Waste Rock Storage Facility 1 (WRSF1) Design Report and Drawings
6515-686-163-REP-001

30-Day Notice to Nunavut Water Board
In Accordance with Water License 2AM-MEL1631 (Part D, item 1)

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1 INTRODUCTION

Agnico Eagle Mines Limited (Agnico Eagle) is operating the Meliadine gold mine, located approximately 25 km north of Rankin Inlet and 80 km southwest from Chesterfield Inlet in the Kivalliq Region of Nunavut. Situated on the western shore of Hudson Bay, the Meliadine site is located on a peninsula between the east, south, and west basins of Meliadine Lake (63°1'23.8'' N, 92°13'6.42"W).

The current mine plan focuses on the development of the Tiriganiaq gold deposit which will be mined using both conventional open-pit and underground mining operations. Existing or proposed mining facilities to support this development include a plant site and accommodations, waste rock storage facilities (WRSFs) and a water management system comprised of collection ponds, diversion channels, dikes and retention berms. A Type "A" Water License (No. 2AM-MEL-1631) was awarded to Agnico Eagle for the development of this project in 2016.

Fragmented rock material with no economic value generated from underground and open pit developments, as well as overburden produced from open pit stripping activities, require storage in permanent, engineered facilities. A total of three WRSFs have been identified for the co-disposal of these mine waste products within the Meliadine mine footprint. Waste material created thus far during mine development has been used for numerous construction projects on the site, with excess waste being expected for the first time during Q4 of 2019.

In accordance with Part D of the Type "A" Water License therefore, this report summarizes the design basis and design criteria for WRSF1. Also provided are construction and operational procedures, thermal instrumentation and monitoring requirements and issued for construction (IFC) drawings. Design reports and drawings for the remaining WRSFs (WRSF2 and WRSF3) will be provided in future submissions.

2 GENERAL SITE CONDITIONS

2.1 CLIMATE

The Meliadine site lies within the Southern Arctic Climatic Region, where daylight reaches a minimum of four hours per day in winter and a maximum of 20 hours per day in summer. The nearest weather station is Rankin Inlet A (Station 2303401), located approximately 25 km south of the mine.

The climate is extreme, experiencing long cold winters and short cool summers. The monthly mean air temperature is typically above 0°C for the months of June to September, and is below 0°C between October and May. July is typically the warmest month with a mean temperature of 12°C and January the coldest with a mean temperature of -31°C. The mean annual temperature for the period of record from 1981 to 2009 was -10.4°C.

Mean annual precipitation at the Meliadine site is estimated to be 411.7 mm, after accounting for rainfall and snowfall undercatch (based on the hydrological year from October 1 to September 30). Approximately 51% of the precipitation occurs as rainfall, while 49% occurs as snow.

The region is known for high winds, blowing from the north and north-northwest direction more than 30% of the time. The mean values for wind speed show that the north-northwest, together with north and northwest winds, have the highest speeds and tend to be the strongest. Mean monthly wind speeds are typically between 19 km/hour and 27 km/hour. Calm winds occur at a frequency of only 2.8%.

The climate in the Meliadine region is projected to be warmer for the 2020s, 2050s, and 2080s time horizons when compared to the observed historic values (Agnico Eagle and Golder 2014).

Precipitation shows an increase compared to historical values, but the majority of projections are not significantly different from the annual recorded precipitation value

2.2 PERMAFROST

The Meliadine site is located within the Southern Arctic terrestrial eco-zone in an area of continuous permafrost. Continuous permafrost to depths of between 360 m to 495 m is expected based on ground temperature data from thermistors installed throughout the mine site and as measured in underground development. The measured ground temperature data indicates that the active layer is 1.0 m to 3.0 m in areas of shallow soils and areas away from the influence of lakes. The typical permafrost ground temperatures at the depths of zero annual amplitude (typically at a depth of below 15 m) are in the range of -5.0°C to -7.5°C in the areas away from lakes and streams. The geothermal gradient ranges from 0.012°C/m to 0.02°C/m (Golder 2012a).

2.3 GROUNDWATER

In areas of continuous permafrost, there are generally two groundwater flow regimes: a shallow groundwater flow regime located in the active layer near the ground surface, and a deep groundwater flow regime located beneath permafrost. From late spring to early autumn, when temperatures are above 0˚C, the active layer thaws. Within the active layer, the water table is expected to be a subdued replica of topography, and is expected to parallel the topographic surface. The Meliadine area groundwater in the active layer flows to local depressions and ponds that drain to larger lakes.

The permafrost in the rock in the mine site area would be virtually impermeable to groundwater flow. The shallow groundwater flow regime, therefore, has little to no hydraulic connection with the deep groundwater regime. A numerical hydrogeological model for the deep groundwater flow regime was developed (Golder 2013a). The results of the hydrogeological model have indicated that the rock at the Meliadine site below the base of the permafrost or in taliks is generally of low hydraulic conductivity, on the order of 3×10^{-9} m/s (Golder 2013b).

To a lesser degree, groundwater beneath the permafrost is influenced by density differences due to the upward diffusion of deep-seated brines (density-driven flow). In the Canadian Shield, concentrations of Total Dissolved Solids (TDS) in groundwater increase with depth, primarily in response to upward diffusion of deep-seated brines. Salinity can induce a freezing point depression, creating a cryopeg in permafrost where water can be unfrozen even though the temperature is below 0°C. At the mine site, the freezing point depression was calculated to be equivalent to -3.3°C (Golder 2012a). The portion of the permafrost, where groundwater may be partially or wholly unfrozen due to the freezing point depression, has been estimated to be at a depth of 350 m to 375 m (Golder 2012a).

2.4 SEISMIC ZONE

The Meliadine area is situated in an area of low seismic risk. The peak ground acceleration (PGA) for the area was estimated from the 2015 National Building Code of Canada seismic hazard website (http://earthquakesscanada.nrcan.gc.ca). The estimated PGA is 0.022 g for a 5% in 50-year probability of exceedance (0.001 per annum or 1 in 1,000 year return) and 0.037 g for a 2% in 50-year probability of exceedance (0.000404 per annum or 1 in 2,475 year return) for the area.

3 DESIGN BASIS

3.1 2019 MINE WASTE MANAGEMENT PLAN

As part of the documentation series produced for the Type “A” Water License, Agnico Eagle presented a Mine Waste Management Plan (MWMP) for the mine site in March of 2019 (Agnico Eagle, 2019a). This plan described the feasibility-level design basis and general operational procedures for the WRSFs.

Key points for the design and construction of the WRSFs from the 2019 MWMP included the following:

- A total of 29.5 Mt of waste rock will be produced through the remaining construction and over an operational mine life of eight (8) years. Approximately 2.8 Mt will be used for surface construction purposes, while an additional 2.1 Mt will be used for underground backfill. The vast majority of the waste rock produced (24.6 Mt) will require permanent storage on the surface;
- A total of 7.1 Mt of overburden will be produced during construction activities and development of the open pits. A small portion of this overburden (0.1 Mt) will be used for reclamation of the tailings storage facility, while the remainder will require permanent storage on the surface.

3.1.1 Refinements Since 2019 Mine Waste Management Plan

Refinements to the expected production schedule and predicted volumes have been made since the release of the March 2019 MWMP. Specifically, although overall quantities of waste rock (31.5 Mt vs 29.5 Mt) and overburden (6.8 Mt vs 7.1 Mt) have generally remained similar, the expected yearly distribution has shifted in order to support an advanced open pit schedule.

Table 1 summarizes the overall production schedule, quantities and distribution of the mine waste by year based on the latest life of mine (LOM) schedule (V11).

Table 1: Schedule and Bank Quantities of Mine Waste Production by Year (V11)

Year	Mine Year	Mine Waste from Underground (t)	Mine Waste from Open Pit Tiri_001 (t)		Mine Waste from Open Pit Tiri_002 (t)	
		Waste Rock	Waste Rock	Overburden	Waste Rock	Overburden
2019	Yr-1	567,358	--	218,149*	--	--
2020	Yr 1	871,289	853,138	238,208	597,162	518,639
2021	Yr 2	705,814	159,028	1,959,165	2,738,869	113,591
2022	Yr 3	734,254	2,583,128	1,644,159	2,153,467	--
2023	Yr 4	766,156	2,733,105	2,020,044	--	--
2024	Yr 5	805,326	6,171,994	130,110	--	--
2025	Yr 6	541,685	2,614,534	--	--	--
2026	Yr 7	332,451	2,332,227	--	--	--
2027	Yr 8	5,006	3,220,643	--	--	--
Total		**5,329,340**	**20,667,797**	**6,209,834**	**5,489,498**	**632,230**

** Includes approximately 142,446 t of excess overburden from various excavation works conducted 2016 – 2018 including CP3, CP4, SP2 and Channel 3*

As shown in Table 2, requirements for waste rock for surface construction (4.0 Mt vs 2.8 Mt) or underground backfill (2.8 Mt vs 2.1 Mt) purposes have increased since the 2019 MWMP, as the need for thermal protection of the overburden in the open pits has been added and underground backfill quantities have risen. However, as the overall total of waste rock generated has slightly increased since the 2019 MWMP, the total amount of waste rock requiring permanent surface storage has remained relatively unchanged (24.7 Mt vs 24.6 Mt).

Table 2: Bank Quantities and Distribution of Mine Waste Production by Year (V11)

Year	Mine Year	Total Waste Rock from Mine Operations (t)	Utilization of Waste Rock (t)		
			Construction/Thermal Protection	Underground Backfill	TSF Closure Cover
2019	Yr-1	567,358	291,400	28,264	188,000
2020	Yr 1	2,321,589	143,149	270,386	192,926
2021	Yr 2	3,603,711	472,545	354,159	188,949
2022	Yr 3	5,470,849	98,492	321,031	166,920
2023	Yr 4	3,499,261	422,093	252,839	229,319
2024	Yr 5	6,977,320	4,262	323,196	538,419
2025	Yr 6	3,156,220	--	311,324	277,896
2026	Yr 7	2,664,678	--	293,718	245,524
2027	Yr 8	3,225,649	--	316,672	99,050
2028	Yr 9	--	--	313,388	453,339
Total		**31,486,635**	**1,431,942**	**2,784,976**	**2,580,342**

3.2 MINE WASTE PROPERTIES AND CHARACTERISTICS

3.2.1 Overburden Geotechnical Properties

Numerous site investigation programs have been conducted at Meliadine since 1998, with a total of twenty (20) geotechnical boreholes and test pits having been drilled/excavated within the proposed footprint of Tiri_001, which will be the source of the overburden placed in WRSF1.

In general, the overburden in Tiri_001 consists of a thin layer of organic material overlying sandy gravel or gravelly sand overlying silty sand or sandy silt till and boulders. Natural moisture contents of the material range from 2.9% to 11.7% and it is non-plastic in nature (Golder, 2010). The overburden materials are assumed to have a specific gravity of 2.70 and an in-place density of 1.62 t/m3 after being placed. The porewater salinity is assumed to be 7 ppt.

3.2.2 Waste Rock Geotechnical Characteristics

The majority of the waste rock is greywacke from the Sam formation and upper oxide formation, and mafic rock from the Wesmeg formation. The waste rock types were generally classified as medium to very strong with uniaxial compressive strength of 92 to 212 MPa (Golder, 2013c). Waste rock from underground sources is typically classified as a 600 mm minus material, with the rock from the open pits expected to be of a larger particle size (1000 mm minus).

The waste rock materials are assumed to have a specific gravity of 2.82 and an in-place density of 1.88 t/m3 after being placed in waste rock piles. These in-place density values are considered to be on the conservative (lower) side for waste rock and overburden management. The actual densities could be higher; therefore, less storage capacity may be required than planned.

3.2.3 Geochemical Characteristics

A series of waste geochemical characterization programs were carried out between 1998 and 2011, with the principle findings presented in Golder 2014. Testing the acid rock drainage and metal leaching potential included mineralogical and chemical composition testing, acid base accounting (ABA), shake flask extraction (SFE), humidity cell tests (HCTs), large column tests and field cell tests. Results of the geochemical characterization indicate that both the tailings from the Tiriganiaq deposit and the waste rock is considered non-potentially acid generating (NPAG) and have low potential for metal leaching (ML).

The overburden geochemical characterization testing was carried out and documented in Golder (2012c). Based on the test findings, the overburden in the Tiriganiaq deposit area is considered to be NPAG.

3.3 LOCATION AND SURFACE CONDITIONS

WRSF1 will be located on the high ground to the west of Portal 2 and east of Lake B7. Figure 1 shown below provides the proposed footprint of WRSF1 in relation to other site infrastructure, including the water management facilities and haulage roads. Haulage distances from Portal 2 to WRSF1 range from 100 m to 800 m, while the distance from Tiri_001 range from 100 m to about 1100 m.

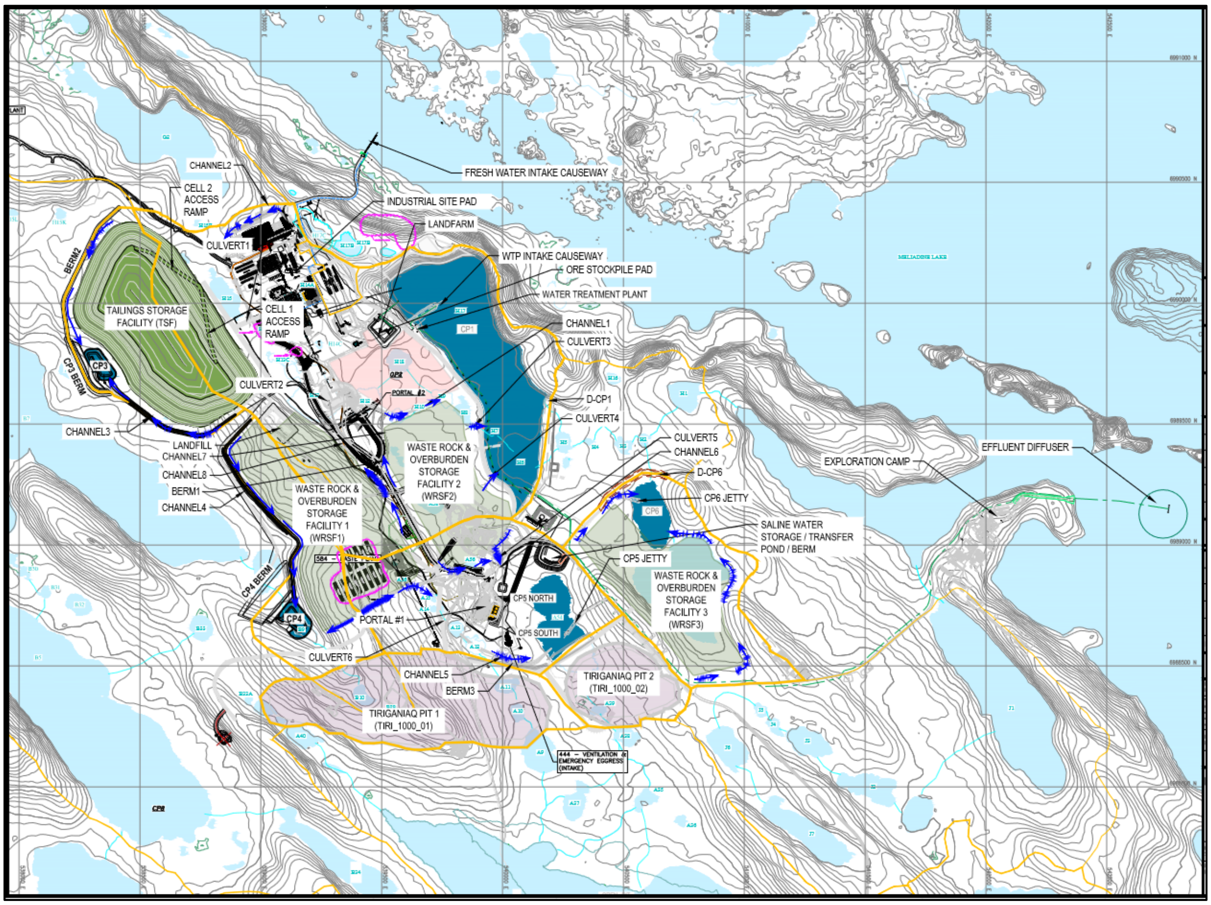

Figure 1: Meliadine General Arrangement (*Agnico Eagle, 2018*)

Straddling three watersheds, WRSF1 envelops a portion of the Tiriganiaq esker. The majority of the facility falls within Watershed B and slopes up to 7% to the southwest towards Lake B7/Pond CP4. A portion of the southeastern side of the footprint lies within Watershed A and slopes towards the CP5 area and a section on the northeastern side of the footprint slopes towards Watershed H and the CP1 area. Vegetation in the area consists of moss/peat cover. The only waterbody of note within the footprint is the small, shallow, non-fish bearing pond A17 near the centre of the facility. Polygonal or linear topographic expressions typically associated with the presence of vertical ice wedges are not readily apparent.

3.4 SUBSURFACE GEOTECHNICAL CONDITIONS

A total of thirteen (13) boreholes have been drilled within or near the proposed WRSF1 footprint, with the location of these boreholes shown below on Figure 2.

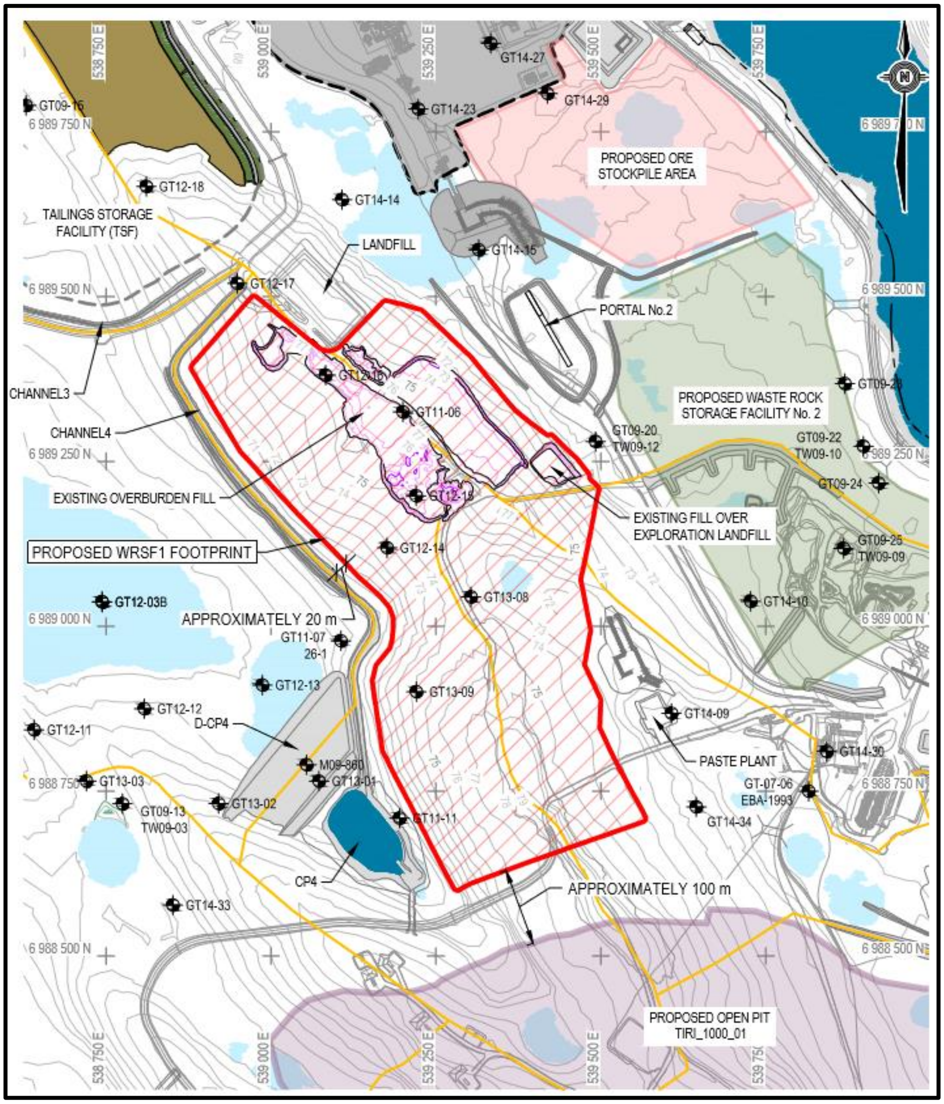

Figure 2: Proposed WRSF1 Footprint with Borehole Locations (*Tetra Tech, 2019a*)

In general, the subsurface of WRSF1 consists of a thin layer of organic material overlying silty sand or sandy silt, ice-rich sandy silt or silty sand, gravelly sand and silt, with traces of clay, shells and boulders and cobbles. Excess ice was observed in most of the boreholes where recovery was possible. The depth to bedrock ranges from 2.2 m just outside the eastern boundary of the WRSF to 13.6 m at the crest of the esker to the north.

Table 3: Summary of Geotechnical Information from Overburden Soils in WRSF1 Area

Borehole No.	Organic Layer Thickness (m)	Overburden Soil Description	Ice Conditions	Bedrock Depth (m)
GT09-20	0.02	Silty sand; sand and silt	Vr>50% from 0.9 to 1.4 m	2.2
GT11-06	--	Low recovery, sand, silt and sand	Vs from 2.5 to 2.75 m	13.6
GT11-07	0.60	Low recovery, silty sand and gravel	Vx from 1.5 to 6.1 m	6.1
GT11-11	0.06	Gravelly sand, ice and silty sand, silty sandy gravel	1.5m ice/silty sand from 2.25m to 3.75m	8.4
GT12-14	0.02	Sandy silty gravel	Not logged	8.5
GT12-15	0.08	Silty sand, sandy silt, gravelly sand and silt	Vr from 1.6 to 3.5 m	12.7
GT12-16	--	Low recovery, sand and gravel, gravelly silty sand, sandy silty gravel	Thawed during drilling	10.4
GT12-17	0.05	Low recovery, silty sand, boulders and cobbles, gravelly sandy silt	Thawed during drilling	8.5
GT13-01	0.20	Sand and silt, gravelly sand	Up to 30% Vx, Vr from 0.6 to 1.2m, 0.2m ice/sand from 1.6 to 1.8m	5.8
GT13-08	0.15	Low recovery, boulders and cobbles	Thawed during drilling	10.4
GT13-09	0.08	Low recovery, gravel, boulders	Thawed during drilling	9.5
GT14-09	0.52	Peat, sand, sandy silt, ice and silt	0.6 m ice and silt from 2.9 to 3.5 m	4.0
GT14-34	0.30	Sandy silt; sand; ice and silt; silty sand	Vs 30%; Vc/Vx 10%; 0.8m ice and silt 1.4 to 2.2m	8.3

3.5 ADDITIONAL KEY DESIGN CONSIDERATIONS

In addition to the expected waste rock production schedule, quantities and characteristics, a number of other factors were reflected in the detailed design of the WRSF. Additional key considerations include:

- **Site climate conditions**: The geographic location of the site was maximized to promote the mine waste freezing process, freeze-back of the underlying foundation soils and encourage permafrost development in the facility;
- **Environmental obligations**: Avoidance of impacts on fish-bearing habitat by maintaining a suitable buffer distance from protected natural lakes and minimizing the overall footprint;
- **Water management**: Facilitate the collection and management of contact water from the WRSF during operations to avoid potentially negative impacts on the outside environment;
- **Geotechnical issues**: Maintain the short and long term stability of the facility;
- **Constructability/Operational concerns**: Minimize haulage wherever feasible and reduce pre-production construction; maintain minimum safe distances from the toe of the WRSF and haul roads and the open pits.

4 DESIGN OF WRSF1

4.1 DESIGN CONCEPT AND PARAMETERS

To address the numerous considerations presented in the design basis for WRSF1, both overburden and waste rock materials will be co-disposed within the same facility. Geochemically, both the overburden and waste rock are similar in that neither material requires a means to prevent oxidation. The overburden will be encapsulated within the waste rock in order to increase the overall stability of the facility. Table 4 presents the key parameters adopted for the detailed WRSF1 design, while the issued for construction (IFC) drawings, including typical cross section, are provided in Appendix A.

Table 4: Key Design Parameters for WRSF1

Design Parameter	Value
Maximum height of each overburden and waste rock bench (m)	5.0
Minimum number of benches	8
Average overall overburden side slopes	4 (H):1 (V)
Average overall waste rock side slopes	3 (H): 1 (V)
Maximum height (elevation) above original ground of facility (m) (masl)	40.0 (112)
Internal overburden setback distance from toe of WRSF (m)	40.0
Width of horizontal offset between overburden benches (m)	20.5
Width of horizontal offset between waste rock benches (m)	16.5
Assumed waste rock in place bulk density (t/m^3)	1.88
Assumed overburden in place bulk density (t/m^3)	1.62

Based on the above design criteria, WRSF1 provides for a total of 5.56 Mm^3 of capacity: 2.09 Mm^3 of overburden and 3.48 Mm^3 of waste rock.

4.1.1 Refinements Since 2019 Mine Waste Management Plan (MWMP)

The total available capacity of WRSF1 has decreased since the 2019 MWMP (5.56 Mm^3 versus 9.4 Mm^3), as the overall footprint has reduced due to the addition of the Paste Plant and ramp in the southeast of the facility, as well as a slight change in the position of the Pond/Berm CP4 structures to the southwest.

To maximize the storage capability of the reduced footprint, the internal overburden setback distance from the toe of the WRSF has been reduced from 120 m to 40 m and the horizontal offset between lifts was reduced. To maintain stability of the facility, average overall side slopes of the overburden has been flattened to approximately 4:1.

4.2 SLOPE STABILITY ANALYSIS

Limit equilibrium analyses were conducted to calculate the deterministic factor of safety (FoS) against slope failure under both static and pseudo-static (seismic) conditions. Two design cross sections of WRSF1 were evaluated under short and long term construction and closure situations assuming various conditions.

The stability acceptance criteria adopted for this analysis is from Hawley and Cunning (2017) and based on the failure consequence and confidence level in foundation conditions, waste material properties, piezometric pressures, overall fill slope angles, height of repose angle slopes and expected precipitation.

Based on the classifications and site conditions, the minimum FoS adopted for the WRSF1 stability design and the minimum calculated FoS for the various failure mechanisms are presented in Table 5.

Table 5: Summary of Slope Stability Analysis Results

Conditions	Required Minimum FoS	Calculated FoS	Comment
Short-term (construction), static, local deep-seated slip surface (less than 15 m depth)	1.30	1.32	Unfrozen, unsaturated waste material; excess pore pressure in underlying sand and silt layers; failure in overburden 87.0 m elev. lift
Long-term (closure), static, global deep-seated slip surface	1.50	1.60	Unfrozen, unsaturated waste material; global failure through waste rock and overburden all lifts
Long-term (closure), seismic, local deep-seated slip surface	1.05	1.26	Unfrozen, unsaturated waste material; addition of appropriate peak ground acceleration for seismic condition; local failure through toe of waste rock first lift
Shallow, static surficial slip surface	1.10	1.18	Shallow, surficial slips along waste rock side slopes

The results indicate that the calculated FoS for WRSF1 meet or exceed industry and AEM requirements for all loading scenarios given the assumed waste material and ground conditions. The stability analyses did not consider the freeze back that is expected to occur in the waste material and the related accompanying increase in strength parameters.

The analysis also highlights the linkage between the WRSF construction schedule and the global stability of the facility due to the assumed presence of a continuous layer of ice-rich silt approximately 1.5 m below the ground surface. Consideration of the requirement to maintain this layer of material in the frozen condition is discussed in the thermal analysis (Section 4.2), overall deposition plan (Section 6.0) and monitoring (Section 8.0) portions of this report.

4.3 THERMAL ANALYSIS

Thermal analysis was conducted to estimate the thermal conditions of the overburden, waste rock and the foundation soils during mine operations and closure. This analysis has been updated since the 2014 feasibility to account for the detailed WRSF design and expected volumes, as well as the latest climate change predictions, and was used to support the stability analysis discussed above.

Given the placement schedule and assumed initial waste temperatures further discussed in Section 6.0, a summary of the thermal analysis is as follows:

- An active layer approximately 3 m in depth below the surface of the WRSF will form. Below this active layer, waste rock and overburden initially placed in an unfrozen state will freeze-back within several years after initial placement.
- The predicted temperatures of the placed waste materials below the active layer in WRSF1 range from -1°C to -2.5°C within 100 years of assumed climate change conditions after initial mine closure.
- Analysis indicates that the initial placement temperatures and placement schedule of the first two benches of overburden (77.0 m and 82.0 m elevation) influence the long-term predicted ground

temperatures in the original ground below the waste materials, particularly the ice-rich silt layer approximately 1.5 m below the ground surface.

- If these first two benches of overburden materials are placed according to the overall deposition plan discussed further in Section 6.0, then original ground below the waste material will be maintained in a frozen condition, with the estimated temperatures being around -1°C and -5°C during operation and in the long term.

The thermal model will be verified and refined on a periodic basis throughout the life-span of the WRSF, as ground/waste temperature monitoring data and as-built information becomes available.

4.4 CREEP AND LONG-TERM DEFORMATION

Frozen soils and ice act as visco-elastic materials under loading and exhibit time dependent deformation (creep). As noted in Section 3.4, the foundation soils underlying WRSF1 tend to be ice-rich, with excess or visible ice observed in most of the boreholes where recovery was possible. Similar foundation conditions are observed under the tailings storage facility (TSF), located just to the northwest of WRSF. Analysis was conducted to evaluate the potential long-term deformation behaviors of the TSF (Tetra Tech EBA, 2014), with this analysis adjusted for WRSF1 design parameters and anticipated ground temperatures in 2019. The results of this updated creep analysis are summarized as follows:

- Maximum horizontal displacements of 0.02 m to 0.06 m per year are expected to occur at the middle of the WRSF side slopes; and

- Maximum vertical displacements of 0.01 m to 0.020 m per year are expected on the crest of the WRSF side slopes.

The above expected deformations assume ductile deformation of a continuous ice-rich silt layer in a primary or secondary creep state. Although the underlying assumptions in this analysis are expected to be conservative, it is observed that the WRSF can tolerate the predicted maximum deformations.

5 CONSTRUCTION METHODS AND PROCEDURES

5.1 PRE-CONSTRUCTION

Limited pre-construction activities are required at WRSF1 prior to waste placement and the design assumes that all waste material will be placed directly over original ground. Excess snow and/or ice will be removed from the ground surface before placement and efforts will be made to avoid placement in areas of localized water accumulation.

A topographical survey of the original ground will be completed prior to waste placement.

5.2 OPERATIONAL CONSTRUCTION

The general construction sequence of WRSF1 during operations will be as follows:

- Excess snow/ice will be pushed out of the dumping area with the bulldozer during winter placement.

- Conduct a topographical survey of the original ground surface and place stakes marking the limits of overburden and waste rock.

- Overburden from Tiri_001 will be hauled and end-dumped to its designated location. The material will be spread after dumping into controlled lifts with a CAT D8 bulldozer. This material will be track-packed only. The side slopes of each lift will be to the natural angle of repose (approximately 1.8H:1V).

- Each subsequent bench of overburden material will be “stepped in”, forming a staircase-like structure around the perimeter to establish the required overall design side slope.
- Waste rock from underground operations and Tiri_001 will be hauled and end-dumped to its designated location. The material will be placed and pushed around the perimeter of the overburden as cover material. This material will be track-packed only. The side slopes of each bench of waste rock will be to the natural angle of repose (approximately 1.2H:1V).

Further details regarding the overall deposition plan are provided in Section 6.0.

5.3 QUALITY CONTROL

A quality control plan will be developed and included as part of the Operation, Maintenance and Surveillance (OMS) plan for the WRSFs. This plan is expected to include on-going verification of design assumptions and parameters, including monitoring of ground/waste temperatures and on-going ARD/ML testing.

6 OVERALL WASTE DEPOSITION PLAN

The overall deposition plan considers the requirement to promote freeze-back of the waste material and the underlying original ground, as well as minimize haulage distances. The general schedule of deposition per lift (elevation), as well as the expected volumes of the placed material is summarized in Table 6.

Table 6: Waste Placement Schedule for WRSF1

Waste Type	Top Bench Elevation (m)	Approx. Period of Waste Placement	Volume of Waste Placed (m3)
Overburden	77.0	December 2019 to February 2020	319,093
Overburden	82.0	January 2021 to June 2021	700,123
Overburden	87.0	October 2021 to December 2021	532,228
Overburden	92.0	January 2022 to March 2022	354,863
Overburden	97.0	January 2022 to March 2022	179,356
Waste Rock	77.0	February 2020 to January 2022	376,730
Waste Rock	82.0	January 2022 to June 2022	486,694
Waste Rock	87.0	June 2022 to September 2022	509,152
Waste Rock	92.0	September 2022 to January 2023	500,625
Waste Rock	97.0	January 2023 to June 2023	500,863
Waste Rock	102.0	June 2023 to October 2023	508,473
Waste Rock	107.0	October 2023 to January 2024	363,602
Waste Rock	112.0	January 2024 to February 2024	231,992

To further promote freeze-back and permafrost development in the waste material and original ground surface, particularly within the ice-rich silt layer previously discussed, the following placement strategies will be adopted:

- Reduced overburden lifts. At a minimum, overburden benches to 77.0 m and 82.0 m will be placed to a maximum height of 2.5 m. The reduced lift thickness of the first few overburden benches is expected to provide better consolidation of the material at the base, increase stability and reduce thermal losses. The decision to further continue with 2.5 m high lifts of overburden will be made after observations of ground temperatures and performance.

- Timing of overburden placement. As shown in Table 6, overburden placement will be optimized, particularly for benches 77.0 m and 82.0 m, in order to ensure below freezing conditions are maintained in the original ground.

While there are no thermal restrictions on overburden placement after bench 82.0 m, the difficulty in removing and placing overburden in the unfrozen condition is expected to be considerable. If required, the placement of lifts of waste rock will be used to facilitate circulation of haul trucks to the deposition point if summer deposition is considered. These intermittent layers will be covered with overburden when surfaces become trafficable. There are no thermal restrictions regarding the placement of waste rock and it will be placed around the overburden as it becomes available from either the underground or open pits.

7 WATER MANAGEMENT

The water management system of WRSF1 consists of berms, channels and collection ponds designed to collect any seepage and runoff from the waste rock, as well as divert water away from the storage facility itself. Design and drawings of the water management infrastructures related to the WRSF have been approved by the Nunavut Water Board.

As indicated previously, three catchment systems are impacted by WRSF1, with the management strategy for each watershed summarized as follows:

1. CP1 Catchment. Seepage and runoff from the waste rock within the CP1 catchment area will flow through Channels 1, 7 and 8 for deposition in CP1.
2. CP5 Catchment. Channels 5 and 6 will stream runoff from WRSF1 into the CP5 catchment area; and
3. Lake B7 Catchment. Seepage and runoff will be collected in Pond CP4 either directly or via Channel 4. Water collected in Pond CP4 will be pumped to H13 where it will flow through Channel 1 into CP1.

All water management infrastructure will remain in place until mine closure activities are complete and monitoring results demonstrate that the contact water quality from the WRSF meets the discharge criteria. Further details on water management for the WRSFs are provided in the Water Management Plan (Agnico Eagle, 2019b).

8 MONITORING AND INSPECTION

Performance monitoring is an integral part of the operation of any structure in an arctic environment. Geotechnical instrumentation is required to monitor the behavior of the placed waste materials and the underlying foundation during operation. The instrumentation is intended to provide the following information:

- Confirmation that the performance of the foundation soils and placed waste materials are consistent with the predictions made during the design studies, notably in terms of stability, deformation, seepage, and thermal analyses.

- Early warning of the development of potentially adverse trends such as seepage, deformation, and permafrost degradation.

The instrumentation plan for WRSF1 therefore includes a minimum of seven (7) ground temperature cables (GTCs) as shown on Drawing 65-686-230-204. Two (2) of these cables will be both horizontal and vertical, installed approximately 15 m into original ground near the centre of the WRSF and then placed horizontally over original ground to the toes of the pile. The remaining five (5) GTCs will be installed vertically after completion of the corresponding benches to a minimum depth below the original ground. Additional vertical and horizontal ground temperature cables may be installed if required after review of monitoring data and operational performance. Thermistor readings will be measured once a month during the first year, and then on a quarterly basis during operation, with the measured readings analyzed and reported in the annual inspection report.

Visual inspection and monitoring can provide early warning of many conditions that can contribute to structure failures and incidents. Agnico Eagle will undertake daily visual inspections of WRSF1 during active development and monthly inspections when placement activity ceases on an interim/seasonal basis. Once construction of WRSF1 has been completed, visual inspection will continue on a semi-annual basis until closure. Records of all inspections will be maintained, and any potential hazards/risks will be identified, including deformations, seepage, slumping or any other signs of instability.

An annual inspection, in accordance with Part I, items 14 and 15 of Water Licence-2AM-MEL1631 will be conducted by a qualified Geotechnical Engineer to document the performance of the facility. The reports will be submitted to the Nunavut Water Board as per the water license requirements.

Further details regarding the monitoring and inspection plan for the WRSF can be located in the 2019 MWMP (Agnico Eagle, 2019a).

REFERENCES

Agnico Eagle, 2018. Tailings Storage Facility (TSF) Design Report and Drawings. 30-Day Notice submitted to Nunavut Water Board November, 2018.

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Tetra Tech, 2019b. Thermal Analysis for Waste Rock Storage Facility No1, Meliadine Project, Nunavut. A Technical Memorandum submitted to Agnico Eagle Mines Ltd. By Tetra Tech, October 11, 2019.

Appendix A

NO. DESSIN / DRAWING NO. 65-686-230-200-R1

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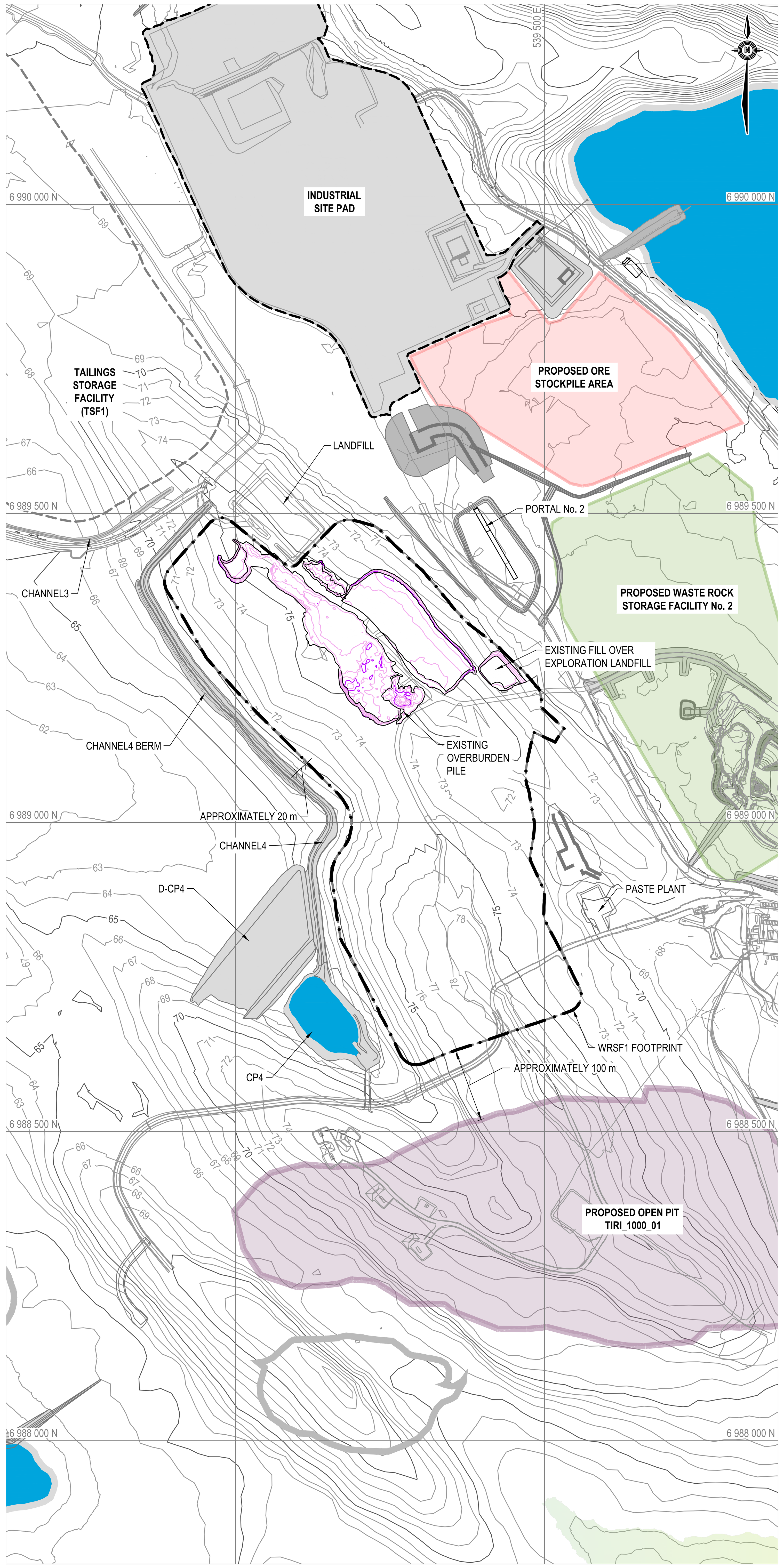

PLAN VIEW SHOWING CURRENT CONDITION

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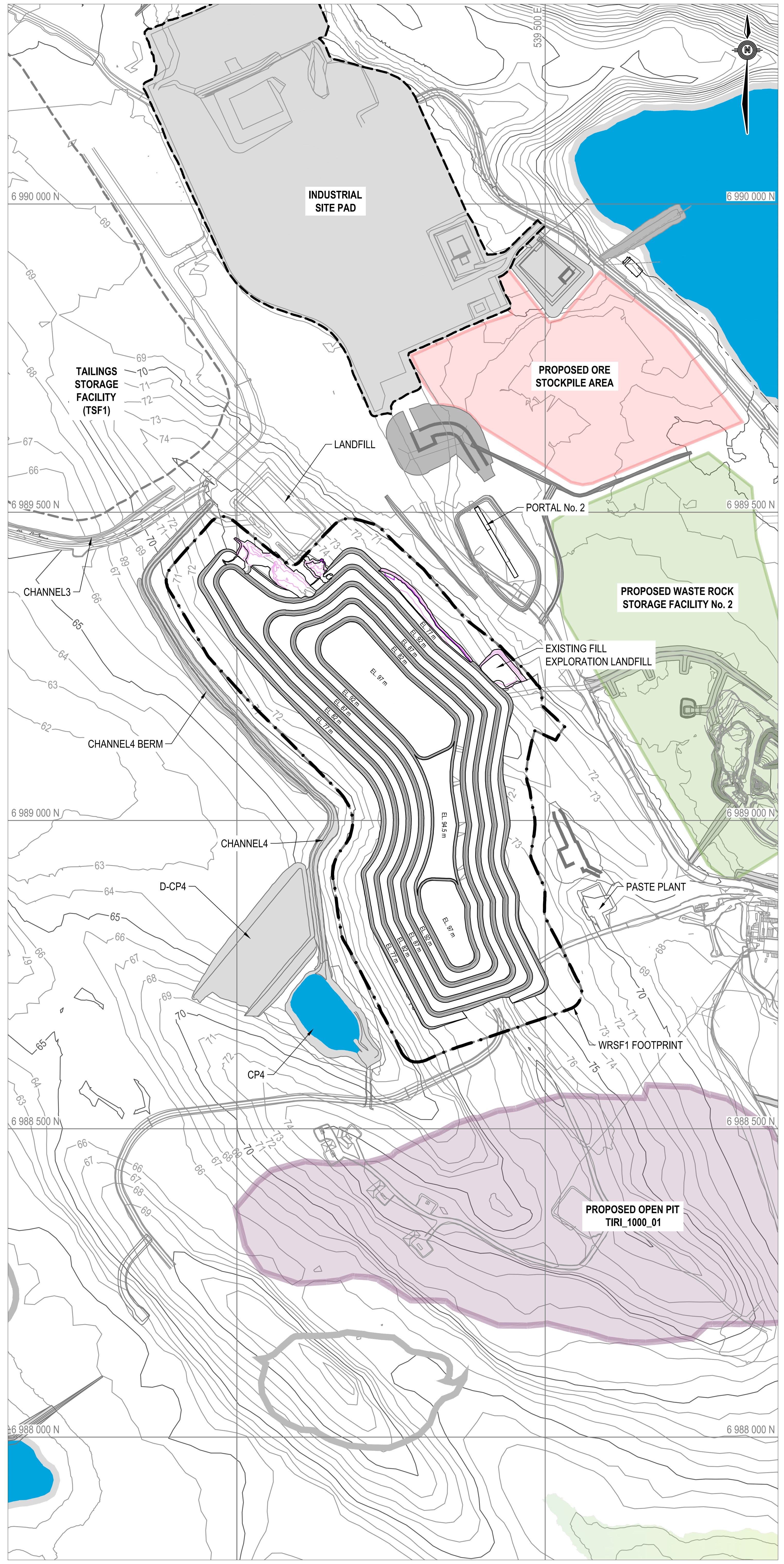

PLAN VIEW SHOWING INTERNAL DESIGN GEOMETRY OF OVERBURDEN WASTE IN WRSF1

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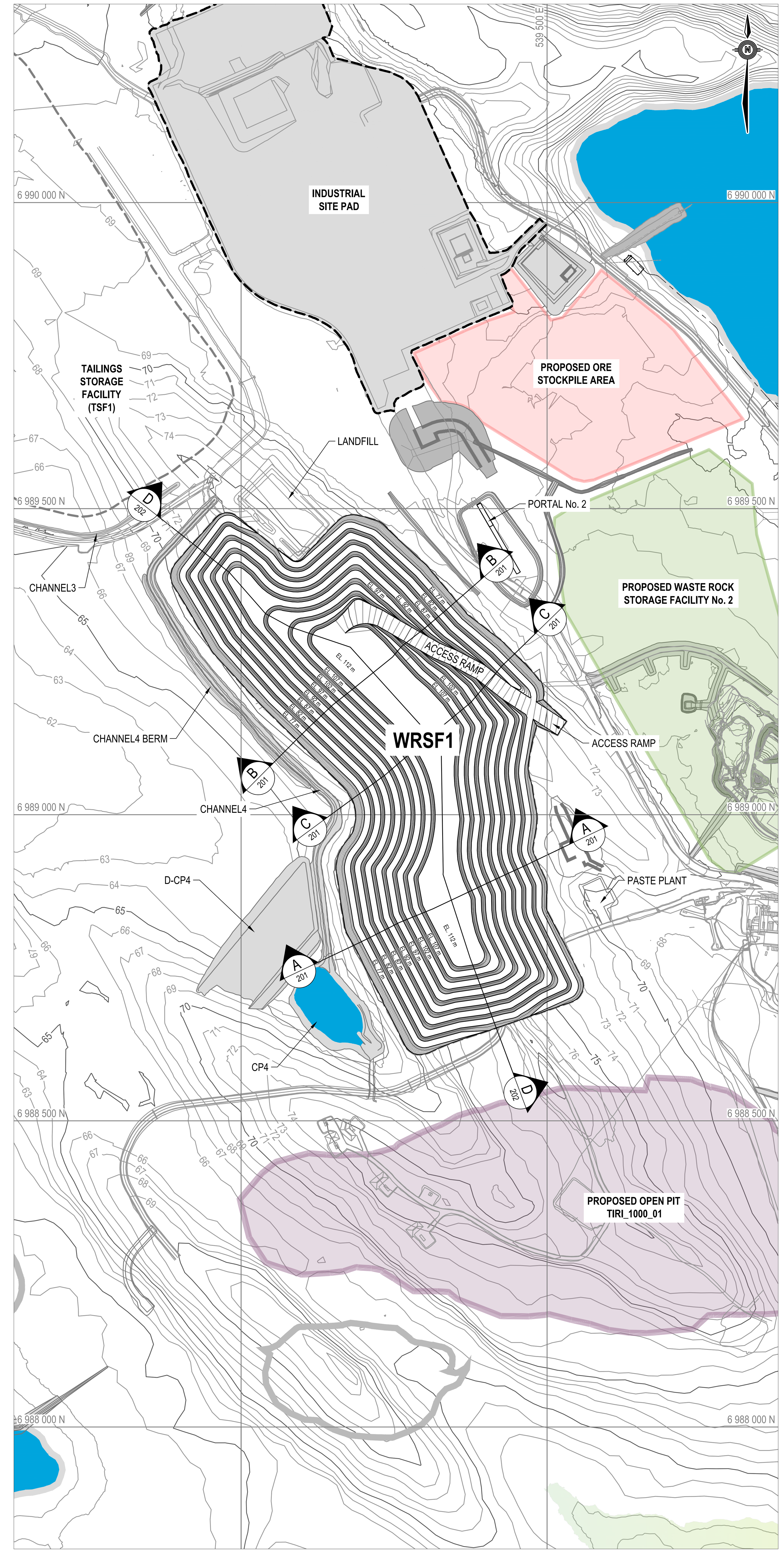

PLAN VIEW SHOWING DESIGN GEOMETRY OF WASTE ROCK OUTSIDE SHELL FOR WRSF1

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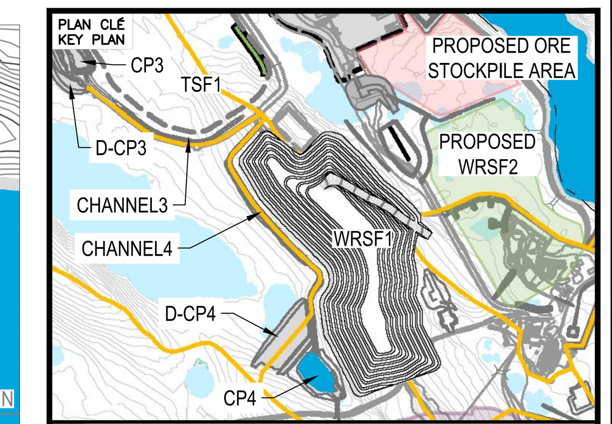
PLAN CLÉ / KEY PLAN



TETRA TECH

NOTES GÉNÉRALES / GENERAL NOTES

1. THE WRSF1 DESIGN PRESENTED HEREIN HAS BEEN BASED ON THE WASTE ROCK AND OVERBURDEN PRODUCTION PLAN THAT WAS PROVIDED ON SEPTEMBER 23, 2019 AND THE CORRESPONDING PRELIMINARY WASTE ROCK AND OVERBURDEN PLACEMENT PLAN THAT WAS DEVELOPED FOR THE DESIGN OF WRSF1. THIS WRSF1 DESIGN SHOULD BE REVIEWED OR UPDATED (IF REQUIRED) IF THE FINAL WASTE ROCK AND OVERBURDEN PLACEMENT PLAN FOR WRSF1, ESPECIALLY THE PLACEMENT PLAN FOR THE INITIAL BENCHES (77 M AND 82 M) OF THE OVERBURDEN WASTE, IS DIFFERENT FROM THAT USED FOR THIS DESIGN.

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
0	2019-11-21	ISSUED FOR CONSTRUCTION	GZ	WTH	

REVISIONS

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Signature
Date November 26, 2019
PERMIT NUMBER: P 018
NT/NU Association of Professional Engineers and Geoscientists

REGISTERED PROFESSIONAL ENGINEER W. T. HORNE LICENSEE N.W.T. Nov 26, 2019

TITRE / TITLE
AGNICO EAGLE MELIADINE GOLD PROJECT
WASTE ROCK STORAGE FACILITY No. 1

PLAN VIEWS FOR WRSF1

DESSINÉ PAR / DRAWN BY	EL	DATE	2019-11-21
VERIFIÉ PAR / CHECKED BY	GZ		2019-11-21
APPROUVÉ PAR / APPROVED BY	WTH		2019-11-21
ÉCHELLE / SCALE	1:2500	DATE	2019-11-21

NO. DESSIN / DRAWING NO. 65-686-230-200

NO. PROJET / PROJECT NO.	REVISION	FEUILLE / SHT
6515	0	1 / 6

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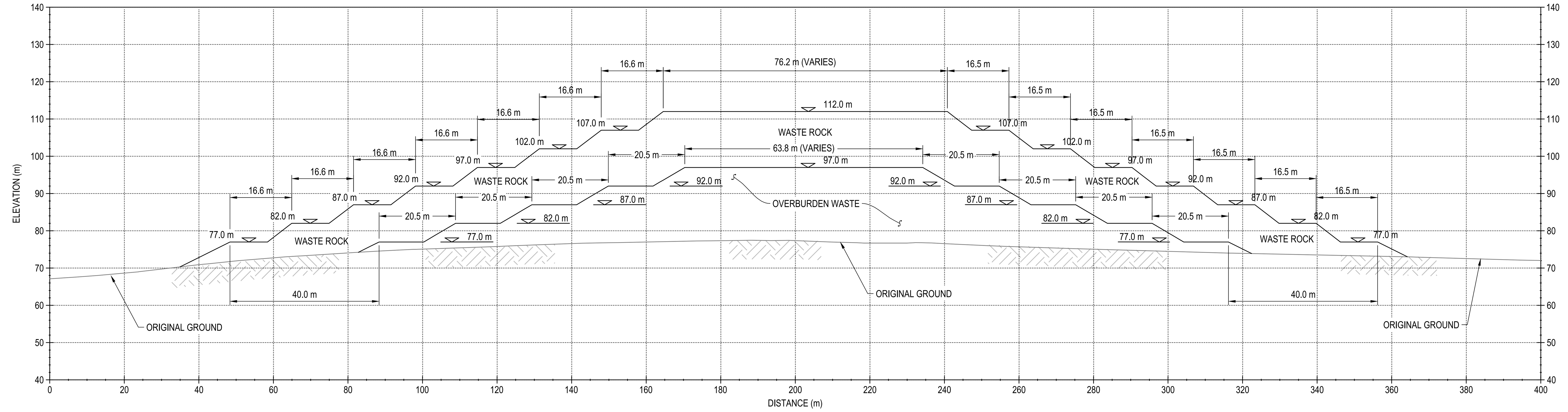

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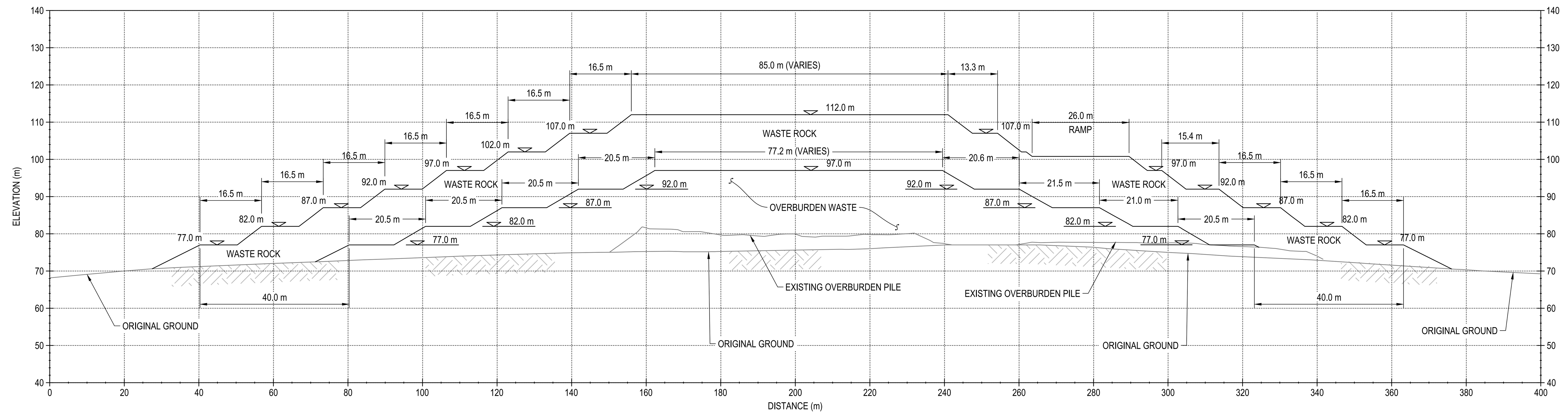

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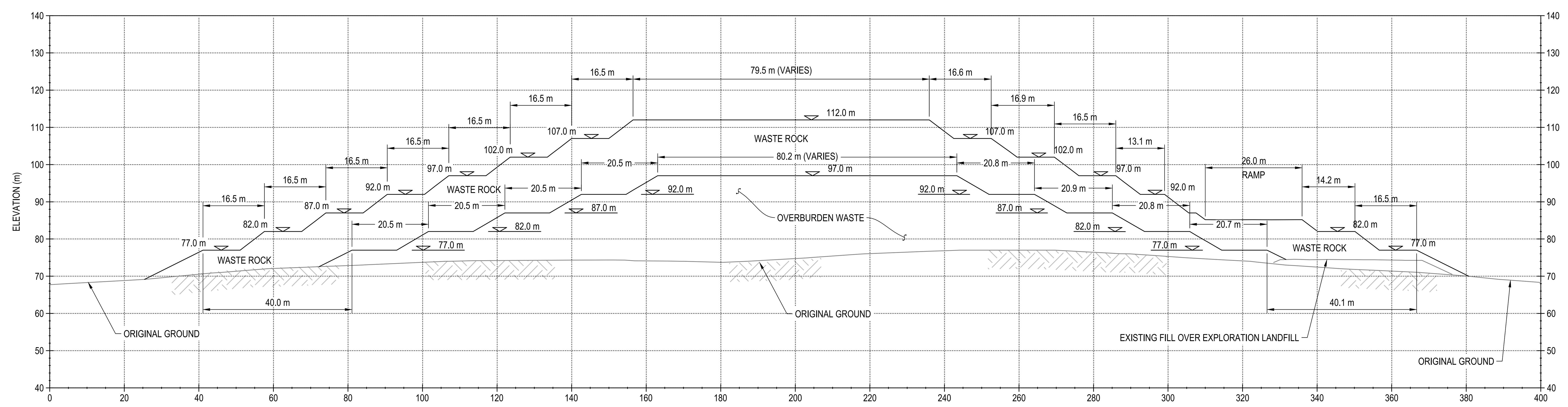

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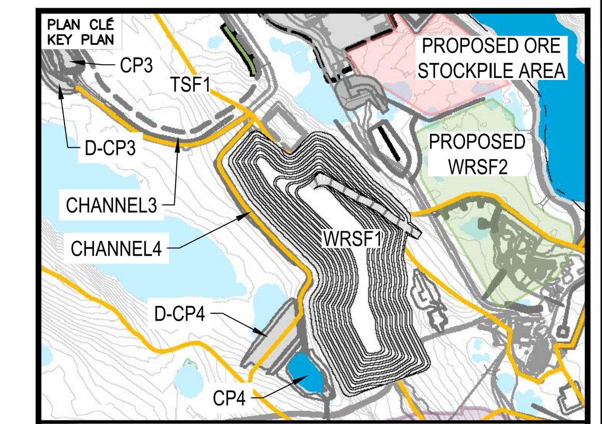
PLAN CLÉ KEY PLAN



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2. THE MAXIMUM LIFT THICKNESS DURING WASTE PLACEMENT SHOULD BE LIMITED TO 2.5 M FOR THE OVERBURDEN WASTE AND TO 5.0 M FOR THE WASTE ROCK.

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
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REGISTERED PROFESSIONAL ENGINEER W.T. HORNE LICENSEE N.W.T. Nov 25, 2019

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AGNICO EAGLE MELIADINE GOLD PROJECT
WASTEROCK STORAGE FACILITY No. 1

SECTIONS A TO C OF WRSF1

DESSINÉ PAR DRAWN BY	EL	DATE 2019-11-21
VERIFIÉ PAR CHECKED BY	GZ	2019-11-21
APPROUVÉ PAR APPROVED BY	WTH	2019-11-21
ÉCHELLE SCALE 1:2500	DATE 2019-11-21	

NO. DESSIN DRAWING NO. 65-686-230-201

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DRAWING NO. 65-686-230-202-R1

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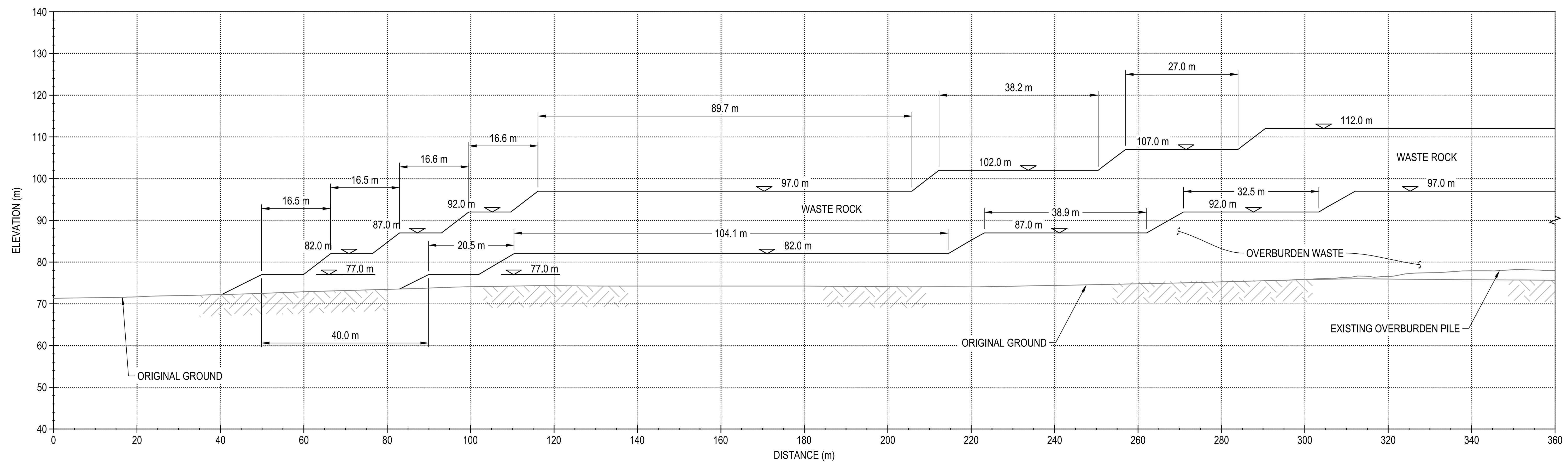

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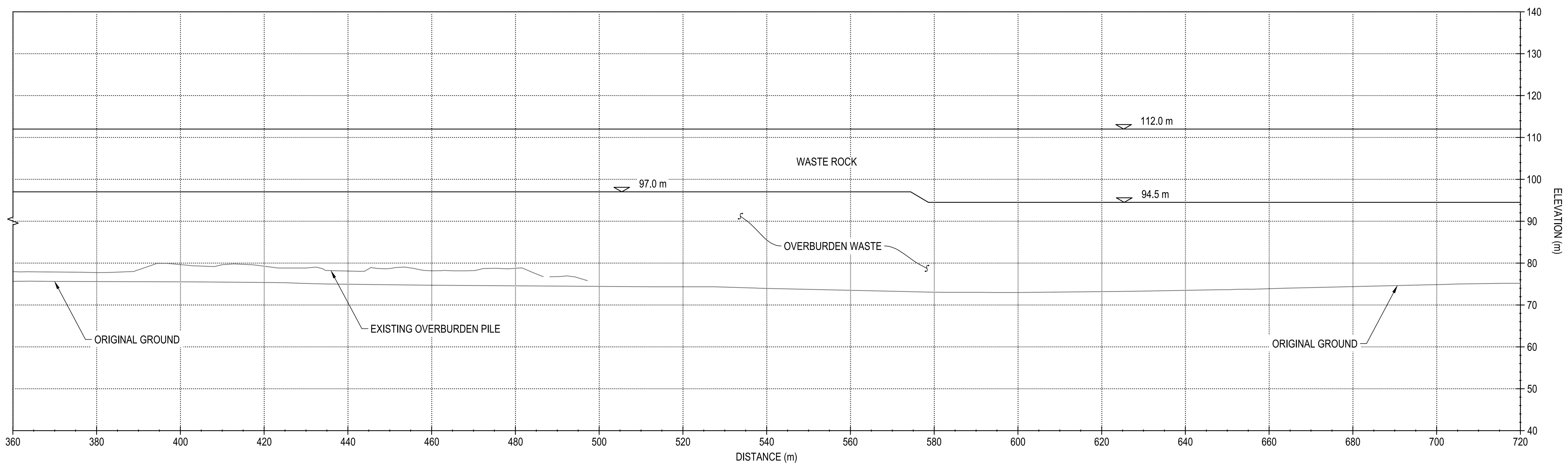

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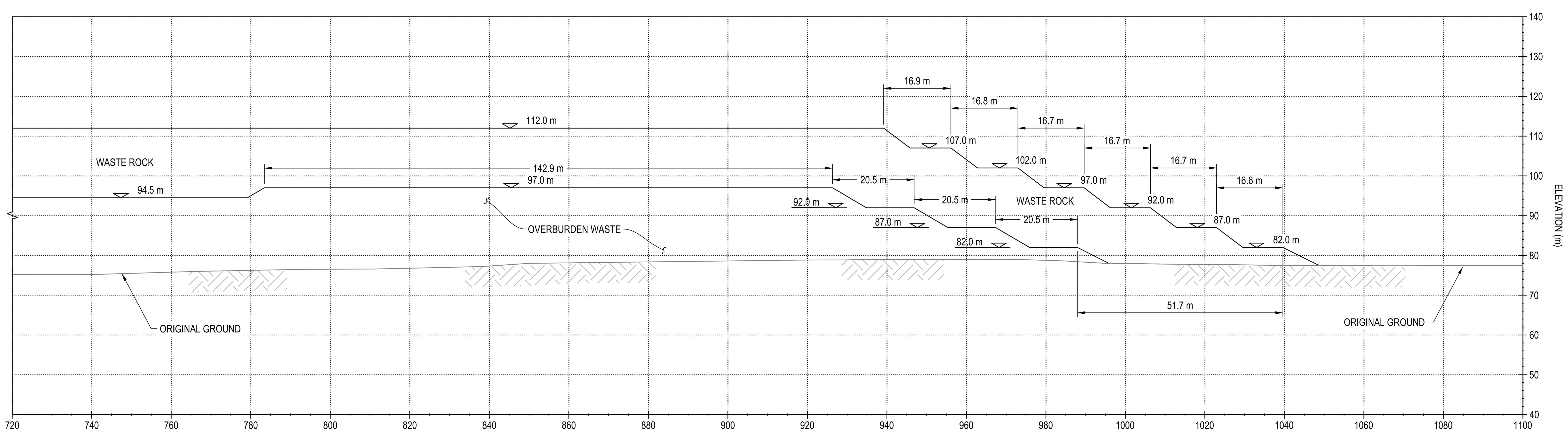

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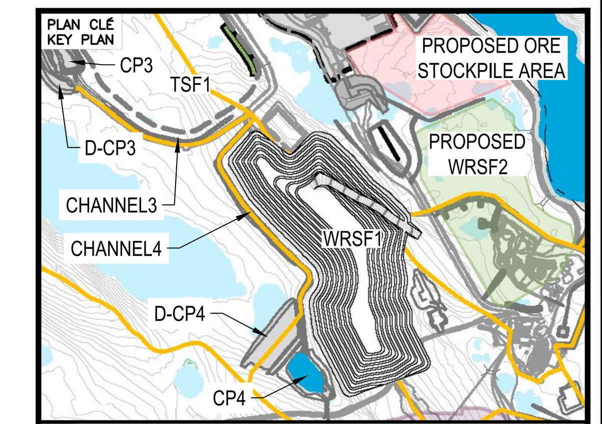

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2. THE MAXIMUM LIFT THICKNESS DURING WASTE PLACEMENT SHOULD BE LIMITED TO 2.5 M FOR THE OVERBURDEN WASTE AND TO 5.0 M FOR THE WASTE ROCK.

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

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REGISTERED PROFESSIONAL ENGINEER W. T. HORNE LICENSEE N.W.T. / NU

TITRE / TITLE
AGNICO EAGLE MELIADINE GOLD PROJECT
WASTEROCK STORAGE FACILITY No. 1

SECTION D OF WRSF1

DESSINÉ PAR DRAWN BY	EL	DATE	2019-11-21
VÉRIFIÉ PAR CHECKED BY	GZ		2019-11-21
APPROUVÉ PAR APPROVED BY	WTH		2019-11-21
ÉCHELLE SCALE	1:2500	DATE	2019-11-21

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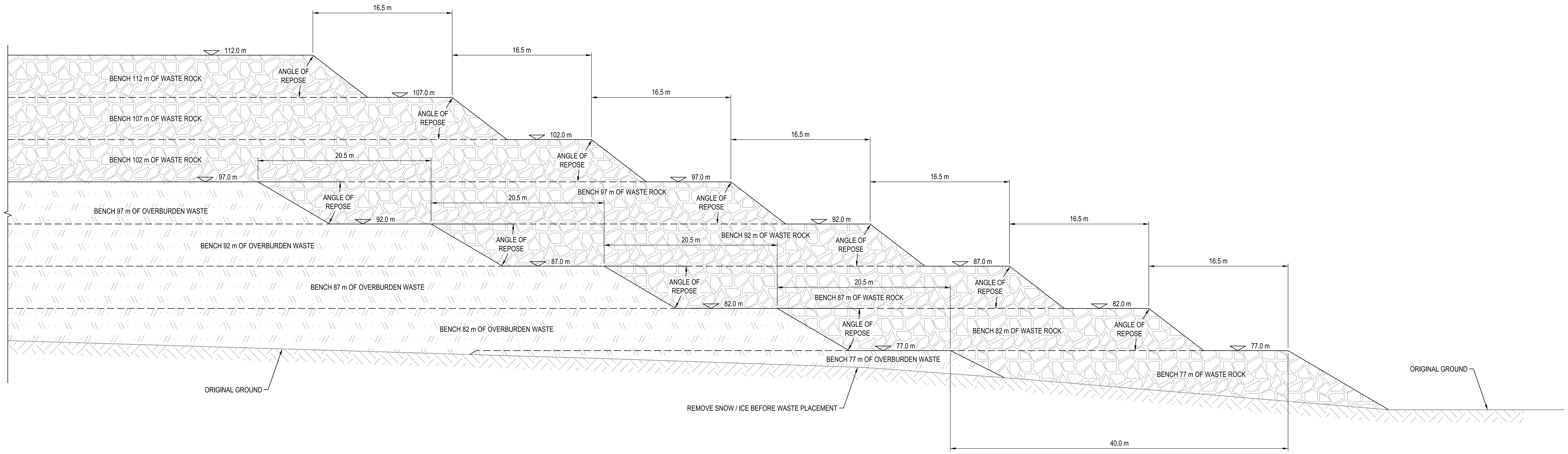

TYPICAL SECTION WITHOUT ACCESS RAMP

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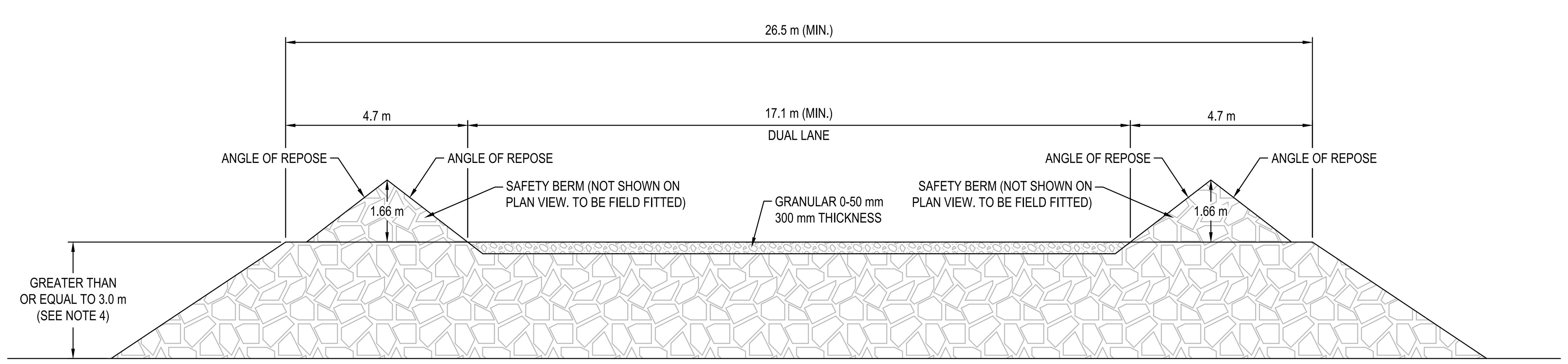
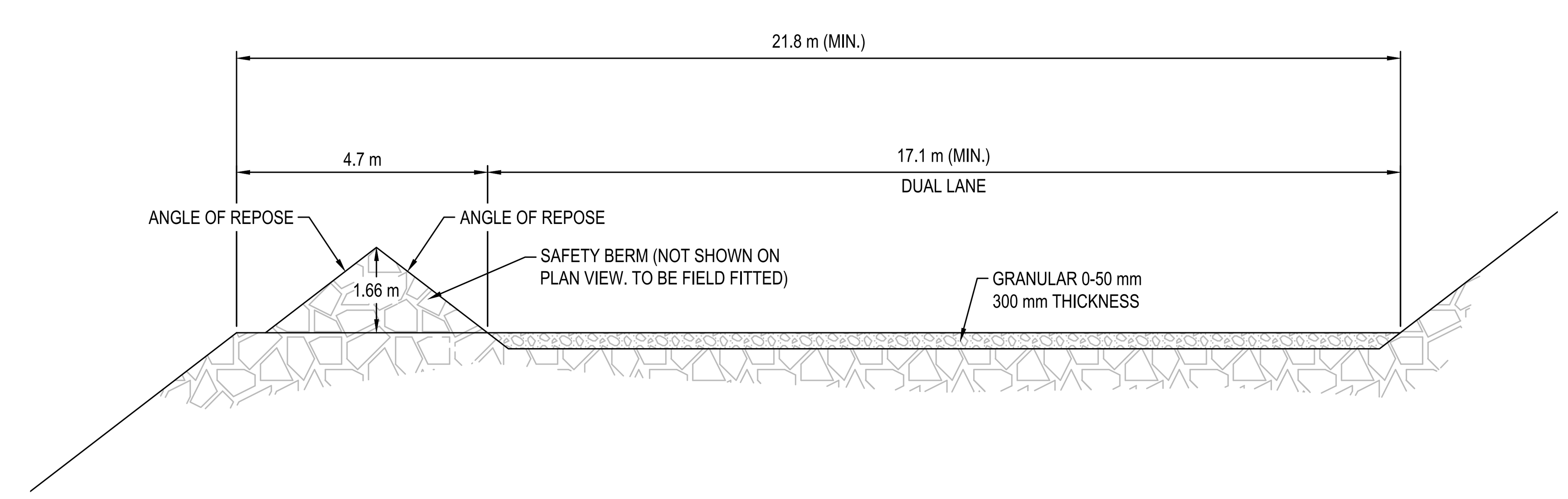


TYPICAL ACCESS RAMP FOR HAUL ROAD WITH TWO SIDE SAFETY BERMS

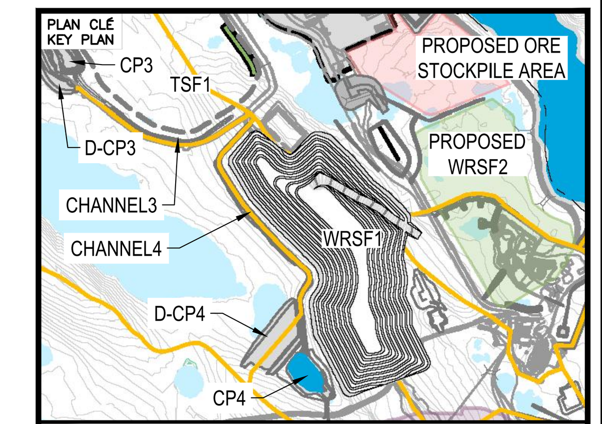
N.T.S.



TYPICAL ACCESS RAMP FOR HAUL ROAD WITH ONE SIDE SAFETY BERM

N.T.S.

PLAN CLÉ KEY PLAN



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NOTES GÉNÉRALES / GENERAL NOTES

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2. THE MAXIMUM LIFT THICKNESS DURING WASTE PLACEMENT SHOULD BE LIMITED TO 2.5 M FOR THE OVERBURDEN WASTE AND TO 5.0 M FOR THE WASTE ROCK.
3. ACCESS RAMP DESIGNED FOR HAUL TRUCK TYPE OF CAT 775G.
4. A SAFETY BERM IS REQUIRED IF A DROP OFF GREATER THAN 3 m EXISTS.

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

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AGNICO EAGLE

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TITRE / TITLE
AGNICO EAGLE MELIADINE GOLD PROJECT
WASTEROCK STORAGE FACILITY No. 1

TYPICAL SECTION AND
ACCESS RAMP DESIGN OF WRSF1

DESSINÉ PAR DRAWN BY	EL	DATE	2019–11–21
VÉRIFIÉ PAR CHECKED BY	GZ		2019–11–21
APPROUVÉ PAR APPROVED BY	WTH		2019–11–21
ÉCHELLE SCALE	1:2500	DATE	2019–11–21

NO. DESSIN DRAWING NO. 65–686–230–203

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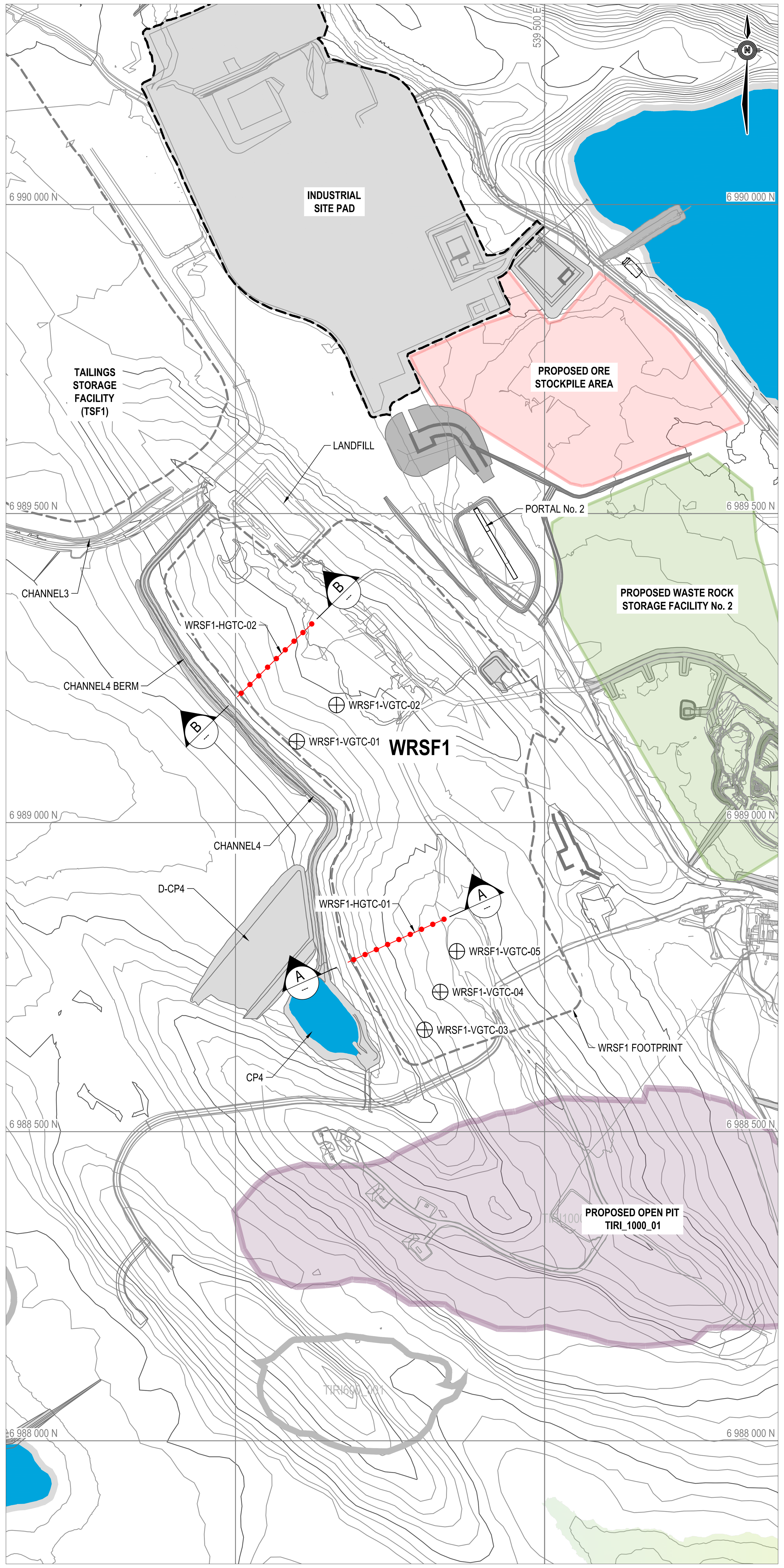

PLAN VIEW SHOWING PROPOSED LOCATIONS OF GROUND TEMPERATURE CABLES FOR WRSF1

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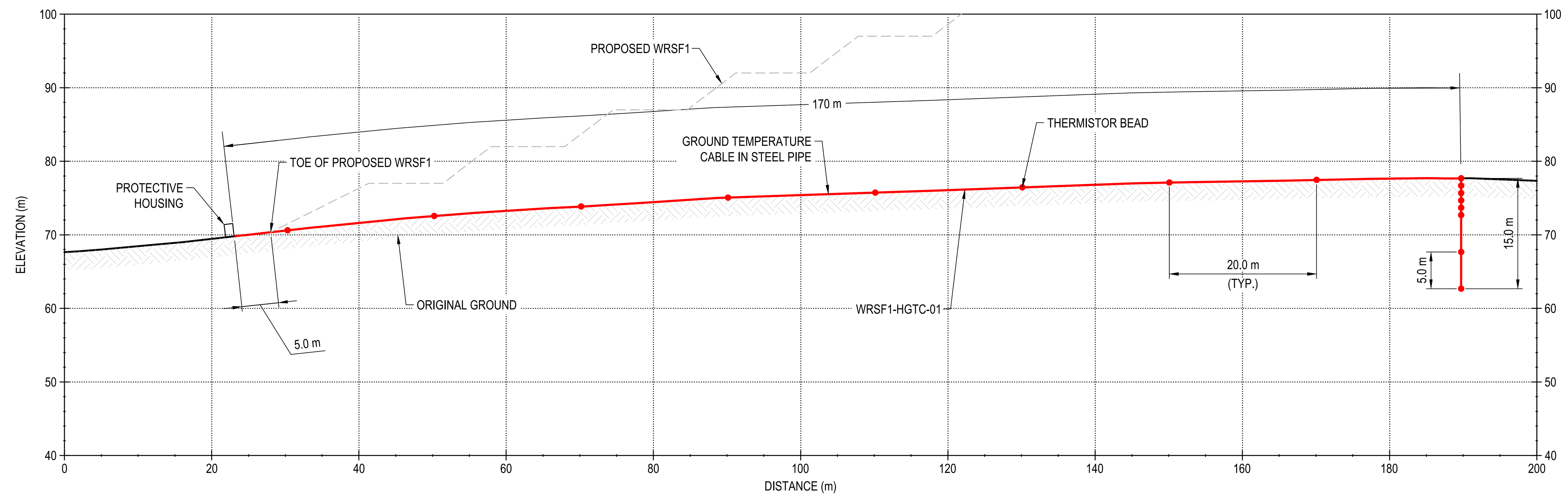

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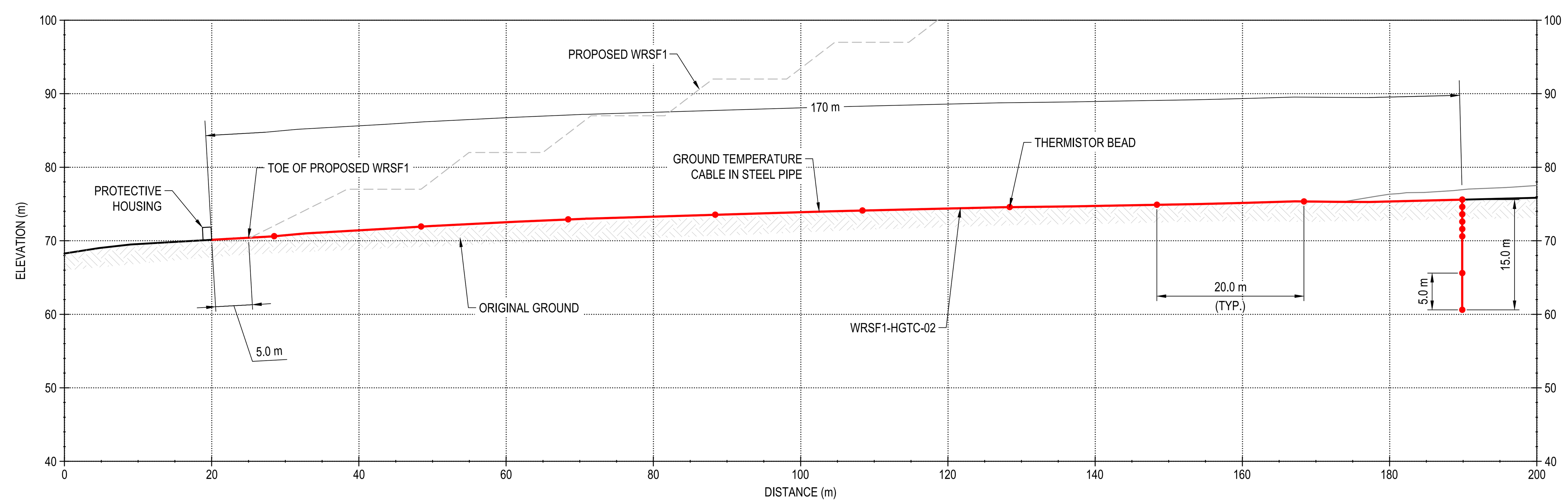

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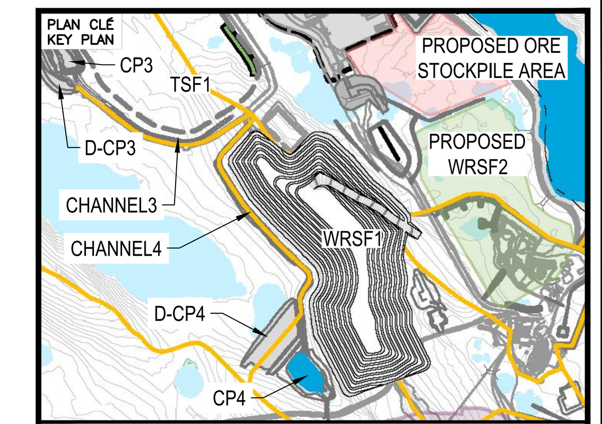
PLAN CLÉ KEY PLAN



TETRA TECH

NOTES GÉNÉRALES / GENERAL NOTES

1. A TOTAL OF 16 THERMISTOR BEADS FOR EACH GROUND TEMPERATURE CABLE

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
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AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
0	2019-11-21	ISSUED FOR CONSTRUCTION	GZ	WTH	

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TITRE / TITLE
AGNICO EAGLE MELIADINE GOLD PROJECT
WASTE ROCK STORAGE FACILITY No. 1

PROPOSED GROUND TEMPERATURE CABLE AND THERMISTOR BEAD LOCATIONS FOR WRSF1

DESSINÉ PAR DRAWN BY	EL	DATE	2019-11-21
VÉRIFIÉ PAR CHECKED BY	GZ		2019-11-21
APPROUVÉ PAR APPROVED BY	WTH		2019-11-21
ÉCHELLE SCALE	1:2500	DATE	2019-11-21

NO. DESSIN DRAWING NO. 65-686-230-204

NO. PROJET PROJECT NO.	REVISION	FEUILLE / SHT
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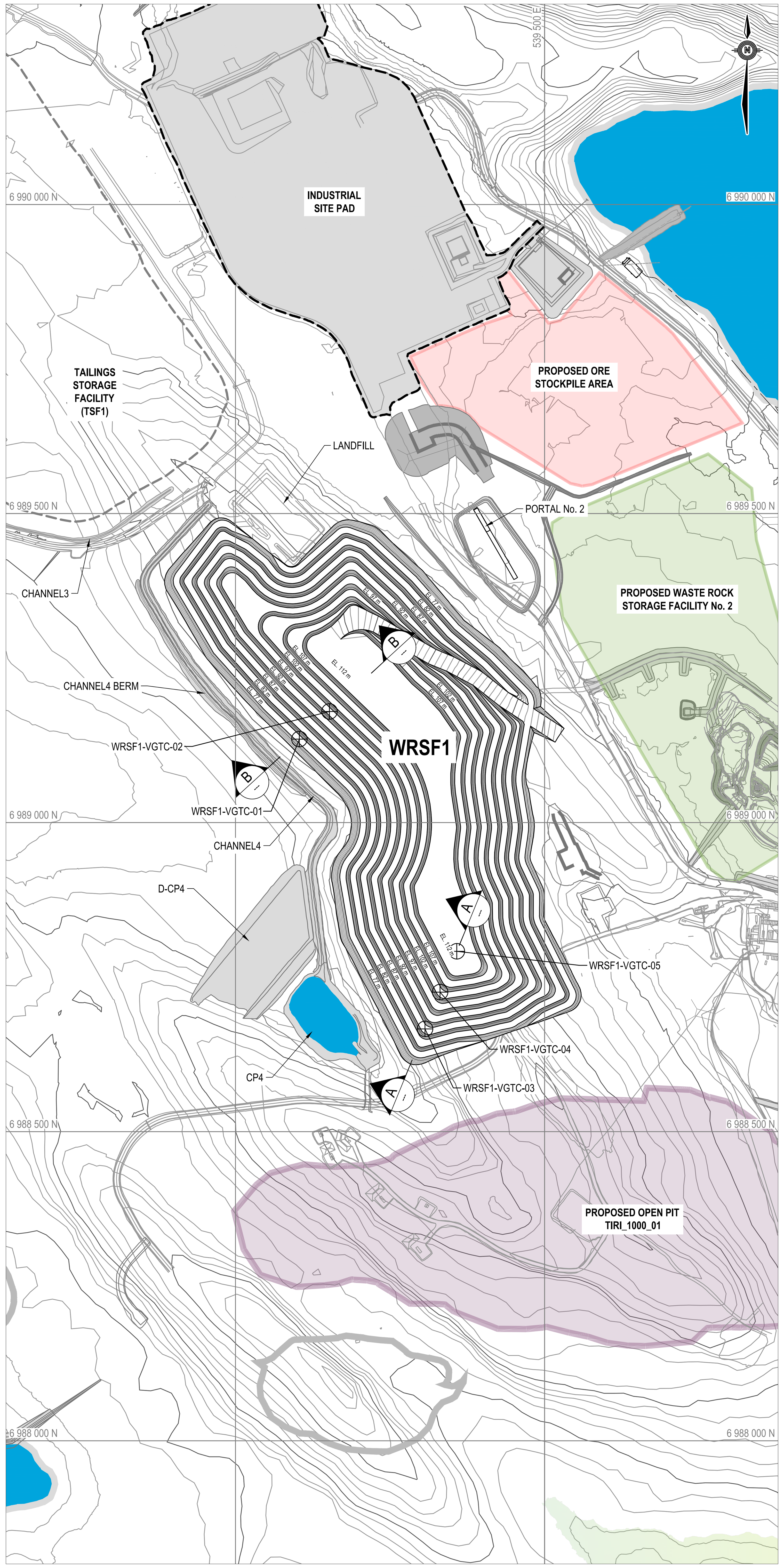

PLAN VIEW SHOWING PROPOSED LOCATIONS OF GROUND TEMPERATURE CABLES FOR WRSF1

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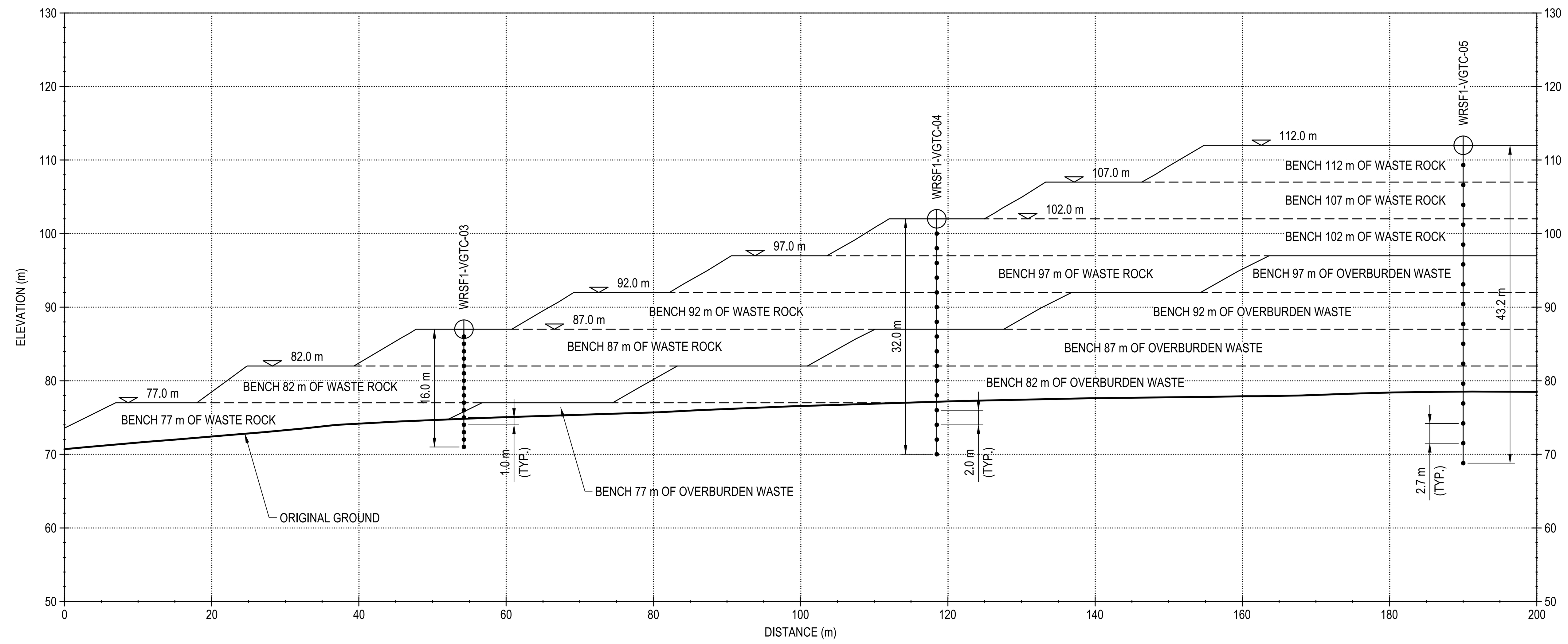
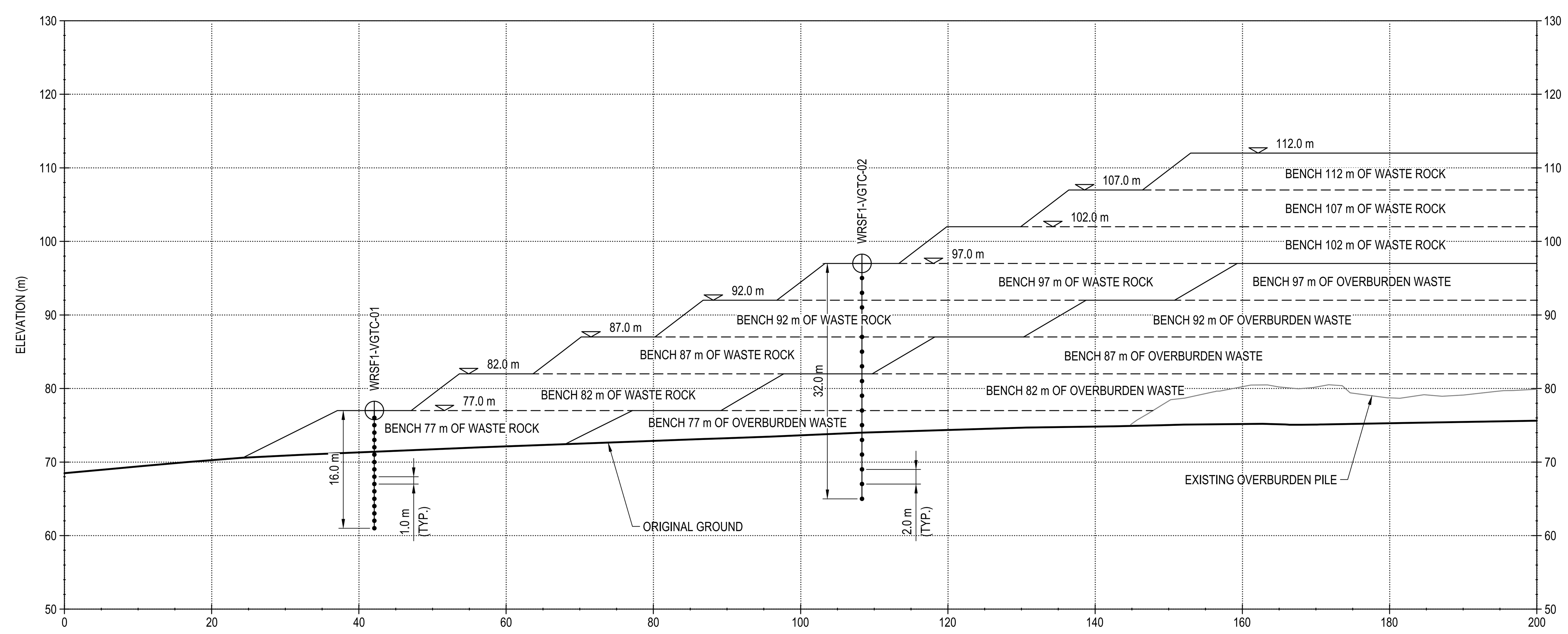


A INSTRUMENTATION

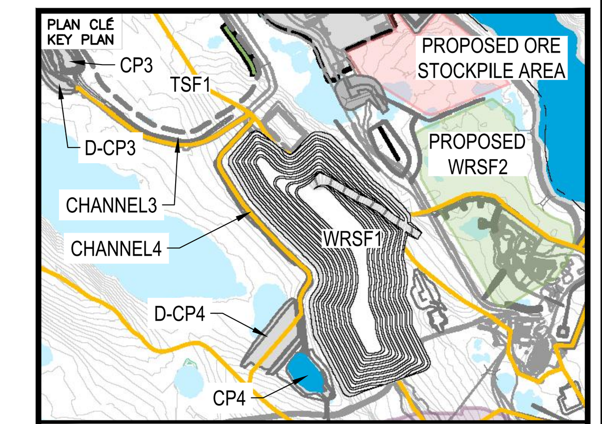
SCALE: 1:500



B INSTRUMENTATION

SCALE: 1:500

PLAN CLÉ KEY PLAN



TETRA TECH

NOTES GÉNÉRALES / GENERAL NOTES

1. A TOTAL OF 16 THERMISTOR BEADS FOR EACH GROUND TEMPERATURE CABLE

DESSINS EN RÉFÉRENCE / REFERENCE DRAWINGS

TITRE / TITLE	# DWG
–	–

AGNICO EAGLE

REV.	DATE	DESCRIPTION	PAR/BY	APP.	CLIENT
0	2019-11-21	ISSUED FOR CONSTRUCTION	GZ	WTH	

REVISIONS

PERMIT TO PRACTICE TETRA TECH CANADA INC.
PERMIT NUMBER: P 018
NT/NU Association of Professional Engineers and Geoscientists

W. T. HORNE LICENSEE NWT/NU

TITRE / TITLE
AGNICO EAGLE MELIADINE GOLD PROJECT
WASTE ROCK STORAGE FACILITY No. 1
PROPOSED GROUND TEMPERATURE CABLE AND THERMISTOR BEAD LOCATIONS FOR WRSF1

DESSINÉ PAR DRAWN BY	EL	DATE	2019-11-21
VÉRIFIÉ PAR CHECKED BY	GZ		2019-11-21
APPROUVÉ PAR APPROVED BY	WTH		2019-11-21
ÉCHELLE SCALE	1:2500	DATE	2019-11-21
NO. DESSIN DRAWING NO.	65-686-230-205		
NO. PROJET PROJECT NO.	6515	REVISION 0	FEUILLE / SHT 6 / 6

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FILE NO. 65-686-230-205-R1.dwg

Appendix B

TECHNICAL MEMO

ISSUED FOR USE

To:	Jennifer Pyliuk, P.Eng., Agnico Eagle	**Date:**	November 25, 2019
c:	Bill Horne, P.Eng., Tetra Tech	**Memo No.:**	001
From:	Guangwen (Gordon) Zhang, P.Eng., Tetra Tech Yuan Li, Tetra Tech	**File:**	ENG.EARC03140-02
Subject:	Thermal Analyses for Waste Rock Storage Facility No1 (WRSF1), Meliadine Project, Nunavut		

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Agnico Eagle Mines Ltd. (Agnico Eagle) to conduct the geotechnical design of the Waste Rock Storage Facility No1 (WRSF1) for the Meliadine Gold Project (the Project), Nunavut, Canada. The Project site is located on a peninsula between the east, south, and west basins of Meliadine Lake at latitude 63°01'N and longitude 92°13'W and is 25 km northwest of Rankin Inlet, Nunavut.

Thermal analyses were carried out to evaluate the thermal conditions of WRSF1 and its foundation during waste placement and under long-term climate change conditions. The main purpose of the analyses is to provide supporting information for stability analyses for the design of WRSF1.

This technical memorandum summarizes the methodology, input parameters, assumptions, and findings of the thermal analyses. It is understood that this memorandum will be included as an appendix to the WRSF1 design report to be prepared by Agnico Eagle.

2.0 GENERAL SITE CONDITIONS

2.1 Climate

The Project site lies within the Southern Arctic Climatic Region where daylight reaches a minimum of 4 hours per day in winter and a maximum of 20 hours per day in summer. The nearest weather station is Rankin Inlet A (Station 2303401), located approximately 25 km south of the Project site. The monthly mean air temperature is typically above 0°C for the months of June to September and is below 0°C between October and May. July is typically the warmest month and January the coldest. The mean annual air temperature for the 1981 - 2010 Climate Normal period was -10.5°C.

Mean annual precipitation at the mine site, based on the hydrological year from 1 October to 30 September, is estimated to be 412 mm after accounting for rainfall and snowfall undercatch. Approximately 51% of precipitation occurs as rain and 49% occurs as snow (Agnico Eagle 2015).

The region is known for high winds, which are due in part to the broad, flat, uninterrupted expanses offered to moving air masses. The wind blows from the north and north-northwest direction more than 30% of the time. The mean values for wind speed show that the north-northwest, together with north and northwest winds, have the highest speeds and tend to be the strongest. Mean monthly wind speeds are typically between 19 km/hour and 27 km/hour.

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2.2 General Subsurface Conditions

Site investigation programs have been conducted at the Project site since 1998. A total of six boreholes were drilled within the proposed WRSF1 footprint, and an additional seven boreholes were drilled within approximately 100 m outside of the boundary of the proposed WRSF1 footprint. Figure 1 presents a plan showing the proposed footprint of WRSF1 and the borehole locations. The detailed geotechnical information and borehole logs can be found in relevant site investigation reports (Golder 2010, 2012a, and 2012c; EBA 2013; Tetra Tech EBA 2014).

In general, the subsurface of the WRSF1 area consists of a thin layer of organic material overlying silty sand or sand and silt, ice-rich sandy silt or silty sand, silty sand or gravelly sand and silt, with traces of clay and shells with cobbles. Excess ice was observed within the overburden soils in most of the boreholes. The depth to bedrock ranges from 2.2 m to 13.6 m. The depth to bedrock appears deeper in the centre of the facility which is due to the naturally higher ground elevations. Table 1 summarizes the key geotechnical information of the overburden soils in the WRSF1 area together with bedrock elevations.

Table 1: Geotechnical Information of Overburden Soils in WRSF1 Area

Borehole No.	Organic Layer Thickness (m)	Major Overburden Soil Types	Ice Conditions	Depth to Bedrock (m)	Bedrock Elevation (m)
GT09-20	0.02	Silty sand; silt and sand	Vr >50% from 0.9 m to 1.4 m	2.2	65.3
GT11-06	-	Low recovery; sand; sand and silt	Vs from 2.5 m to 2.75 m	13.6	64.1
GT11-07	0.60	Low recovery; silty sand and gravel	Vx from 1.5 m to 6.1 m	6.1	59.2
GT11-11	0.06	Gravelly sand; ice and silty sand; silty sandy gravel	1.5 m ice and silty sand from 2.25 m to 3.75 m	8.4	59.7
GT12-14	0.02	Sandy silty gravel	Not logged	8.5	64.3
GT12-15	0.08	Silty sand; sandy silt; gravelly sand and silt	Vr from 1.6 m to 3.5 m	12.7	62.2
GT12-16	-	Low recovery; sand and gravel; gravelly silty sand; sandy silty gravel	Thawed during drilling	10.4	65.8
GT12-17	0.05	Low recovery; silty sand; boulders and cobbles; gravelly sandy silt	Thawed during drilling	8.5	66.3
GT13-01	0.20	Sand and silt; gravelly sand	Up to 30% Vx, Vr from 0.6 m to 1.2 m; 0.2 m ice and sand from 1.6 m to 1.8 m	5.8	59.2
GT13-08	0.15	Low recovery; boulders and cobbles	Thawed during drilling	10.4	63.4
GT13-09	0.08	Low recovery; gravel; boulders	Thawed during drilling	9.5	64.9
GT14-09	0.52	Peat; sand; sandy silt; ice and silt	0.6 m ice and silt from 2.9 m to 3.5 m	4.0	65.0
GT14-34	0.30	Sandy silt; sand; ice and silt; silty sand	Vs 30%; Vc/Vx 10 m; 0.8 m ice and silt from 1.4 m to 2.2 m	8.3	61.7

2.3 Ground Temperature and Permafrost Condition

The Project site is located within the Southern Artic terrestrial eco-zone, one of the coldest and driest regions of Canada, in a zone of continuous permafrost. Data obtained from ground temperature cables (GTCs) installed in some boreholes confirm the presence of continuous permafrost to depths between 360 m and 495 m, with the depth of the active layer ranging from approximately 1 m to 3 m. It is anticipated that the active layer adjacent to lakes or below a body of water could be deeper. Frozen soils have been observed in most of the boreholes drilled on site. The typical permafrost ground temperatures at the depths of zero annual amplitude (typically at the depth of below 15 m) are in the range of -5.0°C to -7.5°C in the areas away from lakes and streams. Limited overburden soil porewater salinity tests (EBA 2013) indicated that the overburden soils may have a porewater salinity of 4 to 12 parts per thousand (ppt). The geothermal gradient ranges from 0.012°C/m to 0.02°C/m (Golder 2012b).

3.0 WASTE ROCK AND OVERBURDEN PROPERTIES, PRODUCTION PLAN, AND PRELIMINARY PLACEMENT PLAN FOR WRSF1

3.1 Waste Rock and Overburden Properties

The Project site is located in the Rankin Inlet Greenstone Belt. The ore deposits are low-sulphide, gold-quartz vein deposits. The principal lithological units include turbiditic sedimentary rocks, volcanic-hosted and sediment-hosted iron formation, sericite altered siltstones and graphitic argillite, and schistose and carbonate-altered mafic volcanic rocks (Agnico Eagle 2015).

A baseline geochemical characterization program for the Project was initiated in 2008 and consisted of static and kinetic testing methods to assess the chemical composition of the mine waste and overburden, its potential to generate acid rock drainage and its potential for metal leaching (ML) upon exposure to ambient conditions. Based on the waste rock geochemical testing findings, the waste rock from the Tiriganiaq deposit area is considered non-potentially acid generating (NPAG) and has a low potential for ML in view of proposed waste rock management for the Project. The results of geochemical characterization indicated that the overburden produced will be NPAG. Waste rock and overburden have compatible geochemical characteristics such that these materials can be managed together in the same disposal facilities (Agnico Eagle 2015).

3.2 Waste Rock and Overburden Production Plan

Agnico Eagle is developing the waste rock and overburden production plan for the Project. The latest waste rock and overburden production plan was provided by Agnico Eagle in an email on September 23, 2019 (Agnico Eagle 2019) for the design of WRSF1. It is understood that the waste rock and overburden from SP4 (saline pond No4) and Open Pit Tiri_1000_01 will be primarily placed in WRSF1 until the design capacity of WRSF1 is reached.

Some overburden waste materials were previously placed over the original ground within the proposed footprint of WRSF1 (Figure 1). The volume of the materials is estimated to be 87,930 m^3. Some fills were also placed over the previous exploration landfill within the proposed footprint of WRSF1. The total volume of the fills and the landfill materials above the original ground is 6,210 m^3.

3.3 Preliminary Waste Rock and Overburden Placement Plan for WRSF1

Agnico Eagle is developing the waste rock and overburden placement plan for mine waste storage facilities including WRSF1. The plan also depends on the final design of WRSF1, which is currently being developed. A preliminary waste rock and overburden placement plan was adopted for thermal evaluation for WRSF1 based on the following information and assumptions:

- The waste rock and overburden production plan as provided in Agnico Eagle (2019);

- The preliminary typical section for thermal analysis of WRSF1 as shown in Figure 2;
- Rough estimates of waste rock and overburden volumes for various benches (as shown in Figure 2) for WRSF1; and
- An assumed in-place bulk density of 1.62 tonnes/m^3 for overburden waste and 1.88 tonnes/m^3 for waste rock.

Table 2 summarizes the preliminary waste rock and overburden placement plan for the design of WRSF1.

Table 2: Preliminary Waste Rock and Overburden Placement Plan for Design of WRSF1

Location of Mine Waste Placement	Approximate Period of Mine Waste Placement	Period when the Majority of Mine Waste Materials are Placed
Bench 77 m of overburden waste	December 2019 to February 2020	December 2019 to January 2020
Bench 82 m of overburden waste	January 2021 to June 2021	January 2021 to April 2021
Bench 87 m of overburden waste	October 2021 to Dec 2021	October 2021 to Dec 2021
Bench 92 m of overburden waste	January 2022 to March 2022	January 2022 to March 2022
Bench 97 m of overburden waste	January 2022 to March 2022	January 2022 to March 2022
Bench 77 m of waste rock	February 2020 to January 2022	February 2020 to April 2020
Bench 82 m of waste rock	January 2022 to June 2022	January 2022 to April 2022
Bench 87 m of waste rock	June 2022 to September 2022	June 2022 to September 2022
Bench 92 m of waste rock	September 2022 to January 2023	September 2022 to November 2022
Bench 97 m of waste rock	January 2023 to June 2023	January 2023 to April 2023
Bench 102 m of waste rock	June 2023 to October 2023	June 2023 to September 2023
Bench 107 m of waste rock	October 2023 to January 2024	October 2023 to December 2023
Bench 112 m of waste rock	January 2024 to February 2024	January 2024 to February 2024

4.0 THERMAL ANALYSIS MODEL AND CLIMATIC DATA

4.1 General

Thermal analyses were carried out using Tetra Tech's proprietary finite element computer model, GEOTHERM. The model simulates transient heat conduction with change of phase for a variety of boundary conditions, including heat flux, convective heat flux, and temperature and ground-air boundaries. The heat exchange at the ground surface is modelled with an energy balance equation considering air temperatures, wind velocity, snow depth, and solar radiation. The model facilitates the inclusion of temperature phase change relationships for saline soils, such that any freezing depression and unfrozen water content variations can be explicitly modelled.

The model has been verified by comparing its results with closed-form analytical solutions and many different field observations since. The model has formed the basis for thermal evaluations and designs of a substantial number of projects in the Arctic and sub-Arctic regions since the 1980's, including mine waste storage facilities, dams, foundations, pipelines, utilidor systems, and landfills.

A one-dimensional thermal analysis was carried out to calibrate the model with the climatic and soil conditions for the original ground prior to WRSF1 construction and to compare with measured ground temperatures. Thereafter, two-dimensional thermal analyses of a typical section for the proposed WRSF1 were carried out to simulate the

WRSF1 construction sequence during mine operation. Thermal analyses were then conducted to predict long-term thermal conditions under adopted climatic and boundary conditions for WRSF1.

4.2 Mean Climatic Data

Climatic data required for the thermal analyses includes monthly air temperature, wind speed, solar radiation, and snow cover. The closest meteorological station from where the long-term climatic data is available is at Rankin Inlet. The mean monthly air temperatures, wind speed, and snow cover at Rankin Inlet Station are from Environment Canada's website (http://www.climate.weatheroffice.ec.gc.ca). Mean daily solar radiation data for the period of 1951 to 1980 at Baker Lake station (Environment Canada 1982) were adopted for the Project site. Table 3 summarizes the mean climatic data for the Project site.

Table 3: Mean Climatic Condition at Meliadine Project Site

Month	Monthly Air Temperature (°C)[a]	Monthly Wind Speed (km/h)[b]	Monthly Average Snow Cover (m)[c]	Daily Solar Radiation (W/m^2)[d]
January	-30.1	24.2	0.26	9.1
February	-30.0	23.6	0.29	38.7
March	-24.9	23.5	0.33	119.5
April	-15.7	22.6	0.35	206.4
May	-5.4	22.2	0.19	259.7
June	4.7	20.3	0.01	252.0
July	11.0	19.4	0.00	226.4
August	10.0	20.9	0.00	160.8
September	4.0	23.8	0.00	124.9
October	-4.4	26.3	0.03	41.3
November	-16.6	25.1	0.13	14.4
December	-25.0	24.0	0.22	3.7

Notes:

[a] Measured monthly air temperatures at Rankin Inlet station (1989-2018).

[b] Measured wind speed data at Rankin Inlet station (1981-2010 Climate Normals).

[c] Measured snow cover data at Rankin Inlet station (1981-2010 Climate Normals).

[d] Measured solar radiation data at Baker Lake station (1951-1980).

4.3 Climate Change Projection

The historical air temperature data at Rankin Inlet indicated that the long-term climatic trend at Rankin Inlet is warming. Based on the observed warming trend in the historical air temperatures and state-of-practice, the thermal evaluations for this Project should consider the long-term effects of climate change (or global warming).

Government of Canada (GC) recently presented new climate change scenarios from the Coupled Model Intercomparison Project Phase 5 (CMIP5). The climate scenarios are presented in the Canadian Climate Data and Scenarios (CCDS) website (http://climate-scenarios.canada.ca/?page=main). The results of the climate scenarios from the CMIP5 climate models were used in the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report (AR5). The website provides projected seasonal climate changes for each province in Canada. A series of tables with projections of climate change computed from the CMIP5 climate models are provided.

Projections are based on the Representative Concentration Pathway (RCP) scenarios. Seasonal averages of projected changes in climate are available for the RCP2.6, RCP4.5, and RCP8.5.

IPCC (2015) stated that "Anthropogenic GHG emissions are mainly driven by population size, economic activity, lifestyle, energy use, land use patterns, technology, and climate policy. The RCPs, which are used for making projections based on these factors, describe four different 21st century pathways of GHG emissions and atmospheric concentrations, air pollutant emissions, and land use. The RCPs include a stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0), and one scenario with very high GHG emissions (RCP8.5)."

Canadian Standards Association (CSA) issued a draft report (CSA 2019) "Technical Guide; Infrastructure in permafrost: A guideline for climate change adaptation" for public review in early 2019. This report is an updated version of CSA (2010). The draft CSA (2019) presents two scenarios – RCP4.5 (a moderately reduced greenhouse gas emission scenario) and RCP8.5 ("high" greenhouse gas emission scenario). In comparison, the projected air temperature changes in the Project site area (Zone C1 in CSA (2019)) for the CSA 2019 RCP4.5 scenario are slightly less than those in Nunavut for the CMIP5 RCP4.5 scenario from GC.

The intermediate scenario, CMIP5 RCP4.5, was adopted in the thermal analyses which represents a reasonably conservative case. Table 4 summarizes the projected seasonal air temperature changes in Nunavut for the climate change scenario CMIP5 RCP4.5. The projected long-term air temperatures from the climate change scenario CMIP5 RCP4.5 are warmer than the A1B scenario in CSA (2010), which was applied in the feasibility level study.

Table 4: Projected Seasonal Air Temperature Changes Adopted for Thermal Analyses (CMIP5 RCP4.5 Scenario for Nunavut (Government of Canada))

Period	Projected Seasonal Air Temperature Changes (50^{th} (median) percentiles) from 1986-2005 Baseline under Representative Concentration Pathway (RCP) 4.5 Scenario for Nunavut (°C)			
	Winter	**Spring**	**Summer**	**Autumn**
2016–2035	2.0	1.3	0.9	2.1
2046–2065	4.4	2.7	1.8	4.0
2081-2100	5.9	3.5	2.4	5.2

Table 5 presents the predicted monthly air temperatures for several selected years used for the long-term thermal evaluation of WRSF1.

Table 5: Measured and Projected Monthly Air Temperatures for Selected Years based on CMIP5 RCP4.5 Scenario

Month	Measured Monthly Air Temperature (1986-2005) [(a)] (°C)	Projected Monthly Air Temperature in 2025 [(b)] (°C)	Projected Monthly Air Temperature in 2055 [(b)] (°C)	Projected Monthly Air Temperature in 2095 [(b)] (°C)
January	-31.7	-29.7	-27.3	-25.6
February	-30.7	-28.7	-26.3	-24.6
March	-25.0	-23.7	-22.3	-21.4
April	-15.9	-14.6	-13.2	-12.3
May	-5.7	-4.4	-3.0	-2.1
June	4.1	5.0	5.9	6.6
July	10.6	11.5	12.4	13.1
August	9.7	10.6	11.5	12.1
September	3.8	5.9	7.8	9.2
October	-5.3	-3.3	-1.4	0.0
November	-17.4	-15.3	-13.4	-12.1
December	-25.7	-23.7	-21.3	-19.6
Mean	**-10.8**	**-9.2**	**-7.6**	**-6.4**

Notes:

[(a)] Based on measured data at Rankin Inlet weather station.

[(b)] Predicted based on measured air temperatures at Rankin Inlet (1986-2005) and the climate change scenario CMIP5 RCP4.5 for Nunavut, as summarized in Table 4.

The climate change scenario CMIP5 RCP4.5 predicts that snow depth will slightly decrease with time in Nunavut. This snow depth reduction in the long term was not considered in the thermal analyses for WRSF1. Less snow cover depth in winter tends to result in colder ground temperatures.

5.0 CALIBRATION THERMAL ANALYSIS

A one-dimensional thermal analysis was carried out to calibrate the model with the climatic and soil conditions for the original ground prior to WRSF1 construction and to compare with measured ground temperatures. Borehole GT09-20 was drilled in 2009 at a location close to the northeast boundary of the proposed WRSF1. A GTC was installed in the borehole. Measured ground temperatures are available from the cable.

The calibration thermal analysis was carried out at GT09-20 borehole location. The soil profile at GT09-20 consisted of 0.9 m silty sand, 0.5 m silt and sand, 0.8 m silty sand overlying bedrock. Table 6 summarizes the material properties used in the thermal calibration analysis. Thermal properties of the materials in the thermal analyses were determined indirectly from well-established correlations with soil index properties (Farouki 1986; Johnston 1981) or experience. Soil index properties were estimated from available geotechnical information and past experience. A geothermal gradient of 0.017°C/m at depth was adopted.

Table 6: Material Properties Used in Thermal Calibration Analysis

Material	Water Content (%)	Bulk Density (Mg/m^3)	Thermal Conductivity (W/m-K)		Specific Heat (kJ/kg-K)		Latent Heat (MJ/m^3)
			Frozen	Unfrozen	Frozen	Unfrozen	
Silty Sand	17	2.00	2.15	1.51	0.93	1.23	97
Silt and Sand	20	2.00	2.37	1.53	0.96	1.31	112
Bedrock	1	2.63	2.90	2.90	0.75	0.77	9

Figure 3 compares the measured and modelled ground temperatures at GT09-20. A good agreement was obtained between the measured and modelled ground temperatures. The calibration analysis results suggest that the model and key input parameters are reasonable and can be used for thermal analysis of WRSF1.

6.0 THERMAL ANALYSES OF WRSF1

6.1 Material Properties for WRSF1 Thermal Analyses

A generalized soil profile for the original ground was used for the thermal analyses of WRSF1, based on the information from the boreholes drilled in the WRSF1 area. It was assumed that the original ground consists of 1.5 m sand and silt, 1.0 m ice-rich sand/silt, 6.0 m silty sand over bedrock. The thin organic layer (0.0 to 0.6 m thick) over the original ground within the WRSF1 area was not specifically modelled in the thermal analyses. It is expected that the organic layer will be compressed under loads from waste rock and overburden. The ground generally tends to be colder with an organic cover. Therefore, it is conservative to ignore the thin, compressed organic layer in the thermal analyses.

Thermal properties of the materials in the thermal analyses were determined indirectly from the well-established correlations with soil index properties (Farouki 1986; Johnston 1981) or assumed based on experience. Soil index properties were estimated from the available geotechnical information or assumed based on experience. The porewater salinity was assumed to be 7 ppt for the overburden waste and foundation overburden soils and 2 ppt for the waste rock and bedrock in the thermal analyses. Table 7 summarizes the material properties used in the thermal analyses.

Table 7: Material Properties Used in Thermal Analyses for WRSF1

Material	Water Content (%)	Bulk Density (Mg/m^3)	Thermal Conductivity (W/m-K)		Specific Heat (kJ/kg-K)		Latent Heat (MJ/m^3)
			Frozen	Unfrozen	Frozen	Unfrozen	
Sand and Silt	20	2.04	2.48	1.58	0.96	1.31	114
Ice-Rich Sand/Silt	60	1.60	2.36	1.03	1.24	2.03	200
Silty Sand	15	2.13	2.44	1.71	0.91	1.18	93
Bedrock	1	2.63	2.90	2.90	0.75	0.77	9
Overburden Waste	17	1.75	1.59	1.22	0.93	1.23	85
Waste Rock	3	1.96	1.04	1.28	0.77	0.83	19

6.2 Thermal Analyses for WRSF1

Table 8 presents the mine waste placement schedules simulated in the thermal analyses of WRSF1. Figure 2 presents the typical section and waste placement benches adopted in the thermal analyses.

Table 8: Waste Placement Schedules Simulated in Thermal Analyses of WRSF1

Waste Type	Bench Top Elevation (m)	Waste Placement Completion Time Simulated in Thermal Analyses	Bench Thickness (m)	Assumed Initial Waste Temperature at Placement (°C)
Overburden	77	December 1, 2019	Up to 5.0	0.0
Overburden	82	January 1, 2021	4.0 to 5.0	-1.0
Overburden	87	October 1, 2021	5.0	1.0
Overburden	92	January 1, 2022	5.0	-1.0
Overburden	97	January 1, 2022	5.0	-1.0
Waste Rock	77	April 1, 2020	Up to 7.0	-5.0
Waste Rock	82	January 1, 2022	4.0 to 5.0	-3.0
Waste Rock	87	August 1, 2022	5.0	5.0
Waste Rock	92	October 1, 2022	5.0	3.0
Waste Rock	97	January 1, 2023	5.0	-3.0
Waste Rock	102	August 1, 2023	5.0	5.0
Waste Rock	107	October 1, 2023	5.0	3.0
Waste Rock	112	January 1, 2024	5.0	-3.0

The projected monthly air temperatures from the climate change scenario CMIP5 RCP4.5 were used in the thermal analyses to simulate the waste rock and overburden placement during the period of 2019 to 2024 and then predict the ground temperatures after 2024. Snow cover thickness over the top of WRSF1 surfaces was assumed to be 50% of mean monthly snow cover thickness during active placement of mine waste and 100% of mean monthly snow cover thickness after the completion of the mine waste placement.

6.3 Analysis Results for WRSF1

The results of the thermal analyses have been presented in the following figures;

- Figures 4 to 7 present the predicted isotherms on September 30 for years 2020 to 2023, respectively, during active placement of waste rock and overburden in WRSF1.
- Figures 8 to 13 present the predicted isotherms on September 30 for years 2024, 2044, 2064, 2084, 2104, and 2124, respectively, after the completion of waste rock and overburden placement in WRSF1.
- Figure 14 shows the predicted temperature profiles (trumpet curves) on October 1 for years 2024, 2034, 2044, 2064, 2084, 2104, and 2124 at a location (about 142 m from the lowest toe of WRSF1) through the crest of WRSF1.
- Similarly, Figures 15 to 18 show the predicted temperature profiles at middles of 107 m, 97 m, 87 m, and 77 m benches, respectively.

These figures indicate that the ground temperatures within the WRSF1 and its foundation change with time and location. The initially unfrozen waste rock and overburden below the active layer zone will freeze back within several years after the initial placement. In 2034 to 2064 the temperatures of the waste rock and overburden in the central zone below the top benches (112 m to 97 m) will get colder (-2.0°C to -3.0°C) in areas that are at least 5 m below the top waste rock surface. Thereafter the predicted temperatures start to gradually warm up due to the assumed long-term climate change. By 2124, the predicted waste rock and overburden temperatures in zones that are at least 5 m below the top waste rock surface, are between -1.0°C and -2.5°C.

The long-term strength of an ice-rich foundation soil depends on the temperature of the soil. The estimated ground temperature of the ice-rich foundation material underlying WRSF1 is required for the WRSF1 stability analysis. Figures 19 and 20 present the predicted ground temperatures with time at eight selected locations along the top surface of the ice-rich layer in the WRSF1 foundation during the construction stage. Similarly Figures 21 and 22 present the predicted ground temperatures with time at the eight selected locations after completion of the WRSF1 construction. These figures suggest that the temperatures change with time and location. The results will be used for the stability analysis for the design of WRSF1.

7.0 DISCUSSIONS AND RECOMMENDATIONS

The predicted ground temperatures in WRSF1 and its foundation in this memorandum are based on the waste rock and overburden production plan that was provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan that was developed for the design of WRSF1. Of concern is the temperature of an ice-rich layer in the WRSF1 foundation (approximately 1.5 to 2.5 metres below the original ground surface). The predicted ground temperature of the ice-rich layer has been used in the stability analysis for the design of WRSF1.

Preliminary sensitivity thermal analyses of WRSF1 indicate that the placement schedules and initial temperatures of the waste rock and overburden, especially the initial benches (77 m and 82 m) of the overburden waste placed over the original ground, will have an influence on the predicted ground temperature in the ice-rich layer underlying WRSF1. For example, if these initial benches are placed in unfrozen conditions in warmer seasons, the temperature in the ice-rich foundation layer could be warm (warmer than -1.0°C) for an extended period after the waste placement, which will result in low shear strength in the ice-rich soil layer with an assumed porewater salinity of 7 ppt. Thus, in order to maintain the necessary factors of safety for slope stability, the geometry of the WRSF would require flatter slopes and lower waste height when compared to the current design simulated in the thermal analyses in this memorandum. This would result in an overall smaller WRSF storage volume, which is not ideal given the available storage footprint for WSRF1. Therefore, in order to mitigate this situation, it is recommended that the initial benches of the future overburden waste be placed in the months when both the original ground and the overburden waste are cold and frozen, which will be equivalent to the conditions simulated in the thermal analyses.

It is recommended that the current design of WRSF1 and the associated thermal and stability analyses be reviewed or updated (if required) if the final waste rock and overburden placement plan in WRSF1, especially the placement plan for the initial benches (77 m and 82 m) of the overburden waste, is different from that simulated in the thermal analysis in this memorandum.

The thermal analyses were based on many assumptions. Therefore, actual temperatures of WRSF1 and its foundation could be different from the predicted. It is recommended that ground temperature cables (GTCs) be installed at selected locations to monitor the actual ground thermal conditions of WRSF1 and its foundation during construction and after completion of WRSF1. The monitored results can be used to confirm the assumptions in the thermal analyses and associated design for WRSF1, evaluate the WRSF1 actual thermal performance, and calibrate the thermal model for future prediction if required. The proposed locations and details for the GTCs will be separately presented in the design drawings for WRSF1.

It is recommended that the maximum lift thickness during waste placement be limited to 2.5 m for the overburden waste and to 5.0 m for the waste rock.

8.0 CLOSURE

Use of this memo is subject to Tetra Tech's Limitations on Use of this Document which are attached in Appendix A. We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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Prepared by:
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Direct Line: 587.460.3650
GuangwenGordon.Zhang@tetratech.com

REGISTERED PROFESSIONAL ENGINEER
W. T. HORNE
LICENSEE
N.W.T.
Nov 25, 2019

FILE: ENG.EARC03140-02
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Reviewed by:
Bill Horne, M.Sc., P.Eng.
Director, Arctic Engineering
Direct Line: 587.460.3528
Bill.Horne@tetratech.com

/jf

PERMIT TO PRACTICE
TETRA TECH CANADA INC.

Signature ____________________

Date November 25, 2019

PERMIT NUMBER: P 018
NT/NU Association of Professional Engineers and Geoscientists

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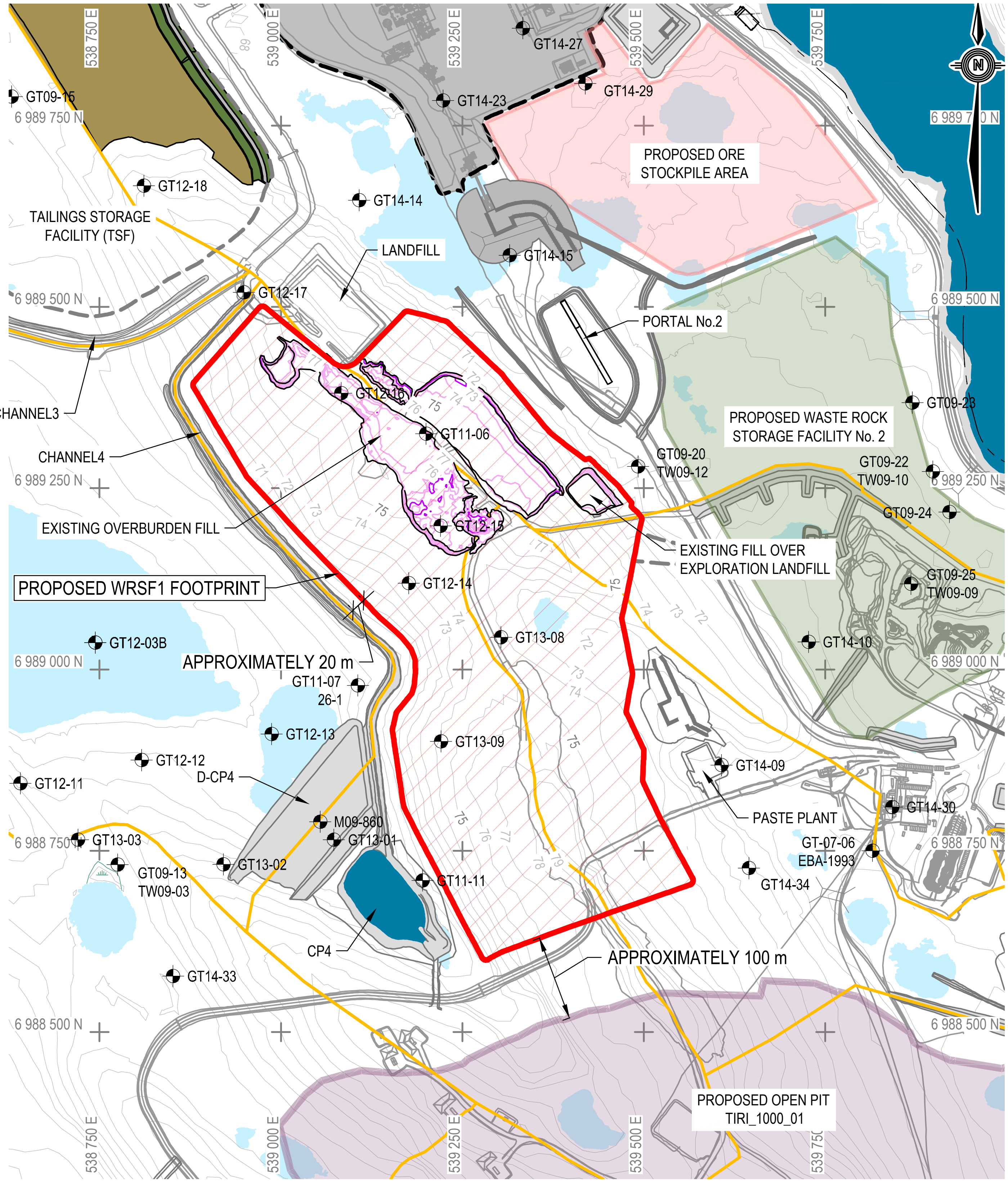
FIGURES



LEGEND:

BOREHOLE

0 250m

Scale: 1:7,500 @ 8.5"x11"

CLIENT

AGNICO EAGLE

TETRA TECH

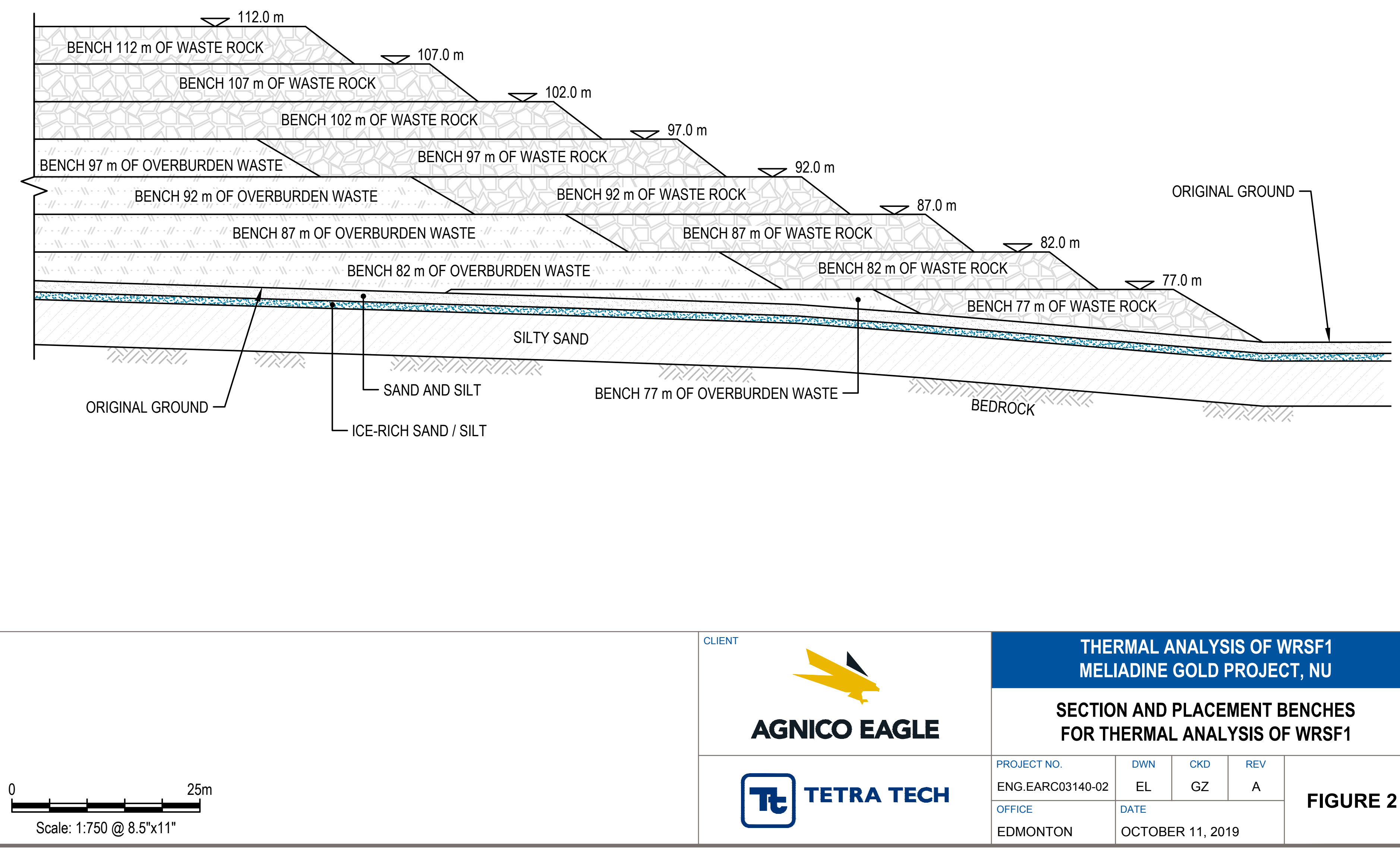
THERMAL ANALYSIS OF WRSF1
MELIADINE GOLD PROJECT, NU

PROPOSED WRSF1 FOOTPRINT
WITH BOREHOLE LOCATIONS

PROJECT NO.	DWN	CKD	REV	
ENG.EARC03140-02	EL	GZ	A	**FIGURE 1**
OFFICE	DATE			
EDMONTON	AUGUST 15, 2019			

Q:\Edmonton\Engineering\E141\Projects_MELIADINE\ENG.EARC03140-02 (WRSF1)\Figure 1-For Thermal Analysis.dwg [FIGURE 1] October 11, 2019 - 9:18:10 am (BY: LEE, ELVIN)

Q:\Edmonton\Engineering\E141\Projects_MELIADINE\ENG.EARC03140-02 (WRSF1)\Figure 2-For Thermal Analysis.dwg [FIGURE 2] October 11, 2019 - 9:02:10 am (BY: LEE, ELVIN)



CLIENT

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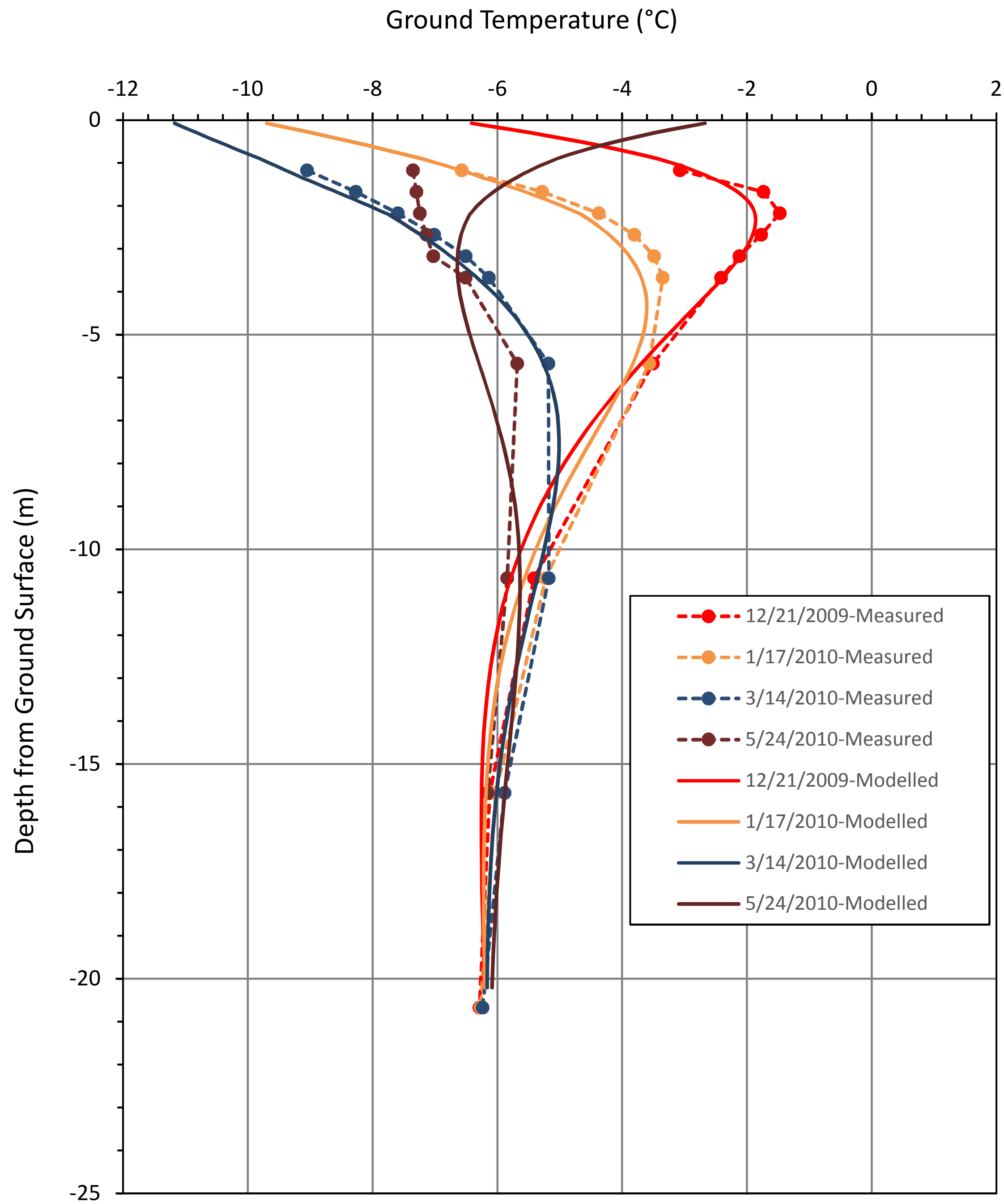
THERMAL ANALYSIS OF WRSF1
MELIADINE GOLD PROJECT, NU

SECTION AND PLACEMENT BENCHES FOR THERMAL ANALYSIS OF WRSF1

PROJECT NO.	DWN	CKD	REV
ENG.EARC03140-02	EL	GZ	A

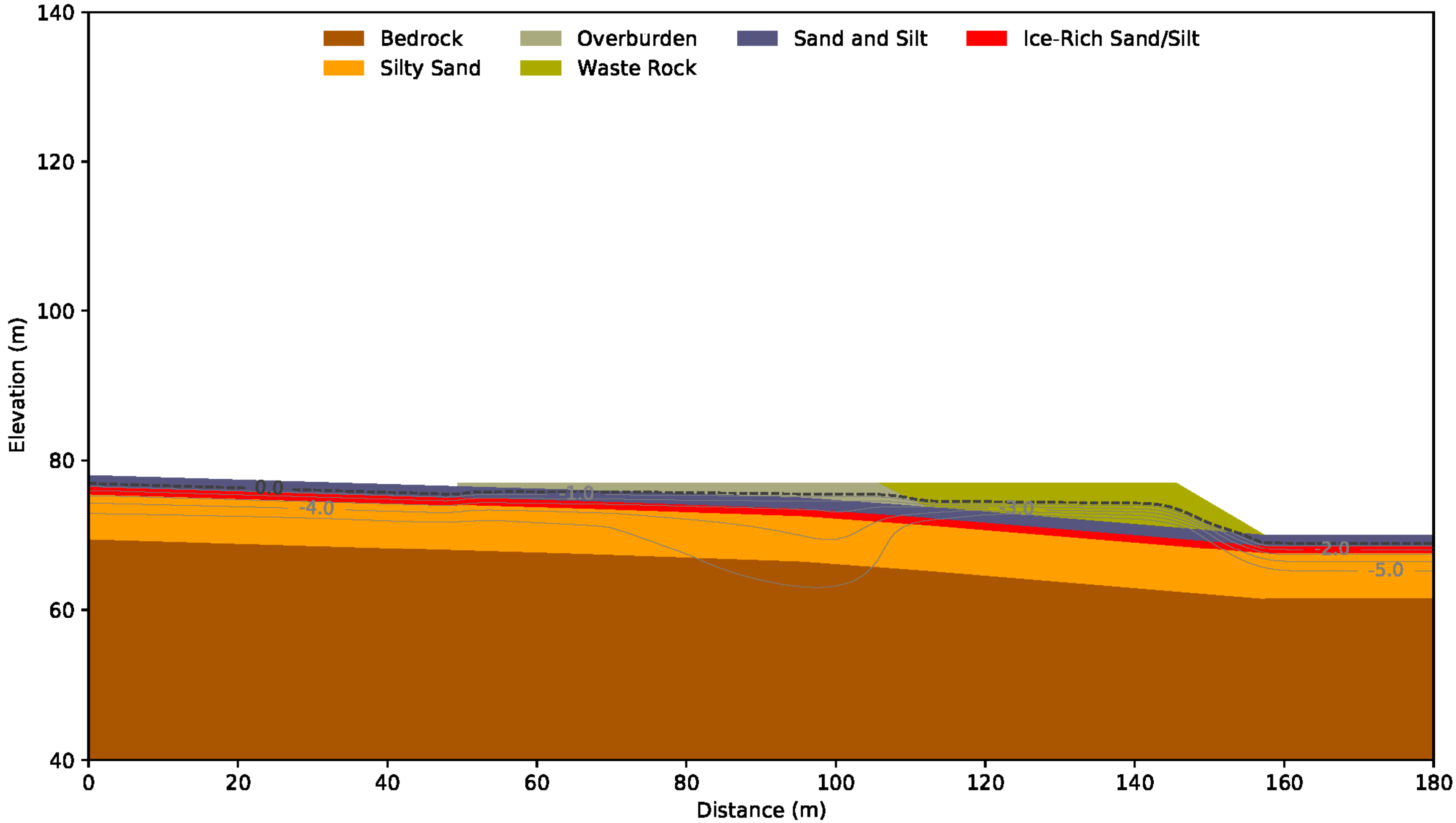
OFFICE	DATE
EDMONTON	OCTOBER 11, 2019

FIGURE 2



LEGEND	NOTES	CLIENT	Thermal Analysis of WRSF1 Meliadine Gold Project, NU
		AGNICO EAGLE	Comparison of the Measured Ground Temperatures at BH GT09-20 with the Modelled in Calibration Thermal Analysis
	STATUS ISSUED FOR USE	TETRA TECH	PROJECT NO. ENG.EARC03140-02 · DWN YY · CKD GZ · APVD WTH · REV A OFFICE EBA-EDM · DATE July 2019

Figure 3



LEGEND

NOTES

Notes:

1. Contours are for 0°C, -1.0°C, -2.0°C, -3.0°C, -4.0°C, and -5.0°C isotherms.

2. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

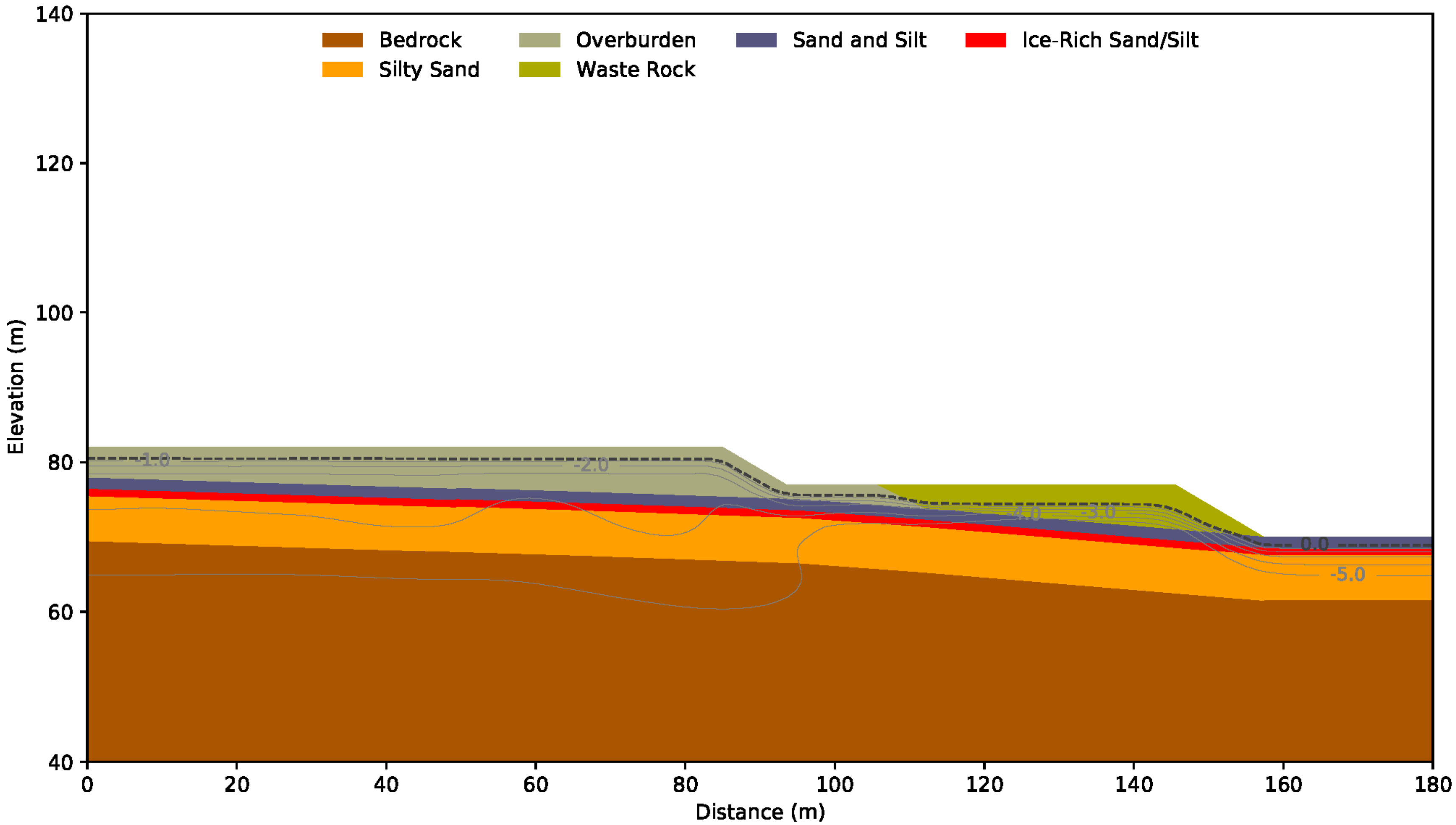
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Isotherms on September 30, 2020

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 4



LEGEND

NOTES

Notes:

1. Contours are for 0°C, -1.0°C, -2.0°C, -3.0°C, -4.0°C, and -5.0°C isotherms.

2. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

STATUS
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CLIENT

AGNICO EAGLE

TETRA TECH

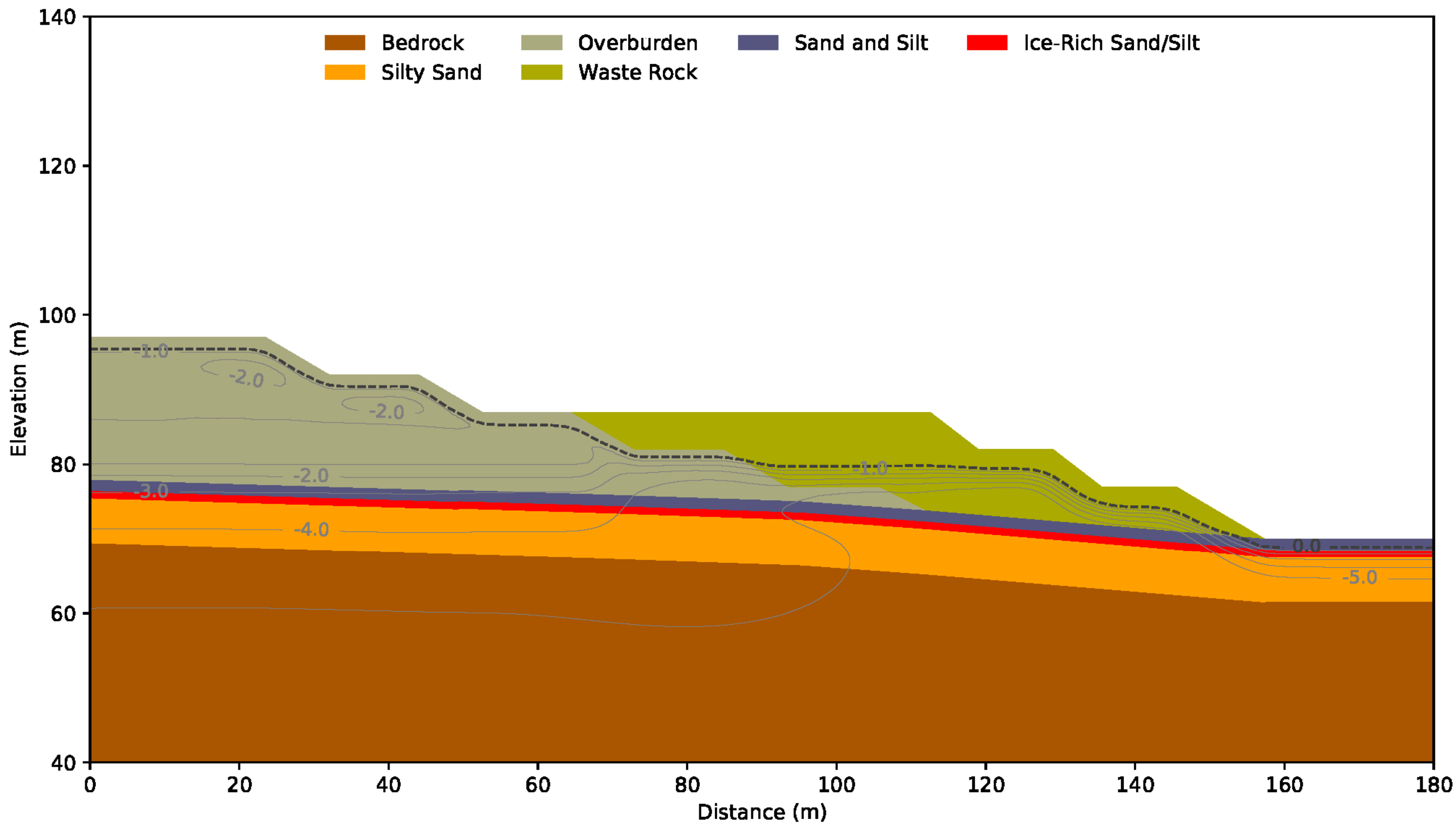
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Isotherms on September 30, 2021

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 5



LEGEND

NOTES

Notes:

1. Contours are for 0°C, -1.0°C, -2.0°C, -3.0°C, -4.0°C, and -5.0°C isotherms.

2. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

STATUS
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CLIENT
AGNICO EAGLE

TETRA TECH

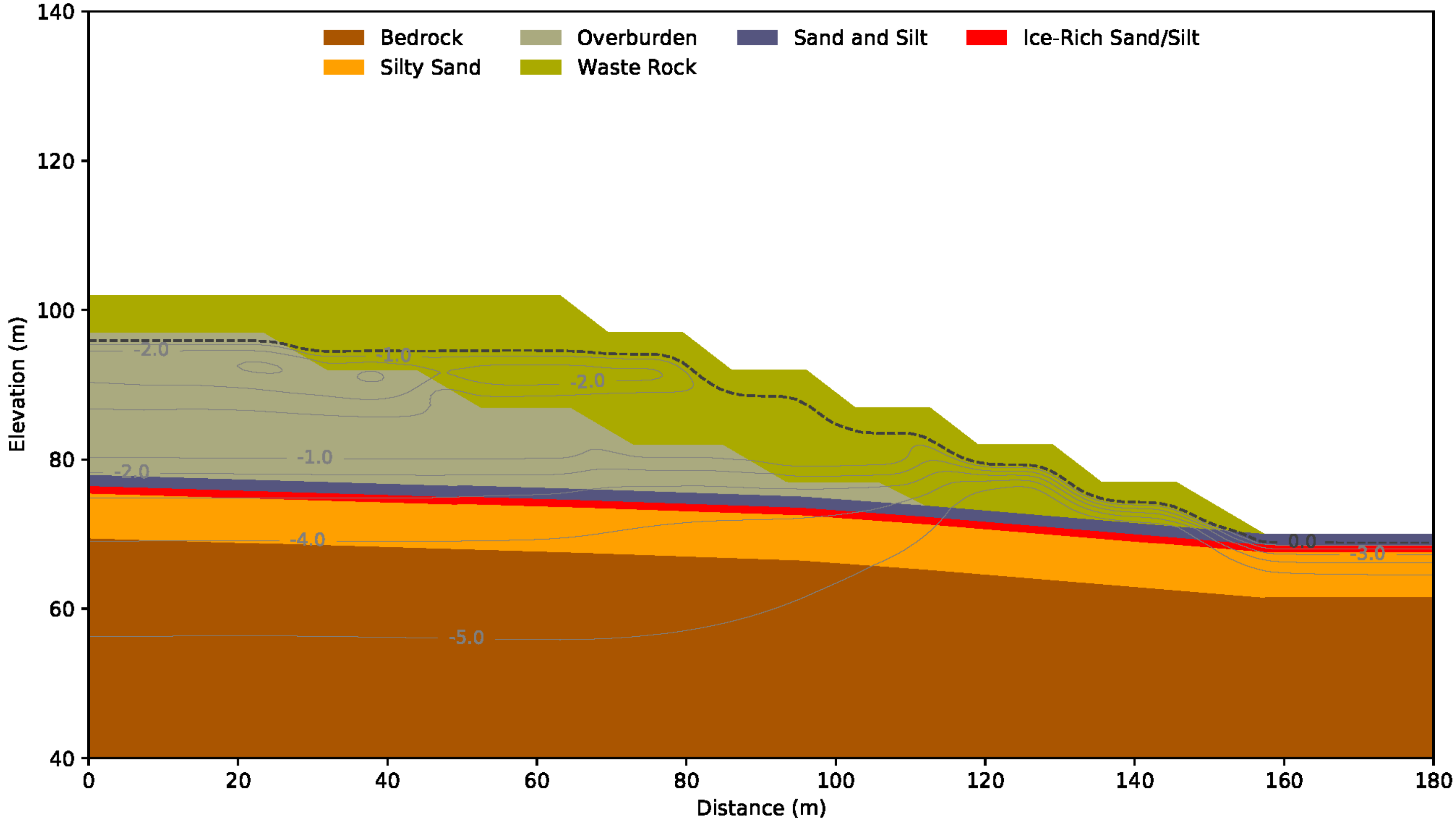
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Isotherms on September 30, 2022

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 6



LEGEND

NOTES

Notes:

1. Contours are for 0°C, -1.0°C, -2.0°C, -3.0°C, -4.0°C, and -5.0°C isotherms.

2. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

STATUS
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AGNICO EAGLE

TETRA TECH

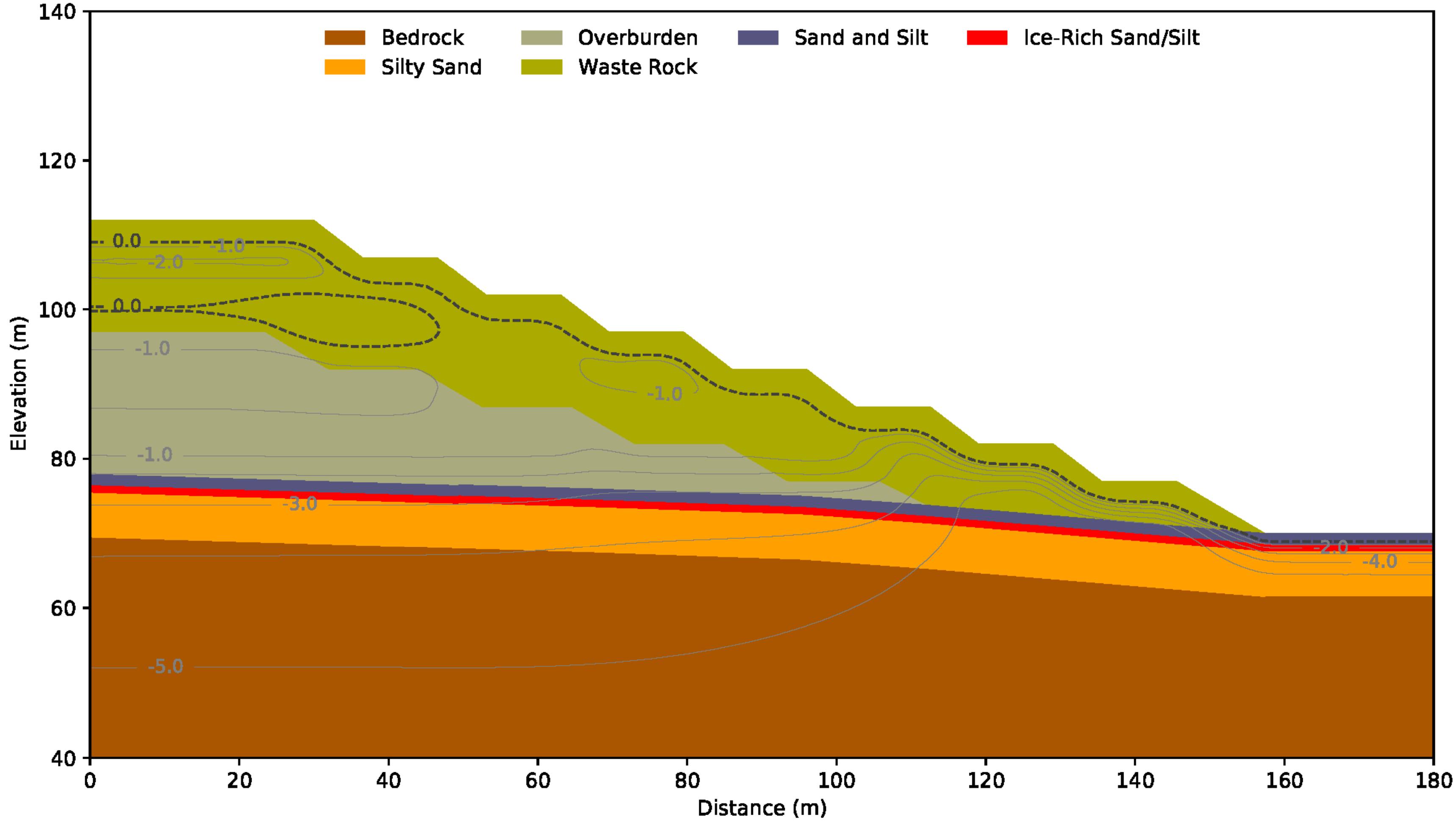
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Isotherms on September 30, 2023

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 7



LEGEND

NOTES

Notes:

1. Contours are for 0°C, -1.0°C, -2.0°C, -3.0°C, -4.0°C, and -5.0°C isotherms.

2. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

STATUS
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TETRA TECH

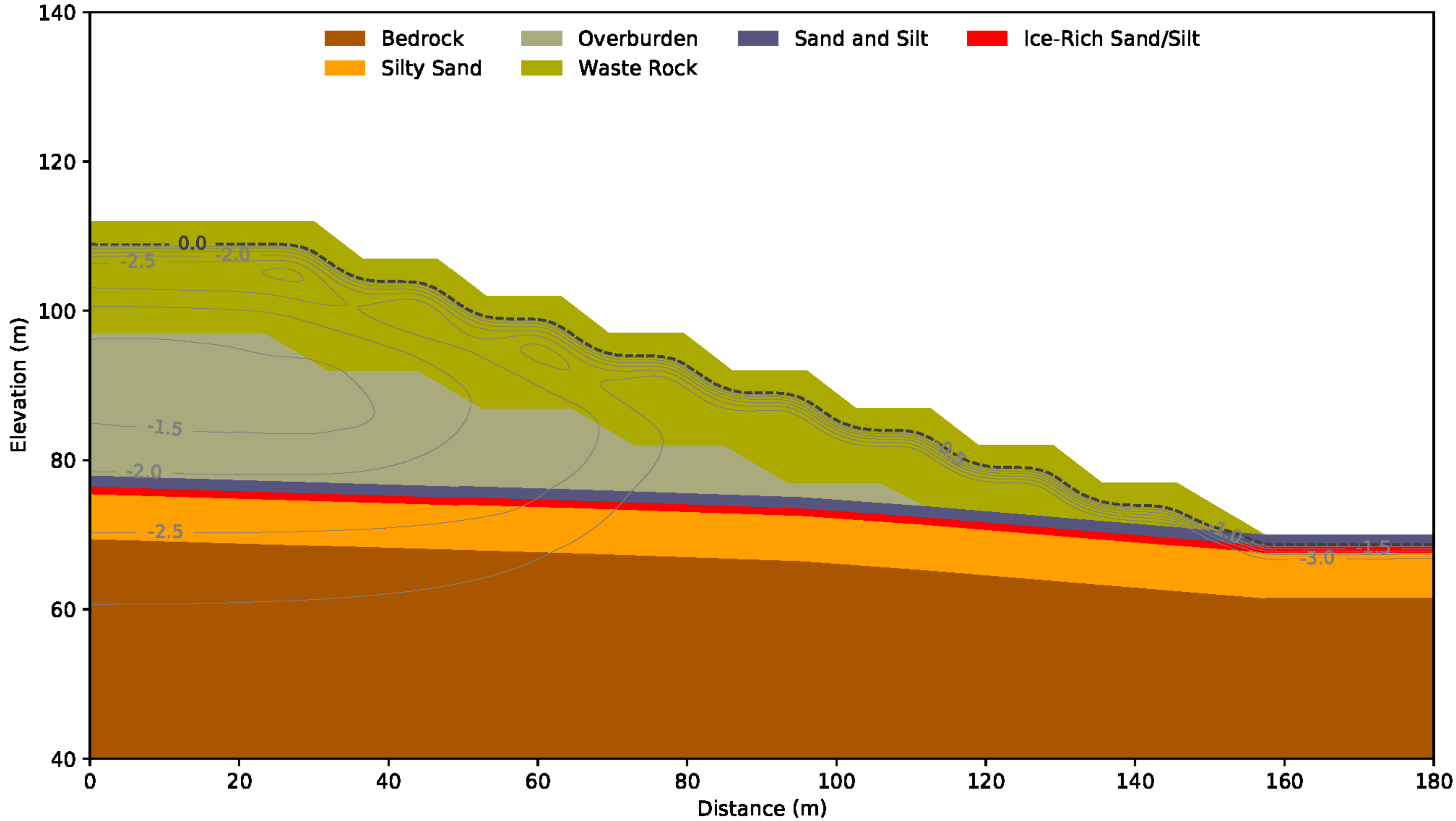
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Isotherms on September 30, 2024

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 8



LEGEND

NOTES

Notes:

1. Contours are for 0°C, -0.5°C, -1.0°C, -1.5°C, -2.0°C, -2.5°C, and -3.0°C isotherms.

2. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

STATUS
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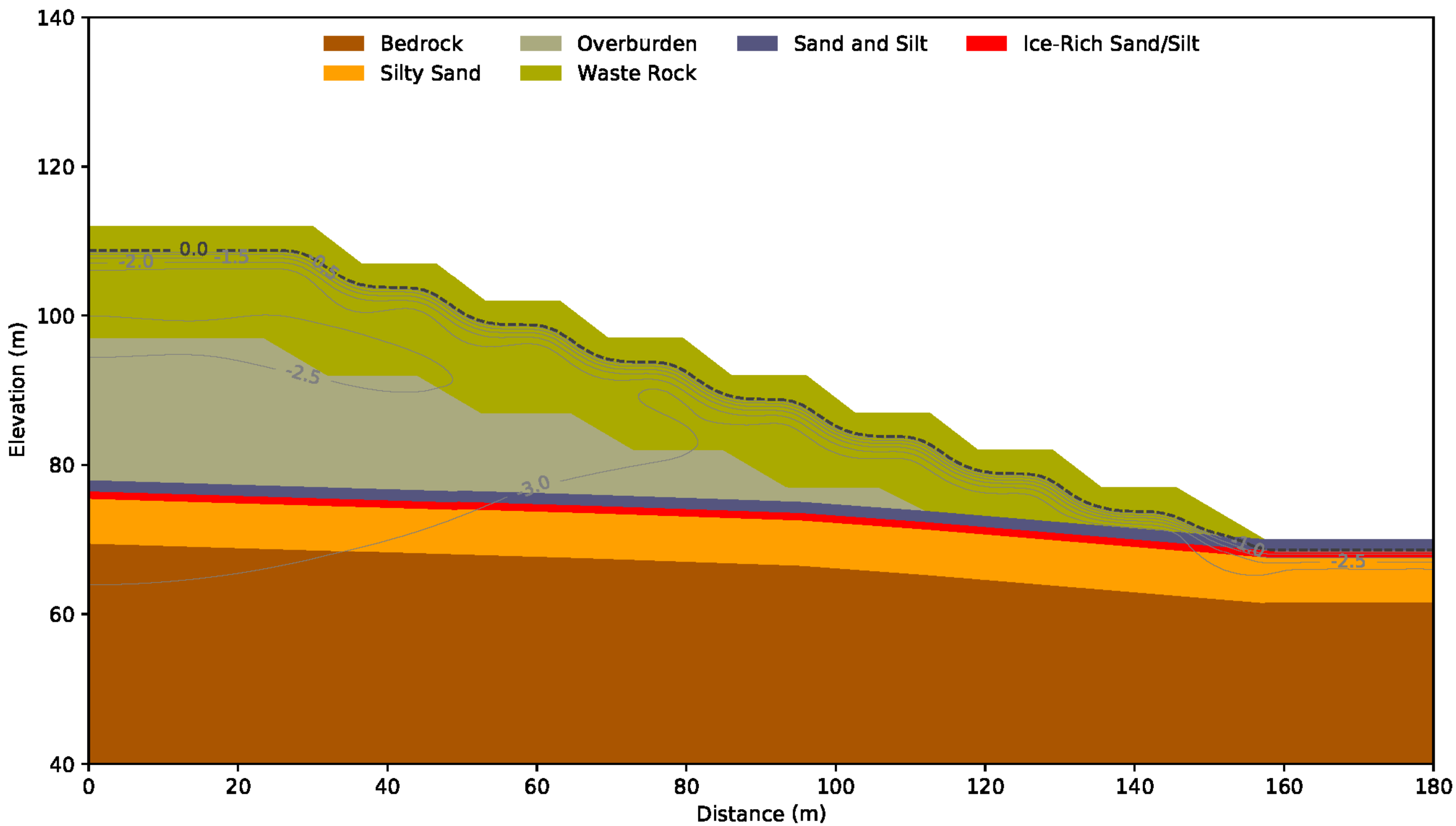
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Isotherms on September 30, 2044

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 9



LEGEND

NOTES

Notes:

1. Contours are for 0°C, -0.5°C, -1.0°C, -1.5°C, -2.0°C, -2.5°C, and -3.0°C isotherms.

2. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

STATUS
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TETRA TECH

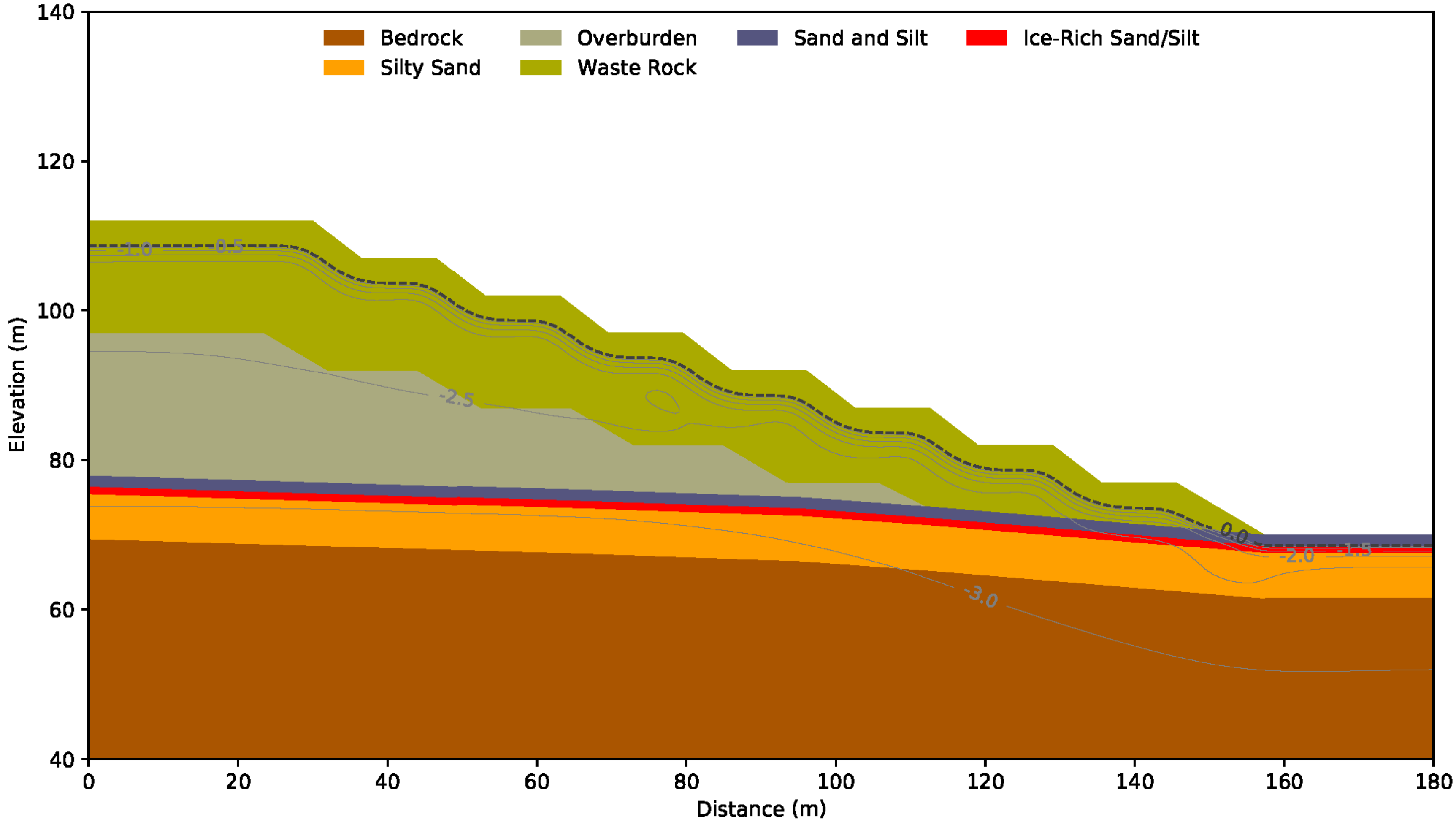
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Isotherms on September 30, 2064

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 10



LEGEND

NOTES

Notes:

1. Contours are for 0°C, -0.5°C, -1.0°C, -1.5°C, -2.0°C, -2.5°C, and -3.0°C isotherms.

2. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

STATUS
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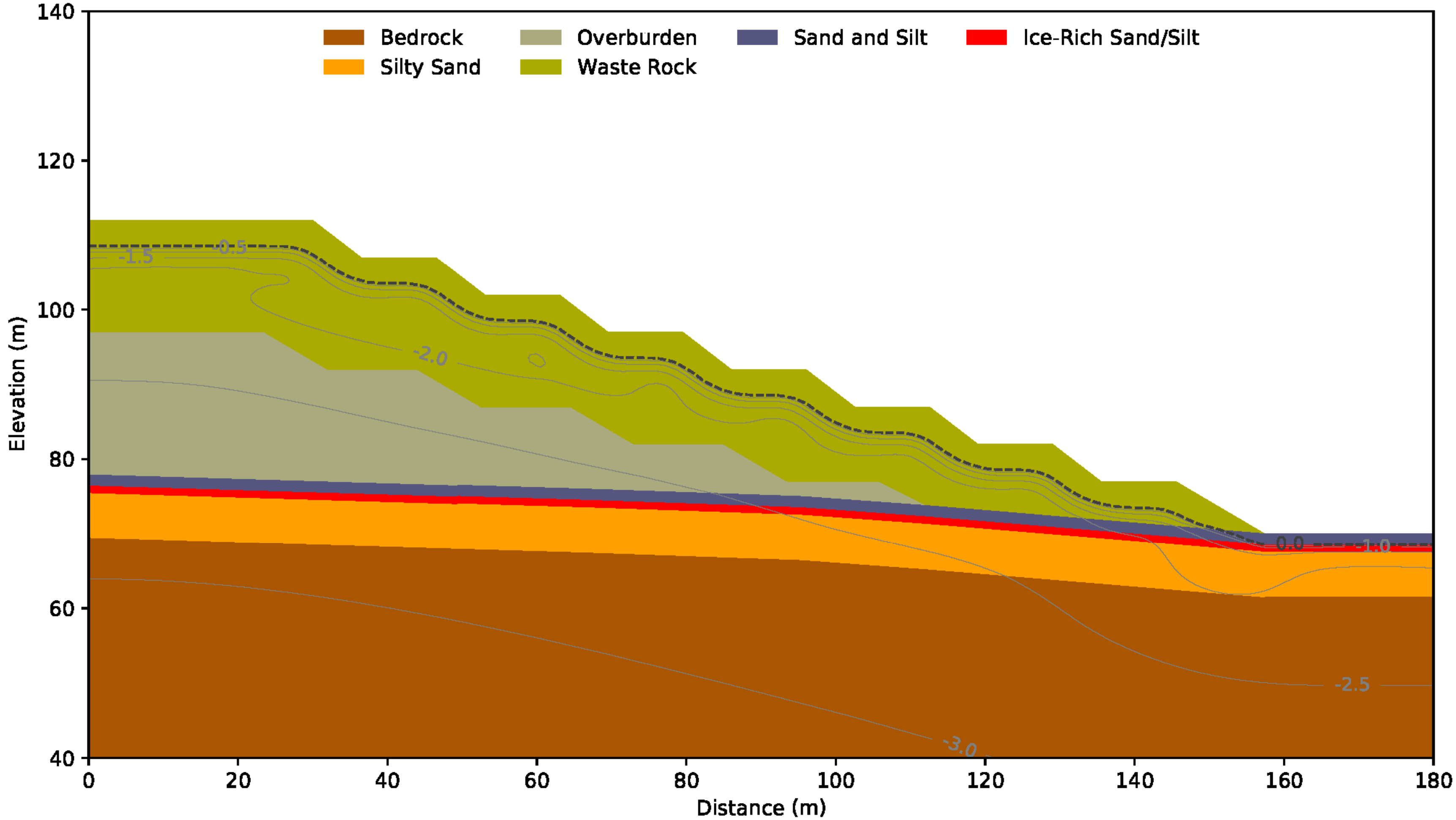
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Isotherms on September 30, 2084

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 11



LEGEND

Notes:

1. Contours are for 0°C, -0.5°C, -1.0°C, -1.5°C, -2.0°C, -2.5°C, and -3.0°C isotherms.

2. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

NOTES

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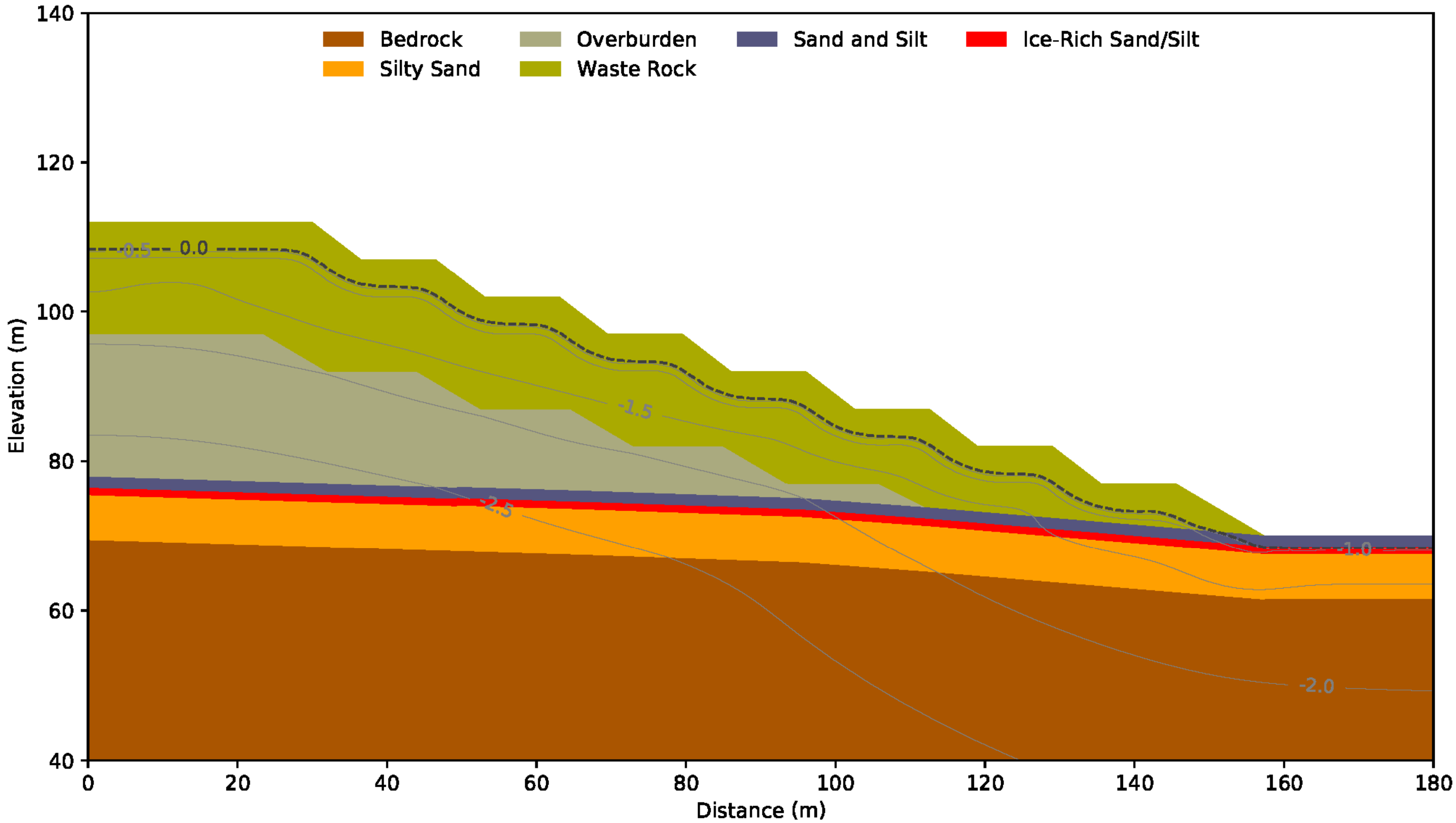
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Isotherms on September 30, 2104

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 12



LEGEND

NOTES

Notes:

1. Contours are for 0°C, -0.5°C, -1.0°C, -1.5°C, -2.0°C, -2.5°C, and -3.0°C isotherms.

2. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

STATUS
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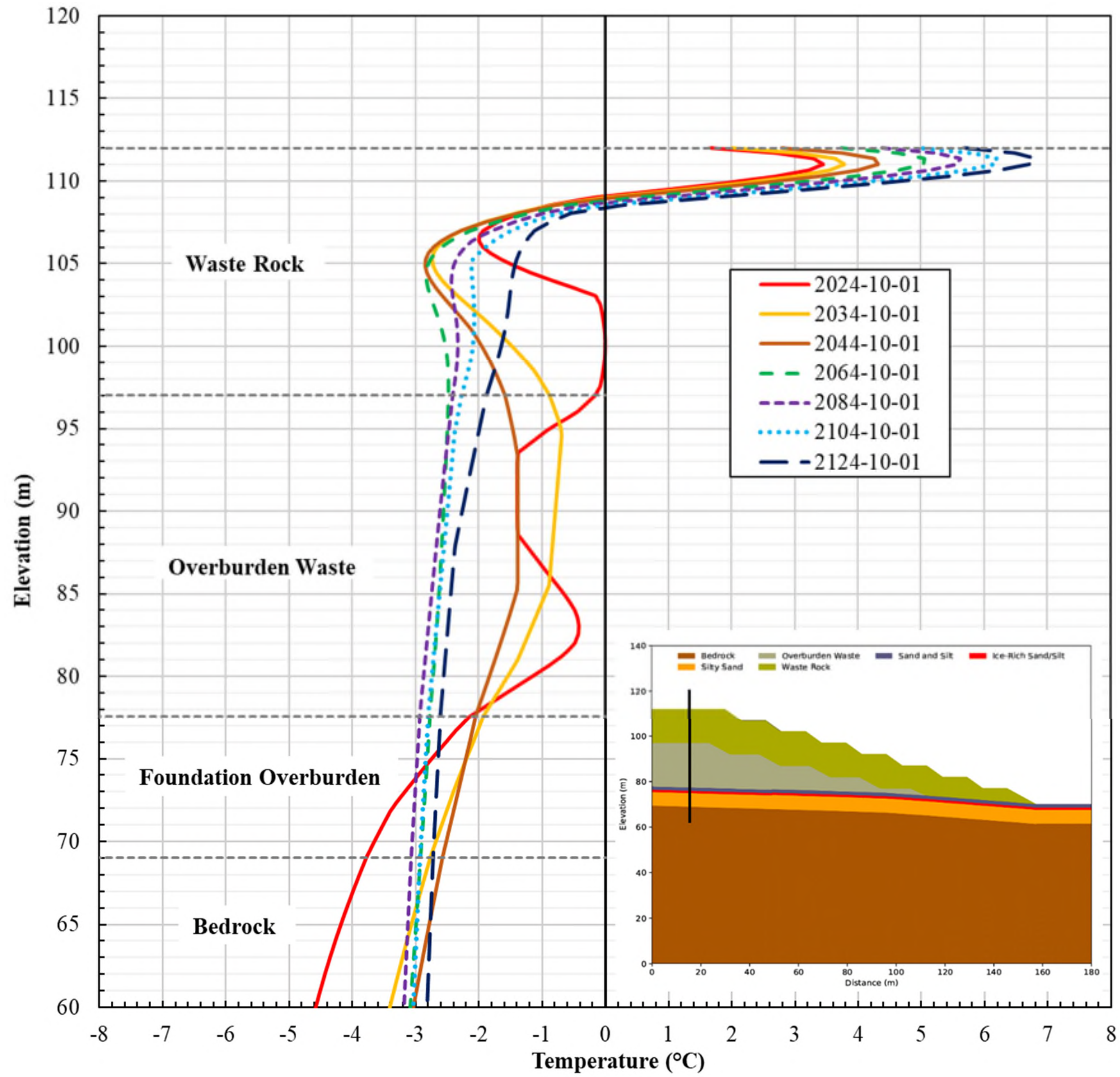
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Isotherms on September 30, 2124

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 13



LEGEND

NOTES

Notes:

1. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

2. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

STATUS
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TETRA TECH

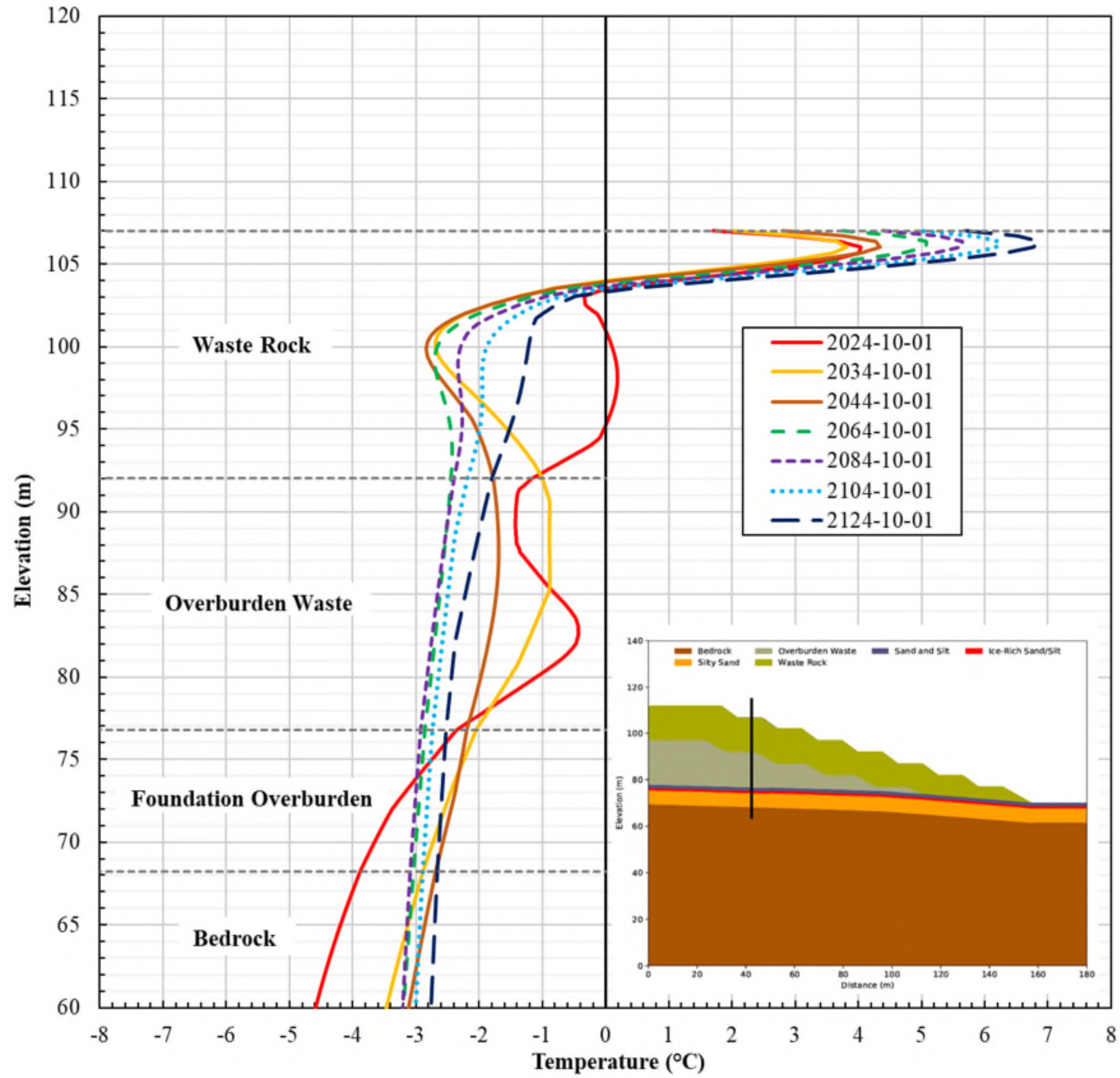
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Temperature Profiles on October 1 in Selected Years at Middle of 112 m Bench Location (about 142 m from the lowest toe of the pile)

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 14



LEGEND

NOTES

Notes:

1. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

2. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

STATUS
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CLIENT

AGNICO EAGLE

TETRA TECH

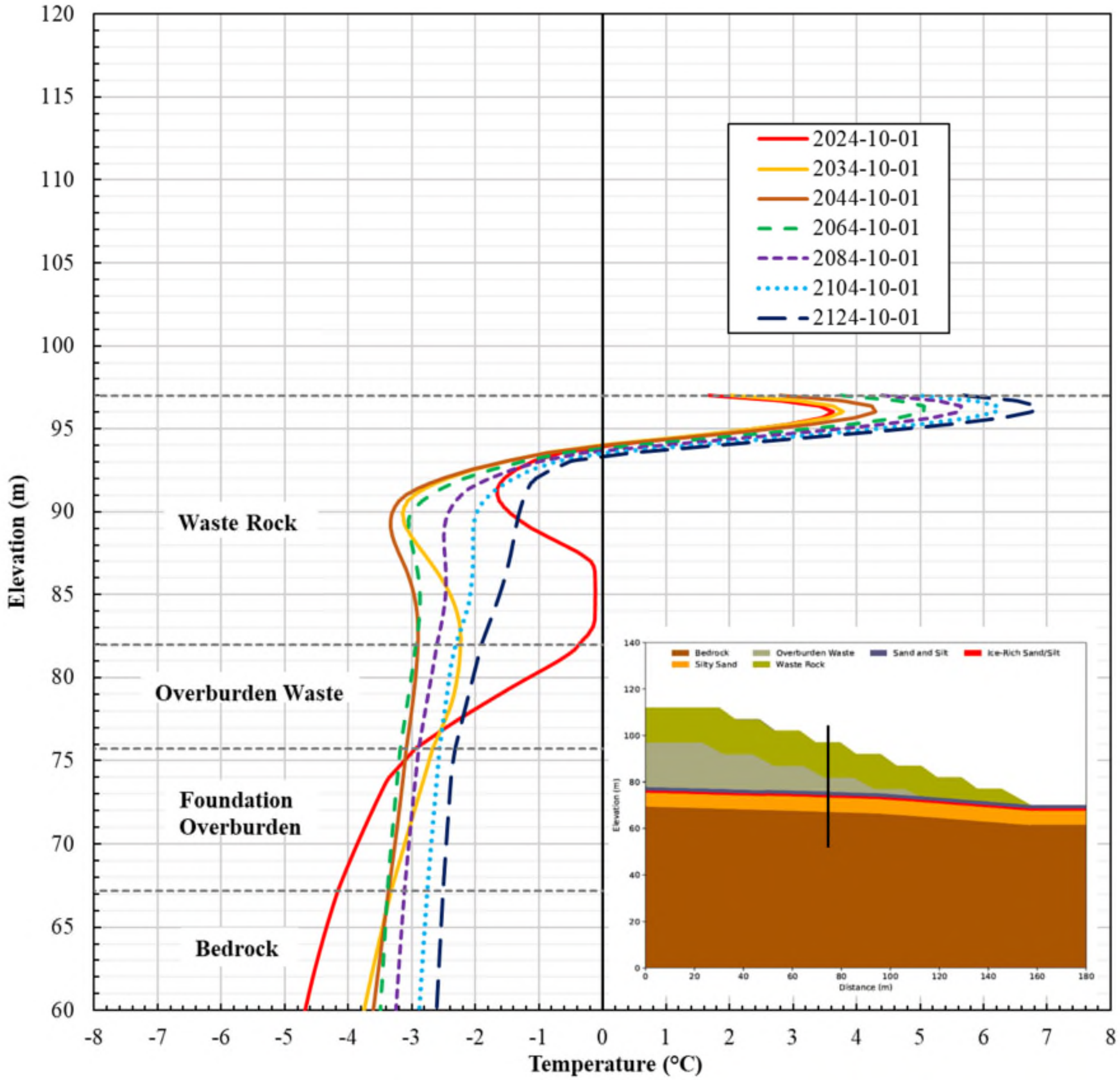
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Temperature Profiles on October 1 in Selected Years at Middle of 107 m Bench Location (about 116 m from the lowest toe of the pile)

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 15



LEGEND

NOTES

Notes:

1. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

2. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

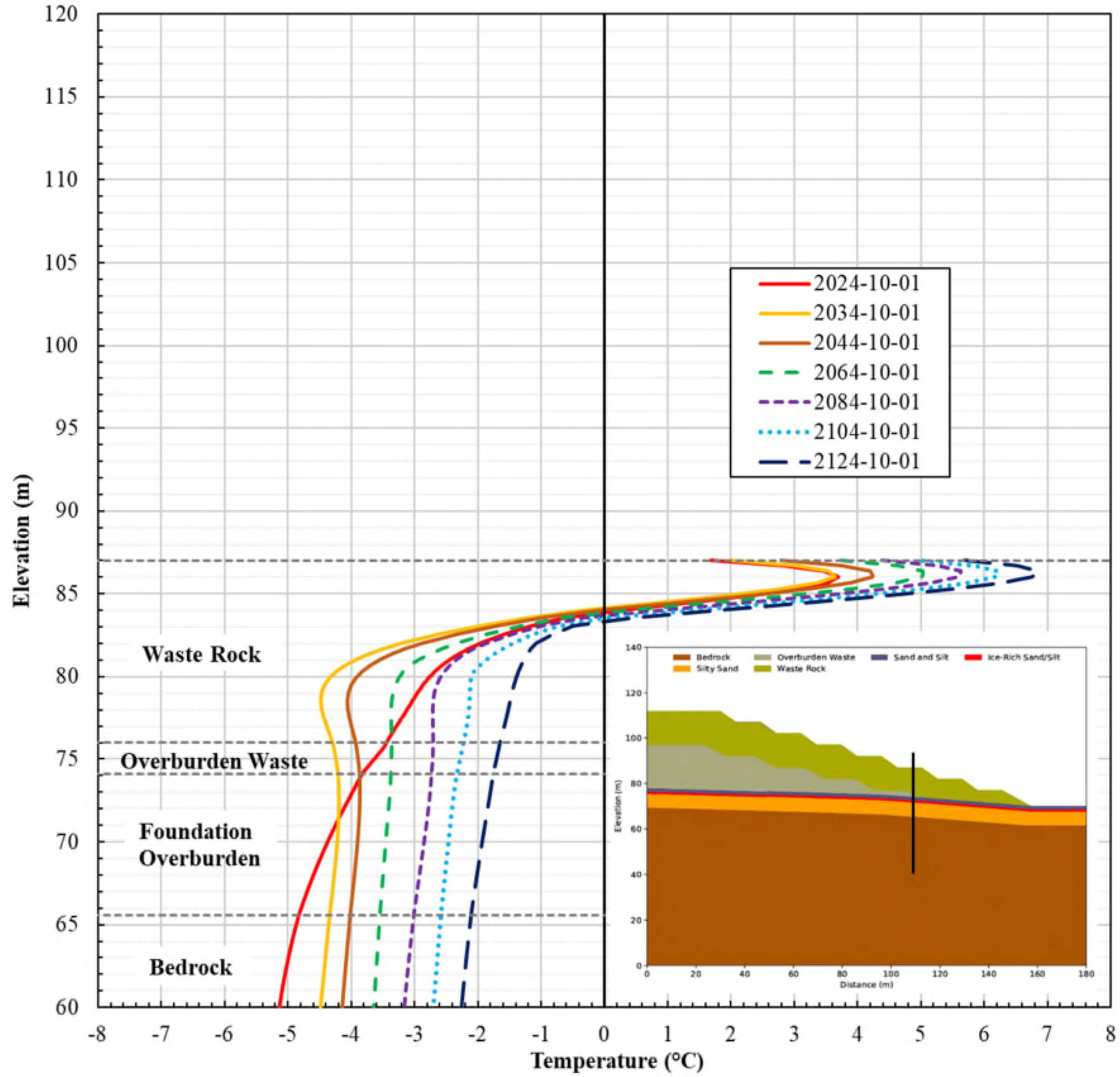
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Temperature Profiles on October 1 in Selected Years at Middle of 97 m Bench Location (about 83 m from the lowest toe of the pile)

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 16



LEGEND

NOTES

Notes:

1. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

2. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

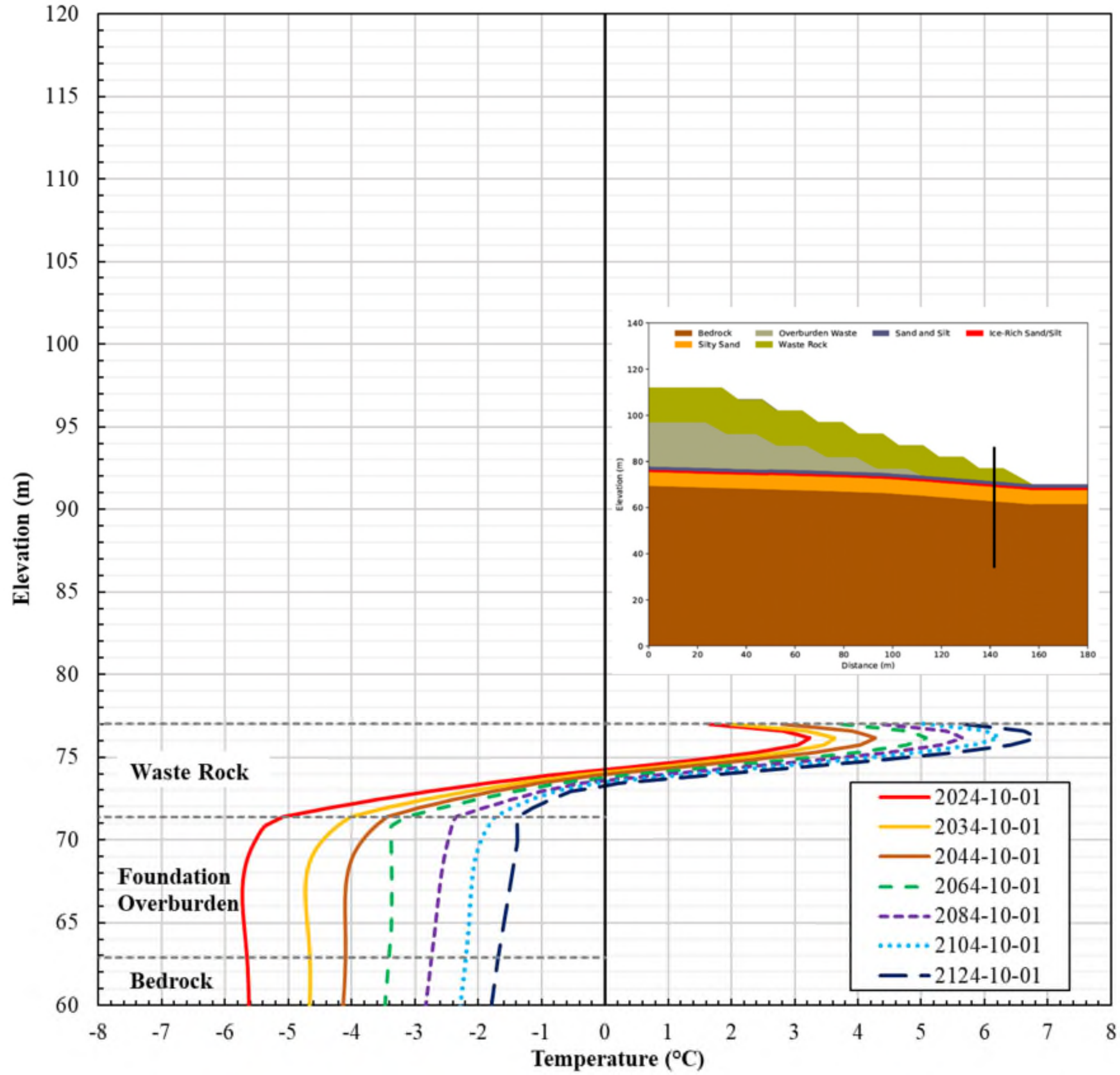
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Temperature Profiles on October 1 in Selected Years at Middle of 87 m Bench Location (about 50 m from the lowest toe of the pile)

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 17



LEGEND

NOTES

Notes:

1. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

2. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

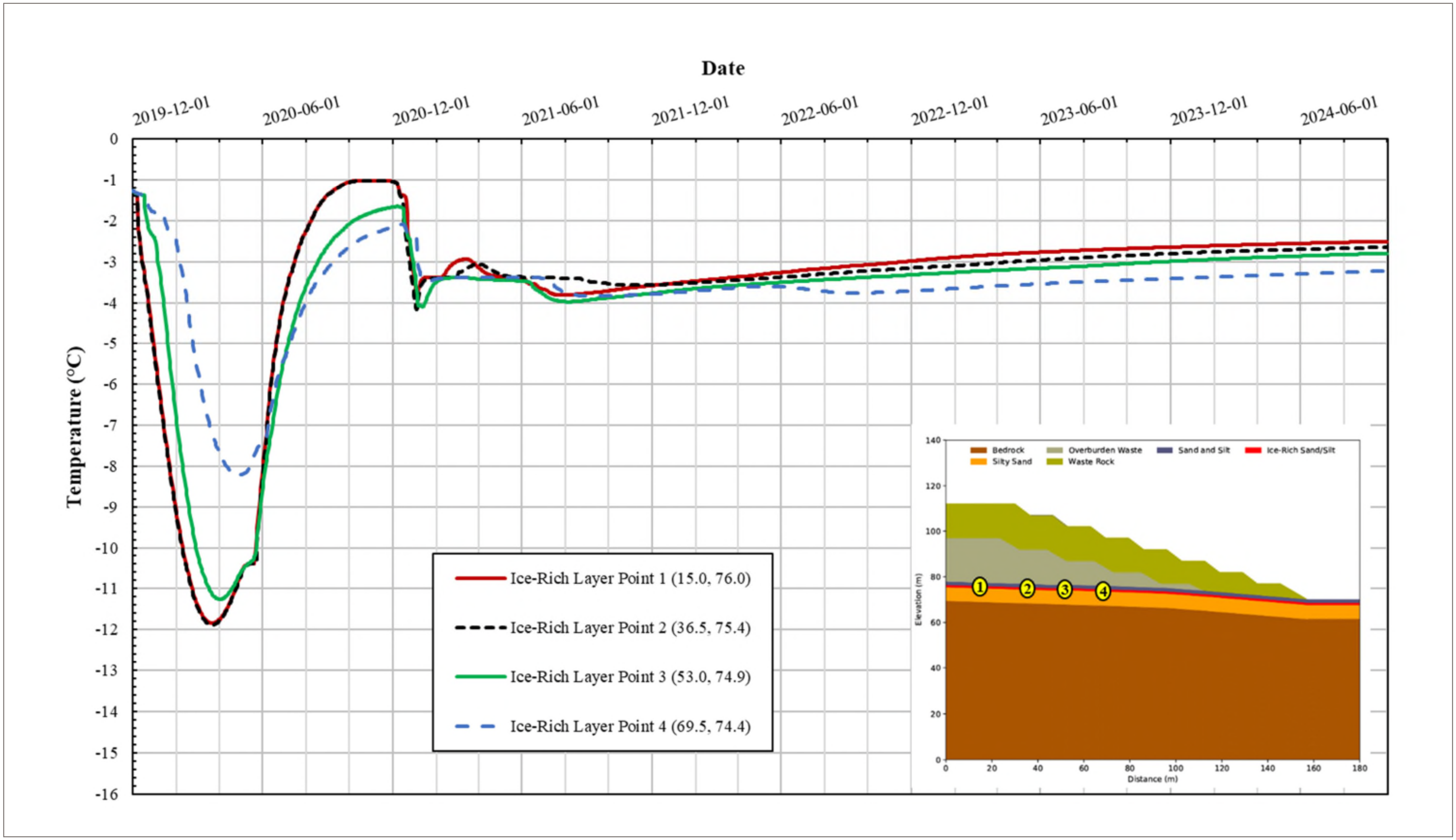
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Temperature Profiles on October 1 in Selected Years at Middle of 77 m Bench Location (about 17 m from the lowest toe of the pile)

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 18



LEGEND

NOTES

Notes:

1. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

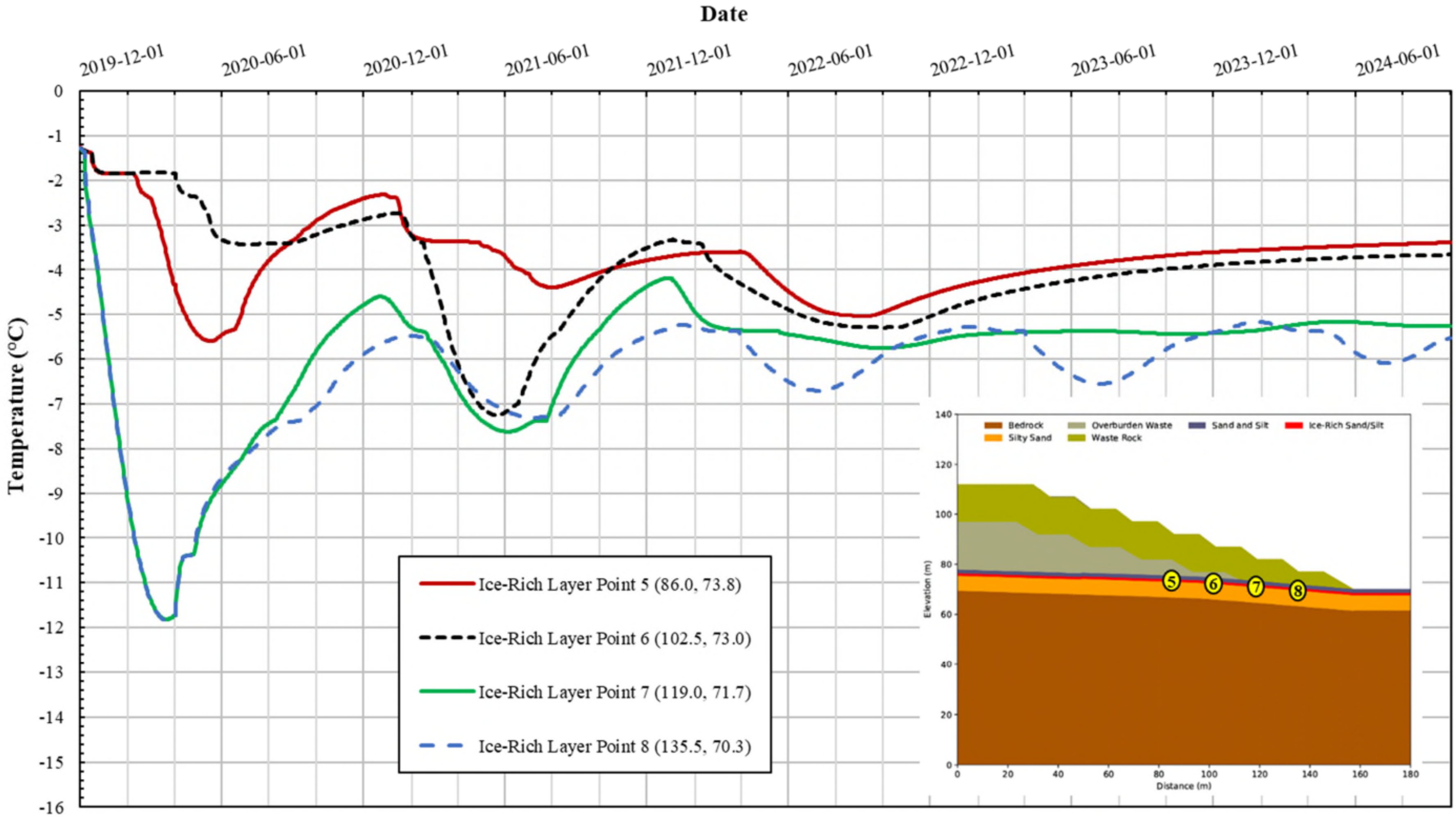
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Temperature History at Points with X=15.0m, 36.5m, 53.0m, and 69.5m on the Top Surface of Ice-Rich Soil Layer in WRSF1 Foundation During Construction

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 19



LEGEND

NOTES

Notes:

1. Based on the waste rock and overburden production plan provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan developed for the design of WRSF1.

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

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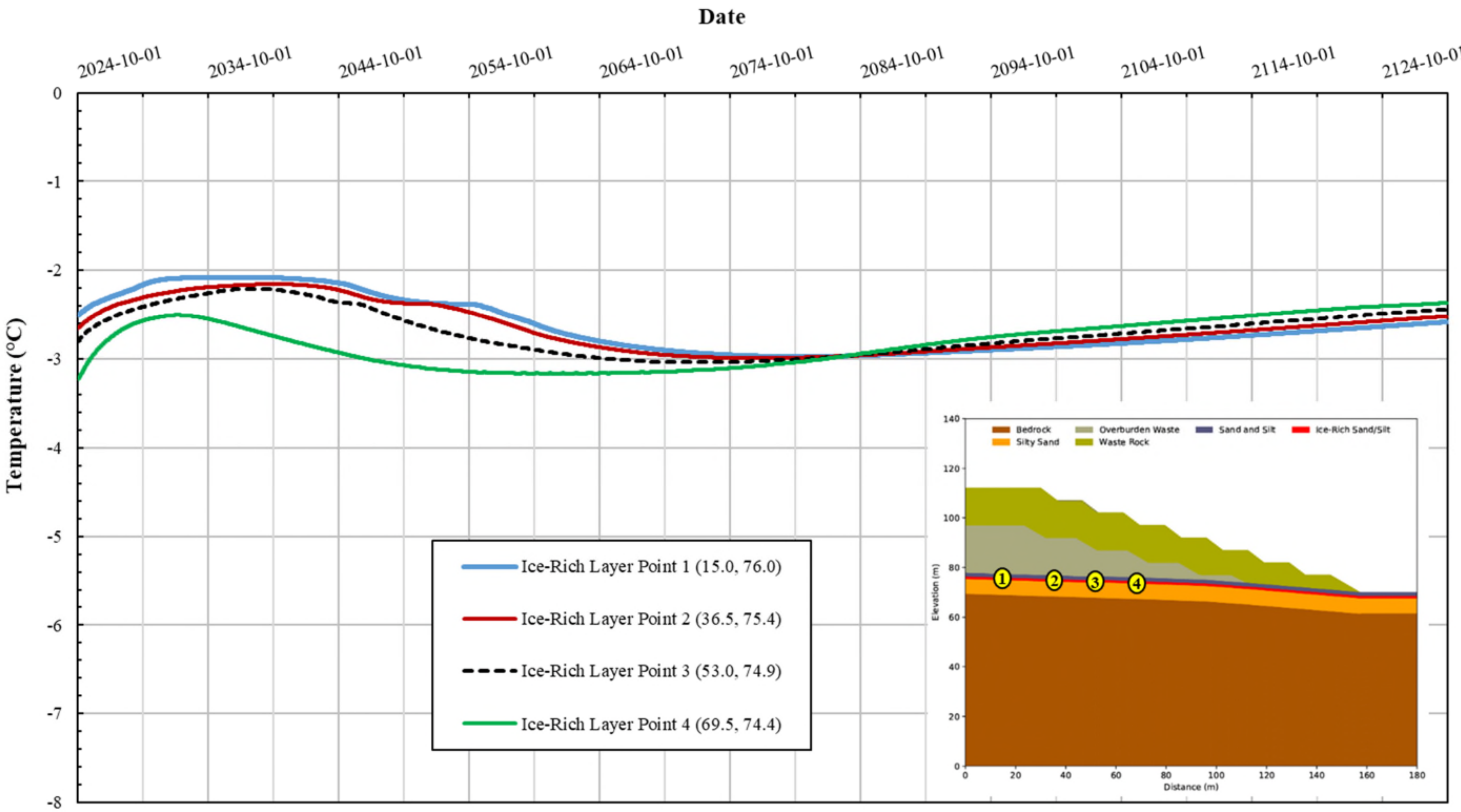
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Temperature History at Points with X=86.0m, 102.5m, 119.0m, and 135.5m on the Top Surface of Ice-Rich Soil Layer in WRSF1 Foundation During Construction

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 20



LEGEND

NOTES

Notes:

1. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

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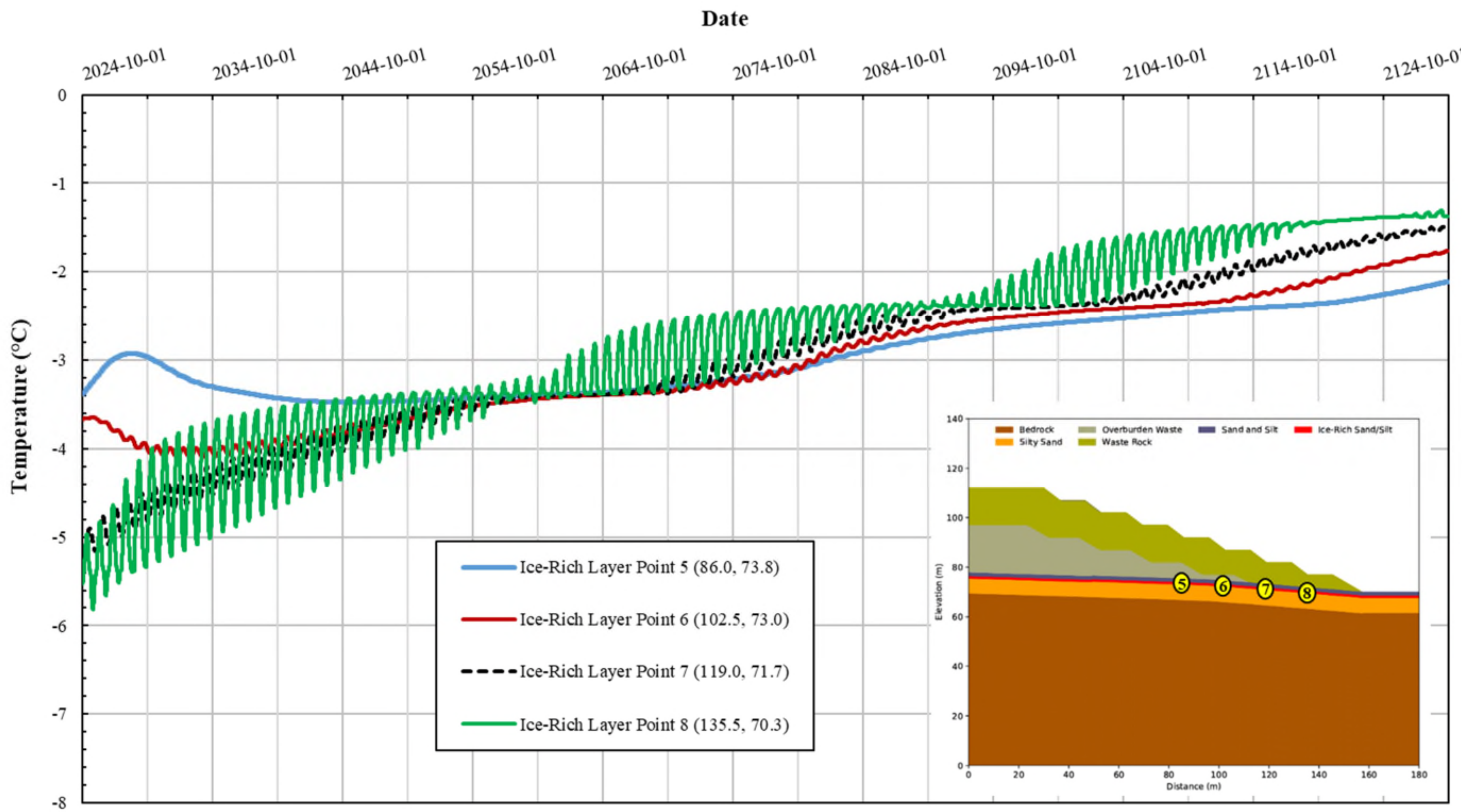
Thermal Analysis of WRSF1
Meliadine Gold Project, NU

Predicted Temperature History at Points with X=15.0m, 36.5m, 53.0m, and 69.5m on the Top Surface of Ice-Rich Soil Layer in WRSF1 Foundation After Construction

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	YL	GZ	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 21



LEGEND

NOTES

Notes:

1. Based on the projected long-term air temperatures at Rankin Inlet for CMIP5-RCP4.5 climate change scenario.

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Thermal Analysis of WRSF1
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Figure 22

APPENDIX A

TETRA TECH'S LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

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Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

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If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

Appendix C

TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE

To:	Jennifer Pyliuk, P.Eng., Agnico Eagle	**Date:**	November 25, 2019
c:	Bill Horne, P.Eng., Tetra Tech	**Memo No.:**	002
From:	Guangwen (Gordon) Zhang, P.Eng., Tetra Tech	**File:**	ENG.EARC03140-02
Subject:	Stability Analyses for Waste Rock Storage Facility No1 (WRSF1), Meliadine Gold Project, Nunavut		

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Agnico Eagle Mines Ltd. (Agnico Eagle) to conduct the geotechnical design of the Waste Rock Storage Facility No1 (WRSF1) for the Meliadine Gold Project (the Project), Nunavut, Canada. The Project site is located on a peninsula between the east, south, and west basins of Meliadine Lake at latitude 63°01'N and longitude 92°13'W and is 25 km northwest of Rankin Inlet, Nunavut.

Slope stability analyses were carried out as a component of the WRSF1 design. The purpose of the slope stability analyses was to assist in developing the typical cross-section and design of WRSF1.

This technical memorandum summarizes the methodology, input parameters, assumptions, and findings of the stability analyses. It is understood that this memorandum will be included as an appendix to the WRSF1 design report to be prepared by Agnico Eagle.

2.0 GENERAL SITE CONDITIONS

2.1 Climate

The Project site lies within the Southern Arctic Climatic Region where daylight reaches a minimum of 4 hours per day in winter and a maximum of 20 hours per day in summer. The nearest weather station is Rankin Inlet A (Station 2303401), located approximately 25 km south of the Project site. The monthly mean air temperature is typically above 0°C for the months of June to September and is below 0°C between October and May. July is typically the warmest month and January the coldest. The mean annual air temperature for the 1981 - 2010 Climate Normal period was -10.5°C.

Mean annual precipitation at the mine site, based on the hydrological year from 1 October to 30 September, is estimated to be 412 mm after accounting for rainfall and snowfall undercatch. Approximately 51% of precipitation occurs as rain and 49% occurs as snow (Agnico Eagle 2015).

The region is known for high winds, which are due in part to the broad, flat, uninterrupted expanses offered to moving air masses. The wind blows from the north and north-northwest direction more than 30% of the time. The mean values for wind speed show that the north-northwest, together with north and northwest winds, have the highest speeds and tend to be the strongest. Mean monthly wind speeds are typically between 19 km/hour and 27 km/hour.

Tetra Tech Canada Inc.
14940 - 123 Avenue
Edmonton, AB T5V 1B4 CANADA
Tel 780.451.2121 Fax 780.454.5688

2.2 General Subsurface Conditions

Site investigation programs have been conducted at the Project site since 1998. A total of six boreholes were drilled within the proposed WRSF1 footprint, and an additional seven boreholes were drilled within approximately 100 m outside of the boundary of the proposed WRSF1 footprint. Figure 1 presents a plan showing the proposed footprint of WRSF1 and the borehole locations. The detailed geotechnical information and borehole logs can be found in relevant site investigation reports (Golder 2010, 2012a, and 2012c; EBA 2013; Tetra Tech EBA 2014a). In general, the subsurface of the WRSF1 area consists of a thin layer of organic material overlying silty sand or sand and silt, ice-rich sandy silt or silty sand, silty sand or gravelly sand and silt, with traces of clay and shells with cobbles. Excess ice was observed within the overburden soils in most of the boreholes. The depth to bedrock ranges from 2.2 m to 13.6 m. The depth to bedrock appears deeper in the centre of the facility which is due to the naturally higher ground elevations. Table 1 summarizes the key geotechnical information of the overburden soils in the WRSF1 area, together with bedrock elevations.

Table 1: Geotechnical Information of Overburden Soils and Bedrock Elevations in WRSF1 Area

Borehole No.	Organic Layer Thickness (m)	Major Overburden Soil Types	Ice Conditions	Depth to Bedrock (m)	Bedrock Elevation (m)
GT09-20	0.02	Silty sand; silt and sand	Vr >50% from 0.9 to 1.4 m	2.2	65.3
GT11-06	-	Low recovery; sand; sand and silt	Vs from 2.5 to 2.75 m	13.6	64.1
GT11-07	0.60	Low recovery; silty sand and gravel	Vx from 1.5 to 6.1	6.1	59.2
GT11-11	0.06	Gravelly sand; ice and silty sand; silty sandy gravel	1.5 m ice and silty sand from 2.25 to 3.75 m	8.4	59.7
GT12-14	0.02	Sandy silty gravel	Not logged	8.5	64.3
GT12-15	0.08	Silty sand; sandy silt; gravelly sand and silt	Vr from 1.6 to 3.5 m	12.7	62.2
GT12-16	-	Low recovery; sand and gravel; gravelly silty sand; sandy silty gravel	Thawed during drilling	10.4	65.8
GT12-17	0.05	Low recovery; silty sand; boulders and cobbles; gravelly sandy silt	Thawed during drilling	8.5	66.3
GT13-01	0.20	Sand and silt; gravelly sand	Up to 30% Vx, Vr from 0.6 to 1.2 m; 0.2 m ice and sand from 1.6 to 1.8 m	5.8	59.2
GT13-08	0.15	Low recovery; boulders and cobbles	Thawed during drilling	10.4	63.4
GT13-09	0.08	Low recovery; gravel; boulders	Thawed during drilling	9.5	64.9
GT14-09	0.52	Peat; sand; sandy silt; ice and silt	0.6 m ice and silt from 2.9 to 3.5 m	4.0	65.0
GT14-34	0.30	Sandy silt; sand; ice and silt; silty sand	Vs 30%; Vc/Vx 10; 0.8 m ice and silt from 1.4 to 2.2 m	8.3	61.7

2.3 Ground Temperature and Permafrost Condition

The Project site is located within the Southern Arctic terrestrial eco-zone, one of the coldest and driest regions of Canada, in a zone of continuous permafrost. Data obtained from ground temperature cables (GTCs) installed in some boreholes confirm the presence of continuous permafrost to depths between 360 m and 495 m, with the depth of the active layer ranging from approximately 1 m to 3 m. It is anticipated that the active layer adjacent to lakes or below a body of water could be deeper. Frozen soils have been observed in most of the boreholes drilled on site. The typical permafrost ground temperatures at the depths of zero annual amplitude (typically at the depth of below 15 m) are in the range of -5.0°C to -7.5°C in the areas away from lakes and streams. Limited overburden soil porewater salinity tests (EBA 2013) indicated that the overburden soils may have a porewater salinity of 4 to 12 parts per thousand (ppt). The geothermal gradient ranges from 0.012°C/m to 0.02°C/m (Golder 2012b).

3.0 WASTE ROCK AND OVERBURDEN PROPERTIES AND PRODUCTION PLAN, AND PRELIMINARY PLACEMENT PLAN FOR WRSF1

3.1 Waste Rock and Overburden Properties

The Project site is within the Rankin Inlet Greenstone Belt. The ore deposits are low-sulphide, gold-quartz vein deposits. The principal lithological units include turbiditic sedimentary rocks, volcanic-hosted and sediment-hosted iron formation, sericite altered siltstones and graphitic argillite, and schistose and carbonate-altered mafic volcanic rocks (Agnico Eagle 2015).

A baseline geochemical characterization program for the Project was initiated in 2008 and consisted of static and kinetic testing methods to assess the chemical composition of the mine waste and overburden, its potential to generate acid rock drainage and its potential for metal leaching (ML) upon exposure to ambient conditions. Based on the waste rock geochemical testing findings, the waste rock from the Tiriganiaq deposit area is considered non-potentially acid generating (NPAG) and has a low potential for ML in view of proposed waste rock management for the Project. The results of geochemical characterization indicated that the overburden produced will be NPAG. Waste rock and overburden have compatible geochemical characteristics such that these materials can be managed together in the same disposal facilities (Agnico Eagle 2015).

3.2 Waste Rock and Overburden Production Plan

Agnico Eagle is developing the waste rock and overburden production plan for the Project. The latest waste rock and overburden production plan was provided by Agnico Eagle in an email on September 23, 2019 (Agnico Eagle 2019) for the design of WRSF1. It is understood that the waste rock and overburden from SP4 (saline pond No4) and Open Pit Tiri_1000_01 will be primarily placed in WRSF1 until the design capacity of WRSF1 is reached.

Some overburden waste materials were previously placed over the original ground within the proposed footprint of WRSF1 (Figure 1). The volume of the materials is estimated to be 87,930 m^3. Some fills were also placed over the previous exploration landfill within the proposed footprint of WRSF1. The total volume of the fills and the landfill materials above the original ground is 6,210 m^3.

3.3 Preliminary Waste Rock and Overburden Placement Plan for WRSF1

Agnico Eagle is developing the waste rock and overburden placement plan for mine waste storage facilities including WRSF1. The plan also depends on the final design of WRSF1, which is currently being developed. A preliminary waste rock and overburden placement plan was adopted for thermal and stability evaluations for WRSF1 based on Agnico Eagle (2019). Further details on the plan are presented in Tetra Tech (2019). Table 2 summarizes the preliminary waste rock and overburden placement plan for the design of WRSF1.

Table 2: Preliminary Waste Rock and Overburden Placement Plan for Design of WRSF1

Location of Mine Waste Placement	Approximate Period of Mine Waste Placement	Period when the Majority of Mine Waste Materials are Placed
Bench 77 m of overburden waste	December 2019 to February 2020	December 2019 to January 2020
Bench 82 m of overburden waste	January 2021 to June 2021	January 2021 to April 2021
Bench 87 m of overburden waste	October 2021 to Dec 2021	October 2021 to Dec 2021
Bench 92 m of overburden waste	January 2022 to March 2022	January 2022 to March 2022
Bench 97 m of overburden waste	January 2022 to March 2022	January 2022 to March 2022
Bench 77 m of waste rock	February 2020 to January 2022	February 2020 to April 2020
Bench 82 m of waste rock	January 2022 to June 2022	January 2022 to April 2022
Bench 87 m of waste rock	June 2022 to September 2022	June 2022 to September 2022
Bench 92 m of waste rock	September 2022 to January 2023	September 2022 to November 2022
Bench 97 m of waste rock	January 2023 to June 2023	January 2023 to April 2023
Bench 102 m of waste rock	June 2023 to October 2023	June 2023 to September 2023
Bench 107 m of waste rock	October 2023 to January 2024	October 2023 to December 2023
Bench 112 m of waste rock	January 2024 to February 2024	January 2024 to February 2024

4.0 STABILITY ANALYSIS METHODOLOGY AND ACCEPTANCE CRITERIA

4.1 Methodology

Limit equilibrium analyses were conducted to determine the factor of safety against slope failure during construction and in the long term after the construction of WRSF1. All analyses were conducted using the two-dimensional, limit equilibrium software, Slope/W of GeoStudio 2016 (Geo-Slope International Ltd., Version 8.16.1.13452). The Morgenstern-Price method with a half-sine interslice force assumption was adopted in the analyses. The analyses were conducted to evaluate the slope stability of WRSF1 during various stages of construction and post-construction. Potential post-construction seismic loading was modelled as pseudo-static with a design horizontal peak acceleration.

The principles underlying the method of limit equilibrium analyses of slope stability are as follows:

- A slip mechanism is postulated;
- The shear resistance required to equilibrate the assumed slip mechanism is calculated by means of statics;
- The calculated shear resistance required for equilibrium is compared with the available shear strength in terms of factor of safety; and
- The slip surface with the lowest factor of safety is determined through iteration.

A design factor of safety is used to account for the uncertainty and variability in the strength and pore water pressure parameters, and to limit deformations.

4.2 Stability Acceptance Criteria for Factors of Safety

The *Guidelines for Mine Waste Dump and Stockpile Design* (Hawley and Cunning 2017) provides guidelines for assigning stability criteria and factors of safety for various waste rock pile configurations and site conditions. The suggested stability acceptance criteria from Hawley and Cunning (2017) are based on the failure consequence and confidence level in foundation conditions, waste material properties, piezometric pressures, overall fill slope angles, height of repose angle slopes, and precipitation. The guidelines in Hawley and Cunning (2017) are considered an update to the previous (PAE 1991) interim design acceptability criteria, which did not specifically distinguish between factors such as the size of facility, consequence of failure, or confidence in foundation conditions. Therefore, the design acceptance criteria for the analyses in this study are based on the guidelines in Hawley and Cunning (2017).

Hawley and Cunning (2017) provides detailed guidelines on how to classify the consequence of failure and the confidence level. The guidelines are quoted below:

> *"Consequence of Failure:*
>
> *Low – waste dumps and stockpiles with overall fill slopes less than 25° and less than 100 m high and repose angle slopes less than 50 m high. No critical infrastructure or unrestricted access within potential runout shadow. Limited potential for environmental impact. Long-term (more than 5 years) exposure for sites subject to very low to low (less than 350 mm) annual precipitation; medium-term (1–5 years) exposure for sites subject to moderate (350–1000 mm) annual precipitation; short-term (less than 1 year) exposure for sites subject to high (1000–2000 mm) annual precipitation; dry season construction/operation only for sites subject to very high (more than 2000 mm) annual precipitation or intensive rainy season(s).*
>
> *Moderate – waste dumps with overall fill slopes less than 30° and less than 250 m high or repose angle slopes less than 100 m high. No critical infrastructure or unrestricted access, or robust containment/mitigative measures to protect critical infrastructure and access within potential runout shadow. Potential for moderate environmental impact, but manageable. Long-term (more than 5 years) exposure for sites subject to moderate (350–1000 mm) annual precipitation; medium-term (1–5 years) exposure for sites subject to high (1000–2000 mm) annual precipitation; short-term (less than 1 year) exposure for sites subject to very high (more than 2000 mm) annual precipitation or intensive rainy season(s).*
>
> *High – waste dumps with overall fill slopes more than 30° and more than 250 m high, or with repose angle slopes more than 200 m high. Critical infrastructure or unrestricted access within potential runout shadow with limited runout mitigation/containment measures. Potential for high environmental impact that would be difficult to manage. Long-term exposure (more than 5 years) for sites subject to high (1000–2000 mm) annual precipitation; medium-term (1–5 years) exposure for sites subject to very high (more than 2000 m) annual precipitation or intensive rainy season(s).*
>
> *Confidence Level:*
>
> *Low – limited confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Poorly defined or optimistic input parameters; high data variability. For proposed structures, investigations at the conceptual level with limited supporting data. For existing structures, poorly documented or unknown construction and operational history; lack of monitoring records; unknown or poor historical performance.*

Moderate – moderate confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential failure mechanism(s). Input parameters adequately defined; moderate data variability. For proposed structures, investigations at the pre-feasibility study level with adequate supporting data. For existing structures, reasonably complete construction documentation and monitoring records; fair historical performance.

High – high confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique and instability mechanism(s). Well-defined, conservative input parameters; low data variability. For proposed structures, investigations at the feasibility study level with comprehensive supporting data. For existing structures, well-documented construction and monitoring records and good historical performance."

The stability acceptance criteria for the WRSF1 design have been adopted to capture different slope slip mechanisms, failure consequence, and confidence levels in stability analysis input parameters, key assumptions, and site conditions. Table **Error! Reference source not found.**3 summarizes the stability criteria for the design of WRSF1.

Table 3: Adopted Stability Criteria for WRSF1 Design

Potential Failure Mechanism and Conditions	Consequence of Failure	Confidence Level	Minimum Factor of Safety for Static Loading	Minimum Factor of Safety for Pseudo-static Loading
Surficial, shallow slips	Low	High	1.1	1.00
Local deep-seated slips	Moderate	Moderate to High	1.3	1.05
Short-term, global deep-seated slips for cases with normal assumptions	Moderate to High	Moderate	1.4	1.10
Long-term, global deep-seated slips for base cases with normal assumptions	Moderate to High	Low to Moderate	1.5	1.15
Long-term, global deep-seated slips for sensitivity cases with conservative assumptions	Moderate to High	Moderate to High	1.4	1.10

The consequence of failure and confidence level in Table 3 are based on the following considerations:

- The surficial, shallow slips are classified as low consequence (the small size of the potential slip material) and high confidence level due to reasonably conservative strength parameters assumed for surficial waste rock and overburden.
- The consequence of failure is classified as moderate for local deep-seated slips (no greater than 15 m deep). The confidence level in the analysis input parameters and assumptions is moderate to high for this potential failure mechanism.
- The consequence of failure is classified as moderate to high for global deep-seated slips. This is due to the following factors:
  - Relatively moderate size of slip material if failure occurs;
  - Potential for manageable environmental impact;

  - Overall design of 20.5°, which is less than 30° slopes from crest to toe;
  - Repose angle slopes of 5 m high;
  - Moderate (mean annual precipitation of 412 mm, which is between 350 mm and 1,000 mm) annual precipitation;
  - Some infrastructure (Paste Plant, Portal No. 2, Pit Tiri_1000_01, Landfill, TSF, WRSF2, CP4, D-CP4, and haul roads) is close to WRSF1 during the operation period of the mine; and
  - No permanent infrastructures around WRSF1 after mine closure, except for the closed TSF, WRSF2, and Pit Tiri_1000_01.
- The confidence level for global deep-seated slips is moderate for cases during short term (during active placement of the waste rock and overburden and within five years after completion of waste placement). The confidence level is low to moderate for long term cases with non-conservative input parameters and assumptions (such as the assumed water table (piezometric surface) at the original ground surface).
- Finally, the confidence level for sensitivity cases with conservative assumptions, such as higher water tables (e.g., the water table assumed on the top surface of the overburden waste) or thawing WRSF1 permafrost foundation, is moderate to high.

5.0 STABILITY ANALYSIS INPUT DATA AND CASES

5.1 Foundation Soil Profile and Material Properties

The foundation geotechnical conditions underlying the WRSF1 area are summarized in Section 2.2. Accordingly, this information was used to develop a generalized foundation soil profile for the stability analyses of WRSF1. It was assumed that the original ground (before waste placement) consists of 1.5 m sand and silt, 1.0 m ice-rich silt, 2.0 m to 10.0 m silty sand over bedrock. The thin organic layer (0.0 to 0.6 m thick) over the original ground was not specifically modelled in the stability analyses. It is expected that the organic layer will be compressed under loads from waste rock and overburden, and its shear strength parameters would be close to the underlying overburden soils (sand and silt or ice-rich silt). Therefore, any local presence of the compressed organic layer can be represented by the equivalent underlying overburden soils in the stability analyses.

Soil strength tests on samples from the Project site are limited. A laboratory consolidated-undrained triaxial test on a silty sand overburden sample was conducted in EBA (2013). The sample was taken from a borehole drilled in an area more than 300 m west of WRSF1. The test indicated the soil had an inferred peak internal angle of friction of 36°. This value is on the high side for a silty sand. In this study, the effective angle of internal friction for the silty sand in the foundation was assumed to be 34°. However, since there are weaker layers above the silty sand layer in the foundation, the strength parameter for the silty sand does not govern the stability analysis results.

Of importance to the slope stability assessment is the strength of the ice-rich silt in the foundation. The long-term cohesion of the ice-rich silt depends on its temperatures – the colder the soil, the higher its long-term cohesion. The long-term cohesion of the frozen ice-rich silt was adopted based Weaver and Morgenstern (1981) and then adjusted for the frozen fraction (change with soil temperature) of the soil porewater for an assumed porewater salinity of 7 ppt. Thermal analyses for WRSF1 in Tetra Tech (2019) indicate that the predicted temperatures of the ice-rich silt vary with location and time. The representative temperatures in various zones along the ice-rich silt layer during construction and long term after construction were adopted based on the thermal analysis results. These temperatures were then used to estimate the long-term cohesion of the ice-rich silt for the stability analyses.

Table 4 summarizes the material properties used for the WRSF1 stability analyses.

Table 4: Material Properties Used in WRSF1 Stability Analyses

<table>
<tr><th colspan="2">Material</th><th>Thickness (m)</th><th>Effective Angle of Internal Friction, Ø (º)</th><th>Cohesion, c (kPa)</th><th>Unit Weight, ϒ (kN/m³)</th></tr>
<tr><td colspan="2">Waste Rock</td><td>Up to 15</td><td>42</td><td>0</td><td>19</td></tr>
<tr><td colspan="2">Overburden Waste</td><td>Up to 25</td><td>28</td><td>0</td><td>17</td></tr>
<tr><td colspan="2">Sand and Silt</td><td>1.5</td><td>31</td><td>0</td><td>20</td></tr>
<tr><td colspan="2">Unfrozen Silt (predicted temperatures of warmer than -0.7°C)</td><td rowspan="6">1</td><td>28</td><td>0</td><td>17</td></tr>
<tr><td rowspan="4">Ice-rich Silt</td><td>Ice-rich Silt C40 (for zones with predicted temperatures of -0.7°C to -1.0°C)</td><td>0</td><td>40</td><td>16</td></tr>
<tr><td>Ice-rich Silt C60 (for zones with predicted temperatures of -1.0°C to -1.5°C)</td><td>0</td><td>60</td><td>16</td></tr>
<tr><td>Ice-rich Silt C100 (for zones with predicted temperatures of -1.5°C to -2.0°C)</td><td>0</td><td>100</td><td>16</td></tr>
<tr><td>Ice-rich Silt C130 (for zones with predicted temperatures of -2.0°C to -2.5°C)</td><td>0</td><td>130</td><td>16</td></tr>
<tr><td colspan="2">Thawing Ice-rich Silt</td><td>28</td><td>0</td><td>16</td></tr>
<tr><td colspan="2">Ice-Poor Silty Sand</td><td>2 to 10</td><td>34</td><td>0</td><td>21</td></tr>
</table>

5.2 Other Input Parameters

An assumed piezometric line, together with a pore pressure coefficient, $\bar{B}$ was used in each of the analyses to simulate pore water conditions. $\bar{B}$ is defined as a ratio of the excess pore-pressure generated in a given soil to the change in vertical stress in the soil due to fill placement above the original ground surface. The following values of $\bar{B}$ were applied in the stability analyses:

- 0.2 in the unfrozen overburden soils in modeling the excess pore-pressure that can be potentially generated in those soils during waste placement;
- 0.0 for the long-term static and seismic loading conditions;
- 0.2 in the sand and silt foundation soil when it is initially thawed after the waste rock or overburden waste is placed over the soil when it is frozen; and
- 0.2 in the thawing ice-rich silt to model the excess pore-pressure that can be potentially generated in the thawing soil for a sensitivity case assuming thawing the ice-rich silt.

The Project site is situated in an area of low seismic risk. The peak ground acceleration (PGA) under a potential earthquake for the Project area was estimated from the 2015 National Building Code of Canada seismic hazard website (http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/calc-en.php). The estimated PGA is 0.022 g for a 5% in 50-year probability of exceedance (0.001 per annum or 1 in 1,000 year return) and 0.037 g for a 2% in 50-year probability of exceedance (0.000404 per annum or 1 in 2,475 year return) for the area. In this study, the horizontal PGA of 0.037 g was used for the analyses under seismic (pseudo-static) loading conditions.

Liquefaction (under both static and cyclic loading) potential of the overburden waste and foundation overburden soils for WRSF1 is very low due to the following factors:

- The foundation overburden soils are predicted to be in frozen conditions, except for a small zone of seasonal unfrozen soils in the active layer close to the lowermost toe of WRSF1;
- The overburden waste is expected to be in unsaturated conditions during waste placement and is predicted to be in frozen conditions in the long term (after freeze back if initially placed in unfrozen conditions); and
- The Project site is in an area of low seismic risk.

As a result, soil properties for liquefied overburden soils were not used in the stability analyses for WRSF1.

5.3 Cases Evaluated

Various preliminary stability analyses were undertaken to develop the typical design section for WRSF1. The typical design section and final design geometry of WRSF1 will be presented in the design drawings to be attached to the WRSF1 design report.

Two design sections (Sections A and B) were evaluated in the final stability analyses. Figure 2 shows the locations of the two sections in the WRSF1 plan. Figure 3 presents the sections for Sections A and B. These sections were selected based on the following:

- Section A was selected to represent the typical section without the access ramp for WRSF1;
- The original ground around the toe area of WRSF1 in Section A has a steeper downward surface slope, which is less favorable and more critical for slope stability;
- Section B was selected to represent the typical section with the access ramp; and
- There is an existing fill over the closed exploration landfill in the toe area of WRSF1 in Section B, which is more critical for slope stability.

Various conditions were evaluated for WRSF1:

- Slope stability under static loading during short-term stage-construction;
- Slope stability under static loading under long-term post-construction conditions;
- Slope stability under seismic (pseudo-static) loading during long-term after construction; and
- Other parametric sensitivity analysis cases.

6.0 FINAL STABILITY ANALYSIS RESULTS FOR DESIGN OF WRSF1

The factors of safety calculated in the stability analyses for WRSF1 are summarized below in Table 5 together with the required minimum factors of safety. Figures 4 to 16 show selected slope stability analysis cases and results.

Table 5: Summary of Slope Stability Analysis Results for WRSF1

Section	Conditions		Required Minimum Factor of Safety	Calculated Minimum Factor of Safety	Figure No.	Comments
A	Placement of waste rock and overburden during construction, static loading	Bench 77.0 m of waste rock and overburden	1.30	1.40	4	Considering potential excess pore water pressure generated in sand and silt close to the toe of the pile after it thaws in the following summer; local deep-seated slip close to the toe
		Bench 87 m of overburden waste	1.30	1.32	5	Local slip close to the side slope of overburden waste
		Bench 97 m of overburden waste	1.30	1.60	6	Local slip close to the side slope of overburden waste
		Bench 112 m of waste rock	1.40	1.85	7	Global deep-seated slip
	Long term after construction, static loading	Local stability	1.30	1.39	8	Local deep-seated slip close to the toe
		Global stability	1.50	1.60	9	Global deep-seated slip
	Long term after construction, seismic loading	Local stability	1.05	1.26	10	Local deep-seated slip close to the toe
		Global stability	1.15	1.39	11	Global deep-seated slip
	Long term after construction, static loading, sensitivity cases	Water table sensitivity case	1.40	1.49	12	Global deep-seated slip; sensitivity case with assuming water table on the top of the overburden waste in WRSF1
		Thawing ice-rich silt sensitivity case	1.40	1.77	13	Global deep-seated slip; sensitivity case with assuming thawing ice-rich silt beneath the entire foundation of WRSF1
	Shallow surficial slip along waste rock side slopes	Static loading	1.10	1.18		Shallow surficial slip along waste rock side slopes
		Seismic loading	1.00	1.09		Shallow surficial slip along waste rock side slopes

Table 5: Summary of Slope Stability Analysis Results for WRSF1

Section	Conditions		Required Minimum Factor of Safety	Calculated Minimum Factor of Safety	Figure No.	Comments
B	Long term after construction, static loading	Local stability	1.30	1.40	14	Local deep-seated slip close to the toe
		Global stability	1.50	1.74	15	Global deep-seated slip
	Long term after construction, seismic loading	Local stability	1.05	1.27		Local deep-seated slip close to the toe
		Global stability	1.15	1.51		Global deep-seated slip
	Ramp stability, static loading	Ramp under haul truck loads during construction	1.30	1.56	16	Local deep-seated slip; ramp under haul truck point loads during construction

The results in Table 5 suggests that the calculated factor of safety for each stability analysis is equal to or greater than the adopted stability criteria as outlined in Section 4.2.

7.0 EFFECTS OF WASTE PLACEMENT SCHEDULE ON STABILITY

Sensitivity thermal analyses of WRSF1 indicate that the placement schedule and initial temperature of the waste rock and overburden, especially the initial benches (77 m and 82 m) of the overburden waste placed over the original ground, will have an influence on the predicted ground temperature in the ice-rich layer underlying WRSF1. For example, if these initial benches are placed in unfrozen conditions in warmer seasons, the temperature in the ice-rich foundation layer could be warm (warmer than -1.0°C) for an extended period after the waste placement, which will result in low shear strength in the ice-rich soil layer with an assumed porewater salinity of 7 ppt.

A sensitivity stability analysis was conducted to illustrate the WRSF1 stability sensitivity to the ice-rich silt long-term cohesion, which is estimated based on the temperature of the ice-rich silt. In the stability analysis, the long-term cohesion of 40 kPa for the ice-rich silt was used. This value was estimated for the assumed temperature of -0.7°C to -1.0°C in the ice-rich silt. For this sensitivity case, the calculated factor of safety is 0.71 (see Figure 17), which does not meet the design requirement of 1.5.

This sensitivity stability analysis suggests that the WRSF1 stability is sensitive to the long-term cohesion of the ice-rich silt, which depends on the placement schedule and initial temperature of the waste rock and overburden, especially the initial benches (77 m and 82 m) of the overburden waste placed over the original ground.

8.0 DEFORMATIONS OF WRSF1 AND ITS FOUNDATION

It is expected that some of the waste materials (especially the overburden waste), which are to be placed in frozen conditions and within the active layer (annual freeze-thaw) zones, will settle when they are initially thawed during the thawing seasons after placement. Most of the thaw settlement will occur during the construction period or several years after the waste placement. The settlement is acceptable and not expected to be detrimental to the overall stability of WRSF1.

Ice-rich soils tend to creep under shear loading. The ice-rich silt layer in the foundation of WRSF1 may creep under loading of the waste rock and overburden. The magnitude of the creep-induced deformations will mainly depend on the stress state, temperature, and porewater salinity of the ice-rich layer.

A soil deformation analysis to consider the long-term creep of the ice-rich silt layer in the foundation was conducted to evaluate the potential long-term deformation behaviours of the TSF in Tetra Tech EBA (2014b). The tailings storage facility (TSF) that is just northwest of WRSF1 has similar foundation conditions. The analysis was carried out using FLAC 7.0, a commercial two-dimensional explicit finite-difference program for engineering applications. The modelled section of the TSF in the analysis had a maximum height of 33 m and side slopes of 3H:1V to 4H:1V. The analysis results were documented in Tetra Tech EBA (2014b).

The potential horizontal and vertical deformations of WRSF1 due to the creep of the ice-rich silt layer in the foundation were assessed based on the analysis results for the TSF and then adjusted for the maximum height of WRSF1 and the predicted temperatures in the ice-rich silt layer for WRSF1 in Tetra Tech (2019). The estimated maximum horizontal deformation in WRSF1 is 20 mm to 60 mm per year. The estimated maximum vertical deformation is 10 mm to 20 mm per year. It is expected that the ice-rich silt layer will deform in a primary or secondary creep state and undergo ductile deformation. WRSF1 can tolerate the deformations. The estimated deformations assumed a continuous layer of the ice-rich silt layer in the foundation of WRSF1. This is likely conservative; therefore, the actual deformations of WRSF1 could be smaller.

9.0 SUMMARY AND DISCUSSIONS

A series of slope stability analyses were carried out to assist in developing the typical design section and final design of WRSF1. The results of the analyses for the final design sections indicate that the calculated minimum factors of safety for WRSF1 meet or exceed the adopted minimum factors of safety for design under various conditions.

The WRSF1 stability is sensitive to the long-term cohesion of the ice-rich silt in the foundation. The latter depends on the soil temperature, which in turn is affected by the placement schedule and initial temperature for the waste rock and overburden, especially the initial benches (77 m and 82 m) of the overburden waste placed over the original ground (Tetra Tech 2019).

The current design sections and geometry of WRSF1 are based on the waste rock and overburden production plan that was provided on September 23, 2019 and the corresponding preliminary waste rock and overburden placement plan that was developed for the design of WRSF1. It is recommended that the current design of WRSF1 and the associated thermal and stability analyses be reviewed or updated (if required) if the final waste rock and overburden placement plan for WRSF1, especially the placement plan for the initial benches (77 m and 82 m) of the overburden waste, is different from that simulated in the thermal analysis in Tetra Tech (2019).

It is recommended that the maximum lift thickness during waste placement be limited to 2.5 m for the overburden waste and to 5.0 m for the waste rock.

It is recommended that regular visual inspection of WRSF1 be taken during and after the construction of WRSF1 to identify any signs of excess deformations, instability, or distress. If any of those signs are identified, the information should be provided to Tetra Tech to evaluate the root cause and develop a mitigation plan if required.

10.0 CLOSURE

Use of this memo is subject to Tetra Tech's Limitations on Use of this Document which are attached in Appendix B. We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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/jf

PERMIT TO PRACTICE
TETRA TECH CANADA INC.

Signature ________

Date November 25, 2019

PERMIT NUMBER: P 018

NT/NU Association of Professional Engineers and Geoscientists

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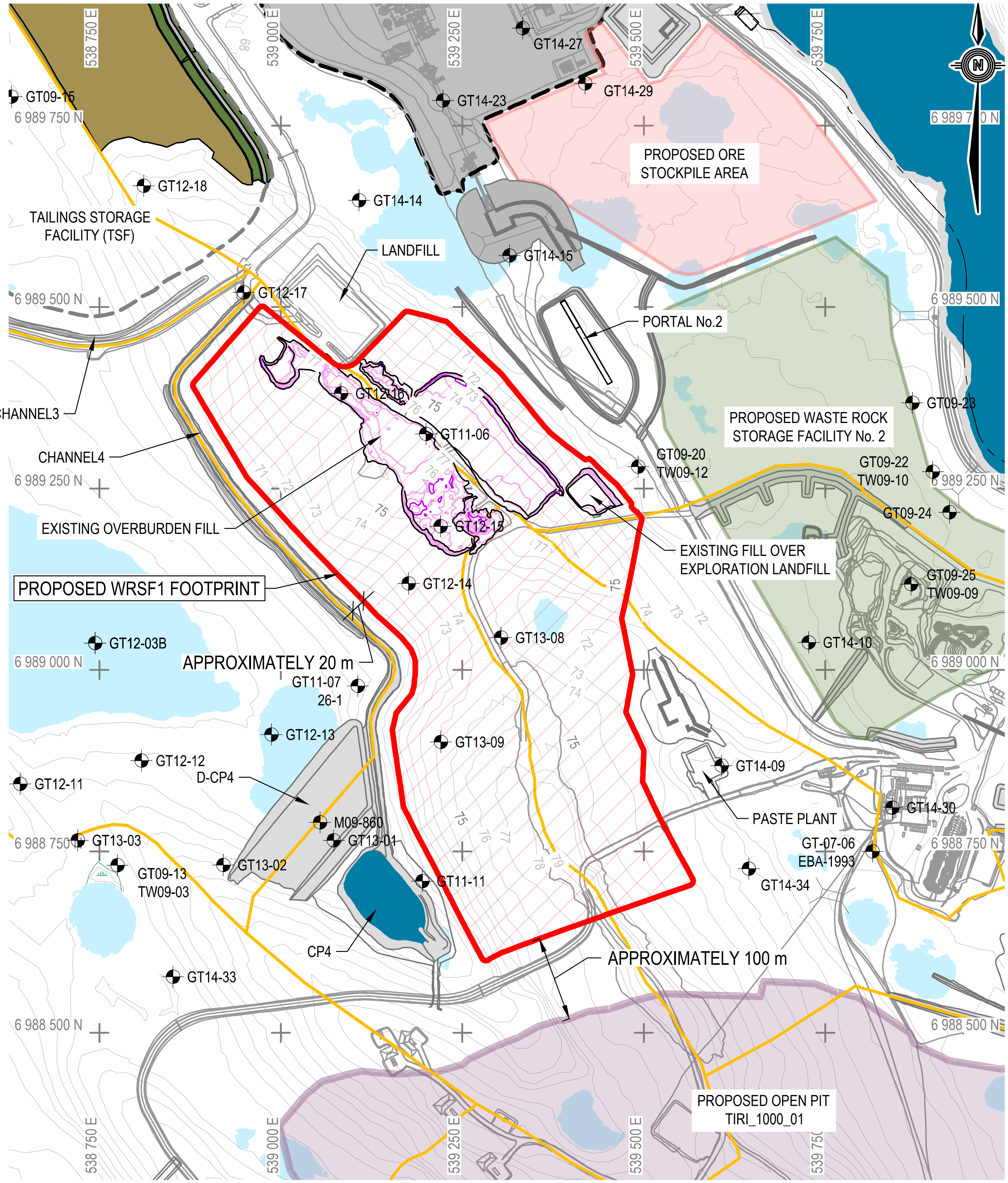
APPENDIX A

FIGURES



Q:\Edmonton\Engineering\E141\Projects_MELIADINE\ENG.EARC03140-02 (WRSF1)\Figure 1-For Stability Analysis.dwg [FIGURE 1] October 23, 2019 - 2:15:33 pm (BY: LEE, ELVIN)

LEGEND:

BOREHOLE

0 250m

Scale: 1:7,500 @ 8.5"x11"

CLIENT

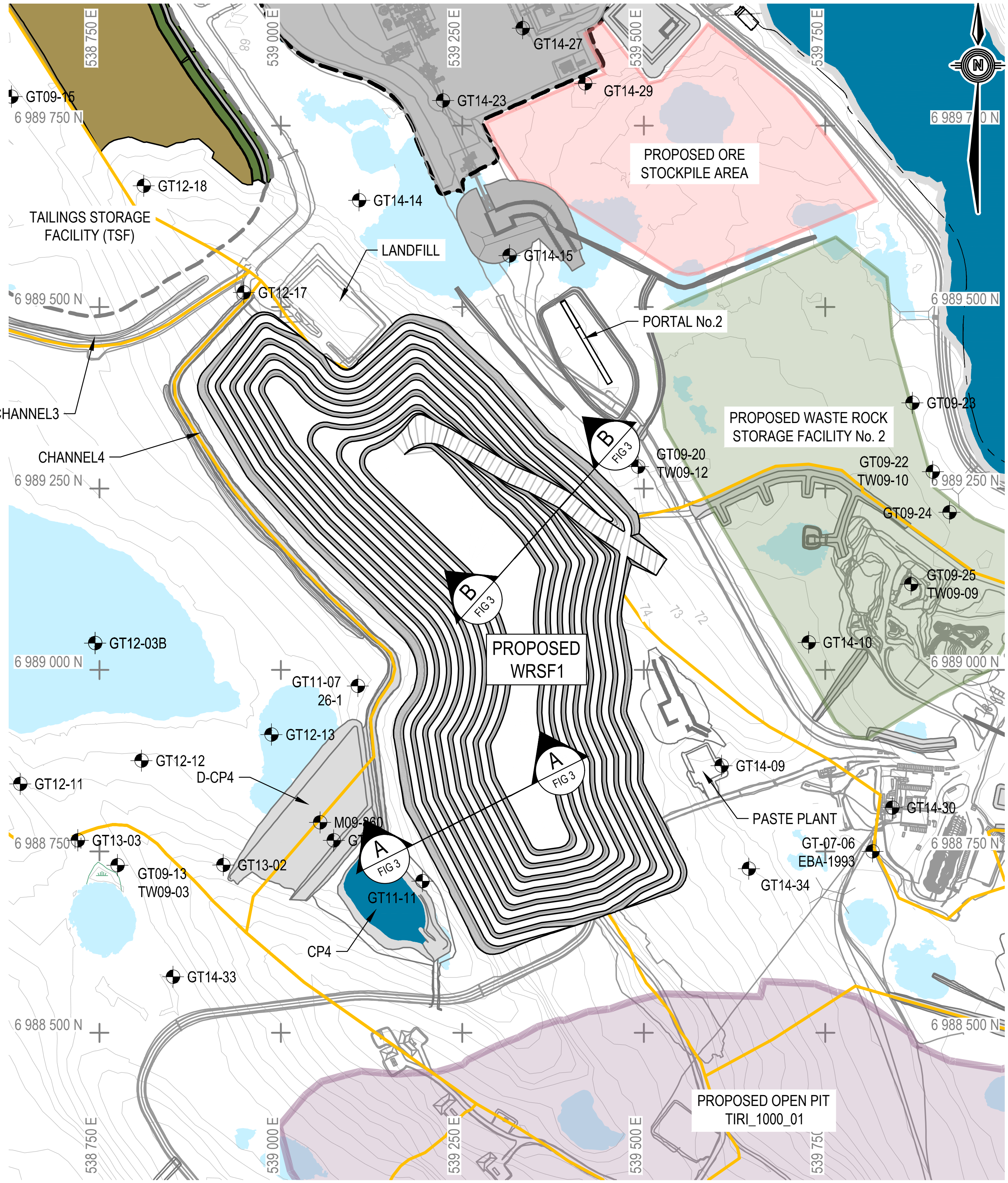
AGNICO EAGLE

TETRA TECH

STABILITY ANALYSIS OF WRSF1
MELIADINE GOLD PROJECT, NU

PROPOSED WRSF1 FOOTPRINT
WITH BOREHOLE LOCATIONS

PROJECT NO.	DWN	CKD	REV	
ENG.EARC03140-02	EL	GZ	A	**FIGURE 1**
OFFICE	DATE			
EDMONTON	OCTOBER 23, 2019			



LEGEND:

BOREHOLE

0 250m

Scale: 1:7,500 @ 8.5"x11"

CLIENT

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TETRA TECH

STABILITY ANALYSIS OF WRSF1
MELIADINE GOLD PROJECT, NU

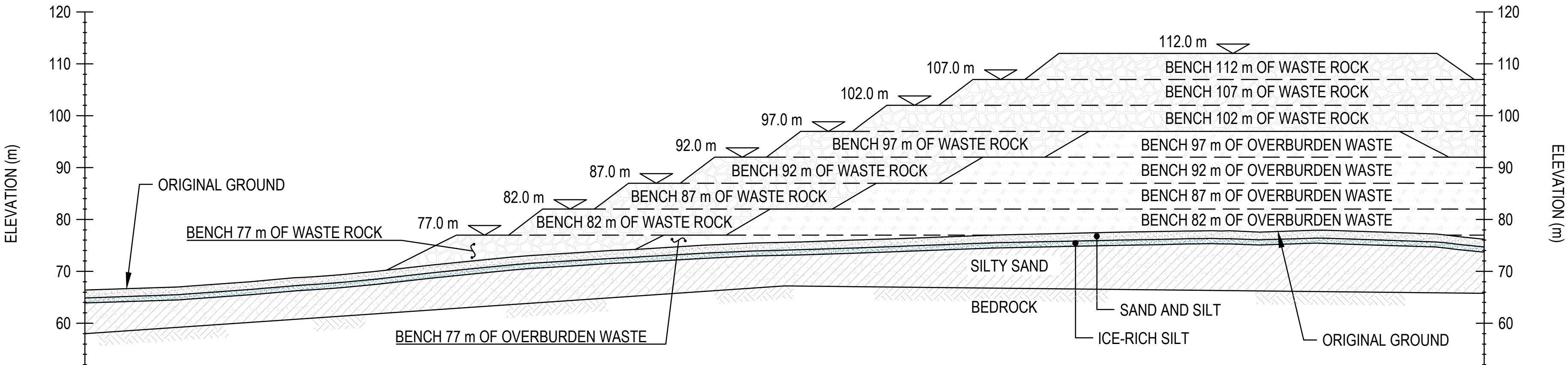
LOCATION OF SECTIONS A AND B FOR STABILITY ANALYSIS

PROJECT NO.	DWN	CKD	REV
ENG.EARC03140-02	EL	GZ	A
OFFICE	DATE		
EDMONTON	OCTOBER 23, 2019		

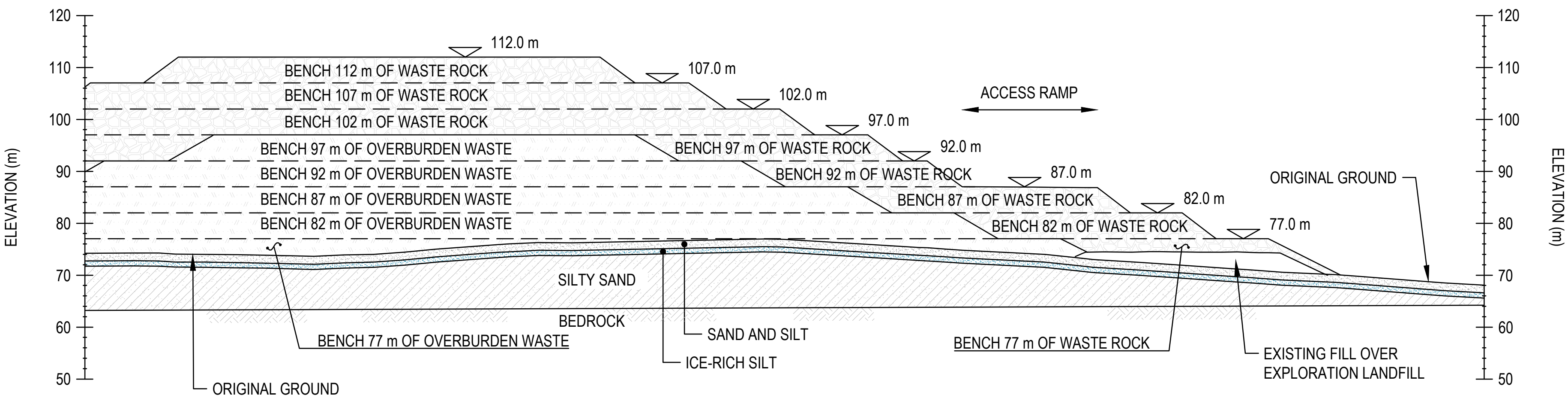
FIGURE 2

Q:\Edmonton\Engineering\E141\Projects_MELIADINE\ENG.EARC03140-02 (WRSF1)\Figure 2-For Stability Analysis.dwg [FIGURE 2] October 23, 2019 - 2:25:08 pm (BY: LEE, ELVIN)

Q:\Edmonton\Engineering\E141\Projects_MELIADINE\ENG.EARC03140-02 (WRSF1)\Figure 3-For Stability Analysis.dwg [FIGURE 3] October 23, 2019 - 3:57:23 pm (BY: LEE, ELVIN)



A SECTION
FIG 2
SCALE: 1:1250



B SECTION
FIG 2
SCALE: 1:1250

0 50m

Scale: 1:1,250 @ 8.5"x11"

CLIENT

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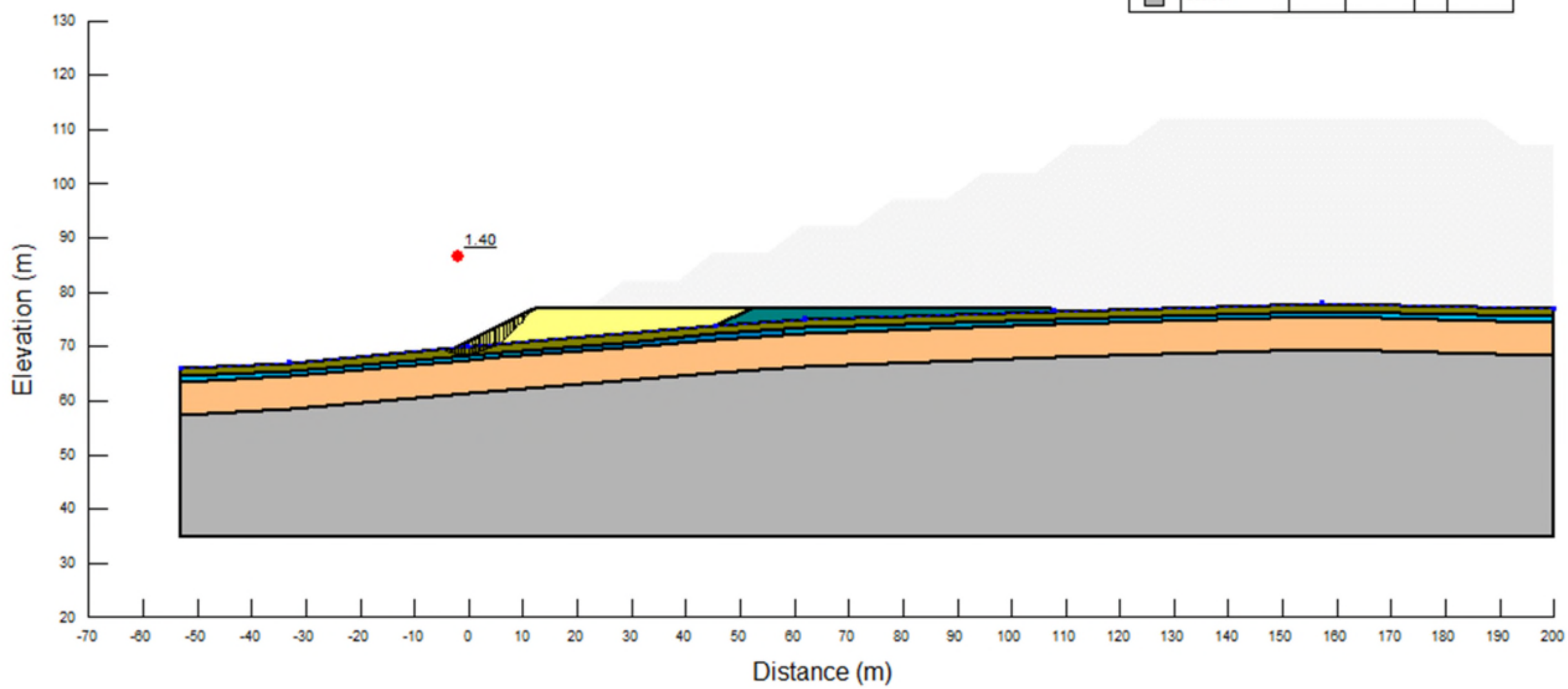
STABILITY ANALYSIS OF WRSF1
MELIADINE GOLD PROJECT, NU

TYPICAL SECTIONS FOR
STABILITY ANALYSIS OF WRSF1

PROJECT NO.	DWN	CKD	REV
ENG.EARC03140-02	EL	GZ	A
OFFICE	DATE		
EDMONTON	OCTOBER 23, 2019		

FIGURE 3

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Cohesion (kPa)
	Waste Rock	19	0	42	
	Overburden Waste	17	0	28	
	Sand and Silt	20	0	31	
	Ice-Rich Silt C60	16			60
	Ice-Rich Silt C100	16			100
	Ice-Rich Silt C130	16			130
	Silty Sand				
	Bedrock				



LEGEND

NOTES

Note: During Construction, Static Loading

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

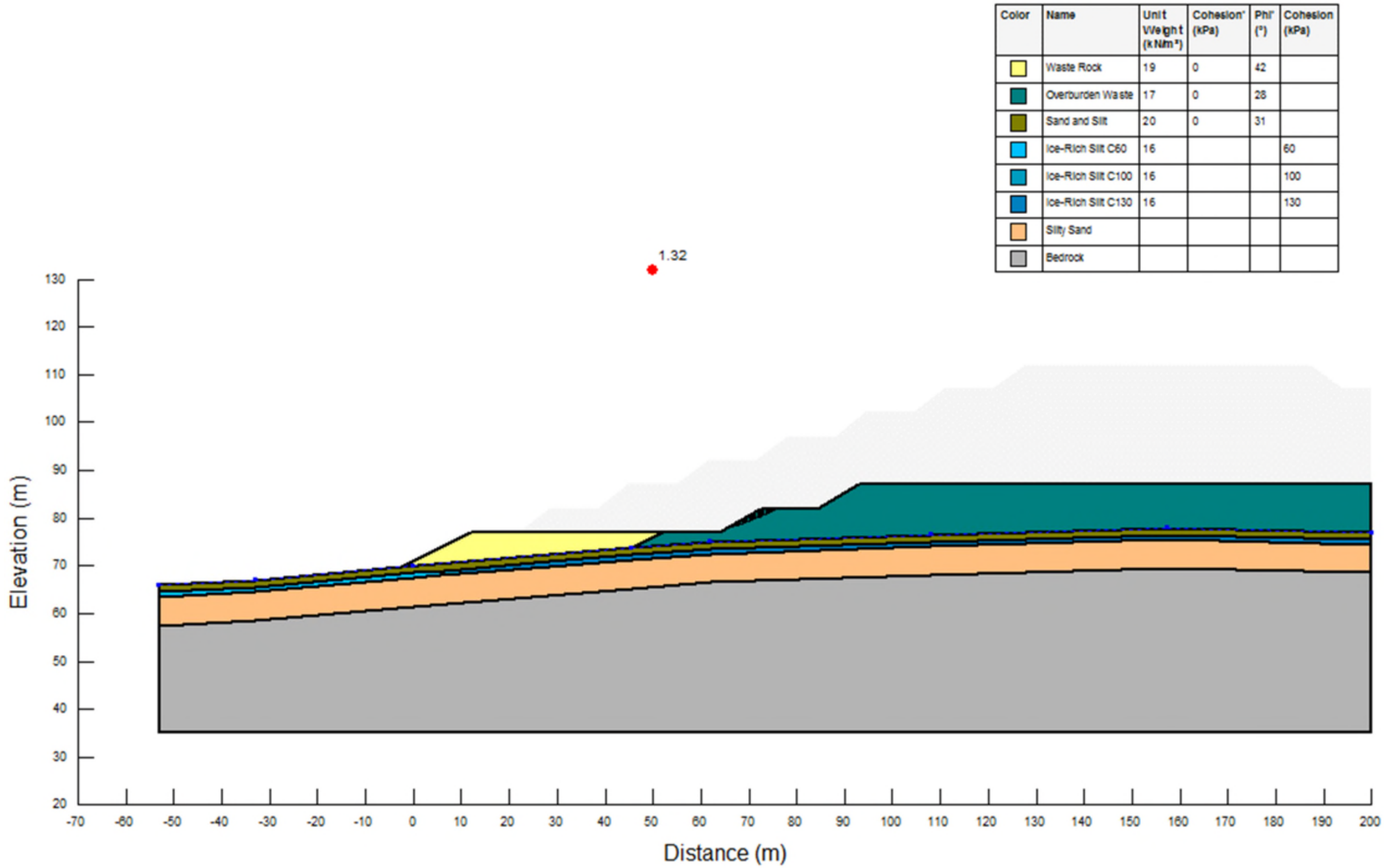
Stability Analysis of WRSF1
Meliadine Gold Project, NU

Section A
Bench 77.0 m of Waste Rock and Overburden - during Construction

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 4



LEGEND

NOTES

Note: During Construction, Static Loading

STATUS
ISSUED FOR USE

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Stability Analysis of WRSF1
Meliadine Gold Project, NU

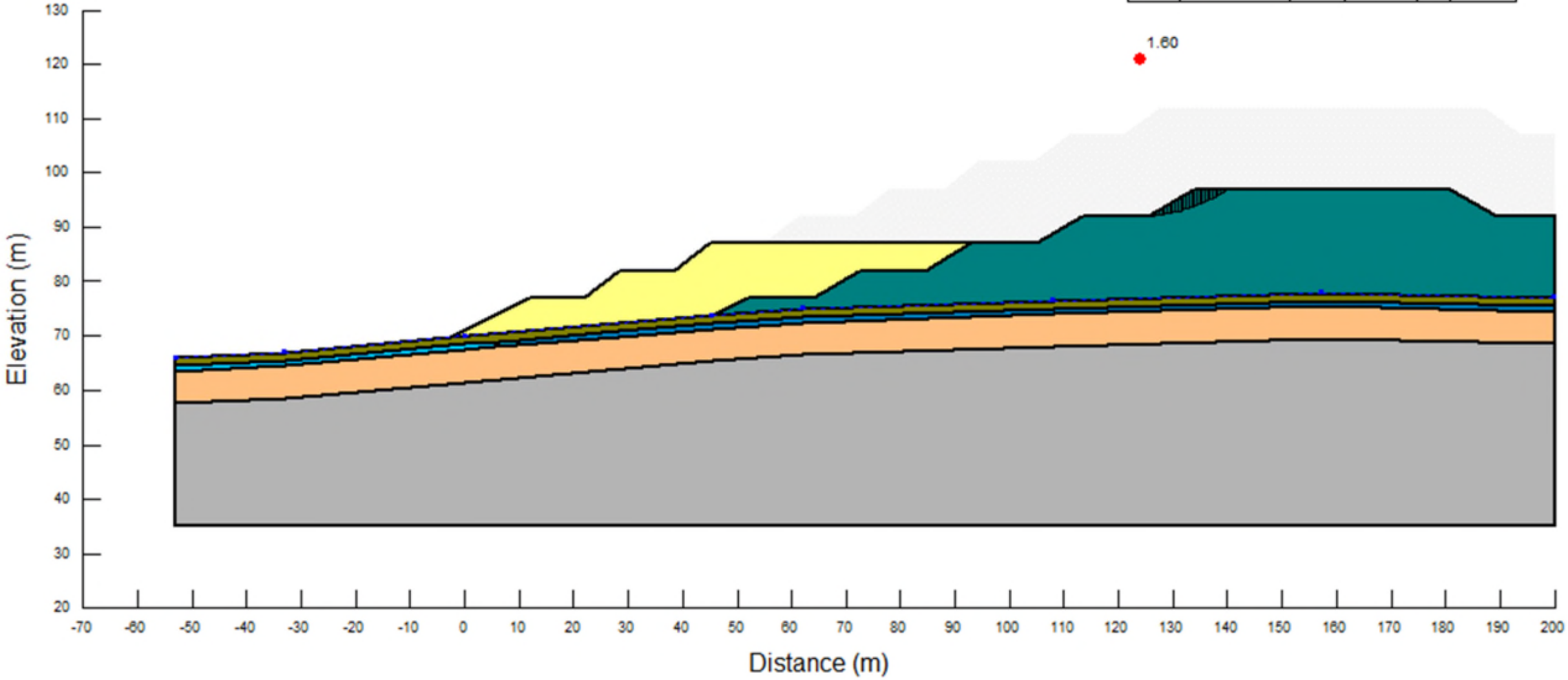
Section A
Bench 87 m of Overburden Waste - during Construction

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Cohesion (kPa)
	Waste Rock	19	0	42	
	Overburden Waste	17	0	28	
	Sand and Silt	20	0	31	
	Ice-Rich Silt C60	16			60
	Ice-Rich Silt C100	16			100
	Ice-Rich Silt C130	16			130
	Silty Sand				
	Bedrock				



LEGEND

NOTES

Note: During Construction, Static Loading

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

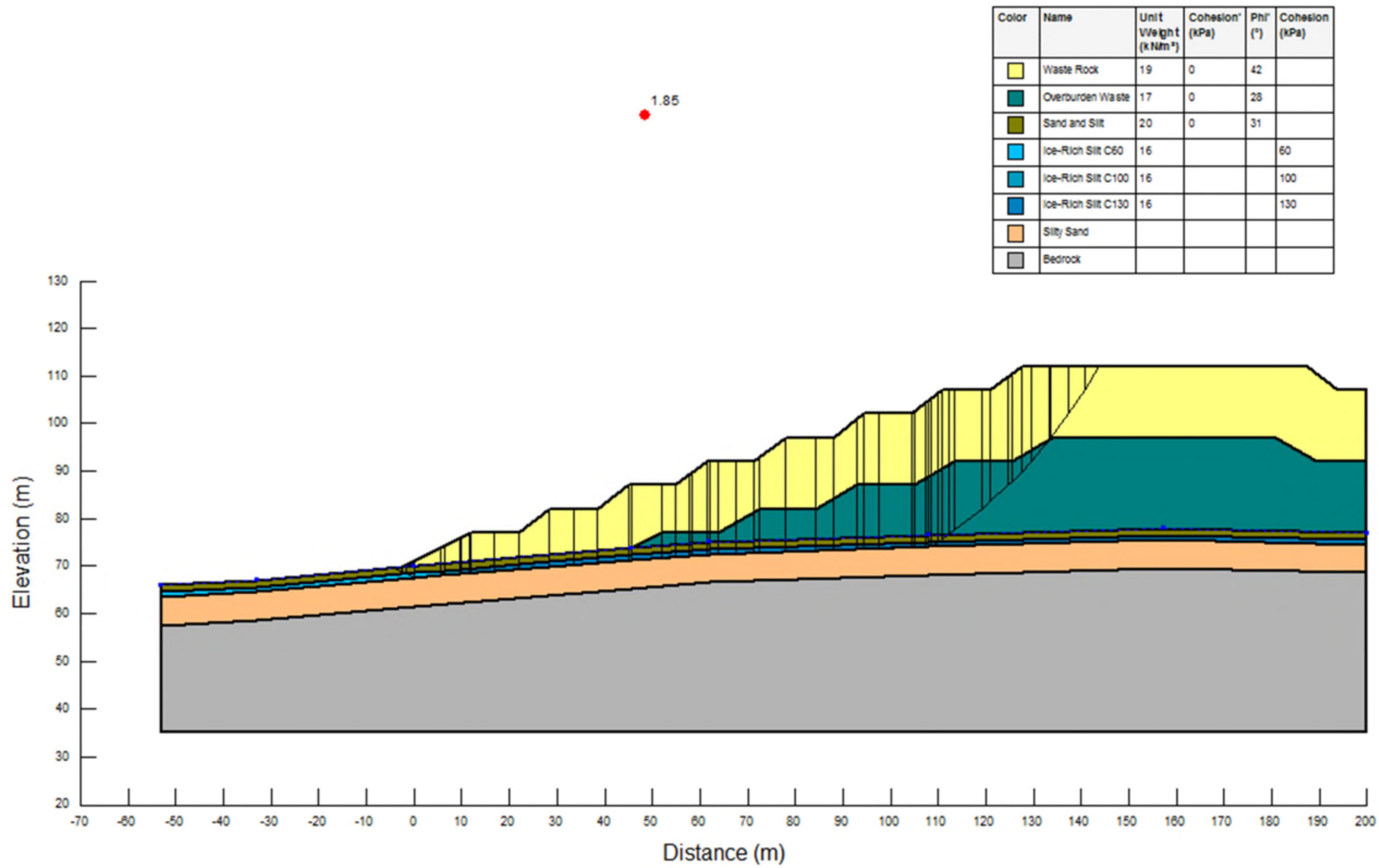
Stability Analysis of WRSF1
Meliadine Gold Project, NU

Section A
Bench 97 m of Overburden Waste - during Construction

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 6



LEGEND

NOTES

Note: During Construction, Static Loading

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

Stability Analysis of WRSF1 Meliadine Gold Project, NU

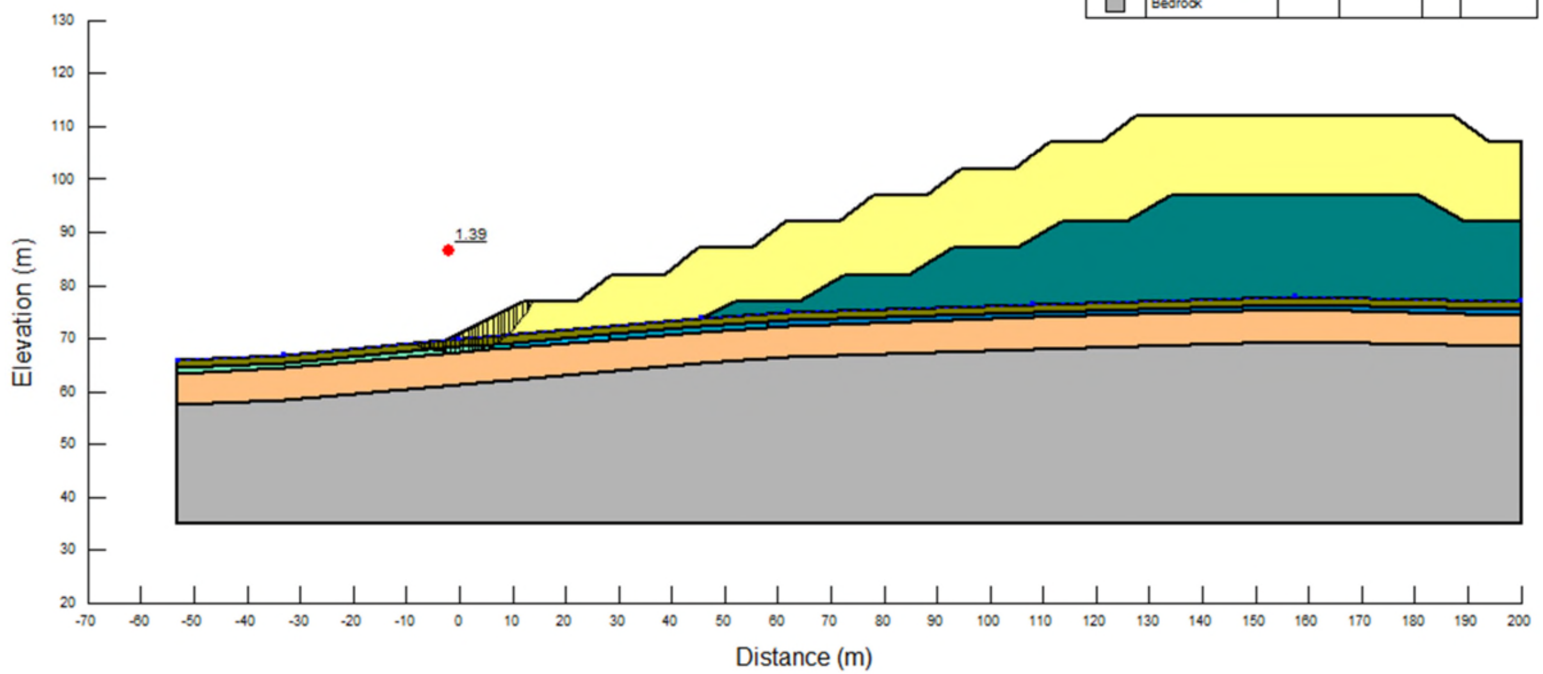
Section A
Bench 112 m of Waste Rock - during Construction, Global Deep-Seated Slip

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 7

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Cohesion (kPa)
	Waste Rock	19	0	42	
	Overburden Waste	17	0	28	
	Sand and Silt	20	0	31	
	Unfrozen Silt	17	0	28	
	Ice-Rich Silt C40	16			40
	Ice-Rich Silt C60	16			60
	Ice-Rich Silt C100	16			100
	Ice-Rich Silt C130	16			130
	Silty Sand				
	Bedrock				



LEGEND

Note: Static Loading

NOTES

CLIENT

AGNICO EAGLE

TETRA TECH

Stability Analysis of WRSF1
Meliadine Gold Project, NU

Section A
Long Term after Construction
Local Slip Close to Toe

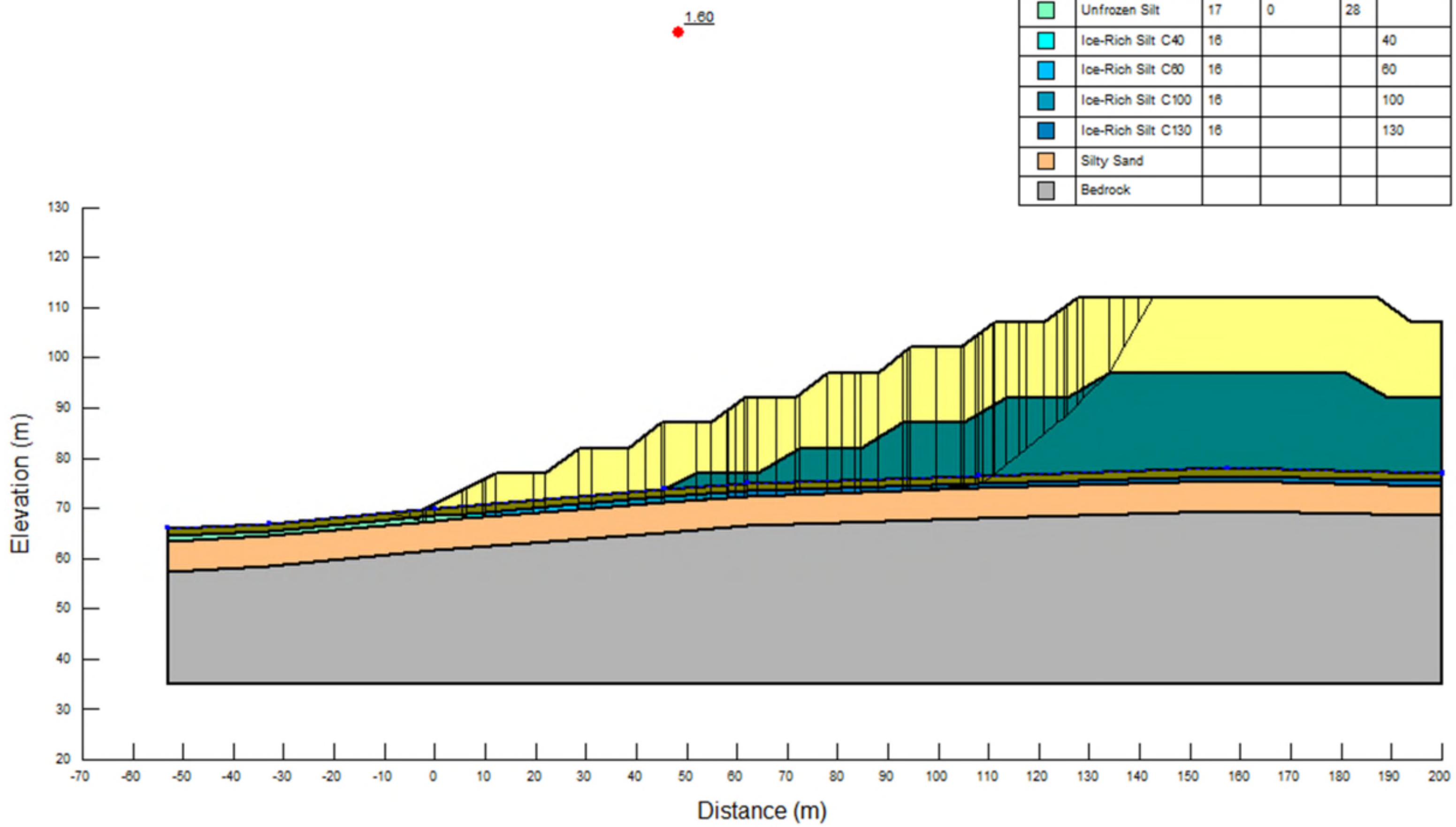
PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 8

STATUS
ISSUED FOR USE

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Cohesion (kPa)
	Waste Rock	19	0	42	
	Overburden Waste	17	0	28	
	Sand and Silt	20	0	31	
	Unfrozen Silt	17	0	28	
	Ice-Rich Silt C40	16			40
	Ice-Rich Silt C60	16			60
	Ice-Rich Silt C100	16			100
	Ice-Rich Silt C130	16			130
	Silty Sand				
	Bedrock				



LEGEND

NOTES

Note: Static Loading

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

Stability Analysis of WRSF1
Meliadine Gold Project, NU

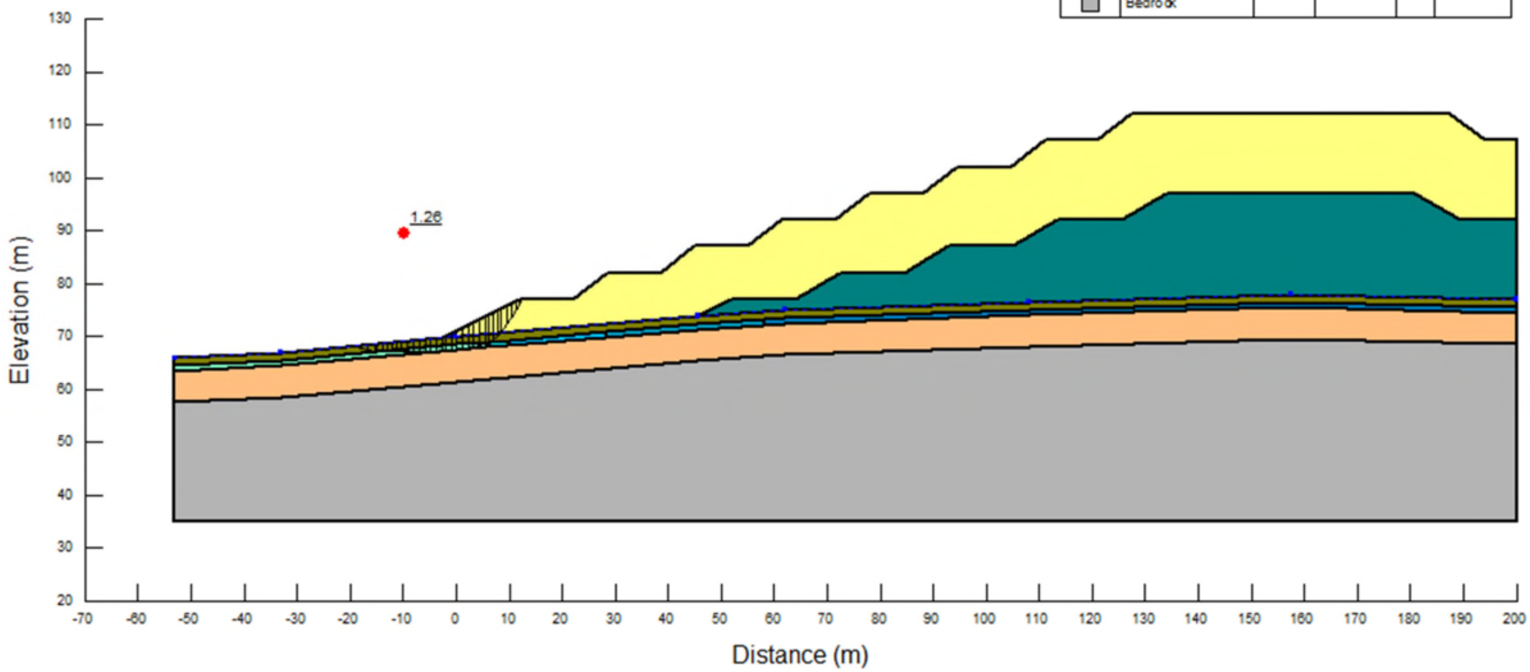
Section A
Long Term after Construction
Deep Seated Global Slip

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 9

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Cohesion (kPa)
	Waste Rock	19	0	42	
	Overburden Waste	17	0	28	
	Sand and Silt	20	0	31	
	Unfrozen Silt	17	0	28	
	Ice-Rich Silt C40	16			40
	Ice-Rich Silt C60	16			60
	Ice-Rich Silt C100	16			100
	Ice-Rich Silt C130	16			130
	Silty Sand				
	Bedrock				



LEGEND

NOTES

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

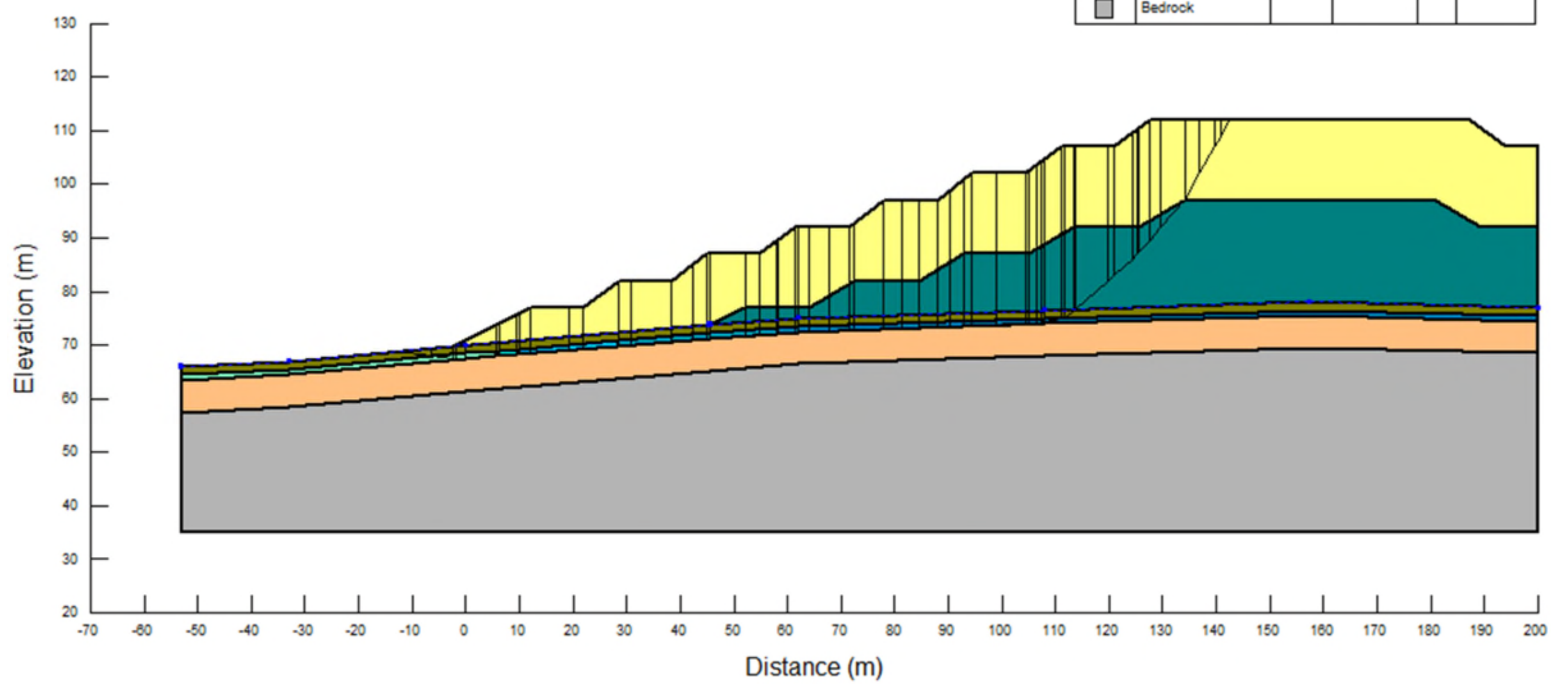
Stability Analysis of WRSF1
Meliadine Gold Project, NU

Section A
Long Term after Construction,
Local Slip Close to Toe, Seismic Loading

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 10



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Cohesion (kPa)
	Waste Rock	19	0	42	
	Overburden Waste	17	0	28	
	Sand and Silt	20	0	31	
	Unfrozen Silt	17	0	28	
	Ice-Rich Silt C40	16			40
	Ice-Rich Silt C60	16			60
	Ice-Rich Silt C100	16			100
	Ice-Rich Silt C130	16			130
	Silty Sand				
	Bedrock				

LEGEND

NOTES

CLIENT

AGNICO EAGLE

TETRA TECH

Stability Analysis of WRSF1
Meliadine Gold Project, NU

Section A
Long Term after Construction,
Deep Seated Global Slip, Seismic Loading

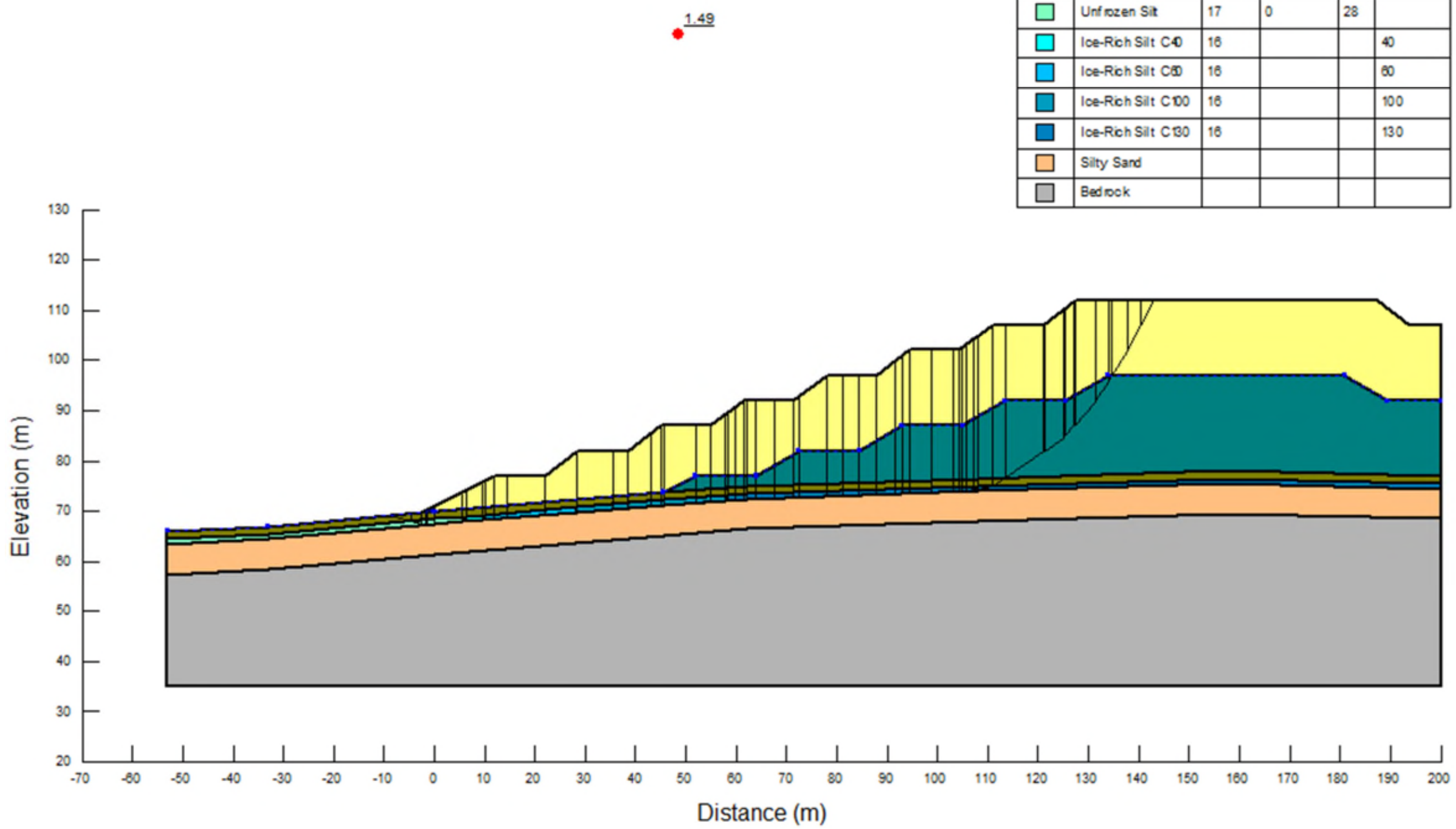
PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 11

STATUS
ISSUED FOR USE

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Cohesion (kPa)
	Waste Rock	19	0	42	
	Overburden Waste	17	0	28	
	Sand and Silt	20	0	31	
	Unfrozen Silt	17	0	28	
	Ice-Rich Silt C40	16			40
	Ice-Rich Silt C60	16			60
	Ice-Rich Silt C100	16			100
	Ice-Rich Silt C130	16			130
	Silty Sand				
	Bedrock				



LEGEND

NOTES

Note: Static Loading, Sensitivity Case with Assumed Water Table on Top of Overburden Waste

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

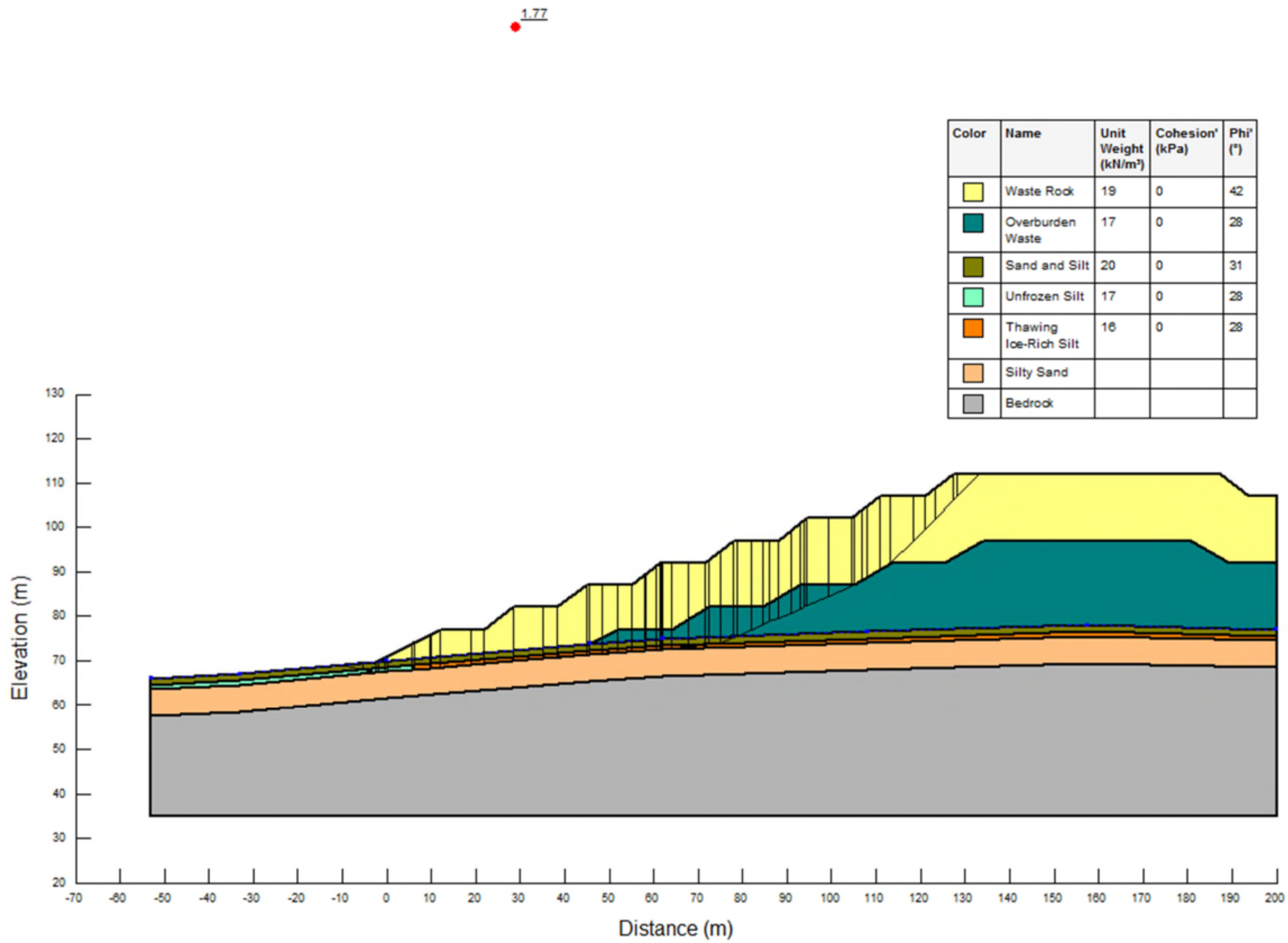
Stability Analysis of WRSF1
Meliadine Gold Project, NU

Section A
Long Term after Construction,
Deep Seated Global Slip, Water Table Sensitivity Case

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 12



LEGEND

NOTES

Note: Static Loading, Sensitivity Case with Assuming Thawing Ice-Rich Silt, Normal Water Table

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

Stability Analysis of WRSF1
Meliadine Gold Project, NU

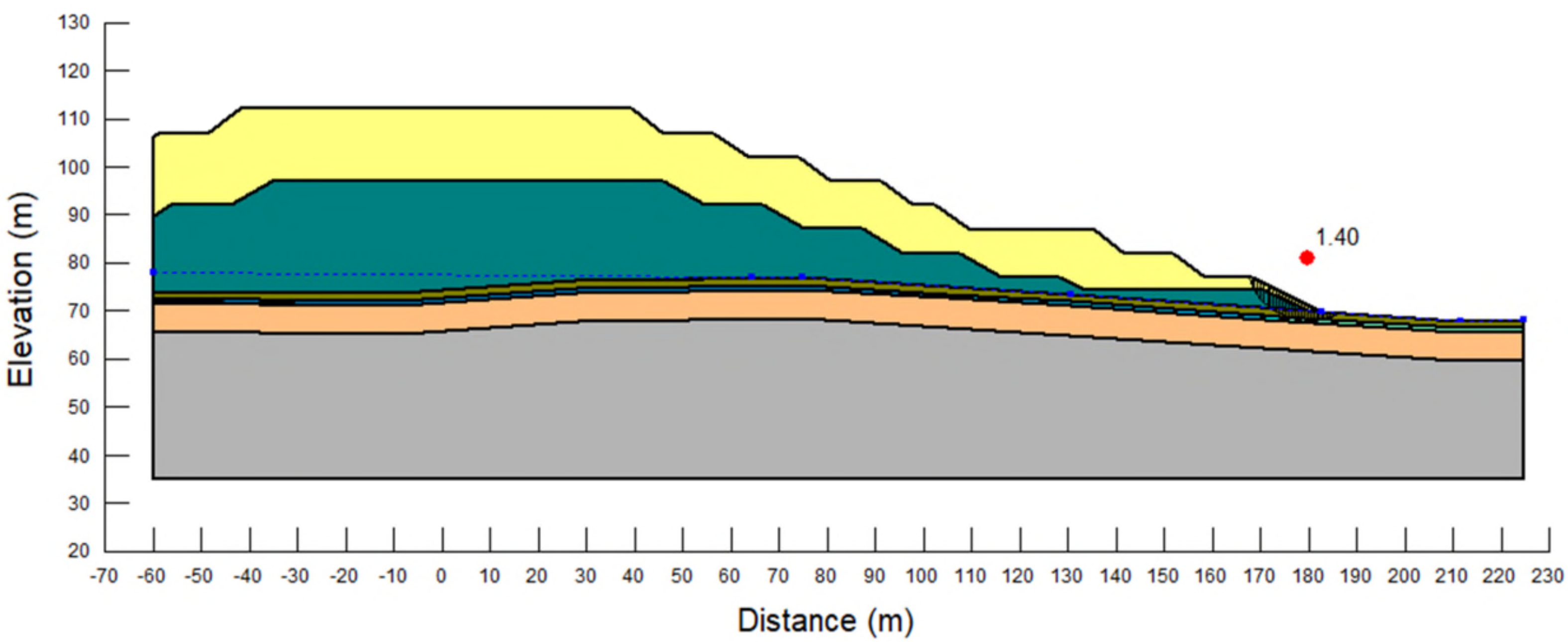
Section A
Long Term after Construction, Deep Seated Global Slip, Thawing Ice-Rich Silt Sensitivity Case

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 13

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Cohesion (kPa)
	Waste Rock	19	0	42	
	Overburden Waste	17	0	28	
	Sand and Silt	20	0	31	
	Unfrozen Silt	17	0	28	
	Ice-Rich Silt C40	16			40
	Ice-Rich Silt C60	16			60
	Ice-Rich Silt C100	16			100
	Ice-Rich Silt C130	16			130
	Silty Sand				
	Bedrock				



LEGEND

NOTES

Note: Static Loading

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

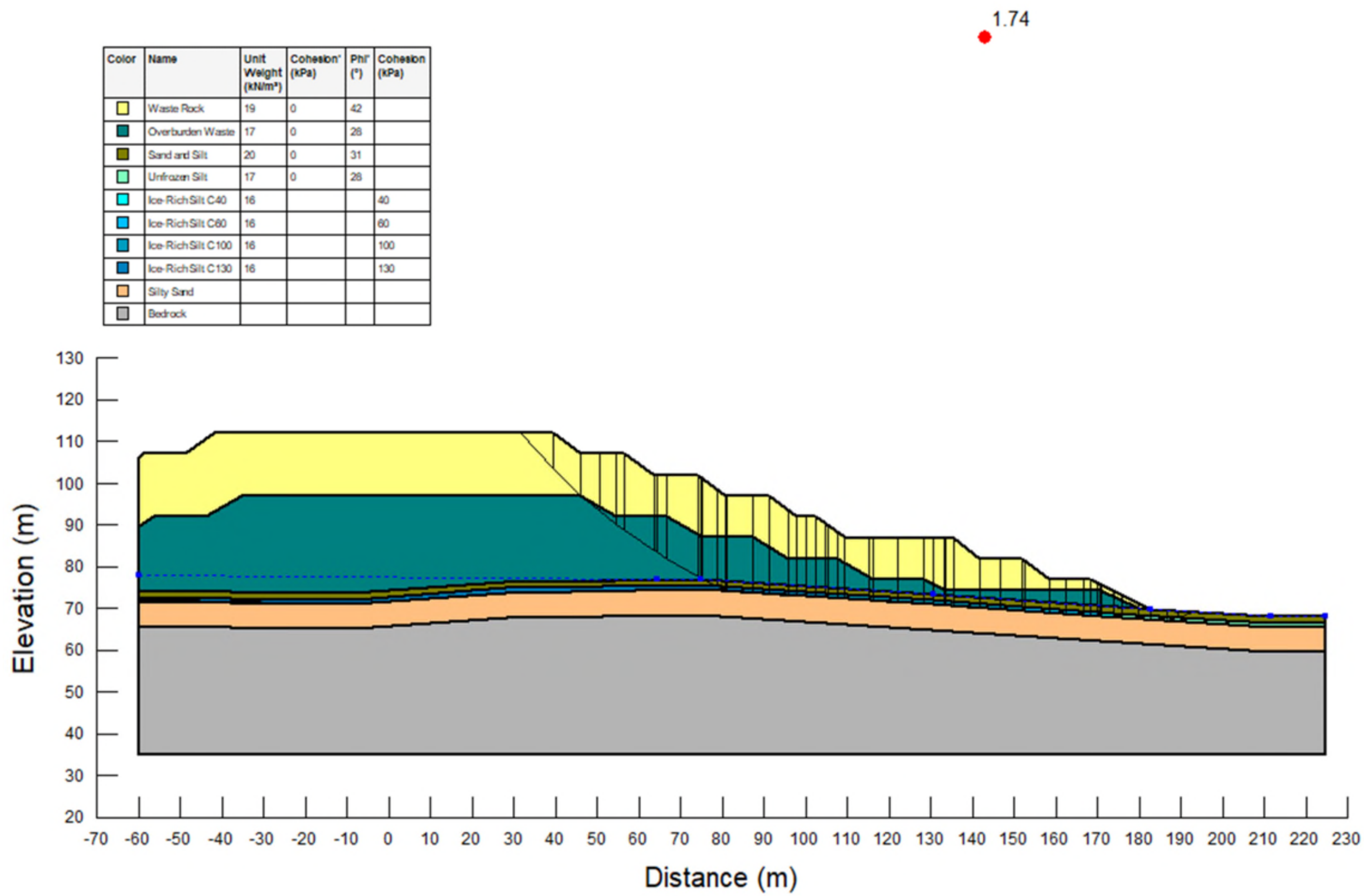
Stability Analysis of WRSF1
Meliadine Gold Project, NU

Section B
Long Term after Construction,
Local Slip Close to Toe

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 14



Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Cohesion (kPa)
	Waste Rock	19	0	42	
	Overburden Waste	17	0	28	
	Sand and Silt	20	0	31	
	Unfrozen Silt	17	0	28	
	Ice-Rich Silt C40	16			40
	Ice-Rich Silt C60	16			60
	Ice-Rich Silt C100	16			100
	Ice-Rich Silt C130	16			130
	Silty Sand				
	Bedrock				

LEGEND

NOTES

Note: Static Loading

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

Stability Analysis of WRSF1 Meliadine Gold Project, NU

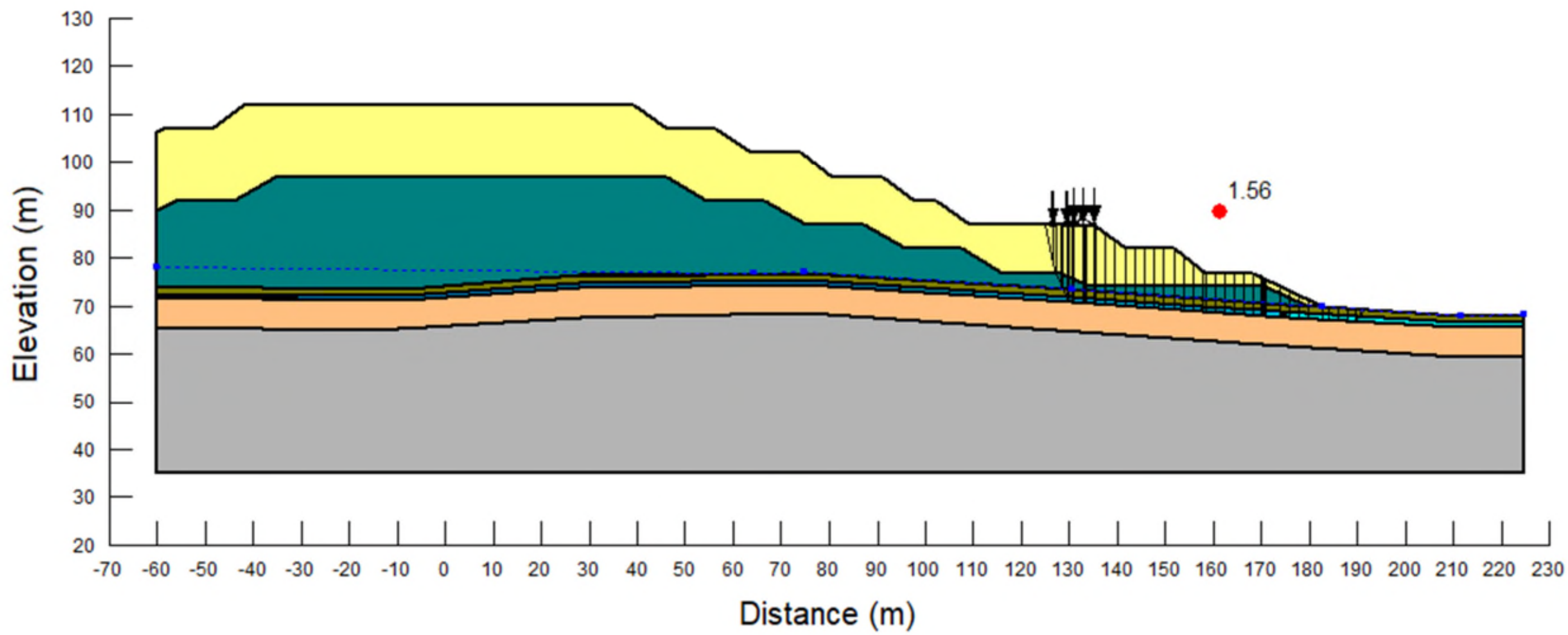
Section B
Long Term after Construction, Global Deep-Seated Slip

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 15

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Cohesion (kPa)
	Waste Rock	19	0	42	
	Overburden Waste	17	0	28	
	Sand and Silt	20	0	31	
	Ice-Rich Silt C40	16			40
	Ice-Rich Silt C60	16			60
	Ice-Rich Silt C100	16			100
	Ice-Rich Silt C130	16			130
	Silty Sand				
	Bedrock				



LEGEND

NOTES

Note: Safety Berm on Access Ramp with Haul Truck (CAT 775G) Tire Point Loads (362 kN), Static Loading

STATUS
ISSUED FOR USE

CLIENT

AGNICO EAGLE

TETRA TECH

Stability Analysis of WRSF1
Meliadine Gold Project, NU

Section B
Ramp under Haul Truck Point Loads during Construction, Local Deep-Seated Slip

PROJECT NO.	DWN	CKD	APVD	REV
ENG.EARC03140-02	GZ	WTH	WTH	A

OFFICE	DATE
EBA-EDM	October 2019

Figure 16

APPENDIX B

TETRA TECH'S LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.