2019 Lupin Mine Tailings Area Inspection Report

Annual Geotechnical Inspection of the Tailings Containment Area

October 24, 2019

Prepared for:

Lupin Mines Incorporated

Prepared by:

Alvin Tong, P.Eng.

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Sign-off Sheet

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REGISTERED PROFESSIONAL ENGINEER
C. A. TONG
LICENSEE
NT/NU

Oct. 24, 2019

Prepared by ______________________________

(signature)

Alvin Tong, P.Eng.

Reviewed by ______________________________

(signature)

Tim Peterson, P.Eng.

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1.0 INTRODUCTION

Lupin Mines Incorporated (LMI) retained Stantec Consulting (Stantec) to complete the annual geotechnical dam inspection at the Lupin Mine tailings containment area (TCA). The Lupin Mine site is currently under care and maintenance status and operates under the Nunavut Water License 2AM-LUP1520 (NWB 2015) for LMI. LMI is a wholly-owned indirect subsidiary of Mandalay Resources.

The Lupin Mine is located on the northwest shore of Contwoyto Lake, approximately 400km northeast of Yellowknife, Northwest Territories (Figure 1). The site consists of a mill, camp and support facilities, fuel storage, airstrip, and the TCA (Figure 2). A detailed view of the mill site is provided in Figure 3 and of the TCA in Figure 4.

The water license explicitly requires an annual geotechnical inspection to be completed for the TCA internal and external dams, TCA reclamation covers, including a quantitative assessment of any seepage from the TCA (NWB 2015). Stantec has provided a qualified person to conduct the geotechnical inspection to fulfill the requirements listed in Part E, Item 6 of the water license, which stipulates the following:

“The tailings containment area shall be constructed, operated and maintained to engineering standards such that:

- A minimum freeboard of 1.0 metre shall be maintained at all times or as recommended by a geotechnical engineer and as approved by the Board in writing;
- Seepage from the Tailings Containment Area is minimized;
- Any seepage that occurs is collected and returned immediately to the Tailings Containment Area;
- Erosion of constructed facilities is addressed immediately;
- The solids fraction of the mill tailings shall be permanently contained within the Tailings Containment Area or underground as backfill.
- Implement measures to ensure that the Tailings Containment Area is adequately covered or managed, including the use of approved binding agents, to prevent windblown tailings from impacting other areas of the project site;
- During care and maintenance, inspection shall be carried out on a bi-weekly basis during the freshet (approx. May and June), and monthly during the reminder of the open water period (approx. July – October) of the following:
  - Collection and return of seepage in Dam 2;
  - Water levels in Ponds 1 and 2, and Cells 3 and 5;
  - General surface erosion and anomalies on dams; and,
  - Toe erosion along Dam K and surface erosion in locations on the crest. Manage and route surface flow as necessary to prevent further erosion over the crest of Dam K.
  - Monitor the condition and any potential seepage through the Divider Dyke.
  - Records of these inspection shall be kept for review upon the request of an Inspector, or as otherwise approved by the Board.
  - More frequent inspections shall be performed at the requests of an Inspector.
  - An inspection of the Tailings Containment Area shall be carried out annually during ice free, open water condition by a geotechnical Engineer. The Engineer’s report shall be submitted to the Board within sixty (60) days following the inspection and shall include a cover letter from the Licensee outlining an implementation plan to respond to the Engineer’s recommendations.”

This report summarizes Stantec's observations of the TCA's condition in 2019 and presents our recommendations. Previous annual inspections, safety reviews, and risk assessments with respect to the TCA made available to Stantec include:

- Inspection Report from 2018 by Stantec Consulting;
- Inspection Report from 2017 by Norwest Corporation;
- Inspection Report from 2016 by Norwest Corporation;
- Inspection Reports from 2012-2015 by SRK Consulting;
- 2015 Dam Safety Review Report by SRK Consulting; and,
- 2012 TCA Risk Assessment and Water Quality Review by SRK Consulting.

While the annual inspection is carried out to satisfy the license requirements, the format and methodology used are in accordance to the best engineering practice using the Inspection and Maintenance of Dams Safety Guidelines issued by the Province of British Columbia, Water Management Branch (BCWMB 2011) and the Mining Association of Canada (MAC) Guidelines.

1.1 PROJECT DESCRIPTION

1.1.1 Location and Access

The Lupin Mine is only assessible by air or winter road. The air access is serviced by a gravel runway, capable of handling large aircraft such as Hercules C-130 and Boeing 737 jets. Charter flights are typically deployed from Yellowknife for worker rotation and re-supply during the open water seasons. When the mine was in operation, it used the Tibbitt to Contwoyto Winter Road to resupply the mine. This winter road currently ends at the Ekati Diamond Mine and has not been extended to the Lupin Mine since 2005, when the mine went into care and maintenance status.

1.1.2 History and Current Status

Currently the Lupin Mine is in care and maintenance status and licensed accordingly. Mining operations ceased in 2005. Current care and maintenance operations include, but are not limited to, earthwork maintenance, water treatment and discharge as needed, water quality monitoring, and waste management as needed.

1.1.3 Site Infrastructure

The mine site consists of the following main structures: mill site, camp and support facilities, fuel storage, airstrip, and tailings containment area (TCA).

- The mill site included an underground hoist and wheelhouse, ball mill, concentrator, and a paste backfill plant (now decommissioned).
- The camp and support facilities included multiple wings of accommodations for workers, an office building, recreation facilities, cool and warm storage, generators, sewage lagoons and dams, and waste management facilities. Gravel roads are in place to connect the facilities.
- Fuel storage includes the main tank farm that contains diesel fuel for annual operation, along with fuel for aircraft. Fuel is pumped to a satellite tank farm as needed for equipment fueling and power generation to minimize the risk of spillage and accidents from using the large fuel tanks at the main farm.
- The airstrip is a gravel runway that can accommodate aircraft up to the size of a Boeing 737 jet.

- The TCA consists of a number of frozen core dams that provide a closed system for tailings and water treatment. Tailings are contained in a number of cells and progressive reclamation is ongoing and has now been completed at several cells. Water treatment is carried out using Pond 1 as a holding pond for effluent, treating the water in a plant, and then using Pond 2 as a polishing pond to allow the solids to precipitate prior to discharge to the environment. Details of the TCA configuration are described in Section 2 of this report.

1.2 CLIMATE

Stantec evaluated the climate data from an automated weather station known as Lupin (CWIJ) available in the Weather Underground database (WU 2016). Intermittent climate data is also available from the Environment Canada database under station Lupin CS Climate ID 230N002. The climate data evaluation was done from May 2005 to April 2017. The climate data evaluation was not updated in since 2018 as the data was not made publicly available. The evaluation results indicate the station reported an annual mean temperature of -13°C. The average winter temperature, from October to April, was around -21°C. The average summer temperature, from May to September, was around 8°C. Annual total precipitation was averaged to be around 592mm, where the data does not differentiate between snow and rain. The mean wind direction was south-southeast, with average wind speed of 16km/h and high of 50km/h.

1.3 SITE GEOLOGICAL CONDITIONS

The Lupin Mine is located in the Archean metaturbidite sequence of the Contwoyto Formation. The rocks have been subjected to both regional and contact metamorphism, including deformations and intrusions.

The area was glaciated, and experienced isostatic rebound after the melt. The glaciers and runoff from the melt washed out the erodible soils and formed lakes in low lying areas. The easily erodible glaciolacustrine and glacio-fluvial sands were reworked and displaced by the meltwater and resulted in the outcrops present with thin soil veneers, abandoned beaches and esker formations (Kinross 2005). Where bedrock is not present at the surface, the overburden typically consists of coarse grained glacial till which is intermittently covered by glaciolacustrine and glacial-fluvial deposits. The till is a silty sand with gravel and boulders, with low plasticity and ice depending on the depth.

1.4 PERMAFROST AND DAM GEOTECHNICAL CONDITIONS

The site is within a continuous permafrost region. The active layer is observed to be variable between the depth of 2m to 3m based on available data. During operation, scheduled monitoring was completed of all instrumentation, recording water levels, water quality and production volumes. This monitoring program was reduced accordingly during the care and maintenance period and is now carried out when work is being done on site. Thermistors are installed in several dams and in the tailings cover to monitor their performance. Some of the thermistors are no longer functional or damaged beyond repair. The remaining thermistors are read at least once annually during the geotechnical inspection and more often when site access allows. The thermistor readings indicate that permafrost remains within the dams and reclaimed tailings, and the readings are consistent with historical variation and limits.

2.0 TAILINGS CONTAINMENT AREA DAMS

The tailings are primarily comprised of amphibole and quartz, which account for 80% of the volume. Pyrrhotite and arsenopyrite make up an additional 17%. The tailings have been shown through various studies to have a potential for acid generation (Kinross 2005). All of the tailings are contained within the TCA.

The Lupin Mine TCA consists of eight (8) perimeter dams and nine (9) internal dams. The perimeter dams are Dams 1A, 1B, 1C, and Dams 2 through 6. The internal dams are Dam 3a through 3e, Dams J through N, and the Divider Dykes. Combinations of the perimeter dams and internal dams form Tailings Cells 1 through 5 for containment. As the progressive reclamation is being completed, some of the internal dams (3a, 3b, 3c, 3e) are incorporated into the cover and are no longer considered as individual dams. Currently, Cells 1 and 2 are completely reclaimed, while Cell 3 is approximately 80% covered and Cell 5 is approximately 70% covered. About 84% of the entire tailings area is reclaimed with at least 1m of sand/gravel cover. No new tailings have been produced since 2005 when the site went into care and maintenance status.

All dams are constructed from esker sands and gravels, with the perimeter dams and Dam K, incorporating a geosynthetic liner for seepage control. All the perimeter dams are designed as frozen core dams founded on permafrost. Generally, the perimeter dams range in height from 1 to 8 metres. The internal dam heights range from 6 to 12 metres.

The care and maintenance procedures for water management, direct runoff and seepage from Cell 3 into Cell 4. The water in Cell 4 then flows through the Divider Dykes either though the control structure or by seepage into Pond 1. Cell 5 runoff is pumped directly into Pond 1. The pond 1 water level is managed by siphoning water into Pond 2. Water treatment is carried out by treating the water in-situ in Pond 2, by adding lime to raise the pH. Precipitates from this treatment are deposited in Pond 2. The treated water in Pond 2 is siphoned into the environment in accordance with the Water License requirements (NWB 2015). Pond 2 does not have any flood overflow structures, such as a spillway or a control gate, to manage the water level. All water is retained, and discharge is restricted until water quality meets the discharge requirement outlined in the Water License (NWB 2015).

2.1 DAM CONSEQUENCE CLASSIFICATIONS

Stantec utilized the Canadian Dam Association Guidelines (CDA 2014) to classify the consequence classification of each dam. The CDA consequence classifications are shown in

Table 2.1.

The dam consequence classifications of the dams based on Stantec's 2019 inspection are outlined in

Table 2.2. These consequence classifications are in line with the classifications outlined in the 2015 Dam Safety Review (SRK 2015).

An emergency preparedness plan (EPP) is noted by the DSR (SRK 2015) to be in place and deemed appropriate for care and maintenance status. Stantec did not review the EPP. Due to the lack of transportable tailings, permanent population, or infrastructure downstream of the perimeter dams, a detailed inundation study is deemed non-applicable.

Table 2.1: CDA Dam Consequence Classifications

Dam Class	Population at Risk(1)	Incremental Losses		
		Loss of Life(2)	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	• Minimal short-term loss; • No long-term loss	Low economic losses Area contains limited infrastructure or services
Significant	Temporary only	Unspecified	• No significant loss or deterioration of fish or wildlife habitat • Loss of marginal habitat only • Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or fewer	• Significant loss or deterioration of important fish or wildlife habitat • Restoration or compensation in kind highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very High	Permanent	100 or fewer	• Significant loss or deterioration of critical fish or wildlife habitat • Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g. highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More than 100	• Major loss of critical fish or wildlife habitat • Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g. hospital, major industrial complex, major storage facilities for dangerous substances)

Note 1. Definition for population at risk:
None - There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure. **Temporary** - People are only temporary in the dam-breach inundation zone (e.g. seasonal cottage use, passing through on transportation routes, participating in recreational activities).
Permanent - The population at risk is ordinarily located in the dam-breach inundation zone (e.g. as permanent resident); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimate of potential loss life (to assist in decision-making if the appropriate analysis is carried out).
Note 2. Implication for loss of life:
Unspecified - The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

Table 2.2: Lupin TCA Dam Consequence Classifications

Dam		Consequence Classification	Rationale
Perimeter Dams	1A	Significant	Release of water that might not meet discharge criteria into the environment
	1B	Significant	Release of water that might not meet discharge criteria into the environment
	1C	Significant	Release of water that might not meet discharge criteria into the environment
	2	Significant	Release of water that might not meet discharge criteria into the environment
	3	Low	No free-standing water; Stable reclaimed tailings with very limited impact consequence upon failure
	4	Significant	Release of water that might not meet discharge criteria into the environment
	5	Low	No free-standing water; Stable reclaimed tailings with very limited impact consequence upon failure
	6	Low	No free-standing water; Stable reclaimed tailings with very limited impact consequence upon failure
Internal Dams	3D	Low	Any release of effluent or tailings are contained within the TCA
	J	Low	Any release of effluent or tailings are contained within the TCA
	K	Low	Any release of effluent or tailings are contained within the TCA
	L	Low	Any release of effluent or tailings are contained within the TCA
	M	Low	Any release of effluent or tailings are contained within the TCA
	N	Low	Any release of effluent or tailings are contained within the TCA
	Divider Dykes	Low	Any release of effluent or tailings are contained within the TCA

3.0 2019 TCA INSPECTION

3.1 GENERAL

Mr. Alvin Tong, P.Eng., a Senior Geotechnical Engineer with Stantec, conducted the geotechnical inspection on the 23rd and 24th of August 2019. Detailed visual inspection was completed on all TCA components, along with readings of instrumentation. Ms. Karyn Lewis, representative of LMI, was on site for communication and organization, but did not accompany Stantec on the inspection.

The weather during inspection was below freezing and overcast with periods of flurries. Detailed inspection and photograph logs are provided in Appendix A.

The general observations indicated that the perimeter dams are in stable condition. The divider dykes and Dam K require maintenance and repairs and Stantec communicated this to Ms. Lewis on site. The Pond 2 water level is at a satisfactory level, providing a freeboard upwards of 2.5m at the perimeter dams.

Since the inspection in August, LMI has transferred some water from Cell 5 to Pond 1, but Stantec was informed that the freeboard was not compromised.

3.2 INSTRUMENTATION

3.2.1 Thermistors

Thermistors were installed in the TCA between 1995 and 2004 to monitor the performance of the dams and tailings covers. From the existing records, there were thirteen thermistors installed in the dams, but only seven of them are currently functional. Of the seven functioning thermistors, five are in the perimeter dams and two are in the internal dams. There are an additional seven thermistors installed in the reclaimed tailings cover, but three of them do not have calibration data on record to evaluate the results. This report focuses on the thermistor readings from dams, using the thermistor readings from the cover for reference and comparison.

The thermistors were read monthly during operation up until 2006, and then read semi-annually during care and maintenance. Not all the functioning thermistors were read consistently throughout the care and maintenance period. To provide a point of reference in this report, selected data series between August and September, from year 2010 to 2019, are shown for comparison, while maximum values are calculated from the entire series from the first available records to 2014.

For the perimeter dams, the five functioning thermistors are less than 20m deep. The five thermistor readings are shown in the figures below. The data suggests the 2019 readings are within the historical variations, taking into account annual climatic variations and time of reading. Generally, the active layer (thaw zone) ranges from 2m to 3m depth, as interpolated by the 0°C gradient line. The largest historical variation in the 2019 data set is approximately 3.3°C (between -1.2°C and -4.5°C) in Dam 1 (D1A-00-01s) at the depth of 7m.

Figure 3-1: Thermistor Reading for Dam 1A

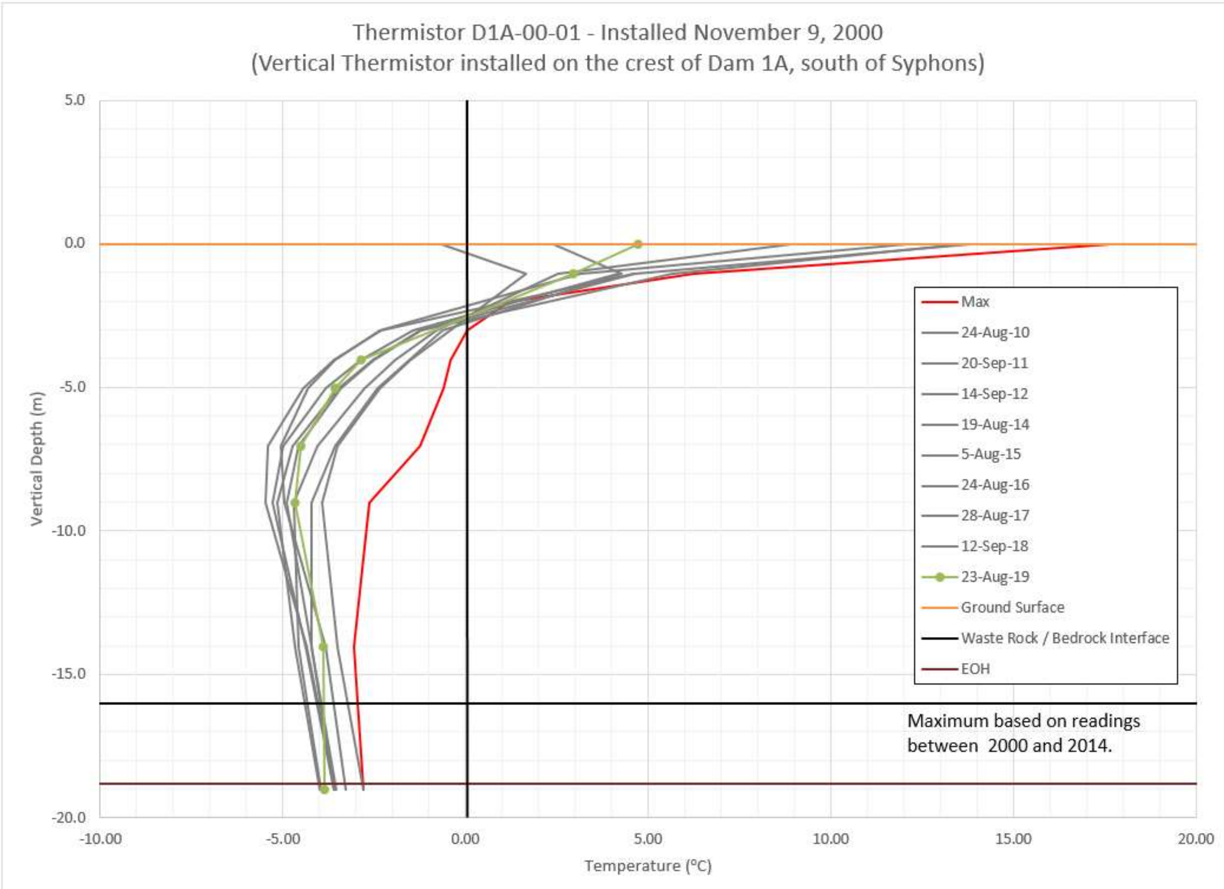


Figure 3-2: Thermistor Reading for Dam 2

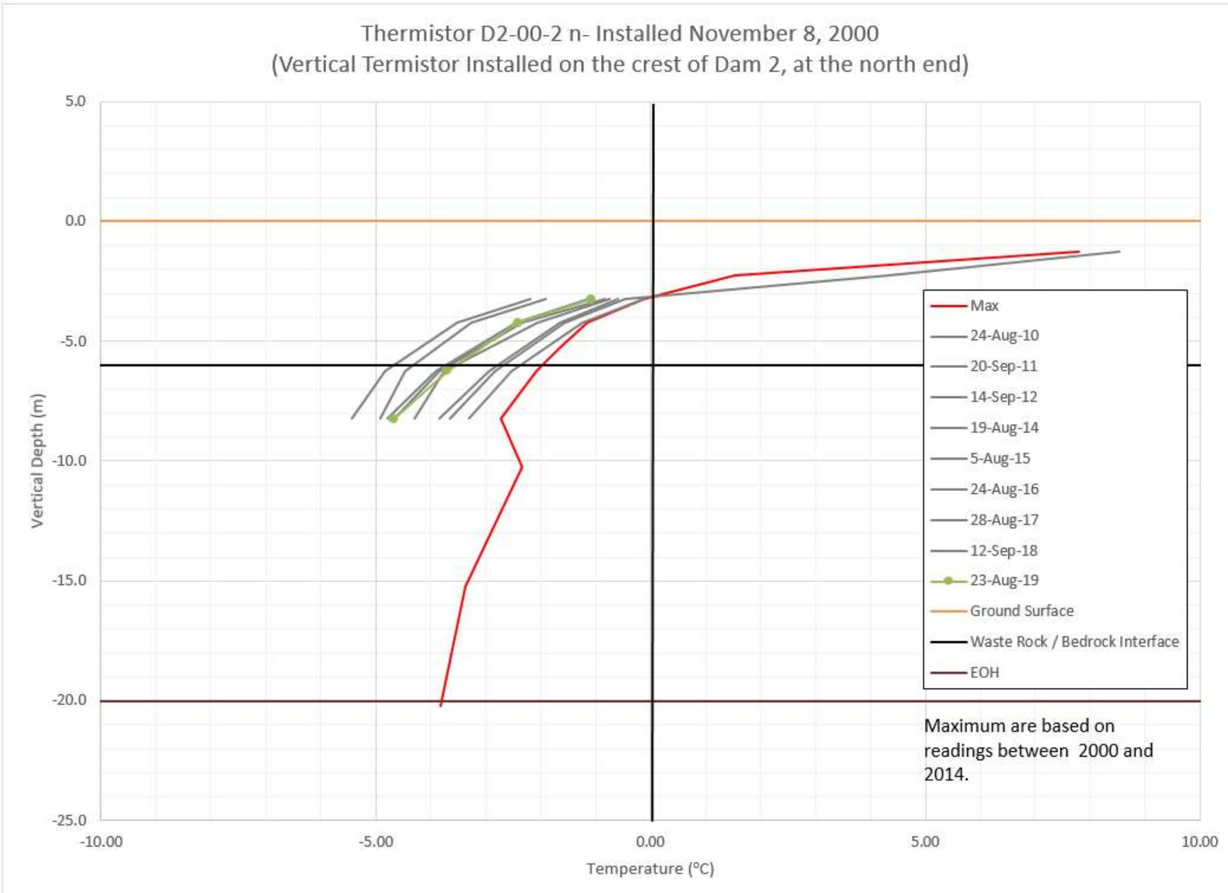


Figure 3-3: Thermistor Reading for Dam 4-1

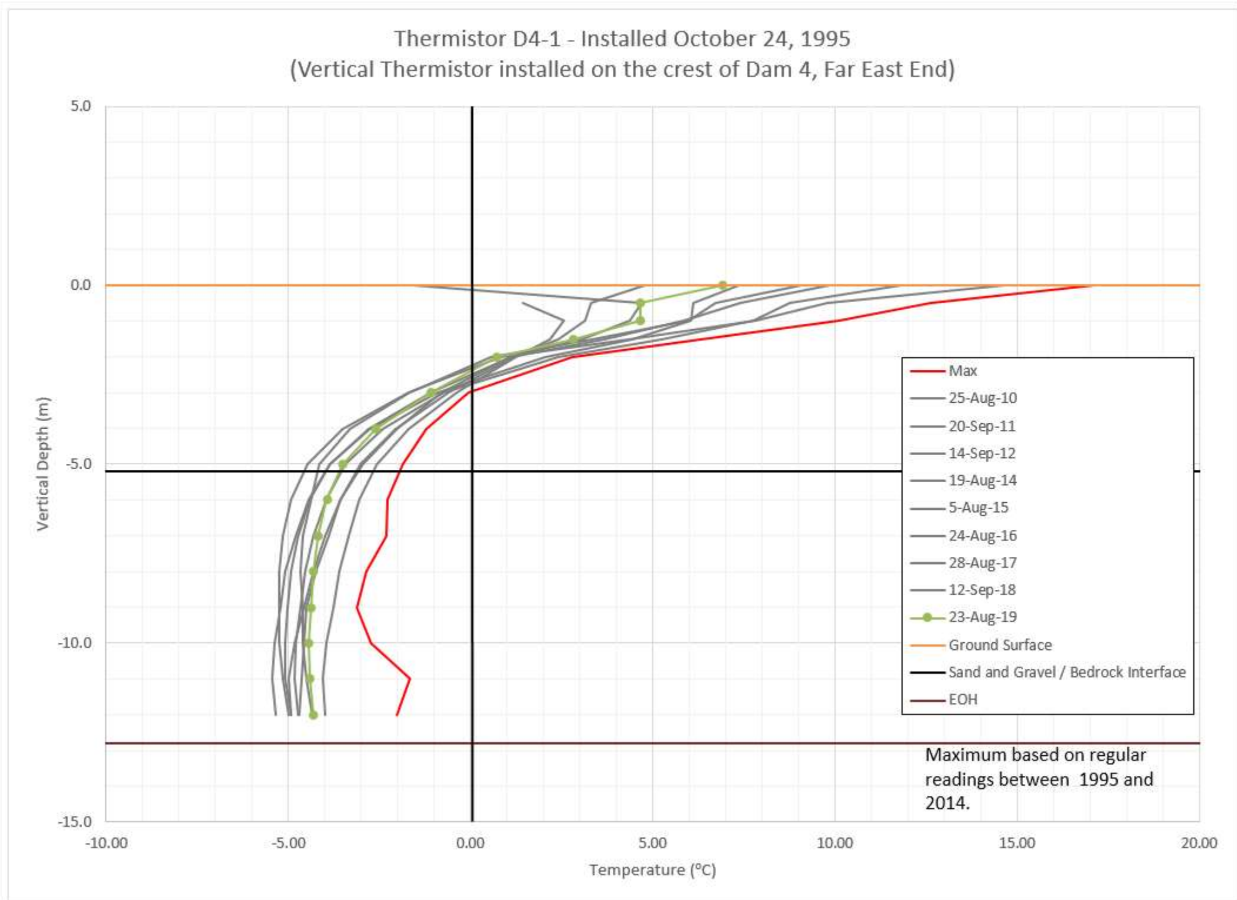


Figure 3-4: Thermistor Reading for Dam 4-3

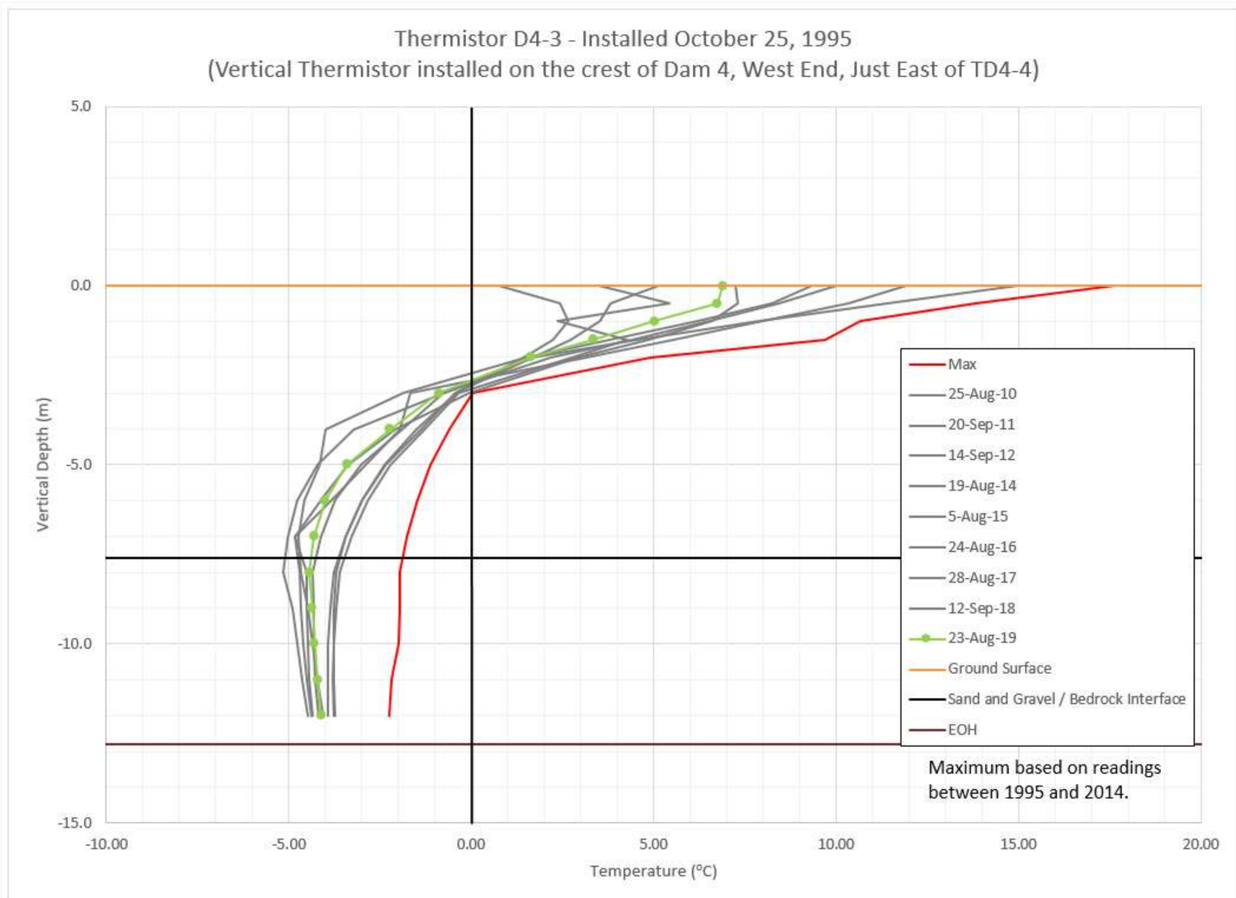
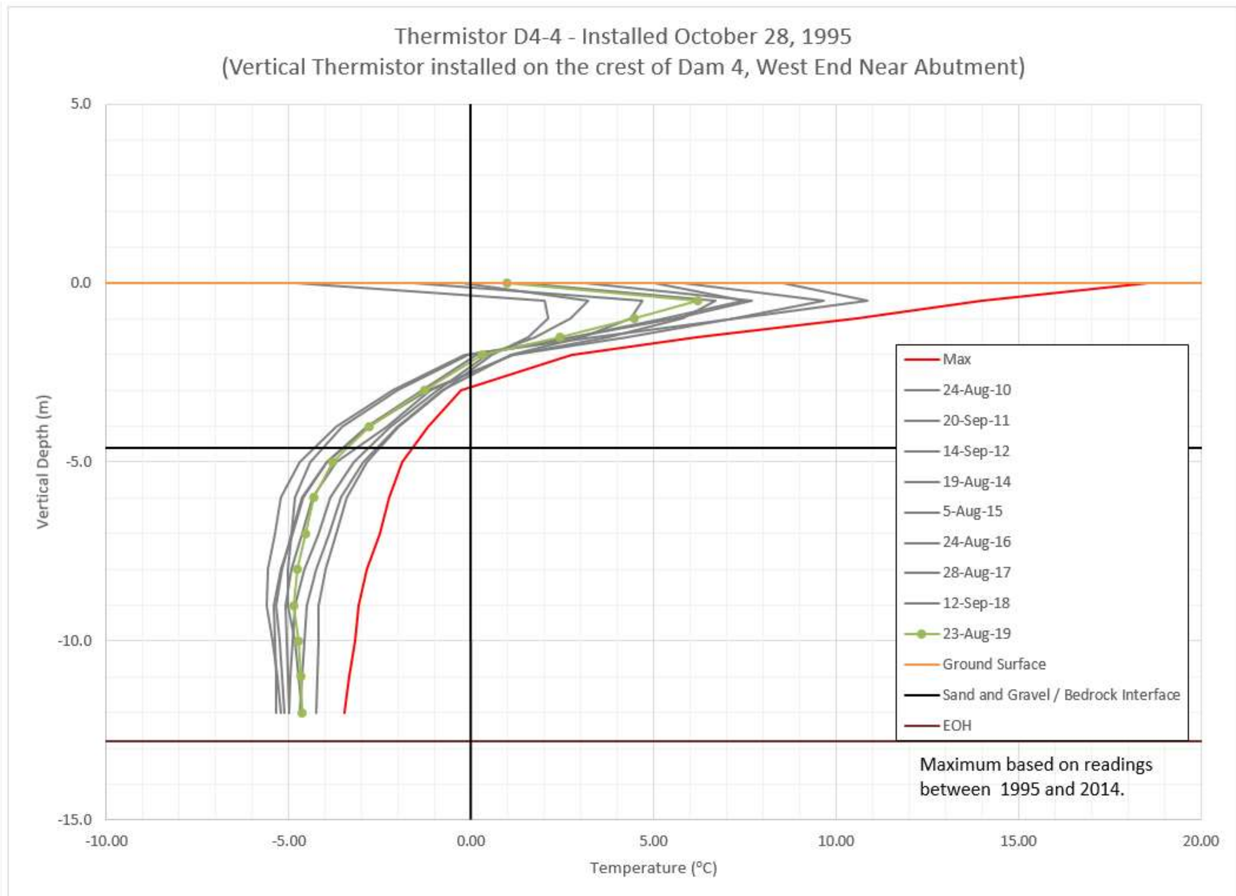


Figure 3-5: Thermistor Reading for Dam 4-4



For the internal dams, the two functional thermistors are also less than 20m deep in Dam K and Dam 3D. These were not historically monitored as rigorously as the ones installed in the perimeter dams, and only have recent data from 2014. The two thermistor readings are shown in the figures below. The active layer is observed to be between 2m to 3m, as interpolated by the 0°C gradient line. The variations between the data set are less than 2°C and generally occur below the historical maximum.

Figure 3-6: Thermistor Reading for Dam 3D

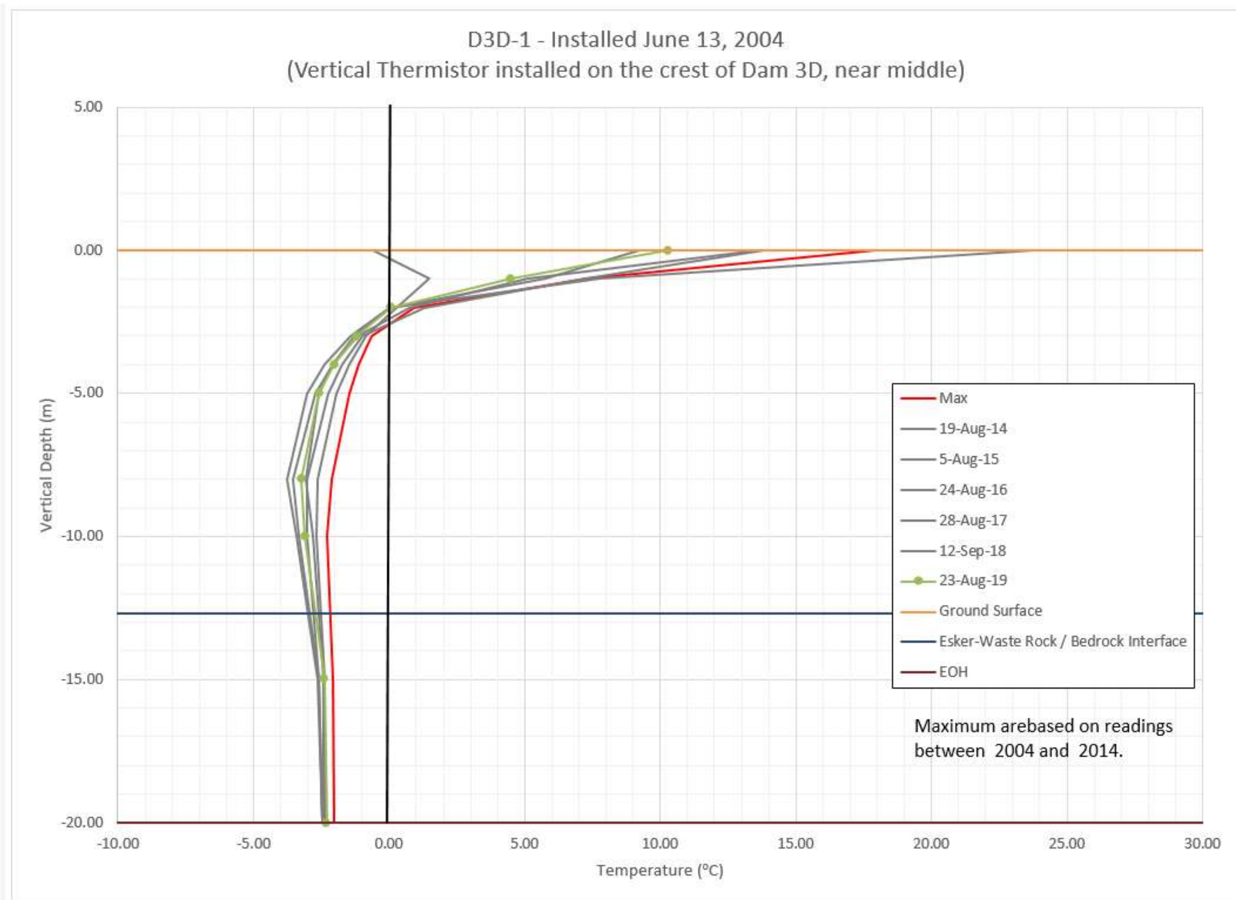
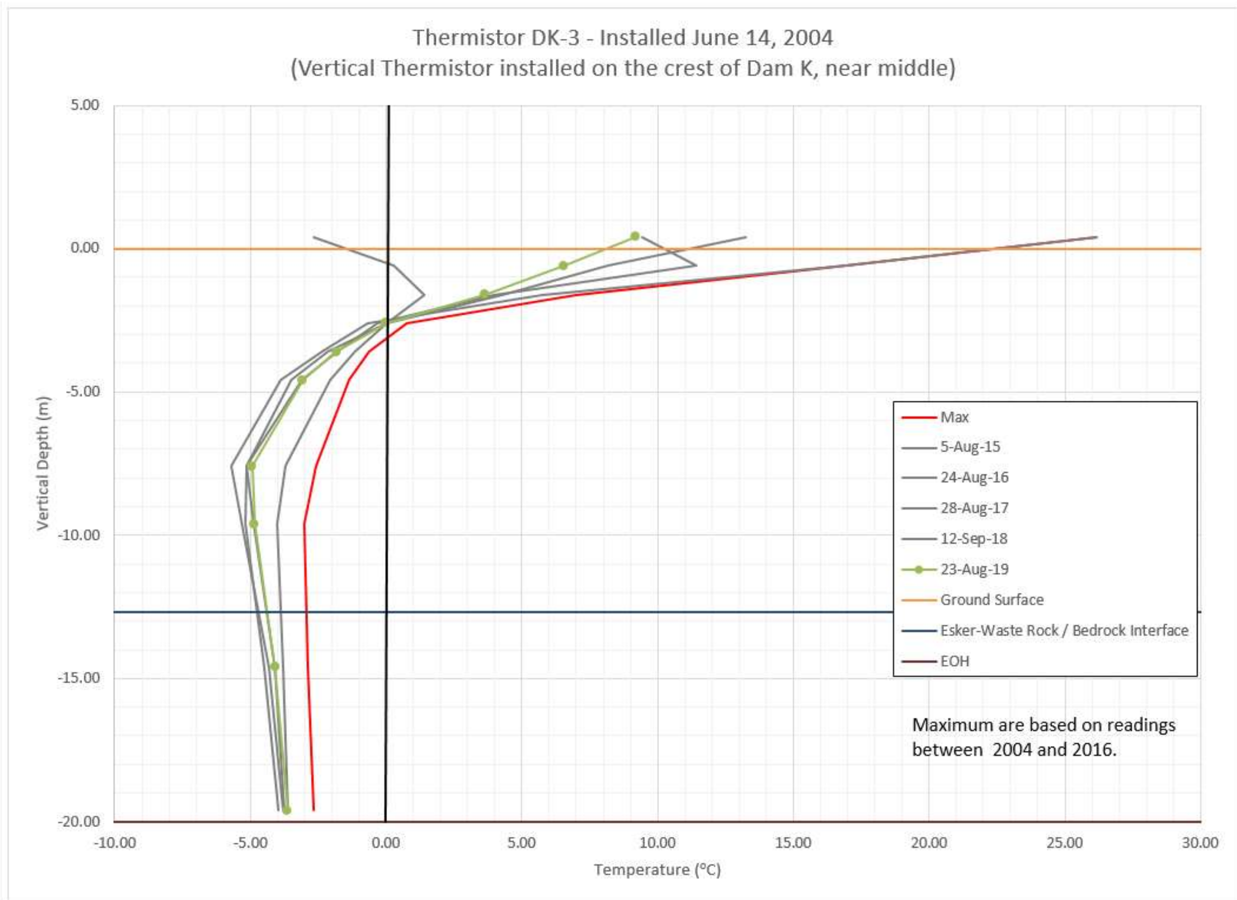


Figure 3-7: Thermistor Reading for Dam K



Readings from the four thermistors in the tailings cover are not presented in this report. The cover thermistor results are comparable to the readings from the dams. All the observed larger temperature variations remained below 0°C and well below the active layer. The observed active layer depths remain consistent with the site recorded data and information provided by national research (Penner 1983). The thermistor readings indicate that the frozen cores within the monitored dams are frozen below the active layer and are performing well.

3.2.2 Moisture Sensors

To provide insight into the performance of the cover, volumetric moisture sensors were installed in the Cell 1 and Cell 3 covers in 2018. The sensors are TEROS-12 VWC sensors that measure volumetric water content, temperature and electrical conductivity. The sensor readings are set to read once every 12 hours and the readings are recorded by dataloggers. Cells 1 and 3 each have one string of five sensors installed within the cover (C2VWC and C3VWC). The sensor spacings and background material are provided in Table 3.1.

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Table 3.1: VWC Installation Details

VWC ID	Cell 1-1		Cell 3-1	
	Depth (m)	Material	Depth (m)	Material
Port 5	1.0	Fine Sand (Cover)	0.35	Sand and Gravel (Cover)
Port 4	1.2	Fine Sand (Cover)	0.5	Sand and Gravel (Cover)
Port 3	1.4	Fine Sand (Cover)	0.6	Sand and Gravel (Cover)
Port 2	1.6	Fine Sand (Cover)	0.7	Sand and Gravel (Cover)
Port 1	1.8	Tailings	1.0	Sand and Gravel (Cover)

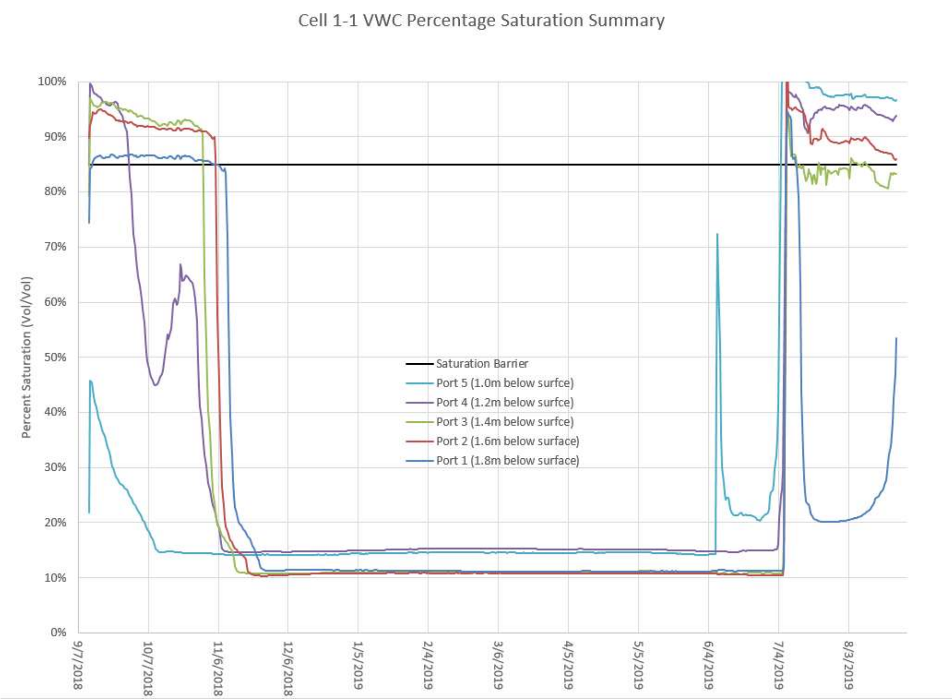
MEND (2009) show that an effective barrier against oxidization can be achieved with a soil cover with a moisture content that is greater than 85%. The intent of the sensor readings is to define the degree of saturation throughout the year at various depths within the cover. It should be noted that sensors register ice as a dry void. Thus, as the pore water freezes and ice forms, the moisture content reading in the sensors drops sharply. In order to calculate the volumetric water content, an assumed void ratio is assigned to each sensor string based on the cover material type. The assumed void ratio for Cell 1 cover is 0.42 which corresponds to a fine sand and Cell 3 cover is 0.33 which corresponds to a gravelly sand.

The data from 2019 indicates at both strings there is a zone of saturated material above the tailings.

3.2.2.1 Cell 1-1 VWC

The figure below shows the percentage saturation for VWC in Cell 1. All sensors show frozen conditions between November and July. In addition, all sensors indicate some variability in the initial data recorded between September and October 2018, potentially related to the method of installation. This variability can be confirmed with longer monitoring periods once a long-term trend is established. There is a spike in the percentage of saturation in all sensors in early July related to overall thawing. The 2019 data indicated Ports 5, 4 and 2 are above 85% saturation once thawed. Port 3 showed a variable trend but remains above 80% saturation.

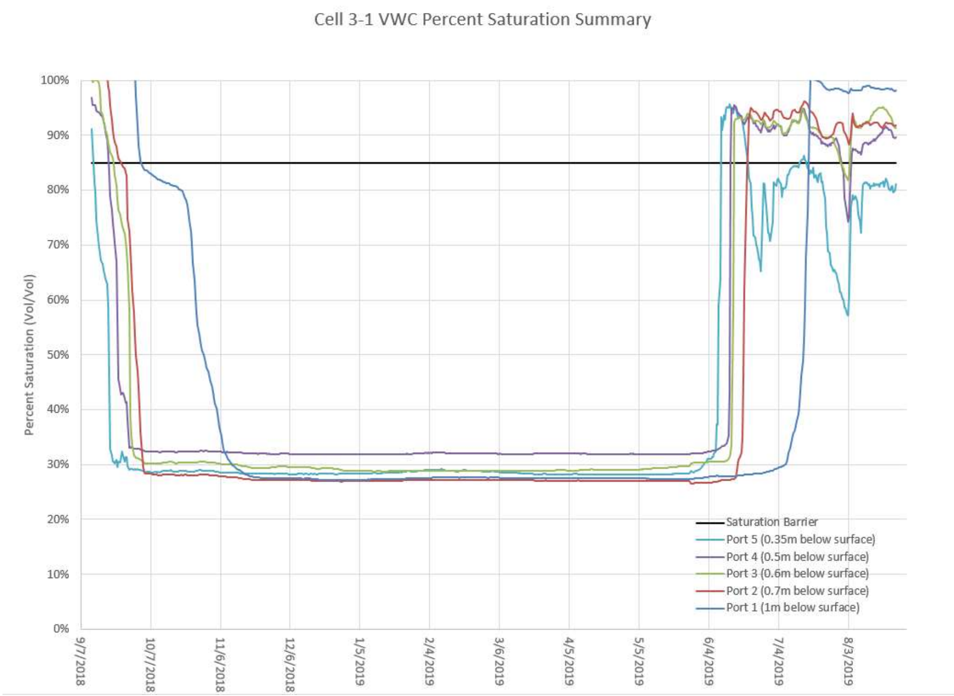
Figure 3-8: Cell 1-1 VWC Percentage Saturation Summary



3.2.2.2 Cell 3-1 VWC

The figure below shows the percentage saturation for VWC in Cell 3. The majority of the sensors show frozen conditions between October and June. Similar to Cell 1-1 VWC, all sensors indicate there might be variability at the initial data collection period between September and October 2018 potentially related to the method of installation. This variability can be confirmed with longer monitoring periods once a long-term trend is established. There is a spike in percentage of saturation in the top sensors in June signaling overall thawing. The 2019 data indicated Ports 4 to 1 are above 85% saturation once thawed. Port 5 showed a variable trend between 57% to 86% saturation, mostly related to surface evaporation and rehydration from rain.

Figure 3-9: Cell 3-1 Port 1 VWC Result



3.3 TCA PERIMETER DAMS

The perimeter dams (Dam 1A through Dam 6) were observed to be in stable condition, although some erosion was observed on the dam slopes from either surface runoff or wave action below the high water mark (HWM). While most of the surface erosion was observed to be minor, repair work should be considered on the downstream face of Dam 1A and some areas along Dam 4. The rest of the dams should be monitored and repaired as needed, to prevent the erosion from becoming worse and creating preferential surface flow paths.

Previous annual inspections noted seepage from the northern toe buttress of Dam 2 into the seepage collection pond adjacent to Dam 2 Lake. This seepage was observed to be at a very low rate (<1L/min), but water was seen to be present in the seepage collection pond. It was communicated on site that the seepage water should be pumped back to Pond 2 as per requirement.

The observed freeboard at the perimeter dams was around 2.8m or greater. This well exceeds the minimum requirement of 1m freeboard as stated in the water license. Dam 1B, 1C, Dam 5 and Dam 6 do not have water on the upstream face of the dams.

3.4 INTERNAL DAMS

All of the internal dams have some erosion on their downstream slopes, associated with either surface runoff or wave action at the HWM. Dam 3D also has some crest erosion from surface runoff. Dam J and Dam L both have wave action erosion at the HWM that has reduced their crest widths. Maintenance should be considered to repair the erosion on the slopes of Dam 3D, Dam J and Dam L.

Dam K has experienced considerable undercutting at the toe from Pond 2 wave action that was previously recommended for repair in this year. However, due to the water level in Pond 2, the undercutting at the toe had not yet been repaired. In addition to the undercutting, there were five large erosion gullies at the downstream crest caused by overland flow over the cover. These gullies were sufficiently wide and deep that the permafrost within the structure could be compromised. The crest gullies were partially repaired in early July 2019 and temporary ditches were constructed upstream of the erosion to mitigate further damage the area. The overall repair plan is to lower the water level in 2020 to allow access to the toe and construct a buttress to reinforce the dam, and also repair crest.

Dam M was repaired with a reinforcement buttress and crest surface backfill in 2016 (Norwest 2016). The toe of the buttress has experienced some wave erosion at the HWM. The water level has risen in 2019 and the buttress toe along with the riprap are now currently submerged and localized minor sloughing was observed. Repair of the buttress sloughing should be carried out when practicable.

Dam N was observed to be in stable condition, but it had only 0.5m of freeboard between it and Pond 2. This was communicated with LMI site personnel, and the need to increase the freeboard to 1m to meet water license requirement was highlighted. It was agreed that the water behind Dam N would be lowered when practicable, after water treatment operations. Dam N and its contents were submerged in previous years and this did not appear to have had any adverse impact on geotechnical stability. The reduced freeboard does not create any geotechnical or environmental concerns as Dam N and its contents are contained within Pond 2.

The northern ends of the divider dykes at the east end of Cell 4 were in poor condition. Signs of erosion, cracks, and sloughing were noted on both the upstream and downstream sides of both dykes. Deformations have created an uneven crest and have reduced crest width to approximately 2m in some areas. The south divider dyke has experienced sufficient sloughing to create a low spot with a freeboard of less than 1m. The gate valve within the dyke was found to be malfunctioning and water was allowed to flow freely from Cell 4 into Pond 1. While the malfunctioning gate does not compromise the stability of the dyke, it does create negative impact on the overall TCA water management. Immediately after the site inspection, Stantec communicated to site personnel that additional fill must be placed along the sloughed section of the south divider dyke to maintain a minimum 1m of freeboard. In addition, the gate valve should be plugged to limit flow into Pond 1 and meet TCA water management objectives. Since the site inspection LMI has informed Stantec that both tasks were partially completed, where fill was placed to restore a minimum 1m freeboard and cement was used to partially plug the flow through from Cell 4 into Pond 1.

4.0 RECOMMENDATIONS

Table 4.1 summarizes the observations and recommendations from the 2019 inspection, together with the findings from the 2018 inspection for comparison.

Table 4.1: Inspection Observation and Recommendations

Inspection Item	2019 Inspection			2018 Inspection	
	Estimated Freeboard (m)	Observation	Recommendations	Observations	Recommendations
Perimeter Dams					
Dam 1A	2.8	Minor erosion on slopes with some deep erosion gullies	Repair deep erosion gullies.	Minor erosion on slopes with some deep erosion gullies	Repair deep erosion gullies.
Dam 1B	N/A(1)	Pond 2 water was approximately 20m upstream from the dam.	Surface maintenance, e.g. grading and backfilling.	Pond 2 water was approximately 50m upstream from the dam.	Surface maintenance, e.g. grading and backfilling.
Dam 1C	N/A(1)	Pond 2 water was approximately 40m upstream from the dam.	Surface maintenance e.g. grading and backfilling.	Pond 2 water was approximately 100m upstream from the dam.	Surface maintenance e.g. grading and backfilling.
Dam 2	3.0	Minor erosion in the slopes. Minor seepage was observed (<1L/min). Water was found in the seepage collection pond.	Surface maintenance e.g. grading and backfilling. Pump seepage back into Pond 2.	Minor erosion in the slopes. Seepage was not observed due to weather conditions. The seepage is assumed to be ongoing as a small amount of open water was found in the seepage collection pond.	Surface maintenance e.g. grading and backfilling. Monitor the seepage and pump back into Pond 2 as necessary.
Dam 3	No water is impounded by this dam	Minor erosion in the downstream slope.	Surface maintenance e.g. grading and backfilling.	Minor erosion in the downstream slope.	Surface maintenance e.g. grading and backfilling.
Dam 4	3.6	Minor erosion in the slopes and wave erosion at HWM.	Surface and toe maintenance e.g. grading and backfilling.	Minor erosion in the slopes and wave erosion at HWM. Geogrid was not observed due to snow cover on the ground.	Surface and toe maintenance e.g. grading and backfilling.
Dam 5	N/A(1)	Cell 3 water is approximately 70m upstream from the dam. Minor erosion on surface.	Surface maintenance e.g. grading and backfilling.	Cell 3 water is approximately 50m upstream from the dam. Minor erosion on surface.	Surface maintenance e.g. grading and backfilling.
Dam 6	N/A(1)	Ponding in a natural low at the south abutment. Erosion	Surface maintenance e.g. grading and	Ponding in a natural low at the south abutment. Erosion	Surface maintenance e.g. grading and backfilling. Monitor

Inspection Item	2019 Inspection			2018 Inspection	
	Estimated Freeboard (m)	Observation	Recommendations	Observations	Recommendations
		gullies in the downstream slope.	backfilling. Monitor the ponded water level in the south abutment.	gullies in the downstream slope.	the ponded water level in the south abutment.
Internal Dams					
Dam 3D	No water is impounded by this dam	Minor erosion in the slopes.	Surface and slope maintenance e.g. grading and backfilling.	Minor erosion in the slopes.	Surface and slope maintenance e.g. grading and backfilling.
Dam J	1.1(2)	Over-steepened slope due to erosion and reduced crest width in some sections.	Repair the eroded slope and crest with compacted sand and gravel.	Over-steepened slope due to erosion and reduced crest width in some sections.	Repair the eroded slope and crest with compacted sand and gravel.
Dam K	N/A(1)	Undercut at HWM and five large erosion gullies in the downstream crest. Near vertical slope at the eroded toe. Temporary ditches constructed upstream of the crest to mitigate further damage.	Execute the proposed 2020 plan to lower Pond 2 water to allow access for toe repair. Repair the crest erosion after the toe repair. Potential regrade the cover provide better drainage to mitigate further damage	Erosion at HWM and five large erosion gullies in the downstream crest. Near vertical slope at the eroded toe.	Prioritize the repair the eroded gullies at the crest and toe, and armor the slope up to the HWM with boulders to limit further erosion. Repair should be done while the Pond 2 water level is lowered for access.
Dam L	1.5(2)	Erosion in the crest and slopes.	Repair the eroded upstream slope, crest and armor the downstream toe for protection.	Erosion in the crest and slopes.	Repair the eroded upstream slope, crest and armor the downstream toe for protection.
Dam M	2.5	Sloughing in localize sections of the buttress due to raised water level.	Repair the sloughed section of the buttress once the water level is lowered.	Minor erosion at the downstream toe above the riprap protection	Repair the eroded toe areas.
Dam N	0.5(2)	Minor wave action erosion at HWM.	Monitor the water level behind Dam N and lower the water when practicable to yield minimum 1m freeboard.	Minor wave action erosion at HWM.	Monitor the water level behind Dam N and lower the water when practicable to yield minimum 1m freeboard.
Divider Dykes	0.4(2)	Erosion, sloughing and cracks along upstream and	Add fill to the uneven crest level to restore minimum	Erosion, sloughing and cracks along upstream and	Second priority to complete the repair

Inspection Item	2019 Inspection			2018 Inspection	
	Estimated Freeboard (m)	Observation	Recommendations	Observations	Recommendations
		downstream of the northern portion of the dyke. Southern portion has uneven crest level and reduced crest width. The gate valve malfunctioned and allow water flow through.	1m freeboard. Plug the malfunctioned gate valve to limit flow through. Both tasks were partially complete in 2019.	downstream of the northern portion of the dyke. Uneven crest level and reduced crest width.	to the northern section

Notes: 1. Water is not adjacent to the dam to determine available freeboard.

2. Freeboard at the lowest point of the dam and below the minimum requirement stated in the Water License (NWB 2015).

4.1 MITIGATION FOR DAM K TOE AND CREST EROSION

The Dam K toe has significant erosion below the HWM from the wave action in Pond 2. The erosion has undercut the toe of the dam and created near vertical slopes in several areas. The downstream crest has five significant erosion gullies caused by surface overflow from the cover. 2019 maintenance and repair were completed to fill some of the crest erosion gullies and temporary ditches were constructed to mitigate further damage from surface water flows. However, the toe erosion repair was not completed due to the high Pond 2 water level. The proposed plan is to lower Pond 2 water in 2020 to allow access along the toe for repair. The repair should include a buttress along the toe to reinforce the dam and riprap at closure water level elevation for protection. Once the repair at the toe is complete, any loose crest material should be removed, and additional compacted fill should be placed in lifts to complete the repair of the erosion gullies. All the proposed work should be endorsed by the Engineer-of-Record prior to commencement.

4.2 MAINTENANCE AND REPAIRS PRIORITIES

Of the repairs and maintenance recommended in Table 3, it is recommended that the following repairs be prioritized:

1. Lower the Pond 2 water and repair the erosion gullies and eroded toe at Dam K. The toe at Dam K should be repaired with compacted sand and gravel to restore the original design configuration and armor the repaired toe with boulders/riprap for wave protection. Once that is completed, remove any loose crest material and repair the crest with compacted sand and gravel.

2. Repair the northern section of the Divider Dyke with compacted sand and gravel to restore the original design configuration, including side slopes, a leveled crest and armoring up to the HWM. Finalize the repair with sufficient fill on the southern section of the Divider Dyke to restore the original configuration. Fully and effectively plug the malfunctioning gate valve to prevent the flow from Cell 4 into Pond 1 and maintain the intended TCA water management.

3. Monitor the water level behind Dam N and lower the water level to maintain a minimum 1m freeboard.

After the completion of the priority repairs, LMI should consider carrying out the following repairs:

- Monitor the seepage at Dam 2 and manage it as necessary by pumping the seepage back into Pond 2.
- Once the Pond 2 water level is lowered, the sloughed section of the buttress should be repaired to original elevation and shape. LMI is currently monitoring and managing the water in Cell 5 as part of the maintenance work. This monitoring and water management should continue to prevent damage to Dam M.
- General repairs on surface and slope erosion at the HWM.

All observations and records from monitoring subsequent to the 2019 inspection should be sent to Stantec and the Engineer-of-Record for review.

5.0 REFERENCES

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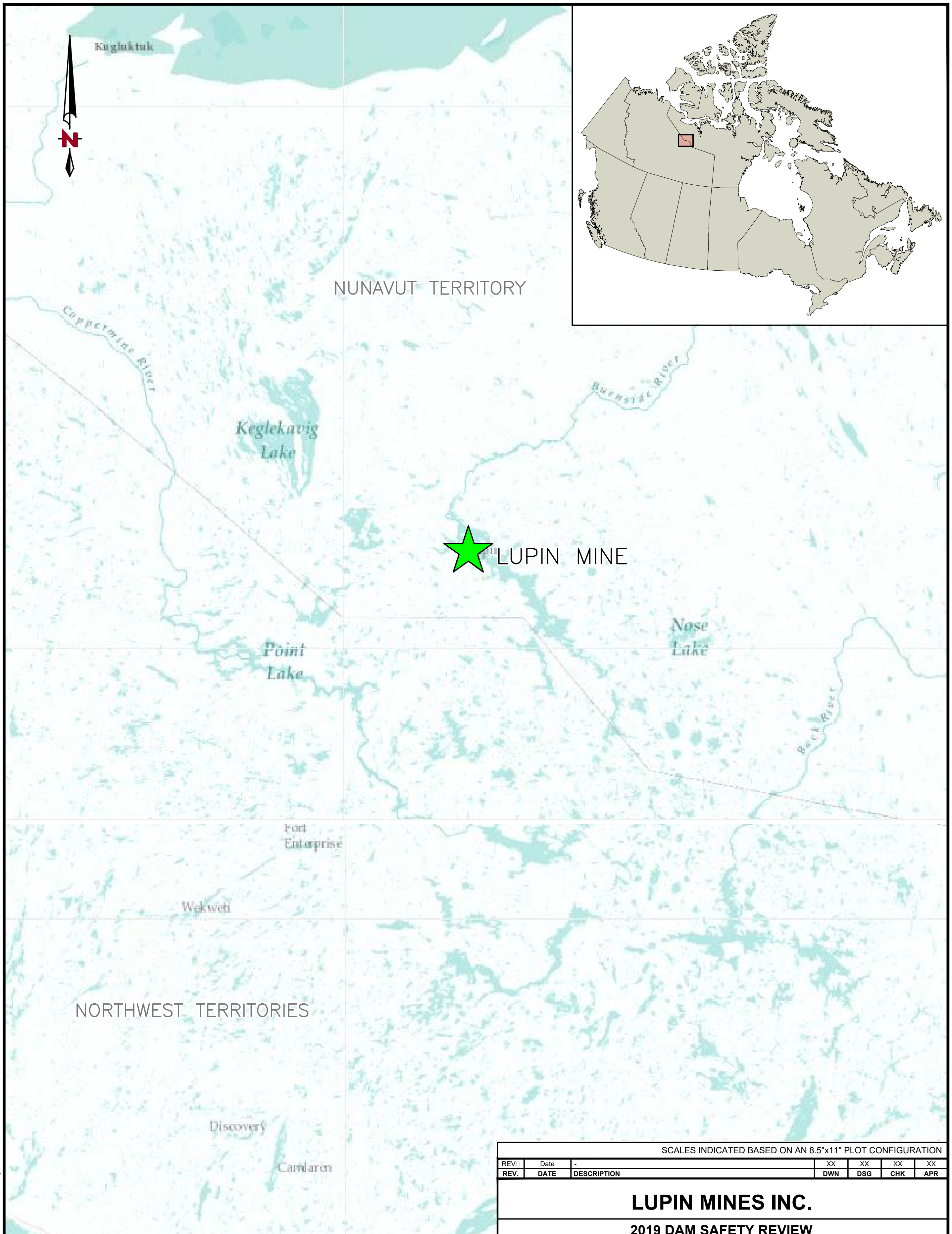
Stantec Consulting, 2018. 2018 Lupin Mine Tailings Area Inspection Report, Annual Geotechnical Inspection of the Tailings Containment Area. Report submitted to Lupin Mine Incorporated, November 16, 2018.

DATE: 9/29/2017 TIME: 16:00:20 PLOT SCALE: 1:3.872



0 50 100□m

SCALES INDICATED BASED ON AN 8.5"x11" PLOT CONFIGURATION

REV.	DATE	DESCRIPTION	DWN	DSG	CHK	APR
REV□	Date	-	XX	XX	XX	XX

LUPIN MINES INC.

2019 DAM SAFETY REVIEW

SCALE:	AS SHOWN
DATE:	2016-10-20
CO-ORD. SYS.:	UTM-NAD83-12
DRW'N BY:	KM
DSG'N BY:	--
REV'D BY:	AT
APP'D BY:	SE

SITE LOCATION

Stantec

PROJECT NO.:	FIG. NO.:	REV.:
129500082	1	A

FILENAME: □\924-2_DSI\DISC\DRAFTING\01.SITE LOCATION.DWG
XREF FILE(S):
IMAGE FILE(S): Lupin-Site Lo□ation-N Lupin-Site Lo□ation-S

SCALES INDICATED BASED ON AN 8.5"x11" PLOT CONFIGURATION

REV.:	Date	-	XX	XX	XX	XX
REV.	DATE	DESCRIPTION	DWN	DSG	CHK	APR

LUPIN MINES INC.

2019 DAM SAFETY REVIEW

SCALE:	AS SHOWN
DATE:	2016-10-20
CO-ORD. SYS.:	UTM-NAD83-12
DRW'N BY:	KM
DSG'N BY:	--
REV'D BY:	AT
APP'D BY:	SE

SITE OVERVIEW

Stantec

PROJECT NO.:	FIG. NO.:	REV.:
129500082	2	A

FILENAME: ☐\924-2_DSI\DSI\DRAFTING\02.SITE OVERVIEW.DWG
XREF FILE(S):
IMAGE FILE(S): Lupin-NE Lupin-NW Lupin-SW lupin_mine_wv2_2012aug21_north lupin_mine_wv2_2012aug21_south

DATE: 9/29/2017 TIME: 16:03:34 PLOT SCALE: 1:3.872

SCALES INDICATED BASED ON AN 8.5"x11" PLOT CONFIGURATION

100m 0 100 200 400m

SCALE 1:6000

REV.	DATE	DESCRIPTION	DWN	DSG	CHK	APR
REV	Date	-	XX	XX	XX	XX

LUPIN MINES INC.

2019 DAM SAFETY REVIEW

SCALE:	AS SHOWN
DATE:	2016-10-20
CO-ORD. SYS.:	UTM-NAD83-12
DRW'N BY:	KM
DSG'N BY:	--
REV'D BY:	AT
APP'D BY:	SE

MILL SITE AND SUPPORT FACILITY PLAN

Stantec

PROJECT NO.:	FIG. NO.:	REV.:
129500082	3	A

PLOT SCALE: 1:3.872 TIME: 16:06:18 DATE: 9/29/2017

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XREF FILE(S):
IMAGE FILE(S): lupin mine wv2 2012aug21 north

LEGEND

THERMISTORS STATUS

- ACTIVELY MONITORED
- DAMAGED
- MONITORED DURING DSR-NO CALIBRATION DATA
- UNLOCATED-LOCATION ESTIMATED FROM HISTORICAL MAP
- VOLUMETRIC WATER CONTENT SENSOR STRINGS
- TEST PITS

500m 0 500 1000m

SCALE 1:20,000

SCALES INDICATED BASED ON AN 8.5"x11" PLOT CONFIGURATION

LUPIN MINES INC.

2019 DAM SAFETY REVIEW

TAILINGS CONTAINMENT AREA

SCALE:	AS SHOWN
DATE:	2019-09-26
CO-ORD. SYS.:	UTM83-12
DRW'N BY:	KM
DSG'N BY:	--
REV'D BY:	AT
APP'D BY:	SE

Stantec

PROJECT NO.:	FIG. NO.:	REV.:
129500082	4	A

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XREF FILE(S):
IMAGE FILE(S): lupin mine wv2 2012aug21 north lupin mine wv2 2012aug21 south

DATE: 9/26/2019 TIME: 12:55:31 PLOT SCALE: 1:3.872

Appendix A Photographic Log

Photo 1: Looking east at the downstream slope of Dam 1A

Photo 2: Looking north at the crest of Dam 1A

Photo 3: Looking southwest at the upstream slope of Dam 1A

Photo 4: Looking south at the upstream slope of Dam 1B.

Photo 5: Looking south at the downstream slope of Dam 1B.

LMI	Lupin Mine Incorporated 2019 Dam Safety Inspection
Site Inspection Photograph Log for Dam 1A and 1B	

Stantec | PN: 129500082 | FIGURE 1 | REV. A

Photo 7: Looking southwest at the crest of Dam 1C

Photo 8: Looking southwest at the upstream slope of Dam 1C.

Photo 9: Looking south at the downstream slope of Dam 1C.

Photo 10: Looking east at the upstream slope of Dam 2.

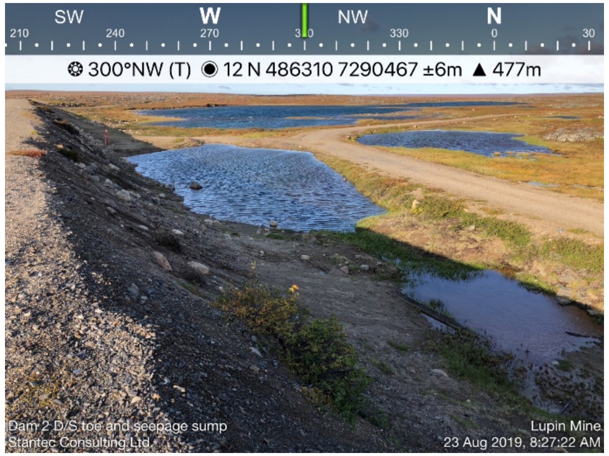

Photo 11: Looking northwest at the downstream slope of Dam 1 with the seepage collection pond.

LMI	Lupin Mine Incorporated 2019 Dam Safety Inspection
Site Inspection Photograph Log for Dam 1C and 2	
Stantec	PN: 129500082 · FIGURE 2 · REV. A

Photo 13: Looking northwest at the surface ditch along Dam 3.

Photo 14: Looking south at the crest of Dam 3.

Photo 15: Looking east at the surface ditch spillway on Dam 3.

LMI	Lupin Mine Incorporated
	2019 Dam Safety Inspection
Site Inspection Photograph Log for Dam 3	
Stantec	PN: 129500082 · FIGURE 3 · REV. A

Photo 16: Looking east from the west abutment at the crest slope of Dam 4

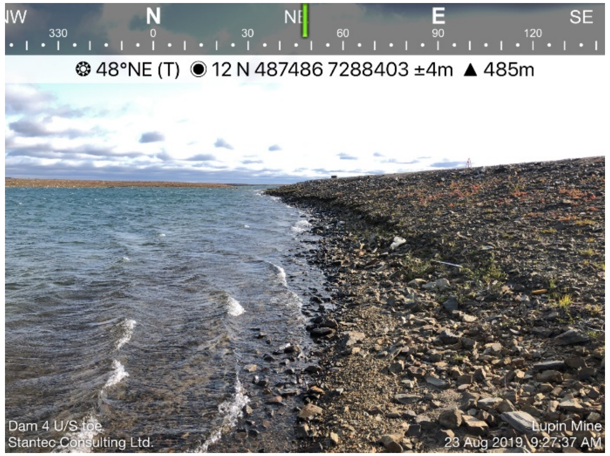

Photo 17: Looking northeast from the west abutment at the upstream slope of Dam 4

Photo 18: Looking east at the upstream slope of Dam 4.

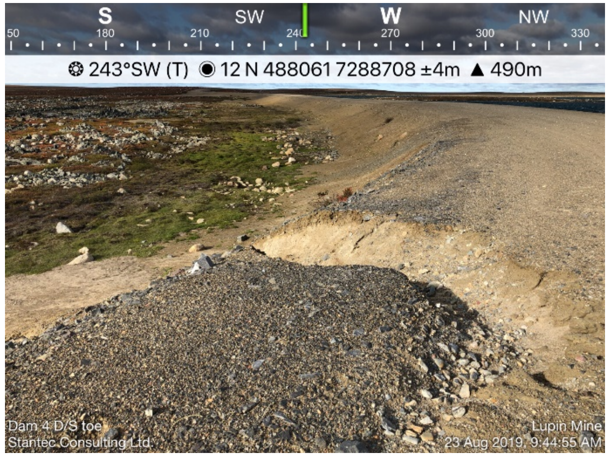

Photo 19: Looking southwest at an erosion gully near the east abutment of Dam 4.

Photo 20: Looking northeast at the downstream slope of Dam 4.

LMI	Lupin Mine Incorporated		
	2019 Dam Safety Inspection		
Site Inspection Photograph Log for Dam 4			
Stantec	PN: 129500082	FIGURE 4	REV. A

Photo 21: Looking north at the crest of Dam 5

Photo 22: Looking east at the upstream slope of Dam 5.

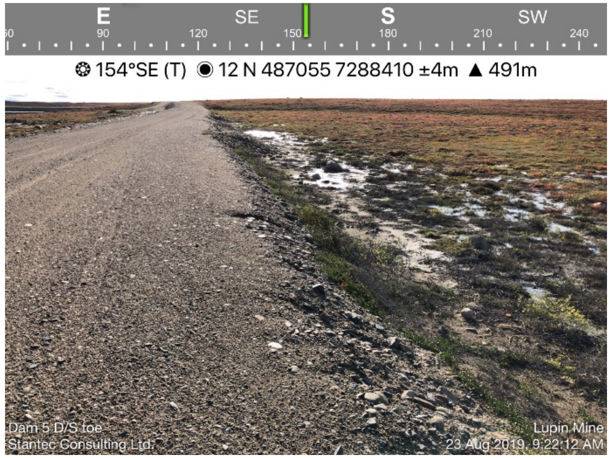

Photo 23: Looking southeast at the downstream crest of Dam 5.

Photo 24: Looking south at the crest of Dam 6

Photo 25: Looking south at the downstream slope of Dam 6.

LMI	Lupin Mine Incorporated 2019 Dam Safety Inspection
Site Inspection Photograph Log for Dam 5 and 6	
Stantec	PN: 129500082 FIGURE 5 REV. A

Photo 26: Looking south at the upstream crest of Dam J, adjacent to Pond 1.

Photo 27: Looking south at the crest of Dam J.

Photo 28: Looking south at the downstream slope of Dam J.

Photo 29: Looking southeast from the west abutment at the downstream slope of Dam 3D.

Photo 30: Looking east from the west abutment at the crest of Dam 3D.

Photo 31: Looking east at the downstream crest of Dam 3D.

LMI	Lupin Mine Incorporated 2019 Dam Safety Inspection		
Site Inspection Photograph Log for Dam 3D and J			
Stantec	PN: 129500082	FIGURE 6	REV. A

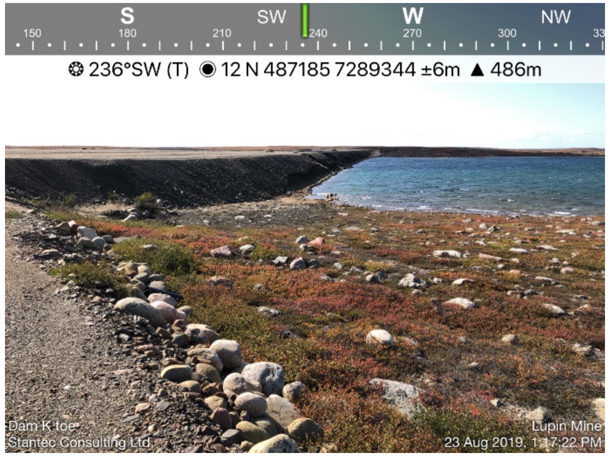

Photo 32: Looking southwest from the east abutment of the eroded toe at Dam K

Photo 33: Looking west at one of the repaired but sloughed gullies along the downstream crest of Dam K

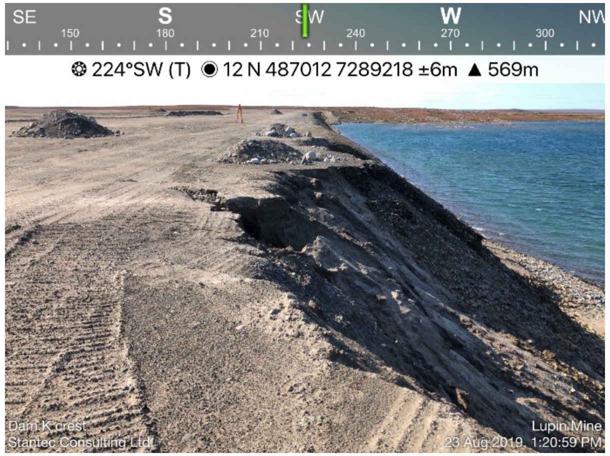

Photo 34: Looking southwest, down toward the toe at one repaired but sloughed gullies along the downstream crest of Dam K

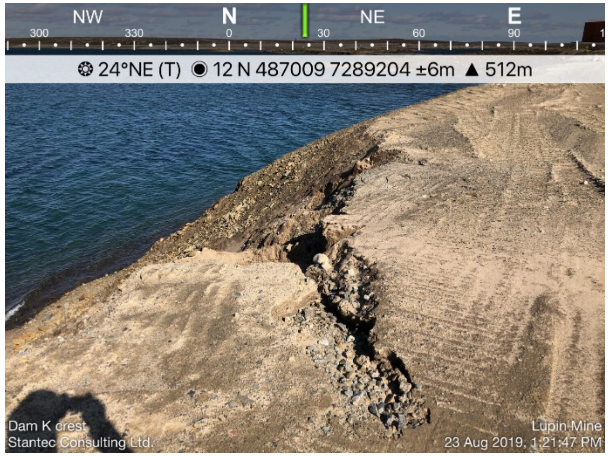

Photo 35: Looking north down toward the toe at one repaired but sloughed gullies along the downstream crest of Dam K

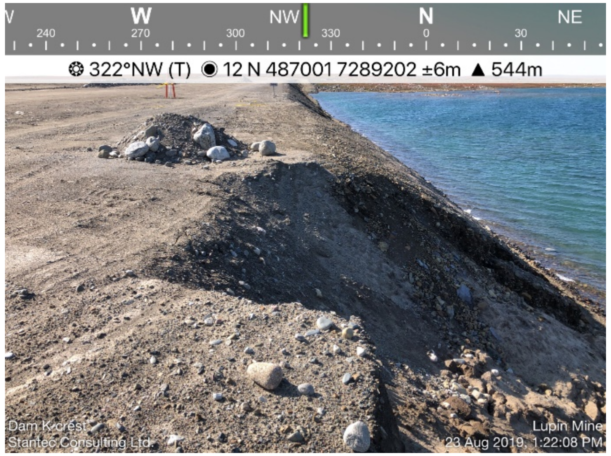

Photo 36: Looking north down toward the toe at one repaired but sloughed gullies along the downstream crest of Dam K

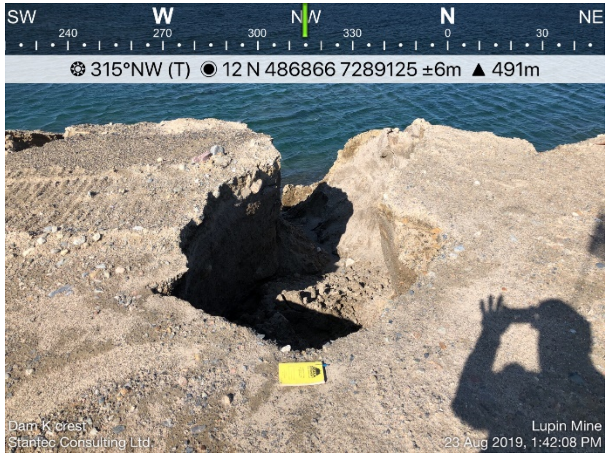

Photo 37: Looking northwest down toward the toe at one repaired but sloughed gullies along the downstream crest of Dam K

LMI	**Lupin Mine Incorporated** **2019 Dam Safety Inspection**
Site Inspection Photograph Log for Dam K	
Stantec	PN: 129500082 · FIGURE 7 · REV. A

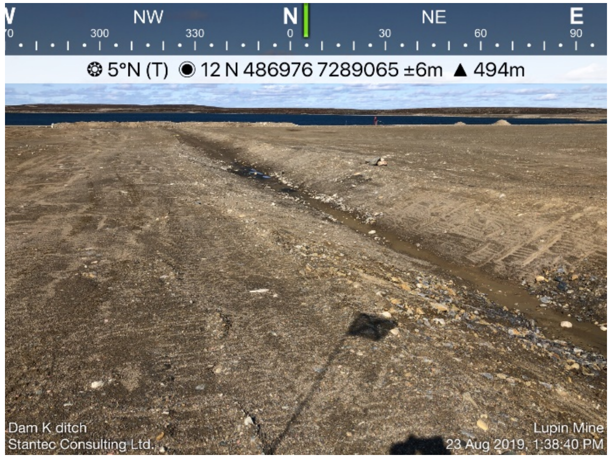

Photo 38: Looking north at the temporary surface ditch in the cover of Cell 3.

Photo 39: Looking south at the temporary surface ditch in the cover of Cell 3.

Photo 40: Looking northeast at the temporary surface ditch in the cover of Cell 3.

Photo 41: Looking south at the Dam L crest from the north abutment.

Photo 42: Looking south at the downstream slope of Dam L.

Photo 43: Looking north at the Dam L crest from the south abutment.

LMI	Lupin Mine Incorporated 2019 Dam Safety Inspection
Site Inspection Photograph Log for Cell 3 Surface Ditch and Dam L	
Stantec	PN: 129500082 — FIGURE 8 — REV. A

Photo 44: Looking west at the crest of Dam M.

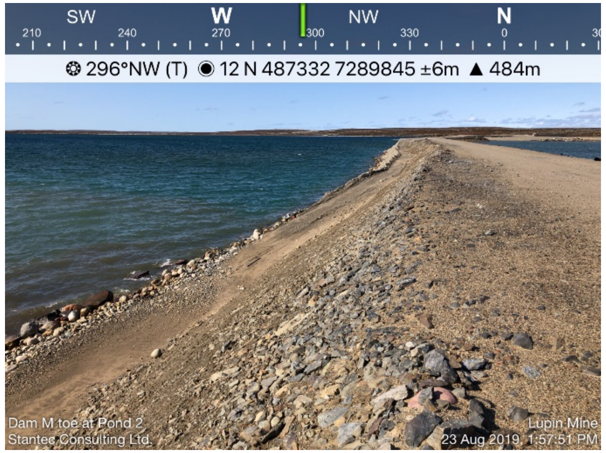

Photo 45: Looking west at the reinforcement buttress of Dam M.

Photo 6 Looking west at the sloughed and submerged toe of reinforcement buttress.

Photo 47: Looking east at the upstream crest of Dam M with the ongoing cover construction in the background.

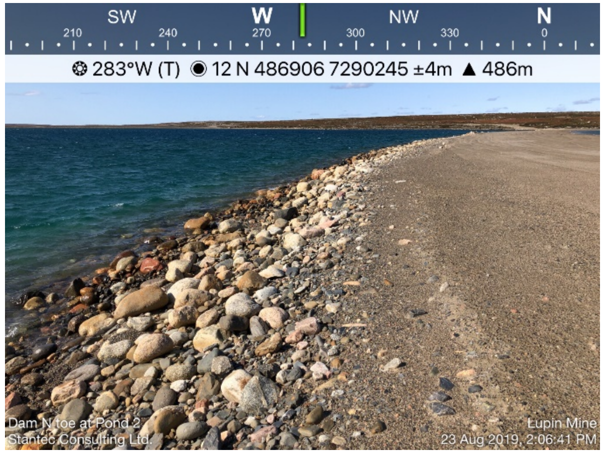

Photo 48: Looking north at the downstream slope of Dam N with Pond 2.

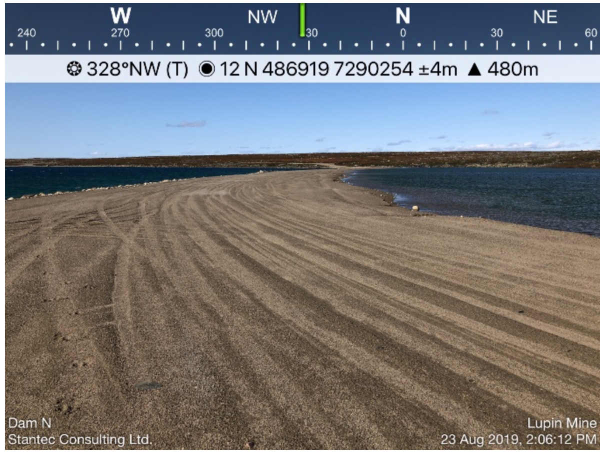

Photo 49: Looking north at the crest of Dam N and ponding water with less than 1m freeboard.

LMI	Lupin Mine Incorporated 2019 Dam Safety Inspection	
Site Inspection Photograph Log for Dam M and N		
Stantec	PN: 129500082	FIGURE 9	REV. A

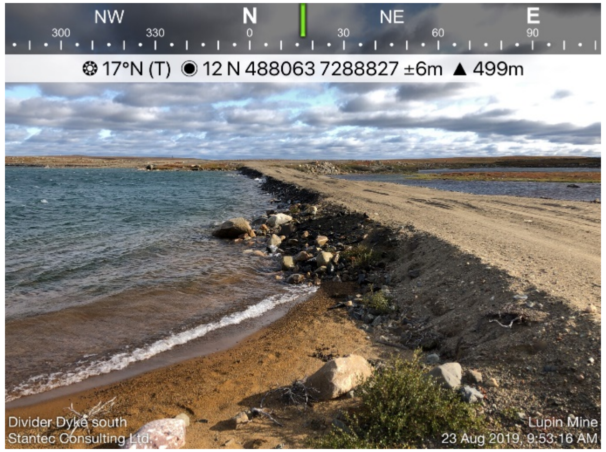

Photo 50: Looking north at the repaired upstream slope and crest of the southern divider dyke.

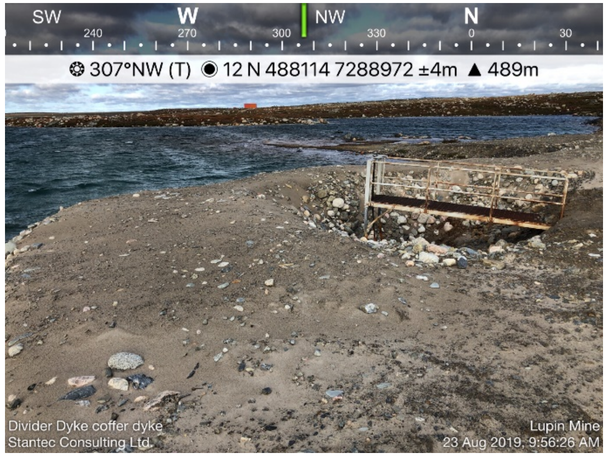

Photo 51: Looking northwest at a temporary coffer dam to reduce the flow through the malfunctioning gate valve.

Photo 52: Looking north at the culvert discharge at the malfunctioning gate valve.

Photo 53: Looking north at the eroded crest slopes and sloughed crest of northern divider dyke.

LMI	Lupin Mine Incorporated
	2019 Dam Safety Inspection

Site Inspection Photograph Log for Divider Dykes

Stantec	PN: 129500082	FIGURE 10	REV. A