee	02110-300-6000/6020	ton			$284.52				$284.52	
NOTES:										
Solid Handling Cost Source										
Solid Disposal Fee Source:										
Hazardous Material Handling - Liquids										
Vacuum Truck Pickup (2200 gal/8300 L)	02110-300-3110	hr.			$137.46				$137.46	
Vacuum Truck Pickup (5000 gal/19000 L)	02110-300-3120	hr.			$196.07				$196.07	
Dump site liquid disposal fee	02110-300-6000/6020	ton			$284.52				$284.52	
NOTES:										
Liquid Handling Cost Source										
Liquid Disposal Fee Source:										
Hydrocarbon Contaminated Soils (HCS)										
Insitu Biotreatment	02115-200-2020/2021	C.Y.			$17.96				$17.96	
HCS disposal fee	02115-200-2050/2055	C.Y.			$284.52				$284.52	
NOTES:										
Insitu Treatment Cost Source										
HCS Disposal Fee Source:										

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Closure Cost Estimate
Misc. Unit Costs

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Concrete Structure Installation

Weekly dumpster rental rates from Means Heavy Construction 2005 Edition with permission by R.S.Means/Reed Construction Data .
Weekly dumpster rental rates include haul to off-site disposal site and disposal fees

	Means Number	Unit	Crew	Daily Output	Materials	Labor	Equipment	Premium	Total	Notes
Reinforced Concrete Bulkheads and Shaft Covers										
Grade walls - 15 in (400mm) thick, 8 ft (2.5m) high	03310-240-4300	C.Y.	C-14D	80.02	$145.99	$164.92	$7.15		$318.06	includes reinforcing
Grade walls - 15 in (400mm) thick, 12 ft (3.7m) high	03310-240-4350	C.Y.	C-14D	26.2	$145.99	$503.70	$21.83		$671.52	includes reinforcing
Elevated conc, 1-way beam & slab - 15ft (4.6m) span	03310-240-2700	C.Y.	C-14B	20.59	$240.83	$667.18	$27.78		$935.79	includes reinforcing
Elevated conc, 1-way beam & slab - 25ft (7.5m) span	03310-240-2750	C.Y.	C-14B	28.36	$232.30	$484.39	$20.17		$736.86	includes reinforcing
Bat Gate/Foam Plug Installation										
Bat Gate (5)		ea.			$2,911.64					materials $/ea. Installed
Culvert Gate (5)		ea.			$5,823.28					materials $/ea. Installed
Adit Foam Plug (6)		ea./C.Y.			$291.16					materials $/cy placed
Production Opening Foam Plug (6)		ea./C.Y.			$291.16					materials $/cy placed

NOTES:

(5) Bat Gate Source:

(6) Foam Plug Source:

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Closure Cost Estimate
Misc. Unit Costs

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Misc. Linear Projects

Hourly productivity rates and crew composition from Means Heavy Construction 2005 Edition by permission of R.S.Means/Reed Construction Data .
All equipment, labor and material unit costs are from Labor Costs, Equipment Costs and Material Costs spreadsheets

	Means Number	Unit	Crew	Daily Output	Materials	Labor	Equipment	Premium	Total	Notes
Fencing Installation										
Barbed 3-strand	02820-170-1650	L.F.	B-80A	760	$0.48	$2.79	$0.12		$3.39	
Barbed 4-strand	extrapolated	L.F.	B-80A	570	$0.64	$3.73	$0.16		$4.53	
Barbed 5-strand	02820-130-0920	L.F.	B-80A	456	$0.80	$4.66	$0.19		$5.65	
Chain link 8-10ft (2.5-3m) Install	02820-130-0920	L.F.	B-80C	180	$34.63	$11.80	$0.49		$46.92	
Wood stockade fence 6 ft (2 m) high - Install	02820-510-1240	L.F.	B-80C	150	$14.65	$14.16	$0.59		$29.40	
	user	L.F.							$0.00	
	user	L.F.							$0.00	
	user	L.F.							$0.00	
	user	L.F.							$0.00	
Fencing Removal										
Barbed 3-strand Removal	02220-220-1600	L.F.	2 Clab	430		$3.67	$0.21		$3.88	
Barbed 4-strand Removal	extrapolated	L.F.	2 Clab	355		$4.44	$0.25		$4.69	
Barbed 5-strand Removal	02220-220-1650	L.F.	2 Clab	280		$5.64	$0.32		$5.96	
Chain link 8-10 ft (2.5-3 m) Removal	02220-220-1700	L.F.	B-6	445		$3.57	$0.83		$4.40	
Wood, all types 4-6 ft ("1.5-2 m) high - Removal	02220-220-1775	L.F.	2 Clab	430		$3.67	$0.21		$3.88	
	user	L.F.								
	user	L.F.							$0.00	
	user	L.F.							$0.00	
	user	L.F.							$0.00	
Culvert Removal										
12 in (300 mm) Diameter	02220-220-2900	L.F.	B-6	175		$9.07	$2.11		$11.18	
18 in (450 mm) Diameter	02220-220-2930	L.F.	B-6	150		$10.58	$2.46		$13.04	
24 in (600 mm) Diameter	02220-220-2960	L.F.	B-6	120		$13.23	$3.08		$16.31	
36 in (1m) Diameter	02220-220-3000	L.F.	B-6	90		$17.64	$4.10		$21.74	
Pipeline Removal										
0.75 in (20mm) - 4 in (100 mm) diameter	02220-381-1600	L.F.	B-20	700		$3.28	$0.13		$3.41	
6 in (150 mm) - 8 in (200 mm)	02220-381-1700	L.F.	B-20	500		$4.60	$0.18		$4.78	
10 in (250 mm) - 18 in (450 mm)	02220-381-1800	L.F.	B-20	300		$7.66	$0.29		$7.95	
20 in (500 mm) - 36 in (1 m)	02220-381-1900	L.F.	B-20	200		$11.49	$0.44		$11.93	
Pipe and Drainpipe Installation										
Water 4in (100mm) 40ft (12m) length, welded HDPE	02510-760-0100	L.F.	B-22A	400	$3.67	$7.79	$3.27		$14.73	
Water 6in (150mm) 40ft (12m) length, welded HDPE	02510-760-0200	L.F.	B-22A	380	$8.31	$8.20	$3.44		$19.95	
Water 12in (300mm) 40ft (12m) length, welded HDPE	02510-760-0500	L.F.	B-22A	260		$11.98	$5.03		$17.01	
Drain 4in (100mm) perforated PVC	02620-630-2100	L.F.	B-14	315	$1.49	$12.27	$1.03		$14.79	
Drain 6in (150mm) perforated PVC	02620-630-2110	L.F.	B-14	300	$3.14	$12.89	$1.08		$17.11	
Drain 4in (100mm) corrugated, perf or plain	02620-660-0040	L.F.	2 Clab	1200	$0.58	$1.31	$0.07		$1.96	
Drain 6in (150mm) corrugated., perf or plain	02620-660-0060	L.F.	2 Clab	900	$1.82	$1.75	$0.10		$3.67	

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Closure Cost Estimate
Misc. Unit Costs

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Drain Rock Preparation										
Crushing		C.Y.								
Screening		C.Y.							$1.07	
TOTAL									$1.07	
Misc.										
Backhoe work	02210-700-0120	C.Y.	B-11M	28		$17.35	$8.45		$25.80	
Powerline and Transformer Removal										
Single Pole		mile							$40,466.58	
Double Pole		mile							$46,247.52	
Transformer (9)		ea.							$29,001.19	
NOTES:										
(7) Single Pole Source:										
(8) Double Pole Source:										
(9) Transformer Source:										

Erosion and Sedimentation Control

Hourly productivity rates and crew composition from Means Heavy Construction 2005 Edition by permission of R.S.Means/Reed Construction Data .
All equipment, labor and material unit costs are from Labor Costs, Equipment Costs and Material Costs spreadsheets

	Means Number	Unit	Crew	Daily Output	Materials	Labor	Equipment	Premium	Total	Notes
Rip-Rap & Rock Lining										
Rip-Rap 3/8 to 1/4 CY (m3) pieces, grouted	02370-450-0110	S.Y.	B-13	80	$21.31	$42.37	$7.37		$71.05	assumes on-site source of rip-rap
Rip-Rap 18 in (450 mm) min thick, no grout	02370-450-0200	S.Y.	B-13	53	$6.29	$63.96	$11.12		$81.37	assumes on-site source of rip-rap
Gabions, 6 in (150 mm) deep	02370-450-0400	S.Y.	B-13	200	$9.38	$16.95	$2.95		$29.28	assumes on-site source rock fill for gabions
Gabions, 9 in (250 mm) deep	02370-450-0500	S.Y.	B-13	163	$11.77	$20.80	$3.61		$36.18	assumes on-site source rock fill for gabions
Gabions, 12 in (300 mm) deep	02370-450-0200	S.Y.	B-13	153	$17.21	$22.16	$3.85		$43.22	assumes on-site source rock fill for gabions
Gabions, 18 in (450 mm) deep	02370-450-0200	S.Y.	B-13	102	$22.91	$33.23	$5.78		$61.92	assumes on-site source rock fill for gabions
Gabions, 36 in (1m) deep	02370-450-0200	S.Y.	B-13	60	$36.76	$56.50	$9.82		$103.08	assumes on-site source rock fill for gabions
HDEP Liner Installation										
Finish grading large area	2310-100-0100	S.F.	B-11L	54000		$0.02	$0.02		$0.04	
Compaction-riding, vibrating roller - 12in (300mm) lifts	2315-310-5100	C.Y.	B-10Y	2600		$0.40	$0.11		$0.51	
60 mil HDPE	2660-610-0010	S.F.	3 Skwk	1600	$0.46	$1.35	$0.22	10%	$2.23	
80 mil HDPE	user	S.F.	3 Skwk	149	$9.00	$14.46	$2.34		$25.80	
40 mil VLDPE	user	S.F.	3 Skwk	150	$7.00	$14.36	$2.33		$23.69	
	user	S.F.	3 Skwk	149		$14.46	$2.34		$16.80	
	user	S.F.	3 Skwk	149		$14.46	$2.34		$16.80	

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Closure Cost Estimate
Misc. Unit Costs

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Construction Management Support											
Office Trailer, Furnished, no hook-ups		0150-500-0250	mo.			$149.18				$149.18	
Toilet Portable, chemical		1590-400-6410	mo.			$211.20				$211.20	
TOTAL						$360.39				$360.39	
Pump and Casing Removal											
	Pump Type	**Measurement**	**Unit**				**Labor**	**Equipment**		**Total**	**Notes**
Pump Removal											
Submersible		ft to pump	L.F.				$2.54	$5.53		$8.08	
Line Shaft		ft to pump	L.F.				$5.94	$12.91		$18.84	
NOTES:											
(10) Pump Removal Source:											

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Fleets (Crews)

EQUIPMENT FLEETS

ACTIVITY AND FLEET		Standard Labor Crew	User Defined Labor Crew	EQUIPMENT UNIT COST (Hourly)	TOTAL LABOR UNIT COST (Hourly)	TOTAL COST (Hourly)
RIPPING						
Rip road						
Waste rock dumps, heaps, tails - rip flat surfaces						
Surface preparation						
Scarify						
Small Dozer w/ multi-shank						
D6R				$76.25	$61.94	$138.19
Totals				$76.25	$61.94	$138.19
Medium Dozer w/ multi-shank						
D8R				$120.62	$61.94	$182.56
Totals				$120.62	$61.94	$182.56
Large Dozer w/ multi-shank						
D10R				$104.07	$61.94	$166.01
Totals				$104.07	$61.94	$166.01
Grader w/ multi-shank						
16G/H				$143.74	$61.94	$205.68
Totals				$143.74	$61.94	$205.68
GRADING						
Grading storage and structure areas						
Grading waste rock dumps and heaps						
Grading landfills						
Constructing pit safety berms						
Small Dozer Fleet						
D6R				$76.25	$61.94	$138.19
Totals				$76.25	$61.94	$138.19
Medium Dozer Fleet						
D8R				$120.62	$61.94	$182.56
Totals				$120.62	$61.94	$182.56
Large Dozer Fleet						
D10R				$104.07	$61.94	$166.01
Totals				$104.07	$61.94	$166.01
EXPLORATION GRADING						
Backfilling and grading exploration trenches						
Grading flat exploration roads						
Small Dozer Fleet						
D7R				$101.00	$61.94	$162.94
Totals				$101.00	$61.94	$162.94
Medium Dozer Fleet						
D8R				$120.62	$61.94	$182.56
Totals				$120.62	$61.94	$182.56
Large Dozer Fleet						
D8R				$120.62	$61.94	$182.56
Totals				$120.62	$61.94	$182.56

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Fleets (Crews)

EQUIPMENT FLEETS

ACTIVITY AND FLEET		Standard Labor Crew	User Defined Labor Crew	EQUIPMENT UNIT COST (Hourly)	TOTAL LABOR UNIT COST (Hourly)	TOTAL COST (Hourly)
EXCAVATING						
Earthen Berms						
Diversion ditch excavation and backfill						
Underground openings backfill - excavate and place						
Pit berm construction (excavator option)						
Small Excavator						
325C				$70.54	$60.71	$131.25
Totals				$70.54	$60.71	$131.25
Medium Excavator						
345B				$104.71	$60.71	$165.42
Totals				$104.71	$60.71	$165.42
Large Excavator						
385BL				$91.99	$60.71	$152.70
Totals				$91.99	$60.71	$152.70
EXCAVATE AND RECONTOUR						
Recontour large roads (haul roads, access roads, etc.)						
Ponds - Excavate and pull liner and bury						
Small Excavator + Dozer						
325C				$70.54	$60.71	$131.25
D6R				$76.25	$61.94	$138.19
Total Equipment				$146.79	$122.65	$269.44
Medium Excavator + Dozer						
345B				$104.71	$60.71	$165.42
D9R				$159.30	$61.94	$221.24
Totals				$264.01	$122.65	$386.66
Large Excavator + Dozer						
385BL				$91.99	$60.71	$152.70
D10R				$104.07	$61.94	$166.01
Totals				$196.06	$122.65	$318.71
EXPLORATION ROAD/PAD RECONTOUR						
Recontour small roads (exploration roads, service roads, etc.)						
Cut and Fill reclamation on slopes						
Drill pad recountour						
Drill sump backfill						
Small Dozer						
D6R				$76.25	$61.94	$138.19
Totals				$76.25	$61.94	$138.19
Large Dozer						
D8R				$120.62	$61.94	$182.56
Totals				$120.62	$61.94	$182.56
Grader						
14G/H				$111.14	$61.94	$173.08
Totals				$111.14	$61.94	$173.08
Small Excavator						
320C				$58.06	$60.71	$118.77
Totals				$58.06	$60.71	$118.77
Medium Excavator						
345B				$104.71	$60.71	$165.42
Totals				$104.71	$60.71	$165.42

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Fleets (Crews)

EQUIPMENT FLEETS

ACTIVITY AND FLEET		Standard Labor Crew	User Defined Labor Crew	EQUIPMENT UNIT COST (Hourly)	TOTAL LABOR UNIT COST (Hourly)	TOTAL COST (Hourly)
LOAD, HAUL AND PLACE MATERIAL						
Rock placement						
Haul overburden for backfill						
Haul borrow for backfill						
Haul cover or growth media						
Small Truck/Loader Fleet						
740				$124.99	$64.75	$189.74
988G	**Loader**			$175.88	$61.94	$237.82
D7R		1		$101.00	$61.94	$162.94
Totals				$401.87	$188.63	$590.50
Medium Truck/Loader Fleet						
740				$124.99	$64.75	$189.74
988G	**Loader**			$175.88	$61.94	$237.82
D8R		1		$120.62	$61.94	$182.56
Totals				$421.49	$188.63	$610.12
Large Truck/Loader Fleet						
777D				$69.41	$64.75	$134.16
992G	**Loader**			$427.58	$61.94	$489.52
D10R		1		$104.07	$61.94	$166.01
Totals				$601.06	$188.63	$789.69
Extra Large Truck/Loader Fleet						
785C				$100.49	$64.75	$165.24
992G	**Loader**			$427.58	$61.94	$489.52
D11R		1		$150.64	$61.94	$212.58
Totals				$678.71	$188.63	$867.34
Scraper/Dozer Fleet						
631G				$87.50	$61.94	$149.44
D10R				$104.07	$61.94	$166.01
D7R		1		$101.00	$61.94	$162.94
Totals				$292.57	$185.82	$478.39
Tandem Scraper Fleet						
637G				$125.68	$61.94	$187.62
D7R		1		$101.00	$61.94	$162.94
Totals				$226.68	$123.88	$350.56
MISC. LOAD AND HAUL AND EARTHWORKS						
Sludge removal						
Drainage controls						
Misc. - Cat 325B Excavator / 10-12 yd3 Truck						
325C				$70.54	$60.71	$131.25
Dump Truck (10-12 yd3)				$40.68	$64.77	$105.45
Totals				$111.22	$125.48	$236.70
Misc. - Cat D9R Dozer/ Loader (5 yd3) / 10-12 yd3 Truck						
D9R				$159.30	$61.94	$221.24
966G				$90.91	$61.94	$152.85
Dump Truck (10-12 yd3)				$40.68	$64.77	$105.45
Totals				$290.89	$188.65	$479.54
Misc. - Cat D6 Dozer / Cat 966 Loader / 10-12 yd3 Truck						
D6R				$76.25	$61.94	$138.19
966G				$90.91	$61.94	$152.85
Dump Truck (10-12 yd3)				$40.68	$64.77	$105.45
Totals				$207.84	$188.65	$396.49

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Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Fleets (Crews)

EQUIPMENT FLEETS

ACTIVITY AND FLEET		Standard Labor Crew	User Defined Labor Crew	EQUIPMENT UNIT COST (Hourly)	TOTAL LABOR UNIT COST (Hourly)	TOTAL COST (Hourly)
CONCRETE BREAKING						
Slab demolition						
Footing demolition						
Wall demolition						
Small - Cat 325B Excavator w/ H140D s Hammer						
325C				$70.54	$60.71	$131.25
H-120 (fits 325)				$38.17	$0.00	$38.17
D9R				$159.30	$61.94	$221.24
Totals				$268.01	$122.65	$390.66
Medium - Cat 345B Excavator w/ H180D s Hammer						
345B				$104.71	$60.71	$165.42
H-160 (fits 345)				$64.48	$0.00	$64.48
D9R				$159.30	$61.94	$221.24
Totals				$328.49	$122.65	$451.14
Large - Cat 385B Excavator w/ H180D s Hammer						
385BL				$91.99	$60.71	$152.70
H-180 (fits 365/385)				$79.93	$0.00	$79.93
D9R				$159.30	$61.94	$221.24
Totals				$331.22	$122.65	$453.87
DRILL HOLE ABANDONMENT						
Drill Hole - Grout or Cement						
Pump (plugging) Drill Rig				$44.34	$60.71	$105.05
Driller's Helper		2		$0.00	$124.20	$124.20
Totals				$44.34	$184.91	$229.25
Drill Hole - Inert Media (Means Crew B-11M+ 1 Laborer)						
420D 4WD Backhoe				$29.58	$60.71	$90.29
General Laborer		1		$0.00	$68.26	$68.26
Totals				$29.58	$128.97	$158.55
Drill Hole - Casing Perforation or Removal						
Heavy Duty Drill Rig				$115.50	$71.84	$187.34
Driller's Helper		2		$0.00	$124.20	$124.20
Totals				$115.50	$196.04	$311.54
MAINTENANCE FLEET						
Road Grading, Dust Suppression, Clean Up						
Maintenance - Small Water Truck and Cat 14G Grader						
613E (5,000 gal) Water Wagon				$51.02	$64.77	$115.79
120H				$47.53	$61.94	$109.47
Totals				$98.55	$126.71	$225.26
Maintenance - Medium Water Truck and Cat 16G Grader						
613E (5,000 gal) Water Wagon				$51.02	$64.77	$115.79
14G/H				$111.14	$61.94	$173.08
Totals				$162.16	$126.71	$288.87
Maintenance - Large Water Truck and Cat 16G Grader						
777D Water Truck				$69.41	$64.77	$134.18
16G/H				$143.74	$61.94	$205.68
Totals				$213.15	$126.71	$339.86
PROJECT SUPERVISION						
Foreman		1		$0.00	$88.76	$88.76
Supervisor's Truck		1		$10.92	$60.71	$71.63
Totals				$10.92	$149.47	$160.39

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Fleets (Crews)

EQUIPMENT FLEETS

ACTIVITY AND FLEET		Standard Labor Crew	User Defined Labor Crew	EQUIPMENT UNIT COST (Hourly)	TOTAL LABOR UNIT COST (Hourly)	TOTAL COST (Hourly)
MEANS CREW DEFINITIONS						
Crew composition from Means Heavy Construction 2005 Edition by permission of R.S.Means/Reed Construction Data . For use with misc. unit costs where Means is the source for productivity						
1 Clab - Seedling Planting/Block Wall Demolition						
General Laborer		1		$0.00	$68.26	$68.26
Totals				$0.00	$68.26	$68.26
2 Clab - Barbed Wire/Wood Fence Removal, Drainpipe Installation, Pumping, Evaporation						
General Laborer		2		$0.00	$136.52	$136.52
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
Totals				$11.05	$197.23	$208.28
2 Clab + Excavator - Pond Liner Cut and Fold						
General Laborer		2		$0.00	$136.52	$136.52
325C				$70.54	$60.71	$131.25
Totals				$70.54	$197.23	$267.77
2 Clab + Welder - Bat Gates						
General Laborer		2		$0.00	$136.52	$136.52
Welding Equipment				$10.03	$60.71	$70.74
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
Totals				$21.08	$257.94	$279.02
3 Clab - Foam Adit Plugs						
General Laborer		2		$0.00	$136.52	$136.52
420D 4WD Backhoe				$29.58	$60.71	$90.29
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
Totals				$40.63	$257.94	$298.57
3 Clab + Welder - Culvert Bat Gate						
General Laborer		2		$0.00	$136.52	$136.52
Welding Equipment				$10.03	$60.71	$70.74
420D 4WD Backhoe				$29.58	$60.71	$90.29
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
Totals				$50.66	$318.65	$369.31
3 Clab D - 3 Laborers + Foreman - Decontamination						
General Laborer		3		$0.00	$204.78	$204.78
Foreman		1		$0.00	$88.76	$88.76
Supervisor's Truck		1		$10.92	$60.71	$71.63
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
Totals				$21.97	$414.96	$436.93
3 SKWK - Liner Installation						
Skilled Laborer		3		$0.00	$208.56	$208.56
HDEP Welder (pipe or liner)		1		$14.09	$0.00	$14.09
420D 4WD Backhoe		1		$29.58	$60.71	$90.29
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
Totals				$43.67	$269.27	$312.94

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Fleets (Crews)

EQUIPMENT FLEETS

ACTIVITY AND FLEET		Standard Labor Crew	User Defined Labor Crew	EQUIPMENT UNIT COST (Hourly)	TOTAL LABOR UNIT COST (Hourly)	TOTAL COST (Hourly)
B-3 - Small Building Demoltion						
LABOR						
General Laborer		2		$0.00	$136.52	$136.52
Foreman		1		$0.00	$88.76	$88.76
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
EQUIPMENT						
928G		1		$46.14	$61.94	$108.08
Dump Truck (10-12 yd3)		2		$81.36	$129.54	$210.90
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
Totals				$127.50	$416.76	$544.26
B-6 - Chain Link Fence/Culvert Removal						
General Laborer		2		$0.00	$136.52	$136.52
928G		1		$46.14	$61.94	$108.08
Totals				$46.14	$198.46	$244.60
B-8 - Large Building Demolition						
LABOR						
General Laborer		2		$0.00	$136.52	$136.52
Foreman		1		$0.00	$88.76	$88.76
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
EQUIPMENT						
928G		1	**0**	$0.00	$0.00	$0.00
20 Ton Crane		1		$51.40	$60.71	$112.11
Dump Truck (10-12 yd3)		2	**0**	$0.00	$0.00	$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
Totals				$51.40	$285.99	$337.39
B-9 - Concrete Wall Demolition						
General Laborer		4		$0.00	$273.04	$273.04
Foreman		1		$0.00	$88.76	$88.76
Air Compressor + tools				$7.43	$60.71	$68.14
Totals				$7.43	$422.51	$429.94

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Fleets (Crews)

EQUIPMENT FLEETS

ACTIVITY AND FLEET		Standard Labor Crew	User Defined Labor Crew	EQUIPMENT UNIT COST (Hourly)	TOTAL LABOR UNIT COST (Hourly)	TOTAL COST (Hourly)
B-10Y - General Compaction						
General Laborer		1		$0.00	$68.26	$68.26
CS533E Vibratory Roller		1		$34.89	$60.71	$95.60
Totals				$34.89	$128.97	$163.86
B-11L - Fine Grading for Evaporation Pond Liner Base						
General Laborer		1		$0.00	$68.26	$68.26
14G/H		1		$111.14	$61.94	$173.08
Totals				$111.14	$130.20	$241.34
B-11M - Backhoe Work						
420D 4WD Backhoe		1		$29.58	$60.71	$90.29
Totals				$29.58	$60.71	$90.29
B-12G - Rip-Rap Machine Placed (Modified)						
966G		1		$90.91	$61.94	$152.85
325C		1		$70.54	$60.71	$131.25
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
Totals				$172.50	$183.36	$355.86
B-13 - Grouted Rip-Rap & Gabion Baskets						
General Laborer		4		$0.00	$273.04	$273.04
Foreman		1		$0.00	$88.76	$88.76
50 Ton Crane		1		$73.65	$61.94	$135.59
Totals				$73.65	$423.74	$497.39
B-14 PVC Drain Pipe Installation						
Foreman		1		$0.00	$88.76	$88.76
General Laborer		4		$0.00	$273.04	$273.04
420D 4WD Backhoe		1		$29.58	$60.71	$90.29
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
Totals				$40.63	$483.22	$523.85
B-20 - Remove Pipelines						
Foreman		1		$0.00	$88.76	$88.76
Skilled Laborer		1		$0.00	$69.52	$69.52
General Laborer		1		$0.00	$68.26	$68.26
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
Totals				$11.05	$287.25	$298.30
B-22A - HDEP Installation - Pipe or Liner						
Skilled Laborer		1		$0.00	$69.52	$69.52
General Laborer		2		$0.00	$136.52	$136.52
D7R		1		$101.00	$61.94	$162.94
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
420D 4WD Backhoe		1		$29.58	$60.71	$90.29
Generator 5KW		1		$7.68	$0.00	$7.68
HDEP Welder (pipe or liner)		1		$14.09	$0.00	$14.09
Totals				$163.40	$389.40	$552.80
B-80A - Install Barbed Wire Fence						
General Laborer		3		$0.00	$204.78	$204.78
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
Totals				$11.05	$265.49	$276.54

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Fleets (Crews)

EQUIPMENT FLEETS

ACTIVITY AND FLEET		Standard Labor Crew	User Defined Labor Crew	EQUIPMENT UNIT COST (Hourly)	TOTAL LABOR UNIT COST (Hourly)	TOTAL COST (Hourly)
B-80C - Install Chain Link Fence (Flatbed truck has small crane)						
General Laborer		3		$0.00	$204.78	$204.78
Light Truck - 1.5 Ton		1		$11.05	$60.71	$71.76
Totals				$11.05	$265.49	$276.54
C-14B - Elevated Concrete Slabs (Reinforced Concrete Shaft Covers)						
Foreman		1		$0.00	$88.76	$88.76
Supervisor's Truck		1		$10.92	$60.71	$71.63
Carpenter		16		$0.00	$988.32	$988.32
General Laborer		2		$0.00	$136.52	$136.52
Rodmen (reinforcing concrete)		4		$0.00	$254.76	$254.76
Cement finisher		2		$0.00	$127.38	$127.38
Gas Engine Vibrator		1		$6.56	$60.71	$67.27
Concrete Pump		1		$54.01	$0.00	$54.01
Totals				$71.49	$1,717.16	$1,788.65
C-14D - Concrete Walls Formed in Place (Reinforced Concrete Adit Bulkheads)						
Foreman		1		$0.00	$88.76	$88.76
Supervisor's Truck		1		$10.92	$60.71	$71.63
Carpenter		18		$0.00	$1,111.86	$1,111.86
General Laborer		2		$0.00	$136.52	$136.52
Rodmen (reinforcing concrete)		2		$0.00	$127.38	$127.38
Cement finisher		1		$0.00	$63.69	$63.69
Gas Engine Vibrator		1		$6.56	$60.71	$67.27
Concrete Pump		1		$54.01	$0.00	$54.01
Totals				$71.49	$1,649.63	$1,721.12

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Closure Cost Estimate
Productivity

Dozer Operator Skill:	Average
Grader Operator Skill:	Average
Truck/Scraper Operator:	Average
Loader Operator Skill:	Average
Excavator Operator Skill:	Average
Dozer Job Efficiency:	50 min/hr
Truck Job Efficiency:	50 min/hr
Scraper Job Efficiency:	50 min/hr
Loader Job Efficiency:	50 min/hr
Excavator Job Efficiency:	50 min/hr
Grader Job Efficiency:	50 min/hr

Productivity - Bulldozers

Dozer Specifications

Description	D11R	D10R	D9R	D8R	D7R	D6R
Blade Width (SU) (ft)	18.33	15.92	14.17	12.92	12.08	10.67
Shank Guage (3 shanks) (ft)	9.83	8.67	7.67	7.08	6.5	6.5
Pocket Spacing (ft)	4.75	4.33	3.87	3.58	3.25	3.25
Ripping Width (Ripper + 1 Pocket) (ft)	14.58	13	11.54	10.66	9.75	9.75
Ripping Speed (mph)	1	1	1	1	1	1
Ripping Maneuver (turn) Time (min)	0.25	0.25	0.25	0.25	0.25	0.25
Altitude Deration Factor	1	1	1	1	1	1
Ripping Hourly Production (excluding maneuvering time) (ft)	5,280	5,280	5,280	5,280	5,280	5,280

Source: Caterpillar Performance Handbook Edition 35

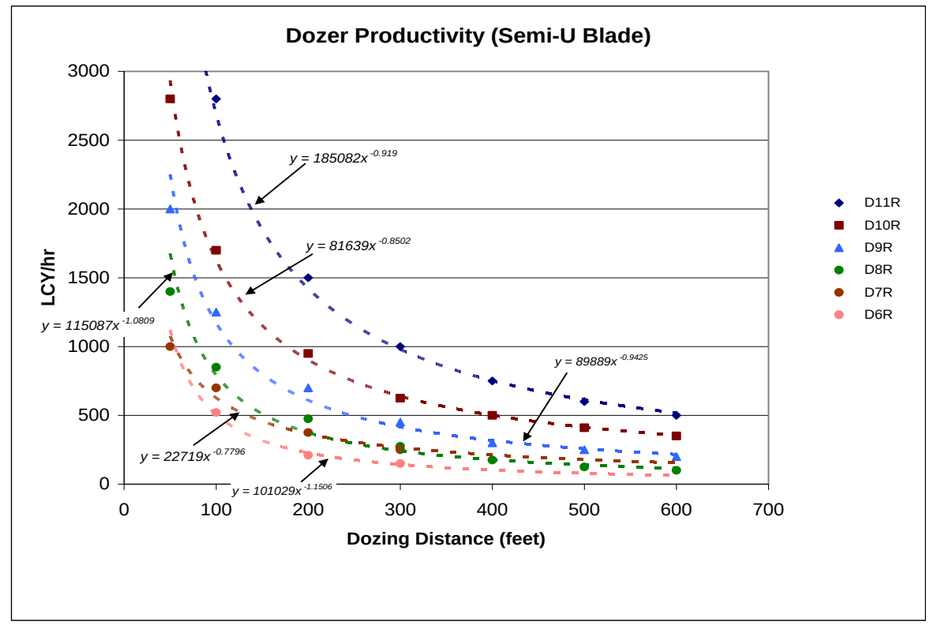
Dozer Productivity vs. Grading Distance

Average Dozing Distance (feet)	Production (LCY/hr) D11R	D10R	D9R	D8R	D7R	D6R
50	4,800	2,800	2,000	1,400	1,000	
100	2,800	1,700	1,250	850	700	520
200	1,500	950	700	475	375	210
300	1,000	625	450	275	250	150
400	750	500	300	175		
500	600	410	250	125		
600	500	350	200	100		

Source: Caterpillar Performance Handbook Edition 35

dozer productivity = k x Dozing Distance^{p}
(see graph)

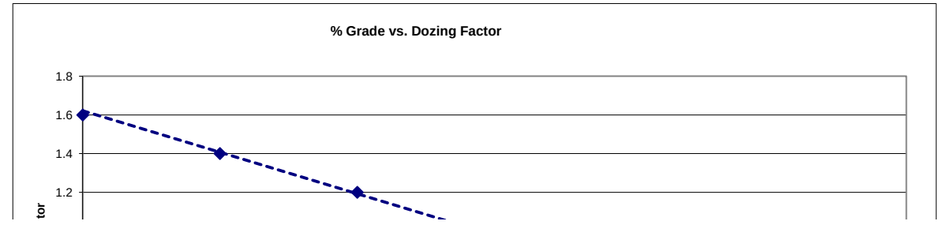
k =	185082	81639	89889	115087	22719	101029
p =	-0.919	-0.8502	-0.9425	-1.0809	-0.7796	-1.1506



Productivity - Bulldozers (cont.)

% Grade vs. Dozing Factor

% Grade	Dozing Factor
-30	1.6
-20	1.4
-10	1.2
0	1
10	0.8
20	0.55
30	0.3



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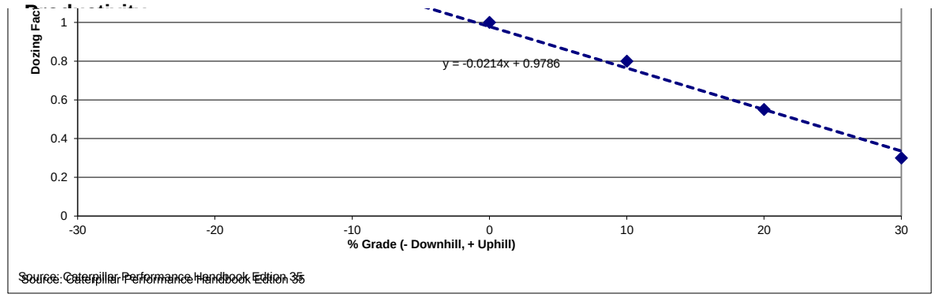
Source: Caterpillar Performance Handbook Edition 35

% Grade Dozing Factor = -0.0214x + 0.9786
(see graph)



Job Condition Correction Factors - Bulldozers	
OPERATOR	
Average	0.75
MATERIAL (1)	
Loose stockpile	1.2
Normal	1
Hard to cut; frozen — with tilt cylinder	0.8
Hard to drift; "dead" (dry,non-cohesive material) or very sticky material	0.8
Rock, ripped or blasted	0.6
SLOT DOZING OR SIDE BY SIDE (1)	1.2
VISIBILITY	
Good conditions	1
JOB EFFICIENCY	
50 min/hr	0.83

(1) Selected in facility worksheets.
Other factors included as standard factors.
Source: Caterpillar Performance Handbook Edition 35

Material Densities(1)		
Material	**lb/cy**	**kg/m^3**
Alluvium	2,900	1,720
Basalt	3,300	1,960
Clay - Dry	2,500	1,480
Granite - broken	2,800	1,660
Gravel	2,550	1,510
LS - broken	2,600	1,540
LS - crushed	2,600	1,540
Sandstone	2,550	1,510
Shale	2,100	1,250
Stone - crushed	2,700	1,600
Tailings - Coarse (dry, loose sand)	2,400	1,420
Tailings - Slimes (loose sand & clay)	2,700	1,600
Topsoil	1,600	950

(1) Source: Caterpillar Performance Handbook Edition 35

Note: uses Sand & Gravel - Dry from Caterpillar Handbook

Productivity - Scrapers

Scraper Specifications		
Description	**631G**	**637G**
Empty Weight	100,600	112,760
Payload Capacity (cy)		
Struck	24	24
Heaped	34	34
Average	29	29
Loaded by	One D10R	Self*
Load Time (min)	1	1
Maneuver and Spread (min)	1	1
Job Efficiency	1	1
Rolling Resistance**	3	3
Altitude Deration Factor	1	1

* Requires pair

**A firm, smooth, rolling roadway with dirt or light surfacing, flexing slightly under load or undulating, maintained fairly regularly, watered

Source: Caterpillar Performance Handbook Edition 35

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Closure Cost Estimate
Productivity

Weight of Materials			Downhill Scraper Speed - Grade Retarding vs. Effective Grade (Grade - Rolling Resistance)											
			631G						637G PP					
Material	lb/cy	Scraper Load lb	Loaded Weight (lbs)	22	16	10	5	1	Loaded Weight (lbs)	25	15	10	5	1
Alluvium	2,900	84,100	184,700	7.5	10	13	33	33	196,860	7	10	18.5	34	34
Basalt	3,300	95,700	196,300	7.5	10	13	24.5	33	208,460	7	10	18.5	25	34
Clay - Dry	2,500	72,500	173,100	7.5	10	13	33	33	185,260	7	10	18.5	34	34
Granite - broken	2,800	81,200	181,800	7.5	10	13	33	33	193,960	7	10	18.5	34	34
Gravel	2,550	73,950	174,550	7.5	10	13	33	33	186,710	7	10	18.5	34	34
LS - broken	2,600	75,400	176,000	7.5	10	13	33	33	188,160	7	10	18.5	34	34
LS - crushed	2,600	75,400	176,000	7.5	10	13	33	33	188,160	7	10	18.5	34	34
Sandstone	2,550	73,950	174,550	7.5	10	13	33	33	186,710	7	10	18.5	34	34
Shale	2,100	60,900	161,500	7.5	10	18	33	33	173,660	10	13.5	18.5	34	34
Stone - crushed	2,700	78,300	178,900	7.5	10	13	33	33	191,060	7	10	18.5	34	34
Tailings - Coarse (dry, loose sand)	2,400	69,600	170,200	7.5	10	13	33	33	182,360	7	10	18.5	34	34
Tailings - Slimes (loose sand & clay)	2,700	78,300	178,900	7.5	10	13	33	33	191,060	7	10	18.5	34	34
Topsoil	1,600	46,400	147,000	7.5	10	18	33	33	159,160	10	13.5	18.5	34	34
			Empty	10	18	24.5	33	33	Empty	10	13.5	18.5	34	34

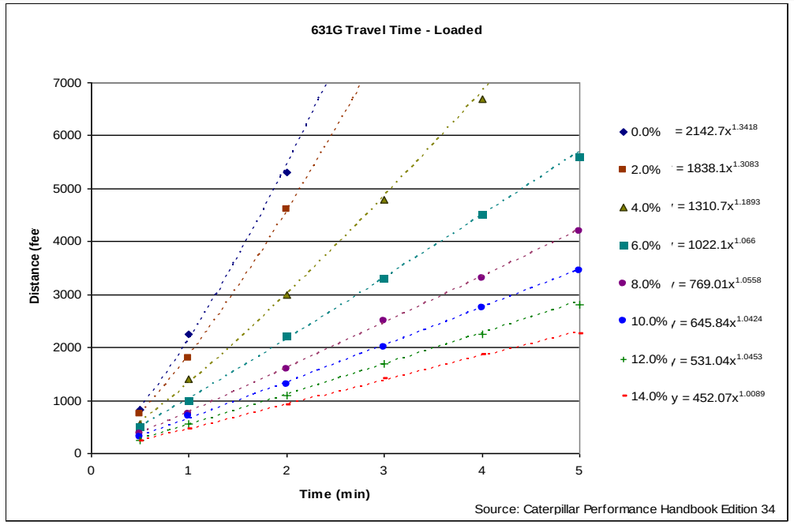
Source: Caterpillar Performance Handbook Edition 34

Productivity - Scrapers (cont.)

631G Scraper Travel Time - Uphill Loaded								
Total Resistance (%) (rolling + grade)	Time (min) 0.5	1	2	3	4	5	k	p
0	825	2,250	5,300				2142.7	1.3418
2	750	1,800	4,600				1838.1	1.3083
4	550	1,400	3,000	4,800	6,700		1310.7	1.1893
6	490	1,000	2,200	3,300	4,500	5,600	1022.1	1.066
8	375	750	1,600	2,500	3,300	4,200	769.01	1.0558
10	300	700	1,300	2,000	2,750	3,450	645.84	1.0424
12	250	550	1,100	1,700	2,250	2,800	531.04	1.0453
14	---	450	900	1,400	1,850	2,250	452.07	1.0089

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

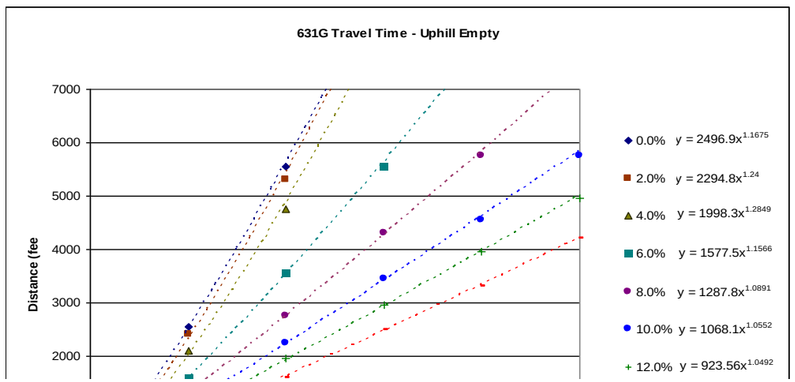
Source: Caterpillar Performance Handbook Edition 35



Source: Caterpillar Performance Handbook Edition 34

631G Scraper Travel Time - Uphill Empty								
Total Resistance (%) (rolling + grade)	Time (min) 0.5	1	2	3	4	5	k	p
0	1,100	2,550	5,550				2496.9	1.1675
2	950	2,400	5,300				2294.8	1.24
4	800	2,100	4,750				1998.3	1.2849
6	700	1,600	3,550	5,550			1557.5	1.1566
8	600	1,300	2,750	4,300	5,750		1287.8	1.0891
10	500	1,100	2,250	3,450	4,550	5,750	1068.1	1.0552
12	450	900	1,950	2,950	3,950	4,950	923.56	1.0492
14		800	1,600	2,500	3,300	4,200	783.37	1.0444

$\sqrt[p]{\frac{distance}{k}}$



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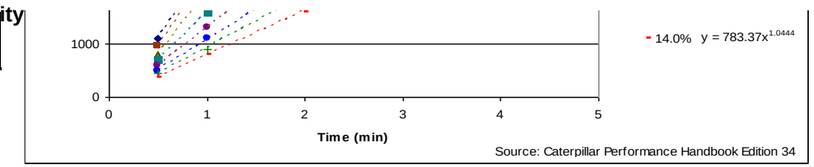
Travel Time (min) =

Source: Caterpillar Performance Handbook Edition 35



Productivity - Scrapers (cont.)

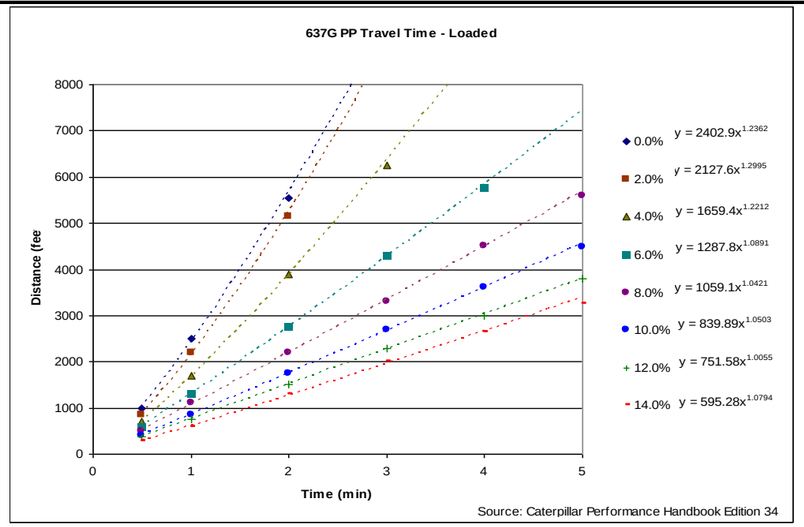
637G Push-Pull Scraper Travel Time - Uphill Loaded

Total Resistance (%) (rolling + grade)	Time (min) 0.5	1	2	3	4	5	k	p
0	1,000	2,500	5,550				2402.9	1.2362
2	850	2,200	5,150				2127.6	1.2995
4	700	1,700	3,900	6,250			1659.4	1.2212
6	600	1,300	2,750	4,300	5,750		1287.8	1.0891
8	500	1,100	2,200	3,300	4,500	5,600	1059.1	1.0421
10	400	850	1,750	2,700	3,600	4,475	839.89	1.0503
12	375	750	1,500	2,300	3,000	3,800	751.58	1.0055
14		600	1,300	2,000	2,650	3,250	595.28	1.0794

$$\sqrt[p]{\frac{distance}{k}}$$

Travel Time (min) =

Source: Caterpillar Performance Handbook Edition 35



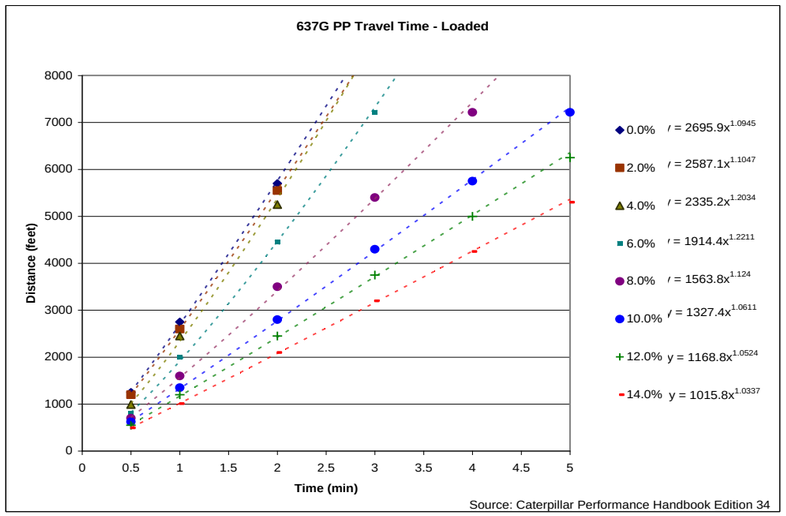
637G Push-Pull Scraper Travel Time - Uphill Empty

Total Resistance (%) (rolling + grade)	Time (min) 0.5	1	2	3	4	5	k	p
0	1,250	2,750	5,700				2695.9	1.0945
2	1,200	2,600	5,550				2587.1	1.1047
4	990	2,450	5,250				2335.2	1.0234
6	800	2,000	4,450	7,216			1914.4	1.2211
8	700	1,600	3,500	5,400	7,216		1563.8	1.124
10	625	1,350	2,800	4,300	5,750	7,216	1327.4	1.0611
12	550	1,200	2,450	3,750	5,000	6,250	1168.8	1.0524
14		1,010	2,100	3,200	4,250	5,300	1015.8	1.0337

$$\sqrt[p]{\frac{distance}{k}}$$

Travel Time (min) =

Source: Caterpillar Performance Handbook Edition 35



Productivity - Haul Trucks

Haul Truck Specifications

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Closure Cost Estimate
Productivity

Description	769D	773E	777D	785C	793C	797B
Chassis Weight (lb)	53,506	70,330	113,160	170,000	259,500	473,600
Body Weight (lb)	17,350	20,300	34,785	36,788	70,785	104,200
Standard Liner Weight (lb)	7,000	8,600	12,040	16,846	24,418	8,800
Total Truck Weight (lb)	77,856	99,230	159,985	223,634	354,703	586,600
Payload Capacity (cy)						
Struck	21.6	34.8	55	78.5	126	228
Heaped	31.7	46	78.6	102	169	290
Average	26.65	40.4	66.8	90.25	147.5	259
Maneuver to Load Time (min)	0.7	0.7	0.7	0.7	0.7	0.7
Maneuver and Dump Time (min)	1.1	1.1	1.1	1.1	1.1	1.1
Job Efficiency	0.83	0.83	0.83	0.83	0.83	0.83
Rolling Resistance**	2.5	2.5	2.5	2.5	2.5	2.5
Altitude Deration Factor	1	1	1	1	1	1

**A firm, smooth, rolling roadway with dirt or light surfacing, flexing slightly under load or undulating, maintained fairly regularly, watered

Source: Caterpillar Performance Handbook Edition 35

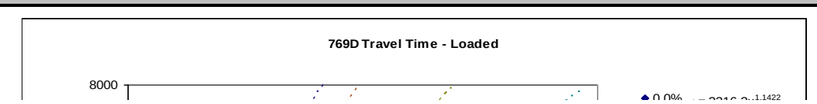
Weight of Materials					Downhill Haul Truck Speed - Grade Retarding vs. Effective Grade (Grade - Rolling Resistance)														
					769D					773E					777D				
Material	lb/cy	Truck (769D) Load lb	Truck (773E) Load lb	Truck (777D) Load lb	Loaded Weight (lbs)	20	15	10	5	Loaded Weight (lbs)	20	15	10	5	Loaded Weight (lbs)	20	15	10	5
Alluvium	2,900	77,285	117,160	193,720	155,141	11	11	15	26	216,390	7	7	13	23	353,705	7	9	12	29
Basalt	3,300	87,945	133,320	220,440	165,801	11	11	11	20	232,550	7	7	13	23	380,425	7	7	12	21
Clay - Dry	2,500	66,625	101,000	167,000	144,481	11	11	15	26	200,230	7	9	13	23	326,985	7	9	16	29
Granite - broken	2,800	74,620	113,120	187,040	152,476	11	11	15	26	212,350	7	7	13	23	347,025	7	9	12	29
Gravel	2,550	67,958	103,020	170,340	145,814	11	11	15	26	202,250	7	9	13	23	330,325	7	9	16	29
LS - broken	2,600	69,290	105,040	173,680	147,146	11	11	15	26	204,270	7	9	13	23	333,665	7	9	12	29
LS - crushed	2,600	69,290	105,040	173,680	147,146	11	11	15	26	204,270	7	9	13	23	333,665	7	9	12	29
Sandstone	2,550	67,958	103,020	170,340	145,814	11	11	15	26	202,250	7	9	13	23	330,325	7	9	16	29
Shale	2,100	55,965	84,840	140,280	133,821	11	11	15	26	184,070	7	9	13	31	300,265	7	9	16	29
Stone - crushed	2,700	71,955	109,080	180,360	149,811	11	11	15	26	208,310	7	7	13	23	340,345	7	9	12	29
Tailings - Coarse (dry, loose sand)	2,400	63,960	96,960	160,320	141,816	11	11	15	26	196,190	7	9	13	23	320,305	7	9	16	29
Tailings - Slimes (loose sand & clay)	2,700	71,955	109,080	180,360	149,811	11	11	15	26	208,310	7	7	13	23	340,345	7	9	12	29
Topsoil	1,600	42,640	64,640	106,880	120,496	11	11	15	26	163,870	7	9	17	31	266,865	9	12	16	29
					Empty	15	15	26	36	Empty	13	17	23	42	Empty	16	16	29	39

Source: Caterpillar Performance Handbook Edition 35

Weight of Materials					Downhill Haul Truck Speed - Grade Retarding vs. Effective Grade (Grade - Rolling Resistance)														
					785C					793C					797B				
Material	lb/cy	Truck (785C) Load lb	Truck (793C) Load lb	Truck (797B) Load lb	Loaded Weight (lbs)	20	15	10	5	Loaded Weight (lbs)	20	15	10	5	Loaded Weight (lbs)	20	15	10	5
Alluvium	2,900	261,725	427,750	751,100	485,359	8	8	14	27	782,453	7	7	10	17	1,337,700	7	7	9	17
Basalt	3,300	297,825	486,750	854,700	521,459	8	8	14	27	841,453	7	7	10	17	1,441,300	7	7	9	17
Clay - Dry	2,500	225,625	368,750	647,500	449,259	8	11	14	36	723,453	7	7	10	25	1,234,100	7	7	9	23
Granite - broken	2,800	252,700	413,000	725,200	476,334	8	8	14	27	767,703	7	7	10	17	1,311,800	7	7	9	17
Gravel	2,550	230,138	376,125	660,450	453,772	8	8	14	36	730,828	7	7	10	25	1,247,050	7	7	9	23
LS - broken	2,600	234,650	383,500	673,400	458,284	8	8	14	27	738,203	7	7	10	25	1,260,000	7	7	9	23
LS - crushed	2,600	234,650	383,500	673,400	458,284	8	8	14	27	738,203	7	7	10	25	1,260,000	7	7	9	23
Sandstone	2,550	230,138	376,125	660,450	453,772	8	8	14	36	730,828	7	7	10	25	1,247,050	7	7	9	23
Shale	2,100	189,525	309,750	543,900	413,159	8	11	14	36	664,453	7	7	10	25	1,130,500	7	7	13	23
Stone - crushed	2,700	243,675	398,250	699,300	467,309	8	8	14	27	752,953	7	7	10	17	1,285,900	7	7	9	23
Tailings - Coarse (dry, loose sand)	2,400	216,600	354,000	621,600	440,234	8	11	14	36	708,703	7	7	10	25	1,208,200	7	7	9	23
Tailings - Slimes (loose sand & clay)	2,700	243,675	398,250	699,300	467,309	8	8	14	27	752,953	7	7	10	17	1,285,900	7	7	9	23
Topsoil	1,600	144,400	236,000	414,400	368,034	8	11	19	36	590,703	7	10	13	25	1,001,000	7	9	13	23
					Empty	14	19	36	36	Empty	10	13	17	33	Empty	13	17	23	42

Source: Caterpillar Performance Handbook Edition 35

Productivity - Haul Trucks (cont.)



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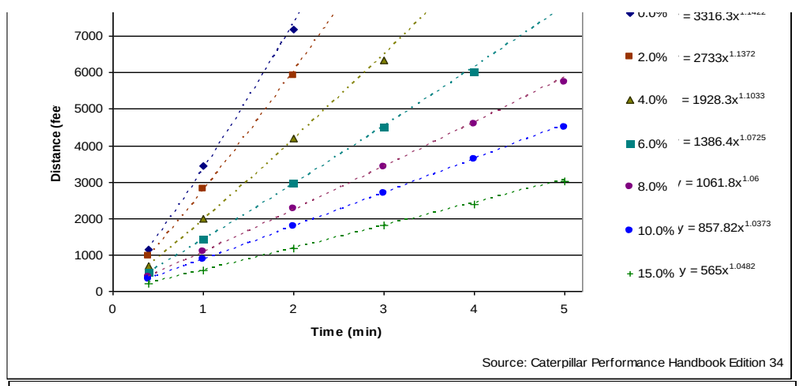
Productivity

769D Haul Truck Travel Time - Uphill Loaded

Total Resistance (%) (rolling + grade)	Time (min) 0.4	1	2	3	4	5	k	p
0	1,148	3,428	7,183				3316.3	1.1422
4	689	1,984	4,198	6,330			1928.3	1.1033
6	508	1,427	2,952	4,510	6,002		1386.4	1.0725
8	394	1,082	2,263	3,411	4,592	5,740	1061.8	1.06
10	328	869	1,771	2,690	3,608	4,510	857.82	1.0373
15	213	574	1,181	1,804	2,394	3,018	565	1.0482

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35



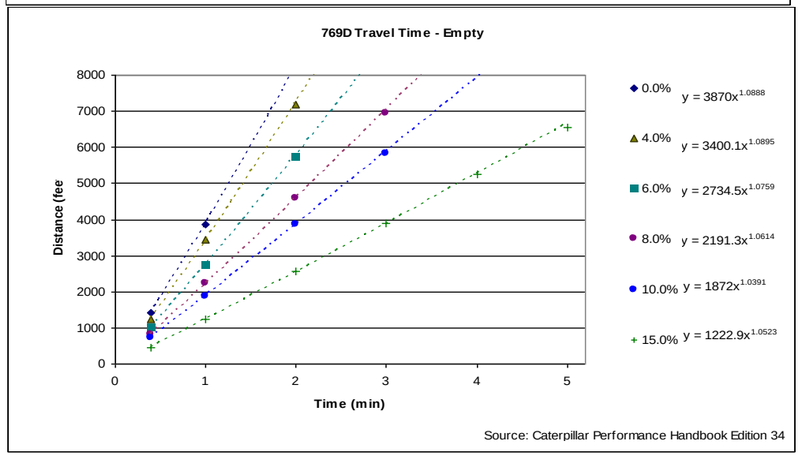
Source: Caterpillar Performance Handbook Edition 34

769D Haul Truck Travel Time - Uphill Empty

Total Resistance (%) (rolling + grade)	Time (min) 0.4	1	2	3	4	5	k	p
0	1,427	3,870					3870	1.0888
4	1,246	3,444	7,183				3400.1	1.0895
6	1,017	2,755	5,740				2734.5	1.0759
8	820	2,230	4,592	6,954			2191.3	1.0614
10	722	1,870	3,870	5,838			1872	1.0391
15	459	1,246	2,558	3,903	5,248	6,560	1222.9	1.0523

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35



Source: Caterpillar Performance Handbook Edition 34

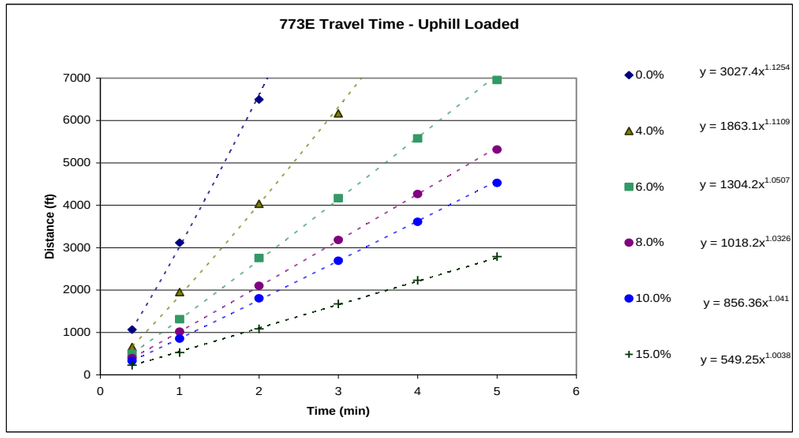
Productivity - Haul Trucks (cont.)

773E Haul Truck Travel Time - Uphill Loaded

Total Resistance (%) (rolling + grade)	Time (min) 0.4	1	2	3	4	5	k	p
0	1,066	3,117	6,496				3027.4	1.1254
4	656	1,952	4,035	6,168			1863.1	1.1109
6	492	1,312	2,756	4,167	5,577	6,955	1304.2	1.0507
8	394	1,017	2,100	3,182	4,265	5,315	1018.2	1.0326
10	328	853	1,804	2,690	3,609	4,528	856.36	1.041
15	226	525	1,083	1,673	2,231	2,789	549.25	1.0038

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35



773E Travel Time - Uphill Loaded

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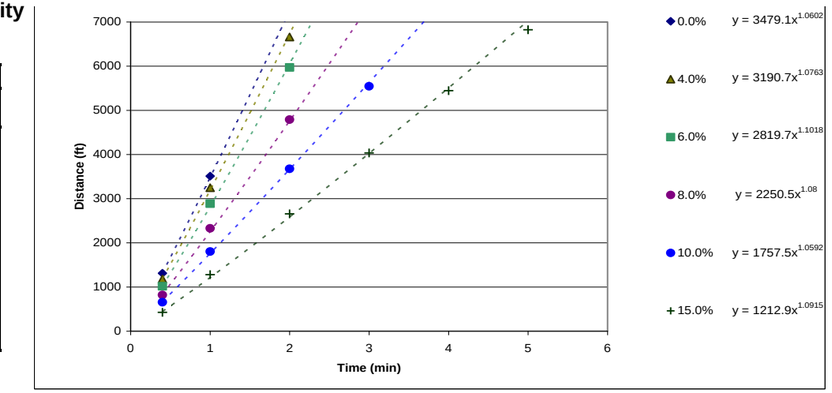
Closure Cost Estimate
Productivity

773E Haul Truck Travel Time - Uphill Empty								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.4	1	2	3	4	5		
0	1,312	3,510	7,218				3479.1	1.0602
4	1,181	3,248	6,660				3190.7	1.0763
6	1,017	2,887	5,971				2819.7	1.1018
8	820	2,329	4,790	7,218			2250.5	1.08
10	656	1,804	3,675	5,545			1757.5	1.0592
15	427	1,280	2,657	4,035	5,446	6,824	1212.9	1.0915

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35

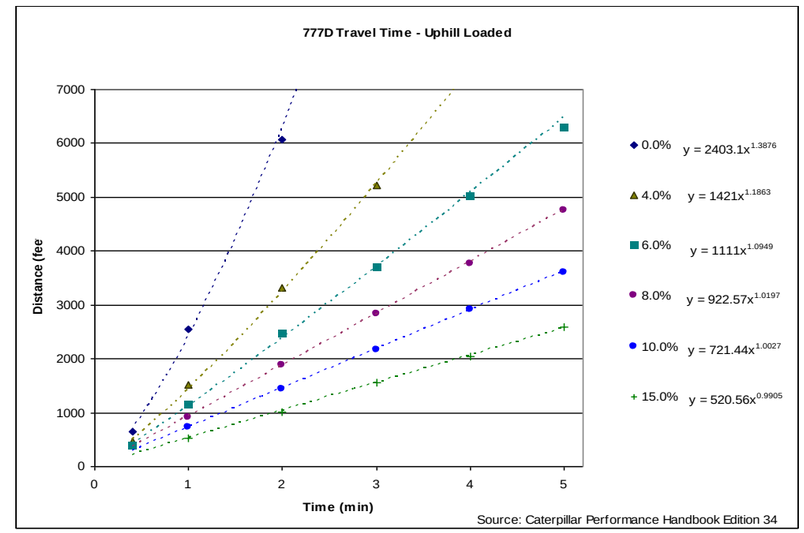


Productivity - Haul Trucks (cont.)

777D Haul Truck Travel Time - Uphill Loaded								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.4	1	2	3	4	5		
0	656	2,558	6,068				2403.1	1.3876
4	459	1,509	3,313	5,215	7,085		1412	1.1863
6	394	1,148	2,460	3,706	5,018	6,298	1111	1.0949
8		918	1,886	2,837	3,772	4,756	922.57	1.0197
10		722	1,443	2,165	2,919	3,608	721.44	1.0027
15		525	1,017	1,558	2,034	2,591	520.56	0.9905

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

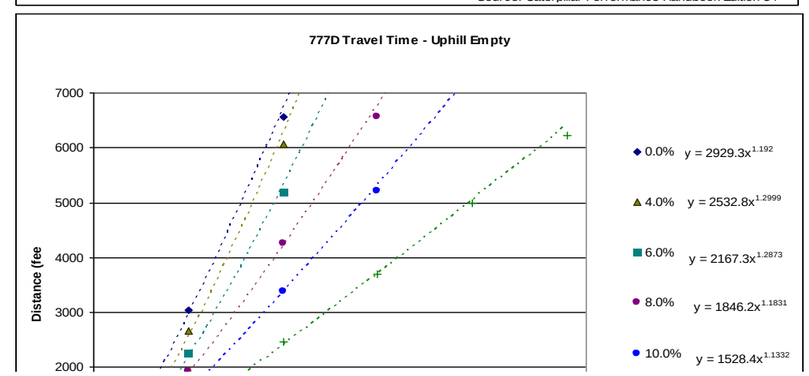
Source: Caterpillar Performance Handbook Edition 35



777D Haul Truck Travel Time - Uphill Empty								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.4	1	2	3	4	5		
0	968	3,034	6,560				2929.3	1.192
4	754	2,657	6,068				2532.8	1.2999
6	656	2,247	5,182				2167.3	1.2873
8	607	1,935	4,248	6,560			1846.2	1.1831
10	525	1,607	3,378	5,215	7,282		1528.4	1.1332
15	410	1,197	2,460	3,706	4,986	6,232	1139.7	1.072

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35



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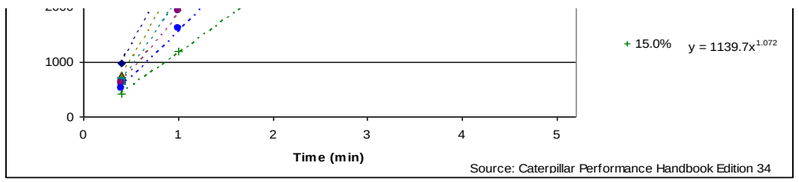


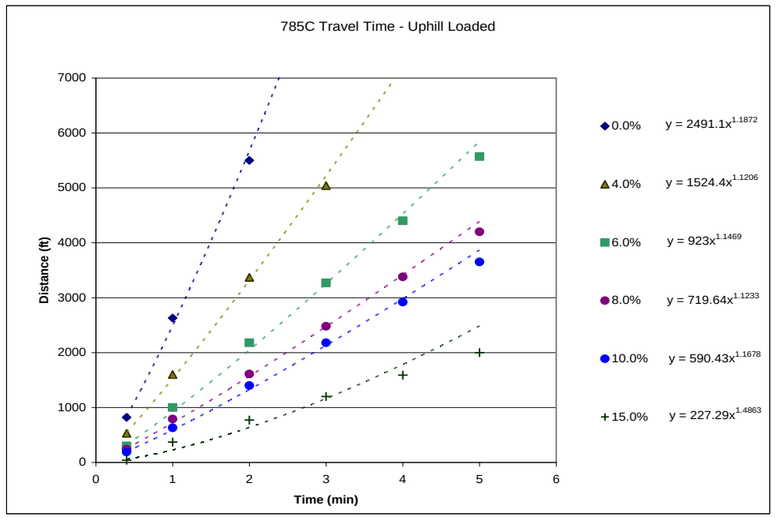
Productivity - Haul Trucks (cont.)

785C Haul Truck Travel Time - Uphill Loaded

Total Resistance (%) (rolling + grade)	Time (min) 0.4	1	2	3	4	5	k	p
0	820	2,630	5,500				2491.1	1.1872
4	530	1,600	3,370	5,040			1524.4	1.1206
6	300	1,000	2,180	3,270	4,400	5,570	923	1.1469
8	240	790	1,610	2,480	3,380	4,200	719.64	1.1233
10	190	630	1,400	2,180	2,920	3,650	590.43	1.1678
15	40	370	770	1,200	1,590	2,000	227.29	1.4863

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35

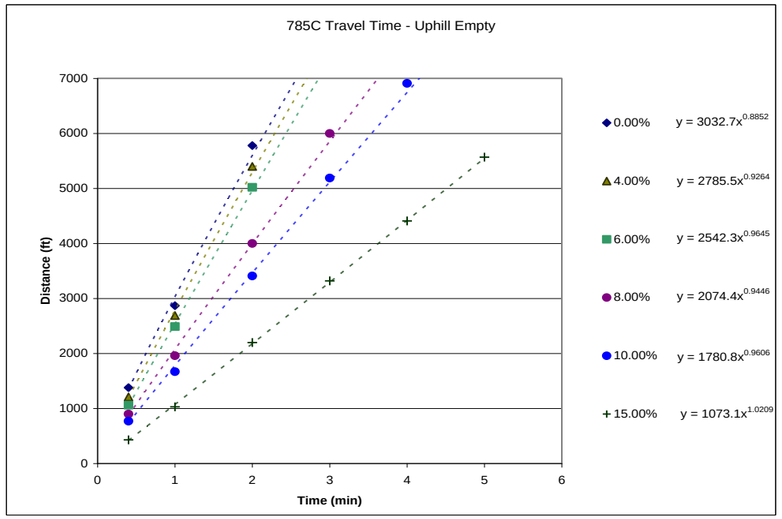


785C Haul Truck Travel Time - Uphill Empty

Total Resistance (%) (rolling + grade)	Time (min) 0.4	1	2	3	4	5	k	p
0	1,380	2,870	5,780				3032.7	0.8852
4	1,210	2,690	5,400				2785.5	0.9264
6	1,060	2,490	5,020				2542.3	0.9645
8	900	1,960	4,000	6,000			2074.4	0.9446
10	770	1,670	3,410	5,190	6,910		1780.8	0.9606
15	430	1,030	2,200	3,320	4,410	5,570	1073.1	1.0209

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35



Productivity - Haul Trucks (cont.)

793C Travel Time - Uphill Loaded

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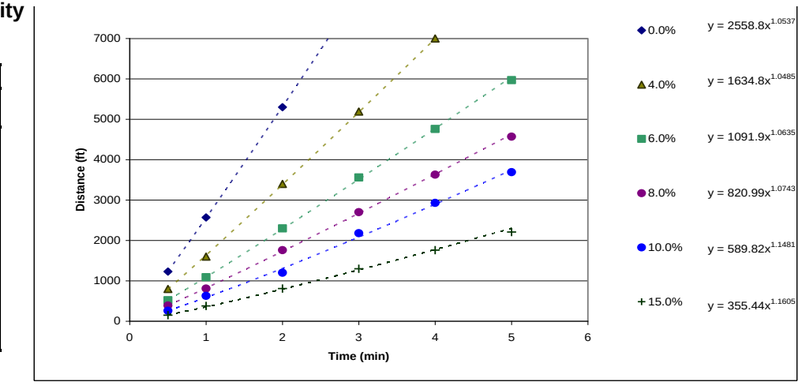
Closure Cost Estimate

Productivity

793C Haul Truck Travel Time - Uphill Loaded								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.5	1	2	3	4	5		
0	1,230	2,570	5,300				2558.8	1.0537
4	800	1,600	3,400	5,190	7,000		1634.8	1.0485
6	520	1,090	2,300	3,560	4,760	5,970	1091.9	1.0635
8	390	810	1,760	2,700	3,630	4,570	820.99	1.0743
10	260	630	1,200	2,180	2,930	3,690	589.82	1.1481
15	150	380	810	1,300	1,760	2,210	355.44	1.1605

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

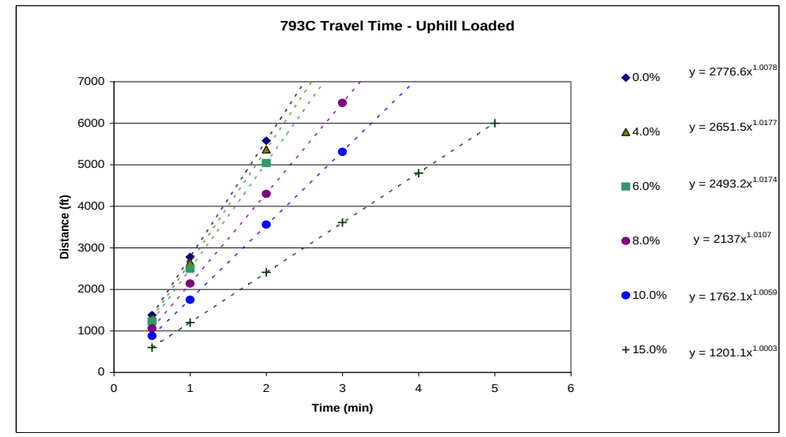
Source: Caterpillar Performance Handbook Edition 35



793C Haul Truck Travel Time - Uphill Empty								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.5	1	2	3	4	5		
0	1,380	2,780	5,580				2776.6	1.0078
4	1,310	2,650	5,370				2651.5	1.0177
6	1,230	2,500	5,040				2493.2	1.0174
8	1,060	2,140	4,300	6,490			2137	1.0107
10	880	1,750	3,560	5,310			1762.1	1.0059
15	600	1,200	2,410	3,610	4,800	6,000	1201.1	1.0003

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35

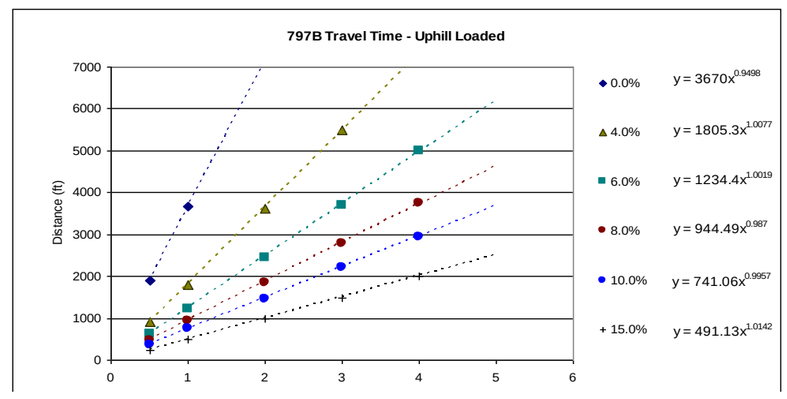


Productivity - Haul Trucks (cont.)

797B Haul Truck Travel Time - Uphill Loaded								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.5	1	2	3	4	5		
0	1,900	3,670					3670	0.9498
4	900	1,800	3,620	5,480			1805.3	1.0077
6	620	1,230	2,450	3,700	5,000		1234.4	1.0019
8	480	940	1,850	2,790	3,750		944.49	0.987
10	370	750	1,460	2,220	2,950		741.06	0.9957
15	240	500	1,000	1,480	2,000		491.13	1.0142

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35



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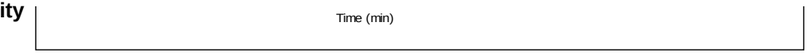
Closure Cost Estimate

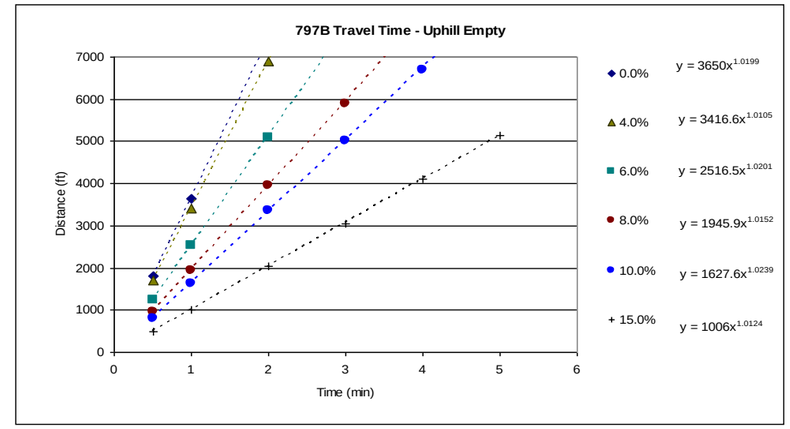
Productivity



797B Haul Truck Travel Time - Uphill Empty								
Total Resistance (%) (rolling + grade)	Time (min) 0.5	1	2	3	4	5	k	p
0	1,800	3,650					3650	1.0199
4	1,700	3,400	6,900				3416.6	1.0105
6	1,240	2,520	5,100				2516.5	1.0201
8	960	1,950	3,960	5,900			1945.9	1.0152
10	800	1,620	3,350	5,000	6,700		1627.6	1.0239
15	500	1,000	2,040	3,050	4,100	5,130	1006	1.0124

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35



Productivity - Articulated Trucks

Articulated Truck Specifications				
Description	725	730	735	740
Chassis Weight (lb)				
Body Weight (lb)				
Standard Liner Weight (lb)				
Operating Weight (Empty) (lb)	50,120	51,220	65,830	72,070
Payload Capacity (cy)				
Struck	14.5	17.1	19.3	23.3
Heaped	18.8	22.1	31.8	30.2
Average	16.65	19.6	25.55	26.75
Maneuver to Load Time (min)	0.7	0.7	0.7	0.7
Maneuver and Dump Time (min)	1.1	1.1	1.1	1.1
Job Efficiency	0.83	0.83	0.83	0.83
Rolling Resistance**	2.5	2.5	2.5	2.5
Altitude Deration Factor	1	1	1	1

**A firm, smooth, rolling roadway with dirt or light surfacing, flexing slightly under load or undulating, maintained fairly regularly, watered

Source: Caterpillar Performance Handbook Edition 35

Weight of Materials				Downhill Haul Truck Speed - Grade Retarding vs. Effective Grade (Grade - Rolling Resistance)									
				725					730				
Material	lb/cy	Truck (725) Load lb	Truck (730) Load lb	Loaded Weight (lbs)	20	15	10	5	Loaded Weight (lbs)	20	15	10	5
Alluvium	2,900	48,285	56,840	98,405	9	9	13	30	108,060	5	8	13	29
Basalt	3,300	54,945	64,680	105,065	5	9	13	22	115,900	5	8	13	29
Clay - Dry	2,500	41,625	49,000	91,745	9	13	13	30	100,220	8	8	13	29
Granite - broken	2,800	46,620	54,880	96,740	9	13	13	30	106,100	5	8	13	29
Gravel	2,550	42,458	49,980	92,578	9	13	13	30	101,200	8	8	13	29
LS - broken	2,600	43,290	50,960	93,410	9	13	13	30	102,180	8	8	13	29
LS - crushed	2,600	43,290	50,960	93,410	9	13	13	30	102,180	8	8	13	29
Sandstone	2,550	42,458	49,980	92,578	9	13	13	30	101,200	8	8	13	29
Shale	2,100	34,965	41,160	85,085	9	13	22	30	92,380	8	13	13	29
Stone - crushed	2,700	44,955	52,920	95,075	9	13	13	30	104,140	8	8	13	29
Tailings - Coarse (dry, loose sand)	2,400	39,960	47,040	90,080	9	13	13	30	98,260	8	8	13	29
Tailings - Slimes (loose sand & clay)	2,700	44,955	52,920	95,075	9	13	13	30	104,140	8	8	13	29
Topsoil	1,600	26,640	31,360	76,760	9	13	22	30	82,580	8	13	22	35

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				Empty	13	13	22	30	Empty	13	13	22	35

Source: Caterpillar Performance Handbook Edition 35

Weight of Materials				Downhill Haul Truck Speed - Grade Retarding vs. Effective Grade (Grade - Rolling Resistance)									
				735					740				
Material	lb/cy	Truck (735) Load lb	Truck (740) Load lb	Loaded Weight (lbs)	20	15	10	5	Loaded Weight (lbs)	20	15	10	5
Alluvium	2,900	74,095	77,575	139,925	7	9	13	27	149,645	7	9	17	23
Basalt	3,300	84,315	88,275	150,145	7	9	13	27	160,345	7	9	13	23
Clay - Dry	2,500	63,875	66,875	129,705	7	9	13	27	138,945	9	13	17	31
Granite - broken	2,800	71,540	74,900	137,370	7	9	13	27	146,970	7	9	17	23
Gravel	2,550	65,153	68,213	130,983	7	9	13	27	140,283	7	9	17	31
LS - broken	2,600	66,430	69,550	132,260	7	9	13	27	141,620	7	9	17	31
LS - crushed	2,600	66,430	69,550	132,260	7	9	13	27	141,620	7	9	17	31
Sandstone	2,550	65,153	68,213	130,983	7	9	13	27	140,283	7	9	17	31
Shale	2,100	53,655	56,175	119,485	9	9	18	27	128,245	7	13	17	31
Stone - crushed	2,700	68,985	72,225	134,815	7	9	13	27	144,295	7	9	17	23
Tailings - Coarse (dry, loose sand)	2,400	61,320	64,200	127,150	7	9	13	27	136,270	9	13	17	31
Tailings - Slimes (loose sand & clay)	2,700	68,985	72,225	134,815	7	9	13	27	144,295	7	9	17	23
Topsoil	1,600	40,880	42,800	106,710	9	13	18	36	114,870	9	13	17	31
				Empty	13	18	27	42	Empty	17	17	23	31

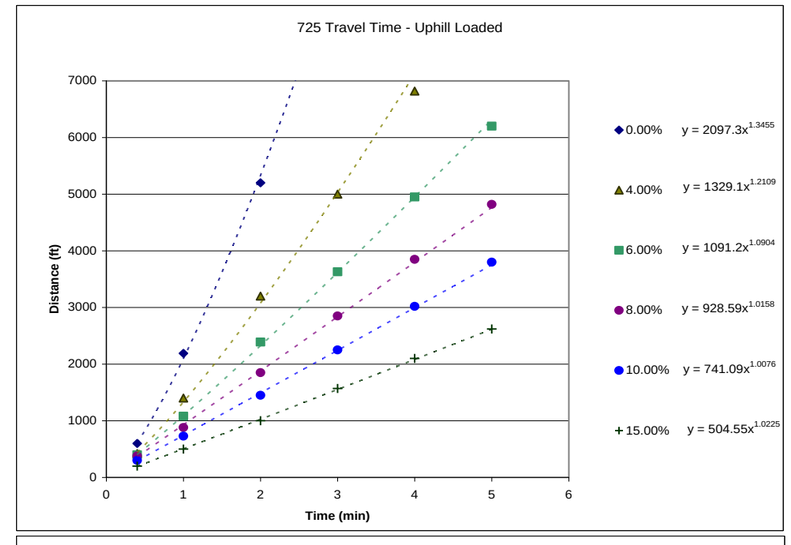
Source: Caterpillar Performance Handbook Edition 35

Productivity - Articulated Trucks (cont.)

725 Articulated Truck Travel Time - Uphill Loaded								
Total Resistance (%) (rolling + grade)	Time (min) 0.5	1	2	3	4	5	k	p
0	600	2,190	5,200				2097.3	1.3455
4	420	1,400	3,200	5,000	6,820		1329.1	1.2109
6	400	1,080	2,390	3,630	4,950	6,200	1091.2	1.0904
8	380	880	1,850	2,850	3,850	4,820	928.59	1.0158
10	300	729	1,450	2,250	3,020	3,800	741.09	1.0076
15	200	500	1,000	1,570	2,100	2,620	504.55	1.0225

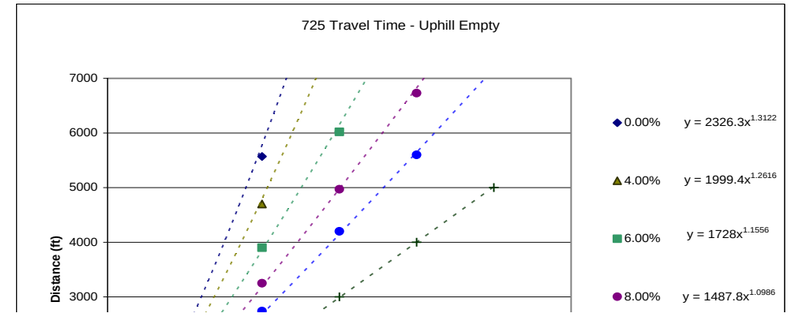
Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35



725 Haul Truck Travel Time - Uphill Empty								
Total Resistance (%) (rolling + grade)	Time (min) 0.5	1	2	3	4	5	k	p
0	680	2,480	5,570				2326.3	1.3122
4	620	2,070	4,700				1999.4	1.2616
6	590	1,770	3,900	6,020			1728	1.1556
8	540	1,490	3,250	4,970	6,730		1487.8	1.0986
10	470	1,270	2,740	4,200	5,600	7,050	1271.2	1.0754
15	390	960	2,000	3,000	4,000	5,000	979.82	1.0145

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$



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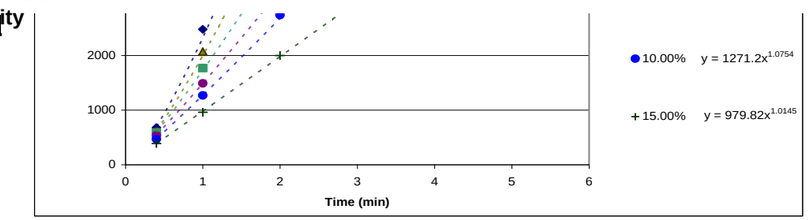
Source: Caterpillar Performance Handbook Edition 35

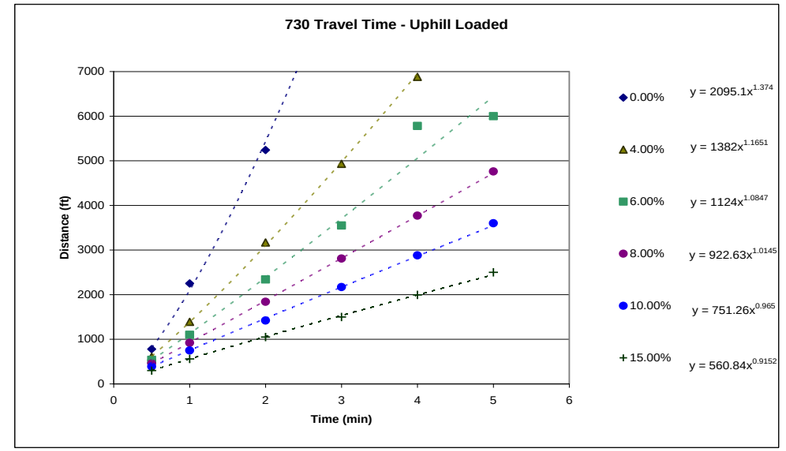


Productivity - Articulated Trucks (cont.)

730 Articulated Truck Travel Time - Uphill Loaded								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.5	1	2	3	4	5		
0	780	2,250	5,240				2095	1.374
4	610	1,390	3,170	4,930	6,880		1382	1.1651
6	540	1,100	2,340	3,550	5,780	6,000	112	1.0847
8	460	920	1,840	2,810	3,770	4,760	922.63	1.0145
10	390	750	1,420	2,170	2,880	3,600	751.26	0.965
15	300	560	1,050	1,500	1,995	2,500	560.84	0.9152

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

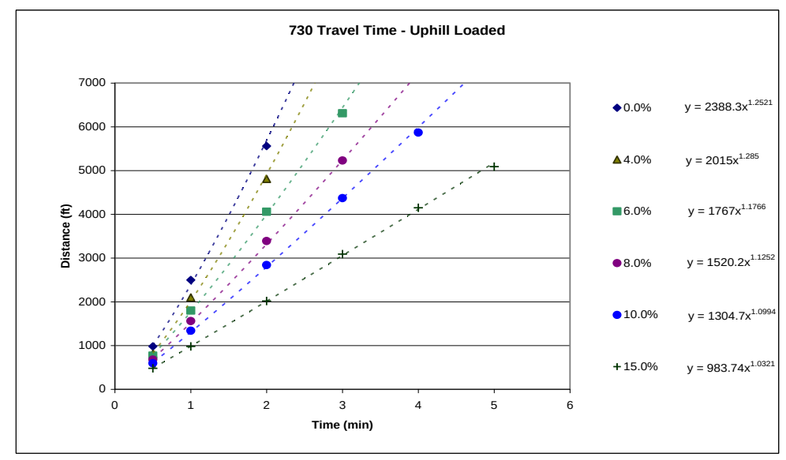
Source: Caterpillar Performance Handbook Edition 35



730 Haul Truck Travel Time - Uphill Empty								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.5	1	2	3	4	5		
0	980	2,500	5,560				2388	1.25621
4	810	2,100	4,810				2015	1.285
6	770	1,800	4,060	6,310			1767	1.1766
8	680	1,560	3,390	5,230	7,070		1520.2	1.1252
10	595	1,340	2,840	4,370	5,870		1304.7	1.0994
15	480	980	2,020	3,090	4,150	5,090	983.74	1.0321

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

Source: Caterpillar Performance Handbook Edition 35



Productivity - Articulated Trucks (cont.)

735 Travel Time - Uphill Loaded

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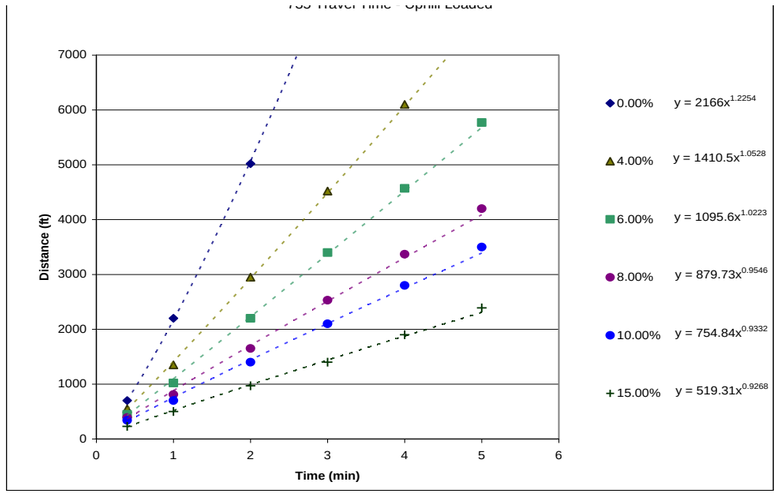
Closure Cost Estimate

Productivity

735 Articulated Truck Travel Time - Uphill Loaded								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.5	1	2	3	4	5		
0	700	2,200	5,020				2166	1.2254
4	550	1,350	2,950	4,520	6,100		1410.5	1.0528
6	450	1,020	2,200	3,400	4,570	5,770	1095.6	1.0223
8	390	810	1,650	2,530	3,370	4,200	879.73	0.9546
10	340	700	1,400	2,100	2,800	3,500	754.84	0.9332
15	230	500	970	1,400	1,900	2,390	519.31	0.9268

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

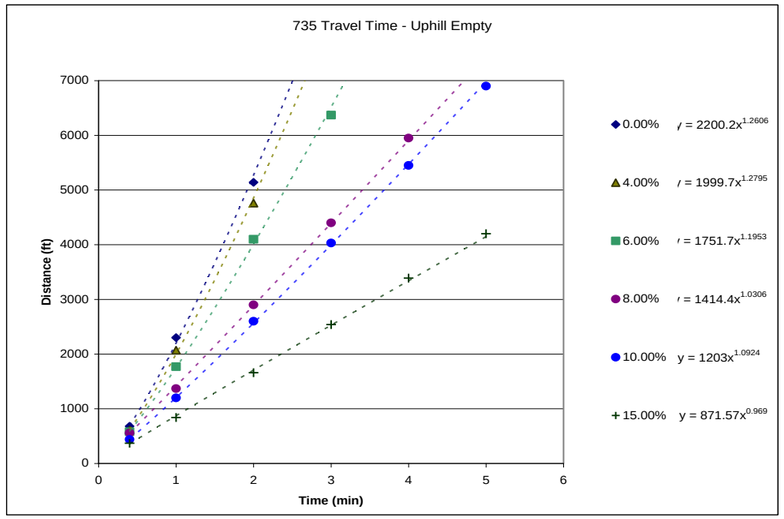
Source: Caterpillar Performance Handbook Edition 35



735 Haul Truck Travel Time - Uphill Empty								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.5	1	2	3	4	5		
0	680	2,300	5,140				2200.2	1.2606
4	610	2,070	4,760				1999.7	1.2795
6	580	1,770	4,100	6,370			1751.7	1.1953
8	560	1,370	2,900	4,400	5,950		1414.4	1.0306
10	440	1,200	2,600	4,030	5,450	6,900	1203	1.0924
15	370	840	1,660	2,540	3,390	4,200	871.57	0.969

Travel Time (min) = $\sqrt[p]{\frac{distance}{k}}$

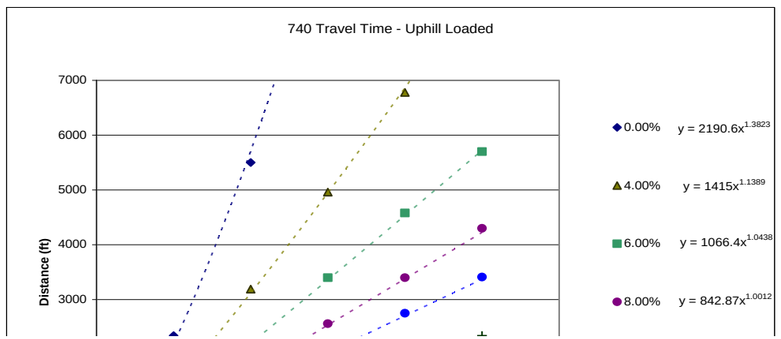
Source: Caterpillar Performance Handbook Edition 35



Productivity - Articulated Trucks (cont.)

740 Articulated Truck Travel Time - Uphill Loaded								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.5	1	2	3	4	5		
0	600	2,340	5,500				2190.6	1.3823
4	500	1,390	3,190	4,960	6,780		1415	1.1389
6	420	1,020	2,200	3,400	4,580	5,700	1066.4	1.0438
8	350	800	1,650	2,560	3,400	4,300	842.87	1.0012
10	290	640	1,350	2,040	2,750	3,410	686.02	0.9889
15	200	450	940	1,400	1,830	2,340	474.86	0.9789

$\sqrt[p]{\frac{distance}{k}}$



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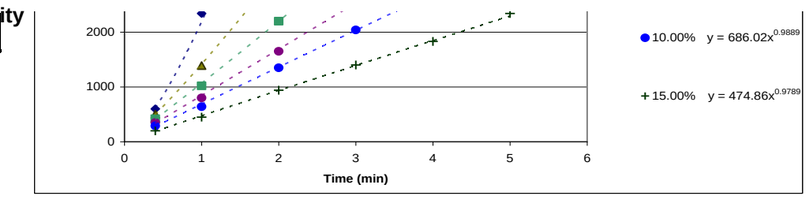
Closure Cost Estimate
Productivity

Travel Time (min) =

Source: Caterpillar Performance Handbook Edition 35

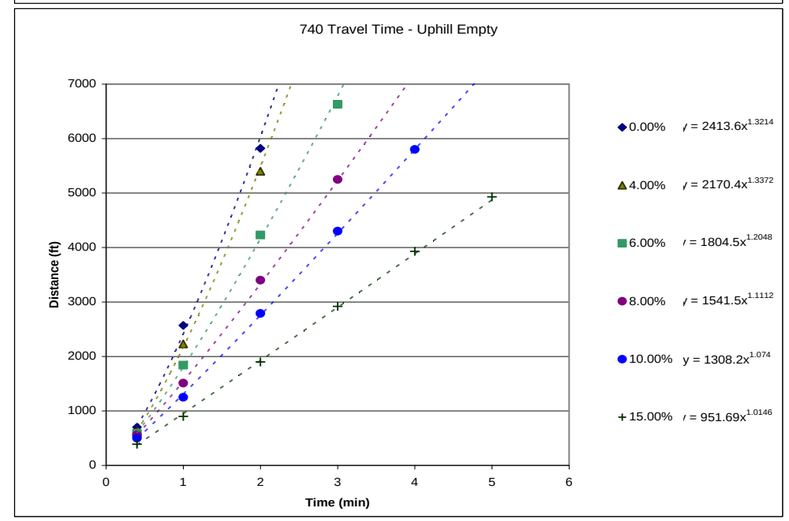


740 Haul Truck Travel Time - Uphill Empty								
Total Resistance (%) (rolling + grade)	Time (min)						k	p
	0.5	1	2	3	4	5		
0	700	2,570	5,820				2413.6	1.3214
4	630	2,230	5,400				2170.4	1.3372
6	590	1,840	4,230	6,630			1804.5	1.2048
8	560	1,510	3,400	5,250	7,120		1541.5	1.1112
10	500	1,250	2,790	4,300	5,800		1308.2	1.074
15	390	900	1,900	2,920	3,930	4,930	951.69	1.0146

$$\sqrt[p]{\frac{distance}{k}}$$

Travel Time (min) =

Source: Caterpillar Performance Handbook Edition 35



Productivity - Wheel Loaders

Wheel Loader Specifications														
Description	924G	928G	950G	966G	972G	972G (2)	980G	988G	988G(2)	990	992G	992G(2)	994D	L2350
Payload Capacity (cy)														
Struck	2.2	2.5	3.46	4.46	4.71	4.71	6.34	6.9	6.9	9.5	13.2	13.2	18	
Heaped	2.7	3.25	4	5.25	5.5	5.5	7.25	8.33	8.33	11.25	16	16	22.5	
Average	2.45	2.875	3.73	4.855	5.105	5.105	6.795	7.615	7.615	10.375	14.6	14.6	20.25	53
Matched Truck	N/A	N/A	N/A	725	730	735	N/A	740	769D	773D	777D	785C	793C	797B
Average Cycle Time (min)	0.45	0.45	0.5	0.5	0.5	0.5	0.55	0.55	0.55	0.55	0.6	0.6	0.6	0.75
Passes to Fill Truck	N/A	N/A	N/A	3	4	5	N/A	4	3	4	5	6	7	5
Altitude Deration Factor	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Operator Efficiency	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Job Efficiency	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Time to Fill Truck	N/A	N/A	N/A	1.5	2	2.5	N/A	2.2	1.65	2.2	3	3.6	4.2	3.75
Rolling Resistance**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Loader matched to small truck fleet
Loader matched to medium truck fleet
Loader matched to large truck fleet
Loader matched to extra large truck fleet

**A firm, smooth, rolling roadway with dirt or light surfacing, flexing slightly under load or undulating, maintained fairly regularly, watered

992G (2) - can be used to load 785 with 6 passes

Source: Caterpillar Performance Handbook Edition 35; LeTourneau/actual Chilean mine operating data for L2350.

Wheeled Loaders	General Purpose	Spade Nose-Rock
928G	3.25 cubic yard	not available
966G	5.0 cubic yard	not available
972G	5.5 cubic yard	not available
988G	not available	8.3 cubic yard
992G	not available	16.0 cubic yard

note: capacities are 2:1 heaped, SAE standards

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Closure Cost Estimate
Productivity

NOTES: Buckets for both Track Excavators and Wheel Loaders are offered by CECo & available for the rental rates quoted. Bucket sizes and capacities obtained from CATERPILLAR PERFORMANCE HANDBOOK, ED 34; Section 12, Wheel Loader and Section 4, Excavators

Bucket capacity and width dictated by material weight and configuration, ie., shot, loose, tight bank, stockpile, rock, etc. Typical Nevada applications were used to determine above bucket capacities as related to materials & densities. Job site specifics may alter specific bucket requirements. (Cashman Equipment, Elko, Nevada - February 21, 2005)

Productivity - Shovels

Shovel Specifications (Komatsu equivalent)

Description	PC2000	PC3000	PC4000	PC5500	PC8000
Payload Capacity (cy)					
Struck	10.46	18.84	26.16	33.48	47.09
Heaped	14.39	25.9	35.97	46.04	64.75
Average	12.43	22.37	31.07	39.76	55.92
Matched Truck	740	777D	785C	793C	797B
Average Cycle Time (min)	0.49	0.49	0.59	0.59	0.69
Passes to Fill Truck	2.05	2.84	3.38	4.69	5.11
Altitude Deration Factor	1	1	0.9	1	1
Operator Efficiency	1	1	1	1	1
Job Efficiency	0.83	0.83	0.83	0.83	0.83
Time to Fill Truck	1.68	2.33	3.32	4.61	5.86
Rolling Resistance**	2.5	2.5	2.5	2.5	2.5

Shovel matched to small truck fleet
Shovel matched to medium truck fleet
Shovel matched to large truck fleet
Shovel matched to extra large truck fleet

**A firm, smooth, rolling roadway with dirt or light surfacing, flexing slightly under load or undulating, maintained fairly regularly, watered
992G (2) - can be used to load 785 with 6 passes

Source: Caterpillar Performance Handbook Edition 35; Komatsu actual Peruvian mine (Lagunas Norte) operating data for PC4000.

Productivity - Motor Graders

Motor Grader Specifications

Description	120H	14G/H	16G/H	24M
Grader Width (ft)	8	9.25	10.08	14.04
Blade Width (ft)	12	14	16	16
Ripper Width (7 shanks) (ft)	7.6	8.5	9.75	12.83
Road Maintence Speed (mph)				
Minimum	3	3	3	3
Maximum	9.5	9.5	9.5	9.5
Average	6.25	6.25	6.25	6.25
Hourly Production	33,000	33,000	33,000	33,000
Ripping Speed (mph)	1	1	1	1
Minimum	0	0	0	0
Maximum	3	3	3	3
Average	1.5	1.5	1.5	1.5
Altitude Deration Factor	1	1	1	1
Hourly Production (with job efficiency correction & altitude deration factors) (excluding manuever time)	6,574	6,574	6,574	6,574
Maneuver time per pass (min)	0.5	0.5	0.5	0.5
Operator Efficiency	1	1	1	1
Job Efficiency	0.83	0.83	0.83	0.83

Source: Caterpillar Performance Handbook Edition 35

Productivity - Excavators

Track Excavator Specifications

Description	312C	320C	325C	330C	345B	365BL	385BL
Bucket Capacity (cy)	0.68	1.57	2.22	2.22	3	4.6	7.3
Fill Factor	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Track Excavators	Hvy Duty Rock	Extreme Service Exc (e.g. haulroad recontour)	Hvy Duty Trench
312C	30", 0.68 cubic yd	47", 0.94 cubic yd	22", .42 cubic yd
320C	30", 0.90 cubic yd	55.1", 1.57 cubic yd	23.6", .58 cubic yd

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Closure Cost Estimate

Productivity

Average Bucket Load (cy)	0.612	1.413	1.998	1.998	2.7	4.14	6.57
Soil Type	packed earth	hard clay	hard clay	hard clay	hard clay	hard clay	hard clay
Job Condition	med-hard	med-hard	med-hard	med-hard	med-hard	med-hard	med-hard
Cycle Times (minutes) - based on hard clay							
Load Bucket	0.07	0.09	0.09	0.09	0.13	0.1	0.19
Swing Loaded	0.06	0.06	0.06	0.07	0.07	0.09	0.06
Dump Bucket	0.03	0.03	0.04	0.04	0.02	0.04	0.03
Swing Empty	0.05	0.05	0.06	0.07	0.06	0.07	0.07
Total Cycle Time	0.21	0.23	0.25	0.27	0.28	0.3	0.35
Job Efficiency	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Operator Efficiency	1	1	1	1	1	1	1
Altitude Deration Factor	1	1	1	1	1	1	1
Corrected Productivity (LCY/hr)	145	306	398	369	480	687	935
Exploration Road Cycle Time (1) (min)	N/A	0.38	0.4	N/A	0.42	N/A	N/A
Exploration Road Corr Prod (LCY/hr)	N/A	185	249	N/A	320	N/A	N/A
Track Width (ft)	8.17	9.17	9.83	10.5	11.42	11.5	11.5
Ditch/Trench Excavation							
Bucket Capacity (cy)	0.42	0.58	0.88	0.89	2.09	3.27	2.75
Fill Factor	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Corrected Productivity (LCY/hr)	50	63	88	82	186	271	196

Source: Caterpillar Performance Handbook Edition 35

325C	36", 1.25 cubic yd	60", 2.22 cubic yd	30", .88 cubic yd
330C	36", 1.25 cubic yd	60", 2.22 cubic yd	30", .89 cubic yd
345B	43.2", 1.69 cubic yd	65", 3.0 cubic yd	48", 2.09 cubic yd
365BL	60", 3.25 cubic yd	82", 4.6 cubic yd	59", 3.27 cubic yd
385BL	85", 6.30 cubic yd.	96.0, 7.30 cubic yd	57", 2.75 cubic yd

Note: capacities are 2:1 heaped, SAE standards

NOTES: Buckets for both Track Excavators and Wheel Loaders are offered by CECo &

available for the rental rates quoted. Bucket sizes and capacities obtained from CATERPILLAR PERFORMANCE HANDBOOK, ED 34; Section 12, Wheel Loader and Section 4, Excavators Bucket capacity and width dictated by material weight and configuration, ie., shot, loose, tight bank, stockpile, rock, etc. Typical Nevada applications were used to determine above bucket capacities as related to materials & densities. Job site specifics may alter specific bucket requirements (Cashman Equipment, Elko, Nevada - February 21, 2005)

(1) Exploration cycle time assumes feathering/smoothing performed by excavator

Concrete Breaking Production

Track Excavator w/Hammer Specifications

Description	325C	345B	385BL
Hydraulic Hammer	H120D s	H160D s	H180D s
Material	reinforced concrete		
Min Shift Production (yd3/8hr)	160	300	350
Max Shift Production (yd3/8hr)	300	850	1,550
Avg Shift Production (8hr)	230	575	950
Job Efficiency	0.83	0.83	0.83
Altitude Deration Factor	1	1	1

Source: Caterpillar Performance Handbook Edition 35

Drill Hole Plugging Productivity

Drill Hole Plugging Productivity

Description	Drill Rig	Pump Rig
Move-to-hole, set-up, tear-down (1)	2	2
Trip in tremmie pipe (1)	500	
Pulling casing (threaded, not	200	
Single-pass perforating (water wells)	Productivity(all p	Passes
4	60	4
6	60	4
8	50	4
12	45	6
18	40	9
24	28	12
Perforation setup,trip in/out,tear-down	2	
Perforation tool cost (wear cost)(3)	2.5	
Inert Material Placement (backfill)		
Grouting/Cement (4) (cy/hr)		5.33
Cuttings (see below) (cy/hr)		3.5

Sources: 1. Drillers daily logs from Newmont, Barrick, New West Gold, Agnico Eagle, Idaho General Mines Inc.

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Closure Cost Estimate
Productivity

2. Drillers daily logs from Newmont, Barrick, Target Minerals
3. Drillers daily logs from Newmont
4. WDC Exploration, Dec 2005

Sournce: WDC Exploration, Dec 2005

Cuttings Placement Productivity		
Shift productivity (Means 02210-700-0120; Crew B11M)	28	cy / shift
Shift length	8	hours
Estimated Hourly Productivity	3.5	cy / hour

Altitude Deration Table

	Elevation											
	0-760 m (0-2500')		760-1500 m (2500-5000')		1500-2300 m (5000-7000')		2300-3000 m (7500-10,000')		3000-3800 m (10,000-12,000')		3800-4600 m (12,500-15,000')	
MODEL	CAT	User	CAT	User	CAT	User	CAT	User	CAT	User	CAT	User
Bulldozers												
D6R	100		100		100		100		92		84	
D6R w/ Winch	100		100		100		100		92		84	
D7R	100		100		100		100		100		96	
D8R	100		100		100		93		85		77	
D9R	100		100		100		93		85		77	
D10R	100		100		100		100		97		89	
D11R	100		100		100		93		85		77	
Wheeled Dozers												
824G	100		100		100		100		92		84	
834G	100		100		100		100		92		84	
844	100		100		100		100		100		96	
854G	100		100		100		93		85		77	
Graders												
120H	100		100		100		100		96		93	
14G/H	100		100		100		100		98		96	
16G/H	100		100		100		100		98		96	
24M	100		100		100		100		98		96	
Excavators												
312C	100		100		100		83		78		73	
320C	100		100		90		87		83		76	
325C	100		100		100		100		100		100	
330C	100		100		100		100		100		100	
345B	100		100		100		100		93		93	
365BL	100		100		100		86		86		86	
385BL	100		100		100		93		85		78	
Scrapers												
631G	100		100		100		100		97		90	
637G	100		100		100		95		87		80	
Loaders												
924G	100		100		100		100		97		89	
928G	100		100		100		100		92		85	
950G	100		100		100		100		100		100	
966G	100		100		100		100		96		88	
972G	100		100		92		84		77		70	
980G	100		100		100		100		96		88	
988G	100		100		100		95		85		75	
990	100		100		100		100		92		85	
992G	100		100		100		100		93		87	
994D	100		100		100		100		96		88	
L2350	100		100		100		100		96		90	
Shovels												
PC2000	100		100		100		100		96		90	
PC3000	100		100		100		100		96		90	
PC4000	100		100		100		100		96		90	
PC5500	100		100		100		100		96		90	
PC8000	100		100		100		100		96		90	
Other Equipment												
420D 4WD Backhoe	99		97		95		91		91		91	
428D 4WD Backhoe	99		97		95		91		91		91	
CS533E Vibratory Roller	100		100		98		95		91		86	
CS633E Vibratory Roller	100		100		100		100		91		86	
CP533E Sheepsfoot Compactor	100		100		98		95		91		100	
CP633E Sheepsfoot Compactor	100		100		100		100		91		86	

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Closure Cost Estimate

Productivity

Light Truck - 1.5 Ton												
Supervisor's Truck												
Flatbed Truck												
Air Compressor + tools												
Welding Equipment												
Heavy Duty Drill Rig												
Pump (plugging) Drill Rig												
Concrete Pump												
Gas Engine Vibrator												
Generator 5KW												
HDEP Welder (pipe or liner)												
5 Ton Crane												
20 Ton Crane												
50 Ton Crane												
120 Ton Crane												
Trucks												
725	100		100		100		100		100		95	
730	100		100		100		100		100		95	
735	100		100		100		100		99		91	
740	100		100		100		100		99		91	
769D	100		100		100		93		88		82	
773E	100		100		100		100		93		85	
777D	100		100		100		100		93		87	
785C	100		100		100		93		86		80	
793C	100		100		100		100		100		93	
797B	100		100		100		100		100		93	
613E (5,000 gal) Water Wagon	100		100		100		100		95		87	
621E (8,000 gal) Water Wagon	100		100		100		100		97		90	
777D Water Truck	100		100		100		100		93		87	
785C Water Truck	100		100		100		93		86		80	
Dump Truck (10-12 yd^3) (5)												

Notes:
User entered deration value will override values from CAT Performance Handbook, except L2350 Loader: data from actual mine performance in Chile.
Komatsu altitude deration assumed from LeTourneau L2350

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STANDARDIZED RECLAMATION COST ESTIMATOR
User Tools
Version 1.4.1

These tools allow easy access to some useful VBA routines and macros that are include in this Model Version

Keyboard Shortcuts	
SHORTCUT KEYS	**ACTION**
Ctrl-Shift-C	***Go to Table of Contents***
Ctrl-Shift-O	***Open Toe Offset Calculator***
Ctrl-Shift-P	***Go to Property Information Sheet***
Ctrl-Shift-S	***Show Slope Conversion Table***
Ctrl-Shift-T	***Go to Tools sheet***
Ctrl-Shift-Z	***Paste Formulas -*** *First Use Ctrl-C to copy a range, then use the mouse (or keyboard) to select the paste range and then use this shortcut to paste formulas only from the copy range to the paste range. Equivalent to the Paste Special/Formulas command.*

Closure Cost Estimate
Seed Mixture

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Seed Mixture						
Common Name	Scientific Name	Species Number of Seeds / lb	Species % in Mix	PLS/acre	Cost/Lb	Cost/Acre
Grasses						
Forbs						
Shrubs						
Total				$0.00		$0.00

Source:

Notes:

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Closure Cost Estimate
User 1

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 1 - Project Basic Data; Shortlag and Residual Rock Removal; Other Mat'l Haulage

SRCE Model Cost Summary $127,447,590

Lime application assumptions	amount/rate	Remarks
RS Means Reference	311,676	
Shortlag density (t/cy):	1.67	610,000 tons divided by 365,000 cy as per Site E material relocation exercise
Shortlag Total (tons)	520,499	
Application rate of lime to shortlag (t/t):	0.01	
Lime required (tons)	5,205	
Density lime:	1.7	
Cost of lime ($/lb):	0.114	
Cost of lime ($/ton):	228	
Annual months of operation	5.5	
# days a year of operation	168	

hours per month	486
months per year	5.5
hours per year	2,673

Anchorage CPI 2019 1st half	228.858
Anchorage CPI 2014 1st half	214.777
Anchorage CPI 2008 1st half	187.659
Inflation rate factor 2008 based costs	1.2195
Inflation rate factor 2014 based costs	1.0656
Past 5 year Inflation rate	1.28%

	rental ($/mo)	hourly ($/hr)	indirects	total hourly ($/hr)
Lowboy trailer	5,743.37	11.82	7.5	19.32
Gradall	5,251.08	10.80	15.5	26.30

$127,284,204.00

Pyritic Rock Removal Requirements			
Site	**PAG cy total**	**Distance to tailings**	**Distance to UG**
5.0 mile A Road	1,000	5.48	
3.9 mile A Road	15,000	4.38	
3.2 mile A Road	600	3.68	
0.9 mile A Road	1,500	1.38	
1.8 mile B Road	5,000	0.8	
2.5 mile B Road	60,000	1.5	
Zinc Ck Bridge	5,000	3.2	
Pit 174	4,000	2.3	
7.3 mile B Road	500	6.3	
1350 Road	8,000	8	
Core Shed	2,000	1	
Truck Pad	30,000	1	
Con Storage	10,000	1	
Tributary Creek (removed with S3P1)	-	0	
Site E	163,400	3.6	
Pit 405	20,000	6.6	
D Pile	120,000	7	0.63
Pond 23 Bedding	6,000	7	
Site C	50,000		0.36
Mill Backslope	25,000		0.18
Mill/Admin Fill	100,000		0.18
Ore Pad	18,000		0.18
Warehouse Pad	13,000		0.18
Water Building	3,500		0.18
Mine Portal	4,000		0.13
960 Site	100		0.13
1350 Site	10,000		0.77
Site 23	1,449,725	7	

See Haul Materials sheet for estimate details.
Distances from User 15.

Site	PAG cy total	Shortlag %	Shortlag cy
5.0 mile A Road	1,000	100	1,000
3.9 mile A Road	15,000	75	11,250
3.2 mile A Road	600	100	600
0.9 mile A Road	1,500	100	1,500
1.8 mile B Road	5,000	80	4,000
2.5 mile B Road	60,000	100	60,000
Zinc Ck Bridge	5,000	100	5,000
Pit 174	4,000	80	3,200
7.3 mile B Road	500	50	250
1350 Road	8,000	40	3,200
Core Shed	2,000	30	600
Truck Pad	30,000	20	6,000
Con Storage	10,000	50	5,000
Tributary Creek (removed with S3P1)	-	100	-
Site E	163,400	10	16,340
Pit 405	20,000	20	4,000
D Pile	120,000	20	24,000
Pond 23 Bedding	6,000	75	4,500
Site C	50,000	20	10,000
Mill Backslope	25,000	75	18,750
Mill/Admin Fill	100,000	25	25,000
Ore Pad	18,000	80	14,400
Warehouse Pad	13,000	75	9,750
Water Building	3,500	50	1,750
Mine Portal	4,000	100	4,000
960 Site	100	100	100
1350 Site	10,000	50	5,000
Site 23	1,449,725	5	72,486

See Haul Materials sheet for estimate details.

User Sheet 1 - Project Basic Data; Shortlag and Residu

Dozer (D6)
Dozer operator
UG Truck(s) $/hr
UG truck Operator(s) $/hr
UG Fleet $/hr

UG Equipment
MT2010 - $27,500 (5.8 gallons per hour)
MT436B - $31,500 (7.3 gallons per hour)
Dozer D6
Loader 966 (operated by operators of other equipment)

Assumptions:

Capacity of underground truck: 32 metric tons.
Capacity of underground truck: 19.2 m3.
Capacity of underground truck: 25 cy.
Conversion from m3 to cy: 1.308 cy.
Default # of underground trucks: 2.
Number of underground fleets: 1.
Surface loader: 966.
Surface loader cycle time: 0.5 minutes.
Surface truck bucket capacity: 4.
Passes to fill truck: 7.
Number of minutes for truck driver to load himself: 4.
Number of months in year: 5.5.

UNDERGROUND HAULAGE

Site
All building debris to UG
Material from Site C
Material from Mill Backslope
Material from Mill/Admin Fill
Material from Ore Pad
Material from Warehouse Pad
Material from Water Building
Material from Mine Portal
Material from 960 Site
Material from 1350 Site
Total

Notes:
Assume truck driver loads truck and stacks load undergro
Underground haul distance is an average estimated haul c

Site
All building debris to UG
Material from Site C
Material from Mill Backslope
Material from Mill/Admin Fill
Material from Ore Pad
Material from Warehouse Pad
Material from Water Building
Material from Mine Portal
Material from 960 Site
Material from 1350 Site
Total

Closure Cost Estimate
User 1

ual Rock Removal; Other Mat'l Haulage

76.25
61.94
280.63
127.24
546.06

Monthly rental	gal/hr	hourly rental	$ fuel/hr	$/hr maint.	hourly rental w/ fuel	operator ($/hr)	total rental rate
29,302.93	5.8	60.29	24.0341444	41	125.33	63.62	188.95
33,565.17	7.3	69.06	30.2498714	41	140.31	63.62	203.93
					76.25	61.94	138.19
		40.63	50.27835651		90.91	0	90.91

32.00
19.16
25.06
1.31
2.00
1.00
966.00
0.50
4.00
7.00
4.00
5.50

Truck cycle time (hrs)	Total amt. (cy)	# loads (trips)	Truck Hrs per site	Fleet hours per site	Mo. per site
0.42	31,420	1254	261.25	130.63	0.27
0.42	50,000	1996	415.83	207.92	0.43
0.42	25,000	998	207.92	103.96	0.21
0.42	100,000	3991	831.46	415.73	0.86
0.42	18,000	719	149.79	74.90	0.15
0.42	13,000	519	108.13	54.06	0.11
0.42	3,500	140	29.17	14.58	0.03
0.42	4,000	160	33.33	16.67	0.03
0.42	100	4	0.83	0.42	0.00
0.42	10,000	400	83.33	41.67	0.09
	255,020		2,121.04	1,060.52	2.18

und. Loader hours equal to total hours divided by the fleet quantity.
distance.

Labor sum ($)	Surface loader hrs	Surface loader cost ($)	Equip. sum ($)	Cost per site	
65,238.72	261	14,817.36	108,051.74	173,290.46	
103,840.90	416	23,584.88	171,986.66	275,827.56	
51,920.45	208	11,792.44	85,993.33	137,913.78	
207,629.78	831	47,157.95	343,887.16	551,516.94	
37,405.62	150	8,495.76	61,953.11	99,358.73	
27,000.72	108	6,132.54	44,719.98	71,720.69	
7,283.43	29	1,654.25	12,063.19	19,346.62	
8,323.92	33	1,890.57	13,786.51	22,110.43	
208.10	1	47.26	344.66	552.76	
20,809.80	83	4,726.43	34,466.27	55,276.07	
529,661.43	2,121	120299.4533	877,252.61	1,406,914.05	**<--Other User item #11**

Closure Cost Estimate
User 2

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 2 - Mobilization/Demobilization

SRCE Model Cost Summary $127,447,590

	Grading	Hauling	Cover Placement	Growth Media Plac	Other	# trucks/cr	YEARS 0	1	2	3	4	5	(...)	99	100
Roads			740/988G		345B (recontouring)	2									
Well Abandonment					Rig										
Underground Openings															
Process Ponds				740/988G	740/988G (backfill)	2									
Waste Rock Dumps															
Tailings															
Foundation & Buildings Areas															
Yards, Etc.	D6			740/988G		2									
Drainage & Sediment Control															
Generic Material Hauling		740/988G/D8				12									
Other User Costs (from Other User sheet)															
Utilization of underground equipment for disposal (User 1)					Minetruck			x	x	x					
Excavator for residual and short-lag material					345 excavator			x	x	x					
C. Detoxification/Water Treatment/Disposal of Wastes**															
Other User Costs (from Other User sheet)															
Various waste disposal (User 14)					Vacuum truck					x					
Decontamination (User 14)					Vacuum truck					x					
Reconfiguration pumps and pipes (User Crew 3)					User Crew 3: 420D 4WD Backhoe, Welding Equipment			x							
D. Structure, Equipment and Facility Removal, and Misc.															
Foundation & Buildings Areas					345B; B-8 (adjusted):20-ton crane; B-9: air compressor										
Other User Costs (from Other User sheet)															
Internal mill infrastructure demolition (User 6)					120 ton crane ; Track Hoe ; 365 Excavator ; 8,000 lbs gradall ; Lowboy Trailer			x							
Bridge Demolition (User 11)					120 Ton Crane; Track Hoe with Shear; Lowboy Trailer; 8,000lbs gradall; 345B Ext			x							
Removal of miscellaneous linear items (1 backhoe+2 laborers) (User Crew 1)					928G			x							
Demolish WTP (User 6)					120 ton crane ; Track Hoe ; Excavator ; 8,000 lbs gradall ; Lowboy Tr										x
Remove log bridges (User Crew 4)					325C; 725										x
E. Monitoring															
Other User Costs (from Other User sheet)															
Post-closure cover maintenance - Tailings (User Crew 2)					D6R; 330C; CP533E Sheepsfoot Compactor			x	x	x	x	x			
F. Construction Management & Support															
Road Maintenance	Small grader				Small water truck										
Other User Costs (from Other User sheet)															
Small crossings over Zinc and Greens Creek bridge locations (User 10) (Crew C-12)					12-ton crane			x							

Rate to ship from Seattle to HGCMC		
Per 100 lb	$ 7.14	Updated CDW 10 April 2019

	Weight (lb)	Mob	Demob	Total	Year 1	Year 2	Year 3	Year 4	Year 5	Year (...)	Year 99	Year 100
Bulldozers												
D6R	45,000	3,213	3,213	6,426	1	1	1	1	1			
D6R w/ Winch	48,000	3,427	3,427	6,854								
D7R	68,500	4,891	4,891	9,782								
D8R	85,000	6,069	6,069	12,138	1	1	1					
D9R	108,000	7,711	7,711	15,422								
Motor Graders												
120H	31,000	2,213	2,213	4,427								
14G/H	47,000	3,356	3,356	6,712								
16G/H												
24M												
Track Excavators												
312C	29,000	2,071	2,071	4,141								
320C	46,500	3,320	3,320	6,640								
325C	65,000	4,641	4,641	9,282								1
330C	80,000	5,712	5,712	11,424	1	1	1	1	1			
345B	100,000	7,140	7,140	14,280	1	1	1					
365BL	155,000	11,067	11,067	22,134	1							
Scrapers												
631G												
637G PP												
Wheeled Loaders												
924G	22,800	1,628	1,628	3,256								
928G	28,000	1,999	1,999	3,998	1							
950G	39,500	2,820	2,820	5,641								
966G	53,000	3,784	3,784	7,568								
972G	56,000	3,998	3,998	7,997								
980G	67,000	4,784	4,784	9,568								
988G	110,000	7,854	7,854	15,708								
990												
992G												
Hydraulic Hammers												
H-120 (fits 325)	4,500	321	321	643								
H-160 (fits 345)	8,500	607	607	1,214								
H-180 (fits 365/385)	13,000	928	928	1,856								
Demolition Shears												
S340 (fits 322/325/330)	4,000	286	286	571								
S365 (fits 330/345)	7,500	536	536	1,071								
S390 (fits 365/385)	9,500	678	678	1,357								
Demolition Grapples												
G315 (fits 322/325)	3,500	250	250	500								
G320 (fits 325/330)	4,500	321	321	643								
G330 (fits 345/365)	8,000	571	571	1,142								
Other Equipment												
420D 4WD Backhoe	17,500	1,250	1,250	2,499	8		1					
428D 4WD Backhoe	18,000	1,285	1,285	2,570								
CS533E Vibratory Roller	25,000	1,785	1,785	3,570								
CS663E Vibratory Roller	41,000	2,927	2,927	5,855								
CP533E Sheepsfoot Compactor	25,000	1,785	1,785	3,570	1	1	1	1	1			
CP663E Sheepsfoot Compactor	41,000	2,927	2,927	5,855								

Closure Cost Estimate
User 2

Light Truck - 1.5 Ton													
Supervisor's Truck													
Flatbed Truck													
Air Compressor + tools	1,300	93	93	186	1	1							1
Welding Equipment	19,500	1,392	1,392	2,785	8		1						
Heavy Duty Drill Rig													
Pump (plugging) Drill Rig	1,000	71	71	143	1								1
Concrete Pump													
Gas Engine Vibrator													
HDEP Welder (pipe or liner)													
Concrete mixer truck	24,200	1,728	1,728	3,456									
5 Ton Crane	25,000	1,785	1,785	3,570									
20 Ton Crane	38,500	2,749	2,749	5,498	1	1							1
50 Ton Crane	70,000	4,998	4,998	9,996									
120 Ton Crane	95,000	6,783	6,783	13,566	1								1
100 ton marine crane	90,000	6,426	6,426	12,852									
Trucks													
725 (articulated)	49,000	3,499	3,499	6,997									1
730 (articulated)	51,000	3,641	3,641	7,283									
735 (articulated)	70,000	4,998	4,998	9,996									
740 (articulated)	73,000	5,212	5,212	10,424	8	8	8						
769D													
613E (5,000 gal) Water Wagon (assume same as 725)				6,997	1	1	1						
621E (8,000 gal) Water Wagon (assume same as 725)				6,997									
Dump Truck (10-12 yd3) (5)	28,600	2,042	2,042	4,084	1	1	1						
Miscellaneous													
Lowboy trailer	55,000	3,927	3,927	7,854	1								
8000 lbs gradall	8,000	571	571	1,142	1								1
Track hoe (assume same as 725)				6,997	1								1
150 kW Generator													
Minetruck MT2010	60,000	4,284	4,284	8,568	2	2	2						
Minetruck MT436B	75,000	5,355	5,355	10,710									
Scooptram ST2G, ST2D	17,500	1,250	1,250	2,499									
Hydroseeder	5,000	357	357	714	1	1	1						1
Vacuum truck (assume same as small water truck)				6,997			1						
				Subtotal	$ 263,951.52	$ 165,847.92	$ 172,445.28	$ 21,420.00	$ 21,420.00	$ -	$ -	$ 44,525.04	$ 689,609.76 <--Other User item #18

Closure Cost Estimate

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 3 - Marine Demo Summary

SRCE Model Cost Summary $127,447,590

Source:
Marine Demo 2008.xls

Sites	Labor	Equipment	Material	Total
Hawk Inlet	77,778.05	125,540.19		203,318.24
Young Bay	35,939.35	42,344.29		78,283.64
Miscellaneous			185,675.24	185,675.24
Other - $500,000 inflation adjusted	177,593.50	177,593.50	177,593.50	532,780.51
SUM	291,310.90	345,477.99	363,268.75	1,000,057.64
Note: Marine environment work includes equipment costs for unique water based demolition needs				

<--Other User item #8

Labor	68.26
Marine demo worker	69.52

	2008 costs	Inflation adjusted
Mobilization	65000	79,270.22
Tug Rental	15000	18,293.13
Barge Rental	15000	18,293.13
Demobilization	40000	48,781.67
Slings/Cables/Misc	17250	21,037.10

		rate	operator	equip+operator
150 Ton Marine Crane*		1200.00	61.94	1261.94
345 Excavator		80.41	60.71	141.12
50-Ton Crane		73.65	61.94	135.59
Lowboy Trailer		19.32	60.71	80.03
8,000lbs Gradall		26.30	60.71	87.01

*150 Ton Marine Crane rental rate updated 8 April 2019 - Western Marine construction email

User Sheet 3 - Marine Demo Summary

Task Cost Estimate

Element: Site General
Area: Marine Demo
Task: Hawk Inlet
Subtask:

Description:
Salvage equipment at shiploader, freight barge and float plane dock
Demolish structures, decontaminate and ship scrap metal
Demolish foundations, removal of all piling, dolphins and support structures/walkways
Maintain SEAPRO preparedness during closure
Decontamination included in Site General - Hawk Inlet Demo

Category	Unit Price	Number Required	Unit	Estimated Cost	Comments
Labor					
Labor	68.26	200	hr	13,652.00	
Marine demo worker	69.52	750	hr	52,140.00	
150 Ton Marine Crane* operator	61.94	100	hr	6,194.00	
345 Excavator operator	60.71	40	hr	2,428.40	
50-Ton Crane operator	61.94	20	hr	1,238.80	
Lowboy Trailer operator	60.71	10	hr	607.10	
8,000lbs Gradall operator	60.71	25	hr	1,517.75	
Labor Subtotal				77,778.05	
Equipment					
150 Ton Marine Crane*	######	100	hr	120,000.00	Barge included
345 Excavator	80.41	40	hr	3,216.40	
50-Ton Crane	73.65	20	hr	1,473.00	Shore based
Lowboy Trailer	19.32	10	hr	193.18	
8,000lbs Gradall	26.30	25	hr	657.62	
Equipment Subtotal				125,540.19	

User Sheet 3 - Marine Demo Summary

Task Cost Estimate

Description:
Salvage decking, breakwater barge, docking bar
Pull pile and salvage, or cut at mudline (may not
Due to shallow depth of beach, may have to utili
Maintain SEAPRO preparedness at site until pro

Category
Labor
Labor
Marine demo worker
150 Ton Marine Crane* operator
345 Excavator operator
50-Ton Crane operator
Lowboy Trailer operator
8,000lbs Gradall operator
Labor Subtotal
Equipment
150 Ton Marine Crane*
345 Excavator
50-Ton Crane
Lowboy Trailer
8,000lbs Gradall
Equipment Subtotal

Closure Cost Estimate

User Sheet 3 - Marine Demo Summary

Element: Site General
Area: Marine Demo
Task: Young Bay
Subtask:

ge and misc equipment
be able to pull out due to screw fin design on piling base)
ze ground based equipment toward the shore
jects are complete.

Unit Price	Number Required	Unit	Estimated Cost	Comments
68.26	100	hr	6,826.00	
69.52	300	hr	20,856.00	
61.94	30	hr	1,858.20	
60.71	50	hr	3,035.50	
61.94	20	hr	1,238.80	
60.71	10	hr	607.10	
60.71	25	hr	1,517.75	
			35,939.35	
######	30	hr	36,000.00	Barge included
80.41	50		4,020.50	
73.65	20	hr	1,473.00	Shore based
19.32	10	hr	193.18	Shore based
26.30	25	hr	657.62	Shore based
			42,344.29	

Task Cost Estimate

Element: Site General
Area: Marine Demo
Task: Miscellaneous Demo Equipment Costs
Subtask:

Description:
Due to specialty aspect of Marine based work, miscellaneous equipment costs are added to the overall estimates
Mobilization/Demobilization of equipment
Tugs rentals
Lifting gear
Salvage equipment
Contractor Profits on services/equipment

Category	Unit Price	Number Required	Unit	Estimated Cost
Materials				
Mobilization	79,270.22	1	lot	79,270.22
Tug Rental	18,293.13	1	lot	18,293.13
Barge Rental	18,293.13	1	lot	18,293.13
Demobilization	48,781.67	1	lot	48,781.67
Slings/Cables/Misc	21,037.10	1	lot	21,037.10
				185,675.24

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 4 - Water Treatment Summary

SRCE Model Cost Summary $127,447,590

Area/Source	Active Production Destination	Flow GPM	Head ft	Pipe Diameter in
Underground				
1350 Drain (el LIDAR 1300')	Main Sump	25	-350	4
Main Sump (el 950'/890'?)	A Pond	75	-52	4
920 Area				
A Pond (el 900'/838', crest 846)	Pond 7	214	-716	8
B Pond Sump (el 890'/826')	A Pond	100	20	4
C Pond (el 850'/796')	23 Pond	7	96	6
D Pond (el 810'/752')	23 Pond PS	129	70	12
23 Pond (el 878'/822')	23 Pond PS	138	0	8
23 Pond Pump Station (el 878'/822')	Pond 7	267	-700	8
800 and 400 GPM WTPs (el 940'/874+20' head)	Pond 7	500	-752	10
Greens Creek Pumps (el 915'/852')	1160 Head Tank	500	296	8
Sewage Treatment (el 940'/876'+10' head)	A Pond	5	-38	lined ditch
1160 Head Tank (1160'/1128'+20' head)	Various 920	variable	-254	10
Hawk Inlet				
Cannery Creek Potable (el 174')	Hawk Inlet Wate	18	-54	6
Hawk Inlet Water Bldg (el 120')	Hawk Inlet Vario	18	-90	4
Hawk Inlet Lift Station (el 18')	Sewage Treatme	18	62	4
Sewage Treatment Plant (el 80')	DB-04	18	-56	4
Seeps (4) (el 18')	DB-04	1	20	2
Herman's Gulch Sump (el 24')	DB-04	2	15	6
DB-04 (el' 24')	Pond 7 via west	31	160	8
Tailings Area				
Cannery Creek Withdrawal (el 174')	Truckwash	35	110	4
Truckwash (el 175')	Pond 7 via east	35	-53	12
Pond 9 (el 186')	Pond 7 via west	55	-64	18
Pond 10 (bottom el 120') (including runoff)	Pond 7	28	25	8
Pond 10 Underdrain Wet well 11 (el 115')	Pond 10	15	31	8
E. Upslope Infiltration (var 190')	Wet well 13	50	-66	
Wet well A (el 132')	Pond 7	17	8	8
Unlined area drains	various wet wells	19	various	
Above liner drains	various wet wells	14	various	
Below liner drains (excluding ponds)	various wet wells	30	various	
Area runoff (excluding Pond 7 and Pond 10)	Pond 7 via ditche	169	various	
Wet well 5 (170')	Pond 9	8	16	8
Wet well 3 (150')	Pond 7 via west	2	10	6
Wet well 12 S3P1 above liner (110')	Pond 7 via east	8	30	8
Wet well 13 S3P1 below liner (110')	Pond 7 via east	70	30	8
Wet well 15 S3P1 toe pumpback (113')	Pond 7 via east	19	27	8
Pond 7 (bottom el 122') including runoff	TDF WTP	1406	48	12
Pond 7 Underdrain pumpback(el 110')	Pond 7	19	36	6
Pond 7/10 system below 110'				
Pond 7/10 system (TBD) below 110'				
TDF WTP (el 170')	APDES Outfall	1406	-170	14
APDES Outfall (el 0')	Hawk Inlet	1406	0	14

Adding green components minus 4 GPM gives Pond 7 input through Year 3
Wet well 15 has 4 GPM included which is already in area runoff total

TBD = To be determined; N/A = Not applicable
Note: GC 920 as-built has elevations ~60 higher than LIDAR survey, Greens Creek elevation at GC bridge is 840' per LIDAR

Original flow data was from the December 2013 Stage 3 Phase 1 water balance. The values used in the model were vetted agai
HGCMC elected to keep the conservative values for the 2019 WMP renewal.

Closure Cost Estimate
User 4

Closure Cost Estimate
User 4

Closure Cost Estimate
User 4

User Sheet 4 - Water Treatment Summary

Holding Year (Year 0)

Destination	Flow	Head	Pipe Diameter
	GPM	ft	in
Main Sump	25	-350	4
A Pond	30	-52	4
Pond 7	169	-716	8
A Pond	100	20	4
23 Pond	7	96	6
23 Pond PS	129	70	12
23 Pond PS	138	0	8
Pond 7	267	-700	8
Pond 7	0	-752	10
1160 Head Tank	0	296	8
A Pond	0	-38	lined ditch
Various 920	0	-254	10
Hawk Inlet Water Bldg	1	-54	6
Hawk Inlet Various	1	-90	4
Sewage Treatment Plant	1	62	4
DB-04	1	-56	4
DB-04	1	20	2
DB-04	2	15	6
Pond 7 via west ditch	14	160	8
Truckwash	0	110	4
Pond 7 via east ditch	0	-53	12
Pond 7 via west ditch	55	-64	18
Pond 7	28	25	8
Pond 10	15	31	8
Wet well 13	50	-66	
Pond 7	17	8	8
various wet wells	19	various	
various wet wells/ditches	14	various	
various wet wells/ditches	30	various	
Pond 7 via ditches	169	various	
Pond 9	8	16	8
Pond 7 via west ditch	2	10	6
Pond 7 via east ditch	8	30	8
Pond 7 via east ditch	70	30	8
Pond 7 via east ditch	19	27	8
TDF WTP	809	48	12
Pond 7	19	36	6
APDES Outfall	809	-170	14
Hawk Inlet	809	0	14

Remove 45 GPM mine operations water use
Remove 35 GPM wheel wash

User Sheet 4 - Water Treatment Summary

Years 1-3

Destination	Flow	Head	Pipe Diameter
	GPM	ft	in
Main Sump	25	-350	4
Mine flooding	30	variable	matrix
Pond 7	139	-716	8
A Pond	100	20	4
23 Pond	7	96	6
23 Pond PS	129	70	12
23 Pond PS	138	0	8
Pond 7	267	-700	8
Pond 7	0	-752	10
Underground	0	40	8
A Pond	0	-38	lined ditch
Various 920	0	-254	10
Hawk Inlet Water Bldg	5	-54	6
Hawk Inlet Various	5	-90	4
Sewage Treatment Plant	5	62	4
DB-04	1	-56	4
DB-04	1	20	2
DB-04	2	15	6
Pond 7 via west ditch	18	160	8
Truckwash	35	110	4
Pond 7 via east ditch	35	-53	12
Pond 7 via west ditch	55	-64	18
Pond 7	28	25	8
Pond 10	15	31	8
Wet well 13	50	-66	
Pond 7	17	8	8
various wet wells	19	various	
various wet wells/ditches	14	various	
various wet wells/ditches	30	various	
Pond 7 via ditches	169	various	
Pond 9	8	16	8
Pond 7 via west ditch	2	10	6
Pond 7 via east ditch	8	30	8
Pond 7 via east ditch	70	30	8
Pond 7 via east ditch	19	27	8
TDF WTP	818	48	12
Pond 7	19	36	6
APDES Outfall	818	-170	14
Hawk Inlet	818	0	14

Add 35 GPM wheel wash back in
Add 4 GPM camp water back in

nst the 2018 water balance and were shown to be more conservative.

Closure Cost Estimate
User 4

Closure Cost Estimate
User 4

Closure Cost Estimate
User 4

User Sheet 4 - Water Treatment Summary

Years 4-10

Destination	Flow	Head	Pipe Diameter
	GPM	ft	in
Mine flooding	25	variable	matrix
Mine flooding	5	variable	matrix
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
Pond 7	120	70	10
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
TDF WTP Batched	13	48	8
Returned to native drainages	N/A	N/A	N/A
Wet well 13	50	-66	
Pond 7/10 system	19	-22	8
various wet wells	19	various	
various wet wells/ditches	14	various	
various wet wells/ditches	10	various	
Returned to native drainages	N/A	N/A	N/A
Returned to native drainages	N/A	N/A	N/A
Wet well A	2	-18	drain
Pond 7/10 system	8	-5	8
Returned to native drainages	N/A	N/A	N/A
Returned to native drainages	N/A	N/A	N/A
TDF WTP Batched	150	48	12
New storage pond (west)	19	-5	6
TDF WTP Batched	38	70	8
TDF WTP Batched	8	70	8
APDES Outfall Batched	209	-170	14
Hawk Inlet	209	0	14

Added two new ponds for gravity flow
Pond 10 is overflow storage for Pond 7
Removed Pond 10 below liner flow
Wet well 3 gravity drains to Wet well A
Removed Pond 9
Removed wheel wash
Removed Site D runoff

20190403 Christopher Wallace
With the change to continuous pumping the additional volume of water from precipitation to the West and South Ponds was removed.

User Sheet 4 - Water Treatment Summary

Year 11-50

Destination	Flow	Head	Pipe Diameter
	GPM	ft	in
Mine flooding	25	variable	matrix
Mine flooding	5	variable	matrix
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
Returned to natural drainage	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
TDF WTP Batched	13	48	8
N/A	N/A	N/A	N/A
Wet well 13	50	-66	
Pond 7/10 system	19	-22	8
various wet wells	19	various	
various wet wells/ditches	14	various	
various wet wells/ditches	10	various	
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
Wet well A	2	-18	drain
Pond 7/10 system	8	-5	8
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
TDF WTP Batched	30	48	12
Pond 7/10 system	19	-5	6
TDF WTP Batched	28	70	8
TDF WTP Batched	8	70	8
APDES Outfall Batched	79	-170	14
Hawk Inlet	79	0	14

Removed 120 GPM of Site D drainage. No Flow from 920.

20190405 Christopher Wallace
Decommissioned Pond 10 in year 11. Dropped 75% (10 gpm) of the 13 gpm di

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User Sheet 4 - Water Treatment Summary

Year 51-100

Destination	Flow	Head	Pipe Diameter
	GPM	ft	in
Pond 7 via portal discharge	25	-768	4-10
Pond 7 via portal discharge	5	-768	4-10
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
TDF WTP Batched	13	48	8
N/A	N/A	N/A	N/A
Wet well 13	50	-66	
Pond 7/10 system	19	-22	8
various wet wells	19	various	
various wet wells/ditches	14	various	
various wet wells/ditches	10	various	
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
Wet well A	2	-18	drain
Pond 7/10 system	8	-5	8
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
TDF WTP Batched	60	48	12
Pond 7/10 system	19	-5	6
TDF WTP Batched	28	70	8
TDF WTP Batched	8	70	8
APDES Outfall Batched	109	-170	14
Hawk Inlet	109	0	14

Added portal drainage back in after mine fills in Year 50.

rect runoff value from the water balance.

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User Sheet 4 - Water Treatment Summary

Gravity flow

Ratio of pipe length to head: 5

			Flow GPM	Length ft	Effective H ft	Pipe Diame in
Active Production - From 1350 Drain (el LIDAR 1300') to Main Sump	Contact Water	Active	25	1750	10	4
Active Production - From Main Sump (el 950'/890'?) to A Pond	Contact Water	Active	75	260	10	4
Active Production - From A Pond (el 900'/838', crest 846) to Pond 7	Contact Water	Active	214	3580	10	8
Active Production - From B Pond Sump (el 890'/826') to A Pond	Contact Water	Active	100	100	20	4
Active Production - From C Pond (el 850'/796') to 23 Pond	Contact Water	Active	7	480	96	6
Active Production - From D Pond (el 810'/752') to 23 Pond PS	Contact Water	Active	129	350	70	12
Active Production - From 23 Pond (el 878'/822') to 23 Pond PS	Contact Water	Active	138	0	0	8
Active Production - From 23 Pond Pump Station (el 878'/822') to Pond 7	Contact Water	Active	267	3500	10	8
Active Production - From 800 and 400 GPM WTPs (el 940'/874+20' head) to Pond 7	Contact Water	Active	500	3760	10	10
Active Production - From Greens Creek Pumps (el 915'/852') to 1160 Head Tank	Contact Water	Active	500	1480	296	8
Active Production - From Sewage Treatment (el 940'/876'+10' head) to A Pond	Contact Water	Active	5	190	10	lined ditch
Active Production - From 1160 Head Tank (1160'/1128'+20' head) to Various 920	Contact Water	Active	variable	1270	10	10
Active Production - From Cannery Creek Potable (el 174') to Hawk Inlet Water Bldg	Contact Water	Active	18	270	10	6
Active Production - From Hawk Inlet Water Bldg (el 120') to Hawk Inlet Various	Contact Water	Active	18	450	10	4
Active Production - From Hawk Inlet Lift Station (el 18') to Sewage Treatment Plant	Contact Water	Active	18	310	62	4
Active Production - From Sewage Treatment Plant (el 80') to DB-04	Contact Water	Active	18	280	10	4
Active Production - From Seeps (4) (el 18') to DB-04	Contact Water	Active	1	100	20	2
Active Production - From Herman's Gulch Sump (el 24') to DB-04	Contact Water	Active	2	75	15	6
Active Production - From DB-04 (el' 24') to Pond 7 via west ditch	Contact Water	Active	31	800	160	8
Active Production - From Cannery Creek Withdrawal (el 174') to Truckwash	Contact Water	Active	35	550	110	4
Active Production - From Truckwash (el 175') to Pond 7 via east ditch	Contact Water	Active	35	265	10	12
Active Production - From Pond 9 (el 186') to Pond 7 via west ditch	Contact Water	Active	55	320	10	18
Active Production - From Pond 10 (bottom el 120') (including runoff) to Pond 7	Contact Water	Active	28	125	25	8
Active Production - From Pond 10 Underdrain Wet well 11 (el 115') to Pond 10	Contact Water	Active	15	155	31	8
Active Production - From E. Upslope Infiltration (var 190') to Wet well 13	Contact Water	Active	50	330	10	0
Active Production - From Wet well A (el 132') to Pond 7	Contact Water	Active	17	40	8	8
Active Production - From Unlined area drains to various wet wells	Contact Water	Active	19	#VALUE!	various	0
Active Production - From Above liner drains to various wet wells/ditches	Contact Water	Active	14	#VALUE!	various	0

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Active Production - From Below liner drains (excluding ponds) to various wet wells/ditches	Contact Water	Active	30	#VALUE!	various	0
Active Production - From Area runoff (excluding Pond 7 and Pond 10) to Pond 7 via ditches	Contact Water	Active	169	#VALUE!	various	0
Active Production - From Wet well 5 (170') to Pond 9	Contact Water	Active	8	80	16	8
Active Production - From Wet well 3 (150') to Pond 7 via west ditch	Contact Water	Active	2	50	10	6
Active Production - From Wet well 12 S3P1 above liner (110') to Pond 7 via east ditch	Contact Water	Active	8	150	30	8
Active Production - From Wet well 13 S3P1 below liner (110') to Pond 7 via east ditch	Contact Water	Active	70	150	30	8
Active Production - From Wet well 15 S3P1 toe pumpback (113') to Pond 7 via east ditch	Contact Water	Active	19	135	27	8
Active Production - From Pond 7 (bottom el 122') including runoff to TDF WTP	Contact Water	Active	1406	240	48	12
Active Production - From Pond 7 Underdrain pumpback(el 110') to Pond 7	Contact Water	Active	19	180	36	6
Active Production - From Pond 7/10 system below 110' to	Contact Water	Active	0	0	0	0
Active Production - From Pond 7/10 system (TBD) below 110' to	Contact Water	Active	0	0	0	0
Active Production - From TDF WTP (el 170') to APDES Outfall	Contact Water	Active	1406	850	10	14
Active Production - From APDES Outfall (el 0') to Hawk Inlet	Contact Water	Active	1406	0	0	14
Holding Year (Year 0) - From 1350 Drain (el LIDAR 1300') to Main Sump	Contact Water	Active	25	1750	10	4
Holding Year (Year 0) - From Main Sump (el 950'/890'?) to A Pond	Contact Water	Active	30	260	10	4
Holding Year (Year 0) - From A Pond (el 900'/838', crest 846) to Pond 7	Contact Water	Active	169	3580	10	8
Holding Year (Year 0) - From B Pond Sump (el 890'/826') to A Pond	Contact Water	Active	100	100	20	4
Holding Year (Year 0) - From C Pond (el 850'/796') to 23 Pond	Contact Water	Active	7	480	96	6
Holding Year (Year 0) - From D Pond (el 810'/752') to 23 Pond PS	Contact Water	Active	129	350	70	12
Holding Year (Year 0) - From 23 Pond (el 878'/822') to 23 Pond PS	Contact Water	Active	138	0	0	8
Holding Year (Year 0) - From 23 Pond Pump Station (el 878'/822') to Pond 7	Contact Water	Active	267	3500	10	8
Holding Year (Year 0) - From 800 and 400 GPM WTPs (el 940'/874+20' head) to Pond 7	Contact Water	Active	0	3760	10	10
Holding Year (Year 0) - From Greens Creek Pumps (el 915'/852') to 1160 Head Tank	Contact Water	Active	0	1480	296	8
Holding Year (Year 0) - From Sewage Treatment (el 940'/876'+10' head) to A Pond	Contact Water	Active	0	190	10	12
Holding Year (Year 0) - From 1160 Head Tank (1160'/1128'+20' head) to Various 920	Contact Water	Active	0	1270	10	10
Holding Year (Year 0) - From Cannery Creek Potable (el 174') to Hawk Inlet Water Bldg	Contact Water	Active	1	270	10	6
Holding Year (Year 0) - From Hawk Inlet Water Bldg (el 120') to Hawk Inlet Various	Contact Water	Active	1	450	10	4
Holding Year (Year 0) - From Hawk Inlet Lift Station (el 18') to Sewage Treatment Plant	Contact Water	Active	1	310	62	4
Holding Year (Year 0) - From Sewage Treatment Plant (el 80') to DB-04	Contact Water	Active	1	280	10	4
Holding Year (Year 0) - From Seeps (4) (el 18') to DB-04	Contact Water	Active	1	100	20	2
Holding Year (Year 0) - From Herman's Gulch Sump (el 24') to DB-04	Contact Water	Active	2	75	15	6
Holding Year (Year 0) - From DB-04 (el' 24') to Pond 7 via west ditch	Contact Water	Active	14	800	160	8
Holding Year (Year 0) - From Cannery Creek Withdrawal (el 174') to Truckwash	Contact Water	Active	0	550	110	4
Holding Year (Year 0) - From Truckwash (el 175') to Pond 7 via east ditch	Contact Water	Active	0	265	10	12
Holding Year (Year 0) - From Pond 9 (el 186') to Pond 7 via west ditch	Contact Water	Active	55	320	10	18
Holding Year (Year 0) - From Pond 10 (bottom el 120') (including runoff) to Pond 7	Contact Water	Active	28	125	25	8
Holding Year (Year 0) - From Pond 10 Underdrain Wet well 11 (el 115') to Pond 10	Contact Water	Active	15	155	31	8
Holding Year (Year 0) - From E. Upslope Infiltration (var 190') to Wet well 13	Contact Water	Active	50	330	10	0
Holding Year (Year 0) - From Wet well A (el 132') to Pond 7	Contact Water	Active	17	40	8	8
Holding Year (Year 0) - From Unlined area drains to various wet wells	Contact Water	Active	19	#VALUE!	various	0
Holding Year (Year 0) - From Above liner drains to various wet wells/ditches	Contact Water	Active	14	#VALUE!	various	0
Holding Year (Year 0) - From Below liner drains (excluding ponds) to various wet wells/ditches	Contact Water	Active	30	#VALUE!	various	0
Holding Year (Year 0) - From Area runoff (excluding Pond 7 and Pond 10) to Pond 7 via ditches	Contact Water	Active	169	#VALUE!	various	0
Holding Year (Year 0) - From Wet well 5 (170') to Pond 9	Contact Water	Active	8	80	16	8
Holding Year (Year 0) - From Wet well 3 (150') to Pond 7 via west ditch	Contact Water	Active	2	50	10	6
Holding Year (Year 0) - From Wet well 12 S3P1 above liner (110') to Pond 7 via east ditch	Contact Water	Active	8	150	30	8
Holding Year (Year 0) - From Wet well 13 S3P1 below liner (110') to Pond 7 via east ditch	Contact Water	Active	70	150	30	8
Holding Year (Year 0) - From Wet well 15 S3P1 toe pumpback (113') to Pond 7 via east ditch	Contact Water	Active	19	135	27	8
Holding Year (Year 0) - From Pond 7 (bottom el 122') including runoff to TDF WTP	Contact Water	Active	809	240	48	12
Holding Year (Year 0) - From Pond 7 Underdrain pumpback(el 110') to Pond 7	Contact Water	Active	19	180	36	6
Holding Year (Year 0) - From TDF WTP (el 170') to APDES Outfall	Contact Water	Active	809	850	10	14
Holding Year (Year 0) - From APDES Outfall (el 0') to Hawk Inlet	Contact Water	Active	809	0	0	14
Years 1-3 - From 1350 Drain (el LIDAR 1300') to Main Sump	Contact Water	Active	25	1750	10	4
Years 1-3 - From Main Sump (el 950'/890'?) to Mine flooding	Contact Water	Active	30	#VALUE!	variable	matrix
Years 1-3 - From A Pond (el 900'/838', crest 846) to Pond 7	Contact Water	Active	139	3580	10	8
Years 1-3 - From B Pond Sump (el 890'/826') to A Pond	Contact Water	Active	100	100	20	4
Years 1-3 - From C Pond (el 850'/796') to 23 Pond	Contact Water	Active	7	480	96	6
Years 1-3 - From D Pond (el 810'/752') to 23 Pond PS	Contact Water	Active	129	350	70	12
Years 1-3 - From 23 Pond (el 878'/822') to 23 Pond PS	Contact Water	Active	138	0	0	8
Years 1-3 - From 23 Pond Pump Station (el 878'/822') to Pond 7	Contact Water	Active	267	3500	10	8
Years 1-3 - From Sewage Treatment (el 940'/876'+10' head) to A Pond	Contact Water	Active	0	190	10	lined ditch
Years 1-3 - From 1160 Head Tank (1160'/1128'+20' head) to Various 920	Contact Water	Active	0	1270	10	10
Years 1-3 - From Cannery Creek Potable (el 174') to Hawk Inlet Water Bldg	Contact Water	Active	5	270	10	6
Years 1-3 - From Hawk Inlet Water Bldg (el 120') to Hawk Inlet Various	Contact Water	Active	5	450	10	4
Years 1-3 - From Hawk Inlet Lift Station (el 18') to Sewage Treatment Plant	Contact Water	Active	5	310	62	4
Years 1-3 - From Sewage Treatment Plant (el 80') to DB-04	Contact Water	Active	1	280	10	4
Years 1-3 - From Seeps (4) (el 18') to DB-04	Contact Water	Active	1	100	20	2
Years 1-3 - From Herman's Gulch Sump (el 24') to DB-04	Contact Water	Active	2	75	15	6
Years 1-3 - From DB-04 (el' 24') to Pond 7 via west ditch	Contact Water	Active	18	800	160	8
Years 1-3 - From Cannery Creek Withdrawal (el 174') to Truckwash	Contact Water	Active	35	550	110	4
Years 1-3 - From Truckwash (el 175') to Pond 7 via east ditch	Contact Water	Active	35	265	10	12
Years 1-3 - From Pond 9 (el 186') to Pond 7 via west ditch	Contact Water	Active	55	320	10	18
Years 1-3 - From Pond 10 (bottom el 120') (including runoff) to Pond 7	Contact Water	Active	28	125	25	8
Years 1-3 - From Pond 10 Underdrain Wet well 11 (el 115') to Pond 10	Contact Water	Active	15	155	31	8
Years 1-3 - From E. Upslope Infiltration (var 190') to Wet well 13	Contact Water	Active	50	330	10	0
Years 1-3 - From Wet well A (el 132') to Pond 7	Contact Water	Active	17	40	8	8
Years 1-3 - From Unlined area drains to various wet wells	Contact Water	Active	19	#VALUE!	various	0
Years 1-3 - From Above liner drains to various wet wells/ditches	Contact Water	Active	14	#VALUE!	various	0
Years 1-3 - From Below liner drains (excluding ponds) to various wet wells/ditches	Contact Water	Active	30	#VALUE!	various	0
Years 1-3 - From Area runoff (excluding Pond 7 and Pond 10) to Pond 7 via ditches	Contact Water	Active	169	#VALUE!	various	0
Years 1-3 - From Wet well 5 (170') to Pond 9	Contact Water	Active	8	80	16	8
Years 1-3 - From Wet well 3 (150') to Pond 7 via west ditch	Contact Water	Active	2	50	10	6
Years 1-3 - From Wet well 12 S3P1 above liner (110') to Pond 7 via east ditch	Contact Water	Active	8	150	30	8
Years 1-3 - From Wet well 13 S3P1 below liner (110') to Pond 7 via east ditch	Contact Water	Active	70	150	30	8
Years 1-3 - From Wet well 15 S3P1 toe pumpback (113') to Pond 7 via east ditch	Contact Water	Active	19	135	27	8
Years 1-3 - From Pond 7 (bottom el 122') including runoff to TDF WTP	Contact Water	Active	818	240	48	12
Years 1-3 - From Pond 7 Underdrain pumpback(el 110') to Pond 7	Contact Water	Active	19	180	36	6
Years 1-3 - From Pond 7/10 system below 110' to	Contact Water	Active	0	0	0	0
Years 1-3 - From Pond 7/10 system (TBD) below 110' to	Contact Water	Active	0	0	0	0
Years 1-3 - From TDF WTP (el 170') to APDES Outfall	Contact Water	Active	818	850	10	14
Years 1-3 - From APDES Outfall (el 0') to Hawk Inlet	Contact Water	Active	818	0	0	14
Years 4-10 - From 1350 Drain (el LIDAR 1300') to Mine flooding	Contact Water	Active	25	#VALUE!	variable	matrix

Years 4-10 - From Main Sump (el 950'/890'?) to Mine flooding	Contact Water	Active	5	#VALUE!	variable	matrix
Years 4-10 - From D Pond (el 810'/752') to Pond 7	Contact Water	Active	120	350	70	10
Years 4-10 - From Pond 10 (bottom el 120') (including runoff) to TDF WTP Batched	Contact Water	Active	13	240	48	8
Years 4-10 - From E. Upslope Infiltration (var 190') to Wet well 13	Contact Water	Active	50	330	10	0
Years 4-10 - From Wet well A (el 132') to Pond 7/10 system	Contact Water	Active	19	110	10	8
Years 4-10 - From Unlined area drains to various wet wells	Contact Water	Active	19	#VALUE!	various	0
Years 4-10 - From Above liner drains to various wet wells/ditches	Contact Water	Active	14	#VALUE!	various	0
Years 4-10 - From Below liner drains (excluding ponds) to various wet wells/ditches	Contact Water	Active	10	#VALUE!	various	0
Years 4-10 - From Wet well 3 (150') to Wet well A	Contact Water	Active	2	90	10	drain
Years 4-10 - From Wet well 12 S3P1 above liner (110') to Pond 7/10 system	Contact Water	Active	8	25	10	8
Years 4-10 - From Pond 7 (bottom el 122') including runoff to TDF WTP Batched	Contact Water	Active	150	240	48	12
Years 4-10 - From Pond 7 Underdrain pumpback(el 110') to New storage pond (west)	Contact Water	Active	19	25	10	6
Years 4-10 - From Pond 7/10 system below 110' to TDF WTP Batched	Contact Water	Active	38	350	70	8
Years 4-10 - From Pond 7/10 system (TBD) below 110' to TDF WTP Batched	Contact Water	Active	8	350	70	8
Years 4-10 - From TDF WTP (el 170') to APDES Outfall Batched	Contact Water	Active	209	850	10	14
Years 4-10 - From APDES Outfall (el 0') to Hawk Inlet	Contact Water	Active	209	0	0	14
Year 11-50 - From 1350 Drain (el LIDAR 1300') to Mine flooding	Contact Water	Active	25	125	25	matrix
Year 11-50 - From Main Sump (el 950'/890'?) to Mine flooding	Contact Water	Active	5	25	5	matrix
Year 11-50 - From Pond 10 (bottom el 120') (including runoff) to TDF WTP Batched	Contact Water	Active	13	65	13	8
Year 11-50 - From E. Upslope Infiltration (var 190') to Wet well 13	Contact Water	Active	50	330	10	0
Year 11-50 - From Wet well A (el 132') to Pond 7/10 system	Contact Water	Active	19	110	10	8
Year 11-50 - From Unlined area drains to various wet wells	Contact Water	Active	19	#VALUE!	various	0
Year 11-50 - From Above liner drains to various wet wells/ditches	Contact Water	Active	14	#VALUE!	various	0
Year 11-50 - From Below liner drains (excluding ponds) to various wet wells/ditches	Contact Water	Active	10	#VALUE!	various	0
Year 11-50 - From Wet well 3 (150') to Wet well A	Contact Water	Active	2	90	10	drain
Year 11-50 - From Wet well 12 S3P1 above liner (110') to Pond 7/10 system	Contact Water	Active	8	25	10	8
Year 11-50 - From Pond 7 (bottom el 122') including runoff to TDF WTP Batched	Contact Water	Active	30	240	48	12
Year 11-50 - From Pond 7 Underdrain pumpback(el 110') to Pond 7/10 system	Contact Water	Active	19	25	10	6
Year 11-50 - From Pond 7/10 system below 110' to TDF WTP Batched	Contact Water	Active	28	350	70	8
Year 11-50 - From Pond 7/10 system (TBD) below 110' to TDF WTP Batched	Contact Water	Active	8	350	70	8
Year 11-50 - From TDF WTP (el 170') to APDES Outfall Batched	Contact Water	Active	79	850	10	14
Year 11-50 - From APDES Outfall (el 0') to Hawk Inlet	Contact Water	Active	79	0	0	14
Year 51-100 - From 1350 Drain (el LIDAR 1300') to Pond 7 via portal discharge	Contact Water	Active	25	3840	10	4
Year 51-100 - From Main Sump (el 950'/890'?) to Pond 7 via portal discharge	Contact Water	Active	5	3840	10	4

Year 51-100 - From Pond 10 (bottom el 120') (including runoff) to TDF WTP Batched	Contact Water	Active	13	240	48	8
Year 51-100 - From E. Upslope Infiltration (var 190') to Wet well 13	Contact Water	Active	50	330	10	0
Year 51-100 - From Wet well A (el 132') to Pond 7/10 system	Contact Water	Active	19	110	10	8
Year 51-100 - From Unlined area drains to various wet wells	Contact Water	Active	19	#VALUE!	various	0
Year 51-100 - From Above liner drains to various wet wells/ditches	Contact Water	Active	14	#VALUE!	various	0
Year 51-100 - From Below liner drains (excluding ponds) to various wet wells/ditches	Contact Water	Active	10	#VALUE!	various	0
Year 51-100 - From Wet well 3 (150') to Wet well A	Contact Water	Active	2	90	10	12
Year 51-100 - From Wet well 12 S3P1 above liner (110') to Pond 7/10 system	Contact Water	Active	8	25	10	8
Year 51-100 - From Pond 7 (bottom el 122') including runoff to TDF WTP Batched	Contact Water	Active	60	240	48	12
Year 51-100 - From Pond 7 Underdrain pumpback(el 110') to Pond 7/10 system	Contact Water	Active	19	25	10	6
Year 51-100 - From Pond 7/10 system below 110' to TDF WTP Batched	Contact Water	Active	28	350	70	8
Year 51-100 - From Pond 7/10 system (TBD) below 110' to TDF WTP Batched	Contact Water	Active	8	350	70	8
Year 51-100 - From TDF WTP (el 170') to APDES Outfall Batched	Contact Water	Active	109	850	10	14
Year 51-100 - From APDES Outfall (el 0') to Hawk Inlet	Contact Water	Active	109	0	0	14

Effective heads take into account the initial positive head, assumed as 10 ft on average.

Closure Cost Estimate
User 4

NA

Head ft	Remarks
-350	
-52	
-716	
20	
96	
70	
0	
-700	
-752	
296	
-38	
-254	
-54	
-90	
62	
-56	
20	
15	
160	
110	
-53	
-64	
25	
31	
-66	
8	
various	
various	

Closure Cost Estimate
User 4

various	
various	
16	
10	
30	
30	
27	
48	
36	
0	
0	
-170	
0	
-350	
-52	
-716	
20	
96	
70	
0	
-700	
-752	
296	
-38	0
-254	
-54	
-90	
62	
-56	
20	
15	
160	
110	
-53	
-64	
25	
31	
-66	
8	
various	
various	
various	
various	
16	
10	
30	
30	
27	
48	
36	
-170	
0	
-350	
variable	
-716	
20	
96	
70	
0	
-700	
-38	
-254	
-54	
-90	
62	
-56	
20	
15	
160	
110	
-53	
-64	
25	
31	
-66	
8	
various	
various	
various	
various	
16	
10	
30	
30	
27	
48	
36	
0	
0	
-170	
0	
variable	

Closure Cost Estimate
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variable	
[redacted]	
70	
[redacted]	
48	
[redacted]	
-66	
-22	
various	
various	
various	
[redacted]	
-18	
-5	
[redacted]	
48	
-5	
70	
70	
-170	
0	
25	
5	
[redacted]	
13	
[redacted]	
-66	
-22	
various	
various	
various	
[redacted]	
-18	
-5	
[redacted]	
48	
-5	
70	
70	
-170	
0	
-768	0
-768	0
[redacted]	

Closure Cost Estimate
User 4

48	
-66	
-22	
various	
various	
various	
-18	drain
-5	
48	
-5	
70	
70	
-170	
0	

Closure Cost Estimate
User 5

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 5 - Administration

SRCE Model Cost Summary $127,447,590

Administrative Staff

Source: Administration Summary 2008 FINAL.xls

Years	# years	Staff days
Holding year	1	168
Year 1	1	168
Year 2	1	168
Year 3	1	168
Year 4-5	2	168
Year 6-14	9	
Year 15-32	18	
Year 33-50	18	
Year 51-100	50	

Air Transport Cost

Cost of helicopter	Cost	Unit
Bell 500	1,078.00	$/hr
A Star B2	2,098.00	$/hr
Beaver Dh2	385.00	round trip

11 April 2019 - CDW updated costs

Monthly Staff Transport for IMP and APDES Monitoring

Months	Staff transport	IMP frequency (see User 8)	APDES frequency (see User 8)	
1	11	1	4	13
2	11	1	4	13
3	11	1	5	14
4	11	1	4	13
5	11	1	4	13
6		1	5	5
7		1	4	4
8		1	4	4
9		1	5	5
10		1	4	4
11		1	4	4
12		1	5	5
		Total		97

Note:
Staff transport is twice a month

Annual Staff Transport for IMP and APDES Monitoring

Years	# years	Staff transport	IMP frequency (see User 8)	APDES frequency (see User 8)	Batches / Year (See User 4)	Treatment days / year	Annual trips
Active period	1						
Holding Year	1	12	12	52	26		52
Y1	1	55	12	52	26		97
Y2	1	55	12	52	26		97
Y3	1	55	12	52	26		97
Y4	1	0	12	6	6	54	12
Y5	1	0	12	6	6	54	12
Y6-Y10	5	0	4	6	6	54	6
Y11-Y15	5	0	2	4	6	30	6
Y16-Y50	35	0	2	4	6	30	6
Y51-Y100	50	0	1	4	8	40	8

Note:
Where there is no staff transport, the greatest of the frequencies of the other columns is assumed.

Total # batch trips: 786

Landing craft for materials/equip	$/batch	$	6,000.00	11 April 2019 - CDW updated costs	$	4,716,000	**<--G&A - Administration item #5**
Meals for WTP, Montioring, and Laborer crews	$/person/day	$	100.00		$	1,683,300	**<--G&A - Administration item #6**

Overall Transporation	# trips/year	Cost/trip	Cost per year	Total cost	Comments
Holding Year	52	385	20,020	20,020	Beaver
Y1	97	385	37,345	37,345	Beaver
Y2	97	385	37,345	37,345	Beaver
Y3	97	385	37,345	37,345	Ave. of passenger/passenger+equipment
Y4	12	1588	19,056	19,056	Ave. of passenger/passenger+equipment
Y5	12	1588	19,056	19,056	Ave. of passenger/passenger+equipment
Y6-Y10	6	1588	9,528	47,640	Ave. of passenger/passenger+equipment

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Y11-Y15	6	1588	9,528	47,640	Ave. of passenger/passenger+equipment
Y16-Y50	6	1588	9,528	333,480	Ave. of passenger/passenger+equipment
Y51-Y100	8	1588	12,704	635,200	Ave. of passenger/passenger+equipment
			TOTAL	**1,234,127**	**<--G&A - Administration item #4**

Staff Transport	# trips/year	Comments
Holding Year	12	
Y1	55	Beaver; 5 months, twice a month, 25 persons divided by 5 person plane capacity
Y2	55	Beaver; 5 months, twice a month, 25 persons divided by 5 person plane capacity
Y3	55	Beaver; 5 months, twice a month, 25 persons divided by 5 person plane capacity
Y4	0	
Y5	0	
Y11-Y15	0	
Y16-Y50	0	
Y51-Y100	0	

Outfall pipeline and facilities maintenance

Cost (2008)	Cost adjusted	Frequency (once per x years)	Total for 100 years
15,000	18,293	3	$ 586,000

NOTE
$15,000 adjusted for inflation and assumed to be repeated every three years over the course of the period

NOTES
1) Management support will be reduced after Year 3 (one year after cover installations)
Additional costs in subsequent years are for the continued use of the APDES 002 outfall line post closure (in perpetuity or as necessary).
The costs represent all aspects of maintaining the outfall pipeline and facilities and provide ample dollars for continued APDES sampling and marine sampling as necessary in conjunction with the line inspection/repair/cleaning on a 3 year schedule.

	Ventilation						General						Yr-by-Yr
Power:	**kW**	**hrs/day**	**days/year**	**kWh**	**Cost**		**kW***	**hrs/day**	**days/year**	**kWh**	**Cost**		**$**
Holding	290	8	165	382,800	57,420		117	24	365	1,028,205	154,231		211,651
Year 1	290	12	165	574,200	86,130		117	24	365	1,028,205	154,231		240,361
Year 2							117	24	365	1,028,205	154,231		154,231
Year 3							117	24	365	1,028,205	154,231		154,231
					143,550						616,923		
					^--G&A - Administration item #3						**^--G&A - Administration item #2**		

Camp Support Costs

Pricing Bands		
MIN	**MAX**	**$ / person**
5	5	$380.99
6	10	$319.25
11	15	$207.06
16	20	$155.36
21	25	$127.51

Source: e-mail 2 Apil 2019 (ESS Worldwide)

Item	f Personnel per	:ost/(person×day	Cost per year	Cost	
Camp support - Holding year	2	$380.99	128,013	128,013	
Camp support - Year 1	25	$127.51	535,542	535,542	
Camp support - Year 2	25	$127.51	535,542	535,542	
Camp support - Year 3	25	$127.51	535,542	535,542	
				1,734,639	**<--G&A - Administration item #1**

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User Sheet 5 - Administration - Schedule

		Δ	HY	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19
Transportation																						
Staff, monitoring, WTP batch combined	$ 1,234,127	-	20,020	37,345	37,345	37,345	19,056	19,056	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528
Transportation total	$ 1,234,127	-	20,020	37,345	37,345	37,345	19,056	19,056	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528
Camp	$ 1,734,639	-	128,013	535,542	535,542	535,542																
Landing craft for materials/equip trips			26	26	26	26	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Landing craft for materials/equip costs	$ 4,716,000	-	156,000	156,000	156,000	156,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
Meals for WTP, Montioring, and Laborer crews	$ 1,683,300	-	153,200	116,700	116,700	116,700	18,000	18,000	14,400	14,400	14,400	14,400	14,400	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800
Soltn Mgmt																						
Pumping	$ 416,796	-	20,148	21,492	21,492	21,492	5,196	5,196	5,196	5,196	5,196	5,196	5,196	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363
Landing craft for materials/equip	$ 4,716,000	-	156,000	156,000	156,000	156,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
Meals for WTP crew	$ 1,683,300	-	153,200	116,700	116,700	116,700	18,000	18,000	14,400	14,400	14,400	14,400	14,400	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800
Subtotal landing aircraft and meals for WTP	$ 6,399,300	-	309,200	272,700	272,700	272,700	54,000	54,000	50,400	50,400	50,400	50,400	50,400	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800
Monitoring labor																						
Crew for monit sched A	$ 293,941		1	1	1	1	1	1														
Crew for monit sched B	$ 33,916								1	1	1	1	1									
Crew for monit sched C	$ 33,916													1	1	1	1	1	1	1	1	1

Camp+transportation (for schedule)	$ 2,968,765.64	-	148,033	572,887	572,887	572,887	19,056	19,056	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528
Power (for schedule)			211,651	240,361	154,231	154,231																
Landing craft for materials/equip costs (for schedule)			156,000	156,000	156,000	156,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
Meals for WTP, Montioring, and Laborer crews			153,200	116,700	116,700	116,700	18,000	18,000	14,400	14,400	14,400	14,400	14,400	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800
Total (for schedule)			668,883	1,085,948	999,818	999,818	73,056	73,056	59,928	59,928	59,928	59,928	59,928	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328

Persons / Crew	HY	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19
Holding crew	2																			
Hourly - Tech 5		2	2	2																
Laborer		1	1	1																
WTP crew - foreman	1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
WTP crew - laborer	1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Crew for monit sched A	2	2	2	2	2	2														
Crew for monit sched B							2	2	2	2	2									
Crew for monit sched C												2	2	2	2	2	2	2	2	2

Days / Person	HY	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19
Holding crew	365																			
Hourly - Tech 5		365	365	365																
Laborer		365	365	365																
WTP crew - foreman	365				54	54	54	54	54	54	54	30	30	30	30	30	30	30	30	30

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WTP crew - laborer	365				54	54	54	54	54	54	54	30	30	30	30	30	30	30	30	30
Crew for monit sched A	36	36	36	36	36	36														
Crew for monit sched B							18	18	18	18	18									
Crew for monit sched C												24	24	24	24	24	24	24	24	24

		Rate	Hrs/Day
Assume field tech	1	88.76	12
Assume laborer	1	68.26	12
Assume # days for sampling, travel, reporting	3		
Total per monit. Campaign	**$ 5,652.72**		

Interval	**Campaign/year**	**$/year**	**Schedule**
holding year	52	293,941	A
years 1 -5	52	293,941	A
years 6 - 10	6	33,916	B
years 11-15	6	33,916	C
years 16 - 100	8	45,222	C

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Y20	Y21	Y22	Y23	Y24	Y25	Y26	Y27	Y28	Y29	Y30	Y31	Y32	Y33	Y34	Y35	Y36	Y37	Y38	Y39	Y40	Y41	Y42	Y43	Y44	Y45	Y46	Y47	Y48
9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528
9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800
2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363	2,363
36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800
46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800	46,800
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528	9,528
36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800
56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328	56,328

Y20	Y21	Y22	Y23	Y24	Y25	Y26	Y27	Y28	Y29	Y30	Y31	Y32	Y33	Y34	Y35	Y36	Y37	Y38	Y39	Y40	Y41	Y42	Y43	Y44	Y45	Y46	Y47	Y48
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Y20	Y21	Y22	Y23	Y24	Y25	Y26	Y27	Y28	Y29	Y30	Y31	Y32	Y33	Y34	Y35	Y36	Y37	Y38	Y39	Y40	Y41	Y42	Y43	Y44	Y45	Y46	Y47	Y48
30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

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30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24

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Y49	Y50	Y51	Y52	Y53	Y54	Y55	Y56	Y57	Y58	Y59	Y60	Y61	Y62	Y63	Y64	Y65	Y66	Y67	Y68	Y69	Y70	Y71	Y72	Y73	Y74	Y75	Y76	Y77
9,528	9,528	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704
9,528	9,528	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704
6	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
36,000	36,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000
10,800	10,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800
2,363	2,363	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026
36,000	36,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000
10,800	10,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800
46,800	46,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

9,528	9,528	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704
36,000	36,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000
10,800	10,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800
56,328	56,328	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504

Y49	Y50	Y51	Y52	Y53	Y54	Y55	Y56	Y57	Y58	Y59	Y60	Y61	Y62	Y63	Y64	Y65	Y66	Y67	Y68	Y69	Y70	Y71	Y72	Y73	Y74	Y75	Y76	Y77
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Y49	Y50	Y51	Y52	Y53	Y54	Y55	Y56	Y57	Y58	Y59	Y60	Y61	Y62	Y63	Y64	Y65	Y66	Y67	Y68	Y69	Y70	Y71	Y72	Y73	Y74	Y75	Y76	Y77
30	30	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40

Closure Cost Estimate
User 5

30	30	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24

Closure Cost Estimate
User 5

Y78	Y79	Y80	Y81	Y82	Y83	Y84	Y85	Y86	Y87	Y88	Y89	Y90	Y91	Y92	Y93	Y94	Y95	Y96	Y97	Y98	Y99	Y100
12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704
12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000
12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800
4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026	4,026
48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000
12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800
60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800	60,800
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704	12,704
48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000
12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800	12,800
73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504	73,504

Y78	**Y79**	**Y80**	**Y81**	**Y82**	**Y83**	**Y84**	**Y85**	**Y86**	**Y87**	**Y88**	**Y89**	**Y90**	**Y91**	**Y92**	**Y93**	**Y94**	**Y95**	**Y96**	**Y97**	**Y98**	**Y99**	**Y100**
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Y78	**Y79**	**Y80**	**Y81**	**Y82**	**Y83**	**Y84**	**Y85**	**Y86**	**Y87**	**Y88**	**Y89**	**Y90**	**Y91**	**Y92**	**Y93**	**Y94**	**Y95**	**Y96**	**Y97**	**Y98**	**Y99**	**Y100**
40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40

Closure Cost Estimate
User 5

40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 6 - Mill Demolition Summary

SRCE Model Cost Summary $127,447,590

Building Demolition and Transportation

#	Task	Crew	Hours	Labor Cost ($/h	Equipment Cost	Labor Cost ($)	Equipment Cost	Material Cost ($	Total Cost ($)
1	Decontamination (User 14)					$ 373,545.05	$ 37,123.20	$ -	$ 410,668.25
2*	Remove all internal mill parts, cut into pieces for transport underground.	B-8	2,916	$ 477.47	$ 178.90	$ 1,392,302.52	$ 521,672.40		$ 1,913,974.92
3	Building Demolition (from "Foundations & Buildings" sheet)					$ -	$ -	N/A	$ -
4	Wall Demolition (from "Foundations & Buildings" sheet)					$ -	$ -	N/A	$ -
5	Slab Demolition (from "Foundations & Buildings" sheet)					$ -	$ -	N/A	$ -
	Totals					$ 1,765,847.57	$ 558,795.60	$ -	$ 2,324,643.17

*** Other User item #2 - Internal mill infrastructure demolition**

NOTES:
Item 1: Decontamination in User Sheet 14.
Item 2: Two crews (B-8) for 3 months.
Item 3-5: Demolition costs are calculated in the Foundations and Buildings worksheet.

Task Cost Estimate

Element: Site General
Area: Tailings Impoundment
Task: Tailings Water Treatment Plant
Subtask:

Description:

Category	Unit Price	Number Required	Unit	Estimated Cost	
Labor					
Steel Worker	70	221	hr	15,364	
Concrete Demo Crew	423	16	hr	6,760	
Labor Subtotal				22,124	**<--Other User item #15**
Equipment					
120 ton crane	118	10	hr	1,183	
Track Hoe	180	13	hr	2,340	
Track Hoe W/ Hammer	360	13	hr	4,680	
Excavator	150	33	hr	4,956	
8,000 lbs gradall	65	26	hr	1,690	
Lowboy Trailer	19	5	hr	97	
Equipment Subtotal				14,946	**<--Other User item #15**

Closure Cost Estimate
User 6

Closure Cost Estimate
User 7

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 7 - Summary of Available Cover Materials

SRCE Model Cost Summary $127,447,590

Cover Materials	Inches	Remarks	Haul Distance	Remarks
Growth Layer	40	Sourced from onsite stockpiles and deficit from new quarry.	5,000	Quarry assumed 25,000 feet down A road
Drain layer	10	Gravel	5,280	Was 12,700 ft - but the deficit will need to be imported and hauled from the beach (5280 ft)
Compacted Till	24	From Site D and Site E	31,100	Average of distance from tails to Site E and Site D.
Capillary break	10	Screened waste rock from Site 23	500	

Material	Location	Volume soil (cy)	
Till	0.9 A Road	4,458	
Till	1.9 B Road	1,000	
Peat/Organics	2.8 B Road	664	
Till	3.2 B Road	5,300	
Till	4.6 B Road	7,640	
Mill Site	4.9 B Road	29,262	
Till	5.9 B Road	1,165	
Till	6.2 B Road	14,402	
Till/Organics	6.3 B Road	672	
Till/Organics	6.4 B Road	720	
Till	7.3 B Road	3,810	
Till	7.4 B Road	1,746	
Till	7.5 B Road	647	
Till	7.6 B Road	4,056	
Till	Pit 405	10,895	
Till	Pit 174	10,375	
Till	Pit 6	18,418	
Till/Organics	Site 23	5,000	
Till	Tailings Pond 7	-	
Till/Organics	Pit 7	163,280	
Sand, Gravel, Peat	A Road Sand P	199,874	12 April 2109 CDW Not included in the total. HGCMC did not include the use of this matreial ir
	Total	283,510	

Source: HGCMC Surface Operations Surveyor (Shelby Edwards, 7 March 2019)

Closure Cost Estimate
User 7

Used in estimating material deficit based on required amount and the available quantity herein. See Other User item #16

Closure Cost Estimate
User 7

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 8 - Monitoring

SRCE Model Cost Summary $127,447,590

Underground Care and Maintenance	$67,936.00
Suite Q	$625.00
QA/QC	$625.00
Stormwater - sites	$156.00
APDES - discharge	$113.45
Hawk Inlet seawater sampling	$3,175.00
Hawk Inlet sediment and organism monitoring	$25,104.00
Site-wide vegetation	$510.34
Shipping	$83.33
PSI Report	$50,000.00
IMP Sulfate	$17.11

Dam Stability Monitoring		
Inspection/hr	$	125.00
Hrs inspection and reporting		40
Cost inspection and reporting	$	5,000.00
Helicopter	$	1,078.00
Total per inspection	$	6,078.00

Sample Suite	Site Number	Site Name	Total Samples	Cost / Sample	Cost	Subtotal	Check	Years 0	1	2	3	4	5	6	7	8	9	10	11
IMP sampling program:																			
Suite Q	48	Greens Creek Upper	187	625	116,875			12	12	12	12	12	12	4	4	4	4	4	2
Suite Q	6	Greens Creek Middle	117	625	73,125			12	12	12	12	12	12	4	4	4	4	4	2
Suite Q	54	Greens Creek Lower 1	117	625	73,125			12	12	12	12	12	12	4	4	4	4	4	2
Suite Q	62	Greens Creek Lower 2	187	625	116,875			12	12	12	12	12	12	4	4	4	4	4	2
Suite Q	61	Greens Creek Flood Plain	117	625	73,125			12	12	12	12	12	12	4	4	4	4	4	2
Suite Q	49	Bruin Creek Lower	35	625	21,875			4	4	4	4	4	4	1	1	1	1	1	1
Suite Q	46	Bruin Creek Upper	35	625	21,875			4	4	4	4	4	4	1	1	1	1	1	1
Suite Q	56	Site 23 Downgradient*	14	625	8,750			4	2	2	2	2	2						
Suite Q	57	Site 23 Upgradient*	14	625	8,750			4	2	2	2	2	2						
Suite Q	13	1350 East	14	625	8,750			4	2	2	2	2	2						
Suite Q	9	Tributary Creek Lower	119	625	74,375			4	4	4	4	4	4	1	1	1	1	1	1
Suite Q	27	Tailings Downgradient South Shallow	119	625	74,375			4	4	4	4	4	4	1	1	1	1	1	1
Suite Q	29	Talings Downgradient West Shallow	119	625	74,375			4	4	4	4	4	4	1	1	1	1	1	1
Suite Q	32	Tailings Downgradient West Shallow 2	119	625	74,375			4	4	4	4	4	4	1	1	1	1	1	1
Suite Q	609	Further Creek Lower	119	625	74,375			4	4	4	4	4	4	1	1	1	1	1	1
Suite Q	60	Tailings Stormwater Pond Downgradient 1	119	625	74,375			4	4	4	4	4	4	1	1	1	1	1	1
Suite Q	711	Greens Creek Above Site E	23	625	14,375			2	2	2	2	2	2	1	1	1	1	1	1
Suite Q	712	Greens Creek Below Site E	23	625	14,375			2	2	2	2	2	2	1	1	1	1	1	1
Suite Q	New Site xx	Mine Drainage	187	625	116,875			12	12	12	12	12	12	4	4	4	4	4	2
Suite Q	New Site xx	Tailings Drainage	187	625	116,875			12	12	12	12	12	12	4	4	4	4	4	2
Suite Q	New Site xx	Site 23 Drainage	94	625	58,750			12	12	12	12	12	12	4	4	4	4	4	
IMP Sulfate		Add to Suite Q	2,065	17	35,332			144	138	138	138	138	138	42	42	42	42	42	24
QA/QC		QA/QC SUBTOTAL	1,122	625	701,250			72	72	72	72	72	72	24	24	24	24	24	12
* Average of quarterly sampling in first three years through the five-year period. Site 23 will have been removed by end of Year 3.					**Section subtotals**	2,027,207	0	137,464	133,611	133,611	133,611	133,611	133,611	41,969	41,969	41,969	41,969	41,969	22,911
APDES permit related sampling:																			
APDES - discharge		002 outfall discharge	610	113	69,205			52	52	52	52	6	6	6	6	6	6	6	4
Stormwater		Stormwater Sites (10 sites)	120	156	18,720			20	20	20	20	20	20						
Marine		Marine water column sampling	431	3,175	1,368,425			16	16	16	16	16	16	8	8	8	8	8	8
Sediment and organism		Hawk Inlet sediment and organism	16	25,104	401,664			1	1	1	1	1	1	1	1	1	1	1	1
					Section subtotals	1,858,014	0	84,923	84,923	84,923	84,923	79,705	79,705	51,185	51,185	51,185	51,185	51,185	50,958
SHIPPING:		(max. of all frequencies)																	
		Yearly	6,309	83	525,729			429	417	417	417	371	371	123	123	123	123	123	73
					Section subtotals	525,729	0	35,749	34,749	34,749	34,749	30,915	30,915	10,250	10,250	10,250	10,250	10,250	6,083
OTHER:																			
		site-wide vegetation	12	510	6,124			2	1	1	1	1	1	1	1	1	1	1	
					Section subtotals	6,124	0	1,021	510	510	510	510	510	510	510	510	510	510	-
Maintenance and Professional Services:																			
		Underground care and maintenance	1	67,936	67,936			1											
		Marine maintenance	185	3,175	587,375									1	1	1	1	1	2
		Dam Stability Monitoring	29	6,078	176,262			1	1	1	1	1	1	1	1	1	1	1	
		PSI Report	22	50,000	1,100,000				1			1			1			1	
					Section subtotals	1,931,573	0	74,014	56,078	6,078	6,078	56,078	6,078	9,253	59,253	9,253	9,253	59,253	6,350
								333,170	309,872	259,872	259,872	300,820	250,820	113,166	163,166	113,166	113,166	163,166	86,302

Closure Cost Estimate
User 8

Post-closure cover maintenance - Tailings	588,725					117,745	117,745	117,745	117,745	117,745				
Outfall pipeline and facilities maintenance	586,000						18,313			18,313				18,313
Section subtotals	1,174,725													
Annual totals		333,170	309,872	259,872	259,872	418,565	386,877	230,911	280,911	249,224	113,166	163,166	104,614	

MONITORING GRAND TOTAL $ 7,523,372

Check: -

Closure Cost Estimate
User 8

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1											
2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1											
2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1											
1	1					1					1										1								
1	1					1					1										1								
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1					1					1										1								
1	1					1					1										1								
2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
											1										1								
24	24	20	20	13	13	17	13	13	13	13	18	13	13	13	13	13	13	13	10	10	15	10	10	10	10	10	10	10	10
12	12	12	12	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
22,911	22,911	20,342	20,342	12,097	12,097	14,666	12,097	12,097	12,097	12,097	15,308	12,097	12,097	12,097	12,097	12,097	12,097	12,097	10,171	10,171	13,382	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
8	8	8	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1	1	1	1																										
50,958	50,958	50,958	50,958	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979
73	73	65	65	39	39	47	39	39	39	39	49	39	39	39	39	39	39	39	33	33	43	33	33	33	33	33	33	33	33
6,083	6,083	5,416	5,416	3,250	3,250	3,917	3,250	3,250	3,250	3,250	4,083	3,250	3,250	3,250	3,250	3,250	3,250	3,250	2,750	2,750	3,583	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
			1					1					1					1					1					1	
			1					1					1					1					1					1	
6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350
86,302	86,302	83,066	139,144	31,676	31,676	34,911	31,676	87,754	31,676	31,676	35,720	31,676	87,754	31,676	31,676	31,676	31,676	87,754	29,250	29,250	33,294	29,250	85,328	29,250	29,250	29,250	29,250	85,328	29,250

Closure Cost Estimate
User 8

18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313
86,302	86,302	101,379	139,144	31,676	49,989	34,911	31,676	106,067	31,676	31,676	54,032	31,676	87,754	49,989	31,676	31,676	49,989	87,754	29,250	47,562	33,294	29,250	103,640	29,250	29,250	47,562	29,250	85,328	47,562	

Closure Cost Estimate
User 8

42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
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10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
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9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979
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2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750
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			1					1					1					1					1					1	
6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350
29,250	29,250	29,250	85,328	29,250	29,250	29,250	29,250	85,328	29,250	29,250	29,250	29,250	85,328	29,250	29,250	29,250	29,250	85,328	29,250	29,250	29,250	29,250	85,328	29,250	29,250	29,250	29,250	85,328	29,250

Closure Cost Estimate
User 8

18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313																								
29,250	29,250	47,562	85,328	29,250	47,562	29,250	29,250	103,640	29,250	29,250	47,562	29,250	85,328	47,562	29,250	29,250	47,562	85,328	29,250	47,562	29,250	29,250	103,640	29,250	29,250	47,562	29,250	85,328	47,562		

Closure Cost Estimate
User 8

72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171	10,171
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979	9,979
33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
			1					1					1					1					1					1
			1					1					1					1					1					1
6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428	6,350	6,350	6,350	6,350	62,428
29,250	29,250	29,250	85,328	29,250	29,250	29,250	29,250	85,328	29,250	29,250	29,250	29,250	85,328	29,250	29,250	29,250	29,250	85,328	29,250	29,250	29,250	29,250	85,328	29,250	29,250	29,250	29,250	85,328

Closure Cost Estimate
User 8

18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313	18,313
29,250	29,250	47,562	85,328	29,250	47,562	29,250	29,250	103,640	29,250	29,250	47,562	29,250	85,328	47,562	29,250	29,250	47,562	85,328	29,250	47,562	29,250	29,250	103,640	29,250	29,250	47,562	29,250	85,328	

Closure Cost Estimate
User 8

Closure Cost Estimate
User 9

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - Novembe

Closure Cost Estimate
User 9

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 10 - Summary of RS Means Cost Calculations

SRCE Model Cost Summary $127,447,590

RS Means Reference	Crew	Daily Output	Labor-Hours/Unit	Unit	Material	Labor	Equipment
32 34 20.10 1700	C-12	153	0.31	S.F.	70.86	123.90	16.14

					Labor	Equipment
C-12	carpenter forem	1	80.30	80.30		
	carpenters	3	61.77	185.31		
	laborer	1	68.26	68.26		
	crane operator	1	60.71	60.71		
	20 ton crane	1	51.40	51.40		
			subtotal	**445.98**	**394.58**	**51.40**

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 11 - Bridge Demolition

SRCE Model Cost Summary $127,447,590

For decontamination, see User Sheet 14

	Labor	Equipment	Total hourly
Steel Worker	63.69	-	64
120 Ton Crane	61.94	118.28	180
Track Hoe with Shear	60.71	204.86	266
Lowboy Trailer	60.71	19.32	80
8,000lbs gradall	61.94	26.30	88
345B Excavator	60.71	104.71	165
740 Articulating Truck	64.75	124.99	190

Summary	Labor	Equipment	Materials*	Subtotal
Zinc Creek Bridge - 3.0 Mile	45,961	31,466		77,427
Falls Creek Bridge - 3.4 Mile	14,589	9,941		24,530
Killer Creek Bridge- 7.4 Mile	21,548	12,244		33,792
Greens Creek Bridge	31,543	20,825		52,367
TOTAL	113,640	74,476		188,116

* included in User Sheet 14
Linked to Other User item #6
Sources: Bridges 2008.xls

		Zinc Creek Bridge - 3.0 Mile		Falls Creek Bridge - 3.4 Mile		Killer Creek Bridge- 7.4 Mile		Greens Creek Bridge	
Category	Unit Price	hours Required	Estimated Cost	hours Required	Estimated Cost	hours Required	Estimated Cost	hours Required	Estimated Cost
Labor									
Steel Worker	63.69	450	28,661	150	9,554	240	15,286	320	20,381
120 Ton Crane operator	61.94	90	5,575	25	1,549	35	2,168	60	3,716
Track Hoe with Shear operator	60.71	80	4,857	30	1,821	35	2,125	50	3,036
Lowboy Trailer operator	60.71	40	2,428	10	607	15	911	25	1,518
8,000lbs gradall operator	61.94	50	3,097	15	929	15	929	25	1,549
345B Excavator operator	60.71	20	1,214	0	-	0	-	20	1,214
740 Articulating Truck operator	64.75	2	130	2	130	2	130	2	130
Labor Subtotal			45,961		14,589		21,548		31,543
Equipment									
120 Ton Crane	118.28	90	10,645	25	2,957	35	4,140	60	7,097
Track Hoe with Shear	204.862908	80	16,389	30	6,146	35	7,170	50	10,243
Lowboy Trailer	19.31764181	40	773	10	193	15	290	25	483
8,000lbs gradall	26.30470108	50	1,315	15	395	15	395	25	658
345B Excavator	104.71	20	2,094		-		-	20	2,094
740 Articulating Truck	124.99	2	250	2	250	2	250	2	250
Equipment Subtotal			31,466		9,941		12,244		20,825

Closure Cost Estimate
User 12

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 12 - Surface Disturbance Summary

SRCE Model Cost Summary $127,447,590

Surface disturbance areas	Area (acres)	
920 mill and portal area	24	
Waste rock site 23	20	
Waste rock site D	8	
Waste rock site 1350 and portal area	3.5	
1350 road	4	
1160 tank	1	
960 waste rock area	1	
Waste rock site C and 860 area	3	
Waste rock site E	10	
Tailings disposal facility	102	86
Hawk inlet and marine load out area	14.5	
Young Bay Dock facility	1	
Access A Road	24	
Access B Road	42	
Powerline right of way	32	
Topsoil stockpiles and borrow sites	31	
TOTAL	321	

Source: HGCMC Surface Operations Surveyor (Shelby Edwards, 7 March 2019)
Linked to Yards.

Closure Cost Estimate
User 13

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - Novembe

Closure Cost Estimate
User 13

r 2019

Closure Cost Estimate
User 14

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 14 - Waste Disposal and Decontamination

SRCE Model Cost Summary $127,447,590

Labor total	Equipment	Materials	Total	
373,545.05	37,123.20		410,668.25	**<--Other User item #9**

Source: 2014 SRCE Model

Task		
Industrial Waste Disposal		122,929.82
Waste Material Disposal		14,817.43
Scrap Shipping and Specialty Equipment for cleanup		645,434.74
Radiation source disposal		1,097.59
	SUM:	784,279.58

	2008 costs	Adjusted/updated	
Industrial Waste Disposal	5600	6,829.43	Rabanco containers
Waste Material Disposal	675	823.19	Adjusted for inflation
Shipping Scrap/Salvage Equip	75000	91,465.64	Adjusted for inflation
Mobilization/Demobe	2500	3,048.85	Adjusted for inflation
Vacuum truck/steam cleaner	6500	6,926.15	Quote February 04, 2014
Pickup transportation	1000	1,219.54	Adjusted for inflation
Extra shipping containers/flats	644	785.38	Adjusted for inflation
Radioactive waste disposal	450	548.79	Adjusted for inflation

Costs for Materials, Equipment	2008 costs	Adjusted/updated	
Prep of Demo Scrap	17.00	20.73	Adjusted for inflation
Prep of Re-Bar Scrap	17.00	20.73	Adjusted for inflation
Stock Piling Scrap	88.00	107.32	Adjusted for inflation
Loading of Scrap	305.00	371.96	Adjusted for inflation
Miscellaneous Demo	1,000.00	1,219.54	Adjusted for inflation
Pond cleaning equipment	12,000.00	14,634.50	Adjusted for inflation
Miscellaneous Materials	2,000.00	2,439.08	Adjusted for inflation
Concrete	205.00	250.01	Adjusted for inflation

Note:
Demolition included in Foundations and Buildings sheet
Salvage included in the User Sheet 6
Decontamination Crew (includes equipment - see 3 Clab - D) 436.93

Task Cost Estimate

Element: Site General
Area: Miscellaneous
Task: Industrial Waste Disposal
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost	Comments
					Small monthly shipments
Industrial Waste Disposal	6,829.43	18	mo	122,929.82	Monthly shipments/small quantities

Closure Cost Estimate
User 14

Task Cost Estimate

Element: Site General
Area: Miscellaneous
Task: Waste Material Disposal
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost	Comments
Waste Material Disposal	823.19	18	mo	14,817.43	Small monthly shipments

Task Cost Estimate

Element: Site General
Area: Miscellaneous
Task: Scrap Shipping and Specialty Equipment for cleanup
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost	Comments
Transportation					
Shipping Scrap/Salvage Equip	91465.64	5	per trip	457,328.19	3000-5000 tons per trip includes weight measurements for salvage equipment and scrap
Equipment rental					
Mobilization/Demobe	3048.85	1	per	3,048.85	For specialty equipment
Vacuum truck/steam cleaner	6926.15	12	per	83,113.76	Monthly rental
4 Pickup transportation	4878.17	18	per	87,807.01	4 pickups-lease
Extra shipping containers/flats	785.38	18	per	14,136.93	Demurrage or purchase

Task Cost Estimate

Element: Site General
Area: Miscellaneous
Task: Radioactive source disposal
Subtask:

Description: Radioactive source disposal includes the removal and shipment off island of radioactive sources

Category	Unit Price	Number Required	Unit	Estimated Cost	Comments
Radioactive waste disposal	548.79	2	units	1,097.6	

Source: 920 General Mill Area 2008.xls
Hawk Inlet2008.xls
Tailings Impoundment 2008.xls
Bridges 2008.xls

20190401 Christopher Wallace - There are only 2 Portable units left all of the Fixed units in the Mill have been disposed of.

Task Cost Estimate

Element: Site General
Area: 920 General Mill Area
Task: Sediment Basins DB01 and DB02 and Pond "A"
Subtask:

Closure Cost Estimate
User 14

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	55	hr	24,031.15
Decon labor+equip subtotal				24,031.15
Equipment				
Pond cleaning equipment	14,634.50	1	lot	14,634.50
Equipment Subtotal				14,634.50

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Water Pump House
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	1.2	hr	524.32
Decon labor+equip subtotal				524.32

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: 920 Warehouse, incl telecommunications
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	3.6	hr	1,572.95
Decon labor+equip subtotal				1,572.95

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Warehouse Sheds
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	0.8	hr	349.54
Decon labor+equip subtotal				349.54

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Coarse Ore Feeder
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost

Closure Cost Estimate
User 14

Decontamination Crew	436.93	4.4	hr	1,922.49
Decon labor+equip subtotal				1,922.49

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Re-Grind Building & Zinc Cleaner Expansion
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	30	hr	13,107.90
Decon labor+equip subtotal				13,107.90

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Back-Fill plant
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	6	hr	2,621.58
Decon labor+equip subtotal				2,621.58

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Tailings Loadout and Tailings Storage
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	30	hr	13,107.90
Decon labor+equip subtotal				13,107.90

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Concentrator
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	235	hr	102,678.55
Decon labor+equip subtotal				102,678.55

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Concentrator
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost

Closure Cost Estimate
User 14

Decon labor+equip				
Decontamination Crew	436.93	235	hr	102,678.55
Decon labor+equip subtotal				102,678.55

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Concentrate Loadout
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	10	hr	4,369.30
Decon labor+equip subtotal				4,369.30

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: 800 GPM Water Treatment Plant @ 920
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	5	hr	2,184.65
Decon labor+equip subtotal				2,184.65

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: 400 GPM Water Treatment Plant @ 920
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	3	hr	1,310.79
Decon labor+equip subtotal				1,310.79

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Power House
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	50	hr	21,846.50
Decon labor+equip subtotal				21,846.50

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Surface Shop and Admin Building
Subtask:

Closure Cost Estimate
User 14

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	27	hr	11,797.11
Decon labor+equip subtotal				11,797.11

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Miscellaneous 920 Support Areas
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	5	hr	2,184.65
Decon labor+equip subtotal				2,184.65

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Surface Paving
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	11	hr	4,806.23
Decon labor+equip subtotal				4,806.23

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: Assay Lab
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	10	hr	4,369.30
Decon labor+equip subtotal				4,369.30

Task Cost Estimate
Element: Site General
Area: 920 General Mill Area
Task: 860 Safety Building
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	1.2	hr	524.32
Decon labor+equip subtotal				524.32

Task Cost Estimate
Element: Site General
Area: Bridges
Task: Zinc Creek Bridge - 3.0 Mile
Subtask:

Closure Cost Estimate
User 14

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	18	hr	7,864.74
Decon labor+equip subtotal				7,864.74

Task Cost Estimate
Element: Site General
Area: Bridges
Task: Greens Creek Bridge
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	14	hr	6,117.02
Decon labor+equip subtotal				6,117.02

Task Cost Estimate
Element: Site General
Area: Hawk Inlet
Task: Concentrate Storage Building
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	50	hr	21,846.50
Decon labor+equip subtotal				21,846.50

Task Cost Estimate
Element: Site General
Area: Hawk Inlet
Task: Wheel Wash
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	4	hr	1,747.72
Decon labor+equip subtotal				1,747.72

Task Cost Estimate
Element: Site General
Area: Hawk Inlet
Task: Degritting Basin DB04
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	2	hr	873.86
Decon labor+equip subtotal				873.86

Task Cost Estimate
Element: Site General
Area: Hawk Inlet
Task: Generator Shack

Closure Cost Estimate
User 14

Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	4	hr	1,747.72
Decon labor+equip subtotal				1,747.72

Task Cost Estimate
Element: Site General
Area: Hawk Inlet
Task: Warehouse
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	5.6	hr	2,446.81
Decon labor+equip subtotal				2,446.81

Task Cost Estimate
Element: Site General
Area: Hawk Inlet
Task: Services Building
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	4	hr	1,747.72
Decon labor+equip subtotal				1,747.72

Task Cost Estimate
Element: Site General
Area: Hawk Inlet
Task: Fuel Tank Farm
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	40	hr	17,477.20
Decon labor+equip subtotal				17,477.20

Task Cost Estimate
Element: Site General
Area: Hawk Inlet
Task: Water Tanks and Potable Building
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	2	hr	873.86

Task Cost Estimate
Element: Site General
Area: Hawk Inlet
Task: Sewage Plant Area

Closure Cost Estimate
User 14

Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	6	hr	2,621.58
Decon labor+equip subtotal				2,621.58

Task Cost Estimate

Element: Site General
Area: Tailings Impoundment
Task: Tank 7 (previsouly Tank 6)
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	6	hr	2,621.58
Decon labor+equip subtotal		161		2,621.58

Task Cost Estimate

Element: Site General
Area: Tailings Impoundment
Task: Wheel Wash
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	2	hr	873.86
Decon labor+equip subtotal				873.86

Task Cost Estimate

Element: Site General
Area: Tailings Impoundment
Task: Wet Well #1
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	0	hr	-
Decon labor+equip subtotal				-

Task Cost Estimate

Element: Site General
Area: Tailings Impoundment
Task: Pond 23 Pump House
Subtask:

Category	Unit Price	Number Required	Unit	Estimated Cost
Decon labor+equip				
Decontamination Crew	436.93	2	hr	873.86
Decon labor+equip subtotal				873.86

Closure Cost Estimate
User 14

Task Cost Estimate						
			Element:	Site General		
			Area:	Tailings Impoundment		
			Task:	Tailings Water Treatment Plant		
			Subtask:			
Category	Unit Price		Number Required	Unit	Estimated Cost	
Decon labor+equip						
Decontamination Crew		436.93	10	hr		4,369.30
Decon labor+equip subtotal						4,369.30

Task Cost Estimate						
			Element:	Site General		
			Area:	1350 Area		
			Task:	Remove 1160' Water Tank		
			Subtask:			
Category	Unit Price		Number Required	Unit	Estimated Cost	
Labor						
Steel Demo Worker		60.71	8	hr		485.68
Laborer		68.26	50	hr		3,413.00
Labor Subtotal						3,898.68
Equipment						
50-Ton Crane		73.65	10	hr		736.50
Excavator		91.99	20	hr		1,839.80
8,000lbs gradall		26.30	5	hr		131.52
Flat bed		26.25	8	hr		210.00
Equipment Subtotal						2,917.82

Closure Cost Estimate
User 14

Closure Cost Estimate
User 15

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

User Sheet 15 - Distances between facilities (miles)

SRCE Model Cost Summary $127,447,590

Site	To TDF	To UG	Mile Marker
5.0 mile A Road	5.48		5.00
3.9 mile A Road	4.38		3.90
0.9 mile A Road	1.38		0.90
Hawk Inlet	1	8.63	0.00
Tailings	0	7.63	1.00
1.8 mile B Road	0.8	6.83	1.80
2.5 mile B Road	1.5	6.13	2.50
3.2 mile A Road	3.68		3.20
Zinc Ck Bridge	2	5.63	3.00
Pit 174	2.3	5.33	3.30
Site E	3.6	4.03	4.60
7.3 mile B Road	6.3	1.33	7.30
1350 Road	8	0.37	9.00
Pit 405	6.6	1.03	7.60
D Pile	7	0.63	8.00
Site 23	7	0.63	8.00
Site C	7.26	0.36	8.26
Mill	7.45	0.18	8.45
960 Site	7.75	0.13	8.75
1350 Site	8.40	0.77	9.40
920 Portal		.	8.63
1160 Site			9.03

Closure Cost Estimate
User 15

Road
A
A
A
B
B
B
B
A
B
B
B
B
B
B
B
B
B
B
B
B
B

Closure Cost Estimate
User 16

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - Novembe

Closure Cost Estimate
User 16

Closure Cost Estimate
User 17

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - Novembe

Closure Cost Estimate
User 17

r 2019

Closure Cost Estimate
User 18

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - Novembe

Closure Cost Estimate
User 18

r 2019

Closure Cost Estimate
User 19

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November 2019

Closure Cost Estimate
User 20

Project Name: Reclamation Plan Update 2019 - Reclamation Plan
Date of Submittal: April 2019
File Name: 20191120 HGCMC SRCE Model V1.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: 2019 SRCE Cost Data File Version 7.xlsm
Cost Estimate Type: Surety Cost Basis: Greens Creek 2019 - November

User Sheet 20 - Fiancial Responsibility

SRCE Model Cost Summary $127,447,590

ROR		3.97%			
Inflation		1.28%			
Calander Year				**2020**	**2021**
Reclamation year				0	1
SRCE Costs	$	192,430,904	$	7,076,031	$ 23,717,686
Reclamtation (years 1-4)					
NPV Total	$	72,721,614			
1 year of inflation	$	73,652,451			
2 year of inflation	$	74,595,202			
3 year of inflation	$	75,550,021			
4 year of inflation	$	76,517,061			
5 year of inflation	$	77,496,480			
Water Treatment (5-200)					
NPV Total	$	13,775,562			
1 year of inflation	$	13,951,889			
2 year of inflation	$	14,130,474			
3 year of inflation	$	14,311,344			
4 year of inflation	$	14,494,529			
5 year of inflation	$	14,680,059			
Grand NPV Total	**$**	**86,497,177**	Some of cells C30 and C22		
Inflation Adjusted Total	**$**	**92,176,539**	Some of cells C35 and C27		
Investment Growth					
Invested in year 2	$	13,775,562			
1 year of growth	$	14,322,452			
2 years of growth	$	14,891,053			
3 years of growth	$	15,482,228			

Closure Cost Estimate
User 20

2019

2022	2023	2024	2025	2026	2027	2028	2029
2	3	4	5	6	7	8	9
$ 21,404,143	$ 20,523,755	$ 1,429,346	$ 1,386,410	$ 775,930	$ 843,680	$ 800,743	$ 597,555
		$ 1,223,222	$ 1,141,173	$ 614,291	$ 642,423	$ 586,447	$ 420,926

Closure Cost Estimate
User 20

2030	2031	2032	2033	2034	2035	2036	2037	2038
10	11	12	13	14	15	16	17	18
$ 704,602	$ 454,457	$ 429,644	$ 429,644	$ 450,074	$ 501,246	$ 355,626	$ 380,440	$ 360,010
$ 477,379	$ 296,145	$ 269,285	$ 259,003	$ 260,958	$ 279,531	$ 190,750	$ 196,268	$ 178,636

Closure Cost Estimate
User 20

2039	2040	2041	2042	2043	2044	2045	2046	2047
19	20	21	22	23	24	25	26	27
$ 355,626	$ 456,426	$ 355,626	$ 355,626	$ 385,919	$ 355,626	$ 431,612	$ 380,440	$ 355,626
$ 169,723	$ 209,512	$ 157,009	$ 151,014	$ 157,620	$ 139,701	$ 163,077	$ 138,254	$ 124,302

Closure Cost Estimate
User 20

2048	2049	2050	2051	2052	2053	2054	2055	2056
28	29	30	31	32	33	34	35	36
$ 355,626	$ 380,440	$ 431,612	$ 352,339	$ 377,152	$ 357,818	$ 352,339	$ 453,138	$ 352,339
$ 119,555	$ 123,013	$ 134,231	$ 105,393	$ 108,507	$ 99,014	$ 93,775	$ 115,998	$ 86,750

Closure Cost Estimate
User 20

2057	2058	2059	2060	2061	2062	2063	2064	2065
37	38	39	40	41	42	43	44	45
$ 352,339	$ 377,152	$ 352,339	$ 428,324	$ 377,152	$ 352,339	$ 352,339	$ 377,152	$ 428,324
$ 83,438	$ 85,904	$ 77,187	$ 90,251	$ 76,434	$ 68,679	$ 66,056	$ 68,008	$ 74,287

Closure Cost Estimate
User 20

2066	2067	2068	2069	2070	2071	2072	2073	2074
46	47	48	49	50	51	52	53	54
$ 352,339	$ 377,152	$ 352,339	$ 352,339	$ 11,436,467	$ 406,989	$ 406,989	$ 431,802	$ 406,989
$ 58,775	$ 60,512	$ 54,372	$ 52,296	$ 1,632,637	$ 55,882	$ 53,748	$ 54,848	$ 49,722

Closure Cost Estimate
User 20

2075	2076	2077	2078	2079	2080	2081	2082	2083
55	56	57	58	59	60	61	62	63
$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989
$ 56,752	$ 48,802	$ 44,241	$ 42,552	$ 43,422	$ 46,713	$ 37,861	$ 38,635	$ 35,025

Closure Cost Estimate
User 20

2084	2085	2086	2087	2088	2089	2090	2091	2092
64	65	66	67	68	69	70	71	72
$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989

Repeating 15 year cycle used for years past 100

$ 33,687	$ 40,426	$ 31,164	$ 29,974	$ 30,587	$ 27,729	$ 31,649	$ 27,215	$ 24,672

Closure Cost Estimate
User 20

2093	2094	2095	2096	2097	2098	2099	2100	2101
73	74	75	76	77	78	79	80	81
$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989

$ 23,730	$ 24,215	$ 26,051	$ 21,114	$ 21,546	$ 19,532	$ 18,787	$ 22,544	$ 17,379

Closure Cost Estimate
User 20

2102	2103	2104	2105	2106	2107	2108	2109	2110
82	83	84	85	86	87	88	89	90
$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974
$ 16,716	$ 17,058	$ 15,463	$ 17,650	$ 15,177	$ 13,759	$ 13,233	$ 13,504	$ 14,528

Closure Cost Estimate
User 20

2111	2112	2113	2114	2115	2116	2117	2118	2119
91	92	93	94	95	96	97	98	99
					67	68	69	70
$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989
$ 11,775	$ 12,016	$ 10,893	$ 10,477	$ 12,572	$ 9,692	$ 9,322	$ 9,513	$ 8,624

Closure Cost Estimate
User 20

2120	2121	2122	2123	2124	2125	2126	2127	2128
100	101	102	103	104	105	106	107	108
71	72	73	74	75	76	77	78	79
$ 11,462,713	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989

1st cycle past year 100, though the cycle started in year 97.
Replacement costs for the WTP, pond cleaning, and pond relining are included in the costs

$ 233,605	$ 8,464	$ 7,673	$ 7,380	$ 7,531	$ 8,102	$ 6,566	$ 6,701	$ 6,075

Closure Cost Estimate
User 20

2129	2130	2131	2132	2133	2134	2135	2136	2137
109	110	111	112	113	114	115	116	117
80	81	67	68	69	70	71	72	73
$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989
		2nd cycle past year 100						

$ 5,843	$ 7,011	$ 5,405	$ 5,199	$ 5,305	$ 4,809	$ 5,489	$ 4,720	$ 4,279

Closure Cost Estimate
User 20

2138	2139	2140	2141	2142	2143	2144	2145	2146
118	119	120	121	122	123	124	125	126
74	75	76	77	78	79	80	81	67
$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989
								3rd cycle pa

$ 4,116	$ 4,200	$ 4,518	$ 3,662	$ 3,737	$ 3,388	$ 3,258	$ 3,910	$ 3,014

Closure Cost Estimate
User 20

2147	2148	2149	2150	2151	2152	2153	2154	2155
127	128	129	130	131	132	133	134	135
68	69	70	71	72	73	74	75	76
$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974

ast year 100

$ 2,899 $ 2,958 $ 2,682 $ 3,061 $ 2,632 $ 2,386 $ 2,295 $ 2,342 $ 2,520

Closure Cost Estimate
User 20

2156	2157	2158	2159	2160	2161	2162	2163	2164
136	137	138	139	140	141	142	143	144
77	78	79	80	81	67	68	69	70
$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989
					4th cycle past year 100			

$ 2,042	$ 2,084	$ 1,889	$ 1,817	$ 2,181	$ 1,681	$ 1,617	$ 1,650	$ 1,496

Closure Cost Estimate
User 20

2165	2166	2167	2168	2169	2170	2171	2172	2173
145	146	147	148	149	150	151	152	153
71	72	73	74	75	76	77	78	79
$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 11,462,713	$ 406,989	$ 431,802	$ 406,989

Replacement costs for the WTP, pond cleaning, an

$ 1,707	$ 1,468	$ 1,331	$ 1,280	$ 1,306	$ 33,349	$ 1,139	$ 1,162	$ 1,054

Closure Cost Estimate
User 20

2174	2175	2176	2177	2178	2179	2180	2181	2182
154	155	156	157	158	159	160	161	162
80	81	67	68	69	70	71	72	73
$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989

ıd pond relining are inclu 5th cycle past year 100

$ 1,013	$ 1,216	$ 937	$ 902	$ 920	$ 834	$ 952	$ 819	$ 742

Closure Cost Estimate
User 20

2183	2184	2185	2186	2187	2188	2189	2190	2191
163	164	165	166	167	168	169	170	171
74	75	76	77	78	79	80	81	67
$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989
								6th cycle pa

$ 714	$ 728	$ 784	$ 635	$ 648	$ 588	$ 565	$ 678	$ 523

Closure Cost Estimate
User 20

2192	2193	2194	2195	2196	2197	2198	2199	2200
172	173	174	175	176	177	178	179	180
68	69	70	71	72	73	74	75	76
$ 406,989	$ 431,802	$ 406,989	$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974

ast year 100

$ 503	$ 513	$ 465	$ 531	$ 457	$ 414	$ 398	$ 406	$ 437

Closure Cost Estimate
User 20

2201	2202	2203	2204	2205	2206	2207	2208	2209
181	182	183	184	185	186	187	188	189
77	78	79	80	81	67	68	69	70
$ 406,989	$ 431,802	$ 406,989	$ 406,989	$ 507,788	$ 406,989	$ 406,989	$ 406,989	$ 406,989
					7th cycle past year 100			

$ 354	$ 361	$ 328	$ 315	$ 378	$ 292	$ 280	$ 270	$ 259

Closure Cost Estimate
User 20

2210	2211	2212	2213	2214	2215	2216	2217	2218
190	191	192	193	194	195	196	197	198
71	72	73	74	75	76	77	78	79
$ 482,974	$ 431,802	$ 406,989	$ 406,989	$ 431,802	$ 482,974	$ 406,989	$ 431,802	$ 406,989

$ 296	$ 255	$ 231	$ 222	$ 227	$ 244	$ 198	$ 202	$ 183

Closure Cost Estimate
User 20

2219	2220
199	200
80	81
$ 406,989	$ 701,036

$ 176 $ 291

GPO Appendix 14
Attachment D
Standardized Reclamation Cost Estimator
Cost Data File

November 2019

Format Version:	***SRCE Data File v1.12***
File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
Date:	***November 11, 2019***
Cost Type:	***User Data***
Author/Source:	***SRK Consulting/Greens Creek***

Units of Measure:	**Imperial**

No. of Bases/Regions:	6

Basis/Region	Basis/Region Name	Basis/Region Description
Basis 1	***Greens Creek 2014***	DB (AK) Sept. '12 for double shifts 8hrs/14days labor, week begins Wednesday, CMI equipment costs
Basis 2	***do not use***	notes
Basis 3	***Greens Creek 2019 - April 2019***	Pamphlet 600 - Issue 37, Effective September 1, 2018 - Davis Bacon for double shifts 8hrs/14days labor, week begins Wednesday. Equipment rental inflation adjusted from 2014 estimate. Cost(2019) = Cost(2014) * 1.0615 (Anchorage CPI 2014-2019)
Basis 4	***do not use***	
Basis 5	***Greens Creek 2019 - November 2019***	Equipment rental inflation adjusted from 2014 estimate. Cost(2019) = Cost(2014) * 1.0656 (Anchorage CPI 2014-2019)
Basis 6	***do not use***	
Basis 7		
Basis 8		
Basis 9		
Basis 10		
Basis 11		
Basis 12		
Basis 13		
Basis 14		
Basis 15		

Equipment Costs

File Name:	*2019 SRCE Cost Data File Version 7.xlsm*
Date:	*November 11, 2019*
Cost Basis:	*User Data*
Author/Source:	*SRK Consulting/Greens Creek*

Monthly Rental Basis (operating hrs/ period)	*486*		*486*		*486*	

MONTHLY EQUIPMENT RATE TABLE [Cost Per Month] (1)

EQUIPMENT TYPE (2)	Basis 1	Basis 2	Basis 3	Basis 4	Basis 5	Basis 6
	Greens Creek 2014	*do not use*	*Greens Creek 2019 - April 2019*	*do not use*	*Greens Creek 2019 - November 2019*	*do not use*
Bulldozers						
D6R	$17,647		$18,733		$18,805	
D6R w/ Winch	$21,177		$22,479		$22,566	
D7R	$25,589		$27,162		$27,267	
D8R	$29,118		$30,909		$31,028	
D9R	$35,295		$37,465		$37,610	
D10R						
D11R						
Wheeled Dozers						
824G						
834G						
844						
854G						
Motor Graders						
120H	$14,118		$14,986		$15,044	
14G/H	$24,706		$26,226		$26,327	
16G/H	$34,412		$36,529		$36,670	
24M						
Track Excavators						
312C	$8,471		$8,992		$9,026	
320C	$13,059		$13,862		$13,916	
325C	$15,000		$15,923		$15,984	
330C	$21,177		$22,479		$22,566	
345B	$24,706		$26,226		$26,327	
365BL	$40,589		$43,085		$43,251	
385BL						
Scrapers						
631G						
637G PP						
Wheeled Loaders						
924G	$6,530		$6,931		$6,958	
928G	$7,941		$8,430		$8,462	
950G	$13,236		$14,049		$14,104	
966G	$18,530		$19,669		$19,745	
972G	$21,177		$22,479		$22,566	
980G	$24,706		$26,226		$26,327	
988G	$38,824		$41,212		$41,371	
990	$61,766		$65,564		$65,817	
992G	$114,708		$121,762		$122,232	
994D						
L-2350						
Shovels						
KOM PC2000						
KOM PC3000						
KOM PC4000						
KOM PC5500						
KOM PC8000						

Equipment Costs

File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
Date:	***November 11, 2019***
Cost Basis:	***User Data***
Author/Source:	***SRK Consulting/Greens Creek***

Monthly Rental Basis (operating hrs/ period)	***486***		***486***		***486***	
Hydraulic Hammers						
H-120 (fits 325)	$15,000		$15,923		$15,984	
H-160 (fits 345)	$24,706		$26,226		$26,327	
H-180 (fits 365/385)	$30,883		$32,782		$32,909	
Demolition Shears						
S340 (fits 322/325/330)						
S365 (fits 330/345)						
S390 (fits 365/385)						
Demolition Grapples						
G315 (fits 322/325)						
G320 (fits 325/330)						
G330 (fits 345/365)						
Other Equipment						
420D 4WD Backhoe	$4,765		$5,058		$5,077	
428D 4WD Backhoe	$5,824		$6,182		$6,206	
CS533E Vibratory Roller	$8,824		$9,366		$9,402	
CS663E Vibratory Roller	$13,236		$14,049		$14,104	
CP533E Sheepsfoot Compactor	$8,824		$9,366		$9,402	
CP663E Sheepsfoot Compactor	$132,355		$140,495		$141,037	
Light Truck - 1.5 Ton	$2,206		$2,342		$2,351	
Supervisor's Truck	$3,088		$3,278		$3,291	
Flatbed Truck	$3,088		$3,278		$3,291	
Air Compressor + tools	$1,500		$1,592		$1,598	
Welding Equipment	$794		$843		$846	
Heavy Duty Drill Rig	$30,000		$31,845		$31,968	
Pump (plugging) Drill Rig	$1,324		$1,405		$1,410	
Concrete Pump	$5,735		$6,088		$6,112	
Gas Engine Vibrator	$1,103		$1,171		$1,175	
Generator 5KW	$670		$711		$713	
HDEP Welder (pipe or liner)	$2,647		$2,810		$2,821	
5 Ton Crane	$7,941		$8,430		$8,462	
20 Ton Crane	$15,883		$16,859		$16,924	
50 Ton Crane	$24,706		$26,226		$26,327	
120 Ton Crane	$44,118		$46,832		$47,012	
Trucks						
725 (articulated)	$21,177		$22,479		$22,566	
730 (articulated)	$22,942		$24,352		$24,446	
735 (articulated)	$28,236		$29,972		$30,088	
740 (articulated)	$31,765		$33,719		$33,849	
769D						
773E						
777D						
785C						
793C						
797B						
613E (5,000 gal) Water Wagon	$7,941		$8,430		$8,462	
621E (8,000 gal) Water Wagon						
777D Water Truck						
785C Water Truck						
Dump Truck (10-12 yd^3) (5)	$7,941		$8,430		$8,462	

NOTES:

(1) Power Equipment Source:	CMIAK 10/12/2012					
(2) Power Equipment Type:	Catepillar model or equivalent, LeTourneau loader, Komatsu shovels	Catepillar model or equivalent, LeTourneau loader, Komatsu shovels	Catepillar model or equivalent, LeTourneau loader, Komatsu shovels	Catepillar model or equivalent, LeTourneau loader, Komatsu shovels	Catepillar model or equivalent, LeTourneau loader, Komatsu shovels	Catepillar model or equivalent, LeTourneau loader, Komatsu shovels
(3) Drilliing Equipment Source:	CMIAK 10/12/2012					
(4) Other Equipment Source:	CMIAK 10/12/2012					

Equipment Costs

File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
Date:	***November 11, 2019***
Cost Basis:	***User Data***
Author/Source:	***SRK Consulting/Greens Creek***

Monthly Rental Basis (operating hrs/ period)	***486***		***486***		***486***	

PREVENTATIVE MAINTENANCE COST [Cost Per Hour] (1)

EQUIPMENT TYPE	Basis 1	Basis 2	Basis 3	Basis 4	Basis 5	Basis 6
	Greens Creek 2014	***do not use***	***- April 2019***	***do not use***	***- November 2019***	***do not use***
Bulldozers						
D6R	$6.64		$7		$7.08	
D6R w/ Winch	$6.64		$7		$7.08	
D7R	$6.59		$7		$7.02	
D8R	$7.13		$8		$7.60	
D9R	$8.65		$9		$9.22	
D10R	$9.74		$10		$10.38	
D11R	$11.67		$12		$12.44	
Wheeled Dozers						
824G						
834G						
844						
854G						
Motor Graders						
120H						
14G/H	$5.78		$6		$6.16	
16G/H	$4.69		$5		$5.00	
24M						
Track Excavators						
312C						
320C	$4.66		$5		$4.97	
325C	$4.76		$5		$5.07	
330C						
345B						
365BL	$6.10		$6		$6.50	
385BL	$6.95		$7		$7.41	
Scrapers						
631G	$7.10					
637G PP	$10.24					
Wheeled Loaders						
924G						
928G	$4.62		$5		$4.92	
950G						
966G	$5.55		$6		$5.91	
972G	$5.67		$6		$6.04	
980G						
988G	$8.51		$9		$9.07	
990						
992G	$12.16		$13		$12.96	
994D						
L-2350						
Shovels						
KOM PC2000						
KOM PC3000						
KOM PC4000						
KOM PC5500						
KOM PC8000						
Hydraulic Hammers						
H-120 (fits 325)	N/A	N/A	N/A	N/A	N/A	N/A
H-160 (fits 345)	N/A	N/A	N/A	N/A	N/A	N/A
H-180 (fits 365/385)	N/A	N/A	N/A	N/A	N/A	N/A
Demolition Shears						
S340 (fits 322/325/330)	N/A	N/A	N/A	N/A	N/A	N/A
S365 (fits 330/345)	N/A	N/A	N/A	N/A	N/A	N/A
S390 (fits 365/385)	N/A	N/A	N/A	N/A	N/A	N/A
Demolition Grapples						
G315 (fits 322/325)	N/A	N/A	N/A	N/A	N/A	N/A
G320 (fits 325/330)	N/A	N/A	N/A	N/A	N/A	N/A
G330 (fits 345/365)	N/A	N/A	N/A	N/A	N/A	N/A

Equipment Costs

File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
Date:	***November 11, 2019***
Cost Basis:	***User Data***
Author/Source:	***SRK Consulting/Greens Creek***

Monthly Rental Basis (operating hrs/ period)	***486***		***486***		***486***	
Other Equipment						
420D 4WD Backhoe	$3.29		$3		$3.51	
428D 4WD Backhoe	$3.29		$3		$3.51	
CS533E Vibratory Roller						
CS663E Vibratory Roller						
CP533E Sheepsfoot Compactor						
CP663E Sheepsfoot Compactor						
Light Truck - 1.5 Ton						
Supervisor's Truck						
Flatbed Truck						
Air Compressor + tools						
Welding Equipment						
Heavy Duty Drill Rig						
Pump (plugging) Drill Rig						
Concrete Pump						
Gas Engine Vibrator						
Generator 5KW						
HDEP Welder (pipe or liner)						
5 Ton Crane						
20 Ton Crane						
50 Ton Crane						
120 Ton Crane						
Trucks						
725 (articulated)	$15.03	Inc's tires	$16		$16.02	
730 (articulated)	$15.39	Inc's tires	$16		$16.40	
735 (articulated)	$21.68	Inc's tires	$23		$23.10	
740 (articulated)	$23.35	Inc's tires	$25		$24.88	
769D						
773E						
777D						
785C						
793C						
797B						
613E (5,000 gal) Water Wagon	$7.24	Assumed equal to du	$8		$7.71	
621E (8,000 gal) Water Wagon						
777D Water Truck						
785C Water Truck						
Dump Truck (10-12 yd3) (5)	$7.24		$8		$7.71	
(1) PM Source:						

Equipment Costs

File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
Date:	***November 11, 2019***
Cost Basis:	***User Data***
Author/Source:	***SRK Consulting/Greens Creek***

Monthly Rental Basis (operating hrs/ period)	***486***		***486***		***486***	

G.E.T CONSUMPTION [Cost Per Hour] (1) (Wear Items)

EQUIPMENT TYPE	Basis 1	Basis 2	Basis 3	Basis 4	Basis 5	Basis 6
	Greens Creek 2014	*do not use*	*- April 2019*	*do not use*	*- November 2019*	*do not use*
Bulldozers						
D6R	$4.30		$5		$4.58	
D6R w/ Winch	$4.30		$5		$4.58	
D7R	$6.38		$7		$6.80	
D8R	$8.24		$9		$8.78	
D9R	$12.81		$14		$13.65	
D10R	$17.93		$19		$19.11	
D11R	$26.65		$28		$28.40	
Wheeled Dozers						
824G						
834G						
844						
854G						
Motor Graders						
120H						
14G/H	$12.81		$14		$13.65	
16G/H	$17.51		$19		$18.66	
24M						
Track Excavators						
312C						
320C	$3.90		$4		$4.16	
325C	$4.91		$5		$5.23	
330C						
345B	$6.21		$7		$6.62	
365BL						
385BL	$11.32		$12		$12.06	
Scrapers						
631G	$7.05		$7		$7.51	
637G PP	$8.86		$9		$9.44	
Wheeled Loaders						
924G						
928G	$3.83		$4		$4.08	
950G						
966G	$8.94		$9		$9.53	
972G	$11.31		$12		$12.05	
980G						
988G	$12.10		$13		$12.89	
990						
992G	$28.66		$30		$30.54	
994D						
L-2350						
Shovels						
KOM PC2000						
KOM PC3000						
KOM PC4000						
KOM PC5500						
KOM PC8000						
Hydraulic Hammers						
H-120 (fits 325)	$4.96		$5		$5.29	
H-160 (fits 345)	$9.67		$10		$10.30	
H-180 (fits 365/385)	$11.46		$12		$12.21	
Demolition Shears						
S340 (fits 322/325/330)						
S365 (fits 330/345)						
S390 (fits 365/385)						
Demolition Grapples						
G315 (fits 322/325)						
G320 (fits 325/330)						
G330 (fits 345/365)						

Equipment Costs

File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
Date:	***November 11, 2019***
Cost Basis:	***User Data***
Author/Source:	***SRK Consulting/Greens Creek***

Monthly Rental Basis (operating hrs/ period)	***486***		***486***		***486***	
Other Equipment						
420D 4WD Backhoe	$3.00		$3		$3.20	
428D 4WD Backhoe	$3.00		$3		$3.20	
CS533E Vibratory Roller						
CS663E Vibratory Roller						
CP533E Sheepsfoot Compactor						
CP663E Sheepsfoot Compactor						
Light Truck - 1.5 Ton						
Supervisor's Truck						
Flatbed Truck						
Air Compressor + tools	N/A	N/A	N/A	N/A	N/A	N/A
Welding Equipment	N/A	N/A	N/A	N/A	N/A	N/A
Heavy Duty Drill Rig						
Pump (plugging) Drill Rig						
Concrete Pump	N/A	N/A	N/A	N/A	N/A	N/A
Gas Engine Vibrator	N/A	N/A	N/A	N/A	N/A	N/A
Generator 5KW	N/A	N/A	N/A	N/A	N/A	N/A
HDEP Welder (pipe or liner)	N/A	N/A	N/A	N/A	N/A	N/A
5 Ton Crane						
20 Ton Crane						
50 Ton Crane						
120 Ton Crane						
Trucks						
725 (articulated)						
730 (articulated)						
735 (articulated)						
740 (articulated)						
769D						
773E						
777D						
785C						
793C						
797B						
613E (5,000 gal) Water Wagon						
621E (8,000 gal) Water Wagon						
777D Water Truck						
785C Water Truck						
Dump Truck (10-12 yd3) (5)	$2.81		$3		$2.99	
Notes: (1) G.E.T. Source:	CAT Historical Data					

Equipment Costs

File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
Date:	***November 11, 2019***
Cost Basis:	***User Data***
Author/Source:	***SRK Consulting/Greens Creek***

Monthly Rental Basis (operating hrs/ period)	***486***		***486***		***486***	

TIRE COST TABLE [Cost Per Tire(1,2,3)]

EQUIPMENT TYPE	Basis 1 *Greens Creek 2014*	Basis 2 *do not use*	Basis 3 *- April 2019*	Basis 4 *do not use*	Basis 5 *- November 2019*	Basis 6 *do not use*
Bulldozers						
D6R	N/A	N/A	N/A	N/A	N/A	N/A
D6R w/ Winch	N/A	N/A	N/A	N/A	N/A	N/A
D7R	N/A	N/A	N/A	N/A	N/A	N/A
D8R	N/A	N/A	N/A	N/A	N/A	N/A
D9R	N/A	N/A	N/A	N/A	N/A	N/A
D10R	N/A	N/A	N/A	N/A	N/A	N/A
D11R	N/A	N/A	N/A	N/A	N/A	N/A
Wheeled Dozers						
824G						
834G						
844						
854G						
Motor Graders						
120H						
14G/H	$6,165.81		$6,545		$6,570.29	
16G/H	$7,419.03		$7,875		$7,905.72	
24M						
Track Excavators						
312C	N/A	N/A	N/A	N/A	N/A	N/A
320C	N/A	N/A	N/A	N/A	N/A	N/A
325C	N/A	N/A	N/A	N/A	N/A	N/A
330C	N/A	N/A	N/A	N/A	N/A	N/A
345B	N/A	N/A	N/A	N/A	N/A	N/A
365BL	N/A	N/A	N/A	N/A	N/A	N/A
385BL	N/A	N/A	N/A	N/A	N/A	N/A
Scrapers						
631G	$16,729.11		$17,758		$17,826.54	
637G PP	$16,729.11		$17,758		$17,826.54	
Wheeled Loaders						
924G	$5,510.69		$5,850		$5,872.19	
928G	$5,510.69		$5,850		$5,872.19	
950G	$7,419.03		$7,875		$7,905.72	
966G	$11,624.64		$12,340		$12,387.22	
972G	$11,624.64		$12,340		$12,387.22	
980G	$14,753.36		$15,661		$15,721.18	
988G	$19,693.61		$20,905		$20,985.51	
990						
992G	$39,345.74		$41,766		$41,926.82	
994D						
L-2350						
Shovels						
KOM PC2000	N/A	N/A	N/A	N/A	N/A	N/A
KOM PC3000	N/A	N/A	N/A	N/A	N/A	N/A
KOM PC4000	N/A	N/A	N/A	N/A	N/A	N/A
KOM PC5500	N/A	N/A	N/A	N/A	N/A	N/A
KOM PC8000	N/A	N/A	N/A	N/A	N/A	N/A
Hydraulic Hammers						
H-120 (fits 325)	N/A	N/A	N/A	N/A	N/A	N/A
H-160 (fits 345)	N/A	N/A	N/A	N/A	N/A	N/A
H-180 (fits 365/385)	N/A	N/A	N/A	N/A	N/A	N/A
Demolition Shears						
S340 (fits 322/325/330)	N/A	N/A	N/A	N/A	N/A	N/A
S365 (fits 330/345)	N/A	N/A	N/A	N/A	N/A	N/A
S390 (fits 365/385)	N/A	N/A	N/A	N/A	N/A	N/A
Demolition Grapples						
G315 (fits 322/325)	N/A	N/A	N/A	N/A	N/A	N/A
G320 (fits 325/330)	N/A	N/A	N/A	N/A	N/A	N/A
G330 (fits 345/365)	N/A	N/A	N/A	N/A	N/A	N/A

Equipment Costs

File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
Date:	***November 11, 2019***
Cost Basis:	***User Data***
Author/Source:	***SRK Consulting/Greens Creek***

Monthly Rental Basis (operating hrs/ period)	***486***		***486***		***486***	
Other Equipment						
420D 4WD Backhoe						
428D 4WD Backhoe						
CS533E Vibratory Roller	N/A	N/A	N/A	N/A	N/A	N/A
CS663E Vibratory Roller	N/A	N/A	N/A	N/A	N/A	N/A
CP533E Sheepsfoot Compactor	N/A	N/A	N/A	N/A	N/A	N/A
CP663E Sheepsfoot Compactor	N/A	N/A	N/A	N/A	N/A	N/A
Light Truck - 1.5 Ton						
Supervisor's Truck						
Flatbed Truck						
Air Compressor + tools	N/A	N/A	N/A	N/A	N/A	N/A
Welding Equipment	N/A	N/A	N/A	N/A	N/A	N/A
Heavy Duty Drill Rig						
Pump (plugging) Drill Rig						
Concrete Pump	N/A	N/A	N/A	N/A	N/A	N/A
Gas Engine Vibrator	N/A	N/A	N/A	N/A	N/A	N/A
Generator 5KW	N/A	N/A	N/A	N/A	N/A	N/A
HDEP Welder (pipe or liner)	N/A	N/A	N/A	N/A	N/A	N/A
5 Ton Crane						
20 Ton Crane						
50 Ton Crane						
120 Ton Crane						
Trucks						
725 (articulated)						
730 (articulated)						
735 (articulated)						
740 (articulated)						
769D						
773E						
777D						
785C						
793C						
797B						
613E (5,000 gal) Water Wagon	$968.00	Assumed = dmp trck	$1,028		$1,031.50	
621E (8,000 gal) Water Wagon						
777D Water Truck						
785C Water Truck						
Dump Truck (10-12 yd3) (5)	$968.00		$1,028		$1,031.50	

Notes:

(1) Unit Cost Basis:	Cost per set					
(2) Cost Basis:	Total cost for all required tires.					
(3) Tire Cost Source:	Purcell Tire Quote 07/09/2012					
(4) Tire Wear Source (defined in model):	Caterpillar Handbook, Edition 35; Ch. 20					

Labor Rates

File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
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Cost Basis:	***User Data***
Author/Source:	***SRK Consulting/Greens Creek***

HOURLY LABOR RATE TABLE

EQUIPMENT TYPE (1) OR JOB DESCRIPTION	Basis 1		Basis 2		Basis 3		Basis 4		Basis 5		Basis 6	
	Greens Creek 2014		*do not use*		*Greens Creek 2019 - April 2019*		*do not use*		*Greens Creek 2019 - November 2019*		*do not use*	
EQUIPMENT OPERATORS - Labor Groups and Base Pay Rate ($/hr) (2)												
Bulldozers												
D6R	A1602	$60.01			A1602	$61.94			A1602	$61.94		
D6R w/ Winch	A1602	$60.01			A1602	$61.94			A1602	$61.94		
D7R	A1602	$60.01			A1602	$61.94			A1602	$61.94		
D8R	A1602	$60.01			A1602	$61.94			A1602	$61.94		
D9R	A1602	$60.01			A1602	$61.94			A1602	$61.94		
D10R	A1602	$60.01			A1602	$61.94			A1602	$61.94		
D11R	A1602	$60.01			A1602	$61.94			A1602	$61.94		
Wheeled Dozers												
824G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
834G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
844	A1602	$60.01			A1602	$61.94			A1602	$61.94		
854G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
Motor Graders												
120H	A1602	$60.01			A1602	$61.94			A1602	$61.94		
14G/H	A1602	$60.01			A1602	$61.94			A1602	$61.94		
16G/H	A1602	$60.01			A1602	$61.94			A1602	$61.94		
24M	A1602	$60.01			A1602	$61.94			A1602	$61.94		
Track Excavators												
312C	A1601	$58.13			A1601	$60.71			A1601	$60.71		
320C	A1601	$58.13			A1601	$60.71			A1601	$60.71		
325C	A1601	$58.13			A1601	$60.71			A1601	$60.71		
330C	A1601	$58.13			A1601	$60.71			A1601	$60.71		
345B	A1601	$58.13			A1601	$60.71			A1601	$60.71		
365BL	A1601	$58.13			A1601	$60.71			A1601	$60.71		
385BL	A1601	$58.13			A1601	$60.71			A1601	$60.71		
Scrapers												
631G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
637G PP	A1602	$60.01			A1602	$61.94			A1602	$61.94		
Wheeled Loaders												
924G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
928G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
950G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
966G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
972G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
980G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
988G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
990	A1602	$60.01			A1602	$61.94			A1602	$61.94		
992G	A1602	$60.01			A1602	$61.94			A1602	$61.94		
994D	A1602	$60.01			A1602	$61.94			A1602	$61.94		
L-2350	A1602	$60.01			A1602	$61.94			A1602	$61.94		
Shovels												
KOM PC2000	A1602	$60.01			A1602	$61.94			A1602	$61.94		
KOM PC3000	A1602	$60.01			A1602	$61.94			A1602	$61.94		
KOM PC4000	A1602	$60.01			A1602	$61.94			A1602	$61.94		
KOM PC5500	A1602	$60.01			A1602	$61.94			A1602	$61.94		
KOM PC8000	A1602	$60.01			A1602	$61.94			A1602	$61.94		
Hydrauilc Hammers												
H-120 (fits 325)												
H-160 (fits 345)												
H-180 (fits 365/385)												
Demolition Shears												
S340 (fits 322/325/330)												
S365 (fits 330/345)												
S390 (fits 365/385)												
Demolition Grapples												
G315 (fits 322/325)												
G320 (fits 325/330)												
G330 (fits 345/365)												

Labor Rates

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HOURLY LABOR RATE TABLE

EQUIPMENT TYPE (1) OR JOB DESCRIPTION	Basis 1		Basis 2		Basis 3		Basis 4		Basis 5		Basis 6	
	Greens Creek 2014		*do not use*		*Greens Creek 2019 - April 2019*		*do not use*		*Greens Creek 2019 - November 2019*		*do not use*	
Other Equipment												
420D 4WD Backhoe	A1601	$58.13			A1601	$60.71			A1601	$60.71		
428D 4WD Backhoe	A1601	$58.13			A1601	$60.71			A1601	$60.71		
CS533E Vibratory Roller	A1601	$58.13			A1601	$60.71			A1601	$60.71		
CS663E Vibratory Roller	A1601	$58.13			A1601	$60.71			A1601	$60.71		
CP533E Sheepsfoot Compactor	A2105	$54.84			A2105	$64.77			A2105	$64.77		
CP663E Sheepsfoot Compactor	A2105	$54.84			A2105	$64.77			A2105	$64.77		
Light Truck - 1.5 Ton	A1601	$58.13			A1601	$60.71			A1601	$60.71		
Supervisor's Truck	A1601	$58.13			A1601	$60.71			A1601	$60.71		
Flatbed Truck	A1601	$58.13			A1601	$60.71			A1601	$60.71		
Air Compressor + tools	A1601	$58.13			A1601	$60.71			A1601	$60.71		
Welding Equipment	A1601	$58.13			A1601	$60.71			A1601	$60.71		
Heavy Duty Drill Rig	S2204	$59.93			S2204	$71.84			S2204	$71.84		
Pump (plugging) Drill Rig	A1601	$58.13			A1601	$60.71			A1601	$60.71		
Concrete Pump												
Gas Engine Vibrator	A1601	$58.13			A1601	$60.71			A1601	$60.71		
Generator 5KW												
HDEP Welder (pipe or liner)												
5 Ton Crane	A1601	$58.13			A1601	$60.71			A1601	$60.71		
20 Ton Crane	A1601	$58.13			A1601	$60.71			A1601	$60.71		
50 Ton Crane	A1602	$60.01			A1602	$61.94			A1602	$61.94		
120 Ton Crane	A1602	$60.01			A1602	$61.94			A1602	$61.94		
Fringe Benefits												
Equip Op Fringe Benefits ($/hr)		$0.00				$0.00				$0.00		
Zone and Area Adjustments - Miles and Rates ($hr) (3)												
Equipment Zone 1	none	$0.00			none	$0.00			none	$0.00		
Equipment Zone 2	none	$0.00			none	$0.00			none	$0.00		
Equipment Zone 3	none	$0.00			none	$0.00			none	$0.00		
Equipment Zone 4	none	$0.00			none	$0.00			none	$0.00		
Equipment Zone 5												
Equipment Zone 6												
Equipment Zone 7												
NOTES:												
(1) Equipment Type:	Catepillar model or equivalent		Catepillar model or equivalent		Catepillar model or equivalent		Catepillar model or equivalent		Catepillar model or equivalent		Catepillar model or equivalent	
(2) Equipment Operator Source:	Alaska Dept. of Labor and											
(3) Zone Basis:												
TRUCK DRIVERS - Labor Groups and Base Pay Rate ($/hr) (4)												
725 (articulated)	A2101	$57.69			A2101	$63.62			A2101	$63.62		
730 (articulated)	A2101	$57.69			A2101	$63.62			A2101	$63.62		
735 (articulated)	A2101	$57.69			A2101	$63.62			A2101	$63.62		
740 (articulated)	A2102	$59.05			A2102	$64.75			A2102	$64.75		
769D	A2102	$59.05			A2102	$64.75			A2102	$64.75		
773E	A2102	$59.05			A2102	$64.75			A2102	$64.75		
777D	A2102	$59.05			A2102	$64.75			A2102	$64.75		
785C	A2102	$59.05			A2102	$64.75			A2102	$64.75		
793C	A2102	$59.05			A2102	$64.75			A2102	$64.75		
797B	A2102	$59.05			A2102	$64.75			A2102	$64.75		
613E (5,000 gal) Water Wagon	A2105	$54.84			A2105	$64.77			A2105	$64.77		
621E (8,000 gal) Water Wagon	A2105	$54.84			A2105	$64.77			A2105	$64.77		
777D Water Truck	A2105	$54.84			A2105	$64.77			A2105	$64.77		
785C Water Truck	A2105	$54.84			A2105	$64.77			A2105	$64.77		
Dump Truck (10-12 yd3)	A2105	$54.84			A2105	$64.77			A2105	$64.77		
Fringe Benefits												
Truck Driver Fringe Benefits ($/hr)		$0.00				$0.00		$0.00		$0.00		$0.00
Zone and Area Adjustments (5)												
Truck Zone 1	none	$0.00			none	$0.00			none	$0.00		
Truck Zone 2	none	$0.00			none	$0.00			none	$0.00		
Truck Zone 3	none	$0.00			none	$0.00			none	$0.00		
Truck Zone 4												
Truck Zone 5												
Truck Zone 6												
Truck Zone 7												
NOTES:												
(4) Truck Driver Source:												
(5) Zone Basis:												

Labor Rates

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HOURLY LABOR RATE TABLE

EQUIPMENT TYPE (1) OR JOB DESCRIPTION	Basis 1		Basis 2		Basis 3		Basis 4		Basis 5		Basis 6	
	Greens Creek 2014		*do not use*		*Greens Creek 2019 - April 2019*		*do not use*		*Greens Creek 2019 - November 2019*		*do not use*	
LABORERS - Labor Groups and Base Pay Rate ($/hr) (6,7)												
General Laborer	S1201	$50.69			S1201	$68.26			S1201	$68.26		
Skilled Laborer	S1203	$57.73			S1203	$69.52			S1203	$69.52		
Driller's Helper	A1604	$56.53			A1604	$62.10			A1604	$62.10		
Rodmen (reinforcing concrete)	S0401	$53.77			S0401	$63.69			S0401	$63.69		
Cement finisher	S0401	$53.77			S0401	$63.69			S0401	$63.69		
Carpenter	A0301	$58.82			A0301	$61.77			A0301	$61.77		
Fringe Benefits												
Laborer Fringe Benefits ($/hr)												
Carpenter Fringe Benefits ($/hr)												
Zone and Area Adjustments (8)												
Laborer Zone 1	none	$0.00			none	$0.00			none	$0.00		
Laborer Zone 2	none	$0.00			none	$0.00			none	$0.00		
Laborer Zone 3	none	$0.00			none	$0.00			none	$0.00		
Laborer Zone 4												
Laborer Zone 5												
Laborer Zone 6												
Laborer Zone 7												
NOTES:												
(6) Laborer Source:	Alaska DB 2012				Alaska DB 2018				Alaska DB 2018			
(7) Carpenter Source:	Alaska DB 2012				Alaska DB 2018				Alaska DB 2018			
(8) Zone Basis:	Not used											
PROJECT MANAGEMENT AND TECHNICAL LABOR - Base Pay Rate ($/hr) (9)												
Project Manager		$150.00										
Foreman		$75.00				$88.76		increased proportionally to the		$88.76		increased p
Field Geologist/Engineer		$125.00										
Field Tech/Sampler		$75.00				$88.76		increased proportionally to the		$88.76		increased p
Range Scientist		$125.00										
Senior Planning Engineer												
Project Engineer												
Mechanic/Fitter												
NOTES:												
(9) Project Manager:	SRK Staff Engineer											
(9) Foreman Source:	SRK Field Tech				SRK Field Tech							
(9) Techical Labor Source:	SRK Typical				SRK Typical							
INDIRECT COSTS												
SOCIAL SECURITY, WORKMAN'S COMP, INSURANCE, ETC.												
Unemployment (%)												
Retirement/SS/Medicare (%)												
Workman's Compensation (%)												
State Payroll Tax (13),(15),(17),(18)												
NOTES:												
(10) Workman's Comp Source:												
(11) Social Security/Medicare												
(12) Workmans Compensation												
(13), (14) & (15) State Payol taxes												

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RECLAMATION MATERIAL COST TABLE

MATERIAL TYPE		Basis 1	Basis 2	Basis 3	Basis 4	Basis 5	Basis 6
		Greens Creek 2014	*do not use*	*Greens Creek 2019 - April 2019*	*do not use*	*Greens Creek 2019 - November 2019*	*do not use*
Revegetation Materials							
Seed Mixes							
Seed Mix	Units						
None							
Mix 1	Cost/Acre	$556.98	mail PC Feb. 14, 14	$1,004.46	HGCMC Costs	$1,004.46	HGCMC Costs
Mix 2	Cost/Acre						
Mix 3	Cost/Acre						
Mix 4	Cost/Acre						
User Mix 1	Cost/Acre						
User Mix 2	Cost/Acre						
User Mix 3	Cost/Acre						
User Mix 4	Cost/Acre						
User Mix 5 (see Seed Mix sheet)	Cost/Acre						
	Notes:						
Mulch							
Item	Units						
None							
Straw Mulch	Cost/lb						
Hydro Mulch	Cost/lb						
Timber Mulch	Cost/lb						
	Cost/lb						
	Cost/lb						
	Notes:						
Amendments							
Item	Units						
None							
Organic Matter	Cost/lb						
Treated Sludge	Cost/lb						
Chemical	Cost/lb						
	Cost/lb						
	Cost/lb						
	Cost/lb						
	Notes:						
Well Abandonment Materials							
Description	Units						
Cement	50lb bag	$46.00	adjusted with inflati	$52.29	2014 costs adjustec	$52.49	Basis 3 cost aduste
Grout (Low Grade Bentonite)	50lb bag	$12.15	NV cost	$13.69	2014 costs adjustec	$13.74	Basis 3 cost aduste
Inert Material/Cuttings	cy						
	Notes:						
Monitoring Costs							
Description	Units	Cost/unit	Cost/unit	Cost/unit	Cost/unit	Cost/unit	Cost/unit
Monitor Well Pump	ea.	$2,150.00	NV cost			$2,291.04	2014 costs adjustec
Sampling Supplies	ea.	$0.00	included			$0.00	2014 costs adjustec
Underground Care and Maintenan	ea.	$64,000.00	2008 costs adjustec	$67,936.00	2014 costs adjustec	$68,198.40	2014 costs adjustec
Suite Q	ea.	$742.52	2008 costs adjustec	$625.00	HGCMC Costs	$625.00	HGCMC Costs
QA/QC	ea.	$972.22	2008 costs adjustec	$625.00	HGCMC Costs	$625.00	HGCMC Costs
Stormwater - sites	ea.	$149.57	2008 costs adjustec	$156.00	HGCMC Costs	$156.00	HGCMC Costs
APDES - discharge	ea.	$186.97	2008 costs adjustec	$113.45	HGCMC Costs	$113.45	HGCMC Costs
Hawk Inlet seawater sampling	ea.	$2,500.00	2008 costs adjustec	$3,175.00	HGCMC Costs	$3,175.00	HGCMC Costs
Hawk Inlet sediment and organism	ea.	$33,000.00	2008 costs adjustec	$25,104.00	HGCMC Costs	$25,104.00	HGCMC Costs
Site-wide vegetation	ea.	$480.77	2008 costs adjustec	$510.34	2014 costs adjustec	$512.31	2014 costs adjustec
Shipping	ea.	$80.13	2008 costs adjustec	$83.33	HGCMC Costs	$83.33	HGCMC Costs
PSI Report	ea.	$16,000.00	2008 costs adjustec	$50,000.00	HGCMC Costs	$50,000.00	HGCMC Costs
IMP Sulfate	ea.			$17.11	HGCMC Costs	$17.11	HGCMC Costs
	ea.						
	ea.						
	ea.						
	ea.						
	Notes:						
Fuel, Etc.							
Description	Units	Cost/unit	Cost/unit	Cost/unit	Cost/unit	Cost/unit	Cost/unit
Off-road Diesel - delivered (1)	$/gal	$4.14	, JS, June 28, 2012	$4.14		$4.14	
Pickup Truck Travel	$/mi						
Electical Power	$/kWh	$0.1000		$0.1500		$0.1500	
Diesel power	$/kWh	$0.32		$0.32		$0.32	
Water treatment reagents	$/gal						

Notes:		March 21, 2014 James Carson at Taku Fuel					

Nevada Standardized Bond Calculation
Misc. Unit Costs

File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
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MISCELLANEOUS COST TABLE

JOB DESCRIPTION		Basis 1		Basis 2		Basis 3		Basis 4		Basis 5		Basis 6	
		Greens Creek 2014		*do not use*		*Greens Creek 2019 - April 2019*		*do not use*		*Greens Creek 2019 - November 2019*		*do not use*	
REVEGETATION													
Item	**Units**	**Labor**	**Equip**	**Labor**	**Equip**	**Labor**	**Equip**	**Labor**	**Equip**	**Labor**	**Equip**	**Labor**	**Equip**
Seeding - Broadcast Manual (1)	$/acres	$0.00	$0.00			$0.00	$0.00			$0.00	$0.00		
Seeding - Broadcast Mechanical (1)	$/acres	$37.17	$20.34			$39.46	$21.59	2014 cost adjusted for i		$39.61	$21.67	2014 cost adjusted for ir	
Seeding - Drill (1)	$/acres	$37.17	$20.34			$39.46	$21.59	2014 cost adjusted for i		$39.61	$21.67	2014 cost adjusted for ir	
Seeding - Hydroseeding (1)	$/acres	$37.17	$20.34			$39.46	$21.59	2014 cost adjusted for i		$39.61	$21.67	2014 cost adjusted for ir	
Item	**Units**	**Materials**		**Materials**		**Materials**		**Materials**		**Materials**		**Materials**	
Shrub Planting - bare root 6-10 in (150- 250mm) (2)	ea.												
Tree Planting - bare root 11-16 in (270- 400mm) (3)	ea.												
Cactus Planting (4)	ea.												
NOTES:													
(1) Seeding Source:													
(2) Shrub Source:													
(3) Tree Source:													
(4) Cactus Source:													
BUILDING and WALL DEMOLITION													
Item	**Units**		**Premium**		**Premium**		**Premium**		**Premium**		**Premium**		**Premium**
Building Demolition													
Lg. steel	C.F.												
Lg. concrete	C.F.												
Lg. masonry	C.F.												
Lg. mixed	C.F.												
Sm. steel	C.F.												
Sm. concrete	C.F.												
Sm. masonry	C.F.												
Sm. wood	C.F.												
Wall Demolition													
Block 4 in thick	S.F.		20%				20%				20%		
Block 6 in thick	S.F.		20%				20%				20%		
Block 8 in thick	S.F.		20%				20%				20%		
Block 12 in thick	S.F.		20%				20%				20%		
Conc 6 in thick	S.F.		10%				10%				10%		
Conc 8 in thick	S.F.		10%				10%				10%		
Conc 10 in thick	S.F.		10%				10%				10%		
Conc 12 in thick	S.F.		10%				10%				10%		
WASTE DISPOSAL													
Item	**Units**	**Materials**		**Materials**		**Materials**		**Materials**		**Materials**		**Materials**	
Rubbish and Waste Handling													
Dumpster delivery (average for all sizes)	ea.												
Haul (average for all sizes)	ea.												
Rent per month (average for all sizes)	ea.												
Disposal fee per ton (tonne) (average for all sizes)	ton												
NOTES:													
Dumpster Cost Source													
Disposal Fee Source:													
Hazardous Material Handling - Solids													
Pickup fees 55 gal. drums	ea.	$230.00				$244.15		2014 cost adjusted for i		$245.09		2014 cost adjusted for ir	
Bulk material (average)	ton	$380.00				$403.37		2014 cost adjusted for i		$404.93		2014 cost adjusted for ir	
Transport - truck load (80 drums, 25 cy (m3), 18 tons)	mile	$5.23				$5.55		2014 cost adjusted for i		$5.57		2014 cost adjusted for ir	
Dump site disposal fee	ton	$267.00				$283.42		2014 cost adjusted for i		$284.52		2014 cost adjusted for ir	
NOTES:													
Solid Handling Cost Source		2012 Means Heavy Construction											
Solid Disposal Fee Source:		2012 Means Heavy Construction											
Hazardous Material Handling - Liquids													
Vacuum Truck Pickup (2200 gal or 9,700 litres)	hr.	$129.00				$136.93		2014 cost adjusted for i		$137.46		2014 cost adjusted for ir	
Vacuum Truck Pickup (5000 gal or 2,000 litres)	hr.	$184.00				$195.32		2014 cost adjusted for i		$196.07		2014 cost adjusted for ir	
Dump site disposal fee	ton	$267.00				$283.42		2014 cost adjusted for i		$284.52		2014 cost adjusted for ir	
NOTES:													
Liquid Handling Cost Source		2012 Means Heavy Construction											
Liquid Disposal Fee Source:		2012 Means Heavy Construction											
Hydrocarbon Contaminated Soils (HCS)													
Insitu Biotreatment	C.Y	$16.85				$17.89				$17.96		2014 cost adjusted for ir	
HCS disposal fee	C.Y	$267.00				$283.42				$284.52		2014 cost adjusted for ir	
NOTES:													
Insitu Treatement Cost Source		Construction, ave. 02 65 1030-2020, 2021											
HCS Disposal Fee Source:		Construction, ave. 02 65 1030-2020, 2021											

Nevada Standardized Bond Calculation
Misc. Unit Costs

File Name:	*2019 SRCE Cost Data File Version 7.xlsm*
Date:	*November 11, 2019*
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MISCELLANEOUS COST TABLE

JOB DESCRIPTION		Basis 1		Basis 2		Basis 3		Basis 4		Basis 5		Basis 6	
		Greens Creek 2014		*do not use*		*Greens Creek 2019 - April 2019*		*do not use*		*Greens Creek 2019 - November 2019*		*do not use*	
UNDERGROUND OPENING CLOSURE													
Item	**Units**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**
Reinforced Concrete Bulkheads and Shaft Covers													
Grade walls - 15 in thick, 8 ft high	C.Y	$137.00				$145.43		2014 cost adjusted for i		$145.99		2014 cost adjusted for ir	
Grade walls - 15 in thick, 12 ft high	C.Y	$137.00				$145.43		2014 cost adjusted for i		$145.99		2014 cost adjusted for ir	
Elevated conc, 1-way beam & slab - 15ft span	C.Y	$226.00				$239.90		2014 cost adjusted for i		$240.83		2014 cost adjusted for ir	
Elevated conc, 1-way beam & slab - 25ft span	C.Y	$218.00				$231.41		2014 cost adjusted for i		$232.30		2014 cost adjusted for ir	
Item	**Units**	**Materials**		**Materials**		**Materials**		**Materials**		**Materials**		**Materials**	
Small Adit Plugging													
Bat Gate [5]	ea.	$2,732.39				$2,900.44		2014 cost adjusted for i		$2,911.64		2014 cost adjusted for ir	
Culvert Gate [5]	C.Y	$5,464.79				$5,800.87		2014 cost adjusted for i		$5,823.28		2014 cost adjusted for ir	
Adit Foam Plug [6]	C.Y	$273.24				$290.04		2014 cost adjusted for i		$291.16		2014 cost adjusted for ir	
Production Opening Foam Plug [6]	C.Y	$273.24				$290.04		2014 cost adjusted for i		$291.16		2014 cost adjusted for ir	
NOTES:													
(5) Bat Gate Source:		NV BLM, 2/2006: 8 hr + 1hr mob/demob + 1hr setup per gate (adjusted to 2011)											
(6) Foam Plug Source:		NV BLM, 2/2006: 8 hr + 1hr mob/demob + 1hr setup per adit; 16 hrs per production opening (adjusted to 2011)											
MISC. LINEAR PROJECTS													
Item	**Units**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**
Fencing Installation													
Barbed 3-strand	ft	$0.45				$0.48		2014 cost adjusted for i		$0.48		2014 cost adjusted for ir	
Barbed 4-strand	ft	$0.60				$0.64		2014 cost adjusted for i		$0.64		2014 cost adjusted for ir	
Barbed 5-strand	ft	$0.75				$0.80		2014 cost adjusted for i		$0.80		2014 cost adjusted for ir	
Chain link 8 ft -10 ft Install	ft	$32.50				$34.50		2014 cost adjusted for i		$34.63		2014 cost adjusted for ir	
Wood stockade fence 6 ft high - Install	ft	$13.75				$14.60		2014 cost adjusted for i		$14.65		2014 cost adjusted for ir	
	ft												
	ft												
Fencing Removal													
Barbed 3-strand Removal	ft												
Barbed 4-strand Removal	ft												
Barbed 5-strand Removal	ft												
Chain link 8 ft -10 ft Removal	ft												
Wood, all types 4 ft -6 ft high Removal	ft												
	ft												
	ft												
Culvert Removal													
12 in (300 mm) Diameter	ft												
18 in (450 mm) Diameter	ft												
24 in (600 mm) Diameter	ft												
36 in (1m) Diameter	ft												
Pipeline Removal													
Plastic Pipe 3/4 in (mm) - 4 in (100 mm) diameter	ft												
6 in (150 mm) - 8 in (200 mm)	ft												
10 in (250 mm) - 18 in (450 mm)	ft												
20 in (500 mm) - 36 in (1 m)	ft												
Pipe and Drainpipe Installation													
Water 4in (100mm) 40ft (12m) length, welded HDPE	ft	$3.44				$3.65		2014 cost adjusted for i		$3.67		2014 cost adjusted for ir	
Water 6in (150mm) 40ft (12m) length, welded HDPE	ft	$7.80				$8.28		2014 cost adjusted for i		$8.31		2014 cost adjusted for ir	
Water 12in (300mm) 40ft (12m) length, welded HDPE	ft												
Drain 4in (100mm) perforated PVC	ft	$1.40				$1.49		2014 cost adjusted for i		$1.49		2014 cost adjusted for ir	
Drain 6in (150mm) perforated PVC	ft	$2.95				$3.13		2014 cost adjusted for i		$3.14		2014 cost adjusted for ir	
Drain 4in (100mm) corrugated, perf or plain	ft	$0.54				$0.57		2014 cost adjusted for i		$0.58		2014 cost adjusted for ir	
Drain 6in (150mm) corrugated., perf or plain	ft	$1.71				$1.82		2014 cost adjusted for i		$1.82		2014 cost adjusted for ir	
Drain Rock Preparation													
Item	**Units**		**Total**		**Total**		**Total**		**Total**		**Total**		**Total**
Crushing	C.Y												
Screening	C.Y		$1.00				$1.06		2014 cost adjusted for i		107%		2014 cost a
Misc.													
Item	**Units**		**Premium**		**Premium**		**Premium**		**Premium**		**Premium**		**Premium**
Backhoe work	C.Y												
Powerline and Transformer Removal			**Total**		**Total**		**Total**		**Total**		**Total**		**Total**
Single Pole Powerlines [7]	mile		$37,975				$40,311		2014 cost adjusted for i		$40,467		2014 cost a
Double Pole Powerlines [8]	mile		$43,400				$46,070		2014 cost adjusted for i		$46,248		2014 cost a
Substation [9]	unit		$27,216				$28,890		2014 cost adjusted for i		$29,001		2014 cost a
NOTES:													
(7) Single Pole Source:		NVEnergy estimate (2009) Adjusted to 2012											
(8) Double Pole Source:		NVEnergy estimate (2009) Adjusted to 2012											
(9) Transformer Source:		Sierra Pacific Power Company estimate (2004) adjusted to 2012											

Nevada Standardized Bond Calculation
Misc. Unit Costs

File Name:	***2019 SRCE Cost Data File Version 7.xlsm***
Date:	***November 11, 2019***
Cost Basis:	***User Data***
Author/Source:	***SRK Consulting/Greens Creek***

MISCELLANEOUS COST TABLE

JOB DESCRIPTION		Basis 1		Basis 2		Basis 3		Basis 4		Basis 5		Basis 6	
		Greens Creek 2014		*do not use*		*Greens Creek 2019 - April 2019*		*do not use*		*Greens Creek 2019 - November 2019*		*do not use*	
EROSION, EVAPORATION and SEDIMENTATION CONTROL													
Item	**Units**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**
Rip-Rap & Rock Lining													
Rip-Rap 3/8 to 1/4 C.Y. pieces, grouted	S.Y.	$20.00				$21.23		2014 cost adjusted for i		$21.31		2014 cost adjusted for i	
Rip-Rap 18 in min thick, no grout	S.Y.	$5.90				$6.26		2014 cost adjusted for i		$6.29		2014 cost adjusted for i	
Gabions, 6 in deep	S.Y.	$8.80				$9.34		2014 cost adjusted for i		$9.38		2014 cost adjusted for i	
Gabions, 9 in deep	S.Y.	$11.05				$11.73		2014 cost adjusted for i		$11.77		2014 cost adjusted for i	
Gabions, 12 in deep	S.Y.	$16.15				$17.14		2014 cost adjusted for i		$17.21		2014 cost adjusted for i	
Gabions, 18 in deep	S.Y.	$21.50				$22.82		2014 cost adjusted for i		$22.91		2014 cost adjusted for i	
Gabions, 36 in deep	S.Y.	$34.50				$36.62		2014 cost adjusted for i		$36.76		2014 cost adjusted for i	
Liner Installation													
Item	**Units**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**	**Materials**	**Premium**
Site grading	S.F.												
Compaction	S.F.												
Item	**Units**		**Materials**		**Materials**		**Materials**		**Materials**		**Materials**		**Materials**
60 mil HDPE Liner	S.F.		$0.43				$0.46		2014 cost adjusted for i		$0.46		2014 cost a
Construction Management Support													
Item	**Units**		**Materials**		**Materials**		**Materials**		**Materials**		**Materials**		**Materials**
Office Trailer, Furnished, no hook-ups	month		$140.00				$148.61		2014 cost adjusted for i		$149.18		2014 cost a
Toilet Portable, chemical	month		$198.20				$210.39		2014 cost adjusted for i		$211.20		2014 cost a
PRODUCTION OR DEWATERING WELL PUMP REMOVAL													
Item	**Units**	**Labor**	**Equip**	**Labor**	**Equip**	**Labor**	**Equip**	**Labor**	**Equip**	**Labor**	**Equip**	**Labor**	**Equip**
Pump Type													
Submersible [10]	ft to pump	$2.39	$5.19			$2.53	$5.51	2014 cost adjusted for i		$2.54	$5.53	2014 cost adjusted for i	
Line Shaft [10]	ft to pump	$5.57	$12.11			$5.91	$12.86	2014 cost adjusted for i		$5.94	$12.91	2014 cost adjusted for i	
NOTES:													
(10) Pump Removal Source:		WDC Exploration 12/2005 (adjusted to 2012)											

File Name:	***CostData STD 3.xls***
Date:	***December 1, 2005***
Cost Basis:	***Standardized Data***
Author/Source:	***SRK Consulting/Greens Creek***

Administrative Cost Rates (%)					
	Cost Ranges for Indirect Cost Percentages				
	<=	**<=**	**<=**	**>**	
1. Engineering, Design and Construction (ED&C) Plan	$500,000	$2,500,000	$25,000,000	$25,000,000	Small Plan
Variable Rate	3%	3%	3%	3%	3%
	<=	**<=**	**<=**	**>**	
2. Contingency (6.5% bid, 6.5% scope)	$500,000	$5,000,000	$50,000,000	$50,000,000	Small Plan
Variable Rate	13%	13%	13%	13%	13%
3. Insurance		of labor costs			
4. Bond (payment and performance)	3.0%	of the O&M costs if O&M costs are >$100,000			
5. Contractor overhead and profit+insurance (@0.5%)	15.5%	of the O&M costs			
	<=	**<=**	**<=**	**>**	
6. Contract Admin and Government Admin (ea. 3.5%)	$1,000,000	$15,000,000	$25,000,000	$25,000,000	
Variable Rate	7%	7%	7%	7%	7%

RECLAMATION COST ESTIMATION SUMMARY SHEET FOOTNOTES

NOTE :
As per WMP 2014DB0003

General Plan of Operations
Appendix 15
Conceptual Suspension of Operations Plan

May 2020

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1. INTRODUCTION

Hecla Greens Creek Mining Company (HGCMC) has prepared this Conceptual Suspension of Operations Plan as required by the Alaska Department of Environmental Conservation (ADEC) Waste Management Permit 2020DB0001 (WMP). This Plan describes in conceptual terms the measures that will be implemented by HGCMC during a temporary suspension of operations to:

- Control surface and groundwater drainage to and from the facility and the surrounding area;
- Collect, store, treat and dispose of process water;
- Control erosion from the tailings disposal facility, waste rock disposal areas, mill, campsite, and any other disturbed areas within the facility boundary;
- Secure storage of chemicals and fuel; and,
- Maintain and monitor the Pond 7/10 dam and site-wide water balance.

Suspension of operations defined as a suspension of mining and milling/processing activities for more than 90 days but less than three years. The length of time for the period of suspension may be extended beyond three years by written authorization from ADEC and the Forest Service.

In the event of a suspension of operations, HGCMC shall notify ADEC and the Forest Service within three days of the suspension and provide the nature of and reason for the suspension and its anticipated duration. No later than ten days after operations have been suspended, HGCMC shall submit a detailed suspension of operations plan that replaces this conceptual Plan with current information and specific details.

During temporary shutdowns, the Company intends to maintain all leases, permits, approvals, and authorizations, continue all of the required monitoring and regulatory mandated compliance, and maintain the mine facilities to allow the resumption of operations as quickly as possible.

2. PERSONNEL

Depending on the circumstances that lead to a suspension of operations, and the anticipated duration, a reduction in the workforce may be necessary until mining/milling operations resume. HGCMC will retain a sufficient staff of qualified personnel to carry out the essential monitoring, maintenance, and water treatment activities described in this Plan.

Staffing needs will be adjusted accordingly for the necessary duties, which may or may not necessitate a change to the regular rotating shifts. Greens Creek will determine staffing needs during a crisis-driven suspension of operation as part of the crisis response, which may or may not necessitate a change to the regular rotating shifts.

3. PERMITS AND LEASES

The mine holds a variety of property leases and permits for mine operations. During a temporary shutdown of any duration, all leases and permits will be maintained. All conditions and stipulations set by the permits and leases will be followed, and lease fees paid. Clause 29 of the Forest Service leases regarding lease termination states: "This lease shall terminate at such time as the Greens Creek mineral deposit is exhausted or upon failure of the lessee to use the leased site for two consecutive years unless

such nonuse is waived annually by the Forest Supervisor." Individual permits and leases must be consulted for details on the requirements. Copies of all permits and leases are on file in the Greens Creek Environmental Affairs office.

4. MONITORING/SAMPLING REQUIREMENTS

In addition to performing compliance monitoring required under the APDES and Title V Air Quality permits, HGCMC will also perform monitoring as described in the Integrated Monitoring Plan (GPO Appendix 1). The only change to monitoring during a suspension of operations would be a potential reduction in the frequency of geochemical monitoring of tailings and waste rock. During operations, acid-base accounting (ABA) samples are collected quarterly from active placement areas at waste rock Site 23 and annually from active placement areas at the tailings disposal facility. During a suspension of operations, these areas would be sampled on the same five-year interval as is performed on inactive waste rock sites and older portions of the tailings pile.

5. WATER MANAGEMENT AND EROSION CONTROL

Water management activities will continue to be performed in the same manner as during active operations. Water from the underground mine will continue to be pumped, as needed, to treatment systems. Runoff diversion and collection systems at the 920 Area, Site 23, and the tailings facility will be maintained to prevent any contact water from escaping containment. Accumulated sediments will be removed from collection ponds, as needed, to maintain capacity for the 25-yr storm event. All pumping systems and pipelines will be maintained to ensure water requiring treatment is routed to Pond 7/10. The only anticipated change to water management activities is that the mill water treatment plants likely would be shut down, and all water treatment operations would be at the Pond 7 WTP.

Erosion control will be accomplished by continuing the monthly visual inspections of waste rock and tailings disposal sites and through the implementation and maintenance of best management practices (BMPs) throughout the facility. A BMP Plan (GPO Appendix 5) has been prepared to control and contain potential pollutants at the site, and this Plan will continue to be implemented during a temporary shutdown. The surface of waste rock Site 23 and the tailings disposal facility will be contoured and compacted to control runoff and minimize erosion. Depending on the anticipated duration of the shutdown, additional measures may be implemented to control erosion and dusting, such as the application of polymer at appropriate intervals or the installation of interim covers. Hydroseeding will also be performed, where appropriate, for site stabilization.

If possible, remaining ore on the ore stockpile will be processed through the mill prior to mill shutdown, and material in the re-muck pile will be hauled underground for disposal. These measures will reduce the amount of pollutants entering the runoff collection system in the 920 Area.

6. MAINTENANCE

6.1. Roads

Roads at the Greens Creek Mine area will be maintained during short- and long-term temporary shutdowns according to road use demand. Road best management practices, as discussed in the BMP plan, will be maintained as necessary. Roads will be graded to maintain proper drainage. Culverts and ditches will be maintained to assure good runoff from the road and nearby watersheds. Damage to roads, bridges, and culverts will be repaired as soon as possible after it is discovered. Road banks will be reseeded and revegetated as needed to minimize erosion. If erosion occurs, it will be repaired and revegetated as soon as possible.

6.2. Docks

The Hawk Inlet Marine Terminal docks and the Young Bay pedestrian dock will be maintained during a temporary shut down of any duration. Damage to docks will be repaired as soon as possible after it is discovered.

6.3. Buildings/Structures

All buildings and structures will be maintained during both short- and long-term temporary closures. Depending on use and need, some buildings may be closed for the duration of the shutdown and may not be heated. This will be decided at the time of the shutdown, based on the anticipated length of the shutdown and the use of the building. Unused and unheated buildings will be inspected at least monthly to check for damage or deterioration. Damage to buildings and structures will be repaired as soon as possible after it is discovered.

6.4. Underground Mine

The underground mine will be maintained as necessary to enable a prompt resumption of operations, or to allow backfill operations to proceed if it is decided to initiate permanent closure following an extended shutdown. It is possible that underground drilling/exploration activities will continue during a suspension of operations.

7. HAZARDOUS MATERIALS STORAGE

7.1. Fuels/Oil

Fuel consumption needs will be less during a shutdown. However, some buildings will need to remain heated. Fuel will also need to be available for on-site power generation and operation of mobile equipment. Therefore, fuel will continue to be stored at the mine during shutdowns in quantities consistent with fuel consumption needs. Unheated buildings will have their fuel tanks drained.

Bulk tanks, pipelines, and containment areas will continue to be inspected monthly as required by Title 40 CFR Part 112. Inspections are recorded on inspection log forms, signed by the inspector, and kept on-site for a period of three years.

Personnel will continue to be trained in the operation and maintenance of equipment to prevent the discharge of oil. A designated person-in-charge will be accountable for oil spill prevention. Reporting any spills to company management will continue to be the responsibility of any employee aware of a spill. If an oil spill occurs or is discovered during a temporary shutdown, Greens Creek will follow the

spill reporting and response procedures contained in GPO Appendix 6, Spill Prevention Control and Countermeasure Plan (SPCC). Damage to fuel storage tanks will be repaired as soon as possible after it is discovered.

An adequate inventory of spill response equipment and materials will be maintained at appropriate locations throughout the facility. HGCMC will also maintain an active membership with the Southeast Alaska Petroleum Resource Organization (SEAPRO).

7.2. Mill Chemicals/Reagents

In the event of a temporary shutdown, the continued storage of chemicals/reagents at the Greens Creek Mine will be assessed. Factors in determining whether to continue the storage of chemicals/reagents during a temporary shutdown include:

- Anticipated duration of the shutdown;
- Known or anticipated use of chemical/reagent during shutdown;
- Future use or need for the chemical/reagent;
- Hazards of chemical/reagent; and
- The shelf life of chemical/reagent.

These and any other relevant factors will be considered in deciding whether to store chemicals/reagents or to remove them during temporary shutdowns. Greens Creek will determine what chemicals/reagents and quantities need to remain in stock and what chemicals/reagents can reasonably be returned to vendors, sold to other mine operators, or disposed of, considering the anticipated length of the shutdown. In the case of a short-term shutdown, the chemical/reagent inventory will most likely be stored in place. Adequate containment will be provided for all stored chemicals.

An overview of hazardous or toxic substances presently used and stored at the Greens Creek Mine is provided in GPO Appendix 5, Best Management Practices Plan. If a spill of chemical/reagent occurs during a temporary shutdown, Greens Creek will follow the spill reporting and response procedures contained in GPO Appendix 6, SPCC, and also GPO Appendix 9, Facility Response Plan.

8. POND 7/10 MANAGEMENT

All collected surface water and groundwater will continue to be routed to Pond 7/10 for storage and subsequent treatment and discharge to Hawk Inlet under an APDES permit. During a suspension of operations, the volume of water requiring treatment and discharge will be substantially reduced. The operation of the water treatment plant will be optimized for efficiency based on the Pond 7/10 water balance and weather conditions. It is likely that during the summer months, the WTP would be able to operate in batch mode with periods of shutdown. Adequate freeboard will be maintained in Pond 7/10 to provide capacity for a 25-yr, 24-hr storm event. Installed instrumentation provides continuous recording of Pond 7/10 water level and inflow rates from the various pumping systems throughout the site.

Visual inspections of Pond 7/10 will continue on a weekly basis and following any significant seismic and precipitation events. More thorough monthly inspections will be performed following the Alaska Dam Safety Program Visual Inspection Checklist. Geotechnical surveys of the Pond 7/10 embankments will continue to be performed on a quarterly basis.

9. RECLAMATION

HGCMC will evaluate the feasibility of initiating or completing reclamation of certain facilities during a suspension period based on the impact on the mine plan assuming operations will resume. Potential areas where reclamation could commence would be inactive waste rock Site E, the 1.4 mile A-road sandpit, or possibly Site 23. Reclamation of any other facilities is likely not practicable until it is determined to initiate the final closure of the mine.

10. REVISION HISTORY

Date	Prepared By	Description
02/27/2020	Chris Wallace	With the issuance of the WMP 2020DB0001, I reviewed and revised appendix 15 to reflect current operations, though there were no substantive changes made.
3/23/2020	Chris Wallace	Made a few modifications to include the Forest Sevice in approvals and that road BMPs will be maintained as necessary.
4/21/2020	Chris Wallace	I made a couple of clarifications at the request of the ADEC. No substantive changes made.
5/20/2020	Chris Wallace	Updated the format of the document.