



Red Dog Mine 2021 Environmental Audit – Final

Teck Alaska Inc.

Anchorage, Alaska

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Abbreviations and Acronyms

AAC	Alaska Administrative Code
ABA	acid–base accounting
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
APDES	Alaska Pollutant Discharge Elimination System
AS	Alaska Statute
Audit Team	HDR Audit Team
AWQS	Aquifer Water Quality Standards
CERCLA	Comprehensive Environmental Responsibility and Compensation Liability Act
CMD	Certificate of Approval to Modify a Dam
COD	Certificate of Approval to Operate a Dam
CPI	Consumer Price Index
DMTS	DeLong Mountain Transportation System
DMLW	Division of Mining, Land and Water (State of Alaska)
EAP	Emergency Action Plan
EPA	U.S. Environmental Protection Agency
Golder	Golder Associates, Inc.
H:V	horizontal to vertical
HDR	HDR Engineering, Inc.
HWSAA	Hazardous Waste Satellite Accumulation Areas
IWMP	Integrated Waste Management Plan
MSWLF	Municipal Solid Waste Landfill
MWD	Main Waste Dump
NID	National Inventory of Dams
O&M	Operations and Maintenance
PAC	Personnel Accommodations Complex
POOA	Plan of Operations Approval
PSI	Periodic Safety Inspection
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RCP	Reclamation and Closure Plan
RCRA	Resource Conservation and Recovery Act
Red Dog	Red Dog Mine
RPA	Reclamation Plan Approval
SAA	ShapeAccelArray
SDS	Safety Data Sheet
SEP	Supplemental Environmental Project
SOP	Standard Operating Procedure
SPCC	Spill, Prevention, Control, and Countermeasure



SRCE	Standardized Reclamation Cost Estimator
SSI	Statistically Significant Increase
SWPPP	Stormwater Pollution Prevention Plan
TAK	Teck Alaska, Inc.
TARP	Trigger-Action-Response Plan
TEOM	tapered element oscillating microbalance
TSCA	Toxic Substances Control Act
TSF	Tailings Storage Facility
USACE	U.S. Army Corps of Engineers
VWP	vibrating wire piezometer
WMP	Waste Management Permit
WRMP	Waste Rock Management Plan
WTP	Water Treatment Plant



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1.0 Introduction

In accordance with Integrated Waste Management Permit (WMP) 2016DB0002, Reclamation Plan Approval (RPA) No. F20169958, and Plan of Operations Approval (POOA) No. F20209958POOA, the environmental audit of the Red Dog Mine (Red Dog) was scheduled to occur during the snow-free season of 2020. However, COVID-19-related travel restrictions and health concerns caused repeated delays in 2020, and Teck Alaska Inc. (TAK) requested that the Alaska Department of Environmental Conservation (ADEC) and the Alaska Department of Natural Resources (ADNR) allow the field inspection portion of the audit to be postponed until COVID-19 safety conditions improved. In a letter dated September 9, 2020, ADEC approved TAK's request to postpone the field portion of the audit until safety restrictions allowed the field visit to occur. In a letter dated September 14, 2020, ADNR approved TAK's request to postpone the field inspection portion of the audit. During summer 2021, travel restrictions eased; using best management practices established by TAK and HDR Engineering, Inc. (HDR), the field visit phase of the environmental audit occurred from July 26 to 29, 2021.

1.1 Purpose and Objectives

HDR conducted an environmental compliance audit of Red Dog for ADNR and ADEC. The mine, owned and operated by TAK, is located approximately 50 miles east of the Chukchi Sea, in the western Brooks Range of Northwest Alaska.

The WMP, RPA, and POOA authorizations require an environmental audit during the final year of the permit term. The audit is to be an objective, systematic, and documented review of the conditions, operations, and practices related to permit requirements and facility management conducted under only these authorizations as well as any authorizations that are adopted by reference. A prior environmental audit was completed at Red Dog in 2014.

The environmental compliance audit was conducted to compare and evaluate facility operations against applicable permits and state regulations. Section 2.0 summarizes program areas and permits included in the audit scope. The State of Alaska may use the audit results to assist in updating, renewing, or issuing authorizations and permits; in updating policies, plans, and procedures; and in determining compliance with permits and authorizations. It is important to note that there is no statutory or regulatory requirement that says the results of the audit must be incorporated into the authorizations.

The objectives of the audit were as follows:

- Assess the facility's compliance with the WMP and RPA.
- Determine if Red Dog environmental controls provide reasonable assurances that environmental objectives in the current WMP and RPA are being met.
- Determine if the facility and environmental controls are functioning as intended.
- Determine if the permit conditions provide necessary environmental protections.



- Determine if both the facility management and regulatory oversight provide reasonable assurances that the facility and controls are functioning as intended.
- Assess the adequacy of financial assurance for reclamation; closure; and long-term operation, maintenance, and inspection of post-closure facilities.

2.0 Permits and Authorizations

The HDR Audit Team (Audit Team) was composed of the following personnel:

- Paul McLarnon, Senior Project Manager
- Molly Reeves, CPG, Hydrogeologist
- Jill Ladegard, P.E., Senior Engineering Project Manager
- Nicholas LaFronz, P.E., Senior Geotechnical Section Manager

The Audit Team reviewed compliance with the state permits and authorizations listed in Table 2-1 as required under the WMP, the RPA, and Certificates of Approval to Operate a Dam (COD) or Modify a Dam (CMD). The ADNR Division of Mining, Land and Water (DMLW) Dam Safety and Construction Unit issues the COD and CMD.

Table 2-1. Environmental Programs and Permits Included in Audit

Program Area/Permit	Site Location	Permit / Reference	Issue Date	Expiration Date
Groundwater Monitoring Supplemental Environmental Project (SEP) and Consent Decree between TAK and the U.S. Environmental Protection Agency (EPA) – Long-term Permafrost and Groundwater Monitoring Program	Red Dog Tailings Main Dam, Tailings Back Dam, Kivalina Overburden Stockpile, background locations downgradient of the Tailings Storage Facility (TSF)	U.S. vs. Cominco Alaska Inc., Civil Action A97-267CV	11/25/1997	N/A
Integrated Waste Management Permit (IWMP)	TSF, Main Waste Dump, Class III Solid Waste Landfill, Overburden Dump, Main Pit Dump, Oxide Dump, Qanaiyaq Pit Dump, Low-grade Ore Stockpile, Mine Water Monitoring Stations, Water Quality and Biomonitoring Locations, Permafrost and Sub-Permafrost Monitoring Locations	2016DB0002	9/23/2016	9/22/2021
Red Dog Reclamation and Closure Plan/RPA	Site-wide Infrastructure, Stockpiles, Tailing Facilities, Treatment Plant, Mine Pits, Waste Rock Sites	F20169958	9/28/2016	9/28/2021
Red Dog Plan of Operations Approval	Red Dog Millsite Lease	F20209958	5/28/2020	9/28/2021
Integrated Waste Management Plan (IWMP)	Mine Site	WMP	6/2019	N/A
Tailings and TSF Water Management Plan	TSF	IWMP	8/2016	N/A

Program Area/Permit	Site Location	Permit / Reference	Issue Date	Expiration Date
Waste Rock Management Plan	TSF, Main Waste Dump, Class III Solid Waste Landfill, Overburden Dump, Main Pit Dump, Oxide Dump, Qanaiyaq Pit Dump, Low-grade Ore Stockpile	IWMP	9/2018	N/A
Monitoring Plan	Mine Site, Areas Outside of Mine Site	IWMP	1/2018	N/A
Water and Load Balance	Mine Site	IWMP	8/2016	N/A
Requirements for Hazardous Waste Accumulation Areas	Mine Site	IWMP	8/2016	N/A
Quality Assurance Project Plan	Mine Site	IWMP	9/2018	N/A
COD Mine Water Diversion Dam	Red Dog Mine Water Diversion Dam (National Inventory of Dams [NID] ID# AK00260)	FY2020-10-AK00260	12/12/2019	12/31/2024
CMD Tailings Main Dam Stage XI-A Interim Raise to Elevation 991 Feet	Red Dog Tailings Main Dam (NID ID# AK00201)	FY2020-23-AK00201	5/19/2020	Commence construction by 6/1/2022; expires 12/31/2021
COD Tailings Back Dam	Red Dog Tailings Back Dam (NID ID# AK00303)	FY2022-06-AK00303	9/16/2021	10/2/2023
COD Tailings Main Dam	Red Dog Tailings Main Dam (NID ID# AK00201)	FY2022-12-AK00201)	11/29/2021	10/2/2023
CMD Tailings Main Dam Stage XI-B Full Raise to Elevation 996 Feet	Red Dog Tailings Main Dam (NID ID# AK00201)	FY2021-25-AK00201	4/29/2021	Commence construction by 6/1/2023
COD Water Supply Dam	Red Dog Water Supply Dam (NID ID# AK00200)	FY2022-13-AK00200	4/30/2021	10/30/2023
CMD Tailings Back Dam Stage V Raise to Elevation 1,006 Feet	Red Dog Tailings Back Dam (NID ID# AK00303)	FY2021-30-AK00303	6/24/2021	Commence construction by 6/1/2023; expires 6/2/2023
CMD Tailings Main Dam Liquefaction Mitigation (ground improvement) in Foundation of Wing Wall Section at East Abutment	Red Dog Tailings Main Dam (NID ID# AK00201)	FY2021-5-AK00201	9/25/2020	Commence construction by 6/1/2022; expires 12/31/2022

Notes: N/A = not applicable

The Audit Team reviewed the following permits and authorizations, which represent the main regulatory drivers for the mine environmental management program:

- ADEC WMP, September 2016
 - Quality Assurance Project Plan (QAPP), September 2018
 - Integrated Waste Management Plan (IWMP), June 2019

- Appendix B – Tailings and Tailing Storage Facility (TSF) Water Management Plan, August 2016
- Appendix C – Waste Rock Management Plan, September 2018
- Appendix D – Monitoring Plan, January 2018
- Appendix E – Water and Load Balance Update, August 2016
- Appendix F – Requirements for Hazardous Waste Accumulation Areas, not dated
- ADNR RPA, August 2016
 - Reclamation and Closure Plan (RCP), August 2016
 - Reclamation Plan Amendments (1 through 4)
 - Teck Incorporated Mining Reclamation Bond, March 2021
- COD for Tailings Main Dam (National Inventory of Dams [NID] ID# AK00201), Tailings Back Dam (NID ID# AK00303), Mine Water Diversion Dam (NID ID# AK00260), and Water Supply Dam (NID ID# AK00200) (listed in Table 2-1)
- CMD for Tailings Main Dam (NID ID# AK00201) and Tailings Back Dam (NID ID# AK00303) (listed in Table 2-1)
- Groundwater Monitoring Supplemental Environmental Project (SEP), Long-term Permafrost and Groundwater Monitoring Program for the Tailings Impoundment Facility
- Red Dog Mine 4th Quarter Report and Annual Report; February 11, 2021, and associated appendices published at a later date
- Fugitive Dust Risk Management Plan

As agreed to by TAK, ADNR, and ADEC, environmental-related permits and plans not reviewed by the Audit Team include:

- Alaska Pollutant Discharge Elimination System (APDES) Water Discharge Permit
- Water Use Authorizations
- U.S. Environmental Protection Agency (EPA) Hazardous Waste Accumulation
- Spill Prevention, Control, and Countermeasure (SPCC) Plan
- Stormwater Pollution Prevention Plan (SWPPP)
- U.S. Army Corps of Engineers (USACE) Section 404 Permit
- Potable Water Supply
- Sewage Treatment
- Toxics Release Inventory
- Federal Aviation Permits
- ADEC Air Quality Control Permit



TAK staff provided information to the Audit Team as requested to facilitate record auditing primarily while onsite. Key permits and related documents were obtained from TAK, ADNR, and ADEC prior to the field audit. TAK provided additional correspondence items as requested. The implementation of each document term was checked during the field audit and found to be in compliance.

3.0 Approach and Methodology

The audit methodology can be generally broken into three main tasks: pre-audit activities, onsite audit, and post-audit reporting. These tasks are discussed in Sections 3.1 through 3.3.

3.1 Pre-audit Activities

Pre-audit activities were performed prior to the facility visits. Activities included review of available project permits and plans as well as participation in a project kickoff meeting prior to the onsite visits.

3.1.1 Permit and Plan Review

The intention of the preliminary review was to obtain a high-level understanding of the applicable permits and plans in place at the time of the permit review. The Audit Team gathered available mine permits, plans, and agency authorizations from online resources, from ADEC and ADNR office visits, and directly from TAK.

3.1.2 Project Kickoff Conference Call

A project kickoff conference call was held on March 11, 2021, with the mine permitting team composed of ADNR, ADEC, TAK, and the Audit Team's Project Manager. This meeting provided a general overview of the assessment process, scope of permits, timing of the audit, authorizations that the audit would address and not address, and overall project schedule.

3.2 Onsite Audit Activities

The Audit Team performed the onsite audit of Red Dog on July 26 through 29, 2021. During this onsite audit, they participated in Mining Safety and Health Administration new miner training, onsite hazard training, onsite walk-through, review of provided documents, interviews, and briefing sessions.

3.2.1 Onsite Hazard Training

Upon arrival at the site, the Audit Team attended a site-specific safety training and a site meeting to introduce them to the TAK Environmental Team. The purpose of the meeting was to review the scope and purpose of the audit, introduce the personnel involved in conducting the audit, and outline the audit schedule for tours and interviews.

3.2.2 Onsite Walk-through

The Audit Team participated in a tour of the mine guided by the TAK Mine Environmental Coordinator, Frank Bendrick. During the walk-through, the Audit Team viewed facilities and activities specific to the environmental permits. Field observations were discussed with site personnel during the walk-through and interviews. In addition to the site-wide tour, individual Audit Team members toured specific facilities with TAK Environmental Team personnel who

have operational knowledge of the facilities and operations. Facilities that were inspected included:

- TSF
- Main Waste Dump (MWD)
- Class III (camp) municipal solid waste landfill (MSWLF)
- Overburden dump
- Main pit dump
- Oxide dump
- Low-grade ore stockpile
- Road-accessible thermistor strings, monitoring wells, and diversion pumps
- Road-accessible mine water monitoring stations
- Assay laboratory
- Hazardous waste storage areas
- Recycling storage areas
- Mine water dams and surface diversions

3.2.3 Records and Document Review

The Audit Team reviewed applicable permits that were readily available and organized onsite. The auditors made observations of operational activities within the context of applicable permits and environmental requirements, taking note of any compliance gaps. Additional documents provided by TAK and reviewed by the Audit Team included various inspection reports, visual monitoring sheets, waste management guidelines, various correspondence, annual reports, and other related documents.

3.2.4 Interviews

The Audit Team conducted interviews with TAK mine representatives with responsibilities of overseeing environmental regulatory requirements as well as TSF, mine water, and dam operations. The purpose of these interviews was to obtain an understanding of the environmental programs and procedures for compliance with permits and plans as well as to assess how well those programs were understood and implemented.

3.2.5 Briefing Sessions

The Audit Team met with the TAK Environmental Team and Red Dog staff on a daily basis during the field visit. The auditors reviewed the day's progress and specific observations as well as discussed plans for the upcoming day.



3.3 Post-audit Activities

Following the audit, the Audit Team followed up with the TAK Environmental Team to discuss any questions or additional information needs. Additionally, the Audit Team interviewed various agency personnel, primarily those who manage the WMP, financial assurance, and dam safety and engineering.



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4.0 Interviews

4.1 Agency Interviews

The Audit Team interviewed agency personnel regarding the following aspects of the audit and TAK's permits:

- Review audit scope
- Review various aspects of the authorizations to understand the intent of the permit language
- Request additional reporting or correspondence
- Request a status update on submitted documents
- Gather information regarding the agency perspective on mine compliance and ongoing ability to meet obligations and agency requests as well as gauge adequacy of state oversight

The regulatory agency personnel were of significant help to the Audit Team on all of these accounts. Table 4-1 lists the interviews that the Audit Team conducted with agency personnel and includes a brief summary of those interactions.

Table 4-1. Audit Interviews with Agency Personnel

Name and Title	Agency or Company	Date	Summary
Tim Pilon, Engineer 2	ADEC	8/19/2021	Email correspondence inquiring about any existing concerns ADEC might have with respect to water quality and waste rock management. ADEC did not indicate that it has any existing concerns for either topic.
Allan Nakanishi, Technical Engineer 2	ADEC	8/22/2021	
Neil Lehner, Environmental Program Specialist 3	ADEC	3/27/2021, 6/8/2021	Topics that were discussed included (1) overall compliance status of the landfills; (2) testing of incinerator ash per permit requirements; (3) a small fire that occurred at the landfill in 2020; and (4) correspondence between the Red Dog and ADEC regarding the disposal of mine concentrate that spilled onto the tundra from a haul truck transiting to the Port. The conclusion was that there is good communication between TAK and the ADEC Solid Waste Program. The fire at the landfill was small, caused no damage, and was quickly extinguished. The incident was reported to ADEC in accordance with requirements of the IWMP. No outstanding compliance issues exist related to solid waste disposal operations occurring under the existing IWMP.

Name and Title	Agency or Company	Date	Summary
Brent Martellaro, Geologist 5; Emily Hart, Large Project Coordinator	ADNR	5/17/2021; 5/7/2021	ADNR requested a review of the financial assurance information, including the Net Present Value calculations, real rate of return, and inflation used in the Standardized Reclamation Cost Estimator (SRCE) model. Additionally, ADNR requested a review of how the waste rock geomembrane cover proposed would affect the water balance and subsequent water treatment requirements.
Charles F. Cobb, P.E., State Dam Safety Engineer; Michael Ori Miller, E.I.T., Assistant State Dam Safety Engineer	ADNR DMLW Dam Safety & Construction Unit	8/9/2021; pre- and post-interview email communications	Several topics were discussed, including (1) TAK compliance with dam safety permit conditions for the four permitted dams; (2) TAK meeting requirements of the current Operations and Maintenance (O&M) Manuals for each of the four permitted dams; (3) recent Periodic Safety Inspections (PSIs) completed for each of the permitted dams and any needed corrective actions by TAK; (4) outstanding design submittals currently under review by the ADNR DMLW Dam Safety and Construction Unit such as for pending dam crest raises, modifications to seepage collection systems, or other appurtenances; (5) Long-term Permafrost and Groundwater Monitoring Program for the Tailings Impoundment Facility; and (6) request for a list of the most current applicable design documents for each of the permitted dams.

4.2 Mine Personnel Interviews

The Audit Team interviewed various TAK Mine personnel who are responsible for environmental management program tasks. Table 4-2 lists these interviews and brief summaries of purpose of each interview.

Table 4-2. Audit Interviews with TAK Mine Personnel

Name	Title & Role	Date	Summary
Mike Gonzales	Superintendent, Tailings and Environment	7/27/2021	The discussion included monitoring of back dam and TSF operating procedures.
David Merritt	Lead Assay Technician	7/27/2021	The discussion included: (1) geology department protocols for classification of waste; (2) sampling and handling waste rock for verification of visual classification; (3) analysis of verification samples; and (4) staff training.
Tristen Pattee	Senior Environmental Technician	7/27/2021	The discussion included: (1) water sampling procedures and note taking; (2) all environmental monitoring implementation (e.g., site selection, sample procedures, calibration, handling, shipping, data validation); (3) permit requirements; and (4) reporting. Pattee provided a tour of the environmental sampling preparation room.

Name	Title & Role	Date	Summary
Nicole Pidgeon	Senior Mine Geologist	7/27/2021	The discussion included: (1) Standard Operating Procedure for the acid–base accounting (ABA) analysis; (2) quality control data and quality objectives for the ABA analysis; and (3) procedure for sampling receipt, handling, and laboratory analysis of both waste rock from the production geologists and tailings from the mill. Pidgeon provided a tour of the laboratory
Frank Bendrick	Environmental Coordinator II	7/28/2021, 8/3/2021, 8/27/2021	Bendrick completed an initial tour of the site with the Audit Team and was available for questions throughout the onsite visit as well as after that visit. Topics discussed included (1) TAK compliance with WMP requirements/conditions; (2) reporting to ADEC; (3) associated recordkeeping; and (4) adjustments to the financial assurance calculation from 2016. Additionally, Bendrick supplied responses and supplemental information via email regarding a list of auditor questions (Excel format) regarding TAK compliance with the requirements of the Long-term Permafrost and Groundwater Monitoring Program for the TSF.
Carla Nelson	Assistant Environmental Coordinator	7/28/2021	The discussion included data validation and the QAPP.
Joanna Salatas	Environmental Coordinator/ Risk Manager	7/28/2021	The discussion included fugitive dust emissions and revegetation practices.
Nancy Tracy	Senior Engineer, Tailings and Water	8/3/2021, 8/26/2021	Tracy provided responses via email regarding a list of auditor questions (Excel format) regarding TAK compliance with the ADNR Dam Safety permit conditions for the four permitted dams.
Jennifer Foster	Water Quality Lead	8/25/2021	The discussion included water and load balance.



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5.0 Compliance with Permits and Authorizations

5.1 Integrated Waste Management Permit

The WMP addresses the disposal of municipal solid waste, construction and demolition waste, waste rock and mill tailings from Red Dog, hazardous chemical storage and containment, reclamation and closure activities related to all facilities specified in the WMP, and RPA.

5.1.1 Permit Coverage

Red Dog operates seven active waste rock disposal sites, which are used to dispose of waste rock that is not expected to have economic value before the end of the mine life. Multiple active and inactive waste rock dumps and low-grade ore stockpiles are located at Red Dog. A brief description of each disposal site is provided below.

The five active waste rock disposal sites are as follows:

- **Overburden Dump:** This dump is located south of the TSF. It consists of mineralized shale mixed with mineralized material, located at the eastern end of the dump, and non-mineralized topsoil, located on the western end of the dump. A shallow groundwater collection system located to the south collects impacted runoff and pumps it to the TSF.
- **Class III (Camp) Municipal Solid Waste Landfill:** This Class III (Camp) MSWLF is located east and directly adjacent to the MWD. All protrusible waste, consisting primarily of a mixture of food and general kitchen waste, is incinerated and the ash is disposed of at the landfill. Non-protrusible wastes, consisting mainly of construction and demolition debris, is disposed of at the working face of the landfill.
- **Main Pit Dump:** This dump has been active since 2012, when mining no longer occurred there. The Main Pit Dump was actively being used for waste rock disposal at the time of the audit.
- **Qanaiyaq Pit Dump:** This is a pit located east of the MWD that will be backfilled with material from the Qanaiyaq Pit itself as well as waste rock from the Aqqaluk Pit. Due to ongoing mining activities and poor weather conditions at the time of the audit, this pit was not visually inspected during the audit.
- **Low-grade Ore Stockpile:** This stockpile contains material that is marginally economical that could be processed in the future because of economic or technological conditions. This site is used only on an as-needed, periodic basis.

The two inactive waste rock disposal sites are as follows:

- **Main Waste Dump:** The MWD is located east of the TSF and contains waste rock from the Main Pit and Aqqaluk Pit. Seepage from the MWD is collected in a series of sumps and drains and is directed to the TSF. The MWD has reached its maximum elevation and was undergoing closure activities at the time of the audit. A

geomembrane, followed by a geo-composite material, and 2 feet of final cover material was being placed on the surface of the MWD. The side slopes appeared to be 3H:1V (horizontal to vertical); however, an inclinometer measurement was not taken. A test portion of the closure area was well vegetated, with no visual signs of erosion or slope failures.

- **Oxide Dump:** Waste rock that is marginally economical is stockpiled at the Oxide Dump. It is possible that it could be processed in the future because of economic or technological conditions. The Oxide Dump was contoured but did not have a vegetative cover as indicated in the IWMP.

5.1.2 Sitewide Waste Disposal

The waste materials permitted for disposal are limited to mine tailings, waste rock, Class III (camp) municipal solid wastes, and mining and mineral processing wastes generated by extraction, beneficiation, and processing activities (e.g., Bevel exemption wastes).

General Disposal Limitations

Section 2.1.1 of the Integrated Waste Management Permit contains a number of general disposal limitations associated with the prevention of water quality exceedances; maintenance of containment; minimizing attractions to waterfowl, shore birds, and other wildlife; and management of truck wash water. Additionally, certain wastes generated onsite are prohibited from being disposed of at the mine site and must be managed using methods other than disposal, depending on the type of waste. Table 5-1 provides a summary of disposal limitations and onsite management practices.

Table 5-1. Waste Disposal Limitations

WMP Section Number	WMP Restriction	TAK Practice	Audit Team Information Resource
2.1.1.5.1	This restriction includes acute hazardous wastes, as defined by 18 Alaska Administrative Code (AAC) 60.990(157), include radioactive material, explosives, strong acids, and untreated pathogenic waste; however, this prohibition does not preclude disposal of natural minerals found in mine rock or residual wastes included as byproducts of the beneficiation.	All hazardous waste is collected at satellite accumulation areas, then shipped off site for disposal at a permitted facility.	Interview (Bendrick) and visual confirmation
2.1.1.5.2	This restriction includes contaminated soils, spill booms, liners used for the containment of spilled hazardous substances, chemicals used in the cleanup of hazardous substance spills, or other hazardous substance spill cleanup wastes.	At the time of the audit, no contaminated soils, hazardous substances, or chemicals from spills were being stored or treated. In the event of a spill, disposal options and requirements are coordinated with ADEC.	Interview (Bendrick and Salatas)



WMP Section Number	WMP Restriction	TAK Practice	Audit Team Information Resource
2.2.10.2	This restriction prohibits disposal of un-combusted household waste.	All household waste is incinerated. At the time of the audit, no combusted household waste was visible at the Class III landfill.	Interview (Bendrick) and visual confirmation
2.2.10.4	This restriction prohibits the disposal of non-incinerated sewage sludge unless it is deposited into a separate trench or cell, containing only sewage sludge.	Sewage sludge is incinerated and placed at the Class III landfill. At the time of the audit, sewage sludge of any kind was not visible at the Class III landfill.	Field Observation
2.2.10.7	This restriction prohibits disposal of lead-acid vehicle batteries at the landfill.	Lead-acid batteries are shipped off site for disposal or reconditioning.	Interview (Bendrick), visual confirmation, and records review
2.2.10.8	This restriction prohibits regular disposal of economically salvageable or recyclable materials, including, but not limited to: prefabricated buildings, vehicles, drums, tankage, major equipment components, and major scrap components.	Contents going into the landfill are monitored by weekly visual inspections. Recyclable material is collected and shipped off site. From 2018–2020, more than 4,500 U.S. tons of recyclable material has been shipped off site.	Interview (Bendrick), visual confirmation, and records review
2.2.10.9	This restriction prohibits the disposal of regulated asbestos-containing materials at this site.	No facilities on site use regulated asbestos containing materials.	Interview (Bendrick)
2.2.10.10	Consolidate and compact all loose refuse and cover with a minimum of 6 inches of compacted cover material as needed to prevent blowing litter.	Waste was consolidated into supersacks, though compaction and cover material had not yet been placed and there was no indication of blowing litter.	Field Observation
2.2.10.11	Ensure that the wastes placed in the disposal cell or trench are compacted in 4-foot increments.	Waste was placed at grade in the active disposal cell, although it could not be confirmed that waste was compacted in 4-foot increments.	Field Observation
2.2.10.12	Apply at least 12 inches of intermediate cover material to any portion of the landfill that will be inactive for a period of 90 days or more. The intermediate cover must be applied within 7 days after the waste is last deposited in the inactive area, and graded to prevent water from ponding.	The depth of intermediate cover was not verified, the cell observed was “active,” and grading at the landfill was adequate to prevent ponding.	Field Observation
2.2.10.14	Ensure that the maximum landfill working face width shall not exceed 200 feet. The maximum height of the working face shall not exceed 10 feet.	At the time of the visit, the working face was estimated to be less than 200 feet wide and less than 10 feet high.	Field Observation

WMP Section Number	WMP Restriction	TAK Practice	Audit Team Information Resource
2.2.10.15	Ensure that the working face is kept as small as practical to reduce the potential for windblown litter.	The working face was well controlled and was not observed to be overly large as indicated by lack of wind-blown litter.	Field Observation
2.2.10.20	Maintain positive control of all persons who are within the landfill boundaries and that refuse will be deposited in approved locations. Dumping in unauthorized areas violates conditions of this permit.	No persons were observed within the landfill boundary, and there was no indication that waste was being placed in unauthorized areas.	Field Observation

5.1.3 Class III MSWLF

The mine site operates a Class III (Camp) MSWLF. According to State of Alaska Solid Waste Regulation 18 Alaska Administrative Code (AAC) 60.300, a Class III (Camp) MSWLF “is a landfill that is not connected by road to a Class I MSWLF or, if connected by road, it is located more than 50 miles from a Class I MSWLF” and accepts, for disposal, ash from incinerated municipal waste and municipal solid waste. A Class III landfill can accept, for disposal, “ash from incinerated municipal waste in quantities less than one ton daily on an annual average,” or “less than five tons daily of municipal solid waste, based on an annual average.”

The Class III (Camp) MSWLF accepts mainly construction debris, wood packing materials (i.e., pallets), used supersacks, and incinerator ash for disposal. At the time of the field audit, a sign was posted at the landfill entrance listing prohibited items. The sign also included the name of the facility, owner/operator name, condition for use, and emergency phone number.

The site was being managed to prevent attracting wildlife, and no birds or other wildlife were present at the time of the field audit. The depth of intermediate cover was not verified, the cell observed was “active,” and despite an abundance of rain, auditors observed very little ponded surface water and no obvious signs of runoff from outside of the facility flowing into uncovered waste. The working face was well contained but was beginning to become large enough that intermediate cover should be applied in the near term. Incinerator ash was present on the landfill surface, and it is placed in an area away from the working face to guard against the fire hazard associated with a potential “hot load” of ash material.

Overall, the site was clean and well organized, waste was consolidated into supersacks, and though compaction and cover material had not yet occurred, the auditors observed little to no litter or wind-blown debris. At the time of the site visit, auditors observed a significant amount of copper wire placed at the working face. The TAK Environmental Coordinator determined that the material was placed by a contractor onsite at the time and had the copper wire removed from the working face so that it could be shipped off site with other recyclables. There was no further indication that salvageable material was to be disposed.

The Integrated Waste Management Permit indicates that waste will be placed in excavated trenches. The active disposal cell is located lower than the surrounding grade, though it would

not be considered “trench” (e.g., a long narrow excavation). The current practice at the landfill is that waste is placed on the surface in the active disposal cell then compacted and covered. It is recommended that the Integrated Waste Management Permit be modified to include the surface placement of waste within a disposal cell located lower than the surrounding grade, but still include the option of placing waste in excavated trenches (Appendix A Photographs 1, 2 and 3).

5.2 Integrated Waste Management Plan

The IWMP describes procedures and sets priorities for managing solid wastes and hazardous materials, as well as for reusing and recycling materials generated at Red Dog.

5.2.1 Waste Management Priorities

The IWMP lists five priorities that the mine should consider in order to prevent and/or minimize waste generation:

1. The potential of materials excavated, mined, or milled to adversely affect water quality
2. Waste source reduction
3. Recycling
4. Waste treatment
5. Waste disposal

The IWMP lists several strategies Red Dog must follow to accomplish the five priorities listed above. Table 5-2 lists these strategies as well as the observed practice at the mine at the time of the audit.

Table 5-2. Strategies to Accomplish IWMP Priorities

Waste Prevention / Minimization Strategy	Audit Finding
Geochemical characterization of materials to be excavated, mined, or milled should be identified/reviewed.	The mine is following the geochemistry monitoring plan and permit requirements, though there are some recommendations related to updating characterization methods and plans to align with onsite practices.
Operations that generate waste should be reviewed to identify opportunities for reducing waste; these opportunities would be implemented whenever possible.	The mine facility employs a full-time staff position dedicated to environmental coordination and compliance. One of responsibilities of the Environmental Coordinator is to work with the Expediter for the mine to identify and reduce waste generation at Red Dog.
The properties for materials should be reviewed prior to purchase, and every effort should be made to minimize the use of hazardous materials and those materials that would be classified as hazardous waste once they can no longer be used for their intended purpose.	The mine appears to be following this strategy. While the mine is considered a Large Quantity Generator of hazardous waste ($\geq 2,204$ pounds/month), the range of hazardous wastes generated onsite is narrow and consists mainly of non-aqueous waste generated by the Assay Laboratory.
Methods for reusing and recycling materials should be promoted and implemented whenever possible to reduce waste.	Reasonable efforts appear to be made to reduce the volume of waste generated, and to recycle or reuse materials when possible. This includes items such as, but not limited to, scrap steel and aluminum, oxygen and acetylene bottles, and batteries. Used coolant and oil is shipped off site (see Table 5-3 for quantities).

Waste Prevention / Minimization Strategy	Audit Finding
Non-hazardous solid wastes that are permitted for disposal onsite can be disposed of at onsite, permitted, solid waste landfills regulated by ADEC and in accordance with 18 AAC 60 or applicable TAK permits.	Non-hazardous solid waste disposal at Red Dog is consistent with the requirements of 18 AAC 60 and Section 2.1.1 Limitations of the IWMP.
Materials that cannot be managed onsite are sent off site for recycling, reuse, treatment, and/or disposal to appropriate facilities.	This waste management strategy appears to be complied with.

5.2.2 Purchasing of Materials

The IWMP provides the following guidance on procedures for materials purchase:

- The generation of hazardous wastes can be minimized by avoiding the purchase of materials that would be regulated as hazardous wastes when the materials are no longer required for their intended purpose.
- To the extent practical, materials will be purchased in containers (e.g., totes or drums) that can be returned to the vendor.
- The Safety Data Sheets (SDSs) for new materials to be purchased will be reviewed to ascertain if the materials require special management under the Resource Conservation and Recovery Act (RCRA), Emergency Planning and Community Right to Know Act, Comprehensive Environmental Responsibility and Compensation Liability Act (CERCLA), Clean Air Act, and Toxic Substances Control Act (TSCA).
- For materials requiring special handling and/or that would be classified as a hazardous waste if disposed of, TAK will evaluate if a suitable substitute is available that is considered “less hazardous.” Less hazardous can include a waste that would not be classified as a hazardous waste if disposed, would not require special handling under the above-noted Acts, would generate less waste when disposed, can be reused or recycled, or is generally considered to have less of an environmental impact (i.e., a material with less discharges to the environment when treated and/or disposed of).

The Audit Team found that Red Dog is following the procedures above. The stimulus to minimize the purchase of materials that, once used, could become hazardous waste is influenced by the requirement and associated cost of shipping all hazardous waste off site for disposal. As a result, TAK tracks incoming and outgoing materials, including chemicals that could become part of the mine’s waste stream (see Table 5-3). This information helps to ensure proper characterization of the materials for disposal, recycling, or reuse. Red Dog also coordinates with vendors when it is practicable to return materials to vendors.

Table 5-3. Tons of Recyclables by Year (in U.S. Tons)

Recyclables by Year	2018	2019	2020
Cardboard/Plastic/Paper/Pallets	158	177	306
Scrap Steel, Copper, and 777 Truck Beds	40	419	451
Glycol	91	12	26
Used Oil	216	386	321

Tires (including 777 and 993 Truck Tires)	295	97	296
Electronic Waste	11	5	2
Used Mantles and Sag Mill Liners	406	396	432
Total U.S. Tons Recycled per Year	1,217	1,492	1,835

5.2.3 Waste Minimization

The IWMP provides a number of strategies to minimize waste generation as well as implement recycling and reuse of materials. The Audit Team found TAK to be implementing these strategies. Some examples of methods listed in the IWMP included:

- *The use of low-toxicity Orange-sol© solvents in parts washers (Appendix A Photograph 4).*
- *The use of low-mercury, fluorescent lamps (“green end cap”) and recycling of lamps and bulbs.* The use of low-mercury, fluorescent lamps (“green end cap”) and recycling of lamps and bulbs is occurring onsite. Used fluorescent lamps are managed as a Universal Waste and shipped off site for disposal (Appendix A Photograph 5).
- *Recycling or reuse of materials such as antifreeze, batteries, scrap metal, and used oil.* Antifreeze, batteries, truck tires, scrap metal, and used oil are shipped off site for disposal or recycling (see Table 5-3).
- *Returning containers to vendors or recycling them as scrap metal, which prevents the need for disposal of containers in landfills; appropriate container management, including the provision of secondary containment and proper labeling.* Containers at Red Dog are well managed, as evidenced by the observation that there appears to be a minimal number of containers, and those present are being used for a specific purpose.
- *Prevention of mixing of hazardous wastes with non-hazardous wastes through waste segregation, established procedures, and personnel training.* Observations at the time of the audit found no evidence of mixing hazardous waste with non-hazardous waste. All waste types are segregated and labeled (see Appendix A, Photograph 6). Based on interview conversations with the Environmental Coordinator, training occurs with personnel on an annual basis and immediately with new employees. If employees are not sure what do with particular waste materials, they are instructed to contact the Environmental Coordinator, or to refer to the Waste Management Guidelines that is maintained by Red Dog and available on the local computer network. These Waste Management Guidelines provide guidance on most of the waste streams generated at Red Dog. Appendix B contains examples of the Waste Management Guidelines used at the mine site.

5.2.4 Waste Segregation

Waste management at Red Dog must include appropriate segregation of wastes to ensure that they are properly managed according to the applicable regulations and the specific waste handling procedures:

- Wastes destined for the incinerator (e.g., putrescible food waste, oily waste) will be placed in incinerator dumpsters. These dumpsters would be kept closed to prevent attracting wildlife. The Audit Team observed that most dumpsters onsite have a lid and are labeled in accordance with their intended use. Putrescible food waste is processed in a solid waste incinerator located onsite (Appendix A, Photographs 7 and 8). TAK also conducts random inspections of dumpsters to ensure that waste is being properly segregated (Appendix A, Photograph 9).
- Approved solid wastes destined for the landfill are placed in dumpsters and transported to the landfill. Dumpsters onsite are spread across the facility and transported to the landfill when full.
- Dumpsters will be marked in a manner such that TAK personnel would be able to distinguish between incinerator and landfill dumpsters. The Audit Team observed that dumpsters onsite are labeled to distinguish between incinerator items or other items per the dumpsters' intended use (Appendix A, Photograph 7).
- Hazardous wastes will be placed in containers at Satellite Accumulation Areas (HWSAAs) (for less than 55 gallons of waste) or will be placed in appropriately labeled containers and brought directly to a Hazardous Waste Accumulation Area. The Audit Team observed HWSAAs. Appendix A shows the HWSAA at the Assay Laboratory (Appendix A, Photograph 6).
- *Universal Wastes (lamps, batteries, mercury-containing equipment) will be placed in containers at Universal Waste Accumulation Areas according to the procedures outlined in IWMP Section 2.8.* The Audit Team inspected the Universal Waste Accumulation Area (Appendix A, Photograph 5). Items are containerized and labeled and are stored in the Universal Waste Accumulation Area prior to shipment off site.
- *Materials to be recycled will be placed in segregated containers designated for the specific type of material and managed as outlined in the IWMP.* The Audit Team observed materials such as lead acid batteries, used florescent light bulbs, compressed gas cylinders, and electronic waste in segregated containers that are labeled accordingly (Appendix A, Photograph 10).

5.2.5 Container Management

Containers at Red Dog are being managed to ensure the safety of personnel and the environment. Staff at Red Dog are given annual training, and new staff receive training upon arrival, that addresses container management, labeling, secondary containment, and container maintenance.

The IWMP discusses the management of empty containers, primarily containers that once held hazardous or acutely hazardous waste. The Audit Team observed that when there is a container holding hazardous waste, it is routine operations that the container is not to be emptied and reused.

5.3 Site Construction, Maintenance, and Operation

Section 2.3 (Site Construction, Maintenance, and Operation) of the WMP requires that changes that may have a significant impact on mine closure, reclamation, or water quality or that are associated with mill processes, waste treatment, and disposal facilities; ground and surface water conveyance systems; or new waste streams that could significantly change the quality or increase the quantity of pollutants must be submitted to ADEC for approval prior to making changes.

5.3.1 MWD Closure Operations

In July 2019, TAK requested an amendment to the Reclamation and Closure Plan Approval (F20169958) to modify the MWD closure plan from an engineered compacted soil cover to a geosynthetic liner and soil design. The basis for the request was to reduce the amount of infiltration into the MWD and decrease the amount of acid rock drainage that could potentially leach into the groundwater.

During the audit, the ongoing closure activities at the MWD were notable. A test section of the geosynthetic liner and soil design was visible, well vegetated, and appeared to be stable, with no evidence of erosion or slump failure. Red Dog crews were working on installing liner material on the side slopes of the facility and covering the liner with soil. Work crews were also installing a draining system at the toe of the sidewall (Appendix A, Photographs 11 and 12). These activities were consistent with the information contained in the amendment request (letter dated July 22, 2019) for modified cover design on the MWD.

5.4 Integrated Monitoring Plan

Section 2.5.1 of the WMP requires monitoring at the locations and frequencies in Table 1 of the IWMP (this table is included by reference in the WMP). Table 1 of the IWMP addresses Oil Spill Response Plans. It is assumed that the WMP is referencing Table 1 Summary of Monitoring During Operations from the Monitoring Plan, which is Appendix D of the IWMP. The Audit Team recommends that the WMP be edited at the time of permit renewal to reference Table 1 in Appendix D of the IWMP (as opposed to Table 1 of the IWMP).

5.4.1 Waste Rock Management

Sections 1.1.2 and 2.5.1 of the WMP require the monitoring locations and frequencies provided in Table 1 of the Monitoring Plan (Appendix D of the IWMP), which includes monitoring waste rock management. Waste rock management is described in Section 2.4 of the Monitoring Plan (Appendix D of the IWMP) and also in the Waste Rock Management Plan (WRMP, September 2018). The waste rock management program consists of tracking quantities and locations of waste rock disposal, geologic and geochemical monitoring of waste rock for segregation, and visual monitoring of the waste rock facilities. Both the Monitoring Plan and the WRMP are consistent with each other in their descriptions of the monitoring, prescribed segregation, and reporting associated with waste rock.

Geochemical monitoring of waste rock is performed for waste rock classification and segregation to characterize metal leaching and acid rock drainage to ensure that there is low potential for the production of leachate that is acidic or contains levels of metals that would contaminate surface or groundwater. The segregation criteria are broken into four categories, described in Table 3 of the WRMP: dam construction, cover material, high-sulfide waste rock (potentially self-heating), and other waste rock that does not meet the criteria of the other categories. Table 3 of the WRMP also describes the disposal locations for each of these four categories. The WRMP provides the segregation criteria for the following disposal locations (from Table 3 of the WRMP):

- Dam construction
- Cover material
- Main Pit Dump: placed below the ultimate water level where possible, or blended to reduce the self-heating capacity
- Main Pit or Qanaiyaq Pit Dumps: to maximize space available for underwater disposal of the high-sulfide waste, it is preferable to place this material in locations that are above the ultimate water level in the Main Pit Dump

In addition to these four disposal locations, the Segregation Plan for Cover Material (Appendix A of the WRMP) includes the location for the disposal of cover material:

- Cover stockpile(s) will be located on the Main Waste Stockpile, or other disturbed areas near the waste rock stockpiles.

The geochemical testing of the blast hole cuttings is required as scheduled to analyze every blast hole. The waste rock quantities placement is supposed to be monitored daily; the visual monitoring of the waste rock dumps is required weekly; and reporting on quantities, geochemistry, waste rock placement, and visual monitoring is required quarterly. The Audit Team observed the weekly waste rock visual inspection forms to confirm compliance with the monitoring requirement.

The Audit Team interviewed the Senior Mine Geologist and the Lead Assay Technician. TAK performs assays on one composite sample from every blast hole. The analysis is completed in the onsite Assay Laboratory and reported to the Geology Department for percent zinc, lead, iron, and barium. The waste rock is first categorized by rock type by a geologist, and second by the blast hole cutting assay results. Based on the classification of the waste into one of the four waste rock categories, the Geology Department determines the appropriate disposal location. The Audit Team reviewed quarterly reporting to ADEC. Each quarterly report reviewed included reported data on waste rock quantities, waste rock placement, and visual monitoring. The breakdown of waste rock placement is in the text of the reports and the average percent zinc, lead, and iron is included in an appendix. In the quarterly reports, disposal locations are reported that are in neither the WRMP segregation table (Table 3) nor the WMP as a permitted waste rock facility. For example, in the First Quarter 2020 Report, TAK reported that the waste was disposed of in the following locations:

- Main Pit Dump
- Oxide/Main Waste Dump Area (specifically to the Cover Dump, Oxide Stockpile, Copper Waste Dump, and landfill)
- Road Construction

The Oxide Stockpile is a facility that is not named in the WMP or the WRMP; however, the WRMP does include description of an Oxide Dump. The WMP states that the Oxide Dump is inactive, recontoured, equipped with a trial cover, and seeded. The Copper Waste Dump is a facility that is not named in the WMP or the WRMP as a disposal facility.

The First Quarter 2020 Report indicates that 9,266 tonnes of Ikalukrok were placed on haul roads. However, road construction is not listed as a disposal location in Table 3 of the WRMP or the WMP. If waste rock is to be used as road construction rock, it is recommended that the WRMP and Table 3 be revised to identify road construction as a disposal option and address any geochemical testing requirements to determine appropriate segregation.

The WRMP Table 2 states that Siksikpuk shale could be used for construction; however, Siksikpuk shale is reported on some quarterly reports as sometimes being “most reactive waste” that is required to be disposed of below the water in the Main Pit. Therefore, Table 2 of the WRMP does not necessarily describe the geochemical characteristics required to use Siksikpuk on roads.

The high-sulfide waste rock category criteria are based on the self-heating capacity risk Region 5 or greater, which is calculated by an equation that requires inputs of percent lead, zinc, barium, iron, and soluble lead. TAK’s quarterly reports do provide average blast hole assay percentages of zinc, lead, and iron, but barium and soluble lead data is not provided. For a quality control check to be completed on any Ikalukrok rock type not sent to the Main Pit Dump below the ultimate water level, the barium data is needed. There is Ikalukrok reported disposal in locations other than the Main Pit Dump (e.g., at the Center Waste Dump and the landfill) that are reported with high enough average percentages of zinc, lead, and iron to potentially exceed the self-heating criterion (e.g., June 2020 with 19.11 percent zinc, 2.91 percent iron, and 4.26 percent lead). However, this cannot be cross-checked without the barium and soluble lead concentrations.

The WRMP (Table 3) requires high-sulfide waste to be placed below the ultimate pit water level in the Main Pit Dump. Numerous quarterly Waste Rock Production Reports over several years submitted to ADEC state that the most reactive waste category was disposed of at Main Pit Dumps 3, 4, and 5. Similarly, in the 2020 Annual Report, Ikalukrok, Kivalina, Okpikruak, and Siksikpuk rock types, which are all in the most reactive waste category, were disposed at Main Pit Dumps 3, 4, and 5. According to the Waste Rock Dumps and Stockpile Locations map (Figure 1) in the WRMP, Main Pit Dumps 3 and 4 are presumably at the highest elevations of the pit and thus the most likely dumps to be above the ultimate pit water level. If Main Pit Dumps 3, 4, and 5 are located above the ultimate pit water level, they would not be appropriate disposal locations for the most reactive waste rock, in accordance with the WRMP. Based on the quarterly and annual reports, it is difficult to differentiate whether the disposal locations are

located above or below the ultimate pit water level. In the same 2020 Annual Report, there is also rock in the other waste rock category that was disposed of in Main Pit Dumps 4 and 5. According to these production reports, both high-sulfide (potentially self-heating) waste rock and other waste rock are disposed of in Main Pit Dumps 4 and 5, indicating that no segregation occurs between high-sulfide (potentially self-heating) waste rock and other waste rock. In accordance with the WRMP, the non-segregated disposal of high-sulfide waste and other waste can occur only if dumps were below the ultimate pit water level *and* there was no longer concern about available disposal space underwater.

The Audit Team recommends the following changes for consideration:

- The single blast hole assay maximum values be included in each quarterly report to ADEC to verify that dam construction waste rock criteria are met, as shown in the WRMP Table 3, Row 1.
- Percentage of barium and percentage of soluble lead be included on the Waste Rock Production report included in each quarterly report to ADEC, per the notes associated with Table 3 of the WRMP.
- The self-heating capacity risk region calculated value be provided for Ikalukrok waste in each quarterly report to ADEC.
- Any reference in quarterly reporting to ADEC to a disposal location that is not included in both the WMP and the WRMP be specifically called out as to how it is an approved disposal location.
- The WRMP and Monitoring Plan be updated to reflect the current disposal locations utilized by TAK, including the geologic and geochemical criteria that must be met for disposal at each location. The Audit Team recognizes that it is possible that a reported name of a facility is an internal name and could fall within WMP permitted facility. For example, the Oxide Stockpile could potentially fall within the Low-grade Ore Stockpile, a facility specifically called out in the WMP. However, the Audit Team would recommend that the reporting to ADEC match both the WMP permitted facility names and the WRMP disposal options by waste category.
- The future quarterly and annual Waste Rock Production Reports submitted to ADEC include more specificity in the rock disposal at the Main Pit; specifically, the reports should identify whether high-sulfide waste material is disposed of above or below the ultimate pit water level.
- At the time of WMP renewal, current disposal locations be updated in the WMP, or the language regarding the activity or inactivity of these dumps be updated (e.g., road construction, Oxide Stockpile, Low Grade Ore Stockpile).
- The QAPP be updated to reflect the procedures for sampling, analysis, data quality objectives, and data validation procedures for the geochemistry monitoring.

5.4.2 Tailings Management

Sections 1.1.2 and 2.5.1 of the WMP require the monitoring locations and frequencies in Table 1 of the Monitoring Plan (Appendix D of the IWMP), which includes monitoring of the tailings. Tailings management is described in Section 2.5 of the Monitoring Plan (Appendix D of the IWMP). The tailings monitoring program consists of tracking quantities of tailings production from the mill, geochemical monitoring, and visual monitoring of the TSF.

Geochemical monitoring of tailings is performed to characterize metal leaching and acid rock drainage potential, and to determine variability in the geochemical composition of tailings solids over time. The Monitoring Plan requires that the tailings production rates be tracked and summarized on a monthly basis; the tailings geochemistry be analyzed on a continuous basis for percent iron, lead, and zinc composition; and the diversion ditches, TSF, and main dam are visually monitored weekly. The quantities, geochemistry, and visual monitoring are to be reported quarterly.

The Monitoring Plan states that the tailings geochemistry will be analyzed continuously by an inline analyzer that estimates the percentage of iron, lead, and zinc in the final tailings slurry. The Audit Team also interviewed the Environmental Coordinator II, who is responsible for ADEC reporting, and the Lead Assay Technician for the onsite Assay Laboratory, who stated that there is an inline XRF analyzer. However, the data used for the reporting to ADEC of the tailings geochemistry is based on sampling of the tailings from a port and analysis in the onsite Assay Laboratory. The tailings samples are collected by mill technical staff approximately every 12 hours and analyzed for iron, lead, and zinc composition. The results are provided to the Environmental Department, which averages the data into a quarterly average for the quarterly reporting. The Audit Team reviewed the quarterly reports to ADEC. The quarterly average percentage of iron, lead, and zinc in the tailings slurry is provided, along with the dry tons of tailings generated that quarter.

The Audit Team recommends that the Monitoring Plan be revised to reflect the sampling and analysis technique and frequency. In addition, the Audit Team recommends that a Standard Operating Procedure (SOP) be developed to reflect the sampling and analysis methods, and that the QAPP be updated to reflect the procedures and data validation. In addition, the Audit Team recommends that future quarterly reporting to ADEC include a graph of the metals composition and production over time to allow the reader to put the data into context and to evaluate the variability in the geochemical composition of tailings solids over time, as that is a primary objective of the monitoring.

5.4.3 Water Quality and Biological Monitoring

Biomonitoring in the Red Dog Creek area was initiated in 1990 with fish tissue sampling and was expanded to the Bons Creek area in 2004. In 1996, invertebrate and periphyton sampling were added. TAK, in consultation with the Alaska Department of Fish and Game (ADF&G), updated these sampling programs in 2007. The program includes aquatic life and water quality monitoring, with data collected at varying frequencies and reported annually.

Sections 1.1.1.10 and 2.5.1 of the WMP require the monitoring locations and frequencies in Table 1 of the Monitoring Plan (Appendix D of the IWMP), which include:

- Bons Creek Monitoring Program: monitoring of the aquatic life and water quality in the Bons Creek drainage and Evaingiknuk Creek
- Mine Drainage Monitoring Program: aquatic life and water quality monitoring within the Red Dog Creek drainage, Ikalukrok Creek, and Wulik River
- Water quality and flow monitoring at select Mine Drainage stations related to discharge from Outfall 001
- Flow measurements at selected sites in the Mine Drainage Monitoring Program

The water quality and biomonitoring program at the mine is described in Section 2.1 of the Monitoring Plan (Appendix D of the IWMP). The program is designed to monitor and evaluate changes that may occur as a result of activities associated with wastewater discharge from Red Dog. The Monitoring Plan requires that seven surface water stations in the Bons Creek Drainage be sampled and analyzed twice per month when flow is present for the Profile I parameter list (Table 2 of the Monitoring Plan [Appendix D of the IWMP]). The Monitoring Plan requires monitoring of 12 surface water stations in the Mine Drainage Monitoring Program, at variable frequencies. Five of these monitoring stations are monitored under Red Dog Mine APDES permit #AK003865-2. The scope of this audit does not include an audit of the APDES compliance program; however, the WMP does incorporate the Monitoring Plan by reference, which does include these monitoring stations. The monitoring is to be reported annually.

The Audit Team interviewed Tristen Pattee, the Senior Environmental Technician who performs the monitoring and trains other technicians in surface water sampling. The Audit Team also interviewed the Environmental Coordinator II, who is responsible for ADEC reporting, and the Assistant Environmental Coordinator, who is responsible for maintaining the QAPP, data validation, and data management. TAK performs sampling at the frequency required in the Monitoring Plan. TAK has a staff of six Environmental Technicians in summer and four in winter to sample at the required frequencies of this and the other monitoring programs. The surface water samples are shipped to an off-site laboratory, ACZ Laboratory.

The Audit Team reviewed the annual reports, which include graphs of all surface water monitoring station analytical results for the last 5 years, as well as provide the analytical data to ADEC. The annual reports do not include any discussion or interpretation of the water quality results for the year for the Mine Drainage or Bons Creek monitoring program.

Based on interviews with TAK, the Audit Team understands that in 2019 TAK regraded the Qanaiyaq 1500 bench to promote surface water runoff towards the Qanaiyaq Pit and placed cover material on the eastern portion of the Qanaiyaq 1500 bench to reduce permafrost melt (if occurring). In 2020, the annual report stated that “a conceptual design plan to collect and divert Kaviqsaaq seep water to an existing mine water collection system water was submitted to ADF&G for review. ADF&G reviewed and approved the conceptual design, a final design from Red Dog Operations was expected to be completed and submitted to ADF&G in mid-March.

The design will utilize a small above ground pipe to gravity transfer the seep water to the Main Pit.”

The Audit Team also learned through interviews that TAK performs flow and water quality monitoring of the Kaviqsaq seep, and that ADEC was notified that monitoring was being implemented.

The Audit Team recommends the following changes for consideration:

- TAK submits the flow and water quality monitoring that is already collected to ADEC as part of quarterly reporting associated with the Kaviqsaq Seep. This data will allow TAK and ADEC to observe if the mitigation measures completed are effective at controlling seepage.
- The Monitoring Plan and QAPP be updated to specify what data, graphs, and findings will be provided in each annual report associated with the Kaviqsaq seep.

5.4.4 Biological Monitoring

The Red Dog Monitoring Plan is required by the ADEC and ADNR, as required by 18 AAC 15.090 and 18 AAC 60 (b)(3)(D) for the WMP. This plan is also a supporting document for the Red Dog Reclamation and Closure Plan and is an appendix to the IWMP.

The plan covers a wide range of sampling activities associated with biological sampling; permafrost and ground water monitoring; water quality and flow monitoring; and monitoring of waste rock, tailings and landfills, fugitive dust, and other media.

ADF&G conducts aquatic biomonitoring, which has occurred annually at the Red Dog Mine since 1995. ADF&G, in consultation with TAK, updated the overall biomonitoring programs in 2007. The programs include a combination of aquatic life and water quality monitoring, with data collected at varying frequencies and reported annually.

Key elements of the water quality and biomonitoring programs include:

- Aquatic life and ambient water quality monitoring within the Bons Creek drainage (Ikalukrok Creek/Wulik River drainage) and Evaingiknuk Creek (Noatak River Drainage), 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, 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

The Audit Team reviewed the aquatic biomonitoring reports, with sampling results from 2017 through 2020. ADF&G and TAK are conducting biomonitoring in accordance with the Red Dog Mine Monitoring Plan; overall, the biomonitoring program appears to be functioning as intended. The results of the biomonitoring program are largely unremarkable related to primary production

sampling, fish presence, and fish tissue sampling. It is also notable that the report includes a discussion and photos regarding change in condition of Ikalukrok Creek at Station 9, above the Red Dog Creek confluence, as well as discussion of recent similar changes in other river systems such as Ivishak, Kavik, and Canning rivers on the North Slope and tributaries of the Middle Fork Koyukuk and Alatna rivers. See Section 5.4.3 for additional water quality information.

5.4.5 Mine Water Management

Mining-impacted water throughout Red Dog is collected from waste dumps, the pit, and seepage collection systems and is stored in the TSF. In addition, Sections 1.1.1.9 and 2.5.1 of the WMP require the monitoring locations and frequencies in Table 1 of the Monitoring Plan (Appendix D of the IWMP), which includes monitoring for mine water management. Mine water management is described in Section 2.3 of the Monitoring Plan (Appendix D of the IWMP). The mine water monitoring program consists of flow and water quality monitoring at various mine water sample locations; maintaining a water and load balance for the Mine; and visual monitoring of the diversion ditches, pipelines, seepage collection, fish weir, and runoff collection systems. The Monitoring Plan (Appendix D of the IWMP) designates locations for monitoring mine-impacted water quality and quantity in Table 7. Data assists in the management of mine water and maintenance of water and load balance models.

The Audit Team interviewed the Senior Environmental Technician, who performs the monitoring and trains other technicians in mine water sampling and reviewed the quarterly and annual reports. TAK is monitoring in accordance with the Monitoring Plan locations, frequency, and reporting frequency. The Audit Team also interviewed the Environmental Coordinator II, who is responsible for ADEC reporting, and the Assistant Environmental Coordinator, who is responsible for maintaining the QAPP, data validation, and data management. The surface water samples are shipped to off-site laboratories, ACZ Laboratory and Pace Analytical.

During the site visit, the Audit Team observed locations where monitoring is completed by TAK; however, it is not included as a mine water monitoring location in the Monitoring Plan and is not reported to ADEC. The Back Dam Sump collects Back Dam seepage and returns the water to the TSF. The Section 2.5.5 of the WMP requires that “Water quality and flow monitoring that accounts for process water discharged to the TSF, process water recycled to the mill, water entering the pits, and any water directed to the TSF, pits, or another water treatment works, and data necessary to maintain facility water and load balances.” The Back Dam Sump operates similarly to the Main Dam Seepage Pumpback monitoring station, which is monitored for flow and water quality on a monthly basis.

The HDR Audit Team recommends that the Back Dam Sump be added to the Monitoring Plan mine water monitoring stations to monitor for changes in Back Dam seepage over time. The Audit Team also observed that the Qanaiyaq Pit water is pumped to the Main Pit. Because this water fits the WMP Section 2.5.5 description of water entering the pits and any water directed to the pits, the Audit Team recommends that the Qanaiyaq Pit flow and water quality be added to the Monitoring Plan mine water monitoring stations to monitor for changes in Main Pit Lake volume and water quality over time. In addition, the flows that report to the TSF from Willy Nilly

Creek are not included in the Monitoring Plan or reported to ADEC. In accordance with Section 2.5.5 of the WMP, the Audit Team recommends that the flow and water quality from Willy Nilly Creek be added to the Mine Water monitoring program to accurately account for all flows into the TSF for the water and load model.

5.4.6 Permafrost and Sub-permafrost Groundwater Monitoring

Sections 1.1.1.11 and 2.5.1 of the WMP require the monitoring locations and frequencies in Table 1 of the Monitoring Plan (Appendix D of the IWMP), which includes the permafrost and sub-permafrost monitoring program. The permafrost monitoring program is described in Section 2.2 of the Monitoring Plan (Appendix D of the IWMP). Thermal modeling of the tailings indicated that the thermal impact of the TSF may affect the underlying permafrost. Therefore, the permafrost monitoring program includes quarterly monitoring of background and dam area thermistors and piezometers to assess trends in temperature changes and water levels in the permafrost, quarterly monitoring of background and dam area piezometers to assess water levels, and annual reporting.

The Audit Team interviewed the Field Technician who collects data, reviewed the monitoring observations in recent monitoring event field data forms, and reviewed annual report data. TAK is performing the monitoring and reporting in accordance with the monitoring program. The Audit Team observed a large number of thermistor readings that were recorded as “Error” on the field data sheet. During the interview with the Environmental Coordinator II, it was explained that TAK uses a consultant to perform the data review, provide TAK a quality control data checklist, provide barometric conversions of the piezometer data, and complete the annual reporting. The third quarter 2021 data checklist confirmed that many of the thermistors have unusable nodes. Of the 16 thermistors, 7 appear to be fully operational. The other nine thermistors have between one and all nodes reporting negative values, indicating an error. Thermistor T-95-004 (Appendix A, Photograph 13) was specifically called out as having had data issues over “past quarters,” implying that an issue has persisted. The thermistor data indicates that numerous nodes had problematic readings (like for T97-28, T96-13, and T96-23). The Audit Team asked if there was a SOP or QAPP for the data validation, data management, and data quality objectives for this monitoring program. The Environmental Coordinator II said there were not; however, the annual reports refer to quality assurance/quality control (QA/QC) measurements and data review checklists, so it appears that some form of QA is being performed. A QA program that lines out data review, identification of issues, and at what point equipment maintenance or replacement is required is recommended to keep the monitoring program operating as intended.

The annual reports state that the data collection was performed in accordance with the Red Dog Mine Long Term Groundwater Monitoring Plan’s SOP in Water Management Consultants, Inc.’s 2001 plan (WMCI 2001). However, this plan is from 20 years ago. The Audit Team recommends that the QAPP be updated to include the data collection, data validation, data management and associated conversions and data drift, and data quality objectives for the thermistors and piezometers. The annual report has data graphs; however, the graphs that show all of the thermistor temperature data over the years has no legend; therefore, it is difficult to determine the trend. Inclusion of a thermistor whose graphs may be indicating a trend (e.g., T-96-021 at

the Back Dam) and the addition of a legend or different style of graph would facilitate reader review. For example, the Audit Team recommends a graph that, instead of showing the temperature at each depth node each year for a busy graph, shows the change in temperature year to year by depth node.

5.4.7 Quality Assurance/Quality Control Program

The Audit Team reviewed the water quality and environmental QAPP and interviewed the Assistant Environmental Coordinator responsible for maintaining the QAPP and performing data validation. The QAPP was last updated in 2018. There are ongoing changes to any monitoring program that require QAPP updating at least annually. Section 2.5.19 of the WMP states that the permittee must amend the QAPP whenever there is a modification in sample collection, sample analysis, or other procedure addressed by the QAPP. In accordance with Section 2.5.19 of the WMP, it is recommended that the QAPP be updated to reflect all current conditions as well as all laboratories used for analysis. The onsite Assay Laboratory maintains its own QAPP and analyzes the mill tailings and waste rock, and ACZ Laboratory in Denver and Pace in Minnesota analyze water samples. It is recommended that the QAPP be updated to include discussion of sampling, sample handling, data quality, and reporting associated with the geochemistry samples.

The Audit Team interviewed a water quality sampler and reviewed the field log books for sampling. The notes included all data recorded; however, no date could be found where any error, sample collection difficulty, malfunctioning equipment, access issues, weather issues, or other problems encountered were noted in the field book. The Audit Team recommends that technicians record difficulties and problems when issues arise so they can be tracked.

The QAPP does not currently address the use of pressure transducers and data loggers (e.g., in-situ flow, thermistors, barometer) for the measurement and recording of water levels in piezometers. It is recommended that the frequency of data download from the data loggers and reference to a separate SOP be included, or the QAPP be updated to cover the quality of this data collection. The QAPP and/or the SOP should describe the data collection programming of the data logger; the equipment, frequency, and process for data download; where data will be stored and how it will be managed; how data drift will be reviewed and corrected; how data will be corrected for barometric pressure; etc.

The QAPP does not describe data validation procedures. It is recommended that there be more clarification in the QAPP regarding the QC sampling and the acceptance criteria limits. Section 1.3.1 of the QAPP includes measurement quality objectives, including how to calculate precision and completeness; however, the section is written as if to address laboratory quality objectives as opposed to quality objectives associated with the sampling QA/QC. For example, Table 1 of the QAPP lists precision and accuracy percentages that are assumed to be data acceptance criteria; however, according to the Assistant Environmental Coordinator, those values are the external laboratory data objectives. The QAPP states that trip blanks, field blanks, equipment blanks, field splits, and duplicates are all sample collection QA/QC completed by TAK; however, there is no description of what is done with those reported results once received. Section 3.6 of the QAPP did not state the frequency a field split should be collected. The Audit Team

recommends that the QAPP be revised to include the data management and data validation process by TAK once laboratory reports are received, including the management of QA/QC data (field duplicates); calculations associated with precision, accuracy, etc.; data quality objectives; flagged data; data acceptance; and, specifically, what staff is responsible for the data validation process for which data.

It is recommended that TAK update the QAPP to provide direction for the statistical analyses and reporting, whether direct comparisons of concentrations to the Aquifer Water Quality Standards (AWQS) or calculations of statistically significant increases (SSIs) over a baseline. It is recommended that Table 5 of the QAPP be updated to state dissolved or total fraction of metals analyzed.

5.4.8 Laboratories and Sample Analysis Procedures

Onsite Assay Laboratory

TAK maintains an onsite laboratory that is used for assay testing for the tailings samples collected at the mill and the blast holes for waste rock management. The Audit Team assessed this laboratory and interviewed the Lead Assay Technician, who led the Audit Team on a tour of the Assay Laboratory and Bucking Room.

The laboratory management, operations, safety, and waste management were found to be within general acceptable practices for environmental testing laboratories. Because the laboratory provides assay data for permit compliance, it is recommended that the water quality and environmental QAPP be updated to reflect the sample handling and general QA/QC associated with the geochemical testing in compliance with the Monitoring Plan.

The Laboratory Manager showed the Audit Team a copy of the assay method, which included laboratory control standards to assess method accuracy; however, no data quality thresholds were described. The Audit Team recommends an update.

Sample Preparation Shack

The Audit Team inspected the environmental sampling room and storage where the Environmental Technicians prepare for sampling and prepare samples for shipment. The sampling room and storage is used for storage of laboratory-supplied sample containers, sample coolers, refrigerated storage for temporary storage of samples and reagents, freezer storage for ice, storage of reagents, storage and calibration of field meters (e.g., pH meter), storage of sample preservative chemicals (e.g., nitric acid), and storage of field sampling equipment and supplies. In general, the rooms were clean and well organized, with equipment and supplies well maintained and labeled. The Audit Team observed the field meters and calibration logs for field meters, as well as example Chain of Custody forms, and reviewed that all of the calibration standards were not expired. The calibration logs for field equipment were evidence that field meters were calibrated before each sampling event. Through discussion with the Senior Environmental Technician, it was discovered that there are no established acceptance criteria for the calibration check (e.g., meter reads +/-5 percent of standard after

calibration). It is recommended that the calibration check acceptance criteria be easily identifiable in the QAPP.

The Senior Environmental Technician showed the Audit Team a location on the TAK network that housed the many SOPs sitewide, including SOPs for sample collection. It is recommended that TAK create a master SOP list just for permit-required environmental sampling and tests. This list should be included in the QAPP and also made available in the sample preparation room. Furthermore, appropriate sampling, sample handling, and field equipment SOPs should be maintained and readily available.

5.5 Waste Rock Management Plan

The Audit Team reviewed the WRMP (September 2018) and compared it against other plans and mine activities. The review of the waste rock program is described in Section 5.4.1. The WRMP briefly states that the waste rock classification is first dependent upon the rock type classification, and second upon the assay results (footnote in Table 3 of the WRMP states “rock type has precedence”). It is recommended that the WRMP include further discussion on this detail and the level of importance associated with rock type classification. For example, the 2020 Annual Report reports quantities of most reactive waste disposal of Ikulukrok, Kivalina, Okpikruak, and Siksikpuk rock types being disposed of in Main Pits 3, 4, and 5. According to Table 3 in the WRMP, the high-sulfide waste rock type is “typically Ikalukrok.” Because of the rock type precedence, it is not clear if Siksikpuk rock or others with high percentages of zinc, iron, and lead should ever be checked for self-heating capacity to determine if underwater disposal at the Main Pit could be warranted.

5.6 Fugitive Dust

The fugitive dust management program covers Red Dog as well as the DeLong Mountain Transportation System (DMTS). The scope of this audit is limited to the WMP boundary (mine boundary); as such, the audit review for the fugitive dust monitoring program is limited to within the WMP boundary.

Fugitive dust emissions have been monitored and evaluated at Red Dog since the early 2000s. The *DMTS Fugitive Dust Risk Assessment* (Exponent 2007) assessed risks to human and ecological receptors from metals in soil, water, sediment, plants, and animals in the area surrounding the air/WMP boundary and the DMTS. The risk assessment resulted in the development of the Fugitive Dust Risk Management Plan, which in turn gave rise to a series of studies and plans, including the Communication Plan, Worker Dust Protection Plan, Monitoring Plan, Remediation Plan, Dust Emissions Reduction Plan, and Uncertainty Reduction Plan. A brief description of each plan is provided below (2019 Annual Report):

- **Communication Plan:** This plan centers around maintaining clear communication with local communities and other interested parties about fugitive dust risk management efforts at Red Dog.

- **Worker Dust Protection Plan.** This plan focuses on programs designed to monitor and minimize workers' exposure to dust while at Red Dog, and to facilitate comprehensive communication about these programs, policies, and practices.
- **Monitoring Plan:** This plan evaluates changes in dust emissions and deposition over time and space, using that information to (1) assess the effectiveness of operational dust control actions; (2) evaluate the effects of the dust emissions on the environment and on human and ecological exposure; and (3) trigger additional actions where necessary.
- **Remediation Plan:** The goal of this plan is to define a consistent method for identifying and selecting affected areas and implementing remediation and/or reclamation.
- **Dust Emission Reduction Plan:** The purpose of this plan is to reduce the amount of fugitive dust released into the environment near the DMTS and Red Dog to protect human health and the environment.
- **Uncertainty Reduction Plan:** This plan was developed to identify and prioritize prospective research or studies to reduce uncertainties in the assessment of effects of fugitive dust to humans and the environment.

Road Dust. During summer, when conditions are dry, calcium chloride is applied to gravel roads as a dust suppressant because it retains moisture for prolonged periods. Additionally, water trucks spread water on Red Dog roads. TAK is using calcium chloride in conjunction with water applications to suppress dust and stabilize unpaved road surfaces.

Tailings Beach Dust Suppression. The TSF is required to have a 600-foot-wide tailings beach. As result, the tailings beach is exposed to high winds and creates windblown dust from the TSF. TAK has tried a number of different methods to control dust from the TSF, including the use of a crop-duster aircraft to apply dust suppressant on the tailings beaches, resulting in varying degrees of success.

In 2019, a piece of equipment, the Terramac RT9, was trialed at Red Dog for laying down suppressant on the tailings beach. The low ground pressure of the Terramac is able to travel over unstable and wet tailings beach conditions without sinking into the tailings. This allows for travel on the tailings beaches year-round so that dust product can be applied year-round.

Mine Area Dust Emissions Reduction Projects. During dry summer months, water trucks conduct continual dust suppression efforts. Additionally, a truck wash is located at Red Dog where pickup trucks wash off road dust on a routine basis.

At the time of the audit, TAK was actively closing the MWD by installing a lined cap with a soil cover material that will be revegetated, which will serve to further reduce windblown dust at the site.

Two tapered element oscillating microbalance (TEOM) samplers are used for air quality monitoring within the Mine's boundary. These TEOMs are located downwind of the pit and

crusher at the Personnel Accommodations Complex (PAC) and at the main tailings dam downwind of the tailings beach, mill, and other facilities.

The TEOMs produce real-time measurements of dust in the air and collect discrete samples that are then analyzed to provide airborne metals concentrations. Measurements are reported as Total Suspended Particulates. Statistical testing methods are used to evaluate whether TEOM datasets have statistically significant temporal trends in metals concentrations.

TAK is following the requirements in the WMP by conducting monitoring, implementing abatement measures and experimenting with various options to control dust, and reporting results. HDR recommends that TAK continue to evaluate dust abatement options and proceed with the vegetated cap for the MWD as well as continue to conduct reclamation activities where possible.

5.7 Certificate of Approval to Operate/Modify a Dam

5.7.1 Dam Safety Permits and Requirements

The ADNR DMLW Dam Safety and Construction Unit issues CODs for each of the four permitted dams at Red Dog that specify requirements for operation of the dams, including:

- Maximum (nominal) dam crest elevation and water storage elevation
- Operations and Maintenance (O&M) Manual
- Inspections, including periodic safety inspections (PSIs)
- Instrumentation and monitoring of the dam and appurtenances
- Emergency action planning and an Emergency Action Plan (EAP) that includes exercises

The ADNR DMLW Dam Safety and Construction Unit issues CMDs for approval of modifications to the Tailings Main Dam and Tailings Back Dam that include specific requirements for the construction of modifications to the permitted dams and appurtenances, including:

- Maximum (nominal) raised crest elevation
- Conditions encountered during construction
- Foundation inspections, geologic mapping, and approvals
- Instrumentation and monitoring, including preservation or replacement of existing instrumentation
- Design Engineer approval of deviations from approved drawings and specifications
- Construction documentation (Completion Report)
- O&M Manual
- Emergency action planning, and an EAP that includes exercises

Table 2-1 lists the specific dam safety permits reviewed by the Audit Team.

Photographs 13 through 19 in Appendix A depict observations of the dams and appurtenances taken during the Red Dog field visit.

5.7.2 Governing Documents

Current documents that govern O&M, periodic safety inspections, and pending modifications (where applicable) for the permitted dams at Red Dog include¹:

- Tailings Main Dam (NID ID# AK00201):
 - Operations and Maintenance Manual Revision 13, Tailings Main Dam (NID ID# AK 00201), Red Dog Mine, Alaska, by Golder Associates, Inc. (Golder), November 5, 2020 (Golder 2020a)
 - 2020 Periodic Safety Inspection, Tailings Main Dam (NID ID# AK00201), Red Dog Mine, Northwest Arctic Borough, Alaska, by NewFields, revised March 2021 (NewFields 2021a); field site inspection was performed from July 31 to August 3, 2020
 - Stage XI-A Interim Raise:
 - Drawings: Red Dog Tailings Main Dam, Stage XI Raise Detailed Design Drawings, Stage XI-A Interim Raise to Elevation 991 Feet (28 Drawings), Issued for Construction, May 18, 2020 (Golder 2020b)
 - Specifications: Specifications for Construction of Tailings Main Dam Stage XI Raise, Issued for Construction, May 18, 2020 (Golder 2020c)
 - CQA Plan: Tailings Main Dam Stage XI Raise, Construction Quality Assurance Plan, Issued for Construction, May 18, 2020 (Golder 2020d)
 - Wing Wall Section (east abutment) Foundation Liquefaction Mitigation:
 - Drawings: Red Dog Tailings Main Dam, Wing Wall Foundation Liquefaction Mitigation, Detailed Design Drawings (23 Drawings), Issued for Construction, July 15, 2020 (Golder 2020e)
 - Specifications: Specifications for Wing Wall Liquefaction Mitigation – Cutter Soil Mixing Ground Improvement, Issued for Construction, September 14, 2020 (Golder 2020f)
 - CQA Plan: Wing Wall Liquefaction Mitigation – Cutter Soil Mixing Ground Improvement, Issued for Construction, July 14, 2020 (Golder 2020g)
 - Stage XI-B Full Raise:
 - Drawings: Red Dog Tailings Main Dam, Stage XI Raise Detailed Design Drawings, Stage XI-B Full Raise to Elevation 996 Feet, (19 Drawings), Issued for Construction, Revision 2, March 20, 2021 (Golder 2020h)

¹ Review of construction documents for the modifications to the Tailings Main Dam and Tailings Back Dam was not within the scope of this audit; the documents are listed solely for record purposes, representing the currently approved designs.

- Specifications: Specifications for Construction of Tailings Main Dam Stage XI Raise, Issued for Raise Construction, Revision 2, March 30, 2021 (Golder 2020i)
- CQA Plan: Tailings Main Dam Stage XI Raise, Construction Quality Assurance Plan, Issued for Raise Construction, Revision 2, March 30, 2021 (Golder 2020j)
- Tailings Back Dam (NID ID# AK00303):
 - Operations and Maintenance Manual Revision 4, Tailings Back Dam (NID ID# AK 00303), Red Dog Mine, Alaska, by Golder, September 25, 2020 (Golder 2020k)
 - 2020 Periodic Safety Inspection, Tailings Back Dam (NID ID# AK00303), Red Dog Mine, Northwest Arctic Borough, Alaska, by NewFields, revised February 2021; field site inspection was performed on August 2, 2020 (NewFields 2021b)
 - Drawings: Tailings Back Dam Stage V Raise, Stage V Raise to Elevation 1006 Ft, (8 Drawings), Issued for Construction, Revision 0, May 27, 2021 (Golder 2020l)
 - Specifications: Specifications for Construction of Tailings Back Dam Stage V Raise, Issued for Construction, Revision 0, May 27, 2021 (Golder 2020m)
 - CQA Plan: Tailings Back Dam Stage V Raise, Construction Quality Assurance Plan, Issued for Raise Construction, Revision 0, May 27, 2021 (Golder 2020n)
- Mine Water Diversion Dam (NID ID# AK00260):
 - Operations and Maintenance Manual Rev 3, Mine Water Diversion Dam, NID ID# AK00260, Revision 3, March 13, 2015 (URS Corporation 2015)
- Water Supply Dam (NID ID# AK00200):
 - Operations and Maintenance Manual Revision 7, Water Supply Dam, April 17, 2020 (Golder 2020o)

Information regarding the facility design, construction history, and inspection history for the permitted dams and appurtenances is provided in the O&M Manuals and PSI reports listed above.

5.7.3 Compliance with Permit Requirements

As is indicated in Table 4-1, ADNR DMLW Dam Safety and Construction Unit personnel (State Dam Safety Engineer and Assistant State Dam Safety Engineer) were interviewed regarding TAK compliance with the requirements of the permits and issues relative to status, O&M, and monitoring of the permitted dams.

During the interview of ADNR DMLW Dam Safety and Construction Unit personnel, they provided the following feedback and comments:

- In general, TAK complies with the dam safety permit conditions for the four permitted dams.
- The final versions of the PSI reports for the Tailings Main Dam and Tailings Back Dam met the intent of the permit requirements.

- Water management has been the biggest challenge for TAK since first beginning mining operations. In 2019 and 2020 Teck had to divert excess water into the Aqqaluk active mine pit to store excess water and has had to construct a dam raise of 5 feet in 2021 for the Main Dam and Back Dam. Wing dams also needed to be raised with foundation ground improvements to mitigate liquefaction potential. TAK has accelerated the dam raise schedule over the history of the project to store excess water. The ongoing TAK strategy is to stay well ahead of the tailings storage level with dam raises to provide sufficient water storage.
- The minimum width of the tailings beach at the Tailings Main Dam was increased from 300 to 600 feet (circa 2014) to reduce seepage gradients through the dam, along with a design change that replaced the coarse rock cover on the Main Dam upstream slope geomembrane liner with a tailings seal layer for subsequent dam crest raises, to reduce hydraulic connection from the impounded water to the toe of the dam, which would result in seepage downstream of the Main Dam. An ongoing operational requirement is to maintain a 1 percent or flatter beach slope. It is noted that the 2020 PSI for the Tailings Main Dam refers to a 300- to 600-foot beach width (NewFields 2021a).
- TAK completed construction of the Stage XI-B half-raise of 5 feet (to elevation 996 feet) for the Main Dam and the Stage IV half-raise of 5 feet for the Back Dam in 2021, increasing the total elevation for the Main Dam to 996 feet and 996.5 feet for the Back Dam. The Wing Dam at the Main Dam also is in the process of being extended and raised to elevation 996 feet, along with Wing Dam foundation ground improvement to mitigate liquefaction potential.
- The Seepage Collection Dam and Seepage Collection Pond at the Tailings Main Dam are in the process of being moved farther downstream. The pumphouse has already been relocated.
- TAK's approach to dam safety response has changed to a Trigger-Action-Response Plan (TARP) approach within approximately the last year. TAK developed TARPs in 2020 for the permitted dams, but the TARPs were not included in the 2020 O&M Manual revisions or in the EAPs for the Tailings Main Dam and Tailings Back Dam. The ADNR DMLW Dam Safety and Construction Unit indicated that TAK will be required to reconcile the O&M Manuals and the EAPs with the newly developed TARPs.

5.7.4 TAK Information Exchange

The TAK Tailings and Water Supervisor (Nancy Tracy) was given a list of questions (in Excel format) regarding TAK compliance with the ADNR DMLW dam safety permit conditions for the four permitted dams at Red Dog Mine and provided responses. In the course of this information exchange, TAK confirmed the following:

- Tailings Main Dam (NID ID# AK00201):

- TAK has not had any issues with conforming to the requirements of the current O&M Manual for the Tailings Main Dam.
- TAK staff have performed daily, weekly, and quarterly inspections and seismic/precipitation event-driven inspections and are collecting inspection data using the Fastfield mobile forms software application.
- Monitoring of seepage water quality for the Tailings Main Dam is being conducted in accordance with the O&M Manual, and the data was reported in the Annual Instrumentation Report (TAK 2020) and in the 4th Quarter and Annual Report (TAK 2019).
- No O&M procedures have deviated from the current O&M Manual.
- Revisions to the O&M Manual were not needed as a result of the most recent PSI in 2020.
- The EAP for the Tailings Main Dam was exercised on February 26, 2021, and notification was sent to the ADNR DMLW Dam Safety and Construction Unit on March 1, 2021.
- Revisions to the EAP were not needed based on the 2021 exercise.
- The EAP has not been activated for the Tailings Main Dam since the last mine audit in May 2014.
- The Annual Instrumentation Report covering the TSF instrumentation, including the Tailings Main Dam, was prepared and submitted to ADNR on March 30, 2021 (TAK 2020).
- The Annual Water Management Plan was prepared and submitted to ADNR on April 20, 2021.
- Tailings Back Dam (NID ID# AK00303):
 - TAK has not had any issues with conforming to the requirements of the current O&M Manual for the Tailings Back Dam.
 - TAK staff have performed daily, weekly, and quarterly inspections and seismic/precipitation event-driven inspections and are collecting inspection data using the Fastfield mobile forms software application.
 - No O&M procedures have deviated from the current O&M Manual.
 - Revisions to the O&M Manual were not needed as a result of the most recent PSI in 2020.
 - The Annual Instrumentation Report covering the TSF instrumentation, including the Tailings Back Dam, was prepared and submitted to ADNR on March 30, 2021 (TAK 2020).
 - The EAP for the Tailings Back Dam was exercised on February 26, 2021, and notification was sent to the ADNR DMLW Dam Safety and Construction Unit on March 1, 2021.
 - Revisions to the EAP were not needed based on the 2021 exercise.

- The EAP has not been activated for the Tailings Back Dam since the last mine audit in May 2014.
- Results of ongoing monitoring of the permafrost conditions at the Kivalina Overburden Stockpile have not indicated that a seepage collection system is required for the Tailings Back Dam.
- Mine Water Diversion Dam (NID ID# AK00260):
 - TAK has not had any issues with conforming to the requirements of the current O&M Manual for the Mine Water Diversion Dam.
 - TAK staff have performed daily, weekly, and quarterly inspections and seismic/precipitation event-driven inspections and are collecting inspection data using the Fastfield mobile forms software application.
 - No O&M procedures have deviated from the current O&M Manual.
 - Revisions to the O&M Manual were not needed as a result of the most recent PSI (date of the PSI is unknown).
 - The Annual Instrumentation Report, including data for the Mine Water Diversion Dam, was prepared and submitted to ADNR on March 30, 2021 (TAK 2020).
 - No reportable incidents have occurred since the last mine audit in 2014.
 - No pending or planned modifications have been made to the Mine Water Diversion Dam.
- Water Supply Dam (NID ID# AK00200):
 - TAK has not had any issues with conforming to the requirements of the current O&M Manual for the Water Supply Dam.
 - TAK staff have performed daily, weekly, and quarterly inspections and seismic/precipitation event-driven inspections and are collecting inspection data using the Fastfield mobile forms software application.
 - No O&M procedures have deviated from the current O&M Manual.
 - Revisions to the O&M Manual were not needed as a result of the most recent PSI completed in 2021.
 - The Annual Instrumentation Report, including data for the Water Supply Dam, was prepared and submitted to ADNR on March 30, 2021 (TAK 2020).
 - The Periodic Safety Inspection for the Water Supply Dam was performed on March 5, 2021.
 - The EAP for the Water Supply Dam was exercised on February 26, 2021, and notification was sent to the ADNR DMLW Dam Safety and Construction Unit on March 1, 2021.
 - Revisions to the EAP were not needed based on the 2021 exercise.
 - The EAP has not been activated for the Water Supply Dam since the last mine audit in May 2014.
 - No reportable incidents have occurred since the last mine audit in 2014.

5.7.5 Results of Periodic Safety Inspections

The recent (2020 inspections) PSI reports for the Tailings Main Dam (NewFields 2021a) and Tailings Back Dam (NewFields 2021b) each included a summary of outstanding issues and recommended action items that were identified during previous annual inspections and PSIs, along with notes regarding the status of progress or completion. These issues and action items are summarized in the “Register of Outstanding Key Issues and Recommended Actions” in Table 3 of each PSI report (NewFields 2021a, 2021b). A majority of the issues/action items are understood to have been addressed by the 2020 updates to the O&M Manuals (Golder 2020a, 2020o).

Based on the Audit Team’s review of the PSI reports for the 2020 inspections of the Tailings Main Dam (NewFields 2021a) and Tailings Back Dam (NewFields 2021b), and the information exchange with TAK Tailings and Water staff, the recommended actions for TAK and status of each action are as follows:

- Tailings Main Dam (NID ID# AK00201):
 - Install additional ShapeAccelArray (SAA) inclinometers and vibrating wire piezometers (VWPs) on the Tailings Main Dam. *This is understood to be planned after construction of the Stage XI-B raise is complete. The additional instruments were indicated as being associated primarily with the Stage XII full build-out of the dam embankment.*
 - Monitor cracks on the crest of the Wing Wall (east abutment). *Visual inspection, monitoring, and documentation of the cracks (if observed) is understood to be ongoing by TAK Tailings and Water staff.*
 - Implement best practices for reduction of SAA and inclinometer data and procedures for verifying repeatable readings. *This is understood to be in process and ongoing by TAK staff.*
 - Given the water management challenges for the TSF, consider incorporating a water management strategy for the TSF into the O&M manuals. *New recommendation.*
- Tailings Back Dam (NID ID# AK00303):
 - Monitor the surface of the Stage IV raise cutoff wall when complete for presence of cracks at wall panel joint locations. *TAK has indicated that ongoing inspection and monitoring is being performed. It was indicated in the PSI report that the previously observed cracks did not rematerialize and were likely associated with minor amounts of frozen fill placed at the very end of construction activity.*
 - Install additional SAA inclinometers upstream and downstream of the cutoff wall where a continuous crack is present in the downstream slope of the Back Dam (between Stations 21+00 and 23+00), at least one SAA inclinometer downstream of the cutoff wall in the Select Fill Zone, and an additional SAA inclinometer downstream of the crack through the Rockfill Zone. *TAK’s current plan is to install a new SAA inclinometer at the toe of the Kivalina Overburden Stockpile between Stations 22+00 and 23+00.*

- Establish a tailings beach at the Tailings Back Dam to reduce seepage gradients through the dam. *This is understood to be a long-term goal for TAK; there are concerns regarding how a tailings beach could affect the cutoff wall underlying the Back Dam, although it was indicated in the PSI report that the Design Engineer (Golder) has reviewed the concept of a tailings beach and did not have any issues.*
- Continue to monitor for cracking along the dam crest, survey any newly observed cracking, and watch for correlations with monitoring data collected in nearby SAAs and survey monuments. Consider revising the daily inspection forms regarding observed cracking as part of the next O&M Manual revision to reduce possible discrepancies between the daily and weekly/quarterly reporting. *New monitoring forms in use by TAK address this documentation concern, along with more consistent documentation and O&M guidance provided in the current version (Revision 4) of the O&M Manual.*
- Make the following improvements to the instrumentation in and near the Kivalina Overburden Stockpile to monitor its performance as a secondary seepage barrier for the system:
 - Replace the three 96-series ground temperature arrays (thermistors) (T-96-21 to T-96-23, inclusive), which range in length from 105 to 115 feet, with three of the Beaded Stream temperature monitoring arrays that were used along the Tailings Back Dam alignment.
 - Replace the frozen VWP at P-12-109 with another that is installed with the instrument above the permafrost surface. Drill and install a new ground temperature array (thermistor) between OS-18-11 and G17-03. Connect the VWPs and, if possible, the temperature arrays into the NavStar data collection system and incorporate them into the O&M Manual.
 - *It is understood that TAK agrees that the above-listed upgrades are needed for thermal monitoring of the Kivalina Overburden Stockpile. TAK is working with the Design Engineer (Golder) to prioritize the above recommendations, and the current plan is that additional instrumentation will be installed over the next 1 to 3 years outside of what has already been addressed.*

The recent PSI reports also included recommendations for items to be reviewed or considered, presented in Section 7 of the PSI reports by NewFields (2021a, 2021b):

- Tailings Main Dam:
 - Continue monitoring piezometers P-18-171-C and P-18-172, and consider further investigation of the collected data should these VWPs continue to trend differently than expected for other piezometers along the Wing Wall.
 - Continue to monitor and document current seeps, and any others that are identified, along the west abutment.
 - Update the GoldSim water balance model as described in Section 7 of the PSI by NewFields (NewFields 2021a).

- Review the GoldSim water balance model annually and update the model logic as appropriate.
- NewFields (2021a) determined at the time of the inspection that the Tailings Main Dam should be considered in Satisfactory condition in accordance with ADNR Dam Safety Program Guidelines, with the caveat that water management and tailings beach width were not in agreement with typical operating conditions, and the tailings beach width was significantly less than the goal presented in the O&M Manual due to water management considerations at the mine. NewFields (2021a) indicated that long-term solutions to these non-typical conditions are necessary and should be evaluated as soon as possible, but that based on their review of the Tailings Main Dam structure and operations, these non-typical conditions did not currently impact the integrity of the structure.
- Tailings Back Dam:
 - NewFields (2021b) determined at the time of the inspection that the Tailings Back Dam should be considered in Satisfactory condition, in accordance with ADNR Dam Safety Program Guidelines.

5.8 Reclamation and Closure Plan and Approval

5.8.1 Regulatory Setting for Reclamation

Mine reclamation and closure is regulated by multiple state entities, including ADNR and ADEC. State law (Alaska Statute [AS] 27.05.010[b]) states that ADNR “is the lead agency for all matters relating to the exploration, development, and management of mining.” ADNR’s Office of Project Management and Permitting coordinates regulatory interactions and requirements, and the Large Mine Permitting Team manages permit development and review for mining projects.

Table 5-4 summarizes RPA conditions and status.

Table 5-4. Reclamation Plan Approval (F20169958) Conditions and Status

#	Requirements	Status
Financial Assurance		
1	The total financial assurance amount of \$558,350,000 has been accepted for the Red Dog Mine (F20169958).	The bond can be released or decreased as allowed per 11 AAC. This amount shall be adjusted annually to account for inflation based on the Anchorage Consumer Price Index. As of March 4, 2021, the bond is \$584,665,168.
Terms of Plan Approval		
2	Reclamation and Closure Plan, Red Dog Mine, Alaska, USA (August 2016); and Integrated Waste Management Plan, Red Dog Mine, Alaska, USA (August 2016)	These 2016 documents represent the current versions approved by ADNR and ADEC.
Authorized Officer		
3	The Authorized Officer: designated as the Mining Section Chief within the Division of Mining, Land and Water, currently: Marty Lentz 550 West 7 th Avenue, Suite 900D	Steve Buckley is the current Mining Section Chief: Steve Buckley 550 W. 7 th Avenue, Suite 900B Anchorage, Alaska 99501-2577 Phone: (907) 269-8642

#	Requirements	Status
	Anchorage, Alaska 99501-2577 Phone: (907) 269-8621	
Monitoring Plan		
4	Annual Reports are due March 1 each year. Quarterly Reports are due 60 days from the last day in the quarter.	The Quarterly and Annual Reports were submitted throughout the period to ADNR and ADEC.
As-Built Maps		
5	The Permittee shall submit to ADNR an annual set of maps illustrating the current development of all facilities within the project area as described in the Reclamation Plan.	The Quarterly and Annual Reports include maps illustrating the required information.
Inspection and Entry		
6	The Permittee shall permit authorized representatives of ADNR to enter into and upon the area and facilities covered under this plan approval at all reasonable times without notice, for the purpose of inspecting the area and activities covered under this plan approval. At any time upon ADNR's written request, the Permittee shall promptly make available any and all records, documents, or other information required to be kept or maintained by law, regulation, ordinance, or this Reclamation Plan Approval.	Documentation is available on the ADNR website and upon request.
Modifications		
7	See Table 5-5 below.	

Table 5-5. Amendments to 2016 Reclamation and Closure Plan

	Items	Status
1	DNR Reclamation Plan Approval Amendment 01 (F20169958) (Issued 6/25/2018)	ADNR DLMW approved the clearing of 47 acres for a TSF and 35 acres for the WMD, including 12.5 acres of wetland disturbance.
2	DNR Reclamation Plan Approval Amendment 02 (F20169958) (Issued 3/20/2019)	ADNR DMLW approved amendments to the TSF final beaching height and cover material depth.
3	DNR Reclamation Plan Approval Amendment 03 (F20169958) (Issued 2/14/2020)	ADNR DLMW approved amendments to the closure design of the Main Waste Stockpile from an engineered compacted soil cover to a geosynthetic liner and cover design.
4	DNR Reclamation Plan Approval Amendment 04 (F20169958) (Issued 9/14/2020)	ADNR DMLW approved a request to allow Environmental Audit field work to be conducted in summer 2021 due to health and safety concerns associated with the COVID-19 pandemic.

5.8.2 Reclamation and Closure Plan Components

For the purposes of closure planning and reclamation bonding, there are three distinct phases of closure: operations, reclamation, and post-reclamation. These phases are described as follows:

- **Operations:** The operations period will extend to the end of mining and ore processing, currently estimated at 2030. Changes to the site resulting from future operations are described in the 2016 RCP Section 2.0. This phase includes early

reclamation of portions of the site and preparations for closure as production operations slow down.

- **Reclamation:** The closure period begins when operations cease and extends until closure activities such as demolition, construction, and reclamation are complete. Closure activities will begin in 2031 when production ceases. It is expected that closure measures will require at least two field seasons to complete. The primary objectives of this phase are:
 - Limiting safety hazards and acid generation associated with the pit walls;
 - Allowing reclamation of waste rock dump areas and limiting the release of acidic drainage;
 - Keeping non-contact water in the Red Dog Creek Diversion; and
 - Ensuring that all contact water is collected and treated prior to discharge.
- **Post-Reclamation:** The post-closure period will commence once the closure measures are completed and will extend indefinitely thereafter. Water treatment, maintenance, and monitoring are post-closure activities that are expected to be required. The principal post-closure requirement will be the collection and treatment of contaminated water. A second post-closure requirement will be the maintenance and repair of the tailings dams, spillway, ditches, soil covers, and other earthworks constructed during the closure period. Substantial maintenance activities are expected during the first few years post-closure; however, as stable conditions develop, activities will decrease. Additional long-term requirements include the infrastructure needed to support water treatment and maintenance, inspection and monitoring, and restriction of site access or uses. NANA, as the landowner, will determine the post-closure uses of the site.

Reclamation and Closure Plan and Financial Assurance Updates

According to WMP Section 2.6.3.3, the permittee will “address the adequacy of the financial responsibility including, but not limited to, significant changes in reclamation activity costs, concurrent reclamation, expansion or other changes to the operation of the facility.”

TAK provided a summary update of reclamation activities and adequacy in the annual reports for 2017 through 2020. During the review period, TAK identified several changes in the Consumer Price Index (CPI), resulting in deflation and inflation, and driving minor changes in the total financial assurance estimate. In addition to changes in the CPI, the annual reports noted the following site changes: water flow changes in the mine, consideration of dry and synthetic covers for TSF and waste dump facilities, approval of a recently constructed reverse osmosis water treatment facility, and disturbance of 111.1 acres of new area since 2017. No substantial reclamation has been performed since 2017.

The Audit Team reviewed TAK’s annual reports from 2017 through 2020. The permit requires periodic assessments of adequacy. A reclamation and closure cost adequacy review was completed during the WMP renewal application and Standardized Reclamation Cost Estimator (SRCE) model development submitted to the State of Alaska in March 2021.

The Main Pit and Qanaiyaq Pit will be backfilled during operations with waste from mining of these pits. The Aqqaluk Pit will be used as a sump for contact water storage, and the remaining wide and accessible benches will be covered. Boulders and berms will be placed near the rim of the pit to demark the high wall as a hazard. The pit high walls will be blasted and sloped where possible, and exposed benches will be revegetated.

All stockpiles and dumps will be covered at closure. The Oxide Dump and most of the MWD will be covered during operations, while the remainder of the MWD, MPD, and any unprocessed material in the Low-grade Ore Stockpile will be covered after 2031. The main haul road, truck run-out, and exposed pit benches will also be covered at the end of closure operations. All remaining stockpile and dump faces will be sloped at 3H:1V, requiring limited re-grading.

Tailings Disposal Facility

Section 3.2 of the RCP describes the tailings closure procedure for the Tailings Disposal Facility. Tailings deposition will cease at the target elevation, and the surface will be re-graded to provide a level surface and consistent water cover. All inflows to the TSF Pond will be treated, and it is estimated that additional water treatment capacity may be needed in 2025. A water cover will be maintained over the tailings for the post-closure period. The beach areas in the TSF will be covered with a geosynthetic liner as described in the RCP. The primary closure objectives for closure of the TSF Pond area include the following:

- Covering the tailings with water to prevent wind-blown dust, restrict oxidation, and prevent acid generation;
- Managing contaminated water to keep the tailings pond as clean as possible;
- Maintaining long-term stability of the dams while minimizing seepage; and
- Reclaiming surface disturbances.

Water Treatment Facilities

Water collection and treatment onsite is expected to continue over the long term and through the closure period. The operations-period water and constituent load balances were used to develop estimates of post-closure flows and water quality. During closure, the Aqqaluk Pit will be the primary storage area for impacted water. Seepage from the MWD, Main Dam, and Back Dam; mine water from the Main Pit area; and direct runoff are all directed into the pit. Approximately 1.2 billion gallons of water is estimated to be extracted from the Aqqaluk Pit and treated annually during the closure period. Constituent loads from each source area will transition from operational levels to the post-closure levels described in the RCP. Treated water, complying with the requirements of the current APDES permit, will be discharged at Outfall 001.

At this time, several closure water treatment options are under consideration. The final plans will depend on the extent of the water treatment upgrades anticipated in 2025 and the cost-effectiveness of each option. One option includes the design and operation of a new treatment plant to focus specifically on post-closure conditions. Another option addresses several modifications to Water Treatment Plant (WTP) 2 and WTP3. Following completion of the operation phase and ore processing, WTP1 will no longer treat reclaimed water from the TSF

Pond, and the facility will be available for decommissioning or modification into the post-closure water treatment system.

Reclamation Success

NANA, as the landowner, will determine the post-closure uses for the site. To achieve reclamation success, water treatment and soil stabilization goals must be met. Infrastructure is needed to support water treatment and maintenance, inspection and monitoring, and restriction of site access or uses during the closure period. Water collection and treatment will continue until constituent levels in the TSF Pond are below discharge criteria and the water can be discharged without treatment. In addition, substantial effort to stabilize the site, including maintenance and repair of ditches, soil covers, and other earthworks, will ensure that stable conditions develop, reducing site maintenance activities. After closure activities are completed, the site will transition to long-term post-closure status.

5.8.3 Financial Responsibility

Proof of Financial Responsibility

Table 5-6 summarizes the mining reclamation financial assurance for Red Dog.

Table 5-6. Mining Reclamation Financial Assurance for TAK Red Dog Mine (March 4, 2021)

Bond Type	Bond Number	Bond Amount
Letter of Credit – Goldman Sachs Bank USA	4000780	\$30,000,000
Letter of Credit – Toronto-Dominion Bank	G390803 Amendment No 2	\$186,416,800
Letter of Credit – Royal Bank of Canada	1905/S24667	\$106,472,393
Letter of Credit – Canadian Imperial Bank of Commerce	SBGT750855 AMD001	\$126,400,000
Letter of Credit – Bank of Montreal	BMT0766017OS	\$14,375,975
Letter of Credit – Canadian Imperial Bank of Commerce	SBGN118815 Amendment 1	\$10,000,000
Surety bonds accepted under 11 AAC 97.405	-	110,000,000
Total		\$583,665,168

5.8.4 Reclamation and Closure Costs Estimation

Per AS 27.19 (Reclamation) and Alaska Administrative Regulations in 11 AAC 97 (Mining Reclamation), the permittee will provide the ADNR with proof of financial responsibility for reclamation and closure of the mine and post-closure monitoring. Following the onsite portion of the audit, the Audit Team performed a desktop review of the closure cost estimate and financial assurance documents. The WMP-approved 2016 financial responsibility for the mine was listed at \$558,350,000. Table 5-7 identifies the changes in inflation and deflation resulting in the current financial responsibility of \$583,665,168.

Table 5-7. Mining Reclamation Financial Assurance Annual Inflation Adjustments

Date	Cost Change	Financial Responsibility	Justification
2016	--	\$558,350,000	Supported by the 2016 cost model

2017	+ \$4,466,800	\$562,816,800	0.8% increase in inflation as reported by the annual Anchorage CPI
2018	+ \$6,472,393	\$569,289,193	Increase in inflation in the annual Anchorage CPI
2019	+ \$18,786,543	\$588,075,736	Increase in inflation in the annual Anchorage CPI
2020	- \$4,410,568	\$583,665,168	Decrease in inflation in the annual Anchorage CPI

The cost estimate accompanying the 2016 WMP renewal was reviewed as part of this audit. The Audit Team understands that a revised cost model was developed as part of the WMP permit renewal in March 2021. General comments are included in the discussion below. The Audit Team did not “re-estimate” the financial assurance estimates; instead, auditors spot-checked calculations, verified assumptions listed in the plan, and evaluated the overall adequacy of the approved financial assurance.

Cost Estimation Approach

The Audit Team reviewed the approved 2016 financial assurance estimates. Overall, the cost estimate approach appears to be complete and consistent with mine activities reviewed during the audit. The Audit Team recommends the following for the 2021 updated plan relating to cost estimation:

- Long-term water treatment into perpetuity as it relates to volume of water, storage of water, and treatment requirements can impact the closure costs. Updates should be made to the hydrologic/water quality model for changes in the water balance due to increased mining activities, surface disturbances, changes in treatment systems, and other site modifications.
- Growth media and cover material mass updates, especially as they relate to estimating material to support closure for additional surface disturbance, should be reviewed.

The following discussion focuses on indirect costs, compares recommended indirect costs with TAK estimates, and makes recommendations for the 2021 update. ADNR and ADEC define the following seven indirect cost categories for reclamation and closure:

- **Contractor Profit:** This is calculated as revenue gained from reclamation/closure activities after accounting for contractor expenses, costs, and taxes.
- **Contractor Overhead:** This refers to all ongoing business expenses not including or related to direct labor, direct materials, or third-party expenses that are billed directly to a project.
- **Performance and Payment Bond:** This is a bond to protect the owner (in this case, the state) from contractor failure to perform the contracted scope of work and to cover payment to subcontractors and others receiving payments from the contractor. State of Alaska statutes (AS 36.25.010) require both a performance bond and payment bond for construction of projects administered by the State of Alaska.
- **Insurance:** Liability insurance is taken out by the contractor and required by the state.

- **Contract Administration:** This is a cost incurred by the state (and cooperating federal agencies, if applicable) to oversee reclamation and closure activities.
- **Engineering Redesign:** This typically involves updating the mine’s RCP and plan of operations. This is often done to provide sufficient details to obtain bids from contractors for mine site reclamation and closure. It is generally performed by an independent engineer contracted with the state.
- **Contingency:** This accounts for unknown or unforeseen costs arising during the reclamation and closure work. The two types of contingency costs are related to the scope of work and contractor bids.

Other indirect costs often reported (may show up in direct costs or are not accounted for) include the following:

- **Inflation Proofing:** Additional anticipated project costs due to general economic inflation are often included in the indirect cost category when determining the total estimated reclamation and closure cost. This is more often shown below direct and indirect costs since inflation adjustments should account for both types of costs.

The 2016 TAK indirect costs calculations were compared to the indirect costs recommended by the ADNR/ADEC draft document *Draft Mine Closure and Reclamation Cost* (Table 5-8).

Table 5-8. Comparison of Indirect Cost Percentages for Reclamation/Closure Costs between 2016 TAK and ADNR/ADEC Guidelines

Indirect Costs Category	Percent of Direct Costs	
	2016 TAK	Alaska Guidelines (2015 DOWL Draft) ^a
Contractor Overhead and Profit	6%	4 to 8% (overhead) 6 to 10% (profit)
Performance and Payment Bond	2%	2.5 to 3.5%
Insurance	0.2%	1.5%
Contract Administration	2%	5 to 9%
Engineering Redesign	2%	3 to 7%
Contingency	6%	6 to 11% (scope) 4 to 9% (bid)
Inflation Proofing (applies to both direct and indirect costs)	-0.75% to +3.3%	Inflation adjustments were provided as an annual adjustment.

^a Appendix A in *Mine Closure and Reclamation Cost Estimation Guidelines: Indirect Cost Categories*, prepared by DOWL.

In summary, TAK’s 2016 indirect cost estimates and assumptions are generally lower than the Alaska guidelines and industry standards. A review of indirect costs should be conducted during the next permit renewal. Inflation was adjusted on an annual basis from 2018 through 2021 and ranged from -0.75% to +3.3 percent during the period. Inflation was the only factor contributing to changes in the closure cost estimate from 2016 through 2021.

6.0 Reliability and Integrity of Information Relating to Environmental Reporting and Compliance

Direct field observations and interviews with key mine personnel were completed to determine the reliability of reported information. The reliability and integrity of information for reporting and compliance are reasonable. The Audit Team reviewed TAK's QAPP, which includes some sampling protocols, data quality, training, and instrument calibration. TAK employs a significant number of staff in their Environmental Department who are well organized, knowledgeable, and well trained on environmental management for Red Dog.

The Environmental Department staff has extensive knowledge of mine operations and has quick access to environmental sampling requirements, permits, and deadlines through the use of compliance software. The Audit Team observed numerous environmental and safety best management practices throughout the mine tour, including recycling and reuse efforts, aerosol disposal stations, materials and storage management, and the shipment of waste off site to the extent practicable. The Environmental Team performs new hire environmental training for all personnel that includes environmental compliance topics related to waste management.



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7.0 Adequacy of State Oversight to Protect State Resources

The Audit Team interviewed various agency representatives and reviewed inspection reports from ADEC and ADNR as well as previous annual agency meeting reports. These reports summarize ADEC/ADNR inspections and any findings/observations and provide photographs. Inspections included construction activities and the general mine site. The regulatory agency personnel for this project are knowledgeable and have ample understanding of mining practices, environmental mitigation measures, and State of Alaska regulations.



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8.0 Conclusion and Recommendations

The Audit Team reviewed programs under the RCP, WMP, IWMP, and other authorizations adopted by reference. Red Dog complies with operations and reporting for all authorizations; recommendations for improved environmental management are listed below.

Integrated Waste Management Permit

1. It is recommended that the IWMP be modified to include the surface placement of waste within an active disposal cell but still include the option of placing waste in excavated trenches.

Waste Rock Management Plan

1. Road construction is not listed as a disposal location in Table 3 of the WRMP or in the WMP. If the road construction material is intended to fall within the dam construction waste rock category, it is recommended that the WRMP be revised to reflect that.
2. It is recommended that the single blast hole assay maximum values be included in each quarterly report to ADEC to verify dam construction waste rock criteria are met, as shown in the WRMP Table 3 Row 1.
3. The Audit Team recommends that percentages of barium and percent soluble lead be included on the Waste Rock Production Report included in each quarterly report to ADEC, per the notes associated with Table 3 of the WRMP.
4. The Audit Team recommends that the self-heating capacity risk region calculated value be provided for Ikalukrok waste in each quarterly report to ADEC.
5. It is recommended that any reference in the quarterly reporting to ADEC to a disposal location that is not included in both the WMP and the WRMP be specifically called out regarding how it is an approved disposal location.
6. It is recommended that the WRMP and Monitoring Plan be updated to reflect the current disposal locations utilized by TAK, including the geologic and geochemical criteria that must be met for disposal at each location. The Audit Team recognizes that it is possible that a reported name of a facility is an internal name and could fall within WMP permitted facility. For example, the Oxide Stockpile could potentially fall within the Low-grade Ore Stockpile, a facility specifically called out in the WMP. However, the Audit Team would recommend that the reporting to ADEC match both the WMP permitted facility names and the WRMP disposal options by waste category.
7. The Audit Team recommends that the future quarterly Waste Rock Production reports that are submitted to ADEC include more specificity regarding Main Pit dumping, specifically disposal locations relative the ultimate pit water level, per the WRMP. The Production Reports state that “Main Pit Dump 3” and “Main Pit Dump 4” are disposal locations, but it is difficult to differentiate if the location is in a dump above or below the ultimate pit water level.

8. The Audit Team recommends that, at the time of WMP renewal, current disposal locations be updated in the WMP or the language regarding the activity or inactivity of these dumps should be updated (e.g., road construction, Copper Waste Dump, Oxide Stockpile, Low-grade Ore Stockpile).
9. The Audit Team recommends that, at the time of WMP renewal, approved cover material for the landfill be specified.
10. It is recommended that the QAPP be updated to reflect the procedures for sampling, analysis, data quality objectives, and data validation procedures for geochemistry monitoring.
11. The Audit Team recommends the WRMP include further discussion on waste rock classification being first dependent upon the rock type classification, and second on the assay results, and the level of importance associated with rock type classification.

Monitoring Plan

1. The Audit Team recommends that the Monitoring Plan be revised to reflect the sampling and analysis technique and frequency. In addition, the Audit Team recommends that a SOP be developed to reflect the sampling and analysis methods, and that the QAPP be updated to reflect the procedures and data validation. In addition, the Audit Team recommends that future quarterly reporting to ADEC include a graph of the metals composition and production over time to allow the reader to put the data into context and to evaluate the variability in the geochemical composition of tailings solids over time, as that is a primary objective of the monitoring.
2. The Audit Team recommends that the Back Dam Sump be added to the Monitoring Plan Mine Water monitoring stations to monitor for changes in Back Dam seepage over time.
3. The Audit Team also observed that Qanaiyaq Pit water is pumped to the Main Pit. Because this water fits the WMP Section 2.5.5 description of water entering the pits and any water directed to the pits, the Audit Team recommends that the Qanaiyaq Pit flow and water quality be added to the Monitoring Plan Mine Water monitoring stations to monitor for changes in Main Pit Lake volume and water quality over time.
4. In accordance with WMP Section 2.5.5, the Audit Team recommends that the flow and water quality from Willy Nilly Creek be added to the Mine Water Monitoring program to accurately account for all flows into the TSF for the water and load model.
5. The Audit Team recommends that the Monitoring Plan and TSF Water Management Plan be updated to specify what data, graphs, and findings will be provided in each annual report. As the mine approaches the closure date (2031), the accuracy of model predictions, pond water volume reduction, and pond loading becomes more important, and the Audit Team assumes that ADEC would be interested in tracking how closely the mine is approaching their closure goals.
6. It is recommended that the annual report include a text summary of the changes and key results of the site water balance.

7. The Audit Team recommends that the SOP for data collection for thermistors and piezometers be updated. The Audit Team recommends that the QAPP be updated to include the data collection, data validation, data management and associated conversions and data drift, and data quality objectives for the thermistors and piezometers. A QA program that lines out data review, identification of issues, and the point at which equipment maintenance or replacement is required is recommended to keep the monitoring program operating as intended.
8. The annual report has data graphs; however, the graphs that show the thermistor temperature data over the years has no legend; therefore, it is difficult to determine the trend. Inclusion of a thermistor whose graphs may be indicating a trend (e.g., T-96-021 at the Back Dam) and the addition of a legend or different style of graph would facilitate reader review. For example, the Audit Team recommends a graph that, instead of showing the temperature at each depth node each year for a busy graph, shows the change in temperature year to year by depth node.

Laboratory and Quality Assurance Project Plan

1. It is recommended that the QAPP be updated to reflect all current conditions as well as all labs that complete analyses in the Monitoring Plan.
2. The Audit Team recommends that each laboratory be listed and that it be specified what they run analyses for.
3. The Audit Team recommends that field technicians record basic “notes” while collecting water quality samples or environmental-related samples that describe current conditions or irregularities that may be present at the time a sample is collected. The purpose of this is that the notes may help to later explain erroneous or abnormal results, should they occur.
4. The QAPP does not currently address the use of pressure transducers and data loggers (e.g., in-situ flow, thermistors, barometer) for the measurement and recordation of water levels in piezometers. It is recommended that the frequency of data download from the data loggers and reference to a separate SOP be included, or the QAPP be updated to cover the quality of this data collection. The QAPP and/or the SOP should describe the data collection programming of the data logger, the equipment, frequency and process for data download, where data will be stored and how it will be managed, how data drift will be reviewed and corrected, how data will be corrected for barometric pressure, etc.
5. The Audit Team recommends that the QAPP be revised to include the data management and data validation process by TAK once laboratory reports are received, including the management of QA/QC data (field duplicates); calculations associated with precision, accuracy, etc.; data quality objectives; flagged data; data acceptance or rejection; and, specifically, which staff person is responsible for the data validation process for which data.
6. It is recommended that TAK update the QAPP to provide direction for the statistical analysis and reporting, whether direct comparisons of concentrations to the AWQS or

calculations of SSIs over a baseline. It is recommended that Table 5 of the QAPP be updated to state dissolved or total fraction of metals analyzed.

7. It is recommended that the calibration check acceptance criteria be easily identifiable in the QAPP and a sign be posted in front of the meter calibration station for personnel.
8. It is recommended that TAK create a master SOP list just for permit-required environmental sampling and tests. This list should be included in the QAPP and made available in the sample preparation room. Furthermore, appropriate sampling, sample handling, and field equipment SOPs should be maintained in a binder in the sample room.
9. The Laboratory Manager showed the Audit Team a copy of the assay method, which included laboratory control standards to assess method accuracy; however, no data quality thresholds were described. The Audit Team recommends an update.
10. The Audit Team recommends that TAK continue to evaluate dust abatement options and proceed with the vegetated cap for the MWD as well as continue to conduct reclamation activities where possible.

Dam Safety

1. The Audit Team's review of the PSI reports for the 2020 inspections of the Tailings Main Dam (NewFields 2021a) and Tailings Back Dam (NewFields 2021b), as well as the information exchange with TAK Tailings and Water staff, indicated that TAK is either in the process of or has plans to implement the recommendations included in these reports.
2. Given the water management challenges of the TSF, TAK should consider incorporating a water management strategy for the TSF into the O&M manuals.

Permafrost and Sub-permafrost Monitoring

1. Of the 16 thermistors, 7 appear to be fully operational; it is recommended that malfunctioning thermistor strings be repaired or replaced.

Recommendations for the 2021 Updated Plan Relating to Cost Estimation

1. Long-term water treatment indefinitely, as it relates to volume of water, storage of water, and treatment requirements, can impact the closure costs. Updates to the hydrologic/water quality model for changes in the water balance due to increased mining activities, surface disturbances, changes in treatment systems, and other site modifications as well as from underground mining are recommended.
2. In-perpetuity closure operations, maintenance, and surveillance of tailings facilities, including dams, covers, liners and appurtenant features, may increase closure costs. Continuous regulatory reviews and updates to monitoring procedures are recommended.
3. Growth media and cover material mass updates, especially as they relate to estimating material to support closure for additional surface disturbance, should be reviewed.



4. The long-term operations, maintenance, and surveillance of the tailings dams and appurtenant features should also be included.

9.0 References

Exponent

- 2007 DMTS fugitive dust risk assessment. Prepared for Teck Cominco Alaska, Incorporated, Anchorage, AK. Exponent, Bellevue, WA. November 2007.

Golder Associates, Inc. (Golder)

- 2020a Operations and Maintenance Manual, Revision 13, Tailings Main Dam (NID # AK 00201), Red Dog Mine, Alaska, November 5.
- 2020b Golder Associates, Inc., 2020, Red Dog Tailings Main Dam, Stage XI Raise Detailed Design Drawings, Stage XI-A Interim Raise to Elevation 991 Feet, Issued for Construction, Red Dog Mine, Alaska, May 18.
- 2020c Golder Associates, Inc., 2020, Specifications for Construction of Tailings Main Dam Stage XI Raise, Issued for Construction, Red Dog Mine, Alaska, May 18.
- 2020d Golder Associates, Inc., 2020, Tailings Main Dam Stage XI Raise, Construction Quality Assurance Plan, Issued for Construction, Red Dog Mine, Alaska, May 18.
- 2020e Golder Associates, Inc., 2020, Red Dog Tailings Main Dam, Wing Wall Foundation Liquefaction Mitigation, Detailed Design Drawings, Issued for Construction, Red Dog Mine, Alaska, July 15.
- 2020f Golder Associates, Inc., 2020, Specifications for Wing Wall Liquefaction Mitigation – Cutter Soil Mixing Ground Improvement, Issued for Construction, Red Dog Mine, Alaska, September 14.
- 2020g Golder Associates, Inc., 2020, Wing Wall Liquefaction Mitigation – Cutter Soil Mixing Ground Improvement, Issued for Construction, Red Dog Mine, Alaska, July 14.
- 2020h Golder Associates, Inc., 2021, Red Dog Tailings Main Dam, Stage XI Raise Detailed Design Drawings, Stage XI-B Full Raise to Elevation 996 Feet, Issued for Construction, Red Dog Mine, Alaska, Revision 2, March 20.
- 2020i Golder Associates, Inc., 2021, Specifications for Construction of Tailings Main Dam Stage XI Raise, Issued for Raise Construction, Red Dog Mine, Alaska, Revision 2, March 30.
- 2020j Golder Associates, Inc., 2021, Tailings Main Dam Stage XI Raise, Construction Quality Assurance Plan, Issued for Raise Construction, Red Dog Mine, Alaska, Revision 2, March 30.
- 2020k Operations and Maintenance Manual, Revision 4, Tailings Back Dam (NID ID# AK 00303), Red Dog Mine, Alaska, September 25.
- 2020l Golder Associates, Inc., 2021, Tailings Back Dam Stage V Raise, Stage V Raise to Elevation 1006 Ft, Issued for Construction, Red Dog Mine, Alaska, Revision 0, May 27.
- 2020m Golder Associates, Inc., 2021, Specifications for Construction of Tailings Back Dam Stage V Raise, Issued for Construction, Red Dog Mine, Alaska, Revision 0, May 27.
- 2020n Golder Associates, Inc., 2021, Tailings Back Dam Stage V Raise, Construction Quality Assurance Plan, Issued for Raise Construction, Red Dog Mine, Alaska, Revision 0, May 27.
- 2020o Golder Associates, Inc., 2020, Operations and Maintenance Manual Revision 7, Water Supply Dam, Red Dog Mine, Alaska, April 17, 2020.



NewFields

- 2021a *2020 Periodic Safety Inspection, Tailings Main Dam (NID# AK00201), Red Dog Mine, Northwest Arctic Borough, Alaska, revised March.*
- 2021b *2020 Periodic Safety Inspection, Tailings Back Dam (NID# AK00303), Red Dog Mine, Northwest Arctic Borough, Alaska, revised February.*

Teck Alaska Inc. (TAK)

- 2019 *Red Dog Mine 4th Quarter and Annual Report, 2019. Waste Management Report Permit No. 2016DB0002, Reclamation Plan Approval F2016995, February 10th 2020.*
- 2020 *Red Dog Mine TSF, 2020 Annual Instrumentation Report.*

URS Corporation

- 2015 *Operations and Maintenance Manual Revision 3, Mine Water Diversion Dam, NID ID# AK00260, Red Dog Mine, Alaska, March 13.*

Water Management Consultants, Inc. (WMCI)

- 2001 *Long-term Permafrost and Groundwater Monitoring Program for the Tailings Impoundment Facility, March.*



Appendix A

Photographs



Photograph 1. Class III Landfill Working Face



Photograph 2. Incinerator Ash, Placed Away from the Working Face to Cool



Photograph 3. Landfill Entrance Sign



Photograph 4. Orange-Sol Parts Washing Station in Maintenance Shop



Photograph 5. Universal Waste Accumulation Area



Photograph 6. Hazardous Waste Accumulation Area



Photograph 7. Dumpster with Signage



Photograph 8. Covered Dumpster



Photograph 7. Waste Management Permit Switchboard, Permit Management System



Photograph 8. Waste Segregation Sign in Living Area

Landfill Random Dumpster Inspection Log		
Prohibited Item List		
<ul style="list-style-type: none"> Flammable liquids (gasoline, oil, etc.) Acids (battery acid, muriatic acid, etc.) Flammable solids (oil-soaked rags, etc.) Compressed gases (aerosol cans, propane tanks, etc.) Refrigerants (air conditioning units, etc.) Flammable solids (oil-soaked rags, etc.) Compressed gases (aerosol cans, propane tanks, etc.) Refrigerants (air conditioning units, etc.) 	<ul style="list-style-type: none"> Stumps Chemical wastes Flammable liquids (gasoline, oil, etc.) Flammable solids (oil-soaked rags, etc.) Compressed gases (aerosol cans, propane tanks, etc.) Refrigerants (air conditioning units, etc.) Flammable solids (oil-soaked rags, etc.) Compressed gases (aerosol cans, propane tanks, etc.) Refrigerants (air conditioning units, etc.) 	<ul style="list-style-type: none"> No liquids Grease Oil-soaked rags Auto oil Wet dirt Stumps Flammable solids (oil-soaked rags, etc.) Compressed gases (aerosol cans, propane tanks, etc.) Refrigerants (air conditioning units, etc.)
Date: 2/11/21	Prohibited Waste observed	yes <input type="checkbox"/> no <input checked="" type="checkbox"/>
Inspector: A. E. B.	Comments: All good	
Dumpster location: H.E. Shop		
Date: 2/11/21	Prohibited Waste observed	yes <input type="checkbox"/> no <input checked="" type="checkbox"/>
Inspector: A. E. B.	Comments: LOOKS GOOD	
Dumpster location: WAREHOUSE		
Date: 5/21/21	Prohibited Waste observed	yes <input type="checkbox"/> no <input checked="" type="checkbox"/>
Inspector: A. E. B.	Comments: OVER SIDE TRUCK	
Dumpster location: WAREHOUSE		
Date: 6/7/21	Prohibited Waste observed	yes <input type="checkbox"/> no <input checked="" type="checkbox"/>
Inspector: Doug C.	Comments: Good	
Dumpster location: H.E. Shop		
Date: 06/19/21	Prohibited Waste observed	yes <input type="checkbox"/> no <input checked="" type="checkbox"/>
Inspector: Andrew Bick	Comments: none	
Dumpster location:		
Date: 6/20	Prohibited Waste observed	yes <input type="checkbox"/> no <input checked="" type="checkbox"/>
Inspector: Doug C.	Comments: Dumpster was over loaded with yard trash	
Dumpster location:		

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 781.226.2152
 PROHIBITED ITEMS INCLUDE: FLAMMABLE LIQUIDS, FLAMMABLE SOLIDS, COMBUSTIBLE GASES, REFRIGERANTS, ACIDIC LIQUIDS, OILS, GREASE, AUTO OIL, WET DIRT, STUMPS, FLAMMABLE SOLIDS (OIL-SOAKED RAGS, ETC.), COMPRESSED GASES (AEROSOL CANS, PROPANE TANKS, ETC.), REFRIGERANTS (AIR CONDITIONING UNITS, ETC.), FLAMMABLE SOLIDS (OIL-SOAKED RAGS, ETC.), COMPRESSED GASES (AEROSOL CANS, PROPANE TANKS, ETC.), REFRIGERANTS (AIR CONDITIONING UNITS, ETC.)

Photograph 9. Random Dumpster Inspection Log



Photograph 10. Electronic Waste Storage Area



Photograph 11. Closure Activities at the MWD



Photograph 12. Closure Activities at the MWD



Photograph 13. Thermistor Location



Photograph 13. Tailings Storage Facility, Main Dam



Photograph 14. Tailings Storage Facility, Main Dam Seepage Pond.



Photograph 15. Back Dam



Photograph 16. Back Dam, Showing Ongoing Dam Raise



Photograph 17. Main Dam West Wing Wall



Photograph 18. Main Dam East Wing Wall



Photograph 19. Dam for Drinking Water Reservoir



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Appendix B

Waste Management Guideline, Examples

MEDICAL WASTE



BIOHAZARD



Sharps Container



Mine or Port
Medical Clinic



Materials Management
Ships to Medical Waste
Disposal Contractor

Description

Syringe needles (“sharps”) generated by PAC residents and general industrial medical waste (examination gloves, syringes & sharps, scalpels, unused pharmaceuticals, etc.) generated in the Mine and Port Medical Clinics.

Hazard Category

Non-hazardous under the Resource Conservation & Recovery Act (RCRA), but a “biohazard” from a safety standpoint.

Nitroglycerin (Pharmaceutical Grade) is no longer a P-Listed, acute **hazardous** waste (P081). However, it should be managed for disposal off site with other medical waste.

Oral Thermometers containing mercury must be handled as universal waste. Consult the [Mercury Containing Equipment Waste Guideline](#) for instructions how to handle this waste.

Management

1. Do not throw medical waste in the trash.
2. If you are a PAC resident who generates medical waste, drop it off at either the Port or the Mine Medical Clinics, or ask the Physician’s Assistant for a sharps container to keep in your room;
3. Drop off full sharps containers at one of the clinics.
4. The Mine Clinic will arrange shipment of all medical wastes generated by the clinic and by PAC residents to a contracted medical waste disposal facility through Materials Management.

Special considerations for Nitroglycerin from Mine/Port Clinics

Nitroglycerin (Pharmaceutical Grade) shall never be disposed of on site. All expired or unused nitroglycerin or containers that once contained nitroglycerin need to be shipped off site for disposal as medical wastes.

Special Instructions

Sharps must not be mixed with other medical wastes or they will not be accepted by the disposal facility.

Note: Epinephrine (P042) derived from salts used in the medical industry is no longer listed as a hazardous waste per EPA 2007 Memo on file with Environmental department.

HAZARDOUS WASTE

Description

Hazardous wastes pose a potential threat to life and/or the environment and require special management. Wastes are considered hazardous if they are ignitable, corrosive, reactive and/or toxic. Some wastes must be tested to determine if they are hazardous (“characteristically hazardous waste”), while others are listed in regulations as known hazardous wastes (“listed waste”).

Hazardous wastes are regulated under the [Resource Conservation and Recovery Act \(RCRA\)](#). RCRA contains requirements on how hazardous waste must be managed (from storage through disposal) and the quantities of waste that can be stored. The type and quantity of hazardous waste stored onsite determines which sections of the regulations apply.

Hazard Categories

This guideline applies to **hazardous waste** and **potentially hazardous waste**.

Management

1. Never dispose of hazardous waste in the trash or in any way onsite. We are NOT permitted to treat or dispose of hazardous waste onsite.
2. Place waste in a sound container, made of or lined with materials that will not react with, and are otherwise compatible with, the waste to be stored.
3. *Label the container (labels available from the Warehouse)*. Refer to the [Waste Finder](#) for appropriate labeling.
4. Ensure secondary containment is provided for wastes containing glycol or oil.
5. If you will accumulate waste over time in your work area, you must set up an Accumulation Area. The requirements depend on the type of waste stored. Refer to the [Waste Finder](#) to determine the applicable management method.
 - o For Hazardous or Potentially Hazardous Waste – refer to the [Satellite Accumulation Area \(SAA\)](#) guideline.
 - o For Universal Waste (e.g. batteries and lamps) – refer to the [Universal Waste Management](#) SOP, or the Waste Management Guideline for your specific waste.
 - o For Lead Acid Batteries – refer to [Lead-Acid Batteries](#) guideline.
6. Have the container delivered to a [Central Accumulation Area](#) *within 24 hours* of:
 - o Filling the container to the maximum allowable limit (55 gallons for hazardous waste or 1 quart for acutely hazardous waste).
 - o Removing the product from service (e.g. aerosol can puncturing filter).
 - o Or when you wish to have the waste removed from your work area (e.g. partially full drum that will not get filled).

Hazardous or Potentially Hazardous Waste



Manage according to Waste Type (see [Waste Finder](#))



Send to Central Accumulation Area (Warehouse or Port Waste Connex) while Waste Awaits Shipment Offsite or Testing

See [Waste Receiving](#) and [CAA Management](#) SOPs for more information



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