Integrated Waste Management Plan

Red Dog Mine, Alaska, USA

Prepared By

Teck Alaska Incorporated

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Executive Summary

This Integrated Waste Management Plan (IWMP) describes procedures for managing multiple types of wastes including mill tailings and waste rock, solid waste and hazardous material generated at the Red Dog Mine. This IWMP also includes procedures for reusing and recycling materials wherever possible, which is a priority of Teck Alaska, Inc.'s (TAK) Red Dog Mine.

Decisions that affect the generation of solid wastes are made with consideration to the following order of priorities:

1. Waste source reduction
2. Recycling of materials (including reuse)
3. Waste treatment
4. Waste disposal

Appropriate management begins at the procurement stage, before TAK purchases materials, with a review of Safety Data Sheets (SDS) for new material proposed for use at the mine. 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 purpose. This is to ensure protection of the workers handling these materials and 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, providing appropriate secondary containment for hazardous materials to prevent releases and the associated generation of waste materials and spill residues, and the reuse and/or recycling of materials whenever possible. Materials that can be recycled include mill liners, antifreeze, batteries, lamps, tires, cardboard, wood, scrap metal, electronics and used oil.

A Class III (camp) municipal solid waste landfill is permitted at the mine site and located within the Main Waste Dump (MWD). Section 2.1.10 describes the wastes approved for onsite disposal in the landfill.

TAK characterize wastes to determine their appropriate management method. Non-liquid, non-hazardous wastes that cannot be recycled are disposed of at the onsite inert landfill (18 AAC 60.460). Liquids, hazardous wastes, and other materials that cannot be managed onsite are shipped off-site for recycling or disposal; this includes solvents, lamps, batteries, liquid paints, tires and assay lab waste, expired chemicals, and waste that cannot be landfilled onsite.

Water resources and reclamation/closure management information for the onsite solid waste facilities (i.e., Tailing Storage Facility, Waste Rock Dumps, etc.) is provided in Appendix B *Red Dog Mine Tailings and TSF Water Management Plan*, Appendix C *Red Dog Mine Waste Rock Management Plan*, and in the *Red Dog Mine Reclamation and Closure Plan* .

The environmental monitoring plan that incorporates monitoring of all solid waste facilities for the Red Dog Mine during operation and post-closure is in Appendix D *Red Dog Mine Monitoring Plan*.

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List of Abbreviations

AAC	Alaska Administrative Code
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 Pollutant Discharge Elimination System
AS	Alaska Statute
CERCLA	Comprehensive Environmental Responsibility and Compensation Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DMTS	DeLong Mountain Regional Transportation System
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
HAZWOPER	Hazardous Hazardouse Waste Operations and Emergency Response
IAEA	International Atomic Energy Agency
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IMDG	International Maritime Dangerous Goods Code
IWMP	Integrated Waste Management Plan
LEPC	Local Emergency Planning Committee
LDR	Land Disposal Restriction
LQG	large quantity generatorMSHA
MSHA	Mine Safety and Health Administration
MSWLF	Municipal Solid Waste Landfills
NANA	NANA Regional Corporation, Inc.
NRC	National Response Center
NAB	Northwest Artic Borough
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
RCRA	Resource Conservation and Recovery Act
RQ	reportable quantity
SOP	Standard Operating Procedures
SDS	Safety Data Sheets
SQG	small quantity generator
TAK	Teck Alaska Incorporated
TDG	Transport Canada's Transportation of Dangerous Goods
TSCA	Toxic Substances Control Act
TSDF	Treatment Storage and Disposal Facility
TSF	Tailings Storage Facility
USCG	United States Coast Guard
USDOT	United States Department of Transportation
USFWS	United States Fish and Wildlife Service
WIS	Waste Information System (Red Dog exclusive waste database)

MWD Main Waste Dump

Units of Measure

°C	degrees Celsius
°F	degrees Fahrenheit
g	gallon
kg	kilogram
lb	pound
L	liter
mL	milliliter
ppm	parts per million

1 Introduction

1.1 Purpose

This Integrated Waste Management Plan (IWMP) describes the required procedures for managing solid wastes[1] and hazardous materials (wastes) generated at the Red Dog Mine facilities. The IWMP also includes procedures for reusing and recycling materials wherever possible, which is a priority of the Red Dog Mine.

This IWMP also includes the following management plans:

- Appendix B - *Tailings and TSF Water Management Plan*
- Appendix C - *Waste Rock Management Plan*
- Appendix D - *Monitoring Plan*

The environmental monitoring program for the Red Dog Mine, which is associated with this IWMP, includes monitoring of surface water, groundwater, seepage, and wildlife, as described in the *Red Dog Mine Monitoring Plan*.

1.1 Project Description

Teck Alaska Incorporated's (TAK) Red Dog Mine is in northwestern Alaska, approximately 82 miles north of Kotzebue, and 46 miles inland from the coast of the Chukchi Sea (Figure 1). The mine is located on the Middle Fork of Red Dog Creek in the DeLong Mountains of the western Brooks Range, on private land owned by NANA Regional Corporation, Inc. (NANA). Some of the support facilities are on both State of Alaska and NANA lands. Red Dog Mine is a joint venture between NANA and TAK, whereby TAK is the mine operator and NANA is the landowner.

Figure 1 shows the location of the Red Dog Mine. Figure 2 shows the boundary of the area considered in this plan. The boundary is the limits of the Waste Management Permit #2021DB0001and coincides with the boundary of the Air Quality Permit #AQ0290TVP02. The boundary encompasses all the areas that are likely to be directly impacted by operations at the site (Appendix A).

The operation consists of an open pit zinc/lead mine, mill, and support facilities. Construction of the mill began in 1988, with the first ore delivered to the mill in November 1989. Conventional drill and blast mining methods are employed. The mineral processing facilities use conventional grinding and sulfide flotation methods to produce zinc and lead concentrates. The concentrates are shipped to markets in North America, Europe, and Asia from the DeLong Mountain Regional Transportation System (DMTS) port facility located on the Chukchi Sea. Access to the Port is via the 52-mile DMTS haul road, owned by the Alaska Industrial Development and Export Authority.

The ore deposits are massive sulfide zinc-lead-silver deposits. The ore and host rocks contain high concentrations of sulfide minerals, and most of the waste rock is acid generating, potentially acid generating, or has potential for metal leaching. Additional information on waste rock management

[1] 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.

is in Appendix C. Water from the mine operations area, e.g., open pit, ore stockpiles, and waste rock dumps is pre-treated where possible and stored in the tailings storage facility (TSF). During the open water season (May to October), water from the TSF is treated and discharged to the Middle Fork of Red Dog Creek. Further information on water management is provided in Appendix B.

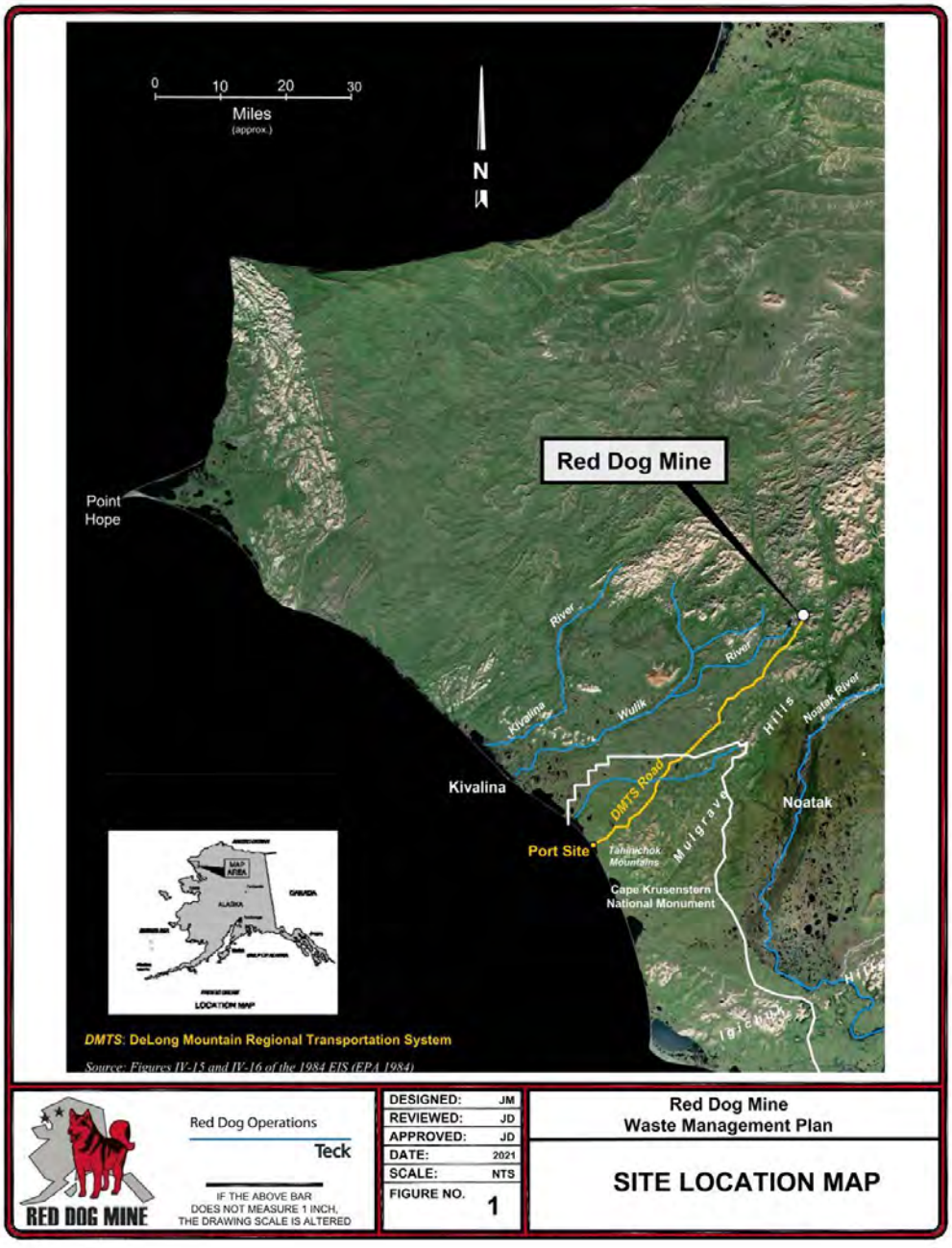

Figure 1: Site Location Map

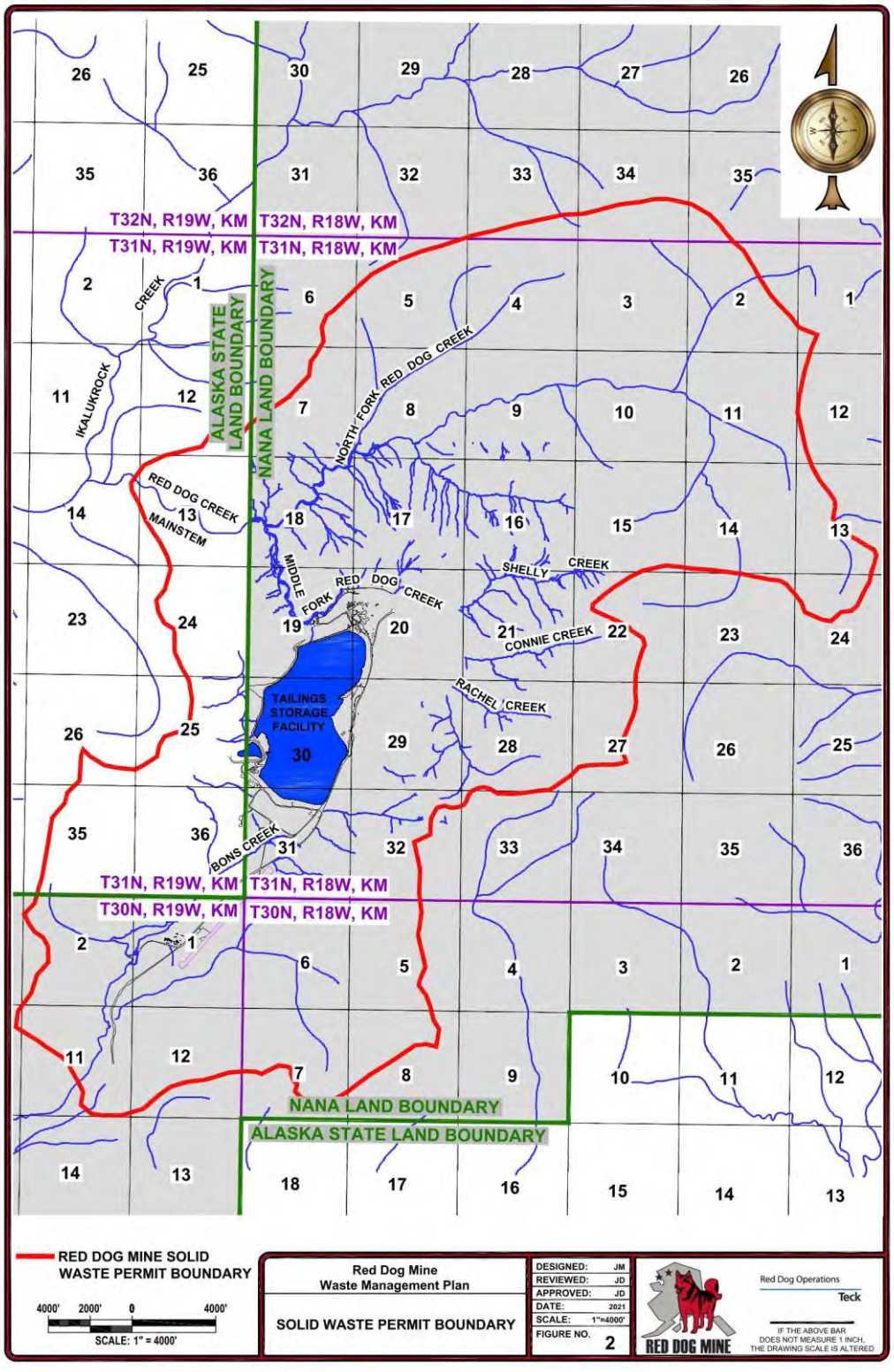

Figure 2: Solid Waste Permit Boundary

2 Waste Management Requirements

The following sections provide an overview of the regulatory requirements applicable to the management of solid wastes and the management procedures that are employed at the Red Dog Mine to handle wastes safely and in accordance with all applicable regulations. Key waste management facilities include solid Class III municipal solid waste landfill (located within the Main Waste Dump), the TSF and Waste Rock Dumps (WRD) as illustrated in Figure 3.

Management of wastes at the Red Dog Mine begins before the materials are purchased by evaluating the potential environmental impacts of materials being considered for the project. In general, the Red Dog Mine minimizes the overall generation of waste to the extent practical and minimizes the use of materials regulated as hazardous wastes when they no longer serve their intended purpose. Waste materials are reused and recycled whenever possible. A permitted solid waste landfill is located onsite for the disposal of approved wastes. The Waste Management Permit (2021DB0001) provides a description of allowable waste types that can be disposed of in the landfill and lists other operating and monitoring parameters required by the permit.

Waste materials that cannot be managed onsite, such as liquid wastes, hazardous wastes, certain items to be recycled or reused, and wastes prohibited from disposal in the landfills, are shipped off-site for reuse, recycle, treatment, or disposal at appropriate facilities.

2.1 Regulatory Review

Solid wastes are managed in the State of Alaska under two separate bodies of law:

- The Resource Conservation and Recovery Act (RCRA) federal regulations contained in Title 40 Code of Federal Regulations (CFR), Parts 260 to 279.
- The State of Alaska regulations contained in 18 AAC 60, Solid Waste Management.

Hazardous wastes are regulated by the U.S. Environmental Protection Agency (EPA), Region 10 in Alaska, in accordance with RCRA regulations. Alaska does not have the authority to administer hazardous waste regulations and, therefore, defers to federal regulations. Non-hazardous solid wastes, tailings, and waste rock are mainly managed under the state regulations in 18 AAC 60, which authorize Class III (camp) municipal solid waste landfills.

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 the solid waste is a *hazardous waste* or not as defined in Section 2.1.2. Waste determinations are discussed in Section 2.10. Once a waste determination has been made, the appropriate management method for the waste can be identified.

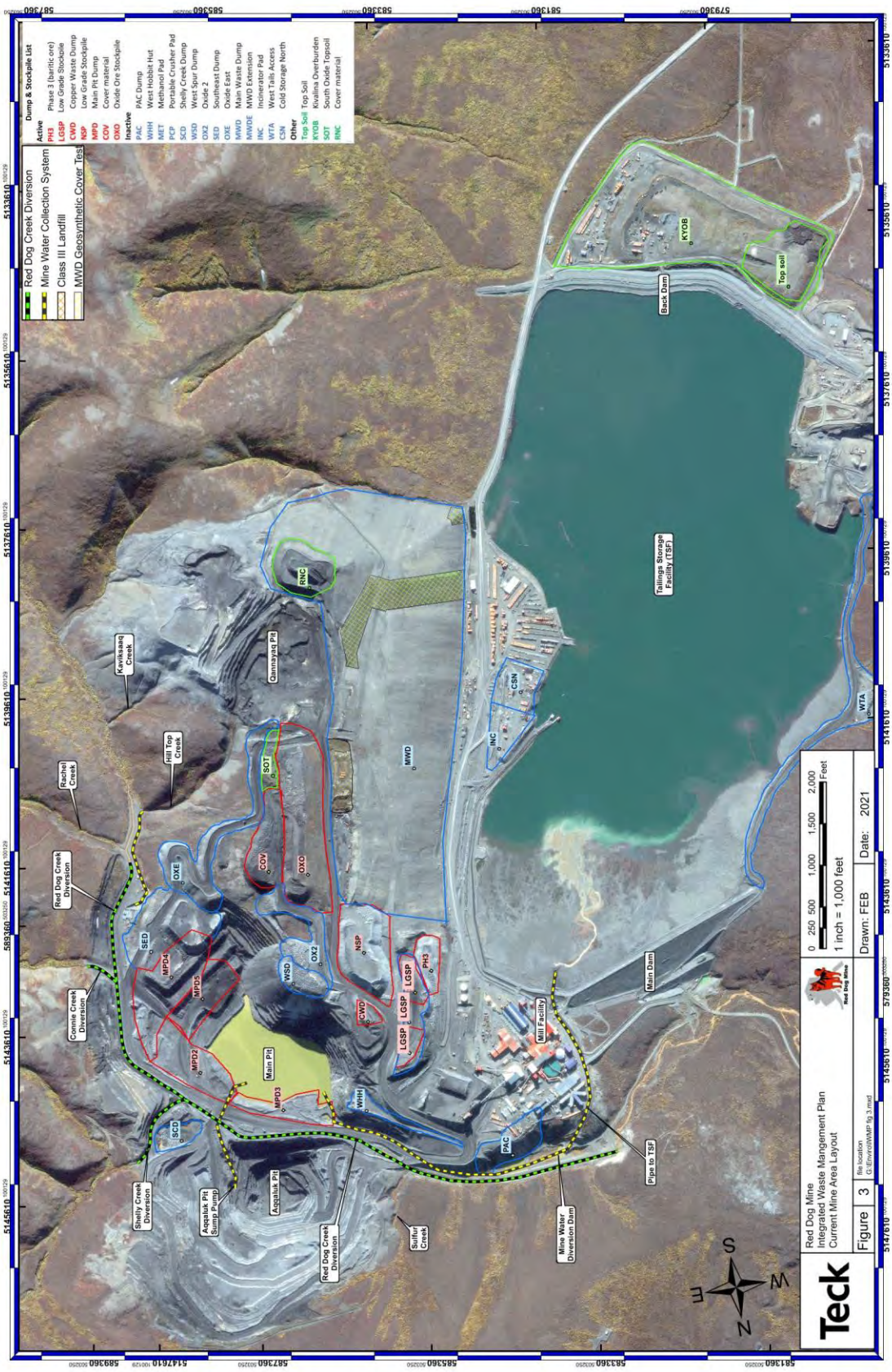

Figure 3: Current Mine Area Layout

2.1.1 Definition of Solid Waste

The EPA definition of solid waste found in 40 CFR §261.2. A solid waste is any material, liquid or solid, except for materials excluded from the regulations that are a discarded ***material***, meaning a material that is:

- Abandoned:
  - disposed of or
  - burned or incinerated or
  - accumulated, stored, or treated (but not recycled) before, or in lieu of, being abandoned by disposal, burned, or incinerated.
- Recycled or accumulated, stored, or treated before recycling if it is:
  - used in a manner constituting disposal,
  - burned for energy recovery,
  - reclaimed,
  - accumulated speculatively,
- Considered inherently waste-like; or
- A military munition identified as a solid waste in 40 CFR §266.202.

There are several exclusions to the definition of solid waste, 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).

2.1.2 Definition of Hazardous Waste

As defined in 40 CFR §261.3, a solid waste is ***hazardous*** if:

- It is not *excluded* from regulation as a hazardous waste under 40 CFR §261.4(b).
- It is a *characteristic hazardous* waste, i.e., it exhibits one of the characteristics of hazardous waste defined in Subpart C of 40 CFR §261:
  - ignitability
  - corrosivity
  - reactivity
  - toxicity
- It is a *listed hazardous waste,* i.e., a waste listed in Subpart D of 40 CFR §261 and has not been excluded in 40 CFR §260.20 or 260.22.
- It is a *mixture* of solid waste and one or more listed hazardous wastes, and it has not been excluded from regulation as a hazardous waste by an exemption to the regulations.

- *Rebuttable presumption for used oil*, i.e., used oil containing more than 1,000 parts per million (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 that are exempt from hazardous waste regulations are listed under 40 CFR §261.4(b). Additionally, several exemptions are also listed in 40 CFR §261.3, which defines a hazardous waste. Some of the important exemptions that apply to the Red Dog Mine include:

- Household waste (e.g., products used for personal use at Personnel Accommodation Complex (PAC)).
- Mining overburden returned to the mine site.
- Solid wastes from the extraction, beneficiation, and processing of ores and minerals, also known as the Bevill Exclusion[2].
- Non-terne-plated used oil filters that are not mixed with a "listed hazardous waste" and have been gravity hot-drained.
- Exemptions for mixtures that 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.

2.2 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 Red Dog Mine consider the following options, in order of priority:

1. Waste source reduction
2. Recycling (includes reuse)
3. Waste treatment
4. Waste disposal, in accordance with applicable law

To accomplish this, the following procedures are followed:

- Operations that generate wastes are periodically reviewed to identify opportunities for waste reduction 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 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.

[2] The "Bevill Exclusion" or "Bevill Exemption" is an amendment to the RCRA, which provides that "mining and mineral processing wastes generated by extraction, beneficiation, and processing activities" are exempt from regulation as hazardous wastes.

- Non-hazardous solid wastes that are permitted for disposal onsite are disposed of at onsite, permitted, solid waste inert landfills, regulated by the ADEC, in accordance with 18 AAC 60.
- Materials that cannot be managed on site are sent off-site to appropriate facilities for recycling, reuse, treatment, and/or disposal.

2.3 Purchasing of Materials

The following procedures are followed when purchasing materials:

- Whenever possible, the Red Dog Mine reduces the generation of hazardous wastes by avoiding the purchase of materials that will be regulated as hazardous wastes once 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 are reviewed prior to purchasing 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).
- For materials requiring special handling or those classified as a hazardous waste if disposed of, the Red Dog Mine evaluates the material to determine if a suitable substitute is available that is considered “less hazardous.” Less hazardous can include a waste not classified as a hazardous waste if disposed of, requires no special handling under the above-noted governing acts, generates less waste when disposed of, 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).

2.4 Waste Minimization

Efforts to minimize waste begin at the purchasing phase and continue to the recycling and reuse materials such as:

- Use primarily low-toxicity solvents in parts washers wherever possible:
- Use low-mercury, fluorescent lamps (“green end cap”) or LED lights where possible.
- Recycle or reuse of materials such as antifreeze, batteries, and reusable light vehicle tires, scrap metal, and used oil, as discussed in Section 2.5 below.
- Return containers to vendors or recycle 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:
- Prevention of mixing of hazardous wastes with non-hazardous wastes through waste segregation, established procedures, and personnel training.

2.5 Recycling and Reuse of Materials

Red Dog Mine fully recycles materials whenever practical. Due to the logistics of shipping recycled materials from the mine site by air or barge and the costs associated with recycling materials, the Red Dog Mine evaluates the cost/benefit of their recycling program on a regular basis. Recycling opportunities are based on the need for recycled materials, vendors available to handle recycled materials, costs, economic factors, etc. The Red Dog Mine adjusts its recycling practices to respond to these changes.

2.6 Waste Segregation

Waste management includes appropriate segregation and management of wastes in accordance with applicable regulations and the specific waste handling procedures listed below:

- Wastes destined for the incinerator are placed in incinerator dumpsters. These dumpsters are kept closed to prevent attraction of wildlife.
- Household and approved solid wastes destined for the landfill are either taken directly to a landfill or placed in landfill dumpsters.
- Dumpsters are marked in a manner such that personnel can distinguish between incinerators and landfill dumpsters.
- Hazardous wastes are placed in containers at Satellite Accumulation Areas or placed in containers, appropriately labeled, and then brought directly to a primary Hazardous Waste Central Accumulation Area.
- Universal Wastes are placed in containers at Universal Waste Accumulation Areas according to the procedures outlined in Section 2.11.
- Materials to be recycled are placed in segregated containers designated for the specific type of material and managed as outlined in Section 2.5.
- All containers are appropriately labeled and managed as described in Section 2.7 below.

2.7 Waste Container Management

Waste containers are managed in accordance with all applicable regulations as follows:

- All waste containers are appropriately labeled according to the, Mine Safety & Health Administration (MSHA) hazard communication standards (or EPA regulations.
- Hazardous wastes containers are labeled according to the requirements of RCRA.
- Waste containers of used oil are labeled with the words “Used Oil”.
- Used oils are stored within appropriate secondary containment systems.
- Waste containers are kept closed except when adding or removing materials.
- Waste container inspections are conducted as required by the regulations and as needed to manage containers appropriately.
- Appropriate firefighting and/or spill response equipment are available as required.

- The applicable training, inspection, reporting, preparedness, spill prevention, contingency planning, and emergency procedures required by RCRA and ADEC Division of Spill Prevention and Response is implemented.

2.7.1 Procedures for Emptying Containers

An empty container is considered 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 §261.7 (b) ((3)], such as cyanide, 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 equipped with an inner liner that prevented contact of the commercial chemical product with the container when the inner liner 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 of residue remains 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.
4. Containers that have been appropriately emptied and returned for reuse would be indicated by applying a label or tag, marking the container Empty or MT or placed in an area where signage indicated containers are empty.
5. All plugs or caps are replaced to seal inlets/outlets if the container is to be reused onsite or sent offsite for reuse.
6. Marking, labeling, or placarding required by the U.S. Department of Transportation's (USDOT) hazardous materials regulations are removed or crossed out if the container is to be sent offsite for reuse.

2.8 Onsite Waste Management

Solid waste management facilities include inert solid waste landfills, the TSF, and waste rock dumps. These key waste management areas are regulated by ADEC under a waste management permit (2021DB0001) and are discussed in the following sections.

2.8.1 Class III (Camp) Municipal Solid Waste Landfill

A Class III (camp) municipal solid waste landfill is located at the mine site for the disposal of inert, non-hazardous, household, or other approved solid wastes. The Class III (camp) municipal landfill is permitted by the ADEC in accordance with 18 AAC 60.300(c)(3)(A).

In general, the Class III (camp) municipal landfill is designed and operated to keep runoff from outside the landfill area separate from the solid wastes, and in such a way as to prevent the attraction of wildlife. Wastes are stored in suitable containers prior to incineration or transfer to the landfill. Windblown litter and littered refuse from the areas around the landfill are collected and returned to the landfill. Visual monitoring is conducted within the landfill to verify compliance with the provisions of the Red Dog Mine Monitoring Plan which serve to satisfy the provisions of 18 AAC 60. The location and volume of waste placed in the Class III (camp) municipal landfill are surveyed and reported annually.

General mine refuse (e.g., wooden packaging, pallets, non-recyclable empty containers, non-putrescible refuse, household, office wastes, etc.) are placed directly into the mine Class III (camp) municipal solid waste landfill. All putrescible materials are incinerated and remaining bottom ash is disposed of in the landfill.

At least annually or when there is a change in the incinerator waste stream, a composite sample of bottom ash must be collected and analyzed it for metals using the Toxicity Characteristic Leaching Procedure. A composite sample consists of ash collected over a three-week period including ash from the incineration of typical quantities of sewage sludge.

Unusable, small vehicle tires that cannot be returned to the vendor may be disposed of in the landfill, though most are collected and shipped offsite. Some large loader and truck tires are utilized in the mine as a barricade wall placed to provide barricades or wall supports.

The mine operates the landfill in accordance with current conditions outlined in the Waste Management Permit 2021DB0001 listed within Section 2.2.

2.8.2 Monitoring

The environmental monitoring program for the Red Dog Mine is described in Appendix D, *Red Dog Mine Monitoring Plan*. This includes monitoring and characterization of surface water, groundwater, tailings, waste rock, seepage, and wildlife observation, in addition to visual monitoring of facilities. In addition, the mine has increased operator awareness training and monitoring of oil-containing equipment, including visual inspections, as part of preventive maintenance with the objective of reducing spills that result from equipment (i.e., hose) failures.

2.8.3 Reporting and Record Keeping

Regular reporting, as required by the ADEC Integrated Waste Management Permit, is provided on waste management activities and results of environmental monitoring. An operating record is maintained onsite, as specified in 18 AAC 60.

The Red Dog Mine's Waste Information System (WIS) is a web-based system that allows Red Dog Mine employees to identify and manage wastes efficiently in compliance with government regulations, Red Dog Mine policies, and this IWMP. WIS provides identification of different waste types, one-page guidelines, Standard Operating Procedures (SOP) including disposal method, and forms/checklists necessary to accurately maintain records and meet reporting requirements.

2.9 Waste Materials Managed Offsite

In addition to liquid wastes and hazardous wastes, certain materials (wastes) are shipped offsite for recycling or disposal, including some of the recyclable materials listed in Section 2.5. These materials are segregated, as described in Section 2.6 and ultimately delivered to the mine site warehouse for processing as described below.

- All waste 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 identification number and entered into an inventory.
- Material characterization testing is conducted if required.
- The material is placed in an appropriate accumulation area (e.g., hazardous waste accumulation area).
  - 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 hazardous wastes are shipped to appropriate facilities (e.g., Treatment Storage and Disposal Facility [TSDF]).

All materials are shipped in accordance with the applicable regulations.

2.10 Hazardous Waste Management

2.10.1 Hazard Waste Determinations

As required by 40 CFR §262.11, hazardous waste determinations are made on all solid wastes generated. Determinations are made by reviewing the regulations, and, if required, testing the waste, or applying generator knowledge.

2.10.2 Hazard Waste Accumulation

The following procedures are followed while hazardous wastes are accumulated:

- In general, hazardous waste is 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.
- Hazardous wastes not accumulated in a satellite accumulation area, such as wastes generated infrequently, are delivered to the 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 2.7 and managed according to the applicable regulations.

2.10.3 Satellite Accumulation Areas

Up to 55 gallons of hazardous waste, or 1 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. Containers are to be kept always closed (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 and the hazard class. 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 would then be transferred to a central hazardous waste accumulation area within three days of becoming full.

2.10.4 Shipments of Hazardous Waste

Hazardous wastes are shipped offsite to appropriate facilities in accordance with the applicable requirements of USDOT. Additional requirements may apply depending on the mode of shipment, as mandated by the ICAO, IATA, or IMDG code. Shipments will be accompanied by a hazardous waste manifest and the appropriate land disposal restriction (LDR) notification and certification forms where applicable.

2.11 Universal Waste Management

The universal waste regulations (40 CFR §273) are streamlined hazardous waste management regulations that can be applied to the management of 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 generated at the Red Dog Mine include batteries, mercury-containing equipment, and lamps.

Universal waste is managed in accordance with the regulations at 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 the universal wastes are accumulated from the date it became a waste or was received.

Universal waste is sent offsite to a permitted destination facility[3], or a foreign destination (consistent with the export requirements of 40 CFR §273) within one year of the accumulation start date. Universal wastes meeting the definition of a hazardous material under the USDOT regulations are

[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).

packaged, labeled, marked, and placarded, and appropriate shipping papers are prepared according to the applicable USDOT regulations under 49 CFR Parts 171 through 180.

2.12 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.

Used oil generated at the Red Dog Mine, which meets the requirements to be regulated as used oil, is burned for energy recovery or shipped offsite for recycling. Used oil that must be regulated as hazardous waste is shipped offsite to an appropriate facility for proper handling and disposal.

The general requirements for managing used oil include:

- Maintaining records of used oil burned onsite and shipped offsite 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 applicable regulations (40 CFR §112, 40 CFR §279 Subpart D, and 18 AAC 75).

2.13 Employee Training

Red Dog Mine trains its employees in the appropriate management of mine wastes as required by MSHA, RCRA, and/or USDOT based on the duties of the employees.

In addition, the mine has increased operator awareness training and monitoring of oil-containing equipment, including visual inspections, as part of preventive maintenance with the objective of reducing spills that result from equipment (i.e., hose) failures.

Records of training are maintained on file according to the applicable regulations.

2.14 Inventory of Waste Materials

Inventories of all hazardous materials used and stored at the site are maintained with warehouse records. Inventories of the locations of hazardous waste, universal waste, and satellite accumulation areas are maintained in WIS.

2.15 Safety Data Sheets

A list of SDS for each hazardous material is maintained onsite, kept up-to-date, and made readily available to employees and contractors employed at the Red Dog Mine.

2.16 Inspections

Inspections of certain waste materials are conducted as required to verify waste materials are handled appropriately, in compliance with all applicable regulations, and in accordance with the inspection requirements of applicable permits and/or plans.

In addition, the mine has increased operator awareness training and monitoring of oil-containing equipment, including visual inspections, as part of preventive maintenance with the objective of reducing spills that result from equipment (i.e. hose) failures.

3 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 Red Dog Mine. Adherence to these methods by employees and contractors is essential to operate in compliance with all applicable regulations and permits and to protect the safety of employees, contractors, and the environment.

This IWMP is kept updated as needed, e.g., as new waste streams are added, procedures or processes are changed, or in response to modifications to the applicable regulations.

3.1 Absorbents

Absorbents, including absorbent pads, socks and booms; absorbent granules; 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 incinerated onsite or disposed of offsite. Any collected free liquid is managed as used oil.
- Absorbents managed as hazardous waste are those contaminated with a material classified as hazardous waste if disposed of and are shipped offsite to an appropriate facility (e.g., TSDF).
- Absorbents managed as non-hazardous waste are those contaminated with a material classified as a non-hazardous waste if disposed of. These absorbents are either incinerated onsite or shipped off site for disposal.

3.2 Antifreeze/Coolant

Ethylene glycol and propylene glycol are commonly referred to as antifreeze or coolants. Ethylene glycol is typically used as a coolant in equipment such as vehicles and generators. Ethylene glycol and propylene glycol are commonly referred to as antifreeze or coolants. Ethylene glycol is typically used as a coolant in equipment such as vehicles and generators. Propylene glycol is commonly used in liquid cooling systems such as heat exchangers. Propylene glycol can be used as de-icing fluid for airplanes.

Used glycol may be recycled onsite or sent offsite for treatment, disposal or recycling.

3.3 Asbestos and Lead Based Paint

If over the course of the mine life, facilities constructed off site are relocated to the project, the presence of asbestos or lead-based paint would be determined prior to any demolition or renovation activities. If asbestos or lead-based paint are present, certified, and trained asbestos and lead paint abatement contractors would be used for any required removal and disposal activities.

Asbestos removal and disposal will comply with 40 CFR §61, Subpart M. Any asbestos containing material purchased and brought to site will be documented and tracked.

3.4 Batteries

Batteries used onsite may include alkaline, lithium, nickel cadmium, nickel metal hydride, and lead acid batteries. *Non-hazardous waste* batteries are shipped offsite for recycling or landfilled onsite. Batteries that exhibit a toxic characteristic managed as *Universal Waste* and shipped offsite for recycling. Lead-acid batteries are shipped offsite for reclamation.

3.5 Building Construction and Demolition Materials

Construction refuse from initial or subsequent facility construction is assessed and appropriately managed for onsite disposal, offsite shipment for disposal, or recycling.

A complete survey of any building or structure to be demolished will be 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 material will be managed as described in Section 3.3.

3.6 Camp Waste

Camps waste may be broken down into two separate categories, household[4] and food related wastes. Household wastes are generated from employees and contractors at the mine site camp facilities, and office areas. Household waste is incinerated; ash is placed in the landfill. Food waste from the camp facilities is segregated from household wastes. Cafeteria, kitchen, and other food related waste is incinerated onsite. All camp wastes are managed to prevent putrescible wastes from being placed in the onsite landfills and becoming an attractant to wildlife.

3.6.1 Sewage Sludge

Domestic sewage from the mine facilities undergoes primary treatment, which removes solids, and the effluent is pumped to the TSF. Solids are dewatered prior to incineration and the ash from the incinerator is then disposed of in the landfill.

[4] Household waste definition: from 18 AAC 60.990 (66) "household waste" means solid waste; “household waste” includes garbage, trash, and sanitary waste in septic tanks, derived from a household; for the purposes of this paragraph, “household” includes single and multiple residences, hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas;

3.7 Chemical Reagents

Any spilled or expired chemicals, reagents or wastes are managed on a case-by-case basis and according to both federal and state waste regulations.

3.8 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 2.7.1.

3.9 Empty Drums

Drums that contained acutely hazardous waste are emptied according to provisions identified in Section 2.7.1, which requires triple rinsing.

3.10 Compressed Gas Cylinders

Compressed gas cylinders include those containing oxygen, acetylene, propane, ether, carbon dioxide, argon, and nitrogen. Most large cylinders are returned to the vendor and refilled. Large propane cylinders are refilled onsite whenever possible.

Cylinders are segregated by type and are managed according to safe handling procedures for compressed gas cylinders, which include ensuring they are stored in a secured upright position in a dry, cool, well-ventilated, secure area, protected from the weather, away from combustible materials.

Smaller disposable cylinders such as those containing ether, propane, or calibration gases, with the valve inside the top fitting, are depressurized through use; valve stems are then removed, and the cylinders are then recycled as scrap steel or landfilled.

3.10.1 Aerosol Cans

All aerosol cans are punctured and drained using aerosol can puncturing units.

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. The punctured and drained aerosol cans are considered *non-hazardous waste* and either landfilled or recycled as scrap metal.

Residues and filters from puncturing aerosol cans are tested to determine if they are hazardous waste. Typically, these wastes must be managed as *hazardous wastes* and are shipped to an appropriate facility.

3.11 Contaminated Soil

The following sections describe procedures for handling specific types of contaminated soil.

3.11.1 Petroleum-Contaminated Soil

Petroleum-contaminated soil is managed onsite and is considered a *non-hazardous waste.*

3.11.2 Caustic / Acid Spills Outside the Mill and Secondary Containment

Where required, caustic and acid spills are neutralized onsite and managed as *non-hazardous waste* either in-situ or by removing the contaminated soil and subsequently neutralizing[5] the material.

3.12 Filters

There are a number of filters used onsite, including those from vehicles, buildings, baghouses, glycol recycling units, aerosol can puncture devices, assay lab, refinery, etc. In general, filters classified as non-hazardous waste are landfilled or incinerated. Filters classified as hazardous waste are shipped offsite for recycling.

The following sections describe procedures for managing filters collected throughout the facilities:

- Filters from glycol recycling units would likely be non-hazardous waste, in which case, they are incinerated or landfilled onsite.
- Filters from aerosol can puncturing units are typically hazardous waste and are managed as described in Section 3.10.1.
- Most of the filters from vehicles, equipment, and buildings onsite are non-hazardous waste and are sent offsite for recycling or disposed of in the onsite landfill. Hazardous waste filters are shipped off-site to an appropriate facility.
- Used oil filters include oil filters from vehicles or equipment and fuel filters from diesel equipment:
  - Used oil filters are considered exempt from hazardous waste regulations if they are gravity hot-drained according to one of the methods described below and if they are non-terne-plated:
    - Puncturing the filter anti-drain back valve or the filter dome end and hot-draining (EPA recommends minimum hot-drain time of 12 hours).
    - hot-draining and crushing
    - dismantling and hot-draining

3.12.1 Food Waste (Putrescibles)

- To prevent attraction of wildlife, food waste is incinerated onsite and not disposed of in onsite landfills. Inert ash from incineration is placed in the onsite landfill.
- Food wastes are placed in trash cans designated for food waste in the cafeteria and break rooms. All trash bags containing putrescibles are placed in an incinerator dumpster. Incinerator dumpsters are kept closed to prevent the attraction of wildlife.

[5] 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)

3.13 Lab Waste

- Hazardous wastes generated in the assay laboratory are shipped off-site for disposal or recycled in the appropriate facility. Other non-hazardous wastes are landfilled.
- Assay lab acid or base solutions are neutralized[6] and pumped into the process plant.
- Laboratory sample preparation wastes are returned to the process plant to recover any valuable minerals.
- Personal 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 is landfilled onsite.

3.14 Light Bulbs/Lamps

Many used bulbs are considered hazardous waste when disposed of and the bulbs can be managed as *universal waste,* if intact (EPA 2006a). Red Dog Mine looks for off-site facilities that recycle bulbs whenever possible. Bulbs classified as hazardous waste that are intentionally broken or crushed must be managed as *hazardous waste*.

3.14.1 Non-Hazardous Lamps

Environmentally friendly, low-mercury, fluorescent lamps (“green end cap”) and light-emitting diodes (LED) are currently available and classified as *non-hazardous waste* when disposed. Red Dog Mine purchases environmentally friendly fluorescent bulbs whenever possible. Halogen lamps are also typically *non-hazardous waste.* Most *n*on-hazardous lamps are sent offsite for recycling; minor amounts may be landfilled onsite.

3.15 Lubricants/Petroleum Products

3.15.1 Brake Fluid

Brake fluid is managed as used oil and burned for energy recovery or shipped offsite for recycling.

3.15.2 Grease

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 in the onsite landfill. Grease-contaminated trash is disposed of at the onsite landfill or incinerated once any excess grease has been removed.

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 Leaching Procedure (TCLP), EPA test Method 1311 in “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,” EPA Publication SW-846.

3.15.3 Used Oil

Used oil generated that meets the applicable RCRA regulatory requirements is burned in space heaters and process boilers to recover energy (Section 2.12addresses use for oil management requirements). Used oil that cannot be used on site is shipped to an offsite facility for recycling.

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 off site are logged.

3.16 Miscellaneous Materials

- Styrofoam packaging and products are landfilled onsite. Styrofoam peanuts and other small pieces are placed in boxes or bags prior to disposal to maintain confinement to the landfill or dumpster. Fiberglass insulation and plastic materials are placed in the onsite landfill. Hoses are drained to the extent they would not drip any previous contents and landfilled onsite. Rubber products are placed in the onsite landfill, unless contaminated with product. Contaminated rubber is evaluated, a waste determination is made, and the material is handled accordingly.
- Draeger test tubes may be *non-hazardous waste* or *hazardous waste* depending on the type. *Non-hazardous waste* tubes are landfilled onsite. *Hazardous waste* tubes are shipped offsite to an appropriate facility. The manufacturer provides a letter with general comments on disposal requirements (based on chemical reactants).

3.17 Oily Waste

Oil- or grease-contaminated rags, pads, gloves, or absorbents are considered non-hazardous used oil. Once the free-flowing used oil has been removed from these materials, they are not considered used oil and are managed as solid waste if they do not exhibit a hazardous waste characteristic. These wastes may be combusted onsite, laundered, and reused onsite, or may be sent offsite for disposal or recycling. Any collected liquid is managed as used oil.

3.18 Paints and Paint Thinner

- Any unused water-based, latex, or acrylic paint in solid form or related painting materials (e.g., rags, brushes, rollers), are *non-hazardous waste* and are landfilled onsite; unused paint in liquid form is shipped offsite.
- Oil-based paints in solid form[8], or related painting materials, are considered *non-hazardous waste* and are landfilled onsite; unused paint in liquid form may be *hazardous waste* and are characterized and managed appropriately.
- Thinners and solvent-based or lead-based paint in liquid or solid form, or related painting materials, may be *hazardous waste* and are characterized and managed appropriately.

[8] Purposely leaving paint containers that contain hazardous waste paints open to dry to render them non-hazardous is not permitted.

3.19 Radioactive Materials

Radioactive materials used onsite include level gauges, scales, analysis equipment and exit signs containing cesium and tritium. These materials are handled by the Radiation Safety Officer according to the applicable regulations of:

- The U.S. Nuclear Regulatory Commission, which regulates the use of source, by-product, and special nuclear material under the authority of the U.S. Atomic Energy Act (10 CFR Parts 1 to 171).
- The USDOT regulations, which establish criteria for the safe transport of radioactive materials in the United States (49 CFR Parts 171 to 178).
- The EPA, which regulates the disposal of low-level radioactive material mixed with hazardous waste (40 CFR §261).

3.20 Rags

Rags are washed and reused whenever possible. 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 incinerated or washed onsite. 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. These rags are shipped offsite to an appropriate facility.
  - Rags managed as non-hazardous waste are those contaminated with a material that is not a hazardous waste if disposed. Excess liquid is removed from these rags, and they are incinerated, washed onsite, or disposed. Any collected liquid is managed according to the procedures described in this IWMP for the liquid.

3.21 Scrap Metal

Scrap metal includes building materials, empty drums, welding rod, compressed gas cylinders, grinding ball chips, mill liners, crusher liners, and copper wire. To the extent practical, scrap metals are recycled. Scrap metal that cannot be recycled is disposed of in the landfill.

3.22 Solvents

Eco-friendly, non-toxic, “Green” solvents are primarily used at the Red Dog Mine. These solvents are non-hazardous. Provided they are appropriately managed and not mixed with other wastes or materials, the solvents 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 are also sampled and characterized. Parts washer solvents and sludge are shipped off-site to an appropriate facility.

3.23 Tires

Worn out tires are used onsite for a variety of applications e.g., safety berms, bumpers on tugboats, and those that cannot be used are sent offsite for recycling. Minor amounts may be placed in the mine landfill.

3.24 Wildlife

Red Dog Mine handles wildlife mortalities in accordance with the procedures identified in the *Red Dog Mine Monitoring Plan*. Mortalities are normally sent to ADF&G in Kotzebue for evaluation.

3.25 Wood, Paper and Cardboard

Wood, paper, and cardboard products are recycled and whenever this is not economically feasible, they are burned in an incinerator or landfilled. Residue ash and debris from open burning or incineration is landfilled onsite.

3.26 Tailings

Tailings from the Red Dog mill are permanently disposed of in the Tailings Storage Facility. The disposal is authorized under the Integrated Waste Management Permit issued by ADEC. The tailings management plan is included in Appendix B

3.27 Waste Rock

Waste rock is managed in accordance with the Waste Rock Management Plan in Appendix C

4 Spill Prevention and Response

The regulations governing spill prevention and response involve multiple agencies, including ADEC, USCG, and EPA.

Table 1 provides a list of required oil spill prevention and response plans, the applicable agency with jurisdiction, and the geographical area. In addition to oil spill response, the Red Dog Mine has multiple fully trained HAZWOPER response personnel trained at the HAZMAT Technician Level and sufficient equipment onsite capable of responding to both petroleum and other hazardous material releases.

Table 1: Oil Spill Response Plans

Plan	Application	Jurisdiction	Reference
Spill Prevention, Control, and Countermeasures (SPCC)	Containers of oil/fuel ≥ 55 gallons Port tank farm/fuel transfer facility Mine site oil/fuel storage	EPA	40 CFR 112
State of Alaska Oil Discharge Prevention and Contingency Plan	Port fuel storage/transfer facility piping Vessels and barges Mine site oil/fuel storage	ADEC	18 AAC 75

The spill response plans required by the State of Alaska are contained in TAK's *Oil Discharge Prevention and Contingency Plan.*

4.1 Spill Notification and Reporting

Spill notification and reporting may involve several different agencies depending on the substance and quantity spilled, including the EPA, USCG, National Response Center (NRC), LEPC and ADEC-SPAR (per 18 AAC 75.300). In addition, other agency, stakeholder, or landowner notification may be required based on specific conditions outlined within permits, agreements and or plans.

5 References

Alaska Department of Environmental Conservation 2010. Solid Waste Management, 18 AAC 60, September 5.

Alaska Department of Environmental Conservation 2012. Oil and Other Hazardous Substances Pollution Control, 18 AAC 75, April 8.

International Air Transport Association 2012. IATA Guidance Document, Transport of Lithium Metal and Lithium Ion Batteries.https://www.iata.org/whatwedo/cargo/dangerous_goods/Documents/Guidance-Lithium-Batteries-Transport-2012.pdf (accessed March 19, 2012).

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Mine Safety and Health Administration 2014. Hazardous Communication Standards, Title 30 CFR §47, July.

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U.S. Environmental Protection Agency (2006b). Solid Waste and Emergency Response, EPA530-R-06-002, Mercury Lamp Drum -Top Crusher Study, August.

U.S. Environmental Protection Agency (2005). Solid Waste and Emergency Response, EPA530-K-05-010, Introduction to Containers, September.

U.S. Environmental Protection Agency (1999). Antifreeze Recycling, Best Environmental Practices for Auto Repair and Fleet Maintenance, November.

U.S. Environmental Protection Agency (2005). Secondary Containment and Impracticability, November.

U.S. Environmental Protection Agency (2011). Spill Prevention Control and Countermeasure (SPCC) Plan, Rectangular or Square Impoundment Structure, July.

U.S. Environmental Protection Agency (2012). List of Lists, Consolidated List of Chemical Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA), CERCLA and Section 112 of the Clean Air Act. EPA 550-B-12-003, October.

Appendices

Appendix A: Legal Description of Property

1. INTRODUCTION

The boundary for the Solid Waste Permit for the Red Dog Mine, as previously approved, is identical to the 1999 Air Shed Ambient Air Quality Boundary. This boundary encompasses all the applicable facilities. In addition, it avoids duplicating the effort of determining the legal description and maintaining multiple permit boundaries.

2. LEGAL DESCRIPTION

Teck Alaska Incorporated submits this legal description of lands encompassed by the 1999 Air Shed Ambient Air Quality Boundary as the geographical boundary for the Solid Waste Permit for Red Dog Mine. It is referred to as the Solid Waste Permit Boundary and applies to the geographic area within the outline depicted on the drawing attached hereto as Figure 1 and located approximately within the following described lands:

Township 30 North, Range 18 West, Kateel River Meridian

Section 5: NW¼NE¼, SW¼NE¼, W½, NW¼SE¼, SW¼SE¼

Section 6: All

Section 7: NE¼, N½NW¼, N½S½NW¼, SW¼SW¼NW¼, NE¼SE¼, NE¼NW¼SE¼

Section 8: W½NE¼NE¼, NW¼NE¼, N½SW¼NE¼, SW¼SW¼NE¼, N½SE¼NE¼, NW¼, N½NW¼SW¼

Township 31 North, Range 18 West, Kateel River Meridian

Section 1: SW¼SW¼

Section 2: NW¼NW¼NE¼, S½NW¼NE¼, SW¼NE¼, SW¼SE¼NE¼, W½, SE¼

Section 3: All

Section 4: All

Section 5: NE¼NE¼, NE¼NW¼NE¼, S½NW¼NE¼, S½NE¼, S½NE¼NW¼, SW¼NW¼, SE¼NW¼, S½

Section 6: S½SE¼NE¼, E½SE¼, E½W½SE¼

Section 7: NE¼NE¼, E½NW¼NE¼, S½NE¼, SE¼SE¼NW¼, NE¼SW¼, S½NW¼SW¼, S½SW¼, SE¼

Section 8: All

Section 9: All

Section 10: All

Section 11: All

Section 12: W½NW¼NW¼, NW¼SW¼NW¼, W½SW¼SW¼

Section 13: W½NW¼, N½SE¼NW¼, SW¼SE¼NW¼, SW¼NE¼NW¼, SW¼NW¼SE¼, SW¼SE¼, SW¼

Section 14: All

Section 15: All

Section 16: All

Section 17: All

Section 18: All

Section 19: All

Section 20: All

Section 21: All
Section 22: N½NE¼NW¼, SW¼NE¼NW¼, W½NW¼, S½SE¼NW¼, SW¼, NW¼SE¼, W½SW¼SE¼
Section 23: N½NW¼NE¼, NE¼NE¼
Section 24: N½NW¼NE¼, SW¼NW¼NE¼, N½NW¼, N½SW¼NW¼, SE¼NW¼
Section 27: W½NW¼NE¼, W¼SW¼NE¼, NW¼, N½SW¼, N½S½SW¼
Section 28: N½, SW¼, N½SE¼, SW¼SE¼, N½SE¼SE¼, SW¼SE¼SE¼
Section 29: All
Section 30: All
Section 31: All
Section 32: N½NE, SW¼NE¼, W½, W½NW¼SE¼, SW¼SE¼
Section 33: N½N½NW¼, NW¼NW¼NE¼

Township 32 North, Range 18 West, Kateel River Meridian

Section 32: SE¼SE¼SE¼
Section 33: S½SW¼SW¼, NE¼SE¼SW¼, S½SE¼SW¼, S½SE¼ Section 34: NE¼NE¼SW¼, S½N½SW¼, S½SW¼, SE¼
Section 35: S½NW¼SW¼, SW¼SW¼, W½SE¼SW¼,

SE¼SE¼SW¼ Township 30 North, Range 19 West, Kateel River Meridian

Section 1: All
Section 2: NE¼, NE¼NW¼, E½NW¼NW¼, SE¼NW¼, NE¼SW¼, SE¼NW¼SW¼, E½SW¼SW¼, SE¼SW¼, SE¼
Section 11: NE¼, NE¼NW¼, NE¼NW¼NW¼, E½NW¼NW¼, E½SE¼NW¼, NE¼NE¼SW¼, N½SE¼, NE¼SW¼SE¼, N½SE¼SE¼
Section 12: N½, N½NE¼SW¼, SW¼NE¼SW¼, NW¼SW¼, N½SW¼SW¼, NW¼NW¼SE¼

Township 31 North, Range 19 West, Kateel River Meridian

Section 12: S½SW¼SE¼, SE¼SE¼
Section 13: E½, NE¼NW¼, NE¼NW¼NW¼, S½NW¼NW¼, S½NW¼, NE¼SW¼, N½NW¼SW¼, SE¼NW¼SW¼, SE¼SW¼
Section 24: E½, E½NW¼, E½NE¼SW¼, NE¼SE¼SW¼
Section 25: E½, E½SE¼NW¼, NE¼SW¼, S½NW¼SW¼, S½SW¼
Section 26: SE¼NE¼SW¼, E½SE¼SW¼, S½NE¼SE¼, NW¼SE¼, S½SE¼
Section 35: E½, E½NW¼, NE¼SW¼, E½SW¼SW¼, SE¼SW¼
Section 36: All

3. BOUNDARY DRAWING

The boundary for the Solid Waste Permit for the Red Dog Mine is shown on the attached drawing “Red Dog Mine Solid Waste Permit Boundary”.


162°58'0"W
162°56'0"W
162°54'0"W
162°52'0"W
162°50'0"W
162°48'0"W
162°46'0"W
162°44'0"W
162°42'0"W
68°8'0"N
68°7'0"N
68°6'0"N
68°5'0"N
68°4'0"N
68°3'0"N
68°2'0"N
68°1'0"N
68°0'0"N
Meridian Kateel River
T32N R19W
Meridian Kateel River
T32N R18W
Meridian Kateel River
T31N R19W
Meridian Kateel River
T31N R18W
Meridian Kateel River
T30N R19W
Meridian Kateel River
T30N R18W
Alaska State Land Boundary
NANA Land Boundary
Red Dod Mine Solid Waste Permit Boundary
N
W
E
S
0 2,900 5,800
Feet

Appendix B : Tailings and TSF Water Management Plan

Tailings and TSF Water Management Plan

Red Dog Mine, Alaska, USA

Prepared by

Teck Alaska Incorporated

Tailings and TSF Water Management Plan

Red Dog Mine, Alaska, USA

June 2021

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List of Abbreviations

ADNR	Alaska Department of Natural Resources
AMSL	above mean sea level
ARD	acid rock drainage
DD2	diversion ditch 2
DMTS	DeLong Mountain Regional Transportation System
EPA	United States Environmental Protection Agency
Golder	Golder Associates Inc.
IDF	Inflow Design Flood
IWMP	Integrated Waste Management Plan
ML/ARD	metal leaching/acid rock drainage
MWD	Main Waste Dump
NANA	NANA Regional Corporation, Inc.
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
SRK	SRK Consulting (U.S.), Inc.
TAK	Teck Alaska Incorporated
TDS	total dissolved solids
TSF	Tailings Storage Facility
URS	URS Corporation
WRD	Waste Rock Dump
WTP	Water Treatment Plant

1 Introduction

Teck Alaska Incorporated (TAK) is submitting the *Red Dog Mine Tailings and TSF Water Management Plan* to the Alaska Department of Environmental Conservation (ADEC), as required by Alaska Statute (AS) S 46.03.100(c) and Title 18 Alaska Administrative Code (AAC) Chapter 60 (18 AAC 60). This Plan is a supporting document to the *Red Dog Mine Reclamation and Closure Plan* (Teck 2020) and an appendix to the *Red Dog Mine Integrated Waste Management Plan* (Teck 2020). This document collects commitments for the *Red Dog Mine Reclamation and Closure Plan* and the *Red Dog Mine Integrated Waste Management Plan* and provides further details. The topics are grouped into two main categories, as follows:

- Tailings management:
  - Main and Back Dams;
  - Tailings beach requirements;
  - Water cover; and
  - Tailings deposition.
- Tailings Storage Facility (TSF) water management:
  - Reduction of pond volume;
  - Pre-treatment of the largest sources of constituent loading; and
  - Construction of improved Main Waste Dump (MWD) Seepage Collection System.

Operational procedures associated with each of these areas are discussed herein. Specific plans pertaining to normal and routine management of tailings and water at Red Dog Mine are maintained separately by Teck Alaska Incorporated (TAK). Mine plans, schedules, and quantities pertaining to tailings and water management were provided by TAK unless otherwise noted.

2 Tailings Management

The Red Dog Mine Tailings Storage Facility (TSF) is in the upper valley of the South Fork of Red Dog Creek (Figure 1). Tailings are impounded by the Main Dam at the north end, the Back Dam at the south end, and the surrounding topography.

As of September 2020, the TSF contained an estimated 57,057,374 tonnes of tailings. If the tailings were uniformly distributed within the TSF, this would be equivalent to a “struck-level” elevation of approximately 963.6 feet above mean sea level (amsl). The surveyed water level as of September 2020 was 980.4 feet amsl, at which time it was estimated that the TSF pond contained approximately 4.1 billion gallons of water.

The 2017 estimate of total tailings production is approximately 84,900,000 tonnes by the end of ore processing in 2032. Estimates of final dry bulk tailings density are 88.0 pounds per cubic foot (pcf) for tailings from Main Pit ore and 94.9 pcf for tailings from Aqqaluk Pit ore (respectively, 1.41 and 1.52 tonnes per cubic meter). The estimate of the final tailings struck elevation will be refined as mining proceeds. Presently the mine uses a bulk density of 1.47 tonnes per cubic meter for estimating tailings tonnages.

The estimate of final tailings density is one of the most significant uncertainties and continued monitoring of bathymetry will reduce that uncertainty over time. Should that monitoring demonstrate a need for additional tailings storage volume, several options are available. These include raising the TSF dams, increasing tailings density, and/or decreasing tailings production.

TAK is in the final stages of completing the Main and Back Dam raises to 991 ft amsl which is anticipated to be completed by mid-September 2020. The dams will be raised another 5 ft to 996 ft amsl in the next three years, and a final raise to 1006 ft amsl is in the conceptual stage.

2.1 Main Dam

The Main Dam crest is presently being raised to 991 ft amsl with completion expected in mid-September 2020. The dam is a zoned rockfill embankment constructed in a downstream configuration. The upstream face of the dam is lined with geomembrane extending to competent bedrock for seepage control. The Wing Wall extends the Main Dam crest to the east and south, using the same zoned rockfill and liner system. The plan view of the dam configuration and tailings bathymetry as of summer 2020 are illustrated in Figure 1. The Main Dam and Wing Wall also use cutoff and curtain walls, respectively, that extend below the embankments for seepage control. Seepage from the Main Dam is collected in the Seepage Collection Pond immediately downstream of the Main Dam and pumped back to the TSF. Routine operation and maintenance requirements for the Main Dam are described by Golder (2018).

Golder (2018) summarized flood storage capacity in the TSF for a dam crest elevation of 991 feet amsl. In addition, the spillway would provide engineered conveyance of water around the Main Dam if the capacity of the TSF was exceeded.

The Surcharge capacity of the Main Dam are summarized in Table 1. Storage volumes considered in the analysis were:

1. Spring freshet: average monthly runoff into TSF in May, including thaw and runoff of November to April precipitation, minus evaporation and seepage losses
2. Probable Maximum Flood (PMF) series: runoff from the 24-hour Probable Maximum Precipitation (PMP) event plus 40% of the runoff from another PMP event
3. 100-year flood: runoff from the 24-hour, 100-year precipitation event

Additional inputs for the spillway design were:

1. Inflow Design Flood (IDF): depth of flow during a one-half PMF event
2. Freeboard: wind setup and wave run-up during the IDF, assuming a 600-foot-wide beach sloping at 1%

Table 1: Surcharge Capacity for Main Dam at Crest Elevation of 991 feet

Component of Storage	Depth (feet)	Resulting Elevation (feet AMSL)
Tailings Surface	N/A	980.0
Minimum Water Cover	2.0	982.0
Spring Freshet	1.4	983.4
Probable Maximum Flood Series	4.2	987.6
100-year Flood	0.9	988.5
Spillway Crest	N/A	988.5
Inflow Design Flood	1.4	985.9
Freeboard for Wind/Wave	1.1	991.0
Dam Crest	N/A	991.0

The spillway design will need to be revised once the final tailings elevation is determined.

TAK commissioned a geophysical survey of the Wing Wall to evaluate potential seepage pathways (Willowstick 2013). The survey identified a possible preferential flow path beneath the Wing Wall. Since 2014, TAK has installed a number of piezometers in the possible preferential flow path: both upstream and downstream of the Wing and continues to monitor the piezometers to develop an understanding of the possible preferential flow path beneath the Wing Wall and provide an update to ADEC and ADNR when the preferential flow path can be confirmed or ruled out, along with plans for additional actions, if needed.

2.2 Back Dam

The Back Dam is located at the south end of the TSF and straddles the divide between the TSF and Bons Creek (Figure 1). The Back Dam crest is currently approaching an elevation of 981 feet amsl (Golder 2018) with raise completion expected in mid-September 2020. Raises of the Back Dam will need to be timed in accordance with Main Dam raises. The dam is a zoned rockfill embankment constructed in a centerline configuration. A vertical, plastic-concrete, cut-off wall extends downward from the center of the dam crest for seepage control. Seepage from the Back

Dam is collected in a sump between the Back Dam and Overburden Dump and pumped back to the TSF. Routine operation and maintenance requirements for the Back Dam are described by Golder (2014).

2.3 Tailings Beaches

Since 1997, tailings have been used to form beaches upstream of the Main Dam that limit seepage from the TSF to the seepage collection system. By 2000, tailings placed along the upstream face of the Main Dam formed a complete beach. Phased beach development upstream of the main dam is expected to continue throughout mining to maintain the beach as water levels rise. TAK's objective is to maintain a 600-foot-wide beach along the Main Dam and Wing Wall during operation. Seepage records maintained by TAK indicate that the tailings beach contributes to seepage control. A seepage analysis conducted by URS (2007) demonstrated that a wide tailings beach reduces seepage from the Main Dam. This reduces the potential for internal erosion.

A seepage analysis conducted by Golder (2006) demonstrates that a 600-foot-wide tailings beach also reduces seepage from the Back Dam. TAK is investigating geochemical interactions to determine the appropriate timing to start constructing a tailings beach upstream of the Back Dam to control seepage from the TSF into Bons Creek. Monitoring of seepage during operations may lead to the conclusion that a narrower beach is adequate.

TAK may develop tailings beaches in other locations in the TSF. Measures to control dust from beaches are currently in place and will be maintained in compliance with air quality regulations. At final closure the beaches will receive a geomembrane cover, soil cover and revegetation.

2.4 Water Cover

Tailings produced at Red Dog Mine are potentially acid generating. A minimum water cover of two feet should be maintained over the non-beach tailings surface throughout operation to minimize metal leaching and acid rock drainage (ML/ARD). More details on management of the water cover are provided in Section 3.

2.5 Tailings Deposition

To minimize tailings oxidation, which can contribute to acid generation, tailings are generally deposited below the water surface (subaqueous deposition). Tailings may also be deposited subaerially to meet operations requirements including, but not limited to: periods of plant maintenance, during placement along dam faces as beaches, during placement in the middle of the impoundment for increased density, during placement in front of other TSF structures such as roads, or during times in winter when it is difficult to swap deposition locations or verify that tailings remain below water due to lack of safe access.

When beaching tailings sub-aerially, TAK generally employs multipoint spigot deposition to achieve enhanced seepage reduction. Tailings are also sometimes beached through single spigots as required depending on environmental or operational conditions.

Subaqueous deposition has resulted in the formation of tailings cones. To ensure that the tailings cones are uniformly distributed, TAK moves the deposition point. To more evenly distribute tailings subaqueously, TAK is evaluating alternative strategies for winter deposition, including deposition from a perforated pipe. TAK reports that perforated pipes have been tested since 2014 and TAK is continuing to refine the application.

In addition to perforated pipe deposition, TAK is evaluating alternatives for tailings redistribution that level the tailings surface as much as practicable to maximize tailings storage capacity.

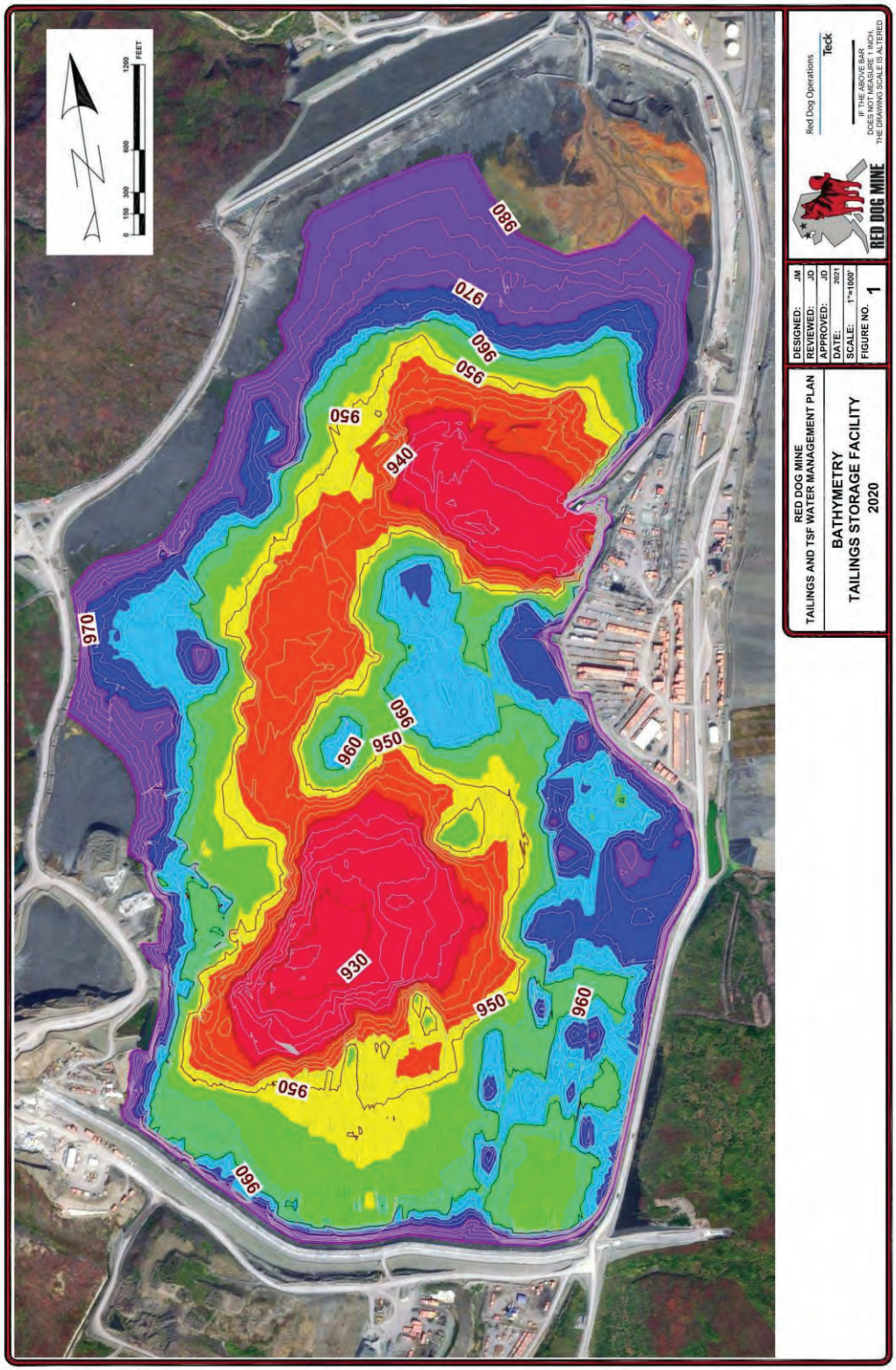

Figure 1: Bathymetry of Tailings Storage Facility

3 TSF Water Management

3.1 TSF Pond Volume Reduction

TAK plans to reduce the water volume in the TSF pond to achieve a two-foot water cover by closure in 2032. Prior to closure, TAK plans to reduce constituent concentrations in the TSF by pre-treating the largest sources of loading, and by maximizing capture of seepage from the Main Waste Dump (MWD).

Tailings water management is linked to the closure objective for the TSF pond. Significantly reducing the TSF volume will allow the benefits of capturing and treating inflows to be attained in a much shorter time. The *Red Dog Mine Water and Load Balance Update* (SRK 2017c) indicates that reducing constituents, such as total dissolved solids (TDS) and metals, in the TSF the last few years of operation prior to closure will improve the quality of the water entrained in the upper few feet of tailings.

3.2 Pre-treatment of Largest Load Sources

Red Dog Mine operates four water treatment plants (WTPs) as summarized in Table 2. WTP3 began operating in 2006. The plant was designed to treat some of the MWD seepage and Mine Sump water before it entered the TSF. Under current capacity limitations, WTP3 and WTP1 treat MWD seepage as a priority. An estimated 60 to 100 million gallons of MWD water is treated annually with the current configurations of WTP3 and WTP1.

TAK is considering several options to increase WTP treatment capacity as part of their water volume quality program. The lime slaking and handling system was upgraded in 2015. Gypsum seeding was initiated in 2017. Future modifications may include upgrading the reclaim piping system, upgrading the clarifiers and process pumps/pipe work, upgrading the sand filters, and winterizing WTP3, but further analysis and engineering are required before options are selected and implemented. TAK also constructed an RO plant at the mine and is commissioning the plant at time of this writing. The output of the plant is anticipated to be 1,000 gpm of treated water and 1,000 gpm of brine. The treated water will be discharged directly to Outfall 001 or comingled with treated water from WTP no. 2. The brine will be pumped to the TSF.

Table 2: Water Treatment Plant Summary

Treatment Plant	Description of Current Role	Operation
WTP1	Treats MWD water and discharges to TSF (winter and part of summer). Treats water from TSF pond for discharge to Red Dog Creek (part of summer)	Year-round
WTP2	Treats water from TSF pond for discharge to Red Dog Creek	Summer
WTP3	Treats MWD water and discharges to TSF	Summer
RO Plant #1	Treats water from WTP1 and discharges to RD Creek	Summer

3.3 MWD Seepage Collection System

The upgraded MWD Seepage Collection System captures a portion of the seepage from the MWD in a series of sumps and pumps the water to WTP3 or WTP1 for treatment. Uncaptured seepage flows to the TSF. The upgrades to the MWD Seepage Collection System were completed in 2019.

4 References

Golder Associates, Inc. (2006). Detailed Design Tailings Impoundment – Back Dam Cut-Off Wall, Red Dog Mine, Alaska. Draft Report prepared for Teck Cominco Alaska Inc. November 2006.

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URS (2007). Seepage Analysis Report, Red Dog Tailings Main Dam, Future Raises to Closure, Red Dog Mine, Alaska.

URS (2014). Design Report: Stage X Widening, Red Dog Tailings Main Dam, Red Dog Mine, Alaska.

URS (2013). Operations and Maintenance Manual, Red Dog Tailings Main Dam, NID ID# AK 00201, Red Dog Mine, Alaska.

Willowstick (2013). Willowstick Investigation of Red Dog Mine Tailings Pond.

Appendix C : Waste Rock Management Plan

Waste Rock Management Plan

Red Dog Mine, Alaska, USA

Teck Alaska Incorporated

Waste Rock Management Plan

Red Dog Mine, Alaska, USA

March 2021

Record of Revisions

Date of Revision	Section/Table Figure	Description
9/14/18	Figure 2	Removed reclamation schedule
9/14/18	Figure 1	Updated dump and stockpile location map
9/14/18	Misc. sections	Removed references for SRK
9/14/18	Sec 2.8 and Table 1	Added PAC dump
9/14/18	Esc 2.9 and Table 1	Added Main Waste Dump Extension
7/20/20	All	Updated to reflect update R/C Plan, IWMP
9/09/20	All	Updated to reflect internal review comments
3/01/21	All	Updated for currency

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List of Abbreviations

ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
AS	Alaska Statute
AMSL	above mean sea level
ML/ARD	Metal Leaching/Acid Rock Drainage
MPD	Main Pit Dump
MWD	Main Waste Dump
S	Sulfide
TAK	Teck Alaska Incorporated
TSF	Tailings Storage Facility
WTP1	Water Treatment Plant 1
WTP3	Water Treatment Plant 3

1 Introduction

Teck Alaska Incorporated (TAK) is submitting the *Red Dog Mine Waste Rock Management Plan* (Plan) to the Alaska Department of Environmental Conservation (ADEC) and the Alaska Department of Natural Resources (ADNR), as required by Alaska Statute (AS) 27.19.010 and AS 46.03.100 (c). This Plan is a supporting document to the *Red Dog Mine Reclamation and Closure Plan* (TAK,2021) and an appendix to the *Red Dog Mine Integrated Waste Management Plan* (TAK, 2021).

The Plan presents strategies for managing waste rock at the Red Dog Mine (Mine) which are summarized in the above referenced plans. Topics are grouped into three categories:

- The status and plans for waste rock dump construction, in a geometry that is compatible with the closure plan.
- Concurrent reclamation of completed waste rock dump areas.
- Segregation of waste rock to obtain clean material suitable for dam and cover construction and, where possible, to place the waste rock with a high sulfide content that is potentially self-heating (high S waste rock), below the ultimate water level in the Main Pit Dump (MPD)

Waste rock management procedures are specified in the Red Dog Mine Waste Rock Management Procedures and follow conditions set forth in this Plan.

2 Current Status and Construction Plan for Waste Rock Dumps

2.1 Overview

Waste rock dumps are used to dispose of waste rock that is not expected to have economic value before the end of the mine life. There are multiple waste rock dumps and low-grade stockpiles at the Mine (Figure 1), and there are plans to backfill the Qanaiyaq Pit with waste rock. Brief descriptions of each of these dumps and stockpiles are provided in Table 1, with further details in the following sections.

Waste rock dumps have been designed to accommodate projected waste volumes and to minimize re-sloping requirements at closure. Where possible and to facilitate reclamation activities (e.g., cover placement), dumps have been constructed to enable final surface slopes of approximately 3H:1V.

2.2 Main Waste Dump

The Main Waste Dump (MWD) is located east of the Tailings Storage Facility (TSF) and contains waste rock from the Main Pit and from the development of the Aqqaluk Pit. The ultimate height of the dump is maintained at an elevation to meet navigational requirements for the airstrip. The surface of the MWD was graded to a slope of 3H:1V or less and the surface has been compacted. Final reclamation will be completed prior to closure as described in Section 3.

Seepage from the MWD is collected in the MWD Collection System, which consists of a series of drains and sumps between the western dump slope toe and the TSF. The collection system intercepts a portion of the seepage and runoff potentially affected by metal leaching and acid rock drainage (ML/ARD), and the remainder enters the TSF. During the summer months the captured water is pre-treated in Water Treatment Plant 3 (WTP3) and in the winter months the water is pre-treated in Water Treatment Plant 1 (WTP1), before being discharged into the TSF.

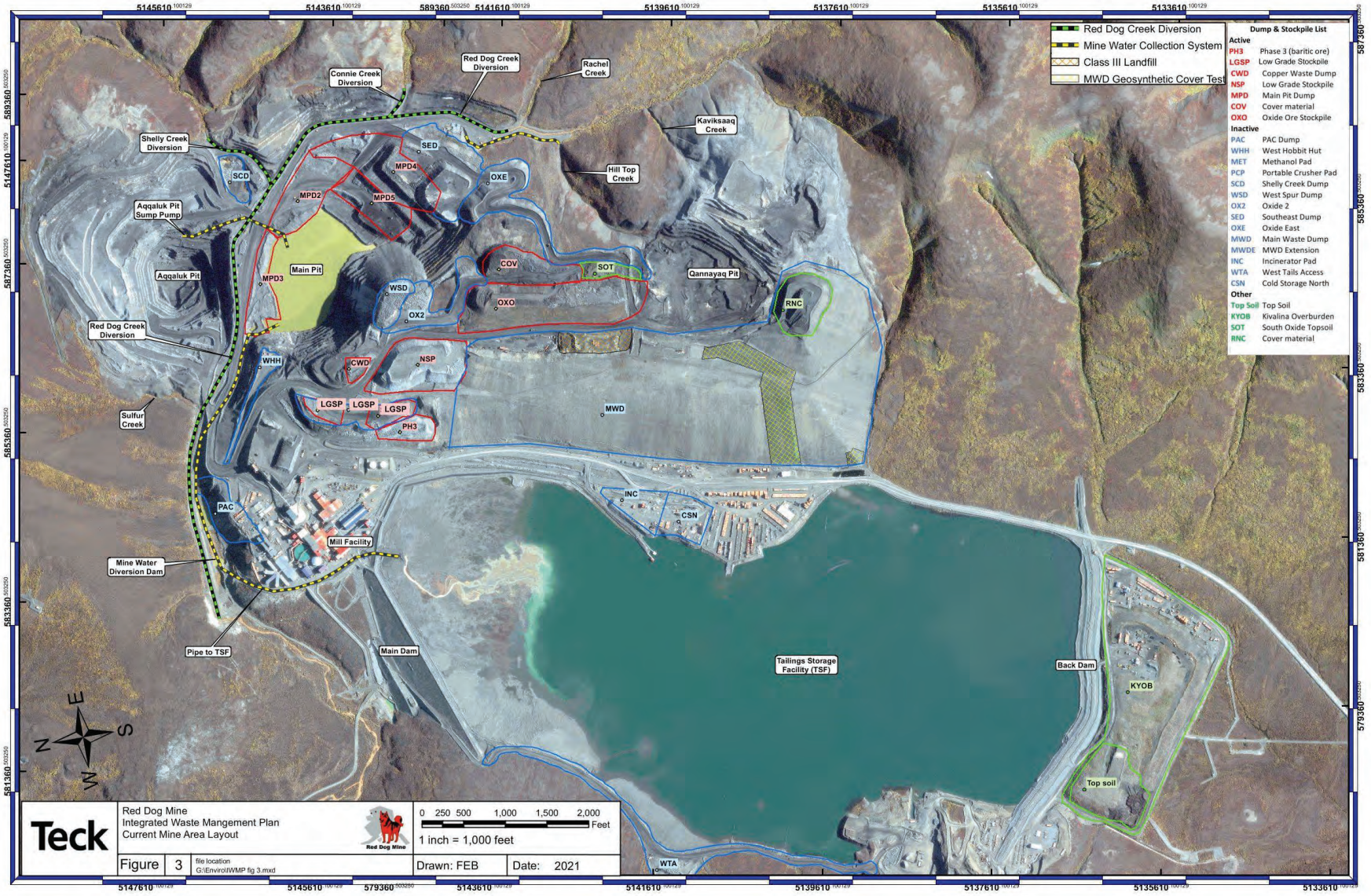

Figure 1: Red Dog Mine Dump and Stockpile Locations

Table 1: Existing and Future Waste Rock Dumps and Low-Grade Ore Stockpiles

Facility	Description
Main Waste Dump	Contains waste rock accumulated from mining the Red Dog deposit (Main Pit) and the initial development of the Aqqaluk deposit (Aqqaluk Pit).
Kivalina Overburden Dump	Contains a mixture of mineralized and non-mineralized material excavated from the tailings and mill site during initial construction. This dump is currently used for storage.
Main Pit Dump	Since the cessation of mining of the Main Pit in 2012, the pit (now referred to as the Main Pit Dump) is and will continue being backfilled with waste rock until final closure.
Oxide Stockpile	Weathered rock that meets the mine's grade cutoff criteria but is not economically recoverable with the available technology. This material may be recovered in the future due to changes in economic conditions and/or technology.
Qanaiyaq Pit Dump	This pit will be backfilled with waste rock upon the completion of mining of Phase 1 of the Qanaiyaq Pit and will continue to be backfilled until the completion of mining.
PAC Dump	Contains waste rock accumulated from mining the Aqqaluk Pit.
Low Grade Ore Stockpiles	Material between the mill cutoff and operating cutoff grades is stored in the Low-Grade Ore Stockpile. This material may be processed at some time in the future if economic conditions change or at the end of the mine life when other operating costs are at a minimum.
Main Waste Dump Extension	Waste rock from the Aqqaluk and Qanaiyaq pits may be place here if needed, Currently not in use

2.3 Kivalina Overburden Dump

The Kivalina Overburden Dump is located between the south end of the TSF and the Bons Creek watershed. The dump consists of Kivalina shale (non-mineralized material) inter-mixed with mineralized material, which is a minor source of zinc loading.

The Kivalina Overburden Dump Collection System captures potentially affected runoff from the Overburden Dump via two catchment basins, which is then pumped into the TSF.

2.4 Main Pit Dump

TAK began placing waste rock from the Aqqaluk Pit in the Main Pit Dumps (MPD) in 2012 and will continue to use this dump through the remaining mine life. The MPD will also receive waste from Phase I of the Qanaiyaq Pit. To the extent possible, the rock with potential for self-heating (high S waste rock) will be placed below the ultimate water level.

Extraction of high S waste rock from the Aqqaluk Pit is expected to be minimal for the first decade. Therefore, other types of waste rock are dumped from higher dump platforms, starting at the south end of the pit and progressing to the north, to maximize the available flooded area for the high S waste rock in the future.

The MPD will be closed and sides sloped upon completion of the Aqqaluk Pit in 2030. Initial side sloping will be 3.7H:1V to allow the final re-sloped surface to be composed of engineered channels

and slopes of 3H:1V, varied where possible to enhance erosional stability and provide more natural-looking landforms.

2.5 Oxide Stockpile

Previously referred to as the Oxide Dump, it is located east of the MWD, immediately east of the Landfill Area. This dump was previously used for a trials test for an earthen compacted cover. The dump is now being used to stockpile Qanaiyaq material for future processing.

2.6 Qanaiyaq Pit Dump – Planned

Waste from the second phase of the Qanaiyaq Pit will be dumped into the first phase of the Qanaiyaq Pit, currently planned for 2023. Waste from the Aqqaluk Pit will be dumped into the second phase, currently planned to begin in 2027 when mining of the Qanaiyaq Pit is complete and will continue until the completion of mining in 2030. Waste rock placed in Qanaiyaq Pit Dump will be segregated according to Table 3, with the exception that waste rock may not be placed under water, if no groundwater accumulates in the Qanaiyaq Pit.

2.7 Low-Grade Ore Stockpiles

The Low-Grade Ore Stockpiles, located north of the MWD, contain rock that meets the criteria for economic mill feed, but does not meet other current economic parameters. Currently, the stockpile is not in active use. However, depending on economic conditions, it may be used for additional storage of low-grade ore, or it may be processed at some point in the future. Any material remaining at the end of the mine life will be reclaimed.

2.8 PAC Dump

The PAC dump located north of the crushers was added to provide an additional storage / laydown area near the mill. The dump remained active from 2015 thru 2017 and is now graded and compacted. No further waste rock placement is expected at this dump.

2.9 Main Waste Dump Extension

The Main Waste Dump Extension is a planned and approved dump location for both Aqqaluk and Qanaiyaq waste rock. Currently this area is not being used.

3 Concurrent Reclamation Plan

Waste rock dumps will be concurrently reclaimed during operations to the extent practical. The primary objective of concurrent reclamation is to reduce geochemical loads to the TSF and subsequently to the water treatment plants. In addition, concurrent reclamation will efficiently utilize existing equipment and reduce the volume of cover material stockpiles managed by mining operations.

- Completed or ongoing activities
  - A 16-acre geosynthetic cover pilot test for the MWD was constructed during 2017. Performance monitoring is ongoing. Monitoring completed to date suggests that the geosynthetic covers are extremely effective at preventing the seepage and infiltration of surface water into the MWD. The use of these covers was approved by ADNR in February 2020.
- Planned Activities
  - Based on construction experience learned from the geosynthetic cover pilot test approximately 20-30 acres would be completed each year (earliest 2021 start date) with the project expected to last a few years. Operations will maintain access to the Low Grade Ore Stockpile and the Qanaiyaq Pit during cover activities.
  - The MPD will be in use until the end of mine life. It may be possible to cover portions of this dump in 2026, with the remainder being covered within two years of cessation of mining.
- The Qanaiyaq Pit Dump will be in use until the end of mine life and covered within two years of cessation of mining the Qanaiyaq deposit.
- Depending on economics at the time of closure, it may be possible to process ore in the Low Grade Ore Stockpile. This would most likely occur in the last year of mining. If it is not economic to process this material, it will be re-sloped and covered within two years of the cessation of mining.
- Suitable material will be required to cover the exposed tailings beaches at the end of the mine life. Material may be stockpiled for this purpose.

4 Waste Rock Classification and Segregation

TAK has developed procedures to implement the classification, segregation, and placement of waste rock and to minimize the need for re-handling. More recently, TAK, with assistance from SRK, assessed the geochemical characteristics of material from the Key Creek Plate, and developed procedures for identifying and segregating this material for use in cover construction. TAK has modified the segregation criteria for high S waste rock that considers rates of sulfide oxidation, potential for self-heating, and production schedules (TAK, in preparation).

Waste Rock is currently subdivided into four categories:

1. Rock with low ML/ARD that is suitable for tailings dam construction.
2. Rock with low ML/ARD that is suitable for cover material.
3. Waste rock with a high sulfide content that is potentially self-heating (high S waste rock).
4. Rock that does not fit any of these other classifications.

TAK has identified different types of rock with suitable characteristics for construction and cover material (Table 2). The updated segregation criteria for both cover material and for high S waste rock are defined in Table 3.

Table 2: Red Dog Mine Construction and Cover Materials

Material	Characteristics	Application
Siksikpuk Shale (S-Shale)	High silica [Si] content and very low total organic carbon [TOC] content	Preferred construction material due to high Si content. The material has insufficient TOC and does not adequately support cover crops.
Kivalina and Kayak Shale of the Key Creek Plate	Low Si and high TOC content. Low potential for ARD	Preferred cover material due to relatively high TOC supporting cover crops. Due to the low Si content, Kiv-Shale breaks down easily and is inadequate for other construction purposes.

Table 3: Current Segregation Criteria

Intended Use/Disposal Location	Allowable Rock Types	Criteria*
Dam Construction	Siksikpuk Shale	Single blast hole assays not to exceed: 1% Zn, 1% Pb, 3.5% Fe Average blast hole assays not to exceed: 0.5% Zn, 0.5% Pb, 2.5% Fe
Cover Material	Kivalina and Kayak Shale of the Key Creek Plate	Material must be from Key Creek structural plate. Identified as predominantly Kivalina and/or Kayak shale, based on visual estimation. Must not contain greater than 10% visual percent sulfide over an area of more than 500 m^2. No more than 5 adjacent blast-holes to exceed 0.25% zinc.
High S Waste Rock (placed below the ultimate water level in the Main Pit Dump where possible, or blended to reduce the self-heating capacity)	Typically, Ikalukrok	Self-Heating Capacity Risk Region 5 or greater**
Other Waste Rock – placed in Main Pit or Qanaiyaq pit dumps. To maximize space available for underwater disposal of the high S waste, it is preferable to place this material in locations that are above the ultimate water level in the Main Pit Dump or MWD expansion	Waste Rock not meeting other criteria	

Notes: *Analytical criteria are only to be applied to the allowable rock type (*i.e*. rock type has precedence).
**Calculated as follows:

Self-Heating Capacity Risk Region = 3.41744 + (%Pb-%sPb) / 0.866 x (-0.33539 + 0.03897 x %Zn / 0.671) - 0.81502 x Log ((%Ba / 0.5886) / (%Fe / 0.4654)).

This equation is based on an empirical relationship between heating capacity (in Joules/gram) and mineralogical data (Nesseteck 2009) and will be modified and refined as more data is gathered by Teck.

Where possible, waste rock suitable for construction or cover material is segregated and stockpiled. The remainder is obtained from local non-mineralized material sites.

The high S waste rock is, to the extent possible, placed below anticipated water table levels in the Main Pit. Where this is not possible, the high S waste rock is blended with other waste rock as required to reduce the potential for self-heating to a level below risk region 5 (Table 3). Where the blending ratio is less than 1-part high S waste rock to 1-part other waste rock, blending is accomplished by end-dumping alternating rows of high S waste rock with other material in the dumps. Where the blending ratios are more than 1-part high S waste rock to 1 part other waste rock, blending is accomplished by dumping single haul-truck loads of high S waste rock ahead of partial haul-truck loads of other waste rock and then mixing the two into each other with a bulldozer when pushing the material over the dump crest.

The remaining waste rock, comprising most of the rock in the waste dumps requires no special placement methods.

Elements of the segregation plans are outlined as follows:

- Segregation criteria are defined for dam construction materials, cover materials, and high S waste rock, as shown in Table 3.
- ML/ARD and resource models are used to identify general areas where these materials may be found and to update material handling schedules. Model and scheduling updates consider and incorporate data generated from routine pit operations.
- An automatic drill cutting sampler is used to collect samples from production blast holes. Samples are analyzed for iron, lead, and zinc content, and are classified by a qualified geologist.
- Material is classified based on geology (plate of origin, rock type, visual sulfide content) and/or applicable assay data (Table 2 and 3) to determine its suitability for dam construction, cover material, or disposal as waste rock. Haul truck drivers are directed to haul these materials to a designated cover stockpile, construction stockpile, or waste rock dump, as appropriate, or for blending where required.

5 References

Nessetech, 2009, Self-Heating Tests – Revised Report #2 Pit Samples – Red Dog. Technical report prepared for Teck Cominco Alaska Incorporated. June 11, 2009.

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Appendix D : Monitoring Plan

Monitoring Plan
Red Dog Mine, Alaska, USA

Waste Management Permit
2021DB0001

Teck Alaska Incorporated

Monitoring Plan
Red Dog Mine, Alaska, USA

Waste Management Permit
2021DB0001

June 2021

Record of Revisions

Date of Revision	Section/Table Figure	Description
January 2018	Table 3 foot note 1	Deleted *"Sampling conducted when flow is present" replaced with* "Sampling conducted according to current Red Dog Mine APDES requirements.*"*
	Table 4 foot note 1	Deleted *"Sampling conducted when flow is present" replaced with* "Sampling conducted according to current Red Dog Mine APDES requirements.*"*
	Table 7 foot note 3	Mine Water Monitoring Stations – added to footnote 3 – *includes reclaim influent flow to Process Water Tank*
	Table 1	Mine Water Management – Visual Monitoring Section added *(monthly visual, conducted with stormwater inspections)* and added under Monitoring Frequency *Monthly for clean water diversions.* Tailings Management – Visual Monitoring Section deleted *diversion ditches,* added *back dam.*
	Section 2.3.4 Visual Monitoring	Diversions Ditches added *(monthly, when flow is present)* Red Dog Creek Diversion added (*monthly, when flow is present)*
7/20/2020	all	Updates for compatibility with '20 R/C Plan and IWMP
12/14/2020		Edits in response to ADEC comments
03/01/2021	all	Updated for currency.
06/01/2021	cover	Update for currency

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List of Abbreviations

ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish & Game
ADNR	Alaska Department of Natural Resources
APDES	Alaska Pollutant Discharge Elimination System
CEC	cation exchange capacity
DMTS	DeLong Mountain Regional Transportation System
EC	electrical conductivity
EPA	United States Environmental Protection Agency
IWMP	Integrated Waste Management Permit
ML/ARD	Metal Leaching/Acid Rock Drainage
MPD	Main Pit Dump
MWD	Main Waste Dump
NPDES	National Pollutant Discharge Elimination System
NANA	NANA Regional Corporation, Inc.
Plan	Integrated Waste Management Plan
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RMP	Risk Management Plan
SEP	Supplemental Environmental Project
SOP	Standard Operating Procedure
TAK	Teck Alaska Incorporated
TDS	Total Dissolved Solids
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
WAD	weak acid dissociable
WTP1	Water Treatment Plant 1
WTP2	Water Treatment Plant 2
WTP3	Water Treatment Plant 3

Units of Measure

m	meter
m^2	square meter

Introduction

Teck Alaska Incorporated (TAK) is submitting the *Red Dog Mine Monitoring Plan* (Plan) to the Alaska Department of Environmental Conservation (ADEC) and the Alaska Department of Natural Resources (ADNR), as required by 18 AAC 15.090 and 18 AAC 60.210 (b)(3)(D) for the Waste Management Permit #2021DB0001. This Plan is a supporting document to the *Red Dog Mine Reclamation and Closure Plan* (TAK 2021) and an appendix to the *Red Dog Mine Integrated Waste Management Plan* (TAK 2021).

Monitoring described in this Plan complies with requirements set forth by the Integrated Waste Management Permit (IWMP) and the *Reclamation and Closure Plan*, and includes the following:

- Biomonitoring, including aquatic life and ambient water quality monitoring, in the Bons Creek and Red Dog Creek drainages[1] (stipulated under the Alaska Pollutant Discharge Elimination System (APDES) permit which incorporates previous stipulations in the 1998 Red Dog Mine National Pollutant Discharge Elimination System (NPDES) Permit #AK-003865-2 and as part of the Bons Creek Monitoring Program under an agreement between TAK and ADEC)
- Permafrost and sub-permafrost groundwater monitoring (previously conducted under the Groundwater Supplemental Environmental Project [SEP])
- Inspections of the Red Dog Fish Weir (previously conducted under the Red Dog Creek Fish Weir Construction and Maintenance SEP)
- Water quality and flow monitoring at locations throughout the mine site and maintenance of water/load balances, including pit lakes and spillways (if applicable, and when possible)
- Monitoring of waste rock and tailings
- Monitoring of solid waste landfills
- Mining and milling activities
- Monitoring of reclamation activities, including cover performance and revegetation success.
- Fugitive dust
- Wildlife

Table 1 summarizes monitoring described in this Plan. Key facilities at the Red Dog Mine (Mine) included in this Plan are shown on Figure 1. This Plan covers the Mine only and excludes the DeLong Mountain Regional Transportation System (DMTS), which includes the road and port facilities.

Monitoring associated with the operations phase is described in Section 2. Section 3 addresses changes to the monitoring program required during the period of active mine closure, while Section 4 describes anticipated requirements for the post-closure period. Section 5 describes the Quality Assurance/Quality Control (QA/QC) programs in place. Reporting and report content requirements are described in Section 6.

[1] [1] This Plan includes some monitoring locations that are not part of the Bons Creek and Red Dog Creek drainages or are outside the jurisdiction of the Waste Management Permit boundary. These locations have been included for reference and program completeness

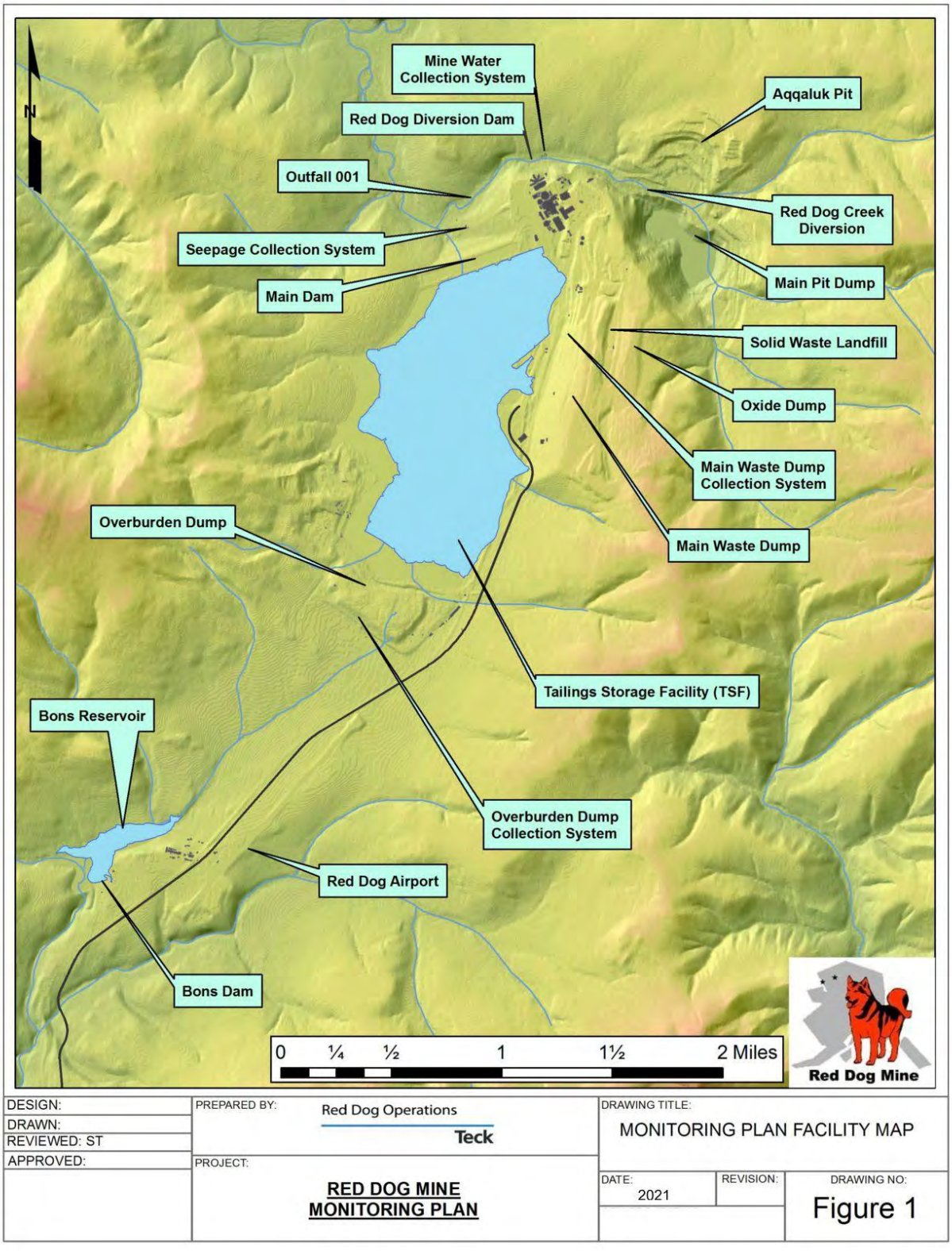


Figure 1: Monitoring Plan Facility Map

Table 1 : Summary of Monitoring During Operations

Monitoring Program Element	Location	Parameters	Stipulation[2]	Plan Section	Monitoring Frequency	Reporting Frequency
Biomonitoring Program						
Bons Creek Monitoring Program	Buddy Creek (below falls and Station 221), Bons Creek (Station 220 and above pond), Anxiety Creek, Evaingiknuk Creek, Lower and Upper Bons Creek, Bons Reservoir, Dudd Creek	See Table 2 for specific parameters at each location (includes Ambient Water Quality Profile I, periphyton, aquatic invertebrates, fish presence and use, and juvenile Dolly Varden tissue metals analyses	Waste Permit 2.5.1	2.1. 3	Ranges from monthly to yearly	Annual
Mine Drainage Monitoring Program	Wulik River, Ikalukrok Creek, Station 9, Station 160, Station 20, Rachel Creek, Connie Creek, Shelly Creek, Sulfur Creek, and Stations 10,12, 150, and 145 on Red Dog Creek.	See Table 2 for specific parameters at each location (includes Ambient Water Quality Profile I, fall aerial surveys for overwintering Dolly Varden in Wulik River and for adult chum salmon in Ikalukrok Creek, periphyton, aquatic invertebrates, fish presence and use, juvenile Dolly Varden tissue metals analysis)	Waste Permit 2.5.1	2.1.4	Ranges from monthly to yearly	Annual
Permafrost and Sub-permafrost Groundwater Monitoring						
Permafrost and Subsurface Temperature	Thermistors T-95-004, T95-005, T95-008, T14-110; T-96-010, T96-012, T96-012S, T96-013, T96-015, T96-021, T96-022, T96-023; T-97-028, T97-029, T97-030; T-05-061	Ground temperature (Table 5)	Waste Permit 2.5.1	2. 2.2	Quarterly	Annual
Groundwater Level	Piezometers P-08A, P-08B; P-96-010, P-96-013, P-96-015; P-97-012, P-97-020, P-97-028; SPP-97-002	Water elevation around the tailings storage facility (TSF) (Table 6)	Waste Permit 2.5.1	2.2.3	Quarterly	Annual
Mine Water Management						
Water Quality and Flow	Main Dam Seepage Pumpback, Bons Creek Total Flow, East/West Overburden Sump, Tailings Water, Reclaim Water, WTP1/Mill Influent from Reclaim, WTP1 Influent from Mine Water Collection System, WTP2 Influent from Reclaim, WTP3 Influent from Main Waste Dump, WTP3 Influent from Mine Water Collection, WTP3 Effluent, Mine Water Collection System, Pit lakes, Mill Pad Runoff Collection System	See Table 7 for specific parameters at each location (includes total monthly water quality and quantity of water treated	Waste Permit 2.5.5, 2.5.6	2.3.2	Continuous, monthly	Quarterly
Water Balance	Mine site	Water quantity	Waste Permit 2.5.5	2.3.3	Continuous	Annual
Load Balance	Mine site	Chemical loadings	Waste Permit 2.5.5	2.3.3	Continuous	Annual

[2] Waste Permit, Sec 2.5.1 incorporates this table by reference. This may be stipulated in other plans.

Monitoring Program Element	Location	Parameters	Stipulation[2]	Plan Section	Monitoring Frequency	Reporting Frequency
Visual Monitoring	Diversion ditches, Red Dog Creek and other clean water diversions, Mine Water Collection System, pipelines and pipeline containment structures, Main Waste Dump seepage collection system, treated water discharge lines, Overburden Dump runoff collection system, Mill Pad runoff collection system	Signs of damage or potential damage; escape of waste or leachate or any unauthorized waste disposal; damage to the structural integrity of a containment structure or diversion structure; evidence of death or stress to fish, wildlife, or vegetation	Waste Permit 2.5.2	2.3.4	Monthly for clean water diversions Weekly for Mine Process Water Systems	Quarterly
	Fish weir	Signs of damage or potential damage	Waste Permit 2.5.1	2.3.4	2/year	Quarterly
Waste Rock Management						
Quantity	Waste rock and construction stockpiles	Volume placed in dumps, placed in stockpiles, or used for construction or cover	Waste Permit 2.5.9	2.4.2	Daily	Quarterly
Geochemical Monitoring	Geological and geochemical characterization of Blast hole cutting	As specified in the *Waste Rock Management Plan* (TAK 2020).	Waste Permit 2.5.1	2.4.3	As scheduled	Quarterly
Visual Monitoring	Waste rock dumps	Signs of damage or potential damage; escape of waste or leachate or any unauthorized waste disposal; damage to the structural integrity of a containment structure or diversion structure; evidence of death or stress to wildlife, or vegetation; inspections to ensure geological properties are appropriate for designated location or use; inspections for waste rock dump fires or “hot spots”	Waste Permit 2.5.2	2.4.4	Weekly	Quarterly
Tailings Management						
Quantity	Tailings Storage Facility (TSF)	Volume of tailings produced and placed in TSF	Waste Permit 2.5.9	2.5.2	Daily	Quarterly
Geochemical Monitoring	Final tailings slurry	Percent iron, lead and zinc composition	Waste Permit 2.5.1	2.5.3	Continuous	Quarterly
Visual Monitoring	TSF, Main Dam, Back Dam	Signs of damage or potential damage, structural integrity of diversion ditches, evidence of death or stress to wildlife or vegetation	Waste Permit 2.5.2	2.5.4	Weekly	Quarterly
Inert Solid Waste Landfill						
Quantity	Landfill	Volume of solid waste placed in landfills	Waste Permit 2.5.1	2.6.2	1/year	Annual

Monitoring Program Element	Location	Parameters	Stipulation[2]	Plan Section	Monitoring Frequency	Reporting Frequency
Mining and Milling Activities						
Quantity	Mine site	Quantity of ore produced, waste rock removed and tailings produced	Waste Permit 2.5.1	2.7	Daily	Quarterly
Reclamation						
Area	Areas disturbed and reclaimed throughout mine site	Size of areas disturbed and reclaimed	Waste Permit 2.5.1	2.8.2	As scheduled	Annual
Research	Reclamation test plots and reclaimed areas	Various monitoring to assess effectiveness of reclamation research	Waste Permit 2.5.1	2.8.3	As scheduled	Annual
Visual Monitoring	Reclaimed areas	Soil properties, plant density and survival, plant cover and taxonomic richness, plant vigor	Waste Permit 2.5.1	2.8.3	As scheduled	Annual
Dust Monitoring						
Risk Management Plan (RMP)	Mine site	As specified in the RMP	Waste Permit 2.5.1	2.9	RMP	Annual
Wildlife Monitoring						
Wildlife	Mine site	Wildlife interactions and casualties	Waste Permit 2.5.14, 2.6.6	2.10	Weekly	Quarterly

Project Description

Red Dog Mine is located in northwestern Alaska, approximately 82 miles north of Kotzebue, and 46 miles inland from the coast of the Chukchi Sea. The Mine is located on the Middle Fork of Red Dog Creek in the DeLong Mountains of the western Brooks Range, on private land owned by NANA Regional Corporation, Inc. (NANA). Support facilities are situated on both State and NANA lands. The Mine is a joint venture between NANA and TAK, whereby TAK is the operator and NANA is the landowner.

The operation consists of an open pit zinc-lead mine, mill, and support facilities. Construction of the mill began in 1988, with the first ore delivered to the mill in November 1989. Conventional drill and blast mining methods are employed. Mineral processing facilities use conventional grinding and sulfide flotation methods to produce zinc and lead concentrates. The concentrates are shipped to markets in North America, Europe, and Asia from the DeLong Mountain Regional Transportation System (DMST) Port facility located on the Chukchi Sea. The Port is accessed via the 52-mile DMTS haul road, owned by the Alaska Industrial Development and Export Authority.

Ore and host rocks of the mine contain high concentrations of sulfide minerals, and the majority of the waste rock is acid generating, potentially acid generating, or has potential for metal leaching. Water from the Main Pit / Main Pit Dump (MPD) and Aqqaluk Pit are collected in the Tailing Storage Facility (TSF). Water from the Main Waste Dump (MWD) is partially captured in the Main Waste Dump Collection System with the remainder reporting to the TSF. Water from the MWD Collection System is pre-treated and discharged to the TSF in the summer and winter. During the open water season (normally May to October), water from the TSF is treated and discharged to the Middle Fork of Red Dog Creek (Outfall 001). Water is not discharged during the remaining months.

Environmental Management

TAK actively complies with over 150 permits, regulations, agreements and environmental plans that contain more than 6,000 individual stipulations, involving over 27,000 tasks that must be met on a daily, weekly, monthly, quarterly, and/or annual basis.

To facilitate management of these tasks, TAK maintains and operates a web-based environmental management system that tracks daily compliance tasks that must be completed; tracks environmental and safety incidents and required corrective and preventive actions; and provides environmental training materials, records, and information on overall environmental performance. This tool is essential in ensuring that the monitoring included in this Plan is completed as required and consistent with stipulations in permits, regulations, plans, and company site-specific operating procedures.

TAK also maintains an environmental management database that stores environmental data, such as water quality data, and includes a system for managing environmental sampling results, including scheduling and preparation of Chain of Custody forms. The database also tracks receipt of data from contract laboratories to ensure that all requested analyses are received, as well as compliance with permit and regulatory standards.

Operations Monitoring

Water Quality and Biomonitoring Program

Biomonitoring in the Red Dog Creek area was initiated in 1990 with fish tissue sampling and expanded to the Bons Creek area in 2004. In 1996, invertebrate and periphyton sampling were added. Programs were updated in 2007 by the Alaska Department of Fish & Game (ADFG) in consultation with TAK. The programs include a combination of aquatic life and water quality monitoring with data collected at varying frequencies and reported annually (refer to Table 1).

Key Elements of the Monitoring Program

Key elements of the water quality and biomonitoring programs include:

- Aquatic life and ambient water quality monitoring within the Bons Creek drainage and

Evaingiknuk Creek, Anxiety Ridge Creek and Buddy Creek, simply referred to as the Bons Creek Monitoring Program.

- Aquatic life and ambient water quality monitoring within the Red Dog Creek drainage, Ikalukrok Creek and Wulik River, simply referred to as the Mine Drainage Monitoring Program.
- Additional monitoring of water quality and flow at select Mine Drainage stations related to discharge from Outfall 001.
- Flow measurements at selected sites in the Mine Drainage Program.

Sampling locations for the above-listed program are shown on Figure 2, 3, and 4. Details of the monitoring program are provided in the following sections.

Water Quality Profiles

Table 2 lists the analytical parameters included in the water quality profiles referenced in Sections 2.1.3 and 2.1.4.

Bons Creek Monitoring Program

An augmented aquatic biomonitoring program was implemented in 2004 within the Bons Creek drainage, which included intensive assessment from 2004 through 2006 to establish current baseline conditions. The current baseline assessment included collection and analysis of fish tissues, evaluations of fish distributions and population estimates, and invertebrate and periphyton sampling in Bons Creek, Bons Reservoir and Buddy Creek.

Tissue sampling of juvenile Dolly Varden in Anxiety Ridge Creek has been conducted since 1993, and continued nearly annually since 1998[33]. Tissue sampling of juvenile Dolly Varden in Buddy Creek was initiated in 2002.

[3] William Morris, ADF&G. Red Dog Biomonitoring (personal communication August 5, 2014).

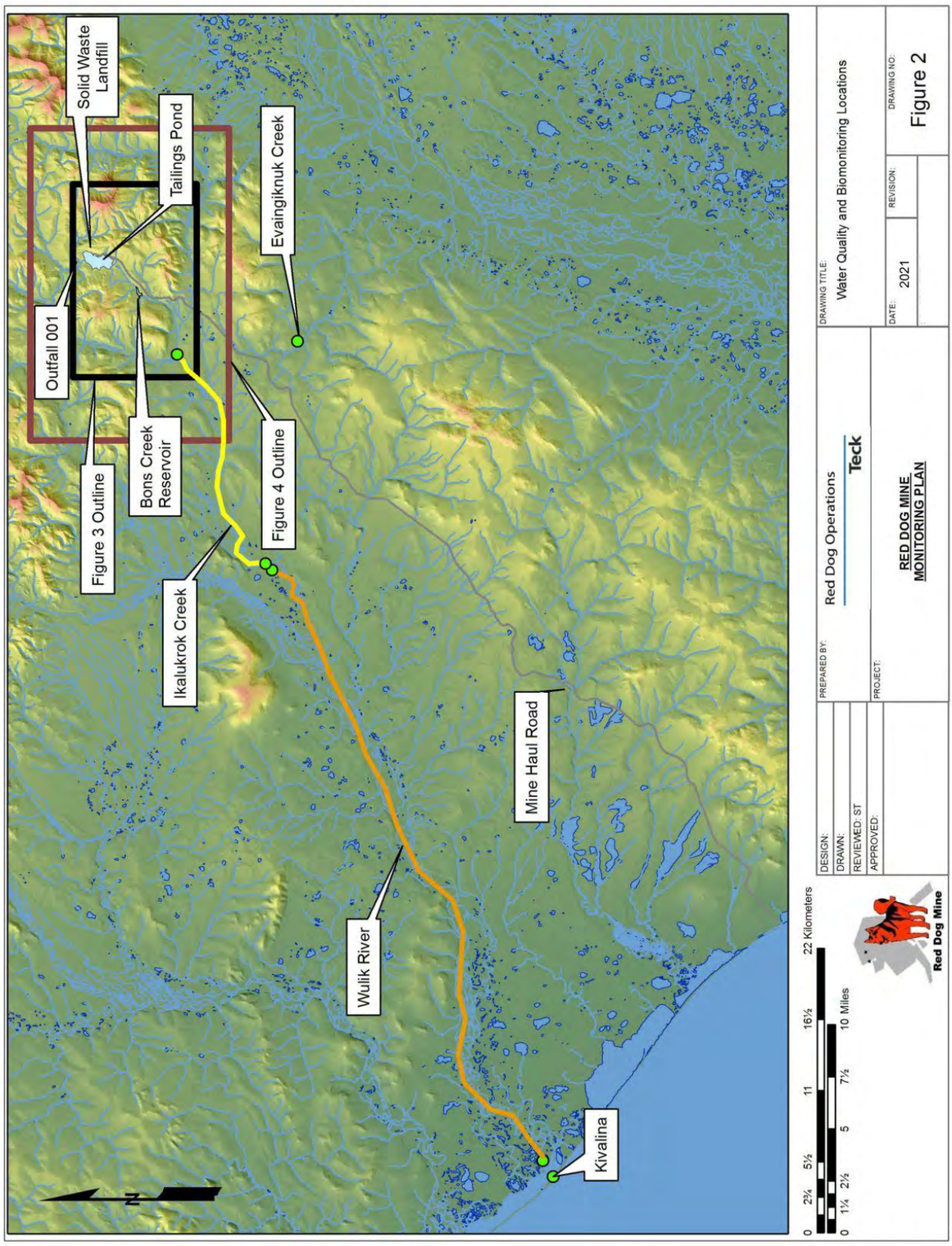


Figure 2: Water Quality and Biomonitoring Locations

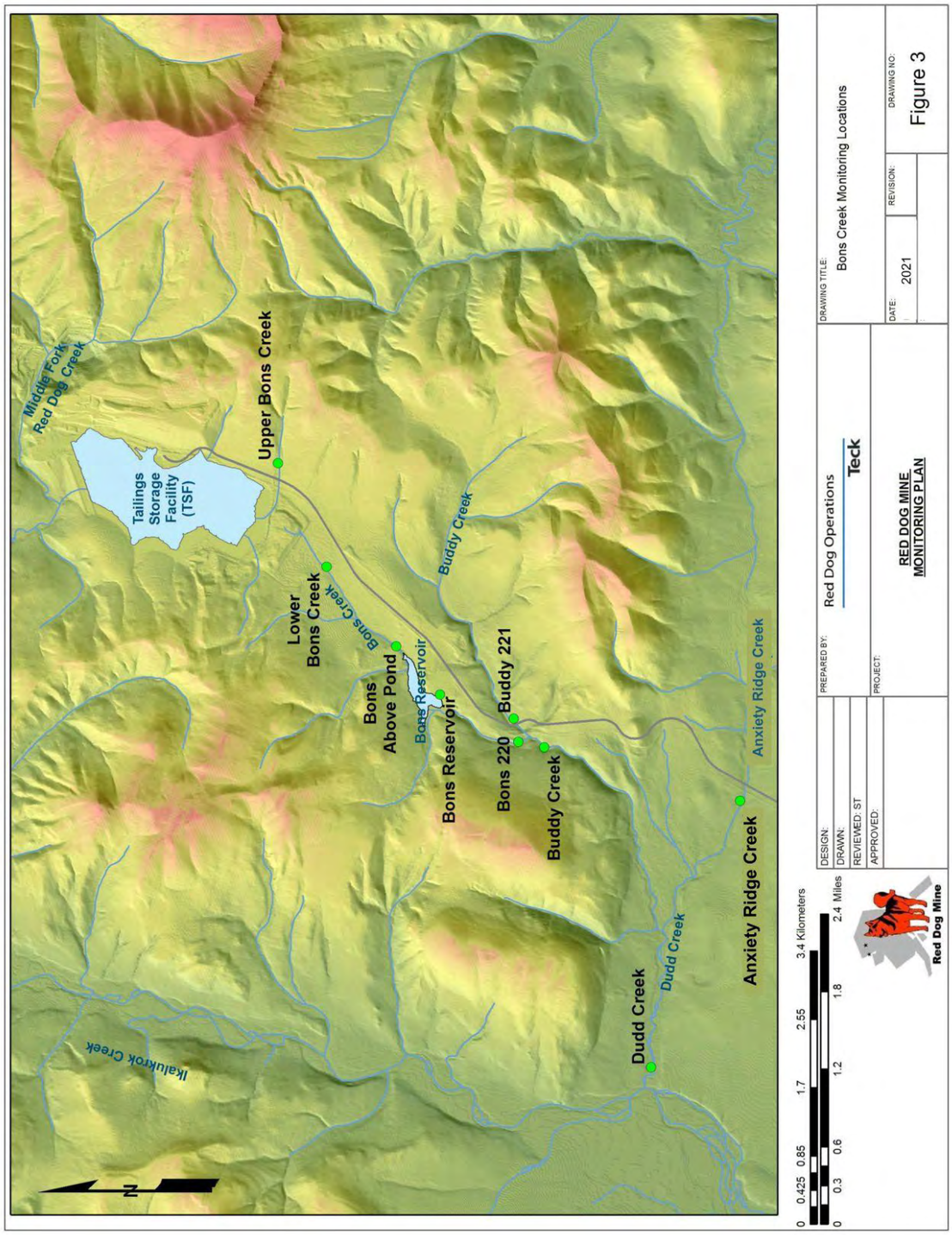


Figure 3: Bons Creek Monitoring Locations

Locations included in the Bons Creek biomonitoring program are shown in Figure 2 and Figure 3 and listed in Table 3. Table 3 also includes a description of the locations and the type of monitoring conducted at each location. Water quality parameters are discussed in Section 2.1.2.

Table 2: Water Quality Profiles

Monitoring Profile	Parameters
Profile I Ambient surface water quality monitored as part of the Biomonitoring Program	Aluminum[1] Calcium[1] Cadmium[1] Chloride[1] Iron[1] Potassium[1] Magnesium[1] Sodium[1] Lead[1] Selenium[1] Zinc[1] Alkalinity Total Dissolved Solids (TDS) Total Suspended Solids (TSS) Sulfate (SO_4) pH Temperature Conductivity
Profile II Water quality monitored as part of the Mine Water Management Program	Aluminum[2] Calcium[2] Cadmium[2] Copper[2] Chloride[2] Iron[2] Potassium[2] Magnesium[2] Manganese[2] Sodium[2] Lead[2] Zinc[2] Ammonia Nitrogen (NH_3-N) Acidity Total Dissolved Solids (TDS) Sulfate (SO_4) pH Temperature Conductivity

Notes: 1. Total recoverable metals
2. Dissolved metals

Table 3: Monitoring Locations in the Bons Creek Drainage

Location	Location Description	Sampling Frequency[1]	Parameters
Buddy Creek	Below falls	1/year	Periphyton[2]
		1/year	Aquatic invertebrates[3]
		1/year	Fish presence and use
		2/month	Water Quality Profile I
		1/year	Juvenile Dolly Varden metals in tissue[4]
Buddy 221	Buddy Creek, above road	1/year	Periphyton[2]
		1/year	Aquatic invertebrates[3]
		2/month	Water Quality Profile I
Bons 220	Bons Creek, below pond[5]	1/year	Periphyton[2]
		1/year	Aquatic invertebrates[3]
		2/month	Water Quality Profile I
Bons Above Pond	Above pond[5]	1/year	Periphyton[2]
		1/year	Aquatic invertebrates[3]
Anxiety Ridge Creek[6]	Below DMTS road	1/year	Fish presence and use
		1/year	Juvenile Dolly Varden metals in tissue[4]
Evaingiknuk Creek[6]	East of DMTS road	1/year	Fish presence and use
Lower Bons Creek	Below Overburden Dump Collection System	2/month	Water Quality Profile I
Upper Bons Creek	Above haul road	2/month	Water Quality Profile I
Bons Reservoir	Above reservoir spillway	2/month	Water Quality Profile I
		1/year	Juvenile Arctic grayling metals in tissue[6]
		1/year	Arctic grayling population estimate
Dudd Creek[6]	Above mouth	2/month	Water Quality Profile I

Notes:

1. Sampling conducted according to current Red Dog Mine APDES requirements
2. Periphyton as Chlorophyll-a concentrations, in July.
3. Aquatic invertebrates monitored for taxonomic richness, abundance, and density, in July.
4. Metals analyzed in fish tissue: Zn, Pb, Se, Hg, and Cd.
5. The “pond” is the freshwater reservoir, referred to as Bons Pond, in the Bons Creek drainage.
6 Monitoring location is outside the jurisdiction of the waste management permit boundary.

Mine Drainage Monitoring Program

Biomonitoring has been carried out in Red Dog Creek since 1990 with fish tissue sampling. Invertebrate and periphyton sampling was added in 1996. The program is designed to monitor and evaluate changes that may occur as a result of activities associated with wastewater discharge from the mine.

- Locations included in the Red Dog Creek biomonitoring program are shown in Figure 2 and Figure 4 and listed in Table 4. Table 4 also includes a description of the locations and the type of monitoring conducted at each location.
- Water quality profiles are discussed in Section 2.1.2.

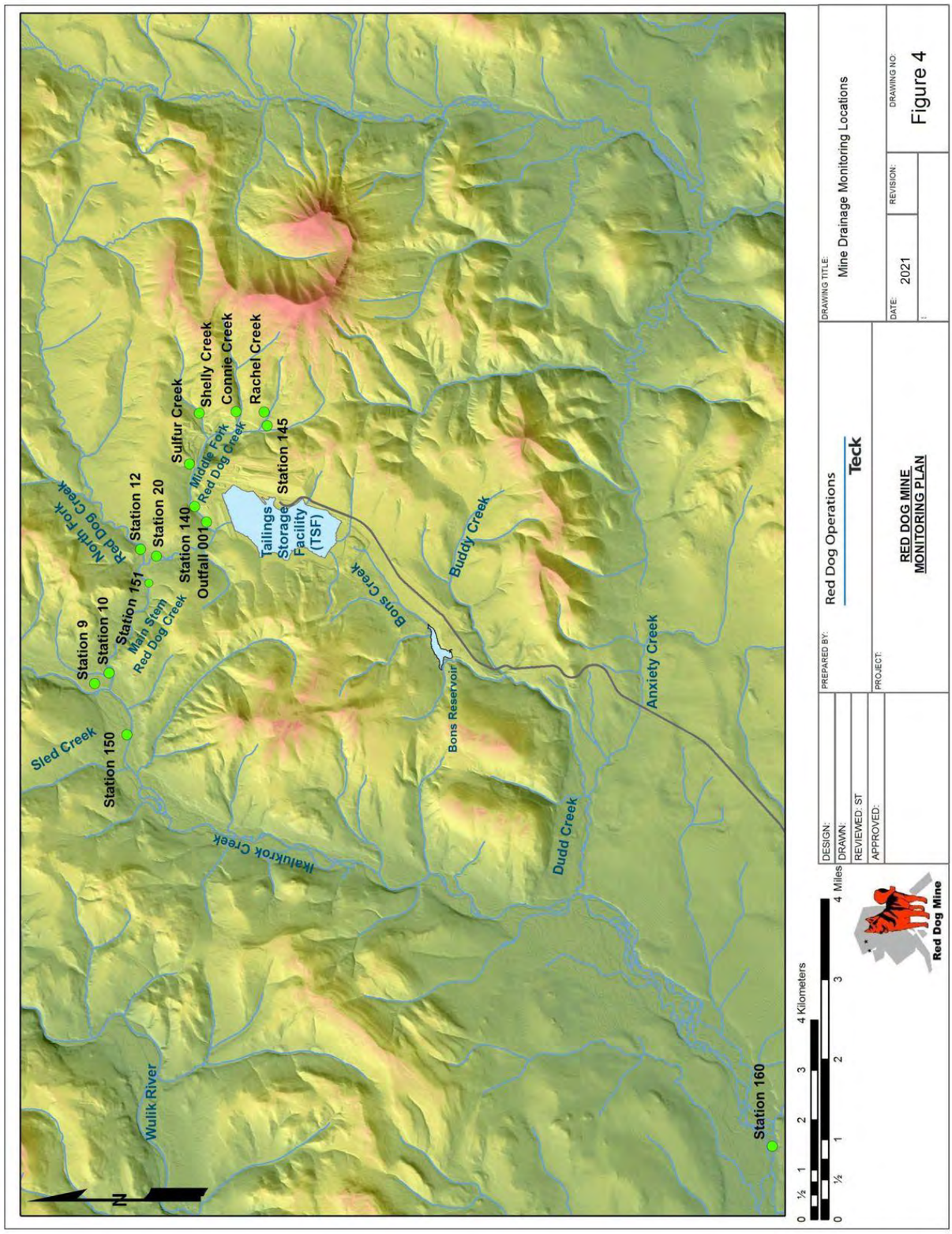


Figure 4: Mine Drainage Monitoring Locations

Table 4: Monitoring Locations and Parameters Monitored in the Mine Drainage Monitoring Program

Location	Location Description	Sampling Frequency[1]	Parameters
Wulik River[2]	Kivalina Lagoon upstream to about 6 miles upstream of the mouth of Ikalukrok Creek	1/year	Dolly Varden (fall aerial surveys)
Ikalukrok Creek[2]	Lower Ikalukrok Creek to mouth of Dudd Creek	1/year	Chum salmon (fall aerial adult surveys)
Station 151[5]	Downstream edge of mixing zone in Red Dog Creek	Varies, weekly to bi-weekly refer to APDES permit	Water Quality Profile[8]
Station 140[5]	Middle Fork Red Dog Creek upstream of the influence of Outfall 001	Varies, weekly to bi-weekly refer to APDES permit	Water Quality Profile[8]
Station 150[5]	Ikalukrok Creek below confluence with Red Dog Creek	Varies, weekly to bi-weekly	Water Quality Profile[8]
		1/month	Water Quality Profile I
Station 145	Upper Middle Fork Red Dog Creek	1/month	Water Quality Profile I
Rachel Creek	Tributary to Red Dog Creek	1/month	Water Quality Profile I
Connie Creek	Tributary to Red Dog Creek	1/month	Water Quality Profile I
Shelly Creek	Tributary to Red Dog Creek	1/month	Water Quality Profile I
Sulfur Creek	Tributary to Red Dog Creek	1/month	Water Quality Profile I
Station 9[2]	Ikalukrok Creek upstream of confluence with Red Dog Creek	1/year	Periphyton[2]
		1/year	Aquatic invertebrates[3]
		1/year	Fish presence and use
		2/month	Water Quality Profile I
Station 160[2, 5]	Lower Ikalukrok Creek	Varies, weekly to bi-weekly	Water Quality Profile[8]
		1/year	Periphyton[3]
		1/year	Aquatic invertebrates[4]
		1/year	Fish presence and use
Station 20	Middle Fork Red Dog Creek upstream of the confluence with North Fork Red Dog Creek	1/year	Periphyton[3]
		1/year	Aquatic invertebrates[4]
Station 10[2, 6]	Mouth of Red Dog Creek	1/year	Periphyton[3]
		1/year	Aquatic invertebrates[4]
		1/year	Fish presence and use
		1/year	Juvenile Dolly Varden metals in tissue[7]
Station 12[5]	North Fork Red Dog Creek	2/month	Water Quality Profile[8]
		1/year	Periphyton[3]
		1/year	Aquatic invertebrates[4]
		1/year	Fish presence and use
		1/year	Record of spawning activity
		1/year	Capture/mark Arctic grayling

Notes: 1. Samples conducted according to current Red Dog Mine APDES requirements.
2. Monitoring location is outside the jurisdiction of the waste management permit boundary but has been included here for reference and program completeness.
3. Periphyton as Chlorophyll-a concentrations.
4. Aquatic invertebrates monitored for taxonomic richness, abundance, and density.
5. Ambient water quality is monitored at Stations 12, 140, 150, 151, and 160 under Red Dog Mine APDES permit #AK-003865-2.
6. Ambient water quality and stream gauge flow to support aquatic life monitoring for Station 10 is obtained from Station 151 under Red Dog Mine APDES permit #AK-003865-2.
7. Metals analyzed in fish tissue: Zn, Pb, Se, Hg, and Cd.
8. See Red Dog Mine APDES permit #AK-003865-2 for parameters.

Permafrost and Sub-permafrost Groundwater Monitoring

Groundwater monitoring is performed as part of the Groundwater Supplemental Environmental Project (SEP) for the Mine. Activities associated with the Groundwater SEP are outlined in Appendix B of the Consent Decree between Cominco Alaska Incorporated (now TAK) and the United States Environmental Protection Agency (EPA), entered on November 25, 1997 (U.S. v. Cominco Alaska Incorporated, Civil Action A97-267CV).

Results of Phase I and II of the SEP were used to develop a detailed understanding of permafrost and groundwater conditions in the vicinity of the TSF, and were the basis for the development of the *Long-Term Permafrost and Groundwater Monitoring Plan for the Tailing Impoundment* (WMCI 2001a), approved by EPA on January 11, 2002. The WMCI (2001) Plan was implemented under Phase III of the SEP and serves as the foundation of the monitoring program outlined here. Results from the first five years of monitoring were reported by Geomatrix (2007). The results included

recommendations for minor refinements to the program. No changes to the monitoring program were made based on the second five-year analysis (AMEC 2012).

Key Elements of the Monitoring Program

Key Elements of the Permafrost and Sub-permafrost Groundwater Monitoring Program include:

- Quarterly monitoring of background and dam area thermistors to assess trends in temperature changes in the permafrost.
- Quarterly monitoring of background and dam area piezometers to assess water levels and gradients.
- An annual data report.
- A detailed assessment of subsurface trends and conditions every five years, including an evaluation of the requirement to update the thermal and numerical flow model developed as part of the SEP.

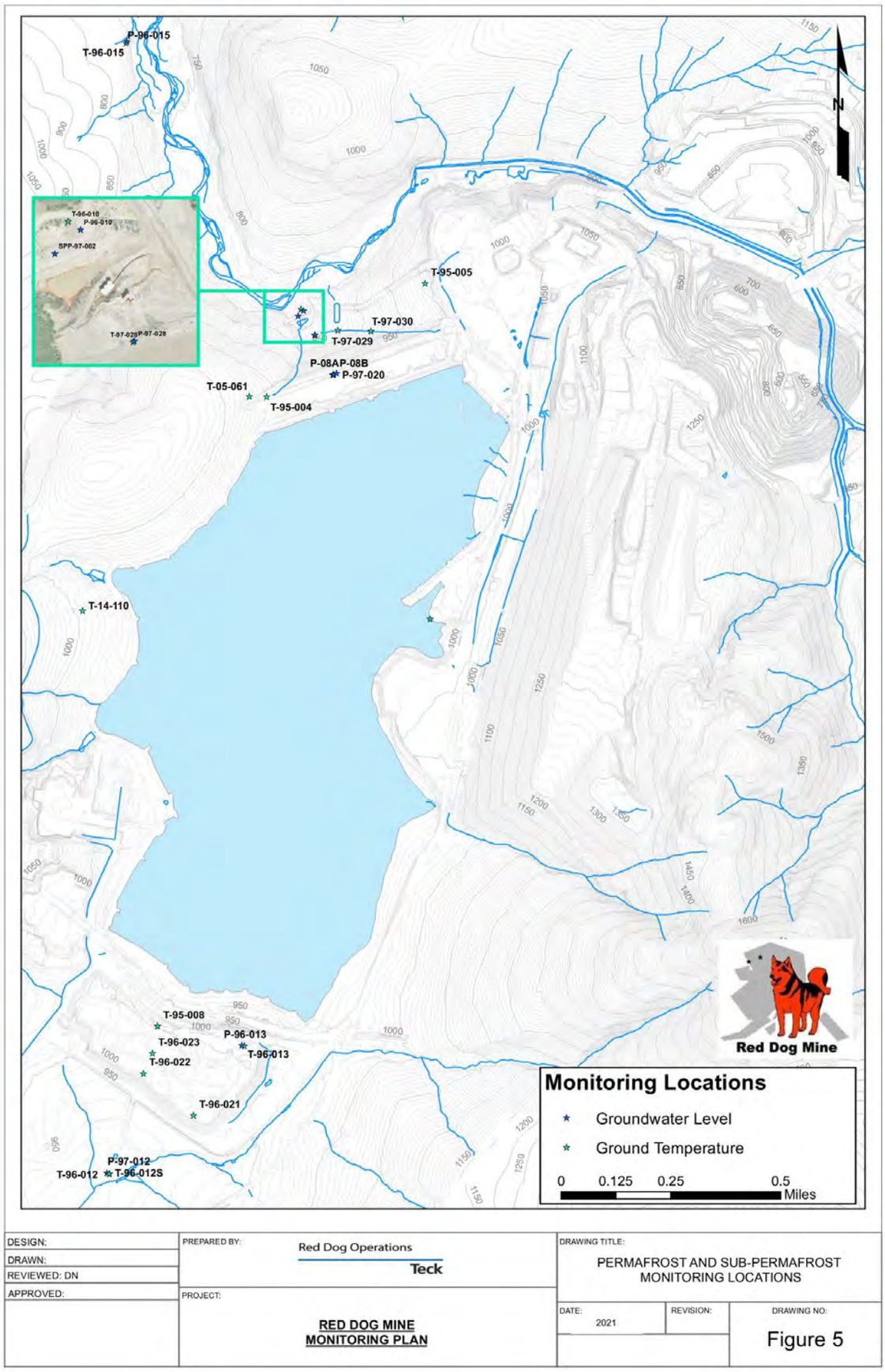
Groundwater monitoring shall continue for thirty years after the cessation of mining and/or milling operations unless it can be shown with at least ten years of data from the monitoring program and other relevant data that there is no reasonable potential that waters from the TSF are being, or could be, discharged into groundwater connected with waters of the United States, other than as allowed by permit.

Permafrost and Subsurface Temperature Monitoring

Thermal modeling of the tailings impoundment performed during Phase II of the SEP indicated that the thermal impact of the TSF may affect the underlying permafrost. Long-term monitoring of subsurface temperatures is focused on collecting data sufficient to allow a continuing assessment of the subsurface thermal regime. Locations used to monitor long-term permafrost and subsurface temperatures are shown on Figure 5 and listed in Table 5.

Sub-permafrost Groundwater Level Monitoring

Data and analyses developed as part of the SEP demonstrated with relative certainty that virtually all shallow flow originating from the TSF is collected within the dam seepage collection system, and that no vertical flow is occurring between the impoundment and the sub-permafrost system. Because the SEP analysis did not indicate that any seepage pathways existed from the TSF, groundwater monitoring is not based on seepage pathways, but rather on assessing any changes over time from observed conditions. The focus of the groundwater monitoring system is therefore based on monitoring water level changes over time as a means to assess potential changes from baseline conditions. Monitoring locations used to measure groundwater levels are shown in Figure 5 and listed in Table 6.



.Figure 5: Permafrost and Sub-permafrost Monitoring Locations

Table 5: Summary of Ground Temperature Monitoring

Thermistor	Data Objective	Sampling Frequency
Red Dog Creek		
T-96-015	Monitors background permafrost temperatures down-gradient of dam within Red Dog Creek alluvium	1/quarter
Dam Area		
T-05-061	T-05-061 will be monitored concurrently with T-95-004 until instrumentation or site access inhibits the use of T-95-004. At such time T-05-061 will become the primary thermistor for monitoring permafrost conditions in the vicinity of the west abutment of the dam.	1/quarter
T-95-005	Monitors background permafrost temperatures in dam area	1/quarter
T-96-010	Monitors permafrost temperatures in seepage dam area	1/quarter
T-97-028	Monitors subsurface temperatures within zone where permafrost is absent	1/quarter
T-97-029	Monitors permafrost temperatures along toe of dam	1/quarter
T-97-030	Monitors subsurface temperatures within zone where permafrost is absent	1/quarter
Tailings Storage Facility		
T-14-110	T-14-110 replaced T-95-009. T-95-009 was inundated by rising pond water.	1/quarter
Overburden Dump		
T-95-008	Monitors subsurface temperatures within Overburden Dump	1/quarter
T-96-013	Monitors subsurface temperatures within Overburden Dump	1/quarter
T-96-021	Monitors subsurface temperatures within Overburden Dump	1/quarter
T-96-022	Monitors subsurface temperatures within Overburden Dump	1/quarter
T-96-023	Monitors subsurface temperatures within Overburden Dump	1/quarter
Bons Creek		
T-96-012	Monitors background permafrost temperatures along Bons Creek	1/quarter
T-96-012S	Monitors shallow subsurface temperatures along Bons Creek	1/quarter

Table 6: Summary of Groundwater Level Monitoring

Piezometer	Data Objective	Sampling Frequency
Red Dog Creek		
P-96-015	Monitors sub-permafrost water levels along Red Dog Creek	1/quarter
Dam Area		
P-08A	Monitors shallow water levels within dam drain area	1/quarter
P-08B	Monitors shallow water levels within dam drain area	1/quarter
P-96-010	Monitors sub-permafrost groundwater within dam area	1/quarter
P-97-020	Monitors groundwater in area where permafrost is absent	1/quarter
P-97-028	Monitors shallow water levels down-gradient of dam toe	1/quarter
SPP-97-002	Monitors shallow water levels in seepage dam area	1/quarter
Overburden Dump		
P-96-013	Monitors sub-permafrost water levels in Overburden Dump area	1/quarter
Bons Creek		
P-97-012	Monitors sub-permafrost water levels along Bons Creek	1/quarter

Mine Water Management

Mining-impacted water throughout the mine site is collected from waste dumps, the pit, and seepage collection systems and stored in the TSF. Water from the TSF is reclaimed and either used in the milling process or treated in Water Treatment Plant 1 (WTP1) or Water Treatment Plant 2 (WTP2) and subsequently discharged to Red Dog Creek at Outfall 001.

A number of diversion ditches have been constructed at the mine site to divert water that has not been affected by mining activities. The Red Dog Creek Diversion is located east of the MWD and is the largest onsite diversion ditch. It diverts water through mining areas and back into Red Dog Creek. Water from Shelly Creek and Connie Creek is diverted into the Red Dog Creek Diversion. A fish weir is located 1.3 miles downstream of where the Red Dog Creek Diversion returns water to the original Red Dog Creek channel and is designed to prevent upstream fish passage.

Contact water east of the MWD is collected in the Main Pit, Aqqaluk Pit, and the Mine Drainage Collection System. Water from the Aqqaluk Pit is pumped to the Main Pit. Excess water from the Main Pit (Main Pit Dump) will be pumped to the Mine Drainage Collection System or directly to the

TSF once the water level in the pit reaches the appropriate level as specified in the *Red Dog Mine Waste Rock Management Plan* (Teck 2020). Water in the Mine Drainage Collection System flows to the Mine Sump and is then pumped to the TSF. Depending on season and capacity, a portion of this water may be pre-treated in WTP1 or WTP3.

Water flowing to the west from the MWD is collected in the MWD Collection System, pre- treated in WTP1 or WTP3, and eventually pumped to the TSF.

Water within the TSF watershed, that is not diverted, drains into the TSF. A pump-back system collects runoff from the south side of the Overburden Dump and pumps it to the TSF. Mine water inputs to the TSF include:

- tailings
- water treatment sludge
- treated water from WTP3

Outflows from TSF include:

- seepage, which is pumped back to the TSF
- water that is treated and discharged at Outfall 001

Freshwater used for potable water, reagent mixing, cooling and other purposes is obtained from the Bons Creek Reservoir, located within the Bons Creek drainage.

TAK maintains a large number of flow and water quality sampling sites throughout the mine site to effectively monitor and manage water. In addition, water and load balances have been created and are maintained to model flows and chemical loads throughout the mine site. Monitoring conducted under the Mine Water Management Program is described below.

Key Elements of the Monitoring Program

Key elements of the Mine Water Management Program consist of the following:

- Flow monitoring at locations throughout the mine site
- Monitoring of water quality at locations throughout the mine site
- Water and load balances to model flows and associated chemical loadings
- Weekly visual monitoring of water management facilities
- Inspections of fish weir twice per year by a qualified professional

Details of the monitoring program are provided in the following sections.

Flow and Water Quality Monitoring

Red Dog Operations currently maintains several flow meters that record volumes of each of the main flows in and out of the TSF. Water quality associated with flows into and out of the TSF is also monitored. This information is used in the water and load balances.

Locations monitored and the period and frequency of monitoring are shown in Figure 6 and summarized in Table 7. Water quality parameters and profiles are discussed in Section 2.1.2. Inputs and outputs of the Water Treatment Plants vary with the needs of the operation and will be sampled based upon water treatment plant utilization.

Water and Load Balances

A water and load balance model for the site is maintained by TAK. The most recent and accurate analytical and modeling tools being used by the mine will be used to measure and report water and load balances. A summary of key results will be presented in the annual reports.

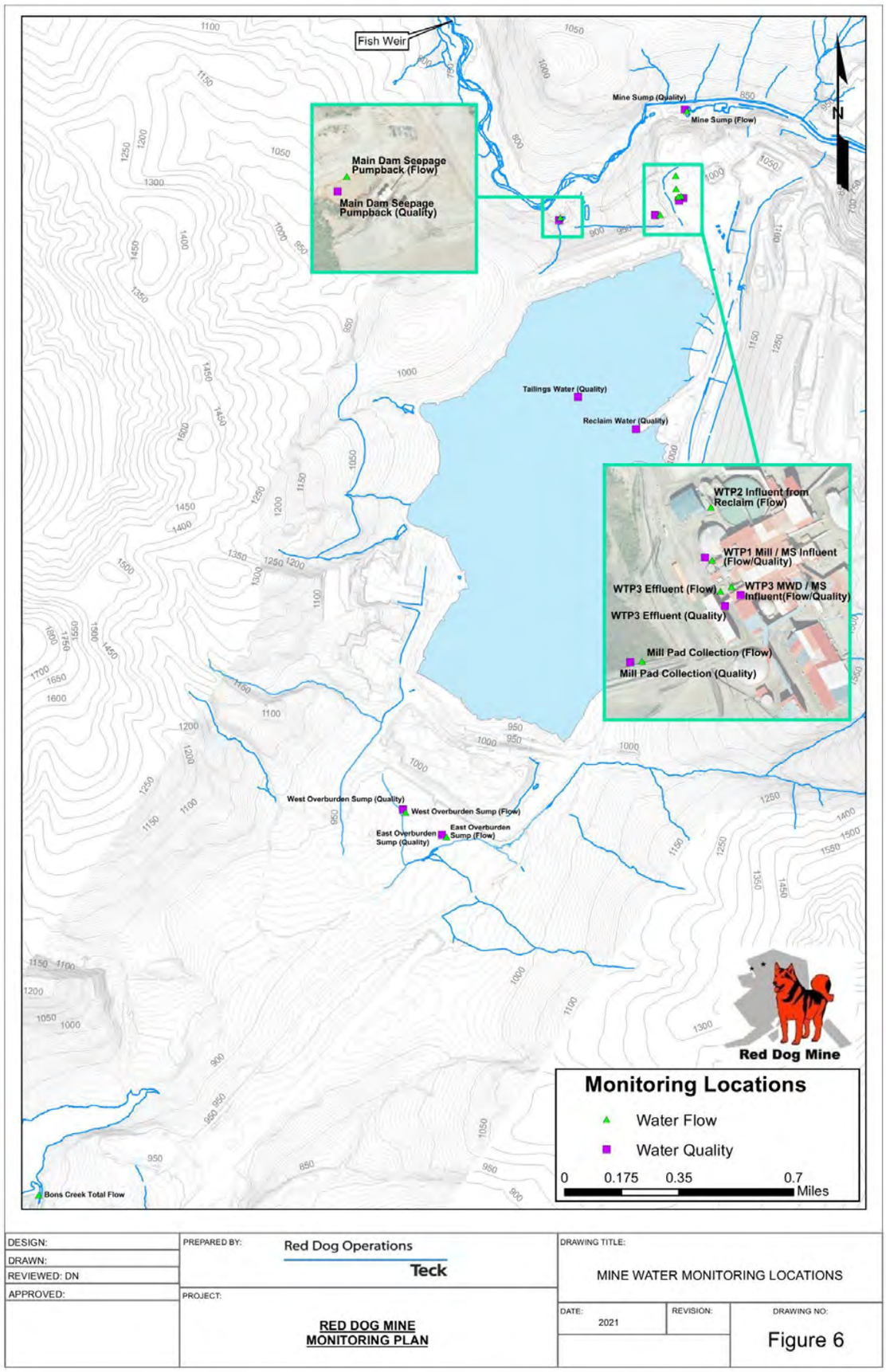


Figure 6: Mine Water Monitoring Locations

Table 7: Mine Water Monitoring Stations

Location	Description	Sampling Frequency[1]	Parameters	Measured Quantity[1]
Main Dam Seepage Pumpback	Main (tailings) Dam seepage water to TSF	1/month	Water Quality Profile II	Total Monthly Gallons
Bons Creek Total Flow	Total withdrawal from Bons Creek reservoir	Water quality not required (flow used in Mill water balance)		Total Monthly Gallons
East Overburden Sump	Runoff from Overburden Dump	1/month	Water Quality Profile II	Total Monthly Gallons
West Overburden Sump	Runoff from Overburden Dump	1/month	Water Quality Profile II	Total Monthly Gallons
Tailings Water	Tailings supernatant discharged to the TSF	1/month	Water Quality Profile II	Calculated[2]
Reclaim Water	TSF water	1/month	Water Quality Profile II	N/A[3,4]
WTP1/Mill Influent from Reclaim[4]	Reclaim water from TSF to WTP1	Water quality equivalent to Reclaim Water location		Total Monthly Gallons
WTP1 Influent from Mine Sump	WTP1 influent from the Mine Water Drainage Collection System	Water quality equivalent to Mine Sump location		Total Monthly Gallons
WTP2 Influent from Reclaim	Reclaim water from TSF to WTP2	Water quality equivalent to Reclaim Water location		Total Monthly Gallons
WTP3 Influent from MWD Collection System	Influent to WTP3 from the Main Waste Dump	1/month	Water Quality Profile II	Total Monthly Gallons
WTP3 Influent from Mine Sump	Influent to WTP3 from the Mine Drainage Collection System	Water quality equivalent to Mine Sump location		Total Monthly Gallons
WTP3 Effluent	Treated effluent from WTP3	1/month	Water Quality Profile II	Calculated[5]
Mine Sump	Water from the Mine Drainage Collection System	1/month	Water Quality Profile II	Total Monthly Gallons
Mill Pad Collection	Runoff from the Mill Pad	1/month	Water Quality Profile II	Total Monthly Gallons

Notes:
1. Sample taken when flow is present.
2. Tailings water volumes calculated from Mill water balance.
3. Reclaim water volumes are accounted for under WTP1 Influent from Reclaim and WTP2 Influent from Reclaim and Process water tank influent from Reclaim.
4. Reclaim water may or may not be treated in WTP1 prior to use in the Mill.
5. WTP3 Effluent = WTP3 Influent from Mine Water Collection + WTP3 Influent from Main Waste Dump.
6. In addition to Water Quality Profile II, samples from this location will also be analyzed for WAD cyanide.

Visual Monitoring

Visual monitoring of the following mine water management facilities will be conducted weekly, unless otherwise noted when flow is present:

- Diversion ditches (monthly, when flow is present)
- Red Dog Creek Diversion (monthly when flow is present)
- Mine Drainage Collection System
- Pipelines and pipeline containment structures
- Main Waste Dump Collection System
- Treated water discharge lines
- Overburden Dump Collection System

The fish weir will be inspected twice per year by a qualified individual.

Waste Rock Management

Waste rock from the Aqqaluk Pit is expected to be placed in the Main Pit Dump. When the Qanaiyaq Pit is mined, waste rock from the first phase is expected to be placed in the MPD and waste rock from the second phase is intended to be placed in the completed first phase of the Qanaiyaq Pit. Waste rock from Aqqaluk Pit may be placed in the second phase of the Qanaiyaq Pit. The MWD is currently not active and has been recontoured (SRK 2016c).

Key Elements of Monitoring Program

Key elements of the Waste Rock Management program consist of the following:

- Monitoring of quantities and locations of waste rock placement

- Geological and geochemical monitoring of waste rock to ensure proper segregation of materials.
- Weekly visual monitoring of facilities

Details of the monitoring program are provided in the following sections.

Quantity of Waste Rock

Waste rock production quantities are monitored daily using reported tonnes hauled from a blasted pit shot. Locations of waste rock placement and quantities of waste rock placed at each location are recorded and will be reported quarterly to ADEC.

Geochemical Monitoring

The *Waste Rock Management Plan* (Teck 2020) outlines criteria and methods for segregating waste rock from the mined areas. Waste rock is segregated into the following categories:

- Rock with low metal leaching and acid rock drainage (ML/ARD) potential suitable for tailings dam construction
- Rock with low ML/ARD potential suitable for cover material.
- Rock with a high sulfide content that is potentially self-heating.
- Rock that does not fit any of these other classifications.

Table 8 summarizes the current waste rock segregation criteria.

Table 8: Current Segregation Criteria

Intended Use/Disposal Location	Allowable Rock Types	Criteria*
Dam Construction	Siksikpuk Shale	Single blast hole assays not to exceed: 1% Zn, 1% Pb, 3.5% Fe Average blast hole assays not to exceed: 0.5% Zn, 0.5% Pb, 2.5% Fe
Cover Material	Kivalina and Kayak Shale of the Key Creek Plate	Material must be from Key Creek structural plate. More than 90% of the material must be comprised of Kivalina and/or Kayak shale, based on visual estimation Must not contain greater than 10% visual percent sulfide over an area of more than 500 m^2. No more than 5 adjacent blast-holes to exceed 0.25% zinc.
High S Waste Rock (placed below the ultimate water level in the Main Pit Dump where possible, or blended to reduce the self-heating capacity)	Typically Ikalukrok	Self-Heating Capacity Risk Region 5 or greater**
Other Waste Rock – placed in Main Pit or Qanaiyaq pit dumps. To maximize space available for underwater disposal of the high S waste, it is preferable to place this material in locations that are above the ultimate water level in the Main Pit Dump	Waste Rock not meeting other criteria	

Notes: *Analytical criteria are only to be applied to the allowable rock type (*i.e.* rock type has precedence).
**Calculated as follows:

Self-Heating Capacity Risk Region = 3.41744 + (%Pb-%sPb) / 0.866 x (-0.33539 + 0.03897 x %Zn / 0.671) - 0.81502 x Log ([%Ba / 0.5886] / [%Fe / 0.4654]).

This equation is based on an empirical relationship between heating capacity (in Joules/gram) and mineralogical data (Nesseteck 2009), and will be modified and refined as more data is gathered by Teck.

Waste rock is segregated by rock type by a geologist and assay of blast hole cuttings. Further detail can be found in the *Red Dog Mine Waste Rock Management Plan* (Teck 2020).

Visual Monitoring

Visual monitoring of un-reclaimed waste rock dumps will be conducted weekly for the following conditions:

- Damage or potential damage to the waste rock dumps from settlement, ponding, thermal instability, frost action, or erosion.
- Escape of waste rock or any unauthorized waste rock disposal.
- Damage to the structural integrity of diversion structures or drainage capture systems.
- Evidence of death or stress to fish, wildlife, or vegetation that might be caused by the waste rock dumps.
- Confirmation that geological properties of the rock are appropriate for the designated storage location or end use.
- Waste rock fires or “hot spots.”

Tailings Management

The *Red Dog Mine Tailings and TSF Water Management Plan* (Teck 2021) describes procedures for management of tailings at the Mine. Disposal of tailings is in the TSF located in the South Fork of Red Dog Creek. TSF monitoring is stipulated in the IWMP.

Key Elements of the Monitoring Program

Key elements of the Tailings Monitoring program include:

- Calculation of quantity of tailings produced and placed and TSF bathymetry.
- Geochemical monitoring of final tailings stream.
- Weekly visual monitoring of the facility.

Additional TSF monitoring includes water quantity and quality monitoring (Mine Water Program Section 2.3.2).

Quantity of Tailings

Tailings production rates are estimated from mill production records, and summarized on a monthly basis.

Geochemical Monitoring

Monitoring of tailings solids will be conducted to determine variability in the geochemical composition of tailings solids over time. Tailings geochemistry is expected to be relatively uniform in comparison to waste rock, due to the methods used to stockpile and blend the ore. An inline analyzer calculates the percent iron, lead, and zinc in the final tailings slurry. Monthly average values of these analyses will be reported quarterly.

Visual Monitoring

Visual Monitoring of the TSF is specified in the Mine Water Management Program; refer to Section 2.3.4 of this Plan.

Inert Solid Waste Landfills

Currently, there is one active inert solid waste landfill at the Mine. The Main Waste Dump Landfill is located within the MWD (Figure 7). The landfill is operated as outlined in the Standard Operating Procedure (SOP) *Landfill, Main Waste Stockpile SOP* (Rev 5).

The former “Old Mine Landfills” were closed out in 2015 and are located within the TSF as depicted in Figure 8 - Red Dog Operations Former "Old Mine Landfill" Location Map.

Key Elements of Monitoring Program

Key elements of the solid waste landfill monitoring program include:

- Calculation of volumes of solid waste placed.
- Monthly visual inspections and random inspections of incoming loads.
- Submission of updated site development and use plans annually.
- Document exact location of landfill trenches and closed trenches.

Details of the monitoring program are provided below.

Quantity of Solid Waste

Estimates of disposal volumes based on fill volume will be conducted and summarized in the Annual Report.

Visual monitoring

Visual monitoring of the landfill includes the following which will be summarized and reported quarterly:

- Monthly visual inspections consistent with the SOPs.
- Inspections for evidence of fire or combustion in the waste
- Random inspections of incoming loads consistent with the current landfill permit.
- Inspections for evidence of death or stress to wildlife or vegetation that might be related to the landfill.

Mining and Milling Activities

Quantities of ore removed and processed, and waste rock and tailings generated are tracked in mine production and milling records and summarized on a monthly basis. Quantities will be reported quarterly to ADEC.

Reclamation Monitoring Program

Two key mine closure methods proposed in the *Red Dog Mine Reclamation and Closure Plan* (SRK 2016a) have been and continue to be tested on site under various programs. These include covers to be placed on various mine waste materials, and revegetation of covered materials and other disturbed land. Concurrent reclamation of some parts of the site will be possible while the mine is still in production, which will include both cover placement and revegetation.

A summary schedule that includes anticipated dates for concurrent reclamation and tailings and water management activities is provided in the *Red Dog Mine Reclamation and Closure Plan* (Teck 2020). In many cases, the precise scheduling of activities will depend on factors that are not fully predictable. The following sections describe monitoring planned for concurrent reclamation projects.

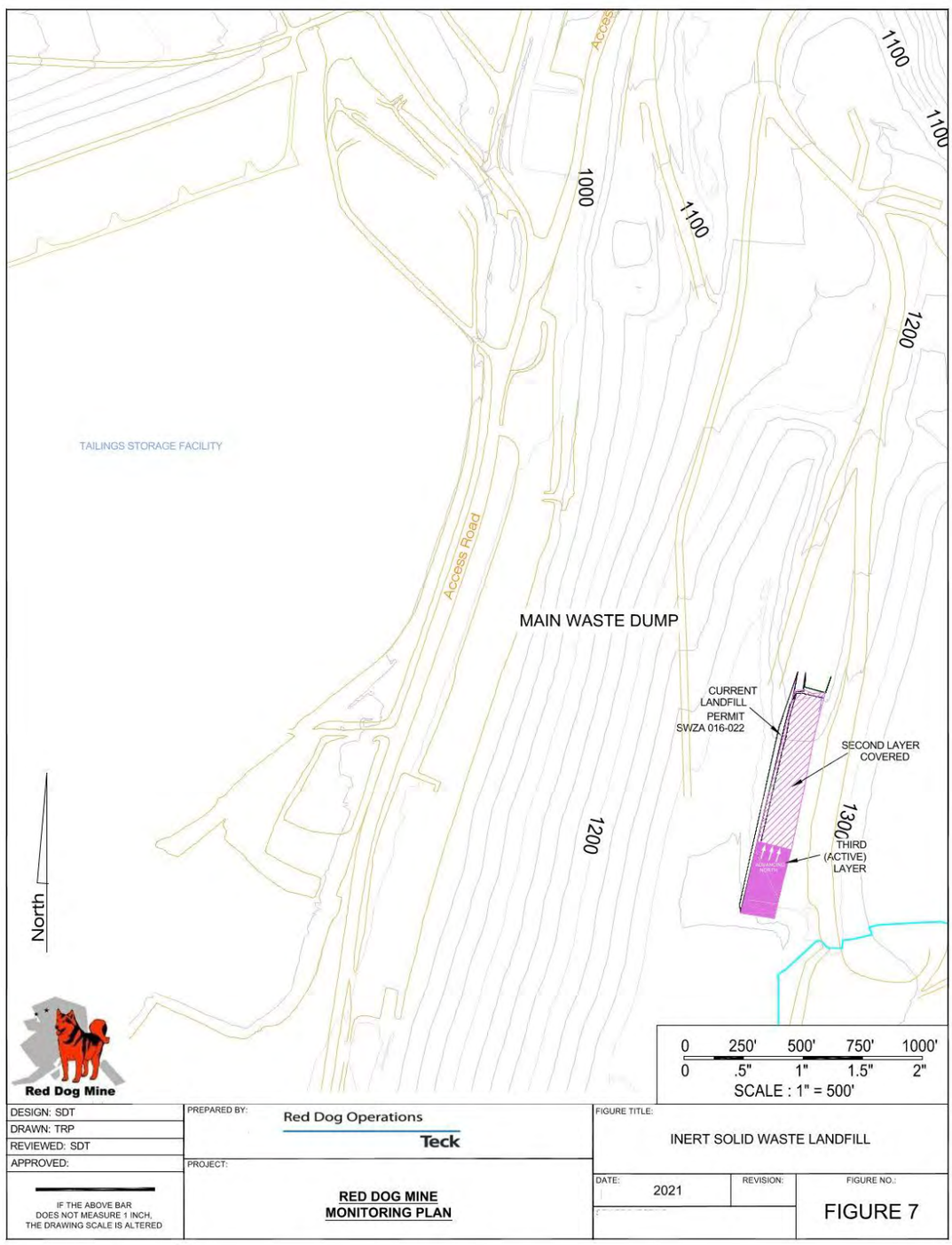


Figure 7: Inert Solid Waste Landfill

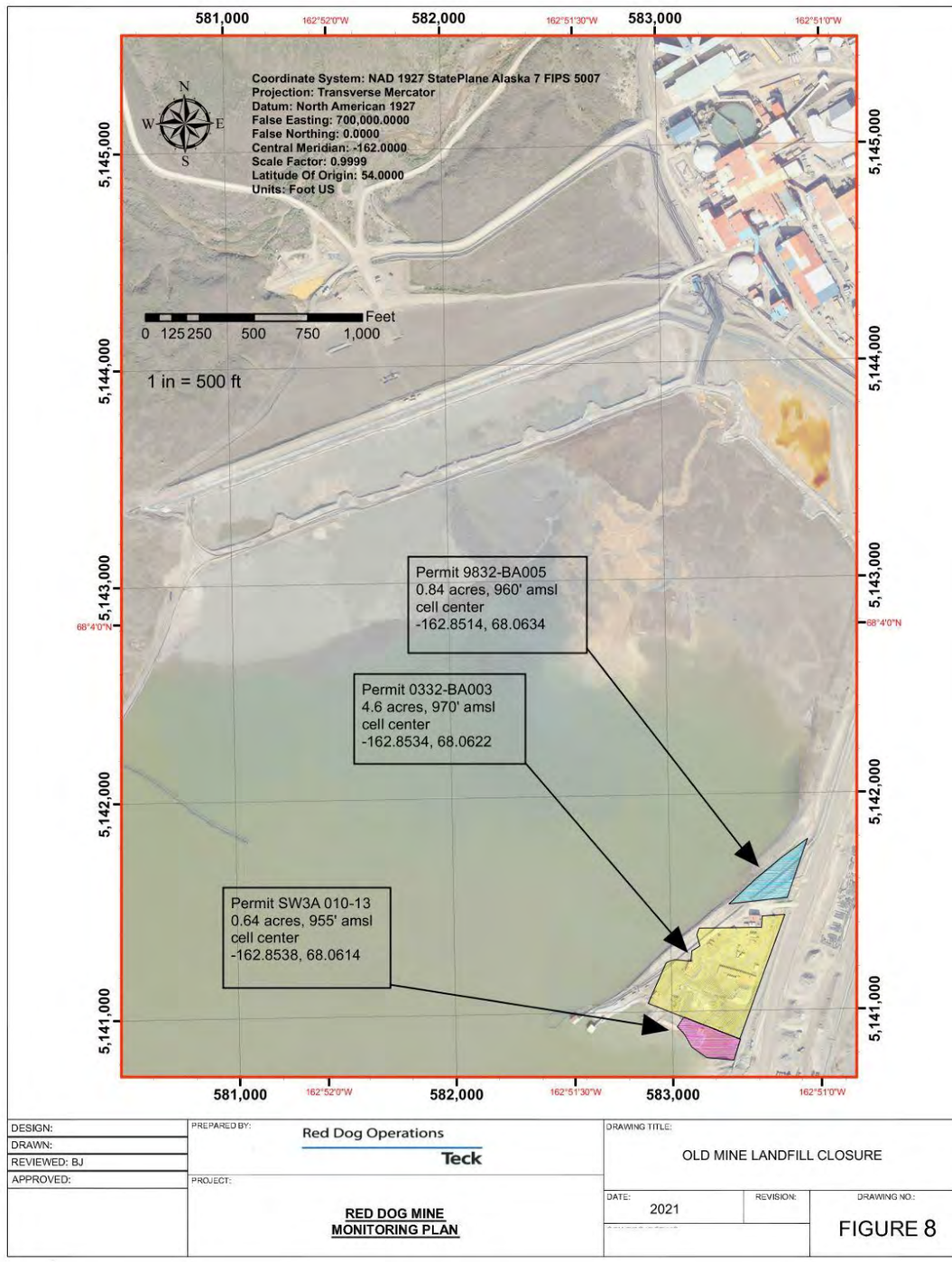


Figure 8: Old Mine Landfill Closure

Key Elements of Monitoring Program

Key elements of the Reclamation Monitoring program include:

- Reporting of areas disturbed and reclaimed
- Research of reclamation methods
- Monitoring of reclamation activities

Areas Disturbed and Reclaimed

The size and locations of areas disturbed and reclaimed are recorded and will be summarized annually. Areas projected for disturbance or reclamation during the next calendar year will be reported annually. Each Annual Report will include a discussion of reclamation actions in sufficient detail, describing reclamation at each location and how it was accomplished.

Reclamation research will continue throughout the life of the operation. Examples may include: Oxide Dump cover instrumentation, seed mixes, transplanting, innovative fertilizers, native species establishment, and native seed collection and propagation. Information on reclamation research conducted during the year and reclamation research planned for the upcoming calendar year will be summarized and reported annually. Any reclamation research data or reports generated will be provided upon request.

Monitoring Approach

The following describes the general approach to monitoring existing revegetation sites and future revegetation undertaken on concurrent reclamation projects.

The success of reclaimed and revegetated areas will be evaluated by measuring parameters that are indicators of overall productivity and habitat quality. The measurements are intended to identify which species are most effectively established in disturbed areas; what factors may be contributing to enhanced or marginal growth; and what kind of recovery can be expected on the various mine disturbances over the long term. This information is needed so that corrective action can be taken in those areas where performance is poor, and to develop performance criteria that can be used to assess the success of revegetation efforts in meeting mine closure objectives.

Soil Properties

To assess the physical and chemical characteristics of reclaimed soils, samples will be collected from 1 to 4 inches in depth for analysis. Parameters measured will include particle size; percent organic matter; carbon and sulfur content; electrical conductivity (EC); cation exchange capacity (CEC); total and exchangeable nitrogen and phosphorous; and exchangeable potassium, sodium, calcium, and magnesium. Levels of micronutrients such as copper, zinc, iron, and manganese will also be measured.

Plant Survival and Density

Plant survival and density will be measured only for transplanted species to assess percent germination and survival in test plots. Density will be measured in one square-meter (m^2) plots, or within belt transects, depending on the size of the assessment area.

Plant Cover and Taxonomic Richness

For most areas, plant cover will be measured along transects using the point-intercept method, plant species are recorded intersecting points at 0.5–1.0-meter (m) intervals delineated along a 50 m or 100 m transect (100 points per transect). The length of each transect will depend on the size of the assessment area.

In some instances, cover may be measured using a point frame. This method is similar to the point intercept method except that sample points are measured within a quadrat (usually 1 m^2) rather than along a transect.

Plant Vigor

Plant vigor is subjectively ranked from 1–9, using the following criteria: plant tissue color, height, flower and/or seed production, and overall health. This ranking system may also be used for assessing the vigor of species in revegetated areas.

Schedule

Soil characteristics will be measured during the first year of seeding (or transplanting), as required depending on the vegetation response following treatment. Soil development occurs very slowly in an Arctic environment due to the low temperatures and short growing season. Thus, monitoring soil characteristics more frequently is unlikely to reveal any measurable differences.

The frequency of evaluating vegetation response will depend on objectives of the revegetation effort. For test plots, assessments would likely be conducted annually for the first three years documenting germination, survival and vigor, and vegetation cover. For mine development units, vegetation will be measured for the first two growing seasons following treatment, with additional monitoring occurring on the same schedule as described for the soils analysis. In some cases (e.g., experimental studies), more frequent monitoring may be required to satisfy specific research objectives. Monitoring will no longer be conducted after an area fulfills the performance standards developed for that unit.

Dust Monitoring

Recognizing that similar efforts to manage dust concerns were underway within a variety of programs, a decision was made to include the mine site within the scope of the area-wide *Fugitive Dust Risk Management Plan* (RMP). Therefore, any monitoring identified in the *Fugitive Dust Risk Management Monitoring Plan* and associated implementation plans, within the physical boundaries of the IWMP, is incorporated by reference into this Plan.

Wildlife Monitoring

TAK has procedures in place for reporting wildlife interactions, issuing wildlife alerts and controlling potential animal attractants. Monitoring of wildlife is conducted as part of the weekly visual monitoring of facilities. Wildlife casualties will be reported to the appropriate state and federal agencies, and the Red Dog Subsistence Committee (if applicable).

Closure Monitoring

The period of intensive mine closure activity, after all mining and processing has ceased, is expected to last approximately two years. The *Red Dog Mine Reclamation Plan* (Teck 2021), indicates that the closure phase is likely to occur in approximately 2032. Concurrent reclamation of some disturbed land can be undertaken while production continues, and this will be done wherever reclamation would not be affected by planned or potential future operations.

Project-specific closure monitoring programs will be designed and implemented for each reclamation task. The discontinuation of mining and implementation of closure activities will bring about changes to the Plan, as follows:

- Some additional localized surface water monitoring for specific closure projects, such as sedimentation monitoring.
- Discontinuation of tailings and waste rock monitoring.
- Modifications to flow and water quality monitoring and water and load balances according to changes associated with closure[4].
- Implementation of performance monitoring programs for specific closure measures.

[4] Water and load balances will continue to be maintained after mining operations cease.

Post Reclamation Monitoring

The “post reclamation” phase of the project begins immediately after the period of intensive reclamation activities. The current plan is for post reclamation phase to start in 2033. This period has no definite endpoint but can be considered in three general phases with respect to required monitoring: Phase 1: 0 to 5 years after closure; Phase 2: 5-30 years after closure; and Phase 3: more than 30 years after closure. It is anticipated that many aspects of the existing monitoring will continue, with the possible modifications provided below:

0 to 5 Years after Closure

- Reduction in monitoring of physical stability of dams where risk of failure is reduced following closure.
- Addition of water quality monitoring of pit water once pit is flooded.
- Reduction of visual monitoring of closed waste management facilities and elimination of monitoring of decommissioned structures.
- Closure performance monitoring, based on annual assessments.

5 to 30 Years after Closure

- Reduction of monitoring of permafrost and sub-permafrost groundwater monitoring program.
- Further reduction of visual monitoring of closed and stabilized waste management facilities.
- Reduction in closure performance monitoring.

Beyond 30 Years after Closure

- Further reduction in monitoring of closed waste management facilities, closure performance monitoring and visual monitoring of closed facilities.

The long-term plan requires a permanent staff presence to operate water collection and treatment systems. Site staff would carry out most of the routine monitoring plus undertake frequent monitoring of access roads, fuel and chemical storage areas, power infrastructure, water pipes, channels and sumps, tailings dams and spillways. Engineered structures with significant failure consequences, such as the dams and some water management infrastructure, would be inspected by a qualified engineer, as required, for as long as they remain active and present any significant risk. The tailings dams (Main Dam and Back Dam) are expected to remain active for the very long term.

Reclamation performance monitoring would commence immediately after reclamation works have been completed. Basic performance objectives for planned reclamation works have been presented in the *Red Dog Mine Reclamation and Closure Plan* (SRK 2016a), with detailed performance standards not yet defined. As such, plans for reclamation performance monitoring cannot be made yet. As information on the success of closure methods becomes available from monitoring concurrent reclamation projects over the next ten or more years, the design of closure projects will be refined and monitoring requirements better understood. In particular, further details of closure and post closure monitoring need to be developed for the planned waste material covers (Oxide Dump, waste rock and tailings beaches) and revegetation of covers and other disturbances.

Quality Assurance/Quality Control Program

The Quality Assurance/Quality Control (QA/QC) program for activities conducted under the APDES permit and the IWMP is described in the *Red Dog Mine Quality Assurance Plan* (SRK 2016e) (QAP). Some programs have additional QA/QC requirements as described below for the various environmental monitoring activities described in this Plan. Most QA/QC plans may require updates as methods, methodologies, regulations, and guidance change. Therefore, documents referenced below are subject to periodic revision.

Water Quality Monitoring

This is the primary focus of the *Red Dog Quality Assurance Plan* (SRK 2016e).

Biomonitoring Program

QA/QC procedures for the bioassessment program are described in *Methods for Aquatic Life Monitoring to Satisfy Requirements of 2010 NPDES Permit, Red Dog Mine Site* (Rev 1) (Bradley 2017).

Groundwater Monitoring SEP

QA/QC for the Groundwater Monitoring SEP is detailed in the *Long-Term Permafrost and Groundwater Monitoring Plan for the Tailings Impoundment* (AMEC 2012). The Plan includes calibration checks and duplicate measurements.

Geochemical Monitoring

The TAK internal laboratory (Assay Lab) performs geochemical analyses in-house according to the Assay Laboratory Quality Assurance SOP.

Reporting

Reporting required under the IWMP and *Reclamation and Closure Plan* approval will be submitted as combined reports. The frequency of reporting varies and includes quarterly reports and a comprehensive Annual Report after the fourth quarter of each year. The Annual Report will cover the period from January 1 through December 31. Quarterly reports will be submitted within 60 days following the end of each calendar quarter with the Annual Report sent by March 1st. Contents of reports are detailed in Table 9.

Table 9: Reporting Requirements

Item	Plan Section	Reporting Requirement	Quarterly	Annual	Five-Year
Water Quality and Biomonitoring Program	2.1	An annual report on the biomonitoring conducted during the previous year, as described in Table 3 and Table 4. Report to be included in the first quarter report.		X	
Mine Drainage Monitoring Program	2.1.4	A summary of results of the water quality monitoring identified in Table 3. The Annual Report will provide water quality data in a flexible electronic format and include graphs over time for all parameters.		X	
Five-Year Data Analysis Report	2.2.1	The long-term trends in subsurface temperatures and groundwater levels are assessed in relation to historical site conditions. The last five-year review was scheduled for 2017 to cover the period from January 1, 2012 to December 31, 2016. The next five-year review is scheduled for 2022 and will cover the period from January 1, 2017 to December 31, 2021 and will be submitted in lieu of the 2021 annual report.			X
Permafrost and Subsurface Temperature Monitoring	2.2.2	The temperature measurements from the thermistors identified in Table 5, including a summary of instrumentation problems and significant temperatures anomalies.		X	
Permafrost and Subsurface Temperature Monitoring	2.2.2	The groundwater level measurements from the piezometers identified in Table 6, including a summary of instrumentation problems and significant groundwater levels changes.		X	
Flow and Water Quality Monitoring	2.3.2	A summary of the metered mine water flows and the results of the water quality monitoring identified in Table 7. The Annual Report will provide water quality data in a flexible electronic format and include graphs over time for all parameters.	X		
Water and Load Balances	2.3.3	A summary of the changes and key results of the site water balance. The Annual Report will provide the data in a flexible electronic format and contain water and load balance schematics similar to those in the Red Dog Ming Closure and Reclamation Plan.		X	
Visual Monitoring	2.3.4	A summary of the visual monitoring conducted during the reporting period.	X		
		A summary of the fish weir inspections conducted during the reporting period.	X		
Significant Activity	2.3	A summary of significant activities associated with the mine water management and water treatment.	X		
Quantities	2.4.2	The amount and placement of waste rock.	X		
Geochemical Monitoring	2.4.3	The results of the geochemical monitoring of waste rock facilities.	X		
Visual Monitoring	2.4.4	A summary of the visual monitoring conducted of waste rock facilities.	X		
Significant Activity	2.4	A summary of significant activities associated with the waste rock storage facilities.	X		
Quantities	2.5.2	The amount of tailings produced and the location of discharge.	X		

Item	Plan Section	Reporting Requirement	Quarterly	Annual	Five-Year
		The pond elevation for the reporting period.	X		
Geochemical Monitoring	2.5.3	The results of the geochemical monitoring of TSF.	X		
Visual Monitoring	2.5.4	A summary of TSF visual monitoring conducted during the reporting period.	X		
Significant Activity	2.5	A summary of significant activities associated with the TSF.	X		
Fire	2.6	Notify the ADEC if any fires occur on the working face of the landfill.			
Quantities	2.6.2	The amount and placement of solid waste in the landfill.		X	
Visual monitoring	2.6.3	A summary of visual monitoring of the landfill conducted during the reporting period.	X		
Significant Activity	2.6	A summary of significant activities associated with the landfill facilities.	X		
Quantities	2.7	The amount of ore milled and mill production.	X		
Significant Activity	2.7	A summary of significant activities associated with the Mill and Mine areas.	X		
Areas Disturbed and Reclaimed	2.8.2	The location and size of disturbed and reclaimed areas and a summary of reclamation activity.		X	
Reclamation Research	2.8.2	A summary of research associated with the reclamation of the facility.		X	
Reclamation Monitoring	2.8.3	A summary of the reclamation monitoring.		X	
Significant Activity	2.8.3	A summary of significant activities associated with reclamation.	X		
Updates to financial assurance		A brief update on the adequacy of the existing financial assurance will be provided annually.		X	X
		A detailed assessment of the adequacy of financial assurance will be carried out every 5 years.			X
Fugitive Dust Risk Management Monitoring Plan	2.9	Summary of dust impact monitoring at the mine site and associated implementation plan.		X	
Wildlife interactions or casualties	2.10	Summary of wildlife interactions and casualties.	X		

References

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