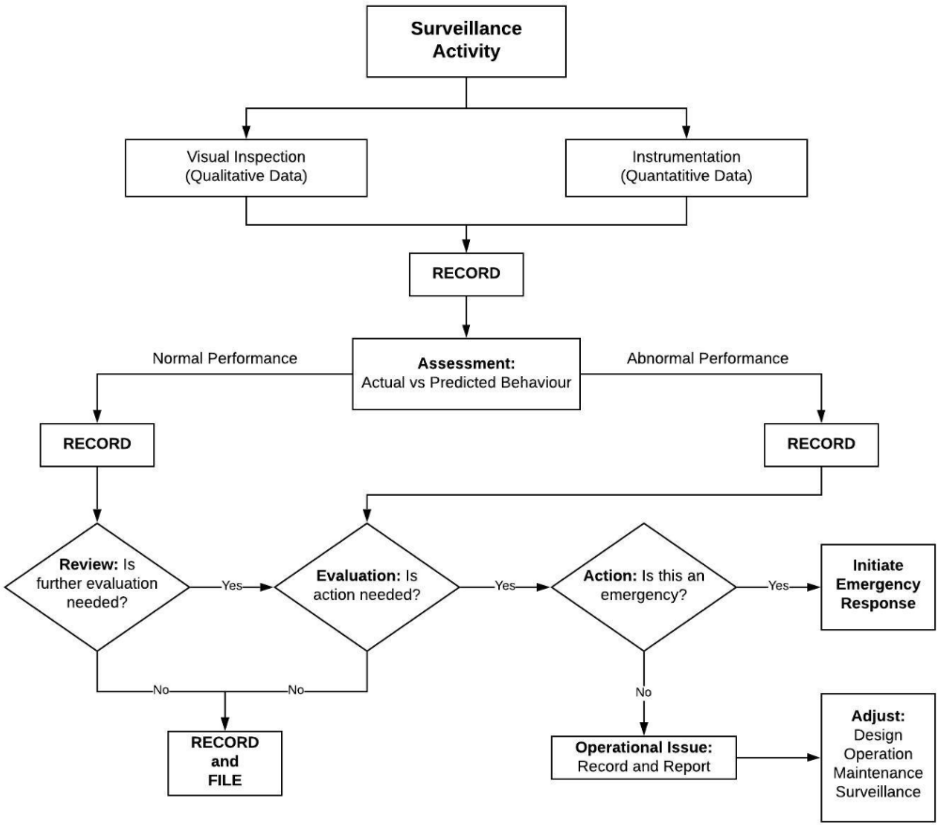


Figure 6.1: Example surveillance flow chart.

6.1 Surveillance and Inspections by Mine and Environment Operations Staff

The purpose of the surveillance program is to identify abnormal performance and/or unsafe conditions. Visual inspections ensure proper maintenance and performance of the WRSFs and water management procedures. Unexpected behaviour that goes unnoticed could result in unsafe conditions, and lead to a failure of operating systems, health and safety concerns, or cause adverse or unexpected environmental effects.

The surveillance program consists of regular visual and instrumentation observations, including:

- The conditions and performance of the WRSF, including cracking, slumping, depressions, seepage, and surface erosion;
- Water levels (in the Collection and Attenuation ponds);
- Thermal monitoring of the WRSF and surrounding ground;
- Function of hydraulic structures (diversions, ditches or spillways); and
- Total WRSF performance.

6.2 Visual Inspections

6.2.1 Weekly Inspections

Routine weekly visual inspections of the WRSFs should be conducted to ensure expected performance. Any deviances, including slumping, cracking, or erosion must be reported to the Engineer-of Record.

6.2.2 Inspection After an Unusual Event

Inspections should be carried out immediately if any of the following events occur:

- Earthquakes;
- Large rainfall or snowmelt;
- Any triggers are activated on installed instrumentation;
- A sudden rise in Collection or Attenuation Pond level.

6.3 Water Quality Monitoring

Contact water from the WRSF and infrastructure will be sampled and monitored in accordance with the Type A Water Licence, and data will be provided to the NWB through annual reporting. During operations, closure, and post-closure, Station ST-WT-3 (the WRSF pond prior to pumping to the attenuation pond/Mammoth Lake), water samples will be collected four times per calendar year, at least two weeks apart, when water is present (Agnico Eagle, 2018b). Two of the annual sampling events will coincide with:

1) The end of the freshet; and
2) When the active zone has penetrated to its greatest depth (assumed to be between August and October).

Water samples will be analyzed for the following parameters: pH, turbidity, hardness, alkalinity, ammonia nitrogen, total metals (aluminum, arsenic, barium, cadmium, chloride, chromium, copper, fluoride, iron, lead, manganese, mercury, molybdenum, nickel, nitrite, nitrate, selenium, silver, thallium, zinc), sulphate, TDS, and TSS.

For a full description of mine site water quality monitoring, refer to the Whale Tail Pit- Expansion Project: Water Quality and Flow Monitoring Plan, Version 4, November 2018.

6.4 Waste Rock Testing and Characterization

Waste rock segregation is completed by characterizing the ARD and ML potential of the various lithologies encountered during mining. NPAG/NML waste rock is intended for mine infrastructure and cover material, while PAG/ML waste rock will be stored exclusively in the WRSFs.

Sampling and testing of waste rock will continue according to the guidelines outlined for the Approved Project, and include:

- Sampling in accordance with the set frequency determined by the Geology Superintendent unless otherwise adjusted based on knowledge from previous drilling, visual inspections, and rock types (default sampling is every fourth drill hole in each drill hole pattern). The sampling frequency is to be reviewed periodically by Agnico Eagle and may be reduced to 1/16 drill holes for specific rock types in specific zones;

- Drill holes should be distributed evenly throughout the blast area;

- Drill cuttings are collected in a consistent manner. After being fully mixed in a stainless-steel sampling tray, the drill cuttings should be placed into a polyethylene plastic bag and labelled using a standard convention prior to transport to the assay lab. Once dried and crushed to 85% passing 10 mesh (2 mm), the cuttings are split through a rotating sample splitter down to 500 - 800 g.

ARD potential is generally characterized using acid-base accounting (ABA) analysis. However, due to the slow turnaround time for completion at a commercial laboratory, samples will be analyzed at the Meadowbank onsite assay laboratory. Mine staff will use total sulphur and total inorganic carbon to calculate the net potential ratio (NPR) of the sample. The results will be compared to commercial laboratory results for QA/QC. Adaptive management actions associated with the ARD/ML plan are provided in Section 7.1.

For full details of the procedure refer to the Agnico Eagle Whale Tail Pit- Expansion Project, 8-E.5: Operational ARD/ML Sampling and Testing Plan, Version 4_NIRB (Agnico Eagle, 2018c).

6.5 Instrumentation and Monitoring

Monitoring of the Whale Tail and IVR WRSFs will be monitored during all stages of operation to demonstrate geotechnical stability, safe environmental performance of the facilities, and efficiency of the waste management procedures. Instrumentation data is reviewed in accordance with detailed instrumentation design plans to identify anomalous readings that could indicate a change in the conditions of the WRSF or water management processes.

Thermal monitoring will be carried out during all stages of the mine life, including closure and post-closure, to demonstrate geotechnical stability and the safe environmental performance of the facilities. If any non-compliant conditions are identified, then maintenance and planning for corrective measures will be completed in a timely manner.

6.6 Reporting Requirements

Documentation of surveillance and monitoring activities should be maintained by the General Mine Manger or as designated. Reports and documentation should include:

- Routine visual observations (weekly routine inspection logs);
- Quarterly instrumentation reports;
- Photographs;
- Instrumentation monitoring and testing;
- Analyses and evaluations.

7 LINKAGES WITH EMERGENCY RESPONSE

7.1 Waste Rock Quality Management Plan

Thresholds	Mitigation Strategies	Potential Issues	Steps	Management Response
Significant variations from model predictions are observed suggesting potential for ARD/ML Drainage	Use only NPAG/NML waste rock for site construction and closure	Observations of visible sulphide minerals or staining, inferring PAG rock was used in construction material across the site	• Notify management • Note location and estimate dimensions of potential PAG/ML material • Collect samples of material from the observed area for analysis (Section 3.2) • Review results; if samples are PAG/ML, establish a monitoring station down gradient of the location • Review water quality sampling; if elevated concentrations are detected, proceed to management response.	• Consider relocation of material to WRSF or cover with additional NPAG/NML rock if possible, otherwise investigate other mitigation strategies. • Review the application of the ARD/ML sampling plan (i.e., sampling frequency, total sulphur and total arsenic threshold value, and material classification)
	Confirm that waste rock being encountered exhibits the anticipated range of behaviour from baseline study	Higher proportion of waste rock is PAG/ML than anticipated	• Geology to document the location and classification of samples to identify trends outside the anticipated geochemical behaviour of the rock types • Notify management if unanticipated trends are observed	• Confirm the availability of sufficient NPAG/NML waste rock for closure • Confirm the availability of sufficient space in the WRSF for PAG/ML waste rock • Initiate a follow-up investigation to evaluate the implications
Significant variations from model predictions are observed in the water quality of the WRSF pond	Manage contact water quality to avoid exceedance to predicted levels	One contact water quality monitoring sample is of significantly lower quality than predicted	• Collect and analyze follow up confirmation samples to confirm results • If confirmed, notify management and proceed to management response	• Initiate an investigation to reduce the effects of poor contact water quality, if possible
		Water quality monitoring program identifies trends outside of those predicted, for a significant period of time (i.e., great than two months)	• Increase monitoring frequency • Notify management	• Investigate alternative strategies to control effects to water quality • Investigate strategies to reduce seepage and runoff from identified sources
	Progressive covering of WRSF with thermal cover waste rock to minimize water in contact with PAG/ML rock in post-closure	Cover placement is incomplete or not of sufficient thickness	• Monitor the placement of cover material on the WRSF to ensure appropriate thickness of cover • Monitor temperature of cover and waste rock • Monitor contact water quality • Modify cover thickness with placement of additional material when thickness is not sufficient	• Waste Rock Facility Monitoring Program to confirm completeness of cover on WRSF (Agnico Eagle 2018b)
		Thermal monitoring indicates that the waste rock cover freeze back is not occurring as anticipated	• Notify management and proceed to management response	• Investigate effects of the different thermal regimes on water quality • Consider alternative strategies to mitigate impacts to water quality from the PAG/ML material in the WRSF

Figure 7.1: Adaptive Management Actions Associated with the ARD/ML Plan (Agnico Eagle, 2018c).

8 REFERENCES

Agnico Eagle (Agnico Eagle – Meadowbank Division). 2018a. Whale Tail Pit – Waste Rock Management Plan (Version 3). September.

Agnico Eagle (Agnico Eagle – Meadowbank Division). 2018b. Whale Tail Pit – Expansion Project: Water Quality and Flow Monitoring Plan (Version 4). November.

Agnico Eagle (Agnico Eagle – Meadowbank Division). 2018c. Whale Tail Pit – Expansion Project: Operational ARD/ML Sampling and Testing Plan (Version 4). November.

Agnico Eagle (Agnico Eagle – Meadowbank Division). 2018d. Whale Tail Pit- Expansion Project: Water Management Plan (Version 4). November.

Agnico Eagle (Agnico Eagle- Meadowbank Division). 2018e. Whale Tail Pit- Expansion Project: Thermal Monitoring Plan (Version 2). November.

Canadian Council of Ministers of the Environment (CCME). 2014. Canadian Environmental Quality Guidelines for the Protection of Aquatic Life. Available at http://st-ts.ccme.ca/.

Government of Canada. 2015. Historical Climate Data. Available online from: http://climate.weather.gc.ca/index_e.html

Health Canada. 2014. *Guidelines for Canadian Drinking Water.* Ottawa, ON. Canada: Prepared by the Federal-Provincial-Territorial Committee on Drinking Water.

Okane. 2019. Amaruq Waste Rock Storage Facility Thermal Cover System Design Basis Memorandum Rev 1. September 24, 2019.

MAC (Mining Association of Canada). 2019. Developing an Operation, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities, second edition. February.

SNC (SNC Lavalin). 2015. Whale Tail Pit Project Permitting Level Engineering, Geotechnical and Water Management Infrastructure, Rev. 00 Ref. 627215-1000-40ER-0004, Agnico Eagle Ref. 6108-REP-004_RA.

For further information contact:

Gillian Allen
Senior Engineer
gallen@okc-sk.com

O'Kane Consultants Inc.

112 - 112 Research Drive
Saskatoon, SK S7N 3R3
Canada

Telephone: (306) 955 0702
Facsimile: (306) 955 1596
Web: www.okc-sk.com

Appendix D

WRSF Stability Analysis

SNC·LAVALIN

SNC-LAVALIN INC.
1140, boul. de Maisonneuve O.
Montréal (Québec)
Canada H3A 1M8
Tél: (514) 393-1000
Fax: (514) 390-2765

TECHNICAL MEMORANDUM

Certifiée ISO 9001

TO :	Mrs Alexandre Lavallée & Frédérick Bolduc	**DATE :**	October 10th, 2018
C.C. :			
FROM :	Amir Zamani Getahun Haile Yohan Jalbert	**REF.**	651298-6000-4GER-0002-00
SUBJECT :	Memorandum of the WRSF Stability analysis update		

1.0 OBJECTIVE

1.1 General

The aim of this document is to respond to the mine inspector's comments on the preliminary stability analyses of the Waste Rock Storage Facility (WRSF) summarized in SNC-Lavalin (2017b)[1]. The memorandum presents the results of stability analyses carried out on the WRSF based on the latest test pit data (Appendix A) and data collected from thermistor strings located in the existing Portage and Vault waste rock dumps which show frozen condition for the waste and the foundation.

The test pit data summarized in Appendix A, which show the overburden to be composed of free draining materials of sand followed by sand and gravel and cobbles coupled with the thermistor data at the existing dumps noted above, resulted in a more realistic geotechnical parameters to be selected for the stability analyses as noted in Section 3. The geometry of the WRSF used for the stability analyses of the WRSF is presented on Figure 1.1. The WRSF has a maximum bench height and setback distances of 20 m.

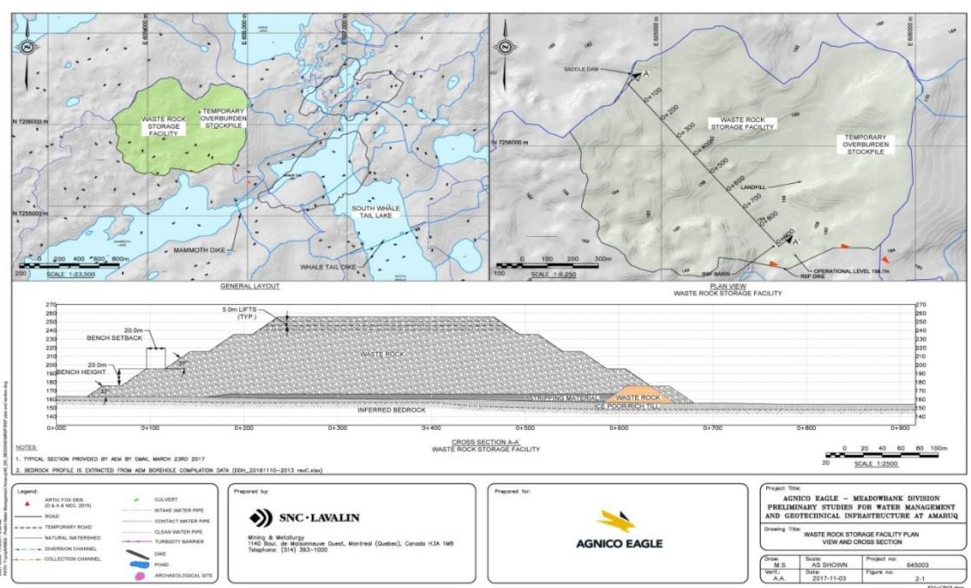


Figure 1.1 – Geometry of the WRSF (SNC, 2017)

[1] SNC-Lavalin (2017b), Report No. 645003-3000-4GER-0002 (November). Stability Analyses of the Waste Rock Storage facility

1.2 Estimated Thermal Regime of WRSF and Foundation

The thermistor data available through the existing Portage and Vault waste dumps show the foundation to be frozen. However, since there was no thermistor data near the toes of the dumps where the foundation will thaw, reliance was placed on the results of available thermal analyses summarized in Golder (2017)[2] and Golder (2018)[3]. These studies estimated thaw depths within the waste rock of 3.3m and 4.2 ±0.5m (or 3.7 to 4.7m) respectively. Based on information communicated to SNC-Lavalin by AEM, the foundation of WRSF will be limited. However, to be on the conservative side near the toe we have assumed that where the waste rock thickness is less than 4.7m, both the waste rock and the foundation will thaw.

1.3 Assumptions

In addition to the updated geotechnical parameters, the stability review took into consideration the following assumptions.

1. As described in section 1.2, all of the waste material or foundation including the stripping material, where the combined thickness is greater than 4.7m will be frozen;
2. Bench slope used (37º) is based on angle of repose of the material in the Vault and Portage Waste dump;
3. The WRSF material is permeable; hence the water table will follow the top of the stripping material (only if thawed) and the top of the foundation;
4. The stripping material is assumed to cover the entire area within the upstream toe of the first bench as shown on Figure 1-1;
5. For the frozen stripping material, the estimated shear strength parameters for frozen condition are similar to the ice rich till (SNC-Lavalin, 2017[4]) but with a reduced friction angle. Based on recent investigation (SNC, 2018[5] and AEM, 2018 in (Appendix A) this material is also glacial till origin with no indication of the presence of clay; see Appendix A for typical grain size distribution curves for the overburden. Incidentally, as will be presented in Section 4, for the configuration of the sectiion analyzed, this material does not control the stability of the it.

2.0 DESIGN CRITERIA

The stability criteria adopted for the WRSF are those applicable for closure in (MERN, 2016)[6] and are provided in Table 2.1. These criteria are derived from the mining rehabilitation guide of the Ministère de l'Énergie et de Ressources Naturelles (MERN, 2016) for closure of mining sites in Quebec. Incidentally, these criteria are the same as those of British Colombia as quoted in Table 8.4 of Hawley et al (2017)[7].

---

[2] Golder (2017), Technical Memo No. 1774579-124-TM-DRAFT (June). Whale Tail Pit Project Waste Rock Storage Facility Cover Thermal Assessment (June 30).
[3] Golder (2018), Technical Memo No. 1789310-177-TM-Rev. 0 (June). Whale Tail Pit Project Waste Rock Storage Facility Cover Thermal Assessment (June 30).
[4] SNC-Lavalin (2017), Report No. 645003-3000 (Oct.). Stability Analyses for Waste Rock Storage Facility.
[5] SNC-Lavalin (2018), Factual Report 651298-4000-4GER-0001_01 | Field Investigation Report, September 2018
[6] MERN (2016), Guidelines for Preparing a Mining Site Rehabilitation Plan and General Site
[7] Hawley, M. Cunning (2017). Guideline for Mine waste Dump and Stockpile Design, April, 2017, CRS Press

Table 2.1: Minimum applicable Factors of safety (MERN, 2016)

Condition	Minimum Factor of Safety
Local stability (for each bank)	
Static analysis – long term	1.2
Global stability (deep rupture or rupture in foundation)	
Static analysis – long term	1.5
Pseudostatic analysis	1.1 to 1.3

3.0 GEOTECHNICAL PARAMETERS

Table 3.1 presents the updated geotechnical parameters used for stability analyses based on the latest (2018) test pit data and detailed geotechnical investigation.

Following review of the latest test pit results within the WRSF footprint (see Appendix A), which show the upper shallow overburden to be composed of mainly sand and gravel and the thermistor data described in Section 1.0, the previously used geotechnical parameters for the stability analyses have been updated. The models for the analyses assume that only the toe area of the WRSF where the thickness of the waste rock is less than 4.7m will thaw and the rest of the foundation below the WRSF will freeze. The strength parameters were updated (where applicable) using data provided in CGE (1999)[8] and all of the strength parameters for frozen till in that document include cohesion due to ice/soil grain bonding (see extract in Appendix A).

The cohesion for the thawed till at the toe of the pile is neglected since the material in non-plastic.

Table 3.1: Geotechnical parameters of the materials and foundation

Material	Bulk density (kN/m^3)	Cohesion (kPa)	Friction angle (°)
Rockfill	22.2	0	(Note 2)
Stripping material (Frozen)	13.5	0	22
Thawed till	20	0	30
Ice poor till [(1)]	19.6	4	31.5
Bedrock	Impenetrable		

Notes:
(1) Ice poor till parameters were obtained from Norman Wells Pipeline (1999) report
(2) .Shear/Normal stress function with 37º max. and 30º min see plot on Figure 3.1

[8] Geological Survey of Canada (CSC, 1999). Open File 3773. Monograph on Norman Wells pipeline – Geotechnical Design and Performance.

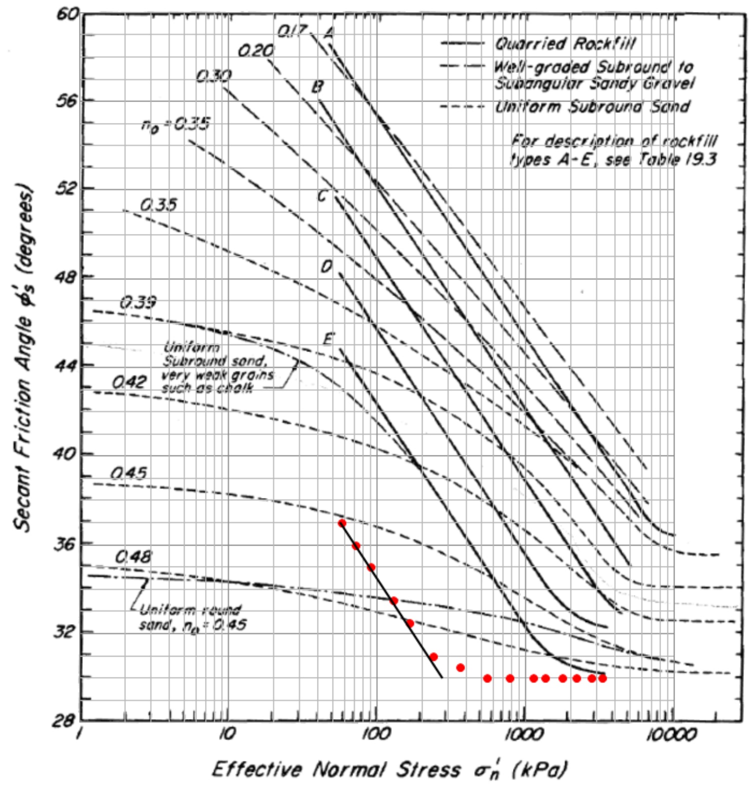


Figure 3.1: Values of secant friction angle for granular soils (Terzaghi et al, 1996)9.

For the pseudo-static analyses, the seismic parameters for a 1:1000 year event were generated from the Geological Survey of Canada (GSC, 2017) online hazard calculator. The 1,000 year return period was obtained from the design criteria for the waste rock dumps at Meadowbank (Golder, 2008). Table 3.2 provides the seismic coefficient adopted.

Table 3.2: Seismic Coefficients

	Design Earthquake (1) Probability of Exceedance		PGA(2) (GSC, 2015)			k_h (6)
	per annum	in 100 years	Firm ground(3)	Rock/Soil Boundary(4)	Hard Rock(5)	
WRSF	1/1,000	10 %	0.030 g	0.025 g	0.025 g	0.013 g

Notes:

(1) Based on the Design Criteria for Waste Rock Dumps at Meadowbank (Golder, 2008).

(2) Peak ground acceleration given in units of g (9.81 m²/s).

(3) NBCC 2015 Site Class C with an average shears wave velocity of 450 m/s.

(4) NBCC 2015 B/C Limit with a shear wave velocity of 760 m/s. Value estimated using the conversion factors provided by GSC (2014)

(5) NBCC 2015 Site Class A with an average shear wave velocity greater than 1,500 m/s. Value estimated using conversion factors recommended by Atkinson and Adams (2013).

(6) Horizontal seismic coefficient estimated based on the methodology proposed by Hynes-Griffin and Franklin (1984).

[9] Terzaghi et al (1996). Soil Mechanics in Engineering Practice, John Wiley & Sons, 1996.

4.0 RESULTS

The results of the stability analyses are summarized in Table 4.1 and on Figures 1 to 3.in Appendix B

Table 4.1 : Stability analyses results

Analysis	Condition/Surface failure	FS obtained	FS required	Figure
1 – Static loading – Frozen foundation and stripping material, with 4.7m deep (maximum) active zone at the toe of the first bench	Local failure through first bench	1.21	1.2	1
2 – Static loading Global failure	Rupture through waste rock stockpile	1.52	1.50	2
3 – Pseudo-Static analysis – Global failure	Rupture through waste rock stockpile	1.48	1.10 -1.30	3

The results of the analyses show that:

1. The effect of cohesion for the till even small is that the both the local and global factors of safety criteria including under pseudo static loading are respected.
2. The stripping material will be frozen hence plays no role in the stability of the pile. As the result it could be placed full waste rock width i.e. between the upstream toes of the first bench as shown on Figure 1-1.
3. The difference between the static and pseudo-static FS's is negligible on account of the low seismicity of the site.

5.0 RECOMMENDATION

It is recommended to install thermistor strings at a minimum of 3 locations around the waste pile to monitor how the thermal regime of the foundation behaves and also make periodic survey to evaluate it there's any deformation during the operation.

APPENDIX A
Test Pit Data
(from AEM)

AMQ - WRSF _ Test Pits Description
Performed on 8/26/2018

By J.Collard & T. Dahm

All pictures are in *P:\Engineering\05-Geotechnic\14- Amaruq\05- Field Campaign\11- AMQ WRSF Test Pit Campaign 2018\Pictures\2018-8-26 AMQ WRSF Test Pits*

AMQ18-TP-09

Depth (m)				Surveyed Coordinates (X,Y,Z) : 605357.743,7256314.891,167.634
0.00	to	0.10	Organic	Comments : The test pit is on top of a hill.
0.10	to	1.65	Sand, Gravel, Cobbles and Boulders	Mix of fine sand w/ cobbles and pocket of coarse sand w/ Gravel and cobble
Depth of Test Pit :		**1.65**	Bedrock	
Water :	NO	N/A		

AMQ18-TP-10

Depth (m)				Surveyed Coordinates (X,Y,Z) : 605642.028,7256282.922,161.266
0.00	to	0.05	Organic	Comments : The test pit is close from a water pounding area.
0.05	to	0.25	Fine grey sand	Then, a big flow was coming. Impossible to see if the refusal is Bedrock or Frozen soil.
0.25	to	1.50	Sand, Gravel, Cobbles and Boulders	
				The water came too fast in the test pit, no sample was taken from inside.
Depth of Test Pit :		**1.50**	Bedrock or Refusal (frozen soil)	
Water :	YES	1.10	Big Flow	

AMQ18-TP-11

Depth (m)				Surveyed Coordinates (X,Y,Z) : 605898.527,7256325.811,165.871
0.00	to	0.05	Organic	Comments : The test pit is in a slope.
0.05	to	1.10	Sand, Gravel, Cobbles and Boulders	Very small water flow was coming at 2 or 3 places, between the 2 differents layers of soil at 1.10m depth.
1.10	to	1.30	Fine beige sand with cobbles	
Depth of Test Pit :		**1.30**	Bedrock or Refusal (frozen soil)	It's hard to see if it's bedrock, because of the presence of cobbles in the bottom soil layer.
Water :	YES	1.15	Very small Flow	

AMQ18-TP-13

Depth (m)				Surveyed Coordinates (X,Y,Z) : 605895.479,7256055.939,163.52
0.00	to	0.08	Organic	Comments : The test pit is in a slope with water pounding area at the toe (kind of small valley)
0.08	to	0.60	Fine beige sand	Water flow was coming out between the 2 differents layers of soil at 0.95m depth.
0.60	to	0.95	Sand, Gravel, Cobbles and stones	
0.95	to	0.95	Fine beige sand with gravel and cobbles	
Depth of Test Pit :		**1.50**	Refusal (frozen soil)	It's hard to see if it's bedrock, because of the presence of cobbles in the bottom soil layer.
Water :	YES	0.95	Medium to Big Flow	

SNC • LAVALIN

AMQ18-TP-12

Depth (m)			Surveyed Coordinates (X,Y,Z) : 605942.085,7255852.612,167.331	
0.00	to	0.07	Organic	Comments : The test pit is on top of a hill.
0.07	to	0.60	Fine beige sand with Gravel	
0.60	to	1.55	Sand, Gravel, Cobbles and stones	
Depth of Test Pit :		1.55	Bedrock	
Water :	NO	N/A		


AMQ18-TP-01

Depth (m)			Surveyed Coordinates (X,Y,Z) : 605838.823,7255632.889,164.365	
0.00	to	0.06	Organic	Comments : The test pit is on a flat area just beside the new WRSF Road.
0.06	to	0.90	Fine beige sand w/ Gravel + Pockets of Sand, Gravel, Cobbles and stones.	The layers were not at the sames depths on eanch side of the Test pit.
0.90	to	1.60	Fine beige sand with Gravel	
				Water flow was coming out between the 2 differents layers of soil at 0.90m depth (south side)
Depth of Test Pit :		1.60	Bedrock	
Water :	YES	0.90	Small flow	


AMQ18-TP-02

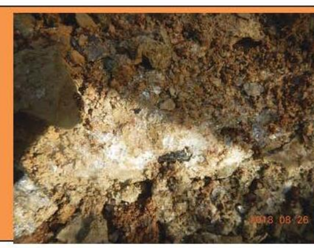
Depth (m)			Surveyed Coordinates (X,Y,Z) : 605692.866,7255629.942,160.703	
0.00	to	0.09	Organic	Comments : The test pit is on a gentle slope.
0.09	to	0.60	Fine beige sand	
0.60	to	1.10	Sand, Gravel, Cobbles and stones	
1.10	to	1.70	Fine beige sand with gravel and cobbles	
				Very small Water flow was coming out between the 2 differents layers of soil at 1.10m depth (2 spots)
Depth of Test Pit :		1.70	Bedrock	
Water :	YES	0.90	Very small flow	



AMQ18-TP-03

Depth (m)			Surveyed Coordinates (X,Y,Z) : 605451.525,7255776.679,155.564	
0.00	to	0.08	Organic	Comments : The test pit is on a flat area (wetland, low point).
0.08	to	0.60	Fine grey sand	
0.60	to	1.10	Fine beige sand with Gravel and cobbles	
				Water flow was coming out between the 2 differents layers of soil at 0.60m depth.
Depth of Test Pit :		1.10	Refusal (frozen soil + ice)	
Water :	YES	0.60	Good flow	





AMQ18-TP-04				
Depth (m)			Surveyed Coordinates (X,Y,Z) : 605332.813,7255721.345,155.28	
0.00	to	0.06	Organic	Comments : The test pit is on a flat area (wetland, low point). Water ponding everywhere around.
0.06	to	0.60	Fine beige sand w/ Gravel + Pockets of Sand, Gravel, Cobbles and stones.	
0.60	to	1.10	Sand, Gravel, Cobbles and stones	
1.10	to	1.70	Fine beige sand with Gravel & Cobbles	
				Big Water flow was coming out from 0.60 to 1.10m depth, Impossible to see if the refusal is Bedrock or Frozen soil.
Depth of Test Pit :		1.70	Bedrock or Refusal (frozen soil)	The water came too fast in the test pit, no sample was taken from inside.
Water :	YES	0.90	Big Flow	

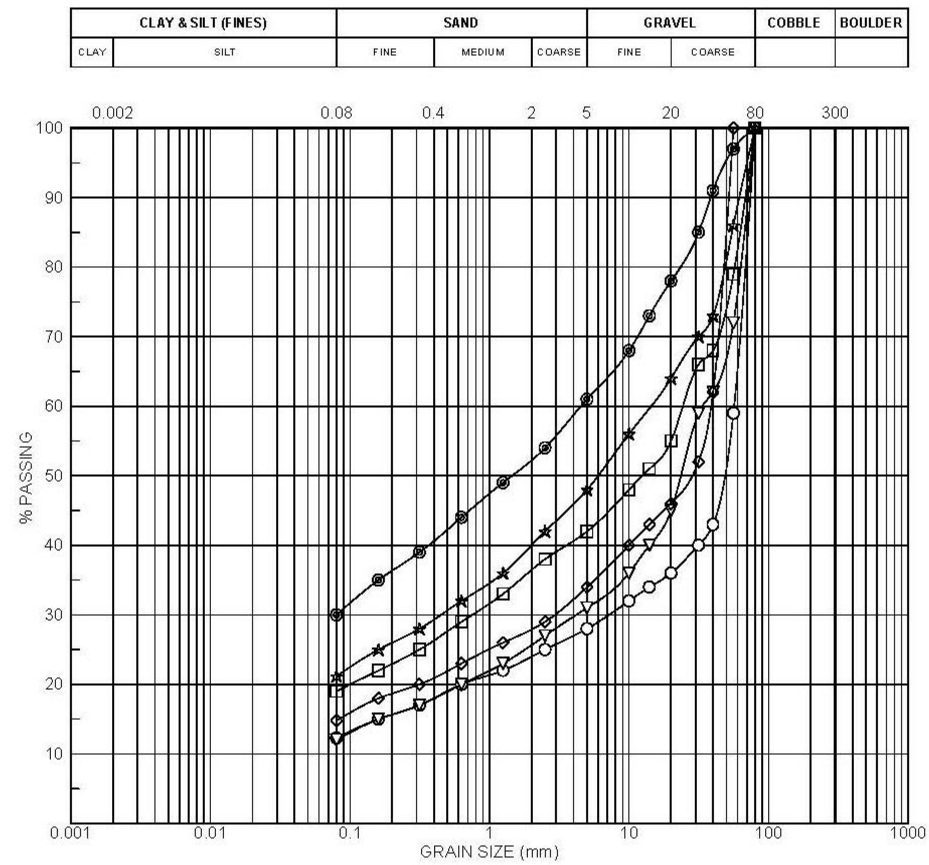


SNC·LAVALIN

GRAIN SIZE DISTRIBUTION

CLIENT : Agnico Eagle Mines Limited
PROJECT : Detailed Engineering of Water Management and Geotechnical Infrastructure
LOCATION : Amaruq, Nunavut
FILE : 651298

FIGURE 3.2



	Borehole	Sample	Depth (m)	Description	Gravel (%)	Sand (%)	Clay & Silt (%)
○	AMQ18-1721	CR-1	0,00 - 0,75	Gravier, un peu de sable et de silt.	72	16	12.3
□	AMQ18-1722	CR-2	0,75 - 2,25	Gravier sableux, un peu de silt.	58	23	19.0
▽	AMQ18-1722	CR-3	2,25 - 3,23	Gravier, un peu de sable et de silt.	69	19	12.0
☆	AMQ18-1727	CR-2A	0,77 - 1,64	Gravier sableux et silteux.	52	27	21.2
◎	AMQ18-1729	CR-2	0,98 - 2,48	Gravier sableux et silteux.	39	31	30.0
◇	AMQ18-1729	CR-3A	2,48 - 2,92	Gravier, un peu de sable et de silt.	66	19	14.8

Remarque:

V:\Projets\00_Base Geotec\0-LAB Lab-granulo-2018(AM).sty

2018-09-13

3.3 Previous Investigations

Prior to the start of the project, a number of other linear corridor studies had been undertaken, which included considerable geotechnical review and data collection. These data were reviewed as part of the Enbridge (IPL) project. Previous studies included geotechnical evaluations from the following studies:

- Canadian Arctic Gas Study Limited
- Foothills Pipe Lines Limited
- Beaufort-Delta Oil Pipeline Ltd.
- Mackenzie Valley Research
- Mackenzie Highway

Most of this previous data and the Enbridge (IPL) borehole data were complied into the Enbridge (IPL) Borehole Database.

3.4 Laboratory Testing

As part of the IPL drilling program, samples were collected for laboratory testing purposes. The primary tests that were conducted were: natural ice/water content, Atterberg (Plasticity) Limits, thaw settlement tests and strength parameters by means of direct shear and triaxial compression tests. On the basis of the laboratory tests, and field identification, the frozen soils on slopes were classified into three groups: ice rich clay, ice rich till, and ice poor till.

Additional data for the Mackenzie River Valley soils was also collected from previous studies, noted in Section 3.3 and from other research (Roggensack, 1977).

Table 3.3 presents a summary of the design soil strength parameters used in the design.

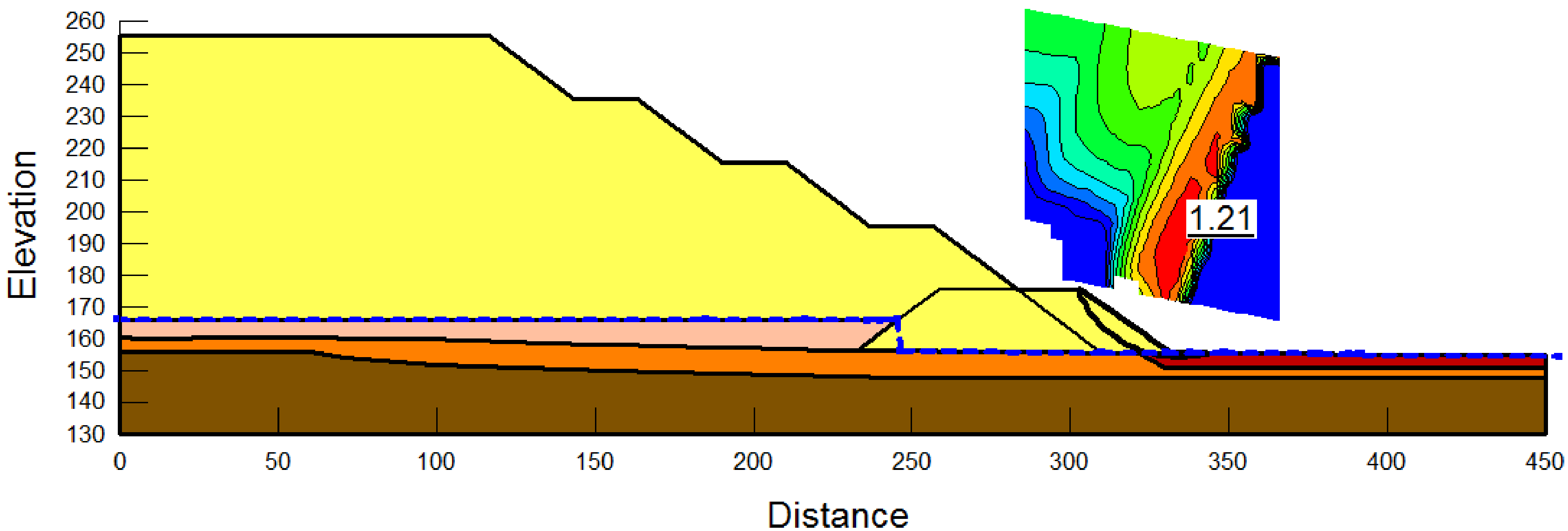
Table 3.3 Summary of Soil Strength Parameters

Soil Type	Friction Angle (°)	Effective Cohesion (kPa)	Bulk Density (kg/m^3)
Ice Rich Clay	24.5	3.5	1760
Ice Poor Till	31.5	4	2000
Ice Rich Till - low normal stress - high normal stress	2231.5	12.54	1760

Table 3.4 presents a summary of the geothermal properties of the soils.

APPENDIX B
Stability Analysis Results

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Cohesion' (kPa)	Phi' (°)
	1 Rockfill (Terzaghi)	Shear/Normal Fn.	22.2	Rockfill fn, PHI max=37 deg		
	2 Stripping material (Frozen)	Mohr-Coulomb	13.5		0	22
	3 Thawed Till	Mohr-Coulomb	20		0	30
	4 Ice poor till	Mohr-Coulomb	19.6		4	31.5
	5 Bedrock	Bedrock (Impenetrable)				



File Name: Memo_WRSF-_with stripping materials.gsz
Name: 1-1- Rupture on ice rich till_GWT

Figure 1: Static conditions – Frozen foundation and stripping material, with 4.7m deep (maximum) active zone at the toe of the first bench

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Cohesion' (kPa)	Phi' (°)
	1 Rockfill (Terzaghi)	Shear/Normal Fn.	22.2	Rockfill fn, PHI max=37 deg		
	2 Stripping material (Frozen)	Mohr-Coulomb	13.5		0	22
	3 Thawed Till	Mohr-Coulomb	20		0	30
	4 Ice poor till	Mohr-Coulomb	19.6		4	31.5
	5 Bedrock	Bedrock (Impenetrable)				

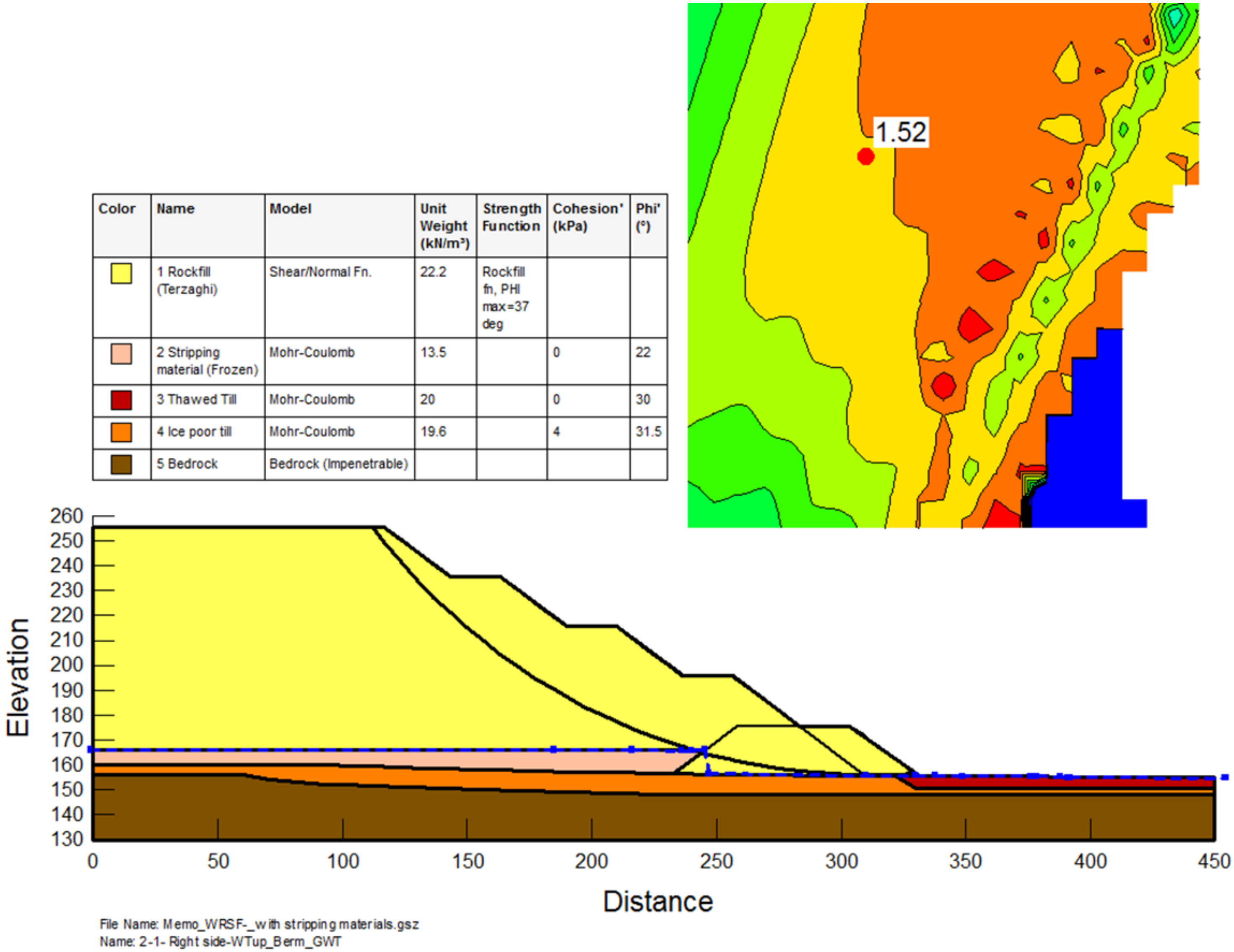
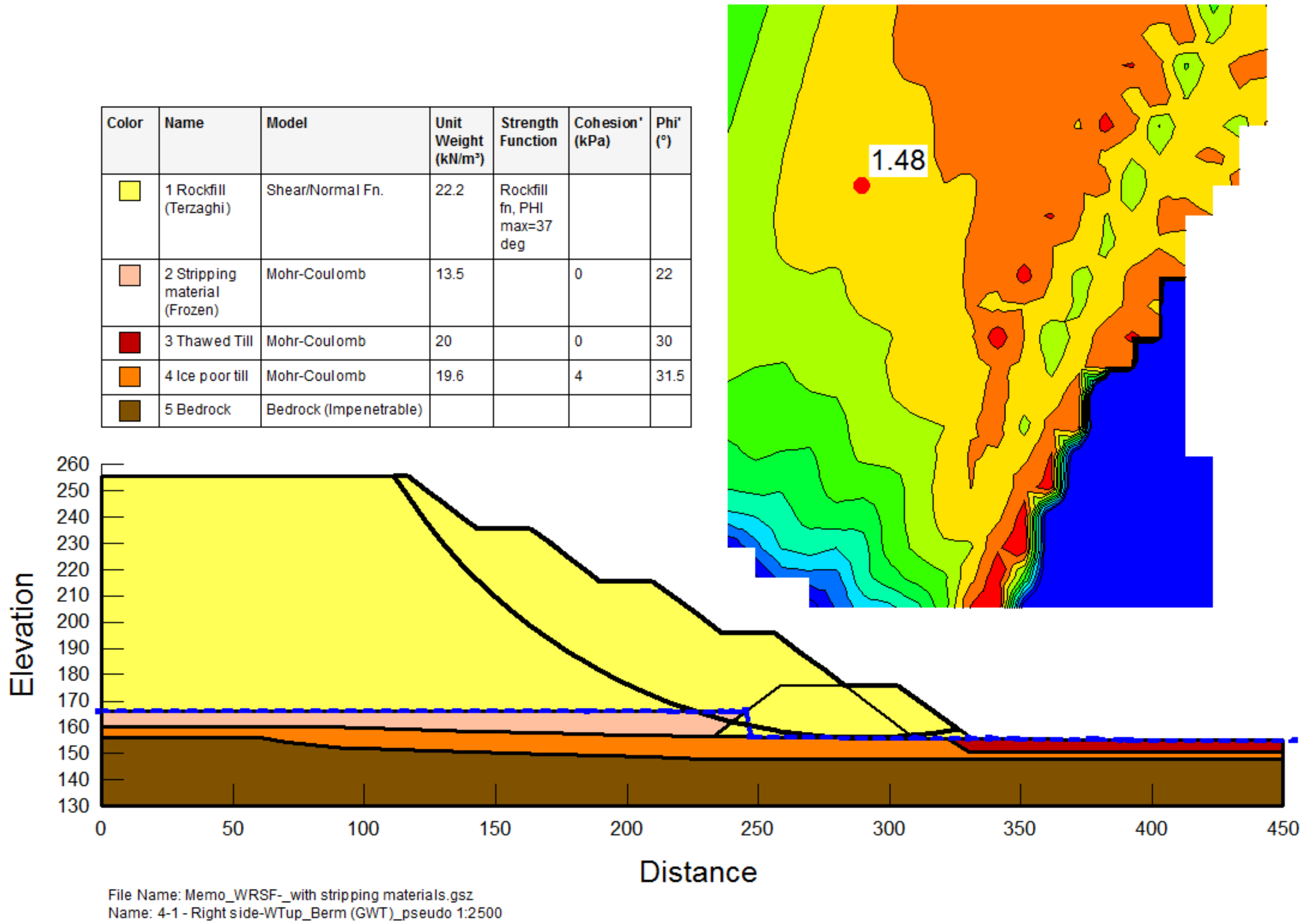


Figure 2: Static conditions – Global slip surface: Frozen foundation and stripping material, with 4.7m deep (maximum) active zone



Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Cohesion' (kPa)	Phi' (°)
	1 Rockfill (Terzaghi)	Shear/Normal Fn.	22.2	Rockfill fn, PHI max=37 deg		
	2 Stripping material (Frozen)	Mohr-Coulomb	13.5		0	22
	3 Thawed Till	Mohr-Coulomb	20		0	30
	4 Ice poor till	Mohr-Coulomb	19.6		4	31.5
	5 Bedrock	Bedrock (Impenetrable)				

Figure 3: Pseudo-Static analysis – Global slip surface: Frozen foundation and stripping material, with 4.7m deep (maximum) active zone

APPENDIX B: Whale Tail WRSF Instrumentation typical cross-section

AGNICO EAGLE

WHALE TAIL MINE

WRSF INSTRUMENTATION DESIGN

CONCEPTUAL DRAWINGS

DRAWING INDEX

DRAWING #	DESCRIPTION
948-011-000	DRAWING INDEX, COVER SHEET AND LOCALITY MAP
948-011-001	WHALE TAIL WRSF GENERAL ARRANGEMENT
948-011-002	WHALE TAIL WRSF MONITORING SECTION DETAILS
948-011-003	WHALE TAIL WRSF TYPICAL THERMISTOR DETAILS
948-011-004	IVR WRSF GENERAL ARRANGEMENT
948-011-005	IVR WRSF MONITORING DETAILS

LOCALITY PLAN:

AERIAL IMAGERY: GOOGLE EARTH 2018
NOT TO SCALE

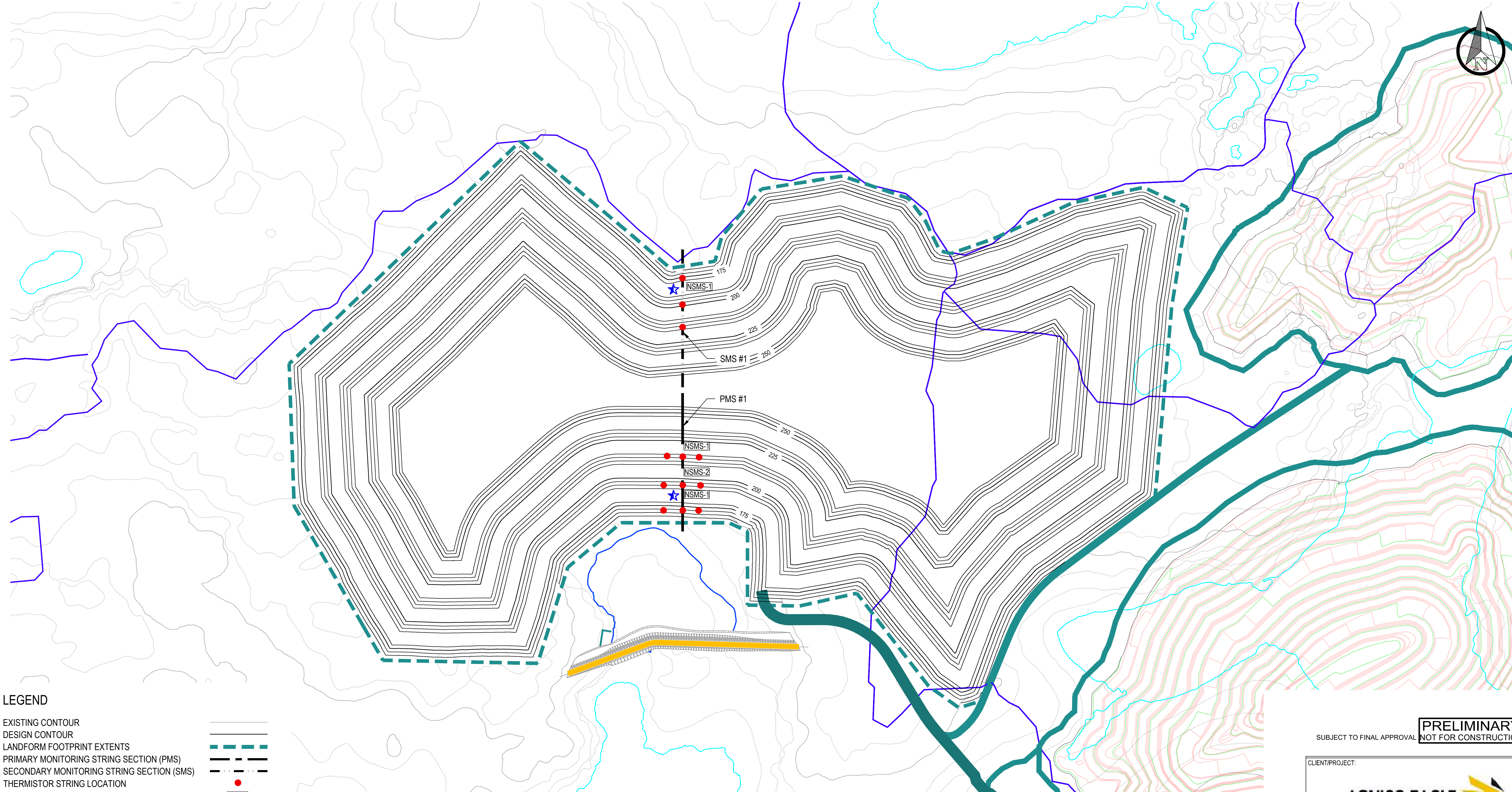
PREPARED BY:

O'Kane Consultants Inc.

Integrated Mine Waste Management and Closure Services
Specialists in Geochemistry and Unsaturated Zone Hydrology

PROVIDED FOR:

AGNICO EAGLE



LEGEND

EXISTING CONTOUR	
DESIGN CONTOUR	
LANDFORM FOOTPRINT EXTENTS	
PRIMARY MONITORING STRING SECTION (PMS)	
SECONDARY MONITORING STRING SECTION (SMS)	
THERMISTOR STRING LOCATION	
NEAR SURFACE MONITORING STATION (NSMS)	NSMS
NET RADIATION MONITORING LOCATION	

NOTE

1. ALL UNITS IN METRES U.N.O.
2. ALL TOPOGRAPHY PROVIDED BY AGNICO EAGLE.
3. REFER TO DWG. 948-011-002 FOR WRSF MONITORING SECTION DETAILS.
4. REFER TO DWG. 948-011-003 FOR TYPICAL THERMISTOR DETAILS.

WHALE TAIL WRSF GENERAL ARRANGEMENT

1:7500

75 0 75 150 225 300 375m

SCALE 1:7500

SUBJECT TO FINAL APPROVAL

PRELIMINARY
NOT FOR CONSTRUCTION

CLIENT/PROJECT:

AGNICO EAGLE

WHALE TAIL WRSF INSTRUMENTATION

PRODUCED BY:

O'Kane Consultants Inc.

Integrated Mine Waste Management and Closure Services
Specialists in Geochemistry and Unsaturated Zone Hydrology

OKC PROJECT NO.: 948/011

REFERENCE: DWG. NO.	DESCRIPTION

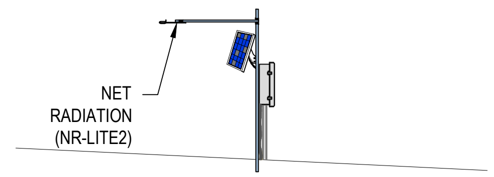
REVISIONS: NO.	DESCRIPTION	DRN. BY:	APPD. BY:	DATE
A	ISSUED FOR CLIENT REVIEW	HSC	GM	12.10.18
B	INSTRUMENTATION UPDATES	HSC	GA	02.10.19

DRN. BY: H. COOPER		DATE: 12.10.18	
APPD. BY: G. MEIERS		DATE: 12.10.18	
SCALE: AS SHOWN	PAGE SIZE: ANSI B	OKC RPT. NO.: 948/011-01	

WHALE TAIL WRSF GENERAL ARRANGEMENT

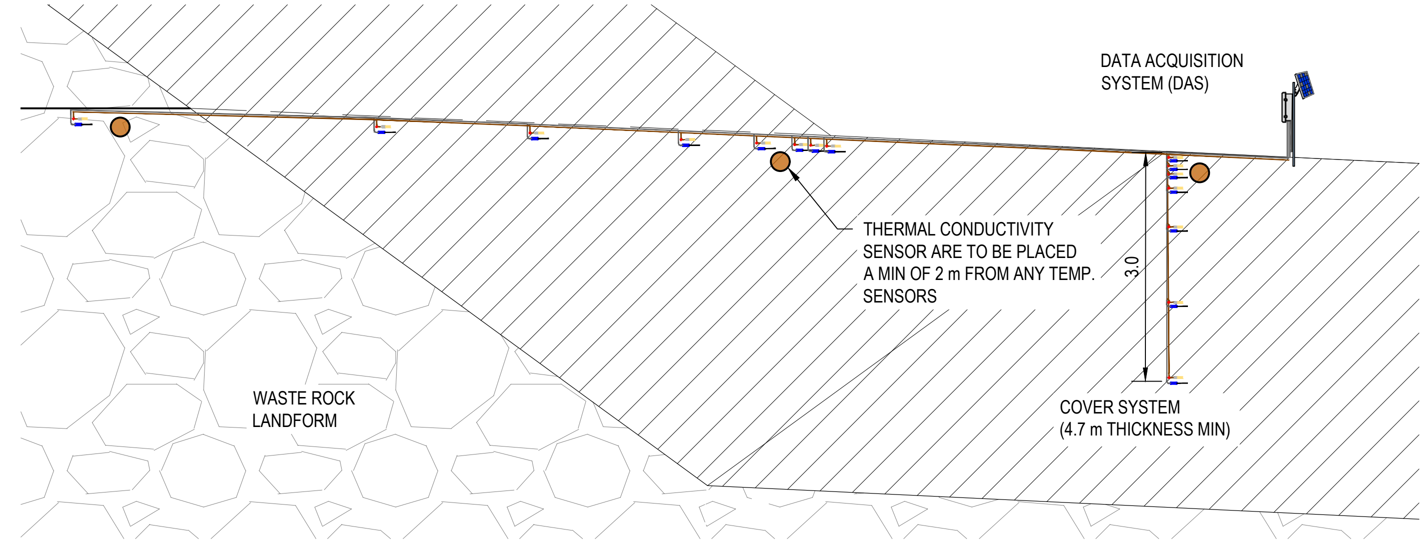
DWG. NO.: 948-011-001 REV.: B

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH OKC REPORT 948/011-01



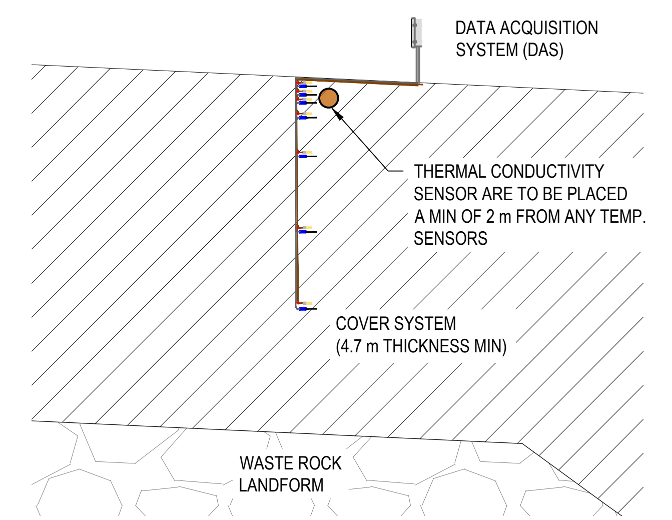
TYPICAL METEOROLOGICAL STATION

DETAIL A
1:50



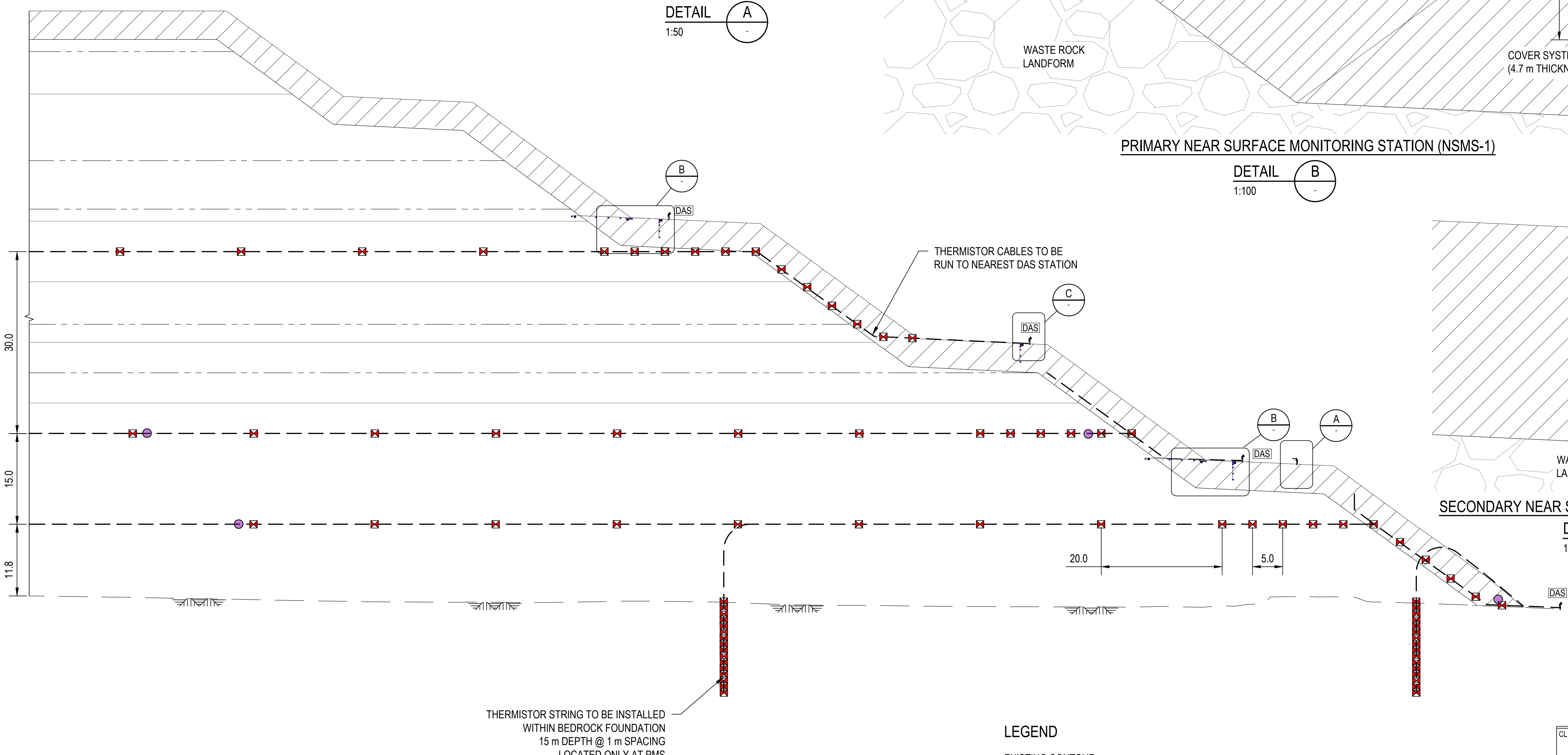
PRIMARY NEAR SURFACE MONITORING STATION (NSMS-1)

DETAIL B
1:100



SECONDARY NEAR SURFACE MONITORING STATION (NSMS-2)

DETAIL C
1:100



SECTION 1
1:750

WRSF THERMISTOR STRING SECTION

PRELIMINARY
SUBJECT TO FINAL APPROVAL NOT FOR CONSTRUCTION

LEGEND

- EXISTING CONTOUR
- DESIGN CONTOUR
- THERMISTOR STRING LOCATION
- THERMISTOR
- THERMAL CONDUCTIVITY
- SOIL MATRIX SUCTION
- VOLUMETRIC WATER CONTENT
- DIFFERENTIAL PRESSURE SENSOR
- DATA ACQUISITION SYSTEM — DAS
- NEAR SURFACE MONITORING STATION — NSMS

1 0.5 0 1 2 3 4 5m
SCALE 1:100
7.5 0 7.5 15 22.5 30 37.5m
SCALE 1:750
50 0 50 100 150 200 250m
SCALE 1:5000

NOTE

1. ALL UNITS IN METRES U.N.O.
2. ALL TOPOGRAPHY PROVIDED BY AGNICO EAGLE.
3. REFER TO DWG 948-011-001 FOR GENERAL INSTRUMENTATION ARRANGEMENT.
4. ALL LOCATIONS ARE PRELIMINARY AND SUBJECT TO CHANGE BASED ON CONDITIONS.
5. PLACEMENT SCHEDULE PROVIDED BY AGNICO EAGLE AND IS SUBJECT TO CHANGE.
6. ALL DATA ACQUISITION SYSTEM AND MET STATION LOCATIONS ARE PRELIMINARY AND SUBJECT TO CHANGE.
7. REFER TO DWG 948-011-003 FOR THERMISTOR STRING DETAILS.

CLIENT/PROJECT:
AGNICO EAGLE
WHALE TAIL WRSF INSTRUMENTATION

PRODUCED BY:
O'Kane Consultants Inc.
Integrated Mine Waste Management and Closure Services
Specialists in Geochemistry and Unsaturated Zone Hydrology
OKC PROJECT NO.: 948/011

REFERENCE

DWG. NO.	DESCRIPTION

REVISIONS

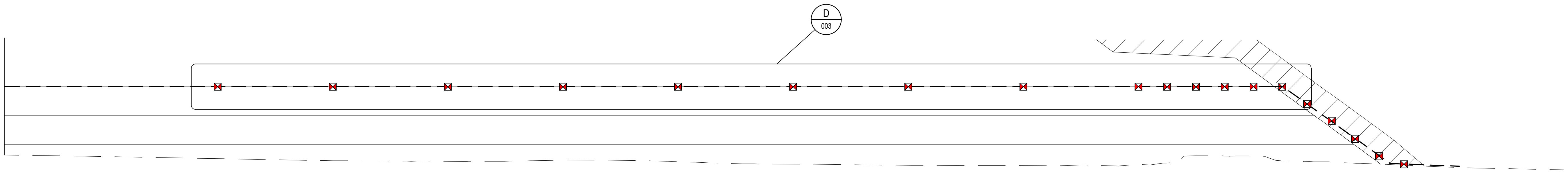
NO.	DESCRIPTION	DRN. BY:	APPD. BY:	DATE
A	ISSUED FOR CLIENT REVIEW	HSC	GM	12.10.18
B	INSTRUMENTATION UPDATE	HSC	GA	02.10.19

DRN. BY: H. COOPER		DATE: 12.10.18	
APPD. BY: G. MEIERS		DATE: 12.10.18	
SCALE: AS SHOWN	PAGE SIZE: ANSI B	OKC RPT. NO.: 948/011-01	

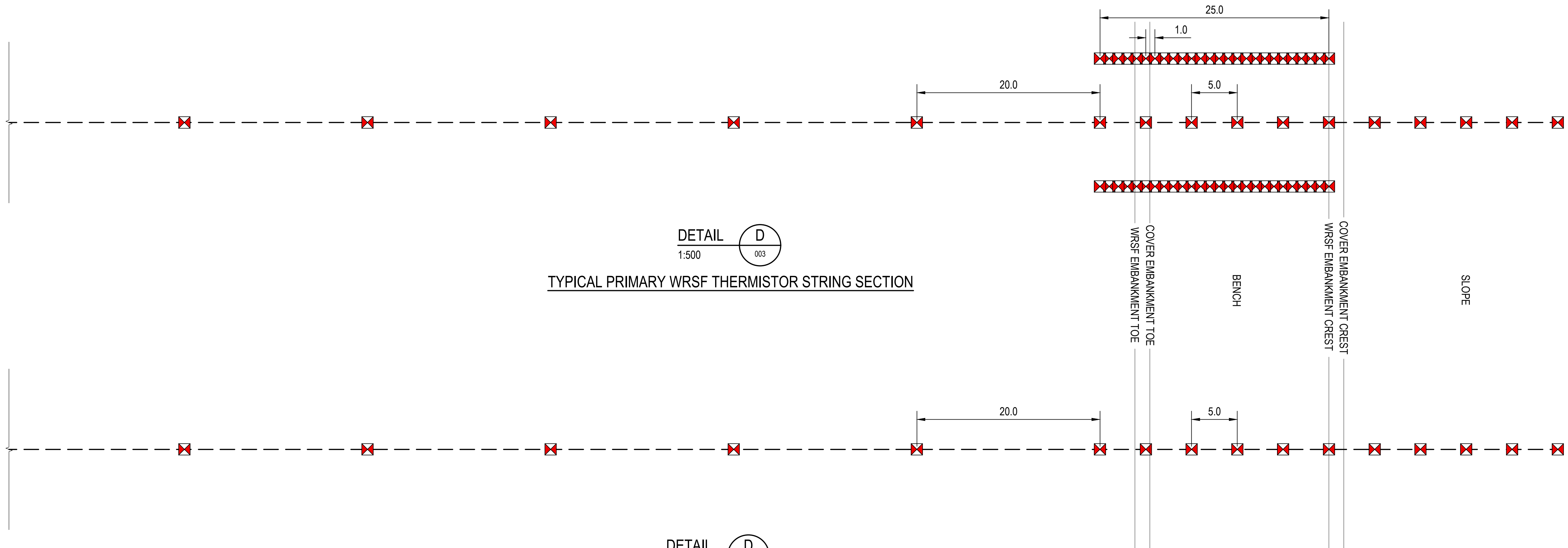
WHALE TAIL WRSF MONITORING
SECTION DETAILS

DWG. NO.: 948-011-002 REV.: B

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH OKC REPORT 948/011-01



TYPICAL WRSF THERMISTOR STRING SECTION
1:750



DETAIL D 1:500 003

TYPICAL PRIMARY WRSF THERMISTOR STRING SECTION

DETAIL D 1:500 003

TYPICAL SECONDARY WRSF THERMISTOR STRING SECTION

PRELIMINARY
SUBJECT TO FINAL APPROVAL NOT FOR CONSTRUCTION

LEGEND

EXISTING CONTOUR
DESIGN CONTOUR
THERMISTOR STRING LOCATION
THERMISTOR
THERMAL CONDUCTIVITY
SOIL MATRIX SUCTION
VOLUMETRIC WATER CONTENT
DIFFERENTIAL PRESSURE SENSOR
DATA ACQUISITION SYSTEM (DAS)
NEAR SURFACE MONITORING STATION (NSMS)

5 0 5 10 15 20 25m
SCALE 1:500

7.5 0 7.5 15 22.5 30 37.5m
SCALE 1:750

NOTE

1. ALL UNITS IN METRES U.N.O.
2. ALL TOPOGRAPHY PROVIDED BY AGNICO EAGLE.
3. REFER TO DWG 948-011-001 FOR GENERAL INSTRUMENTATION ARRANGEMENT.
4. ALL LOCATIONS ARE PRELIMINARY AND SUBJECT TO CHANGE BASED ON CONDITIONS.
5. PLACEMENT SCHEDULE PROVIDED BY AGNICO EAGLE AND IS SUBJECT TO CHANGE.
6. ALL DATA ACQUISITION SYSTEM AND MET STATION LOCATIONS ARE PRELIMINARY AND SUBJECT TO CHANGE.

CLIENT/PROJECT: AGNICO EAGLE
WHALE TAIL WRSF INSTRUMENTATION

PRODUCED BY: O'Kane Consultants Inc.
Integrated Mine Waste Management and Closure Services
Specialists in Geochemistry and Unsaturated Zone Hydrology
OKC PROJECT NO.: 948/011

REFERENCE DWG. NO.	DESCRIPTION

REVISIONS NO.	DESCRIPTION	DRN. BY:	APPD. BY:	DATE
A	ISSUED FOR CLIENT REVIEW	HSC	GM	12.10.18
B	INSTRUMENTATION UPDATES	HSC	GA	02.10.19

DRN. BY: H. COOPER		DATE: 12.10.18	
APPD. BY: G. MEIERS		DATE: 12.10.18	
SCALE: AS SHOWN	PAGE SIZE: ANSI B	OKC RPT. NO.: 948/011-01	

WHALE TAIL WRSF TYPICAL THERMISTOR DETAILS

DWG. NO.: 948-011-003 REV.: B

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH OKC REPORT 948/011-01