Stantec

Memo

To:	Karyn Lewis Lupin Mine Incorporated	From:	Alvin Tong Stantec Consulting Ltd.
File:	Supporting information to the Contingency Contaminants Management Decision Matrix	Date:	January 9, 2020

Reference: Supporting Information to the Contingency Contaminants Management Decision Matrix

INTRODUCTION

Lupin Mine Incorporated (LMI), a wholly owned subsidiary of Mandalay Resources is requesting the renewal and amendment of their existing Type "A" Water License No. 2AM-LUP1520, to allow for Final Closure and Reclamation of the Lupin Mine Project (Lupin). The Nunavut Water Board (NWB or Board) Water License Application No. 2AM-LUP1520 Technical Meeting was held June 6-7th, 2019 in Kugluktuk and Appendix D of the June 18, 2018 Pre-Hearing Conference Decision Report outlines the agreed upon List of Commitments (Commitments). Stantec Consulting Ltd. (Stantec) was retained by LMI to support the responses to select commitments and this technical memo provides the responses to fulfill Commitment No. 8.

The original response to the commitment was provided on October 15, 2019. Follow up comments and a meeting with CIRNAC on January 7th, 2020 identified that additional information is needed to provide clarification and reasoning behind the decision matrix. The decision matrix provided herein is revised from the original submission in October 2019, and this technical memorandum provides supporting details regarding cover performance and risk evaluation. The goal of the decision matrix is to provide a set of determining criteria to decide which one of two mitigation options is most appropriate. The two mitigation options are cover exposed contaminants in place or excavate and relocate to consolidate them within existing tailings cells.

OPTION 1 – EXCAVATE, RELOCATE AND CONSOLIDATE

While excavation and relocation of all exposed contaminants to existing cells would consolidate contaminants within approved storage areas, there are number of risks that are associated with this mitigation option that should be considered. These risks are the determining criteria to drive the selection of the appropriate mitigation option. The subsections below highlight cases where relocation of contaminants may incur significant risks, and cover in place should be considered.

CONTAMINANTS FOUND NEAR DAM TOES

If contaminants are found within a horizontal distance of 1.5x the height of the dam from the dam toe, the excavation associated with the contaminant removal could jeopardize the stability of the existing dams. The existing material at the toe of the dam is effectively providing support to the structure, and excavation, even temporary, could cause sloughing or slumping to a stable structure. It would be more prudent to cover the contaminant in place, thus effectively adding more buttress and support to the dams.

CONTAMINANTS FOUND OVER LARGE AREAS AND REQUIRING LONG ACCESS ROADS

A stepped approach is needed to allow equipment to access and relocate exposed contaminants. New access roads must be built over clean areas to the edge of the exposed contaminants. Then only the contaminants within the operable reach (~4m) of the equipment can be removed and then replaced with clean material to advance the access. Thus, the relocation work can only occur in ~4m increments. During the construction, two separate sets of equipment must be used to prevent cross contamination. LMI has a planned construction schedule to facilitate the closure work. The additional steps will significantly increase the risks of spreading contaminants to nearby environs during excavation and haulage, and will significantly decrease productivity, thus jeopardizing LMI's planned schedule that is tailored to northern climate conditions. If contaminant is found in isolated upland areas, there are also risks associated with adverse downstream impact of undisturbed ground due to construction runoff.

CONTAMINANTS FOUND IN THICKNESS IN EXCESS OF 1.5M

A typical excavator can dig down to approximately 4m depth. However, the typical excavator cannot "bucket" compact loose material below an approximate depth of 2.5m. It is assumed that a construction access road would be constructed from at least 1m thick esker material. Therefore, the approximate depth of contaminant removal would be 1.5m due to the difference between the excavator limitation and the access road thickness. Loose material place below the depth of 2.5m might not get compact sufficient and risk of creating differential settlements. Deeper excavation would also be associated with water management risks (ponding water from rain) and construction health and safety risks. If thick pockets of contaminant are found, material found around 2m or deeper below ground surface would eventually be encapsulated by permafrost. The risks associated with deep excavation and removal are deemed more significant than covering in place.

CONTAMINANTS FOUND ON BEDROCK

The bedrock found around the site is typically uneven with deep narrow crevices. These features would make complete removal of contaminants impractical with conventional earthwork equipment. Conventional removal of the material in small inaccessible areas would typically involve some type of hydraulic equipment. The risks associated with hydraulic removal are downstream impact to undisturbed ground from construction runoff, and agitation of contaminant affecting downstream waterbodies. It would be more prudent to cover the contaminants in place then risk disturbing additional ground and waterbodies.

CONTAMINANTS FOUND WITHIN SOFT LAKEBED SEDIMENTS

Depending on the depositional environment of the contaminant, they could be mixed with soft lakebed sediments. These materials could be highly saturated and contain significant amounts of free-flowing water. Excavating these materials in a soft, saturated environment will incur significant health and safety risks, in addition to the risk of spreading highly saturated (sludge like) contaminant to nearby environs during excavation and haulage. It is considered safer to place a constructed cover over the soft contaminants as this would provide dry, firm and even ground for equipment.

TAILINGS CELL COVERS ARE NOT YET COMPLETED

Depending on the actual length of the construction and discharge season, the tailings cell covers could be completed prior to reaching closure water levels in the TCA. LMI has a planned construction schedule to facilitate the closure work. Any changes due to northern climate conditions (i.e. longer freeze, larger freshet) could impact the water discharge schedule. If contaminants are found after completion of the tailings cell covers, reopening of cover(s) could compromise the quality of work and the overall completion of the TCA closure in accordance with LMI's schedule. It is also not advisable to leave portions of the cell cover incomplete as a contingency to accommodate potential exposed contaminants. Incomplete cell cover will create risks associated with water management and quality, as well as overall closure schedule risks to LMI's planned schedule.

Reference: **Supporting Information to the Contingency Contaminants Management Decision Matrix**

OPTION 2 – COVER IN PLACE

The proposed cover in place mitigation option will utilize the same esker cover that has been approved for the TCA. Sufficient thickness of esker, similar to the approved cover, will be placed over any significant amount of contaminant if found in areas above the closure water level. Based on available information, summarized below, it is believed that an esker cover over the potentially exposed contaminants would perform in a similar manner as the approved cover in the tailings cells.

The existing instrumentation data indicates that esker cover only entirely thaws between the months of July and September and would be partially frozen for the rest of the year. Instrument data also suggests that the lowest parts of the cover would remain at a high degree of saturation (>85% by volume) during the driest months (Stantec 2019). The tailings permeability is low (between 1E-05 cm/s to 5E-05 cm/s) and is not readily free draining. The overall water balance for the site is positive, where there is more precipitation than evaporation, which will ensure the contaminants and the cover will be rehydrated between the seasons (Holubec 2006). The MEND Guideline outlines that a zone of cover material at or above 85% by volume saturation would effectively limit oxidation of the material below (MEND 2004). Given the existing data and analytical results, it is concluded that a sufficient thickness of esker material would mitigate potential acid rock drainage concerns from the potentially exposed contaminants.

ACTIVE MONITORING

The performance of either option would be monitored according to the final closure monitoring plan. LMI's schedule would allow a period of performance monitoring post construction, prior to opening the TCA system to the environment. Any residual risks associated with the options will be identified, monitored and tracked during this period. The monitoring would demonstrate the TCA closure has been completed in accordance with the design and will not be detrimental to environment prior to opening the TCA to the environment.

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Attachment: Contingency Contaminants Management Decision Matrix

c. Jim McKinley; Sara Wilkins

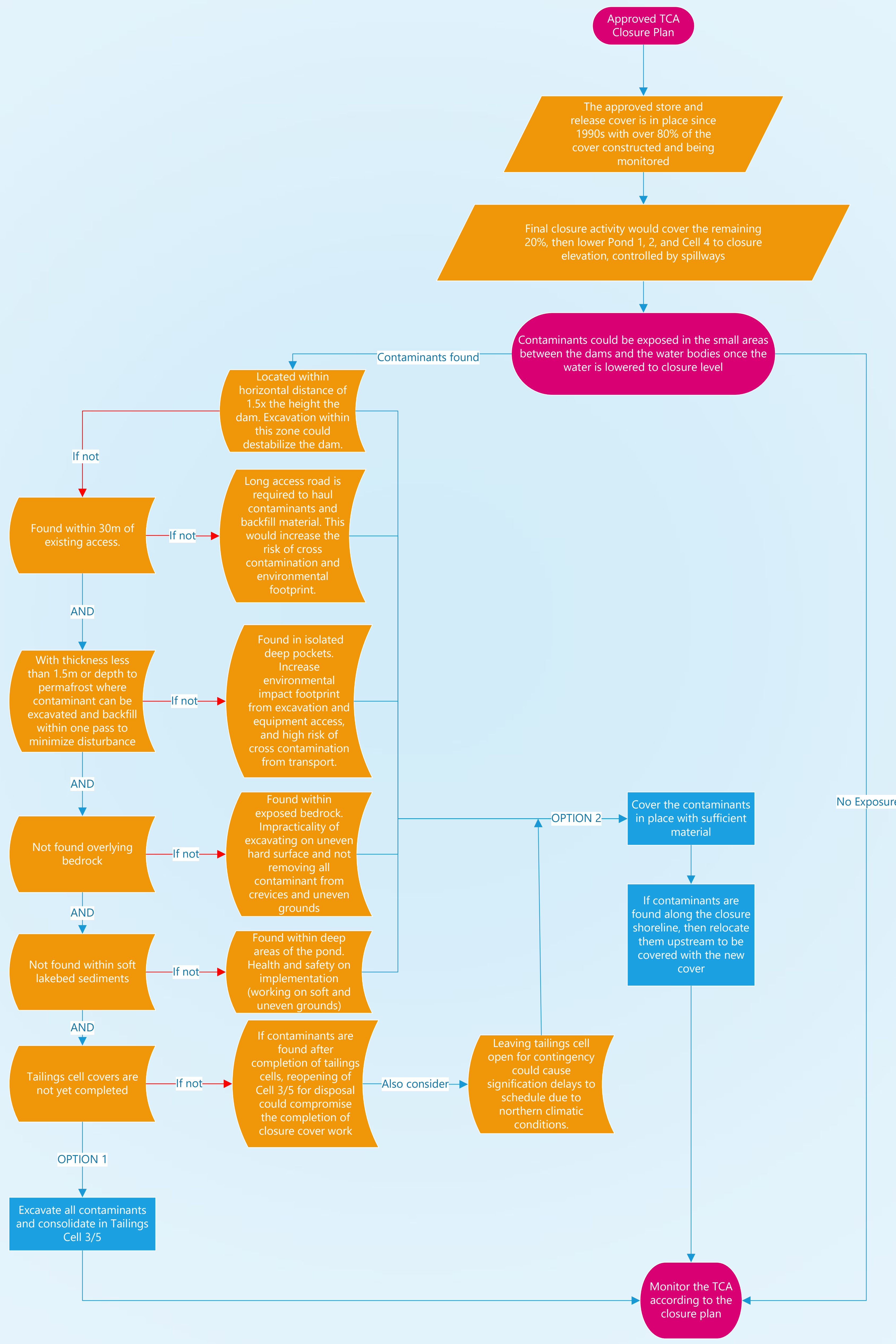
Reference

Holubec 2006. Geotechnical, Seepage and Water Balance. Report prepared for Kinross Gold Corporation by Holubec Consulting Inc., March 2006.

MEND 2004. Design, Construction and Performance monitoring of Cover Systems for Waste Rock and Tailings, Volume 1 and 2. MEND 2.21.4a. July 2004.

Stantec 2019. 2019 Lupin Mine Tailings Area Inspection Report. Report prepared for LMI by Stantec Constructing Ltd., October 2019.

Contingency Contaminants Management Decision Matrix



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Technical Memo

To:	Karyn Lewis, Project Manager Lupin Project Mandalay Resources Corporation Suite 330, 76 Richmond Street Toronto, ON M5C 1P1	From:	Ron Coutts M.Sc., P.Eng Sara Wilkins, P.Geol. Stantec Consulting Ltd. 200-325 25 Street SE Calgary, AB T2A 7H8
File:	Lupin Gold Project - 129500081	Date:	October 15, 2019

Reference: 2 AM-LUP Technical Meeting Commitment Number 13 Response – Lupin Mine Tailings Containment Area Dams Thermal Modelling Results

Introduction

Lupin Mine Incorporated (LMI), a wholly owned subsidiary of Mandalay Resources is requesting the renewal and amendment of their existing Type "A" Water Licence No: 2AM-LUP1520, to allow for Final Closure and Reclamation of the Lupin Mine Project (Lupin). The Nunavut Water Board (NWB or Board) Water Licence Application No. 2AM-LUP1520 Technical Meeting was held June 6-7, 2019 in Kugluktuk and Appendix D of the June 18, 2018 Pre-Hearing Conference Decision Report outlines the agreed upon List of Commitments (Commitments). Stantec Consulting Ltd. (Stantec) was retained by LMI to support the responses to select commitments and this technical memo provides the responses to fulfill Commitment No. 13, shown below, which relates to thermal modelling of the long-term thaw of the Lupin Tailings Containment Area (TCA) frozen tailings containment structures or dams under multiple climate warming scenarios to support the Lupin Mine Final Reclamation and Closure Plan.

13	LMI	ECCC	LMI to use a range of emission scenarios (low to high future forcing) from multiple climate models and considering multiple parameters (precipitation, permafrost thaw, etc.), which will be determined following consultation with climate change experts, for consideration in the Final Reclamation and Closure Plan.	15-Oct-19	Technical Memo

Commitment No. 13 states that climate change experts sub-contracted by LMI will consult with Environment Canada and Climate Change (ECCC) climate change experts to determine the most applicable climate models, warming scenarios, and parameters, for the Lupin Mine site. Meetings with the ECCC climate change expert were requested by Stantec on July 31, 2019, and August 30, 2019, and ECCC responded that, in summary, email communication was preferred. Both email responses directly referenced sections of Canada's Changing Climate Report (CCCR, 2019), most specifically Chapter 8 Section 8.4.1: Changes in northern Canada. This section references two northern Canada emission scenarios and the ECCC climate change expert noted that: "the range of projected changes provided for various global emission scenarios (i.e., Representative Concentration Pathways or RCPs) in Canada's Changing Climate Report are derived from an ensemble of 29 climate models".

Details regarding the projected changes in temperature in various regions across Canada, including Canada's north, were provided in CCCR, 2019, Chapter 4, (Section 4.2.1.3 and Table 4.2). CCCR, 2019, Section 4.2.1.3, indicates that the projected increase in mean annual air temperature (MAAT) was based on a distribution of outcomes from 29 CMIP5 (Coupled Model Intercomparison Project) climate models. The climate models were used to simulate three emission scenarios (low-, medium-, and high-emissions scenarios). Stantec used the low-emissions scenario (LES) and the high-emissions scenario (HES) to fulfill the TCA thermal modelling component of Commitment No. 13 as only these two scenarios were reported in CCCR, 2019.

Thermal Modelling

Stantec performed thermal modelling to assess the potential for long-term permafrost thaw of frozen tailings containment structures (dams) under three climate warming scenarios. The median projected MAAT increase values for the North region from the two climate modelling emission scenarios (LES and HES) from CCCR, 2019, Table 4.2 (shown above) were used to establish the air temperature versus time for input to the thermal modelling. The third climate scenario was modelled using an average of the LES and HES and is termed herein as the average-emissions scenario (AES).

The thermal modelling domain was one-dimensional and represented the thermal conditions at and below the crest of the dams. The LES and HES thermal modelling scenarios considered an increase in the MAAT from the 1986-2005 time period to the 2031-2050 time period, consistent with the time periods reported in CCCR, 2019, Table 4.2. From the time period 2031-2050 to 2081-2100, a second MAAT increase rate was used, again consistent with the time periods and temperature increases reported in CCCR, 2019, Table 4.2. Table 1 below summarizes the time intervals, temperature increases, and the climate warming rates used in the LES, HES and AES thermal modelling as calculated from the projected MAAT increases reported in CCCR, 2019, Section 4.2.1.3, Table 4.2.

Table 1 – Thermal Modelling MAAT Increases and Climate Warming Rates for Emissions Scenarios

Time Period	Time Period Midpoint	Time Interval (years)	LES MAAT Increase (°C)	HES MAAT Increase (°C)	LES Climate Warming Rate (°C/year)	HES Climate Warming Rate (°C/year)	AES Climate Warming Rate (°C/year)
1986 – 2005	1995	0	--	--	--	--	--
2031 – 2050	2040	45	1.8	2.7	0.040	0.060	0.050
2081 – 2100	2090	95	2.1	7.8	0.0060	0.102	0.054
Time-Weighted Average Climate Warming Rate 1995-2100 (°C/year)					0.022	0.082	0.052

(Based on air temperature projections reported in CCCR, 2019, Section 4.2.1.3, Table 4.2)

Reference: 2 AM-LUP Technical Meeting Commitment Number 13 Response – Lupin Mine Tailings Containment Area Dams Thermal Modelling Results

The climate warming rates for the three emissions scenarios in Table 1 were used to ramp-increase the MAAT in the thermal modelling from 1995 to 2100 as shown in Figure 1. The temperature increases for the LES and HES scenarios shown in Table 1 and plotted in Figure 1, are based on, and are consistent with, the temperature warming projections reported in CCCR, 2019, Section 4.2.1.3, Table 4.2.

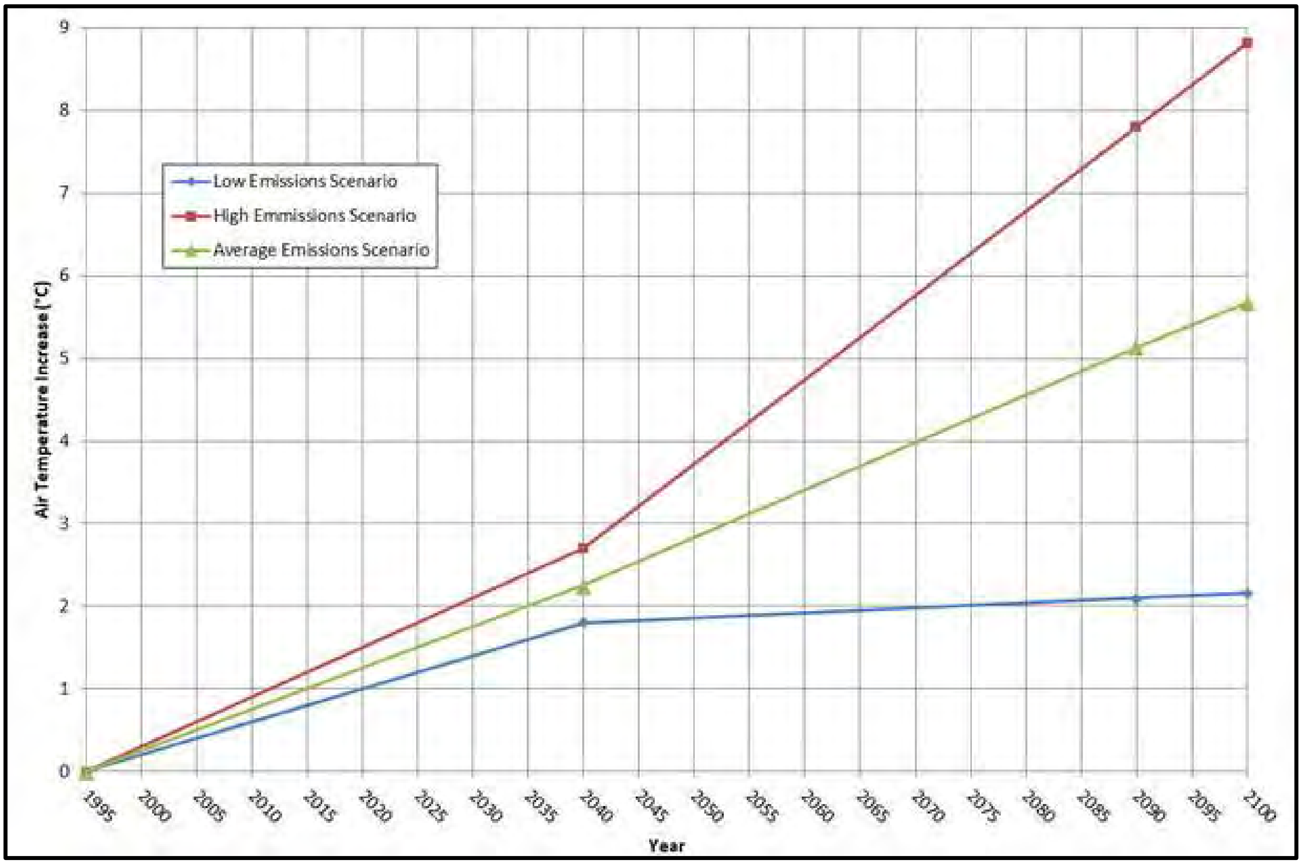

Figure 1: CCCR 2019 Climate Warming Predictions for Canada North Region

High-Emissions Scenario (HES) Thermal Modelling Results

The HES model represents the worst-case emissions scenario (i.e., highest rate of climate warming) of the three climate warming scenarios considered. Figure 2 displays the seasonal variation in air temperature used in the HES thermal modelling. The air temperature data is shown at 5-day intervals represented by red symbols. The MAAT is shown by the blue symbols and is the same air temperature data that was shown for the HES scenario in Figure 1.

Figure 3 displays the model-calculated variation in the thaw depth versus time at the dam crest for the HES. As with Figure 2, the data points are evenly spaced at 5-day intervals. In the thermal model, the maximum annual thaw depth (termed the active layer depth) in 1995 is 2.3 m. Climate warming causes small incremental increases in the depth of the active layer each year until about 2075. After 2075, the annual winter frost depth does not penetrate to the base of the active layer (top of permafrost), and long-term progressive permafrost thaw deepening begins after that point in time. By the year 2100, the top of the permafrost is located 14 m below ground surface. Of the three emissions scenarios considered, the HES is the most extreme given that the observed MAAT in Canada increased by 8.8°C from 1995 to 2100.

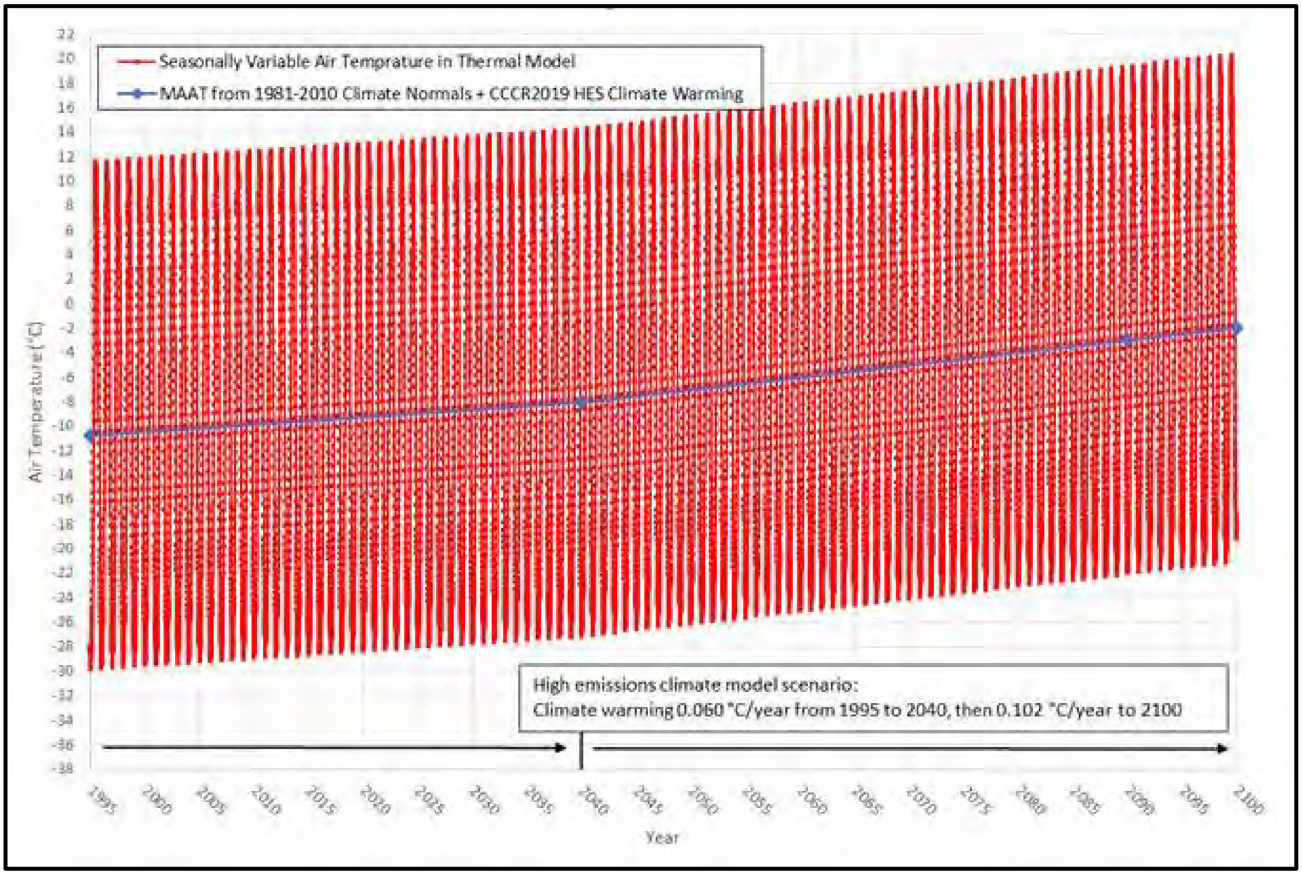

Figure 2: HES Scenario – Lupin Thermal Modelling with Climate Warming, Air Temperature Input Data

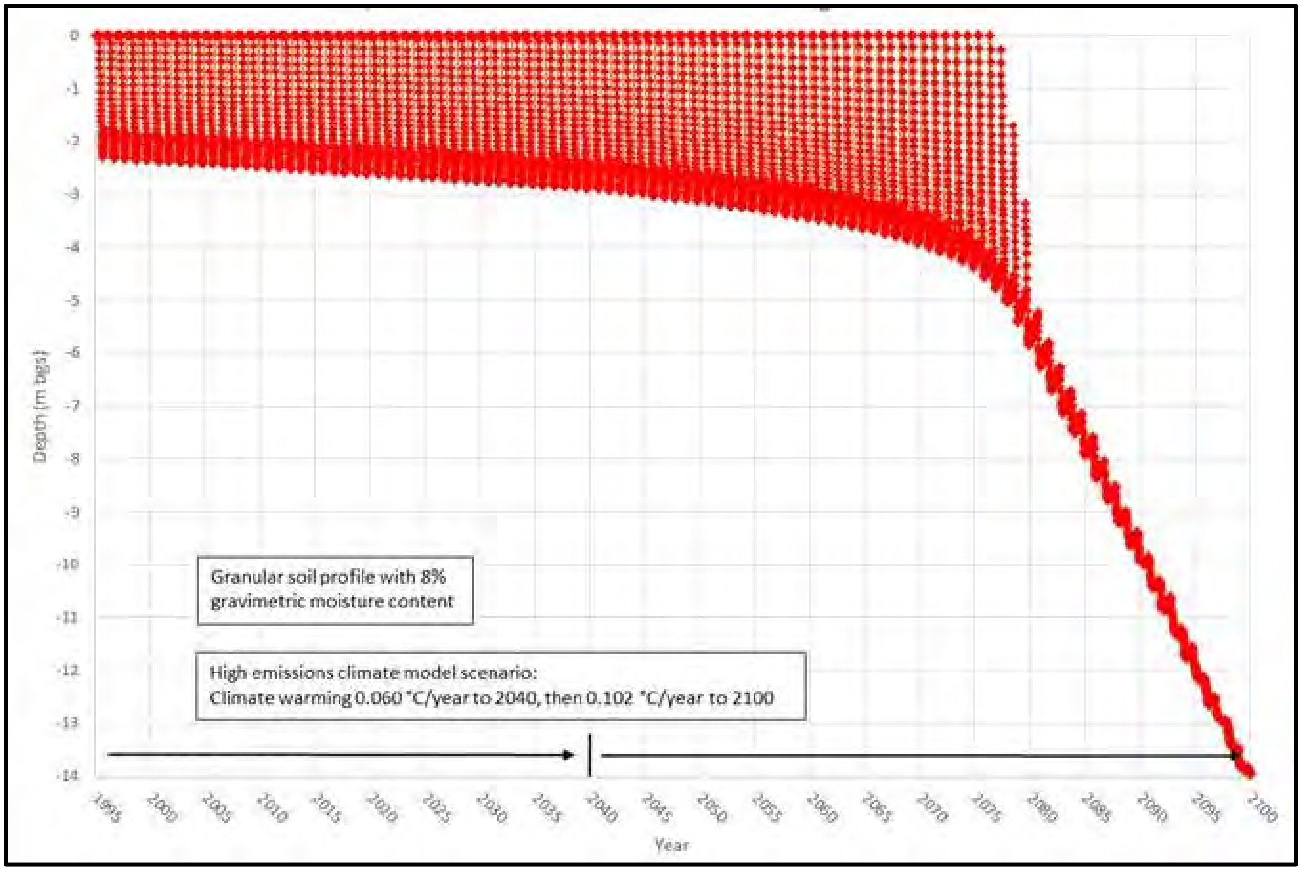

Figure 3: HES Scenario – Lupin Thermal Modelling with Climate Warming, Long-Term Thaw Depth

Low-Emissions Scenario (LES) Thermal Modelling Results

The air temperature data used in the modelling for the LES thermal modelling is shown in Figure 4. The LES scenario uses a MAAT increase of 2.2°C from 1995 to 2100. CCCR, 2019, states that the warming trend observed in Canada from 1948 to 1996 was 1.2°C, representing an average warming rate of 0.025°/yr. Accordingly, the LES is considered to be more realistic than the HES.

Figure 5 shows the model-calculated thaw depth for the LES from 1995 to 2100. The model begins with an active layer depth of 2.3 m in 1995, which deepens to 2.8 m by year 2100, indicating an active layer thickness increase of 0.5 m. The LES does not result in long-term progressive permafrost thaw.

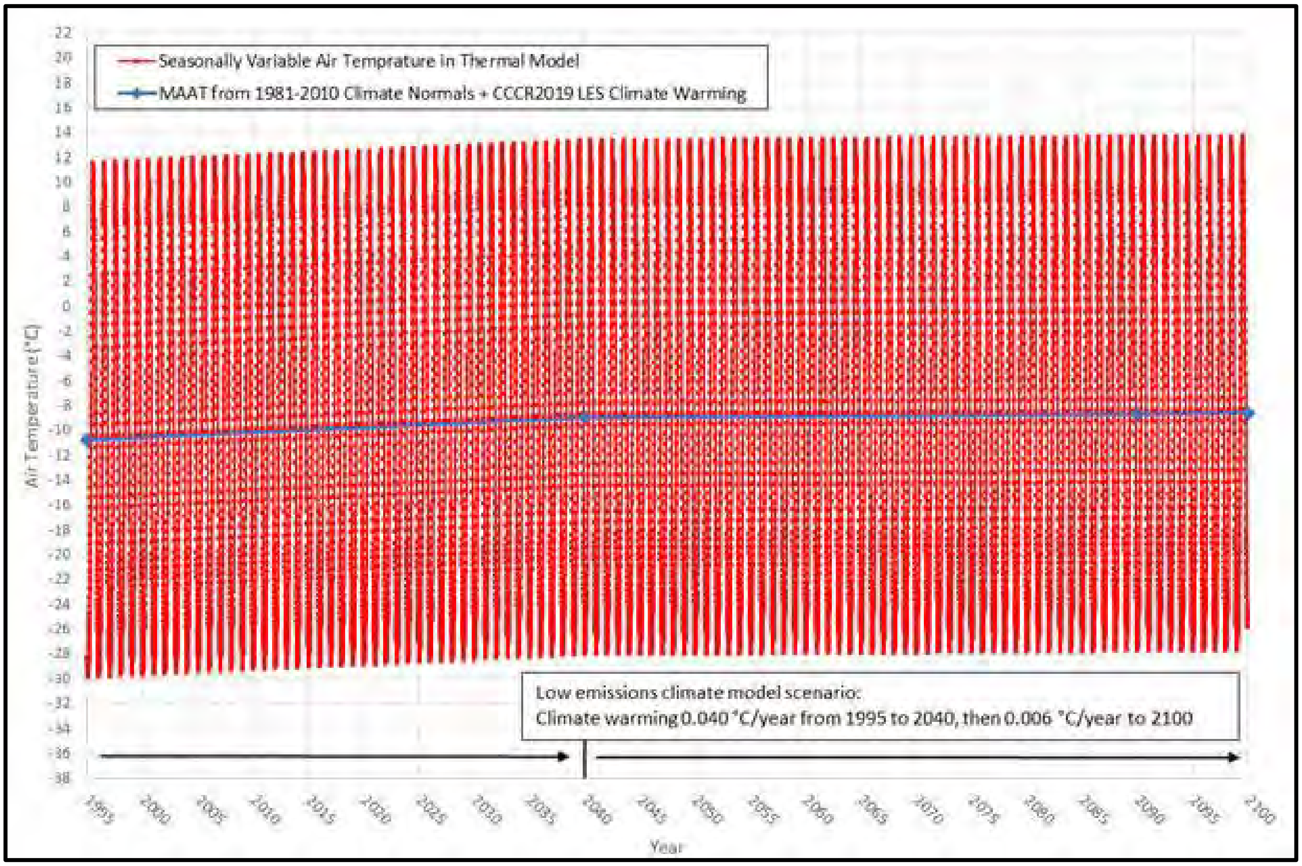

Figure 4: LES Scenario – Lupin Thermal Modelling with Climate Warming, Air Temperature Input Data

Reference: 2 AM-LUP Technical Meeting Commitment Number 13 Response – Lupin Mine Tailings Containment Area Dams Thermal Modelling Results

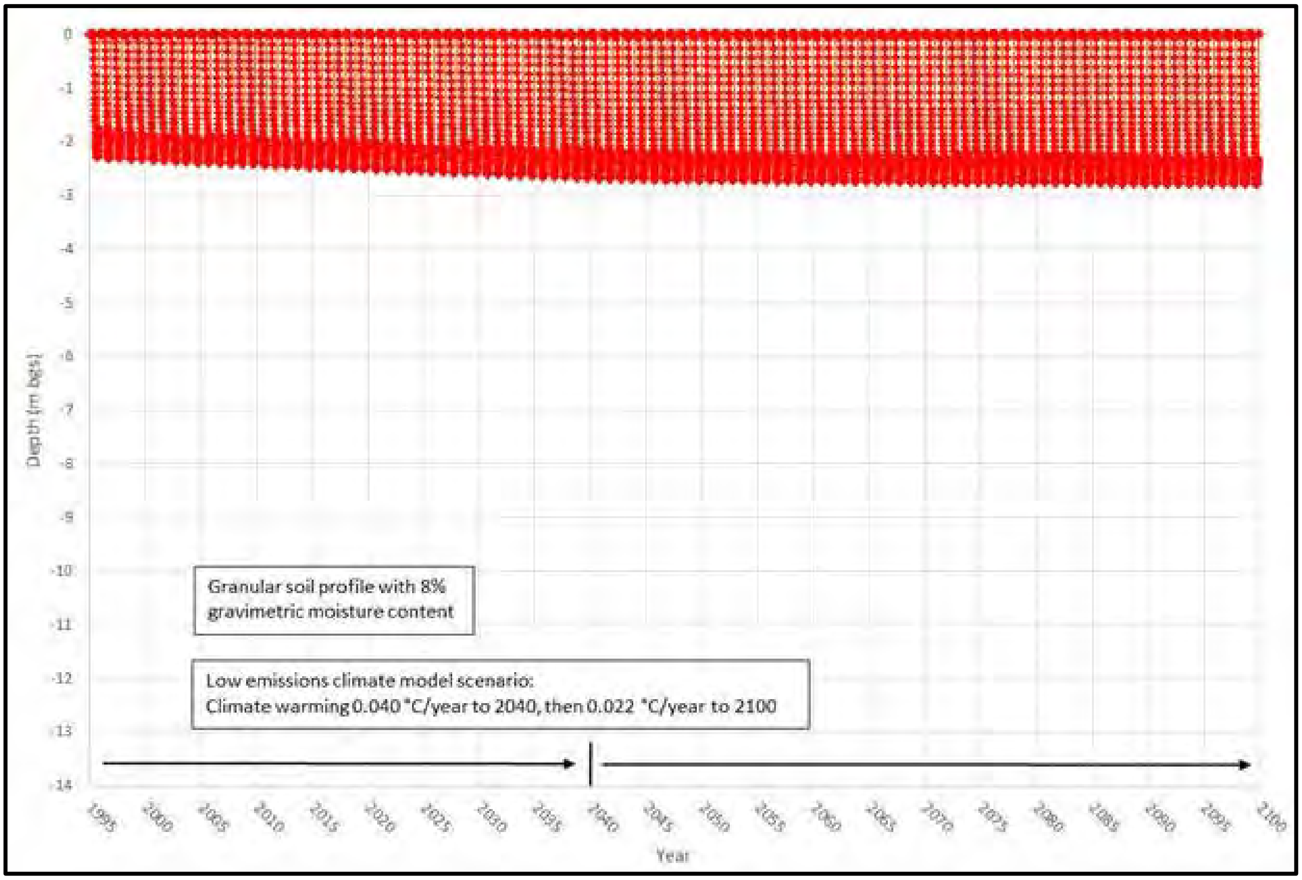

Figure 5: LES Scenario – Lupin Thermal Modelling with Climate Warming, Long-Term Thaw Depth

Reference: 2 AM-LUP Technical Meeting Commitment Number 13 Response – Lupin Mine Tailings Containment Area Dams Thermal Modelling Results

Average-Emissions Scenario (AES) Thermal Modelling Results

The AES scenario is an average of the LES and HES MAAT warming rates. Figure 6 shows the seasonally variable temperature together with the MAAT for the AES. The overall climate warming rate in this scenario is 0.052 °C/yr.

Figure 7 shows the model-calculated thaw depth for the AES from 1995 to 2100. The model begins with an active layer thaw depth of 2.3 m in 1995, which deepens to 3.9 m by year 2100, indicating an active layer thickness increase of 1.6 m. As with the LES, there is no long-term progressive permafrost thaw.

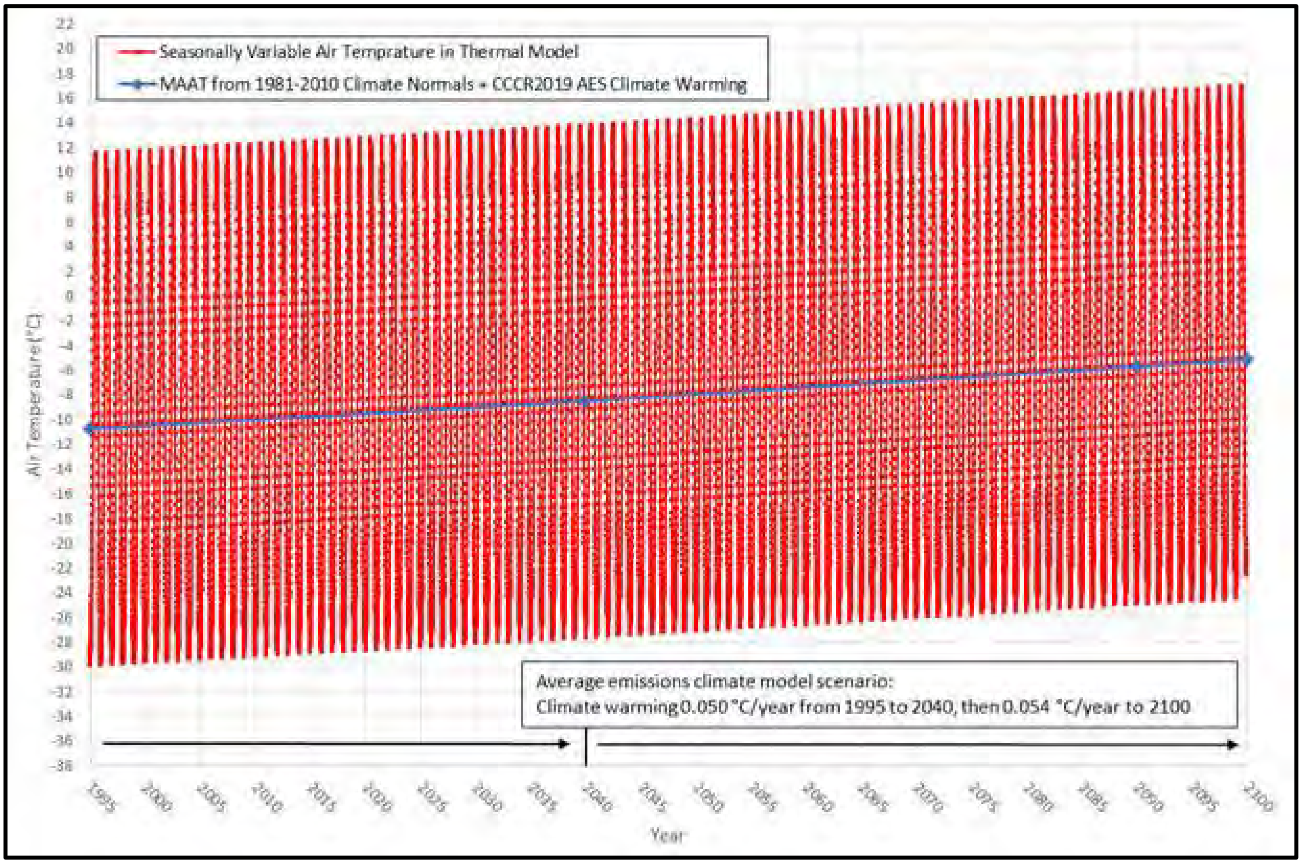

Figure 6: AES Scenario – 1D Model of Climate Warming Air Temperature

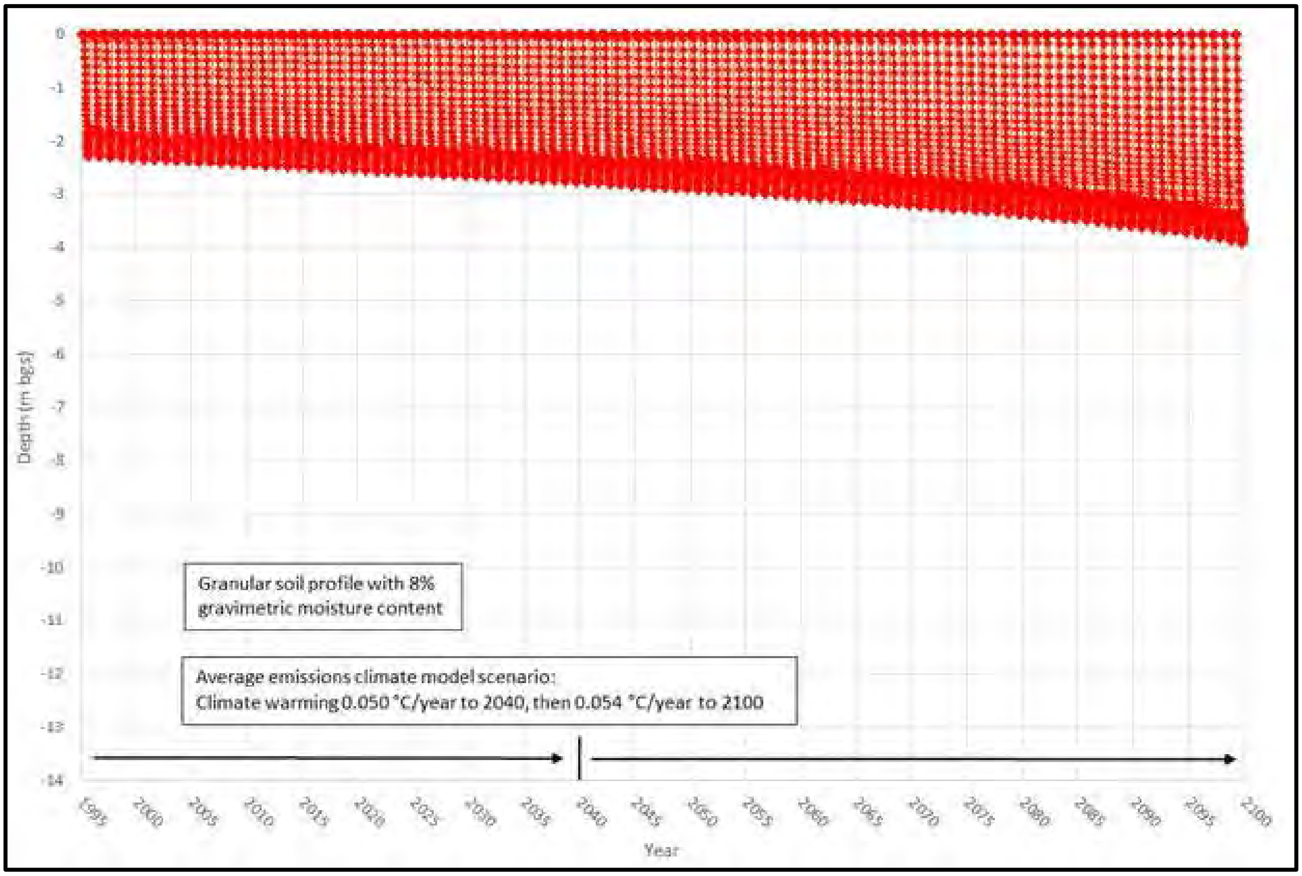

Figure 7: LES Scenario – Lupin Long-Term Thaw Depth with Climate Warming

Reference: 2 AM-LUP Technical Meeting Commitment Number 13 Response – Lupin Mine Tailings Containment Area Dams Thermal Modelling Results

Conclusions

The thermal modelling conducted by Stantec found that the LES and AES did not result in long-term progressive permafrost thaw within the Lupin Mine TCA dams. The LES and AES are considered to be more realistic climate warming emission scenarios compared to the HES, based on reported observations of temperature changes in the latter half of the 20th century in Canada. Thermal modelling showed that the HES emission scenario resulted in long-term progressive permafrost thaw which is not expected to begin until the latter quarter of the 21st century, and which would result in a permafrost thaw depth of 14 m below ground by the year 2100.

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Technical Memorandum

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File:	Lupin Gold Project - 129500081	Date:	November 14, 2019

Reference: 2 AM-LUP Technical Meeting Commitment Number 6 Response – Geotechnical Review on the Long-Term Stability of TCA Dams

INTRODUCTION

Lupin Mine Incorporated (LMI), a wholly owned subsidiary of Mandalay Resources Corporation is requesting the renewal and amendment of their existing Type "A" Water License No: 2AM-LUP1520, to allow for Final Closure and Reclamation of the Lupin Mine Project (Lupin). The Nunavut Water Board (NWB or Board) Water License Application No. 2AM-LUP1520 Technical Meeting was held June 6-7, 2019 in Kugluktuk, Nunavut. Appendix D of the June 18, 2019 Pre-Hearing Conference Decision Report outlines the agreed upon List of Commitments (Commitments). Stantec Consulting Ltd. (Stantec) was retained by LMI to support the responses to select commitments and this technical memorandum provides the responses to fulfill Commitment No. 6, shown below, which relates to conducting a geotechnical stability review of the Tailings Containment Area (TCA) dams to ensure long term stability and erosion control.

6	LMI	CIRNAC	Geotechnical details of engineered structures (e.g. which dams will the rip-rap material be taken from to change slope and which dams will be enhanced, cross sections and details) to ensure long term stability and erosion control.	15-Nov-19	Technical Schematics

This memorandum presents the design basis, stability analyses results, and recommendations to satisfy long term stability and erosion control for all the dams at Lupin.

DESIGN BASIS AND CRITERIA

As-built configurations were generated using 2019 bathymetry and surface survey data. The analyses focus on long-term loading conditions which is appropriate for closure design. Permafrost was assumed to remain at its current level and the remaining cover in Cell 3 and 5 is assumed to be completed. Closure water levels are as follows (if not listed, the area will be dry for closure):

- Pond 1 at 480 meters above sea level (masl),
- Pond 2 at 481 masl, and
- Cell 4 at 485 masl.

Factor of Safety (FOS) criteria are based on Canadian dam safety guidelines for mining dams (CDA, 2014) and are presented in Table 1.

Table 1: Summary of Stability Criteria

Failure Mode	Condition	Factor of Safety (Limit-Equilibrium)
Local	Static	1.3
Global		1.5
Global	Seismic	1.1

Two stability scenarios have been considered for all dams:

1. As-built Scenario (Where permafrost is present at a 2m depth below ground surface).
2. Seismic Condition (PGA of 0.05g at a probability of 2%/50 years, based on the Natural Resources of Canada 2015 Seismic hazard map (NRC 2015)) with a 50% reduction using the Hynes-Griffin method (Hynes-Griffin, 1984).

The assessment also considers local and global stability failure modes. Local failure consists of shallow failure that would not release tailings, such as sloughing, of minimum 1m thickness. The global failure mode considers a deep, large rotational failure that could result in a dam breach and uncontrolled release of stored water and tailings.

STABILITY ANALYSES

Slope stability analyses have been completed for the closure condition of the Lupin dams. The dam cross-sections are based on the historical design sections presented in the dam safety review report (SRK, 2016). A plan view with cross-section locations is shown on Figure 1. Material properties used in the analyses are based on previous work experience with similar materials and are presented in Table 2. The analyses have been completed using the limit equilibrium software, SLOPE-W, from GeoStudio 2018 (Version 9.0.4). The FOS values were calculated using the Spencer method in SLOPE/W.

Reference: 2 AM-LUP Technical Meeting Commitment Number 6 Response – Geotechnical Review on the Long-Term Stability of TCA Dams

Figure 1: Tailings Containment Area Stability Section Locations

Table 2: Material Properties

Material	Unit Weight (kN/m³)	Effective Stress Parameters
Esker (dam and cover fill)	30	c' = 0, φ' = 35°
Gravelly Sand	30	c' = 0, φ' = 35°
Rockfill	20	c' = 0, φ' = 39°
Tailings (Drained)	18	c' = 0, φ' = 30°
Tailings (Undrained)	18	Minimum strength: 20 kPa, Su/σ'v = 0.24
Till	18	c' = 0, φ' = 30°
Bedrock	Impenetrable	
Permafrost	Impenetrable	

A summary of FOS results for each scenario is presented in Table 3 and the SLOPE/W outputs are attached in Appendix A. If the as-built condition does not satisfy the stability criteria, the dam(s) will be re-sloped to meet the criteria.

Table 3: Summary of Stability Analyses Results

Cross-section	Configuration	Scenario		
		Static		Seismic
		Local	Global	Global
2	As-built	1.3	2.6	2.3
3	As-built	4.0	8.3	6.2
3D	As-built	1.3	3.7	3.3
4	As-built	2.9	3.3	2.9
6	As-built	1.3	2.4	2.4
1A	As-built	2.6	3.6	3.5
K	As-built	0.8*	1.8	1.5
	Re-sloped	1.3	1.8	1.6
L	As-built	1.6	2.1	1.9
M	As-built	1.0*	3.0	2.6
	Re-sloped	1.3	3.1	2.7
N	As-built	1.6	2.6	2.5
FOS Acceptance Criteria		≥ 1.3	≥ 1.5	≥ 1.1

*FOS value does not meet design criteria for as-built configuration, repair and re-sloping is required for closure.

Results in Table 3 show that the existing as-built dams meet the target FOS criteria except for dams M and K. Modifications to these dams are required and details are discussed below.

STABILITY CONCLUSIONS

Most of the Lupin dams (2, 3, 3D, 4, 6, 1A, L and N) meet target closure FOS criteria in their current as-built conditions. Dams M and K require re-sloping to satisfy acceptable FOS criteria, as follows:

- Dam M: re-slope to 2.1H:1V;
- Dam K: re-slope to 2.1H:1V

Once dams M and K have been re-sloped as listed above, all of the Lupin dams will satisfy the design closure criteria and will be performing as licensed.

Reference: 2 AM-LUP Technical Meeting Commitment Number 6 Response – Geotechnical Review on the Long-Term Stability of TCA Dams

SURFACE WATER MANAGEMENT

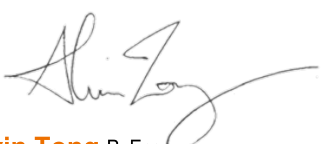
As part of the final closure and reclamation plan (FCRP), surface water management will be incorporated into the Cell 3 and 5 tailings cover to manage long term erosion potential. It is recognized that the existing topographies of the Cell 3 and 5 covers would have surface water flow over the dams that could cause erosion. The FCRP would incorporate surface water management into the to-be-constructed cover to minimize potential erosion of the dams. The to-be constructed tailings covers will be engineered and contoured to allow surface water to flow passively away from the face of the dam and into an engineered outflow structure. Both Cell 1 and 2 do not have significant gradient toward the dams and additional cover regrading is not required based on current information available. The design criteria for the surface water management on the covers are shown in Table 4.

Table 4: Surface Water Management Design Criteria

Parameter	Value
Design Event	1 in 100-year
Design maximum flow	0.8 m^3/s
Design maximum velocity	1.9 m/s
Cover maximum grade	0.5%
Outflow channel side slopes	Min. 3H:1V
Outflow channel bottom	5m
Outflow channel maximum grade	10%
Outflow channel armoring size	D_{50} = 0.26m

The Cell 3 engineered cover design is shown on Figure 2 and Cell 5 engineered cover design is shown on Figure 3. These should mitigate long term erosion potential over the dam face.

Stantec Consulting Ltd.



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Attachment: Figure 2 – Cell 3 Engineered Cover Design
Figure 3 – Cell 5 Engineered Cover Design
Appendix A – Stability Analyses Results

c.

References

CDA, 2014. Canadian Dam Association Publication, Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams.

Hynes-Griffin, 1984. Rationalizing the Seismic Coefficient Method, Department of the Army, Waterways Experiment Station, Corps of Engineers, 1984.

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Natural Resources of Canada, 2015. Natural Resources of Canada, PGA Seismic hazard map #10 (of 11)

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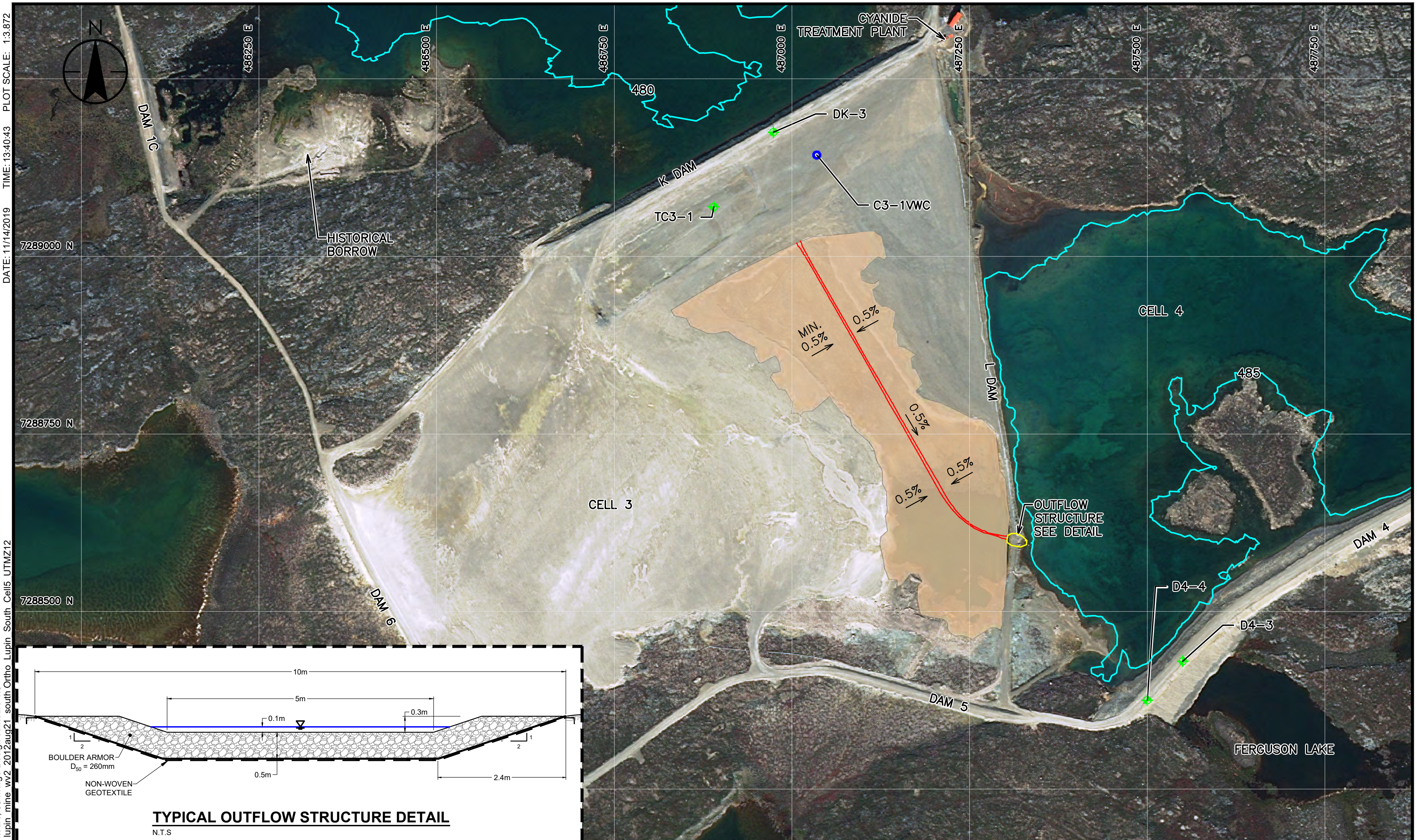


TYPICAL OUTFLOW STRUCTURE DETAIL

N.T.S

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

- SHALLOW SURFACE CHANNEL
- NEW TAILINGS COVER
- SURFACE WATER LEVEL

100m 50 0 100 200 300 400 500m

SCALE 1:7500

SCALES INDICATED BASED ON AN 8.5"x11" PLOT CONFIGURATION

LUPIN MINES INC.

PHC COMMENTS RESPONSE

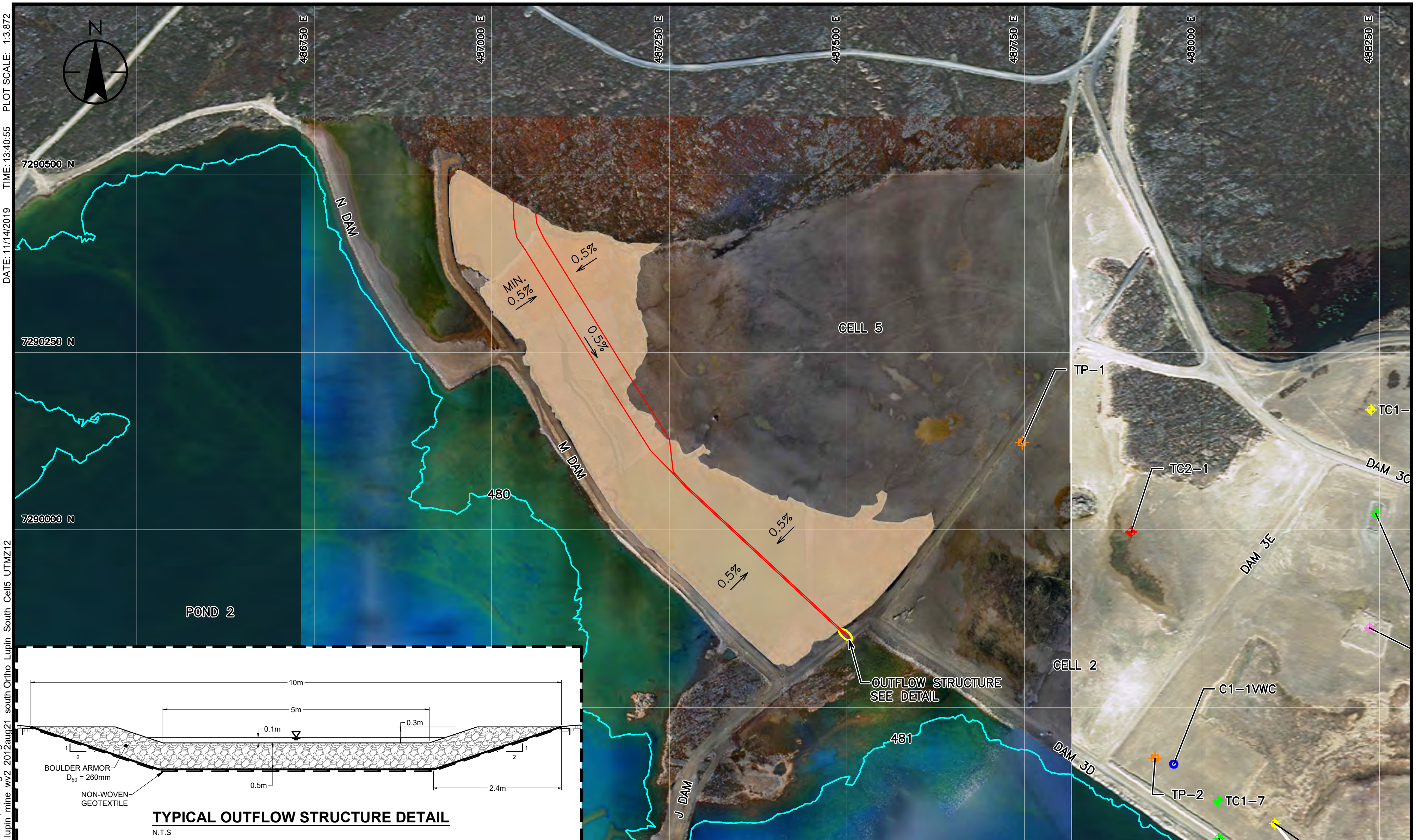
TAILINGS CONTAINMENT AREA
CELL 3 COVER AND SURFACE
WATER MANAGEMENT

SCALE:	AS SHOWN
DATE:	2019-11-14
CO-ORD. SYS.:	UTM83-12
DRW'N BY:	JL
DSG'N BY:	LK
REV'D BY:	AT
APP'D BY:	PK

Stantec

PROJECT NO.:	FIG. NO.:	REV.:
129500081	2	A

FILENAME: \\CA0200-PPFSS01\SHARED_PROJECTS\129500081\DISC\DRAFTING\04_TAILINGS CONTAINMENT AREA\01. CELL DESIGN.DWG
XREF FILE(S): 190924 Topo_cell 3 FIXED 0.5m contours; 03 Merge Design contours 1.0
IMAGE FILE(S): lupin_mine_wv2_2012aug21_north lupin_mine_wv2_2012aug21_south Ortho_Lupin_South_Cell5_UTMZ12



TYPICAL OUTFLOW STRUCTURE DETAIL
N.T.S

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

- SHALLOW SURFACE CHANNEL
- NEW TAILINGS COVER
- SURFACE WATER LEVEL

100m 50 0 100 200 300 400 500m

SCALE 1:7500

SCALES INDICATED BASED ON AN 8.5"x11" PLOT CONFIGURATION

LUPIN MINES INC.

PHC COMMENTS RESPONSE

TAILINGS CONTAINMENT AREA
CELL 5 COVER AND SURFACE
WATER MANAGEMENT

SCALE:	AS SHOWN
DATE:	2019-11-14
CO-ORD. SYS.:	UTM83-12
DRW'N BY:	JL
DSG'N BY:	LK
REV'D BY:	AT
APP'D BY:	PK

Stantec

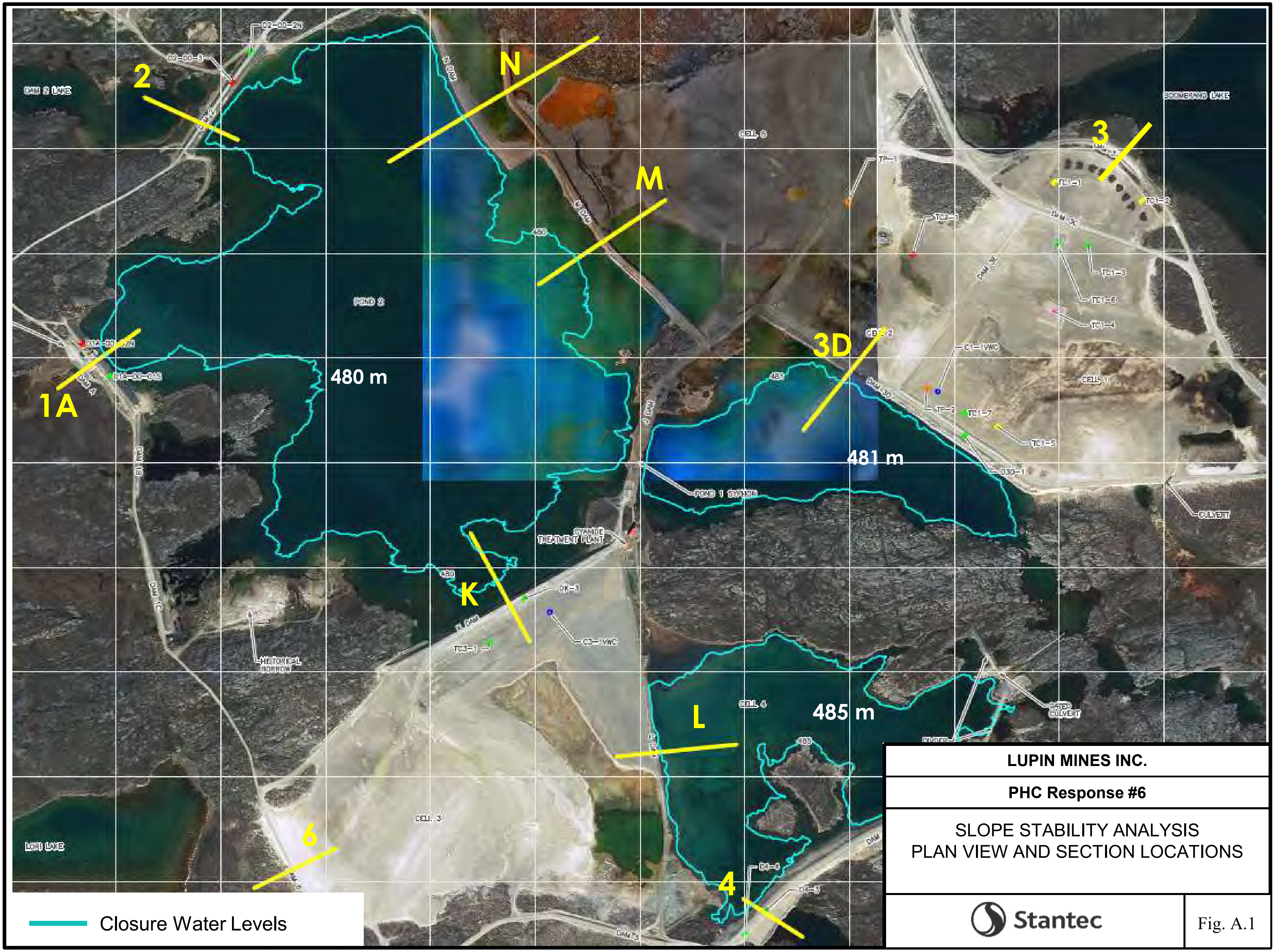
PROJECT NO.:	FIG. NO.:	REV.:
129500081	3	A

Appendix A

Lupin Mines Inc.
PHC Response #6
Tailings Containment Area

Slope Stability Analysis
(Rev 0)

November 13, 2019



LUPIN MINES INC.

PHC Response #6

SLOPE STABILITY ANALYSIS
PLAN VIEW AND SECTION LOCATIONS

Stantec

Fig. A.1

Fig. A1	Plan View Section Locations
Fig. A2	List of Analyses
Fig. A3	Section 2 – Permafrost Conditions, Static Case - Local Failure
Fig. A4	Section 2 - Permafrost Conditions, Static Case - Global Failure
Fig. A5	Section 2 - Permafrost Conditions, Pseudo-Static - Global Failure
Fig. A6	Section 3 - Permafrost Conditions, Static Case - Local Failure
Fig. A7	Section 3 - Permafrost Conditions, Static Case - Global Failure
Fig. A8	Section 3 - Permafrost Conditions, Pseudo-Static - Global Failure
Fig. A9	Section 3D - Permafrost Conditions, Static Case - Local Failure
Fig. A10	Section 3D - Permafrost Conditions, Static Case - Global Failure
Fig. A11	Section 3D - Permafrost Conditions, Pseudo-Static - Global Failure
Fig. A12	Section 4 - Permafrost Conditions, Static Case - Local Failure
Fig. A13	Section 4 - Permafrost Conditions, Static Case - Global Failure
Fig. A14	Section 4 - Permafrost Conditions, Pseudo-Static - Global Failure
Fig. A15	Section 6 - Permafrost Conditions, Static Case - Local Failure
Fig. A16	Section 6 - Permafrost Conditions, Static Case - Global Failure
Fig. A17	Section 6 - Permafrost Conditions, Pseudo-Static - Global Failure
Fig. A18	Section 1A - Permafrost Conditions, Static Case - Local Failure
Fig. A19	Section 1A - Permafrost Conditions, Static Case - Global Failure
Fig. A20	Section 1A - Permafrost Conditions, Pseudo-Static - Global Failure
Fig. A21	Section K - Permafrost Conditions, Static Case - Local Failure
Fig. A22	Section K - Permafrost Conditions, Static Case - Global Failure
Fig. A23	Section K - Permafrost Conditions, Pseudo-Static - Global Failure
Fig. A24	Section L - Permafrost Conditions, Static Case - Local Failure
Fig. A25	Section L - Permafrost Conditions, Static Case - Global Failure
Fig. A26	Section L - Permafrost Conditions, Pseudo-Static - Global Failure
Fig. A27	Section M - Permafrost Conditions, Static Case - Local Failure
Fig. A28	Section M - Permafrost Conditions, Static Case - Global Failure
Fig. A29	Section M - Permafrost Conditions, Pseudo-Static - Global Failure
Fig. A30	Section N - Permafrost Conditions, Static Case - Local Failure
Fig. A31	Section N - Permafrost Conditions, Static Case - Global Failure
Fig. A32	Section N - Permafrost Conditions, Pseudo-Static - Global Failure

LUPIN MINES INC.

PHC Response #6

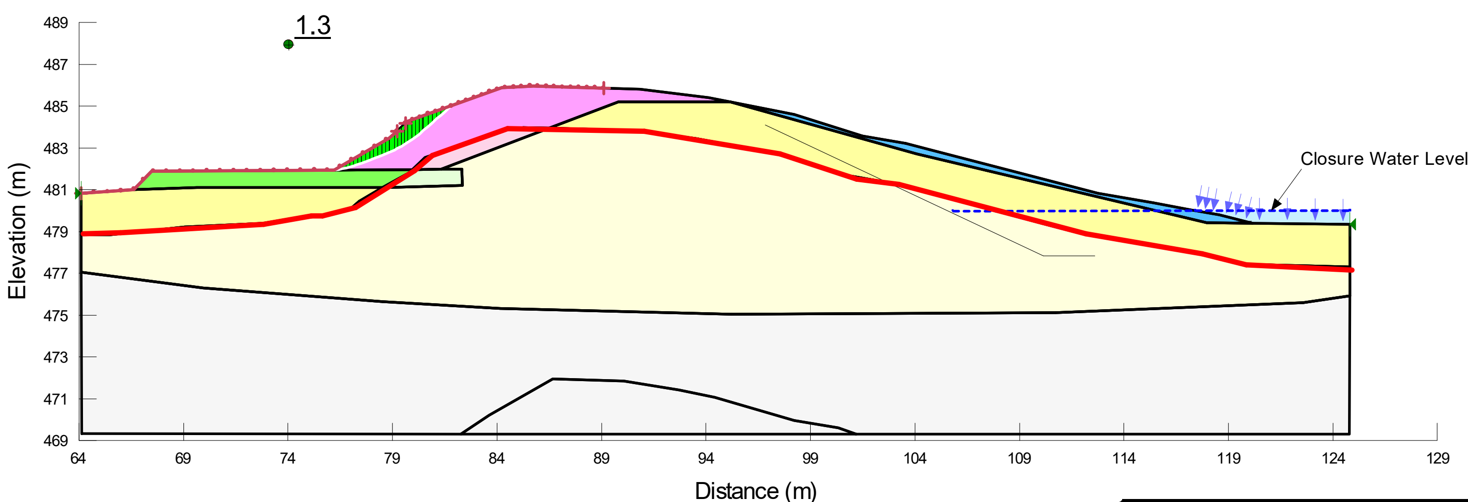
SLOPE STABILITY ANALYSIS
LIST OF ANALYSES

Stantec

Fig. A.2

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



Notes:
1. FOS is for optimized slip surface using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

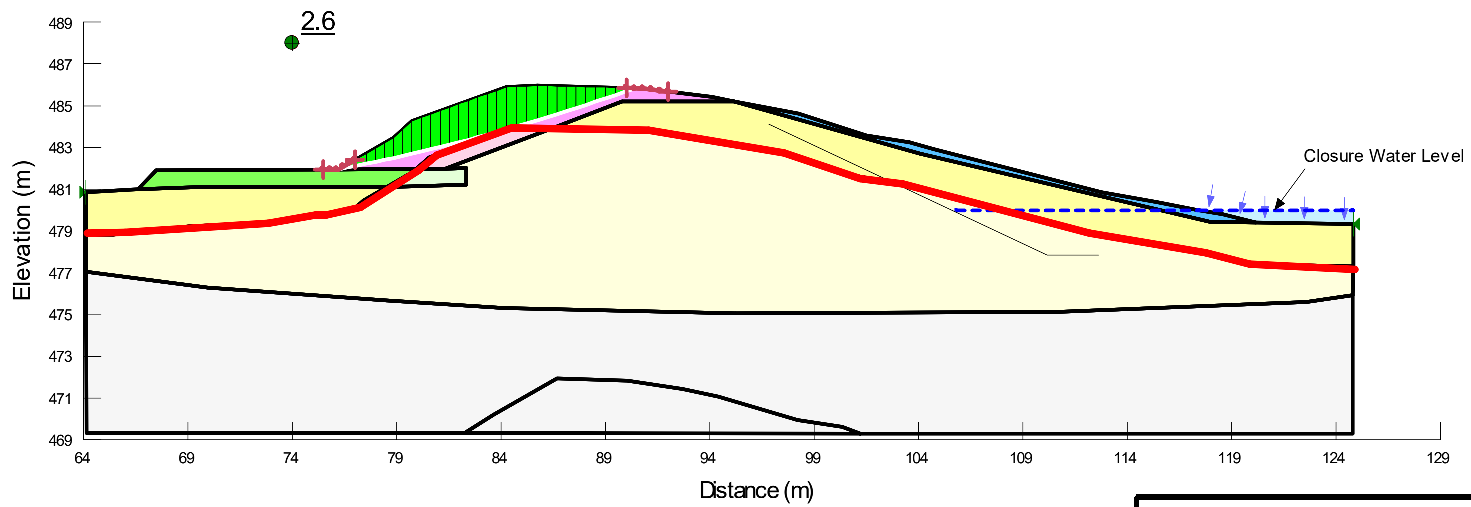
SLOPE STABILITY ANALYSIS
SECTION 2 – PERMAFROST CONDITIONS
STATIC CASE – LOCAL FAILURE

Stantec

Fig. A.3

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

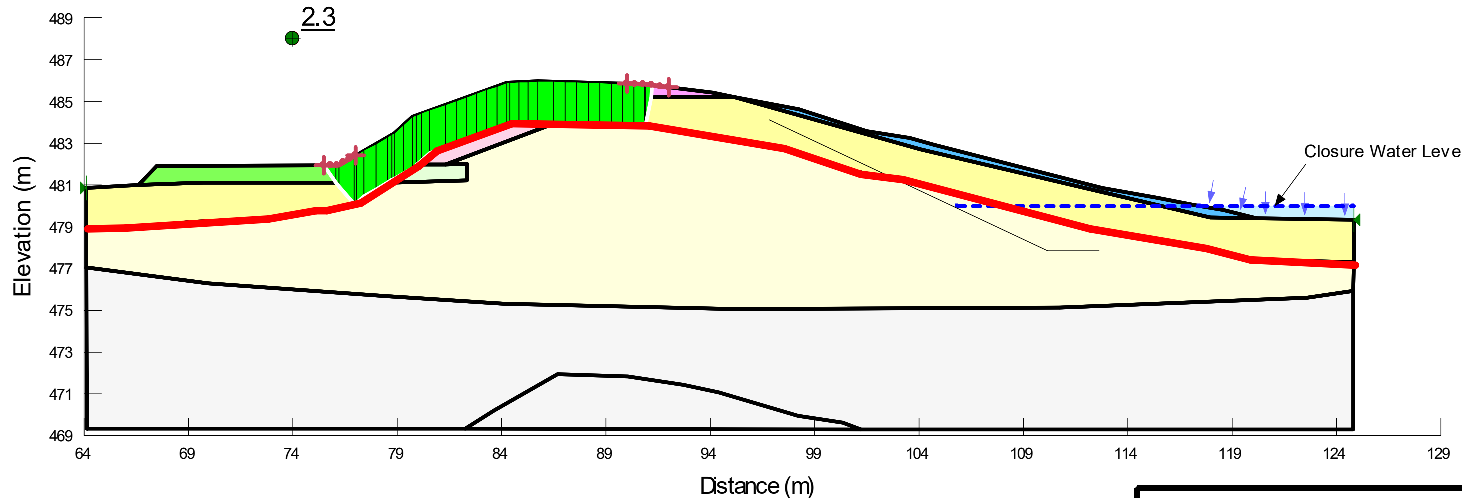
SLOPE STABILITY ANALYSIS
SECTION 2 – PERMAFROST CONDITIONS
STATIC CASE - GLOBAL FAILURE

Stantec

Fig. A.4

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

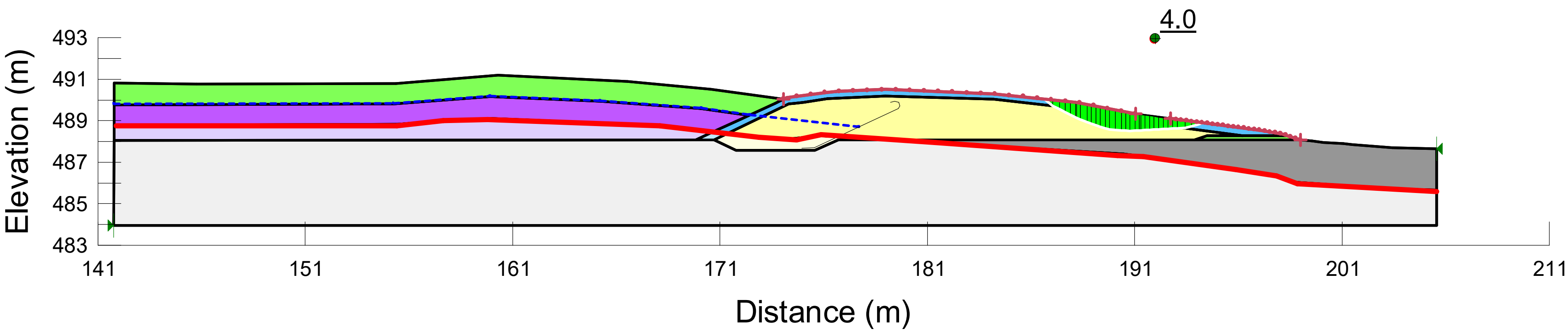
SLOPE STABILITY ANALYSIS
SECTION 2 – PERMAFROST CONDITIONS
PSEUDO-STATIC CASE – GLOBAL FAILURE

Stantec

Fig. A.5

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				



Notes:
1. FOS is for optimized slip surface using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

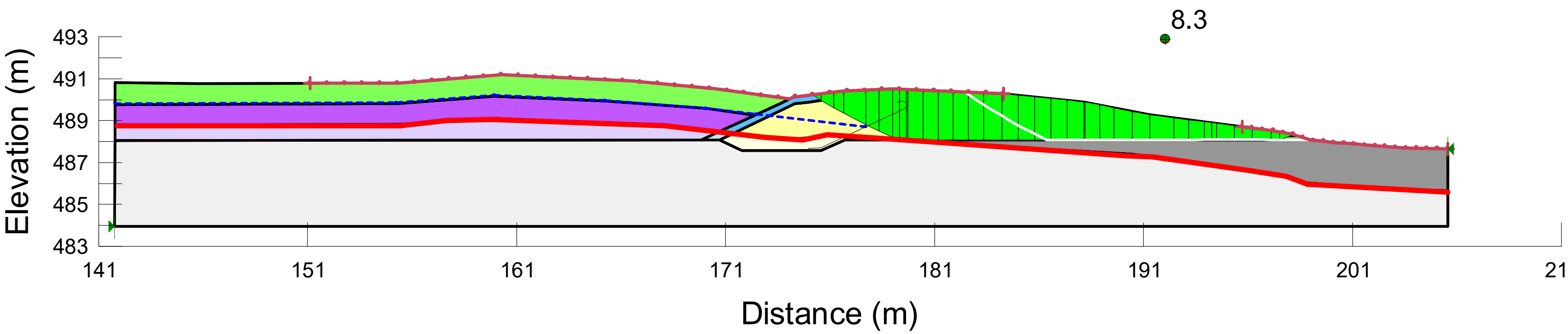
SLOPE STABILITY ANALYSIS
SECTION 3 – PERMAFROST CONDITIONS
STATIC CASE – LOCAL FAILURE

Stantec

Fig. A.6

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				

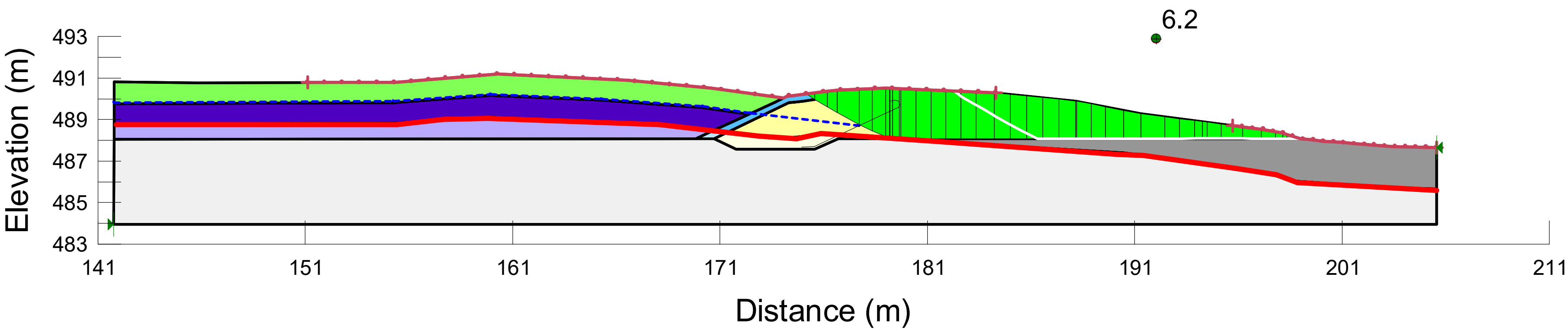


Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.	
PHC Response #6	
SLOPE STABILITY ANALYSIS SECTION 3 – PERMAFROST CONDITIONS STATIC CASE – GLOBAL FAILURE	
Stantec	Fig. A.7

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

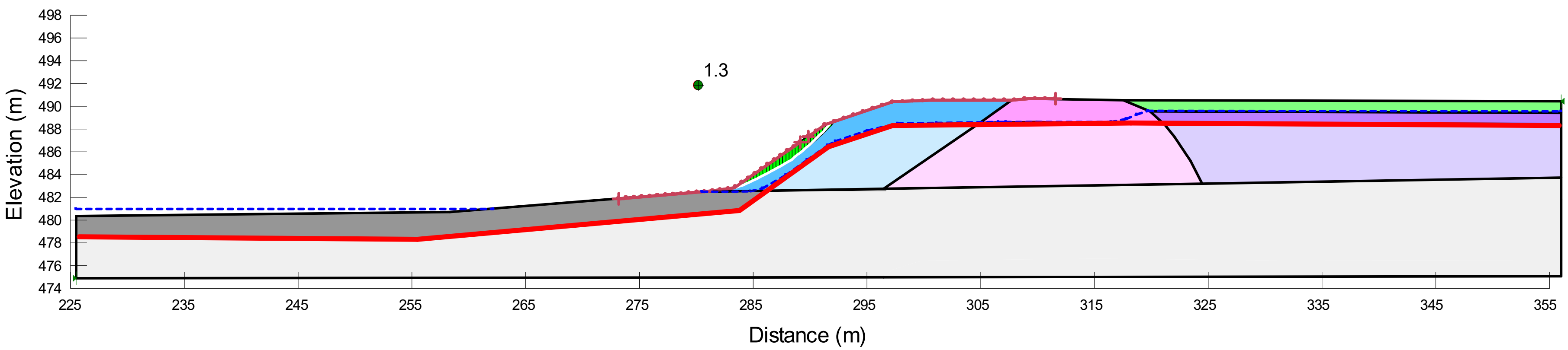
SLOPE STABILITY ANALYSIS
SECTION 3 – PERMAFROST CONDITIONS
PSEUDO-STATIC CASE – GLOBAL FAILURE

Stantec

Fig. A.8

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



Notes:
1. FOS is for optimized slip surface using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

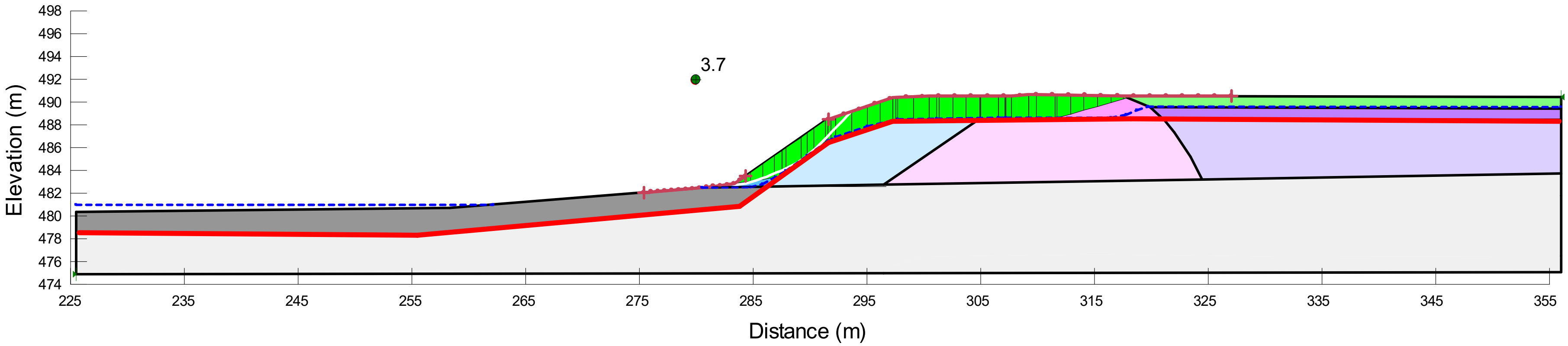
SLOPE STABILITY ANALYSIS
SECTION 3D – PERMAFROST CONDITIONS
STATIC CASE – LOCAL FAILURE

Stantec

Fig. A.9

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

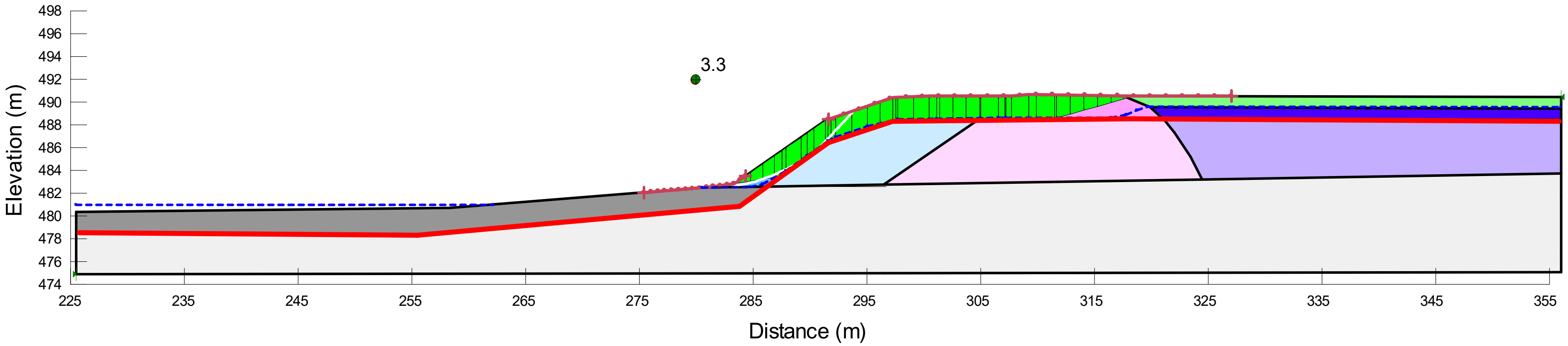
SLOPE STABILITY ANALYSIS
SECTION 3D – PERMAFROST CONDITIONS
STATIC CASE - GLOBAL FAILURE

Stantec

Fig. A.10

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				

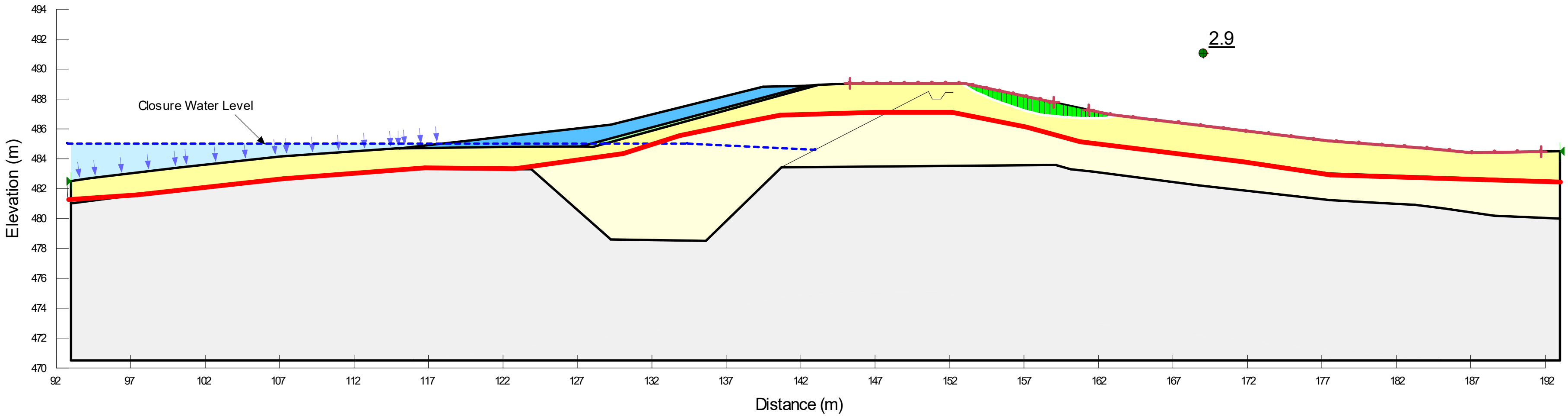


Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.
PHC Response #6
SLOPE STABILITY ANALYSIS SECTION 3D – PERMAFROST CONDITIONS PSEUDO-STATIC CASE – GLOBAL FAILURE
Stantec — Fig. A.11

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



Notes:
1. FOS is for optimized slip surface using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

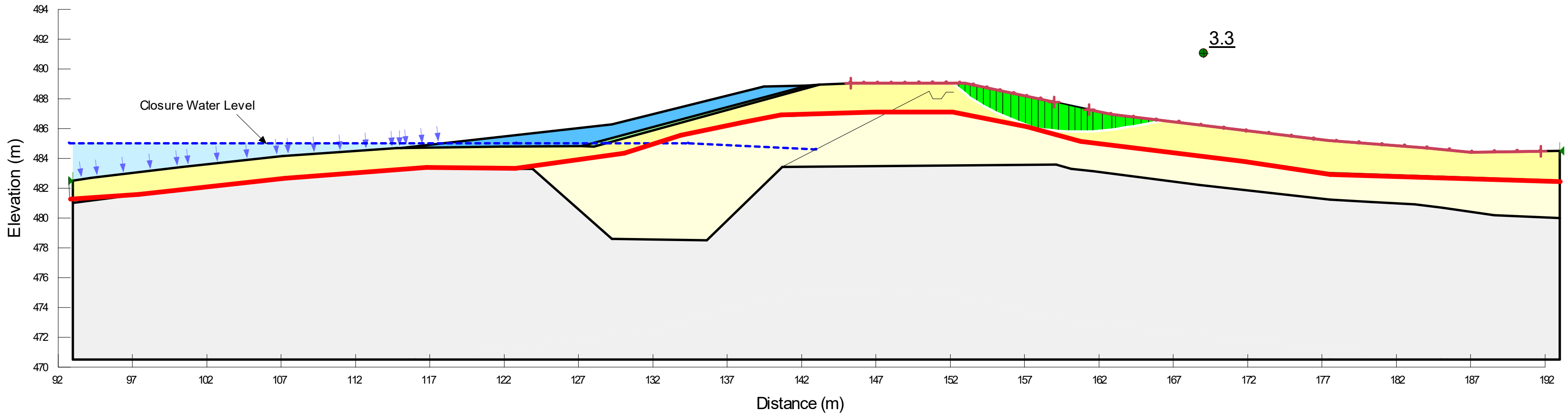
LUPIN MINES INC.
PHC Response #6
SLOPE STABILITY ANALYSIS SECTION 4 – PERMAFROST CONDITIONS STATIC CASE – LOCAL FAILURE

Stantec

Fig. A.12

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				

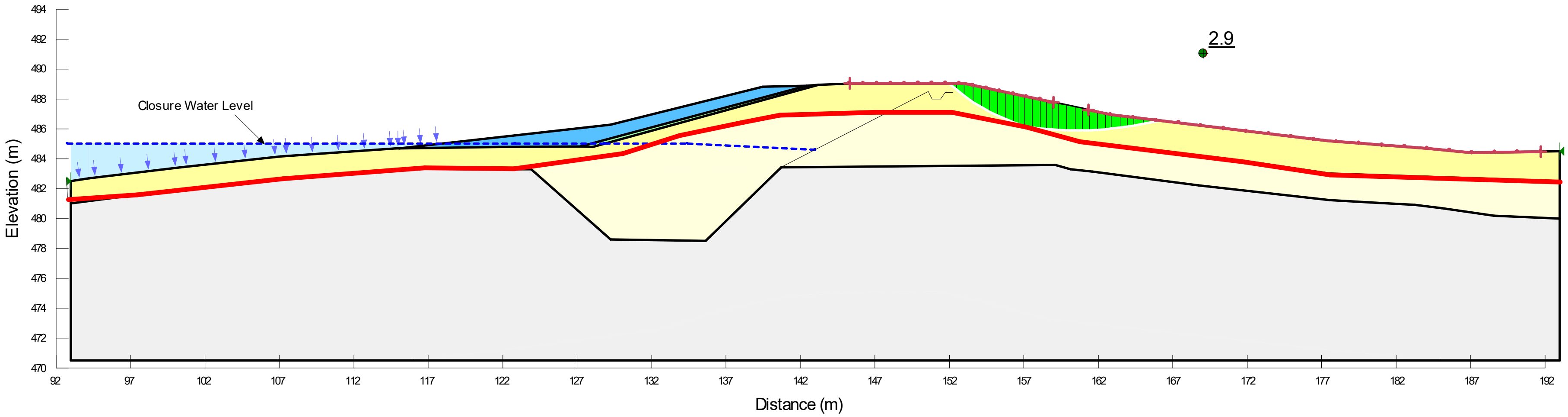


Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.	
2019 DAM SAFETY REVIEW	
SLOPE STABILITY ANALYSIS SECTION 4 – PERMAFROST CONDITIONS STATIC CASE - GLOBAL FAILURE	
Stantec	Fig. A.13

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

SLOPE STABILITY ANALYSIS
SECTION 4 – PERMAFROST CONDITIONS
PSEUDO-STATIC CASE – GLOBAL FAILURE

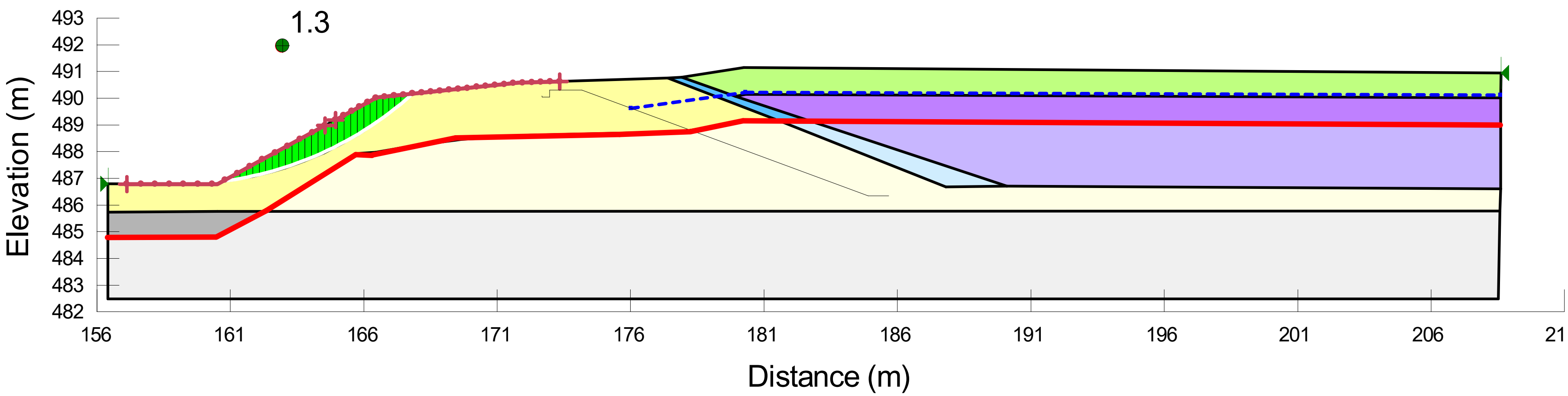
Stantec

Fig. A.14

Details:

Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material	Unit Weight (kN/m^3)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				



Notes:

1. FOS is for optimized slip surface using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

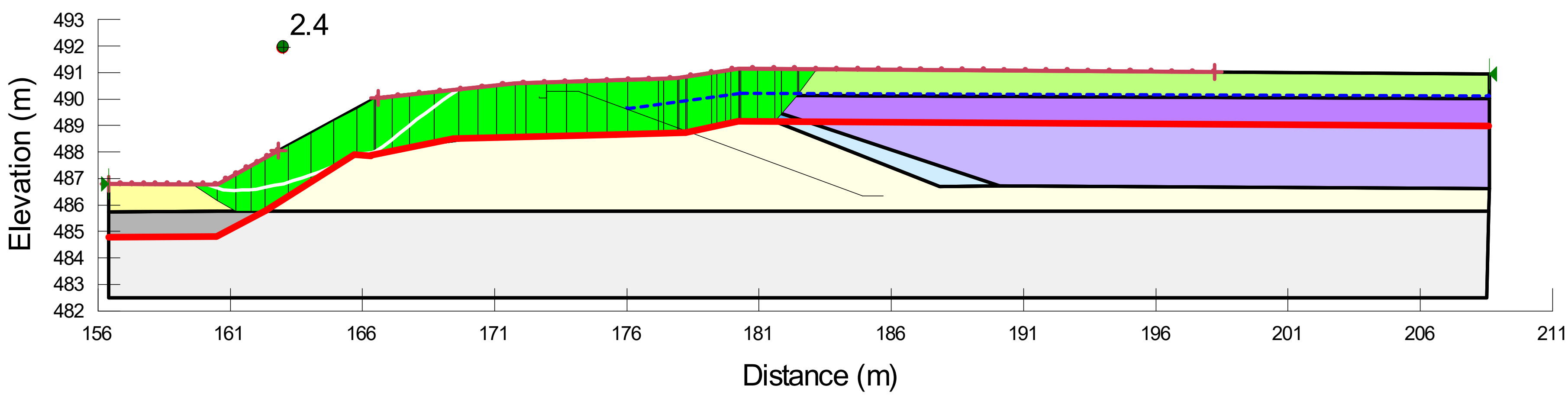
SLOPE STABILITY ANALYSIS
SECTION 6 – PERMAFROST CONDITIONS
STATIC CASE – LOCAL FAILURE

Stantec

Fig. A.15

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

	Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



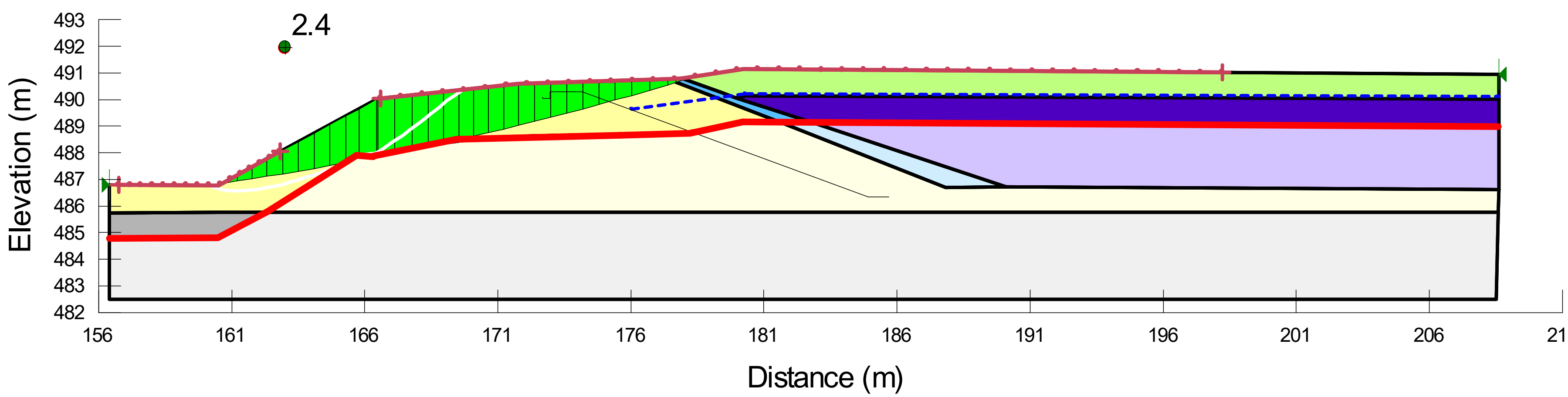
Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.	
PHC Response #6	
SLOPE STABILITY ANALYSIS SECTION 6 – PERMAFROST CONDITIONS STATIC CASE - GLOBAL FAILURE	
Stantec	Fig. A.16

Details:

Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



Notes:

1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

SLOPE STABILITY ANALYSIS
SECTION 6 – PERMAFROST CONDITIONS
PSEUDO-STATIC CASE – GLOBAL FAILURE

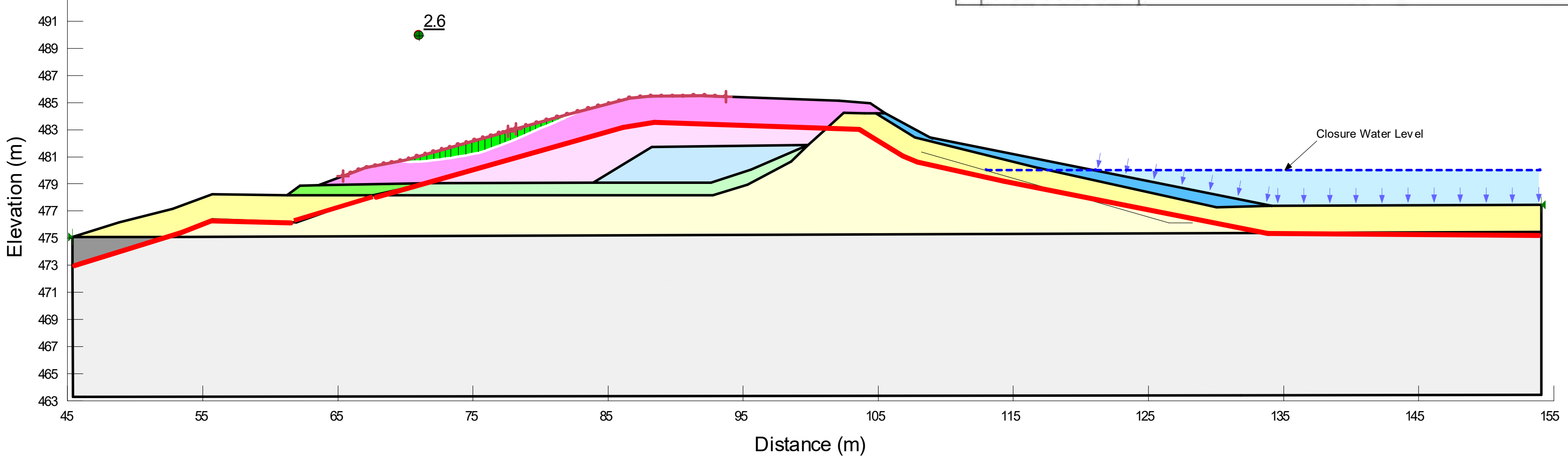
Stantec

Fig. A.17

Details:

Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				



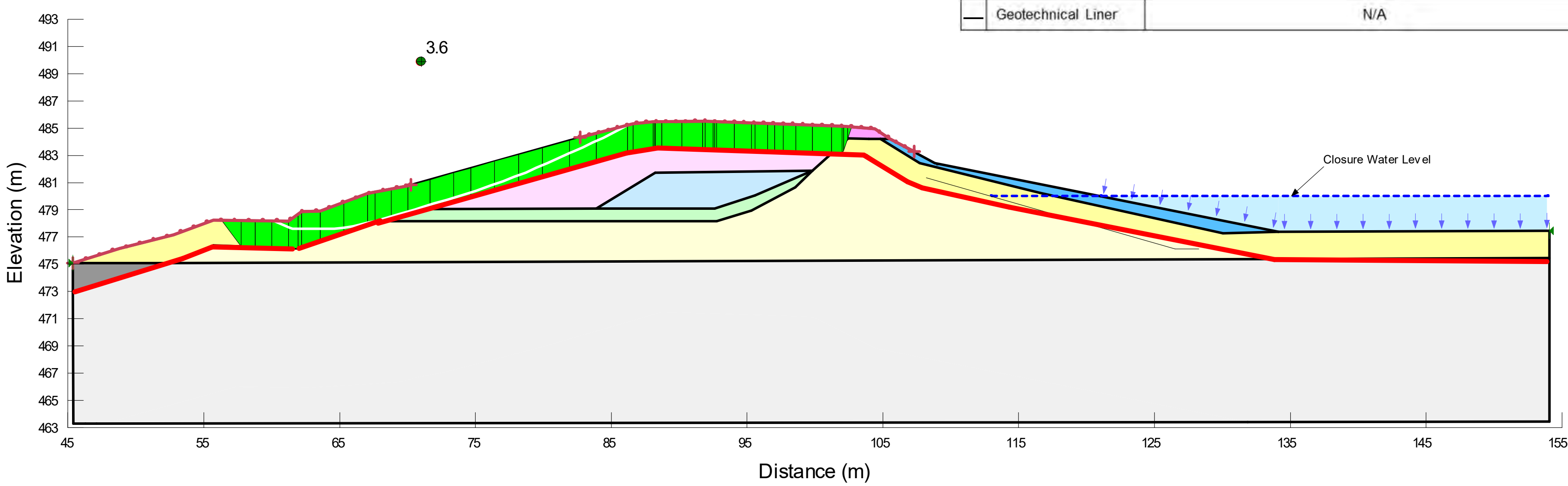
Notes:
1. FOS is for optimized slip surface using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.
PHC Response #6
SLOPE STABILITY ANALYSIS SECTION 1A – PERMAFROST CONDITIONS STATIC CASE – LOCAL FAILURE
Stantec — Fig. A.18

Details:

Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				



Notes:

1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

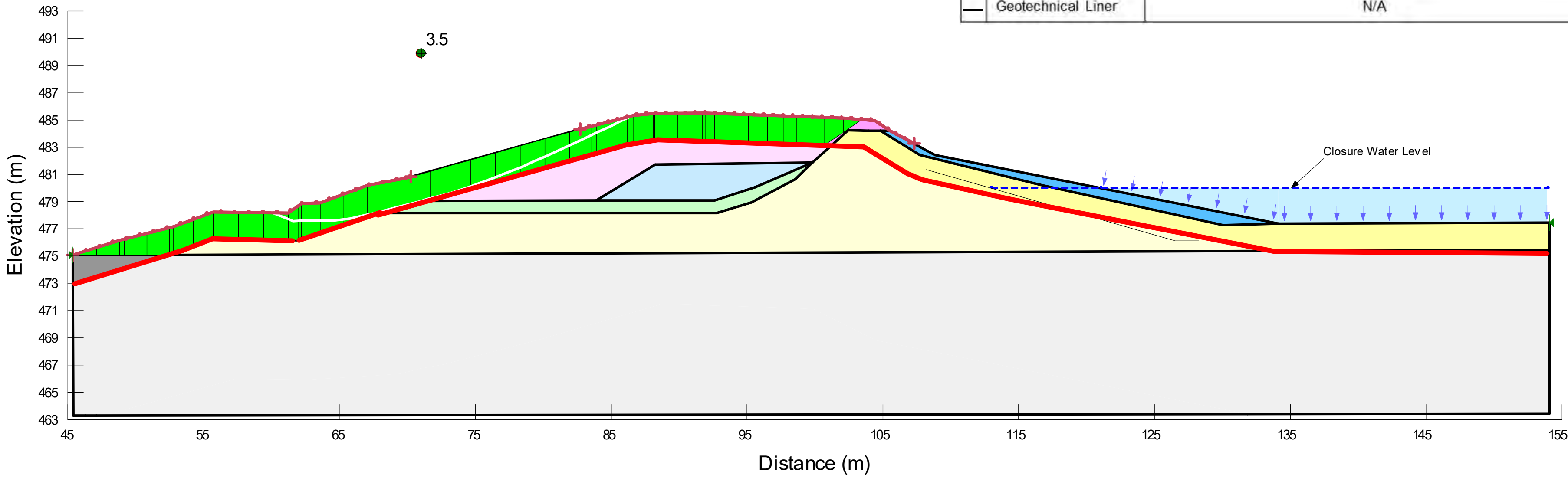
SLOPE STABILITY ANALYSIS
SECTION 1A – PERMAFROST CONDITIONS
STATIC CASE - GLOBAL FAILURE

Stantec

Fig. A.19

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

SLOPE STABILITY ANALYSIS
SECTION 1A – PERMAFROST CONDITIONS
PSEUDO-STATIC CASE – GLOBAL FAILURE

Stantec

Fig. A.20

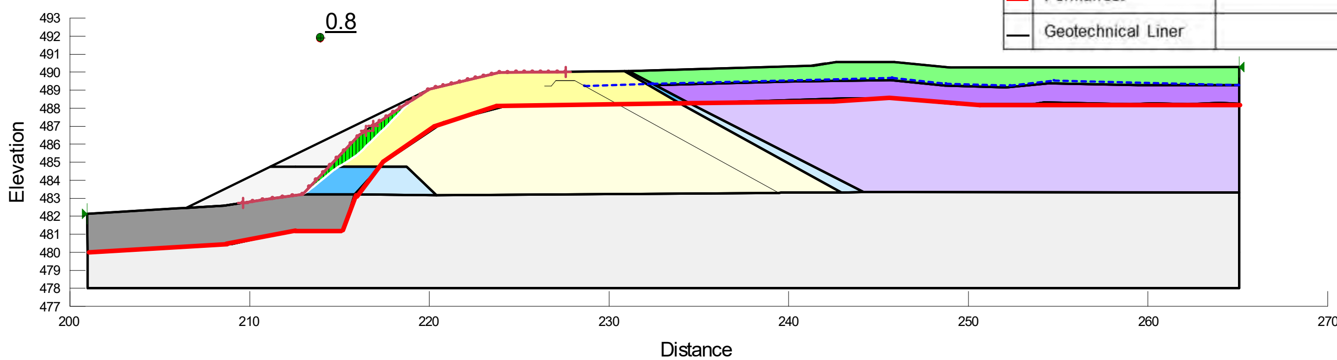
Details:

Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

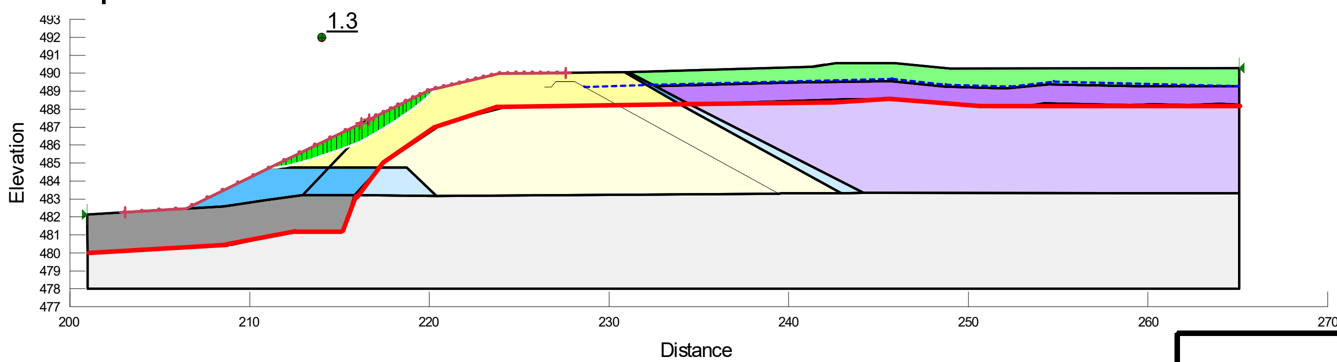
Re-sloped Conditions: regraded to 2H:1V to reach minimum FOS criteria

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				

As Built Conditions



Re-sloped Conditions



Notes:

1. FOS is for optimized slip surface using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

SLOPE STABILITY ANALYSIS
SECTION K – PERMAFROST CONDITIONS
STATIC CASE – LOCAL FAILURE

Stantec

Fig. A.21

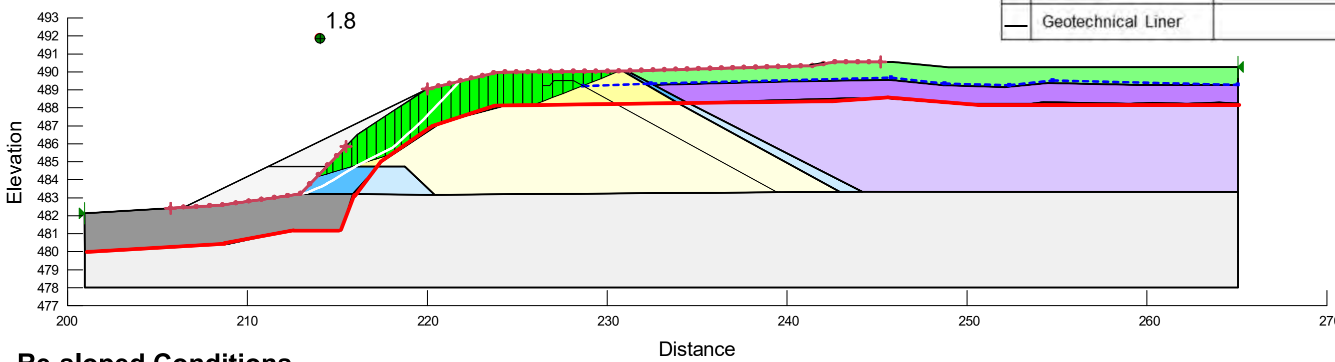
Details:

Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

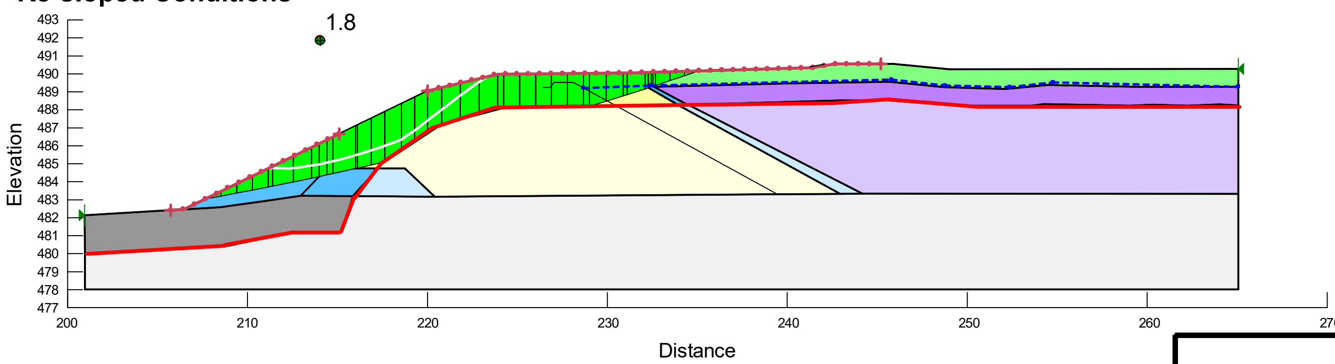
Re-sloped Conditions: regraded to 2H:1V to reach minimum FOS criteria

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				

As Built Conditions



Re-sloped Conditions



Notes:

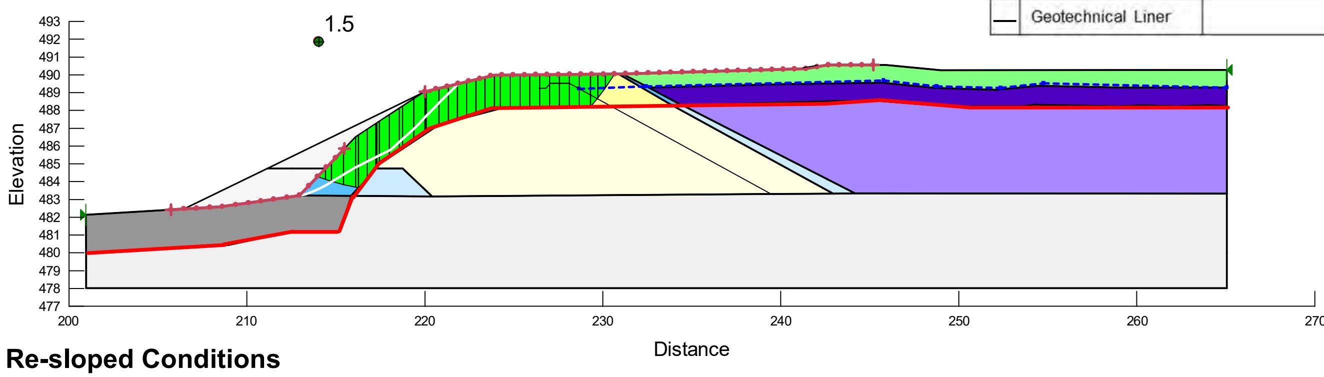
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.
PHC Response #6
SLOPE STABILITY ANALYSIS SECTION K – PERMAFROST CONDITIONS STATIC CASE - GLOBAL FAILURE
Stantec — Fig. A.22

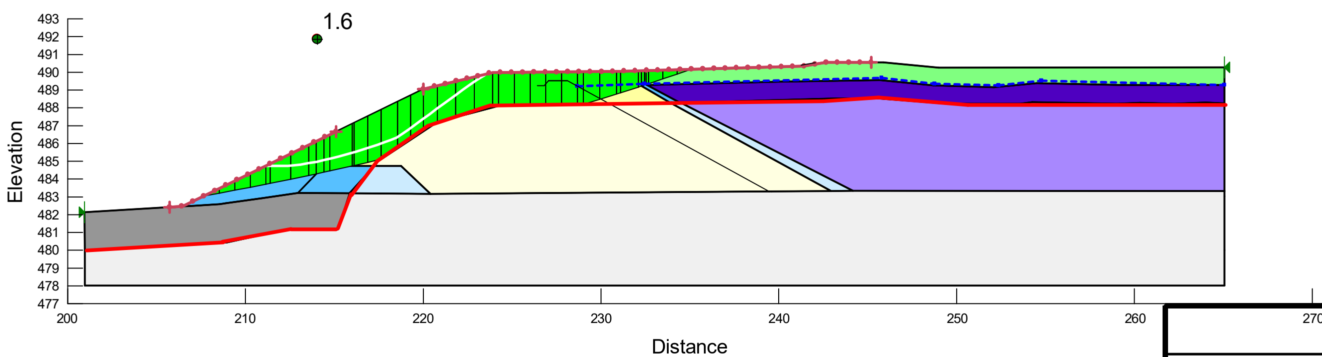
Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface
Re-sloped Conditions: regraded to 2H:1V to reach minimum FOS criteria

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				

As Built Conditions



Re-sloped Conditions



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

SLOPE STABILITY ANALYSIS
SECTION K – PERMAFROST CONDITIONS
PSEUDO-STATIC CASE – GLOBAL FAILURE

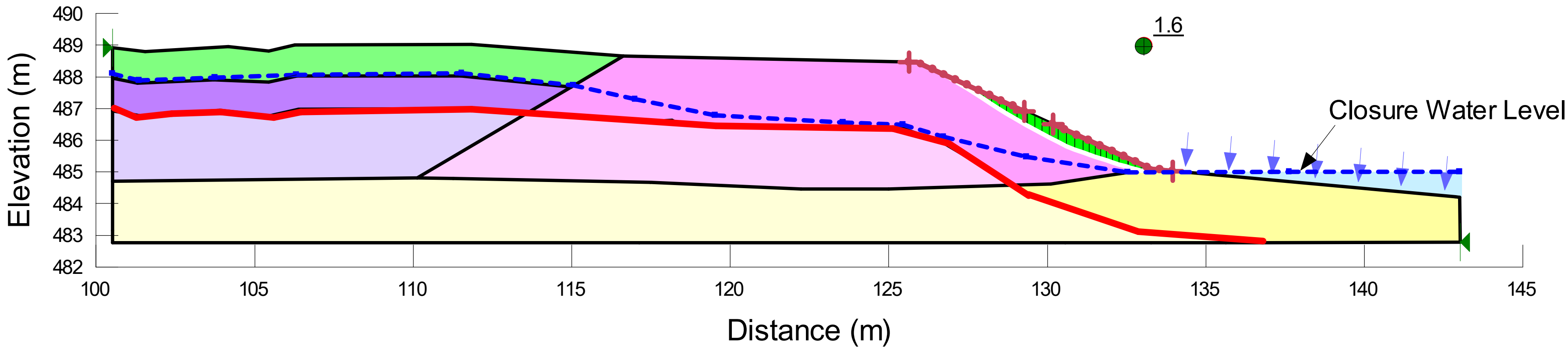
Stantec

Fig. A.23

Details:

Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				



Notes:
1. FOS is for optimized slip surface using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

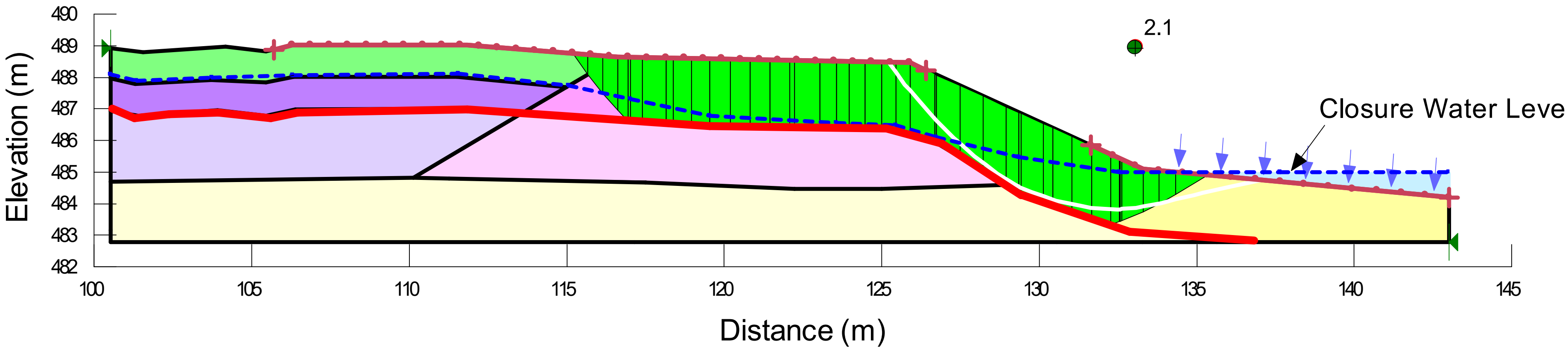
SLOPE STABILITY ANALYSIS
SECTION L – PERMAFROST CONDITIONS
STATIC CASE – LOCAL FAILURE

Stantec

Fig. A.24

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

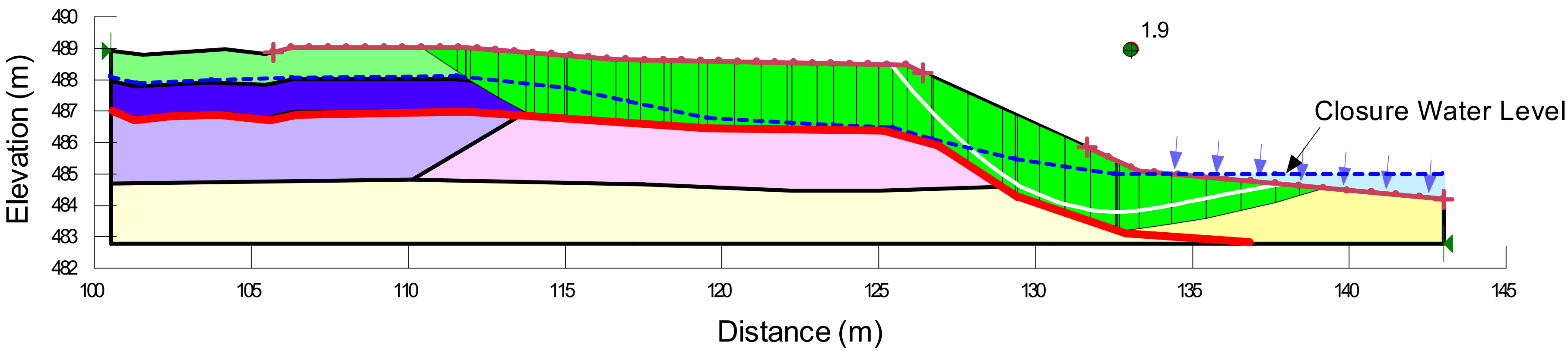
SLOPE STABILITY ANALYSIS
SECTION L – PERMAFROST CONDITIONS
STATIC CASE - GLOBAL FAILURE

Stantec

Fig. A.25

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



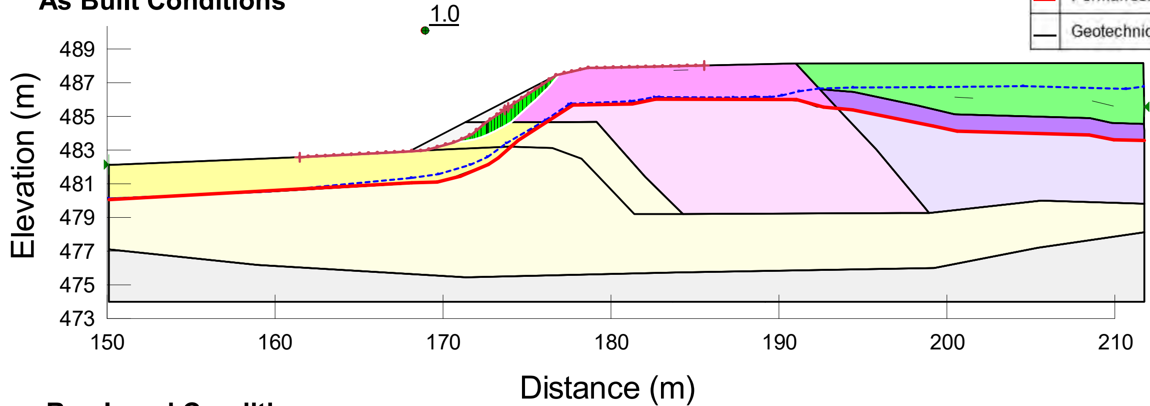
Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.	
PHC Response #6	
SLOPE STABILITY ANALYSIS SECTION L – PERMAFROST CONDITIONS PSEUDO-STATIC CASE – GLOBAL FAILURE	
Stantec	Fig. A.26

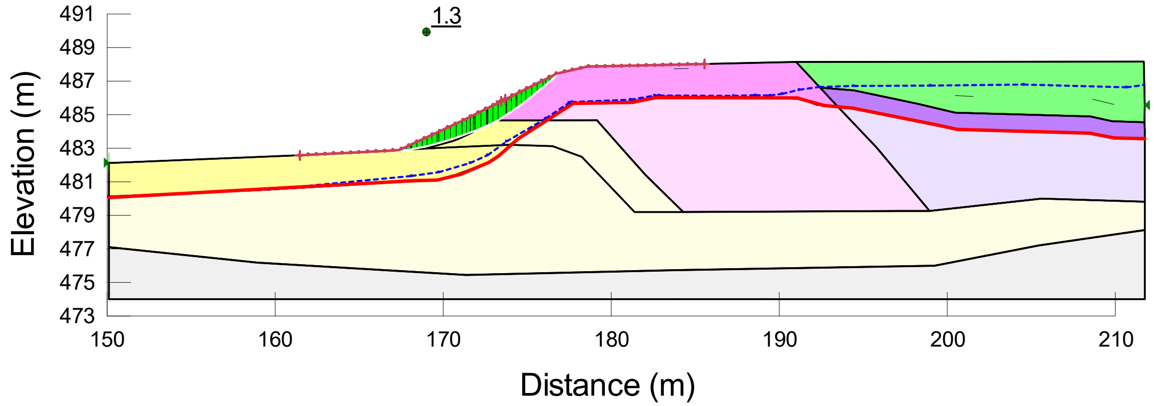
Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface
Re-sloped Conditions: regraded to 2H:1V to reach minimum FOS criteria

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				

As Built Conditions



Re-sloped Conditions



Notes:
1. FOS is for optimized slip surface using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

SLOPE STABILITY ANALYSIS
SECTION M – PERMAFROST CONDITIONS
STATIC CASE – LOCAL FAILURE

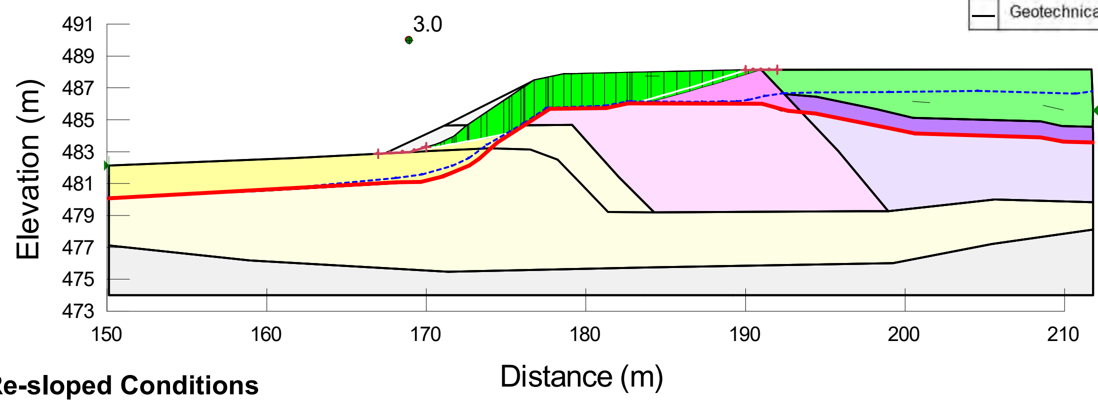
Stantec

Fig. A.27

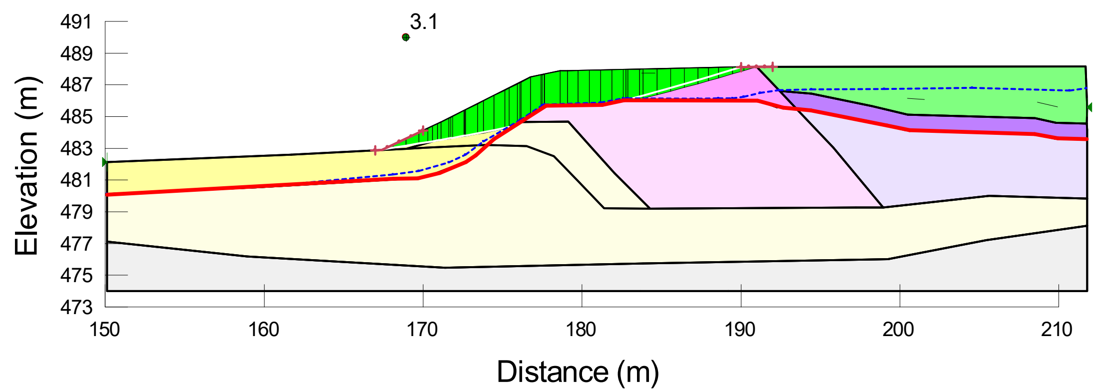
Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface
Re-sloped Conditions: regraded to 2H:1V to reach minimum FOS criteria

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				

As Built Conditions



Re-sloped Conditions



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

SLOPE STABILITY ANALYSIS
SECTION M – PERMAFROST CONDITIONS
STATIC CASE - GLOBAL FAILURE

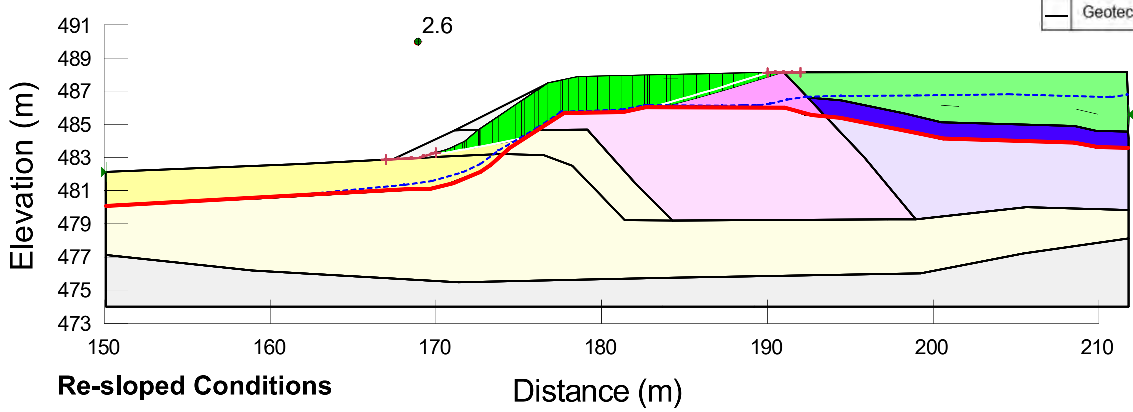
Stantec

Fig. A.28

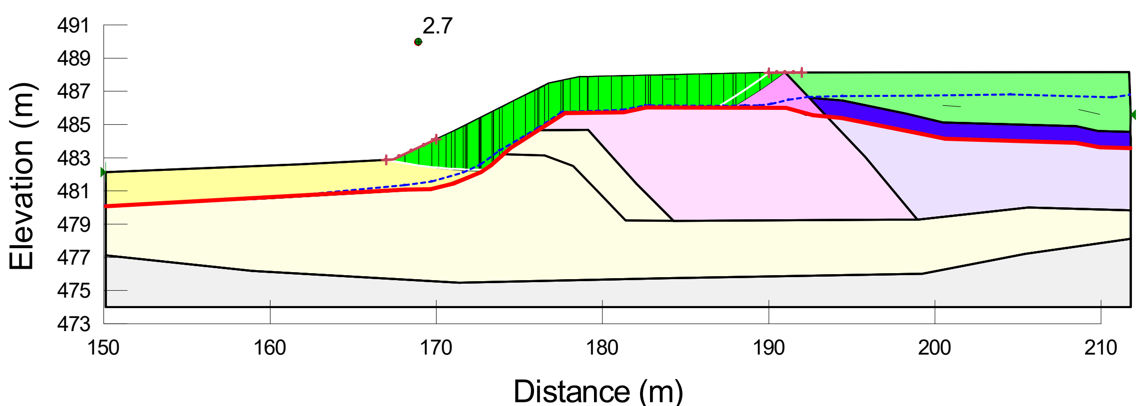
Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface
Re-sloped Conditions: regraded to 2H:1V to reach minimum FOS criteria

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				

As Built Conditions



Re-sloped Conditions



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

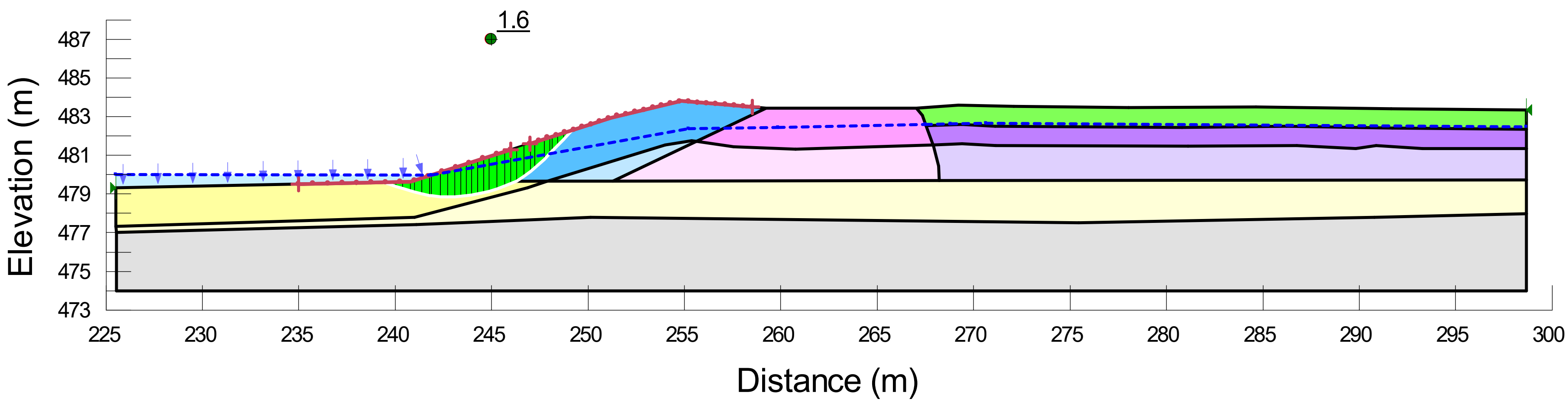
SLOPE STABILITY ANALYSIS
SECTION M – PERMAFROST CONDITIONS
PSEUDO-STATIC CASE – GLOBAL FAILURE

Stantec

Fig. A.29

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material		Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				

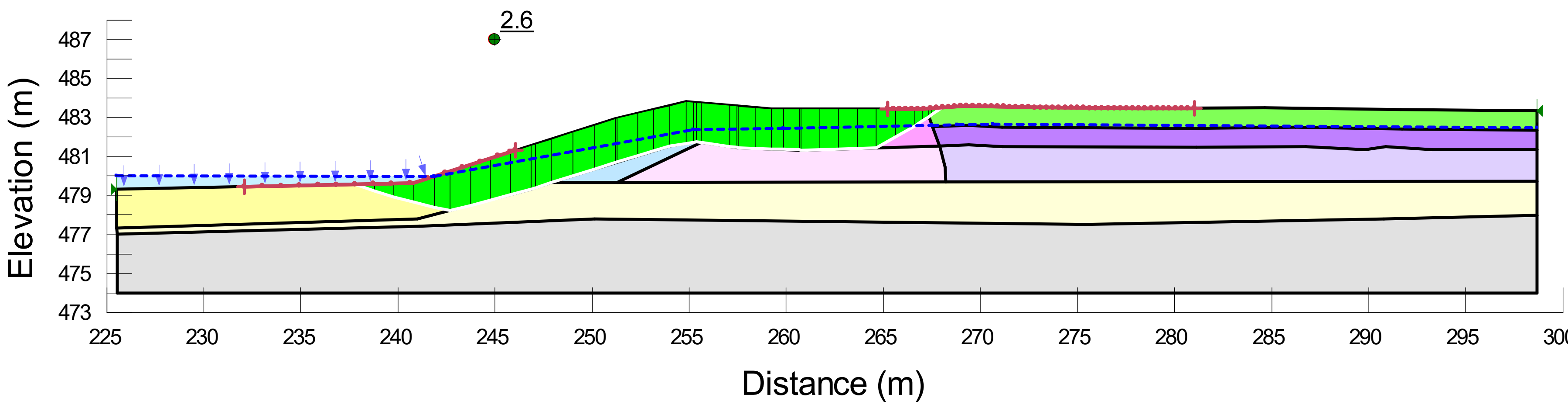


Notes:
1. FOS is for optimized slip surface using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.	
PHC Response #6	
SLOPE STABILITY ANALYSIS SECTION N – PERMAFROST CONDITIONS STATIC CASE – LOCAL FAILURE	
Stantec	Fig. A.30

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

	Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
			Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
	Esker	30	35°	0	N/A	
	Gravelly Sand	30	35°	0	N/A	
	Rockfill	20	39°	0	N/A	
	Tailings (Drained)	18	30°	0	N/A	
	Tailings (Undrained)	18	N/A		20	0.24
	Till	18	30°	0	N/A	
	Bedrock	Impenetrable				
	Permafrost	N/A				
	Geotechnical Liner	N/A				



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

LUPIN MINES INC.

PHC Response #6

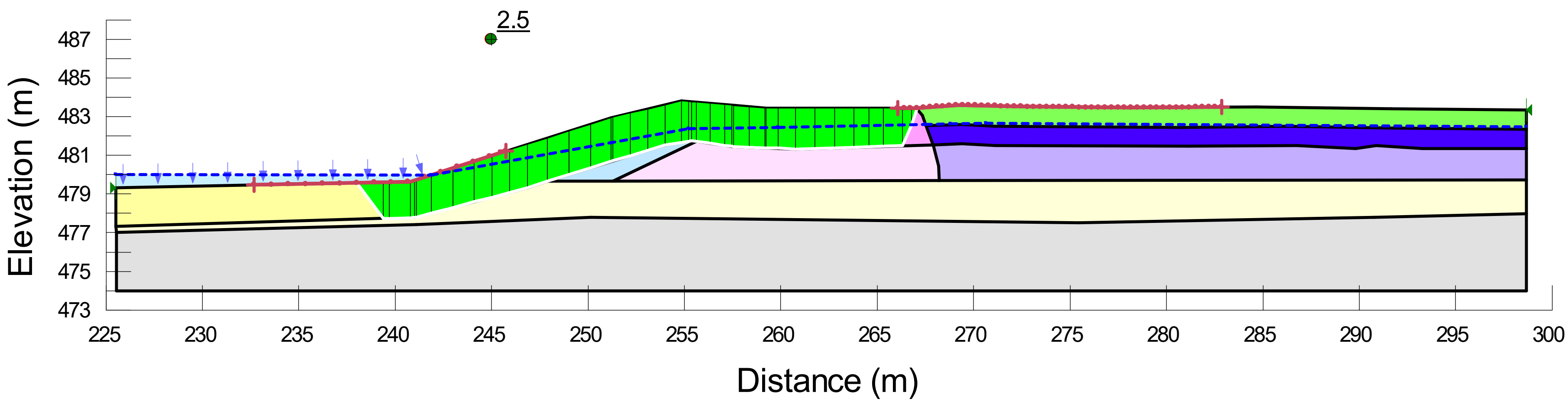
SLOPE STABILITY ANALYSIS
SECTION N – PERMAFROST CONDITIONS
STATIC CASE - GLOBAL FAILURE

Stantec

Fig. A.31

Details:
Current Permafrost Conditions: permafrost is present at depth 2m below ground surface

Material	Unit Weight (kN/m³)	Drained Parameters		Undrained Parameters	
		Friction Angle (°)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio
Esker	30	35°	0	N/A	
Gravelly Sand	30	35°	0	N/A	
Rockfill	20	39°	0	N/A	
Tailings (Drained)	18	30°	0	N/A	
Tailings (Undrained)	18	N/A		20	0.24
Till	18	30°	0	N/A	
Bedrock	Impenetrable				
Permafrost	N/A				
Geotechnical Liner	N/A				



Notes:
1. FOS is for global failure that breaches the dam using Spencer method in SLOPE/W (GeoStudio 2018, version 9.0.4).

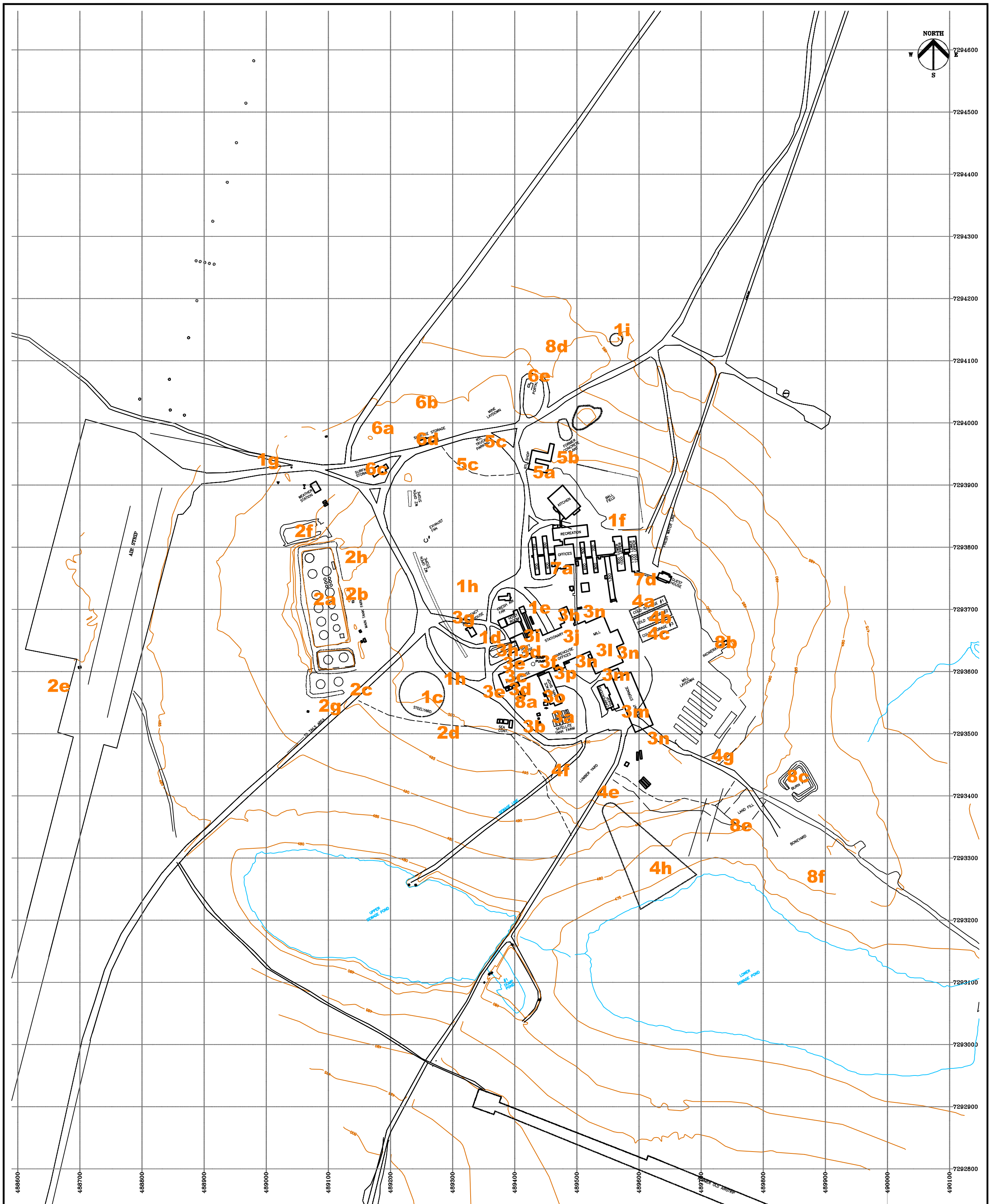
LUPIN MINES INC.

PHC Response #6

SLOPE STABILITY ANALYSIS
SECTION N – PERMAFROST CONDITIONS
PSEUDO-STATIC CASE – GLOBAL FAILURE

Stantec

Fig. A.32



LEGEND	
3b	AREA OF POTENTIAL ENVIRONMENTAL CONCERN

0 50 100 200 METRES

NOTES

1. ORIGINAL DRAWING IN COLOUR.
2. LOCATION OF EXISTING UTILITIES SHOWN ARE APPROXIMATE ONLY AND SHOULD BE CONFIRMED ON SITE. NOT ALL UTILITIES MAY BE SHOWN.

REFERENCE DRAWINGS

DWG. NO.	DATE	DESCRIPTION
–	–	–

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK
0				

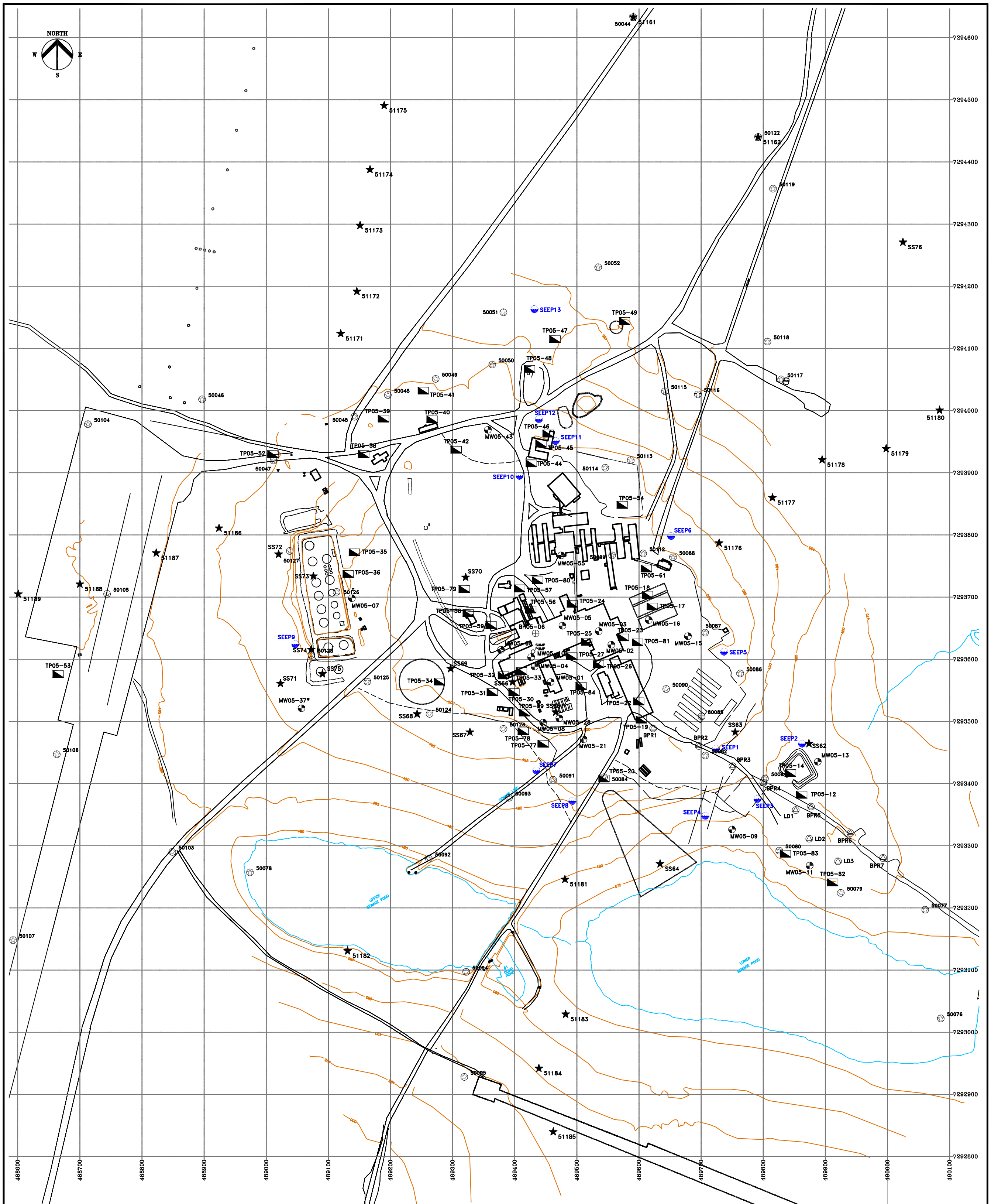
MORROW

CLIENT NAME: KINROSS GOLD CORPORATION

PROJECT LOCATION: LUPIN MINE NUNAVUT

TITLE: **AREAS OF POTENTIAL ENVIRONMENTAL CONCERN**

DWN BY: VAD/CDC	SCALE: 1:4,000	DATE: 2005–08–02	DWG No:	REV.: 0
CHK'D: MT	PLOT: 20040305.1300	CADFILE: A053017R00	A053017-005	



LEGEND

0 50 100 200 METRES

- MONITORING WELL LOCATION (BY MORROW)
- BOREHOLE LOCATION (BY MORROW)
- TEST PIT LOCATION (BY MORROW)
- SURFACE SOIL SAMPLE LOCATION (BY MORROW)
- SURFACE WATER SAMPLE LOCATION (BY MORROW)
- 2004 ABA DRILL LOCATIONS (BY KINROSS)
- 2004 ABA SURFACE SOIL SAMPLE LOCATIONS (BY KINROSS)
- FORMER FACILITIES
- SURFACE WATER FEATURE
- TOPOGRAPHIC CONTOUR LINE

NOTES

1. ORIGINAL DRAWING IN COLOUR.
2. LOCATION OF EXISTING UTILITIES SHOWN ARE APPROXIMATE ONLY AND SHOULD BE CONFIRMED ON SITE. NOT ALL UTILITIES MAY BE SHOWN.

REFERENCE DRAWINGS

DWG. NO.	DATE	DESCRIPTION
–	–	–

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK
0				

MORROW

CLIENT NAME: KINROSS GOLD CORPORATION

PROJECT LOCATION: LUPIN MINE NUNAVUT

TITLE: **INVESTIGATION LOCATIONS**

DWN BY: CZ/VAD	SCALE: 1:4,000	DATE: 2005-08-02	DWG No:	REV.: 0
CHK'D: MT	PLOT: 20040305.1300	CADFILE: A053017R00	A053017-004	

TABLE M: Areas of Potential Environmental Concern Related to Bulk Materials

APEC	Description of Area	Potential Contaminants of Concern (PCOCs)	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
1a[1]	Development rock used for entire footprint of Mill complex	Metals PAG/ARD-ML	Since the padded area of the site is comprised of waste/development rock, metals are considered a PCOC at all locations. Seeps (i.e., direct groundwater discharge) have been observed draining from all sides of the development rock.	All	Samples of development rock collected at all APECs analyzed for total metals, paste pH, and sulphide. Sampling groundwater and all seeps within and around the footprint also addresses the potential for leachate from the rock.	total metals, paste pH, and sulphide	Dissolved metals and sulphate, routine water quality	Total metals and sulphate, routine water quality
1b[1]	Site Roads	per 1a	Site roads are identified as an APEC in the RFP and Restoration Plan. The assessment of the areas described above may adequately assess the site roads since they are constructed of the same materials, with the exception of those specifically referenced below. It is noted that if the roads stay in place they may be considered beneficial use.	All	Kinross had collected samples from the roads during previous ABA assessments. Ten samples collected by Kinross personnel (51161 through 51170).	per 1a	per 1a	per 1a
1c	Former Surface Ore Stockpile	per 1a	Ore may have been left or leached at the former ore stockpile.	n/a	Test pit 05-34.	per 1a	per 1a	per 1a
1d	Ore Loading Ramp	per 1a	Ore or process fines may have been spilled.	9	Test pit 05-59.	per 1a	per 1a	per 1a

[1] APEC not indicated on drawing

TABLE M cont'd: Areas of Potential Environmental Concern Related to Bulk Materials

APEC	Description of Area	Potential Contaminants of Concern (PCOCs)	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
1e	Screening Plant Ramp	per 1a	Mineralized ore or process fines may have been spilled.	n/a	Test pit 05-57.	per 1a	per 1a	per 1a
1f	Ball Field	per 1a	Specifically identified as potentially mineralized.	10	Test pit 05-54.	per 1a	per 1a	per 1a
1g	Road to Airport	per 1a	Specifically identified as potentially mineralized.	n/a	Test pit 05-52.	per 1a	per 1a	per 1a
1h	Overburden Stockpiles	per 1a	Piles of overburden removed to access near surface mineralization.	7	Two composite/ representative samples SS69 and SS70 to screen the metals content.	per 1a	per 1a	per 1a
1i	Former Surface Jaw Crusher	per 1a	Originally used to crush development rock. Fines and dust may have concentrated in the area. It is noted that Kimberlite reportedly distributed on the surface around the area due to more recent related activities by third parties, though this presents no concern for contamination.	11	Test pit 05-49.	per 1a	per 1a	per 1a

TABLE N: Areas of Potential Environmental Concern Related to Main Tank Farm Area

APEC	Description of Area	Potential Contaminants of Concern (PCOCs)	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
2a	Main Tank Farm	Diesel fuel, Jet A Fuel	Approximately twenty-one ASTs containing diesel fuel are located at the main tank farm within three contained berms that are lined with impermeable membrane. The bedding sand on top of the liner has visible hydrocarbon staining. Jet fuel stored in the most southeastern AST. The pump shack is also located with the bermed area. In the spring, water in the berm is reportedly decanted to the west side of the tank farm, which may have resulted in a small areas of stained/stressed vegetation observed on the west side of the tank farm.	4, 12, 13, 14	One hand dug surface soil sample in each bermed area to confirm presence of liner and quality of bedding sand (SS73, SS74, SS75). Surface Soil samples SS71 and SS72 collected on west side of tank farm footprint. Test pit/monitoring well 05-37 on southwest (downgradient) side of footprint. Sampled SEEP9 on west side of footprint.	CCME metals, BETX, PHC F1 to F4, and PAHs	Insufficient water to collect samples	Total metals, sulphate, BETX, PHC F1 to F2, PAHs, and routine water quality
2b	Main Tank Farm Loaders	Diesel fuel	Tank farm loaders are uncontained and hydrocarbon staining observed on ground surface.	14	Test pit/monitoring well 05-07 and test pit 05-36.	per 2a	F2 Insufficient water available to complete other analyses.	per 2a

TABLE N cont'd: Areas of Potential Environmental Concern Related to Main Tank Farm Area

APEC	Description of Area	Potential Contaminants of Concern (PCOCs)	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
2c	Jet Fuel Loader	Jet Fuel	Jet fuel is loaded/unloaded in an uncontained area on the berm to the south of the Jet Fuel tank.	4	Could not drill or test pit due to liner. Surface soil sample SS75 collected and presence of liner confirmed.	BETX, PHC F1 to F4, and PAHs	n/a	n/a
2d	Tank Farm Pipeline	Diesel fuel	Pipeline is above ground and is a pressure, not suction, line. No evidence of staining was observed.	15	Two hand dug surface soil samples SS67 and SS68.	BETX, PHC F1 to F4	n/a	n/a
2e[1]	Former Airport Fuelling Area	Diesel or Jet Fuel	A fuel line formerly ran to the west of the tank farm to a fuelling area located on the west side of the airstrip.	16	Test pit 05-53.	BETX, PHC F1 to F4, and PAHs	n/a	n/a
2f	Third Party Product Storage North	Diesel, fuel oil, varsol, lubrication oil, ATF etc.	New drums of diesel, fuel oil, varsol, ATF, etc. stored within bermed area.	n/a	Could not drill or test pit due to reported liner. Rock was too coarse for hand assessment.	n/a	n/a	n/a
2g	Third Party Wastes Storage South	Waste diesel, fuel oil, varsol, lubrication oil, ATF etc.	Waste drums and cubes of diesel, fuel oil, varsol, ATF, etc. stored within or on top of bermed area that is lined.	4	Could not drill or test pit due to liner. Surface soil sample SS75 collected in the vicinity.	BETX, PHC F1 to F4, and PAHs	n/a	n/a
2h	Tanker Truck Parking Area	Diesel Fuel	Tanker trucks are parked to the east of fuel load area and may release fuel from time to time.	n/a	Test pit 05-35.	CCME metals, sulphide, pH, BETX, PHC F1 to F4	n/a	n/a

[1] APEC not indicated on drawing

TABLE O: Areas of Potential Environmental Concern Related to Central Mill Area and Supporting Facilities

APEC	Description of Area	Potential Contaminants of Concern (PCOCs)	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
3a	Satellite Tank Farm	Diesel and Gasoline	Eight ASTs containing diesel and two ASTs containing gasoline are located within a lined/bermed area. Bedding sand was visibly stained with hydrocarbons and there was sheen on the ponded water within the berm. The diesel is pumped to the tanks via a pipeline from the main tank farm. Gasoline is offloaded to the tanks at the tank farm. There was at least one report of an overfill that resulted in fuel being discharged into the berm. The fuel/ water mixture was pumped out and was stored in one of the small tanks at the main tank farm. On the south side of the area there is a pipe for decanting water from the berm. A hydrocarbon stain was observed below the pipe discharge.	5, 17	SS65 sample within berm. Borehole/monitoring well 05-08 and test pit/monitoring well 05-28 on downgradient side.	BETX, PHC F1 to F4, and PAHs	Dissolved metals, sulphate, BETX, PHC F1 to F2, PAHs, and routine water quality	PHC F2 to F4, PAHs, and glycols
3b	Fuel Pump House	Diesel and Gasoline	Fuel from the tank farm is pumped via above ground lines to the pump house. South of the pump house are two fuelling areas. The fuelling area is uncontained and staining of soil was prevalent in the area.	5	Test pit 05-29.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, and PAHs	n/a	n/a

TABLE O cont'd: Areas of Potential Environmental Concern Related to Central Mill Area and Supporting Facilities

APEC	Description of Area	Potential Contaminants of Concern (PCOCs)	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
3c	Powerhouse Day Tanks	Diesel	Several day tanks were present along the south wall of the powerhouse. There is secondary concrete containment below the tanks however, the concrete is known to have settled and cracked, compromising the integrity of the containment. The high level switches on some of the tanks have reportedly malfunctioned in the past and the tanks have been overfilled.	5, 18	Borehole/monitoring well 05-04. Borehole/ monitoring well 05-10. Test pit 05-31, Test pit 05-32.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, and glycols	Dissolved metals, sulphate, BETX, F1 to F2, PAHs, glycols, and routine water quality	n/a
3d	Powerhouse Radiators and Glycols Tank	Glycols	A glycols tank and several radiators are located outside the south side of the powerhouse. There is no secondary containment in this area. The north radiator is known to have released an undetermined amount of glycols in the past.	5	Borehole/monitoring well 05-04. Test pit 05-31, Test pit 05-32. North radiator could not be assessed due to under-ground power lines.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, and glycols	n/a	n/a
3e	Powerhouse Compressor Spray	Compressor oil	As the compressors cycle, an oily condensate spray discharges at two locations. Oil staining was observed on the ground surface.	n/a	Test pit 05-31. North compressor area could not be assessed due to under-ground power lines.	CCME metals, BETX, PHC F1 to F4	n/a	n/a

TABLE O cont'd: Areas of Potential Environmental Concern Related to Central Mill Area and Supporting Facilities

APEC	Description of Area	Potential Contaminants of Concern (PCOCs)	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
3f	Powerhouse Sumps	Diesel, glycols, compressor oil, lubricants	The powerhouse is underlain by a concrete floor with a surrounding concrete berm. The concrete floors are known to have settled and significant cracking was observed. Never the less, the most likely areas for contaminants to have migrated to the building sump that was confirmed to be connected to groundwater. Since the sump is emptied by a float valve controlled pump, there is essentially a groundwater and contaminant collection system in place.	19	Borehole/monitoring well 05-10, water sample (SUMP) collected directly from sump.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, and PAHs	Dissolved metals, sulphate, BETX, F1 to F2, cyanide, and routine water quality	n/a
3g	Emergency Powerhouse	Diesel fuel	Two ASTs and one transformer associated with emergency powerhouse.	20	Test pit 05-58.	BETX, PHC F1 to F4, and PAHs	n/a	n/a
3h	Brine Mix Area, Underground Equipment Fuelling and Storage area	Salt, diesel fuel, lubricants	Brine was prepared for underground use in this area. The floor of the equipment storage area was unfinished, and evidence of spills were observed. An unloader for pumping fuel to underground workings was also present at this location.	21	Test pit/monitoring well 05-60	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, cyanide, glycols, and salinity	Dissolved metals, sulphate, BETX, F1 to F2, cyanide, glycols, routine water quality, and salinity	n/a

TABLE O cont'd: Areas of Potential Environmental Concern Related to Central Mill Area and Supporting Facilities

APEC	Description of Area	Potential Contaminants of Concern (PCOCs)	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
3i	Crusher and Rebuild Area	Metals	The crusher and underground equipment rebuild area is underlain by a concrete floor with a surrounding concrete berm. One of the crusher units showed evidence of leaking oil. Lubricants are stored in one area that has secondary containment. Floor drains are directed to the sumps in the Recovery Complex.	22	The inside of the crusher area could not be accessed with heavy equipment however, borehole 05-06 was advanced south of the crusher area and test pit 05-56 to the east of the crusher area.	CCME metals, sulphide, pH, BETX F1, PHC F2-F4 and PAHs	n/a	n/a
3j	Grinding Area	Metals	The grinding area is underlain by a concrete floor with a surrounding concrete berm. One sump was present; and there was evidence of a former pump that discharged to the sump in the Recovery Complex. Floor drains are directed to the sumps in the Recovery Complex.	23	Borehole/monitoring well 05-05.	CCME metals, sulphide, and pH	Dissolved metals, sulphate, and routine water quality	n/a
3k	Fine Ore Area	Metals	The fine ore area is underlain by a concrete floor with a surrounding concrete berm. Lubricants are stored in one area that has secondary containment. Floor drains are directed to the sumps in the Recovery Complex.	n/a	Could not be accessed however, the concrete floor appears intact and floor drains drain to Recovery Complex where there was a higher likelihood for contamination proximate the sumps.	n/a	n/a	n/a

TABLE O cont'd: Areas of Potential Environmental Concern Related to Central Mill Area and Supporting Facilities

APEC	Description of Area	Potential Contaminants of Concern (PCOCs)	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
3l	Recovery Complex Sumps	Metals, Cyanide, Zinc, Lead	The mill is underlain by a concrete floor that is in good condition with a surrounding concrete berm. Liquid spillages are directed to two large sumps which discharge to the tailings line. There is also a sump for the tailings discharge pump. There are numerous chemical tanks and storage areas, however the most likely areas for contaminants to have potentially entered the subsurface were the three sumps.	24, 25	Borehole/monitoring well 05-02 and Borehole/monitoring well 05-03.	CCME metals, sulphide, pH, and cyanide	Dissolved metals, sulphate, glycols, cyanide, and routine water quality	n/a
3m	Paste Backfill Plant and Cement Storage	Metals, alkaline, pH	A sump was located below paste backfill plant which discharge to the tailings line. Cement and blotter acid was stored in the Cement Storage (Paste Backfill) Building.	n/a	Test pit 05-25 west of plant. Test pit 05-22 inside cement storage building.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, cyanide, and glycols	n/a	n/a
3n	Misc. Fuel ASTs	Diesel fuel	Three diesel fuel ASTs were located on the periphery of the mill building. All had secondary containment. Valves on the secondary containment allow water to be decanted from time to time. A fourth fuel AST was formerly located south of the cement storage area and was used to power diamond exploration related activities carried out by third parties in this area.	26	Test pits 05-19, 05-23, 05-24, 05-26	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, cyanide, and glycols	n/a	n/a

TABLE O cont'd: Areas of Potential Environmental Concern Related to Central Mill Area and Supporting Facilities

APEC	Description of Area	Potential Contaminants of Concern (PCOCs)	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
3p	Warehouse Hazardous Material Storage	Metals, pH	Hazardous materials (e.g., acids) were delivered to the warehouse and formerly stored in two small shacks to the west of the warehouse entrance.	n/a	Test pit 05-27.	CCME metals, sulphide, pH, and glycols	n/a	n/a
3o	Surface Shop	Diesel, glycols, compressor oil, lubricants	The surface shop is underlain by a concrete floor. Liquid spillages are directed to floor drains that enter a large concrete sump. The sump has a float switch that automatically pumps to the sewage discharge. Oil accumulations are pumped off from time to time for storage in the used oil storage tanks. Steam room has a concrete sump from which sludge is periodically removed and disposed to the landfill.	n/a	Borehole/monitoring well 05-01.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, and glycols	Dissolved metals, sulphate, BETX, F1 to F2, glycols, and routine water quality	n/a

TABLE P: Areas of Potential Environmental Concern Related to Periphery of Mill Area

APEC	Description of Area	Potential Contaminants	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
4a	Cold Storage #1	Machine parts (oils, grease, metals)	Gravel floors, surface spillage observed.	27	Test pit 05-18, SEEP1.	CCME metals, sulphide, pH, BETX, PHC F1 to F4	n/a	Total metals, sulphate, BETX, F1 to F2, cyanide, and routine water quality
4b	Cold Storage #2	Lime, zinc dust storage Hydrochloric and Nitric Acid storage	Gravel floors, surface spillage observed.	28	Test pit 05-17, SEEP1.	CCME metals, sulphide, and pH	n/a	Total metals, sulphate, BETX, F1 to F2, cyanide, and routine water quality
4c	Cold Storage #3 (now removed)	Cyanide and lead nitrate storage	Gravel floors, surface spillage observed.	28	Borehole/monitoring well 05-16, SEEP1.	CCME metals, sulphide, pH, and cyanide	n/a	Total metals, sulphate, BETX, F1 to F2, cyanide, and routine water quality
4e	Tailings Line	Metals, hydrocarbons	Potential leaks, preferential pathway due to heat melting permafrost. Seep observed adjacent the line.	29	Test pit 05-20, sampled SEEP8.	CCME metals	n/a	Total metals, sulphate, BETX, F1 to F2, PAHs, and routine water quality
4f	Sewage Line	Metals, hydrocarbons	Potential leaks, preferential pathway due to heat melting permafrost, Seep observed adjacent the line.	30	Test pit/monitoring well 05-21 SEEP7 was low flow and not sampled.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, and glycols	Dissolved metals, sulphate, BETX, F1 to F2, cyanide, and routine water quality	n/a

TABLE P cont'd: Areas of Potential Environmental Concern Related to Periphery of Mill Area

APEC	Description of Area	Potential Contaminants	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
4g	Remainder Steel Yard, Lumber Yard, East Mill Lay down	Various	Innocuous materials stored in this area. Stressed vegetation near SEEP1 to south may be associated with APECs 4a through 4c. Two areas of ponded water on east side of mine footprint.	6	Covered by the above, plus test pits 05-34, 05-77, 05-78, and 05-81. Surface soil sample SS63 at stressed area. SEEP1 as well as SEEP5 and SEEP6.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, and glycols	Dissolved metals, sulphate, BETX, F1 to F2, cyanide, and routine water quality	Total metals, sulphate, BETX, F1 to F2, cyanide, and routine water quality
4h	Former Mine Water Discharge Area	Metals	Underground mine water was discharged to this area prior to 2001. The surface soil has been scoured by the discharge.	n/a	Surface soil sample SS64.	CCME metals, sulphide, pH, and PHC F2 to F4	n/a	n/a

TABLE Q: Areas of Potential Environmental Concern Related to North Shops

APEC	Description of Area	Potential Contaminants	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
5a	RTL Shop	Fuels, maintenance activities	Equipment parking and maintenance areas are at risk of hydrocarbon contamination due to leaks and spills. Metals concentrations may also be elevated due to parked underground equipment which may have released ore dust. A diesel fuel AST associated with the shop has been reported to have released fuel.	31, 32	Test pits 05-44 and 05-55. SEEP12.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, and PAHs	n/a	Total metals, sulphate, BETX, F1 to F2, PAHs, glycols, and routine water quality
5b	Concrete Plant	Lime (concrete mix), metals in fire debris	Soil pH values may be altered proximate to the concrete plant. Concrete plant involved in a fire and the building was replaced.	31	Test pit 05-57, SEEP11.	CCME metals, sulphide, and pH	n/a	n/a
5c	Former Numa Logistics Winter Road Shop and Tank	Fuels, maintenance activities	Former shop had 14,000 Gallon Diesel Tank. Fold away building now removed. Apparently hydrocarbon contaminated soil was excavated from the ore and disposed to the tailings area.	33	Test pit 05-42 and test pit/monitoring well 05-43.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, and glycols	Dissolved metals, sulphate, BETX, F1 to F2, PAHs, glycols, and routine water quality	n/a

TABLE R: Areas of Potential Environmental Concern Related to North Storage Areas

APEC	Description of Area	Potential Contaminants	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
6a	Third Party Drum Storage Area	Diesel, fuel oil, lubrication oil, jet fuel, ATF, etc.	Third party storage of drums of diesel, fuel oil, lubrication oil, jet fuel, ATF, etc. Most drums were new and stored on wooden skids however, potential exists for releases to have occurred.	34	Test pit 05-39.	CCME metals, sulphide, pH, BETX, PHC F1 to F4	n/a	n/a
6b	Third Party Salt Storage	Salt	Third party storage of bags of salt; some visible spillage observed.	35	Test pit 05-41.	CCME metals, sulphide, pH, and salinity	n/a	n/a
6c	Former Surface Shop #3, now used for storage	Misc. hydrocarbons, metals	Former surface Shop #3 now used for storage of insulation and polyester resin. A small diesel tank for a heater is located inside the building.	n/a	Test pit 05-38.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, and glycols	n/a	n/a
6d	Former Surface Shop #2, now used for storage	Misc hydrocarbons, metals from shotcrete	Former surface Shop #3 now used for storage of shotcrete.	n/a	Test pit 05-40.	CCME metals, sulphide, pH, BETX, PHC F1 to F4	n/a	n/a
6e	Portal Ramp	Spilled materials, development rock	Ore may have been tracked out of the portal and other materials may have been released in this high traffic area.	n/a	Test pit 05-48.	CCME metals, sulphide, and pH	n/a	n/a

TABLE S: Areas of Potential Environmental Concern Related to Residential Area

APEC	Description of Area	Potential Contaminants	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
7a	Offices, accommoda-tion, recrea-tion and kitchen complex	Diesel fuel	One diesel AST for emergency boiler. Tank has secondary containment. Glycol circuit is above ground so leaks would be seen. Otherwise no obvious environmental concerns exist in this area.	36	Test pit/monitoring well 05-55.	CCME metals, BETX, PHC F1 to F4, and PAHs	CCME metals, BETX, PHC F1 to F2, and PAHs	n/a
7b[1]	Water intake and fuelling area at dock	Diesel fuel, metals, PAG	One fuel AST for emergency power. Development rock use to construct breakwater.	8	Test pit 05-51.	CCME metals, sulphide, pH, BETX, PHC F1 to F4	n/a	n/a
7c[1]	Sea Plane and Boat Fuelling	Fuel	Small volumes fuelled from drums or truck on occasion. Spills were unlikely or small, and no staining was visible during inspection. A former boat fuelling AST was located in a lined and bermed area west of the dock.	8	Test pit 05-50.	BETX, PHC F1 to F4	n/a	n/a
7d	Guesthouse Emergency Fuel Storage	Diesel fuel	An AST is located in the basement below the guesthouse.	37	Test pit 05-61.	BETX, PHC F1 to F4	n/a	n/a

[1] APEC not indicated on drawing

TABLE T: Areas of Potential Environmental Concern Related to Wastes Management and Disposal Areas

APEC	Description of Area	Potential Contaminants	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
8a	Used Oil Storage	Used oil	Used oil was collected and pumped into two ASTs located within a lined berm. The bedding sand above the liner was visibly stained with hydrocarbons. The tanks are periodically emptied into tanker trucks for off-site disposal.	5	SS66 sample within berm. Test pit 05-30 on southwest (downgradient side).	CCME metals, PHC F2 to F4, PAHs, glycols, and cyanide	n/a	n/a
8b	Incinerator	Metals, diesel fuel	1,000 Gal diesel tank supplies fuel for the incinerator. Potential for contamination from released fuel or incinerator ash.	38	Test pit/monitoring well 05-15.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, and PAHs	n/a	n/a
8c	South Surface Burn Pit	Various wastes burned	Burn pits are frequently contaminated due to the incomplete combustion of wastes and residue materials. There is an abandoned AST and some staining visible on the south side of the burn pit, which may be from fuel used to start the burning process. Some buried debris and orange precipitate-stained water and stressed vegetation observed on the east (downgradient) side of the burn pit.	6	Test pit 05-12, test pit/monitoring well 05-13, test pit 05-14. Surface soil sample SS62 at location of stressed vegetation. Surface water seep sample at SEEP2.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, glycols, and cyanide	Dissolved metals, sulphate, BETX, F1 to F2, glycols, cyanide, and routine water quality	Total metals, sulphate, BETX, F1 to F2, PAHs, glycols, cyanide, and routine water quality
8d	North Underground Burn Pit	Various wastes burned	Burn pits are frequently contaminated due to the incomplete combustion of wastes and residue materials. It was also reported the drums may have been cleaned in this area.	39	Test pit 05-47 to northeast on downgradient side. SEEP13.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, glycols, and cyanide	n/a	Total metals, sulphate, BETX, F1 to F2, and routine water quality Insufficient amount of water to analyze for cyanide

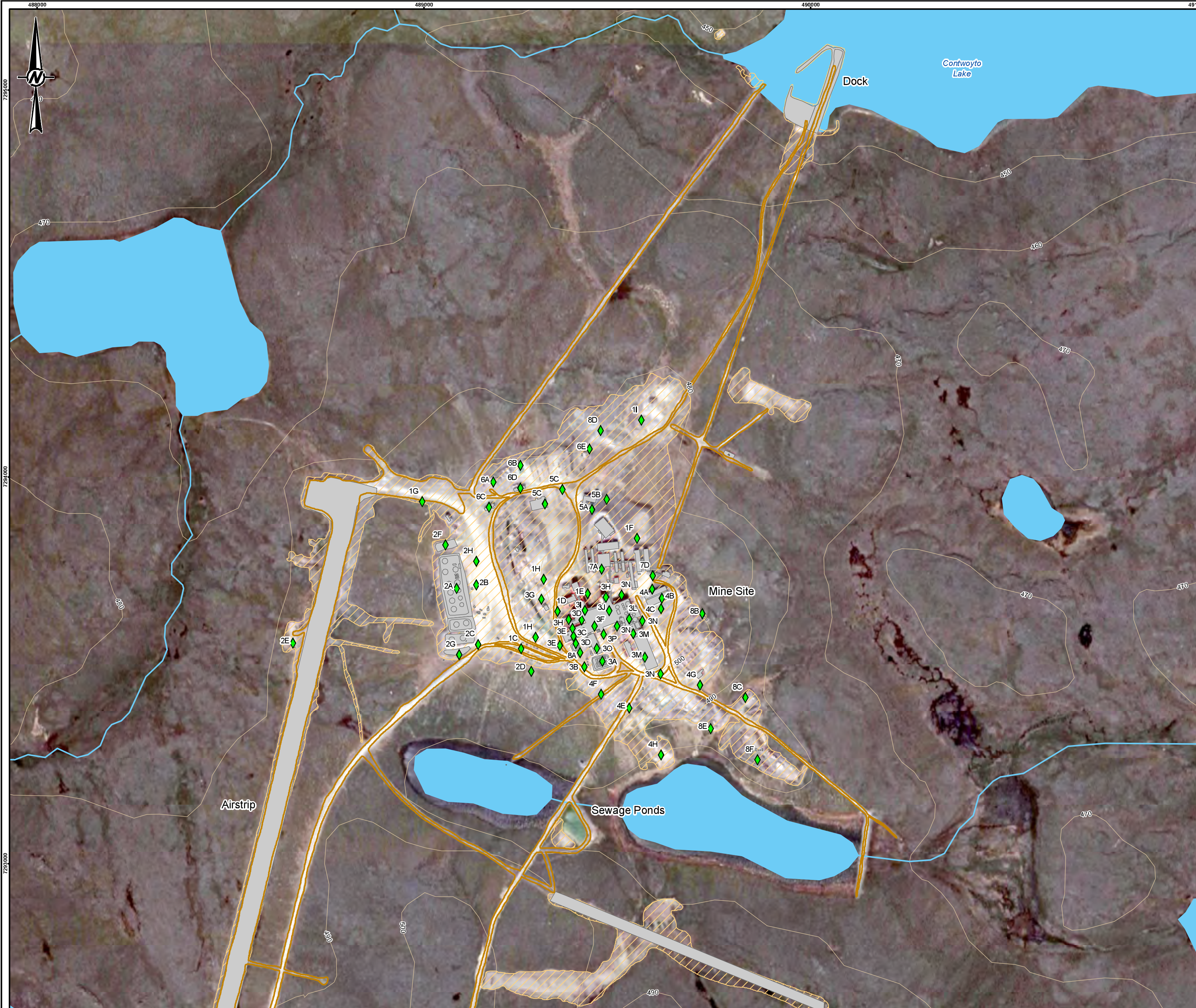
TABLE T cont'd: Areas of Potential Environmental Concern Related to Wastes Management and Disposal Areas

APEC	Description of Area	Potential Contaminants	Discussion of Possible Contamination	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
8e	Landfill	Various wastes	Landfill is unlined. Three seeps with some oxide staining identified discharging on the west and south side of the landfill. INAC inspector identified elevated contaminants in the seep at the south side of the landfill.	6, 40	Borehole/monitoring well 05-09 at southwest (downgradient). Surface water sample from SEEP3.	n/a	Dissolved metals, sulphate, BETX, F1 to F2, glycols, and routine water quality Insufficient amount of water to analyze for cyanide	Total metals, sulphate, BETX, F1 to F2, PAHs, glycols, cyanide, and routine water quality
8f	Bone Yard	Hydrocarbons, metals	Used for storage of derelict equipment. Reportedly there have been releases of hydrocarbons from some of the equipment.	41	Test pit/monitoring well 05-11, test pits 05-82 and 05-83.	CCME metals, sulphide, pH, BETX, PHC F1 to F4, PAHs, and glycols	Dissolved metals, sulphate, BETX, F1 to F2, glycols, and routine water quality	n/a

TABLE U: Areas of Potential Environmental Concern Related to Background Reference Areas

APEC	Description of Area	Potential Contaminants	Discussion	Photos	Assessment Method	PCOCs in Soil Analytical Program	PCOCs in Groundwater Analytical Program	Surface Water Seep Analytical Program
9a[1]	Soil Background	Natural background concentrations	Background reference for soil – mineralized areas described by geology map. Orange coloured oxides observed in some bedrock outcrops around the mill site.	n/a	Surface soil sample SS76. Kinross transect samples (51161 through 51190) collected to north, south, east, and west of the mill site.	CCME metals, sulphide, and pH	n/a	n/a
9b[1]	Water Background	Natural background concentrations	Background reference for water – creek to north of site. Orange staining on rocks.	n/a	Surface water sample CREEK.	n/a	n/a	Total metals, sulphate, and routine water quality

[1] APEC not indicated on drawing



LEGEND

- CONTOUR
- WATERCOURSE
- ROAD
- INFRASTUCTURE FOOTPRINT
- DISTURBANCE FOOTPRINT
- WATERBODY

0 250 500

1:10,000 METRES

REFERENCE(S)

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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT
MANDALAY RESOURCES CORPORATION

PROJECT
LUPIN MINE CLOSURE COST REVIEW

TITLE
AREAS OF POTENTIAL ENVIRONMENTAL CONCERN

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-17
DESIGNED	DY
PREPARED	MM
REVIEWED	SF
APPROVED	AC

PROJECT NO.	CONTROL	REV.	FIGURE
1664316	6000	0	4

PATH: I:\2016\1664316\Mapping\MXD\General\Fig4_Lupin_Mine_APEC_Locations_Rev0.mxd PRINTED ON: 2017-10-17 AT: 2:07:41 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
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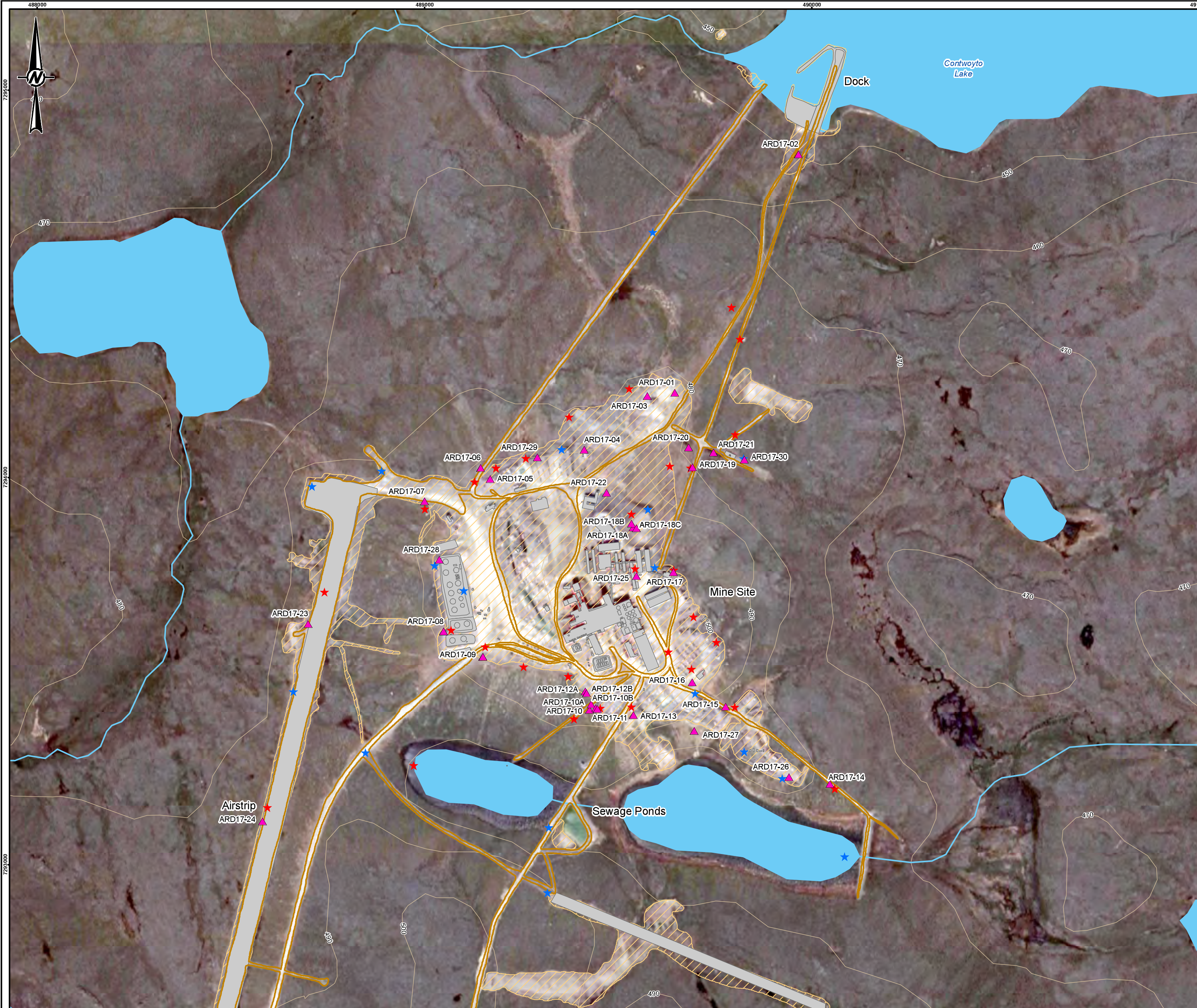

LEGEND

- 2017 ACID ROCK DRAINAGE SAMPLE LOCATION

ABA SAMPLES

- NPAG
- PAG
- CONTOUR
- WATERCOURSE
- ROAD
- INFRASTUCTURE FOOTPRINT
- DISTURBANCE FOOTPRINT
- WATERBODY

0 250 500
1:10,000 METRES

REFERENCE(S)
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DATUM: NAD83 PROJECTION: UTM ZONE 12

CLIENT
MANDALAY RESOURCES CORPORATION

PROJECT
LUPIN MINE CLOSURE COST REVIEW

TITLE
CURRENT ACID ROCK DRAINAGE SAMPLE LOCATIONS

CONSULTANT

YYYY-MM-DD	2017-10-17
DESIGNED	DY
PREPARED	MM
REVIEWED	SF
APPROVED	AC

PROJECT NO.	CONTROL	REV.	FIGURE
1664316	6000	0	8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Stantec

Technical Memo

To:	Karyn Lewis, Project Manager Lupin Project	From:	Sara Wilkins, P.Geo. Jim McKinley, Ph.D., P.Eng.
	Mandalay Resources Corporation Suite 330, 76 Richmond Street Toronto, ON M5C 1P1		Stantec Consulting Ltd, 200-325 25 Street, Calgary, AB T2A 7H8
File:	Lupin Gold Project – 129500081	Date:	August 14, 2019

Reference: 2AM-LUP1520 Technical Meeting Commitment Number 3 and 4 Responses – Waste Rock Information from Lupin Mine Tailings Containment Area

Introduction

Lupin Mine Incorporated (LMI), a wholly owned subsidiary of Mandalay Resources is requesting the renewal and amendment of their existing Type "A" Water Licence No: 2AM-LUP1520, to allow for Final Closure and Reclamation of the Lupin Mine Project (Lupin). The Nunavut Water Board (NWB or Board) Water Licence Application No. 2AM-LUP1520 Technical Meeting was held June 6-7, 2019 in Kugluktuk and Appendix D of the June 18, 2018 Pre-Hearing Conference Decision Report outlines the agreed upon List of Commitments (Commitments). Stantec Consulting Ltd. (Stantec) was retained by LMI to support the responses to select commitments and this technical memo provides the responses to fulfill Commitments No. 3 and No. 4, pasted below, which relate to historical data analysis regarding acid rock drainage (ARD) potential of waste rock at the Lupin Tailings Containment Area (TCA).

3	LMI	CIRNAC	LMI to go through records and provide historical data analysis regarding ARD potential of tailings dams and roadways, etc. and to indicate whether, based on the historical information, the additional study in line #4 will/will not be provided	15-Aug-19	Summary of historical data in a Technical Memo
4	LMI	CIRNAC	Based on the results of #3 above, if required ARD Potential (rock characterization, and potentially including geochemical and pathway analysis) to be conducted at the TCA dams.	15-Nov-19	Technical Memo

Stantec reviewed historical information from the Lupin TCA for information pertaining to materials testing for the waste rock used in the construction of earthen dams in the TCA. More specifically, the review focused on any chemical data describing the potential of the TCA waste rock to generate ARD. This memo contains a brief description of the information reviewed and presents the data to fulfil the commitments listed above.

Historical Information

The primary documents used for the review are the following:

- URS. 2005. ARD/ML Assessment of Waste Rock at Lupin Mine
- Golder. 2017. Updated Phase I and II Environmental Site Assessment
- Price, W.A. 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. Draft Report prepared for MEND. MEND Report 1.20.1

The URS (2005) memo includes the results of acid/base accounting (ABA) work that was conducted at various sites at Lupin, including ten sites that are well distributed through the TCA dams as shown on Table 1. The memo presents data on total sulfur percentage and the ratio of neutralization potential values to maximum potential acidity values (NP/MPA). Typically, NP/MPA values less than one indicate likely ARD generation, values between one and two indicate the uncertain potential for ARD, and values greater than two indicate likely non-ARD (Price, 2009). Of the ten samples from the Lupin dams, one displayed a NP/MPA value less than one, five displayed values between one and two, and four displayed values higher than two. Only one of the samples that had NP/MPA values less than two had a total sulfur percentage significantly higher than 0.3%. The URS memo concluded overall that “the bulk of the waste rock at Lupin is not expected to generate acid in the foreseeable future. This is supported by observational evidence which indicates that the waste rock has shown no evidence of acid generation after surface weathering for up to approximately 25 years.”

Table 1 – 2005 TCA Waste Rock Results

Sample	Description	pH	Total Sulfur	NP	MPA	NP/MPA
		NA	%	mg $CaCO_3$/kg	mg $CaCO_3$/kg	NA
50058	Dam 4	8.6	0.31	12	9.7	1.24
50059	Dam 5	8.6	0.51	14	15.9	0.88
50060	Dam 6	8.3	0.07	9	2.2	4.11
50061	Dam 1c	9.4	0.03	11	0.9	11.73
50062	Dam 1b	9.5	0.17	9	5.3	1.69
50063	Dam 1a	9.5	0.03	10	0.9	10.67
50064	Dam 2	8.6	0.31	10	9.7	1.03
50073	L Dam, south	8.6	0.19	10	5.9	1.68
50074	L Dam, north	8.6	0.24	12	7.5	1.6
50075	J Dam	9	0.15	15	4.7	3.2

Reference: 2AM-LUP1520 Technical Meeting Commitment Number 3 and 4 Responses

Conclusions

The work conducted in 2005 sampled ten waste rock sites located throughout the TCA dams. Based on a preliminary analysis of the extent of waste rock material in the TCA dams from aerial photos, and assumptions related to waste rock density (≈2 kg/m^3) and the depth (0.5 m) of waste rock material on the face of the TCA dams, a total TCA waste rock weight of approximately 100,000 tons was calculated. Based on direction from Price (2009), a minimum number of eight samples is recommended to characterize that amount of waste rock material. It is Stantec's position that the 2005 data set adequately represents the characteristics of the waste rock used in the construction of the dams and fulfills Commitment No.3 from the Lupin Technical Meeting.

Additionally, the results of the Golder (2017) assessment indicated that in the sampled waste rock, sulfide concentrations were significantly less than total sulfur, indicating the majority of the sulfur was present in the oxidized sulfate form. As only one of the TCA waste rock sampling sites indicated significant potential for ARD generation in 2005 and the waste rock has been exposed to weathering action for decades (oxidizing the sulfide since the early 1990s), as noted in Commitment No.3 there is no need to proceed to the geochemical modeling mentioned in Commitment No.4.

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Technical Memo

To:	Karyn Lewis, Project Manager Lupin Project	From:	Alvin Tong, P.Eng. Jim McKinley, Ph.D., P.Eng.
	Mandalay Resources Corporation Suite 330, 76 Richmond Street Toronto, ON M5C 1P1		Stantec Consulting Ltd, 200-325 25 Street, Calgary, AB T2A 7H8
File:	Lupin Gold Project – 129500081	Date:	October 15, 2019

Reference: 2AM-LUP1520 Technical Meeting Commitment Number 10 Response – Cover Data from Lupin Mine Tailings Containment Area

INTRODUCTION

Lupin Mine Incorporated (LMI), a wholly owned subsidiary of Mandalay Resources Corporation is requesting the renewal and amendment of their existing Type "A" Water Licence No: 2AM-LUP1520, to allow for Final Closure and Reclamation of the Lupin Mine Project (Lupin). The Nunavut Water Board (NWB or Board) Water Licence Application No. 2AM-LUP1520 Technical Meeting was held June 6-7, 2019 in Kugluktuk, Nunavut. Appendix D of the June 18, 2018 Pre-Hearing Conference Decision Report outlines the agreed upon List of Commitments (Commitments). Stantec Consulting Ltd. (Stantec) was retained by LMI to support the responses to select commitments and this technical memo provides the responses to fulfill Commitment No. 10, shown below, which relates to data collection from Cell 1 and Cell 2 in the Lupin Tailings Containment Area (TCA).

10	LMI	ECCC	One-time visual inspection (testpit) to "ground truth" the status of the cover nearby one of the installed standpipes (note: water quality data will be collected from all standpipes and presented in the context of historical water quality data from the standpipe information).	15-Oct-19	Technical Memo

At Cell 1 in the Lupin TCA, Stantec excavated a test pit and collected water level and water quality data in standpipes completed in the esker cover. The water quality data is compared to historical information collected between 2002 and 2004 as part of the TCA Closure Plan (Holubec, 2005). A second test pit was also excavated in Cell 2 of the Lupin TCA. This memo contains a brief description of the field work and presents the data to fulfill the commitment listed above.

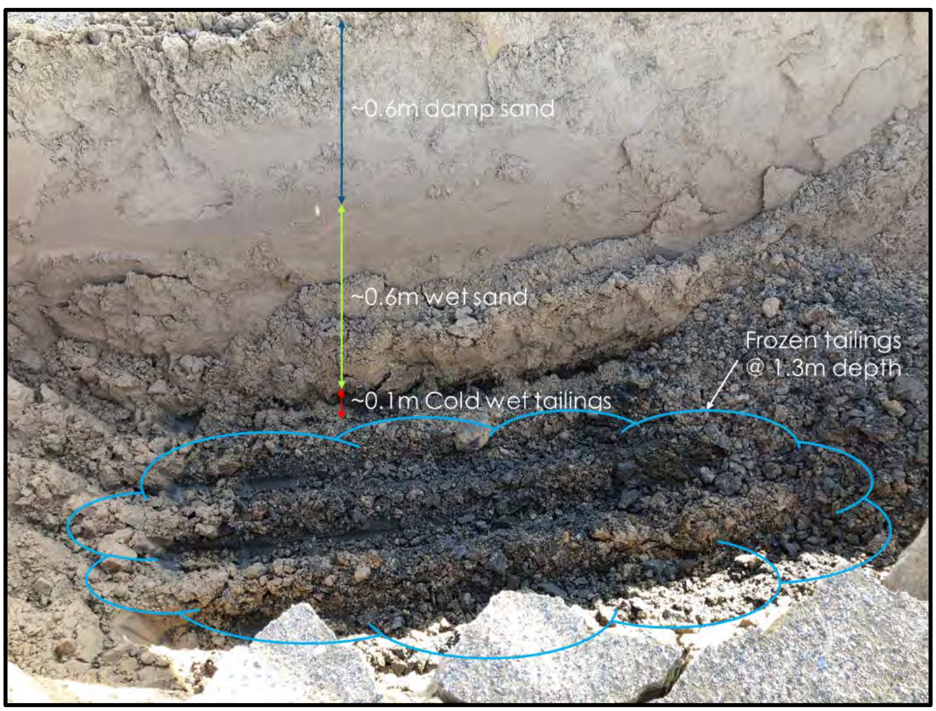
TEST PIT OBSERVATIONS

Two test pits were completed in Cell 1 and Cell 2 using an excavator and the locations are presented on Figure 1. Mr. Alvin Tong, P.Eng., a senior Geotechnical Engineer with Stantec, oversaw the excavation of the test pit on August 24 and 25, 2019. The weather during the excavation work was clear and warm. The general condition of the cover was dry without any nearby ponded water.

Test Pit 1

Test Pit 1 was excavated within Cell 2, which was covered in 2004. The cover material was observed to be a well graded sand with some gravel. Wet material was encountered approximately 0.6 m below ground surface (bgs). A thin layer of cold, wet tailings was encountered approximately 1.2 m bgs and frozen tailings was encountered approximately 1.3 m bgs. No oxidized tailings were observed in the test pit. A photograph of the test pit is provided below.

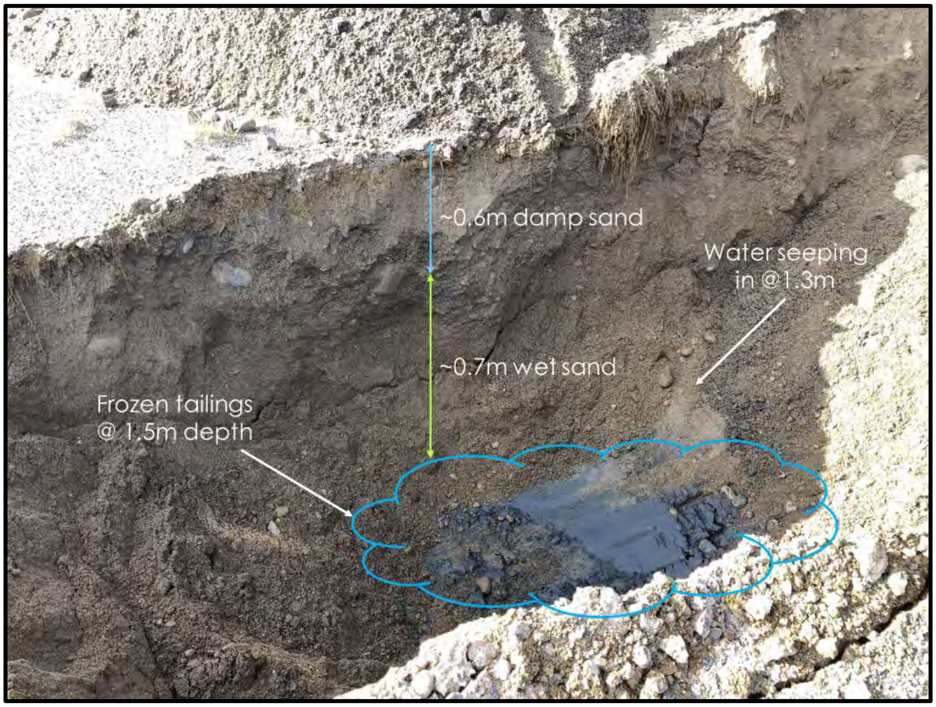
Test Pit 1 Photograph and Descriptions



Test Pit 2

Test Pit 2 was excavated within Cell 1, which was covered in 1995. The test pit is located approximately 30 m southwest of standpipe P-7. The cover material was observed to be a well graded sand and gravel with cobbles. Wet material was encountered approximately 0.6 m bgs, which generally corresponds with the water level measured in standpipe P-7 at 0.83 m bgs. A layer of cold wet tailings was encountered approximately 1.3 m bgs and frozen tailings was encountered approximately 1.5 m bgs. No oxidized tailings were observed in the test pit. Groundwater was observed seeping into the test pit at approximately 1.3 m bgs. A photograph of the test pit is provided below.

Reference: 2AM-LUP1520 Technical Meeting Commitment Number 10 Response



Test Pit 2 Photograph and Descriptions

STANDPIPE DATA COLLECTION

From August 23 to 26, 2019 water levels were measured and water quality samples were collected from standpipes completed in Cell 1 of the Lupin TCA. A minimum of three wellbore volumes were purged from the standpipes prior to sample collection. Cover saturated thickness, estimated based on the depth of water in the wells, and water quality results are presented in Table 1 and Table 2 with historical data from Holubec (2005). Each parameter is split into two columns in the tables; the first column represents historical data collected in 2002 and the second column represents data collected in 2019.

Table 1 – TCA Cell 1 Cover Saturated Thickness

Standpipe ID	Cover Saturated Thickness - (m)	
	2002	2019
P-2	0.32	0.44
P-3	0.22	0.17
P-4	0.49	0.58
P-5	0.94	0.74
P-6	0.62	0.61
P-7	0.21	0.37
P-8	0.42	0.59
P-9	0.20	0.28

Table 2 – TCA Cell 1 Standpipe Water Quality Results

Standpipe ID	pH		Arsenic-Total (mg/L)		Copper-Total (mg/L)		Cyanide-Total (mg/L)		Lead-Total (mg/L)		Nickel-Total (mg/L)		Zinc-Total (mg/L)	
	2002	2019	2002	2019	2002	2019	2002	2019	2002	2019	2002	2019	2002	2019
P-2	3.96	4.80	0.005	0.008	0.310	0.177	0.002	<0.0050	0.025	0.001	1.320	0.319	0.620	0.191
P-4	5.70	5.10	0.004	0.013	0.190	0.079	0.060	<0.0050	0.010	0.001	0.850	0.318	0.320	0.120
P-5	5.00	5.10	0.020	0.676	0.250	0.023	0.004	<0.0050	0.020	0.003	3.510	0.550	0.910	0.152
P-6	5.90	5.10	0.004	0.078	0.006	0.013	0.002	<0.0050	0.002	0.001	0.015	0.125	0.035	0.049
P-8	4.90	4.90	0.019	0.058	0.042	0.288	0.002	<0.0050	0.003	0.004	1.110	0.661	0.300	0.342

CONCLUSIONS

The test pit observations and standpipe water level measurements indicate that there is a saturated layer of cover above the tailings in the cells that were studied. Oxidized tailings were not observed within the test pits. In general, the water quality results from 2002 and 2019 are comparable. Based on these observations and measurements, the cover appears to be functioning as permitted.

References

I. Holubec Consulting Inc. 2005. Closure Plan for Tailings Containment Area. Prepared for Kinross Gold Corporation – Lupin Operation.

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Technical Memo

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File:	Lupin Gold Project - 129500081	Date:	October 15, 2019

Reference: 2 AM-LUP Technical Meeting Commitment Number 8 Response – Lupin Mine TCA Exposed Contaminants at Closure Water Levels

Introduction

Lupin Mine Incorporated (LMI), a wholly owned subsidiary of Mandalay Resources is requesting the renewal and amendment of their existing Type "A" Water Licence No: 2AM-LUP1520, to allow for Final Closure and Reclamation of the Lupin Mine Project (Lupin). The Nunavut Water Board (NWB or Board) Water Licence Application No. 2AM-LUP1520 Technical Meeting was held June 6-7, 2019 in Kugluktuk and Appendix D of the June 18, 2018 Pre-Hearing Conference Decision Report outlines the agreed upon List of Commitments (Commitments). Stantec Consulting Ltd. (Stantec) was retained by LMI to support the responses to select commitments and this technical memo provides the responses to fulfill Commitment No. 8, shown below, which relates to a decision matrix that will be used to determine how exposed tailings (or contaminants) will be handled on a case by case basis when lowering the water level in the Lupin Tailings Containment Area (TCA) at closure.

08	LMI	CIRNAC	Decision matrix/tree that determines how exposed tailings will be handled on a case by case basis when lowering the water level in the TCA.	15-Oct-19	Technical Memo

Commitment No. 8 was fulfilled by preparing the attached Figure 1 Decision Matrix for Contaminants Exposed above Lupin Mine Tailings Containment Area Closure Water Levels. The options, risks and advantages supporting each decision item in the matrix are detailed within.

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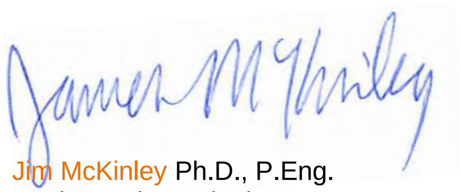

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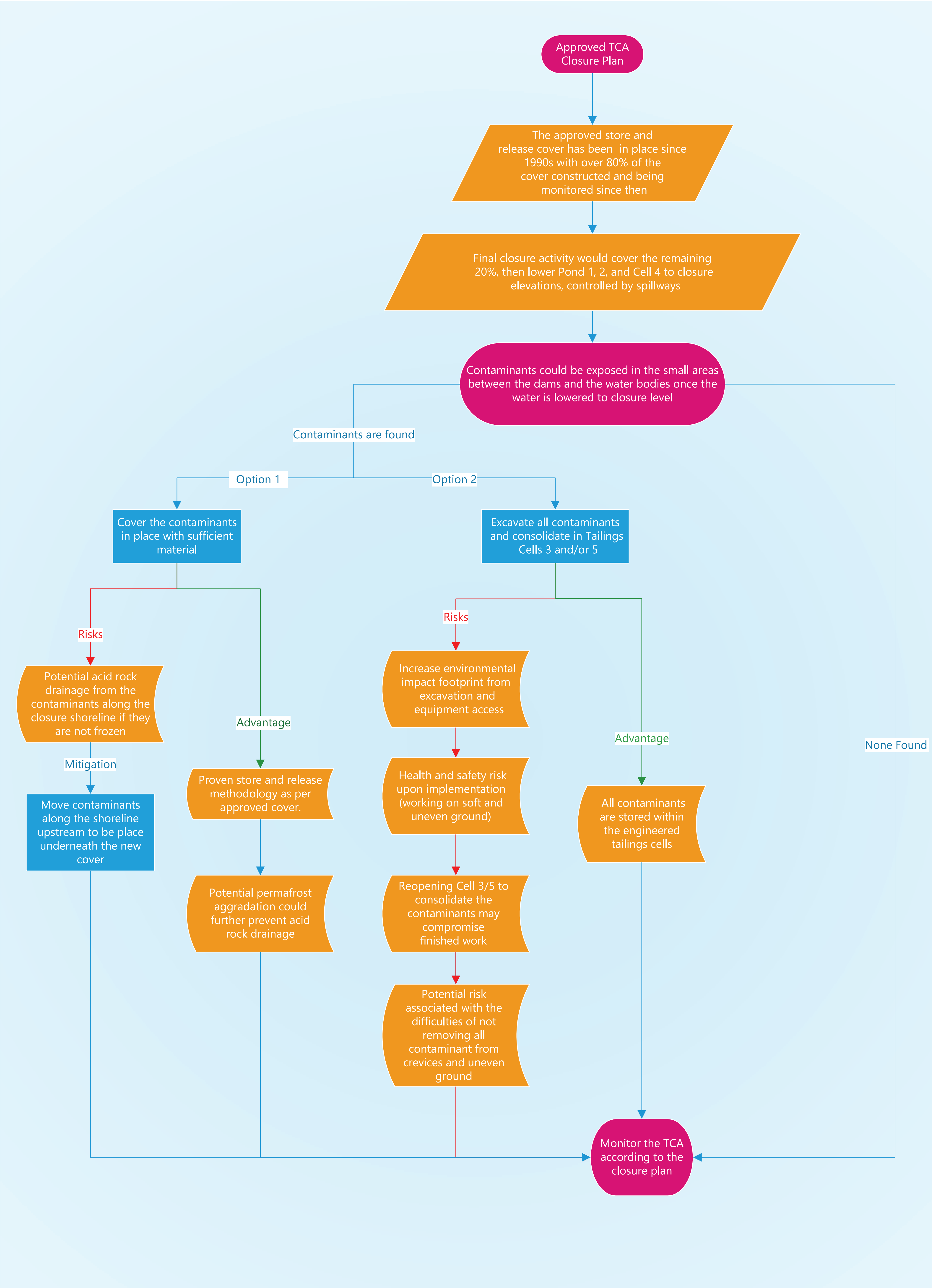
Figure 1: Decision Matrix for Contaminants Exposed above Lupin Mine Tailings Containment Area Closure Water Levels



Technical Memo

To:	Karyn Lewis, Project Manager Lupin Project Mandalay Resources Corporation Suite 330, 76 Richmond Street Toronto, ON M5C 1P1	From:	Alvin Tong, P.Eng. Stantec Consulting Ltd, 200-325 25 Street, Calgary, AB T2A 7H8
File:	Lupin Gold Project – 129500081	Date:	October 15, 2019

Reference: 2AM-LUP1520 Technical Meeting Commitment Number 11 Response – Geophysical Survey Lupin Mine Tailings Containment Area Dams

INTRODUCTION

Lupin Mine Incorporated (LMI), a wholly owned subsidiary of Mandalay Resources Corporation is requesting the renewal and amendment of their existing Type "A" Water Licence No: 2AM-LUP1520, to allow for Final Closure and Reclamation of the Lupin Mine Project (Lupin). The Nunavut Water Board (NWB or Board) Water Licence Application No. 2AM-LUP1520 Technical Meeting was held June 6-7, 2019 in Kugluktuk, Nunavut. Appendix D of the June 18, 2018 Pre-Hearing Conference Decision Report outlines the agreed upon List of Commitments (Commitments). Stantec Consulting Ltd. (Stantec) was retained by LMI to support the responses to select commitments and this technical memo provides the responses to fulfill Commitment No. 11, shown below, which relates to conducting a geophysical survey along two selected Lupin Mine Tailings Containment Area (TCA) dams.

11	LMI	ECCC	One-time geophysical survey conducted along two selected dams to confirm the condition of frozen cores.	15-Oct-19	Technical Memo

Two dams were selected by Stantec for the geophysical surveys; Dam 3D representing and internal TCA dam and Dam 4 representing an external TCA dam (Figure 1). Dam 3D and Dam 4 were specifically selected since they both have thermistors installed for calibration. Aurora Geosciences Ltd. completed the surveys and the methods, results and interpretation are include in the attached memorandum titled "Lupin Tailings Dams Geophysics Survey 2019".