NewFields
Perspective. Vision. Solutions.

March 4, 2021
NewFields Project No. 475.0433.000

Teck Alaska Incorporated
2525 C Street, Suite 310
Anchorage, AK 99503

Attention: **Aaron Sangha**
Tailings and Water Geotechnical Lead

RE: **2020 Periodic Safety Inspection**
Tailings Main Dam (NID ID#AK00201)
Red Dog Mine

Transmitted herewith is the final report for the August 2020 Periodic Safety Inspection for the Tailings Main Dam (NID ID#AK00201). If you have any questions or require additional information, please contact the undersigned.

Sincerely,

NewFields Mining Design & Technical Services

Ryan T. Baker, P.E.
Principal Engineer

RTB/KCW/ng

Reviewed by:

Keith C. Williams, P.E.
Principal Engineer

Addressee: electronic

P:\Projects\0433.000 Red Dog Safety Inspections (PSI)\J-REPORTS\TMD\475.0433.000 TMD-FINAL.docx

2020 Periodic Safety Inspection
Tailings Main Dam (NID ID#AK00201)
Red Dog Mine
Northwest Arctic Borough, Alaska

Prepared for:

Teck Alaska Incorporated
2525 C Street, Suite 310
Anchorage, AK 99503

Prepared by:

NewFields Mining Design & Technical Services
9400 Station Street, Suite 300
Lone Tree, Colorado 80124

NewFields Project No. 475.0433.000
November 2020, Revised March 2021

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

This report presents the results of the 2020 Periodic Safety Inspection (PSI) of the Tailings Main Dam (TMD) at the Red Dog Mine. Mr. Steve Anderson of Golder Associates (Golder) is the current Engineer of Record (EOR) for the facility and has been responsible for the current engineering design, and recent site investigations, instrumentation monitoring, construction Quality Assurance/Quality Control (QA/QC) and annual reviews. NewFields Mining Design & Technical Services, LLC (NewFields) has been retained by Teck Alaska Incorporated (TAK) to complete the 2020 PSI for the facility. Safety Inspections are performed on the TMD on a three-year interval as required by 11 AAC 93.159 for Class I and II dams.

At the time of the site inspection the TMD was being operated as a Class II (Significant) hazard dam under the "Certificate of Approval to Operate a Dam" Certificate No. FY2019-7-AK00201 (ADNR 2019). The requirement for the performance of this PSI is stipulated within the Special Conditions for this certificate and the guidance for performance of the PSI is provided in the Alaska Dam Safety Program guidelines (ADNR, 2017). After the site inspection was complete a new temporary "Certificate of Approval to Operate a Dam" Certificate No. FY2021-3-AK00201 (ADNR 2020) was issued. The new hazard potential classification on this certificate was specified as Class I (High) dam.

1.1. Project Description

Red Dog Mine is a zinc-lead mine located in northwest Alaska within the Northwest Arctic Borough of Alaska near the southwestern end of the DeLong Mountains. The mine is owned and operated through a partnership between TAK and the Northwest Alaska Native Association (NANA) Regional Corporation.

The main components of the mine are multiple open pits, a Main Waste Stockpile (MWS), mineral processing facility, Tailings Storage Facility (TSF), water supply dam (WSD), and additional ancillary facilities to support the mining process and associated workforce. The WSD, also referred to as the freshwater dam, forms Bons Reservoir and was developed to provide a consistent clean water supply for the mine. The TSF includes the Back Dam and Main Dam, of which the Wing Wall is a component.

1.2. Location

The TSF is located on the South Fork of Red Dog Creek, adjacent to the Red Dog mine complex. The TMD forms the northern extent of the TSF while the Tailings Back Dam (TBD) forms the southern extent. The latitude and longitude along the center of the TMD embankment are 68.070° and -162.858°, respectively.

1.3. Hazard Potential Review

The Hazard Potential Classification is a parameter assigned to a dam which establishes the standards to which a dam is designed and operated. These standards not only apply to design criteria but extend to other elements associated with the dam, such as the need for an Operating and Maintenance (O&M) manual, Emergency Action Plan (EAP), and the schedule for conducting PSIs. The hazard classifications for dams in Alaska are defined in the Alaska Administrative Code, Title 11, Chapter 93, Section 157 (11 AAC 93.157) and summarized in the Alaska Dam Safety Program guidelines (ADNR 2017).

From 2003 until September 2020, when the current Temporary Certificate to Operate (FY2021-7-00201) was issued, TMD has been classified as a Class II (Significant) structure by the Alaska Department of Natural Resources (ADNR) Dam Safety and Construction Unit. Previously completed PSI and Annual EOR Inspection reports noted agreement with this classification (KCB 2017). As indicated, the current hazard potential classification has been revised to Class I (High) by ADNR (ADNR 2020). NewFields has reviewed the design and operation of the TMD and prepared a Hazard Potential Classification and Jurisdictional Review form as part of this PSI. The form is included in Appendix A. NewFields agrees with the change in hazard classification for the TMD. The reason for this agreement is the potential loss of life in the event of a dam breach as presented in the 2019 Dam Breach and Inundation Study (Golder 2019). This study was performed using the future Stage XII crest elevation (1,006 feet) and storage characteristics and indicated that in the event of a dam breach at the Wing Wall the peak flow depths and velocities through the man-camp and Mill Site could be up to 36 feet and 20 feet/second, respectively.

2. FACILITY HISTORY

Documentation of the TMD design, construction and inspections are well presented in previous reports and summarized in the following sections. Those facility specific documents should be referenced for a more detailed summary of facility history. A general arrangement of the TSF is shown in Figure 1 with plan views of the Main Dam and Wing Wall areas presented in Figures 2 and 3 respectively.

2.1. Facility Design

The TMD was initially designed by Dames and Moore in 1987. Under the guidance of Dames and Moore, which later became URS and then AECOM, the TMD was expanded from the initial Stage I dam through to Stage X of the facility. Mr. Steve Anderson of Golder is the current design engineer for the facility, in which Stage XI-A is permitted. Future planned expansions include Stages XI-B and XII, which may be constructed in multiple phases.

The TMD was initially an east-west oriented embankment forming the northern containment barrier of the TSF, with the natural topography providing containment on the east, west, and south sides of the facility. As the TMD elevation increased with subsequent expansions it became necessary to extend the eastern section of the embankment southward to avoid inundating the Mill Site. This north-eastern portion of the TMD is identified as the Wing Wall. An additional embankment was constructed at the southern limit of the TSF, identified as the TBD, to prevent the tailings and solutions from flowing into the adjacent watershed.

The TMD is founded on heterogeneous foundation conditions varying from structurally competent bedrock, organic materials, and native fine and coarse soils. Investigation and characterization of the foundation materials has continued, including a significant investigation performed in support of the Stage XI design. The current area of focus is along the wing wall alignment and the native fine and coarse soils within the foundation. TAK is taking a conservative approach to investigating and designing the TMD in this area, which is prudent at this point.

The TMD is a zoned rockfill embankment with hydraulic containment provided by a high-density polyethylene (HDPE) geomembrane. The embankment fill provides the mass for the TMD structure and supports the overlying filter and HDPE geomembrane elements. The embankment fill consists of various rockfill materials, some processed or selectively chosen while others are run-of-mine material. The zones are selectively specified to provide the necessary internal shear strength and mass required by the geometry. To facilitate the Stage XI expansion, a buttress was constructed at the downstream toe of the TMD.

Multiple filter layers on the upstream section of the TMD have been installed in conjunction with the HDPE geomembrane to protect the embankment (Golder 2020). The filters consist of both graded filters and geotextiles, depending on the expansion stage. The purpose of the filters is to prevent seepage flow from washing fine particles from and through the coarser embankment fill, creating voids and potential conduits for solution through the embankment. Selection of properly sized or graded filters is critical to the performance of the dam which includes the selection of materials placed adjacent to the geotextile in order to prevent damage to the fabric. Filter compatibility and evaluations have been performed in support of the design.

Seepage is controlled through a combination of the HDPE geomembrane on upstream face of the embankment and the management/development of the tailings beach. At the base of the Stage I embankment, the HDPE geomembrane keys into an HDPE-lined cut-off trench that is backfilled with compacted soil. For all other stages, the HDPE geomembrane is connected to either a cut-off wall, curtain wall, slurry wall or secant wall excavated into the underlying bedrock and backfilled with either concrete, grout or plastic concrete. Downstream of the embankment is a Seepage Collection Pond (SCP) for the collection and management of collected seepage. Seepage rates, based on seepage pumpback data, vary seasonally and with the length of tailings beach

maintained. Active tailings management is being utilized to keep a tailings beach in front of the TMD with a target length of 600 feet. Data indicates that when this is achieved, reductions in seepage collection rates are realized. Downstream of the TMD, and the SCP, seepage recovery wells capture and return seepage to the SCP and subsequently the impoundment.

A 50-foot wide rockfill underdrain exists along the original South Fork of Red Dog Creek channel over which the TMD is constructed. This underdrain exists from the downstream toe of the Stage I embankment to the SCP. The purpose of the system is to collect seepage flow from the embankment fill and foundation and convey it to the SCP.

Tailings are subaerially discharged into the TSF at multiple locations around the impoundment, including along a tailings pipe bench constructed out of deposited tailings and positioned upstream of the TMD. Deposition during the summer months utilize many drop bars around the facility with a significant portion of the deposition occurring from the tailings pipe bench to create a tailings beach adjacent to the TMD. Subaqueous tailings deposition during the winter months is generally from one or two locations due to snow and ice coverage over the facility.

Reclamation of supernatant water from the facility is from two floating barges positioned along the eastern limit of the TSF, south of the TMD Wing Wall termination.

2.2. Construction History

The TMD Starter Dam (Stage I) was constructed in 1988 and 10 subsequent raises, through Stage X have been completed. Table 1 below presents the TMD as-built crest elevations and year(s) of construction (Golder 2020).

Table 1: As-Built TMD Crest Elevation and Year(s) of Construction per Stage

Stage	Crest Elevation (feet)	Year(s) of Construction
I	865	1988
II	890	1989
III	910	1990
IV	925	1991
V	940	1993
VI	950	1993
VII-A	955	2003 – 2004
VII-B	960	2005 – 2007
VIII	970	2008 – 2011
IX	976	2012 – 2013
X	986	2015 – 2016
XI-A	991	2018 – 2020

At the time of the field inspection construction of Stage XI-A was in progress. It has subsequently been completed.

2.3. Inspection History

Previous PSIs were completed in 1994, 1998, 2004, 2010 and 2014 by Dames and Moore / URS. The 2017 PSI was completed by Klohn Crippen Berger (KCB), the first by an independent engineer not associated with the TMD EOR. Since 2014, the PSIs have been completed on a 3-year schedule which is consistent with the current Class I (High) and II (Significant) hazard classification requirements as required by 11 AAC 93.159. Inspections by the EOR are conducted annually except for years when a PSI is completed.

As part of the current PSI, a review of key issues and recommendations from previous PSIs and annual inspections was completed with TAK. A summary of the outstanding items is included in the appended Table 3. Several of these items are noted to be completed upon the issuance of the next O&M Manual, which was issued after the PSI document review and issuance of the draft PSI report.

3. CURRENT FACILITY INSPECTION

The inspection was completed between July 31 and August 3, 2020 by Ryan Baker and Nick Rocco of NewFields, and Troy Thompson of ERC. Ryan was the PSI lead, Nick was the geotechnical reviewer, and Troy was they hydrology and hydraulics reviewer for the inspection.

The work items involved the following: visual inspection of the facility, document review, and interviews with appropriate TAK personnel who operate, maintain, and monitor the facility.

- A site visit and visual inspection was completed.
- The management and operational surveillance programs were discussed with site personnel and relevant documents were reviewed.
- A closeout meeting was held on the last day of the site visit to present preliminary findings. The meeting was attended by Mark Smith (Operating Manager), Mike Gonzalez (Tailings & Water Superintendent), Aaron Sangha (Tailings & Water, Geotechnical), Tanna DeRuyter (Tailings Dam Operation Engineer), Matt Gee (Maintenance Superintendent), Simon Yu (Principal Metallurgist, Mill Operations), Matt Kzewinski (Construction Manager), and Kevin Palmer (Chief Geologist, Mine Operations).
- Instrumentation records were obtained and reviewed.
- Design, construction, and engineering analyses documents were obtained and reviewed.
- The O&M manual was obtained and reviewed.
- Photographs were taken of typical and key features noted during the inspection.
- Inspection tables and hazard classification forms were completed to document the PSI, and
- This report was prepared.

Appendix A includes the Hazard Classification and Jurisdictional Review Form, Appendix B includes the Photograph Log, and Appendix C includes the Visual Inspection Form completed for the current PSI. Figure 1 provides an overall view of the tailings impoundment and mine facilities. Figure 2 presents plan view of the main TMD embankment, including the seepage collection dam and Figure 3 presents the plan view of the wing wall portion of the TMD.

3.1. Visual Inspection Highlights

Visual inspection of the facility was conducted over two days. Aaron Sangha of TAK accompanied our team throughout the visual inspection. No parts of the visual inspection were impeded by weather conditions, which were generally dry and sunny. As previously indicated, at the time of the inspection the Stage XI-A construction was in progress. While the construction activities did not impede the inspection, items such as cracks in the embankment or wing wall as were identified during the 2019 Annual Inspection (Golder 2019b) were not visible due to new fill placement or recent ground disturbance.

3.2. Embankment

Similar to previous inspections, the main TMD embankment is in good condition. The crest and upstream slope were generally smooth and relatively uniform or under construction at the time

of the inspection (Photos 11, 12, 16 and 17). The downstream slope of the embankment was smooth and uniform with no signs of slope deformation or instability (Photos 13, 14 and 15). Although there were minor amounts of ponded water on the downstream bench for the Stage XI Buttress (Photo 01) as a result of recent rainfall, these pools or general grading of the area are not a concern.

There were two areas of seepage noted along the west abutment (Photos 02, 03 and 04). These were located on the natural hillside and not on the embankment. Seep #1 was located below the Stage XI Buttress elevation while Seep #2 was located near the Stage X TMD crest elevation. No discoloration or turbidity was noted in the flows and the flow rates were estimated at less than one gallon per minute. Based on discussions with TAK personnel these seeps have been noted and are likely the result of the ground thawing in the area. These seeps do not appear to pose a stability risk to the embankment although continued monitoring of these seeps is recommended. No other signs of seepage were observed along the embankment.

The seepage collection pond contained minimal water at the time of the inspection (Photo 05) and active discharge into or reclaim from the pond was not occurring. The geomembrane-lined spillway and riprap outfall (refer to Photo 13) were inspected with no items of concern being noted.

The tailings beach width was visually estimated to be 200 feet or less (Photos 06 and 07) at the time of the inspection. A review of the tailings beach lengths measured by TAK personnel from photoSAT records show the tailings beach width at approximately 270 feet during the weeks previous to and post-inspection. These lengths are all less than the desired distance of 600 feet, as referenced in the O&M Manual (AECOM 2016). Due to the ongoing construction activities the tailings discharge was limited to a single location south of the wing wall.

General housekeeping practices around the embankment were good, especially considering the ongoing construction activities and the presence of a materials laydown yard on the downstream bench.

3.3. Wing Wall

Construction activities were in progress at both north and south ends of the wing wall and consisted of fill placement (~Sta. 32+00), geomembrane installation (~Sta. 36+00 to 38+00) (Photos 19 and 20) and secant wall construction (~Sta. 58+75) (Photo 21). Cracks in the embankment which were previously noted in the 2019 Annual Inspection (Golder 2019b) were not evident due to the construction activities which had occurred or were still in progress at the time of the inspection. The field inspection did not identify any items of concern.

3.4. Pumping System

Two reclaim barges are located south of the wing wall along the western edge of the impoundment. Active reclaim was occurring at the time of the inspection with both barges in operation. Both barges were visually inspected along with the associated HDPE pipes back toward the mine complex (Photos 08 and 09) and no items of concern were noted.

4. OPERATIONS AND MAINTENANCE REVIEW

4.1. Manual Review

Revision 12 of the O&M Manual (AECOM 2016) was reviewed as part of the PSI. This revision of the manual was published in 2016 and a new update was in progress at the time of the draft PSI report issuance. The O&M Manual describes procedures necessary for safe operation of the TMD along with requirements for monitoring and inspection of the facility performance. Daily, weekly, monthly, and quarterly inspections are outlined, and example checklists and forms are included. Daily and weekly inspections forms have recently been transitioned to a digital format, and according to TAK, the transition has led to more robust record keeping and operational efficiencies. Examples of the digital format and quarterly summaries were reviewed as part of the PSI. The Revision 12 of the O&M Manual meets the requirements provided in the Alaska Dam Safety Program guidelines (ADNR, 2017).

Revision 13 of the O&M Manual was issued prior to finalizing this 2020 PSI report but NewFields has not reviewed the document or revised the PSI report accordingly. Recommended items to be included in the Revision 13 O&M Manual as presented in the 2017 PSI by KCB and the 2019 Annual Inspection by Golder were also reviewed. NewFields is in general agreement with these recommendations. NewFields did not verify whether these recommendations were incorporated into the updated manual.

4.2. O&M Inspections

Monitoring and inspection requirements for the TMD that are required in addition to the PSI and annual inspections are identified in the O&M Manual. These inspections are summarized in Table 2.

The monitoring and inspection requirements for the TMD that are required in addition to the PSI and annual inspections are identified in the O&M Manual. The inspections required by Revision 12 of the O&M Manual are summarized in the following Table 2.

Table 2: O&M Required Inspections

Inspection Type	Inspection Activity
Daily	Document temperature and general weather conditions
	Visually inspect dam and surrounding areas
	Report unexpected behavior to responsible party
Weekly	Document temperature and general weather conditions
	Visually inspect TMD crest, abutments, slopes for signs of cracking, slumps or seepage.
	Inspect seepage collection dam, tailings beach and discharge, water reclaim system and surrounding areas for unexpected behavior.
	Report unexpected behavior to responsible party
Monthly	Collect water samples from Tailings Decant Pond, Well Upstream of Seepage Collection Pond, Seepage Collection Pond and Well Downstream of Seepage Collection System Dam.
	Perform field testing on samples and submit for laboratory testing.
Quarterly	Visually inspect all exposed dam surface for evidence of deformation, displacement, cracks, settlement, slumping, frost heaving, etc. Identify vegetation to be removed as part of period maintenance.
	Inspect downstream toe, abutments and downstream area for springs, seeps, boils or other wet spots.
	Inspect instrument installations for physical damage, malfunction or maintenance needs.
	Review recent instrumentation readings for trends that could be related to observed conditions.
	Inspect upstream slope for wave erosion, slumps, sides.
	Inspect pipes for damage, leaks or maintenance requirements.
	Pump operation at seepage systems.
	Operational status of emergency generators.
Special / Event Driven	Immediately inspect after any unusual occurrence that are not normally encountered during routine operations (large storm events or floods, earthquakes, changes in seepage, slope movement, etc.).
	Inspected items to be similar to weekly and quarterly inspections.

4.3. Water Management Review

Water that is captured in the TSF is considered process water. Discharge of process water can occur via treatment at the on-site water treatment plant (WTP) and release to Red Dog Creek. Releases are limited by effluent standards, water quality standards at three downstream monitoring points, when Red Dog Creek is flowing and an annual volumetric limit of 2.4 billion gallons. As is evident from background data review, inspection of the site and discussions with mine personnel, water management is a critical aspect of dam safety. Increased water storage within the TSF reduces the length of exposed beach at the main dam, which data has shown leads

to increased seepage from the main dam (AECOM 2015). Additionally, increased water storage negatively impacts the ability to store large precipitation events within the facility and increases the reliance on the Aqqaluk Pit or treatment options. Should issues exist at these facilities such as the pit does not have capacity or the treatment plant cannot discharge, the TMD could be at risk of permit violation, freeboard encroachment or worst-case scenario overtopping of the dam.

In 2019 and 2020 releases have been limited due to the water quality of the receiving body and inflows to the TSF have been high due to site precipitation. As a result, the volume of process water has grown beyond previously predicted levels. As a mitigation to the water volume issue, the mine accelerated the Stage XI TMD expansion, worked to build and permit a reverse osmosis (RO) treatment facility and utilized storage in the Aqqaluk Pit. The mine's water management planning was reviewed by the PSI team given the critical nature of water management on dam safety.

A GoldSim probabilistic water balance model has been developed for the site. The current model received its last major structural update in 2013. Model inputs are updated weekly by site personnel and projections are made based on the conditions as part of these weekly updates. Given changes to site conditions, the mine has engaged SRK Consulting to update the model. Based on the PSI team's review of the current model and discussions with the tailings and water management team, we recommend that the following be addressed as part of the model update.

- Incorporate Aqqaluk Pit and the pumping between the pit and the TSF;
- Incorporate the new RO water treatment system;
- Update the water chemistry in the TSF in order to better predict WTP effluent parameters that impact the mine's ability to treat and release water;
- Complete an evaluation of recent site precipitation records and update the GoldSim model's precipitation predictions to capture observed site conditions;
- Ensure that precipitation estimates generated as part of the predictive portion of the GoldSim model accurately reflect short duration, annual and long-term wet and dry precipitation trends observed from recorded site data;
- Add the ability for model predictions to incorporate potential future precipitation increases due to climate change;
- Add the ability to evaluate water balance results assuming future windows for water treatment and release are limited; and
- Complete calibration model runs using both full observed/recorded operational data as well as calibration runs with precipitation estimated by stochastic precipitation.

It is our understanding that all these recommendations are part of the current GoldSim model updates. Additionally, we recommend that a full review of the performance of the water balance be completed annually and the model logic updated as appropriate.

4.4. Operations Review

Based upon discussions with TAK personnel it is evident that progress has continued with respect to operational stewardship and management of the TSF, including the TMD. The tailings, water and environmental personnel met during the PSI provided in-depth responses to queries and were able to provide access to the necessary documents and data with little delay. Operational staff are engaged with engineering personnel and the collection, review, and management of large amounts of monitoring data is efficient. Historic documents on the facility have been organized for quick access and design basis documents created for reference and updating as needed.

5. MONITORING DATA REVIEW AND PERFORMANCE

The performance of the TMD is monitored with instrumentation and visual inspection by Operations. Performance of the seepage control systems are monitored with the piezometers and flow meter on the SCP pumpback system. Ground temperature measured by the thermistors are used to monitor the rate of thaw that is occurring in the foundation materials. Structural performance of the TMD is monitored visually and by the inclinometers. The review of monitoring data provided by TAK included vibrating wire piezometers, pumpback system flows, thermistors, inclinometers, and visual monitoring (field inspection reports and photos).

5.1. Thermal Monitoring

Ground temperature monitoring data is available from five (5) ground temperature monitoring arrays located at both the TMD main embankment and the wing wall. Two of the thermistors are located in the west abutment of the main embankment and the other three are located downstream of the wing wall. The instruments are not connected to data loggers and are read manually throughout the year.

The 2012 report on Long-Term Permafrost and Groundwater Monitoring Program for the Tailing Impoundment Five-Year Permafrost and Groundwater Data Analysis (AMEC 2012) indicated groundwater levels peak in the summer and are lowest in the winter months. Based on the report, between 2007 and 2011 the Red Dog mine has experienced rising air temperatures of approximately 0.045 deg C/year. Rising air and ground temperatures contribute to melting permafrost and increased groundwater water levels observed and documented (AMEC 2012). This analysis is generally supported by the most recent data which shows the permafrost in the

west abutment is continuing to degrade. Two of the three thermistors located downstream of the wing wall show some degradation of the permafrost, but it is also noted that the mill site structures and an active convection cooling system installed at the Concentrate Storage Building may have some influence on nearby instruments.

5.2. Pore Pressure Monitoring

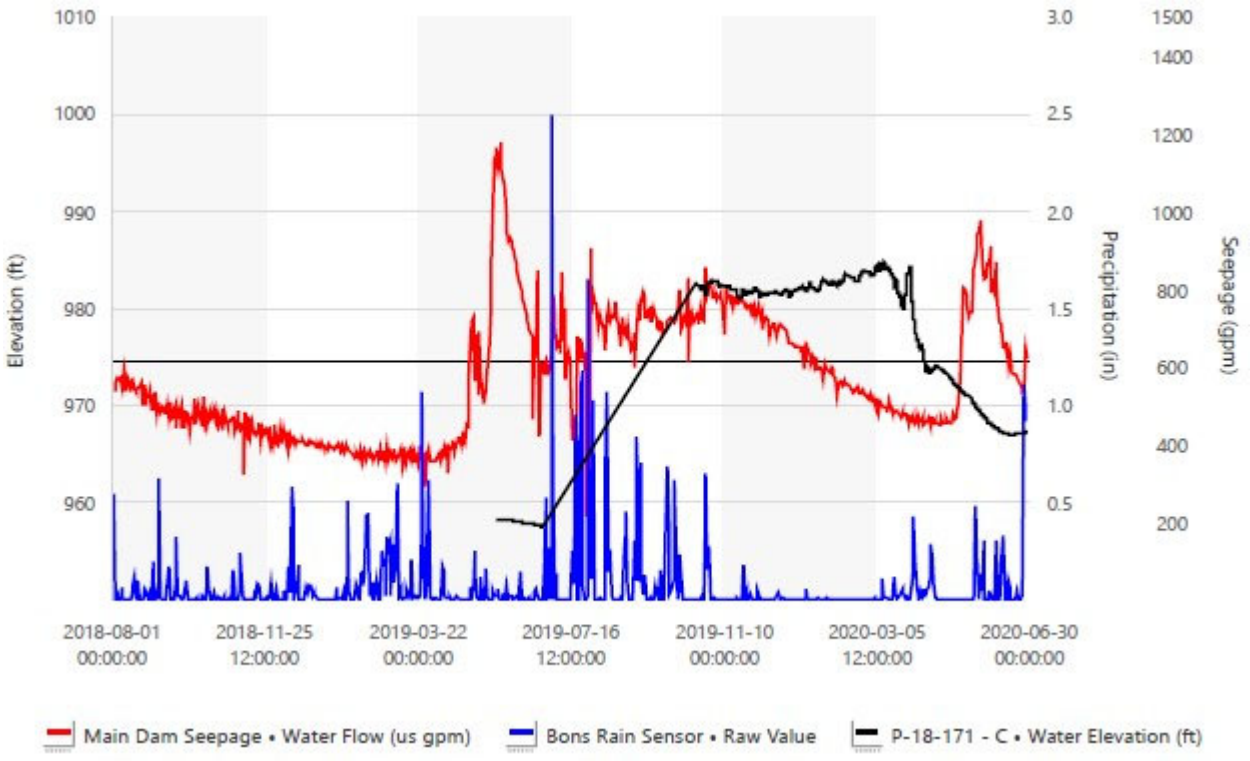
Piezometer data was provided for 54 piezometers. Twenty-five (25) instruments were installed within the main dam footprint, two instruments were installed in the SCP embankment and 27 instruments were installed in the wingwall. Per the O&M Manual piezometers are classified as either "critical" or "non-critical" by TAK. The piezometers designated as critical are classified as such due to their location and phreatic conditions being monitored. The non-critical piezometers provide are being monitored and provide supplementary data for TAK and the EOR. It should be noted that Revision 12 of the O&M Manual identifies 38 piezometers within the facility with 19 of them being designated as critical while the 2019 Annual Inspection included a data review for 64 piezometers. Data is collected daily and is stored on data loggers, some of which transmit data wirelessly and can be monitored in real time, some must be manually downloaded by TAK personnel on a periodic basis. All downloaded data is readily available to TAK personnel.

Previous reports provided by TAK suggest that seasonal weather patterns, precipitation rates, and increasing temperatures have the most significant effect on groundwater levels. A thorough review of data provided by TAK has identified minimal changes or abnormalities in the TMD piezometer data. All changes noted in the data review have been explained or accounted for by seasonal variation or changes in precipitation, except for piezometers P-18-171-C and P-18-172. The piezometers locations are within the Wing Wall South and are shown on Figure 3. It should be noted that these are not identified as critical piezometers.

Piezometer P-18-171-C indicates a decrease in pressure head between approximately late March and May 2020 (Figure 4). While P-18-172 indicates a sharp increase in pressure head in February 2020 (Figure 5) followed by a steady increase in pressure head which precedes the increase in the main dam seepage flow rate. Data for both piezometers, in addition to the other piezometers installed along the southern portion of the Wing Wall, is presented in Figure 6. The source and cause of the change in pressure head and subsequent leveling at these two piezometers are not explained by changes in precipitation, barometric conditions, or seasonal changes, based on the information reviewed. The most recent instrumentation assessment (TAK 2020b) found no abnormalities in the Wing Wall South embankment or piezometer data although the February 2020 (TAK 2020a) assessment did note the changes in P-18-172 as summarized in Table 4. Further evaluation of weekly reporting (TAK 2020c) and images provided by TAK and gathered

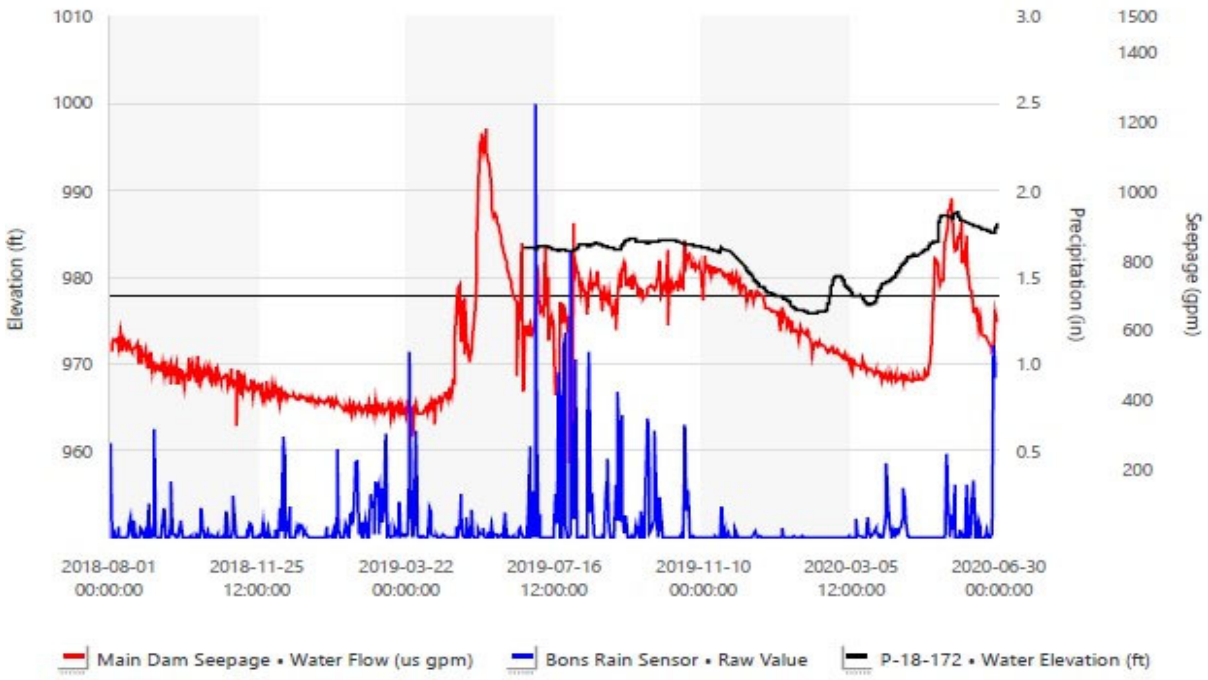
during the NewFields site visit and previous Dam Safety Inspections indicate no seepage or unusual findings requiring further inspection.

Figure 4 – P-18-171-C Water Elevation



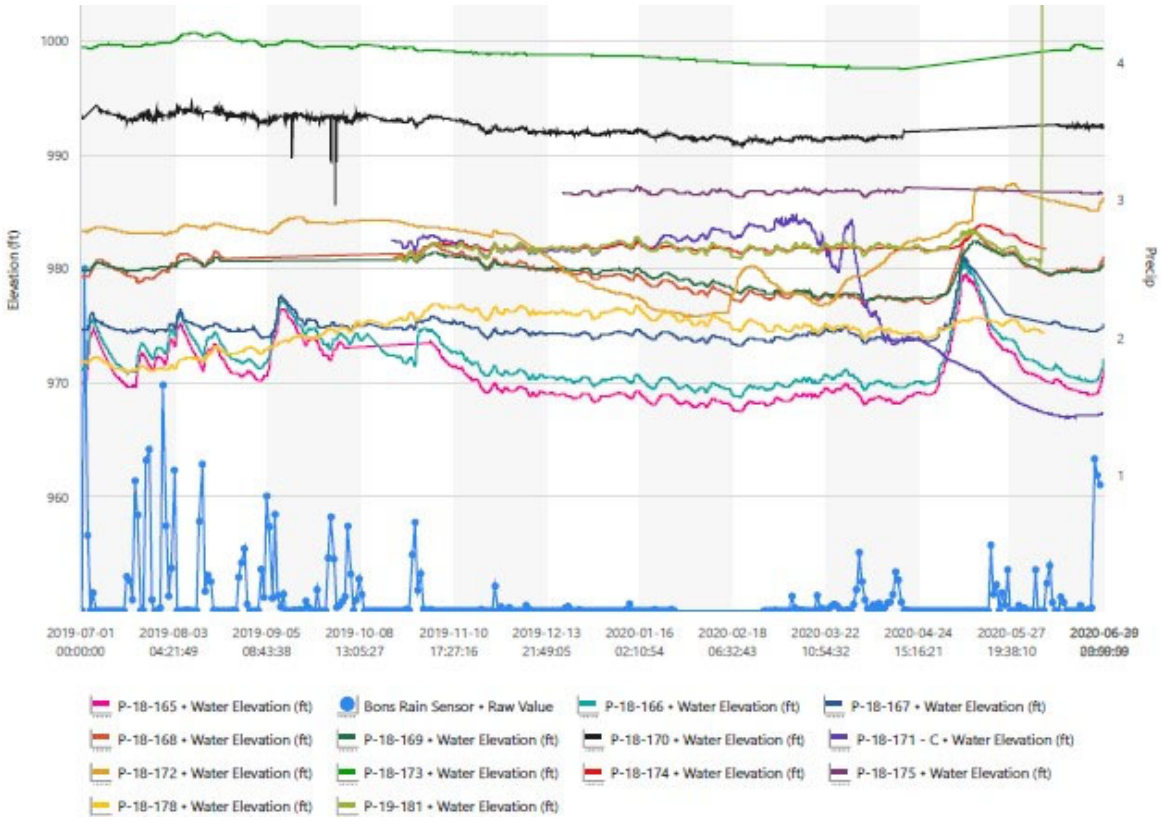
- Taken from TAK Periodic Instrumentation Assessment June 2020
- Sharp decrease noted between late March 2020 and May 2020

Figure 5 – P-18-172 Water Elevation



- Taken from TAK Periodic Instrumentation Assessment June 2020
- Sharp increase noted in February 2020 followed by steady rise prior to increase in Main Dam Seepage

Figure 6 – Wing Wall South Piezometer Data (June 2020)



- Taken from TAK Periodic Instrumentation Assessment June 2020
- P-18-171-C data shows decrease in water level beginning in late March 2020
- P-18-172 data shows two sharp increases in water level, with subsequent leveling after each

Table 4 – Periodic Instrument Assessment Monitoring Observation Summary

#	Group	Instruments	Comments February 2020	Comments June 2020
1	Seepage Pumpback and TSF Water Elevation	TMD Sump Pump Flow; TSF Pond Elevation	Pumpback average for January was 625gpm, Max = 665, Min = 568 Pond level decreased 0.08 feet to 980.536 Continuing Aqqaluk Pit pumping from SPP	Pumpback average for June was 661 gpm, Max = 911, Min = 535 Pond level increased 0.28 feet to 979.65 as of June 29 Pumping continues from Aqqaluk Pit to the TSF
2	Foundation Erosion Index	P-16-146Z, P-16-145Z, P-16-145Y	Index for P-16-145Z has leveled to a higher trend in February after deviating from the trend with a sudden decrease in pore water pressure on Jan-15	FEI was decreasing until a small spike was observed at the end of month due to precipitation and increase in seepage flow All values between 8-18
4	Hydraulic Gradients	Horizontal and Vertical Gradients	Horizontal: no major observations in downstream gradients Upstream Horizontal: decreasing trends for P-06-74 <- P-16-146Z and for P-06-74 <- P-16-145Z Vertical: P-16-145 gradient within tailings continues to rise (between ports X and Y). P-16-146 also appears to be raising at a lower rate	Horizontal: slight decrease in gradients due to freshet Upstream Horizontal: decreased gradient across the starter dam toe. Horizontal gradient within the tailings are steady Vertical: P-16-145 gradient within tailings increased slightly. Vertical gradient between P-05-62 and P-97-28 switched back to positive value indicating downward flow. This is due to P-97-28 reduction is piezometric head
5	Critical Underdrain Piezometers	P-05-62; P-10A; P-16-151A;P-08A; P-06-74	All piezometers steady throughout the month	All piezometers steady for decreasing
6	Critical Near-Underdrain Piezometers	P-97-28; P-10B; P-16-151B; P-14-130; P-08B; P-14-134;P-16-145Z;	P-16-145B decreasing throughout month	All piezometers steady for decreasing No major response to precipitation Large decrease in P-97-28 had been observed in historically post freshet
7	Deep Foundation Piezometer	P-97-20	Steady	Decreased throughout the month Slight increase near the end of the month due possibly due to precipitation
8	Critical Downstream Shell Piezometers	P-14-129A; P-14-129B; P-14-132; P-97-29; P-05-69; P-97-30; P-18-177	All Piezometers stable: no observations	P-05-69 started reading anomalous readings again No other unusual observations
9	Non-Critical Crest Piezometers	P-11; P-12A; P-12B; P-13; P-14	All Piezometers stable: no observations	No unusual observations

#	Group	Instruments	Comments February 2020	Comments June 2020
10	Seepage Dam Piezometers	SPP-97-002; P-96-10	Seepage pond increased by 1 ft in February in response to the secondary pump chambers beginning to freeze. EOR emailed on 2/5/2020 Piezometers stable throughout month	No unusual observations
11	Wing Wall Piezometers	P-05-63, 67; P-16-148, P-16-149; P-16-150, P-18-160, 161, 162, 163, 164, P-19-184, 185	P-16-148, 149, not shown due to tips installed in frozen ground Most piezometers trending down due to low ground water flow. P-05-63 shows the most downward trend	P-05-67, 162, 185, 63, 150 increased due to precipitation 164, 160, 161, 163 remained steady
12	Wing Wall South Piezometers	P-18-165, 166, 167,168, 169, 170, 171, 172, 173, 174, 175, 178, P-19-181	P-18-172 shows 2 sharp increases in water level with subsequent leveling. Unsure what cause may be All other piezometers only show barometric fluctuation	P-165, 166, 167, 168, 169, 172, increased slightly due to precipitation
13	Upstream Select Piezos	P-06-74, P-14-134, CPT-13-06C, 09C, 04C, P-16-146, P-16-145	All piezometers appear to have slight downward trend P-16-145Z has leveled-off	Steady or slight decrease in upstream tailings piezometers
14	TMD SAA Inclinometers	SAA-01-13; SAA-02-13; SAA-03-13	No unusual observations	N/A
15	Weekly Inspections	N/A	Beaching on West tails road Snow cover	N/A
Note: Comments presented are TAK Tailings and Water Staff notes compiled from TAK Periodic Instrumentation Assessments dated February 2020 and June 2020				

5.3. Seepage Monitoring

Seepage from the TMD is measured by the seepage pumpback system at the SCP. It is acknowledged that this is not an accurate measurement of the TMD seepage as it also includes local run-off and direct precipitation into the SCP in addition to the seepage collected by a sump located downstream of the SCP. The flows reporting to this sump may also include natural subsurface flows within Red Dog Creek.

A review of the seepage pumpback rates shows a consistent seasonal trend with peak rates recorded in late spring and the lowest rates recorded in late winter. The peak rates coincide with the spring freshet and the thawing of the ground in addition to the rise and fall of the stored pond elevation. It is also noted that seepage rates respond to summer precipitation. This is noted in the 2019 data, in which the site had significant precipitation during the summer months

and an increase in seepage pumping rates but returned to a normal trend during the winter months of 2020.

5.4. Tailings Beach

Tailings beach widths are determined from photoSAT records during the summer months and estimated from water levels and beach slopes during the winter months when snow coverage prevents visual inspection. Beach lengths are also visually estimated by TAK personnel during facility inspections. During the PSI inspection the beach width was estimated to be 200 feet or less, which is significantly less than the target distance of 600 feet. This was at least partially due to the Stage XI-A construction activities and the pipe bench located upstream of the TMD was being reconstructed in addition to the fact that water treatment and release was not occurring due to water quality restrictions as previously discussed. Upon completion of construction TAK indicated the multi-point subaerial tailings deposition will resume.

5.5. Deformation Monitoring

Three SAA inclinometers are positioned within the TMD downstream shell in the center portion of the embankment. The inclinometers monitor the magnitude and direction of horizontal movement within the embankment and underlying foundation. The inclinometers are generally monitored weekly although there have been issues with data reduction and inconsistent readings. It is our understanding that these issues are being addressed by TAK with assistance from Golder and NavStar.

A review of the available inclinometer data does not identify any items of concern although the instruments have shown responses to construction activities on the main dam, particularly during the Stage X construction as noted during the 2019 Annual Inspection (Golder 2019b). Inclinometer IN-01-13 has shown a cumulative maximum horizontal displacement of just over 1.1 inch at the surface at an elevation of approximately 809 feet with a displacement of approximately 0.07 inches being recorded within the past year. Inclinometer IN-02-13 has also shown a cumulative maximum horizontal displacement of just over 0.36 inch at the surface at an elevation of approximately 822 feet with a displacement of approximately 0.07 inches being recorded within the past year. Inclinometer IN-03-14 has also shown a cumulative maximum horizontal displacement of approximately 0.1 inches at the surface at an elevation of approximately 784 feet with a displacement of approximately 0.05 inches being recorded within the past year. All the displacements over the past year are within the tolerance limits of the instruments.

6. REVIEW OF PERFORMANCE PARAMETERS

Key performance parameters for the TMD are seepage, water management, and stability based on our understanding of the facility design and operation.

6.1. Seepage and Phreatic Levels

Monitoring of the phreatic surface, hydraulic gradients and flow rates through the embankment and underdrain is an ongoing and critical activity to ensure a stable structure. Changes in flow rate, turbidity or abnormal trends in phreatic levels are early signs of changed conditions that should be investigated. Phreatic levels within the TMD embankment, foundation and tailings mass are monitored with piezometers. The data is available real-time to TAK, and it is our understanding that personnel from the Tailings and Water group review the data daily. Using this data, hydraulic gradient checks are performed.

TAK has identified critical and non-critical piezometers for the monitoring of the TMD and established trigger levels for the critical instruments. It is our opinion that the number and location of the existing piezometers, and the trigger levels identified, are appropriate for monitoring the performance of the TMD.

Seepage pumping is monitored by a flowmeter attached to the pumpback pipeline and the data is available in real-time. This is appropriate and no changes to the operating or monitoring procedures are recommended.

6.2. Tailings Beach

Seepage rates can be directly correlated to pond elevation and offset distance from the main embankment. Visual monitoring during site inspections in addition to photoSAT record reviews monitor the shape of the tailings beach and the offset distance for the pond. Utilizing these monitoring techniques along with depositional plans the tailings beach can significantly contribute to the reduction of seepage from the TMD. TAK has the appropriate techniques and personnel in place to maintain the desired 600-foot beach provided the volume of water stored within the facility is controlled.

6.3. Freeboard Review

Freeboard calculations are an important component of dam safety. The current freeboard requirement is a minimum of five (5) feet between the pond level and the dam crest. In June of 2019, Golder completed a site-wide hydrological assessment to update freeboard requirements for the TMD and other TSF designs. As a result of this assessment Golder recommends increasing the PMP at the site to a 24-hour PMP event of 11.7 inches (Golder 2020). We believe the analysis

was appropriate and observed precipitation data supports this greater PMP criteria. We do, however, believe that it is more appropriate to establish minimum freeboard requirements using a 72-hour PMP rather than a 24-hour PMP event. The 72-hour PMP would result in greater runoff into the TSF. Given that the facility will be required to store rather than pass the full PMP inflow volume, we recommend that changing the design PMP to a 72-hour storm be considered.

6.4. Water Management

TAK closely monitors the pool elevation with the TSF and actively manages the pool volume with the goal of reducing it as much as possible during the summer months. This is demonstrated through the construction of a new RO plant for the treatment and discharge of stored water and active transferring water to the Aqqaluk Pit. Given the understanding that the current water balance model is being revised to calibrate it to recent precipitation and storage data and to improve predictive runs, NewFields has no additional recommendations or comments on water management at the TSF.

6.5. Geotechnical Studies

TAK and their EOR have, and continue to, put forth a significant effort to qualify foundation conditions within the limits of the TMD. Specifically, recent investigation activities at the Wing Wall have been advanced to confirm the presence of potentially liquefiable materials. Upon completion of currently planned geotechnical investigation and evaluations, the identification of critical monitoring instruments along the Wing Wall and establishment of threshold limits should be performed.

7. CONDITION ASSESSMENT AND CONCLUSIONS

Based on the visual inspection performed in August 2020, discussion with TAK personnel, and subsequent review of provided monitoring data, the TMD is functioning as the design intended and is well maintained. Additionally, TAK has sufficient external third-party professionals providing technical oversight to the facility in addition to active EOR involvement.

In addition to the outstanding issues and recommended action items identified during previous annual inspections and PSIs, summarized in Table 3, it is recommended that the following items be further reviewed or considered:

- Continue monitoring piezometers P-18-171-C and P-18-172 and consider further investigation of the data should they continue to trend differently than expected and other piezometers on Wing Wall.
- Evaluate the selected PMP storm event and consider selection of the 72-hour PMP storm as the design storm.

- Continue to monitor and document the seeps, and any others that are identified, along the west abutment.
- Update the GoldSim water balance model to:
    - Incorporate Aqqaluk Pit and the pumping between the pit and the TSF;
    - Incorporate the new RO water treatment system;
    - Update the water chemistry in the TSF in order to better predict WTP effluent parameters that impact the mine's ability to treat and release water;
    - Complete an evaluation of recent site precipitation records and update the GoldSim model's precipitation predictions to capture observed site conditions;
    - Ensure that precipitation estimates generated as part of the predictive portion of the GoldSim model accurately reflect short duration, annual and long-term wet and dry precipitation trends observed from recorded site data;
    - Add the ability for model predictions to incorporate potential future precipitation increases due to climate change;
    - Add the ability to evaluate water balance results assuming future windows for water treatment and release are limited; and
    - Complete calibration model runs using both full observed/recorded operational data as well as calibration runs with precipitation estimated by stochastic precipitation.
- Review the GoldSim water balance model annually and update model logic as appropriate.

Based on the data review, and as discussed in Section 1.3, NewFields agrees with the change to a Class I (High) hazard classification as a catastrophic failure of the structure endanger lives within the adjacent man-camp and mill site.

Overall, it is the opinion of the PSI team that the TMD, at the time of the inspection, should be considered in *Satisfactory* condition with the following caveat. As inspected, the water management and tailing beach width are not in agreement with typical operating conditions. The tailings beach was significantly less than the goal presented in the O&M Manual and their operational target and cycling of supernatant between other mine structures is on-going due to the mine' inability to release to the environment in consideration of their current permit. Long-term solutions to these non-typical conditions are necessary and should be evaluated as soon as possible. That said, based on our review of the structure and operations, these non-typical conditions do not currently impact the integrity of the structure.

Per the ADNR Dam Safety Program Guidelines (ADNR 2017), a *Satisfactory* condition is defined as:

- No existing or potential dam safety deficiencies are recognized.
- Acceptable performance is expected under normal and extreme loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.
- Meets applicable hydrologic and seismic regulatory criteria.

8. REFERENCES

ADNR, 2017. Guidelines for Cooperation with the Alaska Dam Safety Program – Draft Revision. Prepared by the Dam Safety Construction Unit, Water Resources Section, Division of Mining, Land and Water, Alaska Department of Natural Resources. July 28.

ADNR, 2019. Certificate of Approval to Operate a Dam, Red Dog Tailings Main Dam, Issued to Teck Alaska Incorporated. Certificate No. FY2020-7-AK00201, dated November 1, 2019.

ADNR, 2020. Temporary Certificate of Approval to Operate a Dam, Red Dog Tailings Main Dam, Issued to Teck Alaska Incorporated. Certificate No. FY2021-3-AK00201, dated September 22, 2020.

AECOM, 2015. Seepage Analysis Report, Red Dog Mine Tailings Main Dam, December 29.

AECOM, 2016. Operations and Maintenance Manual, Revision 12, Red Dog Tailings Main Dam, NID ID AK 00201, Red Dog Mine, Alaska, November 4.

AMEC, 2012. Long-Term Permafrost and Groundwater Monitoring Program for the Tailing Impoundment Five-Year Permafrost and Groundwater Data Analysis 2007 – 2011, February 2012

Golder, 2019a. Red Dog Tailings Main Dam, 2019 Dam Breach and Inundation Study, October 4.

Golder, 2019b. 2019 Annual Performance Report for Tailings Main Dam, Red Dog Mine, Alaska, October 24.

Golder, 2020. Tailings Main Dam Stage XI Detailed Design, Interim Raise to EL 991, Red Dog Mine, Alaska, June 22.

KCB, 2017. Tailings Main Dam Facility Periodic Safety Inspection Report, Red Dog Tailings Main Dam, AK-00201, December 2017.

TAK 2020a. Teck Alaska Red Dog Mine, Periodic Instrumentation Assessment, Tailings Main Dam, February.

TAK 2020b. Teck Alaska Red Dog Mine, Periodic Instrumentation Assessment, Tailings Main Dam, June.

TAK 2020c. Weekly Dam Inspection Log - TMD, July 14.

TABLES

Table 3
Red Dog Mine
Register of Outstanding Key Issues and Recommended Actions
Tailings Main Dam

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
2	If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

ID	Applicable Regulation or O&M Reference	Deficiency or Non-Conformance	Risk to Structure	Priority	Recommended Action	Recommended Timing for the Action	NewFields Notes
2017-02 (PSI-R-02)	n/a	Design and site characterization information is not summarized	None	4	Standalone reports are recommended that summarize key project information applicable to the TMD, specifically for: Design Basis/ Criteria and Dam Site Characterization. These documents should be reviewed annually (minimum), then, if appropriate, updated and reissued (with revision control) by the EoR, similar to O&M and emergency planning documents.	Q4 2019	Completed by Golder; was done as part of their due diligence when taking over as EOR. Compilation of design criteria changes over time is available. Plan is to re-issue documents as needed when new site characterization data is available.
2017-03 (PSI-R-03)	n/a	Observation Method needs to be reviewed and updated	Mitigation options to prevent dam failure may not be available	4	Review and action, as appropriate, recommendations and opportunities to improve implementation of the Observational Method at the TMD.	Q4 2021	Teck is implementing the observational method as part of on-going surveillance; they feel like they are doing a good job at training for new staff in this method.
2017-09 (PSI-R-09)	n/a	Monitoring programs needs to be updated	Mitigation options to prevent dam failure may not be available	3	The risk reduction measures identified by AECOM during the filter workshop (TMD11), or similar, should be incorporated into the TMD monitoring program and documented in the O&M Manual in manner consistent with the Observational Method framework.	Q4 2021	This comment is in reference to the Stage X filter zone; Aaron thinks. He'll look into what this comment means and what has been done.
2017-10 (PSI-R-10)	n/a	A seepage model is needed as tailings level rise	Seepage through the tailings beach is critical for embankment stability	3	Teck and AECOM are recommended to develop a 3D seepage model for the TMD. The effort associated with this activity is believed justified because of increasing importance of understanding of seepage and prediction capability as the tailings level rises and the project approaches closure.	TBD	Teck is not planning on implementinga 3D seepage model at this time.

Table 3
Red Dog Mine
Register of Outstanding Key Issues and Recommended Actions
Tailings Main Dam

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
2	If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

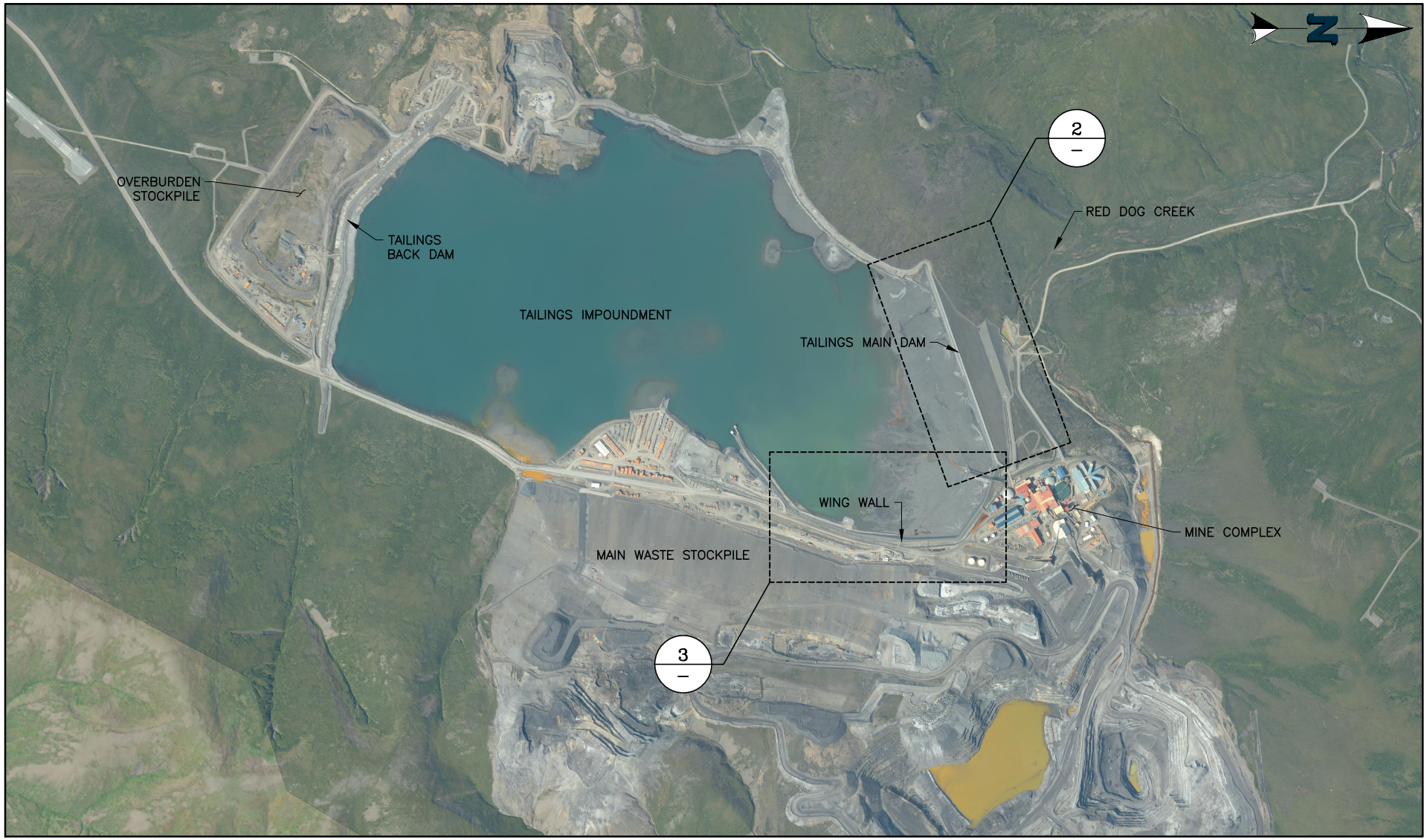
ID	Applicable Regulation or O&M Reference	Deficiency or Non-Conformance	Risk to Structure	Priority	Recommended Action	Recommended Timing for the Action	NewFields Notes
2017-11 (PSI-R-11)	O&M Manual Section 3.0	Teck has not designated the Responsible Party	In an emergency situation, there could be initial confusion related to the chain of command	3	Recommended inclusions that should be incorporated into the next revision of the O&M Manual to improve the document further include: • Update the discussion of the Observational Method based on the discussion herein and recommended activities, specifically the threshold values, refer to Section 6.2.2. • Identify the Responsible Position for the TMD, who currently holds that position and their designated alternates. • Clearing of vegetation growth from the Seepage Collection Dam spillway should be defined as part of routine maintenance.	Q4 2020	Will be closed when new O&M manul comes on-line. New O&M in 2020; QP/RP has been identified. Spillway is a moot point as it was redesigned and rebuilt in 2019.
2017-12 (PSI-R-12)	n/a	Key information on the tailings storage facility are not summarized	None	4	To limit risks associated with omission of key information and staff turnover, Teck is recommended to prepare a document that summarizes design basis information for the TSF and key components as an integrated system, such as: TMD; Tailings Back Dam; water balance; deposition planning and beach management; seepage management; regulatory; closure and other relevant information. This document would consolidate information similar to that recommended in PSI-R-02 for all components of the TSF.	Q4 2020	An update to the site-wide OMS manual for the TSF is planned to be completed by end of 2020 and the design basis memo will be incorporated into this document.
2017-13 (PSI-R-13)	O&M Manual Section 5.0	Monitoring programs needs to be updated	Current program may not adequately address all dam failure modes	3	Installation of inclinometers and additional piezometers to monitor displacement and pore pressure generation within the colluvium / alluvium unit is recommended. Number of instruments, type and locations should be recommended by the EoR.	Q4 2020	EOR has provided recommendation for additional SAA on main dam; plan is to wait until Stage XIb is complete. Many additional piezometers have been installed since this time; EOR has recommendations for additional piezometers. Outstanding VWP recommendations are defined as low priority and mainly associated with full build-out of the embankment.

Table 3
Red Dog Mine
Register of Outstanding Key Issues and Recommended Actions
Tailings Main Dam

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
2	If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrences of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

ID	Applicable Regulation or O&M Reference	Deficiency or Non-Conformance	Risk to Structure	Priority	Recommended Action	Recommended Timing for the Action	NewFields Notes
2017-14 (PSI-R-14)	O&M Manual Section 5.0	Monitoring programs needs to be updated	Current program may not adequately address all dam failure modes	3	Teck's plan to establish additional threshold levels that improve the implementation of the Observational Method is supported and should be completed. Additional recommendations related to thresholds include: • EoR to review whether horizontal gradient thresholds should be defined between piezometers referenced in Section 6.2.2 of main text. • Establish thresholds for seepage pumpback based on pumping rate, in addition to the existing thresholds that are based on Seepage Collection Dam pond level. • Establish thresholds for tailings beach width based on design assumptions and observations of impact of beach width on seepage rates. • Develop incremental and cumulative inclinometer thresholds for each foundation and dam fill unit, as appropriate, based on deformation model predictions of "most probable conditions" and "most unfavorable conditions."	Q4 2020	Will be addressed in O&M update that will be published in 2020. Teck currently monitors these items and is working with EOR to establish thesholds. Not all instruments are considered "critical". Only critical instruments will be in O&M Manual.
2017-15 (PSI-R-15)	O&M Manual Section 5.0	Monitoring programs needs to be updated	Current program may not adequately address all dam failure modes	4	Given the importance of the tailings beach on seepage management and structural stability in the short and long-term, Teck has refined their tailings planning to maintain a wide beach at the TMD. The same criteria should be defined in TMD design basis and O&M Manual, including an appropriate monitoring program.	Q4 2020	Will be included in O&M update. Quarterly tailings beach reports are presented internally for management and planning. 700' is the target beach length (100' upstream of upstream toe). 300' width is "warning" level; 50' is "emergency" level.
2018-01	n/a	None	None	4	Continue monitoring the TMD in accordance to the O&M Manual until it is revised.	Ongoing	on-going
2018-02	n/a	Cracks on the Wing Wall	May indicate deformation of the embankment	3	Continue monitoring the lateral cracks on the crest of the Wing Wall, looking for changes in length, width, or depth. Survey, photograph, and document in writing any increase observed.	Ongoing	Visual monitoring on-going
2019-01	O&M Manual Section 5.0	Monitoring programs needs to be updated	Current program may not adequately address all dam failure modes	3	Continue working with Measurand, NavStar, and Golder to determine best practices for SAA inclinometer data reduction and replicability procedures	Ongoing	On-going; Teck making progress.

FIGURES



0 900 1800 FEET

REFERENCE:

AERIAL IMAGERY ACQUIRED BY WORLD IMAGERY BY ArcGIS, FILE NAMES:
overall flyover NAD27 Alaska State Plane Zone 7.tif AND
RedDog Minesite 2ft Ortho.tif

NewFields

CLIENT: TECK ALASKA INCORPORATED

PROJECT: 2020 PERIODIC SAFETY INSPECTION

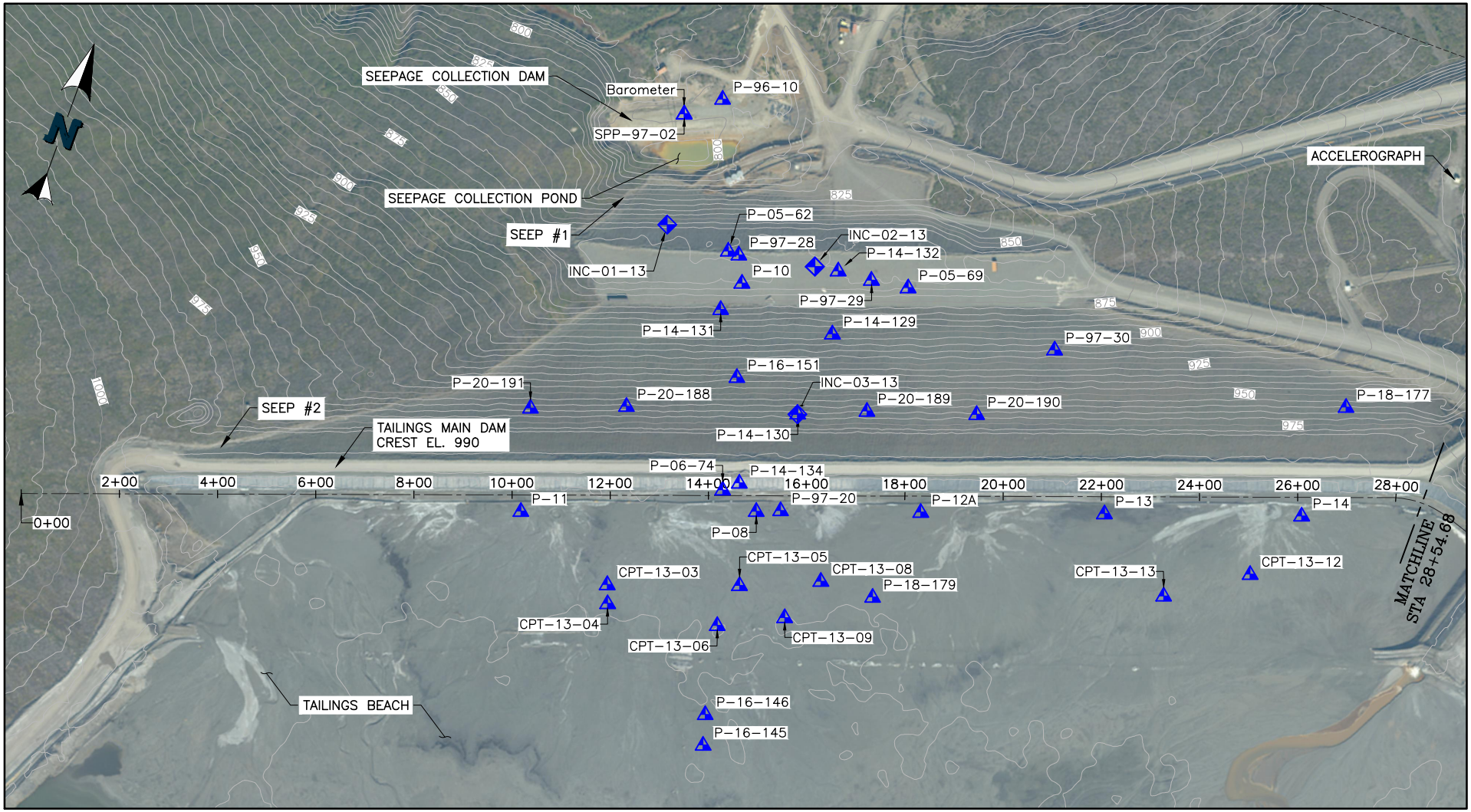
TITLE: TAILING IMPOUNDMENT OVERVIEW

FILENAME: 0433.000 FIG 1_R3

FIGURE NO.: 1

REVISION: 0

P:\Projects\0433.000 Red Dog Safety Inspections (PSI)\A-CAD\FIGS\TMD Report\0433.000 FIG 1_R3.dwg-10/26/2020 3:26 PM



0 150 300 FEET

REFERENCE:

AERIAL IMAGERY ACQUIRED BY WORLD IMAGERY BY ArcGIS, FILE NAMES: RedDog Minesite 2ft Ortho.tif

THE CONTOURS LINES AND BATHYMETRY FILE WE RECEIVED FROM TAK, FILE NAME:
TAILINGS BATHY 2019.xml
red_dog_wo4136f_2ft_contours_2020jun20_mine_grid_all.dwg

LEGEND:

- EXISTING GROUND CONTOURS
- BATHYMETRY CONTOURS
- XXX-XX-XXX PIEZOMETER
- XXX-XX-XXX INCLINOMETER

NewFields

CLIENT: TECK ALASKA INCORPORATED

PROJECT: 2020 PERIODIC SAFETY INSPECTION

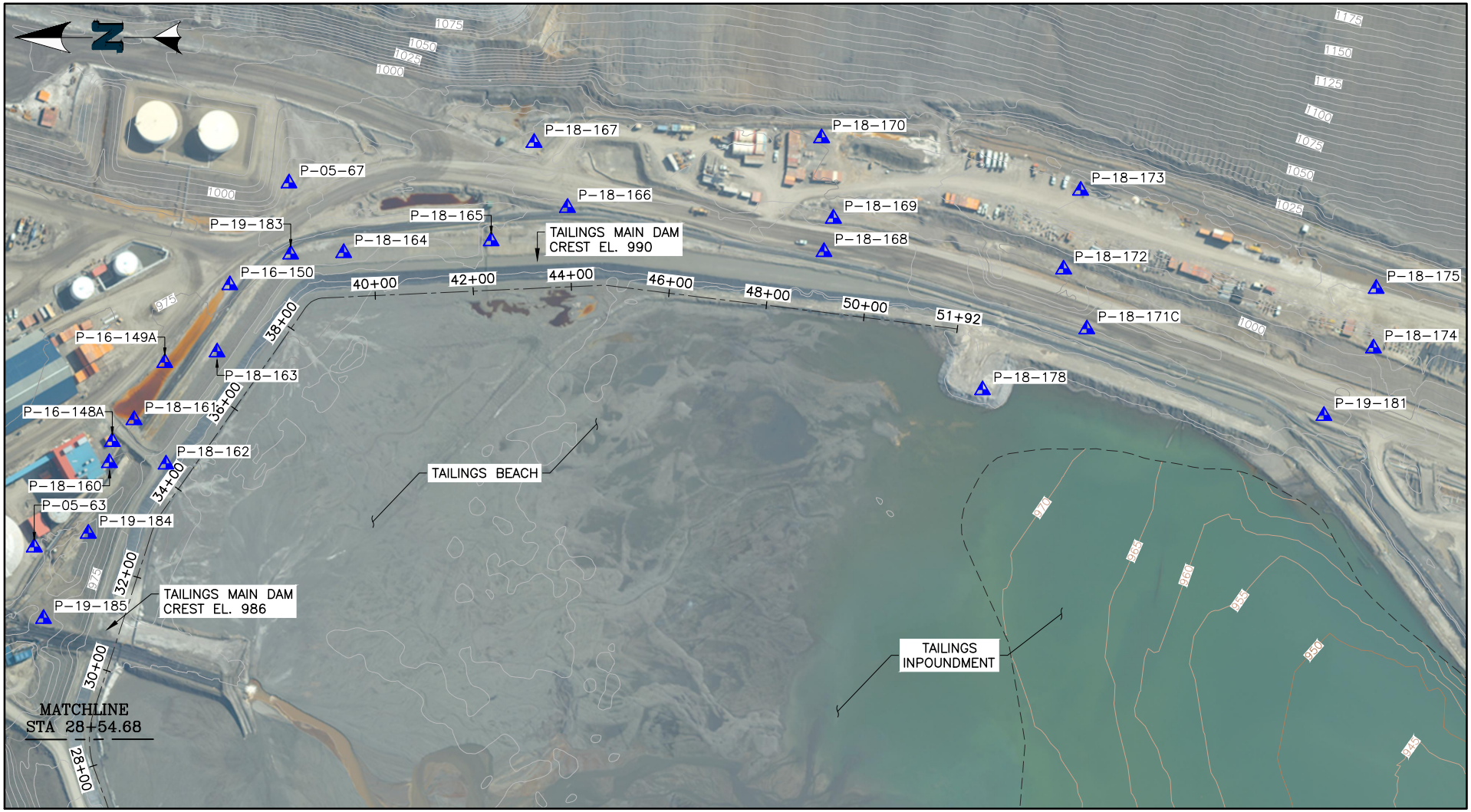
TITLE: MAIN EMBANKMENT AND SEEPAGE COLLECTION DAM PLAN VIEW

FILENAME: 0433.000 FIG 2_R3_JS

FIGURE NO.: 2

REVISION: 1

P:\Projects\0433.000 Red Dog Safety Inspections (PSI)\A-CAD\WORK\0433.000 FIG 2_R3_JS.dwg-3/2/2021 3:22 PM



0 150 300 FEET

REFERENCE:

AERIAL IMAGERY ACQUIRED BY WORLD IMAGERY BY ArcGIS, FILE NAMES: RedDog Minesite 2ft Ortho.tif

THE CONTOURS LINES AND BATHYMETRY FILE WE RECEIVED FROM TAK, FILE NAME:
TAILINGS BATHY 2019.xml
red_dog_wo4136f_2ft_contours_2020jun20_mine_grid_all.dwg

LEGEND:

EXISTING GROUND CONTOURS

BATHYMETRY CONTOURS

XXX-XX-XXX PIEZOMETER

NewFields

CLIENT: TECK ALASKA INCORPORATED

PROJECT: 2020 PERIODIC SAFETY INSPECTION

TITLE: WING WALL PLAN VIEW

FILENAME: 0433.000 FIG 3_R3

FIGURE NO.: 3

REVISION: 0

P:\Projects\0433.000 Red Dog Safety Inspections (PSI)\A-CAD\FIGS\Report 3\0433.000 FIG 3_R3.dwg-8/26/2020 3:32 p. m.

APPENDIX A – Hazard Classification Review Form

Form completed by Golder (February 17, 2019) and included with the Stage XI Detailed Design Report

Alaska Dam Safety Program

HAZARD POTENTIAL CLASSIFICATION AND JURISDICTIONAL REVIEW

This form is used to review and indicate the hazard potential classification of an artificial barrier in accordance with 11 AAC 93.157 and to determine if the barrier is a dam under the jurisdiction of the Alaska dam safety regulations, based on the definition articulated under Alaska Statute 46.17.900 (3), and summarized as follows:

"Dam" includes an artificial barrier, and its appurtenant works, which may impound or divert water and which...

- has or will have an impounding capacity at maximum water storage elevation of 50 acre-feet and is at least 10 feet in height measured from the lowest point at either the upstream or downstream toe of the dam to the crest of the dam; or
- is at least 20 feet in height measured from the lowest point at either the upstream or downstream toe of the dam to the crest of the dam; or
- poses a threat to lives and property as determined by the department after an inspection.

In accordance with 11 AAC 93.151, an artificial barrier with a Class I or Class II designation is determined to meet the third definition of a dam, regardless of its geometry.

Please complete items 1 through 20. Attach additional information as necessary. This form must be certified and stamped on page 3 by an Alaska-registered professional engineer, qualified in accordance with 11 AAC 93.193.

1. Name of barrier: Red Dog Mine Tailings Main Dam

   National Inventory of Dams (NID) number: AK 00201 (Assigned by Department)

   Name of stream: South Fork Red Dog Creek

   General location and region: Delong Mountains, NANA Region, NW Arctic Borough

   Legal location: Township 31N Range 18W Section 19 Meridian Kateel River

   Purpose and type of barrier: Tailings, Tailings Water, and Surface Runoff Storage

   This barrier is: ☑ Existing ☐ Proposed ☐ Under construction

   Current hazard potential classification: ☐ I ☑ II ☐ III ☐ Not assigned

2. Owner: Teck Alaska Incorporated

   Address: 3105 Lakeshore Dr.; Building A, Suite 101

   Anchorage, AK 99517

   Contact name: Mike Gonzales

   Phone: 907-754-5320

3. Is barrier federally owned, or regulated by the Federal Energy Regulatory Commission?

   ☐ Yes (stop here) ☑ No (complete form)

4. Maximum crest height of barrier: 201 feet
   Measured from: ☐ Upstream toe ☑ Downstream toe ☐ Offstream toe
   Basis of height: ☐ Conceptual design drawing ☑ Detailed design drawing
   ☐ As-built drawing ☐ Field measurement ☐ NID data

5. Maximum impoundment volume: 19,157 acre-feet
   Surface area of reservoir at maximum storage: 700 acres
   Average depth of reservoir above bottom of barrier: 27 feet (live storage)
   Basis of volume estimate:
   ☐ Surface area multiplied by average depth
   ☑ Bathymetry
   ☐ NID data
   ☑ Other: MUK3D modeling

6. Downstream development: ☑ Yes ☐ No ☐ Unknown
   Type of development (check all that apply):
   ☑ Homes
   ☑ School
   ☑ Community halls, churches, etc.
   ☑ Industrial or commercial property
   ☐ Major highway
   ☐ Primary roads
   ☑ Secondary or rural roads
   ☐ Railroads
   ☑ Power or communication utilities
   ☑ Water or wastewater treatment facilities or lines
   ☐ Overnight campgrounds
   ☐ Public parks or trails
   ☐ Fish hatchery or processor
   ☑ Barrier owner's property or facilities
   ☐ Other utilities:
   ☑ Other development: Seasonal recreation cabins

   Basis of observations: ☐ Ground reconnaissance ☐ Aerial reconnaissance
   ☑ Aerial photo ☑ Other: Reported by Owner
   Date of observations: aerial photos dated 2010 and 2017

7. Proximity of development to downstream channel (add maps or other information as necessary):
   Distance downstream from barrier: 0 ft
   Distance from stream bed: 0 ft
   Relative elevation above streambed: 0 ft

8. Is development in the inundation zone of a flood from an uncontrolled release of water from the barrier?
   ☑ Yes ☐ No ☐ Unknown

9. Was a dam break analysis conducted? ☑ Yes ☐ No

   What model was used to determine inundation zone: : HEC-HMS, FLOW-3D for dam at crest elev. 1,006' (Stage XII -Golder, October 4, 2019)
   (Please attach calculations)

   Maximum depth and velocity of flow through development: >20' through mill site at over 40 feet per second (Stage XII -Golder, October 4, 2019)

10. Is development at risk from improper operation or a "sunny day" failure?
    ☑ Yes ☐ No ☐ Unknown

11. Is development at risk from an incremental increase in the flood if the barrier fails under flood conditions?
    ☑ Yes ☐ No ☐ Unknown
    Flood condition evaluated: ☑ 100 year ☐ ½ PMF ☐ PMF ☐ Other

12. Could an uncontrolled release cause other significant property damage or loss? ☑ Yes ☐ No ☐ Unknown

Description: Mill Facilities, concentrate building, zinc thickener

13. Could an uncontrolled release effect public health? ☑ Yes ☐ No ☐ Unknown

Description: Mill facilities work force

14. Is the reservoir created by the barrier the primary water supply for a community of more than 500 residents? ☐ Yes ☑ No ☐ Unknown

Is a backup water supply available? ☐ Yes ☐ No ☐ Unknown ☐ N/A

15. Is barrier located on waters important to anadromous fish? ☐ Yes ☑ No ☐ Unknown

Are anadromous fish waters at risk of damage or loss if an uncontrolled release occurs? ☑ Yes ☐ No ☐ Unknown ☐ N/A

16. Does the barrier contain mine mill tailings, process water or contact water? ☑ Yes ☐ No

17. Proposed hazard potential classification: ☑ Class I (High) ☐ Class II (Significant) ☐ Class III (Low)

18. Basis of classification:
- ☑ Quantitative - Numerical dam break analysis conducted
- ☐ Qualitative - Limited engineering calculations
- ☐ Preliminary - No engineering calculations

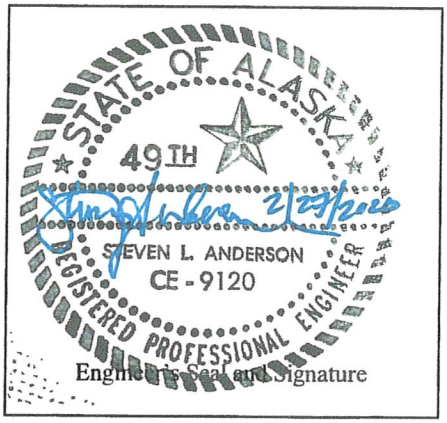
19. Comments: This hazard potential classification was performed for the Stage XI-A Tailings Main Dam for a crest elevation of 991 feet. At this elevation the Wing Wall embankment near the Power House will be 18 feet high (downstream toe). Based on the results dam from the Stage XII inundation analyses (Golder, October 4, 2019), raising the dam to the Stage XI-A configuration will change the hazard potential classification of the dam from Class II (significant) to Class I (high) due to the loss of life potential downstream of the north leg of the Wing Wall in the event of dam failure.

20. Certified by: Steven L. Anderson, PE (Print name)

Date: February 17, 2019

Company: Golder Associates Inc.

Phone: 907 344-6001



Engineer's Seal and Signature

Notes:
1. *This form must be certified and stamped by an Alaska-registered professional engineer qualified in accordance with 11 AAC 93.193.*
2. *The information presented in this form may be overruled based on current data that reveals a higher level of confidence in the quality of information necessary to make the appropriate determinations.*
3. *Anadromous fish waters are determined in accordance with 11 AAC 195.010 (a).*
4. *Alaska dam safety regulations are articulated under 11 AAC 93.151 through 11 AC 93.291 (Article 3).*

FOR DEPARTMENT USE ONLY

Jurisdictional Status of Barrier:

☐ Dam under state jurisdiction

Reasons:
- ☐ Height
- ☐ Height and storage volume
- ☐ Hazard potential classification
- ☐ Anadromous fish stream
- ☐ Other:_____

☐ Barrier is not a dam under state jurisdiction

Reasons:
- ☐ Height
- ☐ Height and storage volume
- ☐ Hazard potential classification
- ☐ Federal ownership or regulation
- ☐ Other:_____

Concur with proposed hazard potential classification: ☐ Yes ☐ No

Hazard potential classification based on current information: ☐ Yes ☐ No

Official hazard potential classification:

☐ Class I (High) ☐ Class II (Significant) ☐ Class III (Low)

Comments:_____

Reviewed by: _____

Title: _____

Signature: _____

Date: _____

Form completed by NewFields during 2020 PSI

Alaska Dam Safety Program

HAZARD POTENTIAL CLASSIFICATION AND JURISDICTIONAL REVIEW

This form is used to review and indicate the hazard potential classification of an artificial barrier in accordance with 11 AAC 93.157 and to determine if the barrier is a dam under the jurisdiction of the Alaska dam safety regulations, based on the definition articulated under Alaska Statute 46.17.900 (3), and summarized as follows:

"Dam" includes an artificial barrier, and its appurtenant works, which may impound or divert water and which...

- has or will have an impounding capacity at maximum water storage elevation of 50 acre-feet and is at least 10 feet in height measured from the lowest point at either the upstream or downstream toe of the dam to the crest of the dam; or
- is at least 20 feet in height measured from the lowest point at either the upstream or downstream toe of the dam to the crest of the dam; or
- poses a threat to lives and property as determined by the department after an inspection.

In accordance with 11 AAC 93.151, an artificial barrier with a Class I or Class II designation is determined to meet the third definition of a dam, regardless of its geometry.

Please complete items 1 through 20. Attach additional information as necessary. This form must be certified and stamped on page 3 by an Alaska-registered professional engineer, qualified in accordance with 11 AAC 93.193.

1. Name of barrier: RED DOG MINE - TAILINGS MAIN DAM

   National Inventory of Dams (NID) number: AK 00201 (Assigned by Department)

   Name of stream: SOUTH FORK OF RED DOG CREEK

   General location and region: DELONG MOUNTAINS, NANA REGION, NW ARCTIC BOROUGH

   Legal location: Township 31N Range 18W Section 19 Meridian KATEEL RIVER

   Purpose and type of barrier: Tailings, process water, and stormwater storage

   This barrier is: ☑ Existing ☐ Proposed ☐ Under construction

   Current hazard potential classification: ☑ I ☐ II ☐ III ☐ Not assigned

2. Owner: TECK ALASKA INCORPORATED

   Address: 2525 C STREET, SUITE 310

   ANCHORAGE, AK 99503

   Contact name: MIKE GONZALEZ

   Phone: (907) 426-9278

3. Is barrier federally owned, or regulated by the Federal Energy Regulatory Commission?

   ☐ Yes (stop here) ☑ No (complete form)

4. Maximum crest height of barrier: 201 feet
   Measured from: ☐ Upstream toe ☑ Downstream toe ☐ Offstream toe
   Basis of height: ☐ Conceptual design drawing ☑ Detailed design drawing
   ☐ As-built drawing ☐ Field measurement ☐ NID data

5. Maximum impoundment volume: 19,157 acre-feet
   Surface area of reservoir at maximum storage: 700 acres
   Average depth of reservoir above bottom of barrier: 27 feet (live storage)
   Basis of volume estimate:
   ☐ Surface area multiplied by average depth
   ☐ Bathymetry
   ☐ NID data
   ☑ Other: Stage XI Design Report

6. Downstream development: ☑ Yes ☐ No ☐ Unknown
   Type of development (check all that apply):
   ☑ Homes
   ☑ School
   ☑ Community halls, churches, etc.
   ☑ Industrial or commercial property
   ☐ Major highway
   ☐ Primary roads
   ☑ Secondary or rural roads
   ☐ Railroads
   ☑ Power or communication utilities
   ☑ Water or wastewater treatment facilities or lines
   ☐ Overnight campgrounds
   ☐ Public parks or trails
   ☐ Fish hatchery or processor
   ☑ Barrier owner's property or facilities
   ☐ Other utilities:
   ☑ Other development: Seasonal recreational cabins

   Basis of observations: ☑ Ground reconnaissance ☐ Aerial reconnaissance
   ☐ Aerial photo ☑ Other: Stage XI Design Report
   Date of observations:

7. Proximity of development to downstream channel (add maps or other information as necessary):
   Distance downstream from barrier: 50 feet
   Distance from stream bed: 0 feet
   Relative elevation above streambed: 0 feet

8. Is development in the inundation zone of a flood from an uncontrolled release of water from the barrier?
   ☑ Yes ☐ No ☐ Unknown

9. Was a dam break analysis conducted? ☑ Yes ☐ No

   What model was used to determine inundation zone: : HEC-HMS, FLOW-3D for dam at crest elev. 1,006' (Golder 2019)
   (Please attach calculations)

   Maximum depth and velocity of flow through development: >20' at mill site at over 40 fps (Golder 2019)

10. Is development at risk from improper operation or a "sunny day" failure?
    ☑ Yes ☐ No ☐ Unknown

11. Is development at risk from an incremental increase in the flood if the barrier fails under flood conditions?
    ☑ Yes ☐ No ☐ Unknown
    Flood condition evaluated: ☐ 100 year ☐ ½ PMF ☑ PMF ☐ Other

12. Could an uncontrolled release cause other significant property damage or loss? ☑ Yes ☐ No ☐ Unknown
    Description: Mill Facilities, concentrate building, zinc thickener

13. Could an uncontrolled release effect public health? ☑ Yes ☐ No ☐ Unknown
    Description: Mill Facilities workforce

14. Is the reservoir created by the barrier the primary water supply for a community of more than 500 residents? ☐ Yes ☑ No ☐ Unknown

    Is a backup water supply available? ☐ Yes ☐ No ☐ Unknown ☑ N/A

15. Is barrier located on waters important to anadromous fish? ☐ Yes ☑ No ☐ Unknown

    Are anadromous fish waters at risk of damage or loss if an uncontrolled release occurs? ☐ Yes ☑ No ☐ Unknown ☐ N/A

16. Does the barrier contain mine mill tailings, process water or contact water? ☑ Yes ☐ No

17. Proposed hazard potential classification: ☑ Class I (High) ☐ Class II (Significant) ☐ Class III (Low)

18. Basis of classification:
    ☑ Quantitative - Numerical dam break analysis conducted
    ☐ Qualitative - Limited engineering calculations
    ☐ Preliminary - No engineering calculations

19. Comments: Agree with current classification based upon dam breach analysis performed by Golder (2019) for a future Stage XII embankment raise. The results indicate a loss of life is likely in the event of a due to the location of the embankment in relation to the mill facilities and an active and present workforce.

20. Certified by: Ryan T. Baker, P.E. (Print name)

    Date: March 3, 2021

    Company: NewFields Mining Design & Technical Services, LLC

    Phone: (720) 508-3300

Engineer's Seal and Signature

3-4-21

Notes:

1. *This form must be certified and stamped by an Alaska-registered professional engineer qualified in accordance with 11 AAC 93.193.*
2. *The information presented in this form may be overruled based on current data that reveals a higher level of confidence in the quality of information necessary to make the appropriate determinations.*
3. *Anadromous fish waters are determined in accordance with 11 AAC 195.010 (a).*
4. *Alaska dam safety regulations are articulated under 11 AAC 93.151 through 11 AC 93.291 (Article 3).*

FOR DEPARTMENT USE ONLY

Jurisdictional Status of Barrier:

☐ Dam under state jurisdiction

Reasons:
- ☐ Height
- ☐ Height and storage volume
- ☐ Hazard potential classification
- ☐ Anadromous fish stream
- ☐ Other:_____

☐ Barrier is not a dam under state jurisdiction

Reasons:
- ☐ Height
- ☐ Height and storage volume
- ☐ Hazard potential classification
- ☐ Federal ownership or regulation
- ☐ Other:_____

Concur with proposed hazard potential classification: ☐ Yes ☐ No

Hazard potential classification based on current information: ☐ Yes ☐ No

Official hazard potential classification:

☐ Class I (High) ☐ Class II (Significant) ☐ Class III (Low)

Comments:_____
_____
_____
_____

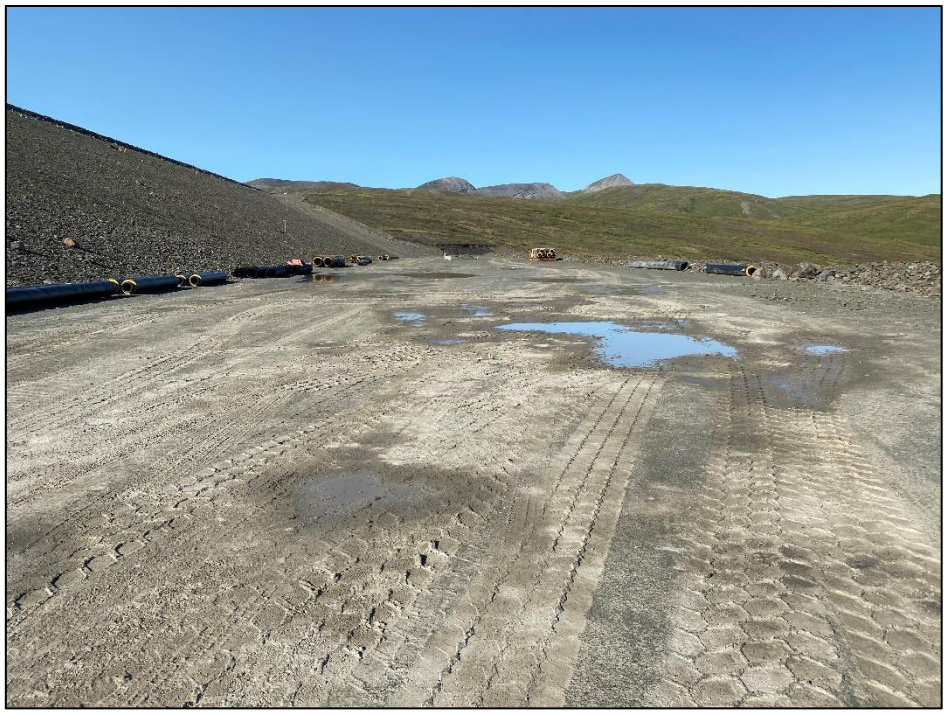
Reviewed by: _____

Title: _____

Signature: _____

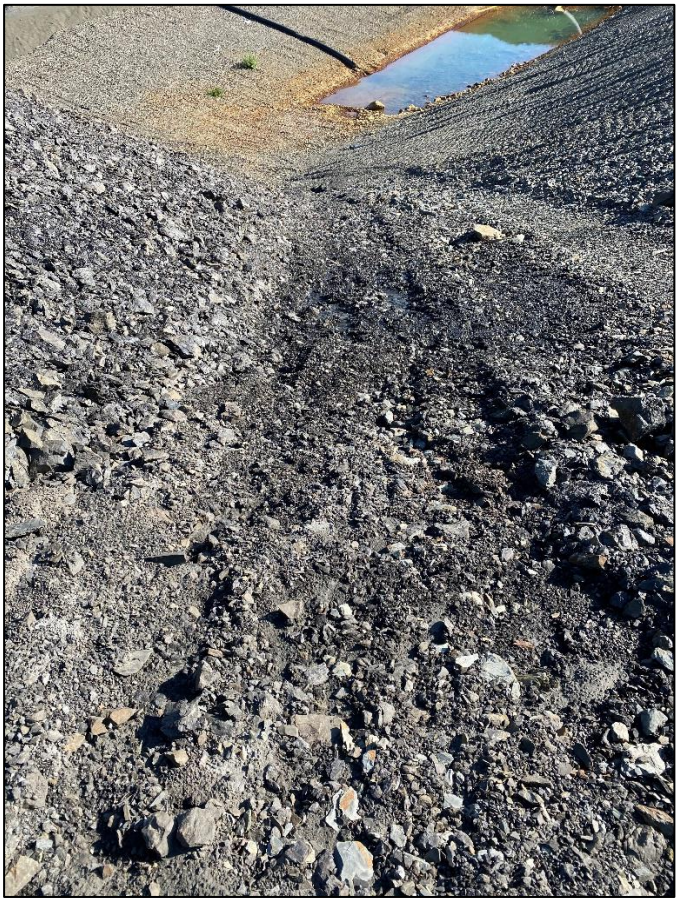
Date: _____

APPENDIX B – Photo Log



Photograph 01: Ponded water on Stage XI Buttress (looking southwest)

Photograph 02: Seep #1 at west abutment, below Stage XI Buttress elevation (looking southwest)



Photograph 03: Close-up view of seep #1 at west abutment, below Stage XI Buttress elevation

Photograph 04: Close-up view of seep #2 at west abutment, below Stage XI Buttress elevation

Photograph 05: Seepage Collection Pond (minimal volume of water)

Photograph 06: Tailings beach (looking southwest)

Photograph 07: Tailings beach from TMD (looking south)

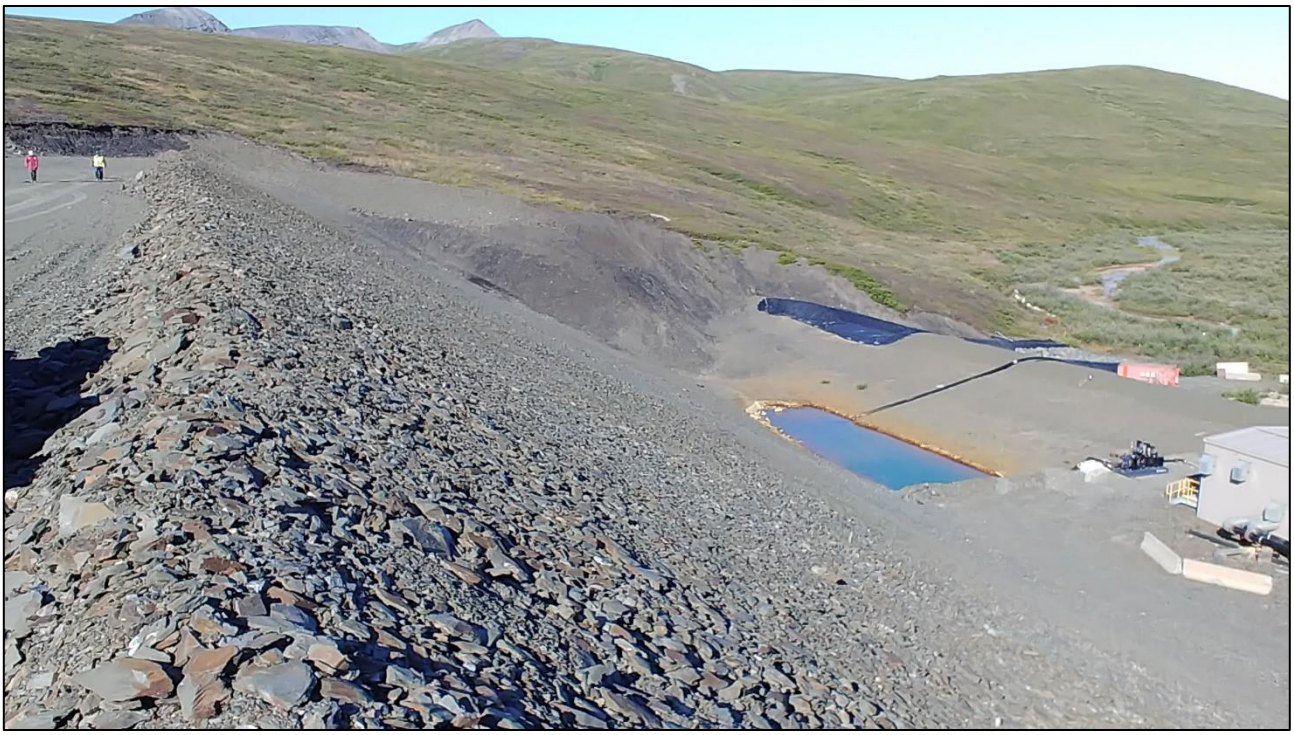
Photograph 08: Reclaim barges

Photograph 09: Reclaim pumps inside reclaim barge

Photograph 10: Seepage collection pond spillway (looking northwest)

Photograph 11: Upstream slope of TMD under construction (looking toward west abutment)

Photograph 12: Looking down TMD embankment centerline towards northeast from west abutment



Photograph 13: Lower downstream slope (looking west) from Stage XI Buttress

Photograph 14: Upper downstream slope (looking east) from Stage XI Buttress

Photograph 15: Upper downstream slope (looking toward west abutment)

Photograph 16: TMD crest (looking toward west abutment)

Photograph 17: TMD crest (looking northeast toward mill site)

Photograph 18: West abutment cut-off wall extension under construction

Photograph 19: Stage XIa wing wall under construction (near Sta. 40+00 looking south)

Photograph 20: Stage XIa wing wall under construction (near Sta. 40+00 looking northwest)

Photograph 21: Secant wall drilling

APPENDIX C – Visual Inspection Checklist

AK00201
NID ID#_____
SHEET 1 OF 4

ALASKA DAM SAFETY PROGRAM
VISUAL INSPECTION CHECKLIST

GENERAL INFORMATION

NAME OF DAM: TAILINGS MAIN DAM	POOL ELEVATION: 981 feet
NATIONAL INVENTORY OF DAMS ID#: AK00201	TAILWATER ELEVATION: N/A
OWNER: TECK ALASKA INC.	CURRENT WEATHER: SUNNY, 50 DEGREE FAHRENHEIT
HAZARD POTENTIAL CLASSIFICATION: Class II	PREVIOUS WEATHER: N/A
SIZE CLASSIFICATION: II	INSPECTED BY: RYAN BAKER, NICK ROCCO, TROY THOMPSON
PURPOSE OF DAM: SEE NOTE 1	INSPECTION FIRM: NEWFIELDS
O & M MANUAL REVIEWED: YES	DATE OF INSPECTION: 08/02/2020
EMERGENCY ACTION PLAN REVIEWED: YES	

ITEM	YES	NO	REMARKS
RESERVOIR			
1. Any upstream development?		✓	
2. Any upstream impoundments?		✓	Adjacent waste dump to the east
3. Shoreline slide potential?		✓	
4. Significant sedimentation?	✓		Tailings impoundment
5. Any trash boom?		✓	
6. Any ice boom?		✓	
7. Operating procedure changes?	✓		Temporary due to Stage XI-A construction
DOWNSTREAM CHANNEL			
1. Channel			
a. Eroding or Backcutting		✓	
b. Sloughing?		✓	
c. Obstructions?		✓	
2. Downstream Floodplain			
a. Occupied housing?	✓		Seassonally used cabins, See note 2
b. Roads or bridges?	✓		Miscellaneous mine roads
c. Businesses, mining, utilities?	✓		See note 3
d. Recreation Area?	✓		Hunting and Fishing Camps. See note 2
e. Rural land?	✓		
f. New development?		✓	
EMERGENCY ACTION PLAN			
1. Class I or Class II Dam?	✓		
2. Emergency Action Plan Available?	✓		
3. Emergency Action Plan current?	✓		Being updated as part of O&M Manual update
4. Recent emergency action plan exercise?	✓		**DATE:** 2019
INSTRUMENTATION			
1. Are there			
a. Piezometers?	✓		
b. Weirs?		✓	
c. Observation wells?	✓		
d. Settlement Monuments?		✓	
e. Horizontal Alignment Monuments?	✓		
f. Thermistors?	✓		
2. Are readings			
a. Available?	✓		
b. Plotted?	✓		
c. Taken periodically?	✓		

ALASKA DAM SAFETY PROGRAM
VISUAL INSPECTION CHECKLIST

SAFETY

ITEM	YES	NO	REMARKS
SAFETY			
1. ACCESS			**TYPE:** UNPAVED ROAD
a. Road access?	✓		
b. Trail access?		✓	
c. Boat access?		✓	
d. Air access?		✓	
e. Access safe?	✓		
f. Security gates and fences?		✓	Remote site, no security fence but mine is monitored by security personnel
g. Restricted access signs?	✓		
2. PERSONNEL SAFETY			
a. Safe access to maintenance and operation areas?	✓		
b. Necessary handrails and ladders available?	✓		
c. All ladders and handrails in safe condition?	✓		At barges
d. Life rings or poles available?	✓		At barge and seepage pond
e. Limited access and warning signs in place?	✓		
f. Safe walking surfaces?	✓		
3. DAM EMERGENCY WARNING DEVICES			
a. Emergency Action Plan required?	✓		
b. Emergency warning devices required by EAP?	✓		**TYPE(S):** Instrumentation
c. Emergency warning devices available?	✓		
d. Emergency warning devices operable?	✓		
e. Emergency warning devices tested?	✓		
f. Emergency warning devices tested by owner?	✓		**WHEN:** July 2020 Monitoring Report at the Mine Office
g. Emergency procedures available at dam?	✓		
h. Dam operating staff familiar with EAP?	✓		
4. OPERATION AND MAINTENANCE MANUAL			
a. O & M Manual reviewed?	✓		
b. O & M Manual current?	✓		**DATE:** November 4, 2016 (being updated)
c. Contains routine inspection schedule?	✓		
c. Contains routine inspection checklist?	✓		

ALASKA DAM SAFETY PROGRAM
VISUAL INSPECTION CHECKLIST

EMBANKMENT DAMS

ITEM	YES	NO	REMARKS
EMBANKMENT DAMS			**TYPE:** See note 4
1. CREST			
a. Any settlement?	☐	✓	
b. Any misalignment?	☐	✓	
c. Any cracking?	☐	✓	
d. Adequate freeboard?	✓	☐	Yes, but recommend using a 72 hr PMP rather than 24 hr PMP event
2. UPSTREAM SLOPE			
a. Adequate slope protection?	✓	☐	
b. Any erosion or beaching?	☐	✓	
c. Trees or brush growing on slope?	☐	✓	
d. Deteriorating slope protection?	☐	✓	
e. Visual settlement?	☐	✓	
f. Any sinkholes?	☐	✓	
3. DOWNSTREAM SLOPE			**TYPE:** Exposed Fill Slope
a. Adequate slope protection?	✓	☐	Based on lack of surface erosion
b. Any erosion?	☐	✓	
c. Trees or brush growing on slope?	☐	✓	
d. Animal burrows?	☐	✓	
e. Sinkholes?	☐	✓	
f. Visual settlement?	☐	✓	
g. Surface seepage?	☐	✓	
h. Toe drains dry?	☐	✓	See note 5
i. Relief wells flowing?	☐	☐	N/A
j. Slides or slumps?	☐	✓	
4. ABUTMENT CONTACTS			
a. Any erosion?	☐	✓	
b. Seepage present?	✓	☐	Two seeps noted near west abutment
c. Boils or springs downstream?	☐	✓	
5. FOUNDATION			**TYPE:** Alluvial and Colluvial Deposits
a. If dam is founded on permafrost			Has been considered in design
(1) Is fill frozen?	✓	☐	See note 6
(2) Are internal temperatures monitored?	✓	☐	
b. If dam is founded on bedrock			**TYPE:** Weathered inact shale
(1) Is bedrock adversely bedded?	☐	✓	
(2) Does rock contain gypsum?	☐	✓	
(3) Weak strength beds?	✓	☐	Considered in Design
c. If dam founded on overburden			**TYPE:**
(1) Pipeable?	☐	✓	
(2) Compressive?	✓	☐	
(3) Low shear strength?	✓	☐	Conditions considered in design

Notes: Tailings Main Dam
1. Tailings, process water, and storm water runoff storage.
2. Seasonally used cabins (38, 49, and 50 miles downstream).
3. Kivalina drinking water intake 70 miles downstream
4. Zoned rockfill and granular fill embankment with upstream HDPE geomembrane
5. Flows not visible at surface but seepage reports to downstream seepage collection.
6. Thermistors indicate generally stable ground temperatures.

AK00201
NID ID#_____
SHEET 4 OF 4

ALASKA DAM SAFETY PROGRAM
VISUAL INSPECTION CHECKLIST

SPILLWAYS 4

ITEM	YES	NO	REMARKS
SPILLWAYS			**TYPE(S):** Seepage Control Pond
1. CREST			**TYPE(S):** Rockfill
a. Any settlement?	☐	✓	
b. Any misalignment?	☐	✓	
c. Any cracking?	☐	✓	
d. Any deterioration?	☐	✓	
e: Exposed reinforcement?	☐	☐	N/A
f. Erosion?	☐	✓	
g. Silt deposits upstream?	✓	☐	WITHIN SEEPAGE POND
2. CONTROL STRUCTURES			
a. Mechanical equipment operable?	☐	☐	N/A
b. Are gates maintained?	☐	☐	N/A
c. Will flashboards trip automatically?	☐	☐	N/A
d. Are stanchions trippable?	☐	☐	N/A
e. Are gates remotely controlled?	☐	☐	N/A
3. CHUTE			
a. Any cracking?	☐	✓	HDPE GEOMEMBRANE
b. Any deterioration?	☐	✓	
c. Erosion?	☐	✓	
d. Seepage at lines or joints?	☐	✓	
4. ENERGY DISSIPATERS			
a. Any deterioration?	☐	✓	RIPRAP
b. Erosion?	☐	✓	
c. Exposed reinforcement?	☐	☐	N/A
5. METAL APPURTENANCES			
a. Corrosion?	☐	☐	N/A
b. Breakage?	☐	☐	N/A
c. Secure anchorages?	☐	☐	N/A
6. EMERGENCY SPILLWAY			
a. Adequate grass cover?	☐	☐	N/A
b. Clear approach channel?	☐	☐	N/A
c. Erodible downstream channel?	☐	☐	N/A
d. Erodible fuse plug?	☐	☐	N/A
e. Stable side slopes?	☐	☐	N/A
f. Beaver dams present?	☐	☐	N/A