

## **Appendix 47**

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# **Whale Tail 2019 Groundwater Monitoring Report**

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## TECHNICAL MEMORANDUM

**DATE** 21 April 2020

**Project No.** 20137375-477-TM-Rev0

**TO** Marie-Pier Marcil  
Agnico Eagle Mines Limited

**CC** Robin Allard

**FROM** Don Chorley / Jennifer Levenick

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### WHALE TAIL PIT PROJECT – 2019 GROUNDWATER MANAGEMENT MONITORING REPORT

Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) received a Project Certificate No.008 from the Nunavut Impact Review Board for the development of the Whale Tail Pit, a satellite deposit located on the Amaruq Exploration Property. To comply with the Terms and Conditions No.15 and 16 included in the Project Certificate a Groundwater Monitoring Plan (GWMP) was developed that included commitments made with respect to submissions provided during the technical review of the FEIS (Agnico Eagle 2019). This GWMP was approved by the Nunavut Water Board (NWB) on 25 April 2019 (NWB 2019).

This memorandum provides a compilation of the site-specific data collection in 2019 and the review of 2019 monitoring data undertaken by Agnico Eagle to meet the requirements established in the GWMP. Each of these requirements and the relevant sections of the GWMP that are addressed are described. Section 1 of this report provides site-specific data collected in 2019 including groundwater quality data (Section 3.2 of the GWMP); assessment of horizontal and vertical hydraulic gradients (Section 3.1 of the GWMP); and thermistor data (Section 3.1 of the GWMP). Section 2 of this report provides an update of predicted groundwater inflows in support of the annual update of the site-wide water quality and water balance model; and Section 3 discusses the status of mine inflow monitoring data and comparison to model predictions (Section 3.3 of the GWMP). In 2019, dewatering of the North Basin was progressing and measured inflow to the pits are not yet available for comparison to the model predictions.

#### 1.0 SITE-SPECIFIC DATA COLLECTION

The following section presents a summary of the thermal monitoring and Westbay multi-level well system monitoring conducted in 2019, that respectively meets the requirements of Sections 3.3 and 3.1 of the GWMP.

##### 1.1 Westbay Sampling and Assessment of Groundwater Quality

In accordance with Section 3.1 and 3.2 of the GWMP, groundwater sampling and hydraulic head measurements of the Westbay multi-level system (AMQ16-626) was undertaken in March 2019. A technical memorandum was prepared documenting the work and is presented as Attachment A. The following presents a summary of the work. Attachment A includes results from previous groundwater sampling at the Westbay multi-level system.

Groundwater samples were collected from ports 2, 3, 4 and 6 of the Westbay multi-level well in March 2019. During drilling and installation of the Westbay, the drilling fluid was tagged with fluorescein. During collection of the water

samples, the fluorescein concentration was measured to estimate the proportion of the sample that could be attributed to drilling fluid.

Given the Westbay well had to be installed through permafrost, removal of groundwater for well development, purging and sampling must be carried out using a small volume sampler which substantially lengthens the time requirement for these activities for each port (months). Consequently, the sampling program prioritizes key ports that optimized groundwater quality data collection; each port is accessed for hydraulic pressure measurements. The rationale for ports selected for sampling is provided below.

- Ports 4 and 3, which are in the anticipated ramp development zone, were targeted for sampling because these intervals had been previously developed in 2016 (i.e., drill water had been largely removed from the interval). Field activities prioritized obtaining representative samples of groundwater quality from Port 3, because this interval has been the most developed previously, and then prioritized continued development of Port 4.
- Port 6 is interpreted to be located within the cryopeg zone. In the cryopeg, groundwater has the potential to yield variable water quality even following periods of sufficient development because this zone is partially frozen, and salt can concentrate in the liquid phase relative to ice. The liquid phase is likely preferentially conveyed to the sampling device. A groundwater sample was collected from Port 6 to verify previous sampling results.
- Port 2 was sampled although it was less developed than other intervals in 2016, to document if the aquifer is being naturally flushed of the drilling water over time.
- Port 1 was not sampled because of its residual fluorescein and based on the limited development completed to date but field measurements of fluorescein content and electrical conductivity were recorded.
- Port 5 was never intended for groundwater sampling and was installed for pressure measurements only.

Groundwater quality of each water sample was estimated using a mass balance calculation to remove the proportion of residual drill fluid from the collected samples. The 2019 program estimated groundwater quality at Ports 6 and 3 are in the same range as estimated in 2016 and the water quality data collected from these ports were considered reliable. Port 3 is considered the most likely to be representative of the natural groundwater quality and total dissolved solids (TDS) concentration because of the relatively low fluorescein concentrations at the time of sampling. TDS measured at Port 2 is similar to historical measurements in 2016, which indicates the TDS assumptions in the conceptual hydrogeological model based on the 2016 data are consistent with the recent data collection. Electrical conductivity and fluorescein values were higher in water sampled from Ports 4 and 2 in 2019 compared to 2016, consequently the data collected from these ports is considered less reliable to evaluate groundwater quality than the data collected in 2016 due to the higher proportion of intercepted drill fluid.

Considering that the estimated groundwater quality at Ports 6 and 3 are in the same range as estimated in 2016, and that the vertical gradients measured at the Westbay Ports (Section 1.3) are consistent with the conceptual model in the FEIS, an additional Westbay well installation is not recommended.

## 1.2 Thermal Monitoring in Support Assessment of Groundwater Flow Direction

Updated thermal modelling was completed in April 2019, which involved the calibration of the two-dimensional (2D) thermal models to measured data at ten thermistors near the Whale Tail Pit area. A report was prepared documenting the work and is presented as Attachment B. Results from the thermal modelling were used to develop

a 3D representation of the permafrost in the Whale Tail Lake area. Based on the April 2019 thermal modelling and the available thermistor data, the permafrost characteristics in the Project area are summarized below:

- The depth of permafrost outside of the influence of lakes is estimated to be between 452 m and 522 m based on thermal gradients and ground temperatures at the lowest portions of the thermistor strings. The depth of permafrost increases with increasing distance from lakes with taliks.
- Considering the 2D thermal modelling and 3D block model, the assessment indicated that:
  - Under the northern portion of the lake below Whale Tail Pit, there is likely a closed talik formation
  - Open talik conditions are probable in the southern portion of the lake where the Whale Tail Lake becomes wider
  - Permafrost depth is between 480 m and 550 m for ground away from the Whale Tail Lake, and between 350 m and 450 m below surface in portions beneath the Whale Tail Lake where a closed talik is present.
  - The cryopeg thickness at the bottom of the permafrost is likely between 20 m to 30 m.

Review of the 2D thermal analysis and 3D block model indicates that the predicted closed and open taliks are consistent with the previously understood conceptual hydrogeological conditions. Relative to the FEIS, the depth of the closed talik below the northern portion of the lake is slightly less resulting in the base of the Phase 1 pit being located within the permafrost underlying the talik (previously the pit bottom was slightly above the underlying permafrost).

Data reviewed in the April 2019 modelling report included four thermistors installed between Nemo Lake and Whale Tail Pit. These four thermistors each indicate the presence of deep permafrost below land and confirm the horizontal groundwater flow below the active layer is restricted by permafrost in at least the upper 425 m. It also confirms that the sub-horizontal groundwater flow system can only be recharged by vertical flow through open taliks beneath sufficiently large lakes, such as Whale Tail and Nemo.

On-going thermal monitoring at the Site is documented in the Whale Tail Pit Project Thermal Monitoring Report 2020, dated March 2020, which is included in Attachment C for reference.

### **1.3 Hydraulic Head Monitoring and Definition of Horizontal and Vertical Groundwater Flow**

Hydraulic heads were derived from the formation pressures measured at each monitoring port installed along the Westbay system, prior to development or sampling. The data collected at AMQ16-626 in March 2019 indicates an overall downward gradient of 0.006 is present, which is consistent with observations in November 2018 (0.008 downward).

Thermal monitoring data supports that the sub-permafrost groundwater flow system can only be recharged by vertical flow through open taliks beneath lakes of sufficiently large size such as Whale Tail and Nemo lake. The driving force in the sub-permafrost under baseline and post-closure conditions is the hydraulic heads at each of these lakes. Groundwater generally flows down to the sub-permafrost groundwater flow system with the direction of groundwater flow controlled by the surface water levels in the lakes with open talik.

During sampling of the Westbay (AMQ16-626), hydraulic heads measurements were recorded at the sampling ports prior to any sampling or development. The data collected at AMQ16-626 indicates the presence of an overall downward hydraulic gradient of 0.006, which is consistent with the thermistor data and the interpreted conditions of horizontal and vertical groundwater flow below the active zone (vertical flow down to the sub-permafrost zone and lateral flow towards a lake of lower elevation in the sub-permafrost zone). The magnitude of the 2019 measured gradient (0.006) is consistent with what would be expected based on the relative lake elevations of Whale Tail Lake and DS1, which is the predicted receptor for flow from Whale Tail Lake.

The relative difference in hydraulic heads in the lakes near Whale Tail Pit is very small and combined with the very low hydraulic conductivity of the deep sub-permafrost bedrock ( $8 \times 10^{-8}$  m/s; geometric mean of available test data) and the low measured vertical hydraulic gradient, the groundwater flow quantities at baseline and post-closure are calculated to be very small and negligible when compared to annual surface water exchange in the lakes near Whale Tail Pit (Golder 2019e).

As part of the Whale Tail Dike Operation Maintenance and Surveillance manual, performance of the Whale Tail dike will be monitored with piezometers located in the principal horizontal groundwater flow pathway between Whale Tail South Basin and the Whale Tail pit. Piezometer readings and the water level in the Whale Tail South Basin and the Attenuation Pond will be available to calibrate the hydrogeological model during operation, if deemed necessary. As of the end of 2019, dewatering of the North Basin was in progress and these piezometers are understood to be targeted for installation in 2020.

## **2.0 UPDATE OF PREDICTED GROUNDWATER INFLOWS QUANTITY AND QUALITY**

### **2.1 Rational for Model Update**

Potential groundwater inflow quantity and quality with respect to TDS was predicted in the FEIS using a groundwater numerical model (Volume 6, Appendix 6.B of the FEIS). Included within this FEIS Appendix are discussions regarding the assumptions and uncertainties associated with the predicted inflows and groundwater salinity.

Supplemental hydrogeological investigations have been undertaken since the FEIS between 2015 and 2018 to further characterize the hydraulic conductivity of the bedrock in the vicinity of the Whale Tail Pit. These investigations have been documented in reports by Knight Piésold (2016), Golder (2016a, 2017, Golder 2019b), and SNC (2017). These investigations included the completion of over 50 packer tests in unfrozen areas of bedrock (i.e., within the talik or below the regional permafrost).

Figure 1 presents the updated hydraulic conductivity profile for the bedrock based on the results of the supplemental testing in combination with the data available in the FEIS. The bulk bedrock hydraulic conductivity, estimated based on the geometric averages of the combined data, ranges from  $1 \times 10^{-5}$  m/s near surface (i.e., up to depths of 40 m) to approximately  $8 \times 10^{-10}$  m/s at greater depths. Many of the supplemental test results at depths greater than 200 m were at the lower limit of the test methodology, meaning the actual hydraulic conductivity would be lower than the reported test value and because of this, the calculated geometric averages are likely biased high.

Relative to the FEIS Appendix, the refined hydraulic conductivity estimated from the expanded test data set is higher near surface and lower at depth; the hydraulic conductivity in the FEIS was estimated to be between  $2 \times 10^{-7}$  m/s near surface and  $1 \times 10^{-8}$  at depth. As presented in the GWMP V2.1, it was acknowledged that the groundwater flows to the pit could be up to five times higher (up to 1,400 m<sup>3</sup>/day) than predicted for the FEIS as result of the inflows to the pit being controlled by the shallower bedrock hydraulic conductivity (connection of the Whale Tail Pit

to the South Whale Tail Basin and Whale Tail Attenuation Pond). This higher flow rate was considered within the limits of the water treatment system and water management infrastructure and adaptive management of the flows was not recommended at the end of 2018. The lower hydraulic conductivity of the bedrock at depth also indicated that the seepage rates from the pit are likely to be lower than predicted in the post closure hydrogeological assessment, which indicates that the predicted post closure seepage rates were conservatively high, and that actual seepage rates from the Whale Tail pit lake will be slightly lower due to the lower bedrock hydraulic conductivity.

In consideration of the changes in the bedrock hydraulic conductivity profile and that an annual update of the site-wide water quality and water balance models was being undertaken, a decision was made to update the groundwater inflow predictions to support the updated water quality and water balance models. Consistent with the FEIS, higher hydraulic conductivities than the geometric averages were adopted for the updated groundwater inflow predictions, presented as the EA scenario on Figure 1. The EA Scenario is designed to be a reasonable, yet more conservative, assessment of potential groundwater inflow quantity and TDS quality than values that might be adopted for mine operation planning (i.e., Base Case Scenario). Results from the more conservative EA Scenario are used in the Site-Wide Water Balance and Water Quality models. Updated inflow predictions for the EA Scenario are summarized in Section 2.2.

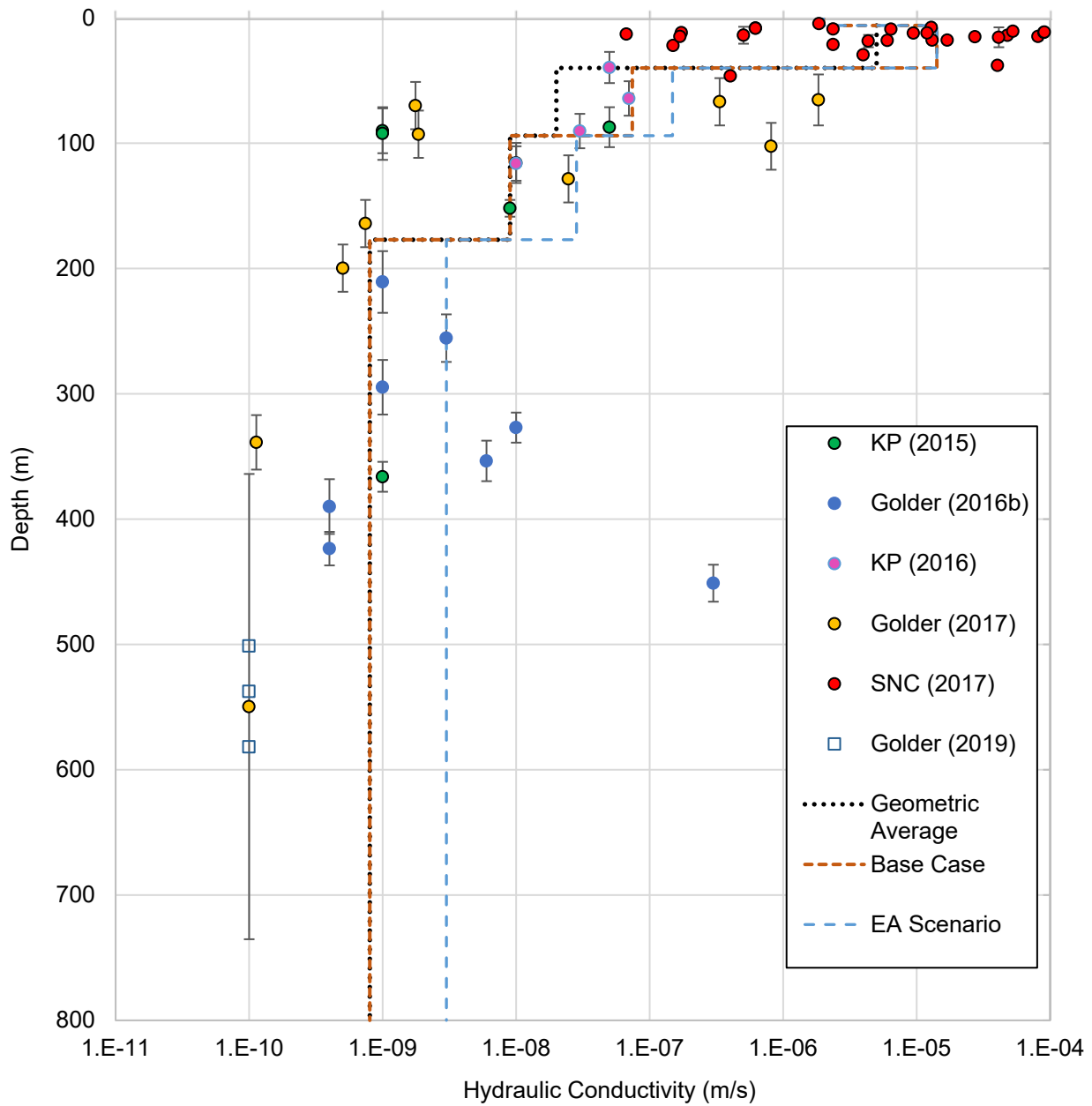


Figure 1: Updated Hydraulic Conductivity Profile Following Supplemental Data Collection

## 2.2 Updated Predicted Groundwater Inflows

Updated predictions utilized the existing model with the incorporated changes to the hydraulic conductivity profile (EA Scenario on Figure 1 in Section 1.2) the results of the 3D permafrost model (Section 1.2 and Attachment B). The TDS profile in the model was also modified slightly to reflect the additional TDS data collected since the FEIS (Figure 2). Consistent with the FEIS, TDS at depth is extrapolated to greater depths based on data from other sites in the Canadian Shield. General details on the model mesh, boundary conditions and other model assumptions for the existing model are presented in Golder (2018b and 2019d).

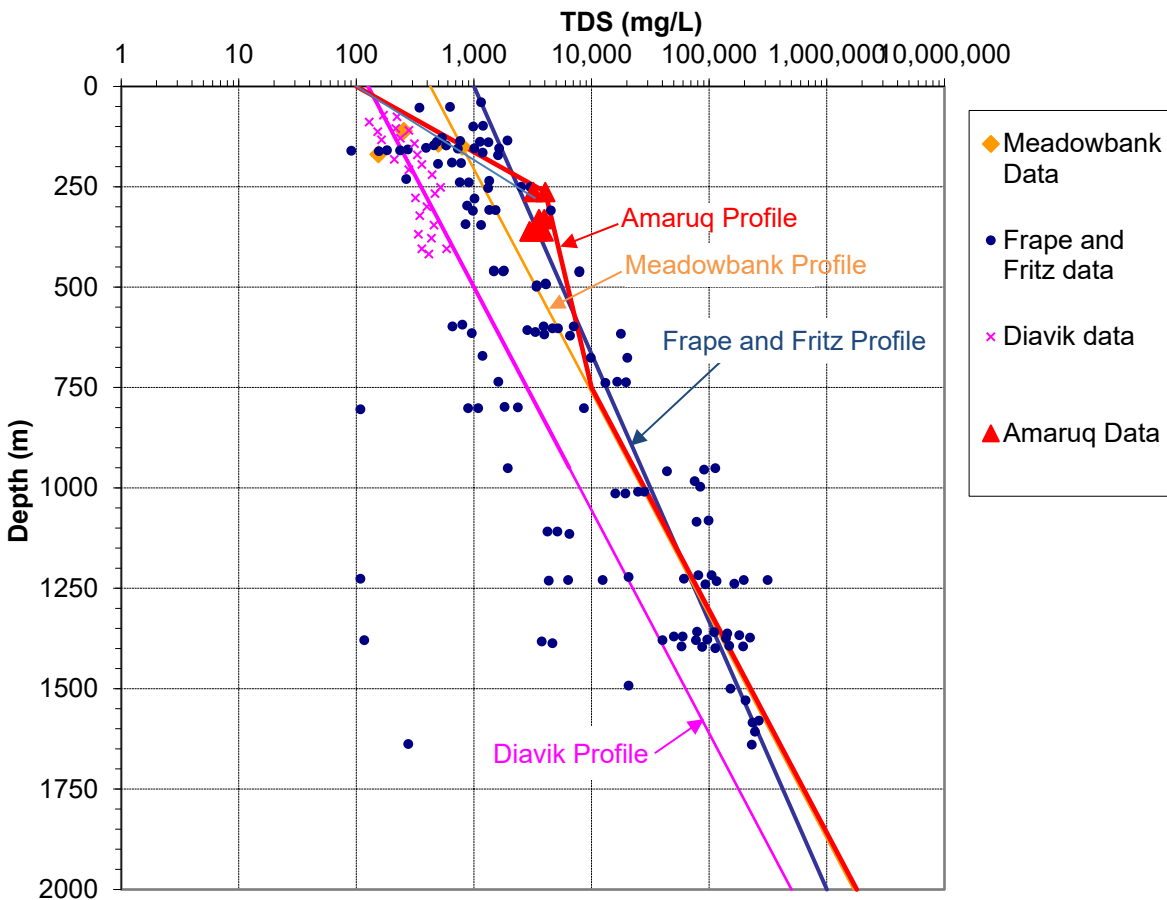


Figure 2: TDS Profile Incorporated in Numerical Model



## 2.2.1 Dewatering and Mining Predictions

Table 1 presents a summary of the predicted discharge to the North Basin of Whale Tail Lake during dewatering and Table 2 presents a summary of the updated predicted groundwater flow rates and groundwater TDS concentrations to the mine facilities during mining. The predictions presented on Table 3 and Table 4 include: predicted groundwater inflow to Whale Tail Pit, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom).

**Table 1: Predicted Groundwater Discharge to North Basin of Whale Tail Lake during Dewatering – Base Case Scenario**

Phase	Base Case Scenario	
	Groundwater Discharge (m <sup>3</sup> /day)	TDS Concentration (mg/L)
Lake Dewatering (Q1-Q3 2019)	895	120

Groundwater inflow predictions during mining conservatively assumes that no freeze-back will occur in the pit walls. Although not simulated, if freeze back does occur as is the case at Meadowbank, actual groundwater inflow to the pit could be substantively lower than the predicted values in Table 2 (i.e., reduce to zero during periods of full freeze back).

In 2020, following dewatering of the North Basin of Whale Tail Lake, mining is expected to intersect unfrozen rock, and groundwater inflow to the pit is predicted to be 940 m<sup>3</sup>/day. The groundwater inflow to the open pit was predicted to slightly decrease in 2021 to 680 m<sup>3</sup>/day. The higher inflow in 2020 is attributed to additional groundwater inflow from storage. The overall inflow to the pit does not increase significantly as the pit deepens because the flow of groundwater is primarily through the permeable shallow (weathered) bedrock.

The predicted peak quantity of groundwater inflow into the open pit during mining for the updated EA scenario is approximately 3.4 times the groundwater inflow predicted for the FEIS. As discussed in the V2.1 of the GWMP, this change resulted from the supplemental data collection indicating a higher shallow bedrock hydraulic conductivity.

TDS concentration in the groundwater inflow to the pit was predicted to be between 160 and 175 mg/L. These TDS concentrations are lower than what was predicted during the FEIS; the relatively low TDS concentration reflects the minimal upwelling of higher salinity waters at depth and the identified increased connection of the pit to the South Basin of Whale Tail Lake through the permeable shallow bedrock which results in lower TDS in the groundwater inflow. Consistent with the FEIS, the predicted TDS concentrations in this model only account for TDS loading from groundwater. TDS loading from the Whale Tail Attenuation Pond and South Basin of Whale Tail Lake is accounted for in the water quality model.

**Table 2: Predicted Groundwater Inflow and Groundwater Salinity during Dewatering and Mining – Updated EA Scenario – Whale Tail Pit, Whale Tail Attenuation Pond and Whale Tail Lake (North Basin)**

Phase	Time Period	Whale Tail Pit				Whale Tail Attenuation Pond				North Basin of Whale Tail Lake (within the diked area) <sup>1</sup>		
		Groundwater Inflow (m <sup>3</sup> /day) <sup>3</sup>	Inflow TDS Concentration (mg/L) <sup>2</sup>	Portion of Inflow from Attenuation Pond (%)	Portion of Inflow from South Basin of Whale Tail Lake (%)	Groundwater Inflow (m <sup>3</sup> /day)	Inflow TDS Concentration (mg/L) <sup>2</sup>	Portion of Inflow from South Basin of Whale Tail Lake (%)	Pond Outflow (m <sup>3</sup> /day)	Net Groundwater Inflow (m <sup>3</sup> /day) <sup>3</sup>	TDS Concentration (mg/L) <sup>2</sup>	Portion of Inflow from South Basin of Whale Tail Lake (%)
Mining	2020	940	175	14	<1%	265	280	<1%	320	830	130	83
	2021	680	170	60	<1%	125	365	<1%	430	760	120	98
	January-July 2022	675	160	66	<1%	120	320	3%	430	750	110	99

Notes:

<sup>1</sup> Predictions of groundwater inflow to North Basin of Whale Tail lake represents the discharge of groundwater to the lake basin during dewatering and mining. This excludes discharges to the pit and Whale Tail Attenuation Pond, which are within the North Basin of Whale Tail Lake.

<sup>2</sup> TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources are accounted for in the Site Wide Water Quality model.

NA = not applicable; TDS = total dissolved solids; m<sup>3</sup>/day = cubic metres per; mg/L = milligrams per litre; % = percent.

**Table 3: Predicted Groundwater Inflow and Groundwater Salinity during Reflooding – Updated EA Scenario – Whale Tail Pit, Whale Tail Attenuation Pond, North Basin of Whale Tail Lake**

Phase	Approximate Time Period	Water Level in Pit (masl)		Whale Tail Pit				Whale Tail Attenuation Pond				North Basin of Whale Tail Lake (within the diked area)		
		From	To	Net Groundwater Inflow/Outflow <sup>1</sup> (m <sup>3</sup> /day)	Inflow TDS Concentration <sup>2</sup> (mg/L)	Portion of Inflow from Attenuation Pond (%)	Portion of Inflow from South Basin of Whale Tail Lake (%)	Groundwater Inflow (m <sup>3</sup> /day)	Inflow TDS Concentration (mg/L) <sup>2</sup>	Portion of Inflow from South Basin of Whale Tail Lake (%)	Pond Outflow (m <sup>3</sup> /day)	Net Groundwater Inflow/Outflow <sup>1</sup> (m <sup>3</sup> /day)	TDS Concentration (mg/L) <sup>2</sup>	Portion of Inflow from South Basin of Whale Tail Lake (%)
Flooding	2022	-5	112	640	155	69	<1%	120	300	47	430	530	110	>99%
	2023	112	122	580	150	71	<1%	115	270	36	395	320	105	>99%
	2024	122	131	450	150	72	<1%	120	220	55	310	320	100	>99%
	2025	131	138	260	150	73	<1%	135	180	69	185	330	90	>99%
	2026	138	148	65	145	72	<1%	145	150	75	85	330	80	>99%
	2027	148	152.5	-225	-	-	-	25	150	77	660	230	85	>99%
	2028	152.5	152.5	-5	-	-	-	-5 to 5	-	-	-	5	-20	-

Notes:

<sup>1</sup> Positive values indicate flow to the pit/pond and negative values indicate flow to bedrock.

<sup>2</sup> TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.

NA = not applicable; TDS = total dissolved solids; m<sup>3</sup>/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

## 2.2.2 Reflooding of Pits

Table 3 presents a summary of the predicted groundwater inflow rates and groundwater TDS concentration to the mine development areas during reflooding of the Whale Tail Pit. The predictions presented in Table 3 include: predicted groundwater inflow to Whale Tail Pit Lake, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom surface).

The predictions presented for the reflooding phase utilize a conceptual filling schedule for the Whale Tail Pit based on initial water balance predictions. Fine tuning of the flooding sequence was conducted as part of the site wide water balance after the conceptual filing schedule was developed; however, these adjustments will not have a significant impact on the predicted flow rates and salinity for a given elevation range.

The groundwater inflow to the pit lake was predicted to be initially 640 m<sup>3</sup>/day and to decline as the pit lake rises and then ultimately switch to a groundwater recharge boundary (i.e., the pit lake starts to recharge the sub-permafrost groundwater flow system). Consistent with the inflow predictions during mining, the filling rates are higher than the FEIS, which had a peak filling rate of 65 m<sup>3</sup>/day and is attributed to the interpreted more permeable shallow bedrock. Freeze back in the pit walls may alter (lower) these predict flows from those presented in Table 3 if the freeze back is sufficient to substantively reduce the flow in the shallow bedrock.

## 2.2.3 Fully Flooded Open Pit

The long-term predicted pit lake discharge to the sub-permafrost groundwater flow system is predicted to be less than 1 m<sup>3</sup>/day, which is consistent with previous post-closure analysis (Golder 2018a) and estimates made using measured data (Section 2.3.4 of V.3 GWMP; Agnico Eagle 2020). The predicted pit lake discharge assumes the permafrost below the pit fully degrades, connecting the bedrock below the lake to the sub-permafrost flow system through the open talik.

## 3.0 DATA COMPILATIONS AND COMPARISON TO PREDICTIONS

In 2019, dewatering of the North Basin was progressing and measured inflow to the pits are therefore not yet available for comparison to the model predictions (Section 2.2). As mining in the unfrozen bedrock proceeds in 2020, comparisons will be made and reviewed relative to the triggers and thresholds presented below in accordance with Section 3.3 of the GWMP.

Groundwater inflow quantity and quality will be compared to model predictions on an annual basis. If significant variations between predictions and measured values are observed, then the data and hydrogeological model will be reviewed, and a determination made of if these variations require re-calibration of the hydrogeological model and prediction of future inflows. Variations considered significant were:

- Groundwater inflow to the mine, based on 6-month rolling average over six consecutive months, is 20% higher than predicted.
- The TDS of collected water samples, based on a 6-month rolling average, is more than 25% higher than the estimated water quality.
- Temperature profiles observed in thermistors between Nemo Lake and Whale Tail lake are showing signs of permafrost degradation below the active layer.

Inflow to the pit sump will be used to estimate groundwater inflow quantity and quality. It should be noted that inflow to the pit sump is not only groundwater but there are contributions to both the TDS concentrations and the total quantity by surface water inflow. These other components are accounted for by the site-wide water quality model.

## 4.0 SUMMARY

The following presents a summary of the data contained in this document and reference to the relevant sections of the GWMP v.2.1.

- The Westbay multi-level well was re-sampled in March 2019 (section 3.2 of the GWMP). Considering that the estimated groundwater quality at Ports 6 and 3 are in the same range as estimated in 2016, and that the vertical gradients measured at the Westbay Ports (Section 1.3) are consistent with the conceptual model in the FEIS, an additional Westbay well installation is not recommended. Reliable TDS data collected at the Westbay well up to the end of 2019 was used in groundwater model update.
- To define horizontal and vertical groundwater flow (section 3.1 of the GWMP), thermistor, lake water levels and Westbay hydraulic head measurements were used. Thermistor data and modelling confirmed that horizontal groundwater flow below the active layer is restricted by permafrost in at least the upper 425 m. Horizontal groundwater flow in the sub-permafrost is therefore controlled by the relative hydraulic heads of lakes that are sufficiently large and deep to have an open talik beneath them. Hydraulic head measurements in the Westbay multi-level well indicated a downward vertical hydraulic gradient of 0.006 m/m that is consistent with the estimated hydraulic gradient derived from the relative difference in the hydraulic head at Whale Tail Lake and DS1 divided by the distances between these lakes (including the distance down through the open talik beneath Whale Tail lake and up through the open talik of DS1).
- Updated EA Scenario groundwater inflows were provided in support of the annual update to the site wide water quality and water balance models. The updated flows considered the revisions to interpreted bedrock hydraulic conductivity, based on packer testing conducted since the FEIS between 2016 and 2018, updated thermal modelling, and interpreted TDS profile from the Westbay sampling.
- Groundwater inflows to the pit sumps did not occur in 2019; dewatering of the North Basin was occurring. In the absence of groundwater inflow, comparison of observed groundwater inflow to the Whale Tail Pit to the predicted inflows (section 2.2 of this report) could not be undertaken in 2019.

## 5.0 CLOSURE

We trust the above meets your needs, please contact the undersigned for any questions or concerns.



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Senior Hydrogeology Specialist

DC/JL/jr



Jennifer Levenick, M.Sc., P.Eng.  
Associate - Mine Water Group

[https://golderassociates.sharepoint.com/sites/121416/project files/5 technical works/01\\_monitoring/pt/rev0/20137375-477-tm-2019-gw monitoring-rev0.docx](https://golderassociates.sharepoint.com/sites/121416/project%20files/5%20technical%20works/01_monitoring/pt/rev0/20137375-477-tm-2019-gw-monitoring-rev0.docx)

<b>PERMIT TO PRACTICE GOLDER ASSOCIATES LTD.</b>	
Signature	<u>Nashan</u>
Date	<u>21 April 2020</u>
<b>PERMIT NUMBER: P 049</b>	
NT/NU Association of Professional Engineers and Geoscientists	

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**ATTACHMENT A**

**2019 Westbay Sampling Technical  
Memorandum**

## TECHNICAL MEMORANDUM

**DATE** 29 July 2019

**Project No.** 18108905-303-TM-Rev0

**TO** Michel Groleau  
Agnico Eagle Mines Ltd.

**FROM** Valerie Bertrand, Jennifer Levenick

**EMAIL** vbertrand@golder.com

### 2019 AMQ16-626 WESTBAY GROUNDWATER MONITORING INVESTIGATION, AMARUQ, NUNAVUT

#### 1.0 INTRODUCTION

Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) is developing the Whale Tail Pit Project that was approved by the Nunavut Impact Review Board (NIRB). The property is a 408 square kilometre (km<sup>2</sup>) site located on Inuit Owned Land approximately 150 kilometres (km) north of the hamlet of Baker Lake and approximately 50 km northwest of the Meadowbank Mine in the Kivalliq Region of Nunavut.

As part of the Approved Project baseline studies, groundwater samples were collected from a Westbay monitoring well installed in borehole AMQ16-626, drilled in March and April 2016 targeting the area of the talik below Whale Tail Lake near future mine developments. Agnico Eagle retained Nuqsana Golder Engineering and Environmental Inc. (Nuqsana Golder) to complete a three-week groundwater monitoring program during spring 2019. The objective of the program was to obtain additional pre-development hydraulic head and groundwater quality data in support of the Whale Tail Pit Project Certificate No. 008, Term and Condition No. 15 (TC15) (NIRB 2018).

This technical memorandum provides an interpretation of the data collected from AMQ16-626 in 2019 with respect to hydraulic gradients and groundwater quality. The collected data was reviewed in the context of conceptual model and predictions of the numerical model for the Whale Tail Pit Project to evaluate if follow-up assessment is required (i.e., if significant differences in the model assumptions or predictions was indicated by the collected data).

#### 2.0 BACKGROUND

##### 2.1 Westbay Well Installation

A Westbay groundwater well system was installed on site between March and April in 2016 to obtain groundwater quality and verify the vertical hydraulic gradient within the talik of Whale Tail Lake, in the area of future mine development, to define future effects of the mine workings on the groundwater flow regime and overall site water quality from development to post-closure.

The well was installed in the purpose-specific borehole (AMQ16-626) which was drilled at an inclination of -69 degrees, an azimuth of 152.6 degrees and advanced to a depth of 499 m along the borehole, through massive diorite throughout the borehole. The Westbay well was designed to tap discrete zones of unfrozen bedrock and, if encountered, zones of higher hydraulic conductivity that were observed during drilling and well testing conducted prior to well installation. Six sampling ports were installed at and below the depth of anticipated ramp development (0 to 385 metres below ground surface [mbgs]). The locations of the ports are provided in Table 1. Borehole drilling, packer test results along the borehole and well installation details are documented in Golder (2016b). A schematic of the Westbay well instrument that was installed in borehole AMQ160626 is included in Appendix A for reference.



**Table 1: Borehole AMQ16-626 Westbay System Zones**

Sampling Interval	Depth Along Borehole			Depth Below Ground Surface		
	From	To	Length	From	To	Thickness
	(mah)	(mah)	(m)	(mbgs)	(mbgs)	(m)
Port 6	276.0	287.4	11.4	257.7	268.3	10.6
Port 5	298.9	310.3	11.4	279.0	289.7	10.6
Port 4	349.3	359.1	9.8	326.1	335.2	9.1
Port 3	381.3	392.7	11.4	356.0	366.6	10.6
Port 2	440.8	452.2	11.4	411.5	422.2	10.6
Port 1	488.1	499.0	10.9	455.7	465.9	10.2

Notes: Depth values were provided by Westbay Instruments Completion Report.  
m = metres; mah = metres along the hole, relative to top of hole; mbgs = metres below ground surface.

Upon completion of the installation in 2016, the well was used to collect groundwater samples from select intervals that were within and below the proposed development; Ports 3, 4, and 6 ranging in depths from 276 m to 392 m. Sampling methods, data interpretation and water quality results were presented in Golder 2016a. The total dissolved solids (TDS) content in the Formation groundwater<sup>1</sup> was determined to range between 3,198 mg/L and 4,042 mg/L (Golder 2016a).

The groundwater quality were used to predict groundwater inflow salinity into future mine developments, which were used as input to operational and post-closure hydrogeological and permafrost models (Golder 2018a), and as input to the Whale Tail pit lake hydrodynamic model (Golder 2018b). These models were ultimately used to assess effects of hydrogeological processes on site contact water quality during development, operations and closure and on pit lake water quality during closure and post-closure.

The results of the compendium of these studies for the Whale Tail Pit Project indicated that mass transfer from the pit to the pit lake is very low, that groundwater seepage into and out of the pit lake are negligible in volume, particularly compared to surface water exchanged annually during post-closure when flows are re-established based on average climate yearly watershed runoff. The combination of results supports the conclusion that the hydrogeological regime around the pit lake is not critical to pit lake water quality at post-closure.

Groundwater quality and hydraulic head data collected as part of the 2018 (Golder 2019a) and 2019 monitoring programs add to the pre-operational database of results and were used to verify model inputs and model outcomes obtained to date.

<sup>1</sup> Formation water in this report refers to the natural groundwater in the rock formation, as opposed to sampled water which is a mixture of drilling water and true groundwater.

## 2.2 Groundwater Monitoring Program

The 2019 groundwater monitoring program was completed to support the requirements of the Groundwater Monitoring Program stated in TC15 (NIRB 2018). TC15 requirements were as follows:

*Subject to the additional direction and requirements of the Nunavut Water Board, the Proponent shall prepare and implement a Groundwater Monitoring Plan that, at a minimum includes:*

- *The collection of additional site-specific hydraulic data (e.g., from new monitoring wells) in key areas during the pre-development, construction and operation phases;*
- *Definition of vertical and horizontal groundwater flows in the project development areas; and*
- *Delineates monitoring plans for both vertical and horizontal ground water.*

The groundwater monitoring program documented in this technical memorandum consisted of measurements of hydraulic head (vertical gradients) and sampling of the Formation groundwater to evaluate groundwater quality with depth.

Groundwater monitoring data collected at this stage is representative of the pre-development condition of the project, and therefore an evaluation of trends in flow quantity and quality is not possible for the operational and closure phases. Results of the monitoring has been compared to assumptions adopted in the initial conditions for groundwater conceptual and numerical models and has been used to assess if the post-closure predictions are likely reasonable in consideration of the observed vertical hydraulic gradients and flow directions in the 2019 monitoring program.

## 2.3 Thresholds for Additional Assessment or Adaptive Management

Groundwater monitoring data collected thus far in the pre-development and construction phases are being compiled into a Project-specific database that documents the existing range of groundwater flow and quality prior to open pit development. These data will be used in combination with future data collected during operational and closure phases of the Project to evaluate trends with respect to the quantity and quality of groundwater inflow to Whale Tail open pit.

Measured groundwater inflow rates and groundwater quality will be compared to the Approved Project FEIS model predictions on an annual basis. If significant variations between actual mine inflow and model predictions are observed, the assumptions behind the modeled data will be reviewed and the analysis updated if required. In addition, updates to the groundwater model will be made if operational changes occur as the open pit advances which could significantly alter actual open pit groundwater inflow or quality.

Variations between actual data and modeled data that would be considered significant include:

- Actual groundwater inflows to the mine, based on rolling monthly average of inflow over six consecutive months, is 20% higher than predicted groundwater inflow in the model.
- Groundwater quality data collected from seeps of groundwater flowing into the pit indicate that the concentration of total dissolved solids (TDS) is more than 25% higher than the estimated water quality.

If the above variations are observed during operation, the groundwater data (quantity and quality) would be assessed to evaluate trends, the potential causes of the greater than expected groundwater inflow quantity or quality, and the potential for long-term effect associated with the groundwater flow or quality. If the greater than predicted flows were correlated to a short-term effect such as freezing in the pit walls, changes in mining rate, freshet or transient drainage of a high storage feature, then further reassessment of groundwater inflows may not be required, and the adaptive management of these short-term effects would be evaluated under the Water Management Plan.

If the greater than predicted flows or quality would be considered as potentially long term, consideration will be given to reviewing the model calibration. The six-month averaging period of observation is based on observed seasonal variations in inflow quantities in mines situated in permafrost regions.

If model re-calibration is deemed necessary, future groundwater inflow quantity and quality would be predicted using this re-calibrated model and new results will be considered as part of the adaptive management of the groundwater quantity contribution to the Water Management Plan.

Modification of groundwater management strategies: the ponds, sumps and water conveyance strategies around the pit can be modified to mitigate the effect of additional groundwater volume or salinity prior to treatment and discharge. The water conveyance strategy will be evaluated and optimized during operations and closure to maintain post-closure commitment.

Groundwater monitoring data collected at this stage is representative of the pre-development and initial construction condition of the project, and therefore an evaluation of trends in flow quantity and quality is not possible for the operational and closure phases. Results of the monitoring has been compared to assumptions adopted in the initial conditions for groundwater conceptual and numerical models and has been used to assess if the post-closure predictions are likely reasonable in consideration of the observed vertical hydraulic gradients and flow directions in this March 2019 monitoring program.

### **3.0 2019 GROUNDWATER MONITORING PROGRAM**

#### **3.1 Objectives**

The objectives of the program are as follows:

- To collect site-specific hydraulic head data through the measurement of the hydrostatic pressure profile from the existing Westbay well installed in borehole AMQ16-626.
- Assess the vertical hydraulic gradient and groundwater flow direction in that location of the Whale Tail Lake talik.
- Collect groundwater samples from the Westbay Well for chemical analysis in target sample intervals, adding to the database of groundwater quality results which will be used to compare against water quality samples collected from the open pit during operation and closure.

#### **3.2 Monitoring Methods**

##### **3.2.1 Hydraulic Head Measurements and Assessment of Vertical Hydraulic Gradients**

Hydraulic heads were derived from the formation pressures measured at each monitoring port installed along the Westbay system. The formation pressure for each monitoring port was measured on March 16, 2019 using the Mosdax sampler manufactured and supplied by Westbay Instruments (refer to Appendix B for instrument calibration record).

##### **3.2.2 Groundwater Sampling**

Groundwater samples were collected from fixed ports in the Westbay well system that are positioned at different intervals along the hole to assess baseline groundwater chemistry with depth. As part of the designated 2019 program samples were collected from Ports 2, 3, 4 and 6. Port 1 was not sampled because of its elevated residual fluorescein and based on the limited development completed to date but field measurements of fluorescein content and electrical conductivity were recorded. Port 5 was meant to measure hydraulic pressure only, it was not intended for collection of groundwater samples. The Westbay well being installed through permafrost, removal of groundwater for well

development, purging and sampling must be carried out using a small volume sampler which substantially lengthens the time requirement for these activities for each port (months). Consequently, the sampling program prioritizes key ports that optimize groundwater quality data collection; all ports are accessed for hydraulic pressure measurements. The rationale for ports selected for sampling is provided below.

- Ports 4 and 3, which are located within the anticipated ramp development zone, were targeted for sampling because these intervals had been previously developed in 2016 (i.e. drill water had been largely removed from the interval).
- Port 6 is interpreted to be located within the cryopeg zone (temperature below 0 degrees where water still flows). In the cryopeg groundwater has the potential to yield variable water quality even following periods of sufficient development (Golder 2019a) because this zone is partially frozen, salt could concentrate in the liquid phase relative to ice, and the liquid phase is likely preferentially conveyed to the sampling device. A groundwater sample was collected from Port 6 to verify previous sampling results.
- Port 2 was sampled, although it was less developed than the other intervals in 2016, to document if the aquifer is being naturally flushed of the drilling water over time.

Throughout the development and upon water sample collection, field chemical parameters (pH, conductivity, fluorescein content and temperature) were measured in order to track the fluid introduced into the Formation by drilling and to follow the removal of this fluid from the formation during development and sampling of groundwater. Fluorescein tracer was added to the 2016 drilling water to differentiate between the drilling fluid and the Formation water. It is assumed that drilling water is the only source of fluorescein introduced during the 2016 drilling activities of borehole AMQ16-626 such that it is a reliable tracer of introduced water into the Formation. Fluorescein content was measured using the AquaFluor handheld Fluorometer manufactured by Turner Designs. Temperature, pH and electrical conductivity values were measured with a Hanna Combo tester (HI 98130). A drilling water content of less than 5% (estimated using fluorescein content) is targeted in order to provide a reliable estimate of Formation groundwater quality. Higher residual drilling fluid content can be used for this purpose but decreases the precision of the calculation of groundwater quality. Information on each of the Ports that were purged is presented in Table 2.

**Table 2: Summary of AMQ16-626 2019 Westbay Well Monitoring Program - Development**

Port	Sampling Port Interval (mah)		Final 2016 Sample Parameters		Total Volume Removed in 2016 (L)	Final 2018 Sample Parameters		Total Volume Removed in 2018 (L)	Final 2019 Field Parameters		Total Volume Removed in 2019 (L)	2016 – 2019 Cumulative Volume Removed (L)
	To	From	F	EC		F	EC		F	EC		
6	276	287	48 [9%]	4.6	282	87 [17%]	9.0	8.25	62.76 [12%]	9.59	9	299.25
4	350	359	93 [18%]	4.9	1850	73 [14%]	14.8	13.25	120.0 [22%]	22.08	41	1,909.25
3	382	392	114 [22%]	7.5	177	97 [19%]	7.6	12.5	44.1 [9%]	5.27	76	265.5
2	441	452	120 [23%]	23	424	78 [15%]	17.7	6.25	201.7 [39%]	32.48	8	437.25
1	488	499	550	4.8	50	248 [48%]	9.4	0.25	137 [27%]	10.69	2	52.25

**Notes:** mah = metres along hole, relative to ground surface; F = fluorescein content (ppb); [%] = denotes F percentage achieved; EC = electrical conductivity (mS/cm)

F target for sampling based on removal of most of the drilling water introduced into the Formation in 2016 determined based on F content of the raw water sample. A minimum of 90% removal is targeted (90 % of 512 ppb). The average F content of drill water in 2016 was 512 ppb (F ranged between 173 and 1000 ppb during 2016 drilling activities)

2016 Sampling Targets – 90% target was not achieved during the allocated development period. Sample collected upon stabilization of field parameters (EC and F)

2018 Sampling Targets – collect sample to obtain groundwater quality information at a specific point in time

2019 sampling Targets – Port 3 (50 ppb, 10% target of initial F measured in 2016), Port 4 (coupled decreasing trends of F and EC as time permits) and Ports 2 and 6 (1 day each, as time permits).

Groundwater sampling was preformed using the Westbay Mosdax sampler in a similar fashion as the previous development and sampling programs completed in 2016 and 2018. The Mosdax sampler collects 1 Litre of groundwater at a time (per sampling instrument descent into the well); multiple sampler runs were carried out to collect one complete groundwater sample set from each interval. Information on the sampling completed in each Port is presented in Table 2 and Table 3.

**Table 3: Summary of AMQ16-626 Westbay Well 2019 Monitoring Program – Sample Collection**

Sample Port	Sampling Interval (mah)		Volume of Water Removed in 2019 (L)	Sample Date	Groundwater Parameters at Sampling Period (average field measured during sampling runs)		
	From	To			Residual Fluorescein (ppb)	Electrical Conductivity (mS/cm)	pH
6	276.0	287.4	9	3-Apr-19	74.08 ± 9.5	9.64	6.27
4	349.3	359.1	41	2-Apr-19	120.46 ± 2.1	22.28	6.84
3	381.3	392.7	76	29-Mar-19	55.82 ± 2.8	4.74	6.84
2	440.8	452.2	8	30-Mar-19	175.94 ± 18.9	29.67	8.35
1	488.1	499.0	2	not sampled	-	-	-

**Notes:** m = metres; mah = metres along hole; relative to ground surface; L = litres; ± standard deviation

Groundwater samples were collected in triplicate from sample Ports 2 and 3 and in duplicate from sample intervals 4 and 6 (due to time constraints). Groundwater samples were filtered and preserved in the field, as required, and collected in laboratory-supplied bottles which were packed and shipped to the analytical laboratory following the collection of each sample. Duplicate samples collected from Ports 3 and 2 were submitted for analysis, while the third sample set was kept on site as backup and disposed of upon receipt of the samples by the analytical laboratory. Field blanks were also collected for quality assurance/quality control (QA/QC) purposes. Analysis of general chemistry was completed at ALS Environmental (ALS) in Vancouver for the following parameters:

- Physical tests, including hardness, pH, conductivity, total suspended solids and total dissolved solids
- Anions and nutrients, including alkalinity, ammonia, bicarbonate, bromide, carbonate, chloride, fluoride, nitrate, nitrite, phosphorus (total and dissolved) and sulphate
- Metals (dissolved and total), including aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, selenium, silicon, silver, sodium, strontium, sulfur, tellurium, thallium, tin, titanium, uranium, vanadium and zinc. Additional metals were also analyzed by the analytical laboratory as part of the metals package, however they are not of interest to the project and will not be discussed herein out: cesium, rhenium, rubidium, sulfur, thorium, tungsten, yttrium and zirconium
- Petroleum Hydrocarbons, including total petroleum hydrocarbons (C10-C50)
- Radioactive Ions, including Radium 226
- Silicate (as requested by Agnico Eagle)

Certificates of analysis from ALS are included in Appendix C.

### **3.3 Evaluation of Formation Water Quality**

To properly assess the quality and salinity of true rock Formation groundwater, the drilling fluid present in the sampling interval must be removed as much as possible by purging. The amount of drilling fluid present in the Formation is estimated from the concentration of fluorescein in the raw groundwater sample at each interval, compared to the fluorescein content of the drilling fluid used during drilling of the borehole. In 2016 upon well installation, the sampling intervals were purged to remove as much of the drilling fluid as possible within the task schedule, prior to collecting a sample for chemical analysis.

In 2019, the fluorescein and electrical conductivity of groundwater was monitored during sampling in the field and compared to data from the end of development in 2016 and 2018 to assess whether the interval remained purged and still reflected true Formation groundwater quality. Fluorescein and conductivity were within the range of values recorded in 2016 for Ports 6 and 3, but higher in Ports 4 and 2 as compared to 2018. Groundwater samples were collected and submitted for chemical analysis from Ports 6, 4, 3 and 2.

The following summarizes the calculations made to estimate true Formation water quality and TDS from field measurements of electrical conductivity and laboratory analytical results of raw groundwater samples in 2019 and drilling water fluid in 2016, consistent with the approach used to calculate the Formation water quality from the 2018 investigation (Golder 2019a).

- 1) **Estimation of the chemistry of the drilling fluid introduced in the Formation during the 2016 well borehole drilling and installation activities.** The drilling fluid consisted of very low TDS lake water to which was added a concentrated brine. The range of composition of the drill fluid (the dilute brine) was estimated by comparing both the initial and maximum conductivity values measured in samples from the Formation (for each port 6, 4, 3, and 2; conductivity varied between sampling ports) against the conductivity of the concentrated brine<sup>2</sup>. This Dilute Brine Factor was used to calculate composition of the drilling fluid introduced into the sampling interval during the 2016 drilling and well installation activities as per equation (1) below.

$$(1) \quad \text{Dilute Brine Factor}_{\text{port } i} = \frac{\text{Field Conductivity}_{\text{port } i}}{\text{Brine Conductivity}_{\text{calculated}}}$$

This calculation assumes an insignificant proportion of formation water is present immediately after drilling, which is a fair assumption given that a high volume of drilling water was lost to the Formation (Golder, 2016a).

The drilling brine composition for each parameter was calculated from the product of the dilution brine factors and the chemistry of the drilling brine fluid for each port per equation (2).

$$(2) \quad \text{Dilute Brine}_{\text{port } i} = \text{Laboratory Result}_{\text{brine}} \times \text{Dilution Brine Factor}_{\text{port } i}$$

- 2) **Calculation of the proportion of drill brine remaining in the Formation upon sampling.** This was calculated based on the amount of residual fluorescein measured upon sample collection at each port in 2019 compared to the initial fluorescein content of the drilling fluid measured in 2016 (i.e. 512.7 ppb).
- 3) **Removal of the drilling fluid chemistry from the raw groundwater sample analysis.** The concentration of constituents from the drilling fluid are removed from the reported analytical results for each chemical constituent per the below equation (3). The 2019 laboratory results are provided in Appendix C.

$$(3) \quad \text{Groundwater Quality}_{\text{calculated}} = \text{Laboratory Result} - \frac{\text{Proportion of Drill Brine} \times \text{Dilute Brine Chemistry}}{\text{Proportion of Formation Water}}$$

The estimated chemistry of the drilling brine, proportion of residual drilling brine and Formation water for each sampling port are summarized in Table 4. The calculated groundwater quality for Ports 6, 4, 3 and 2 are summarized in Table 5.

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<sup>2</sup> Brine conductivity was estimated from the calculated TDS of the drilling brine fluid using a conversion factor of 0.75 which is appropriate for brine solutions (Rusydi, 2017). Brine TDS was calculated based on constituent concentrations (refer to Table 4 and Appendix C). Laboratory-reported TDS and conductivity were not reliable as they exceeded instrument calibration.

## 4.0 RESULTS AND DISCUSSION

### 4.1 Hydraulic Head Profile and Groundwater Flow Direction Below Whale Tail Lake

The planned Whale Tail Pit is located within a closed talik below the North Basin of Whale Tail Lake. The closed talik is inferred to transition to open talik below the South Basin due to the increased width and depth of the lake towards the south. The water table below both basins will be equivalent to the lake surface elevation.

Permafrost underlies the land surrounding the lake, which restricts the lateral flow of groundwater to the talik and restricts the recharge of the sub-permafrost groundwater flow system by precipitation. Groundwater flow is controlled by surface water elevations in lakes with open talik; water moves vertically through the open talik to the underlying sub-permafrost groundwater flow system. In effect, lakes with open taliks in continuous permafrost regions are equivalent to large monitoring wells.

AMQ16-626 was installed to evaluate groundwater quality in the unfrozen bedrock and to verify the hydraulic gradient that exists below Whale Tail Lake. The hydraulic gradient, in combination with the bedrock hydraulic conductivity, will control the potential flux to or from Whale Tail Lake, and the flooded Whale Tail Pit post-closure.

Table 6 summarizes the calculated hydraulic heads based on the measured pressure in each sampling port. Although Port 6 (shallowest interval) is included in Table 6, it is suspected that this port may be in the cryopeg near the permafrost contact, which could affect the measured hydraulic head. This inference is supported by the formation temperature measured in 2018, which is less than zero (Golder 2019a). In 2019, stabilized temperature readings were not recorded. Data from the deeper ports, which are confirmed to be in unfrozen rock based on the formation temperature measured in 2018, were used to assess the vertical gradient.

**Table 6: AMQ16-626 Westbay Well Hydraulic Heads (16 March 2019)**

Port/Zone	Measurement Interval (mah)		Measurement Interval (mbgs)		Port Depth (mah)	Port Depth (mbgs)	Calculated Depth to Water (mbgs)	Calculated Hydraulic Head (masl)
	From	To	From	To				
6	276.0	287.4	257.7	268.3	276.2	257.9	1.3	153.2
4	349.3	359.1	326.1	335.2	349.5	326.3	1.4	153.1
3	381.3	392.7	356.0	366.6	381.5	356.2	0.8	153.7
2	440.8	452.2	411.5	422.2	441.0	411.7	1.9	152.6
1	488.1	499.0	455.7	465.9	488.3	455.9	2.2	152.3

Notes: m = metres; mah = metres along hole relative to ground surface (borehole angled to surface); mbgs = metres below ground surface (vertical down from surface); masl = metres above sea level (elevation)

Source: Golder (2016a).

The data collected at AMQ16-626 in March 2019 indicates the overall downward gradient is present between the shallowest and deepest port, which is consistent with the observations in November 2018 and modelling results, which predicts that groundwater flows downwards from Whale Tail Lake and upwards to DS1. Data collected at Port 3 somewhat deviates with this trend, and in consideration of the 2018 data, it is suspected a recording error was made in the field during the 2019 measurement. During future monitoring events, the hydraulic head will be calculated in the field to identify these potential errors, and allow for re-measurement, if needed. Assuming the measured hydraulic head is representative of the midpoint of the measurement interval, a downward hydraulic gradient of 0.006 m/m was present between Ports 1 and 4. This hydraulic gradient is similar to what was measured in November 2018 (0.008 m/m).



Based on the geometric average of test data collected at the site, the hydraulic conductivity of the deep bedrock is estimated to be  $8 \times 10^{-10}$  m/s (Golder 2019c). This data and geometric average consider data available at the time of the FEIS submission for the Approved Project, and supplemental data collection since its submission. The expanded hydraulic conductivity data set was also presented in the Attachment B of the Groundwater Management Monitoring Report (Golder 2019b). Consistent with the development of the EA Scenario in the FEIS, an upper bound estimate of deep bedrock hydraulic conductivity was assumed to be three times the geometric average ( $3 \times 10^{-9}$  m/s).

Considering the range in deep bedrock hydraulic conductivity ( $8 \times 10^{-10}$  m/s to  $3 \times 10^{-9}$  m/s), the measured hydraulic gradients in 2018 and 2019 (0.008 to 0.006), and assuming an effective porosity of 0.001 (Maidment 1992; Stober and Bucher 2007), the estimated downward groundwater flow velocity is between approximately 0.2 m/yr and 0.8 m/yr. The lower end of this range is considered the most likely groundwater velocity, as it is based on the geometric average of the hydraulic conductivity measurements in the deep bedrock ( $8 \times 10^{-10}$  m/s).

Gradients measured during this monitoring program are considered a reasonable interpretation of what long-term gradients could be post-closure following the formation of the pit lake. Recharge and discharge from the base of Whale Tail Lake or a flooded pit lake will be controlled by the vertical hydraulic gradients and the bedrock hydraulic conductivity near the base of the permafrost. Considering the approximate area of the Whale Tail Pit ( $0.5 \text{ km}^2$ ), the updated range in bedrock hydraulic conductivity since the FEIS ( $8 \times 10^{-10}$  to  $3 \times 10^{-9}$  m/s), and the measured downward gradients (0.006 to 0.008), the data would indicate long-term downward groundwater flux would be between approximately  $0.2 \text{ m}^3/\text{day}$  to  $1 \text{ m}^3/\text{day}$ . This groundwater flux is lower than historical estimates of groundwater flux (up to  $11 \text{ m}^3/\text{yr}$ ; Golder 2019a), and reflects the increased hydraulic testing of the bedrock, which has resulted in a lower interpreted bedrock hydraulic conductivity (Golder 2019c).

Overall, the estimated downward groundwater flux is similar to the long-term predicted discharge from the Whale Tail pit lake at post-closure for the Approved Project ( $1.7 \text{ m}^3/\text{day}$ ; Golder 2016c) and supports the conclusion in the FEIS that long-term predicted flows from the pit lake to the groundwater flow system will be negligible relative to the surface water exchange into the pit lake.

## 4.2 Groundwater Quality

Field measurements of electrical conductivity and fluorescein concentration serve, in part, to evaluate whether the groundwater accessed via the Westbay well sampling ports continues to be representative of Formation groundwater quality.

The electrical conductivity and fluorescein concentrations measured in water pumped from ports 6, 4, 3, 2, and 1 of the Westbay well throughout the sampling programs since well installation in 2016, are summarized in Figures 1. A detail of development for the 2019 program is shown on Figure 2. Field measurements of electrical conductivity and fluorescein recorded at the time of sampling are summarized in Table 3. The values are averages from the subsamples collected to obtain the required volume of water for analysis.

Figure 3 depicts the hydraulic conductivity measured at the borehole prior to installing the Westbay well (Golder, 2016c), along with fluorescein content and electrical conductivity measured after purging and prior to sampling in the 2016, 2018 and 2019 field programs. This figure illustrates that the fluorescein content is relatively stable at Ports 3 and 6; trending toward stability at Port 4; and still elevated at Ports 2 and 1. Although still elevated, the declining trend in fluorescein content observed in the most conductive zone (i.e. Port 1) likely represents natural flushing over time. Elevated fluorescein content in samples is indicative of a high proportion of drilling fluid in groundwater and therefore, not representative of Formation groundwater quality.

Groundwater samples were collected from Ports 6, 4, 3, and 2. Port 1 was not sampled because of its elevated residual fluorescein and based on the limited development completed to date but field measurements of fluorescein content and electrical conductivity were recorded. Field activities prioritized obtaining representative samples of groundwater quality from Port 3 as this interval has been the most developed previously, then to continue the development of Port 4 for the remainder of the scheduled field work. Sampling and limited development of intervals 6 and 2 were also planned. The field schedule remaining after sampling of Ports 3 and 6 allowed for limited development of Ports 2 and 4. Field measurements of fluorescein and electrical conductivity at Ports 2 and 4 in 2019 indicate that these zones are still not representative of Formation groundwater. These ports were nonetheless sampled to track the evolution of groundwater quality with natural flushing which, in time, is expected to displace drilling fluids and return the interval to pre-drilling groundwater quality.

Calculated Formation groundwater quality is shown in Table 5, presenting the estimated range of constituent concentrations of Formation water at each Port sampled in 2016, 2018 and 2019. Analytical results on raw samples are included in Appendix C. The results of the 2019 groundwater quality data for Ports 6 and 3 are generally within the same order of magnitude to those reported in 2016 albeit slightly higher than in 2016, except for a few parameters. This is attributed to the higher proportion of drilling brine fluid in the Formation from samples collected in 2019 compared to 2016. Formation groundwater quality at Ports 2 and 4 was calculated but results are considered approximations only; the elevated proportion of drilling brine in the samples decreases the accuracy of the estimate<sup>3</sup>.

The following provides an assessment of water quality at each Port.

### **Port 6**

The temperature measured by the Mosdax sampler during the 2018 pressure profile at Port 6 was below zero (-0.17 °C; Golder, 2019a). Considering the calculated freezing point depression of 0.2 °C suggests Port 6 is within the basal cryopeg. The cryopeg zone is interpreted to extend to at least 258 m depth (top interval of Port 6) within the vicinity of the Westbay well. Groundwater from the cryopeg (Port 6) flows through the permeable (unfrozen) sections of the aquifer. Throughout the 2019 monitoring program, electrical conductivity and fluorescein progressed at different rates during purging (conductivity stabilized while fluorescein content continued to decrease over time; Figure 2) possibly because of partial freezing of drilling water and likely exclusion of fluorescein in ice (i.e., potential variability of fluorescein within the cryopeg).

The estimation of true Formation groundwater quality was completed per the method described in Section 2.3. Table 5 presents the minimum and maximum of the range of calculated concentrations of Formation water at Port 6 sampled in 2016, 2018, and 2019 for comparison.

The 2019 field-measured groundwater electrical conductivity and/or fluorescein content at the port remained within the same order of magnitude albeit slightly higher than values recorded at the end of the well development period in 2016 and 2018 (electrical conductivity only). This suggests that groundwater quality at that location remained relatively stable and thus, is anticipated to be representative of Formation water. The results of the 2019 groundwater quality estimation (Table 5) are also within the same order of magnitude but slightly higher than those previously reported in 2016 and 2018, with the exception of a few parameters.

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<sup>3</sup> The variability in fluorescein and brine content of the drilling fluid induces uncertainty of the drilling brine composition; the effect of this is controlled by removal of drilling brine via purging (Golder 2016b).

Based on the 2019 calculations of groundwater quality at Port 6, the concentration of trace metals and arsenic in groundwater is low. The 2019 calculated radium-226 concentration is estimated to be 1 Bq/L and above the MDMER limit of 0.37 Bq/L slightly higher than the 2016 concentration range (i.e., 0.43 to 0.52 Bq/L). Radium 226 is a naturally occurring element in deep bedrock groundwater.

The 2016 data is considered the most reliable based on the lower fluorescein content measured at the time of sampling; however, the 2019 data is considered valid. The initial model input is still considered accurate and consistent with the 2019 data and therefore the new data does not warrant revising the conceptual model of groundwater TDS.

#### **Port 4**

The 2019 field-measured groundwater fluorescein content and electrical conductivity at Port 4 were higher than values recorded at the end of the well development period in 2016 and 2018. The increasing trend observed in 2018 continued throughout the 2019 investigation, but conductivity and fluorescein trended toward stabilization at the end of the 2019 program. Higher 2019 fluorescein content and electrical conductivity is believed to represent an influx of drilling fluid present in undeveloped zones that migrated back into the Port 4 sampling interval. The higher proportion of drilling fluid in the Formation and in the samples collected results in a lower accuracy of calculated groundwater quality from samples collected in 2019 compared to those collected in 2016 after a more complete purge.

The groundwater quality was calculated but is not considered sufficiently reliable to use for validation of results because of the large proportion of residual drilling fluid present in the sample collected. Given the absence of radium-226 in the drilling fluid, concentrations of radium-226 in the raw water sample suggests MDMER criteria could be exceeded for this constituent. Radium 226 is a naturally occurring element in deep bedrock groundwater.

Given the higher fluorescein content of the groundwater sample collected in 2019 compared to the sample collected in 2016 at Port 4, the 2016 data is considered to be more reliable in representing Formation groundwater quality. The initial model input is still considered accurate and the new data does not warrant revising the conceptual model of groundwater TDS.

#### **Port 3**

The 2019 field-measured fluorescein content and electrical conductivity at Port 3 were similar to values recorded at the end of the well development period in 2016, suggesting that water quality remains representative of Formation groundwater in this zone. Concentrations of fluorescein and electrical conductivity continued to decrease throughout the 2019 monitoring program in Port 3 (Figure 2), where the fluorescein content dropped to below the 2016 level. A lower proportion of drill fluid was present in the 2019 sample than in 2016.

Estimated Formation groundwater quality is included in Table 5. The results of the 2019 groundwater quality data are within the same order of magnitude to those reported in 2016, albeit slightly lower with the exception of a few parameters. Compared to 2018 data, the 2019 water sample had a lower fluorescein content and therefore are considered more reliable.

Arsenic and radium-226 concentrations at Port 3 are estimated to be low and in the same order of magnitude as concentration ranges calculated in 2016. Calculated concentrations arsenic and radium-226 at Port 3 meet the Water license and MDMER criteria respectively.

The 2019 data are considered to be valid and is consistent with the 2016 data. The initial model input is still considered accurate and the new data does not warrant revising the conceptual model of groundwater TDS.

## Port 2

The 2019 field-measured groundwater fluorescein content and electrical conductivity increased throughout the limited development program (refer to Figure 2). Values were higher than in 2016 and 2018 and continued to increase throughout the brief purging period in 2019. Given the continued high proportion of drilling brine, a proper estimation of Formation groundwater quality is not deemed possible for from this Port at this time.

## Summary

Based on the groundwater monitoring programs completed to date, the Formation groundwater quality calculated as part of the 2016 investigation at Ports 6 and 4, and the 2016 and 2019 investigation at Port 3 are considered sufficiently reliable to assess Formation groundwater quality.

Based on the above-stated results from Ports 6, 4 and 3, the TDS content of Formation groundwater is estimated to range between 2,980 mg/L and 4,042 mg/L. This range in TDS is consistent with the developed conceptual model (which ranged between 3,198 and 4,042 mg/L) and no changes to the model are warranted. The TDS profile that was adopted in the FEIS for the Approved Project is presented in Figure 4, along with the TDS data that is considered to be reliable from 2016 and 2019.

Arsenic concentrations in samples collected from the groundwater sampling ports in 2019 were low and consistent with previous reliable data collected from the Westbay well. Radium-226 in groundwater is slightly higher in 2019 at Port 6 and Port 3 and consistent with previous reliable data, this constituent may exceed MDMER criteria in Formation groundwater.

## 5.0 QUALITY ASSURANCE/QUALITY CONTROL

Groundwater samples were collected from Ports 2 and 3 in triplicate and submitted in duplicate for analysis to the analytical laboratory as part of the quality assurance/quality control ('QA/QC') protocol. In addition, field blanks were also submitted for analysis of select parameters. The analytical laboratory performs equipment blanks as a method of internal QA/QC verification.

Analytical repeatability was tested by assessing the similarity between duplicate pairs of results. For each duplicate pairs of analysis where both results were higher than 5 times the method detection limit (MDL), the relative percent difference (RPD) was calculated as follows:

$$RPD = \frac{\text{absolute [difference (concentration of a given parameter)]}}{\text{[average (concentration of a given parameter)]}} \times 100$$

Per USEPA recommended methods (USEPA, 1994), an RPD of 20% or less was considered acceptable. Where one or both results of the duplicate pair were less than 5 times the MDL, a margin of +/- MDL was considered acceptable.

Table 7 presents the RPD or +/- MDL value calculated from the duplicate pair of results. Approximately 50% of duplicate pairs of analyses had one or both results below the method detection limit and consequently could not be assessed for repeatability. QA/QC results for the duplicate samples were within acceptable tolerance limits (RPD or +/- MDL) with the exception of duplicate concentrations of total chromium and iron in Port 3 as well as duplicate concentrations of total and dissolved concentrations of chromium, iron, nickel and zinc in Port 2. All other trace components and major elements for samples are considered adequately repeatable. The results of the analysis of the travel blank and equipment blanks submitted to the ALS indicate all parameters to be below the laboratory method detection limit, with the exception of elevated concentrations of total and dissolved zinc in the equipment blank (L2253513-5) submitted to the lab along with samples collected from Ports 2 and 3. The concentrations of zinc reported in the field blank were an order of magnitude higher than those reported in the Westbay well samples. The

elevated concentrations of zinc in the equipment blank may be the result of leaching from the stainless steel Westbay sample bottles. Therefore, detected concentrations of zinc reported in 2019 for port 3 may not be qualitative.

The original brine fluid was analyzed by Multilab analytical laboratory. TDS values were also calculated from the laboratory results in order to assess potential discrepancies between the ionic balance and uncertainty of the results (refer to Tables 4 and 7). The results of the field, calculated, and laboratory measured values were within reasonable range limits for all samples, with the exception of the brine fluid. The TDS result reported for the brine fluid (36,946 mg/L) was significantly less than the calculated value (130,500 mg/L). The laboratory measured TDS and consequently electrical conductivity (55.42 mS/cm) of the brine fluid were deemed unreliable due to the ionic imbalance discrepancy. The calculated TDS of the brine fluid was used to correct the groundwater quality data as discussed in Section 2.3 of the report (Golder 2019a).

Uncertainty in the calculated groundwater water quality results from the variability in drill water composition augmented by probable mixing between aquifer zones having different levels of development (purging of drill water); this has an influence on the accuracy of all calculated groundwater quality; the effect of which is decreased with lower drilling brine proportion. The 2019 data remain valid to estimate water quality at Port 3 and 6, however the Port 6 2016 results may be a more accurate representation of Formation groundwater quality than 2019 based on the lower fluorescein content measured in the samples. Based on the elevated concentrations of electrical conductivity, fluorescein content and lab measured TDS values, all indicative of the presence of drilling brine, samples collected from Ports 4 and 2 in 2019 do not offer an accurate representation of Formation groundwater quality.

## 6.0 CONCLUSION

The 2019 Westbay Well field program was carried out in support of the Whale Tail Pit Project Certificate No. 008, Term and Condition No. 15, to obtain additional pre-development groundwater quality data and to verify the hydraulic gradient. These data were used to verify modelling assumptions related to the groundwater quality and the hydraulic gradient near the mine development areas.

Hydraulic head measurements in 2018 and 2019 indicate that a downward vertical hydraulic gradient is present in the North Basin of Whale Tail Lake, which is consistent with the conceptual understanding of groundwater flow directions and the predicted conditions post-closure following the formation of the Whale Tail Pit Lake. Revisions to the numerical or conceptual models is not considered necessary based on the vertical gradients as the data is consistent the model assumptions.

Groundwater quality was estimated from the samples collected, subtracting the effect of residual drilling water in the Formation (in the raw water sample). The 2019 program estimated groundwater quality at Ports 6 and 3 are in the same range as estimated in 2016 and the data collected from these ports were considered reliable. Conductivity and fluorescein values were higher in water sampled from Ports 4 and 2 in 2019 compared to 2016, consequently the data collected from these ports is considered less reliable to evaluate groundwater quality than the data collected in 2016. The assumptions for the conceptual model, which were developed based on 2016 data are consistent with the recent data collection in Ports 6 and 3, are still considered to be appropriate. Changes to the water management plan are therefore not considered necessary based on the data presented in this report.

The concentrations of metals and arsenic in groundwater at Ports 6 and 3 are low similar to previous reliable data. Given that the arsenic concentrations remain similar to the assumptions adopted in the geochemical models (low arsenic in Formation groundwater), the contention that groundwater arsenic content is not likely to have a significant effect on mine surface water quality is still valid.

## 7.0 STUDY LIMITATIONS

This technical memorandum was prepared for the exclusive use of Agnico Eagle Mines Limited. The technical memorandum, which specifically includes all tables and attachments, is based on data and information collected by Golder Associates Ltd. and is based solely on the conditions of the property at the time of the work, supplemented by historical information and data obtained by Golder Associates Ltd. as described in this technical memorandum.

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The services performed, as described in this technical memorandum, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

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The findings and conclusions of this technical memorandum are valid only as of the date of this technical memorandum and for the locations investigated. If new information is discovered in future work, including excavations, borings, or other studies, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this technical memorandum and provide amendments as required.

## 8.0 CLOSURE

We trust this report meets your needs at this time. Should you have any questions, please do not hesitate to contact the undersigned.

### Golder Associates Ltd.



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DH/VJB/DC/jr

[https://golderassociates.sharepoint.com/sites/102627/technical work/reporting/westbay/rev 0/18108905-303-tm-westbay gw monitoring\\_rev0\\_29july19.docx](https://golderassociates.sharepoint.com/sites/102627/technical%20work/reporting/westbay/rev%2018108905-303-tm-westbay%20gw%20monitoring_rev0_29july19.docx)

- Attachments: Tables 4, 5, 7  
Figure 1 – 2016, 2018 and 2019 Development Record  
Figure 2 – 2019 Development Record  
Figure 3 – AMQ16-626 Electrical Conductivity, Fluorescein and Hydraulic Conductivity Depth Profile  
Figure 4 – TDS Profile Adopted in the FEIS for the Approved Project  
Appendix A – AMQ16-626 Westbay System Installation Details  
Appendix B – Westbay Instruments Mosdax Sampler Calibration Reports  
Appendix C – 2019 Laboratory Certificates of Analysis  
Appendix D – 2016 Laboratory Certificate of Analysis – Brine Fluid

<b>PERMIT TO PRACTICE GOLDER ASSOCIATES LTD.</b>	
Signature	<i>J. Levenick</i>
Date	<i>July 29/2019</i>
<b>PERMIT NUMBER: P 049</b>	
NT/NU Association of Professional Engineers and Geoscientists	

## 9.0 REFERENCES

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**Table 4**  
**Dilute Brine Chemistry Westbay Well AMQ16-626**  
**Whale Tail Lake Talik**  
**Whale Tail Project, Nunavut**

Sample	Brine Fluid	Calculated Dilute Brine Port 6		Calculated Dilute Brine Port 4		Calculated Dilute Brine Port 3		Dilute Brine Port 2		
		Initial Brine	Maximum Brine	Initial Brine	Maximum Brine	Initial Brine	Maximum Brine	Initial Brine	Maximum Brine	
Date	17-Apr-16	21-Jul-16	21-Jul-16	24-Apr-16	27-Apr-16	02-Sep-16	02-Sep-16	08-Aug-16	09-Aug-16	
<b>Field measured parameters</b>	<b>Units</b>									
Fluorescein Concentration	mg/L	512.70	138.00	158.10	512.70	341.90	445.90	437.20	133.00	397.10
Drilling Fluid Proportion		1.00	0.27	0.31	1.00	0.67	0.87	0.85	0.26	0.77
Formation Water Proportion		0.00	0.73	0.69	0.00	0.33	0.13	0.15	0.74	0.23
Initial Conductivity Reading	uS/cm	0	10240	12210	3810	19400	52280	53800	11700	19980
Dilution of Brine Factor in Port		0.00	0.06	0.07	0.02	0.11	0.30	0.31	0.07	0.11
<b>Conventional Parameters</b>										
Total dissolved solids (calculated)	mg/L	130500	7680	3122	2858	14550	39210	40350	8775	14985
Total dissolved solids (lab)	mg/L	36946	-	-	-	-	-	-	-	-
pH	S.U.	10	11.25	7.40	12	11	11	11	11	11
Conductivity (lab)	uS/cm	55420	-	-	-	-	-	-	-	-
Conductivity (calculated)	uS/cm	174000	10240	4684	3810	19400	52280	53800	11700	19980
Reported Hardness	mg CaCO <sub>3</sub> /L	105554	6212	2230	2311	11769	31715	32637	7098	12121
Alkalinity	mg CaCO <sub>3</sub> /L	145.0	8.5	38.0	3.2	16.2	43.6	44.8	9.8	16.7
Bicarbonate (HCO <sub>3</sub> )	mg CaCO <sub>3</sub> /L	27.0	1.6	38.0	0.6	3.0	8.1	8.3	1.8	3.1
<b>Major ions</b>										
Calcium (Ca)	mg/L	42266	2487	2966	925	4712	12699	13068	12699	13068
Magnesium (Mg)	mg/L	3.9	0.2	0.3	0.1	0.4	1.2	1.2	1.2	1.2
Potassium (K)	mg/L	1717	101	120	38	191	516	531	516	531
Sodium (Na)	mg/L	838	49	59	18	93	252	259	252	259
Bromide (Br)	mg/L	1066	63	75	23	119	320	330	320	330
Chloride (Cl)	mg/L	83700	4926	5873	1833	9332	25149	25880	25149	25880
Fluoride (F)	mg/L	0.06	0.004	0.004	0.001	0.01	0.02	0.02	0.02	0.02
Sulphate (SO <sub>4</sub> )	mg SO <sub>4</sub> /L	<0.6	0	0	0	0	0	0	0	0
<b>Nutrients</b>										
Nitrates (NO <sub>3</sub> )	mg N/L	0.54	0.03	0.04	0.01	0.06	0.2	0.2	0.04	0.06
Nitrites (NO <sub>2</sub> )	mg N/L	0.06	0.004	0.004	0.001	0.007	0.02	0.02	0.004	0.007

**Table 4  
Dilute Brine Chemistry Westbay Well AMQ16-626  
Whale Tail Lake Talik  
Whale Tail Project, Nunavut**

Sample	Brine Fluid	Calculated Dilute Brine Port 6		Calculated Dilute Brine Port 4		Calculated Dilute Brine Port 3		Dilute Brine Port 2		
		Initial Brine	Maximum Brine	Initial Brine	Maximum Brine	Initial Brine	Maximum Brine	Initial Brine	Maximum Brine	
Date	17-Apr-16	21-Jul-16	21-Jul-16	24-Apr-16	27-Apr-16	02-Sep-16	02-Sep-16	08-Aug-16	09-Aug-16	
<b>Field measured parameters</b>	<b>Units</b>									
Fluorescein Concentration	mg/L	512.70	138.00	158.10	512.70	341.90	445.90	437.20	133.00	397.10
Drilling Fluid Proportion		1.00	0.27	0.31	1.00	0.67	0.87	0.85	0.26	0.77
Formation Water Proportion		0.00	0.73	0.69	0.00	0.33	0.13	0.15	0.74	0.23
Initial Conductivity Reading	uS/cm	0	10240	12210	3810	19400	52280	53800	11700	19980
Dilution of Brine Factor in Port		0.00	0.06	0.07	0.02	0.11	0.30	0.31	0.07	0.11
<b>Metals (dissolved)</b>										
Aluminum (Al)	mg/L	0.5	0.03	0.03	0.01	0.06	0.1	0.2	0.03	0.06
Antimony (Sb)	mg/L	0.035	0.002	0.002	0.001	0.004	0.011	0.011	0.002	0.004
Silver (Ag)	mg/L	<0.0001	0	0	0	0	0	0	0	0
Arsenic (As)	mg/L	0.8	0.05	0.05	0.02	0.09	0.2	0.2	0.05	0.09
Barium (Ba)	mg/L	0.1	0.007	0.008	0.002	0.01	0.03	0.03	0.008	0.013
Berillium (Be)	mg/L	<0.0005	0	0	0	0	0	0	0	0
Bismuth (Bi)	mg/L	<0.0005	0	0	0	0	0	0	0	0
Boron (B)	mg/L	13.2	0.8	0.9	0.3	1.5	4.0	4.1	0.9	1.5
Cadmium (Cd)	mg/L	<0.00002	0	0	0	0	0	0	0	0
Chromium (Cr)	mg/L	<0.0006	0	0	0	0	0	0	0	0
Cobalt (Co)	mg/L	0.0406	0.002	0.003	0.001	0.005	0.012	0.013	0.003	0.005
Copper (Cu)	mg/L	0.0039	0.0002	0.0003	0.0001	0.0004	0.0012	0.0012	0.0003	0.0004
Tin (Sn)	mg/L	<0.001	0	0	0	0	0	0	0	0
Iron (Fe)	mg/L	2.6	0.2	0.2	0.1	0.3	0.8	0.8	0.2	0.3
Lithium (Li)	mg/L	34.52	2.0	2.4	0.8	3.8	10.4	10.7	2.3	4.0
Manganese (Mn)	mg/L	<0.0005	0	0	0	0	0	0	0	0
Mercury (Hg)	mg/L	0.0	0.00002	0.00003	0.00001	0.00004	0.00012	0.00012	0.00003	0.00004
Dissolved Mercury (Hg)	mg/L	-	0.00002	0.00003	0.00001	0.00004	0.00012	0.00012	0.00003	0.00004
Molybdenum (Mo)	mg/L	<0.0005	0	0	0	0	0	0	0	0
Nickel (Ni)	mg/L	1.35	0.08	0.09	0.03	0.15	0.41	0.42	0.09	0.16
Lead (Pb)	mg/L	<0.0003	0	0	0	0	0	0	0	0
Selenium (Se)	mg/L	3.83	0.23	0.27	0.08	0.43	1.15	1.18	0.26	0.44
Silica (Si)	mg/L	2.93	0.17	0.21	0.06	0.33	0.88	0.91	0.2	0.34
Strontium (Sr)	mg/L	656.0	38.61	46.03	14.36	73.14	197.1	202.83	44.11	75.33
Telluride (Te)	mg/L	<0.0005	0	0	0	0	0	0	0	0
Thallium (Tl)	mg/L	<0.002	0	0	0	0	0	0	0	0
Titanium (Ti)	mg/L	45.2	2.66	3.17	0.99	5.04	13.58	13.98	3.04	5.19
Uranium (U)	mg/L	-	0	0	0	0	0	0	0	0
Vanadium (V)	mg/L	<0.001	0	0	0	0	0	0	0	0
Zinc (Zn)	mg/L	<0.0005	0	0	0	0	0	0	0	0
<b>Radioactive Ions</b>										
Radium (Ra 226)	Bq/L	<0.066	0	0	0	0	0	0	0	0
<b>Hydrocarbons</b>										
Hydrocarbons (C10-C50)	mg/L	0	0	0	0	0	0	0	0	0
<b>QA/QC</b>										
Calculated TDS (lab)	-	130500	-	-	-	-	-	-	-	-
Lab measured vs Calculated TDS	-	28%	-	-	-	-	-	-	-	-
Lab measured TDS vs Conductivity	-	0.7	-	-	-	-	-	-	-	-
Calculated TDS vs Calculated Conductivity	-	0.8	-	-	-	-	-	-	-	-

**Table 5**  
**Rock Formation Groundwater Quality Corrected to Remove Residual Drilling Water**  
**Whale Tail Lake Talik**  
**Whale Tail Project, Nunavut**

Sample	Port 6						Port 4				Port 3						
	2-Aug-2016		13-Nov-2018		3-Apr-2019		20-Jul-2016		11-Nov-2018		14-Sep-2016		12-Nov-2018		29-Mar-2019		
Drilling Fluid Proportion	0.04	0.24	0.16		0.14		0.09	0.18	0.13		0.08	0.18	0.20		0.11		
Formation Water Proportion	0.96	0.76	0.84		0.86		0.91	0.82	0.87		0.92	0.82	0.80		0.89		
Sampling interval depth (metres along borehole)	274.0 m - 287.4 m						349.3 m - 359.1 m				381.3 m - 392.7 m						
Sampling interval vertical depth (metres)	257.7 m - 268.3 m						326.1 m - 335.2 m				356.0 m - 366.6 m						
Estimated concentration range (calculated)	minimum	maximum	minimum	maximum	minimum	maximum	minimum	maximum	minimum	maximum	minimum	maximum	minimum	maximum	minimum	maximum	
Average Field measured parameters																	
Fluorescein	ppb	41.77		83.54		74.08		93.00		66.21		81.90		100.05		55.82	
pH	S.U.	-	-	6.36		6.27		-	-	7.50		-	-	8.35		6.93	
Conductivity	uS/cm	4610		9083		9644		6650		14555		4450		7500		4747	
Conventional parameters																	
Total dissolved solids	mg/L	3198	4042	4681	5171	5712	5962	3581	3966	7970	9945	3483	3918	<4980	<5100	<2980	<2990
pH	S.U.	7.41	7.27	6.50	6.57	6.29	6.29	7.87	7.82	6.88	6.91	7.96	7.91	7.31	7.41	6.73	6.84
Conductivity	uS/cm	4797	6042	8041	8496	8388	8720	5366	5938	13084	15511	5220	5866	<7350	<7530	<4660	<4730
Reported Hardness	mg CaCO <sub>3</sub> /L	2397	3030	2883	3127	3167	3369	2627	2910	4169	5582	1680	1891	<2600	<2740	<1300	<1320
Alkalinity	mg CaCO <sub>3</sub> /L	40	51	30	31	34	34	18	20	9	11	52	58	51	52	54	54
Bicarbonate (HCO <sub>3</sub> )	mg CaCO <sub>3</sub> /L	40	51	31	32	35	35	18	20	11	12	52	58	60	61	58	59
Major ions																	
Calcium (Ca)	mg/L	960	1213	1071	1164	1194	1275	1032	1143	1563	2125	671	756	<1040	<1090	<521	<528
Magnesium (Mg)	mg/L	22	27	51	51	44	44	12	14	62	66	1	1	1	1	<1.0	<1.0
Potassium (K)	mg/L	8	10	<20	<20	11	11	38	42	67	67	16	18	<38	<40	<11.5	<11.8
Sodium (Na)	mg/L	232	293	287	293	308	310	267	296	341	365	306	344	285	313	323	332
Bromide (Br)	mg/L	25	32	34	37	40	42	32	35	51	77	22	25	<32.5	<32.7	<17	<18.2
Chloride (Cl)	mg/L	2089	2641	2453	2697	2959	3119	2582	2860	3818	5722	1714	1929	<2700	<2700	<1580	<1580
Fluoride (F)	mg/L	0.21	0.27	<1.0	<1.0	<1.0	<1.0	0.5	0.5	<1.0	<1.0	1.1	1.2	<1.0	<1.0	<0.80	<0.80
Sulphate (SO <sub>4</sub> )	mg SO <sub>4</sub> /L	-	-	<15	<15	<15	<15	-	-	<15	<15	-	-	<15	<15	<6.0	<6.0
Nutrients																	
Ammonia N (NH <sub>3</sub> +NH <sub>4</sub> )	mg N/L	-	-	<0.437	<0.443	<0.466	<0.466	-	-	<0.157	<0.158	-	-	0.169	0.173	0.103	0.106
Nitrates (NO <sub>3</sub> )	mg N/L	0.063	0.079	<0.25	<0.25	<0.25	<0.25	0.06	0.06	<0.25	<0.25	0.016	0.018	<0.25	<0.25	<0.10	<0.10
Nitrites (NO <sub>2</sub> )	mg N/L	0.010	0.013	<0.050	<0.050	<0.050	<0.050	0.011	0.012	<0.050	<0.050	0.038	0.043	<0.050	<0.050	<0.020	<0.020
Total Phosphorous (P)	mg P/L	0.021	0.026	<0.0043	<0.0043	<0.0020	<0.0020	0.011	0.012	0.01	0.01	0.049	0.055	0.01	0.01	0.003	0.005



**Table 7**  
**QA/QC of Rock Formation Groundwater Quality**  
**Whale Tail Lake Talik**  
**Whale Tail Project, Nunavut**

Sample			Port 6	Port 4		Travel Blank
Date			3-Apr-2019	2-Apr-2019		3-Apr-2019
Certificate No.			L2255221-3	L2255221-2		L2255221-1
Sample ID			PORT 6	PORT 4		ALS Travel Blank
Paramètres	Units	MDL			MDL	
<b>Physical Tests (Water)</b>						
Conductivity	uS/cm	2	8940	21300	2	<2.0
pH	pH	0.1	6.36	6.75	0.1	5.83
Total Suspended Solids	mg/L	3	5.1	9.1	3	<3.0
Total Dissolved Solids	mg/L	15	6210	13300	3	<3.0
<b>Anions and Nutrients</b>						
Alkalinity, Bicarbonate (as CaCO <sub>3</sub> )	mg/L	1.0	30.3	18.7	1	<1.0
Alkalinity, Carbonate (as CaCO <sub>3</sub> )	mg/L	1.0	<1.0	<1.0	1	<1.0
Alkalinity, Hydroxide (as CaCO <sub>3</sub> )	mg/L	1.0	<1.0	<1.0	1	<1.0
Alkalinity, Total (as CaCO <sub>3</sub> )	mg/L	1.0	30.3	18.7	1	<1.0
Ammonia, Total (as N)	mg/L	0.0050	0.466	0.238	0.005	<0.0050
Bromide (Br)	mg/L	1	44.8	99.6	0.05	<0.050
Chloride (Cl)	mg/L	2	3380	7430	0.1	<0.10
Fluoride (F)	mg/L	0.8	<1.0	<2.0	0.02	<0.020
Nitrate (as N)	mg/L	0.1	<0.25	<0.50	0.005	<0.0050
Nitrite (as N)	mg/L	0.02	<0.050	<0.10	0.001	<0.0010
Phosphorus (P)-Total	mg/L	0.002	<0.0020	0.0065	0.002	<0.0020
Silicate (as SiO <sub>2</sub> )	mg/L	0.5	<50	<50	0.5	<0.50
Sulfate (SO <sub>4</sub> )	mg/L	6	<15	<30	0.3	<0.30
<b>Physical Tests</b>						
Hardness (as CaCO <sub>3</sub> )	mg/L	4.8	3780	10200	4.8	<4.8
<b>Dissolved Metals</b>						
Aluminum (Al)-Dissolved	mg/L	0.005	<0.0050	0.008	0.005	-
Antimony (Sb)-Dissolved	mg/L	0.001	<0.0010	0.0025	0.001	-
Arsenic (As)-Dissolved	mg/L	0.0004	0.00245	0.0026	0.0004	-
Barium (Ba)-Dissolved	mg/L	0.001	0.856	0.538	0.001	-
Beryllium (Be)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	0.0005	-
Bismuth (Bi)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	0.0005	-
Boron (B)-Dissolved	mg/L	0.3	0.32	0.94	0.3	-
Cadmium (Cd)-Dissolved	mg/L	0.00001	0.000018	0.000018	0.00001	-
Calcium (Ca)-Dissolved	mg/L	1	1450	4000	1	-
Cesium (Cs)-Dissolved	mg/L	0.0005	<0.00050	0.00115	0.0005	-
Chromium (Cr)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	0.0005	-
Cobalt (Co)-Dissolved	mg/L	0.00005	<0.000050	0.00008	0.00005	-
Copper (Cu)-Dissolved	mg/L	0.0002	<0.00020	0.00042	0.0002	-
Gallium (Ga)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	0.0005	-
Iron (Fe)-Dissolved	mg/L	0.01	0.275	0.059	0.01	-
Lead (Pb)-Dissolved	mg/L	0.00005	<0.000050	<0.000050	0.00005	-
Lithium (Li)-Dissolved	mg/L	0.02	0.427	2.8	0.02	-
Magnesium (Mg)-Dissolved	mg/L	1	37.8	42.4	1	-
Manganese (Mn)-Dissolved	mg/L	0.0001	0.0981	0.0855	0.0001	-
Mercury (Hg)-Dissolved	mg/L	0.000005	<0.0000050	<0.0000050	0.000005	-
Molybdenum (Mo)-Dissolved	mg/L	0.0001	0.0217	0.0192	0.0001	-
Nickel (Ni)-Dissolved	mg/L	0.0005	<0.00050	0.00139	0.0005	-
Phosphorus (P)-Dissolved	mg/L	0.05	<0.050	<0.050	0.05	-
Potassium (K)-Dissolved	mg/L	1	11.2	159	1	-
Rhenium (Re)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	0.0005	-
Rubidium (Rb)-Dissolved	mg/L	0.005	0.0161	0.167	0.005	-
Selenium (Se)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	0.0005	-
Silicon (Si)-Dissolved	mg/L	0.5	2.75	2.39	0.5	-
Silver (Ag)-Dissolved	mg/L	0.0001	<0.00010	<0.00010	0.0001	-
Sodium (Na)-Dissolved	mg/L	2.5	272	389	2.5	-
Strontium (Sr)-Dissolved	mg/L	0.01	20.3	66.3	0.01	-
Sulfur (S)-Dissolved	mg/L	5	<5.0	<5.0	5	-
Tellurium (Te)-Dissolved	mg/L	0.0005	0.00108	0.00406	0.0005	-
Thallium (Tl)-Dissolved	mg/L	0.00005	<0.000050	<0.000050	0.00005	-
Thorium (Th)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	0.0005	-
Tin (Sn)-Dissolved	mg/L	0.001	<0.0010	<0.0010	0.001	-
Titanium (Ti)-Dissolved	mg/L	0.005	<0.0050	<0.0050	0.005	-
Tungsten (W)-Dissolved	mg/L	0.001	0.0225	0.0636	0.001	-
Uranium (U)-Dissolved	mg/L	0.00005	<0.000050	0.000072	0.00005	-
Vanadium (V)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	0.0005	-
Yttrium (Y)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	0.0005	-
Zinc (Zn)-Dissolved	mg/L	0.001	0.03	0.0184	0.001	-
Zirconium (Zr)-Dissolved	mg/L	0.0005	<0.00050	<0.00050	0.0005	-

**Table 7**  
**QA/QC of Rock Formation Groundwater Quality**  
**Whale Tail Lake Talik**  
**Whale Tail Project, Nunavut**

Sample			Port 6	Port 4		Travel Blank
Date			3-Apr-2019	2-Apr-2019		3-Apr-2019
Certificate No.			L2255221-3	L2255221-2		L2255221-1
Sample ID			PORT 6	PORT 4		ALS Travel Blank
Paramètres	Units	MDL			MDL	
<b>Total Metals</b>						
Aluminum (Al)-Total	mg/L	0.005	0.017	<0.025	0.005	<0.0050
Antimony (Sb)-Total	mg/L	0.001	<0.0030	<0.0050	0.001	<0.0010
Arsenic (As)-Total	mg/L	0.0004	0.0029	0.0035	0.0004	<0.00040
Barium (Ba)-Total	mg/L	0.001	0.793	0.483	0.001	<0.0010
Beryllium (Be)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
Bismuth (Bi)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
Boron (B)-Total	mg/L	0.3	<0.90	<1.5	0.3	<0.30
Cadmium (Cd)-Total	mg/L	0.00001	<0.000030	<0.000050	0.00001	<0.000010
Calcium (Ca)-Total	mg/L	1	1360	3720	1	<1.0
Cesium (Cs)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
Chromium (Cr)-Total	mg/L	0.0005	0.0139	0.0027	0.0005	<0.00050
Cobalt (Co)-Total	mg/L	0.00005	0.00024	<0.00025	0.00005	<0.000050
Copper (Cu)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
Gallium (Ga)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
Iron (Fe)-Total	mg/L	0.01	0.448	0.267	0.01	<0.010
Lead (Pb)-Total	mg/L	0.00005	0.00026	<0.00025	0.00005	<0.000050
Lithium (Li)-Total	mg/L	0.02	0.466	2.71	0.02	<0.020
Magnesium (Mg)-Total	mg/L	1	41.2	47.7	1	<1.0
Manganese (Mn)-Total	mg/L	0.0002	0.0977	0.0819	0.0002	<0.00020
Mercury (Hg)-Total	mg/L	0.000005	<0.0000050	<0.0000050	0.000005	<0.0000050
Molybdenum (Mo)-Total	mg/L	0.0001	0.0225	0.0165	0.0001	<0.00010
Nickel (Ni)-Total	mg/L	0.0005	0.0095	0.0029	0.0005	<0.00050
Phosphorus (P)-Total	mg/L	0.05	<0.15	<0.25	0.05	<0.050
Potassium (K)-Total	mg/L	1	10	128	1	<1.0
Rhenium (Re)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
Rubidium (Rb)-Total	mg/L	0.005	0.016	0.15	0.005	<0.0050
Selenium (Se)-Total	mg/L	0.0005	0.0028	<0.0025	0.0005	<0.00050
Silicon (Si)-Total	mg/L	0.5	2.53	2.39	0.5	<0.50
Silver (Ag)-Total	mg/L	0.0001	<0.00030	<0.00050	0.0001	<0.00010
Sodium (Na)-Total	mg/L	2.5	282	446	2.5	<2.5
Strontium (Sr)-Total	mg/L	0.01	19.5	60.2	0.01	<0.010
Sulfur (S)-Total	mg/L	5	<15	<25	5	<5.0
Tellurium (Te)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
Thallium (Tl)-Total	mg/L	0.00005	<0.00015	<0.00025	0.00005	<0.000050
Thorium (Th)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
Tin (Sn)-Total	mg/L	0.001	<0.0030	<0.0050	0.001	<0.0010
Titanium (Ti)-Total	mg/L	0.005	<0.015	<0.025	0.005	<0.0050
Tungsten (W)-Total	mg/L	0.001	0.0205	0.0572	0.001	<0.0010
Uranium (U)-Total	mg/L	0.00005	<0.00015	<0.00025	0.00005	<0.000050
Vanadium (V)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
Yttrium (Y)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
Zinc (Zn)-Total	mg/L	0.003	0.93	0.6	0.003	<0.0030
Zirconium (Zr)-Total	mg/L	0.0005	<0.0015	<0.0025	0.0005	<0.00050
<b>Radioactive Ions</b>						
Radium (Ra 226)	Bq/L	0.0085	0.85	1.3	0.0079	<0.0079
<b>Hydrocarbons</b>						
F2 (C10-C16)	mg/L	0.3	<0.30	<0.30	0.3	<0.30
F3 (C16-C34)	mg/L	0.3	<0.30	<0.30	0.3	<0.30
F4 (C34-C50)	mg/L	0.3	<0.30	<0.30	0.3	<0.30
TPH (C10-C50)	mg/L	0.52	<0.52	<0.52	0.52	<0.52
<b>QA/QC</b>						
Calculated TDS (lab)	mg/L	-	5170	12000	-	-
Lab measured vs Calculated TDS	-	-	144%	160%	-	-
Lab measured TDS vs conductivity	-	-	0.7	0.6	-	-

## Notes:

Concentrations are mg/L unless otherwise noted.

MDL - Method Detection Limit

RPD = relative percent difference

RPD value exceeds 20%

- parameter was not analyzed

-- not calculated (one or both result below MDL)

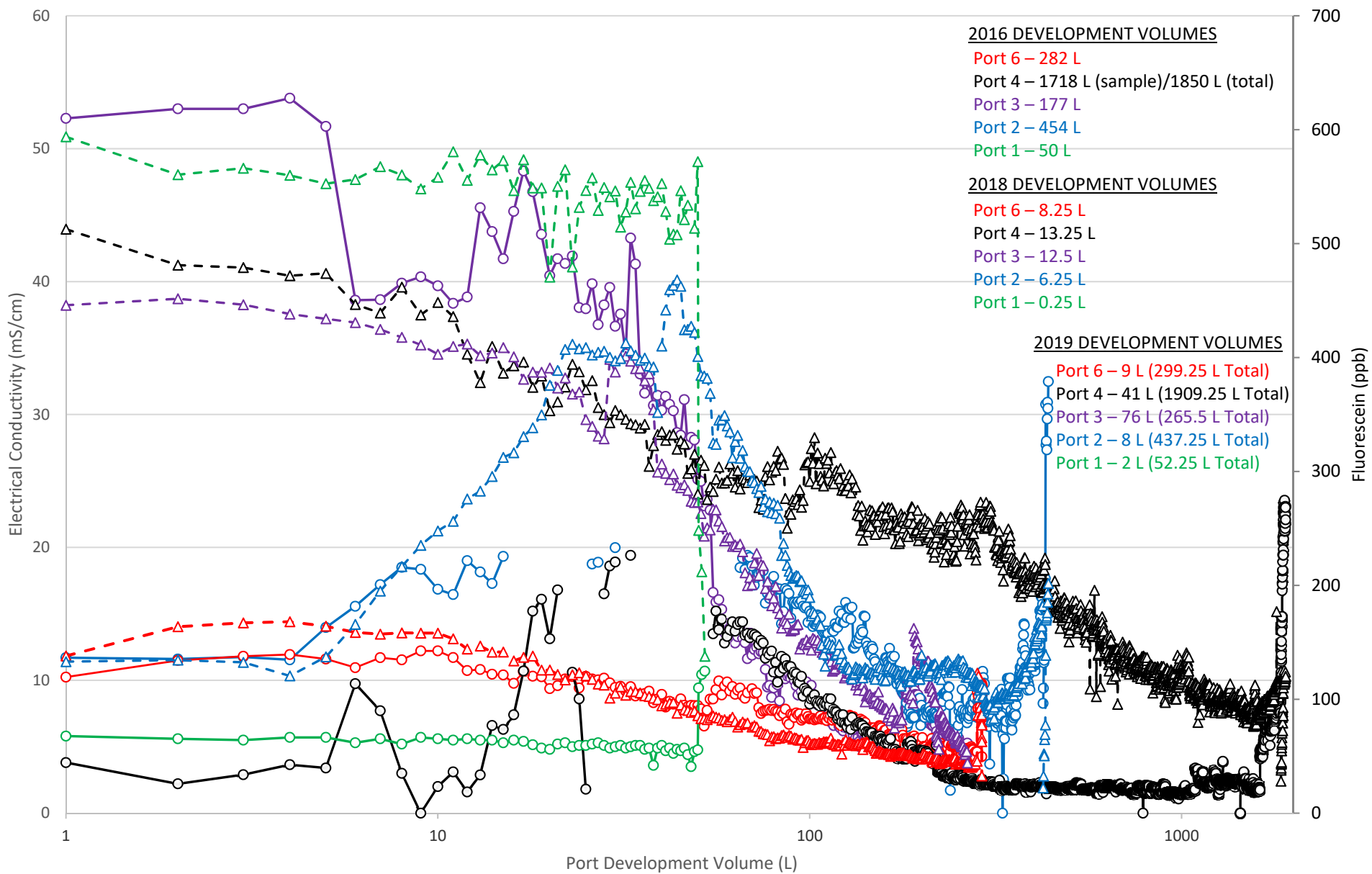


Table 7
QA/QC of Rock Formation Groundwater Quality
Whale Tail Lake Talik
Whale Tail Project, Nunavut

Table with columns for Sample, Date, Certificate No., Sample ID, Parameters, Units, MDL, Port 6, Port 4, Travel Blank, Port 3, RPD, Port 2, Equipment Blank. Rows include various metals (Aluminum, Arsenic, Barium, etc.), radioactive ions (Radium), and hydrocarbons (F2, F3, F4, TPH). Includes a QA/QC summary section at the bottom.

Notes:
Concentrations are mg/L unless otherwise noted.
MDL - Method Detection Limit
RPD = relative percent difference
RPD value exceeds 20%
- parameter was not analyzed
-- not calculated (one or both result below MDL)





Notes: conductivity  
 fluorescein

CLIENT  
 AGNICO EAGLE MINES LIMITED

CONSULTANT

YYYY-MM-DD	2019-05-21
PREPARED	DH
DESIGN	--
REVIEW	X
APPROVED	X

PROJECT  
 2019 WESTBAY SYSTEM GROUNDWATER MONITORING INVESTIGATION

TITLE  
 2016, 2018 and 2019 DEVELOPMENT RECORD

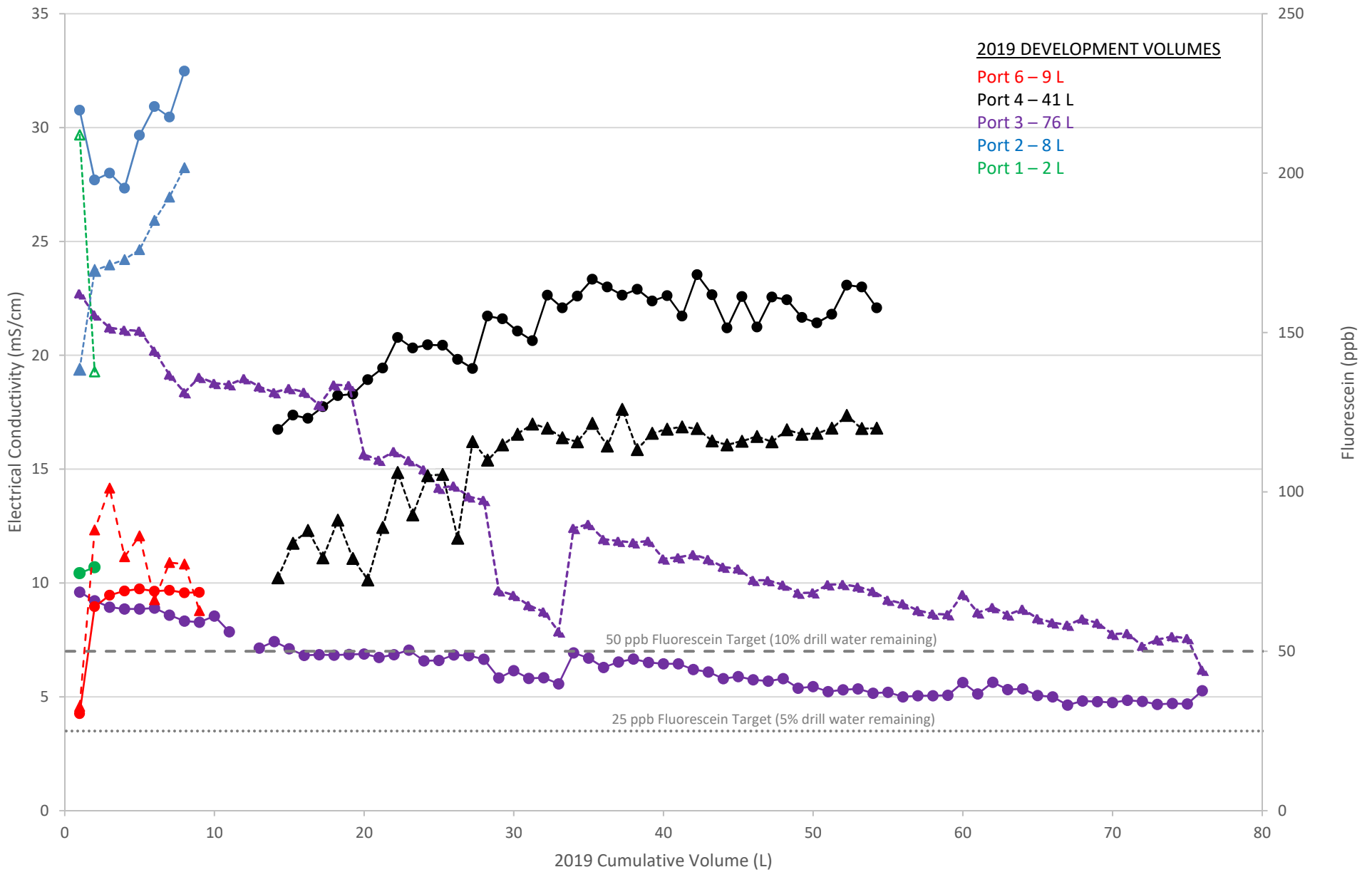
PROJECT No.  
 18108905-303

Rev.

Colours **Port 6**, **Port 4**, **Port 3**, **Port 2** and **Port 1**  
 Disconnected points (Ports 2 and 4) correspond to  
 missing electrical conductivity field measurements



FIGURE 1



Notes: ● conductivity  
▲ fluorescein

Volumes reported at time of sample collection and/or end of development (for Port 1)

Colours Port 6, Port 4, Port 3, Port 2 and Port 1

CLIENT  
AGNICO EAGLE MINES LIMITED

CONSULTANT



YYYY-MM-DD	2019-02-08
PREPARED	DH
DESIGN	--
REVIEW	X
APPROVED	X

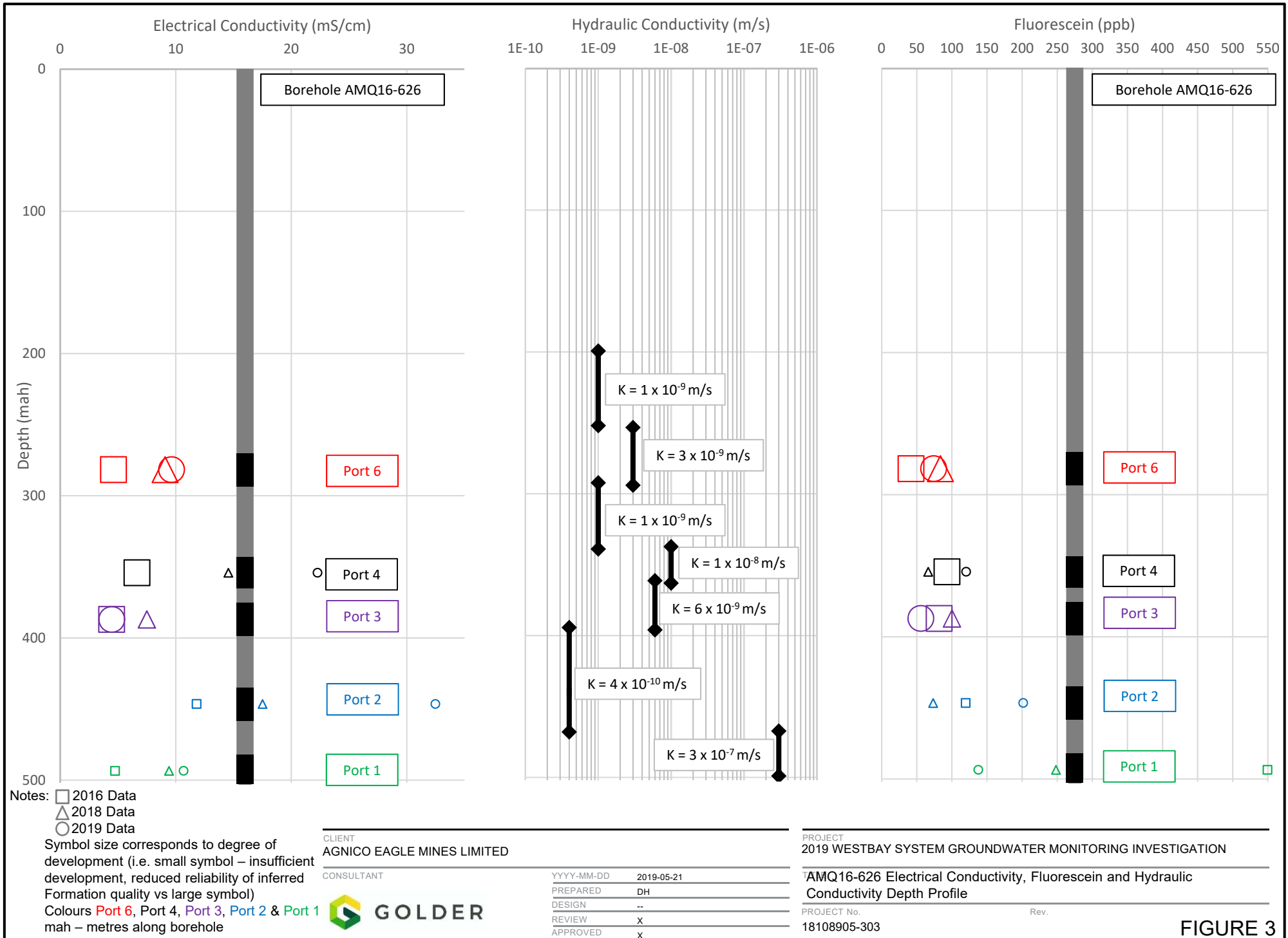
PROJECT  
2019 WESTBAY SYSTEM GROUNDWATER MONITORING INVESTIGATION

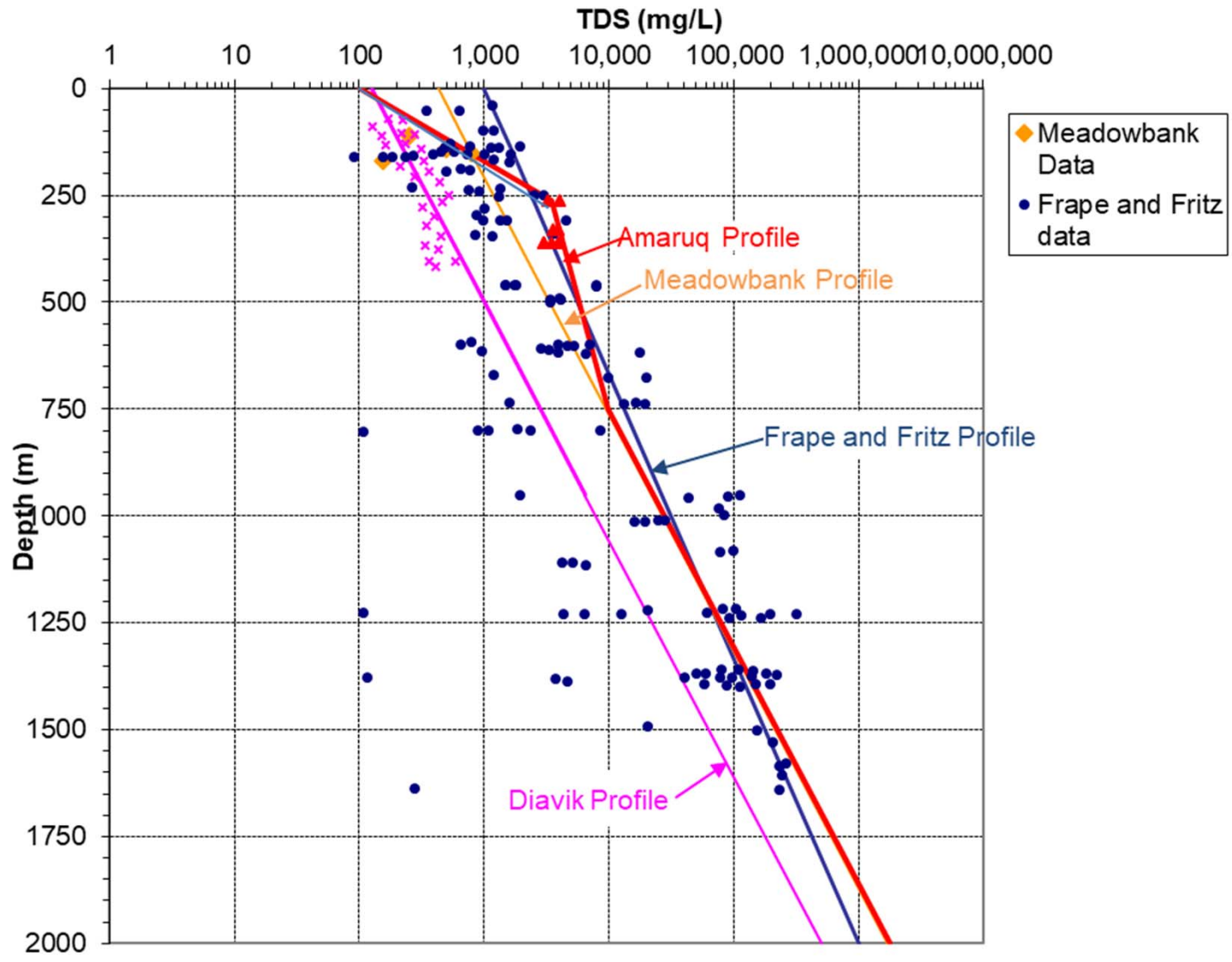
TITLE  
2019 DEVELOPMENT RECORD

PROJECT No.  
18108905-303

Rev.

FIGURE 2





□  
△  
○

CLIENT  
AGNICO EAGLE MINES LIMITED

CONSULTANT



YYYY-MM-DD	2019-05-21
PREPARED	DH
DESIGN	--
REVIEW	X
APPROVED	X

PROJECT  
2019 WESTBAY SYSTEM GROUNDWATER MONITORING INVESTIGATION

TDS Profile Adopted in the FEIS for the Approved Project

PROJECT No.  
18108905-303

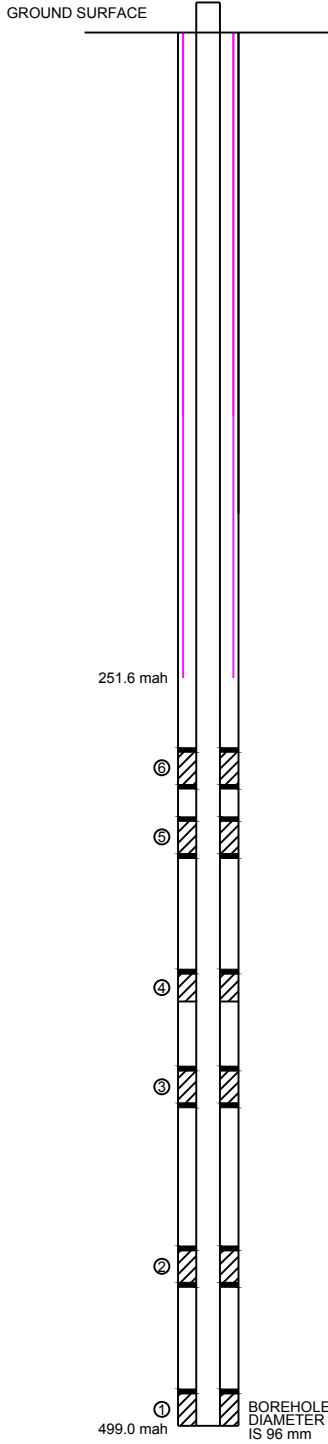
Rev.

FIGURE 4

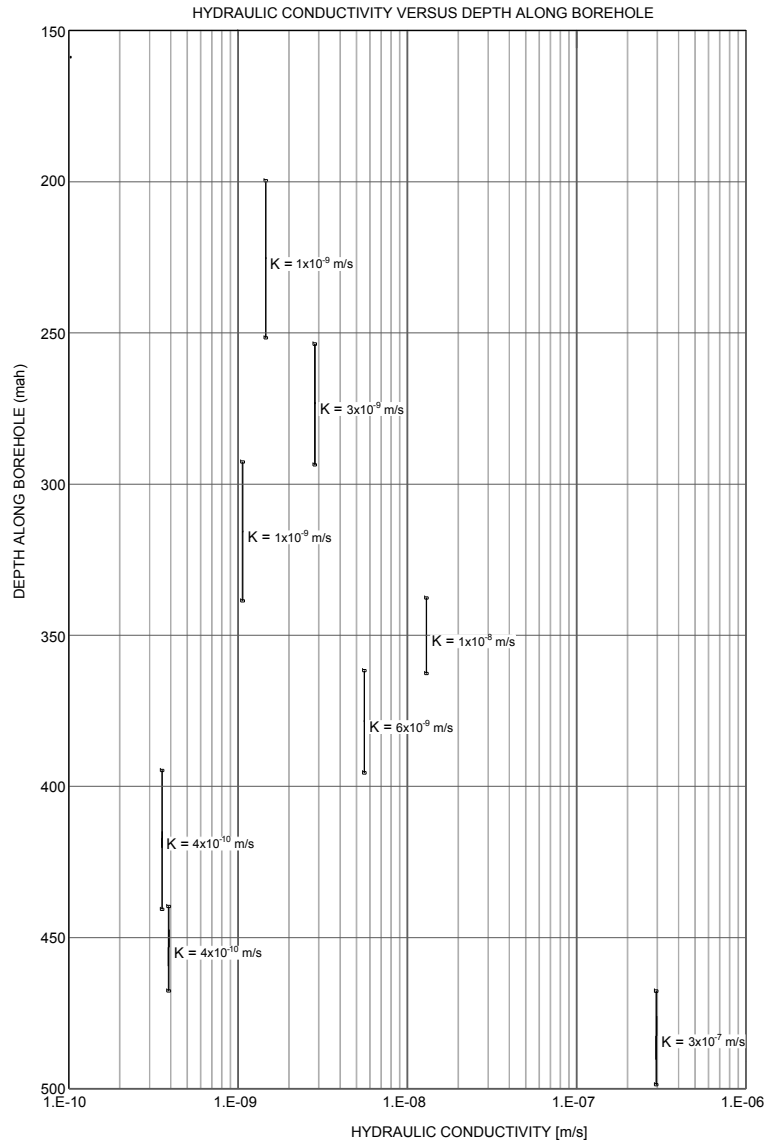
**APPENDIX A**

# AMQ160626 Westbay System Installation Details

BOREHOLE AMQ16-626



WESTBAY SYSTEM ZONE DEPTH SUMMARY						
ZONE	DEPTH ALONG HOLE			VERTICAL DEPTH		
	FROM	TO	LENGTH	FROM	TO	THICKNESS
	(mah)	(mah)	(m)	(mbgs)	(mbgs)	(m)
6	276.0	287.4	11.4	257.7	268.3	10.6
5	298.9	310.3	11.4	279	289.7	10.6
4	349.3	359.1	9.8	326.1	335.2	9.1
3	381.3	392.7	11.4	356.0	366.6	10.6
2	440.8	452.2	11.4	411.5	422.2	10.6
1	488.1	499.0	10.9	455.7	465.9	10.2



LEGEND

	PACKER	K	HYDRAULIC CONDUCTIVITY
	WESTBAY MONITORING ZONE	mah	METRES ALONG BOREHOLE, RELATIVE TO GROUND SURFACE
	STEEL CASING	mbgs	METRES BELOW GROUND SURFACE
		m/s	METRES PER SECOND

NOTES

- ALL UNITS ARE IN METERS UNLESS OTHERWISE NOTED
- PERMAFROST ASSUMED 200 m ALONG HOLE ALIGNMENT.
- DRILL RODS TO 251.6 m ALONG HOLE.
- BOREHOLE LOCATED IN UTM NAD 83 ZONE 14, N = 7255363.5 E = 607181.68 ELEVATION = 154.46 m.
- AVERAGE BOREHOLE INCLINATION IS 69°.

**NOT TO SCALE  
SCHEMATIC ONLY**

2016-07-06	ISSUED FOR FINAL	JJ	PP	DV	DC			
2016-05-27	ISSUED FOR REVIEW	JJ	PP					
REV	DATE	REVISION DESCRIPTION			DES	CADD	CHK	R/W

PROJECT

**AGNICO EAGLE** MINES LIMITED  
WHALE TAIL PIT PROJECT  
NUNAVUT, CANADA

TITLE

**AMQ16-626 WESTBAY SYSTEM  
INSTALLATION DETAILS**

	PROJECT No.	1649355.4000.3000	FILE No.	1649355-4000-3000-03	
	DESIGN	JJ	2016-07-06	SCALE	NOT TO SCALE
	CADD	PP	2016-07-06	FIGURE	<b>3</b>
	CHECK	DV	2016-07-06		
	REVIEW	DC	2016-07-06		

\\golder-gds\gaitburmah\CAD-GIS\client\Agnico\_Eagle\_Mines\_Ltd\What\_1\109\_PROJECTS\1649355\02\_PROD\DUCTION\4000\3000\DWG\1649355-4000-3000-03.dwg | Layout: AMQ16-626 WESTBAY SYSTEM INSTALLATION DETAILS | Modified: ppapouhesh 05/26/2016 1:35 PM | Plotted: ppapouhesh 07/06/2016

**APPENDIX B**

Westbay Instruments Mosdax Sampler  
Calibration Reports

# MOSDAX Calibration Report 1: EMS - 2653 Module 1393

Full Scale: 2000 (psia)

File: E:\DATA\CAL\0-2018\2000\5JUNE2-1\02653

Pressure Reference: Paroscientific Model 42K-101 S/N 59937

Range: 2K PSI

Date of last reference to traceable standard: Oct 5 2017

EMS - 2653 Jun 05 07:21:40 2018 Range 1 Temp 3.2° C			EMS - 2653 Jun 05 02:31:32 2018 Range 2 Temp 10.2° C			EMS - 2653 Jun 04 21:30:38 2018 Range 3 Temp 20.1° C		
Ref Pres (psia)	Error (psia)	(% FS)	Ref Pres (psia)	Error (psia)	(% FS)	Ref Pres (psia)	Error (psia)	(% FS)
14.710	0.033	0.002	14.708	-0.053	-0.003	14.739	-0.004	0.000
193.556	-0.035	-0.002	192.410	-0.077	-0.004	194.053	0.004	0.000
393.645	-0.060	-0.003	393.839	-0.119	-0.006	393.092	-0.022	-0.001
592.405	-0.084	-0.004	592.676	-0.157	-0.008	593.152	-0.030	-0.002
792.635	-0.086	-0.004	792.170	-0.141	-0.007	792.298	-0.006	0.000
991.406	-0.034	-0.002	991.220	-0.011	-0.001	991.666	-0.027	-0.001
1190.983	-0.058	-0.003	1190.818	-0.111	-0.006	1191.095	-0.177	-0.009
1390.360	-0.043	-0.002	1389.783	-0.023	-0.001	1389.222	-0.073	-0.004
1589.131	0.027	0.001	1589.250	0.108	0.005	1589.547	-0.007	0.000
1788.616	0.029	0.001	1789.150	0.041	0.002	1788.425	-0.007	0.000
1990.489	-0.174	-0.009	1990.481	0.064	0.003	1990.256	-0.023	-0.001
1819.261	0.070	0.004	1818.525	0.102	0.005	1818.673	0.031	0.002
1620.036	0.056	0.003	1619.742	0.094	0.005	1615.832	0.108	0.005
1413.330	0.062	0.003	1413.044	0.093	0.005	1414.262	0.033	0.002
1211.986	0.077	0.004	1217.553	0.063	0.003	1215.621	-0.051	-0.003
1009.674	0.060	0.003	1009.353	0.092	0.005	1009.884	0.132	0.007
807.939	0.060	0.003	808.096	-0.031	-0.002	807.824	0.077	0.004
606.818	0.054	0.003	607.340	-0.057	-0.003	615.725	-0.003	0.000
406.413	-0.004	0.000	406.398	-0.075	-0.004	406.364	-0.010	0.000
206.210	0.050	0.002	205.799	0.017	0.001	205.698	0.069	0.003
14.727	0.050	0.003	14.705	-0.052	-0.003	14.743	0.003	0.000
EMS - 2653 Jun 04 16:34:31 2018 Range 4 Temp 29.8° C			EMS - 2653 Jun 04 11:23:49 2018 Range 5 Temp 39.6° C					
Ref Pres (psia)	Error (psia)	(% FS)	Ref Pres (psia)	Error (psia)	(% FS)			
14.754	0.030	0.001	14.757	-0.001	0.000			
193.480	-0.014	-0.001	190.670	-0.082	-0.004			
393.032	-0.034	-0.002	393.473	-0.130	-0.007			
592.483	-0.030	-0.001	593.303	-0.106	-0.005			
792.754	0.019	0.001	790.836	-0.067	-0.003			
991.110	0.097	0.005	991.220	0.008	0.000			
1191.415	-0.038	-0.002	1191.109	-0.127	-0.006			
1390.037	-0.020	-0.001	1390.133	-0.101	-0.005			
1588.463	0.003	0.000	1590.290	0.000	0.000			
1788.797	0.075	0.004	1789.154	-0.018	-0.001			
1990.520	-0.035	-0.002	1990.498	-0.012	-0.001			
1818.799	0.003	0.000	1818.208	0.040	0.002			
1619.341	0.068	0.003	1618.827	0.042	0.002			
1413.488	0.038	0.002	1413.424	0.002	0.000			
1211.694	0.026	0.001	1212.970	-0.091	-0.005			
1007.402	0.180	0.009	1009.825	0.053	0.003			
807.671	0.135	0.007	807.826	-0.014	-0.001			
606.918	0.046	0.002	606.620	-0.122	-0.006			
406.653	0.036	0.002	406.227	-0.078	-0.004			
205.799	0.053	0.003	205.718	-0.047	-0.002			
14.761	0.036	0.002	14.760	-0.058	-0.003			

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# MOSDAX Calibration Report 2: EMS - 2653 Module 1393

Full Scale: 2000 (psia)

File: E:\DATA\CAL10-2018\2000\5JUNE2-1\02653

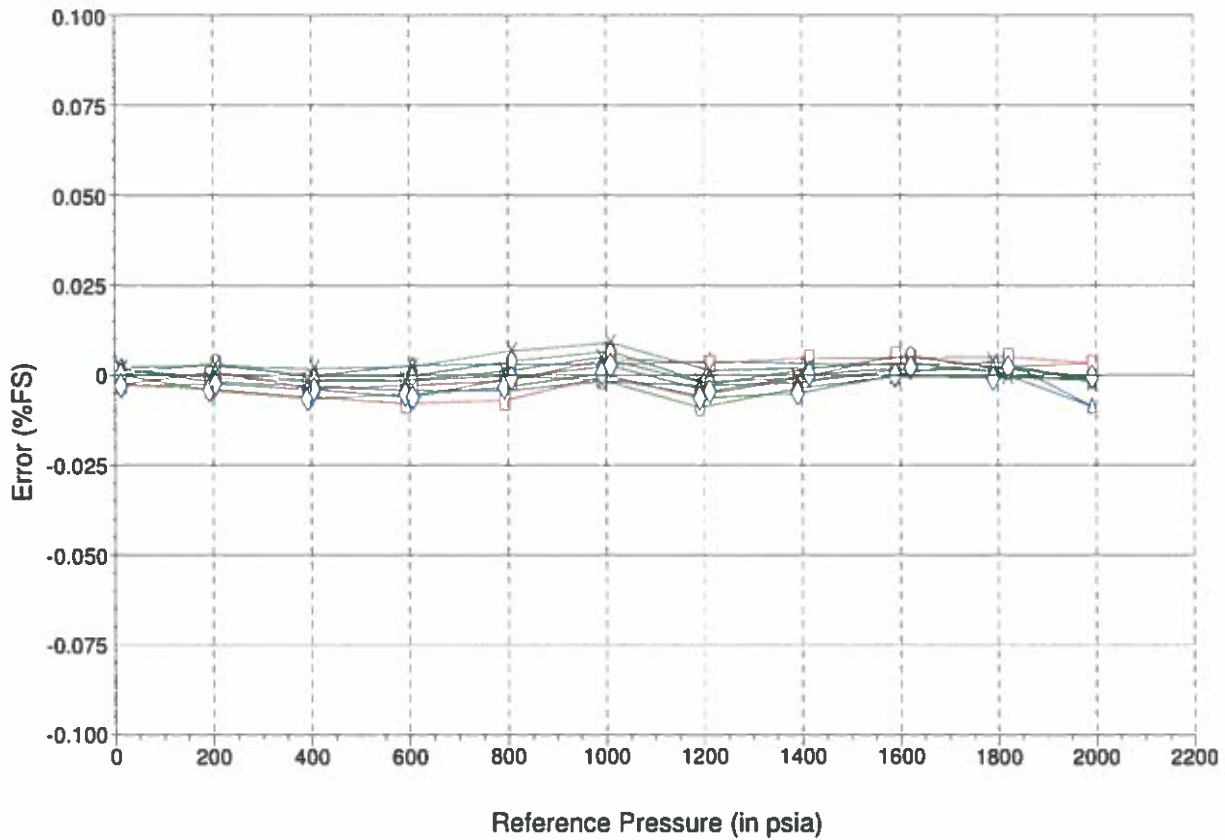
Pressure Reference: Paroscientific Model 42K-101 S/N 59937

Range: 2K PSI

Date of last reference to traceable standard: Oct 5 2017

## Plot of Error vs. Reference Pressure

EMS - 2653 Module 1393



—△— 3.2° C      —□— 10.2° C      —○— 20.1° C      —×— 29.8° C      —◇— 39.6° C

Comments

Issued by

# MOSDAX Calibration Report 1: EMS - 5239 Module 3019

Full Scale: 2000 (psia)

File: E:\DATA\CAL\0-2018\2K\21FEB2-1\05239

Pressure Reference: Paroscientific Model 42K-101 S/N 59937

Range: 2K PSI

Date of last reference to traceable standard: Oct 5 2017

EMS - 5239 Feb 21 13:16:29 2019 Range 1 Temp 3.2° C			EMS - 5239 Feb 21 08:33:43 2019 Range 2 Temp 10.2° C			EMS - 5239 Feb 21 03:50:55 2019 Range 3 Temp 19.9° C		
Ref Pres (psia)	Error (psia)	(% FS)	Ref Pres (psia)	Error (psia)	(% FS)	Ref Pres (psia)	Error (psia)	(% FS)
14.804	-0.163	-0.008	14.817	-0.097	-0.005	14.785	-0.114	-0.006
194.487	0.014	0.001	193.074	0.029	0.001	192.759	0.001	0.000
390.179	-0.067	-0.003	393.218	0.098	0.005	389.865	0.048	0.002
593.031	0.045	0.002	593.224	0.119	0.006	593.528	0.063	0.003
789.444	-0.074	-0.004	792.947	0.037	0.002	792.968	0.038	0.002
991.575	-0.137	-0.007	992.123	-0.043	-0.002	992.520	-0.077	-0.004
1192.000	-0.073	-0.004	1190.659	-0.012	-0.001	1191.374	-0.113	-0.006
1390.458	-0.208	-0.010	1390.137	-0.080	-0.004	1389.650	-0.076	-0.004
1589.054	-0.084	-0.004	1589.920	-0.075	-0.004	1590.224	-0.047	-0.002
1786.851	0.018	0.001	1788.944	0.021	0.001	1789.417	0.080	0.004
1986.956	0.054	0.003	1987.148	0.249	0.012	1987.047	0.248	0.012
1816.362	-0.096	-0.005	1816.346	0.178	0.009	1815.391	0.134	0.007
1618.050	-0.133	-0.007	1616.246	0.041	0.002	1617.486	0.078	0.004
1413.486	-0.061	-0.003	1414.032	-0.013	-0.001	1413.023	0.064	0.003
1212.916	-0.085	-0.004	1205.963	0.013	0.001	1213.269	0.064	0.003
1009.275	-0.044	-0.002	1009.556	0.078	0.004	1019.100	0.098	0.005
807.674	0.055	0.003	807.804	0.136	0.007	807.775	0.027	0.001
606.505	0.100	0.005	606.633	0.066	0.003	606.584	0.152	0.008
406.873	0.118	0.006	406.257	0.136	0.007	407.197	0.066	0.003
205.868	0.082	0.004	206.123	0.026	0.001	206.774	0.028	0.001
14.795	-0.172	-0.009	14.813	-0.182	-0.009	14.789	-0.180	-0.009
EMS - 5239 Feb 20 23:07:39 2019 Range 4 Temp 29.8° C			EMS - 5239 Feb 20 18:20:11 2019 Range 5 Temp 39.6° C					
Ref Pres (psia)	Error (psia)	(% FS)	Ref Pres (psia)	Error (psia)	(% FS)			
14.777	-0.143	-0.007	14.688	-0.114	-0.006			
194.505	-0.051	-0.003	192.678	0.018	0.001			
390.763	0.029	0.001	393.297	0.005	0.000			
592.862	-0.044	-0.002	592.933	0.038	0.002			
791.922	-0.170	-0.009	792.936	-0.005	0.000			
991.867	-0.146	-0.007	992.115	0.016	0.001			
1191.582	-0.173	-0.009	1191.335	0.109	0.005			
1390.037	-0.291	-0.015	1389.111	-0.054	-0.003			
1588.987	-0.226	-0.011	1589.837	-0.009	0.000			
1789.078	-0.110	-0.005	1781.524	0.117	0.006			
1987.547	0.053	0.003	1986.689	0.304	0.015			
1817.961	-0.031	-0.002	1816.914	0.154	0.008			
1618.112	-0.133	-0.007	1615.561	0.032	0.002			
1413.679	-0.133	-0.007	1413.112	0.009	0.000			
1214.322	-0.037	-0.002	1213.523	0.128	0.006			
1009.278	-0.023	-0.001	1009.449	0.127	0.006			
807.618	-0.048	-0.002	807.448	0.113	0.006			
606.717	0.018	0.001	606.509	0.084	0.004			
406.329	0.010	0.001	406.320	0.079	0.004			
206.564	0.019	0.001	205.860	-0.012	-0.001			
14.793	-0.061	-0.003	14.704	-0.100	-0.005			

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# MOSDAX Calibration Report 2: EMS - 5239 Module 3019

Full Scale: 2000 (psia)

File: E:\DATA\CAL\0-2019\2K\21FEB2-1\05239

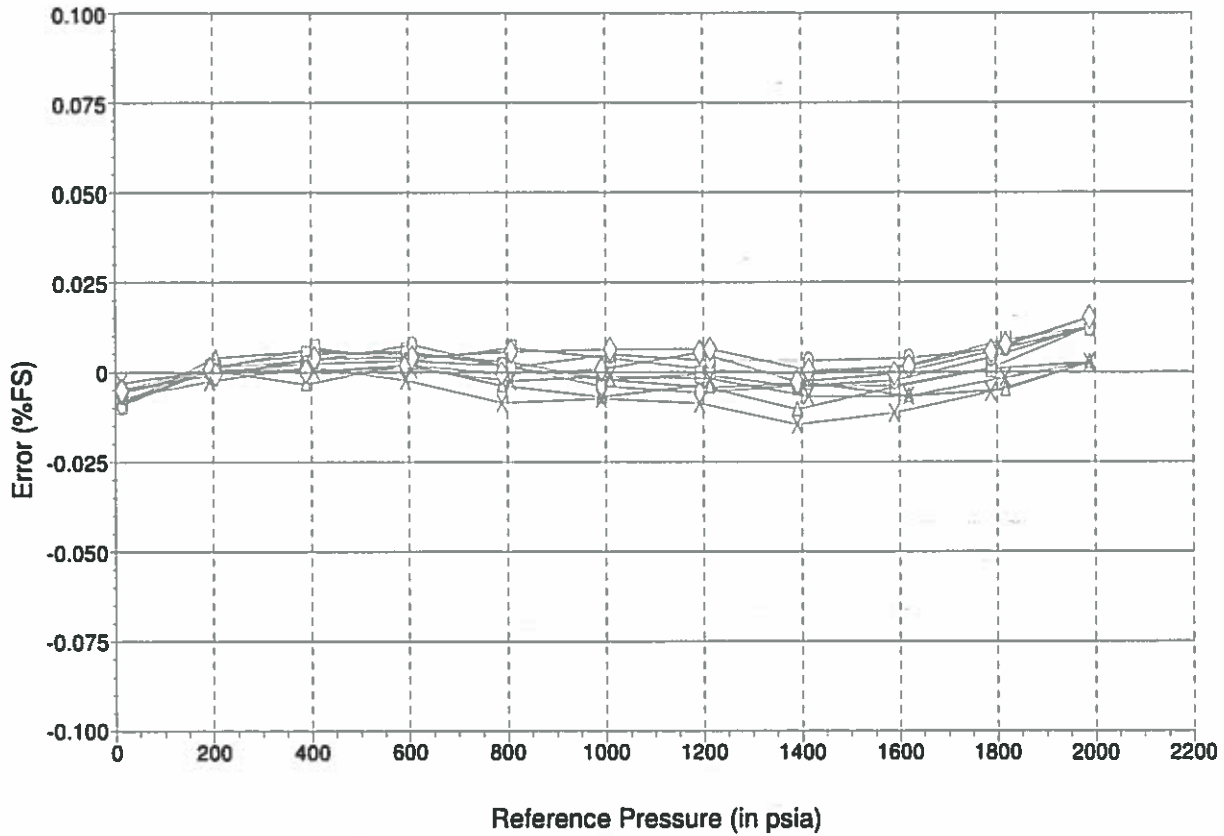
Pressure Reference: Paroscientific Model 42K-101 S/N 59937

Range: 2K PSI

Date of last reference to traceable standard: Oct 5 2017

## Plot of Error vs. Reference Pressure

EMS - 5239 Module 3019



△ 3.2° C    □ 10.2° C    ○ 19.9° C    × 29.8° C    ◇ 39.6° C

Comments

Issued by



**APPENDIX C**

# 2019 Laboratory Certificates of Analysis



AGNICO-EAGLE MINES LTD.  
ATTN: Jenyfer Mosquera  
Nunavut Permitting Lead  
11600 rue Louis-Bisson, Suite 540  
Mirabel QC J7N 1G9

Date Received: 04-APR-19  
Report Date: 17-MAY-19 14:48 (MT)  
Version: FINAL REV. 3

Client Phone: --


## Certificate of Analysis

Lab Work Order #: L2253513  
Project P.O. #: NOT SUBMITTED  
Job Reference: 18108905  
C of C Numbers: 18-1789310  
Legal Site Desc:

Comments: ADDITIONAL 13-MAY-19 15:57  
Radium-226 data is presented in 2 separate reports (1904131 and 1904211) provided by ALS Fort Collins. Both reports are embedded within this PDF.

15-MAY-2019 Report now including calculated TDS result.

17-MAY-2019 This report includes corrected TDS results for samples L2253513-1 and -2 (Port 3 and Port 33 respectively) as a result of a requested re-check.

  
Heather McKenzie  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
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## ALS ENVIRONMENTAL ANALYTICAL REPORT

17-MAY-19 14:48 (MT)

Version: FINAL REV. 3

Sample ID Description Sampled Date Sampled Time Client ID		L2253513-1 Groundwater 29-MAR-19 09:30 PORT 3	L2253513-2 Groundwater 29-MAR-19 09:30 PORT 33	L2253513-3 Groundwater 30-MAR-19 09:00 PORT 2	L2253513-4 Groundwater 30-MAR-19 09:00 PORT 22	L2253513-5 Other 31-MAR-19 10:00 FIELD BLANK
Grouping	Analyte					
<b>SEAWATER</b>						
<b>Physical Tests</b>	Hardness (as CaCO3) (mg/L)	1320	1300	12700	12400	<4.8
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)	0.0140	0.0139	0.041	0.062	<0.0050
	Antimony (Sb)-Total (mg/L)	0.0017	0.0017	<0.0050 <sup>DLA</sup>	<0.0050 <sup>DLA</sup>	<0.0010
	Arsenic (As)-Total (mg/L)	0.00228	0.00238	0.0024	0.0023	<0.00040
	Barium (Ba)-Total (mg/L)	0.0571	0.0595	0.130	0.139	<0.0010
	Beryllium (Be)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050
	Boron (B)-Total (mg/L)	0.70	0.78	1.8	1.9	<0.30
	Cadmium (Cd)-Total (mg/L)	<0.000010	<0.000010	<0.000050 <sup>DLA</sup>	<0.000050 <sup>DLA</sup>	<0.000010
	Calcium (Ca)-Total (mg/L)	535	526	4400 <sup>DTC</sup>	4660	<1.0
	Cesium (Cs)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050
	Chromium (Cr)-Total (mg/L)	0.0116	0.00706	0.0075	0.0290	<0.00050
	Cobalt (Co)-Total (mg/L)	0.000180	0.000115	<0.00025 <sup>DLA</sup>	0.00044	<0.000050
	Copper (Cu)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050
	Gallium (Ga)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050
	Iron (Fe)-Total (mg/L)	0.082	0.059	0.184	0.319	<0.010
	Lead (Pb)-Total (mg/L)	0.000159	0.000148	0.00091	0.00106	<0.000050
	Lithium (Li)-Total (mg/L)	0.173	0.176	3.31 <sup>DTC</sup>	3.56 <sup>DTC</sup>	<0.020
	Magnesium (Mg)-Total (mg/L)	<1.0	<1.0	<5.0 <sup>DLA</sup>	<5.0 <sup>DLA</sup>	<1.0
	Manganese (Mn)-Total (mg/L)	0.00629	0.00576	0.0258	0.0290	<0.00020
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00584	0.00514	0.0118	0.0154	<0.00010
	Nickel (Ni)-Total (mg/L)	0.00776	0.00494	0.0059	0.0206	<0.00050
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.25 <sup>DLA</sup>	<0.25 <sup>DLA</sup>	<0.050
	Potassium (K)-Total (mg/L)	11.5	12.0	169 <sup>DTC</sup>	187	<1.0
	Rhenium (Re)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050
	Rubidium (Rb)-Total (mg/L)	0.0175	0.0179	0.226 <sup>DLA</sup>	0.245 <sup>DLA</sup>	<0.0050
	Selenium (Se)-Total (mg/L)	0.00252	0.00113	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050
	Silicon (Si)-Total (mg/L)	3.50	3.49	2.87	3.07	<0.50
	Silver (Ag)-Total (mg/L)	<0.00010	<0.00010	<0.00025 <sup>DLM</sup>	<0.00050 <sup>DLA</sup>	<0.00010
	Sodium (Na)-Total (mg/L)	343	339	486	502	<2.5
	Strontium (Sr)-Total (mg/L)	8.23	8.13	68.7 <sup>DTC</sup>	77.6	<0.010
	Sulfur (S)-Total (mg/L)	<5.0	<5.0	<25 <sup>DLA</sup>	<25 <sup>DLA</sup>	<5.0
	Tellurium (Te)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050
	Thallium (Tl)-Total (mg/L)	<0.000050	<0.000050	<0.00025 <sup>DLA</sup>	<0.00025 <sup>DLA</sup>	<0.000050
	Thorium (Th)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050
	Tin (Sn)-Total (mg/L)	<0.0010	<0.0010	<0.0050 <sup>DLA</sup>	<0.0050 <sup>DLA</sup>	<0.0010

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2253513-1	L2253513-2	L2253513-3	L2253513-4	L2253513-5
		Description	Groundwater	Groundwater	Groundwater	Groundwater	Other
		Sampled Date	29-MAR-19	29-MAR-19	30-MAR-19	30-MAR-19	31-MAR-19
		Sampled Time	09:30	09:30	09:00	09:00	10:00
		Client ID	PORT 3	PORT 33	PORT 2	PORT 22	FIELD BLANK
Grouping	Analyte						
<b>SEAWATER</b>							
<b>Total Metals</b>	Titanium (Ti)-Total (mg/L)	<0.0050	<0.0050	<0.025 <sup>DLA</sup>	<0.025 <sup>DLA</sup>	<0.0050	
	Tungsten (W)-Total (mg/L)	0.0361	0.0360	0.0767	0.0819	<0.0010	
	Uranium (U)-Total (mg/L)	<0.000050	<0.000050	<0.00025 <sup>DLA</sup>	<0.00025 <sup>DLA</sup>	<0.000050	
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050	
	Yttrium (Y)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050	
	Zinc (Zn)-Total (mg/L)	0.507	0.476	0.465	0.770	0.0135 <sup>RRV</sup>	
	Zirconium (Zr)-Total (mg/L)	<0.00050	<0.00050	<0.0025 <sup>DLA</sup>	<0.0025 <sup>DLA</sup>	<0.00050	
<b>Dissolved Metals</b>	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0067	0.0069	0.0102	0.0106	<0.0050	
	Antimony (Sb)-Dissolved (mg/L)	0.0013	0.0012	0.0017	0.0016	<0.0010	
	Arsenic (As)-Dissolved (mg/L)	0.00203	0.00199	0.00200	0.00189	<0.00040	
	Barium (Ba)-Dissolved (mg/L)	0.0609	0.0619	0.168	0.171	<0.0010	
	Beryllium (Be)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
	Bismuth (Bi)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
	Boron (B)-Dissolved (mg/L)	0.75	0.79	2.1	2.2	<0.30	
	Cadmium (Cd)-Dissolved (mg/L)	<0.000010	<0.000010	0.000015	0.000016	<0.000010	
	Calcium (Ca)-Dissolved (mg/L)	528	521	5090	4960	<1.0	
	Cesium (Cs)-Dissolved (mg/L)	<0.00050	<0.00050	0.00285	0.00284	<0.00050	
	Chromium (Cr)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
	Cobalt (Co)-Dissolved (mg/L)	<0.000050	<0.000050	0.000098	0.000096	<0.000050	
	Copper (Cu)-Dissolved (mg/L)	<0.00020	<0.00020	0.00028	0.00029	<0.00020	
	Gallium (Ga)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
	Iron (Fe)-Dissolved (mg/L)	<0.010	<0.010	<0.010	0.011	<0.010	
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Dissolved (mg/L)	0.163	0.156	4.10	4.16	<0.020	
	Magnesium (Mg)-Dissolved (mg/L)	<1.0	<1.0	<5.0 <sup>DLA</sup>	<5.0 <sup>DLA</sup>	<1.0	
	Manganese (Mn)-Dissolved (mg/L)	0.00454	0.00428	0.0231	0.0231	<0.00010	
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00416	0.00418	0.0143	0.0145	<0.00010	
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050	0.00161	0.00167	<0.00050	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)	11.8	11.5	198	233	<1.0	
	Rhenium (Re)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
	Rubidium (Rb)-Dissolved (mg/L)	0.0179	0.0176	0.274	0.270	<0.0050	
Selenium (Se)-Dissolved (mg/L)	0.00081	0.00074	<0.00050	<0.00050	<0.00050		
Silicon (Si)-Dissolved (mg/L)	3.34	3.18	2.61	2.65	<0.50		

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## ALS ENVIRONMENTAL ANALYTICAL REPORT

17-MAY-19 14:48 (MT)

Version: FINAL REV. 3

Sample ID Description Sampled Date Sampled Time Client ID		L2253513-1 Groundwater 29-MAR-19 09:30 PORT 3	L2253513-2 Groundwater 29-MAR-19 09:30 PORT 33	L2253513-3 Groundwater 30-MAR-19 09:00 PORT 2	L2253513-4 Groundwater 30-MAR-19 09:00 PORT 22	L2253513-5 Other 31-MAR-19 10:00 FIELD BLANK
Grouping	Analyte					
<b>SEAWATER</b>						
<b>Dissolved Metals</b>	Silver (Ag)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Sodium (Na)-Dissolved (mg/L)	323	316	455	450	<2.5
	Strontium (Sr)-Dissolved (mg/L)	8.65	8.76	92.6	92.5	<0.010
	Sulfur (S)-Dissolved (mg/L)	<5.0	<5.0	<5.0	<5.0	<5.0
	Tellurium (Te)-Dissolved (mg/L)	<0.00050	<0.00050	0.00600	0.00653	<0.00050
	Thallium (Tl)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Thorium (Th)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Tin (Sn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Titanium (Ti)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Tungsten (W)-Dissolved (mg/L)	0.0388	0.0383	0.0875	0.0890	<0.0010
	Uranium (U)-Dissolved (mg/L)	<0.000050	<0.000050	0.000135	0.000131	<0.000050
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Yttrium (Y)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0052	0.0041	0.0063	0.0108	0.0148 <sup>RRV</sup>
	Zirconium (Zr)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.



## ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID	L2253513-1 Groundwater 29-MAR-19 09:30 PORT 3	L2253513-2 Groundwater 29-MAR-19 09:30 PORT 33	L2253513-3 Groundwater 30-MAR-19 09:00 PORT 2	L2253513-4 Groundwater 30-MAR-19 09:00 PORT 22	L2253513-5 Other 31-MAR-19 10:00 FIELD BLANK
Grouping	Analyte				
<b>WATER</b>					
<b>Field Tests</b>	Conductivity, Client Supplied (uS/cm)				
	4750	4750	29670	29670	10
<b>Physical Tests</b>	Conductivity (uS/cm)				
	4660	4730	24300	24200	<2.0
	pH (pH)				
	6.78	6.89	7.07	7.07	5.27
	Total Suspended Solids (mg/L)				
	<3.0	<3.0	4.3	7.1	<3.0
	Total Dissolved Solids (mg/L)				
	2980 <sup>HTD</sup>	2990 <sup>HTD</sup>	19300	19600	<3.0
	TDS (Calculated) (mg/L)				
	2470	2460	15700	15000	<1.0
<b>Anions and Nutrients</b>	Alkalinity, Bicarbonate (as CaCO3) (mg/L)				
	53.0	53.1	56.7	57.3	<1.0
	Alkalinity, Carbonate (as CaCO3) (mg/L)				
	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)				
	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)				
	53.0	53.1	56.7	57.3	<1.0
	Ammonia, Total (as N) (mg/L)				
	0.0920	0.0943	0.207	0.202	<0.0050
	Bromide (Br) (mg/L)				
	18.2	17.0	129	123	<0.050
	Chloride (Cl) (mg/L)				
	1580	1580	9910	9340	<0.10
	Fluoride (F) (mg/L)				
	<0.80 <sup>DLCl</sup>	<0.80 <sup>DLCl</sup>	<2.0 <sup>DLDS</sup>	<2.0 <sup>DLDS</sup>	<0.020
	Nitrate (as N) (mg/L)				
	<0.10 <sup>DLDS</sup>	<0.10 <sup>DLDS</sup>	<0.50 <sup>DLDS</sup>	<0.50 <sup>DLDS</sup>	<0.0050
	Nitrite (as N) (mg/L)				
	<0.020 <sup>DLDS</sup>	<0.020 <sup>DLDS</sup>	<0.10 <sup>DLDS</sup>	<0.10 <sup>DLDS</sup>	<0.0010
	Phosphorus (P)-Total (mg/L)				
	0.0029	0.0041	0.0068 <sup>DLM</sup>	0.0296 <sup>DLM</sup>	<0.0020
	Silicate (as SiO2) (mg/L)				
	6.80 <sup>DLDS</sup>	6.65 <sup>DLDS</sup>	<5.0 <sup>DLDS</sup>	<5.0 <sup>DLDS</sup>	<0.50
	Sulfate (SO4) (mg/L)				
	<6.0	<6.0	<30	<30	<0.30
	Anion Sum (meq/L)				
	45.5	45.6	281	265	<0.10
	Cation Sum (meq/L)				
	40.7	40.1	279	273	<0.10
	Cation - Anion Balance (%)				
	-5.6	-6.5	-0.3	1.5	0.0
<b>Hydrocarbons</b>	F2 (C10-C16) (mg/L)				
	<0.30	<0.30	<0.30	<0.30	<0.30
	F3 (C16-C34) (mg/L)				
	<0.30	<0.30	<0.30	<0.30	<0.30
	F4 (C34-C50) (mg/L)				
	<0.30	<0.30	<0.30	<0.30	<0.30
	TPH (C10-C50) (mg/L)				
	<0.52	<0.52	<0.52	<0.52	<0.52
	Surrogate: 2-Bromobenzotrifluoride, F2-F4 (%)				
	103.9	112.1	105.9	101.6	102.9
<b>Radiological Parameters</b>	Ra-226 (Bq/L)				
	0.19	0.20	1.4 <sup>DLRC</sup>	1.8	<0.0080

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## Reference Information

### QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Laboratory Control Sample	Boron (B)-Dissolved	MES	L2253513-3, -4
Laboratory Control Sample	Lithium (Li)-Dissolved	MES	L2253513-3, -4
Laboratory Control Sample	Tellurium (Te)-Dissolved	MES	L2253513-3, -4
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2253513-1, -2, -5
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2253513-3, -4
Matrix Spike	Boron (B)-Dissolved	MS-B	L2253513-1, -2, -5
Matrix Spike	Boron (B)-Dissolved	MS-B	L2253513-3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2253513-1, -2, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2253513-3, -4
Matrix Spike	Lithium (Li)-Dissolved	MS-B	L2253513-3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2253513-3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2253513-3, -4
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2253513-1, -2, -5
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2253513-3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2253513-1, -2, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2253513-3, -4
Matrix Spike	Phosphorus (P)-Total	MS-B	L2253513-1, -2, -3, -4

### Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLCI	Detection Limit Raised: Chromatographic Interference due to co-elution.
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DLRC	Detection Limit Raised for RadioChemistry test due to sample matrix (e.g. high TDS) or instrument detector conditions.
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
<b>ALK-TITR-VA</b>	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
<b>BR-L-IC-N-VA</b>	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
<b>CL-L-IC-N-VA</b>	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
<b>EC-PCT-VA</b>	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
<b>EC-SCREEN-VA</b>	Water	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
<b>F-IC-N-VA</b>	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
<b>F2-F4-ME-FID-VA</b>	Water	CCME F2-F4 Hydrocarbons in Water	CCME CWS-PHC, Pub #1310, Dec 2001
F2-F4 is extracted from water using a hexane micro-extraction technique. Instrumental analysis is by GC-FID, as per the Reference Method for the			

## Reference Information

Canada-Wide Standard for Petroleum Hydrocarbons in Soil Tier 1 Method, CCME, Dec 2001.

<b>HARDNESS-CALC-VA</b>	Seawater	Hardness	APHA 2340B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO <sub>3</sub> equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
<b>HG-DIS-C-CVAFS-VA</b>	Seawater	Diss. Mercury in Seawater by CVAFS	PUGET SOUND PROTOCOLS, EPA 245.7
This analysis is carried out using procedures adapted from "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples" prepared for the United States Environmental Protection Agency and the Puget Sound Water Quality Authority, 1995. The procedures may involve preliminary sample treatment by filtration (EPA Method 3005A) and involves a cold-oxidation of the acidified seawater sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).			
<b>HG-TOT-C-CVAFS-VA</b>	Seawater	Total Mercury in Seawater by CVAFS	PUGET SOUND PROTOCOLS, EPA 245.7
This analysis is carried out using procedures adapted from "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples" prepared for the United States Environmental Protection Agency and the Puget Sound Water Quality Authority, 1995. The procedure involves a cold-oxidation of the acidified seawater sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).			
<b>IONBALANCE-VA</b>	Water	Ion Balance Calculation	APHA 1030E
Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.			
Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:			
Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]			
<b>MET-D-F-HMI-CCMS-VA</b>	Seawater	Diss. Metals in Seawater by CRC ICPMS	APHA 3030B/EPA 6020B (mod)
Seawater samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS (HMI Mode).			
<b>MET-DIS-C-LOW-MS-VA</b>	Seawater	Diss. Metals in Seawater by ICPMS	PUGET SOUND PROTOCOLS, EPA 6020A
This analysis is carried out using procedures adapted from "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples" prepared for the United States Environmental Protection Agency and the Puget Sound Water Quality Authority, 1995. The procedures may involve preliminary sample treatment by acid digestion or filtration (EPA Method 3005A). Instrumental analysis is by atomic inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
<b>MET-T-HB-F-HMI-MS-VA</b>	Seawater	Tot Metals in Seawater by CRC ICPMS (BC)	EPA 200.2/6020B (mod)
Seawater samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS (HMI Mode). This method is compliant with digestion requirements of the British Columbia Environmental Laboratory Manual.			
<b>MET-TOT-C-LOW-MS-VA</b>	Seawater	Total Metals in Seawater by ICPMS	PUGET SOUND PROTOCOLS, EPA 6020A
This analysis is carried out using procedures adapted from "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples" prepared for the United States Environmental Protection Agency and the Puget Sound Water Quality Authority, 1995. The procedures may involve preliminary sample treatment by acid digestion or filtration (EPA Method 3005A). Instrumental analysis is by atomic inductively coupled plasma - mass spectrometry (EPA Method 6020A).			
<b>NH3-F-VA</b>	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC
This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.			
<b>NO2-L-IC-N-VA</b>	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
<b>NO3-L-IC-N-VA</b>	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
<b>P-T-PRES-COL-VA</b>	Water	Total P in Water by Colour	APHA 4500-P Phosphorus
This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample. Samples with very high dissolved solids (i.e. seawaters, brackish waters) may produce a negative bias by this method. Alternate methods are available for these types of samples.			
Arsenic (5+), at elevated levels, is a positive interference on colourimetric phosphate analysis.			
<b>PH-PCT-VA</b>	Water	pH by Meter (Automated)	APHA 4500-H pH Value

## Reference Information

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

<b>RA226-MMER-FC</b>	Water	Ra226 by Alpha Scint, MDC=0.01 Bq/L	EPA 903.1
<b>SILICATE-COL-VA</b>	Water	Silicate by Colourimetric analysis	APHA 4500-SiO2 E.

This analysis is carried out using procedures adapted from APHA Method 4500-SiO2 E. "Silica". Silicate (molybdate-reactive silica) is determined by the molybdosilicate-heteropoly blue colourimetric method. Arsenic (5+) above 100 mg/L is a negative interference on this test.

<b>SO4-IC-N-VA</b>	Water	Sulfate in Water by IC	EPA 300.1 (mod)
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Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

<b>TDS-CALC-VA</b>	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)
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This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".

The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

<b>TDS-LOW-VA</b>	Water	Low Level TDS (3.0mg/L) by Gravimetric	APHA 2540C
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This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total dissolved solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

<b>TPH(C10-C50)-CALC-CL</b>	Water	Total Petroleum Hydrocarbons (C10-C50)	CCME CWS-PHC, Pub #1310, Dec 2001
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TPH (C10-C50) is determined as the sum of CCME F2, F3 and F4. The CCME F2-F4 test includes an in-situ silica gel cleanup to remove polar organic constituents that are not representative of petroleum hydrocarbons. Even after silica gel cleanup, some non-petroleum source hydrocarbons may be detected by this test.

<b>TSS-VA</b>	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC
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This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
FC	ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

### Chain of Custody Numbers:

18-1789310

### GLOSSARY OF REPORT TERMS

*Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*

*mg/kg - milligrams per kilogram based on dry weight of sample.*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample.*

*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.*

*mg/L - milligrams per litre.*

*< - Less than.*

*D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

**UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.**

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



Wednesday, April 17, 2019

Heather McKenzie  
ALS Environmental  
8081 Lougheed Hwy, Suite 100  
Burnaby, BC V5A 1W9

Re: ALS Workorder: 1904131  
Project Name:  
Project Number: L2253513

Dear Ms. McKenzie:

Three water samples were received from ALS Environmental, on 4/8/2019. The samples were scheduled for the following analysis:

Radium-226

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

ALS Environmental  
Katie M. O'Brien  
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
AIHA	214884
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
PJ-LA (DoD ELAP/ISO 170250)	95377
Louisiana (LA)	05057
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280



**1904131**

**Radium-226:**

The samples were prepared and analyzed according to the current revision of SOP 783.

All acceptance criteria were met.

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1904131

**Client Name:** ALS Environmental

**Client Project Name:**

**Client Project Number:** L2253513

**Client PO Number:** L2253513

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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
L2253513-1	1904131-1		WATER	29-Mar-19	
L2253513-2	1904131-2		WATER	29-Mar-19	
L2253513-5	1904131-3		WATER	31-Mar-19	





L2253513

VANCOUVER

1904131

Subcontract Request Form

Subcontract To:

ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA

225 COMMERCE DRIVE
FORT COLLINS, CO 80524

NOTES: Please reference on final report and invoice: PO# L2253513
ALS requires QC data to be provided with your final results.

Please see enclosed 3 sample(s) in 3 Container(s)

Table with columns: SAMPLE NUMBER, ANALYTICAL REQUIRED, DATE SAMPLED, DUE DATE, Priority Flag. Rows include L2253513-1 PORT 3, L2253513-2 PORT 33, and L2253513-5 FIELD BLANK.

Subcontract Info Contact: Walter Lin (604) 253-4188

Analysis and reporting info contact: Heather McKenzie
8081 LOUGHEED HWY
SUITE 100
BURNABY, BC V5A 1W9

Phone: (604) 253-4188

\*NEW\* Reporting Contacts:
1.Account Manager Listed Below
2.ALSEVDataSublet@ALSGlobal.com (PDF / EXCEL)
3.ALSE.CASDG@ALSGlobal.com (EDD/Database Formats)

Email: Heather.McKenzie@alsglobal.com

Please email confirmation of receipt to: Heather.McKenzie@alsglobal.com

Shipped By: \_\_\_\_\_ Date Shipped: \_\_\_\_\_

Received By: Emily Lyons \_\_\_\_\_ Date Received: 04.08.19 0825

Verified By: \_\_\_\_\_ Date Verified: \_\_\_\_\_

Temperature: \_\_\_\_\_

Sample Integrity Issues: \_\_\_\_\_



ALS Environmental - Fort Collins  
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: ALS - Burnaby  
Project Manager: KMO

Workorder No: 1904131  
Initials: Em Date: 04.08.19

1. Are airbills / shipping documents present and/or removable?		DROP OFF	<input checked="" type="radio"/> YES	NO
2. Are custody seals on <b>shipping</b> containers intact?		<input checked="" type="radio"/> NONE	YES	NO *
3. Are custody seals on <b>sample</b> containers intact?		<input checked="" type="radio"/> NONE	YES	NO *
4. Is there a COC (chain-of-custody) present?			<input checked="" type="radio"/> YES	NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)			<input checked="" type="radio"/> YES	NO *
6. Are short-hold samples present?			YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?			<input checked="" type="radio"/> YES	NO *
8. Were all sample containers received intact? (not broken or leaking)			<input checked="" type="radio"/> YES	NO *
9. Is there sufficient sample for the requested analyses?			<input checked="" type="radio"/> YES	NO *
10. Are all samples in the proper containers for the requested analyses?			<input checked="" type="radio"/> YES	NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)		N/A	YES	<input checked="" type="radio"/> NO
12. Are all aqueous non-preserved samples pH 4-9?		<input checked="" type="radio"/> N/A	YES	NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)		<input checked="" type="radio"/> N/A	YES	NO
14. Were the samples shipped on ice?			<input checked="" type="radio"/> YES	NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*:	#1	<input checked="" type="radio"/> #3	#4
			RAD ONLY	YES
				<input checked="" type="radio"/> NO
	Cooler #:	<u>1</u>		
	Temperature (°C):	<u>12.0</u>		
	No. of custody seals on cooler:	<u>0</u>		
DOT Survey/Acceptance Information	External µR/hr reading:	<u>8</u>		
	Background µR/hr reading:	<u>10</u>		
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? YES / NO / NA (If no, see Form 008.)				

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

#11) Samples 1 and 2 each had initial pHs of 3. 1mL of HNO<sub>3</sub> (lot #197345) was added to each bottle. The final pH of each bottle was 1.6.

All client bottle ID's vs ALS lab ID's double-checked by: Em

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_ Date/Time: \_\_\_\_\_

Project Manager Signature / Date: [Signature] 4/8/19



**Client:** ALS Environmental

**Date:** 17-Apr-19

**Project:** L2253513

**Work Order:** 1904131

**Sample ID:** L2253513-1

**Lab ID:** 1904131-1

**Legal Location:**

**Matrix:** WATER

**Collection Date:** 3/29/2019

**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
<b>Radium-226 by Radon Emanation - Method 903.1</b>			<b>SOP 783</b>		Prep Date: <b>4/9/2019</b>	PrepBy: <b>JXH</b>
<b>Ra-226</b>	<b>0.19 (+/- 0.052)</b>		<b>0.0055</b>	<b>BQ/l</b>	NA	4/16/2019 12:10
<i>Carr: BARIUM</i>	<i>90.9</i>		<i>40-110</i>	<i>%REC</i>	DL = NA	4/16/2019 12:10

**Client:** ALS Environmental

**Date:** 17-Apr-19

**Project:** L2253513

**Work Order:** 1904131

**Sample ID:** L2253513-2

**Lab ID:** 1904131-2

**Legal Location:**

**Matrix:** WATER

**Collection Date:** 3/29/2019

**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
<b>Radium-226 by Radon Emanation - Method 903.1</b>			<b>SOP 783</b>		Prep Date: <b>4/9/2019</b>	PrepBy: <b>JXH</b>
<b>Ra-226</b>	<b>0.20 (+/- 0.054)</b>		<b>0.0085</b>	<b>BQ/l</b>	NA	4/16/2019 12:10
<i>Carr: BARIUM</i>	<i>91.3</i>		<i>40-110</i>	<i>%REC</i>	DL = NA	4/16/2019 12:10

**Client:** ALS Environmental

**Date:** 17-Apr-19

**Project:** L2253513

**Work Order:** 1904131

**Sample ID:** L2253513-5

**Lab ID:** 1904131-3

**Legal Location:**

**Matrix:** WATER

**Collection Date:** 3/31/2019

**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
<b>Radium-226 by Radon Emanation - Method 903.1</b>			<b>SOP 783</b>		Prep Date: <b>4/9/2019</b>	PrepBy: <b>JXH</b>
Ra-226	0.0024 (+/- 0.0046)	U	0.008	BQ/l	NA	4/16/2019 12:10
Carr: <i>BARIUM</i>	87.6		40-110	%REC	DL = NA	4/16/2019 12:10

**Client:** ALS Environmental  
**Project:** L2253513  
**Sample ID:** L2253513-5  
**Legal Location:**  
**Collection Date:** 3/31/2019

**Date:** 17-Apr-19  
**Work Order:** 1904131  
**Lab ID:** 1904131-3  
**Matrix:** WATER  
**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
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**Explanation of Qualifiers**

**Radiochemistry:**

- "Report Limit" is the MDC
- U or ND - Result is less than the sample specific MDC.
- Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
- Y2 - Chemical Yield outside default limits.
- W - DER is greater than Warning Limit of 1.42
- \* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.
- # - Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.
- G - Sample density differs by more than 15% of LCS density.
- D - DER is greater than Control Limit
- M - Requested MDC not met.
- M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
- L - LCS Recovery below lower control limit.
- H - LCS Recovery above upper control limit.
- P - LCS, Matrix Spike Recovery within control limits.
- N - Matrix Spike Recovery outside control limits
- NC - Not Calculated for duplicate results less than 5 times MDC
- B - Analyte concentration greater than MDC.
- B3 - Analyte concentration greater than MDC but less than Requested MDC.

**Inorganics:**

- B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).
- U or ND - Indicates that the compound was analyzed for but not detected.
- E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.
- M - Duplicate injection precision was not met.
- N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.
- Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.
- \* - Duplicate analysis (relative percent difference) not within control limits.
- S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

**Organics:**

- U or ND - Indicates that the compound was analyzed for but not detected.
- B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.
- E - Analyte concentration exceeds the upper level of the calibration range.
- J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).
- A - A tentatively identified compound is a suspected aldol-condensation product.
- X - The analyte was diluted below an accurate quantitation level.
- \* - The spike recovery is equal to or outside the control criteria used.
- + - The relative percent difference (RPD) equals or exceeds the control criteria.
- G - A pattern resembling gasoline was detected in this sample.
- D - A pattern resembling diesel was detected in this sample.
- M - A pattern resembling motor oil was detected in this sample.
- C - A pattern resembling crude oil was detected in this sample.
- 4 - A pattern resembling JP-4 was detected in this sample.
- 5 - A pattern resembling JP-5 was detected in this sample.
- H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.
- L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.
- Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
  - gasoline
  - JP-8
  - diesel
  - mineral spirits
  - motor oil
  - Stoddard solvent
  - bunker C

ALS -- Fort Collins

Date: 4/17/2019 3:12:

Client: ALS Environmental

QC BATCH REPORT

Work Order: 1904131

Project: L2253513

Batch ID: **RE190409-1-1** Instrument ID **Alpha Scin** Method: **Radium-226 by Radon Emanation**

LCS		Sample ID: <b>RE190409-1</b>			Units: <b>BQ/I</b>		Analysis Date: <b>4/16/2019 12:59</b>				
Client ID:		Run ID: <b>RE190409-1A</b>			Prep Date: <b>4/9/2019</b>		DF: <b>NA</b>				
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.96 (+/- 0.489)	0.0186	1.771		111	67-120					P,M3
Carr: BARIUM	13900		15340		90.4	40-110					

LCSD		Sample ID: <b>RE190409-1</b>			Units: <b>BQ/I</b>		Analysis Date: <b>4/16/2019 12:59</b>				
Client ID:		Run ID: <b>RE190409-1A</b>			Prep Date: <b>4/9/2019</b>		DF: <b>NA</b>				
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.65 (+/- 0.414)	0.0184	1.771		93.2	67-120		1.96	0.5	2.1	P,M3
Carr: BARIUM	14600		15330		95.4	40-110		13900			

MB		Sample ID: <b>RE190409-1</b>			Units: <b>BQ/I</b>		Analysis Date: <b>4/16/2019 12:59</b>				
Client ID:		Run ID: <b>RE190409-1A</b>			Prep Date: <b>4/9/2019</b>		DF: <b>NA</b>				
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	-0.00049 (+/- 0.0045)	0.0088									U
Carr: BARIUM	14000		15330		91.6	40-110					

The following samples were analyzed in this batch: 

1904131-1	1904131-2	1904131-3
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Wednesday, April 24, 2019

Heather McKenzie  
ALS Environmental  
8081 Lougheed Hwy, Suite 100  
Burnaby, BC V5A 1W9

Re: ALS Workorder: 1904211  
Project Name:  
Project Number: L2253513

Dear Ms. McKenzie:

Two water samples were received from ALS Environmental, on 4/11/2019. The samples were scheduled for the following analysis:

Radium-226

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

ALS Environmental  
Katie M. O'Brien  
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
AIHA	214884
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
PJ-LA (DoD ELAP/ISO 170250)	95377
Louisiana (LA)	05057
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280



**1904211**

**Radium-226:**

The samples were prepared and analyzed according to the current revision of SOP 783.

All acceptance criteria were met.

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1904211

**Client Name:** ALS Environmental

**Client Project Name:**

**Client Project Number:** L2253513

**Client PO Number:** L2253513

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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
L2253513-3	1904211-1		WATER	30-Mar-19	
L2253513-4	1904211-2		WATER	30-Mar-19	



L2253513

VANCOUVER

Subcontract Request Form

1904211

Subcontract To:

ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA

225 COMMERCE DRIVE
FORT COLLINS, CO 80524

NOTES: Please reference on final report and invoice: PO# L2253513
ALS requires QC data to be provided with your final results.

Please see enclosed 2 sample(s) in 2 Container(s)

Table with columns: SAMPLE NUMBER, ANALYTICAL REQUIRED, DATE SAMPLED, DUE DATE, Priority Flag. Contains entries for PORT 2, PORT 22, and FIELD BLANK.

Subcontract Info Contact: Walter Lin (604) 253-4188
Analysis and reporting info contact: Heather McKenzie
8081 LOUGHEED HWY
SUITE 100
BURNABY, BC V5A 1W9
Phone: (604) 253-4188

\*NEW\* Reporting Contacts:
1. Account Manager Listed Below
2. ALSEVDataSublet@ALSGlobal.com (PDF / EXCEL)
3. ALSE.CASD@ALSGlobal.com (EDD/Database Formats)

Email: Heather.McKenzie@alsglobal.com

Please email confirmation of receipt to: Heather.McKenzie@alsglobal.com

Shipped By: Date Shipped:
Received By: [Signature] Date Received: 4/11/19 1255
Verified By: Date Verified:
Temperature: 7.3

Sample Integrity Issues:



**ALS Environmental - Fort Collins**  
**CONDITION OF SAMPLE UPON RECEIPT FORM**

Client: ALS Burnaby Workorder No: 1904211  
 Project Manager: Katie Initials: KP Date: 4/11/19

1. Are airbills / shipping documents present and/or removable?		DROP OFF	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?		<input checked="" type="radio"/> NONE	<input type="radio"/> YES	<input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?		<input checked="" type="radio"/> NONE	<input type="radio"/> YES	<input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?			<input type="radio"/> YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)		N/A	<input type="radio"/> YES	<input checked="" type="radio"/> NO *
12. Are all aqueous non-preserved samples pH 4-9?		<input checked="" type="radio"/> N/A	<input type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)		<input checked="" type="radio"/> N/A	<input type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?			<input checked="" type="radio"/> YES	<input type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*:	#1	<input checked="" type="radio"/> #3	#4
			<input checked="" type="radio"/> RAD ONLY	<input type="radio"/> YES
				<input checked="" type="radio"/> NO
Cooler #:	<u>1</u>			
Temperature (°C):	<u>7.3</u>			
No. of custody seals on cooler:	<u>0</u>			
External µR/hr reading:	<u>8</u>			
Background µR/hr reading:	<u>10</u>			
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? <input checked="" type="radio"/> YES / <input type="radio"/> NO / <input type="radio"/> NA (If no, see Form 008.)				

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

pH of port 2, port 22, port 4, and port 6 was above 2. Added concentrated HNO<sub>3</sub> to each. lot 197345.

port 4 1.0ml HNO<sub>3</sub> for pH < 2  
port 2 1.0ml HNO<sub>3</sub> for pH < 2  
port 6 .5ml HNO<sub>3</sub> for pH < 2  
port 22 1.0ml HNO<sub>3</sub> for pH < 2

All client bottle ID's vs ALS lab ID's double-checked by: KP

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_ Date/Time: \_\_\_\_\_

Project Manager Signature / Date: [Signature] 4/12/19

ORIGIN ID: YBYA (604) 253-4188  
HARJIT GILL  
ALS ENVIRONMENTAL LAB GROUP  
LOUGHEED HIGHWAY  
BURNABY, BC V5A1W9  
CANADA, CA

Ship Date: 10APR19  
ActWgt: 15.00 LB MAN  
CAD: 0347419/CAFE3211

BILL SENDER  
EINWAT:

(970) 490-1511

TO SAMPLE RECEIVING  
ALS ENVIRONMENTAL  
225 COMMERCE DRIVE



FORT COLLINS, CO 80524

(US)



AWB



XH FTCA

PKG TYPE: CUSTOMER

TRK# 4897 4512 8473 Form 0430

10:30A

INTL PRIORITY

REF: Sublets  
DESC1: environmental water samples for analysis only.  
DESC2:  
DESC3:  
DESC4:

8-0  
7.3

COUNTRY MFG: CA  
CARRIAGE VALUE: 0.00 CAD  
CUSTOMS VALUE: 5.00 CAD

SIGN: HARJIT GILL  
T/C: S  
D/T: R

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FEDEX AWB COPY - PLEASE PLACE IN POUCH

1904211

After printing this label:  
1. Fold the printed page along the horizontal line.  
2. Place label in shipping pouch and affix it to your shipment.

FEDEX AWB COPY - PLEASE PLACE BEHIND CONSIGNEE COPY

Client: ALS Environmental

Date: 24-Apr-19

Project: L2253513

Work Order: 1904211

Sample ID: L2253513-3

Lab ID: 1904211-1

Legal Location:

Matrix: WATER

Collection Date: 3/30/2019

Percent Moisture:

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
<b>Radium-226 by Radon Emanation - Method 903.1</b>			<b>SOP 783</b>		Prep Date: <b>4/12/2019</b>	PrepBy: <b>JXH</b>
<b>Ra-226</b>	<b>1.4 (+/- 0.34)</b>	M3	<b>0.011</b>	<b>BQ/l</b>	NA	4/23/2019 11:21
<i>Carr: BARIUM</i>	<i>82.4</i>		<i>40-110</i>	<i>%REC</i>	DL = NA	4/23/2019 11:21



**Client:** ALS Environmental

**Date:** 24-Apr-19

**Project:** L2253513

**Work Order:** 1904211

**Sample ID:** L2253513-4

**Lab ID:** 1904211-2

**Legal Location:**

**Matrix:** WATER

**Collection Date:** 3/30/2019

**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
<b>Radium-226 by Radon Emanation - Method 903.1</b>			<b>SOP 783</b>		Prep Date: <b>4/12/2019</b>	PrepBy: <b>JXH</b>
<b>Ra-226</b>	<b>1.8 (+/- 0.44)</b>		<b>0.009</b>	<b>BQ/l</b>	NA	4/23/2019 11:21
<i>Carr: BARIUM</i>	<i>82.6</i>		<i>40-110</i>	<i>%REC</i>	DL = NA	4/23/2019 11:21

**Client:** ALS Environmental  
**Project:** L2253513  
**Sample ID:** L2253513-4  
**Legal Location:**  
**Collection Date:** 3/30/2019

**Date:** 24-Apr-19  
**Work Order:** 1904211  
**Lab ID:** 1904211-2  
**Matrix:** WATER  
**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
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**Explanation of Qualifiers**

**Radiochemistry:**

- "Report Limit" is the MDC
- U or ND - Result is less than the sample specific MDC.
- Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
- Y2 - Chemical Yield outside default limits.
- W - DER is greater than Warning Limit of 1.42
- \* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.
- # - Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.
- G - Sample density differs by more than 15% of LCS density.
- D - DER is greater than Control Limit
- M - Requested MDC not met.
- M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
- L - LCS Recovery below lower control limit.
- H - LCS Recovery above upper control limit.
- P - LCS, Matrix Spike Recovery within control limits.
- N - Matrix Spike Recovery outside control limits
- NC - Not Calculated for duplicate results less than 5 times MDC
- B - Analyte concentration greater than MDC.
- B3 - Analyte concentration greater than MDC but less than Requested MDC.

**Inorganics:**

- B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).
- U or ND - Indicates that the compound was analyzed for but not detected.
- E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.
- M - Duplicate injection precision was not met.
- N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.
- Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.
- \* - Duplicate analysis (relative percent difference) not within control limits.
- S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

**Organics:**

- U or ND - Indicates that the compound was analyzed for but not detected.
- B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.
- E - Analyte concentration exceeds the upper level of the calibration range.
- J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).
- A - A tentatively identified compound is a suspected aldol-condensation product.
- X - The analyte was diluted below an accurate quantitation level.
- \* - The spike recovery is equal to or outside the control criteria used.
- + - The relative percent difference (RPD) equals or exceeds the control criteria.
- G - A pattern resembling gasoline was detected in this sample.
- D - A pattern resembling diesel was detected in this sample.
- M - A pattern resembling motor oil was detected in this sample.
- C - A pattern resembling crude oil was detected in this sample.
- 4 - A pattern resembling JP-4 was detected in this sample.
- 5 - A pattern resembling JP-5 was detected in this sample.
- H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.
- L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.
- Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
  - gasoline
  - JP-8
  - diesel
  - mineral spirits
  - motor oil
  - Stoddard solvent
  - bunker C

ALS -- Fort Collins

Date: 4/24/2019 12:25

Client: ALS Environmental  
 Work Order: 1904211  
 Project: L2253513

**QC BATCH REPORT**

Batch ID: **RE190412-1-1** Instrument ID **Alpha Scin** Method: **Radium-226 by Radon Emanation**

LCS		Sample ID: <b>RE190412-1</b>			Units: <b>BQ/I</b>		Analysis Date: <b>4/23/2019 11:21</b>				
Client ID:		Run ID: <b>RE1904112-1A</b>			Prep Date: <b>4/12/2019</b>		DF: <b>NA</b>				
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.76 (+/- 0.443)	0.0101	1.771		99.6	67-120					P,M3
Carr: BARIUM	14600		15750		92.8	40-110					

LCSD		Sample ID: <b>RE190412-1</b>			Units: <b>BQ/I</b>		Analysis Date: <b>4/23/2019 11:21</b>				
Client ID:		Run ID: <b>RE1904112-1A</b>			Prep Date: <b>4/12/2019</b>		DF: <b>NA</b>				
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.78 (+/- 0.448)	0.0121	1.771		101	67-120		1.76	0.03	2.1	P,M3
Carr: BARIUM	15000		15730		95.4	40-110		14600			

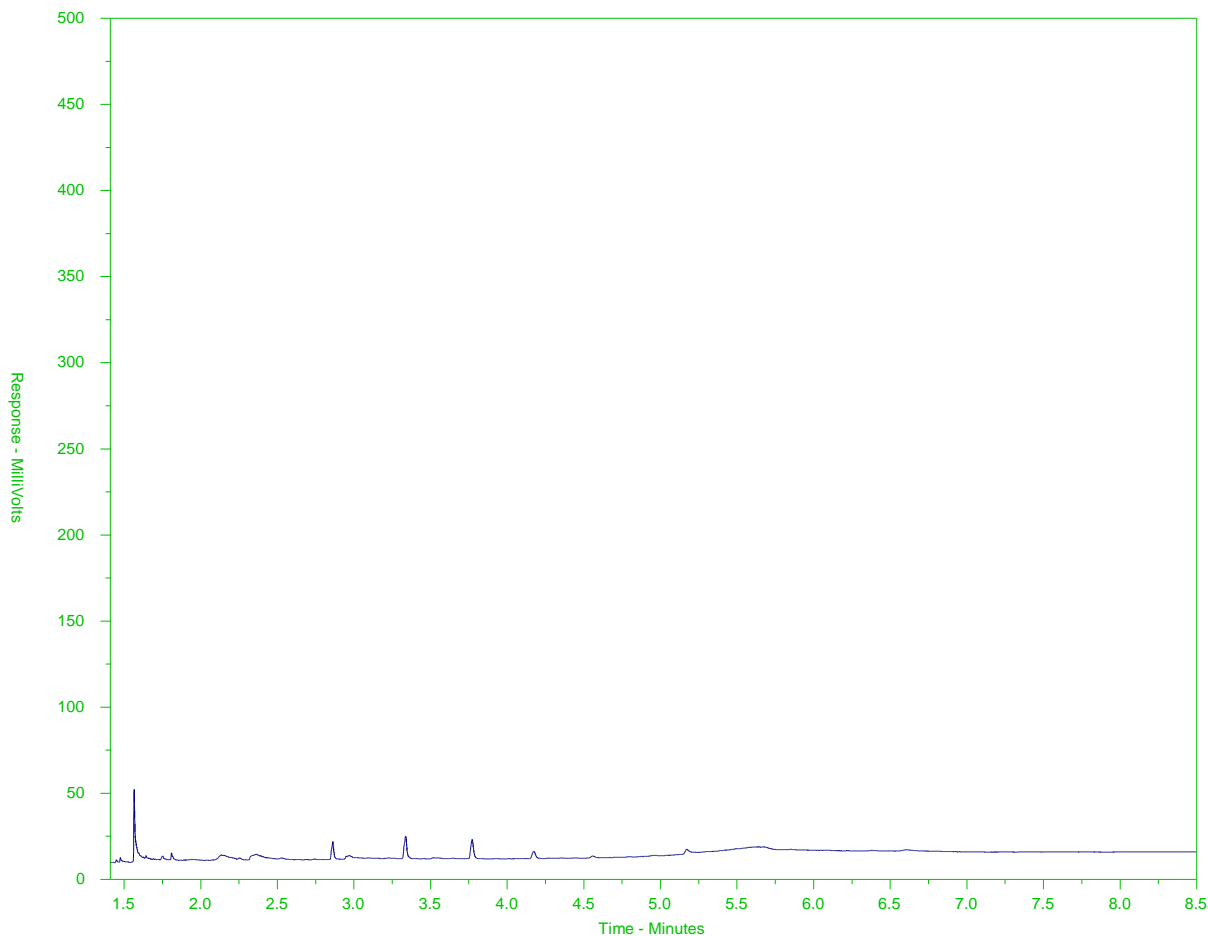
MB		Sample ID: <b>RE190412-1</b>			Units: <b>BQ/I</b>		Analysis Date: <b>4/23/2019 11:21</b>				
Client ID:		Run ID: <b>RE1904112-1A</b>			Prep Date: <b>4/12/2019</b>		DF: <b>NA</b>				
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	-0.00051 (+/- 0.0030)	0.0067									U
Carr: BARIUM	14400		15740		91.3	40-110					

The following samples were analyzed in this batch: 1904211-1 1904211-2

# CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: L2253513-C-1  
 Client Sample ID: PORT 3



← F2 →		← F3 →		← F4 →	
nC10	nC16	nC34	nC50		
174°C	287°C	481°C	575°C		
346°F	549°F	898°F	1067°F		
← Gasoline →		← Motor Oils/ Lube Oils/ Grease →			
← Diesel/ Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

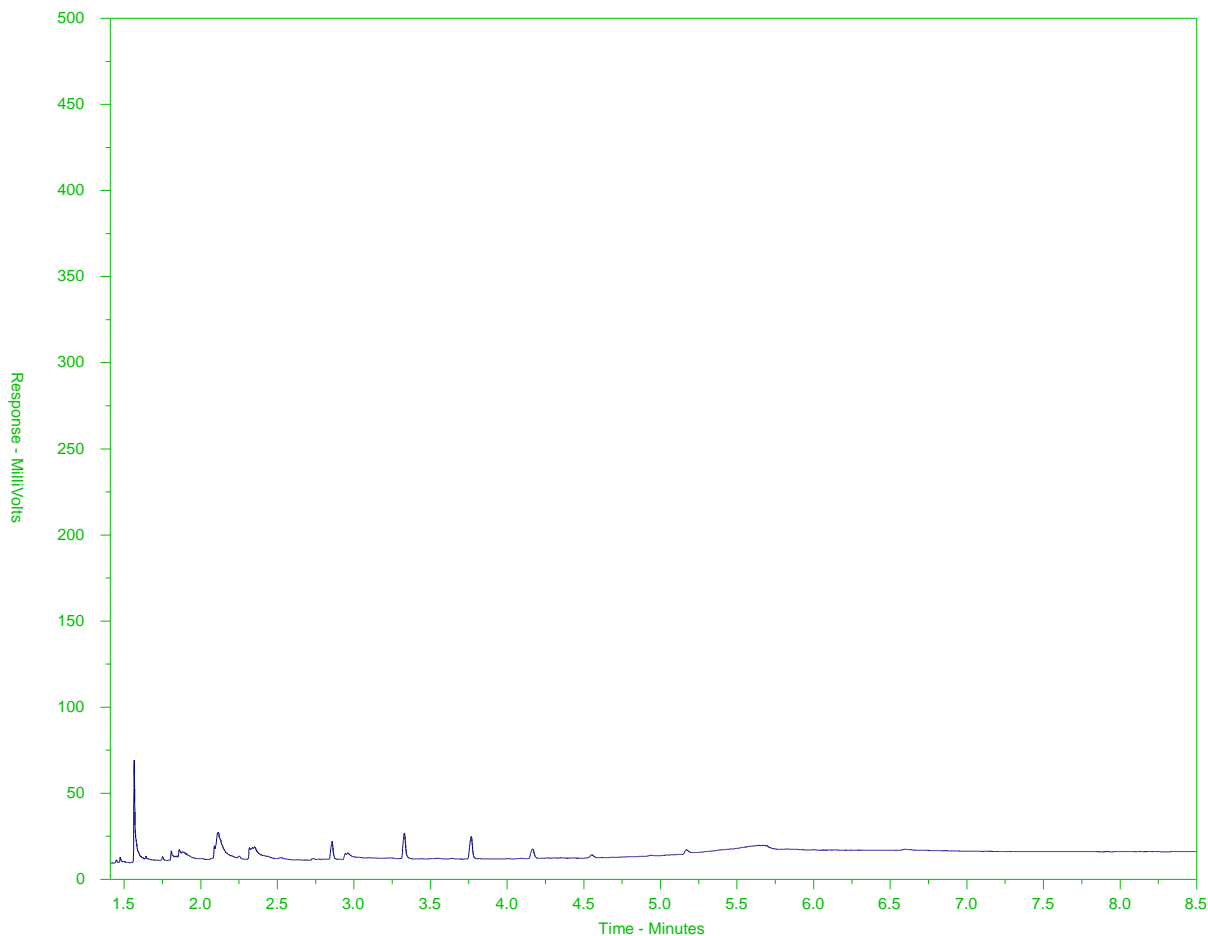
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at [www.alsglobal.com](http://www.alsglobal.com).

# CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: L2253513-C-2  
 Client Sample ID: PORT 33



← F2 →		← F3 →		← F4 →	
nC10	nC16	nC34	nC50		
174°C	287°C	481°C	575°C		
346°F	549°F	898°F	1067°F		
← Gasoline →		← Motor Oils/ Lube Oils/ Grease →			
← Diesel/ Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

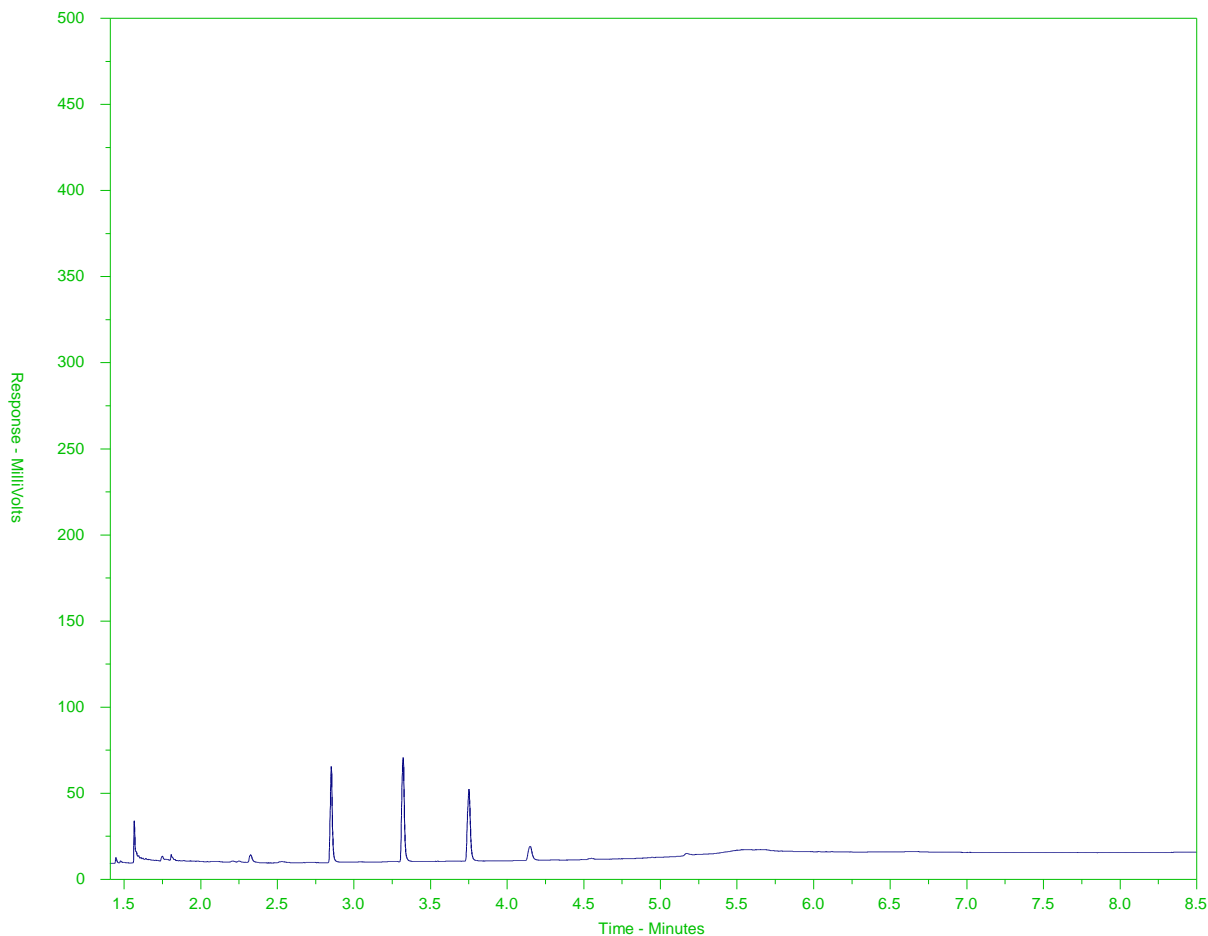
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at [www.alsglobal.com](http://www.alsglobal.com).

# CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: L2253513-C-3  
 Client Sample ID: PORT 2



← F2 →		← F3 →		← F4 →	
nC10	nC16	nC34	nC50		
174°C	287°C	481°C	575°C		
346°F	549°F	898°F	1067°F		
← Gasoline →		← Motor Oils/ Lube Oils/ Grease →			
← Diesel/ Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

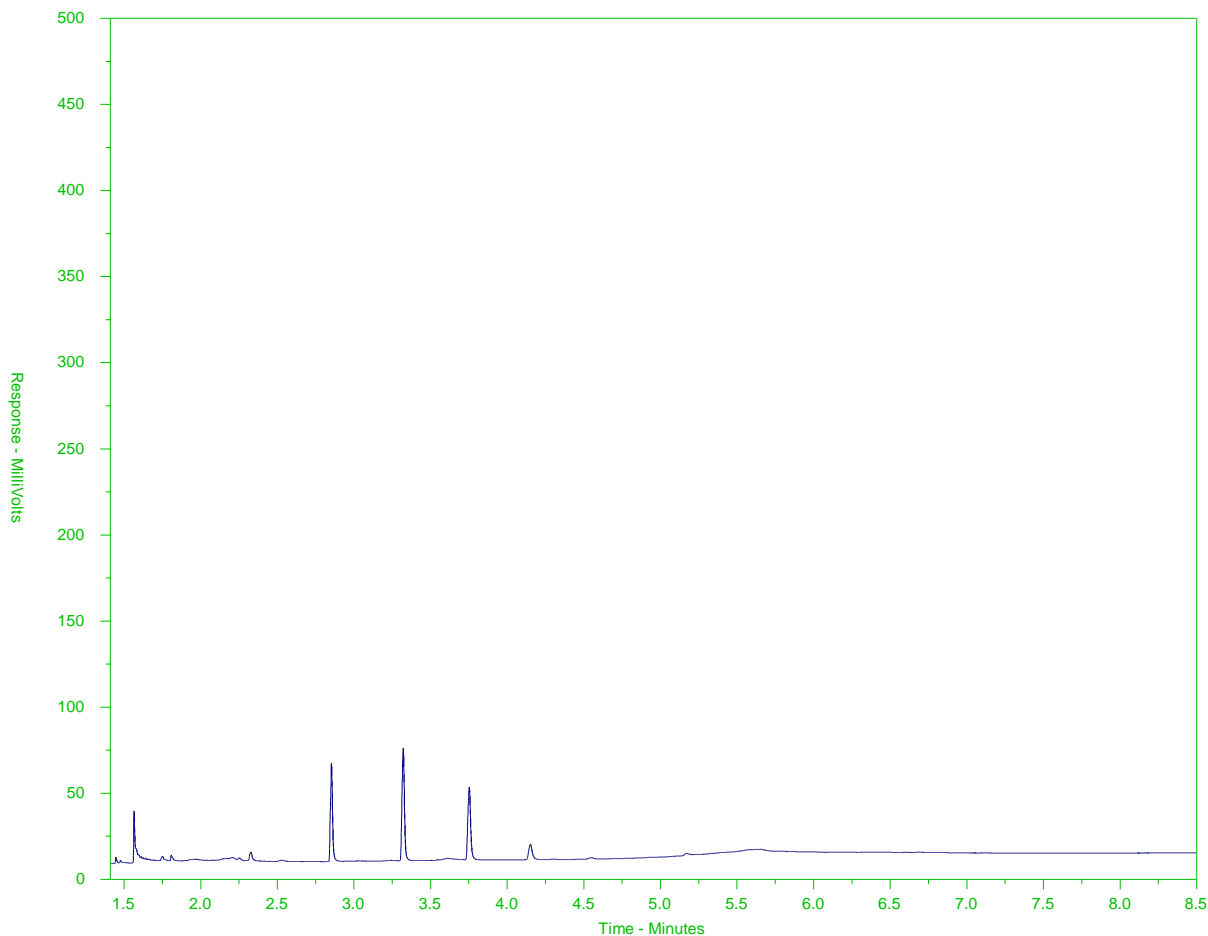
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at [www.alsglobal.com](http://www.alsglobal.com).

# CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: L2253513-C-4  
 Client Sample ID: PORT 22



← F2 →		← F3 →		← F4 →	
nC10	nC16	nC34	nC50		
174°C	287°C	481°C	575°C		
346°F	549°F	898°F	1067°F		
← Gasoline →		← Motor Oils/ Lube Oils/ Grease →			
← Diesel/ Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

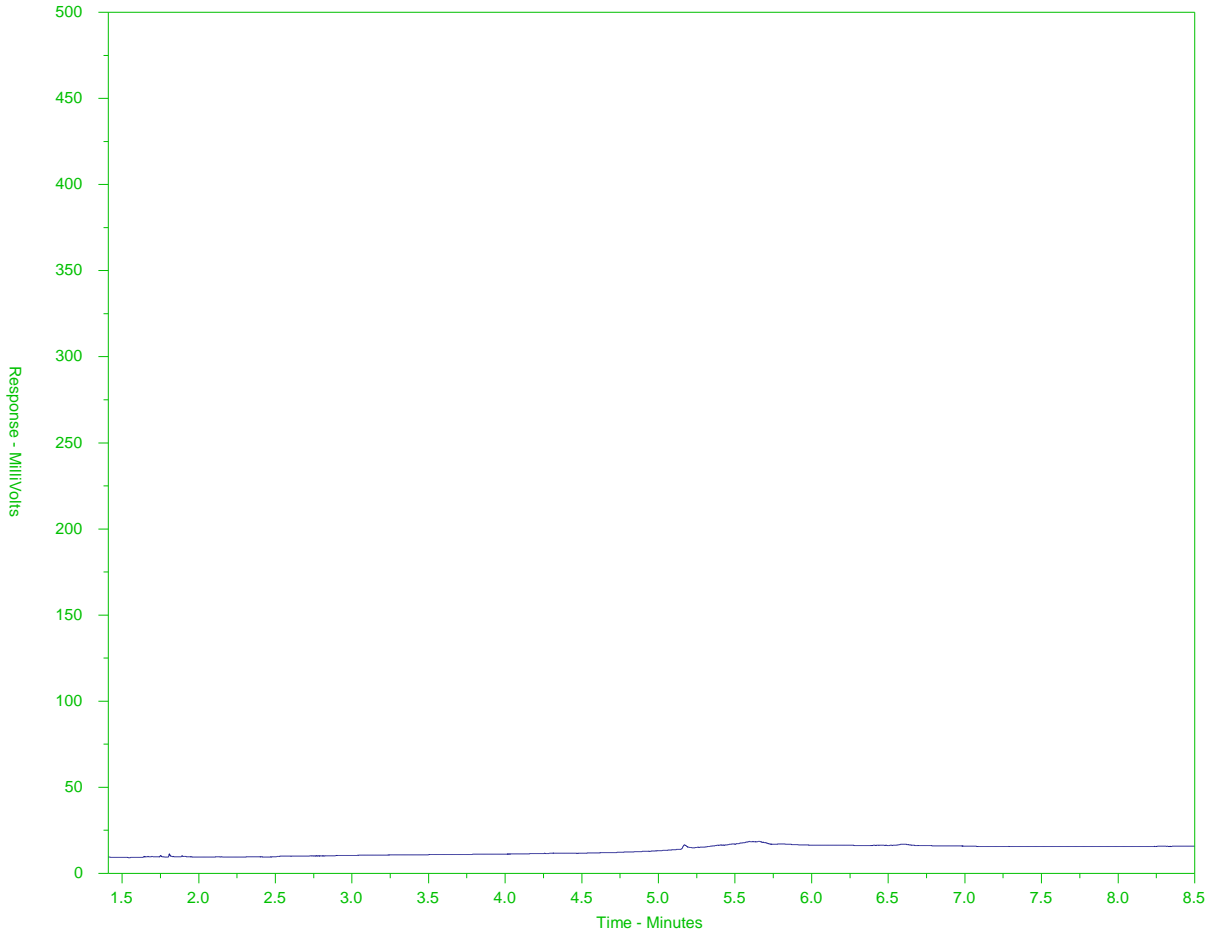
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at [www.alsglobal.com](http://www.alsglobal.com).

# CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: L2253513-C-5  
 Client Sample ID: FIELD BLANK



← F2 →		← F3 →		← F4 →	
nC10	nC16	nC34	nC50		
174°C	287°C	481°C	575°C		
346°F	549°F	898°F	1067°F		
← Gasoline →		← Motor Oils/ Lube Oils/ Grease →			
← Diesel/ Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at [www.alsglobal.com](http://www.alsglobal.com).





Chain of Custody / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

COC # 18-1789310

<b>Report To</b>		<b>Report Format / Distribution</b>		<b>Service Requested</b> (Rush for routine analysis subject to availability)							
Company: Agnico-Eagle Mines Limited		<input checked="" type="checkbox"/> Standard <input type="checkbox"/> Other		<input checked="" type="radio"/> Regular (Standard Turnaround Times - Business Days)							
Contact: Jenyfer Mosquera		<input checked="" type="checkbox"/> PDF <input checked="" type="checkbox"/> Excel <input type="checkbox"/> Digital <input type="checkbox"/> Fax		<input type="radio"/> Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT							
Address: 11600 rue Louis-Bisson, Suite 540 - Mirabel		Email 1: jenyfer.mosquera@agnicoeagle.com		<input type="radio"/> Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT							
Quebec, Canada J7N 1G9		Email 2: dholtze@golder.com; Akowalchuk@golder.com		<input type="radio"/> Same Day or Weekend Emergency - Contact ALS to Confirm TAT							
Phone: 819-759-3555 Fax: x 4608170		Email 3: valerie_bertrand@golder.com									

<b>Invoice To</b> Same as Report? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		<b>Client / Project Information</b>		<b>Analysis Request</b>														
Hardcopy of Invoice with Report? <input type="checkbox"/> Yes <input type="checkbox"/> No		Job #: 18108905		Please indicate below Filtered, Preserved or both (F, P, F/P)														
Company:		PO / AFE:		F		P		P										
Contact:		LSD:		DISSOLVED METALS	TOTAL METALS	TOTAL NUTRIENTS	GENERAL CHEMISTRY	Ra226	PHC C10-C50	Reactive Silica	AVG Conductivity - 4.75 mS/cm	AVG Conductivity - 29.67 mS/cm	AVG Conductivity - 0.01 mS/cm	On Hold	Number of Containers			
Address:		Quote #: Q72802																
Phone: Fax:		ALS Contact: Heather Mckenzie		Sampler: A.Kowalchuk														
Lab Work Order # (lab use only)																		

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	DISSOLVED METALS	TOTAL METALS	TOTAL NUTRIENTS	GENERAL CHEMISTRY	Ra226	PHC C10-C50	Reactive Silica	AVG Conductivity - 4.75 mS/cm	AVG Conductivity - 29.67 mS/cm	AVG Conductivity - 0.01 mS/cm	On Hold	Number of Containers
Port 3		29-Mar-19	9:30	Groundwater	X	X	X	X	X	X	X	X				9
Port 33		29-Mar-19	9:30	Groundwater	X	X	X	X	X	X	X	X				9
Port 2		30-Mar-19	9:00	Groundwater	X	X	X	X	X	X	X		X		X	9
Port 22		30-Mar-19	9:00	Groundwater	X	X	X	X	X	X	X		X		X	9
Field Blank		31-Mar-19	10:00	Other	X	X	X	X	X	X	X			X		9



Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)				Observations:
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:		Yes / No ?
Adrian Kowalchuk	31-Mar-19	16:30	JC	APR - 4 2019	835AM	11 °C					If Yes add SIF

*Emailed revised Coc*



<b>Report To</b>	<b>Report Format / Distribution</b>	<b>Service Requested</b> (Rush for routine analysis subject to availability)
Company: Agnico-Eagle Mines Limited	<input checked="" type="checkbox"/> Standard <input type="checkbox"/> Other	<input checked="" type="radio"/> Regular (Standard Turnaround Times - Business Days)
Contact: Jenyfer Mosquera	<input checked="" type="checkbox"/> PDF <input checked="" type="checkbox"/> Excel <input type="checkbox"/> Digital <input type="checkbox"/> Fax	<input type="radio"/> Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address: 11600 rue Louis-Bisson, Suite 540 - Mirabel Quebec, Canada J7N 1G9	Email 1: jenyfer.mosquera@agnicoeagle.com	<input type="radio"/> Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
Phone: 819-759-3555 Fax: x 4608170	Email 2: dholtze@golder.com; Akowalchuk@golder.com	<input type="radio"/> Same Day or Weekend Emergency - Contact ALS to Confirm TAT
	Email 3: valerie.bertrand@golder.com	

<b>Invoice To</b> Same as Report? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	<b>Client / Project Information</b>	<b>Analysis Request</b>																	
Hardcopy of Invoice with Report? <input type="checkbox"/> Yes <input type="checkbox"/> No	Job #: 18108905	Please indicate below Filtered, Preserved or both (F, P, F/P)																	
Company:	PO / AFE:	F		P		P													
Contact:	LSD:	DISSOLVED METALS	TOTAL METALS	TOTAL PHOSPHORUS	MAJOR IONS, TDS, TSS	Ra226	PHC C10-C50	Reactive Silica					AVG Conductivity - 4.75 mS/cm	AVG Conductivity - 29.67 mS/cm	AVG Conductivity - 0.01 mS/cm				
Address:	Quote #: Q72802																		
Phone:																			
Lab Work Order # (lab use only)	ALS Contact: Heather Mckenzie	Sampler: A.Kowalchuk																	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	DISSOLVED METALS	TOTAL METALS	TOTAL PHOSPHORUS	MAJOR IONS, TDS, TSS	Ra226	PHC C10-C50	Reactive Silica	AVG Conductivity - 4.75 mS/cm	AVG Conductivity - 29.67 mS/cm	AVG Conductivity - 0.01 mS/cm	Number of Containers
	Port 3	29-Mar-19	9:30	Groundwater	X	X	X	X	X	X	X	X			9
	Port 33	29-Mar-19	9:30	Groundwater	X	X	X	X	X	X	X	X			9
	Port 2	30-Mar-19	9:00	Groundwater	X	X	X	X	X	X	X		X		9
	Port 22	30-Mar-19	9:00	Groundwater	X	X	X	X	X	X	X		X		9
	Field Blank	31-Mar-19	10:00	Other	X	X	X	X	X	X	X		X		9



Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

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<b>SHIPMENT RELEASE (client use)</b>			<b>SHIPMENT RECEPTION (lab use only)</b>			<b>SHIPMENT VERIFICATION (lab use only)</b>				
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Adrian Kowalchuk	31-Mar-19	16:30	JC	APR - 4 2019	8:35 AM	11 °C				

Recd COC with amp



AGNICO-EAGLE MINES LTD.  
ATTN: Jenyfer Mosquera  
Nunavut Permitting Lead  
11600 rue Louis-Bisson, Suite 540  
Mirabel QC J7N 1G9

Date Received: 09-APR-19  
Report Date: 16-MAY-19 16:13 (MT)  
Version: FINAL REV. 2

Client Phone: --

## Certificate of Analysis

Lab Work Order #: L2255221  
Project P.O. #: NOT SUBMITTED  
Job Reference: 18108905  
C of C Numbers: 18-1789310  
Legal Site Desc:

Comments: ADDITIONAL 13-MAY-19 15:59  
16-MAY-2019 Report now including calculated TDS results.

Heather McKenzie  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2255221-1 Other 03-APR-19 08:00 ALS TRAVEL BLANK	L2255221-2 GroundWater 02-APR-19 14:30 PORT 4	L2255221-3 GroundWater 03-APR-19 10:20 PORT 6	
Grouping	Analyte				
<b>SEAWATER</b>					
<b>Physical Tests</b>	Hardness (as CaCO3) (mg/L)	<4.8 <sup>HTC</sup>	10200	3780	
<b>Total Metals</b>	Aluminum (Al)-Total (mg/L)	<0.0050	<0.025 <sup>DLA</sup>	0.017 <sup>DLA</sup>	
	Antimony (Sb)-Total (mg/L)	<0.0010	<0.0050 <sup>DLA</sup>	<0.0030 <sup>DLA</sup>	
	Arsenic (As)-Total (mg/L)	<0.00040	0.0035	0.0029	
	Barium (Ba)-Total (mg/L)	<0.0010	0.483	0.793	
	Beryllium (Be)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
	Boron (B)-Total (mg/L)	<0.30	<1.5 <sup>DLA</sup>	<0.90 <sup>DLA</sup>	
	Cadmium (Cd)-Total (mg/L)	<0.000010	<0.000050 <sup>DLA</sup>	<0.000030 <sup>DLA</sup>	
	Calcium (Ca)-Total (mg/L)	<1.0	3720	1360	
	Cesium (Cs)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
	Chromium (Cr)-Total (mg/L)	<0.00050	0.0027	0.0139	
	Cobalt (Co)-Total (mg/L)	<0.000050	<0.00025 <sup>DLA</sup>	0.00024 <sup>DLA</sup>	
	Copper (Cu)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
	Gallium (Ga)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
	Iron (Fe)-Total (mg/L)	<0.010	0.267 <sup>DLA</sup>	0.448	
	Lead (Pb)-Total (mg/L)	<0.000050	<0.00025 <sup>DLA</sup>	0.00026	
	Lithium (Li)-Total (mg/L)	<0.020	2.71	0.466	
	Magnesium (Mg)-Total (mg/L)	<1.0	47.7	41.2	
	Manganese (Mn)-Total (mg/L)	<0.00020	0.0819	0.0977	
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Total (mg/L)	<0.00010	0.0165	0.0225	
	Nickel (Ni)-Total (mg/L)	<0.00050	0.0029	0.0095	
	Phosphorus (P)-Total (mg/L)	<0.050	<0.25 <sup>DLA</sup>	<0.15 <sup>DLA</sup>	
	Potassium (K)-Total (mg/L)	<1.0	128	10.0	
	Rhenium (Re)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
	Rubidium (Rb)-Total (mg/L)	<0.0050	0.150 <sup>DLA</sup>	0.016	
	Selenium (Se)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	0.0028	
	Silicon (Si)-Total (mg/L)	<0.50	2.39	2.53	
	Silver (Ag)-Total (mg/L)	<0.00010	<0.00050 <sup>DLA</sup>	<0.00030 <sup>DLA</sup>	
	Sodium (Na)-Total (mg/L)	<2.5	446	282	
	Strontium (Sr)-Total (mg/L)	<0.010	60.2	19.5	
	Sulfur (S)-Total (mg/L)	<5.0	<25 <sup>DLA</sup>	<15 <sup>DLA</sup>	
	Tellurium (Te)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
	Thallium (Tl)-Total (mg/L)	<0.000050	<0.00025 <sup>DLA</sup>	<0.00015 <sup>DLA</sup>	
	Thorium (Th)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
	Tin (Sn)-Total (mg/L)	<0.0010	<0.0050 <sup>DLA</sup>	<0.0030 <sup>DLA</sup>	

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2255221-1 Other 03-APR-19 08:00 ALS TRAVEL BLANK	L2255221-2 GroundWater 02-APR-19 14:30 PORT 4	L2255221-3 GroundWater 03-APR-19 10:20 PORT 6	
Grouping	Analyte				
<b>SEAWATER</b>					
<b>Total Metals</b>	Titanium (Ti)-Total (mg/L)	<0.0050	<0.025 <sup>DLA</sup>	<0.015 <sup>DLA</sup>	
	Tungsten (W)-Total (mg/L)	<0.0010	0.0572	0.0205	
	Uranium (U)-Total (mg/L)	<0.000050	<0.00025 <sup>DLA</sup>	<0.00015 <sup>DLA</sup>	
	Vanadium (V)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
	Yttrium (Y)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
	Zinc (Zn)-Total (mg/L)	<0.0030	0.600	0.930	
	Zirconium (Zr)-Total (mg/L)	<0.00050	<0.0025 <sup>DLA</sup>	<0.0015 <sup>DLA</sup>	
<b>Dissolved Metals</b>	Dissolved Mercury Filtration Location		FIELD	FIELD	
	Dissolved Metals Filtration Location		FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)		0.0080	<0.0050	
	Antimony (Sb)-Dissolved (mg/L)		0.0025	<0.0010	
	Arsenic (As)-Dissolved (mg/L)		0.00260	0.00245	
	Barium (Ba)-Dissolved (mg/L)		0.538	0.856	
	Beryllium (Be)-Dissolved (mg/L)		<0.00050	<0.00050	
	Bismuth (Bi)-Dissolved (mg/L)		<0.00050	<0.00050	
	Boron (B)-Dissolved (mg/L)		0.94	0.32	
	Cadmium (Cd)-Dissolved (mg/L)		0.000018	0.000018	
	Calcium (Ca)-Dissolved (mg/L)		4000	1450	
	Cesium (Cs)-Dissolved (mg/L)		0.00115	<0.00050	
	Chromium (Cr)-Dissolved (mg/L)		<0.00050	<0.00050	
	Cobalt (Co)-Dissolved (mg/L)		0.000080	<0.000050	
	Copper (Cu)-Dissolved (mg/L)		0.00042	<0.00020	
	Gallium (Ga)-Dissolved (mg/L)		<0.00050	<0.00050	
	Iron (Fe)-Dissolved (mg/L)		0.059	0.275	
	Lead (Pb)-Dissolved (mg/L)		<0.000050	<0.000050	
	Lithium (Li)-Dissolved (mg/L)		2.80	0.427	
	Magnesium (Mg)-Dissolved (mg/L)		42.4	37.8	
	Manganese (Mn)-Dissolved (mg/L)		0.0855	0.0981	
	Mercury (Hg)-Dissolved (mg/L)		<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)		0.0192	0.0217	
	Nickel (Ni)-Dissolved (mg/L)		0.00139	<0.00050	
	Phosphorus (P)-Dissolved (mg/L)		<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)		159	11.2	
	Rhenium (Re)-Dissolved (mg/L)		<0.00050	<0.00050	
	Rubidium (Rb)-Dissolved (mg/L)		0.167	0.0161	
	Selenium (Se)-Dissolved (mg/L)		<0.00050	<0.00050	
	Silicon (Si)-Dissolved (mg/L)		2.39	2.75	

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2255221-1 Other 03-APR-19 08:00 ALS TRAVEL BLANK	L2255221-2 GroundWater 02-APR-19 14:30 PORT 4	L2255221-3 GroundWater 03-APR-19 10:20 PORT 6	
Grouping	Analyte				
<b>SEAWATER</b>					
<b>Dissolved Metals</b>	Silver (Ag)-Dissolved (mg/L)		<0.00010	<0.00010	
	Sodium (Na)-Dissolved (mg/L)		389	272	
	Strontium (Sr)-Dissolved (mg/L)		66.3	20.3	
	Sulfur (S)-Dissolved (mg/L)		<5.0	<5.0	
	Tellurium (Te)-Dissolved (mg/L)		0.00406	0.00108	
	Thallium (Tl)-Dissolved (mg/L)		<0.000050	<0.000050	
	Thorium (Th)-Dissolved (mg/L)		<0.00050	<0.00050	
	Tin (Sn)-Dissolved (mg/L)		<0.0010	<0.0010	
	Titanium (Ti)-Dissolved (mg/L)		<0.0050	<0.0050	
	Tungsten (W)-Dissolved (mg/L)		0.0636	0.0225	
	Uranium (U)-Dissolved (mg/L)		0.000072	<0.000050	
	Vanadium (V)-Dissolved (mg/L)		<0.00050	<0.00050	
	Yttrium (Y)-Dissolved (mg/L)		<0.00050	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)		0.0184	0.0300	
	Zirconium (Zr)-Dissolved (mg/L)		<0.00050	<0.00050	

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2255221-1 Other 03-APR-19 08:00 ALS TRAVEL BLANK	L2255221-2 GroundWater 02-APR-19 14:30 PORT 4	L2255221-3 GroundWater 03-APR-19 10:20 PORT 6	
Grouping	Analyte				
<b>WATER</b>					
<b>Field Tests</b>	Conductivity, Client Supplied (uS/cm)		22280	9640	
<b>Physical Tests</b>	Conductivity (uS/cm)	<2.0	21300	8940	
	pH (pH)	5.83	6.75	6.36	
	Total Suspended Solids (mg/L)	<3.0	9.1	5.1	
	Total Dissolved Solids (mg/L)	<3.0	13300	6210	
	TDS (Calculated) (mg/L)	<1.0	12000	5170	
<b>Anions and Nutrients</b>	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	<1.0	18.7	30.3	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	<1.0	18.7	30.3	
	Ammonia, Total (as N) (mg/L)	<0.0050	0.238	0.466	
	Bromide (Br) (mg/L)	<0.050	99.6	44.8	
	Chloride (Cl) (mg/L)	<0.10	7430	3380	
	Fluoride (F) (mg/L)	<0.020	<2.0 <small>DLDS</small>	<1.0 <small>DLDS</small>	
	Nitrate (as N) (mg/L)	<0.0050	<0.50 <small>DLDS</small>	<0.25 <small>DLDS</small>	
	Nitrite (as N) (mg/L)	<0.0010	<0.10 <small>DLDS</small>	<0.050 <small>DLDS</small>	
	Phosphorus (P)-Total (mg/L)	<0.0020	0.0065 <small>DLM</small>	<0.0020 <small>DLM</small>	
	Silicate (as SiO2) (mg/L)	<0.50	<50 <small>DLDS</small>	<50 <small>DLDS</small>	
	Sulfate (SO4) (mg/L)	<0.30	<30	<15	
	Anion Sum (meq/L)	<0.10	210	95.8	
	Cation Sum (meq/L)	<0.10	224	87.6	
	Cation - Anion Balance (%)	0.0	3.3	-4.5	
<b>Hydrocarbons</b>	F2 (C10-C16) (mg/L)	<0.30	<0.30	<0.30	
	F3 (C16-C34) (mg/L)	<0.30	<0.30	<0.30	
	F4 (C34-C50) (mg/L)	<0.30	<0.30	<0.30	
	TPH (C10-C50) (mg/L)	<0.52	<0.52	<0.52	
	Surrogate: 2-Bromobenzotrifluoride, F2-F4 (%)	89.5	96.7	96.5	
<b>Radiological Parameters</b>	Ra-226 (Bq/L)	<0.0079	1.3	0.85	

\* Please refer to the Reference Information section for an explanation of any qualifiers detected.

## Reference Information

### QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Laboratory Control Sample	Boron (B)-Dissolved	MES	L2255221-2, -3
Laboratory Control Sample	Lithium (Li)-Dissolved	MES	L2255221-2, -3
Laboratory Control Sample	Tellurium (Te)-Dissolved	MES	L2255221-2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2255221-2, -3
Matrix Spike	Boron (B)-Dissolved	MS-B	L2255221-2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2255221-2, -3
Matrix Spike	Lithium (Li)-Dissolved	MS-B	L2255221-2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2255221-2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2255221-2, -3
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2255221-2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2255221-2, -3

### Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

### Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
<b>ALK-TITR-VA</b>	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity
		This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.	
<b>BR-L-IC-N-VA</b>	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)
		Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	
<b>CL-L-IC-N-VA</b>	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)
		Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	
<b>EC-PCT-VA</b>	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.
		This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.	
<b>EC-SCREEN-VA</b>	Water	Conductivity Screen (Internal Use Only)	APHA 2510
		Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.	
<b>F-IC-N-VA</b>	Water	Fluoride in Water by IC	EPA 300.1 (mod)
		Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	
<b>F2-F4-ME-FID-VA</b>	Water	CCME F2-F4 Hydrocarbons in Water	CCME CWS-PHC, Pub #1310, Dec 2001
		F2-F4 is extracted from water using a hexane micro-extraction technique. Instrumental analysis is by GC-FID, as per the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil Tier 1 Method, CCME, Dec 2001.	
<b>HARDNESS-CALC-VA</b>	Seawater	Hardness	APHA 2340B
		Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO <sub>3</sub> equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.	
<b>HG-DIS-C-CVAFS-VA</b>	Seawater	Diss. Mercury in Seawater by CVAFS	PUGET SOUND PROTOCOLS, EPA 245.7
		This analysis is carried out using procedures adapted from "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples" prepared for the United States Environmental Protection Agency and the Puget Sound Water Quality Authority, 1995. The procedures may involve preliminary sample treatment by filtration (EPA Method 3005A) and involves a cold-oxidation of the acidified seawater sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).	
<b>HG-TOT-C-CVAFS-VA</b>	Seawater	Total Mercury in Seawater by CVAFS	PUGET SOUND PROTOCOLS, EPA 245.7





## Reference Information

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

**TDS-CALC-VA** Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".

The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

**TDS-LOW-VA** Water Low Level TDS (3.0mg/L) by Gravimetric APHA 2540C

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total dissolved solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

**TPH(C10-C50)-CALC-CL** Water Total Petroleum Hydrocarbons (C10-C50) CCME CWS-PHC, Pub #1310, Dec 2001

TPH (C10-C50) is determined as the sum of CCME F2, F3 and F4. The CCME F2-F4 test includes an in-situ silica gel cleanup to remove polar organic constituents that are not representative of petroleum hydrocarbons. Even after silica gel cleanup, some non-petroleum source hydrocarbons may be detected by this test.

**TSS-VA** Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

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\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

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The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

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Laboratory Definition Code	Laboratory Location
FC	ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

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### Chain of Custody Numbers:

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18-1789310

### GLOSSARY OF REPORT TERMS

*Surrogate* - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

*mg/kg* - milligrams per kilogram based on dry weight of sample.

*mg/kg wwt* - milligrams per kilogram based on wet weight of sample.

*mg/kg lwt* - milligrams per kilogram based on lipid-adjusted weight of sample.

*mg/L* - milligrams per litre.

*<* - Less than.

*D.L.* - The reported Detection Limit, also known as the Limit of Reporting (LOR).

*N/A* - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



Wednesday, April 24, 2019

Heather McKenzie  
ALS Environmental  
8081 Lougheed Hwy, Suite 100  
Burnaby, BC V5A 1W9

Re: ALS Workorder: 1904213  
Project Name:  
Project Number: L2255221

Dear Ms. McKenzie:

Three water samples were received from ALS Environmental, on 4/11/2019. The samples were scheduled for the following analysis:

Radium-226

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

ALS Environmental  
Katie M. O'Brien  
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
AIHA	214884
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
PJ-LA (DoD ELAP/ISO 170250)	95377
Louisiana (LA)	05057
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280



**1904213**

**Radium-226:**

The samples were prepared and analyzed according to the current revision of SOP 783.

All acceptance criteria were met.

# ALS -- Fort Collins

## Sample Number(s) Cross-Reference Table

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**OrderNum:** 1904213

**Client Name:** ALS Environmental

**Client Project Name:**

**Client Project Number:** L2255221

**Client PO Number:** L2255221

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Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
L2255221-1	1904213-1		WATER	03-Apr-19	
L2255221-2	1904213-2		WATER	02-Apr-19	
L2255221-3	1904213-3		WATER	03-Apr-19	



L2255221

VANCOUVER

Subcontract Request Form

1904213

Subcontract To:

ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA

225 COMMERCE DRIVE
FORT COLLINS, CO 80524

NOTES: Please reference on final report and invoice: PO# L2255221
ALS requires QC data to be provided with your final results.

Please see enclosed 3 sample(s) in 3 Container(s)

Table with 4 columns: SAMPLE NUMBER, ANALYTICAL REQUIRED, DATE SAMPLED DUE DATE, Priority Flag. Contains 3 rows of sample data.

Subcontract Info Contact: Walter Lin (604) 253-4188
Analysis and reporting info contact: Heather McKenzie
8081 LOUGHEED HWY
SUITE 100
BURNABY, BC V5A 1W9
Phone: (604) 253-4188

\*NEW\* Reporting Contacts:
1.Account Manager Listed Below
2.ALSEVDataSublet@ALSGlobal.com (PDF / EXCEL)
3.ALSE.CASDG@ALSGlobal.com (EIDD/Database Formats)

Email: Heather.McKenzie@alsglobal.com

Please email confirmation of receipt to: Heather.McKenzie@alsglobal.com

Shipped By: Date Shipped:
Received By: [Signature] Date Received: 4/11/19 12:55
Verified By: Date Verified:
Temperature: 7.3

Sample Integrity Issues:



ALS Environmental - Fort Collins  
CONDITION OF SAMPLE UPON RECEIPT FORM

1904213

Client: ALS Burnaby

Workorder No: 19042H KP 4/11/19

Project Manager: Katie

Initials: KP Date: 4/11/19

1. Are airbills / shipping documents present and/or removable?		DROP OFF?	<input checked="" type="radio"/> YES	<input type="radio"/> NO
2. Are custody seals on <b>shipping</b> containers intact?			<input checked="" type="radio"/> NONE	<input type="radio"/> YES <input type="radio"/> NO *
3. Are custody seals on <b>sample</b> containers intact?			<input checked="" type="radio"/> NONE	<input type="radio"/> YES <input type="radio"/> NO *
4. Is there a COC (chain-of-custody) present?			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
5. Is the COC in agreement with samples received? (IDs, dates, times, # of samples, # of containers, matrix, requested analyses, etc.)			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
6. Are short-hold samples present?			<input type="radio"/> YES	<input checked="" type="radio"/> NO
7. Are all samples within holding times for the requested analyses?			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
8. Were all sample containers received intact? (not broken or leaking)			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
9. Is there sufficient sample for the requested analyses?			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
10. Are all samples in the proper containers for the requested analyses?			<input checked="" type="radio"/> YES	<input type="radio"/> NO *
11. Are all aqueous samples preserved correctly, if required? (excluding volatiles)		N/A	<input type="radio"/> YES	<input checked="" type="radio"/> NO *
12. Are all aqueous non-preserved samples pH 4-9?		<input checked="" type="radio"/> N/A	<input type="radio"/> YES	<input type="radio"/> NO *
13. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, radon) free of bubbles > 6 mm (1/4 inch) diameter? (i.e. size of green pea)		<input checked="" type="radio"/> N/A	<input type="radio"/> YES	<input type="radio"/> NO
14. Were the samples shipped on ice?			<input checked="" type="radio"/> YES	<input type="radio"/> NO
15. Were cooler temperatures measured at 0.1-6.0°C?	IR gun used*:	#1	<input checked="" type="radio"/> #3	#4 <input checked="" type="radio"/> RAD ONLY <input type="radio"/> YES <input checked="" type="radio"/> NO
Cooler #: <u>1</u>				
Temperature (°C): <u>7.3</u>				
No. of custody seals on cooler: <u>0</u>				
External µR/hr reading: <u>8</u>				
Background µR/hr reading: <u>10</u>				
Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? <input checked="" type="radio"/> YES <input type="radio"/> NO / NA (If no, see Form 008.)				

\* Please provide details here for NO responses to gray boxes above - for 2 thru 5 & 7 thru 12, notify PM & continue w/ login.

pH of port 2, port 22, port 4, and port 6 was above 2. Added concentrated HNO<sub>3</sub> to each. Lot 197345.

port 4 1.0ml HNO<sub>3</sub> for pH < 2  
~~port 2 1.0ml HNO<sub>3</sub> for pH < 2~~  
port 6 .5ml HNO<sub>3</sub> for pH < 2  
~~port 22 1.0ml HNO<sub>3</sub> for pH < 2~~ 4/12/19

All client bottle ID's vs ALS lab ID's double-checked by: KP

If applicable, was the client contacted? YES / NO / NA Contact: \_\_\_\_\_ Date/Time: \_\_\_\_\_

Project Manager Signature / Date: [Signature] 4/12/19



1904213

SHIP DATE: 10APR19  
ACT WGT: 15.00 LB MAN  
CAD: 0347419/CAFES211

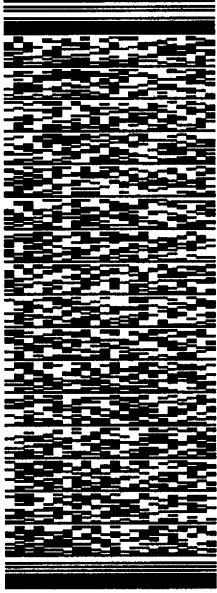
ORIGIN ID: YBYA (604) 253-4188  
HARJI GILL  
ALS ENVIRONMENTAL LAB GROUP  
LOUGHHEAD HIGHWAY  
BURNABY, BC V5A1W9  
CANADA CA

BILL SENDER

TO SAMPLE RECEIVING  
ALS ENVIRONMENTAL  
225 COMMERCE DRIVE

FORT COLLINS CO 80524  
(970) 490-1511  
REF: SUBLETS

8-0  
7-3  
(US)  
551C1D7E5M04C



10:30A  
INTL PRIORITY

TRK# 4897 4512 8473  
0430

80524  
CO-US  
DEN



After printing this label:  
1. Fold the printed page along the horizontal line.  
2. Place label in shipping pouch and affix it to your shipment.

**DEFINITIONS:** On the Air Waybill, "We," "Our," "us," and "FedEx" refer to Federal Express Corporation, its subsidiaries and branches and their respective employees, agents and independent contractors. "You" and "your" refer to the shipper, its employees, principals and agents. If your shipment originates outside the United States, your contract of carriage is with the Federal Express subsidiary, branch or independent contractor who originates the shipment from you. "Package" means any container or enclosure that is accepted by us for delivery. By giving us such items, you agree, regardless of whether you are a customer, agent or independent contractor, to all terms on the NON-NEGOTIABLE AIR WAYBILL. In any applicable bill of lading, we agree, regardless of whether you are a customer, agent or independent contractor, to all terms on the Standard Conditions of Carriage or Standard Conditions of Carriage, copies of which are available upon request. If there is a conflict between the Air Waybill and either the bill of lading, Standard Conditions of Carriage or Standard Conditions of Carriage, the Air Waybill shall prevail. This Air Waybill shall be binding on you and the shipper's acceptor.

**YOUR OBLIGATIONS:** You warrant that each article in the shipment is properly described on the Air Waybill and is acceptable for transport by us, and that the shipment is properly marked, addressed (including postal codes) and packaged to ensure safe transportation with ordinary care in handling.

**NOTE CONCERNING LIMITATIONS OF LIABILITY:** Air Carriage Notice. If the carriage of your shipment by air involves an ultimate destination or stop in a country other than the country of departure, the Warsaw Convention, an International Treaty relating to international carriage by air, may be applicable, which Treaty would then govern and in most cases limit our liability for loss or damage to your shipment. In the U.S., the Warsaw Convention limits our liability to U.S. \$20.36 per kilogram. Unless you declare a higher value for carriage as described below, the interpretation of the Warsaw Convention liability limits may vary in other countries. There are no stopping places which are agreed at the time of tender of the shipment and we reserve the right to route shipments in any way we deem appropriate.

**Limitation of Liability:** If not governed by the Warsaw Convention or the CMR, as described above, our maximum liability for loss, damage or delay is limited by this Air Waybill to U.S. \$100 per shipment or U.S. \$9.07 per pound (U.S. \$20.36 per kilo) or equivalent local currency, whichever is higher value for carriage as described below. FedEx does not provide cargo liability or other insurance, but you may pay an additional charge to each additional U.S. \$100 (or equivalent local currency) of declared value for carriage. If a higher value for carriage is declared and the additional charge is paid, FedEx maximum liability will be the lesser of the declared value for carriage or your actual damages. LIMITATION NOT ASSIGNED IN ANY EVENT BE LIABLE FOR ANY DAMAGES WHETHER DIRECT, INCIDENTAL, SPECIAL, OR CONSEQUENTIAL, IN EXCESS OF THE DECLARED VALUE FOR CARGO (INCLUDING BUT NOT NECESSARILY LIMITED TO LOSS OF INCOME OR PROFITS) WHETHER OR NOT WE HAD ANY KNOWLEDGE THAT SUCH DAMAGES MIGHT BE INCURRED, UNLESS SUCH DAMAGES WERE CAUSED BY OUR OWN WILLFUL MISCONDUCT OR GROSS NEGLIGENCE.

We warrant the liability for your actions or omissions, including but not limited to incorrect declaration of cargo, improper or incomplete packing, securing, marking or addressing of the shipment, or for the acts or omissions of the recipient or anyone else with an interest in the shipment. Also we warrant to be liable if you (or the recipient) violate any of the terms of our agreement. We won't be liable for loss of or damage to shipments of cash, currency or other prohibited items. We won't be liable for loss, damage or delay caused by events we cannot control, including but not limited to acts of God, perils of the air, weather conditions, mechanical delays, acts of public enemies, war, strikes, civil commotions, or acts or omissions of public authorities (including customs and health officials) which actual or apparent authority.

**CLAIM FOR LOSS, DAMAGE FOR DELAY, AND CLAIMS MUST BE NOTIFIED TO US WITHIN 15 DAYS AFTER DELIVERY OF THE SHIPMENT WHICH NO ACTION FOR DAMAGES MAY BE BROUGHT.** All claims for loss, non-delivery or mis-delivery must be received by us within 90 days after the shipment is accepted by us. The right to damages against us shall be extinguished unless an action is brought within two years from the date of delivery of the shipment or from date on which the amount may not be deducted from your charges. If the recipient accepts the shipment without noting any damage on the delivery record, we will assume the shipment was delivered in good condition. In order for us to consider a claim for damage, the content(s), original shipping cartons, and packing must be available to us for inspection.

**RIGHT TO INSPECT:** Your shipment may, at our option or at the request of governmental authorities, be opened and inspected by us or such authorities or us at any time.

**CUSTOMS CLEARANCE:** It is your responsibility to provide proper customs documentation and completion, where required.

**EXPORT CONTROL:** You authorize Federal Express to act as forwarding agent for you for export control and customs purposes. You hereby certify that all statements and information contained in this air waybill relating to exportation are true and correct. Furthermore, you understand that all international shipments, including for return and sale, may be imposed for meeting false or fraudulent statements or for the violation of any United States laws on exportation, including but not limited to, 13 USC Sec. 305, 22 USC Sec. 401, 18 USC Sec. 1001, 50 USC app. 2410.

**MANUFACTURER'S WARRANTY:** Insofar as any provision contained or referred to in this air waybill may be contrary to any applicable international treaty, law government regulations, orders or requirements such provision shall remain in effect as part of our agreement to the extent that it is not overridden. The invalidity or unenforceability of any provision shall not affect any other part of this Air Waybill. Unless otherwise indicated the Sender's address indicated on the face of this Waybill is the place of execution and the place of departure, and Recipient's address listed on the face of this Waybill is the place of destination. Unless otherwise indicated Federal Express Corporation, P.O. Box 727, Memphis, TN 38194 USA is the first carrier of this shipment.

**Client:** ALS Environmental

**Date:** 24-Apr-19

**Project:** L2255221

**Work Order:** 1904213

**Sample ID:** L2255221-1

**Lab ID:** 1904213-1

**Legal Location:**

**Matrix:** WATER

**Collection Date:** 4/3/2019

**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
<b>Radium-226 by Radon Emanation - Method 903.1</b>			<b>SOP 783</b>		Prep Date: <b>4/12/2019</b>	PrepBy: <b>JXH</b>
Ra-226	-0.00065 (+/- 0.0035)	U	0.0079	BQ/l	NA	4/23/2019 11:21
Carr: <i>BARIUM</i>	96		40-110	%REC	DL = NA	4/23/2019 11:21

**Client:** ALS Environmental

**Date:** 24-Apr-19

**Project:** L2255221

**Work Order:** 1904213

**Sample ID:** L2255221-2

**Lab ID:** 1904213-2

**Legal Location:**

**Matrix:** WATER

**Collection Date:** 4/2/2019

**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
<b>Radium-226 by Radon Emanation - Method 903.1</b>			<b>SOP 783</b>		Prep Date: <b>4/12/2019</b>	PrepBy: <b>JXH</b>
<b>Ra-226</b>	1.3 (+/- 0.32)		<b>0.0073</b>	<b>BQ/l</b>	NA	4/23/2019 11:21
<i>Carr: BARIUM</i>	91.3		40-110	%REC	DL = NA	4/23/2019 11:21

Client: ALS Environmental

Date: 24-Apr-19

Project: L2255221

Work Order: 1904213

Sample ID: L2255221-3

Lab ID: 1904213-3

Legal Location:

Matrix: WATER

Collection Date: 4/3/2019

Percent Moisture:

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
<b>Radium-226 by Radon Emanation - Method 903.1</b>			<b>SOP 783</b>		Prep Date: <b>4/12/2019</b>	PrepBy: <b>JXH</b>
<b>Ra-226</b>	<b>0.85 (+/- 0.21)</b>		<b>0.0052</b>	<b>BQ/l</b>	NA	4/23/2019 11:21
<i>Carr: BARIUM</i>	<i>95.4</i>		<i>40-110</i>	<i>%REC</i>	DL = NA	4/23/2019 11:21

**Client:** ALS Environmental

**Date:** 24-Apr-19

**Project:** L2255221

**Work Order:** 1904213

**Sample ID:** L2255221-3

**Lab ID:** 1904213-3

**Legal Location:**

**Matrix:** WATER

**Collection Date:** 4/3/2019

**Percent Moisture:**

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
----------	--------	------	--------------	-------	-----------------	---------------

**Explanation of Qualifiers**

**Radiochemistry:**

- "Report Limit" is the MDC
- U or ND - Result is less than the sample specific MDC.
- Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
- Y2 - Chemical Yield outside default limits.
- W - DER is greater than Warning Limit of 1.42
- \* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.
- # - Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.
- G - Sample density differs by more than 15% of LCS density.
- D - DER is greater than Control Limit
- M - Requested MDC not met.
- M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
- L - LCS Recovery below lower control limit.
- H - LCS Recovery above upper control limit.
- P - LCS, Matrix Spike Recovery within control limits.
- N - Matrix Spike Recovery outside control limits
- NC - Not Calculated for duplicate results less than 5 times MDC
- B - Analyte concentration greater than MDC.
- B3 - Analyte concentration greater than MDC but less than Requested MDC.

**Inorganics:**

- B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).
- U or ND - Indicates that the compound was analyzed for but not detected.
- E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.
- M - Duplicate injection precision was not met.
- N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.
- Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.
- \* - Duplicate analysis (relative percent difference) not within control limits.
- S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

**Organics:**

- U or ND - Indicates that the compound was analyzed for but not detected.
- B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.
- E - Analyte concentration exceeds the upper level of the calibration range.
- J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).
- A - A tentatively identified compound is a suspected aldol-condensation product.
- X - The analyte was diluted below an accurate quantitation level.
- \* - The spike recovery is equal to or outside the control criteria used.
- + - The relative percent difference (RPD) equals or exceeds the control criteria.
- G - A pattern resembling gasoline was detected in this sample.
- D - A pattern resembling diesel was detected in this sample.
- M - A pattern resembling motor oil was detected in this sample.
- C - A pattern resembling crude oil was detected in this sample.
- 4 - A pattern resembling JP-4 was detected in this sample.
- 5 - A pattern resembling JP-5 was detected in this sample.
- H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.
- L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.
- Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
  - gasoline
  - JP-8
  - diesel
  - mineral spirits
  - motor oil
  - Stoddard solvent
  - bunker C

ALS -- Fort Collins

Date: 4/24/2019 12:27

Client: ALS Environmental  
 Work Order: 1904213  
 Project: L2255221

**QC BATCH REPORT**

Batch ID: **RE190412-1-1** Instrument ID **Alpha Scin** Method: **Radium-226 by Radon Emanation**

LCS		Sample ID: <b>RE190412-1</b>			Units: <b>BQ/I</b>		Analysis Date: <b>4/23/2019 11:21</b>				
Client ID:		Run ID: <b>RE1904112-1A</b>			Prep Date: <b>4/12/2019</b>		DF: <b>NA</b>				
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.76 (+/- 0.443)	0.0101	1.771		99.6	67-120					P,M3
Carr: BARIUM	14600		15750		92.8	40-110					

LCSD		Sample ID: <b>RE190412-1</b>			Units: <b>BQ/I</b>		Analysis Date: <b>4/23/2019 11:21</b>				
Client ID:		Run ID: <b>RE1904112-1A</b>			Prep Date: <b>4/12/2019</b>		DF: <b>NA</b>				
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.78 (+/- 0.448)	0.0121	1.771		101	67-120		1.76	0.03	2.1	P,M3
Carr: BARIUM	15000		15730		95.4	40-110		14600			

MB		Sample ID: <b>RE190412-1</b>			Units: <b>BQ/I</b>		Analysis Date: <b>4/23/2019 11:21</b>				
Client ID:		Run ID: <b>RE1904112-1A</b>			Prep Date: <b>4/12/2019</b>		DF: <b>NA</b>				
Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	-0.00051 (+/- 0.0030)	0.0067									U
Carr: BARIUM	14400		15740		91.3	40-110					

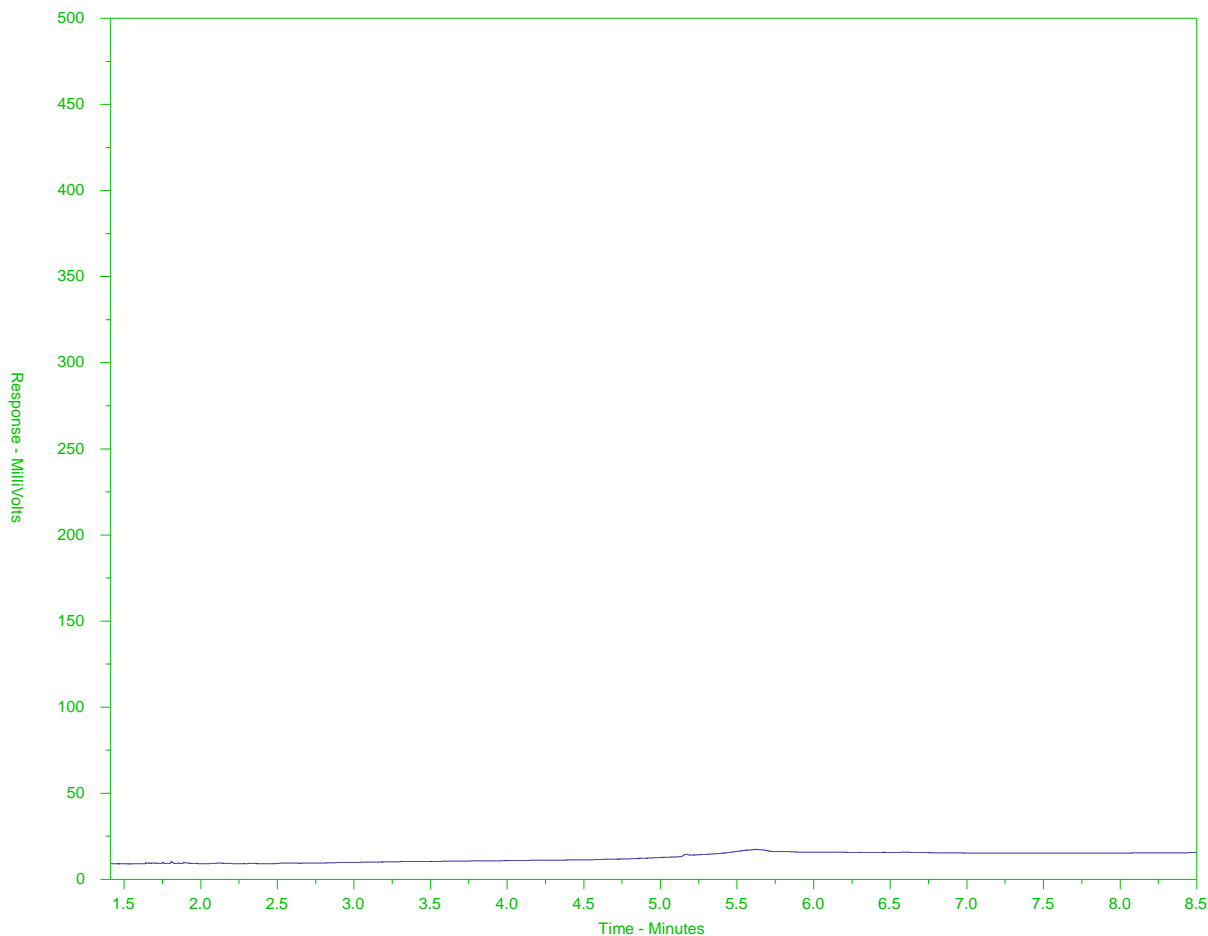
The following samples were analyzed in this batch: 

1904213-1	1904213-2	1904213-3
-----------	-----------	-----------

# CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: L2255221-C-1  
 Client Sample ID: ALS TRAVEL BLANK



← F2 →		← F3 →		← F4 →	
nC10	nC16	nC34	nC50		
174°C	287°C	481°C	575°C		
346°F	549°F	898°F	1067°F		
← Gasoline →		← Motor Oils/ Lube Oils/ Grease →			
← Diesel/ Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

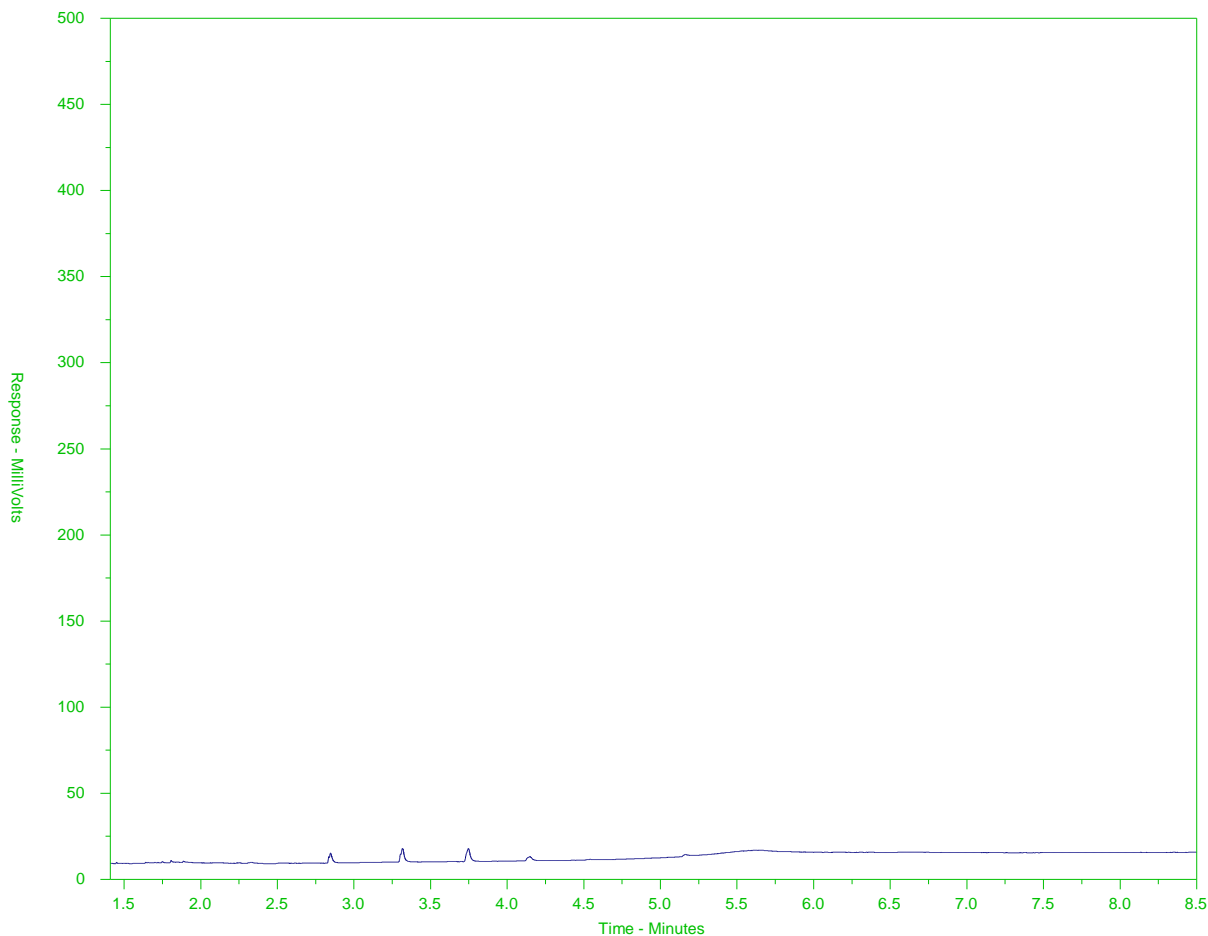
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at [www.alsglobal.com](http://www.alsglobal.com).

# CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: L2255221-C-2  
 Client Sample ID: PORT 4



← F2 →		← F3 →		← F4 →	
nC10	nC16			nC34	nC50
174°C	287°C			481°C	575°C
346°F	549°F			898°F	1067°F
← Gasoline →		← Motor Oils/ Lube Oils/ Grease →			
← Diesel/ Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

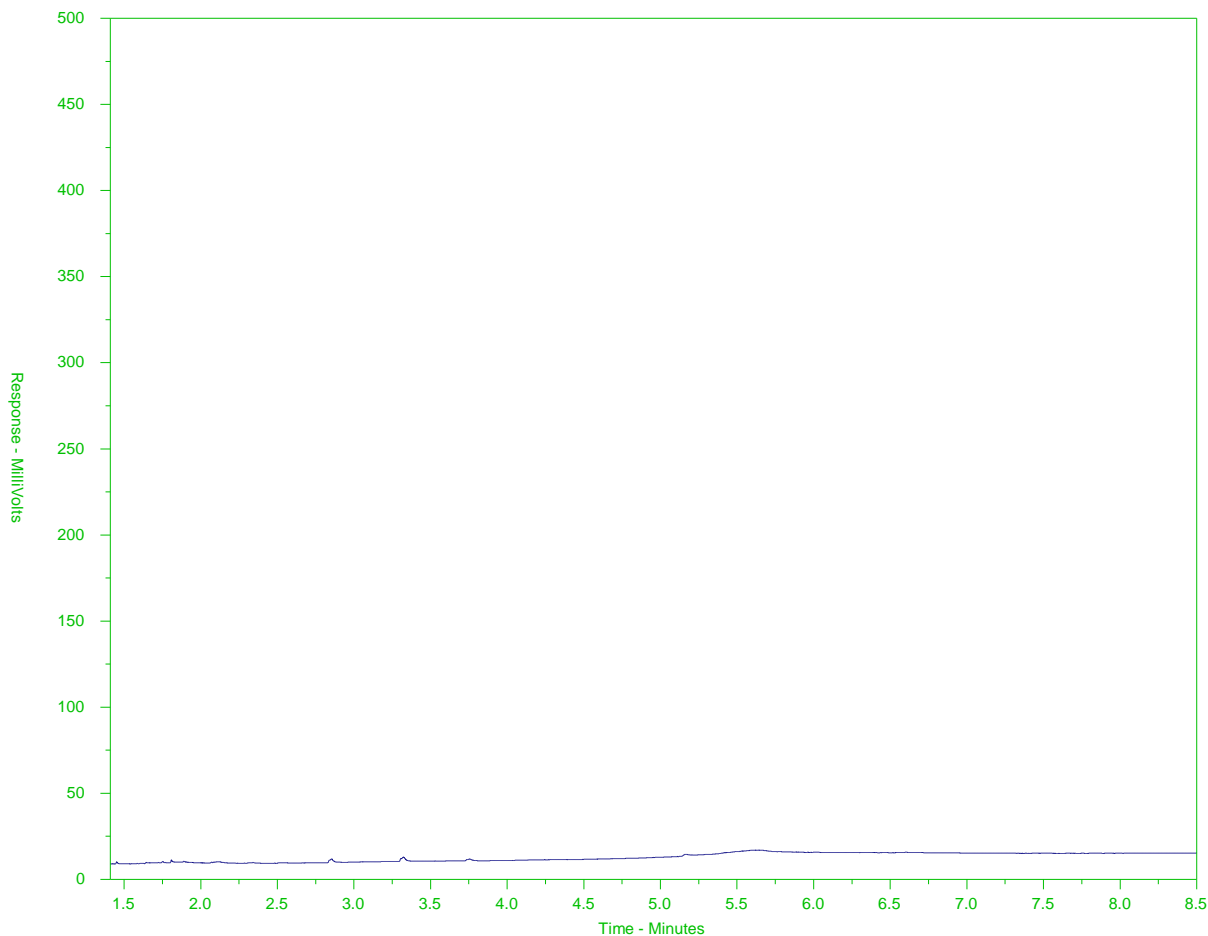
Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at [www.alsglobal.com](http://www.alsglobal.com).



# CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: L2255221-C-3  
 Client Sample ID: PORT 6



← F2 →		← F3 →		← F4 →	
nC10	nC16	nC34	nC50		
174°C	287°C	481°C	575°C		
346°F	549°F	898°F	1067°F		
← Gasoline →		← Motor Oils/ Lube Oils/ Grease →			
← Diesel/ Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at [www.alsglobal.com](http://www.alsglobal.com).



<b>Report To</b>	<b>Report Format / Distribution</b>	<b>Service Requested</b> (Rush for routine analysis subject to availability)
Company: Agnico-Eagle Mines Limited	<input checked="" type="checkbox"/> Standard <input type="checkbox"/> Other	<input checked="" type="radio"/> Regular (Standard Turnaround Times - Business Days)
Contact: Jenyfer Mosquera	<input checked="" type="checkbox"/> PDF <input checked="" type="checkbox"/> Excel <input type="checkbox"/> Digital <input type="checkbox"/> Fax	<input type="radio"/> Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address: 11600 rue Louis-Bisson, Suite 540 - Mirabel	Email 1: jenyfer.mosquera@agnicoeagle.com	<input type="radio"/> Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
Quebec, Canada J7N 1G9	Email 2: dholtze@golder.com; Akowalchuk@golder.com	<input type="radio"/> Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone: 819-759-3555 Fax: x 4608170	Email 3: valerie.bertrand@golder.com	<b>Analysis Request</b>

Invoice To Same as Report? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	<b>Client / Project Information</b>	Please indicate below Filtered, Preserved or both (F, P, F/P)																							
Hardcopy of Invoice with Report? <input type="checkbox"/> Yes <input type="checkbox"/> No	Job #: 18108905	F				P																			
Company:	PO / AFE:	DISSOLVED METALS	TOTAL METALS	TOTAL PHOSPHORUS	MAJOR IONS, TDS, TSS	Ra226	PHC C10-C50	Reactive Silica																	
Contact:	LSD:																								
Address:	Quote #: Q72802																								
Phone: Fax:	ALS Contact: Heather Mckenzie	Sampler: A.Kowalchuk																							
Lab Work Order # (lab use only)																									

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	DISSOLVED METALS	TOTAL METALS	TOTAL PHOSPHORUS	MAJOR IONS, TDS, TSS	Ra226	PHC C10-C50	Reactive Silica															Number of Containers
	ALS Travel Blank	03-Apr-19	8:00	Other		X	X	X	X	X	X															7
	Port 4	02-Apr-19	14:30	Groundwater	X	X	X	X	X	X	X								X	X						9
	Port 6	03-Apr-19	10:20	Groundwater	X	X	X	X	X	X	X								X	X						9



**Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC-CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details**

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.  
 By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.  
 Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Adrian Kowalchuk	4-Apr-19	8:30	<i>[Signature]</i>	Apr 9 2019	8:50am	13 °C				

**APPENDIX D**

**2016 Laboratory Certificate of Analysis – Brine Fluid**

## Certificat d'analyse

**Client : Agnico-Eagle CSD - Amaruq Study**

Responsable : Mme Odrée-Maude Vachon

Adresse : CSD

tél.: (819) 759-3555 ()

fax.: (000) 000-0000

**Numéro de projet : V-52584**

Lieu de prélèvement : Brine Fluid

Date de prélèvement : 17 avril 2016

Échantillon : Brine Fluid

Heure de prélèvement : N/D

Nom du préleveur : N/D

Date de réception : 19 avril 2016

Type d'échantillon : Eau surface

Réseau:

**Certificat corrigé, remplace le certificat V-52584 émis le 09 mai 2016**

Les résultats ne se rapportent qu'aux échantillons soumis pour analyse.

Les échantillons seront conservés pendant 30 jours à partir de la date du rapport à moins d'avis écrit du client.

## Certificat d'analyse

**Numéro de projet :** V-52584

Échantillon : Brine Fluid

Date de prélèvement : 17 avril 2016

Lieu de prélèvement : Brine Fluid

Heure de prélèvement : N/D

Paramètres	Résultats	Méthode d'analyse	Date d'analyse
Aluminium (Al)	0.498 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Antimoine (Sb)	0.0354 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Argent (Ag)	<0.0001 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Arsenic (As)	0.7662 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Baryum (Ba)	0.1126 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Béryllium (Be)	<0.0005 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Bicarbonate (HCO3)	27 mg CaCO3/L	M-TIT-1.0	19 avril 2016
Bismuth (Bi)	<0.0005 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Bore (B)	13.2 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Bromures	1066 mg/L	Sous-traitance\Multilab Direct	22 avril 2016
Cadmium (Cd)	<0.00002 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Calcium (Ca)	42266 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Carbone inorganique total (C.I.T.)	2.1 mg/L	M-COT-1.0	19 avril 2016
Carbone organique total (C.O.T.)	28.5 mg/L	M-COT-1.0	19 avril 2016
Chlorure (Cl)	83700 mg/L	Sous-traitance\Multilab Direct	29 avril 2016
Chrome (Cr)	<0.0006 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Cobalt (Co)	0.0406 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Conductivité	55420 µmhos/cm	M-TIT-1.0	19 avril 2016
Cuivre (Cu)	0.0039 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Dureté	105554 mg CaCO3/L	Sous-traitance\Multilab Direct	20 avril 2016
Étain (Sn)	<0.001 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Fer (Fe)	2.60 mg/L	Sous-traitance\Multilab Direct	22 avril 2016
Fluorures (F)	0.06 mg/L	Sous-traitance\Multilab Direct	27 avril 2016
Lithium (Li)	34.52 mg/L	Sous-traitance\Multilab Direct	22 avril 2016
Magnésium (Mg)	3.92 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Manganèse (Mn)	<0.0005 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Mercure (Hg)	0.00039 mg/L	Sous-traitance\Multilab Direct	21 avril 2016
Molybdène (Mo)	<0.0005 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
NH3 (NH3 non-ionisé)	1.52 mg N/L	Sous-traitance\Multilab Direct	20 avril 2016
NH4	0.67 mg N/L	Sous-traitance\Multilab Direct	20 avril 2016
Nickel (Ni)	1.350 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Nitrates (NO3)	0.54 mg N/L	Sous-traitance\Multilab Direct	19 avril 2016
Nitrites (NO2)	0.06 mg N/L	Sous-traitance\Multilab Direct	21 avril 2016
pH	10.02	M-TIT-1.0	19 avril 2016
Plomb (Pb)	<0.0003 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Potassium (K)	1717 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Radium (RA 226)	<0.066 Becquerels/L	M-RA-2.0	02 mai 2016
Sélénium (Se)	3.83 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Silice (Si)	2.93 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Sodium (Na)	838 mg/L	Sous-traitance\Multilab Direct	20 avril 2016

Sauf indication contraire, tous les échantillons ont été reçus en bon état.

Toute reproduction, sinon en entier, est interdite sans l'autorisation écrite du laboratoire.

## Certificat d'analyse

**Numéro de projet :** V-52584

Échantillon : Brine Fluid

Date de prélèvement : 17 avril 2016

Lieu de prélèvement : Brine Fluid

Heure de prélèvement : N/D

Paramètres	Résultats	Méthode d'analyse	Date d'analyse
Solides dissous	36946 mg/L	M-TIT-1.0	19 avril 2016
Solides totaux	149736 mg/L	M-SOLI-1.0	27 avril 2016
Strontium (Sr)	656 mg/L	Sous-traitance\Multilab Direct	22 avril 2016
Tellure (Te)	<0.0005 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Thallium (Tl)	<0.002 mg/L	Sous-traitance\Multilab Direct	22 avril 2016
Titane (Ti)	45.2 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Uranium (U)	<0.001 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Vanadium (V)	<0.0005 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Zinc (Zn)	<0.001 mg/L	Sous-traitance\Multilab Direct	20 avril 2016
Alcalinité	145 mg CaCO3/L	M-TIT-1.0	20 avril 2016
Sulfate (SO4)	<0.6 mg SO4/L	Sous-traitance\Multilab Direct	12 mai 2016

Sauf indication contraire, tous les échantillons ont été reçus en bon état.

Toute reproduction, sinon en entier, est interdite sans l'autorisation écrite du laboratoire.

## Limite de détection rapportée

Numéro de projet : V-52584

Échantillon : Brine Fluid

Date de prélèvement : 17 avril 2016

Lieu de prélèvement : Brine Fluid

Heure de prélèvement : N/D

Paramètre	Valeur	Unité	Méthode	Accréditation
Aluminium (Al)	0.006	mg/L	Sous-traitance	
Antimoine (Sb)	0.0001	mg/L	Sous-traitance	Oui
Argent (Ag)	0.0001	mg/L	Sous-traitance	Oui
Arsenic (As)	0.0005	mg/L	Sous-traitance	Oui
Baryum (Ba)	0.0005	mg/L	Sous-traitance	Oui
Béryllium (Be)	0.0005	mg/L	Sous-traitance	
Bicarbonate (HCO <sub>3</sub> )	2	mg CaCO <sub>3</sub> /L	M-TIT-1.0	
Bismuth (Bi)	0.0005	mg/L	Sous-traitance	
Bore (B)	0.01	mg/L	Sous-traitance	Oui
Bromures	0.01	mg/L	Sous-traitance	
Cadmium (Cd)	0.00002	mg/L	Sous-traitance	Oui
Calcium (Ca)	0.03	mg/L	Sous-traitance	Oui
Carbone inorganique total (C.I.T.)	0.2	mg/L	M-COT-1.0	--
Carbone organique total (C.O.T.)	0.2	mg/L	M-COT-1.0	Oui
Chlorure (Cl)	0.5	mg/L	Sous-traitance	Oui
Chrome (Cr)	0.0006	mg/L	Sous-traitance	Oui
Cobalt (Co)	0.0005	mg/L	Sous-traitance	
Conductivité	1	µmhos/cm	M-TIT-1.0	Oui
Cuivre (Cu)	0.0005	mg/L	Sous-traitance	Oui
Dureté	1	mg CaCO <sub>3</sub> /L	Sous-traitance	
Étain (Sn)	0.001	mg/L	Sous-traitance	Oui
Fer (Fe)	0.01	mg/L	Sous-traitance	Oui
Fluorures (F)	0.02	mg/L	Sous-traitance	Oui
Lithium (Li)	0.005	mg/L	Sous-traitance	
Magnésium (Mg)	0.02	mg/L	Sous-traitance	Oui
Manganèse (Mn)	0.0005	mg/L	Sous-traitance	Oui
Mercure (Hg)	0.00001	mg/L	Sous-traitance	Oui
Molybdène (Mo)	0.0005	mg/L	Sous-traitance	Oui
NH <sub>3</sub> (NH <sub>3</sub> non-ionisé)	0.01	mg N/L	Sous-traitance	-
NH <sub>4</sub>	0.01	mg N/L	Sous-traitance	-
Nickel (Ni)	0.0005	mg/L	Sous-traitance	Oui
Nitrates (NO <sub>3</sub> )	0.01	mg N/L	Sous-traitance	Oui
Nitrites (NO <sub>2</sub> )	0.01	mg N/L	Sous-traitance	Oui
pH			M-TIT-1.0	Oui
Plomb (Pb)	0.0003	mg/L	Sous-traitance	Oui
Potassium (K)	0.05	mg/L	Sous-traitance	
Radium (RA 226)	0.002	Becquerels/L	M-RA-2.0	Oui
Sélénium (Se)	0.001	mg/L	Sous-traitance	Oui
Silice (Si)	0.01	mg/L	Sous-traitance	
Sodium (Na)	0.05	mg/L	Sous-traitance	Oui

Sauf indication contraire, tous les échantillons ont été reçus en bon état.

Toute reproduction, sinon en entier, est interdite sans l'autorisation écrite du laboratoire.

## Limite de détection rapportée

**Numéro de projet :** V-52584

Échantillon : Brine Fluid

Date de prélèvement : 17 avril 2016

Lieu de prélèvement : Brine Fluid

Heure de prélèvement : N/D

Paramètre	Valeur	Unité	Méthode	Accréditation
Solides dissous	1	mg/L	M-TIT-1.0	
Solides totaux	2	mg/L	M-SOLI-1.0	Oui
Strontium (Sr)	0.005	mg/L	Sous-traitance	
Tellure (Te)	0.0005	mg/L	Sous-traitance	
Thallium (Tl)	0.002	mg/L	Sous-traitance	
Titane (Ti)	0.01	mg/L	Sous-traitance	
Uranium (U)	0.001	mg/L	Sous-traitance	
Vanadium (V)	0.0005	mg/L	Sous-traitance	Oui
Zinc (Zn)	0.001	mg/L	Sous-traitance	Oui
Alcalinité	2	mg CaCO <sub>3</sub> /L	M-TIT-1.0	
Sulfate (SO <sub>4</sub> )	0.6	mg SO <sub>4</sub> /L	Sous-traitance	Oui

Sauf indication contraire, tous les échantillons ont été reçus en bon état.  
Toute reproduction, sinon en entier, est interdite sans l'autorisation écrite du laboratoire.



## Certificat contrôle qualité

**Numéro de projet :** V-52584

Échantillon : Brine Fluid

Date de prélèvement : 17 avril 2016

Lieu de prélèvement : Brine Fluid

Heure de prélèvement : N/D

### Paramètres

Alcalinité mg CaCO <sub>3</sub> /L	Nom Standard STD alcalinité Valeur obtenue 144 Justesse 99.3% Intervalle 123 - 167
Aluminium (Al) mg/L	Blanc <0.006 Nom Standard DMR-0009-2016-Eu Valeur obtenue 6.82 Justesse 92.9% Intervalle 5.10 - 7.64
Antimoine (Sb) mg/L	Blanc <0.0001 Nom Standard DMR-0009-2016-Eu Valeur obtenue 0.2049 Justesse 92.3% Intervalle 0.178 - 0.266
Argent (Ag) mg/L	Blanc <0.0001 Nom Standard DMR-0009-2016-Ag Valeur obtenue 0.6004 Justesse 82.9% Intervalle 0.579 - 0.869
Arsenic (As) mg/L	Blanc <0.0005 Nom Standard DMR-0009-2016-Eu Valeur obtenue 0.2700 Justesse 95.4% Intervalle 0.198 - 0.368
Baryum (Ba) mg/L	Blanc <0.0005 Nom Standard DMR-0009-2016-Eu Valeur obtenue 2.572 Justesse 94.2% Intervalle 1.94 - 2.92
Béryllium (Be) mg/L	Blanc <0.0005 Nom Standard DMR-0009-2016-Eu Valeur obtenue 1.900 Justesse 88.2% Intervalle 1.36 - 2.04
Bismuth (Bi) mg/L	Blanc <0.0005
Bore (B) mg/L	Blanc <0.01 Nom Standard DMR-0009-2016-Eu Valeur obtenue 3.43 Justesse 83.7% Intervalle 2.36 - 3.54

Sauf indication contraire, tous les échantillons ont été reçus en bon état.

Toute reproduction, sinon en entier, est interdite sans l'autorisation écrite du laboratoire.

## Certificat contrôle qualité

**Numéro de projet :** V-52584

Échantillon : Brine Fluid

Date de prélèvement : 17 avril 2016

Lieu de prélèvement : Brine Fluid

Heure de prélèvement : N/D

### Paramètres

Bromures mg/L	Blanc <0.01 Nom Standard DMR-0123-2016-Br Valeur obtenue 5.39 Justesse 95.7% Intervalle 4.50 - 6.76
Cadmium (Cd) mg/L	Blanc <0.00002 Nom Standard DMR-0009-2016-Eu Valeur obtenue 0.89802 Justesse 99.8% Intervalle 0.720 - 1.080
Calcium (Ca) mg/L	Blanc <0.03 Nom Standard DMR-0009-2016-Eu Valeur obtenue 17.1 Justesse 98.3% Intervalle 13.9 - 20.9
Chlorure (Cl) mg/L	Blanc <0.5 Nom Standard DMR-0175-2016-Cl Valeur obtenue 53.7 Justesse 96.7% Intervalle 46 - 58
Chrome (Cr) mg/L	Blanc <0.0006 Nom Standard DMR-0009-2016-Eu Valeur obtenue 4.115 Justesse 98.4% Intervalle 3.24 - 4.86
Cobalt (Co) mg/L	Blanc <0.0005 Nom Standard DMR-0009-2016-Eu Valeur obtenue 1.549 Justesse 99.9% Intervalle 1.24 - 1.86
Conductivité µmhos/cm	Nom Standard STD cond maison Valeur obtenue 1407 Justesse 99.4% Intervalle 1203 - 1627
Cuivre (Cu) mg/L	Blanc <0.0005 Nom Standard DMR-0009-2016-Eu Valeur obtenue 1.379 Justesse 94.7% Intervalle 1.05 - 1.57
Étain (Sn) mg/L	Blanc <0.001

Sauf indication contraire, tous les échantillons ont été reçus en bon état.

Toute reproduction, sinon en entier, est interdite sans l'autorisation écrite du laboratoire.

## Certificat contrôle qualité

Numéro de projet : V-52584

Échantillon : Brine Fluid

Date de prélèvement : 17 avril 2016

Lieu de prélèvement : Brine Fluid

Heure de prélèvement : N/D

### Paramètres

Fer (Fe) mg/L	Blanc <0.01 Nom Standard DMR-0009-2016-Eu Valeur obtenue 16.0 Justesse 88.1% Intervalle 11.4 - 17.2
Lithium (Li) mg/L	Blanc <0.005 Nom Standard DMR-0009-2016-Eu Valeur obtenue 0.827 Justesse 97.8% Intervalle 0.677 - 1.015
Magnésium (Mg) mg/L	Blanc <0.02 Nom Standard DMR-0009-2016-Eu Valeur obtenue 8.04 Justesse 89.4% Intervalle 5.82 - 8.72
Manganèse (Mn) mg/L	Blanc <0.0005 Nom Standard DMR-0009-2016-Eu Valeur obtenue 3.781 Justesse 97.2% Intervalle 3.11 - 4.67
Mercure (Hg) mg/L	Blanc <0.00001 Nom Standard DMR-0123-2016-HgEu Valeur obtenue 0.00062 Justesse 93.9% Intervalle 0.00040 - 0.00092
Molybdène (Mo) mg/L	Blanc <0.0005 Nom Standard DMR-0009-2016-Eu Valeur obtenue 0.6382 Justesse 90.1% Intervalle 0.566 - 0.850
Nickel (Ni) mg/L	Blanc <0.0005 Nom Standard DMR-0009-2016-Eu Valeur obtenue 1.110 Justesse 98.2% Intervalle 0.90 - 1.36
Nitrates (NO <sub>3</sub> ) mg N/L	Blanc <0.01
Nitrites (NO <sub>2</sub> ) mg N/L	Blanc <0.01 Nom Standard DMR-0175-2016-NO <sub>2</sub> Valeur obtenue 1.97 Justesse 97.5%

Sauf indication contraire, tous les échantillons ont été reçus en bon état.

Toute reproduction, sinon en entier, est interdite sans l'autorisation écrite du laboratoire.

## Certificat contrôle qualité

**Numéro de projet :** V-52584

Échantillon : Brine Fluid

Date de prélèvement : 17 avril 2016

Lieu de prélèvement : Brine Fluid

Heure de prélèvement : N/D

### Paramètres

pH	Intervalle	1.72 - 2.32
	Nom Standard	STD pH 7.0
	Valeur obtenue	7.01
	Justesse	99.9%
	Intervalle	6.96 - 7.04
Plomb (Pb) mg/L	Blanc	<0.0003
	Nom Standard	DMR-0009-2016-Eu
	Valeur obtenue	0.9397
	Justesse	96.6%
	Intervalle	0.727 - 1.091
Potassium (K) mg/L	Blanc	<0.05
	Nom Standard	DMR-0009-2016-Eu
	Valeur obtenue	20.2
	Justesse	89%
	Intervalle	14.6 - 21.8
Radium (RA 226) Becquerels/L	Blanc	<0.002
	Nom Standard	STD 45462
	Valeur obtenue	0.0700
	Justesse	85%
	Intervalle	0.0700 - 0.0948
Sélénium (Se) mg/L	Blanc	<0.001
	Nom Standard	DMR-0009-2016-Eu
	Valeur obtenue	1.33
	Justesse	98.5%
	Intervalle	1.08 - 1.62
Sodium (Na) mg/L	Blanc	<0.05
	Nom Standard	DMR-0009-2016-Eu
	Valeur obtenue	29.0
	Justesse	91%
	Intervalle	21.3 - 31.9
Solides totaux mg/L	Blanc	<2
	Nom Standard	DMR-0124-2016-3
	Valeur obtenue	289
	Justesse	99%
	Intervalle	243 - 329
Strontium (Sr) mg/L	Blanc	<0.005
	Nom Standard	DMR-0009-2016-Eu
	Valeur obtenue	1.25
	Justesse	97.7%
	Intervalle	1.02 - 1.54

Sauf indication contraire, tous les échantillons ont été reçus en bon état.

Toute reproduction, sinon en entier, est interdite sans l'autorisation écrite du laboratoire.

## Certificat contrôle qualité

Numéro de projet : V-52584

Échantillon : Brine Fluid

Date de prélèvement : 17 avril 2016

Lieu de prélèvement : Brine Fluid

Heure de prélèvement : N/D

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### Paramètres

---

Sulfate (SO4) mg SO4/L	Blanc <0.6 Nom Standard DMR-0175-2016-SO4 Valeur obtenue 71.2 Justesse 93.7% Intervalle 60.3 - 73.7
Tellure (Te) mg/L	Blanc <0.0005
Thallium (Tl) mg/L	Blanc <0.002 Nom Standard TI-S140909023-1000ppm Valeur obtenue 989 Justesse 98.9% Intervalle 800 - 1200
Titane (Ti) mg/L	Blanc <0.01
Uranium (U) mg/L	Blanc <0.001 Nom Standard DMR-0009-2016-Eu Valeur obtenue 1.93 Justesse 90.3% Intervalle 1.41 - 2.11
Vanadium (V) mg/L	Blanc <0.0005 Nom Standard DMR-0009-2016-Eu Valeur obtenue 2.023 Justesse 98.3% Intervalle 1.59 - 2.39
Zinc (Zn) mg/L	Blanc <0.001 Nom Standard DMR-0009-2016-Eu Valeur obtenue 4.67 Justesse 97.7% Intervalle 3.82 - 5.74

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Sauf indication contraire, tous les échantillons ont été reçus en bon état.  
Toute reproduction, sinon en entier, est interdite sans l'autorisation écrite du laboratoire.

## Informations supplémentaires

Numéro de projet : V-52584

Échantillon : Brine Fluid

Lieu de prélèvement : Brine Fluid

Date de prélèvement : 17 avril 2016

Heure de prélèvement : N/D

<u>Méthode laboratoire</u>	<u>Méthode de référence</u>
M-MET-3.0	MA.200-Mét. 1.2
M-TIT-1.0	MA.303-Titr Auto 2.0
M-CL-2.0	MA.300-Ions 1.3
M-CI-1.0	MA.300-Anions 1.0
M-NITR-2.0	MA.300-NO3 2.0
M-RA-2.0	APHA 7500-Ra B et EPA P.13 (EMSL-CI)
M-SOLI-1.0	MA.104-S.S. 1.1
M-SULF-2.0	MA.300-Ions 1.3

Sauf indication contraire, tous les échantillons ont été reçus en bon état.  
Toute reproduction, sinon en entier, est interdite sans l'autorisation écrite du laboratoire.

**ATTACHMENT B**

**Whale Tail Lake Thermal  
Assessment**



**REPORT**

# Whale Tail Lake Thermal Assessment

Submitted to:

**Agnico Eagle Mines Limited - Meadowbank Division**

Submitted by:

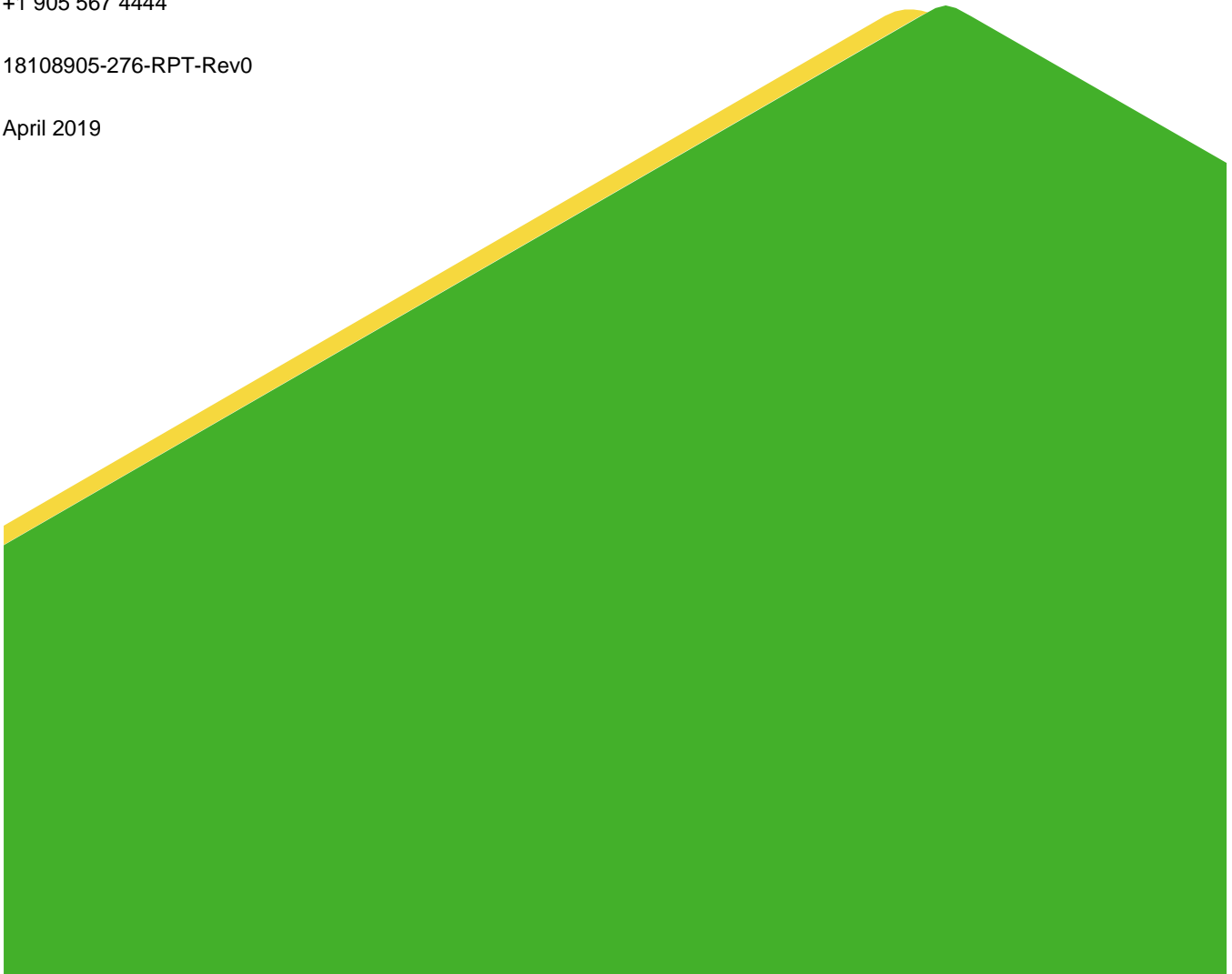
**Golder Associates Ltd.**

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## 1.0 INTRODUCTION

Agnico Eagle Mines Limited (Agnico Eagle) is planning mining of the Whale Tail Pit Project, a satellite deposit located on the Amaruq exploration property in Nunavut. The project site is located approximately 50 km northwest of Agnico Eagle's operating Meadowbank Mine.

Agnico Eagle plans to mine the Whale Tail deposit by open pit and underground mining. Agnico Eagle holds an advanced exploration Type B licence (2BB-MEA1318) for the underground development, which requires minimizing contact water discharge during the ramp advancement. The proposed ramp extends down to an elevation of about 225 m below sea level (or about 375 m below Whale Tail Lake surface level). To the extent possible according to the orebody depth, the ramp needs to be maintained within the permafrost regime to minimize the groundwater inflow into the ramp. Figure 1 shows the Amaruq Exploration site plan with Whale Tail Lake bathymetry, proposed mine facility locations, proposed open pit outlines, and thermistor locations. This figure also shows the locations of seven cross sections (A to G) used to prepare thermal models to evaluate current permafrost conditions in the project area.

Golder Associates Ltd. (Golder) was retained to carry out a thermal assessment for the Project to:

- Evaluate existing permafrost characteristics in the Whale Tail Lake and Project area.
- Evaluate existing talik conditions under the Whale Tail Lake adjacent to the Project site.

This report presents a review and summary of estimated permafrost conditions based on available thermistor data to date, as well as the results of a thermal modelling exercise prepared to assess permafrost conditions and the extent of talik formations beneath the Whale Tail Lake.

## 2.0 SITE CONDITIONS

### 2.1 Regional Permafrost Conditions

The Whale Tail Pit Project is in the zone of continuous permafrost. Permafrost refers to subsurface soil or rock where temperatures remain at or below 0°C for at least two consecutive years. This is synonymous with perennially cryotic ground, which may be frozen, partially frozen, or non-frozen depending on the ice/water content of the ground, and the salinity of the groundwater. The base of the permafrost is expected to be an undulating surface and the actual depth to permafrost is variable.

The land surface of the Whale Tail Pit Project is underlain by permafrost except under the lake where water is too deep to freeze to the bottom during winter. Taliks (areas of unfrozen ground) are expected beneath a water body where the water depth is greater than the ice thickness. Closed talik formations show a depression in the permafrost table below relatively shallower and smaller lakes. Open talik formations that penetrate through the permafrost and connect the lake waterbody with the sub-permafrost regime are to be expected for relatively deeper and larger lakes in the Project area.

Published data regarding permafrost indicates that the ground ice content in the region is expected to be between 0% and 10% (dry permafrost) based on Natural Resources Canada (1995).

### 2.2 Subsurface Geology

The Whale Tail deposit is in the northern portion of the Whale Tail Lake. Based on previous site investigation data, soils in the project area are typically medium to coarse grained glacial till and colluvium with high coarse fragment content overlying bedrock at shallow depths (less than 1 m). Saturated soil layers overlying frozen layers have been

observed on site. A review of the records of the six thermistor boreholes indicates soil thicknesses varying from 6.1 to 12.4 m. Underlying the soil, bedrock in the area generally consists of a stratigraphic sequence of greywacke, komatiite, and ultramafics, with varying thicknesses.

## 2.3 Site Climatic Conditions

Table 1 presents a summary of the site climate data for air temperature and precipitation. A mean annual air temperature of -11.3 °C was obtained for the site, based on climate data provided by Agnico Eagle (Golder 2016a).

**Table 1: Mean Climate Characteristics (Golder 2016a)**

Month	Mean Air Temperature (°c)	Monthly Precipitation	
		Rainfall (mm)	Snowfall Water Equivalent (mm)
January	-31.3	0	11
February	-31.1	0	9
March	-26.3	0	14
April	-17.0	0.5	20
May	-6.4	6	12
June	4.9	21	5
July	11.6	45	0
August	9.8	48	2
September	3.1	40	11
October	-6.5	7	34
November	-19.3	0	26
December	-26.8	0	16
Annual	-11.3	168	160

The thermal modelling exercise described in this document was prepared to allow for assessment of existing permafrost conditions in the project site, and therefore does not incorporate climate change in the long-term. Climate change is anticipated to be minimal and to have no impact on permafrost conditions during the operational stage of the Project.

## 2.4 Lake Elevation and Temperature

Lake elevation measurements for Whale Tail Lake were available from 25 July 2016 to 4 September 2016. The lake elevation varies from 151.2 m above sea level (masl) to 152.7 masl with an average elevation of 151.7 masl. The average depth of Whale Tail Lake is 4.4 m based on the bathymetry provided by Agnico Eagle. Based on bathymetry data, the maximum lake depth is 16.7 m, located in the area near borehole AMQ16-626 (Figure 1) and where the project's attenuation pond is planned.

Golder (2016b) reported that water temperature in the Whale Tail Lake ranged from 9 to 11.5°C during the summer months in 2015. In May 2017, thermistor AMQ17-1265A was installed in the Whale Tail Lake with its upper two beads being in water, which can be used as reference for lake water temperature at that location where the lake is about 11 m deep. Few scattered data for this thermistor was available between August and September 2017, and between July 2018 and the end of October 2018. During this period, the maximum lake temperature was 13.9 °C on July 26, 2018, the minimum lake temperature was 0.08°C measured on September 28, 2018, and the average water temperature was 3.2 °C. Winter lake water temperature data was not available at the time of this study, but it is anticipated that the average annual lake temperature would be lower when considering lake winter temperatures. Typically, mean annual lake temperature is related to the depth of water in a permafrost region: the deeper the lake, the higher the lake bottom temperature. A typical lake bottom temperature range for northern lakes is +2 °C to +4 °C based on literature review and past project experience in the area (Burn 2002; Golder 2003).

### 3.0 SITE PERMAFROST CONDITIONS

The following sections present a summary of site permafrost conditions estimated based directly on available thermistor data and, indirectly on a Westbay well system.

#### 3.1 Site Thermistor

##### 3.1.1 Locations

The location of active thermistors within the vicinity of the area of interest is shown in Figure 1 and Table 2 presents a summary of installation information.

**Table 2: Borehole and Thermistor Summary**

Borehole	Collar Coordinates				Drilled Length (m)	Thermistor
	Northing (m)	Easting (m)	Inclination (°)	Azimuth (°)		Depth Below Ground Surface (m)
AMQ15-294	607,073	7,255,676	-45	221	323	144
AMQ15-306	606,715	7,255,364	-45	96	201	141
AMQ15-324	606,497	7,254,995	-45	300	501	317
AMQ15-349A	607,065	7,255,628	-45	204	203	141
AMQ15-421	607,098	7,255,491	-51	274	501	388
AMQ15-452	606,627	7,255,688	-50	106	501	382
AMQ17-1265A	606,950	7,255,414	-80	198	366	350
AMQ17-1233	606,778	7,256,254	-59	255	156	132
AMQ17-1337	607,078	7,256,522	-60	262	252	218
AMQ17-1277A	606,911	7,255,964	-61	195	252	217

### 3.1.2 Thermistors Data Summary

Table 3 presents a summary of the permafrost conditions estimated from site thermistors and used as reference for calibration of thermal models as described in Section 4.

**Table 3: Summary of Permafrost Conditions in Site Thermistors**

Hole ID	Approx. Collar Distance to Lake (m)	Zero Annual Amplitude		Temperature at location of Thermistor Tip (°C)	Thermal Gradient (°C/m) <sup>(b)</sup>	Estimated Permafrost Depth (m) <sup>(c)</sup>
		Approximate Depth (m)	Approximate Temperature (°C)			
AMQ15-294	31	19	-3.1	-1.5	0.004	507
AMQ15-306	55	20	-7.4	-2.1 <sup>(a)</sup>	0.052	164
AMQ15-324	370	35	-8.6	-3.0	0.022	452
AMQ15-349A	40	18	-5.2	-1.4	0.011	262
AMQ15-421	40	26	-3.1	-0.5	0.004	522
AMQ15-452	50	23	-3.3	-1.1	0.012	472
AMQ17-1265A	n/a	20	2.7	-0.35	0.006	410
AMQ17-1233	32	10	-4.6	-5.2	-0.013	Insufficient data
AMQ17-1337	12	37	-6.6	-5.3	0.017	535
AMQ17-1277A	32	14	-4.2	-3.2	0.004	>600

a) For AMQ15-306, temperature about 17 m above the thermistor tip due to erratic temperature readings below that point.

b) Gradients estimated based on temperature data along the lower 70 to 100 m of thermistor lines.

c) Estimated based on temperature at thermistors' tips and thermistor's thermal gradients

The parameters were estimated using average temperature values up to November 2018. It should be noted that these thermistors were installed adjacent to the Whale Tail Lake, and the thermal conditions are likely influenced by the warm (relative to the ground surface temperatures) lake water temperatures.

## 3.2 Westbay Well System

A Westbay well system that was installed on site with a drilled depth of 499 m, was completed from March to April in 2016 for monitoring of hydraulic heads, testing of hydraulic conductivity, and collection of groundwater samples from multiple intervals within this single borehole (Golder 2016c).

The 2018 groundwater monitoring program (Golder 2019) indicates that water samples were collected from fixed ports along the Westbay system between 276 m and 499 m below the ground surface, which suggests that the Westbay system is installed in open talik, or water sampling would not have been possible in depth. This information was also taken into consideration for calibration of the thermal models described in Section 4.

Groundwater salinity based on Total Dissolved Solids (TDS) data from the 2016 water sampling program varied between 3198 mg/L and 4100 mg/L, with an average of 3700 mg/L. Salinity estimated from the 2016 program is more accurate than 2018 data due to issues with water purge in 2018, as described in Golder 2019. Based on Andersland and Ladanyi (2004), this average salinity level would cause a depression in the freezing point of water

from 0 °C to -0.21 °C, which was taken into consideration when estimating the limits of the cryopeg zone based on results of the thermal models.

## 4.0 THERMAL MODEL

To assess permafrost conditions in the project site and the extent of talik formations beneath the Whale Tail Lake, steady state two-dimensional (2D) thermal modelling was carried out using the finite element program TEMP/W of GeoStudio 2019 (Version 10.0), developed by GEO-SLOPE international Ltd. (GEO-SLOPE 2019).

The 2D thermal models were prepared for seven cross sections defined along the underground mine developments in areas influenced by the Whale Tail Lake and for areas away from the lake to evaluate the extent of talik formations in the project site. Following completion of the 2D models, a three-dimensional (3D) block model was completed using the software Datamine Studio RM (v1.4.175.0), developed by Datamine Corporate Ltd. The 3D block was prepared based on results obtained from the 2D sections as control reference temperatures.

This section presents the modelling limitations, assumptions, modelling approach, input parameters, and results.

### 4.1 Model Limitations

This study consisted of steady state 2D thermal models prepared for several cross sections defined within the Project site as shown in Figure 1. The models constitute a simplification of the field reality and carry limitations that shall be taken into consideration during interpretation of model results. The most important model limitations are as follows:

- The 2D nature of the thermal models can only capture heat transfer along the cross sections and does not incorporate 3D heat transfer coming from adjacent areas. This limitation has stronger impact on model results for cross sections that include large stretches of the Whale Tail Lake, or sections crossing shallow and narrow lakes, where the 3D nature of heat transfer from adjacent ground would greatly limit the impact of the lake on permafrost conditions. This limitation was partially overcome by using wide cross sections and adjusting the mean temperature of shallow lakes.
- Results of steady-state models show a condition where an equilibrium is attained among all the model input parameters and boundary conditions, including material thermal properties, ground and lake surface temperatures and upward heat flux coming from the earth. The permafrost has formed over many millennia and its conditions adjust continuously to changes in surface conditions such as ground and lake temperatures. This means that current permafrost conditions might not represent an equilibrium and therefore model results can differ from real field conditions. This limitation was partially overcome by calibrating the models against site thermistors data, but field information is limited compared to the size of area modelled.
- The 3D block was prepared using information from the 2D thermal models as reference. The model interpolates temperatures in-between cross sections along with additional control temperatures along the Whale Tail Lake. Therefore, the spatial distribution of the cross sections affects the model accuracy, with interpolation between cross sections that are separated by large distances being less accurate than interpolation between cross sections that are nearby.

### 4.2 Model Approach and Calibration Process

Steady-state thermal modelling was performed initially along six cross sections (A to F) as shown in Figure 1. The locations of the cross sections were defined in such a way that allowed for models to be partially calibrated based on data from existing site thermistors. Locations of the different cross sections were also defined to provide an

estimate of current permafrost conditions along the alignment of the proposed underground mining and in areas where the existence of open or closed talik is uncertain.

The calibration process consisted of adjusting model input parameters until the predicted temperature profiles were in good agreement with measured temperatures along reference thermistors located near each of the cross sections. The following model input parameters were adjusted during the calibration process:

- Material thermal properties;
- Mean surface ground temperature;
- Mean Whale Tail Lake temperature;
- Mean temperature of shallow lakes other than the Whale Tail Lake; and
- Thermal gradients in areas under the Whale Tail Lake and away from the lake, based on site thermistors as presented in Table 3.

The models were considered calibrated when the same set of input parameters could be applied to the different cross sections and result in predicted temperature profiles that were in reasonable agreement with the thermistors data used as reference in each individual section. It should be noted that the thermistors were not aligned with the cross sections and their relative locations were defined using perpendicular projections onto the cross sections.

In addition to the cross sections A to F, a new cross section G was later included in the southern portion of the Whale Tail Lake parallel to Sections A and C (as shown in Figure 1), and closer to the planned location of the Whale Tail Dike where the nature of talik, whether open or closed, is uncertain. Section G was not used for calibration purpose, and ground temperatures were rather computed using the calibrated model input parameters obtained from Sections A to F. Nevertheless, a temperature profile computed for Section G was compared to measured temperatures along the thermistor AMQ15-306, which although is far away from the section, presents similarities in terms of the distance from the lake and dipping direction.

Table 4 summarizes the thermistors used as reference for calibration of each section. As Sections D and F had only one nearby thermistor, information from one additional thermistor was added to the calibration process for each of these sections. Although the added thermistors were far from the sections' alignments, their locations had similarities in terms of ground conditions and distance from the lake.



**Table 4: Thermistors used for calibration for each section.**

Cross-section	Thermistor near section	Thermistor far from section
A	AMQ15_421	
	AMQ15-324	
	AMQ17-1265A	
B (not used for calibration)	AMQ15-421	
	AMQ 17-1265A	
C	AMQ15-306	
	AMQ15_349A	
D	AMQ15-324	AMQ15-452
E	AMQ15-294	
	AMQ17-1277A	
	AMQ17-1233	
F	AMQ17-1337	AMQ15-324
G (not used for calibration)		AMQ15-306

Based on the calibration approach described above, calibration of Section B was not achieved. This section included thermistors AMQ15-421, which shows temperatures below the freezing point all along the thermistor string, and AMQ17-1265A, which shows the existence of a closed talik about 115 m deep underlain by frozen ground. However, the calibrated input parameters that produced good calibration results for Sections A, C, D, E, and F predicted temperatures in Section B along the alignments of AMQ15-421 and AMQ17-1265A that were always above the freezing point, suggesting the existence of an open talik in those locations, which isn't consistent with the reference calibration thermistors. It would not be possible to calibrate Section B unless a specific set of input parameter was defined only for this section and using temperature of the Whale Tail Lake that would be neither consistent with field measurements nor realistic. Therefore, Section B was deemed not possible to be calibrated and was further discarded.

For the other sections (i.e., A, C, D, E, and F), the calibration process resulted in two sets of model input parameters that produced predicted temperature profiles in general agreement with the reference calibration thermistors, but with variable depths of permafrost. Model results using the calibrated input parameter for Scenario 1 predicted a shallower permafrost location compared to model predictions using the calibrated input parameters defined in Scenario 2.

Model results for Sections A, C, D, E, F and G using the calibrated input parameters defined for Scenario 1 and Scenario 2, including temperature distribution, permafrost limits, and plots comparing predicted vs. measured temperatures from the reference calibration thermistors, are presented in Appendix A (Figures A1 to A6) and Appendix B (Figures B1 to B6), respectively. The modelled temperatures were in good agreement with the

thermistor data in the end of the calibration process. The calibrated parameters were then applied to Section G to model the permafrost and talik conditions underneath a wider stretch of the Whale Tail Lake.

The calibrated model input parameters and boundary conditions are presented in the next sections.

### 4.3 Material Properties

The thermal properties adopted for the overburden and bedrock in the end of the calibration phase are summarized in Table 5. The thermal properties were based on typical values presented in Andersland and Ladanyi (2004) and were adjusted during the model calibration process.

It is expected that the thermal properties of the bedrock will have a more significant effect on thermal conditions than the overburden soils because of the relatively shallow layer of overburden compared to the bedrock. Each section assumed a thickness of overburden till of about 12 m underlain by close to 600 m of bedrock to an elevation of -450 m below sea level at the base of the model geometry.

**Table 5: Material Thermal Properties Used in the Models**

Material	Volumetric Water Content	Thermal Conductivity (W/m-°C)		Volumetric Heat Capacity (MJ/m <sup>3</sup> -°C)	
		Frozen	Unfrozen	Frozen	Unfrozen
Till	30%	1.8	1.5	2.0	2.5
Bedrock	1%	3.0	3.0	2.0	2.0

The thermal models were simplified using constant thermal conductivities without considering phase change. This assumption is considered reasonable as the bedrock is expected to have low water content and the latent heat due to phase change is not significant.

The thermal models were solved considering groundwater with a phase change temperature of 0 °C. Salinity in the groundwater would result in a freezing point depression and would possibly lower the phase change temperature below 0 °C. However, considering the very low water content assumed for the bedrock, the effect of salinity would have no important impact on the model results in terms of predicted permafrost limits in the project site. Considerations to water salinity and water flow through zones with temperatures slightly below 0°C are made in the hydrogeology modelling component of this study presented in a separate document.

### 4.4 Boundary Conditions

As discussed in Section 4.2, the calibration process resulted in two sets of model input parameters that produced model predicted temperature profiles generally in good agreement with temperature profiles measured at the locations of the reference thermistor strings in each cross section (as presented in Appendices A and B). Specifically, both sets of calibration parameters resulted in predicted temperature profiles that were consistent with temperature measured along thermistor AMQ17-1265A, which was a key reference thermistor for calibration purposes due to its strategic installation location in the lake, crossing talik and permafrost zones.

As the predicted depths of permafrost limits are affected by the model input parameters, thermal models were prepared using the two sets of calibration parameters for model sensitivity purposes, in an attempt to define the

lower and upper bounds of predicted permafrost limits. The model input parameters defined for the two calibration scenarios are described below.

#### 4.4.1 Calibrated Scenario 1

The calibrated boundary conditions for Scenario 1 models were as follows:

- A mean ground surface temperature of -10 °C was used as the model upper boundary condition outside of the Whale Tail Lake. This temperature is considered reasonable as compared with the -11.3 °C mean annual air temperature.
- Mean annual Whale Tail Lake bottom temperatures between 0°C and +3°C depending on lake depth as follows, assuming an average lake elevation of 151.7 m.
  - 0°C for lake depth less than 1 m;
  - 2°C for lake depths between 1 and 4 m; and
  - 3°C for portions of the Whale Tail Lake deeper than 4 m.
- For the shallow lakes or ponds that appear in Sections E and F, a mean annual lake bottom temperature of -7 °C was applied in the end of the calibration process. As described in Section 4.1, this approach was required to deal with limitations associated with the two-dimensional nature of the models.
- A heat flux of 0.048 J/sec was defined as the model lower boundary condition based on a bedrock thermal conductivity of 3 W/m-°C and a thermal gradient of 0.016 °C/m. The adopted geothermal gradient is in line with the thermal gradients estimated from thermistors data as summarized in Table 3.

#### 4.4.2 Calibrated Scenario 2

The calibrated boundary conditions for Scenario 2 models were as follows:

- A ground surface temperature of -9.5 °C was applied to ground surface outside of the Whale Tail Lake.
- A mean annual lake bottom temperature of +3 °C was applied to the Whale Tail Lake irrespective of lake depth.
- For the shallow lakes or ponds that appear in Sections E and F, a mean annual lake bottom temperature of -7 °C was applied.
- A heat flux of 0.048 J/sec (geothermal gradient of 0.016 °C/m) was applied as the lower boundary condition of the model geometry in areas away from the Whale Tail Lake.
  - A heat flux of 0.018 J/sec (geothermal gradient of 0.006 °C/m) was applied at the base of the model geometry for areas beneath the Whale Tail Lake. This was based upon the lower thermal gradients estimated for thermistors located mostly under the Whale Tail Lake, specifically thermistor AMQ17-1265A, which is installed in the lake and shows thermal gradient of 0.0058 °C/m for the lower 100 m of the thermistor string.

### 4.5 Three-Dimensional Block Model

A 3D block model was produced from the results of the 2D thermal modelling using Datamine Studio software, following the procedures summarized below.

- A block model volume was described to encompass the 2D thermal sections.
- Blocks of size of 20 m in Easting, 20 m in Northing and 10 m in Elevation were created below topography down to a depth of -450 m (i.e., base of the 2D thermal model cross sections).
- Temperature was estimated into each block using the temperature contours obtained from the 2D thermal sections, with the following controls applied:
  - Inverse power of distance cubed estimation methodology; 2D section temperature values closer to the block centroid carry more weight than those further away.
  - An elliptical search volume with a 5:1 horizontal to vertical anisotropy; horizontal continuity carries more weight than vertical continuity. The maximum search distance was 800 m horizontally.
  - Data points from at least two sections were needed to contribute to a block estimate.
  - The Whale Tail Lake boundary was used as a constraint, such that 2D section temperature values inside and outside the lake boundary had differing weights applied based on depth below surface. This results in the lake acting as a hard boundary close to the topographic surface and an increasingly soft boundary with increasing depth from the topographic surface. This constraint was necessary to prevent smoothing of temperature values across the lake boundary, which, when close to the topographic surface, results in positive temperature values outside the lake boundary.

Figure 2 shows the arrangement of the 2D cross sections used as input for the 3D block model.

## 5.0 MODEL RESULTS

### 5.1 Two-Dimensional Thermal Models

Permafrost limits computed for Sections A, C, D, E, F and G for both calibration Scenarios 1 and 2 are presented in Figures 3 to 8, which also show the estimated extent of the cryopeg zone where water could potentially flow through ground frozen at temperature of  $-0.21^{\circ}\text{C}$  due to the effect of salinity. Details of temperature distribution, as well as comparison of predicted temperature profiles with thermistor data are provided in Appendices A and B.

Section A was cut through the proposed underground ramp as shown in Figures 1 and 3, where the lake is approximately 300 m wide. Thermistors AMQ15-421 and AMQ17-1265A were projected onto the section to allow for comparison of predicted vs. measured temperature profiles under the Whale Tail Lake. In addition, thermistor AMQ15-324 was projected onto the section to represent ground temperature away from the lake. Plots of predicted temperatures compared to measured temperatures are presented in Appendices A and B for the calibration models Scenarios 1 and 2, respectively.

The thermal results indicate a closed talik formation underneath the lake for both calibration scenarios, which is consistent with temperature data obtained from thermistor AMQ17-1265A installed in the lake, and AMQ15-421 installed adjacent to the lake but that dips toward the Whale Tail Lake. In terms of permafrost depth, the predicted location of permafrost under the Whale Tail Lake was about 100 m shallower for Scenario 1 (lower permafrost limit approximately 350 m below lake level) compared to Scenario 2 (lower permafrost limit about 450 m below lake level). The location of permafrost in areas away from the lake was similar for both calibration scenarios with permafrost depth of about 480 m below ground.

The model results for Section A obtained for Scenario 1 suggest that the lower 25 m of the proposed underground ramp shown in Figure 3 may be in unfrozen ground. Based on the model results, the cryopeg zone extends to a maximum of 20 to 30 m above the base of permafrost.

Section C was also modelled through the proposed underground ramp as shown in Figures 1 and 4, where the lake is approximately 300 m wide. Thermistors AMQ15-306 and AMQ15-349A were projected onto the section to compare measured temperatures to the model results under the Whale Tail Lake; both thermistors' collars are located near the lake and dip toward ground portions beneath the lake. Plots of measured vs. predicted temperatures are presented in Appendices A and B.

Results of the thermal models indicate a closed talik formation underneath the lake for both scenarios, which is consistent with thermistor data. The location of the lower permafrost limit below the closed talik under the lake was about 100 m shallower for Scenario 1 (about 325 m below the lake) compared to Scenario 2 (about 425 m below the lake). The proposed ramp layout shown in Figure 4 indicates that the lower 50 m of the ramp may be in unfrozen ground for the calibration Scenario 1. The models also predict a permafrost depth of about 500 m below ground in areas away from the Whale Tail Lake.

Section D was modelled through the proposed underground ramp perpendicular to Sections A and C as shown in Figures 1 and 5, where the lake is approximately 200 m wide. The thermistor AMQ15-452 was projected onto the section to compare measured temperatures with the model results under the whale Tail Lake, while the projection of thermistor AMQ15-324 is in ground away from the lake. Details of computed vs. measured temperatures are presented in Appendices A and B.

The thermal results indicate a closed talik formation underneath the lake for both scenarios, in good agreement with the reference thermistor data. The lower permafrost limit computed for Scenario 1 was about 50 m shallower than computed for Scenario 2 (i.e., 450 m and 500 m below the lake, respectively). The model results suggest that the proposed ramp layout shown in Figure 5 will be in frozen ground for both scenarios. The models also predicted permafrost depth of about 510 m below ground in areas away from the Whale Tail Lake.

Section E was modelled to assess the talik beneath the lake south of the proposed ramp. The section crosses the Whale Tail Lake at different locations as shown in Figure 1 and 6. The lake width in the middle of the section is approximately 300 m and at the south end of the section it is about 350 m. The models predicted that, for both calibration scenarios, the area south of the proposed underground ramp will be in open talik. The model also results suggest that the proposed ramp layout shown in Figure 6 will be in frozen ground for both scenarios.

Section E was modelled to assess the nature of talik beneath the lake south of the proposed ramp. The section crosses the Whale Tail Lake at different locations as shown in Figure 1 and 6. The lake width in the middle of the section is approximately 300 m and at the south end of the section it is about 350 m. The models predicted that, for both calibration scenarios, the area south of the proposed underground ramp will be in open talik.

The predicted open talik in Section E is heavily influenced by the extent of lake in the two-dimensional configuration of the model. There were no thermistors available for model calibration in the south portion of Section E, and calibration based on thermistors installed north of the proposed ramp (i.e., AMQ15-294 and AMQ17-277A) showed model predicted temperature profiles generally warmer than measured temperatures (as presented in Appendices A and B). Therefore, the actual permafrost conditions beneath and in-between the two portions of the Whale Tail Lake that appear in Section E are possibly colder than predicted by the models.

Section E is perpendicular to the alignment of the proposed ramp, so the projected ramp location is shown in Figure 6 for reference. The upper 200 m of the ramp is relatively close to Section E, and the model results indicate that portion of the ramp will be in frozen ground. The lower portion of the ramp dips away from Section E and therefore model results cannot be used to evaluate whether that area would be in talik or not.

Section F was modelled to assess permafrost conditions away from the Whale Tail Lake as shown in Figures 1 and 7. Section F mainly passes through ground and crosses two small shallow lakes close to the north end of the section. The permafrost depth was estimated to be 500 m and 550 m below ground surface for Scenario 1 and Scenario 2, respectively.

The calibrated parameters were then applied to Section G, where the lake is approximately 500 m wide, to assess permafrost limits and the extent of the open talik predicted in Section E. Temperature profiles from thermistor (AMQ15-306) were extrapolated and projected onto Section G to evaluate consistency of the model predicted temperatures with the actual measurements. Although predicted temperatures were warmer than measured temperatures for both calibration scenarios, the thermal model indicates the existence of an open talik beneath the Whale Tail Lake as shown in Figure 8.

## 5.2 Three-Dimensional Block Model

The 3D block model was prepared using results obtained from the 2D models for the calibration Scenario 1, which predicted a shallower permafrost compared to the calibration Scenario 2. Although both Scenarios 1 and 2 had good agreement with temperature profiles obtained from the reference thermistors, the shallower permafrost predicted in Scenario 1 is considered to be a more critical scenario as it shows more of the underground may be located in unfrozen rock.

Results of the 3D block model were exported to CSV format with the following columns: X (Easting), Y (Northing), Z (Elevation) and Temperature, for use in the hydrogeology model. Figure 9 shows a 3D plot of the 0°C isoline computed based on the results of the 2D thermal modelling.

The model representation of temperature is good where the sections are close together and where sections of different orientations contribute to the temperature estimates. The model is less reliable as distance from sections increases. Also, although the lake constraint worked well, it was not completely successful within the entire block model.

The 3D block model is a basic construct and is intended for guidance rather than providing a definitive picture of temperature and permafrost limits in 3D. As the results obtained from the 2D thermal models are used as input for the 3D block, any limitation carried forward from the 2D models impacts the results of the 3D block model. Additional refinements would be necessary if the model was to be used for detailed understanding of permafrost limits in the Project site.

## 6.0 SUMMARY AND RECOMMENDATIONS

Golder has carried out thermistor data review and numerical modelling of the lake talik formations for the Whale Tail Lake area. Based on the latest thermistor data available, the permafrost characteristics in the project area are summarized below:

- The depth of permafrost in the Project site is estimated to be between 452 m and 522 m based on thermal gradients and ground temperatures at the lowest portions of the thermistor strings.
- The estimated depth of zero amplitude from the temperature profiles ranges from 18 m to 35 m.
- The temperatures at the depths of zero amplitude are in the range of -3.1 °C to -8.6 °C for on land thermistors and 2.7 °C for AMQ17-1265A.
- Temperatures in depth at the locations of the thermistors' tip vary between -0.35°C for AMQ17-1265A and -3 °C for AMQ15-324.
- The geothermal gradient estimated based on the lowest 70 to 100 m of the thermistor strings is in the range of 0.004 °C/m (AMQ15-294) to 0.052 °C/m (AMQ15-306).

The results of numerical modelling thermal assessment indicate that:

- Under the northern portion of the lake along the proposed ramp area, there is likely a closed talik formation.
- Open talik formations are probable in the southern portion of the lake where the Whale Tail Lake becomes wider.
- Permafrost depth between 480 m and 550 m for ground away from the Whale Tail Lake, and between 350 m and 450 m below surface in portions beneath the Whale Tail Lake.

The thermal model indicated that the lower 25 to 50 m of the proposed exploration ramp alignment in the northern portion of the lake may be in unfrozen ground. This range might be extended depending on salinity levels in the water that will result in depression of the water freezing point. A depression of the freezing point of about 0.2 °C (i.e. water freezing at temperature of -0.2°C instead of 0 °C) would result in about an additional 20 to 35 m of the ramp being subject to groundwater inflow based on predictions of the extent of the cryopeg zone in the models as shown in Figures 3 to 8.

The minimum ground temperature measured by thermistor AMQ17-1265A below the closed talik portion in the Whale Tail Lake is about -1°C, while ground temperature at the tip of the thermistor is -0.35°C. As mentioned above, increasing salinity levels will cause the freezing point of water to depress; the higher the salinity the greater the extent groundwater can flow through frozen ground. An estimation based on Andersland O.B. (2004) shows that groundwater salinity would need to be about 1.8% for the freezing point to depress to -1°C, in which condition water could potentially flow through frozen ground beneath the Whale Tail Lake and into the ramp. The average water salinity is currently estimated as 0.37% with a freezing point depression of -0.21°C, suggesting that water would not flow through the closed talik under the Whale Tail lake at current salinity conditions. Nevertheless, close monitoring of groundwater salinity levels during operation will be required to assess the extent of groundwater flow.

Sections E and F used information from thermistors AMQ17-1233 and AMQ17-1337, respectively, as reference for model calibration. These thermistors are installed within the proposed footprint of the IVR open pit, which will have

an ultimate base elevation of 46 masl. Based on the results obtained for Sections E and F, the permafrost limits below thermistors AMQ17-1233 and AMQ17-1377 will be below the base of the IVR Pit.

Based on the thermal model results and thermistor data, it is interpreted that the ultimate base of the Whale Tail open pit (i.e. -127 masl) is expected to be within the permafrost regime, and the upper portion in the talik zone beneath the lake.

There currently are no deep thermistors installed in the south portion of the Whale Tail Lake, where the existence of open or closed talik is uncertain. Although results of water sampling obtained from the Westbay well system and results of the thermal models suggest there is open talik formation in that area, it is recommended that Agnico Eagle considers the installation of supplemental deep thermistors in the south portion of the lake to confirm this assumption.

## 7.0 CLOSURE

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this technical memorandum.

We trust this document satisfies your current requirements. If you have any questions or require further assistance, please do not hesitate to contact the undersigned.



# Signature Page

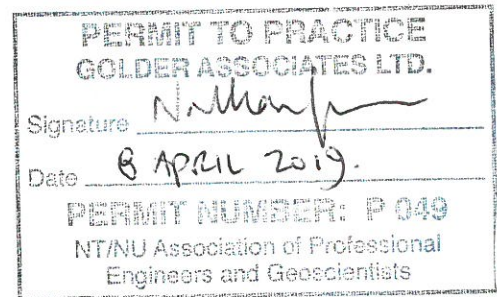
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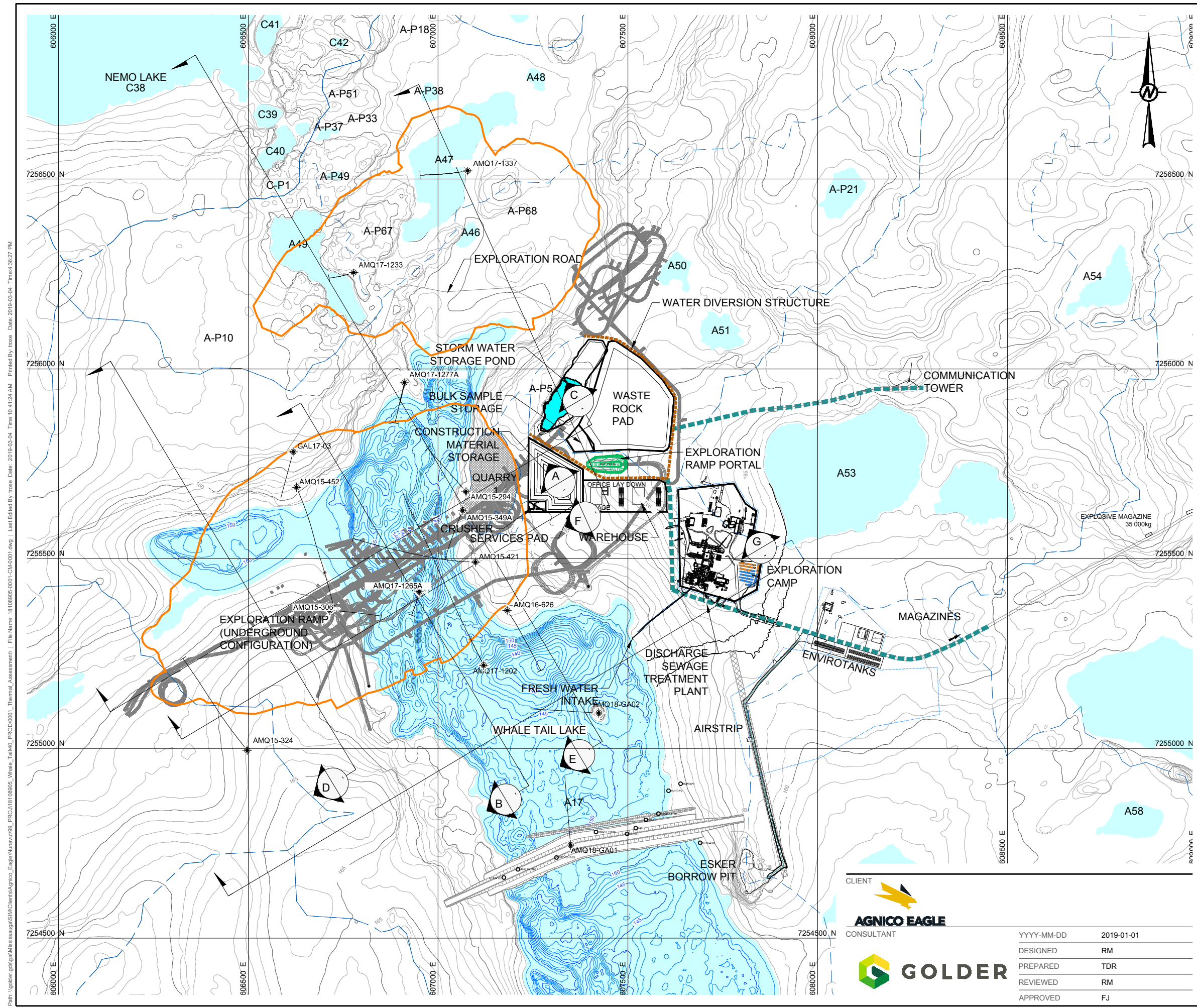


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**FIGURES**



- LEGEND**
- ROAD
  - - - - TEMPORARY ROAD
  - NATURAL WATERSHED
  - - - - DITCH
  - - - - WATER DIVERSION STRUCTURE
  - - - - INTAKE (FRESHWATER PIPE)
  - EXPLORATION ROAD
  - |— THERMISTOR
  - AMQ-POTENTIAL PIT

**REFERENCE**  
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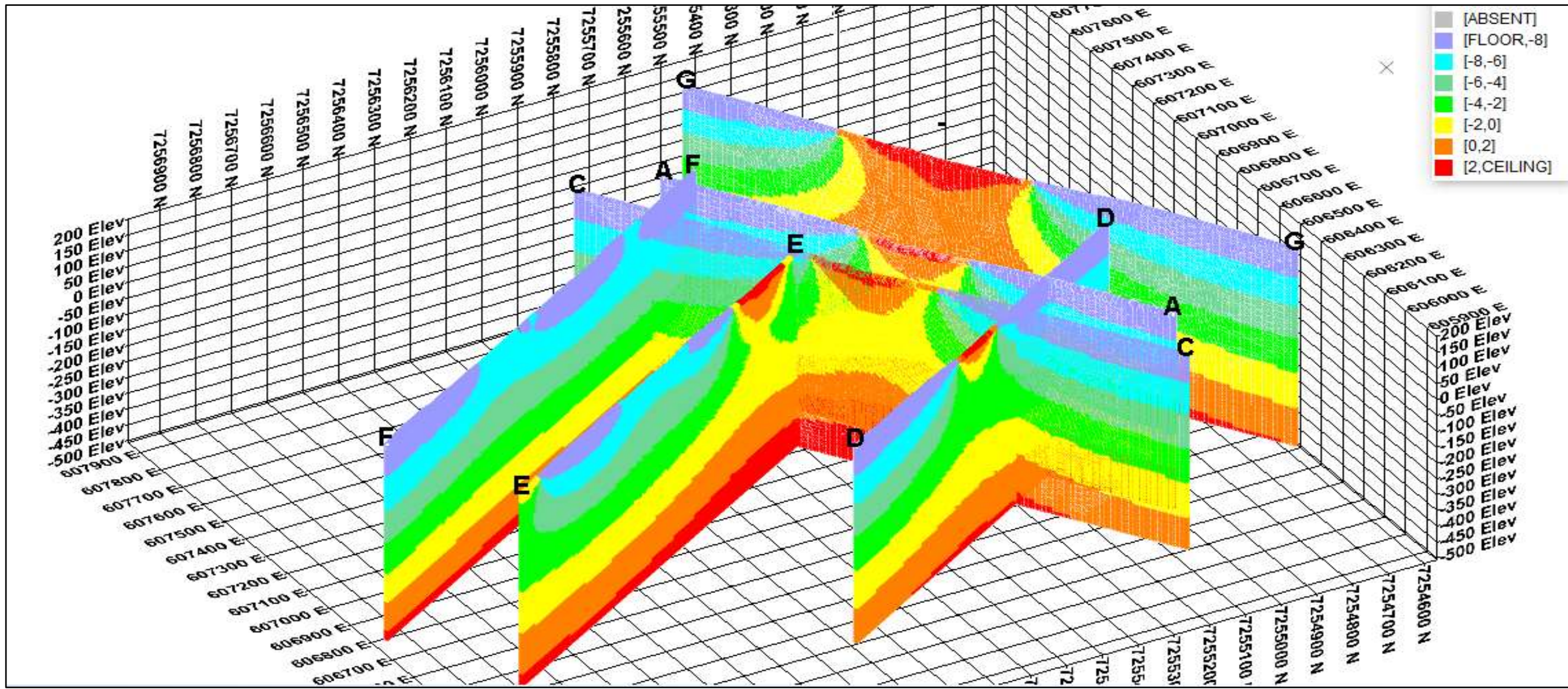
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 CONSULTANT  
  
 GOLDER

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PREPARED	TDR
REVIEWED	RM
APPROVED	FJ

PROJECT			
WHALE TAIL PIT PROJECT			
WHALE TAIL LAKE THERMAL ASSESSMENT			
NUNAVUT			
TITLE			
SITE PLAN			
PROJECT NO.	CONTROL	REV.	FIGURE
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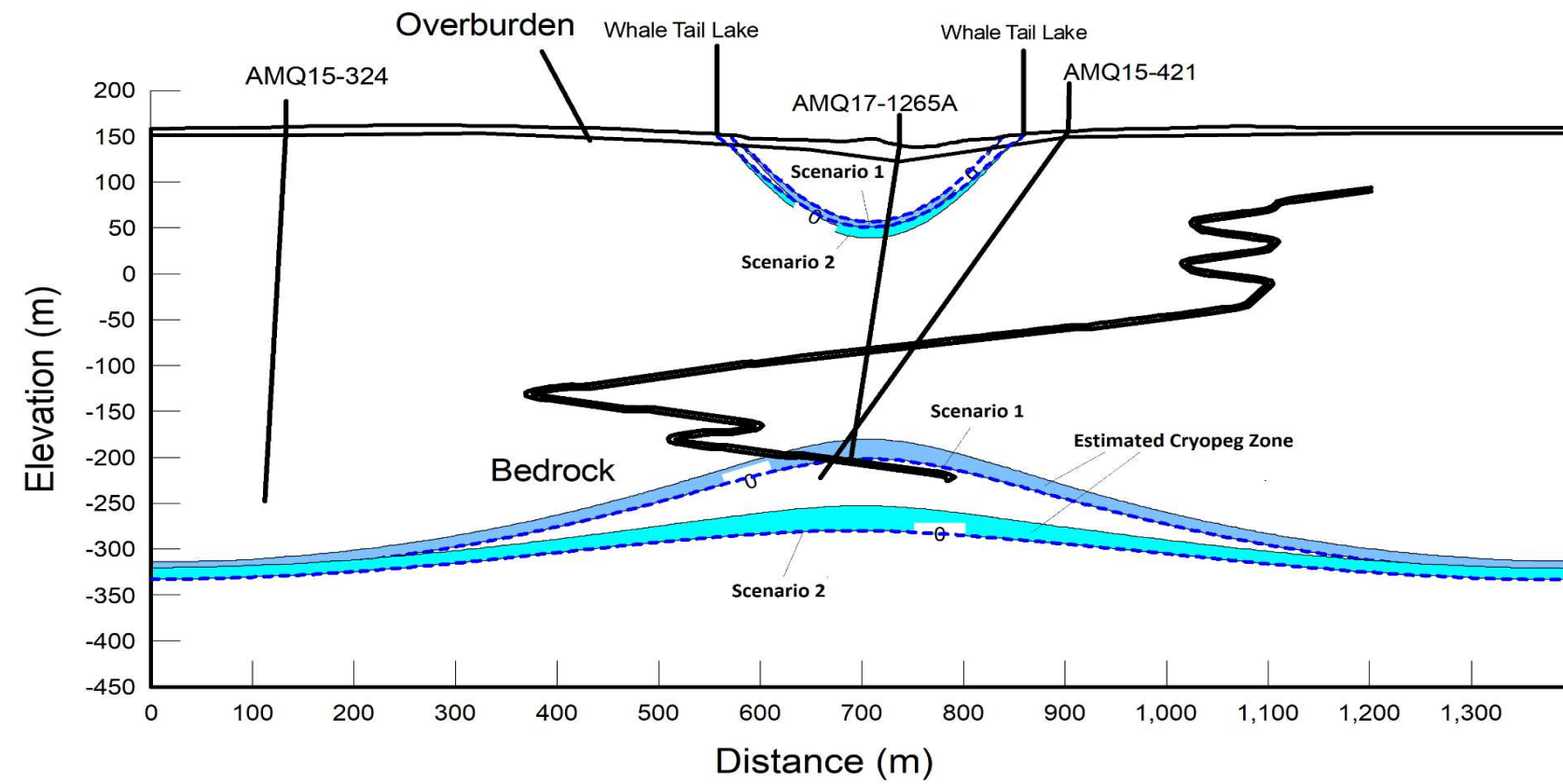


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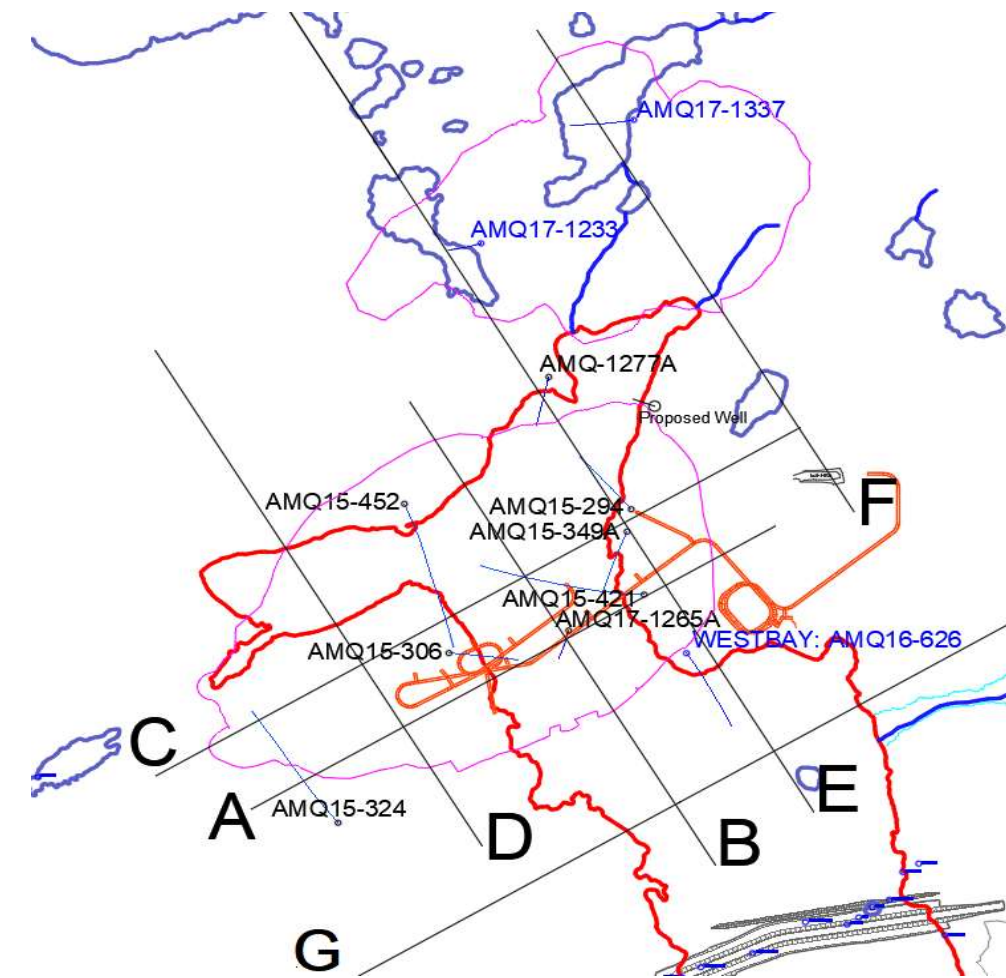
Project: Whale Tail Pit Project

Title: 2D-thermal section used as input to create the 3D-thermal model

Project No.	Phase	Version	Figure No.:
18108905			2



Zero Temperature Isoline



Scenario	1
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	0 to 3
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	n/a
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Scenario	2
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	3
Other shallow lake Temperature (oC)	n/a
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	0.018
Thermal Gradient (oC/m)	0.006

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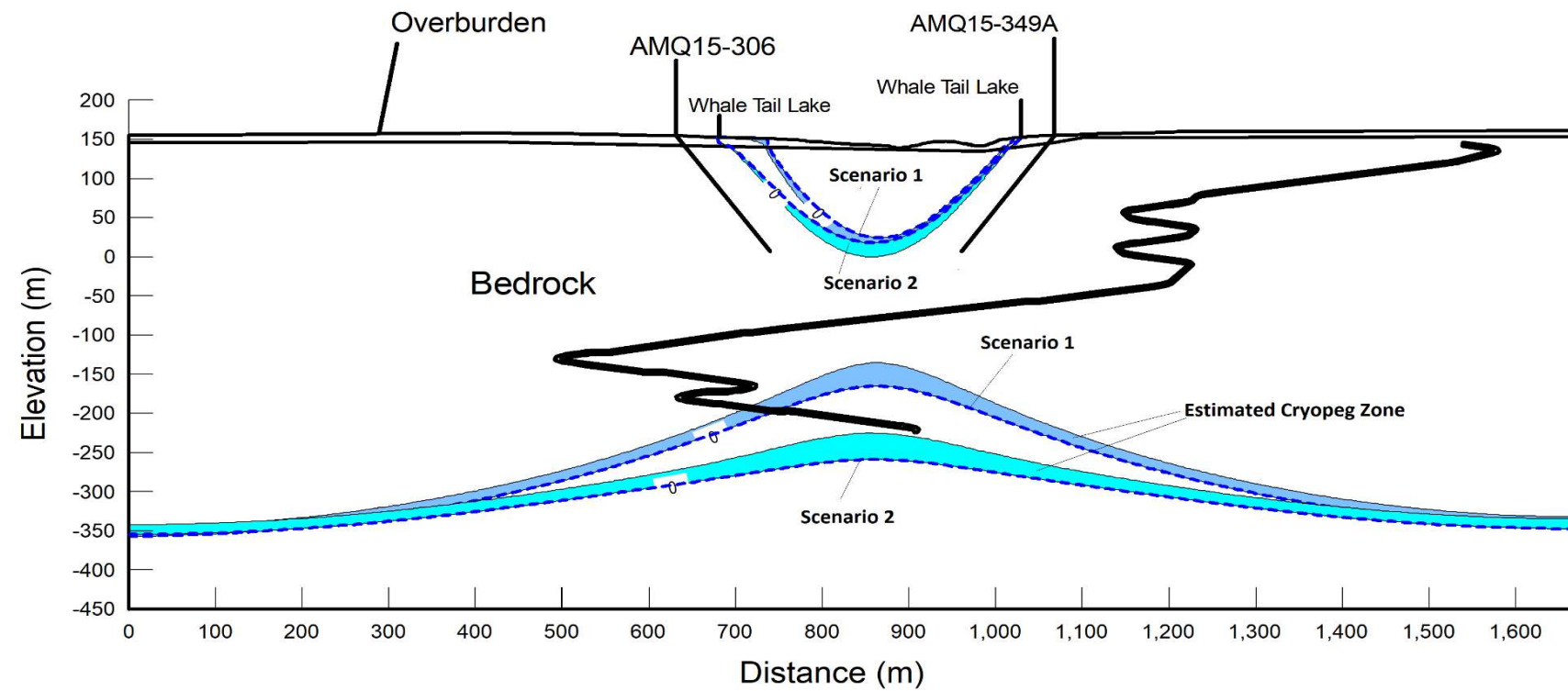


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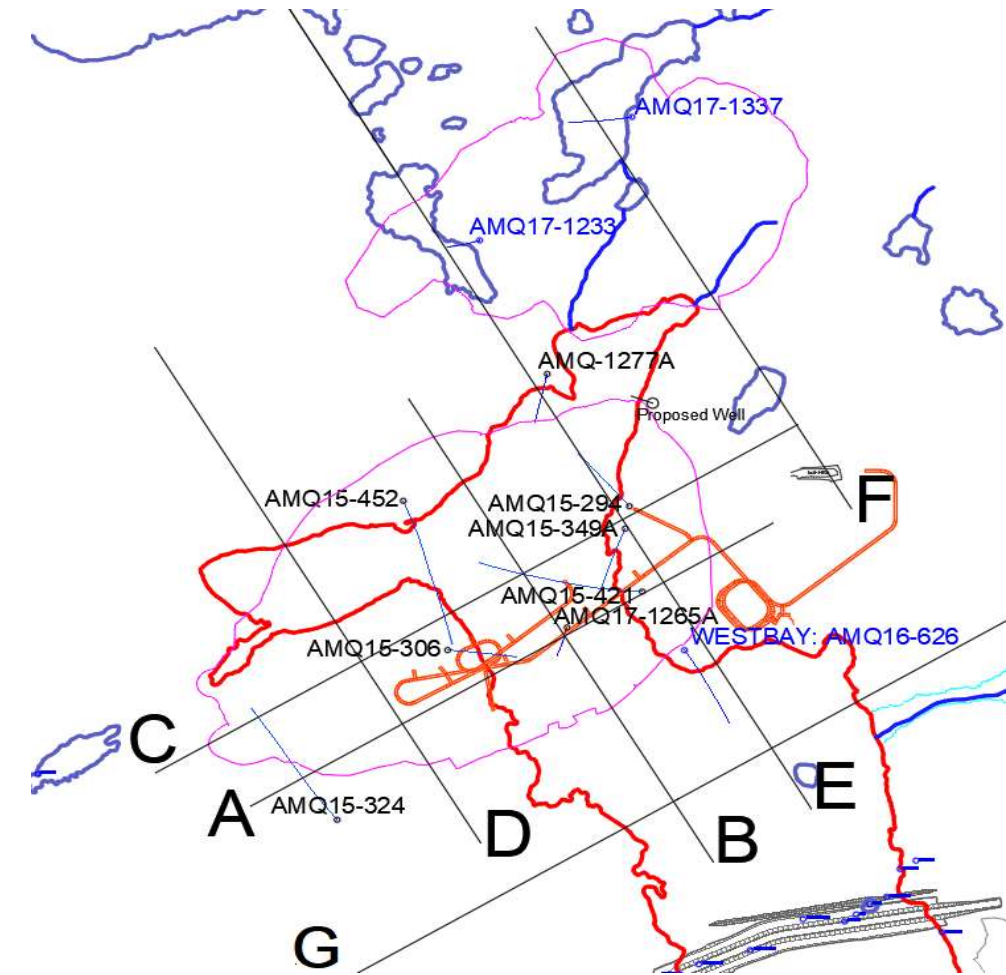
Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenarios 1 & 2 - Section A

Project No.	Phase	Version	Figure No.:
18108905			3



Zero Temperature Isoline



Scenario	1
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	0 to 3
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	n/a
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Scenario	2
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	3
Other shallow lake Temperature (oC)	n/a
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	0.018
Thermal Gradient (oC/m)	0.006

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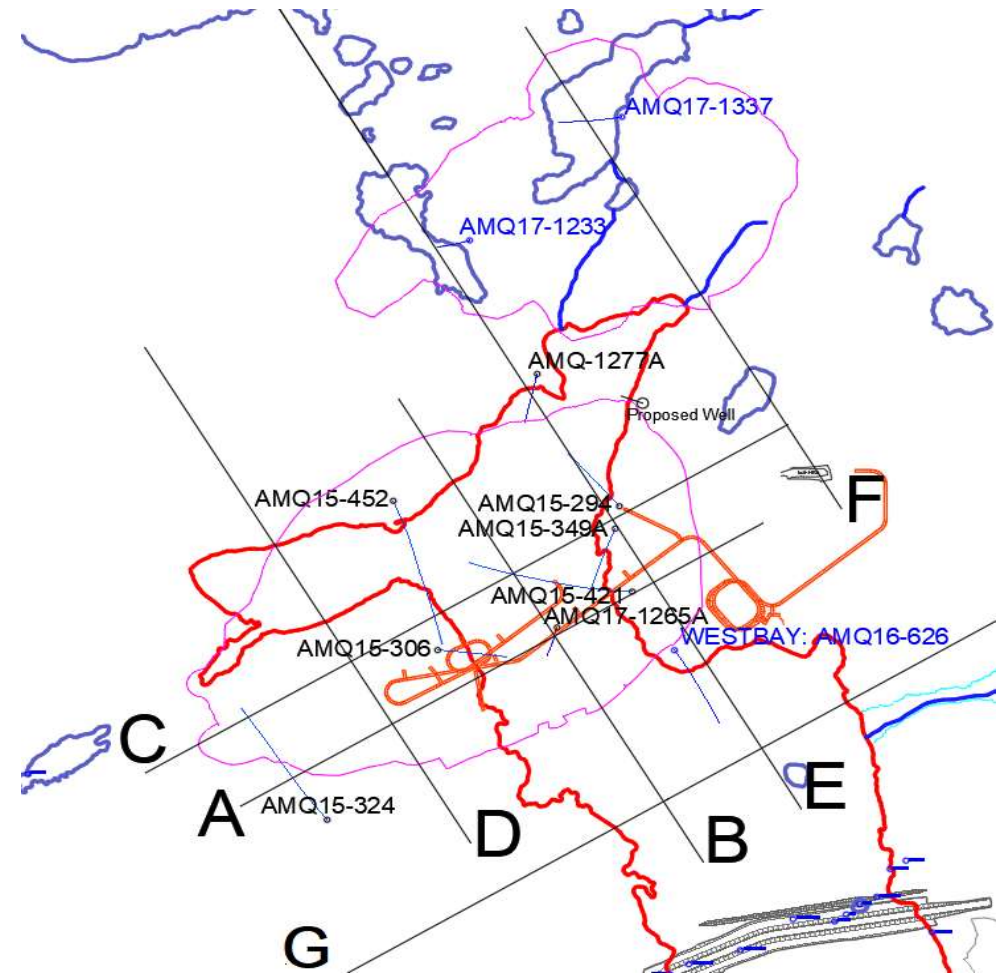
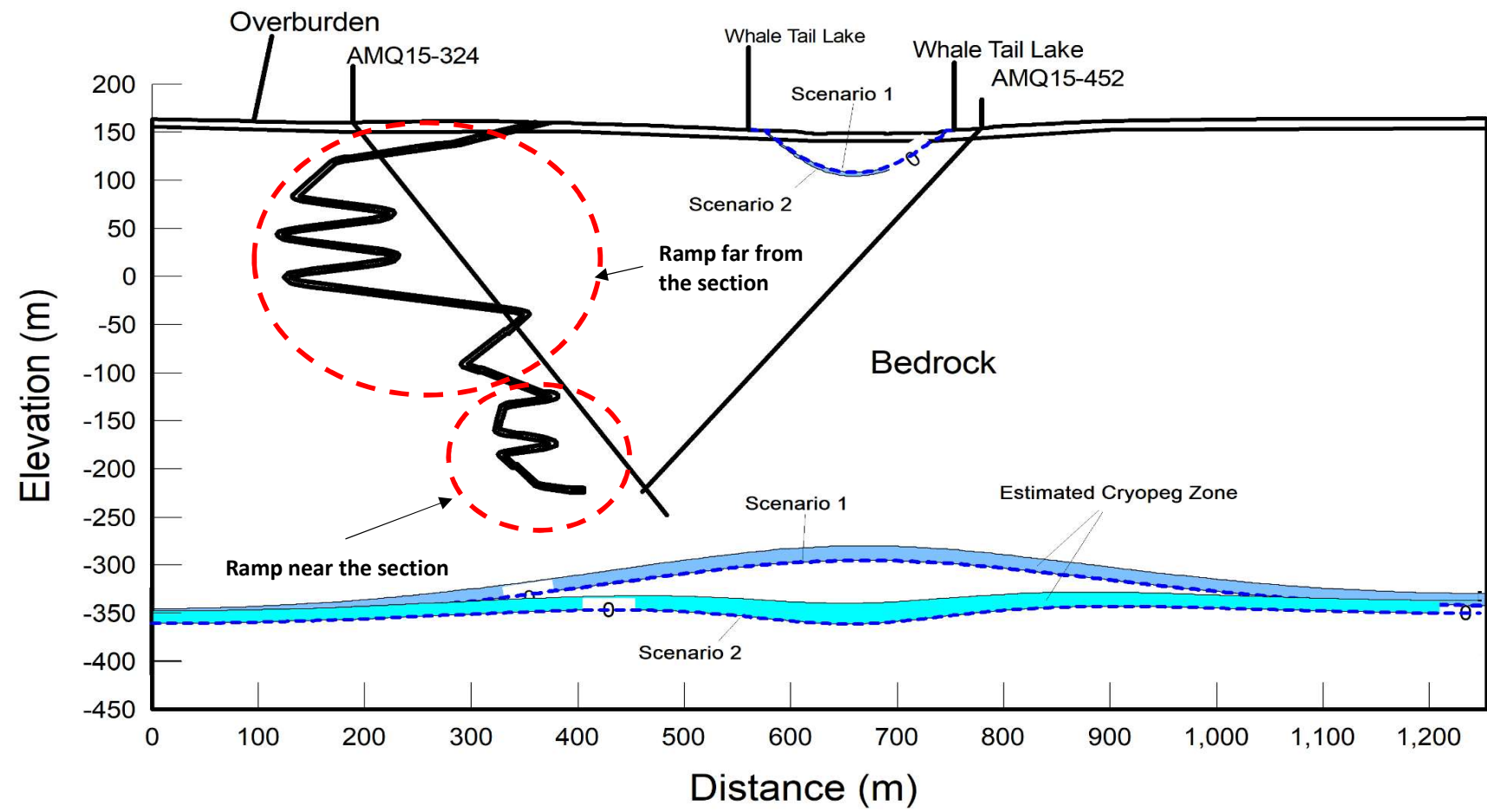


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Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenarios 1 & 2- Section C

Project No.	Phase	Version	Figure No.:
18108905			4



Zero Temperature Isoline      - - - - -

Scenario	1
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	0 to 3
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	n/a
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Scenario	2
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	3
Other shallow lake Temperature (oC)	n/a
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	0.018
Thermal Gradient (oC/m)	0.006

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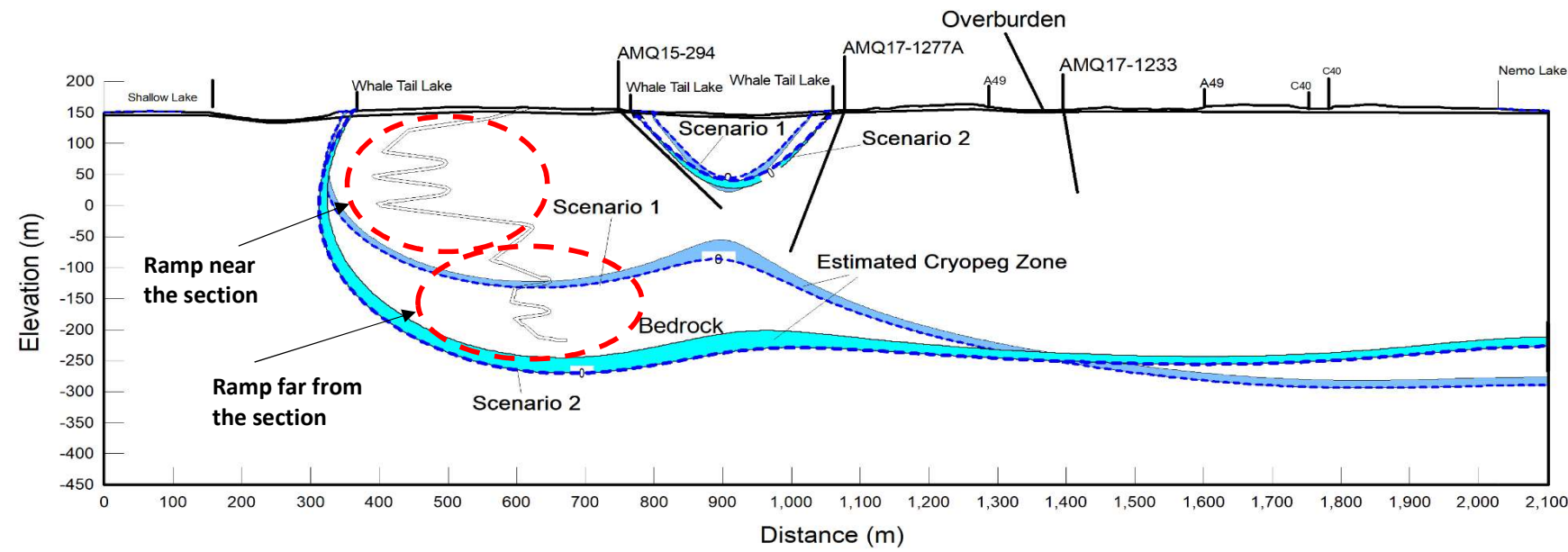
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Project: Whale Tail Pit Project

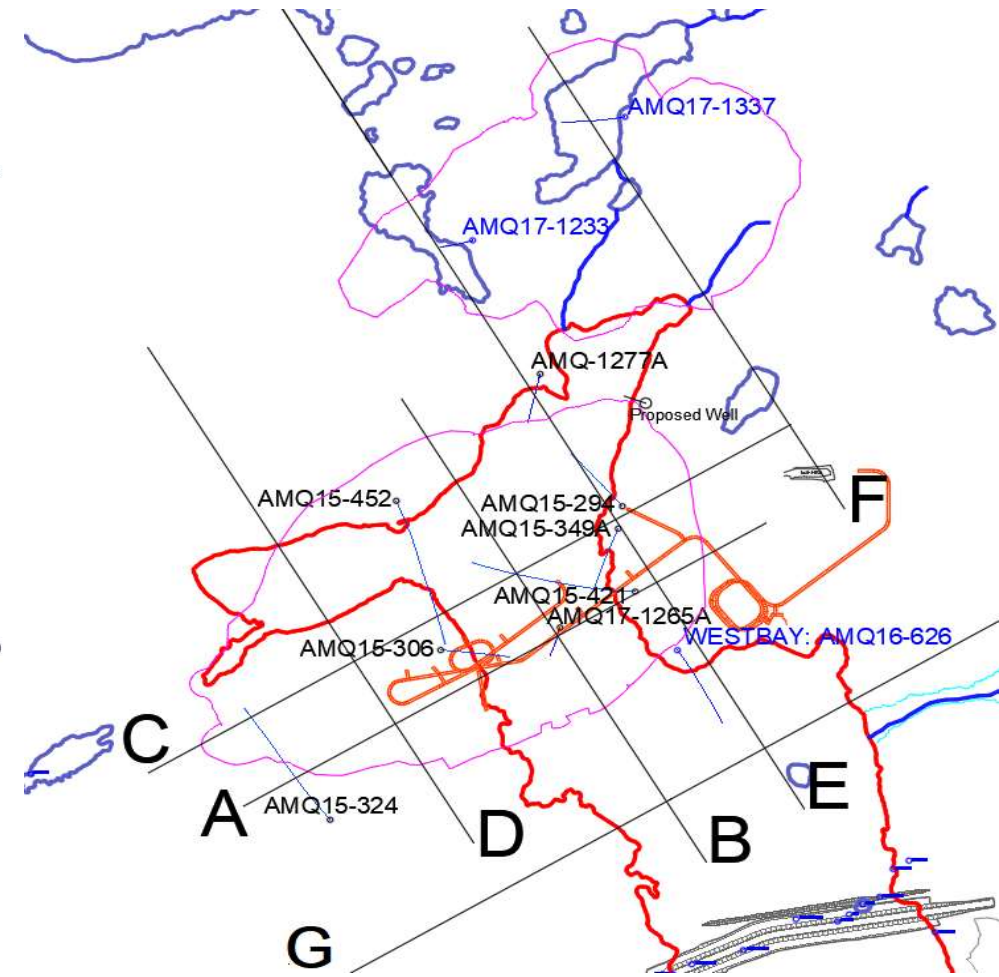
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Project No.	Phase	Version	Figure No.:
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Zero Temperature Isoline ————



Scenario	1
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	0 to 3
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	-7
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Scenario	2
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	3
Other shallow lake Temperature (oC)	-7
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	0.018
Thermal Gradient (oC/m)	0.006

Client:  
Agnico Eagle Mines Ltd.

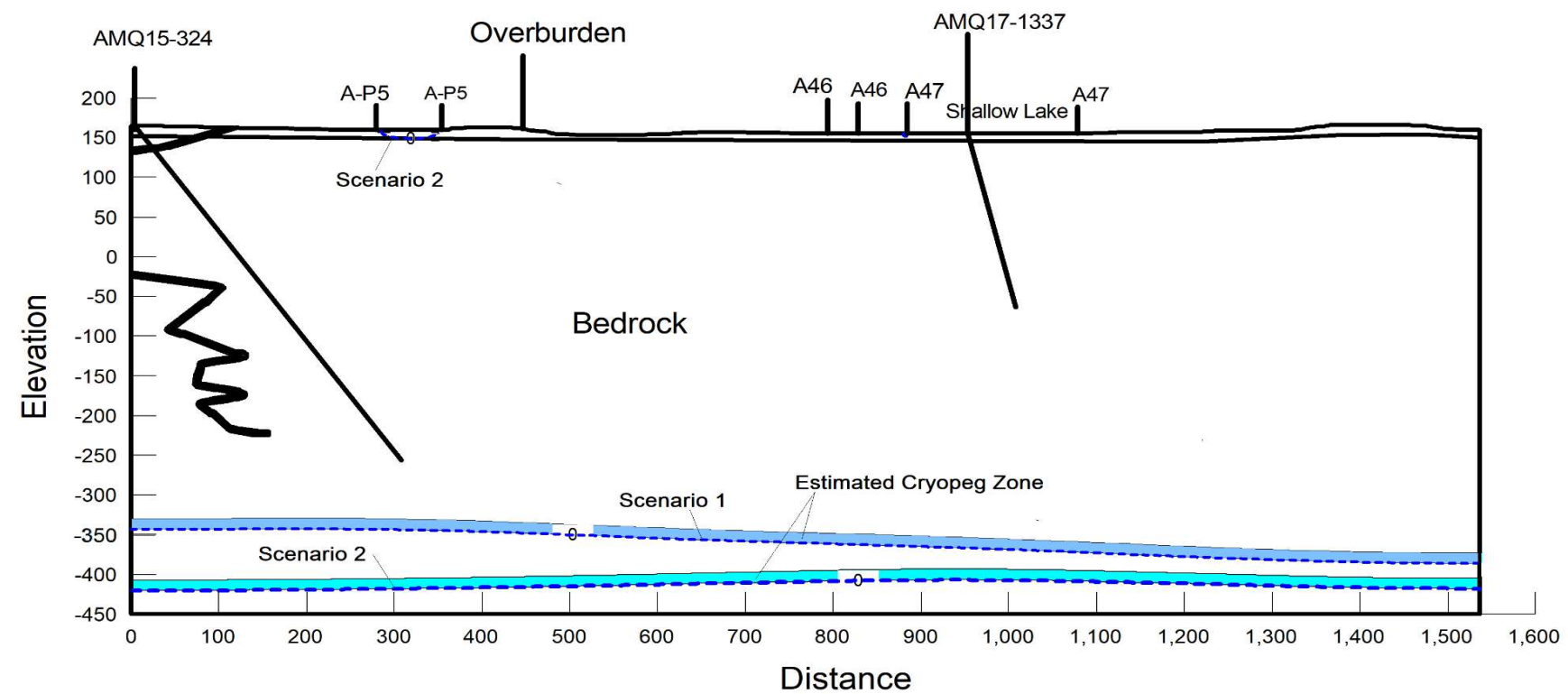


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Design: RM  
Check: FJ  
Review:

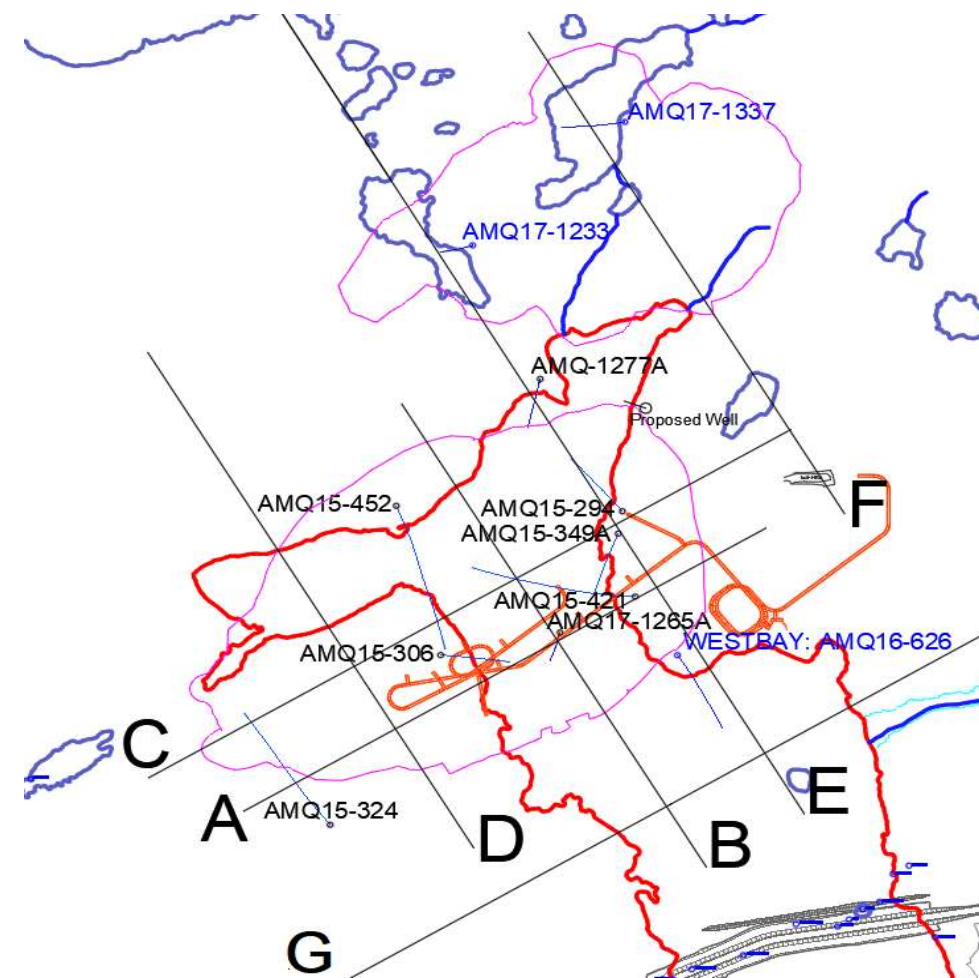
Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenarios 1 & 2 - Section E

Project No.	Phase	Version	Figure No.:
18108905			6



Zero Temperature Isoline - - - - -



Scenario	1
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	n/a
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	-7
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Scenario	2
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	n/a
Other shallow lake Temperature (oC)	-7
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	n/a
Thermal Gradient (oC/m)	n/a

Client:  
Agnico Eagle Mines Ltd.

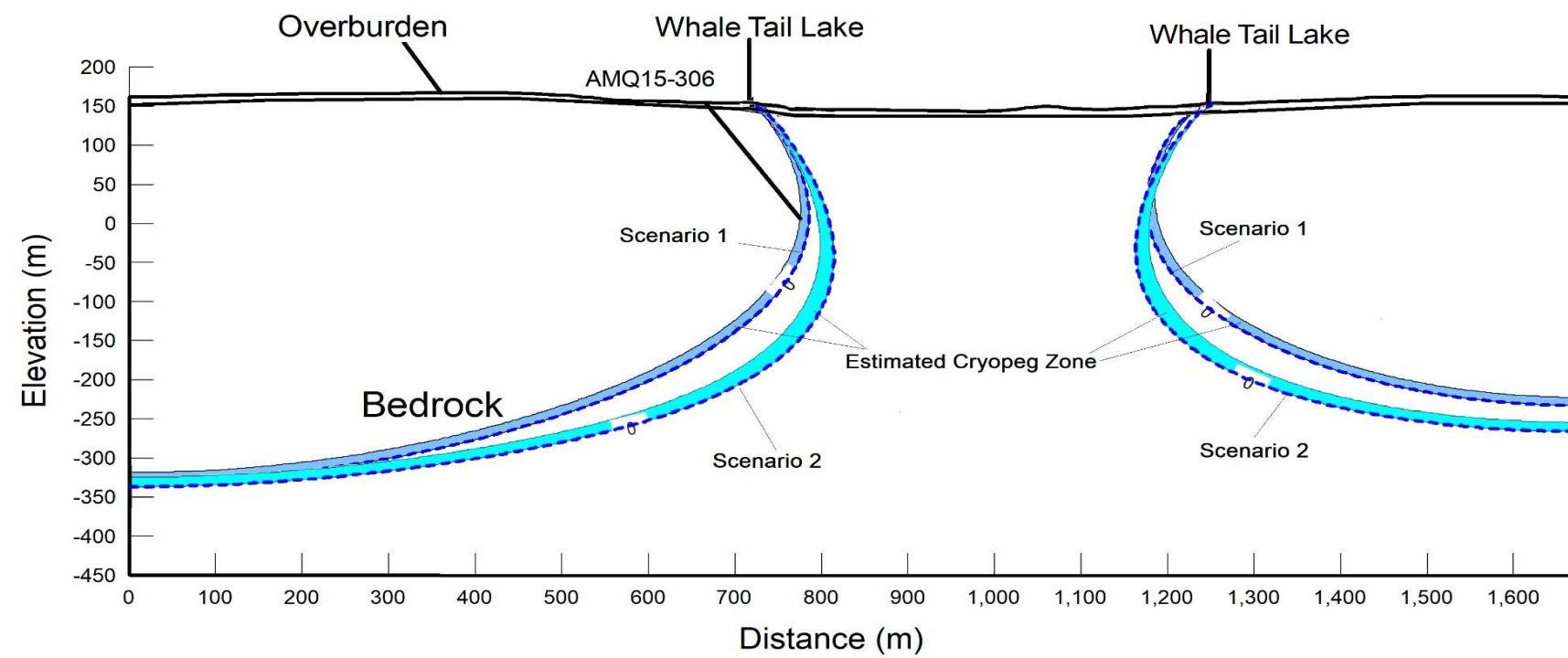


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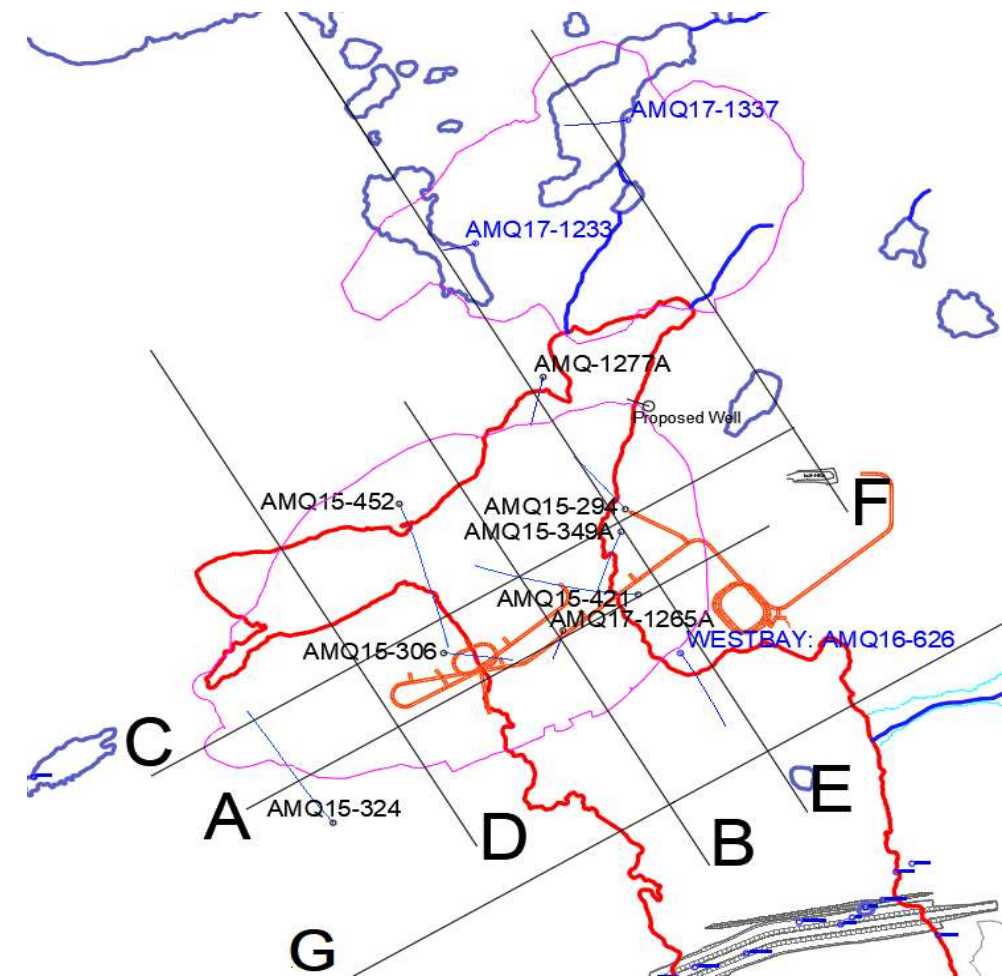
Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenarios 1 & 2 - Section F

Project No.	Phase	Version	Figure No.:
18108905			7



Zero Temperature Isoline - - - - -



Scenario	1
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	0 to 3
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	n/a
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Scenario	2
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	3
Other shallow lake Temperature (oC)	n/a
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	0.018
Thermal Gradient (oC/m)	0.006

Client:  
Agnico Eagle Mines Ltd.

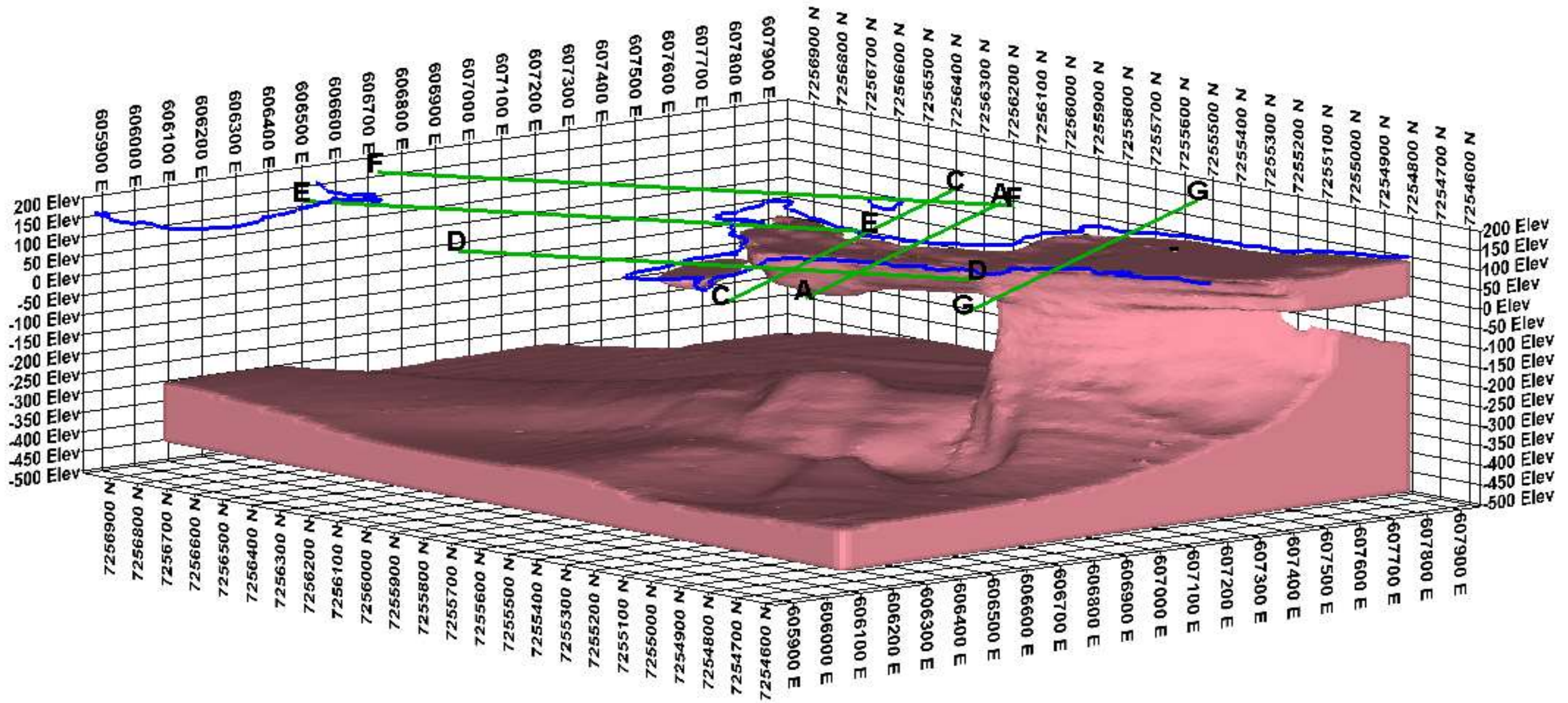


Date: Mar-19  
Design: RM  
Check: FJ  
Review:

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenarios 1 & 2 - Section G

Project No.	Phase	Version	Figure No.:
18108905			8



Client:  
Agnico Eagle Mines Ltd.



Date: Mar-19  
Design: RM  
Check: FJ  
Review:

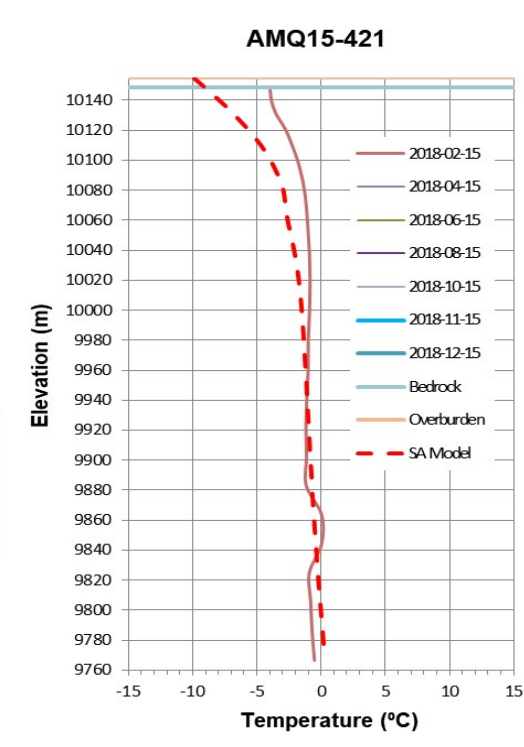
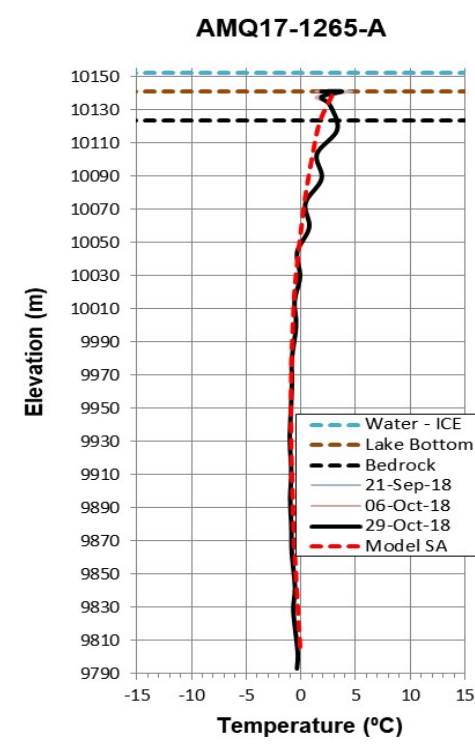
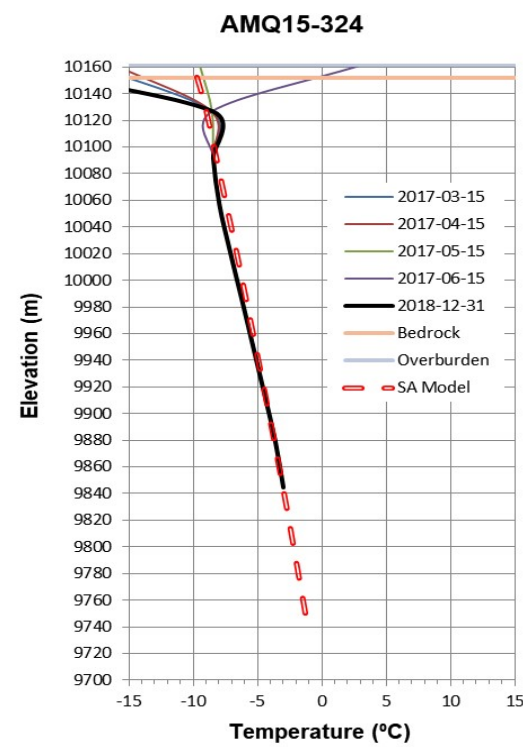
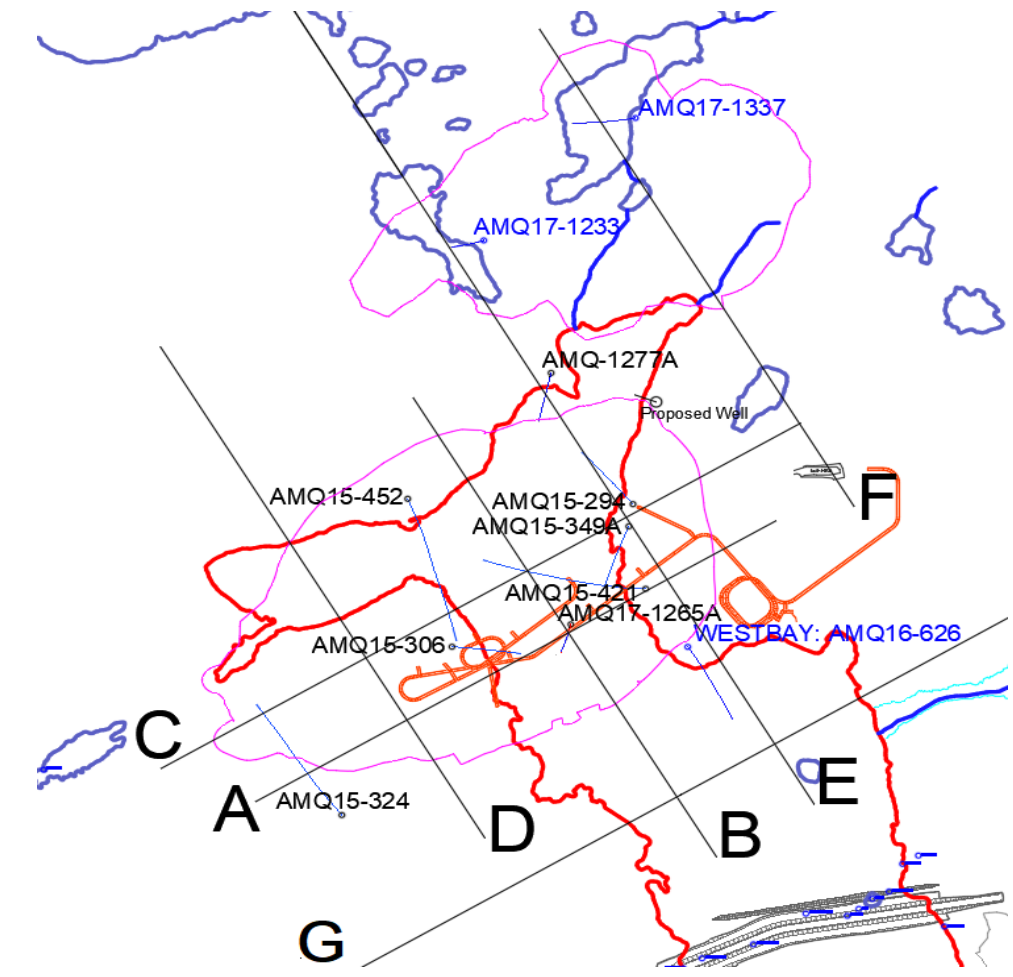
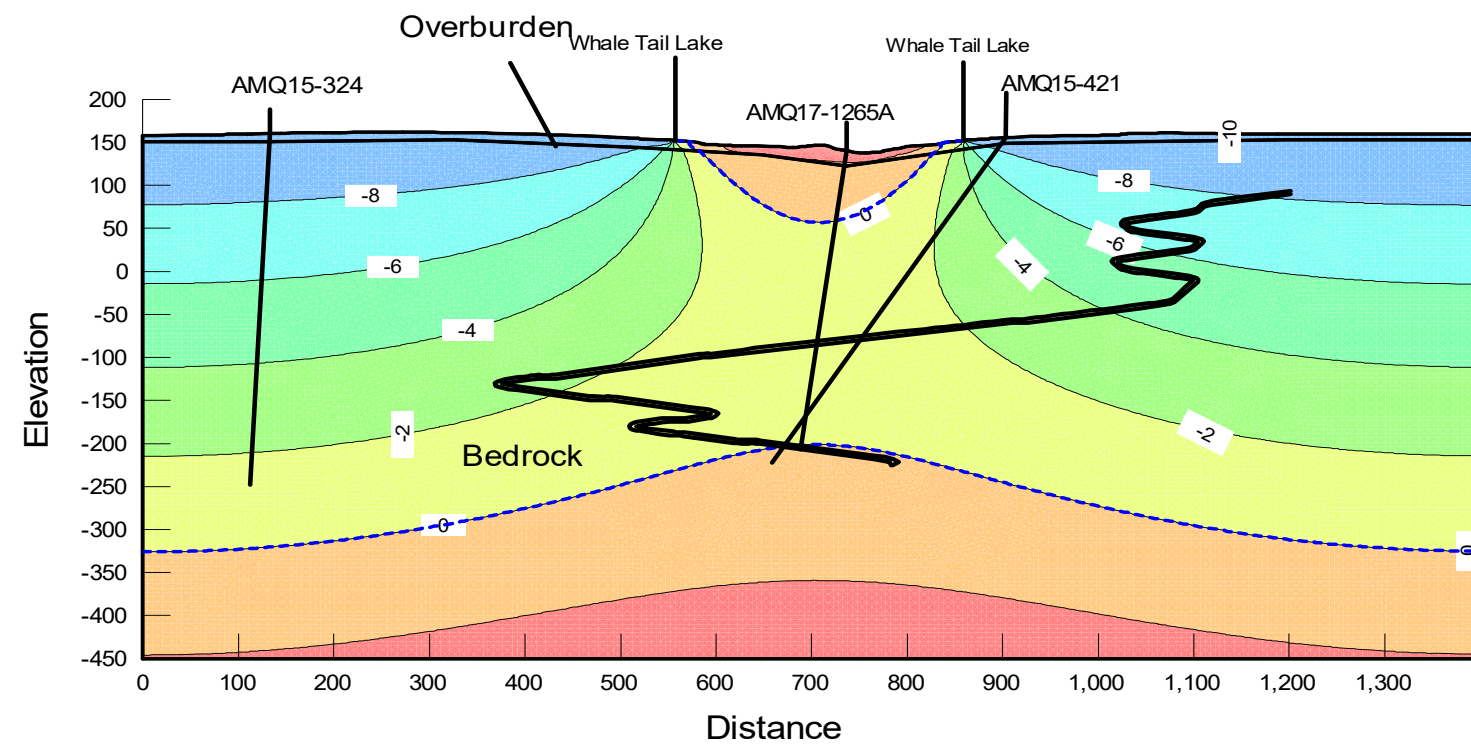
Project: Whale Tail Pit Project

Title: Zero-degree iso-surface produced from the 3D thermal model

Project No.	Phase	Version	Figure No.:
18108905			9

**APPENDIX A**

**Thermal Model Calibration -  
Scenario 1**



Section	A-A
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	0 to 3
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	n/a
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Client:  
Agnico Eagle Mines Ltd.

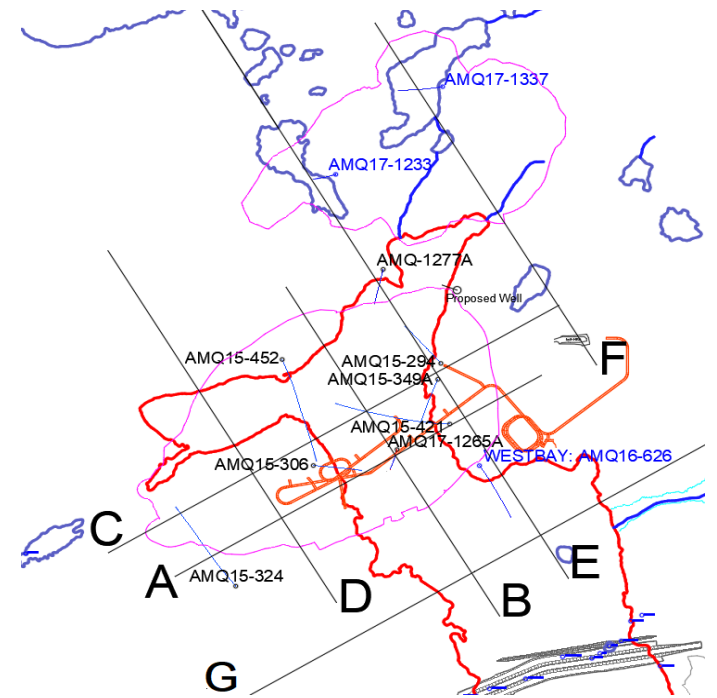
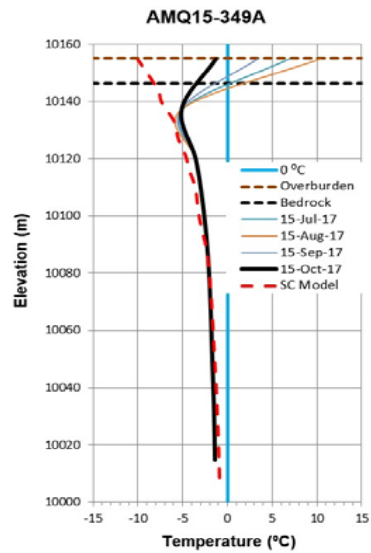
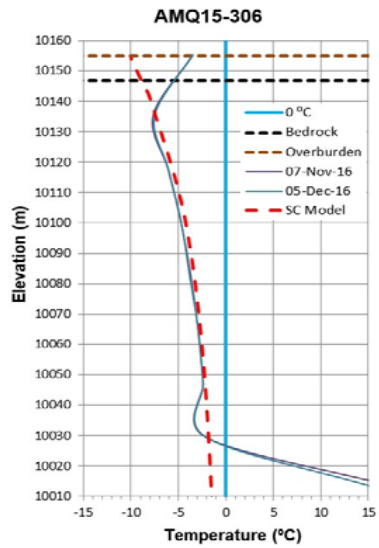
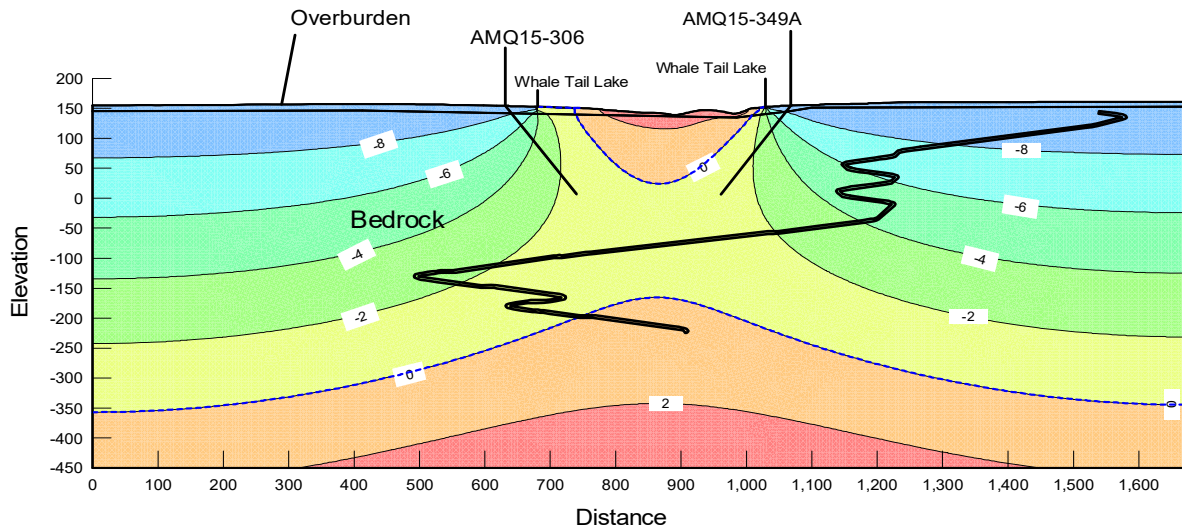


Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 1 - Section A

Project No.	Phase	Version	Figure No.:
18108905			A1



Section	C-C
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	0 to 3
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	n/a
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Client:  
Agnico Eagle Mines Ltd.

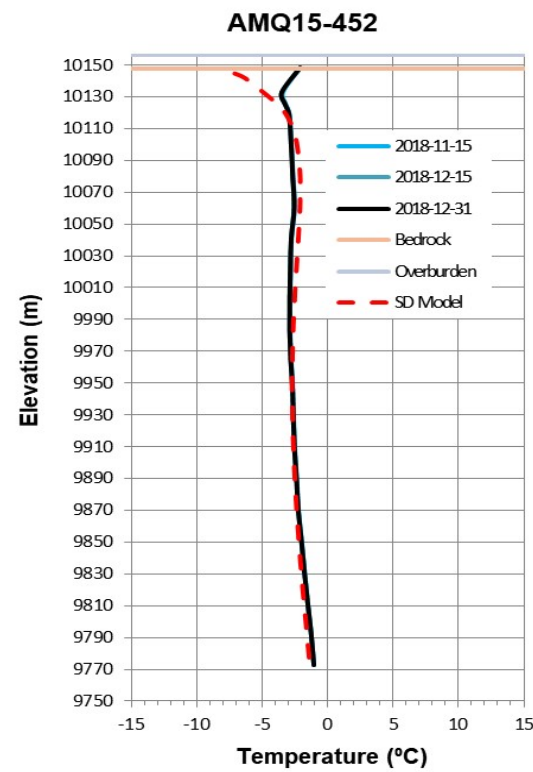
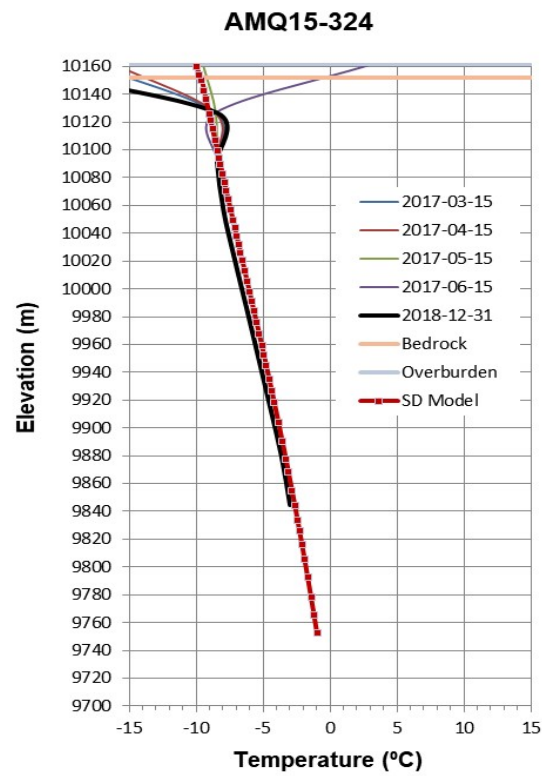
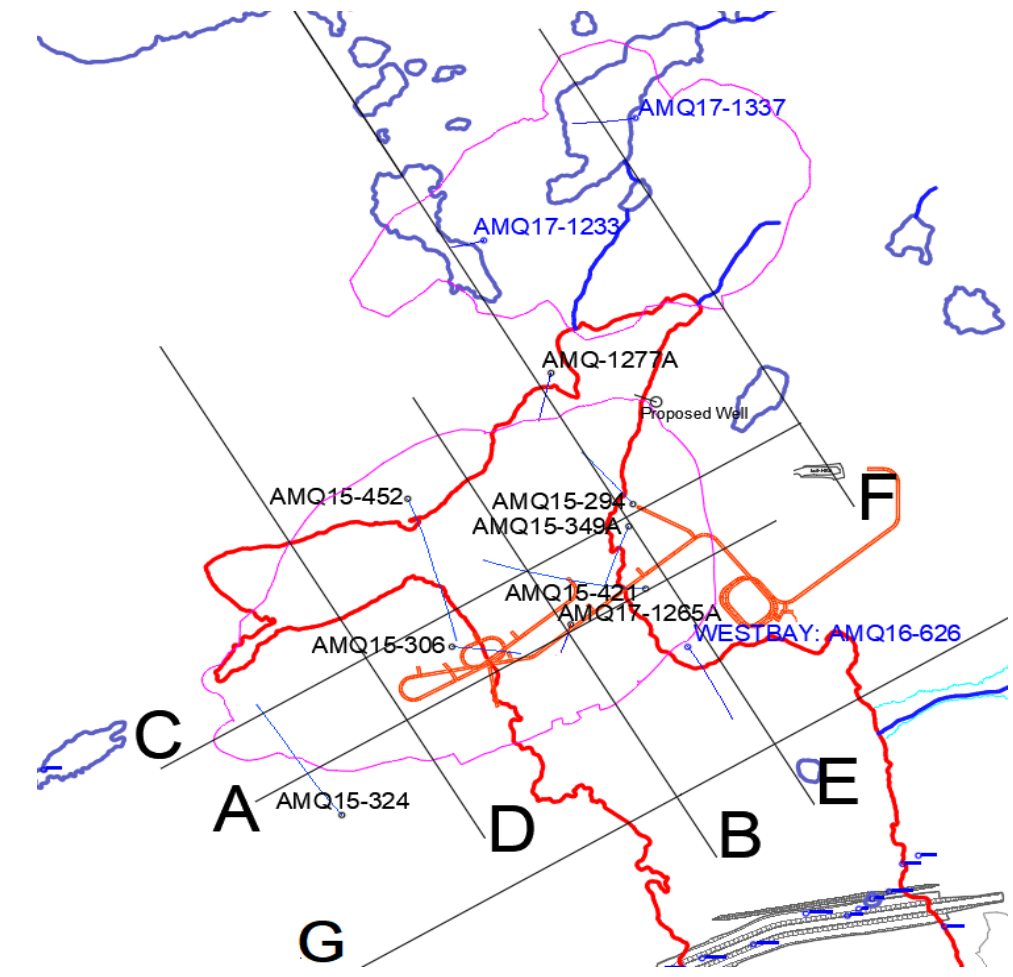
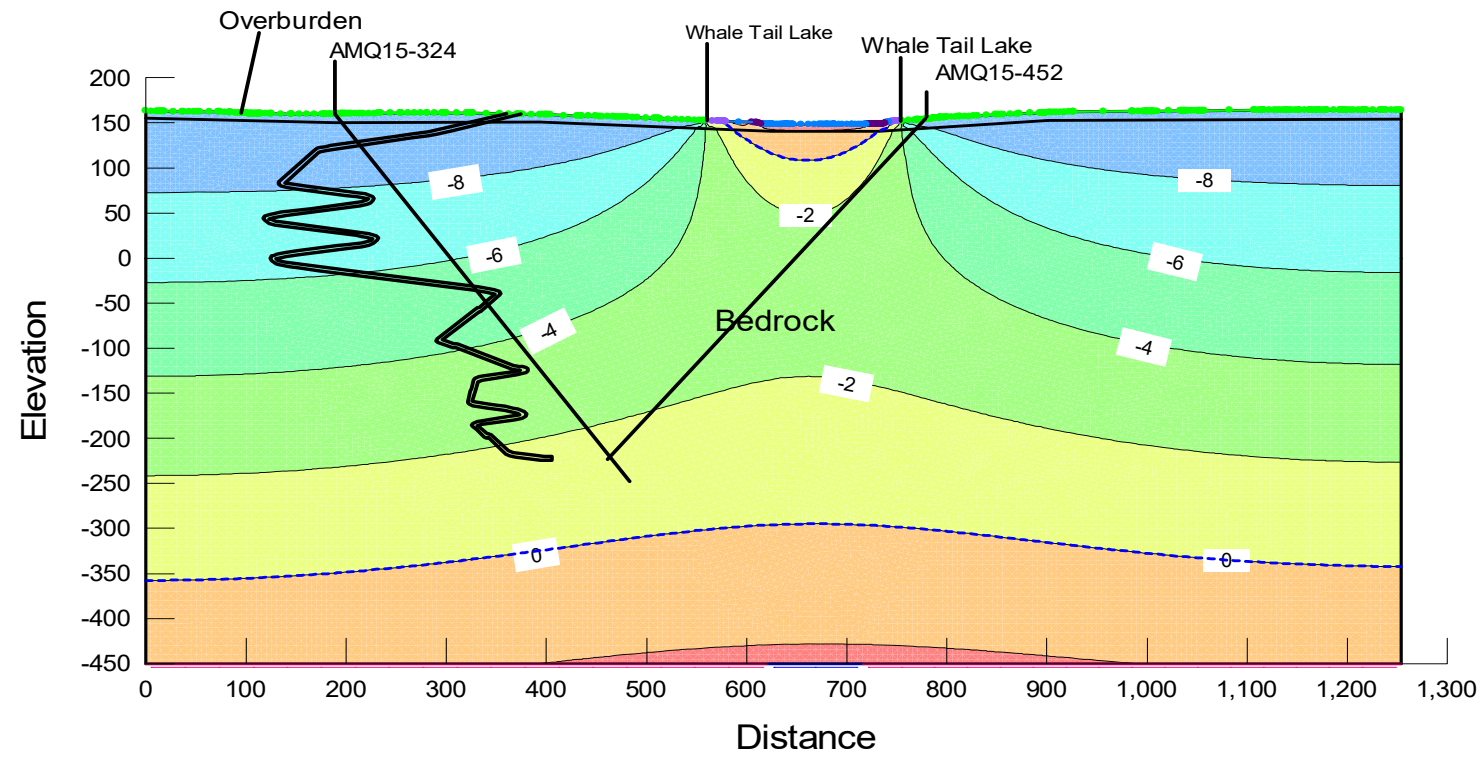


Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 1 - Section C

Project No.	Phase	Version	Figure No.:
18108905			A2



Section	D-D
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	0 to 3
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	n/a
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Client:  
Agnico Eagle Mines Ltd.



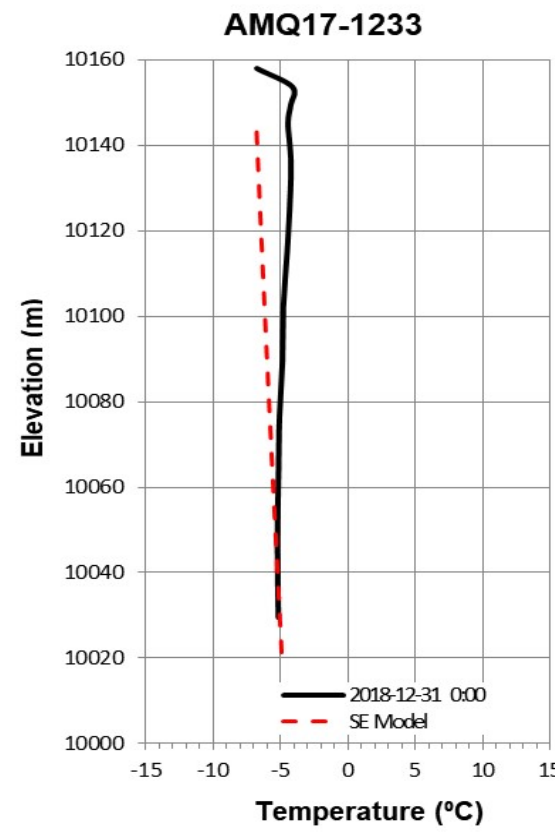
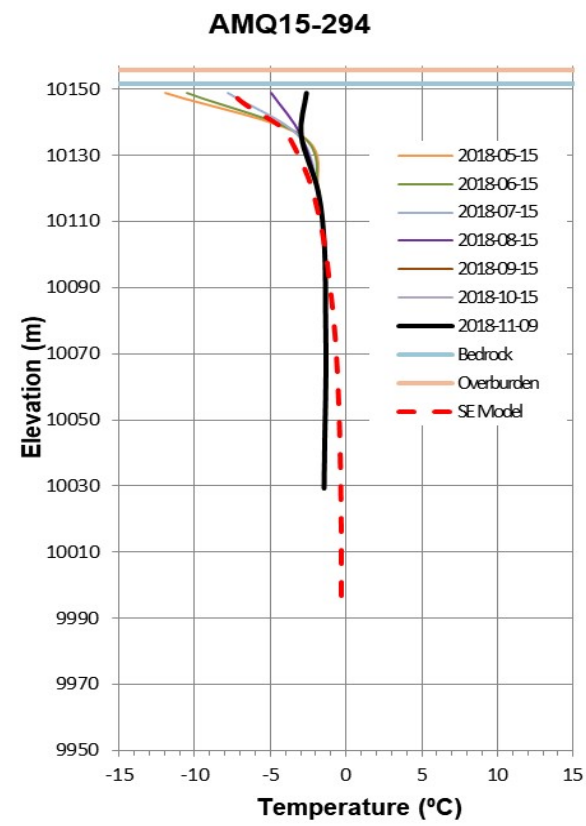
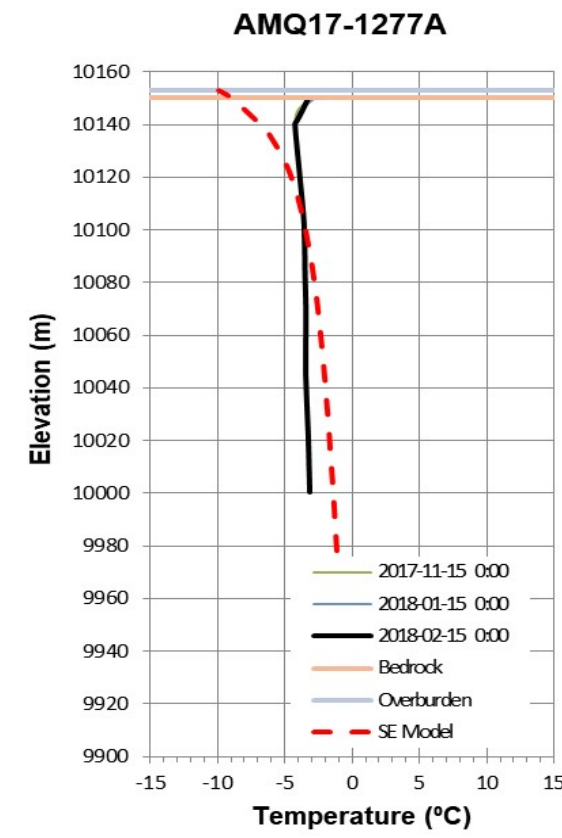
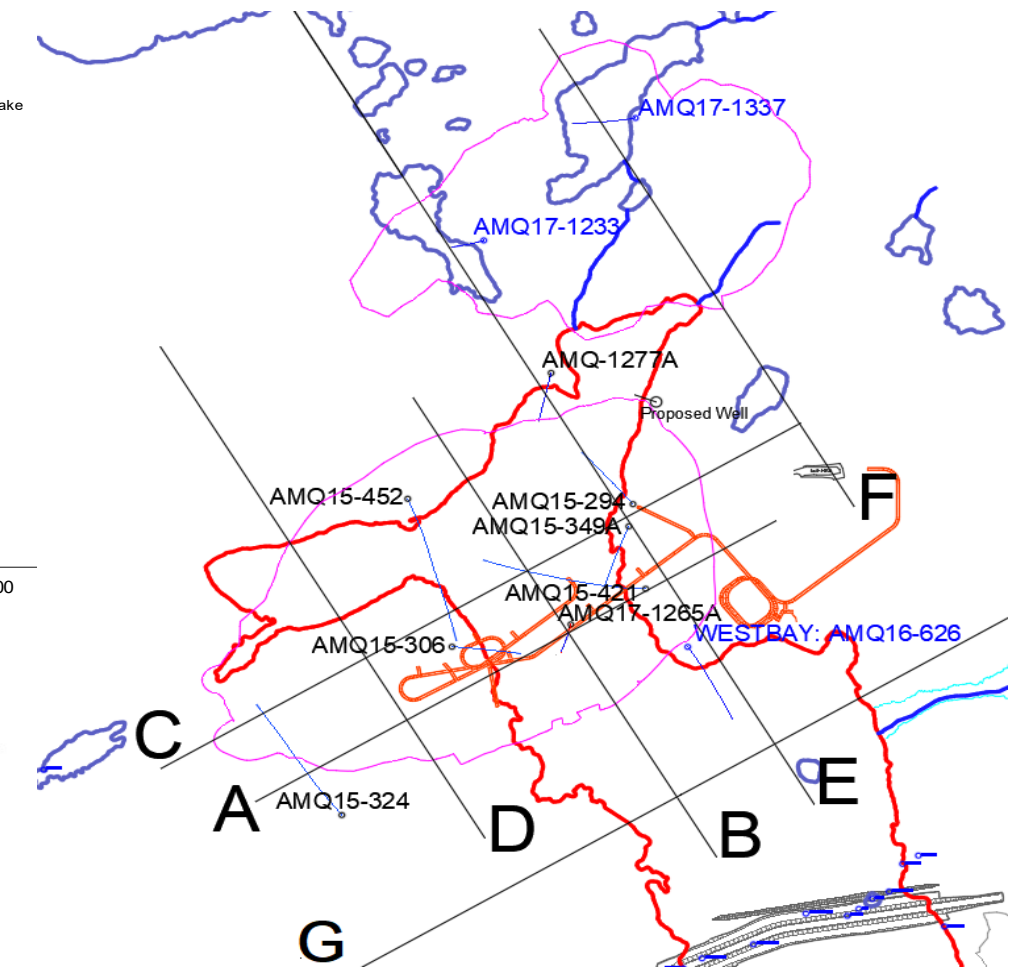
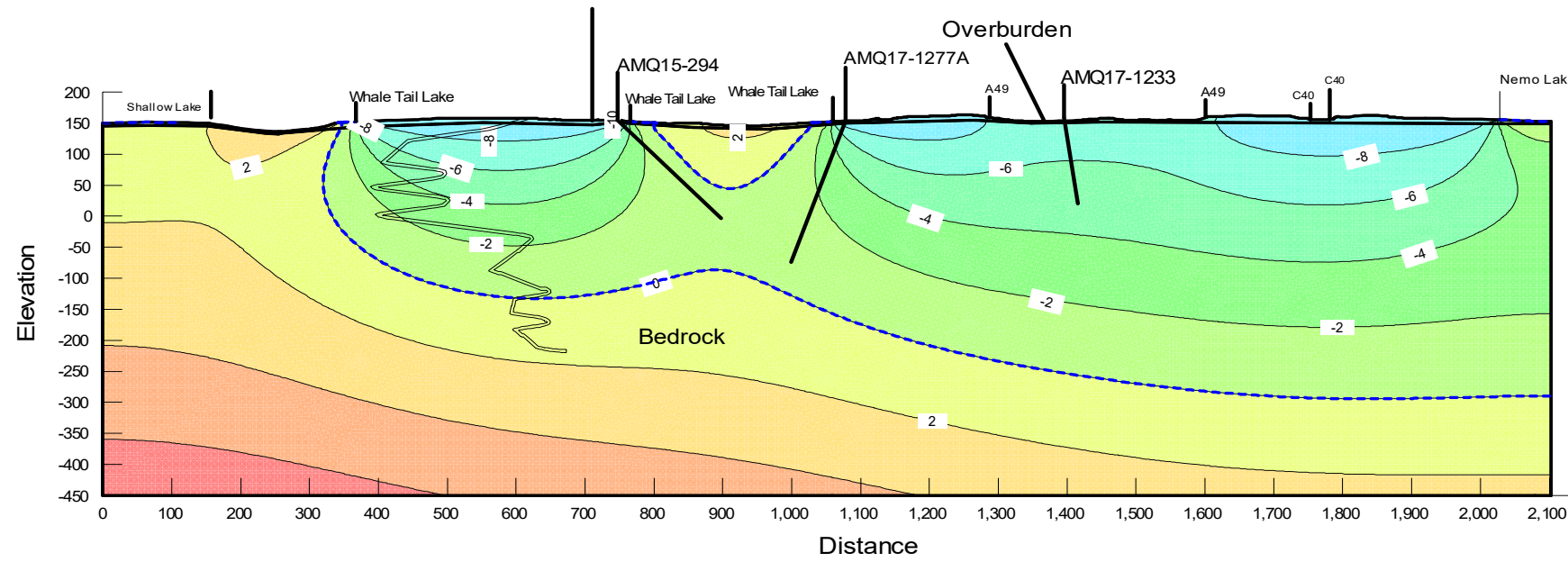
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Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 1 - Section D

Project No.	Phase	Version	Figure No.:
18108905			A3





Section	E-E
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	0 to 3
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	-7
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Client:  
Agnico Eagle Mines Ltd.

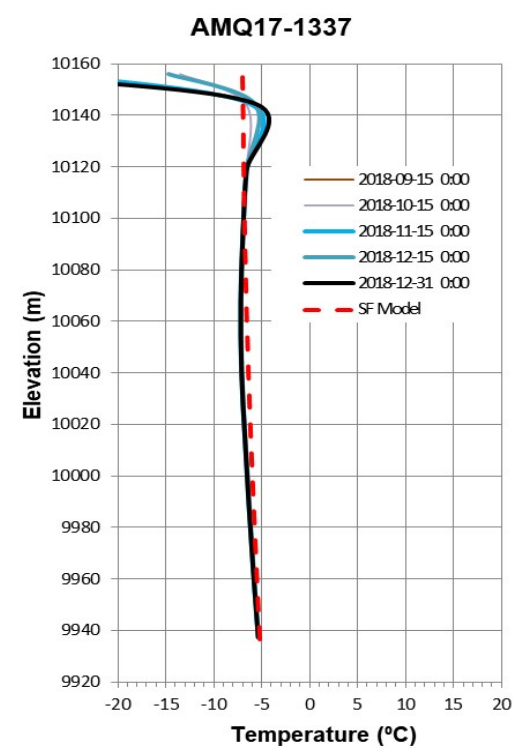
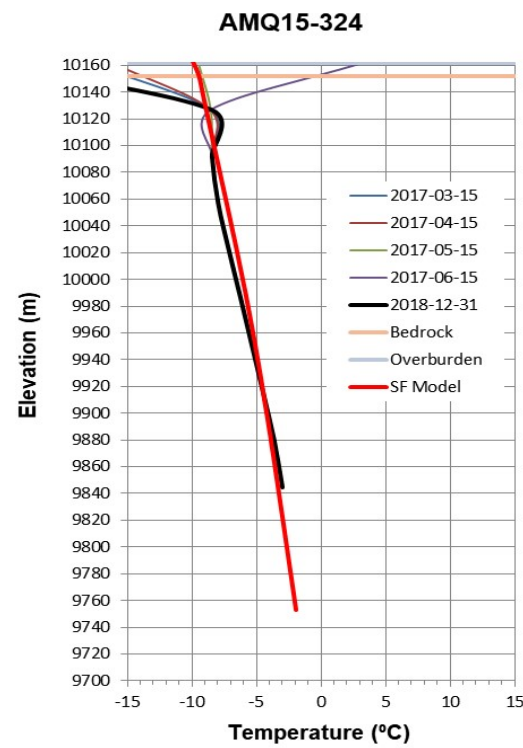
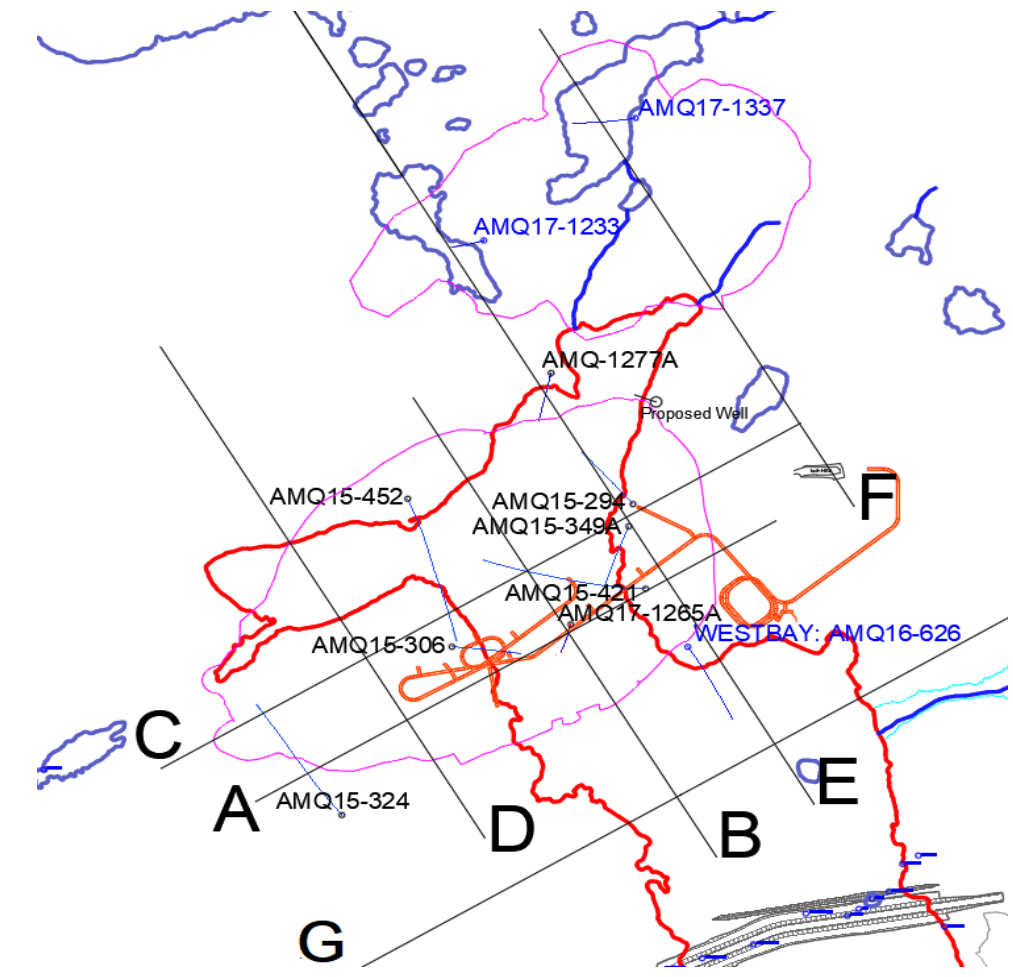
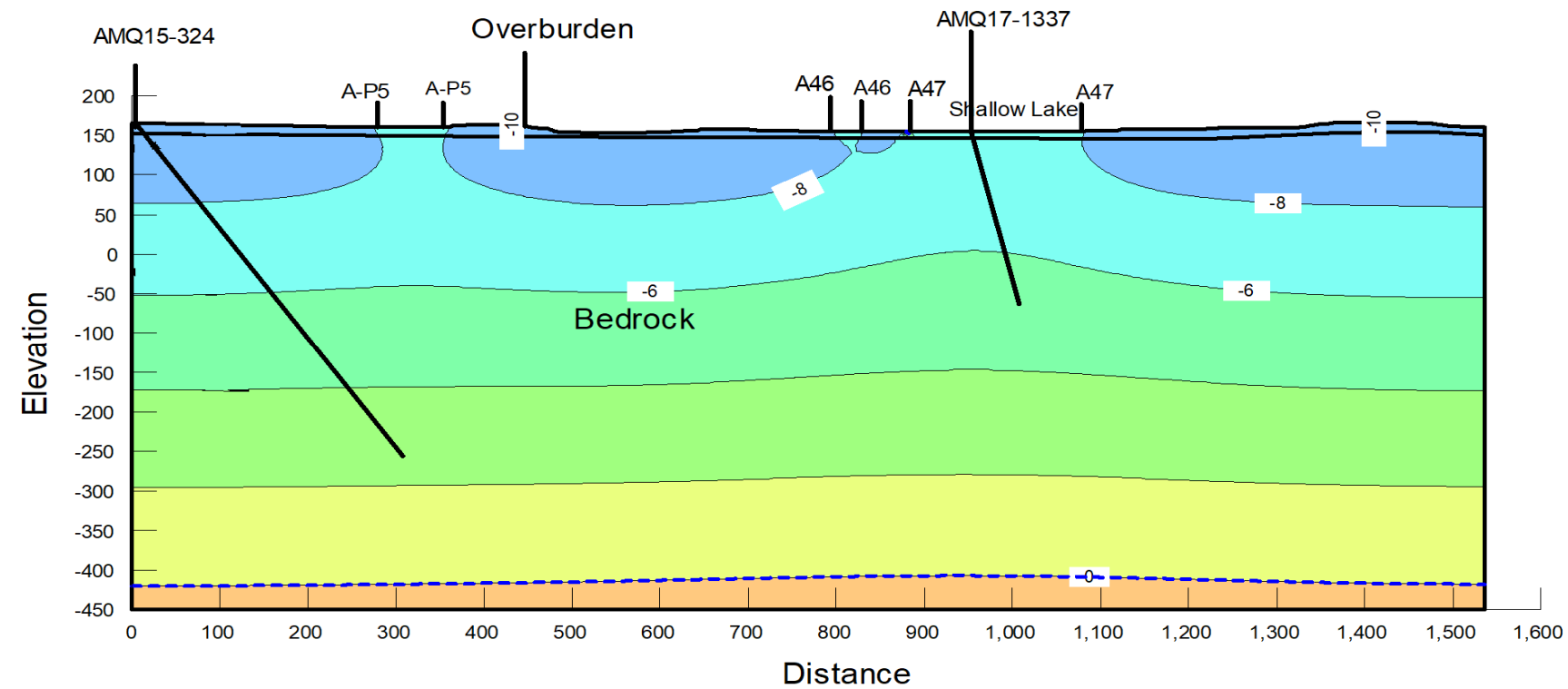


Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 1 - Section E

Project No.	Phase	Version	Figure No.:
18108905			A4



Section	F-F
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	n/a
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	-7
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Client:  
Agnico Eagle Mines Ltd.

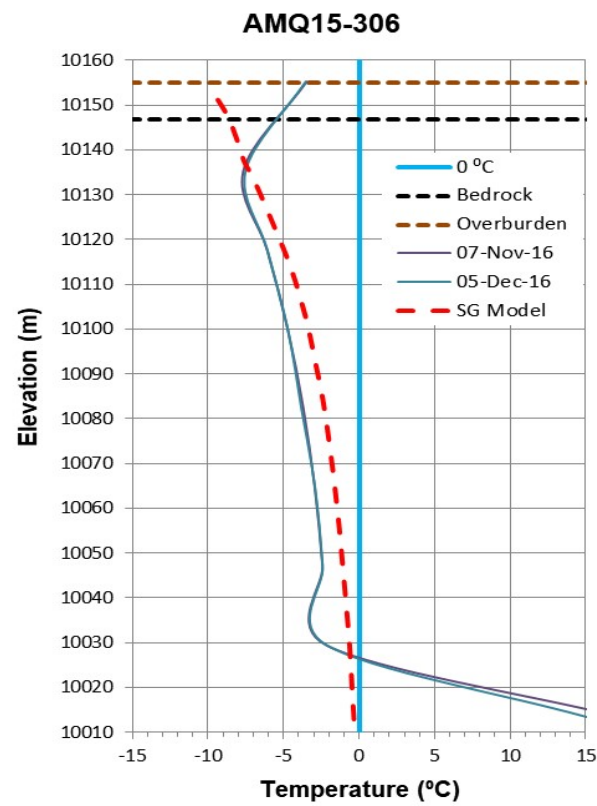
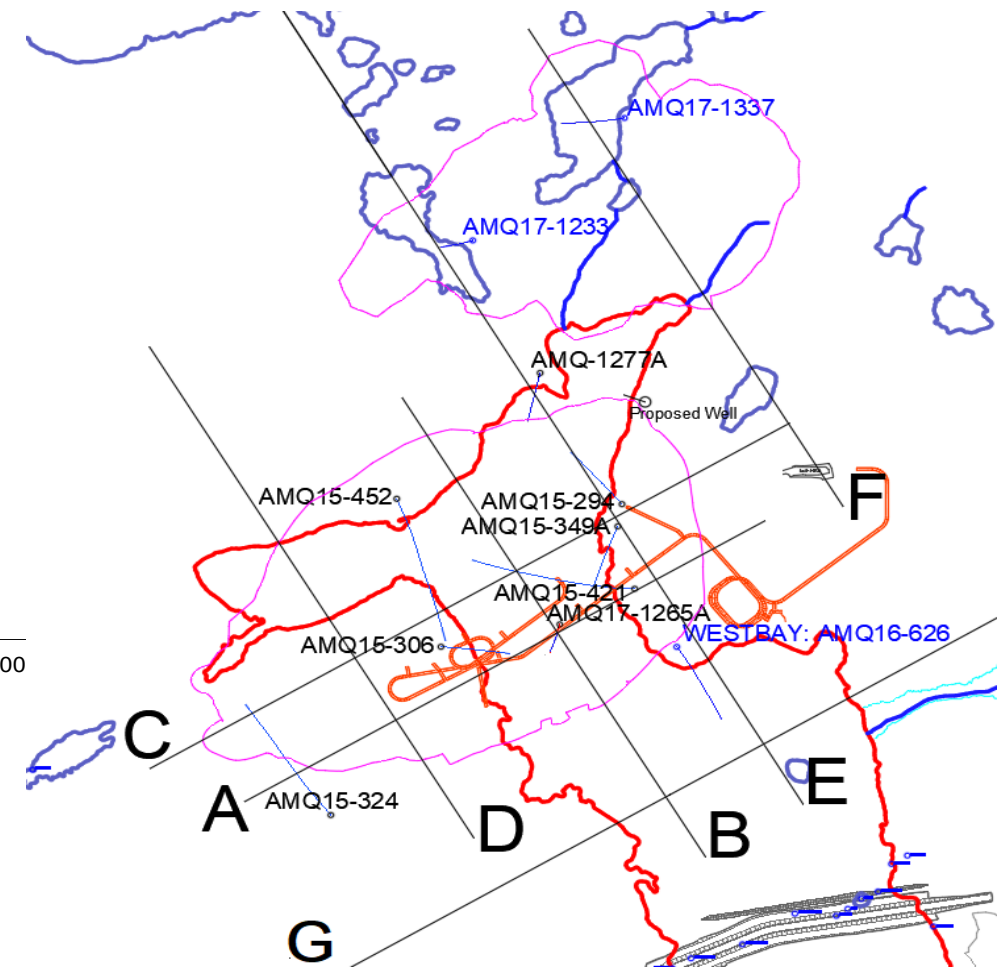
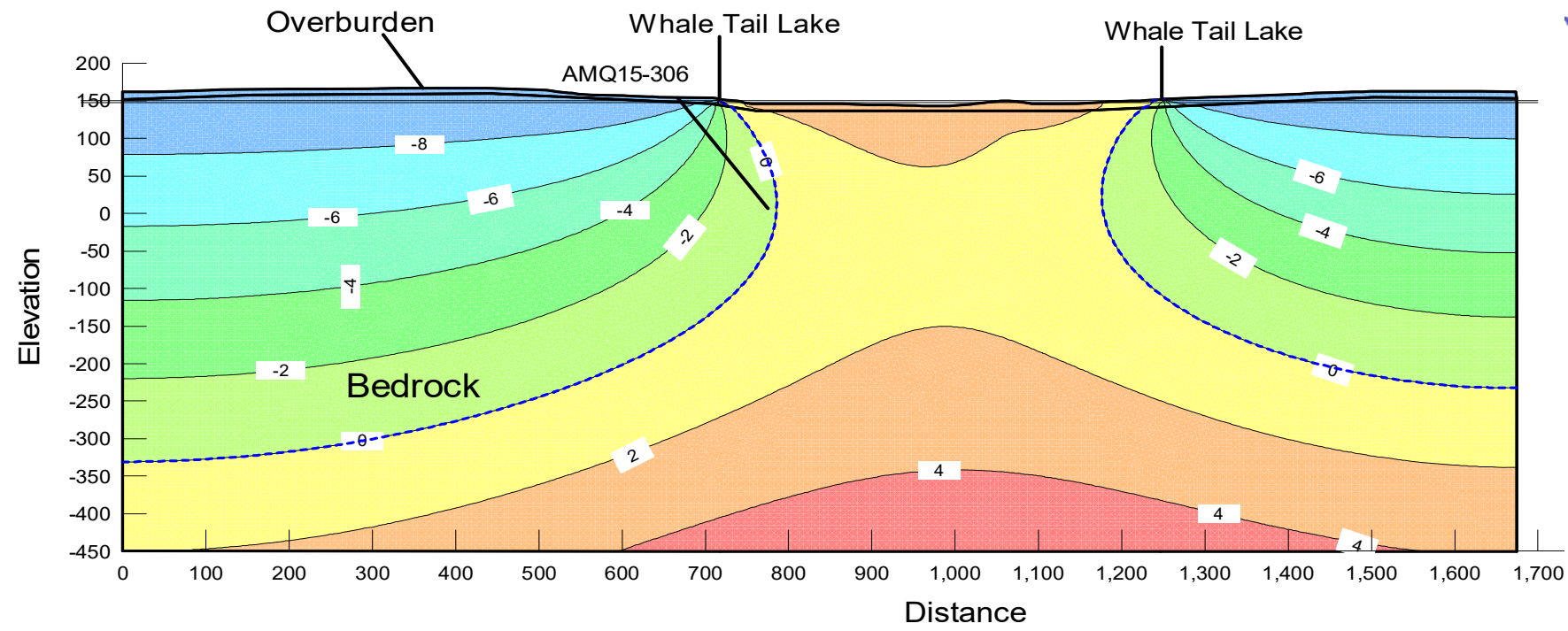


Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 1 - Section F

Project No.	Phase	Version	Figure No.:
18108905			A5



Section	G-G
Ground Temperature (oC)	-10
Whale Tail Lake Temperature (oC)	0 to 3
Shallow Lakes Temperature – other than Whale Tail Lake (oC)	n/a
Heat Flux (J/s)	0.048
Thermal Gradient (oC/m)	0.016

Client:  
Agnico Eagle Mines Ltd.



Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

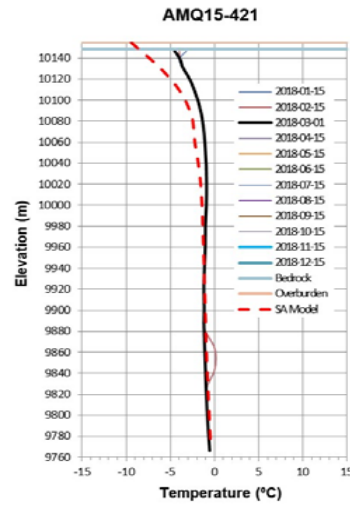
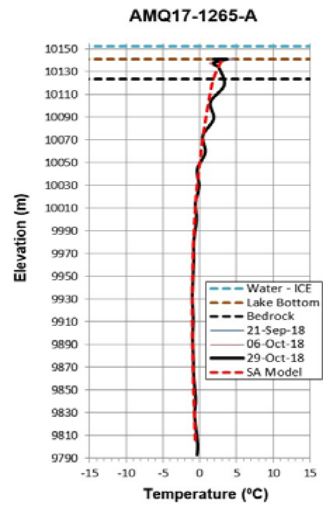
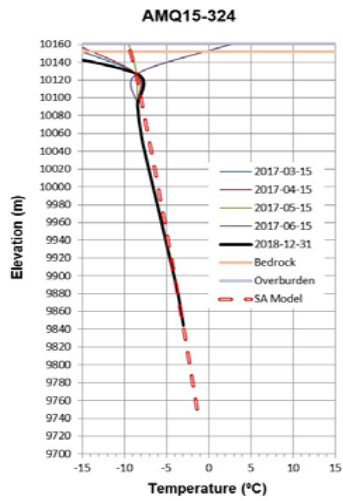
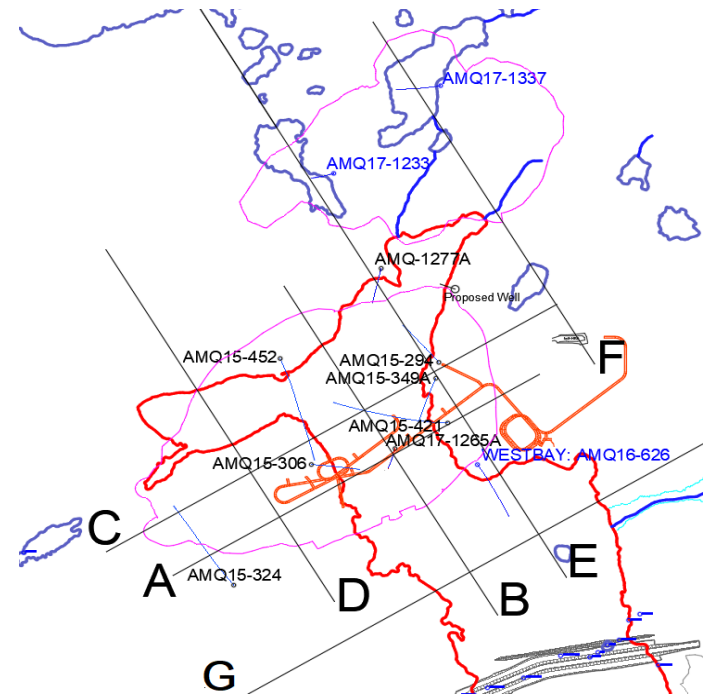
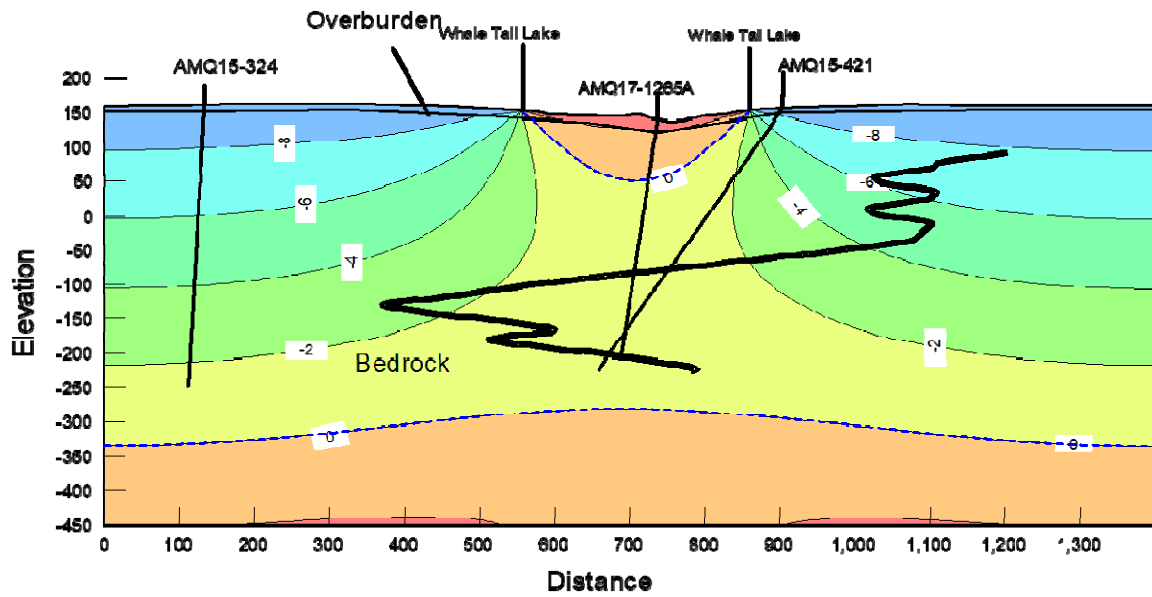
Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 1 - Section G

Project No.	Phase	Version	Figure No.:
18108905			A6

**APPENDIX B**

**Thermal Model Calibration -  
Scenario 2**



Section	A-A
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	3
Other shallow lake Temperature (oC)	n/a
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	0.018
Thermal Gradient (oC/m)	0.006

Client:  
Agnico Eagle Mines Ltd.

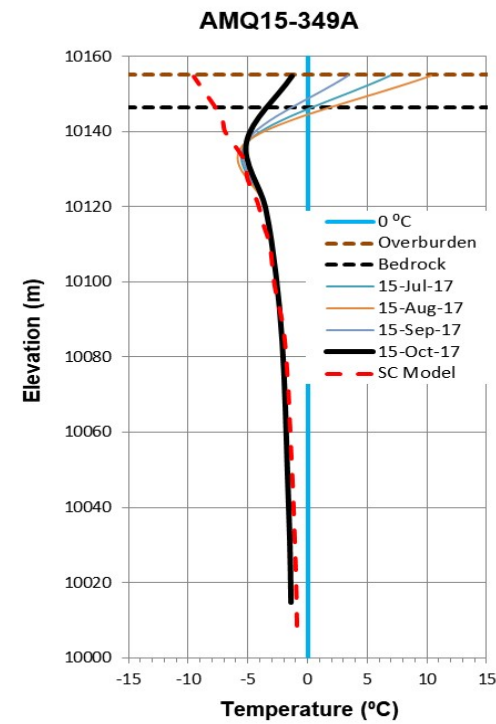
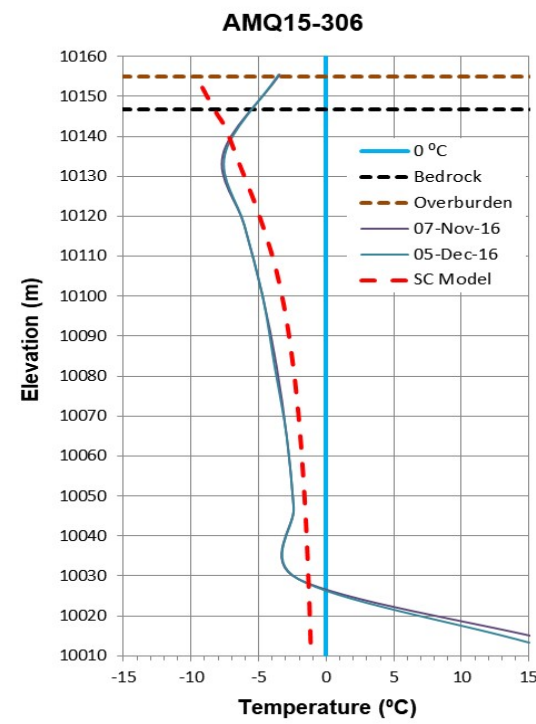
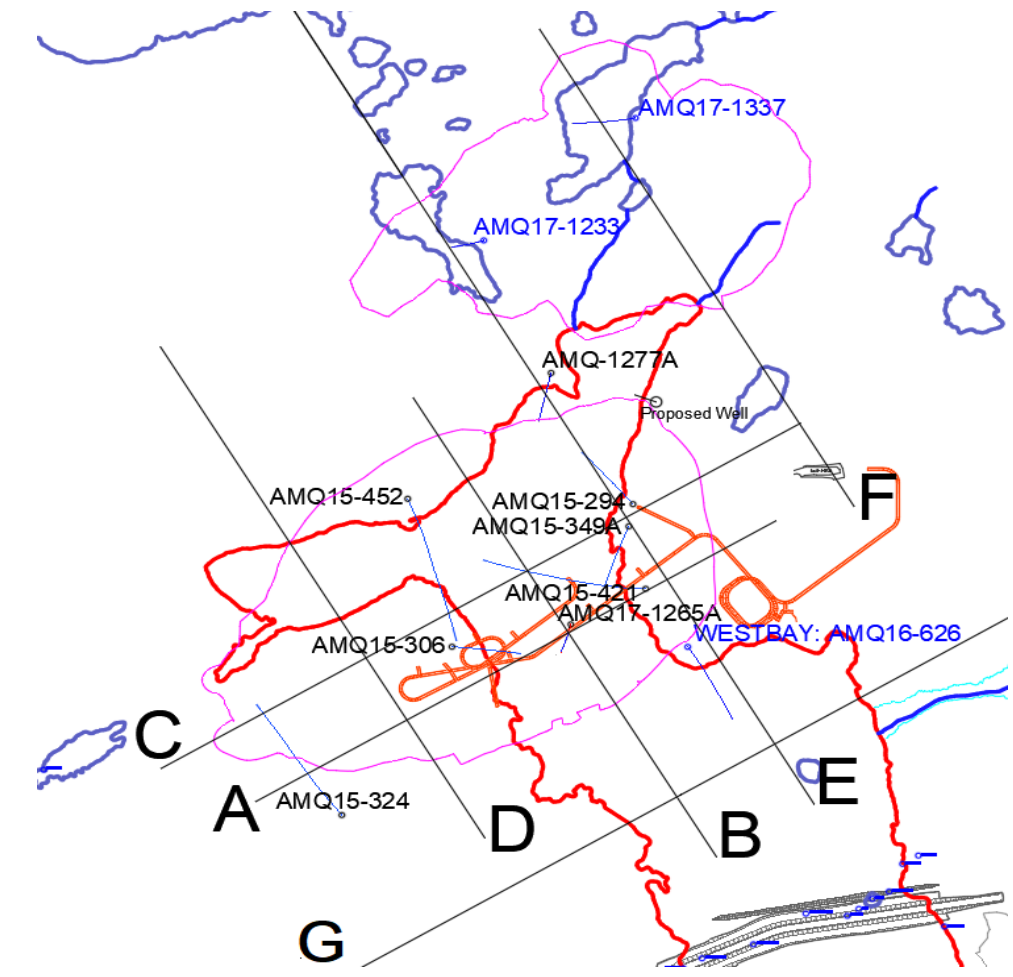
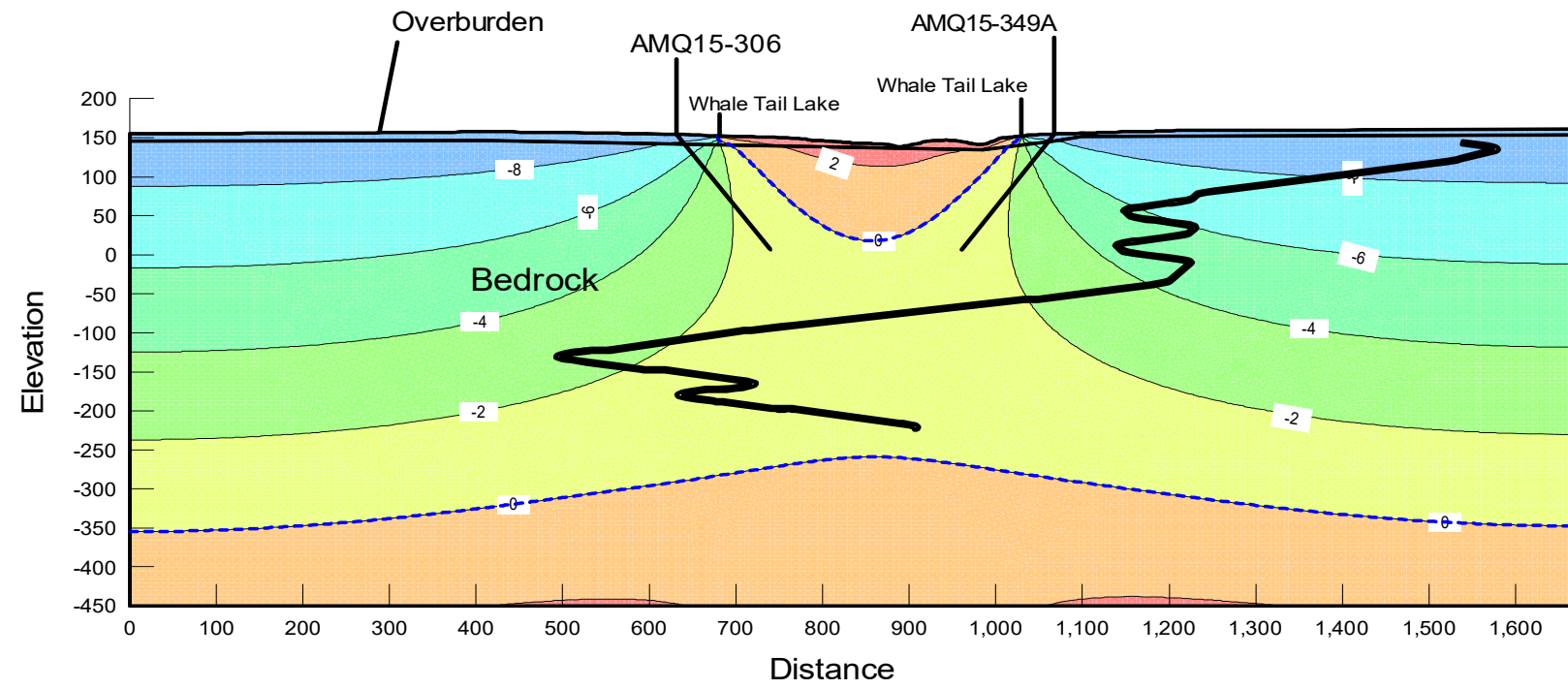


Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 2 - Section A

Project No.	Phase	Version	Figure No.:
18108905			B1



Section	C-C
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	3
Other shallow lake Temperature (oC)	n/a
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	0.018
Thermal Gradient (oC/m)	0.006

Client:  
Agnico Eagle Mines Ltd.

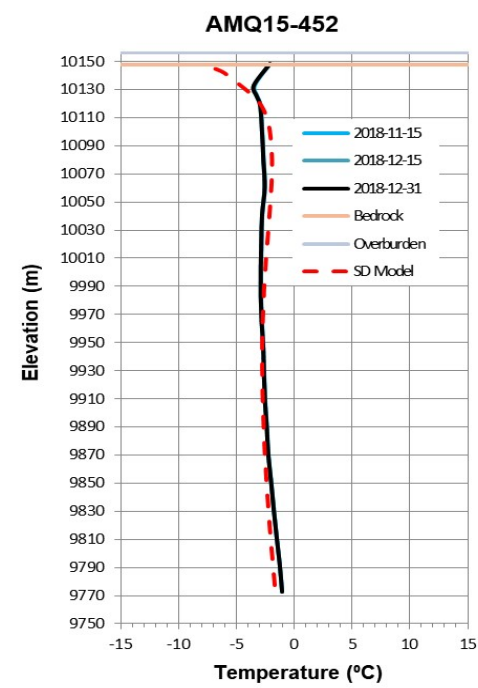
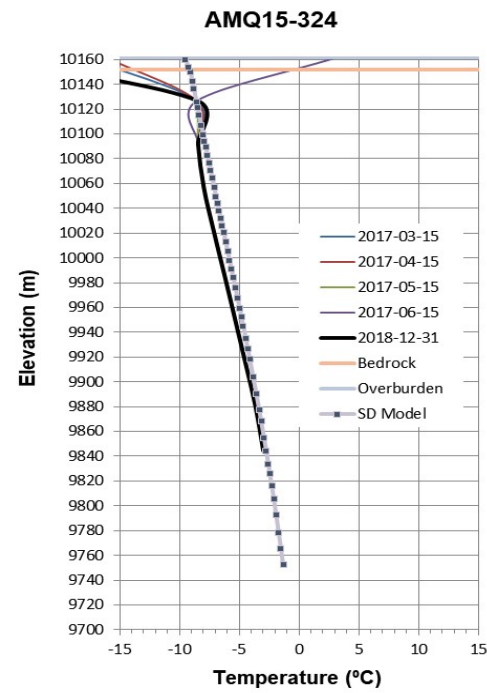
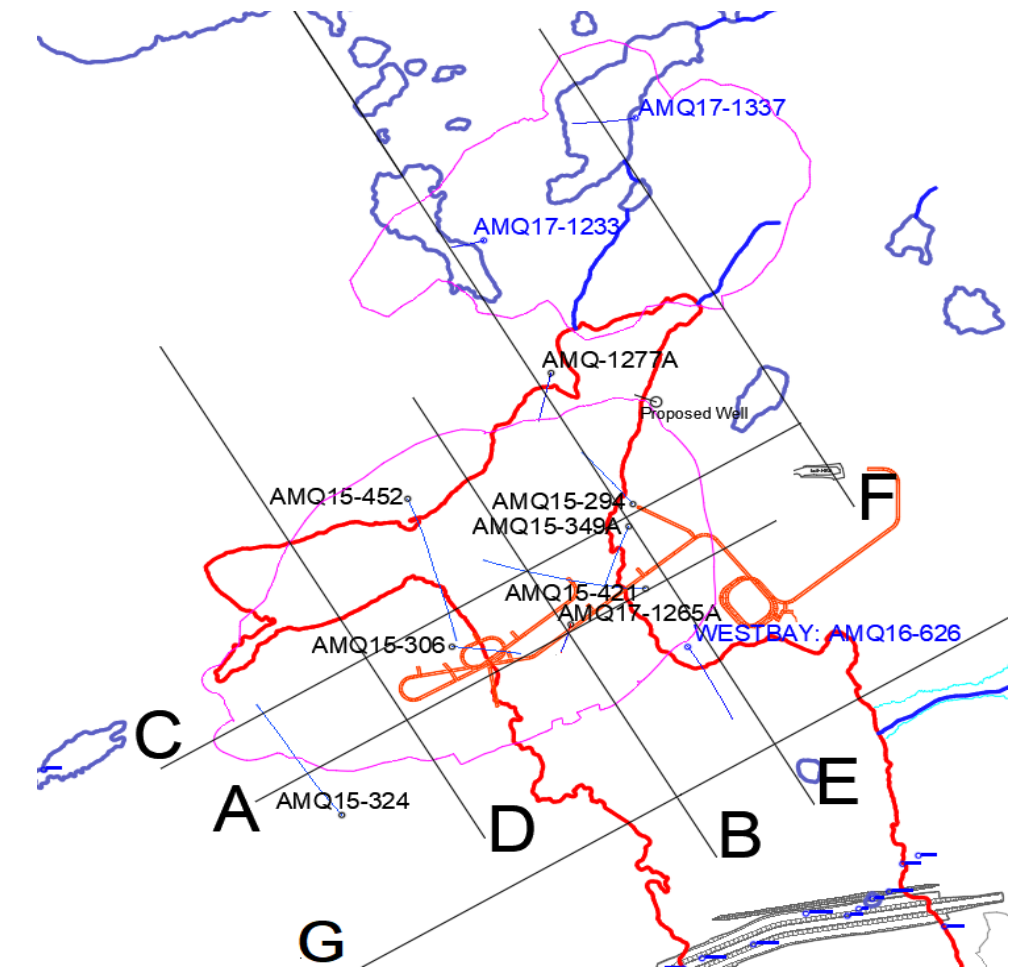
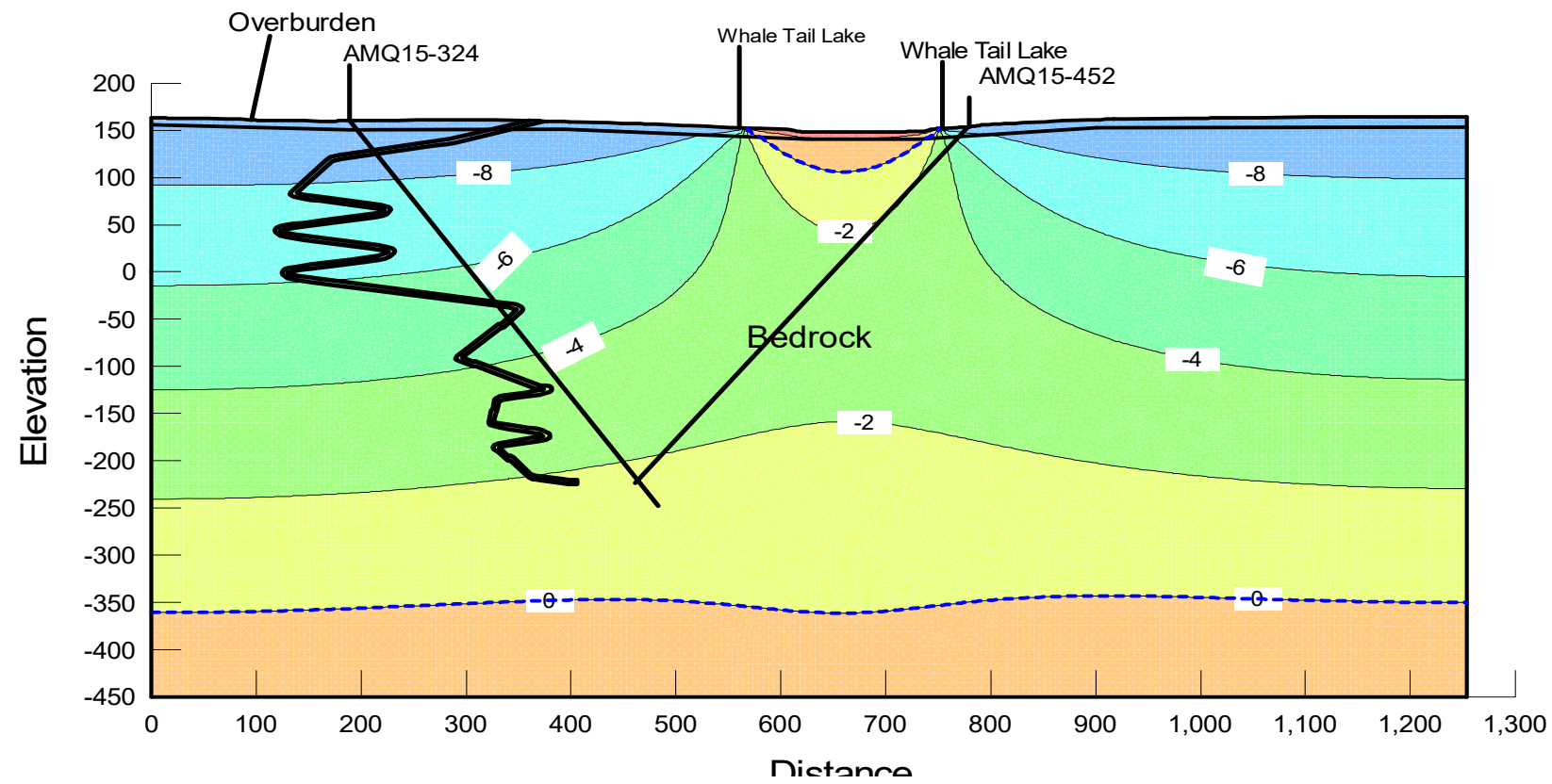


Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 2- Section C

Project No.	Phase	Version	Figure No.:
18108905			B2



Section	D-D
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	3
Other shallow lake Temperature (oC)	n/a
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	0.018
Thermal Gradient (oC/m)	0.006

Client:  
Agnico Eagle Mines Ltd.

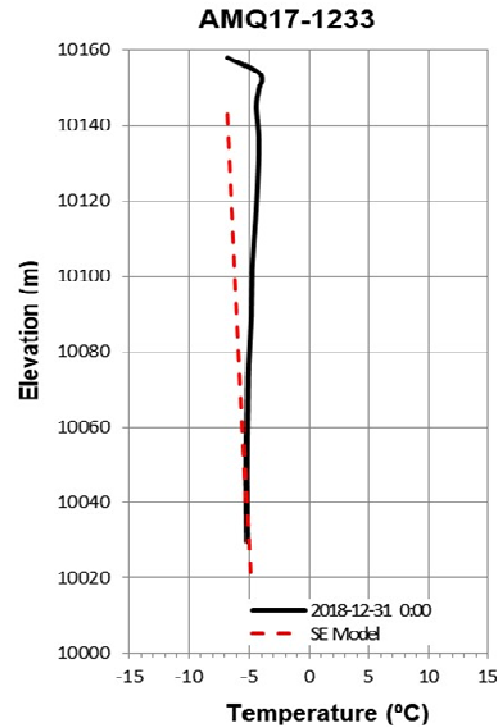
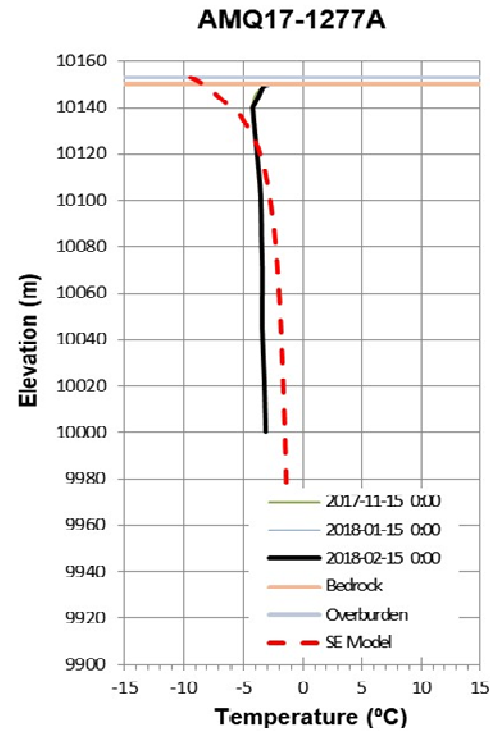
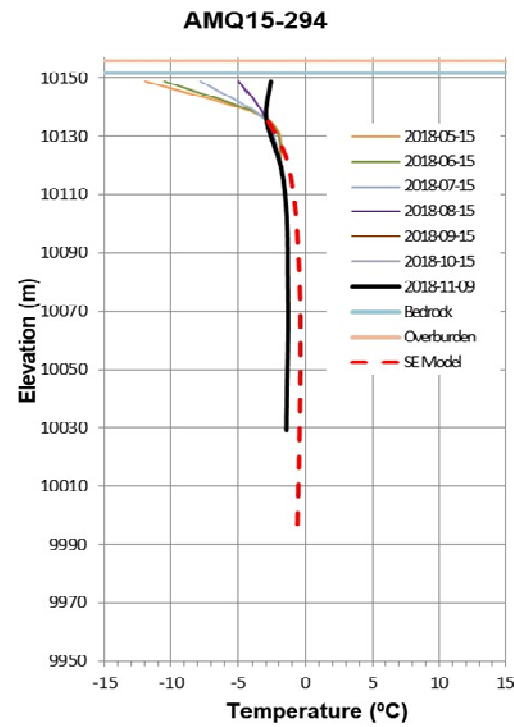
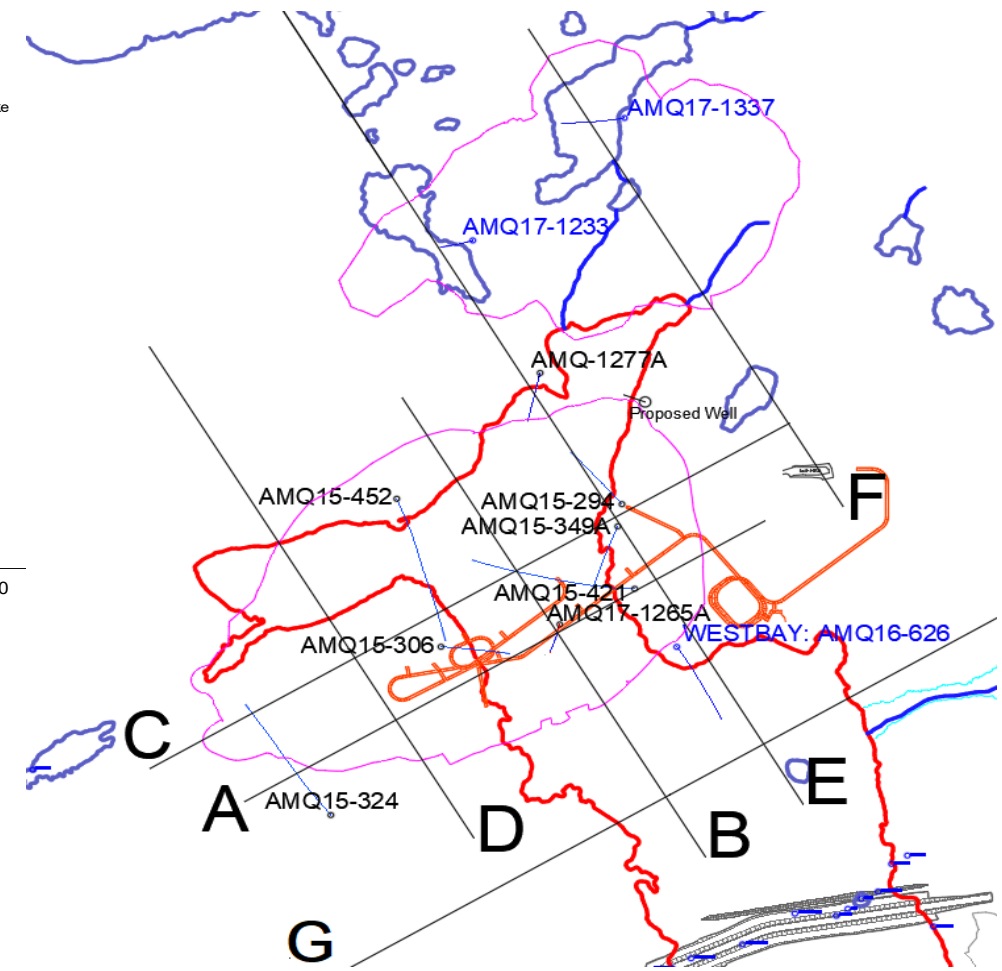
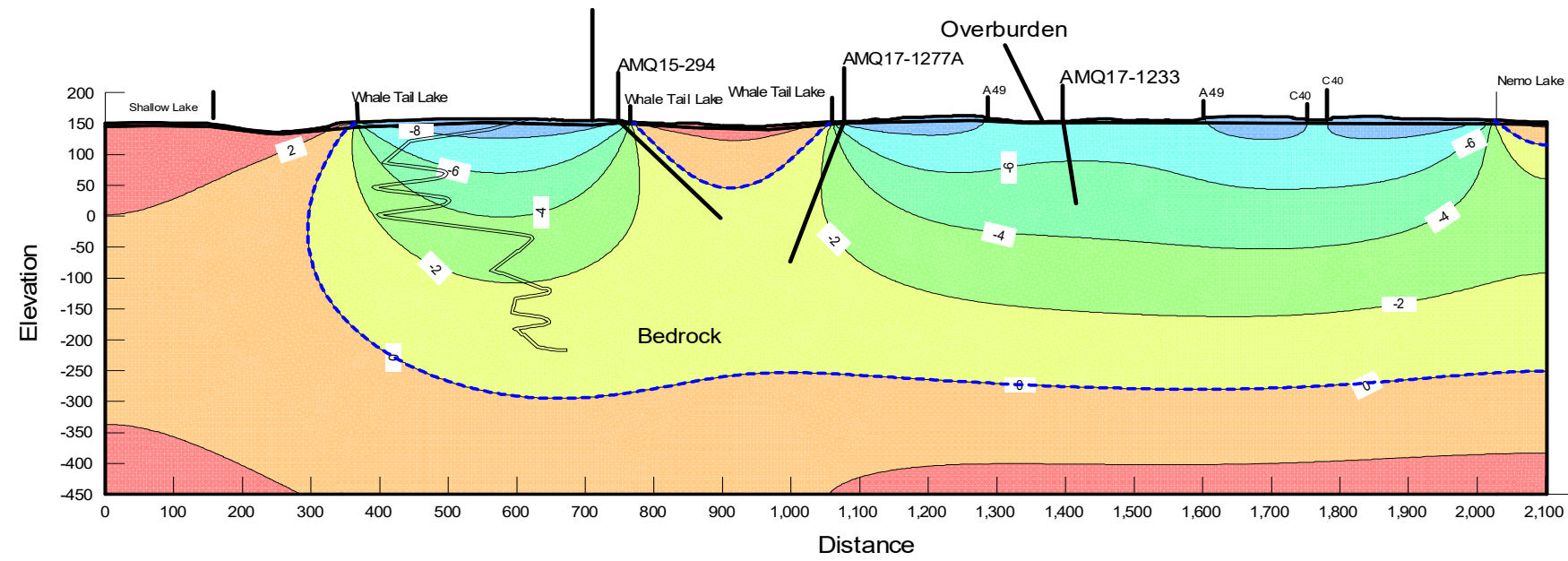


Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 2 - Section D

Project No.	Phase	Version	Figure No.:
18108905			B3



Section	E-E
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	3
Other shallow lake Temperature (oC)	-7
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	0.018
Thermal Gradient (oC/m)	0.006

Client:  
Agnico Eagle Mines Ltd.



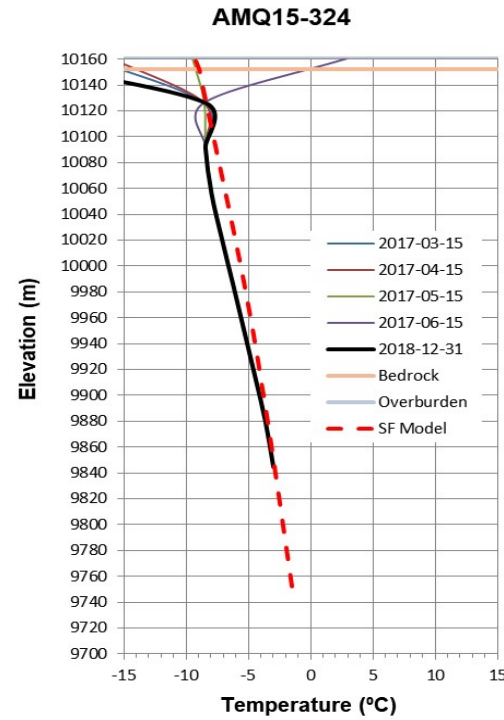
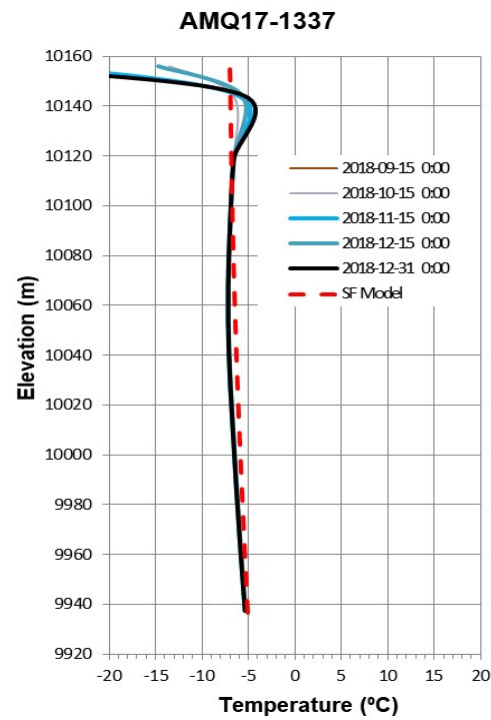
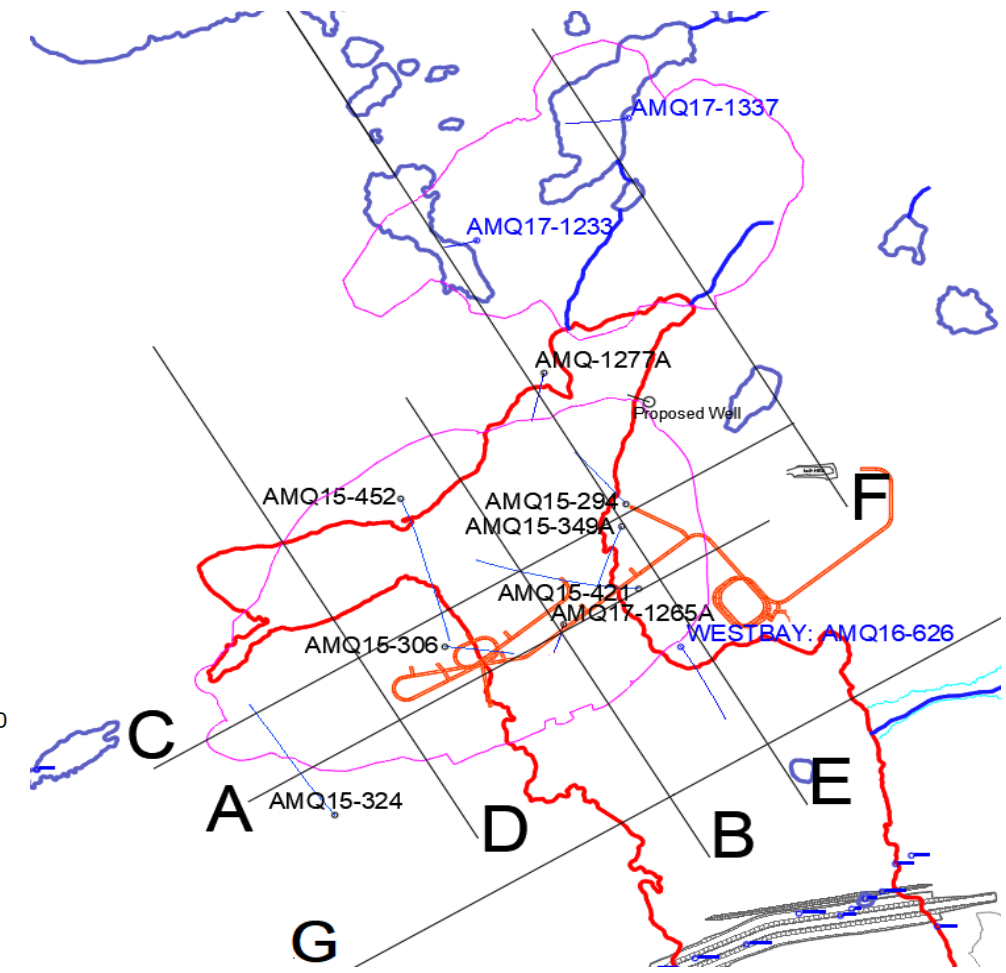
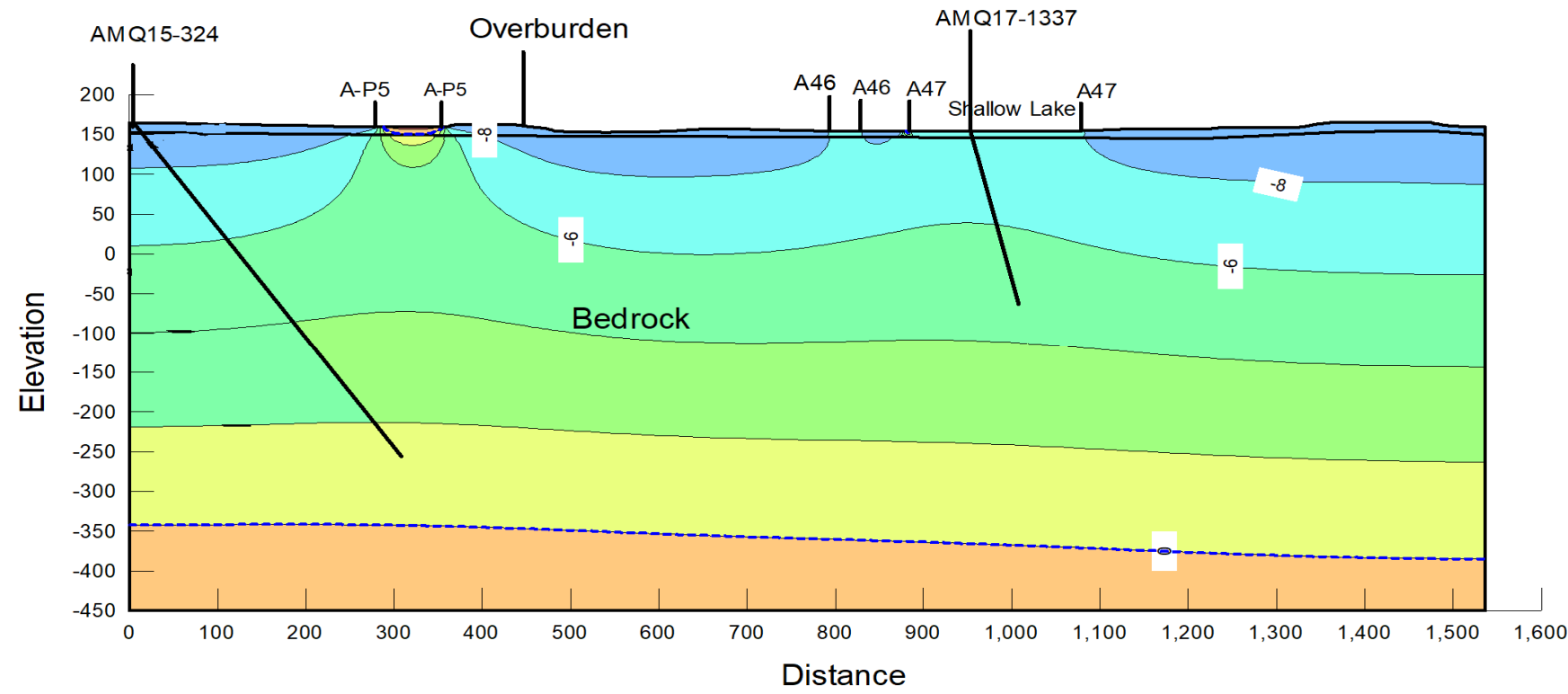
Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 2 - Section E

Project No.	Phase	Version	Figure No.:
18108905			B4





Section	F-F
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	n/a
Other shallow lake Temperature (oC)	-7
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	n/a
Thermal Gradient (oC/m)	n/a

Client:  
Agnico Eagle Mines Ltd.

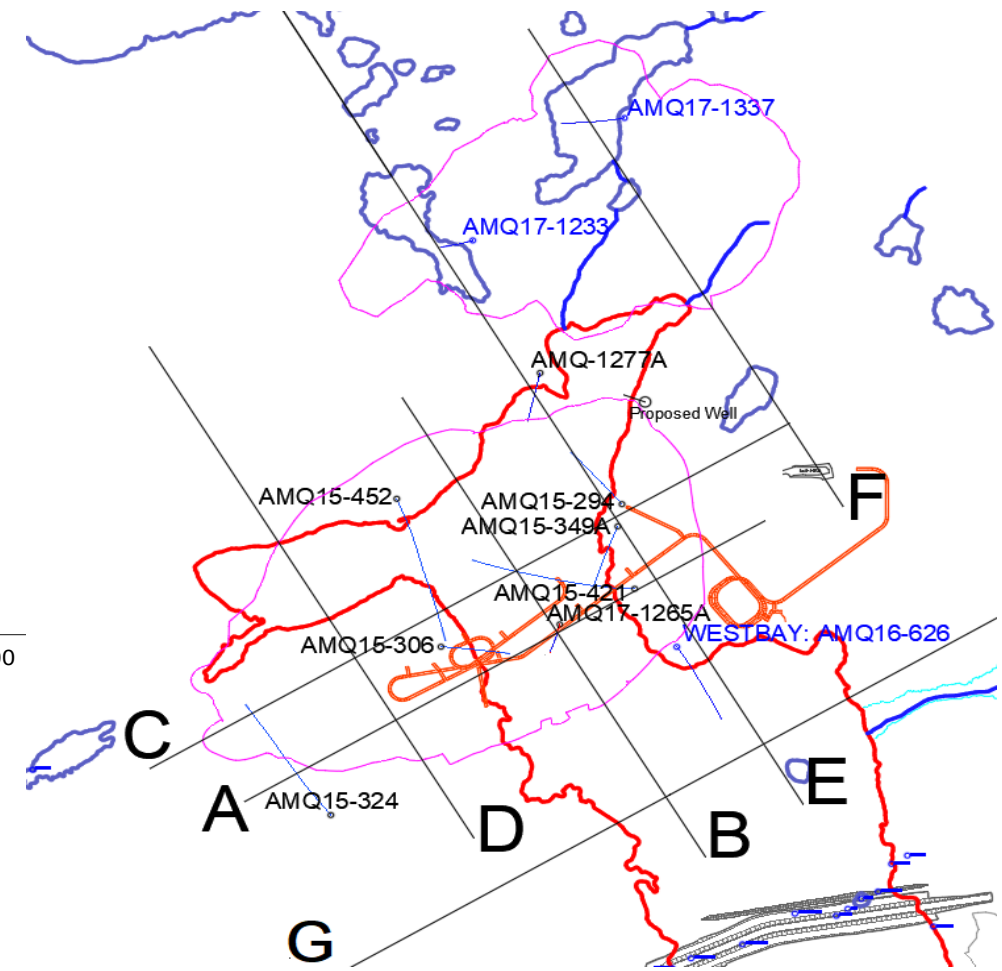
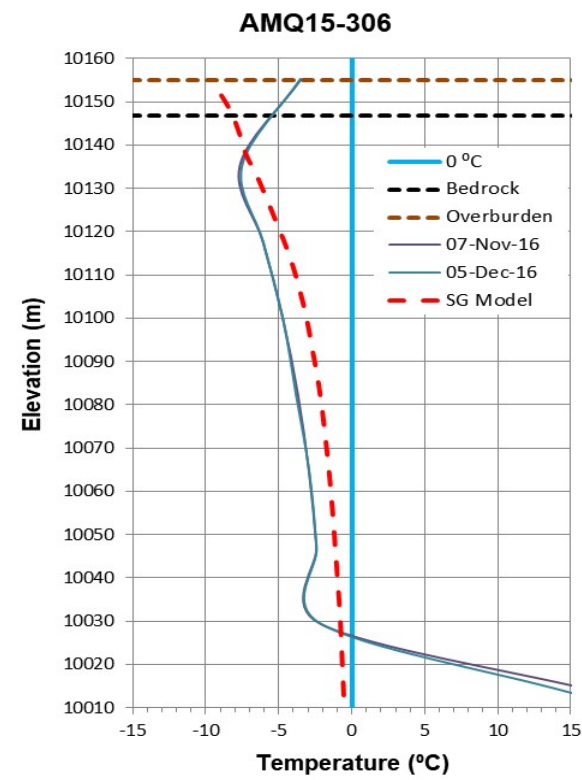
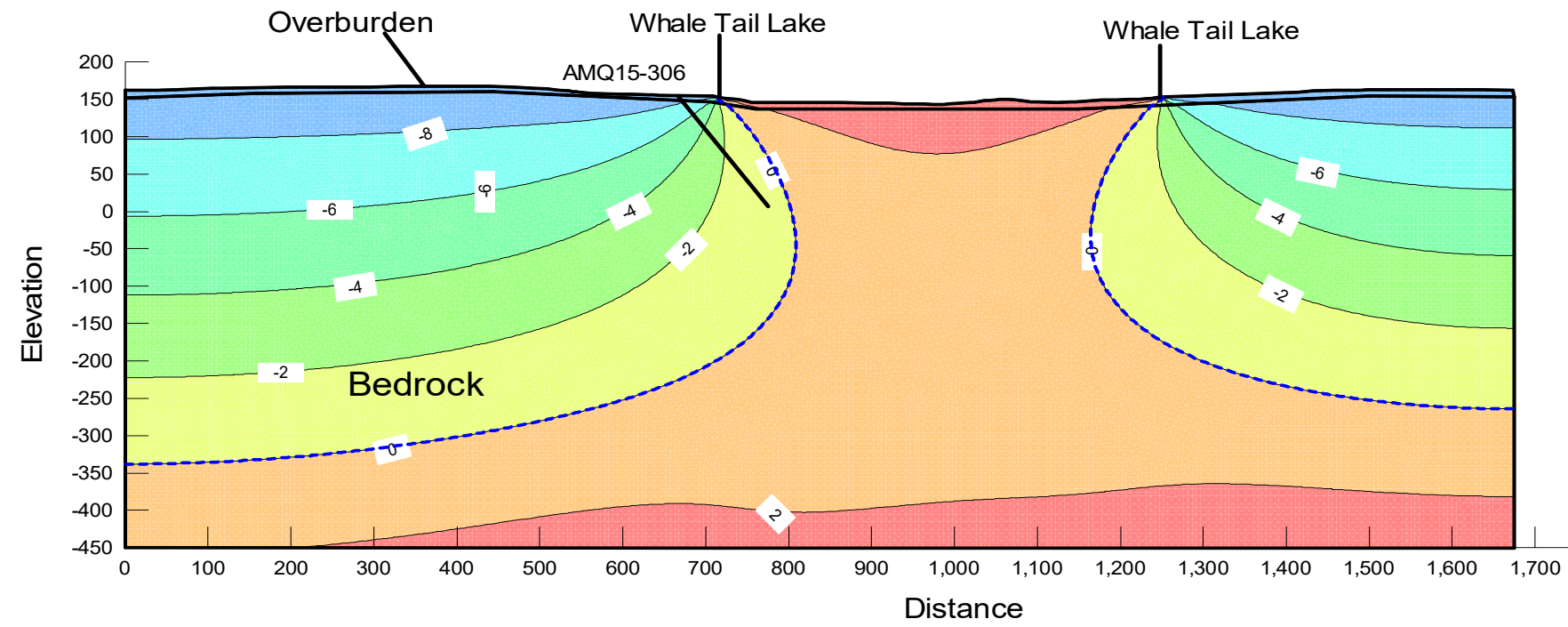


Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 2 - Section F

Project No.	Phase	Version	Figure No.:
18108905			B5



Section	G-G
Ground Temperature (oC)	-9.5
Whale Tail Lake Temperature (oC)	3
Other shallow lake Temperature (oC)	n/a
Heat Flux (beneath ground) J/s	0.048
Thermal Gradient (oC/m)	0.016
Heat Flux (beneath WT Lake) J/s	0.018
Thermal Gradient (oC/m)	0.006

Client:  
Agnico Eagle Mines Ltd.



Date: Mar-19  
Design: RM  
Check: FJ  
Review: JL

Project: Whale Tail Pit Project

Title: Thermal Model Calibration - Scenario 2 - Section G

Project No.	Phase	Version	Figure No.:
18108905			B6



**[golder.com](http://golder.com)**

**ATTACHMENT C**

# Thermal Monitoring Report



WHALE TAIL PIT PROJECT

## **Thermal Monitoring Report 2020**

In Accordance with  
Project Certificate No. 008, T&C 14

Prepared by:  
Agnico Eagle Mines Limited – Meadowbank Division

March 2020

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**Appendix A: Whale Tail Thermal Data**

## **1 INTRODUCTION**

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Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) is developing the Whale Tail Pit Project (Project), a satellite deposit located on the Amaruq property, to continue mine operations and milling at Meadowbank Mine.

This document presents the Thermal Monitoring Report include the following mine facilities and natural locations as described in the Thermal Monitoring Plan:

- Waste rock storage facility (WRSF)
- Water management facilities including Whale Tail Dike, Mammoth Dike, North-East Dike, WRSF Dike, and the Whale Tail Attenuation Pond
- Whale Tail Pit
- Whale Tail Lake shore

The Thermal Monitoring Report provides the instrumentation data and their interpretation. Refer to the Thermal Monitoring Plan for a general descriptions of the different facilities, the anticipated impact of operation of the facilities on the permafrost and the general guidelines that are used to define instrumentation needs for each facility.

## **2 AVAILABLE DATA**

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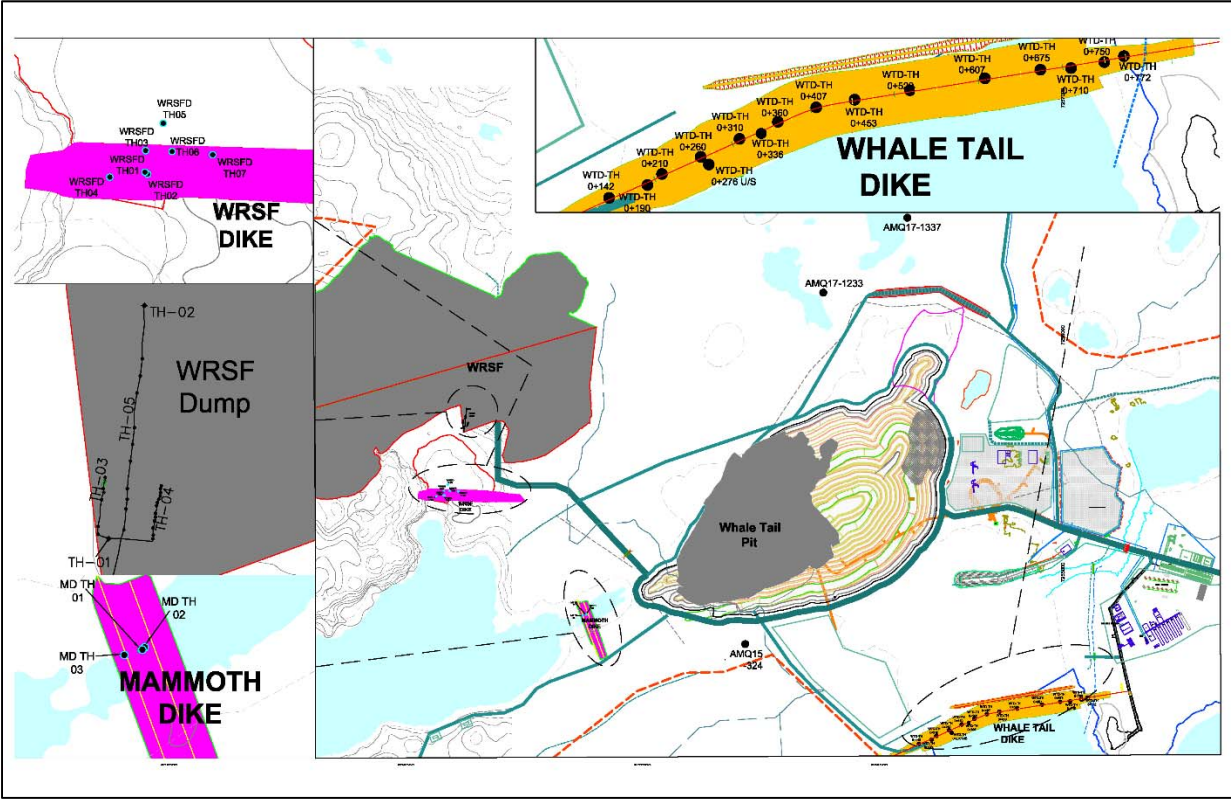
There are currently 33 active thermistors at the Whale Tail Site project area. Data from these thermistors have been used to estimate the site permafrost and talik conditions (Golder 2017a, 2018a).

The location and installation summary of the 33 active thermistors within the Project site are presented in Table 1. Figure 1 shows locations of active and inactive thermistors. Data are collected from the thermistors by data loggers or using manual readout units.

Results of active thermistors are presented in Appendix A.



Figure 1. Location of Thermistors



**Table 1: Summary of Active Thermistors within the Project Site**

<b>Name</b>	<b>Area</b>	<b>Easting (X)</b>	<b>Northing (Y)</b>	<b>Elevation (Z)</b>	<b>Azimuth</b>	<b>Dip</b>	<b>Installed</b>	<b>Active (Y) or (N)</b>
AMQ15-324	WTP	606496.80	7254995.20	161.79	323.41	-55.46	2015	Y
AMQ17-1233	IVR	606778.00	7256254.00	162.00	252.71	-59.06	2017	Y
AMQ17-1337	IVR	607078.00	7256522.00	155.00	260.37	-59.62	2017	N
WTD 0+142	WTD	607119.94	7254637.98	156.75		-90	2018	Y
WTD 0+190 U/S	WTD	607165.34	7254653.83	157.42		-90	2018	Y
WTD 0+210	WTD	607182.85	7254666.19	157		-90	2018	Y
WTD 0+260	WTD	607227.51	7254686.28	157		-90	2018	Y
WTD 0+276 U/S	WTD	607237.2	7254677.3	157		-90	2018	Y
WTD 0+310	WTD	607237.98	7254707.09	157		-90	2018	Y
WTD 0+336 U/S	WTD	607298.44	7254713.45	157		-90	2018	Y
WTD 0+360	WTD	607318.81	7254727.15	157		-90	2018	Y
WTD 0+407	WTD	607363.08	7254744.86	157		-90	2018	Y
WTD 0+453	WTD	607408.60	7254753.72	157		-90	2018	Y
WTD 0+520	WTD	607473.78	7254764.22	157		-90	2018	Y
WTD 0+607	WTD	607561.24	7254778.35	157		-90	2018	Y
WTD 0+675	WTD	607262.31	7254788.86	157		-90	2018	Y
WTD 0+710 U/S	WTD	607662.32	7254790.63	157		-90	2018	Y
WTD 0+750	WTD	607701.81	7254797.04	157		-90	2018	Y
WTD 0+772 U/S	WTD	607724.15	7254804.63	157		-90	2018	Y
WRSF TH01	WRSF	615797.25	7238129.77	161.546		-90	2019	Y
WRSF TH02	WRSF	615861.49	7238133.24	162.053		-90	2019	Y
WRSF TH03	WRSF	615814.31 to 615799.6	7238118.6 to 7238117	162.744 to 162.042		0	2019	Y
WRSF TH04	WRSF	615813.38 to 615797.7	7238134.1to 7238132.8	162.138 to 161.619		0	2019	Y
WRSF TH05	WRSF	615860.9 to 615800.3	71238133.3 to 7238126	162.202		0	2019	Y
MD-TH01	MD	Slope	Slope	-		Slope	2019	Y
MD-TH02	MD	605926.19	7255102.52	154.9		-90	2019	Y
MD-TH03	MD	605926.74	7255102.6	154.9		-90	2019	Y
WRSF TH01	WRSF Dike	Slope	Slope	-		Slope	2019	Y
WRSF TH02	WRSF Dike	605416.44	7255526.7	159.07		-90	2019	Y
WRSF TH03	WRSF Dike	605414.98	7255545.01	155.29		-90	2019	Y
WRSF TH04	WRSF Dike	605387.14	7255524.47	158.15		-90	2019	Y

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<i>WRSF TH05</i>	WRSF Dike	<b>605428.59</b>	<b>7255566.21</b>	<b>153.63</b>		-90	2019	Y
<i>WRSF TH06</i>	WRSF Dike	<b>605435.56</b>	<b>7255544.29</b>	<b>155.35</b>		-90	2019	Y
<i>WRSF TH07</i>	WRSF Dike	<b>605466.94</b>	<b>7255541.78</b>	<b>155.13</b>		-90	2019	Y

### **3 THERMAL MONITORING RESULT**

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This section presents a summary expected thermal effect as well as interpretation of the instrumentation data gathered for the reporting period.

#### **3.1 WASTE ROCK STORAGE FACILITY**

##### **3.1.1 Expected Thermal Effects on Permafrost**

Construction of the WRSF on the permafrost is expected to result in aggradation of permafrost into the pile. The permafrost under the pile would remain, but temperatures in the upper permafrost zone are expected to increase gradually until a thermal equilibrium is established with the active zone and zero-amplitude zone moving upward and being located within the waste rock pile. Convective cooling conditions often occur in waste piles and would potentially offset some of the temperature increase in the permafrost.

The waste rock pile itself is expected to freeze back with time and have an active layer formed on the upper portion (Okane 2019b). Climate change in the long-term is expected to extend the depth of the active layer in the pile, but the thick waste rock pile will constitute a protection to the underlying permafrost. If heat generation occurs associated with the oxidation of sulphide-bearing minerals within the pile, the process of freeze-back would be delayed and, depending on the location of the heat generation source, the upper portion of the permafrost foundation could be impacted.

##### **3.1.2 Thermal Monitoring Results**

The instrumentation data are showing thermal behaviour along the expected trend (no permafrost degradation) but there is less than 6 months of data available and the cover has not been installed yet over the instrumented section which is mostly measuring air temperature.

#### **3.2 WATER MANAGEMENT FACILITIES**

##### **3.2.1 Expected Thermal Effects on Permafrost**

The Whale Tail Dike is constructed within the lake where talik is anticipated to exist, therefore there will be no direct negative impact on the permafrost zone underneath the talik. The construction of the Whale Tail Dike is expected to have a cooling effect on the lake ground underneath the dike due to exposure to lower dike temperature than lake water. Minimal effects to the permafrost at the abutment areas are expected.

Following lake dewatering and beginning of operations, areas downstream of the Whale Tail Dike are expected to freeze back progressively, and the upstream area of the dike is expected to remain unfrozen.

After the dike is breached in the final stages of closure, the Whale Tail Lake will be restored, causing frozen zones located downstream of the dike to thaw and progressively restoring the original lake talik.

The other dewatering dike areas are expected to have similar thermal impacts on the permafrost associated with construction, operation and closure of the dikes.

The WRSF Dike will periodically contain a pond formed from water flowing out of the waste rock facility. Depending on pond depth and operational conditions there would be impact with possible thawing of a shallow upper permafrost zone underlying the pond.

The talik zone under the Attenuation Pond would remain, but depth of the talik could be reduced as the Attenuation Pond will likely be shallower than the existing lake at that location. The surrounding areas to the pond would freeze back progressively after dewatering but would restore to talik condition after breaching of the dewatering dikes and flooding of the area.

### **3.2.2 Thermal Monitoring Results**

The instrumentation data are showing thermal behaviour along the expected trend at Mammoth Dike and in the talik area of Whale Tail Dike (no change in existing talik condition).

A degradation of the permafrost at the Eastern abutment of Whale Tail Dike was observed following flooding of the area in the summer of 2019 (0+710 U/S). This was predicted to occur eventually based on the thermal model of the structure but not within such a short timeframe.

A degradation of the thermal condition in the keytrench of WRSF Dike was observed in the summer of 2019 leading to seepage. This fluctuation was due to heat transfer from ponded water and the data are indicating that the area that thawed were freezing back at the end of 2019.

## **3.3 OPEN PIT**

### **3.3.1 Expected Effects on Permafrost**

The pit will be excavated through an upper closed talik zone and underlying permafrost. During operations of the pit the talik zone is expected to freeze back progressively and the lower permafrost zone surrounding the pit walls will, in general, experience reduction in temperature other than at a shallow active zone adjacent to the pit walls subjected to seasonal thawing during summer.

Upon closure and subsequent flooding of the pit, permafrost areas underneath the pit lake are expected to gradually thaw. Thermal assessments have indicated this process would take hundreds of years (Golder 2018a). The pit lake would eventually reduce the permafrost depth in the pit surrounding ground, but this process could take significantly longer time (in the order of 10,000 years) to complete.

### **3.3.2 Thermal Monitoring Results**

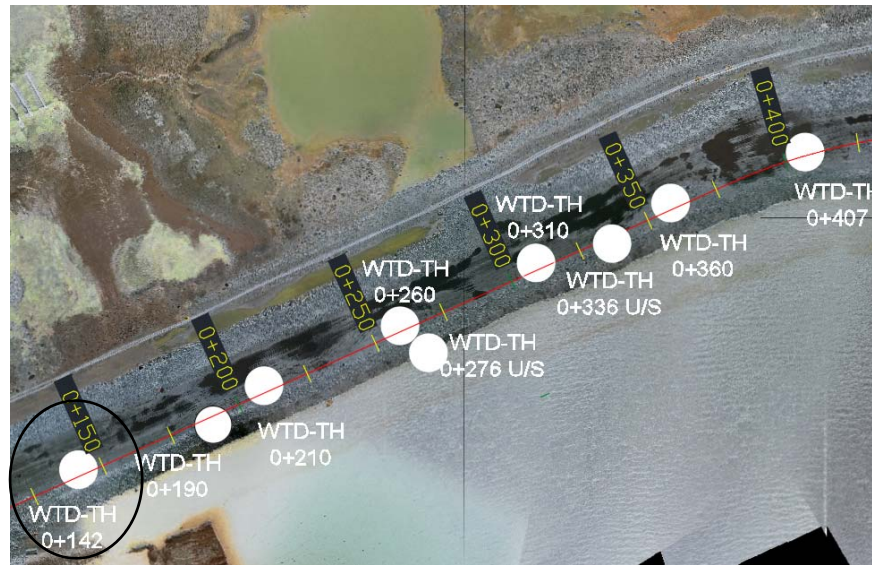
The thermistor currently installed near the pit area are following the expected trend and are not showing any impact on the surrounding permafrost.

## **3.4 WHALE TAIL LAKE SHORE**

There are no functional thermistors on the lake shore of Whale Tail North Basin.

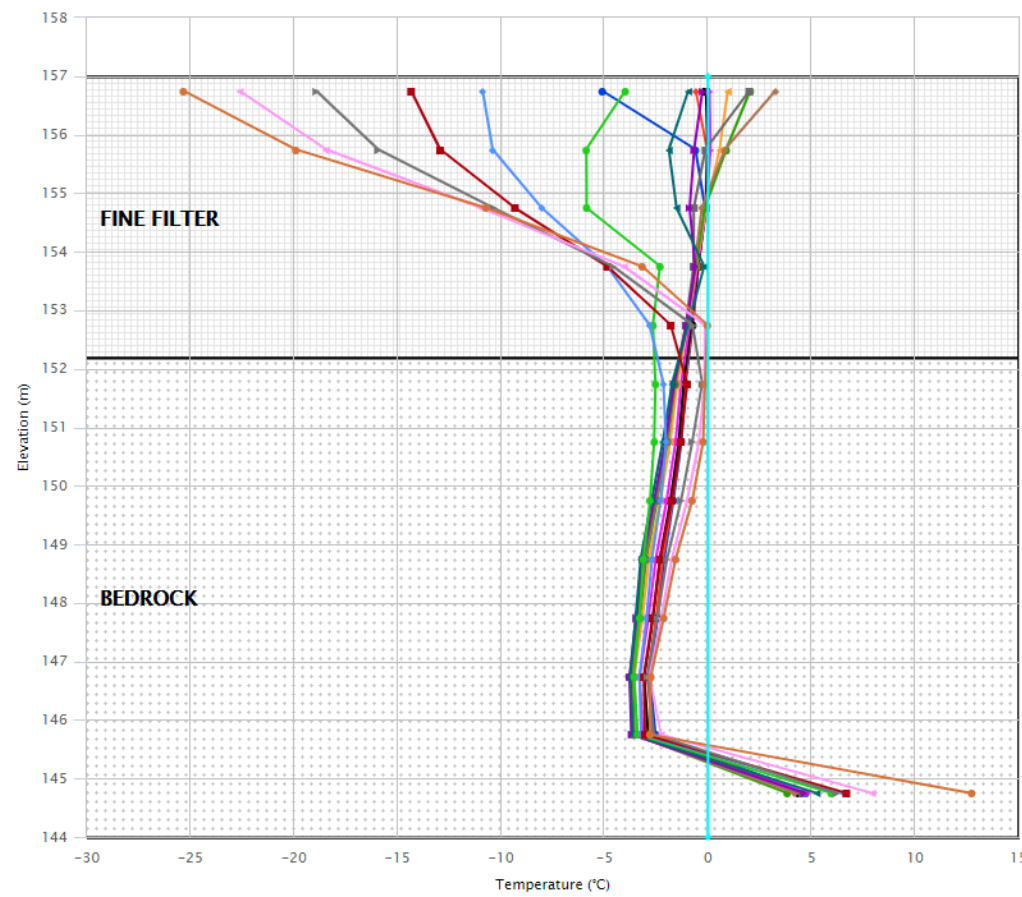
## **APPENDIX A – THERMAL MONITORING DATA**

### WTD-TH 0+142



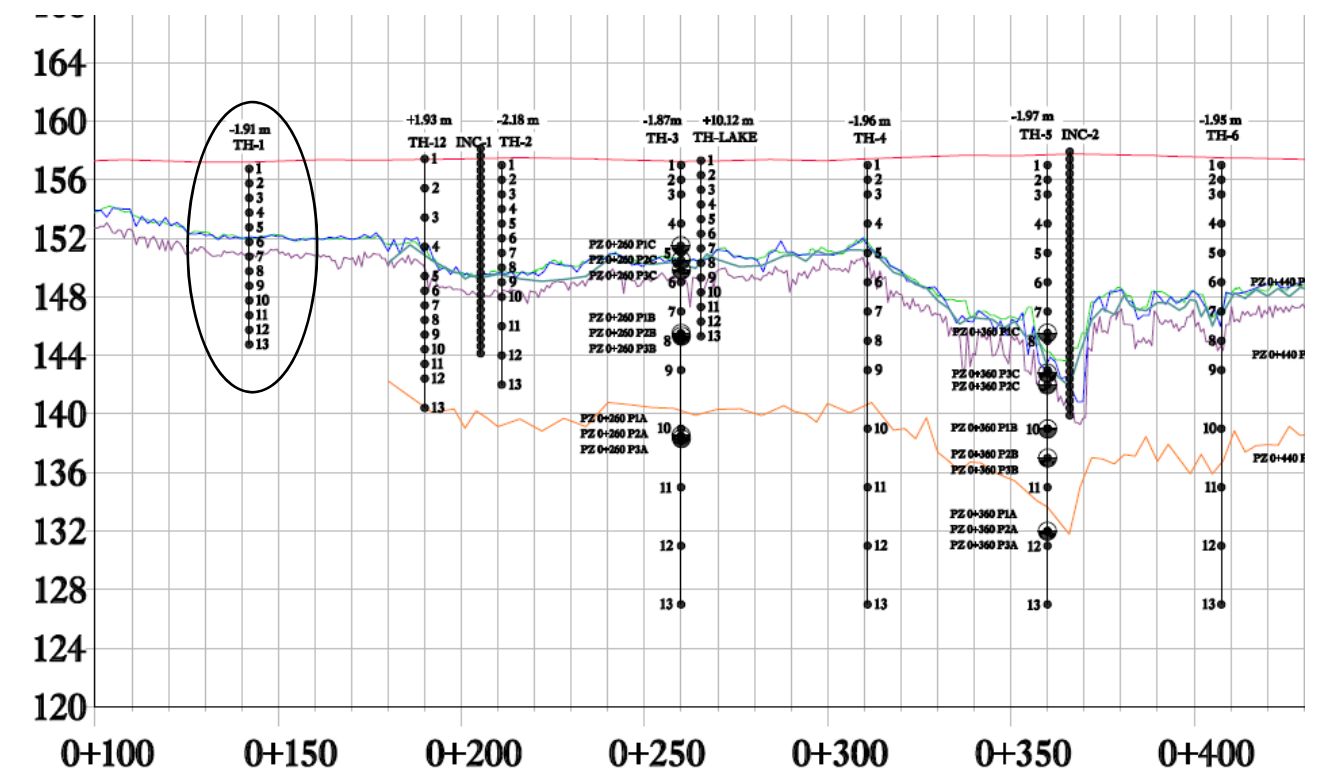
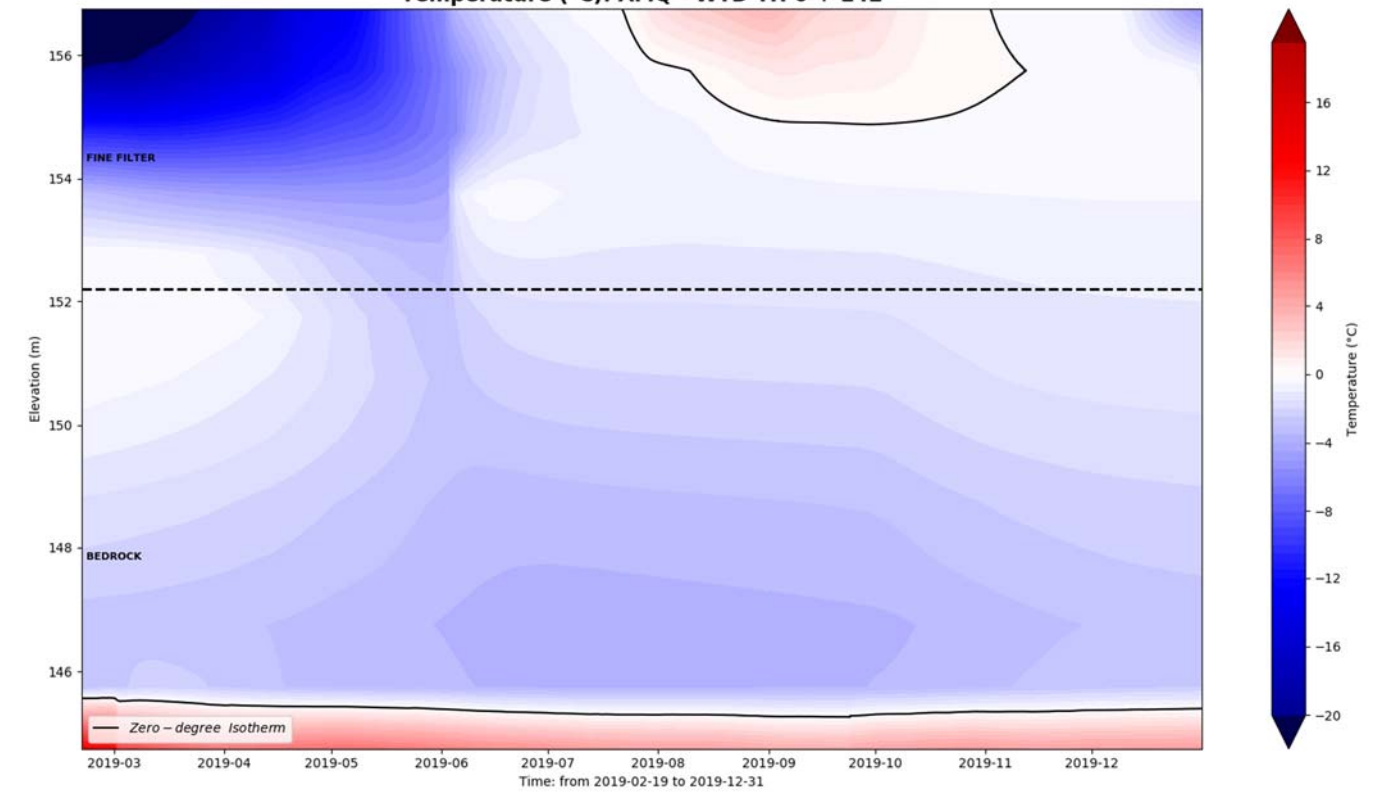
AMQ - WTD TH: 0+142

Significant capacitive effect Bead #12 and #13

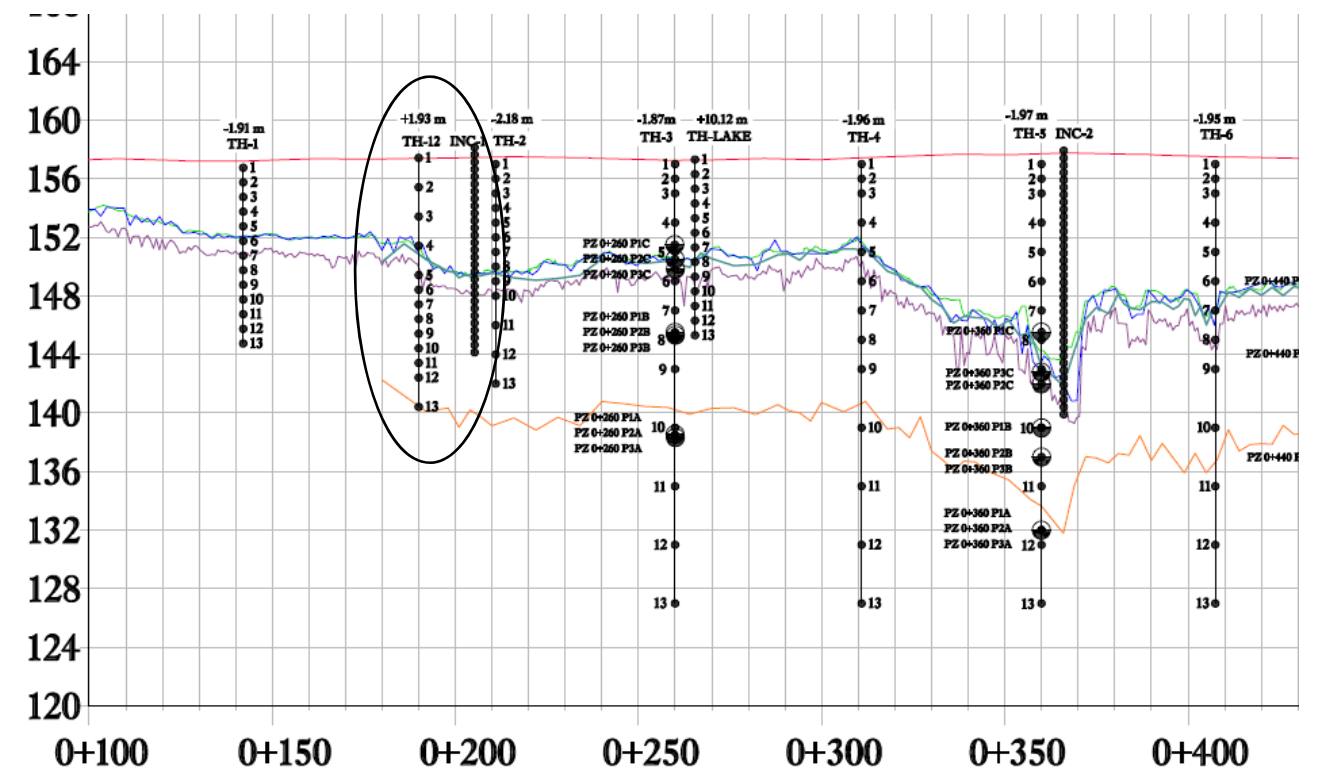
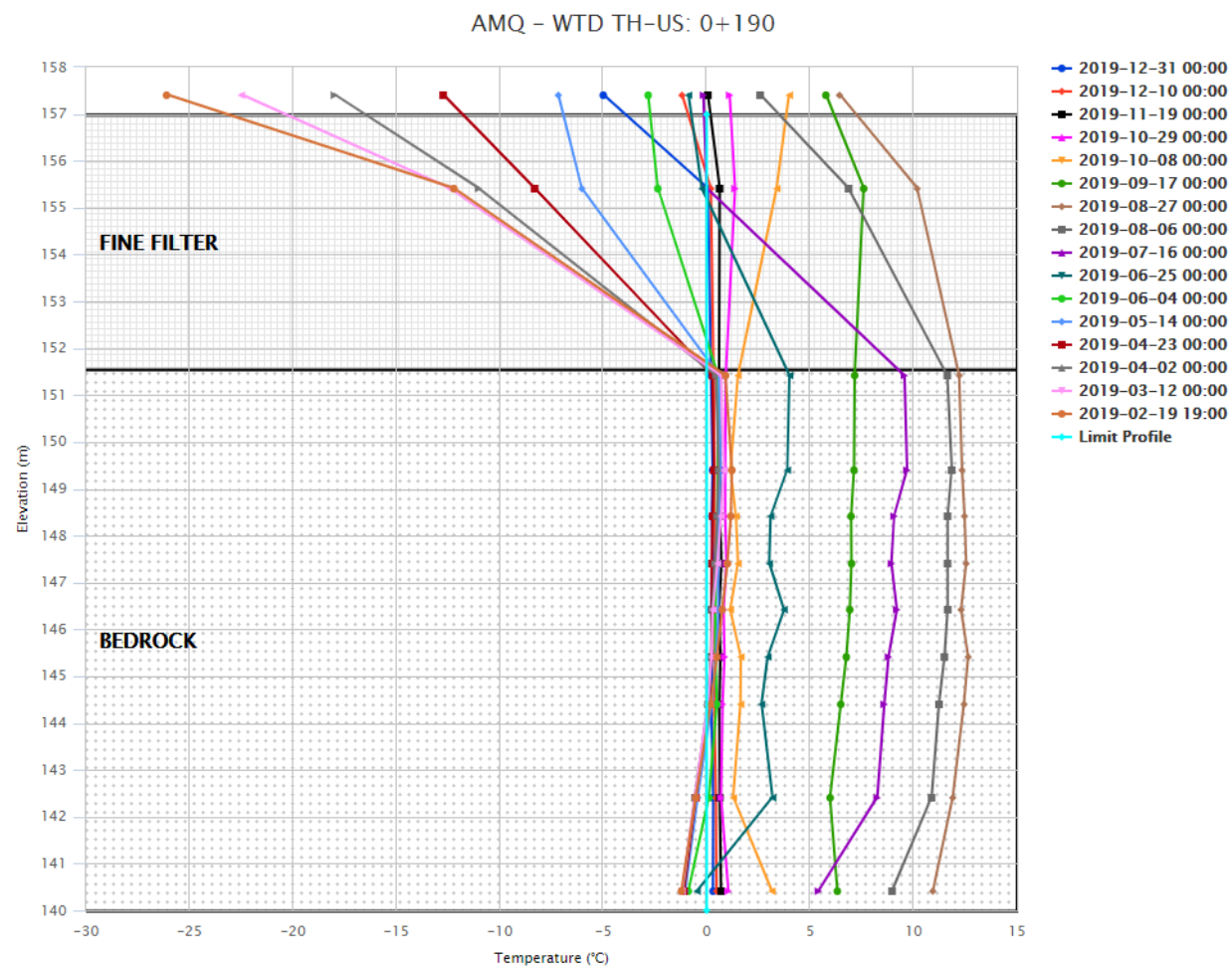
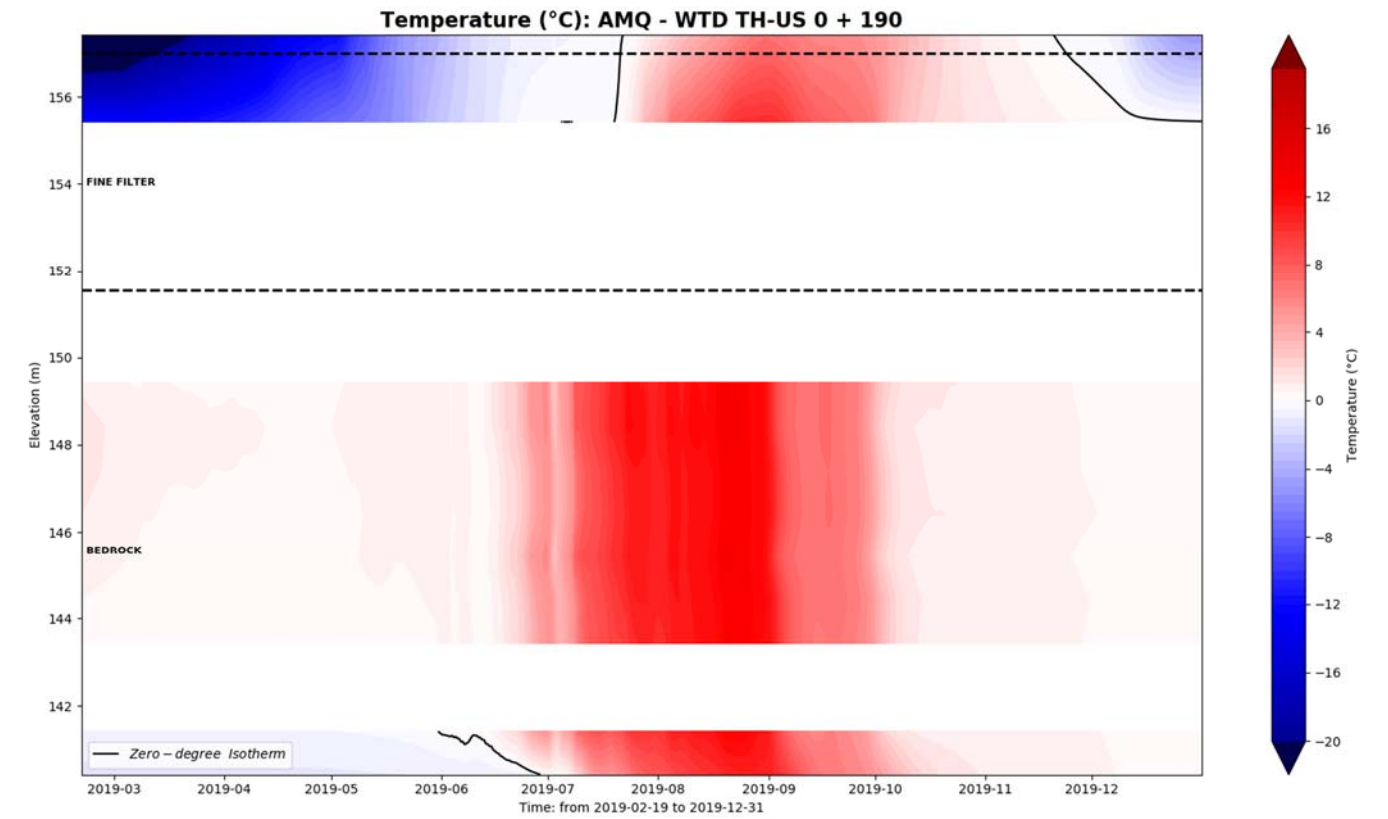
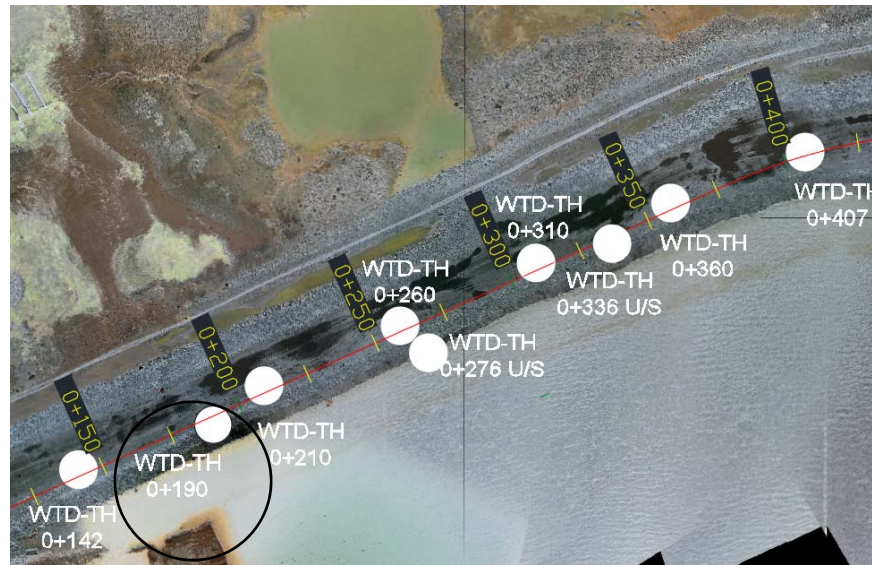


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- 2019-05-14 00:00
- 2019-04-23 00:00
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Temperature (°C): AMQ - WTD TH 0 + 142

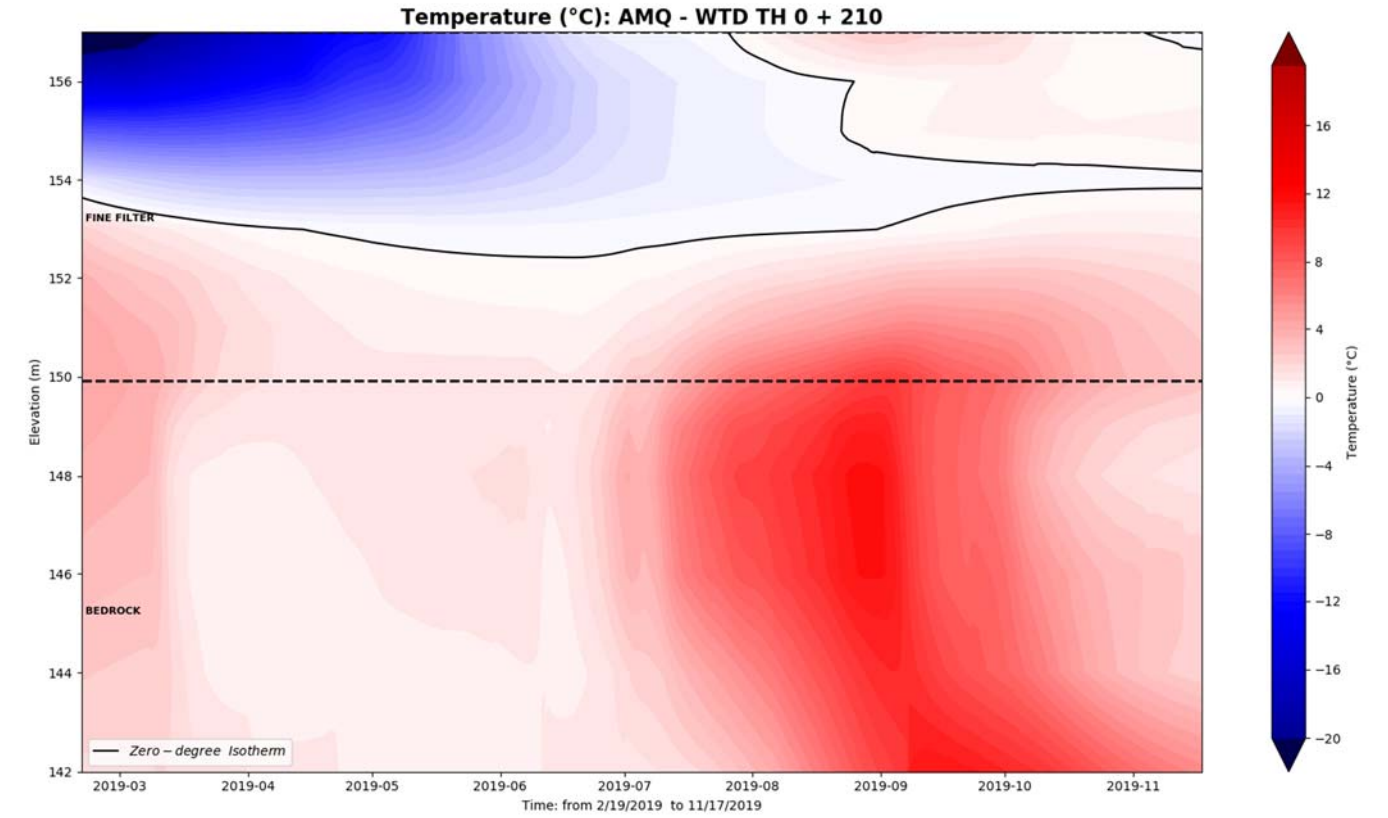
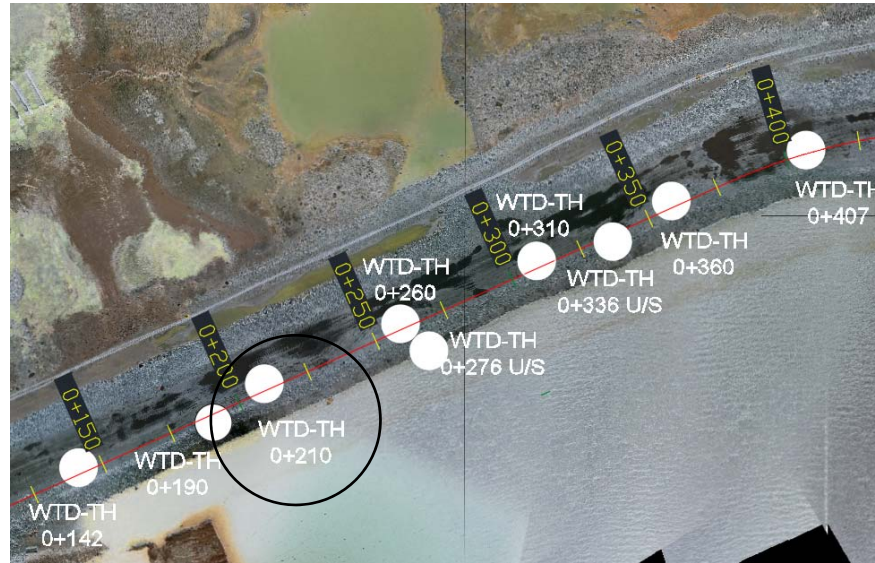


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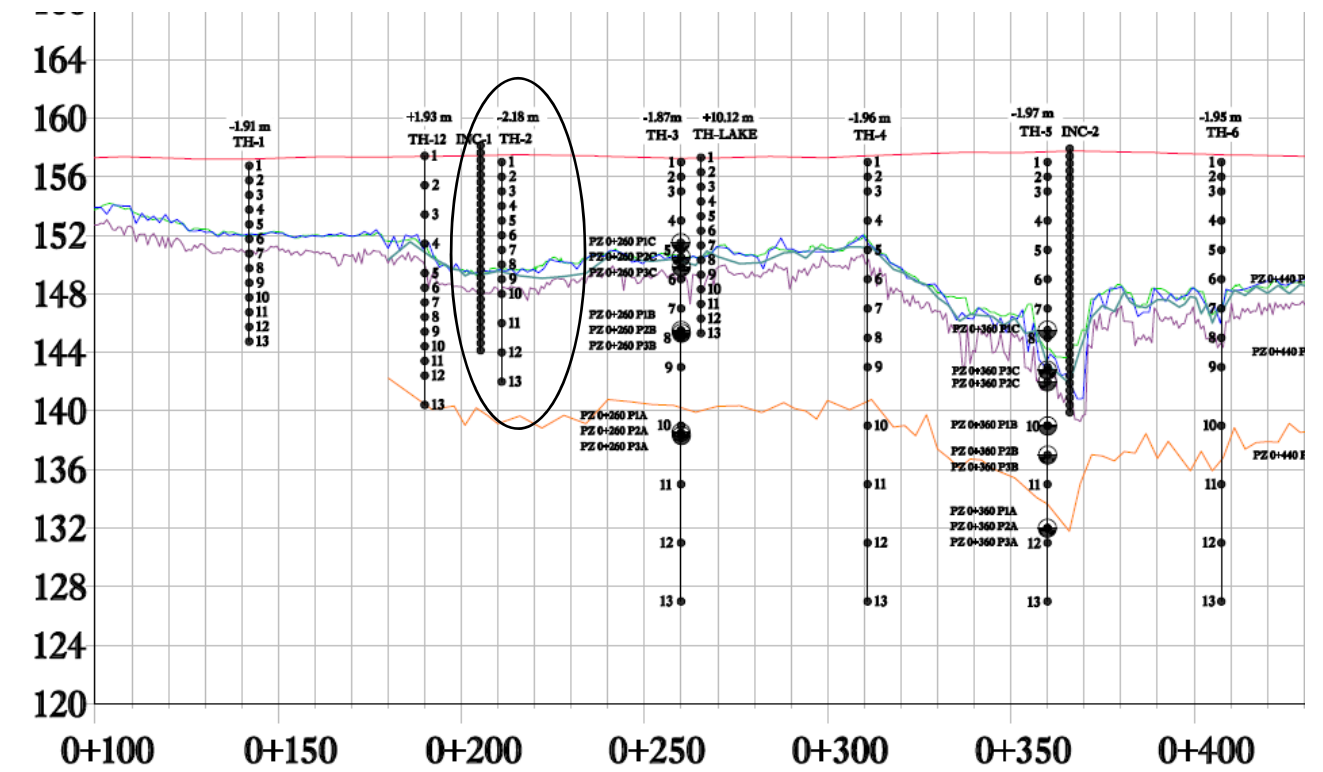
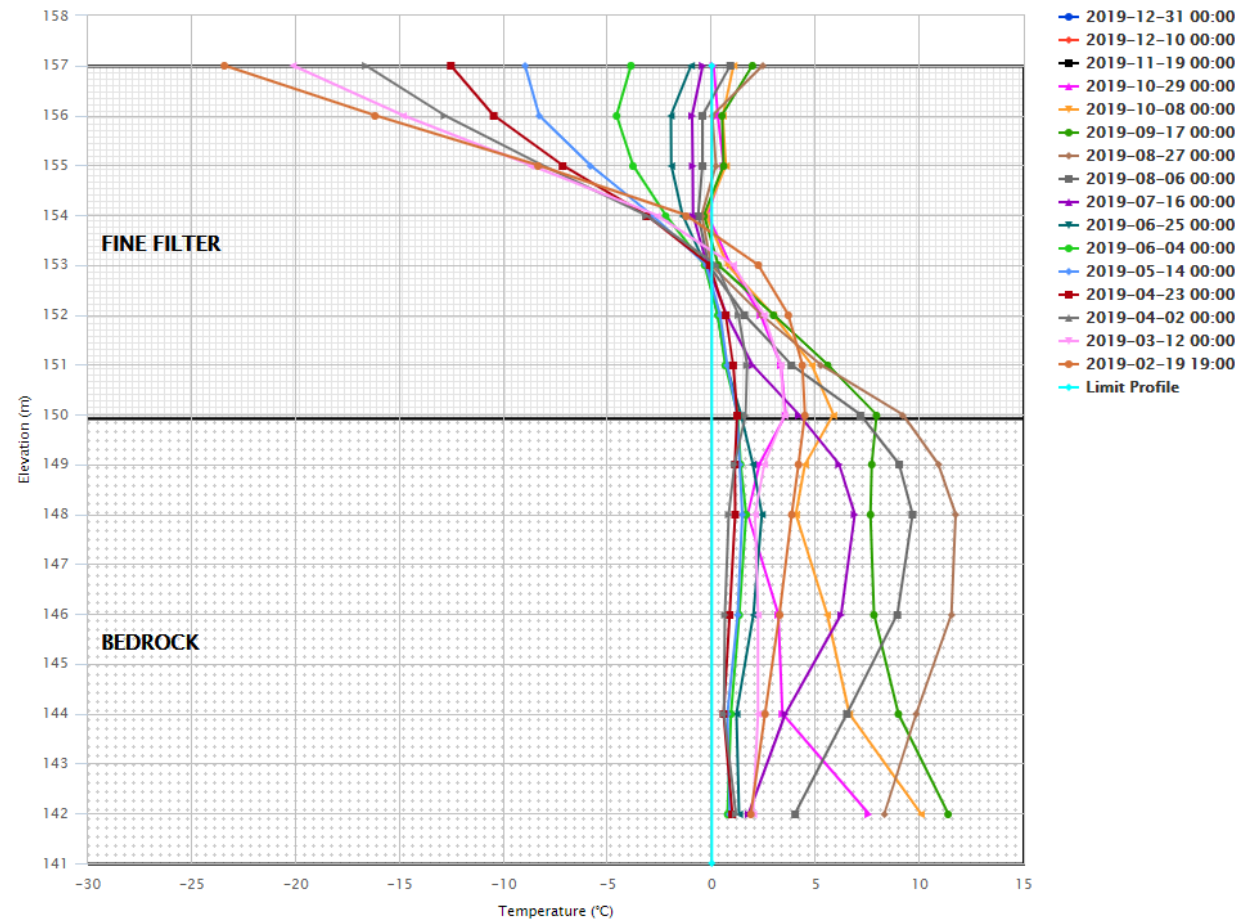




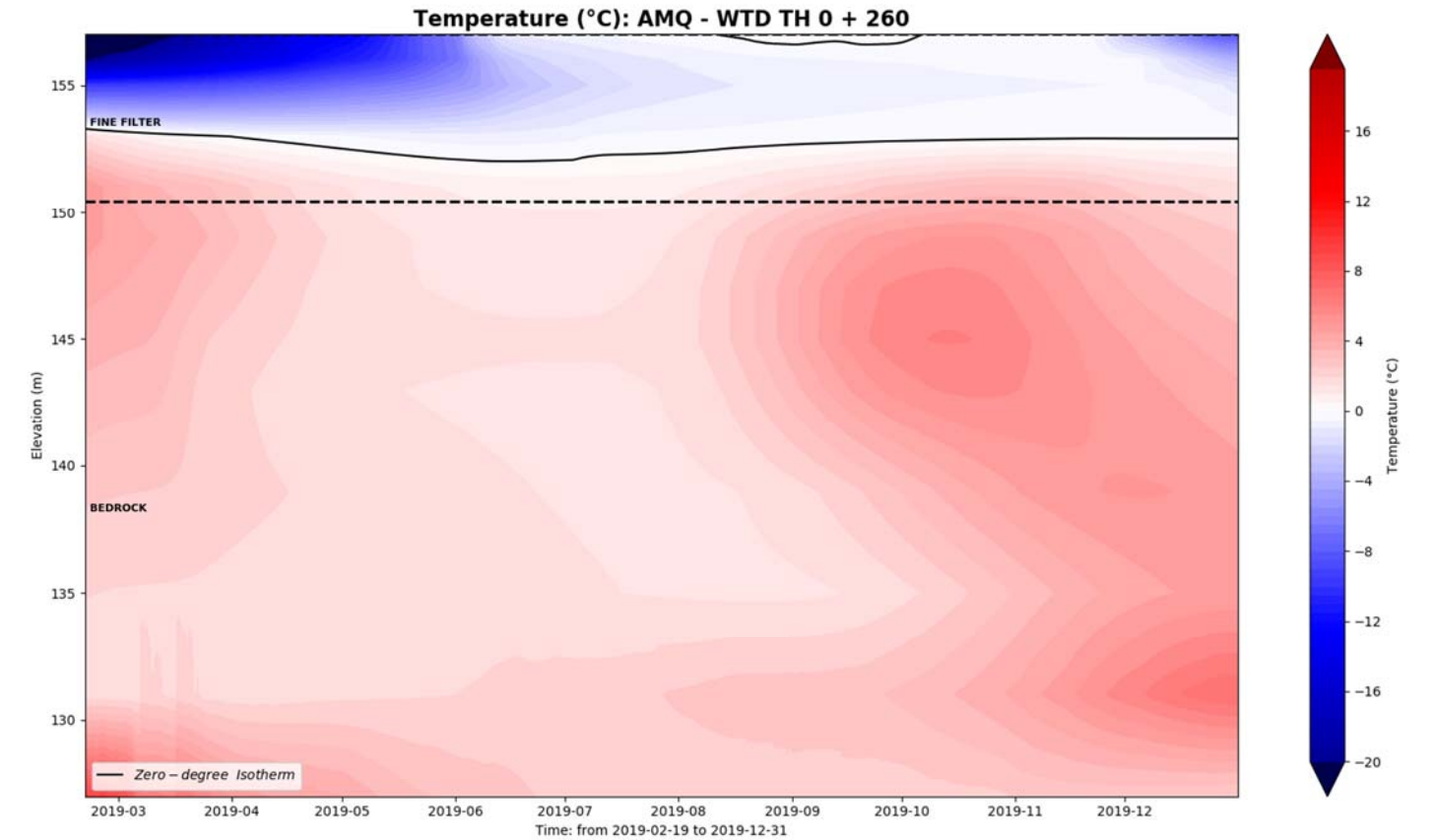
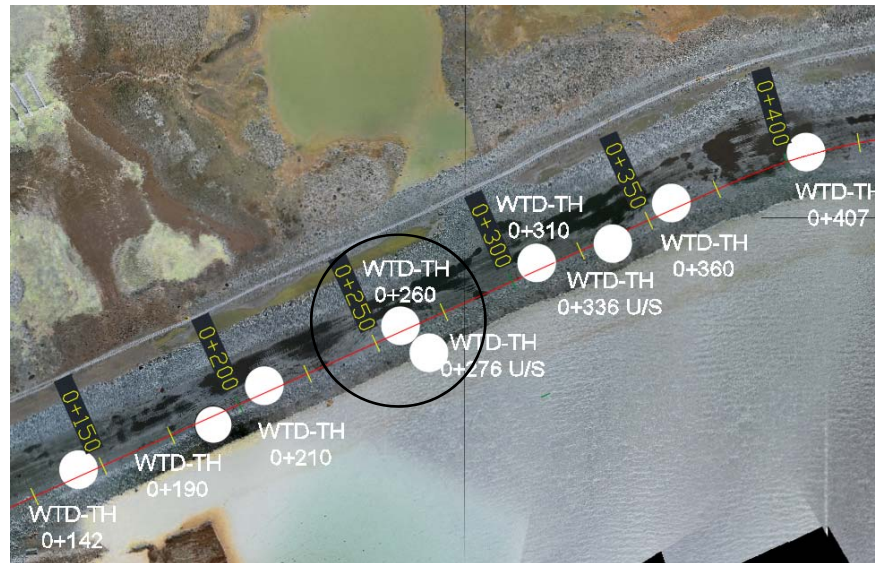
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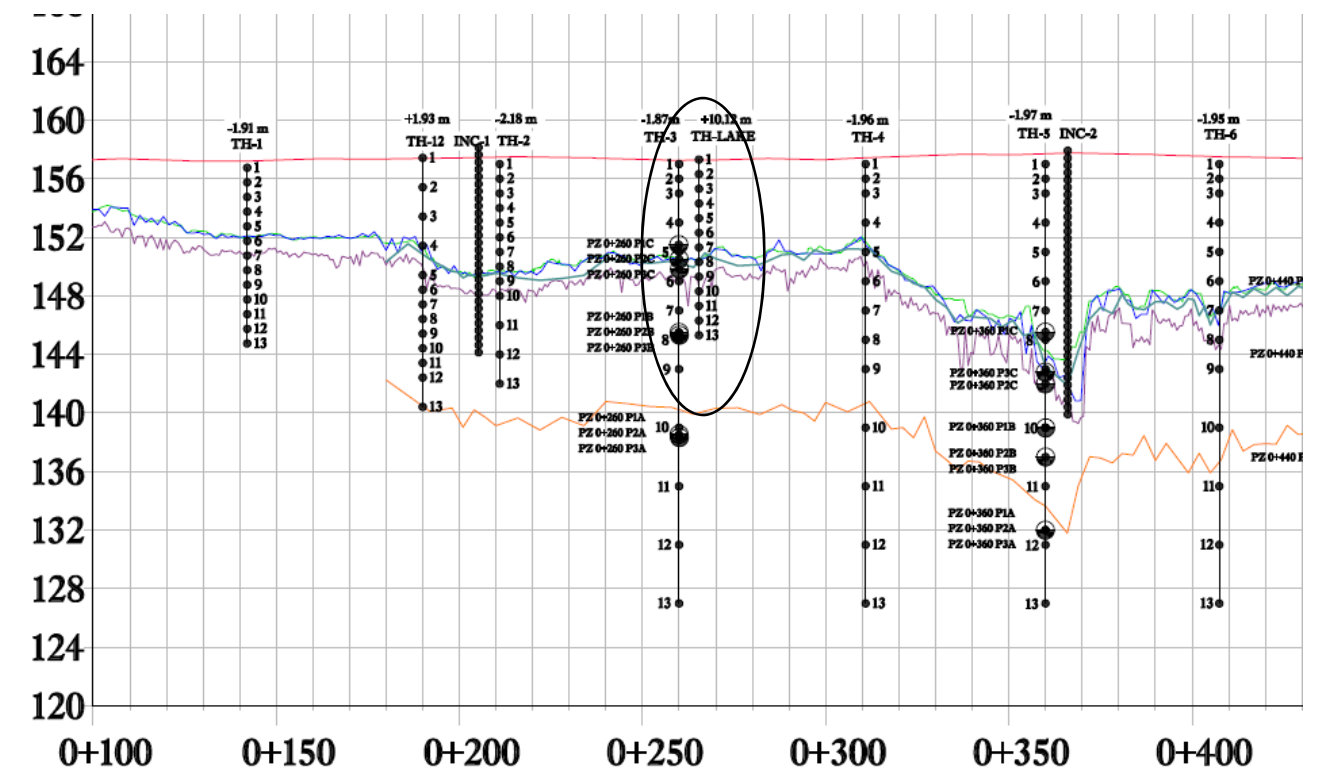
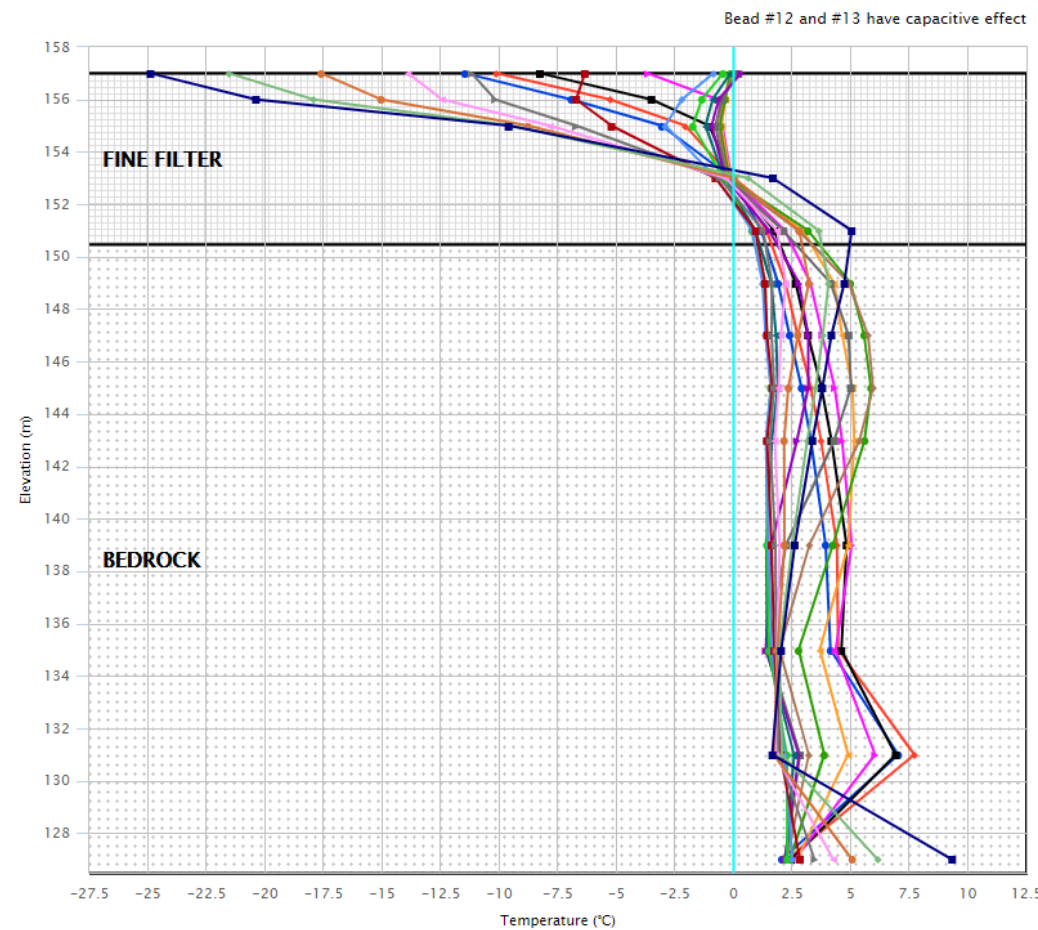
AMQ - WTD TH: 0+210



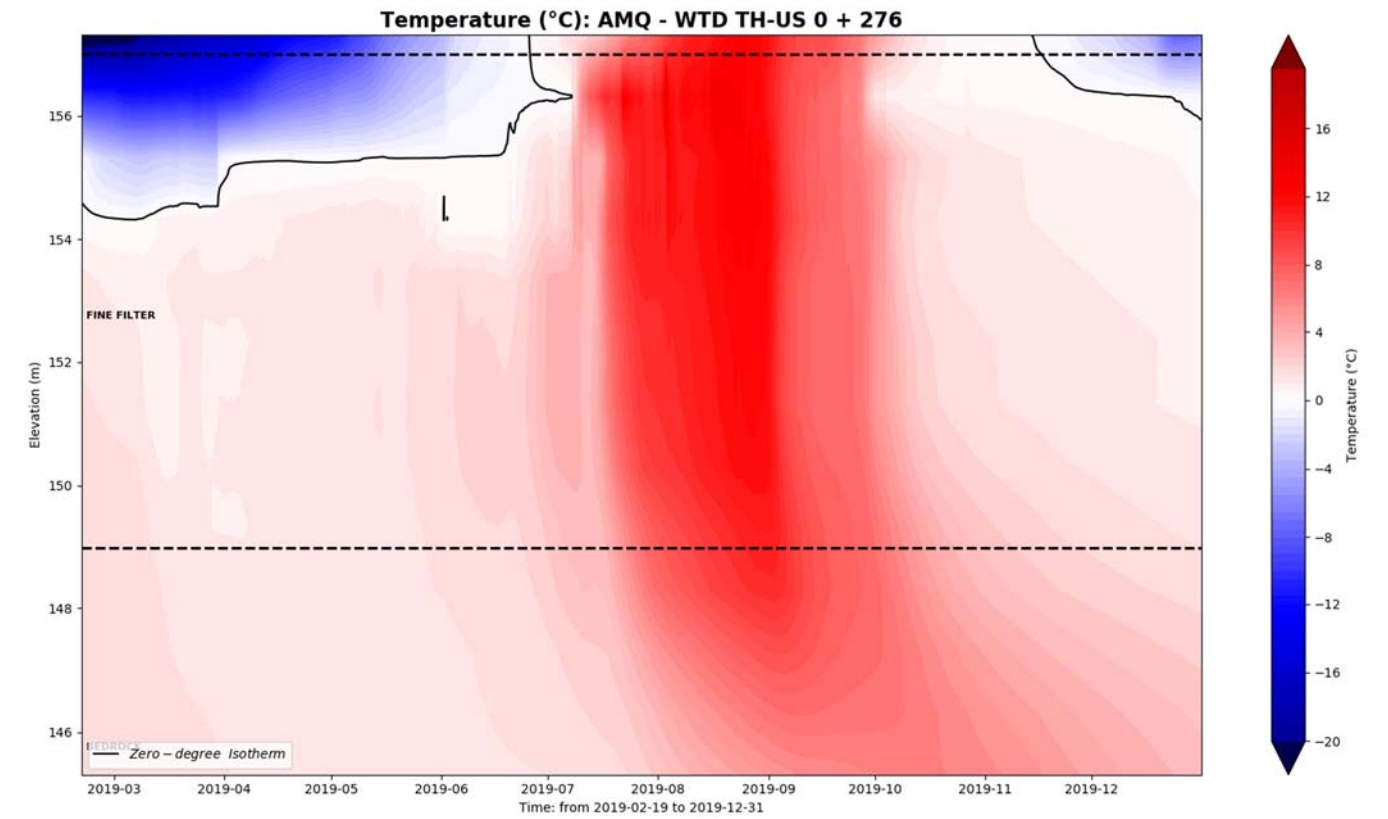
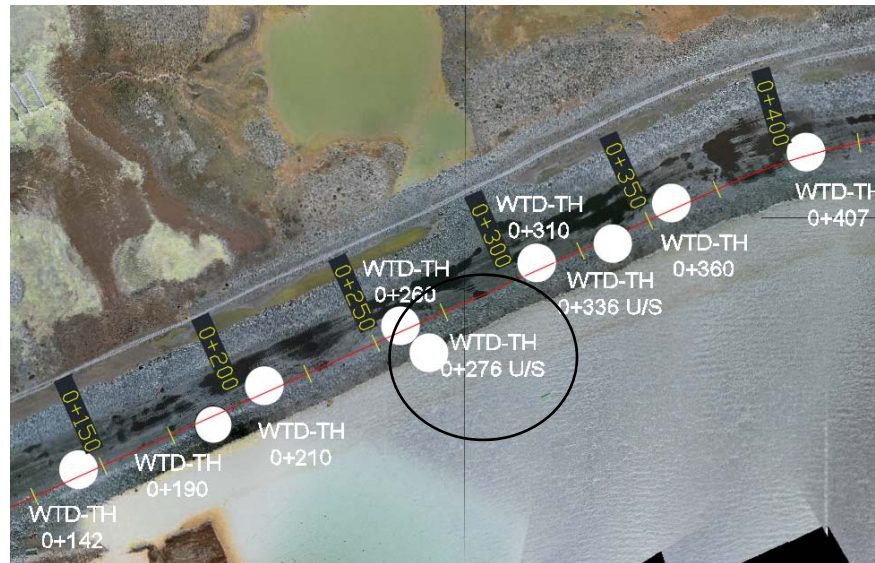
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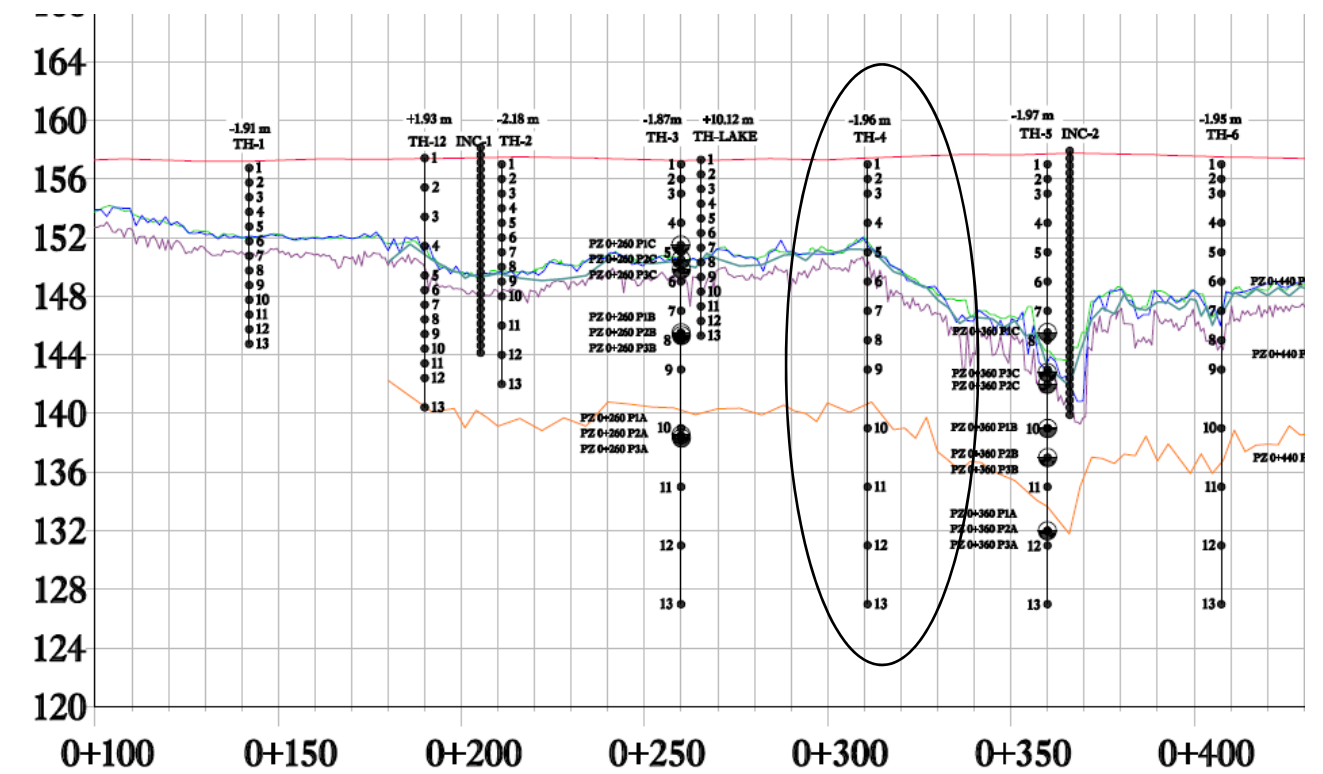
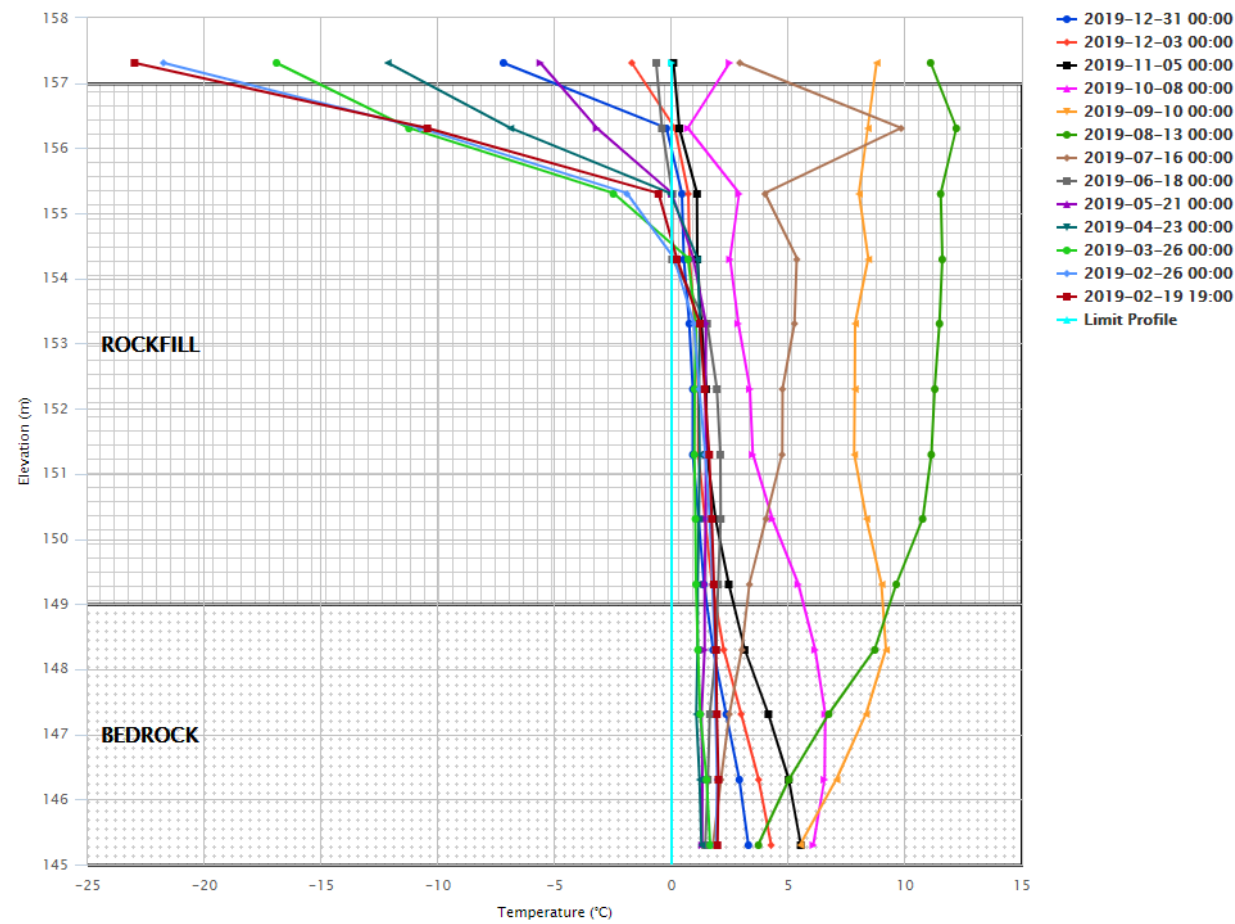
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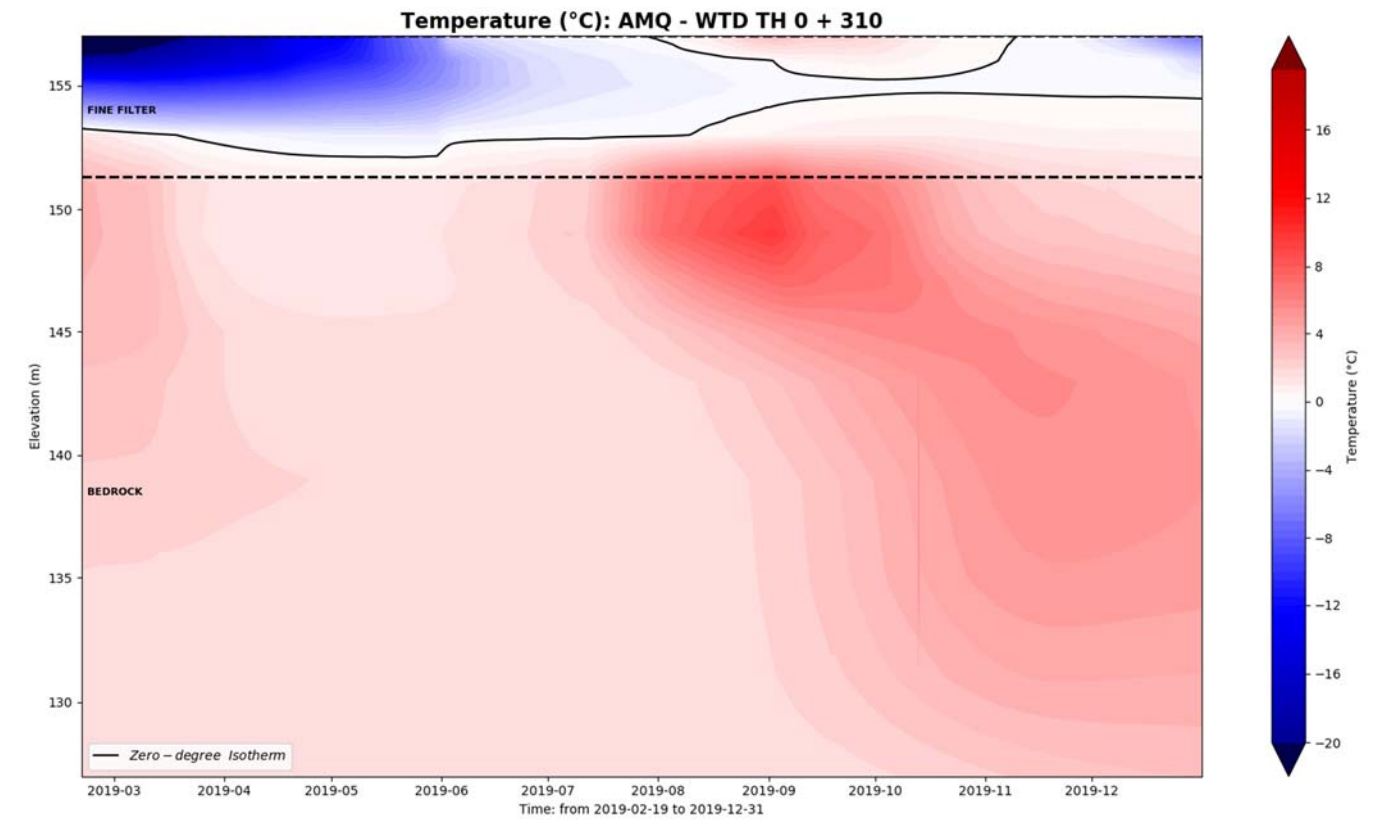
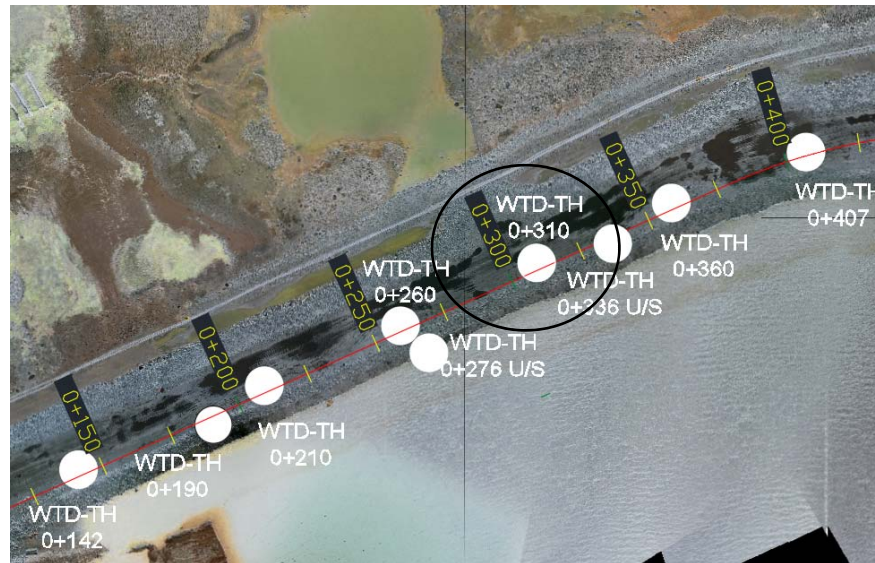
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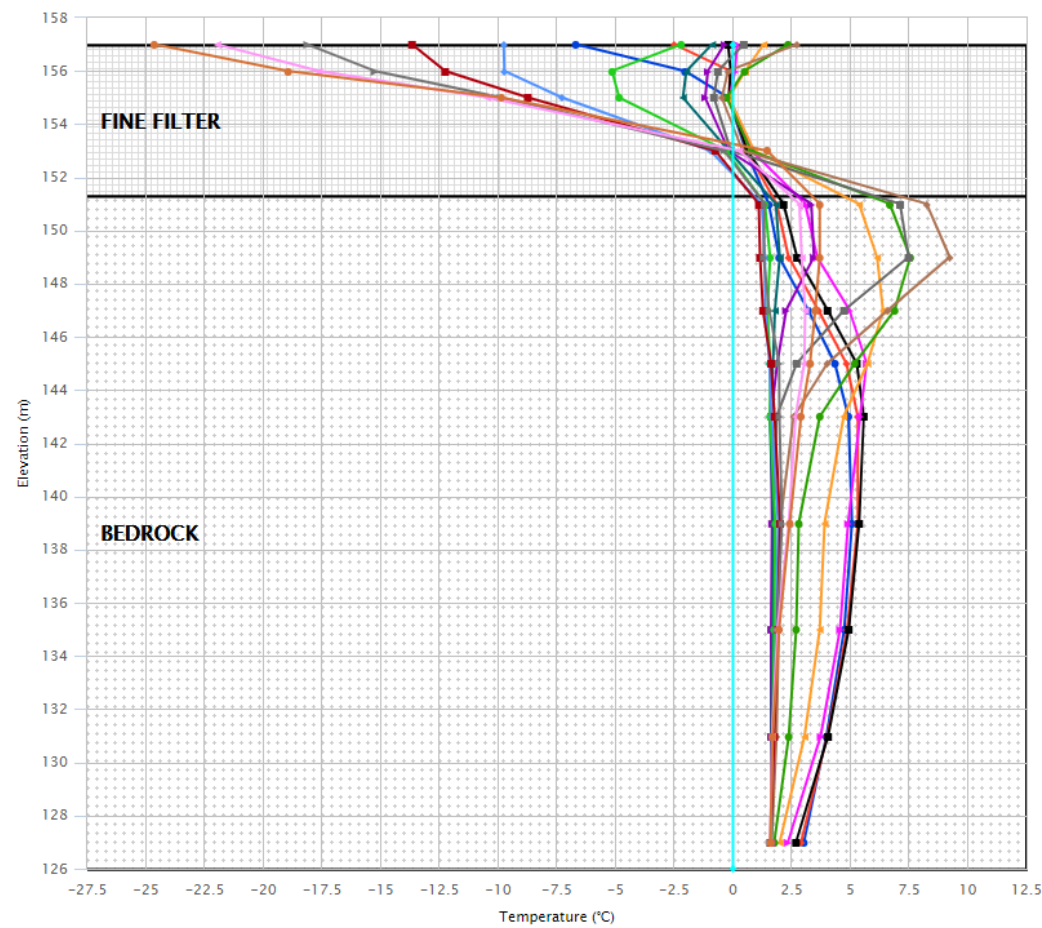
AMQ - WTD TH-US: 0+276



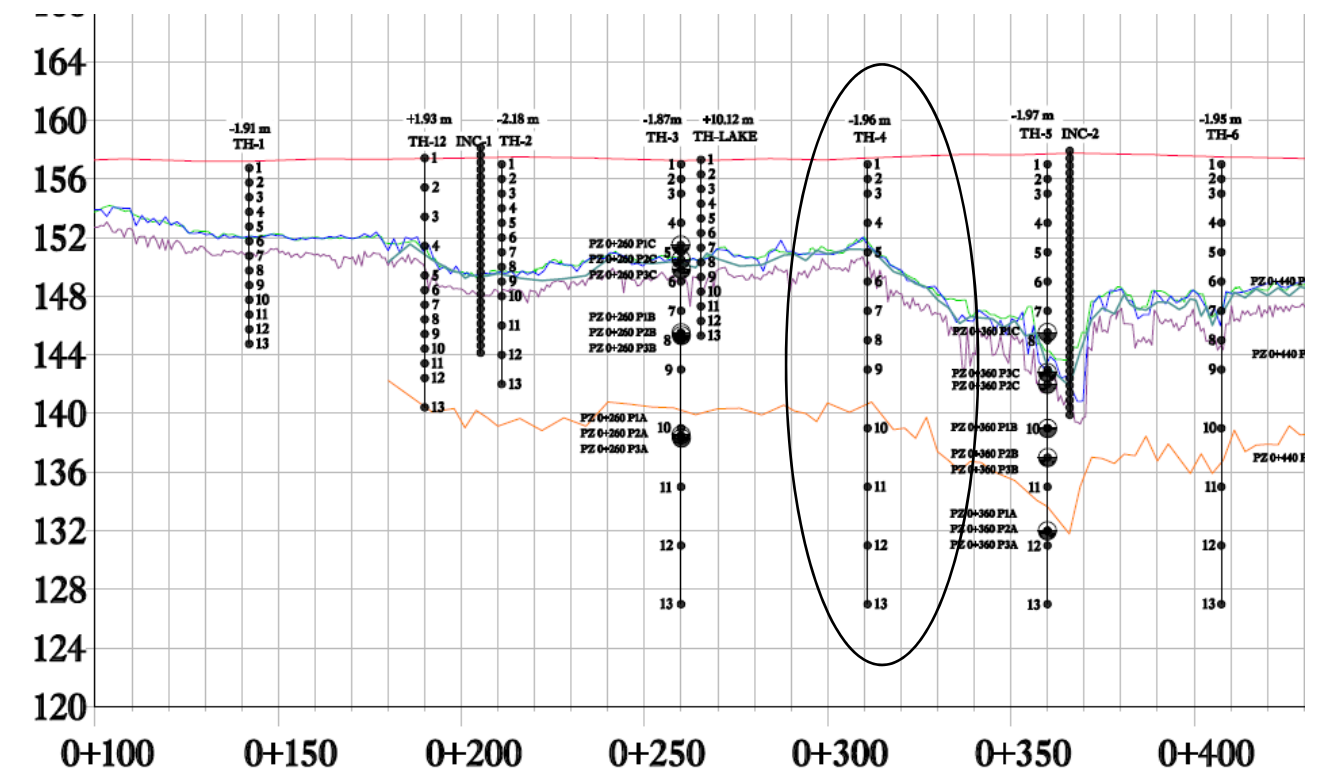
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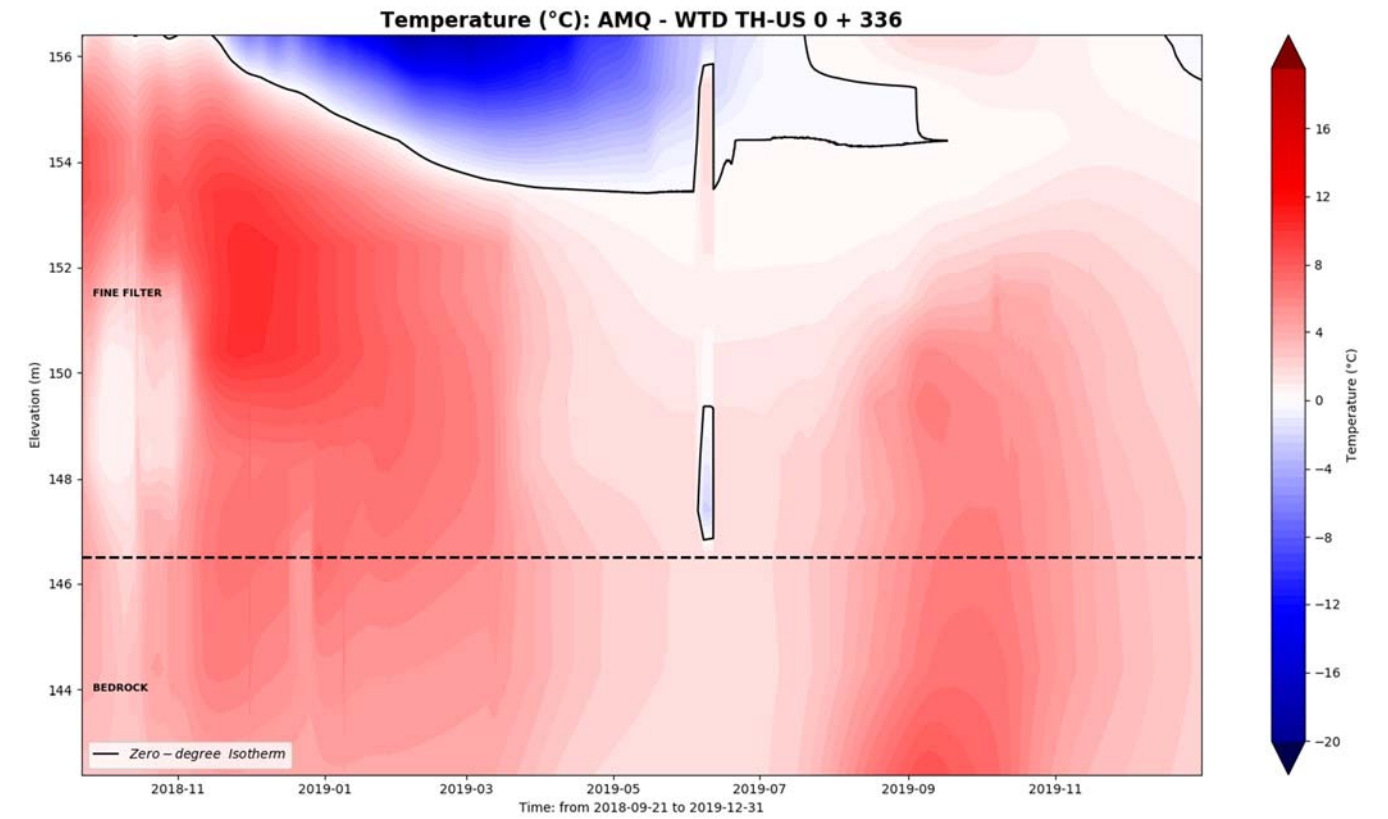
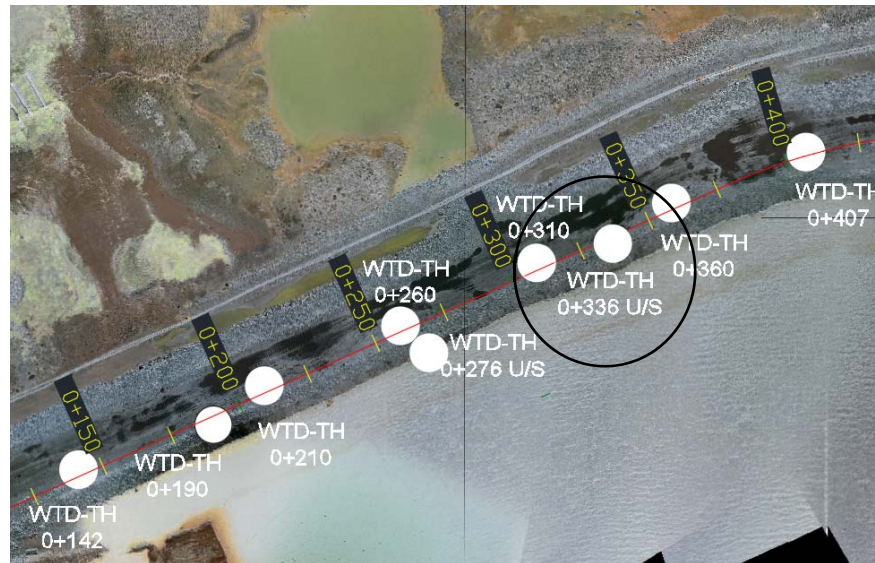
AMQ - WTD TH: 0+310



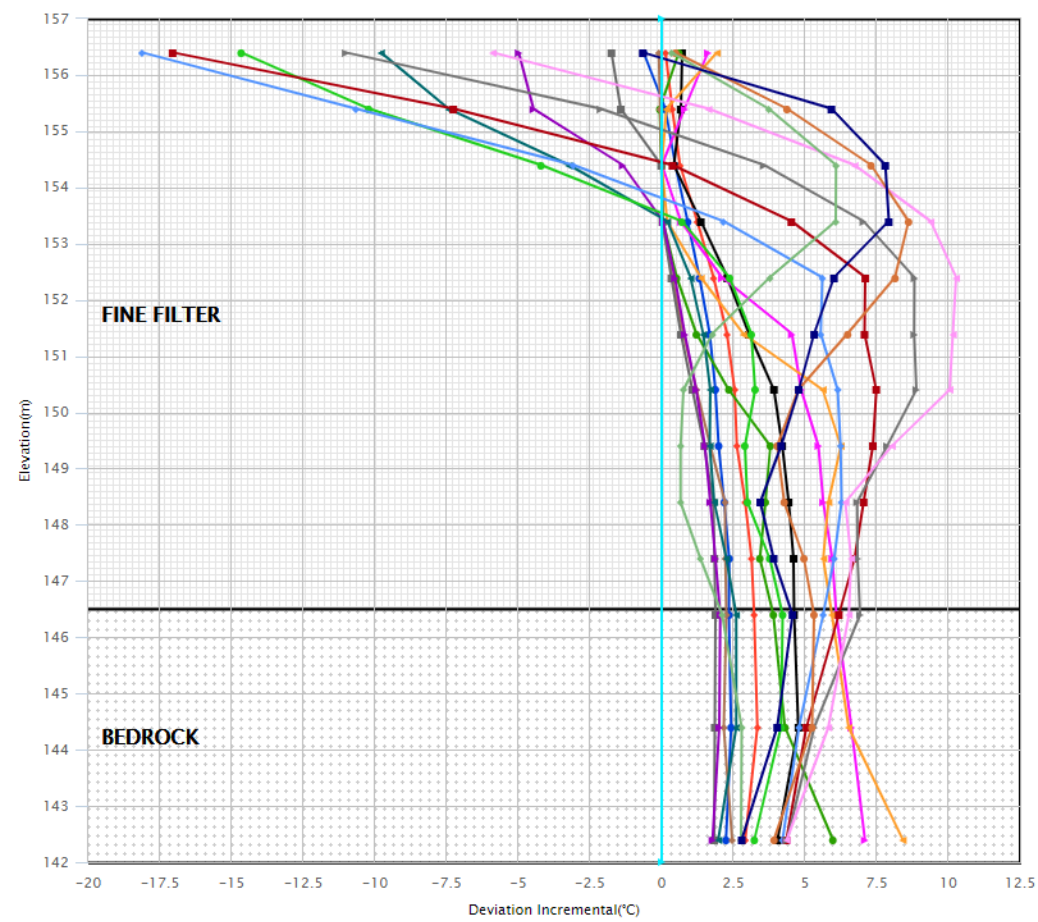
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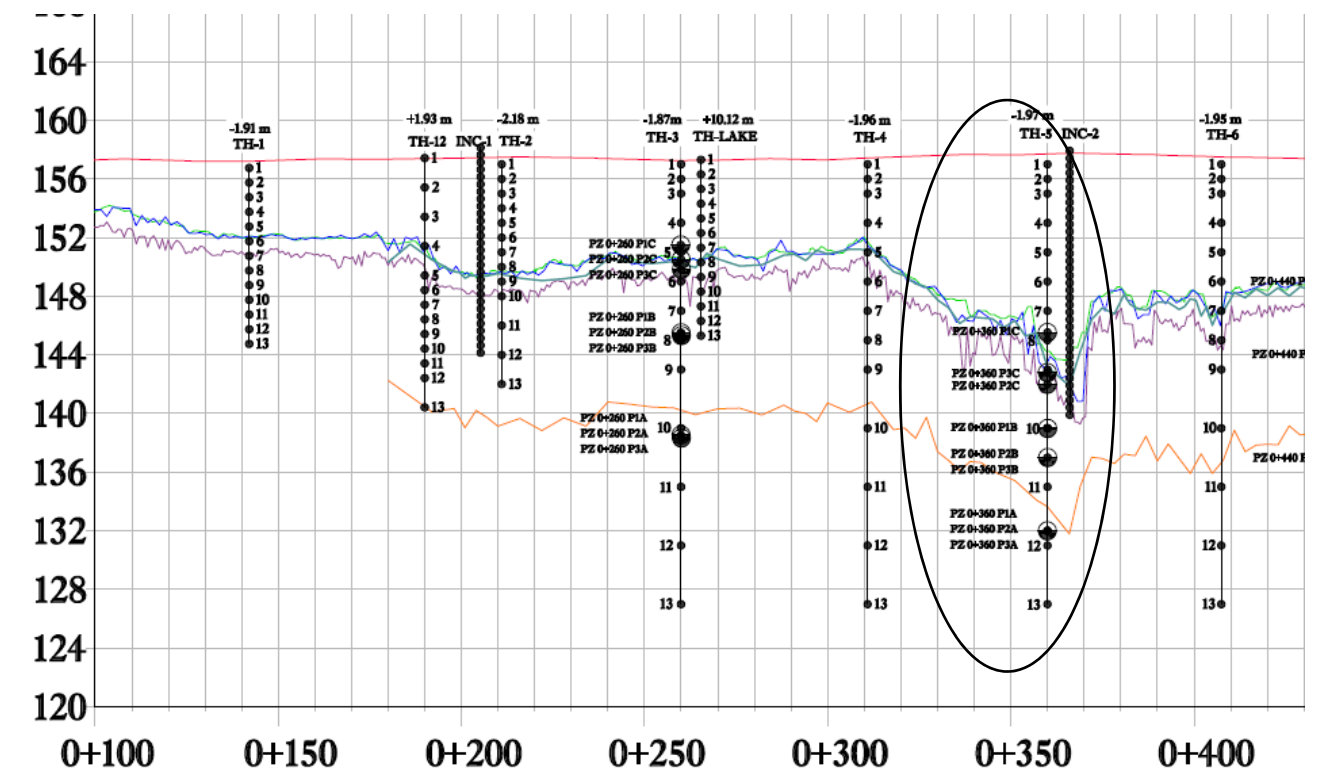
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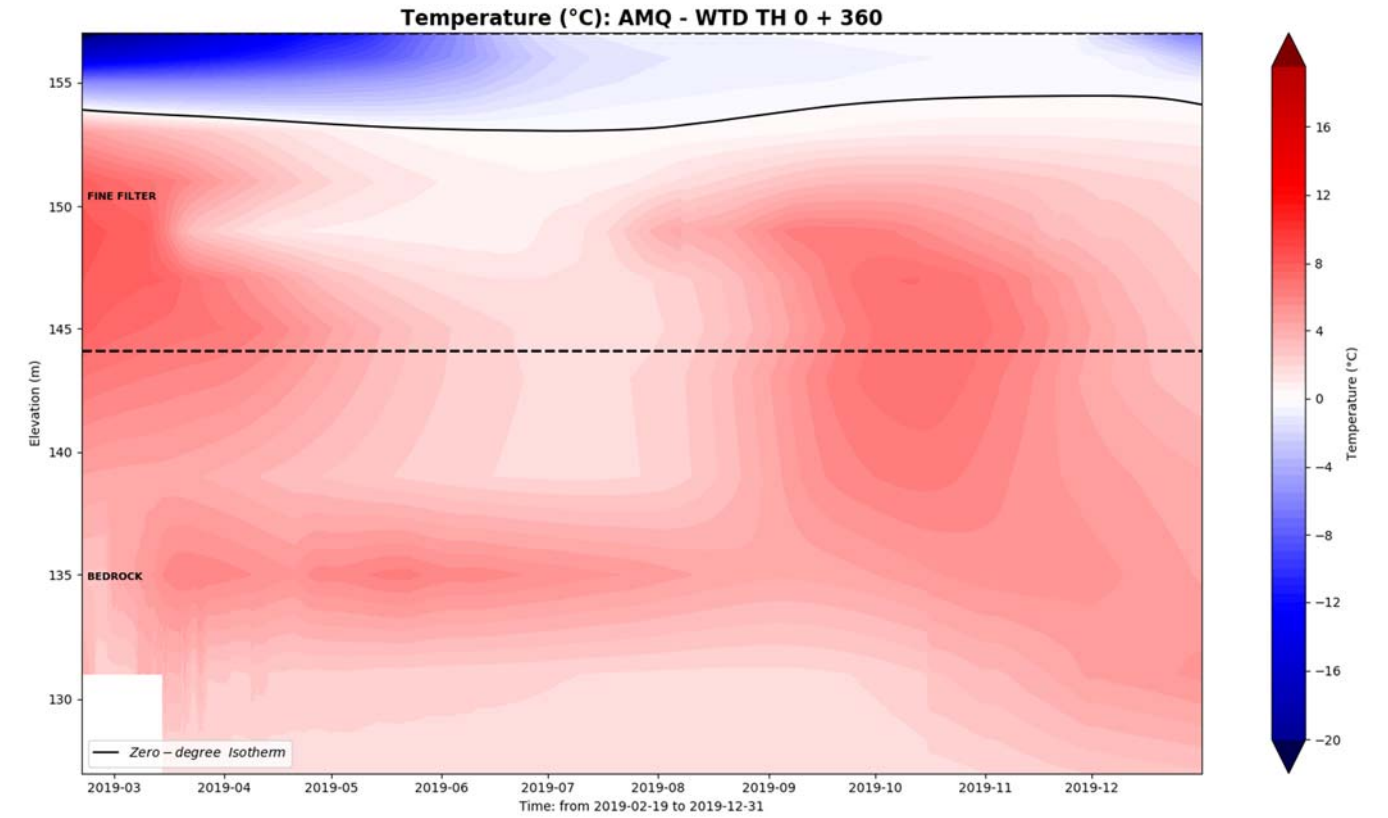
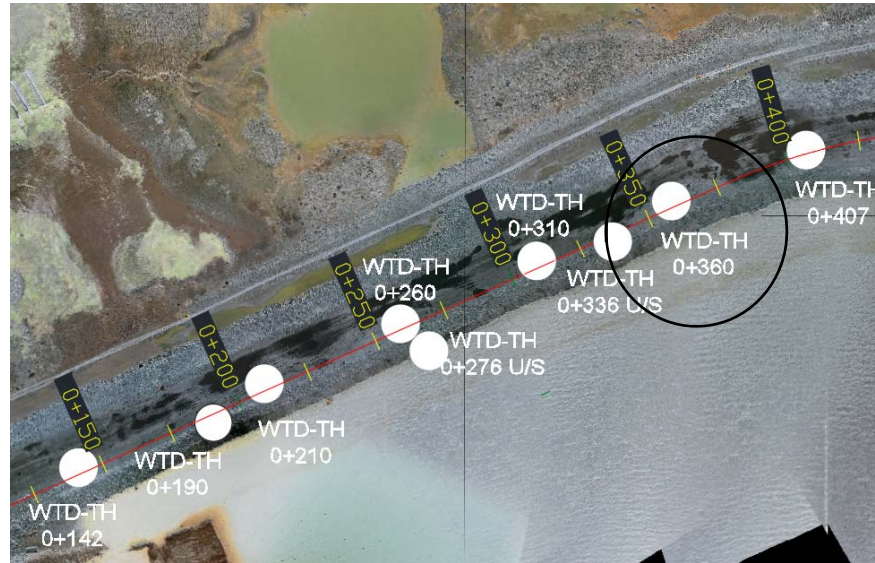
AMQ - WTD TH-US: 0+336



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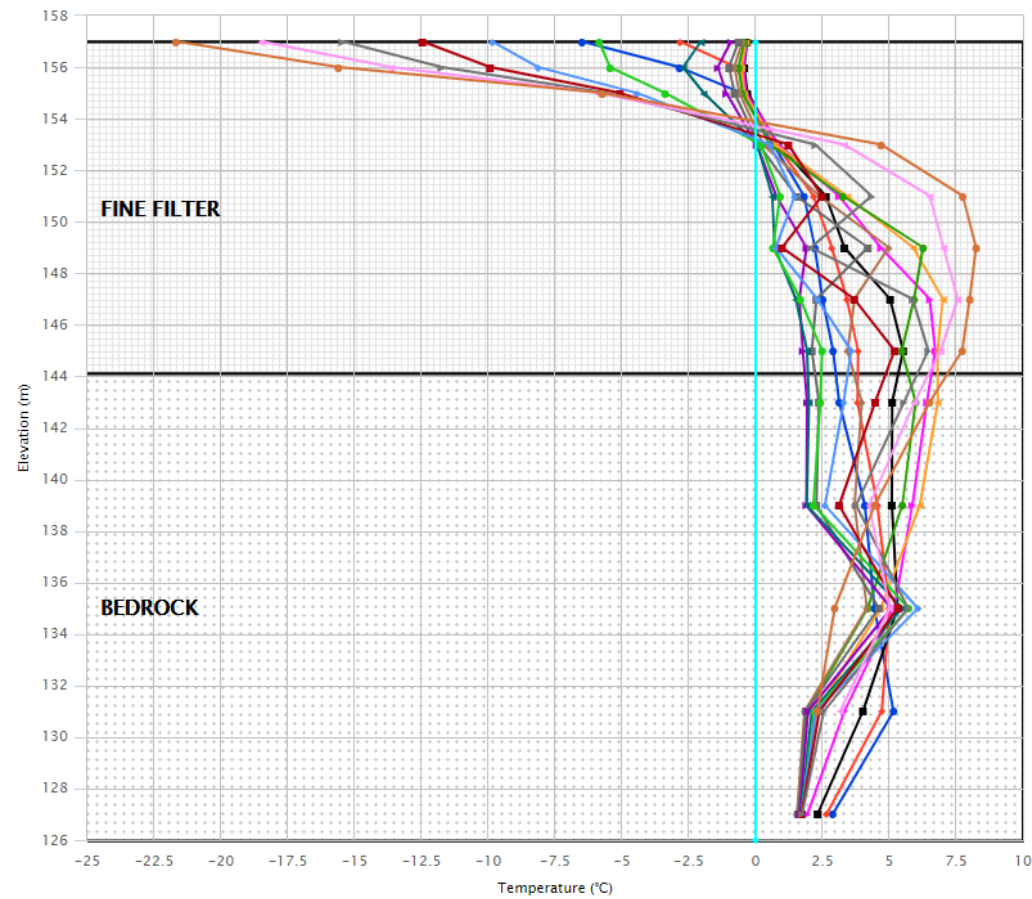


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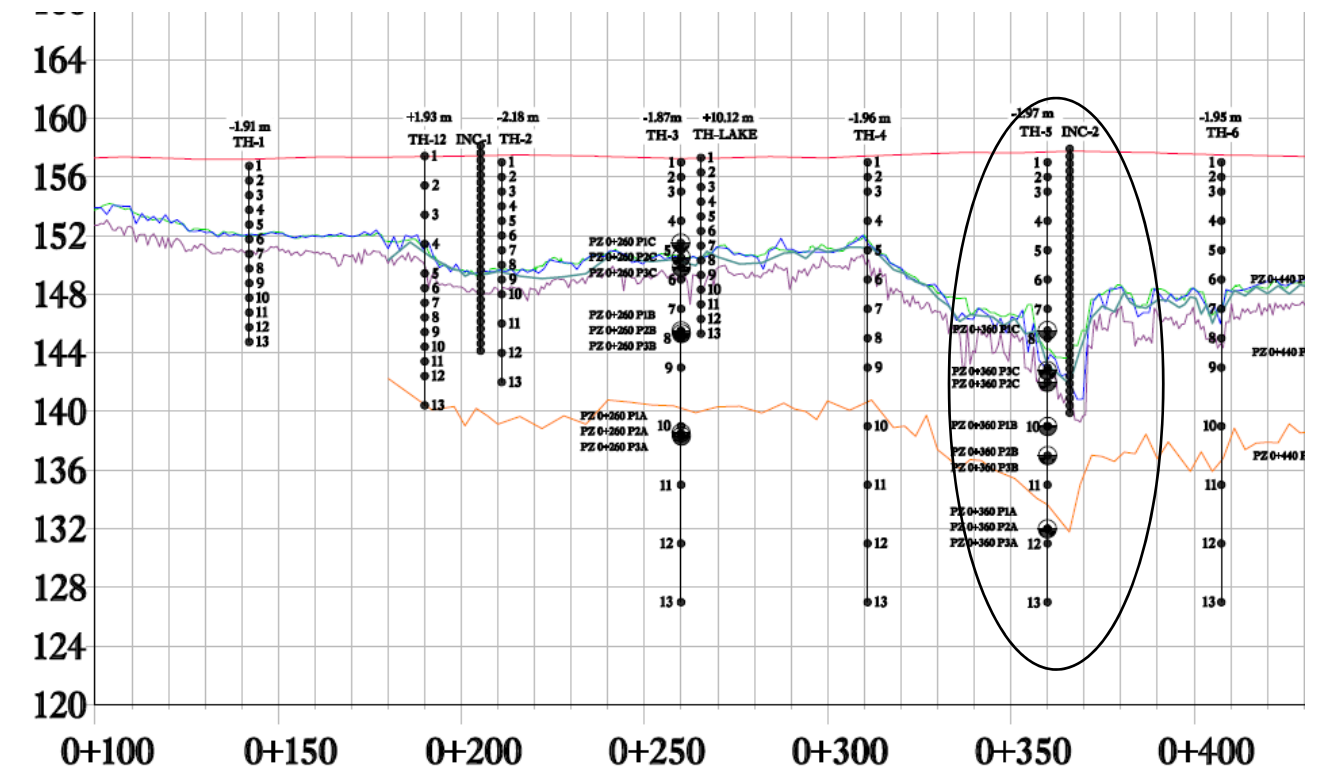


AMQ - WTD TH: 0+360

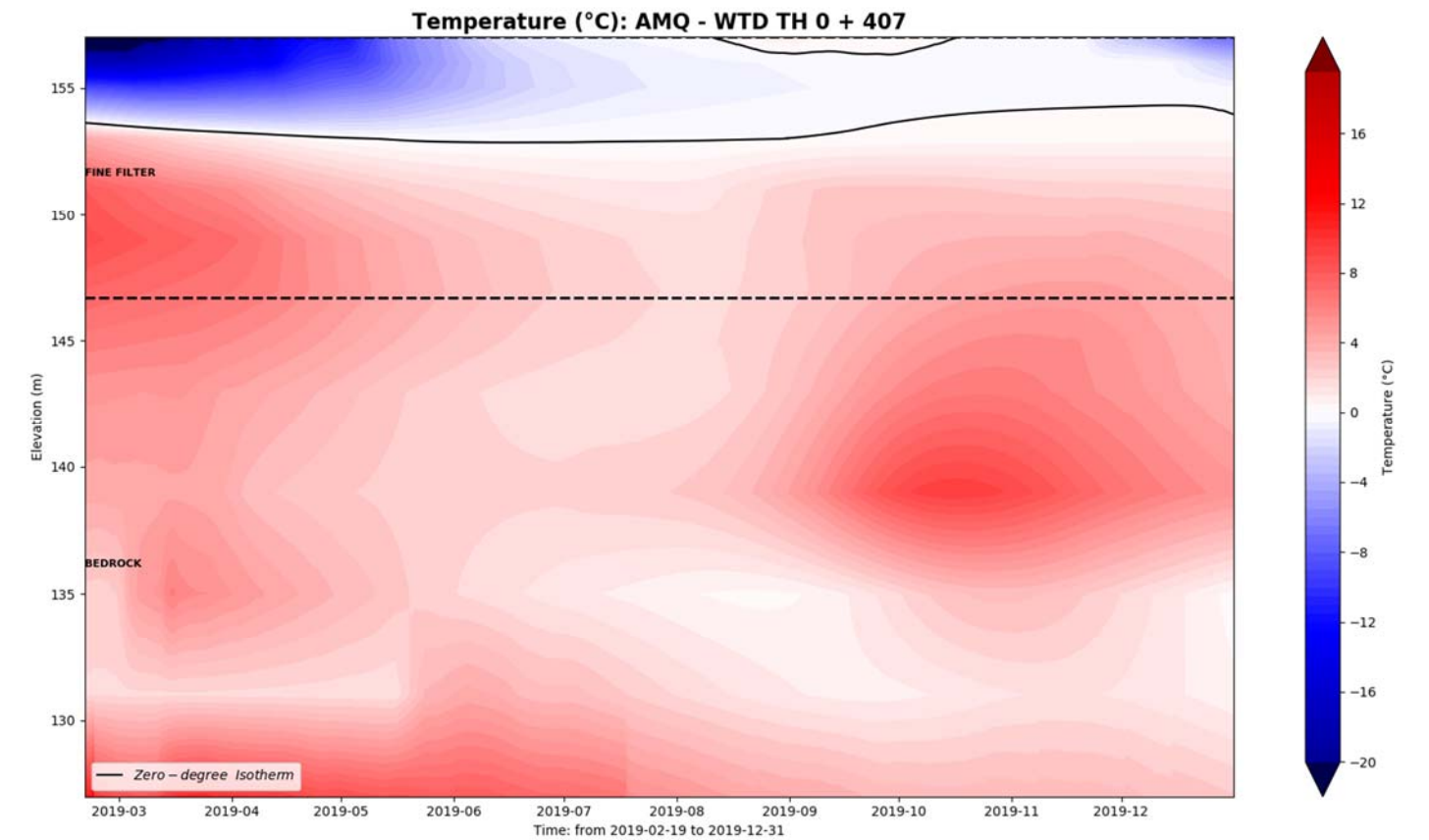
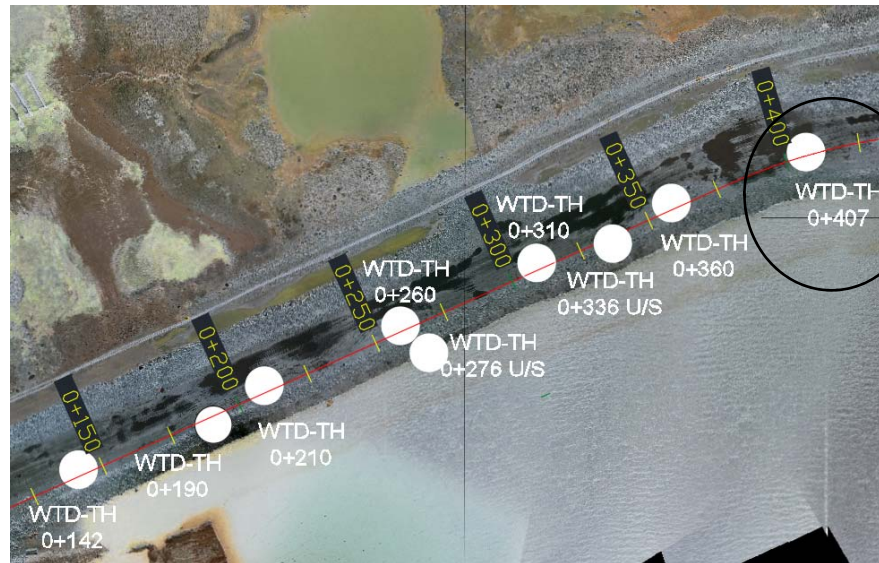
Significant capacitive effect Beads # 11.



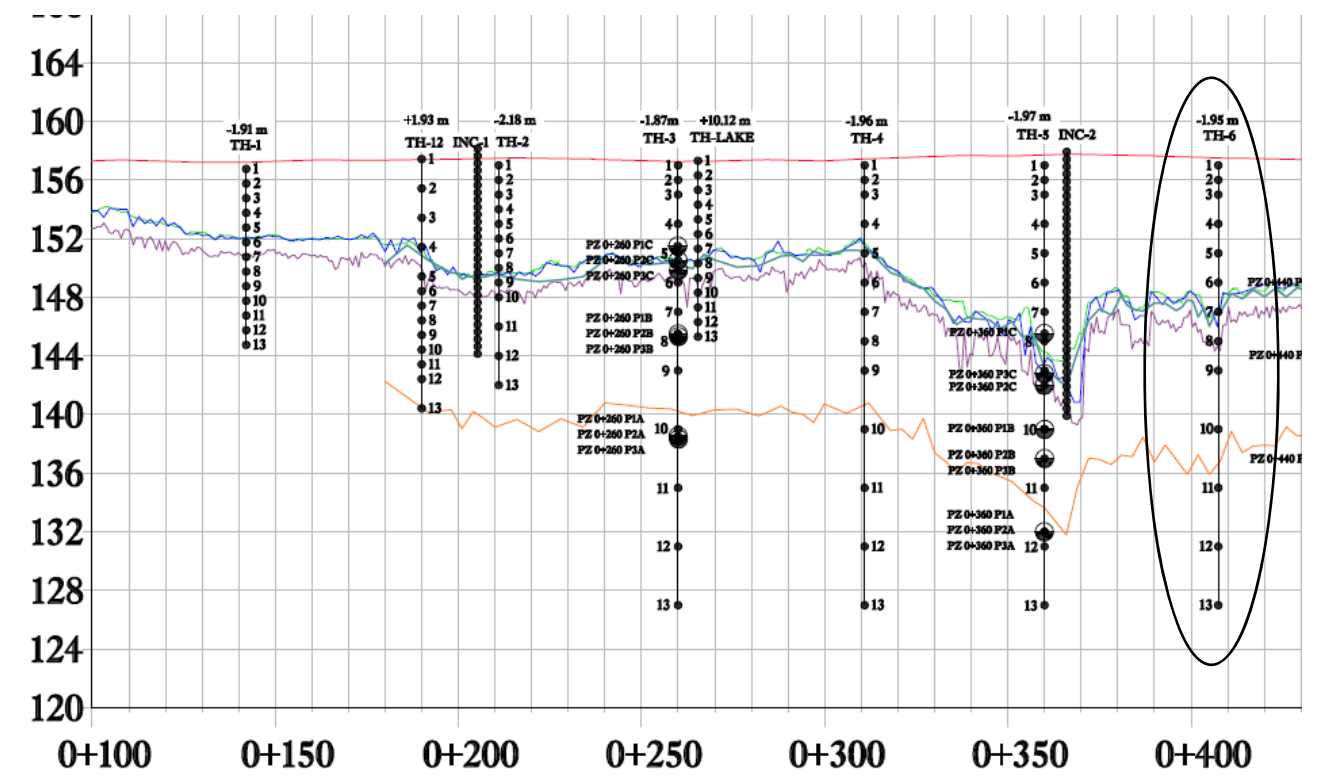
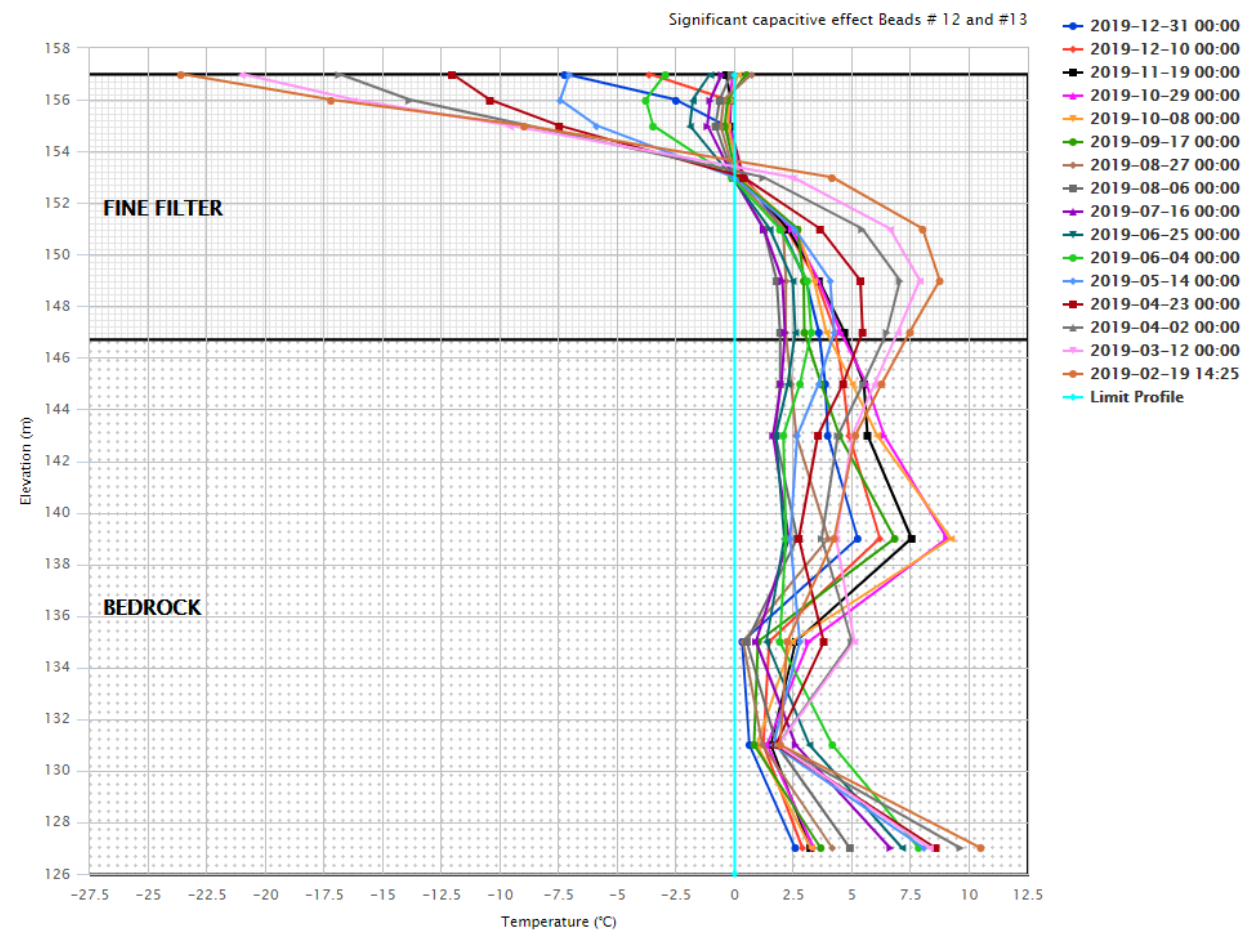
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### WTD-TH 0+407



AMQ - WTD TH: 0+407

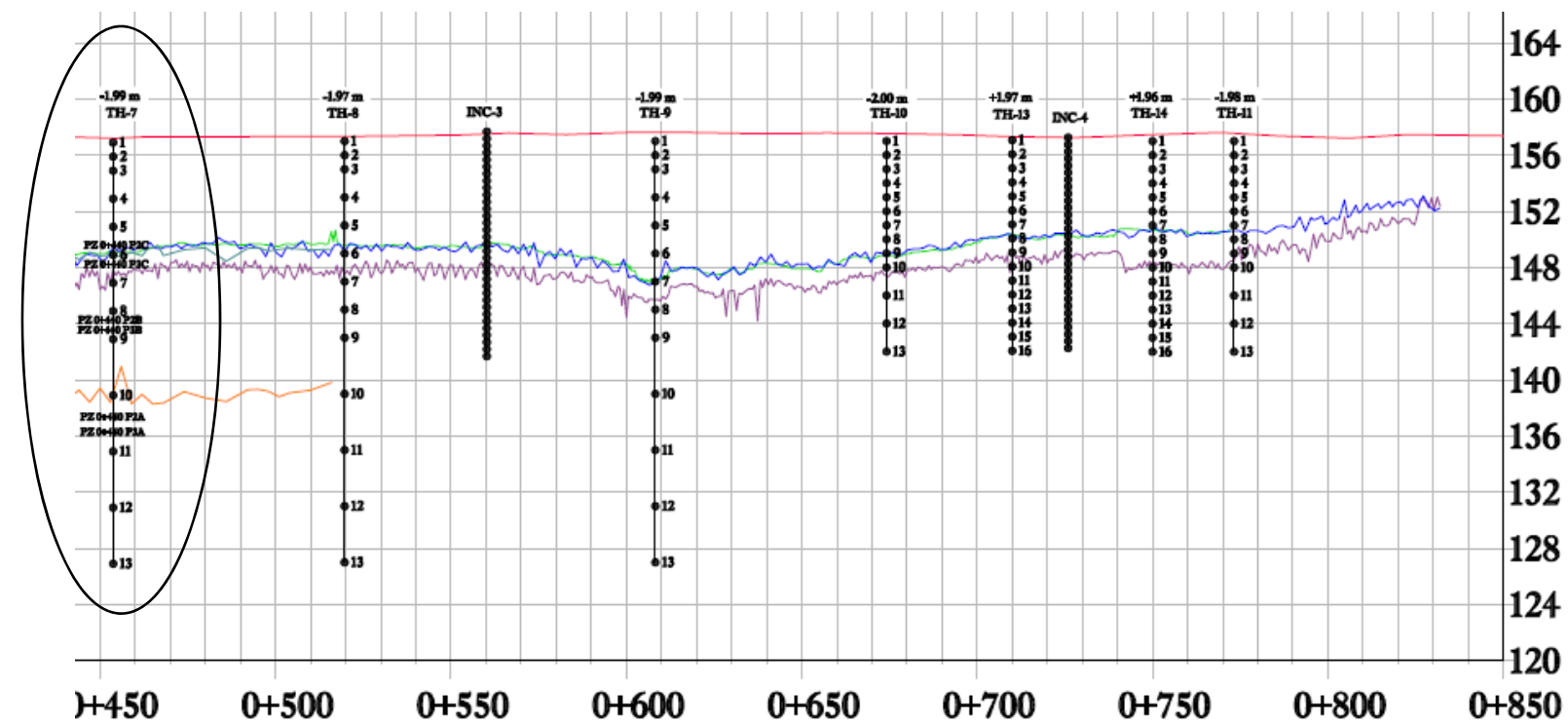
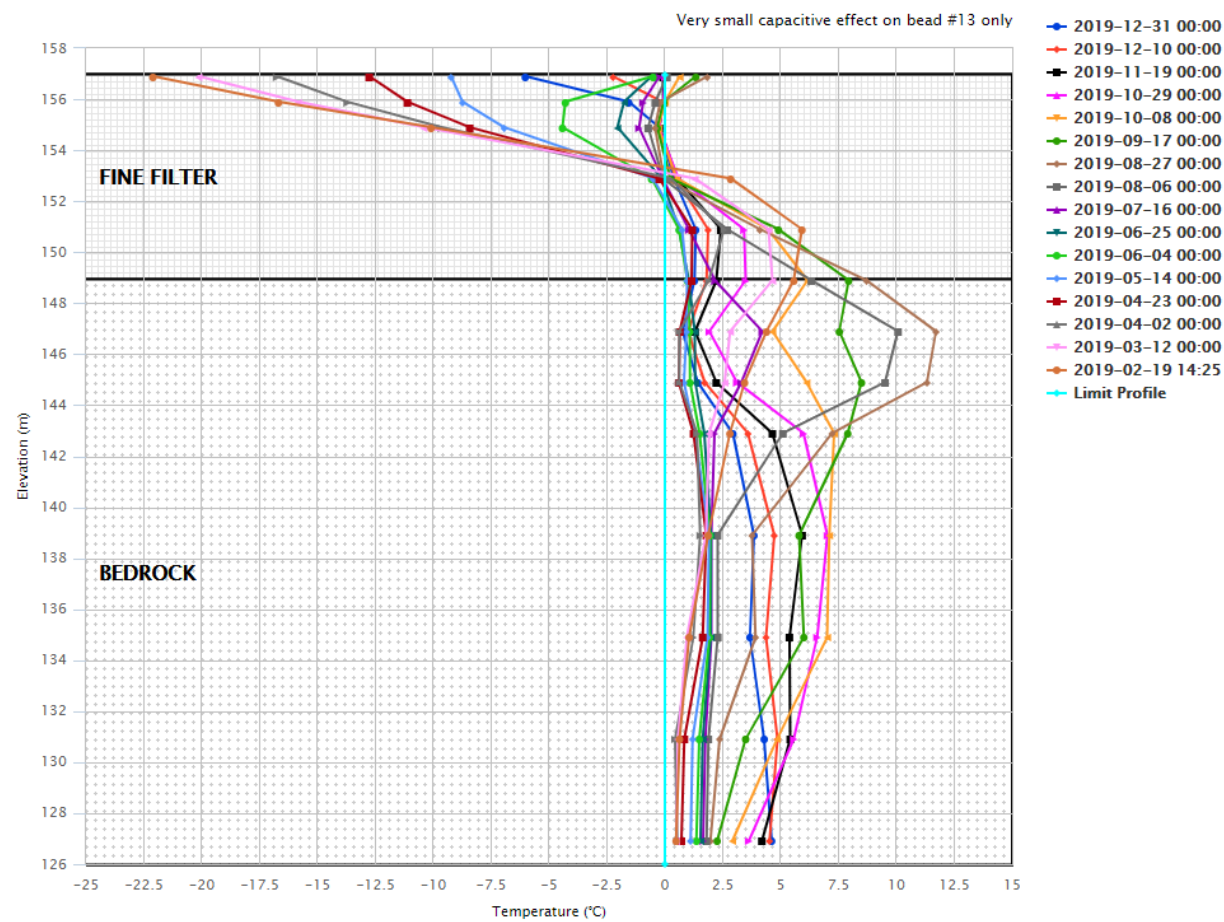
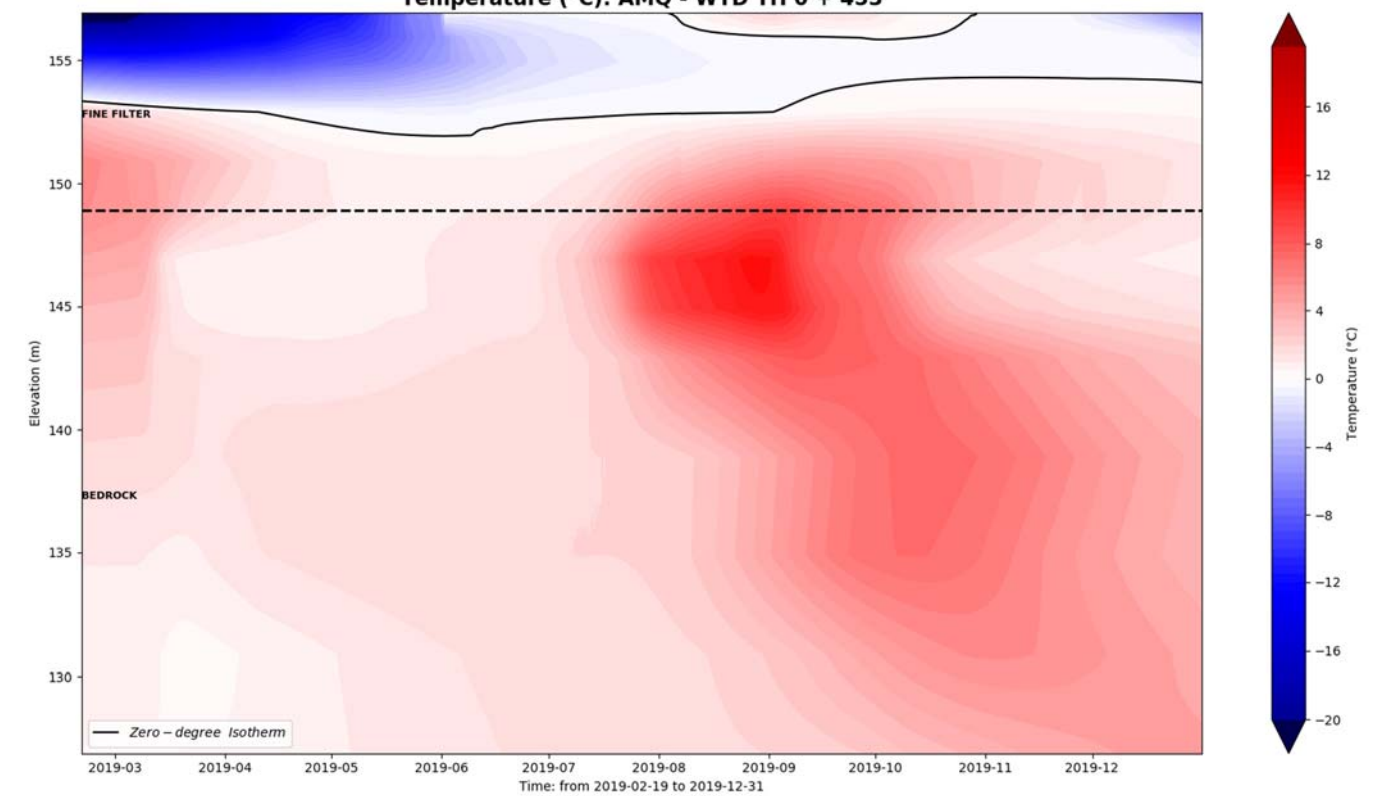


WTD-TH 0+453



AMQ - WTD TH: 0+453

Temperature (°C): AMQ - WTD TH 0 + 453

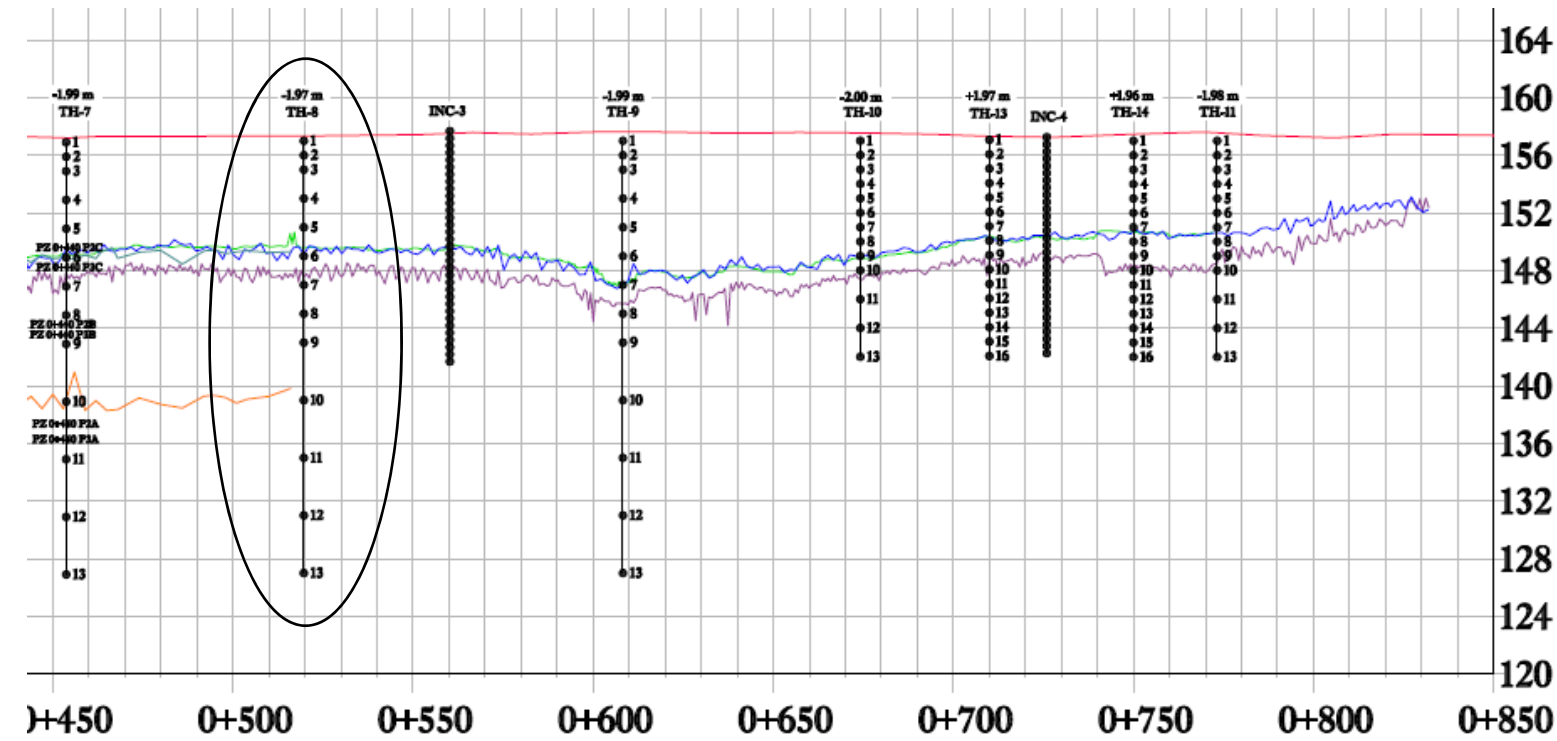
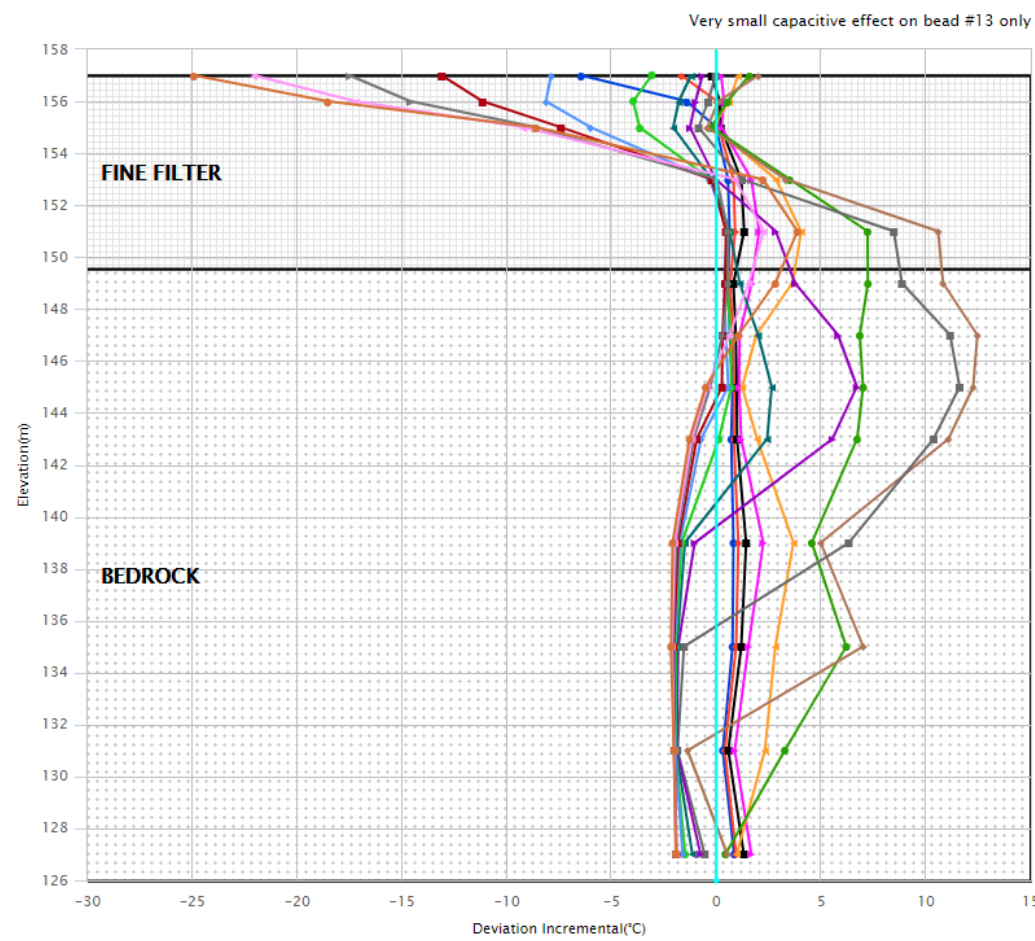
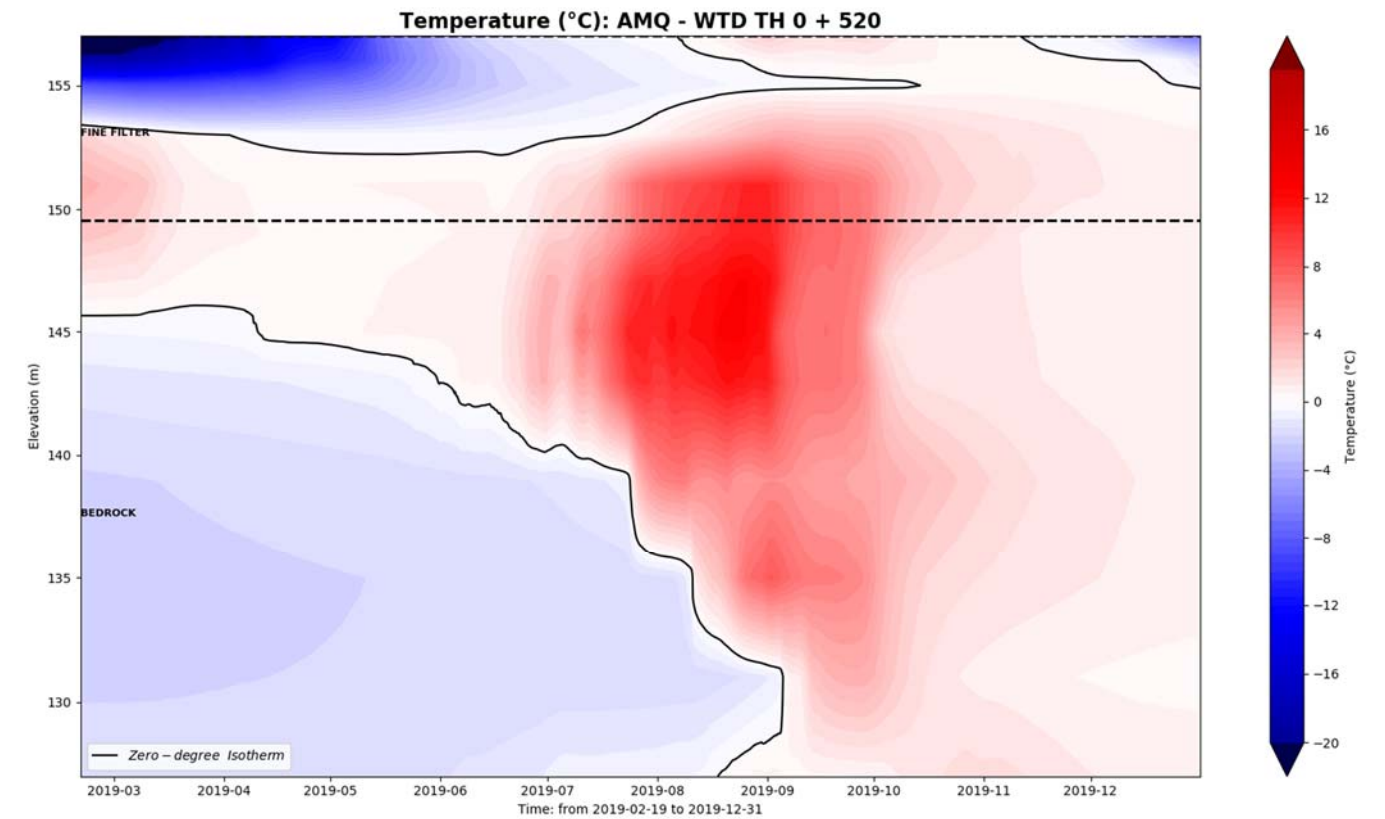




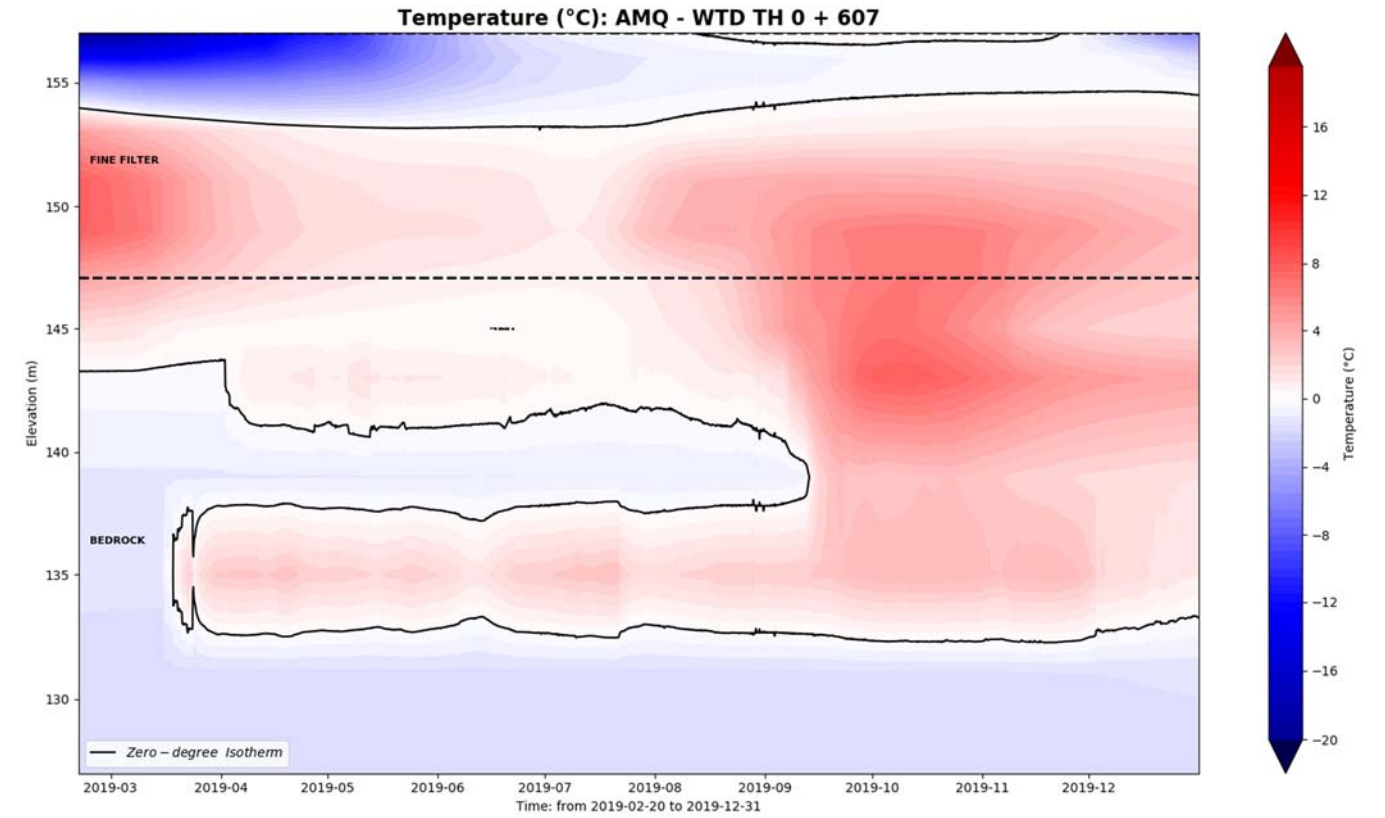
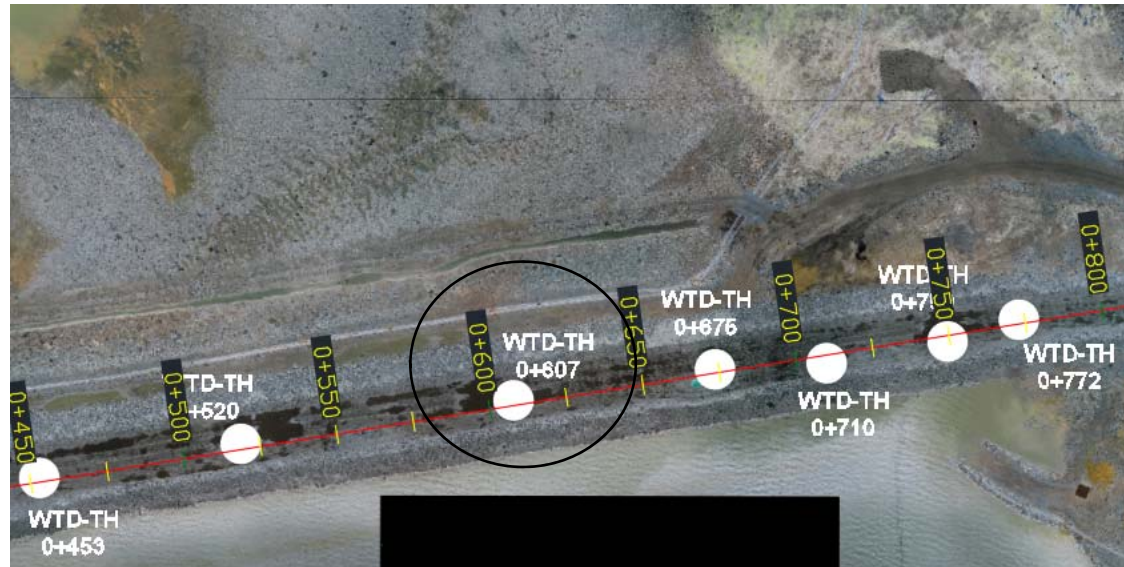
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AMQ - WTD TH: 0+520

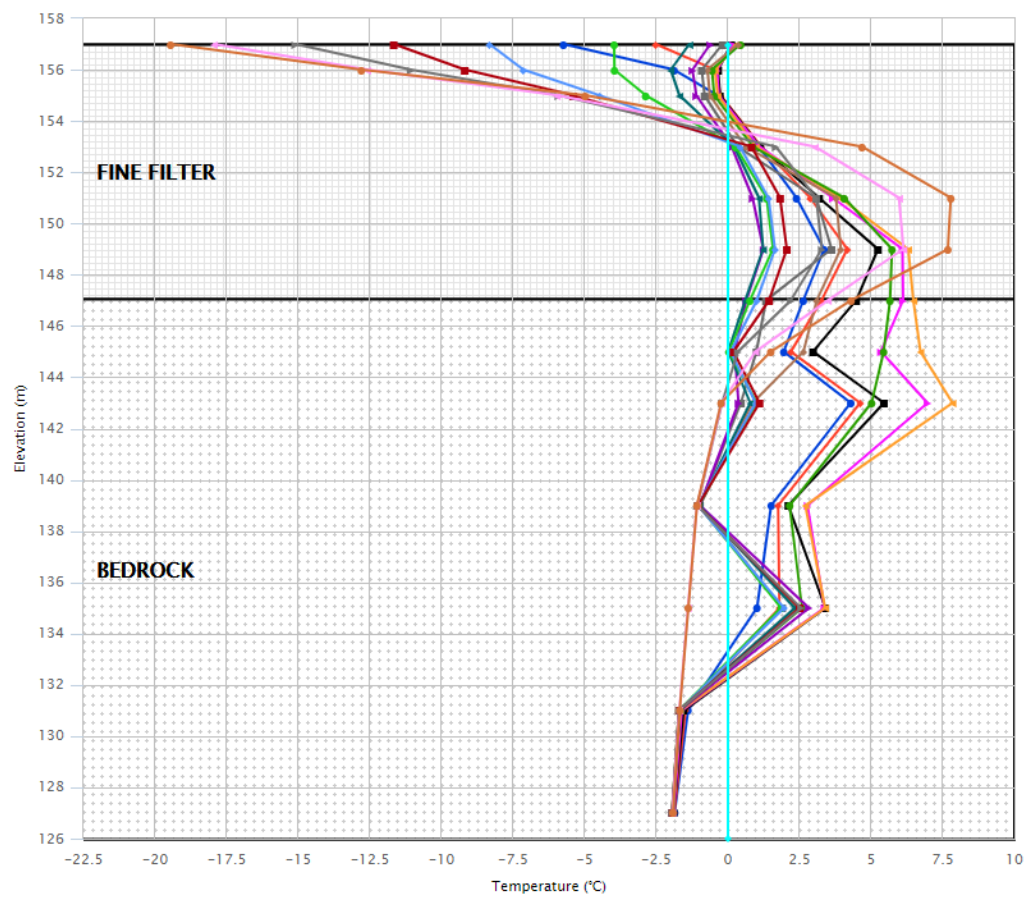


WTD-TH 0+607

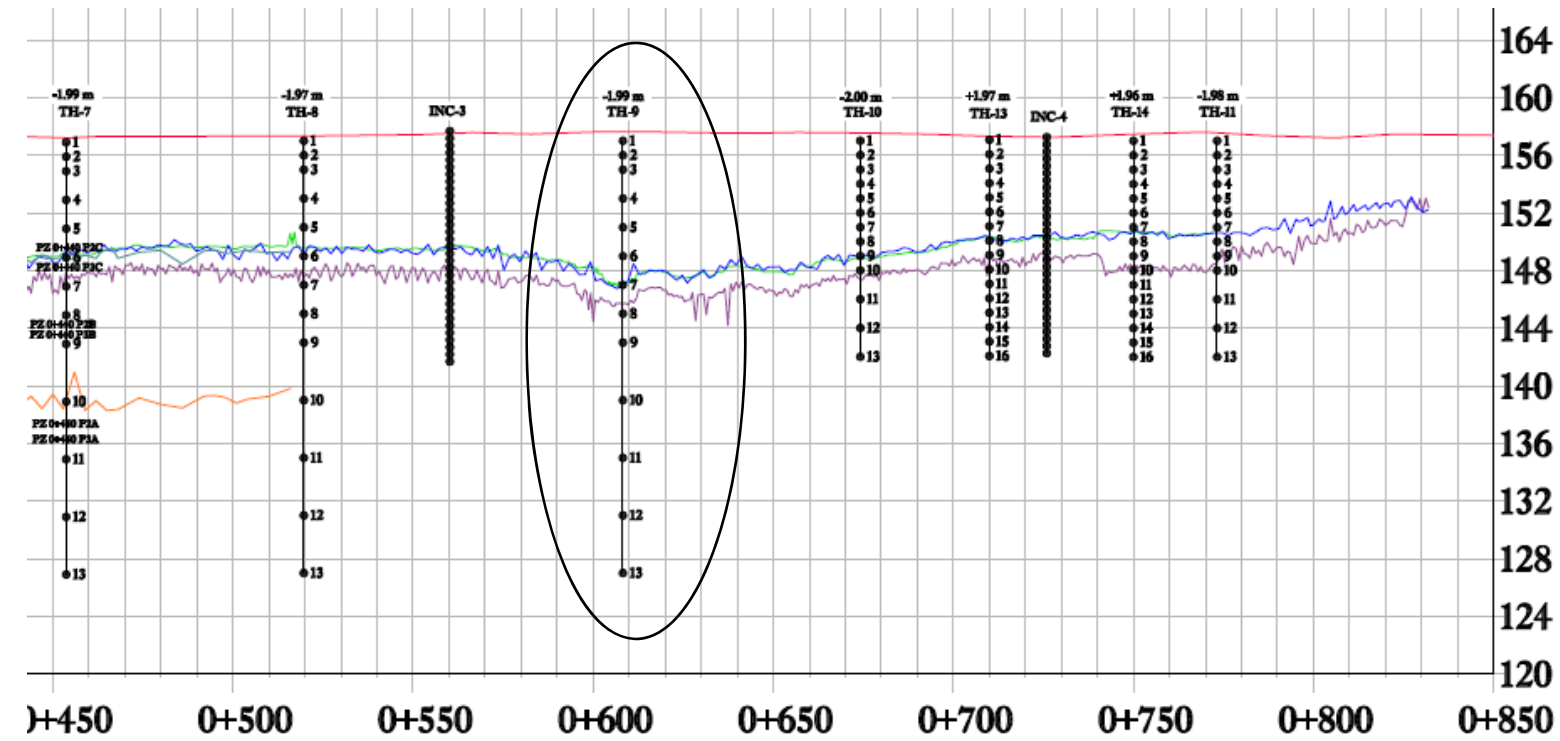


AMQ - WTD TH: 0+607

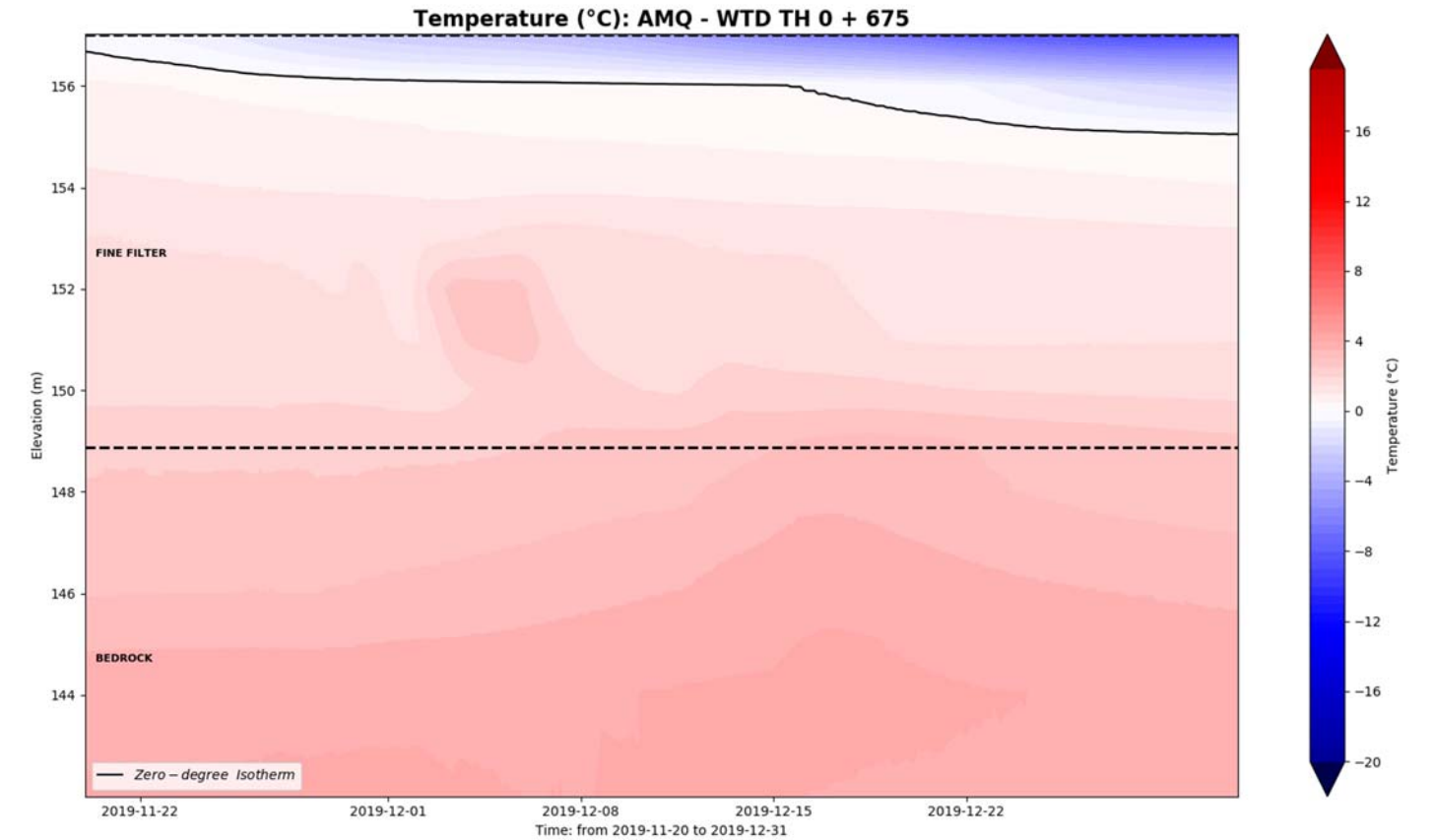
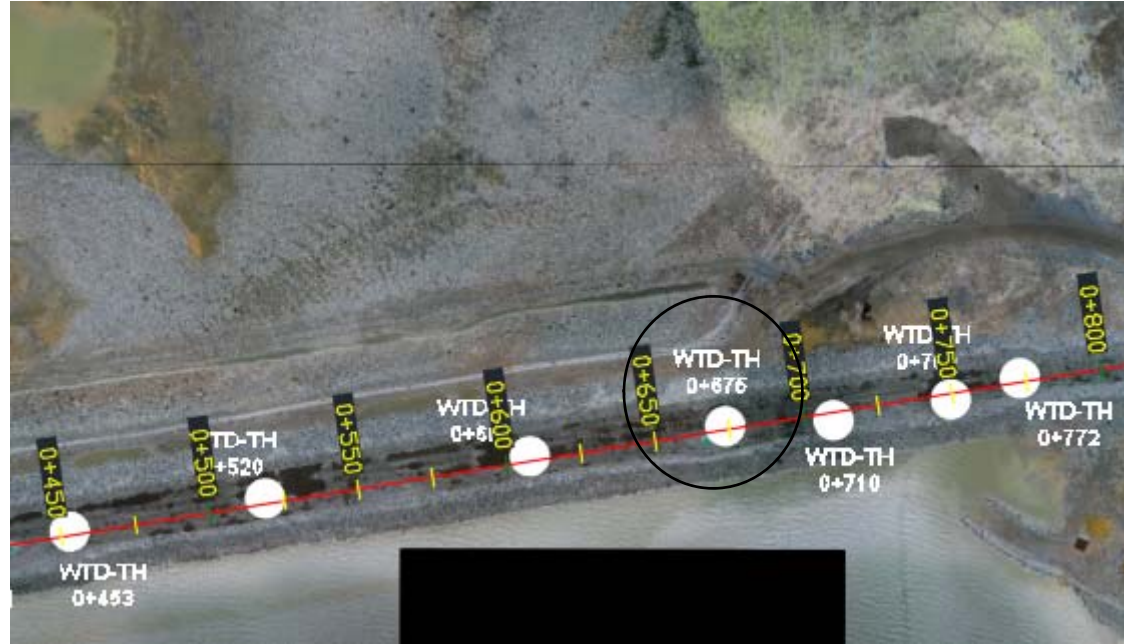
Significant capacitive effect Beads # 9 and #11. Bd #4, #6 and #7 have small effect.



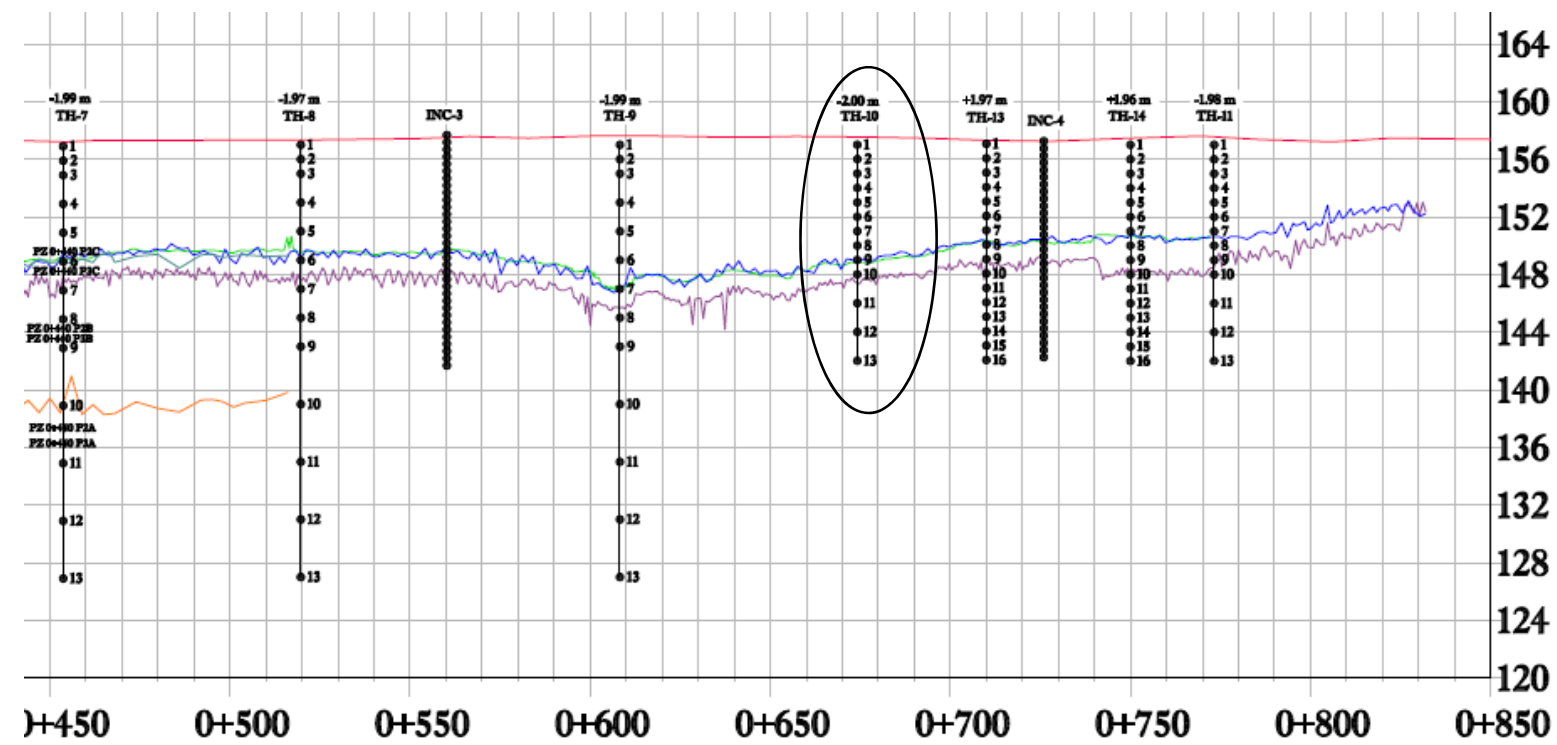
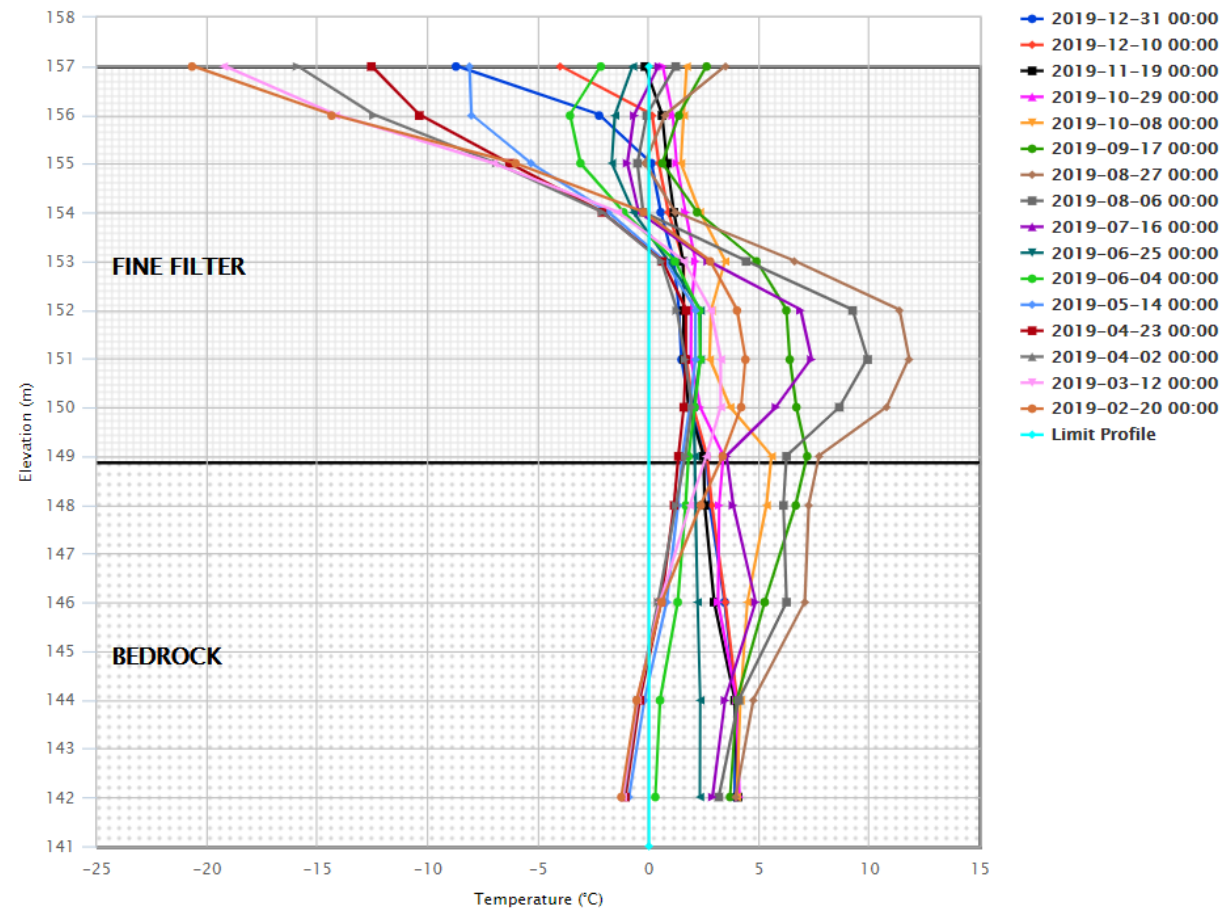
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-04-23 00:00
- 2019-04-02 00:00
- 2019-03-12 00:00
- 2019-02-20 00:00
- Limit Profile



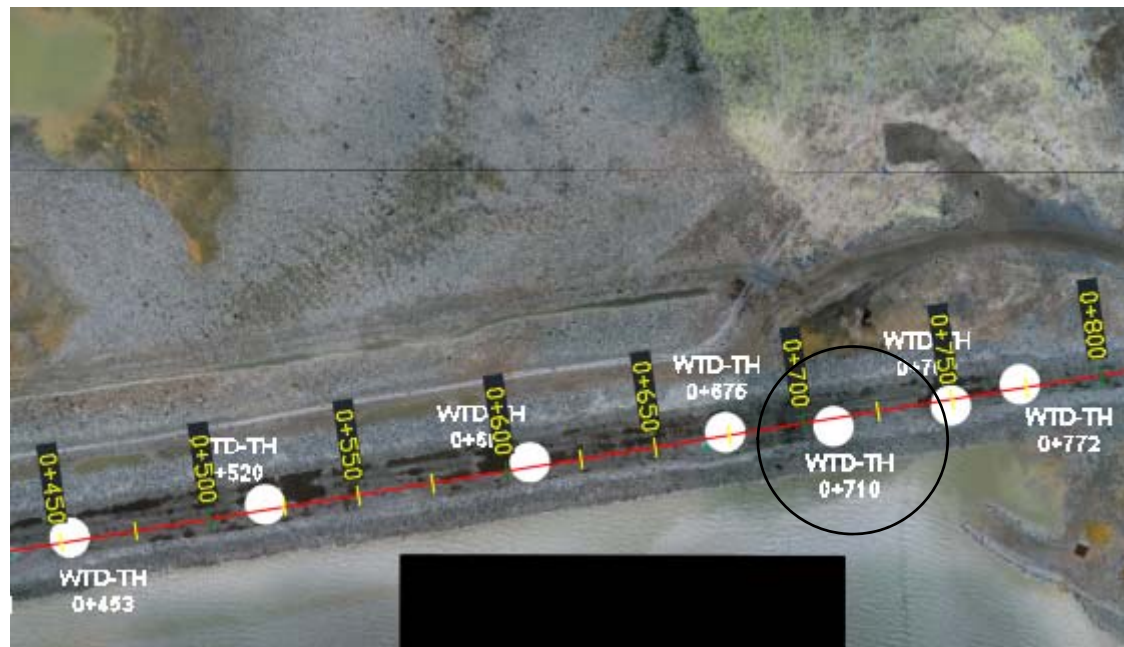
WTD-TH 0+675



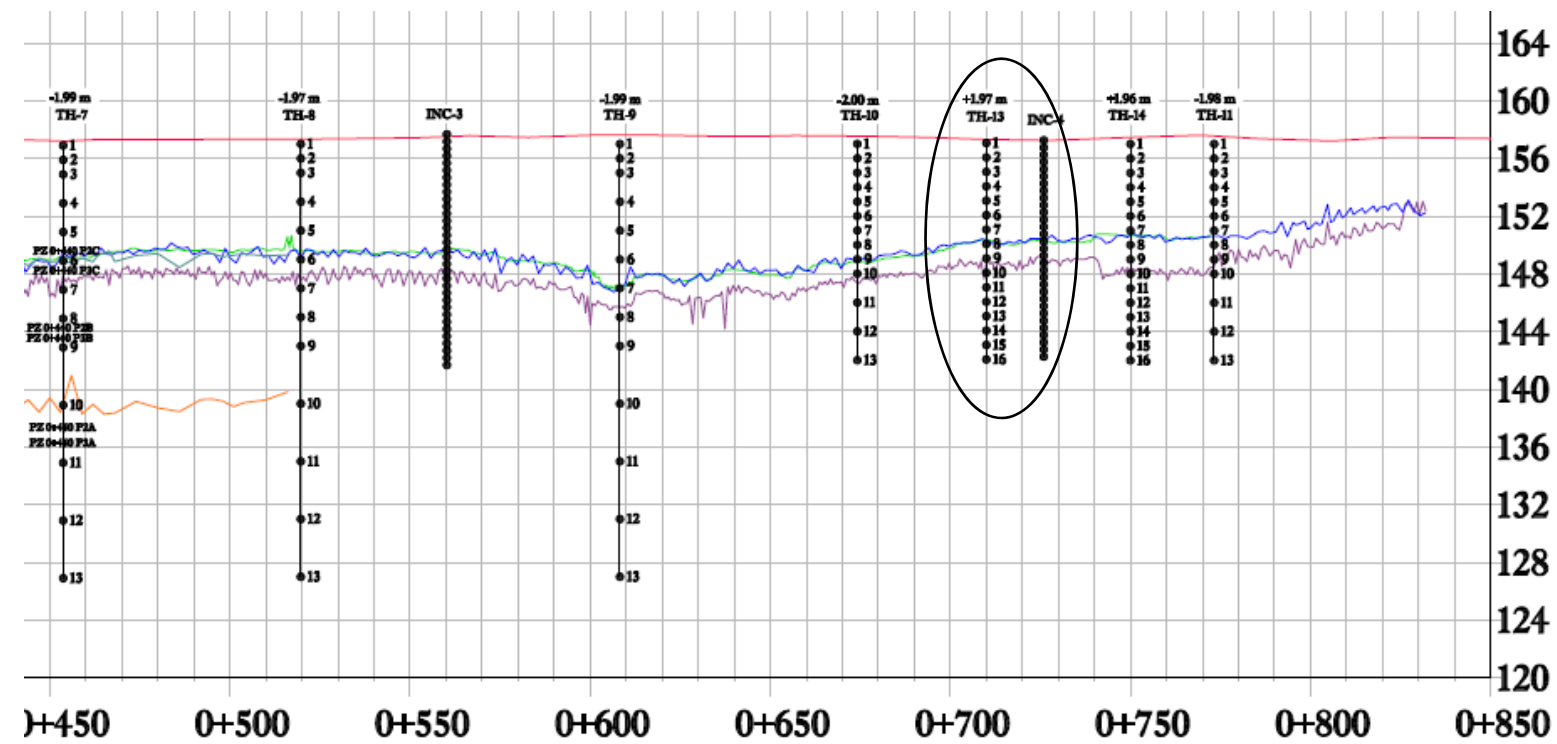
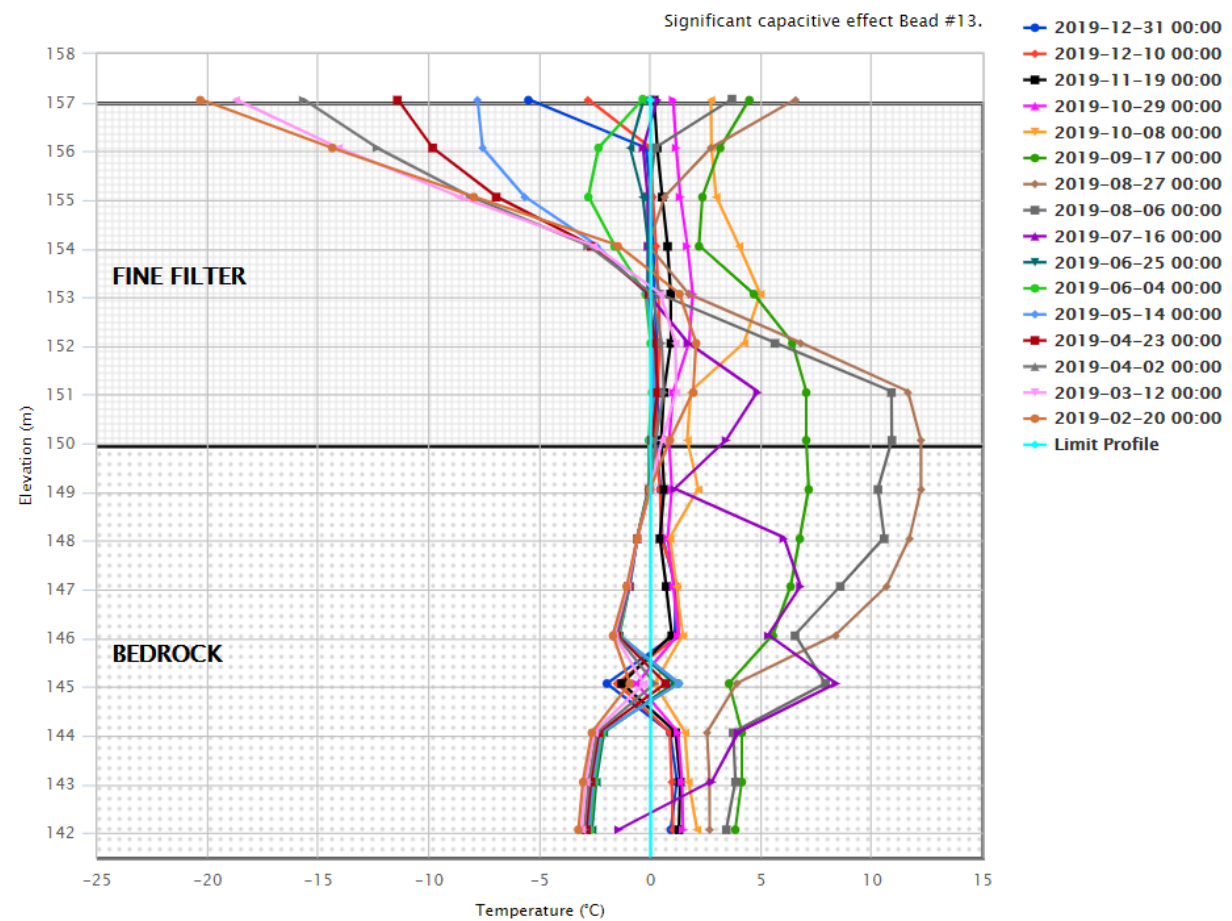
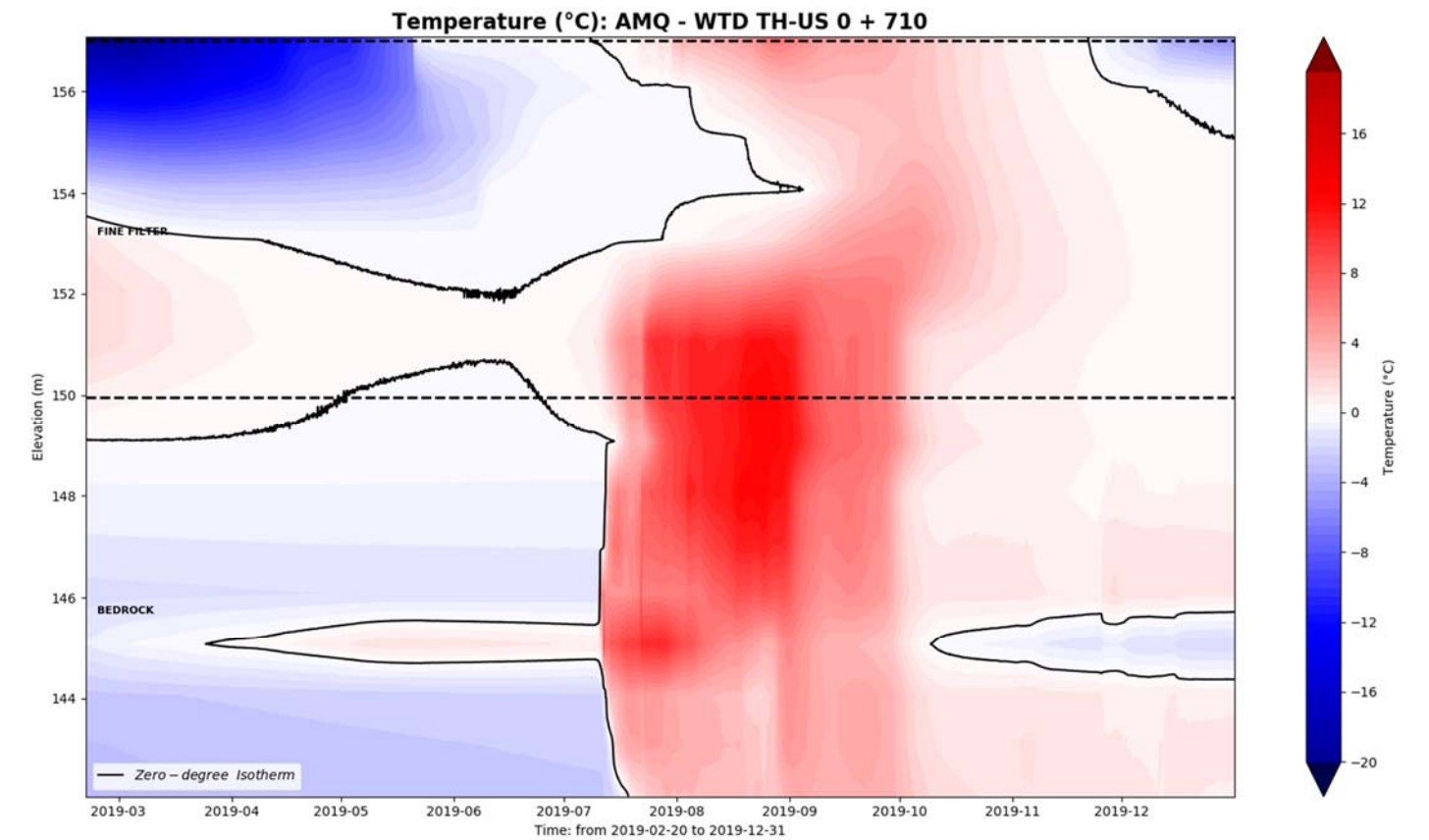
AMQ - WTD TH: 0+675



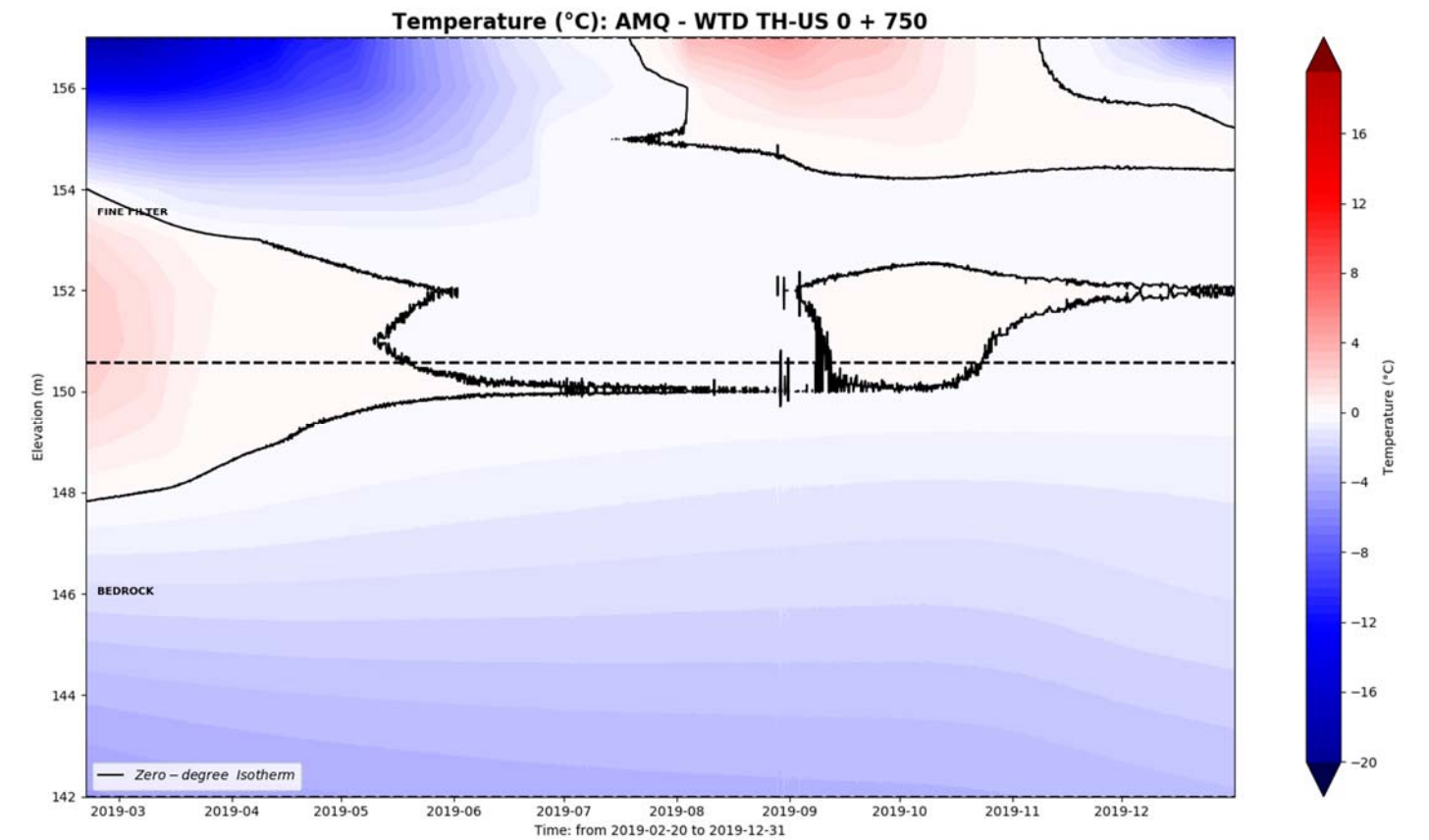
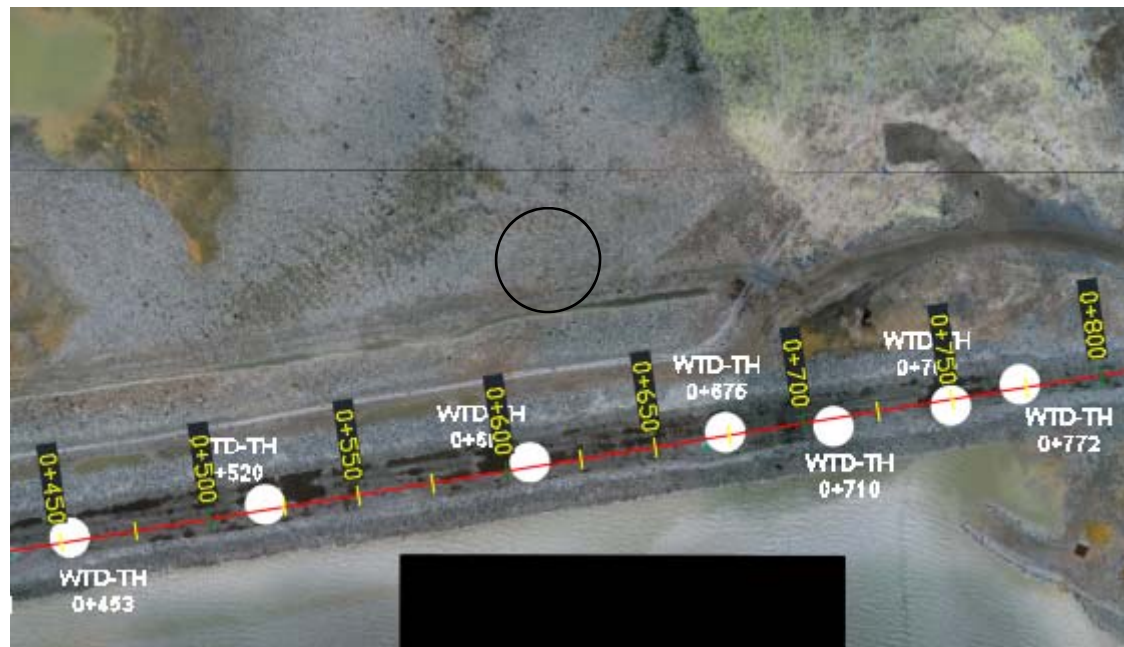
WTD-TH 0+710 U/S



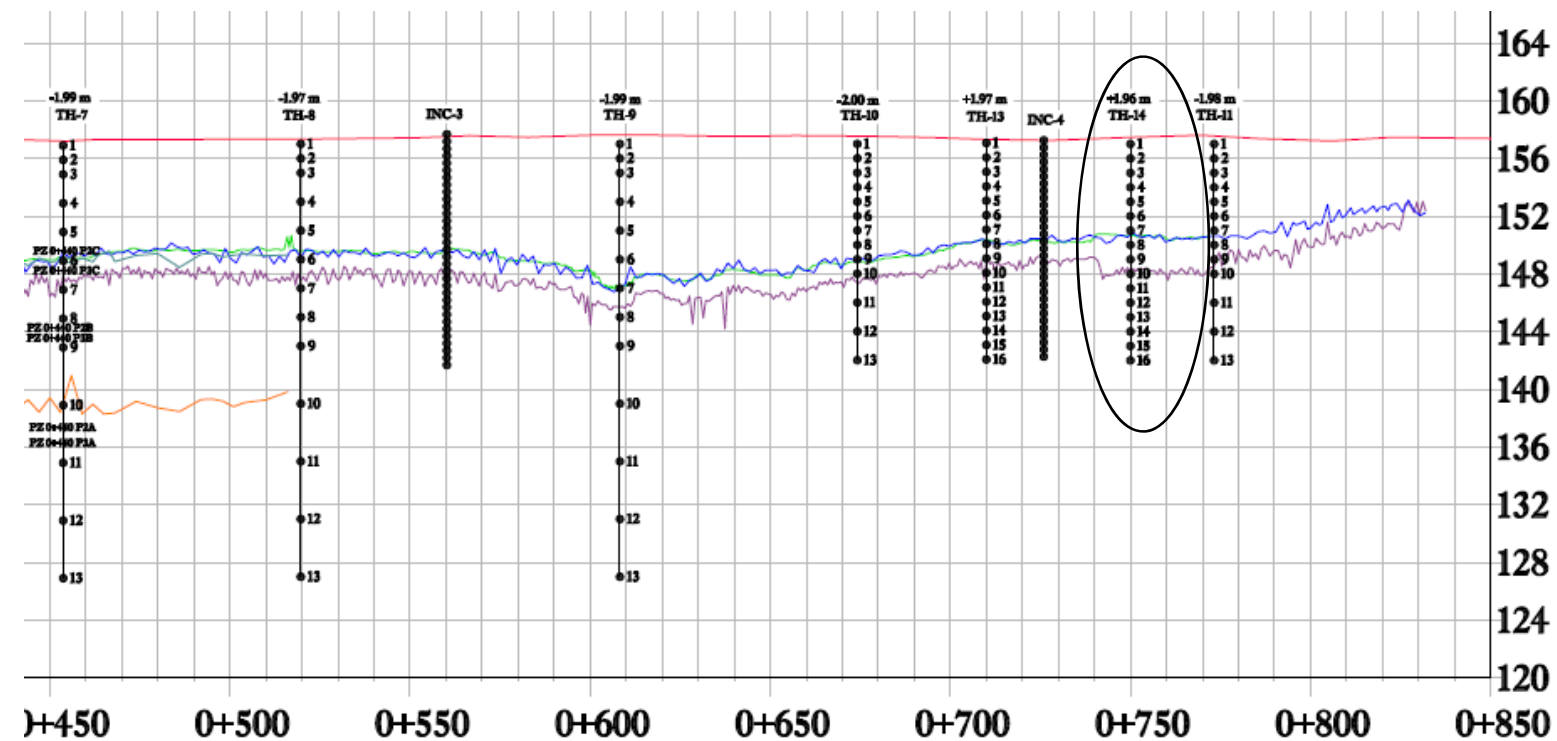
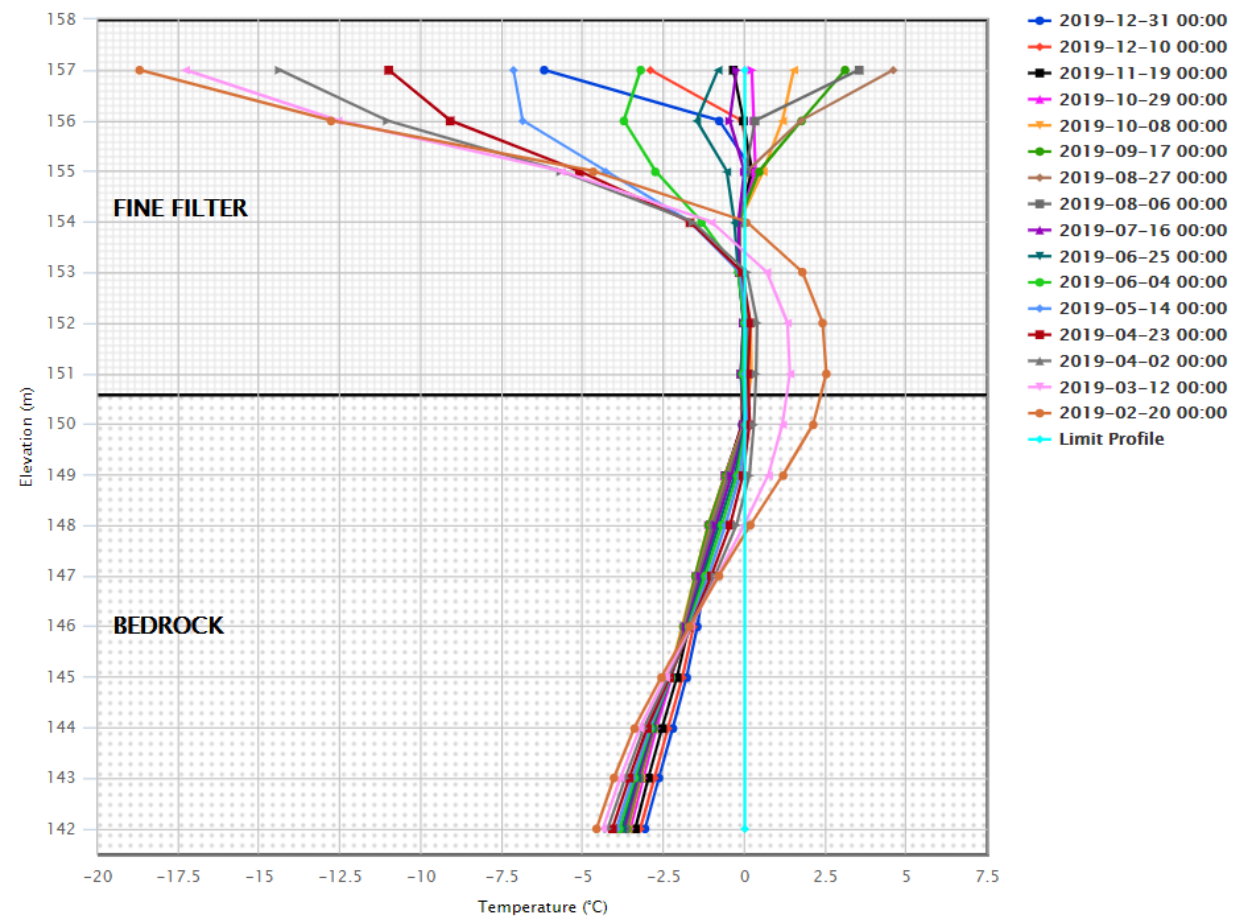
AMQ – WTD TH-US: 0+710



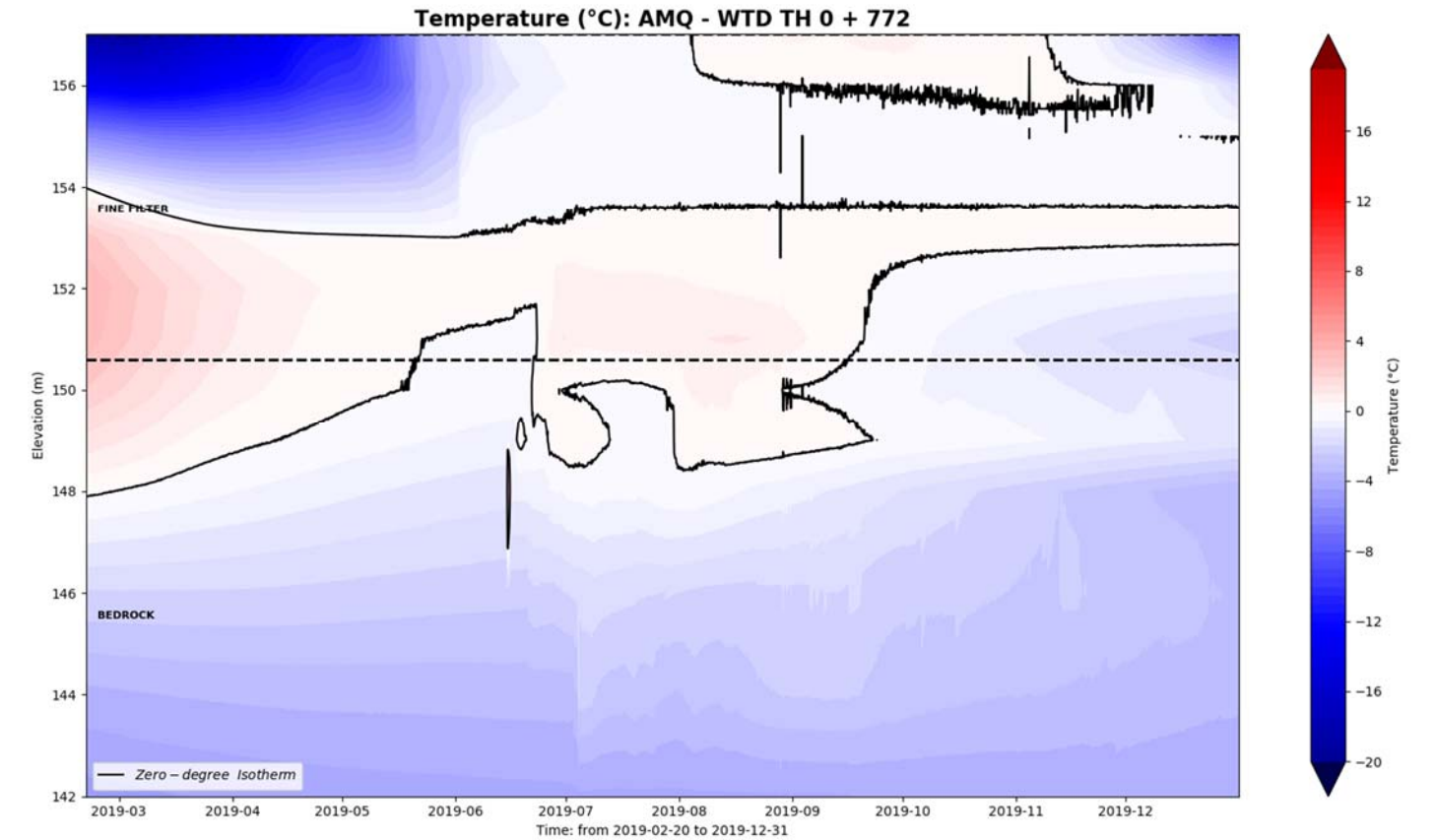
WTD-TH 0+750



AMQ - WTD TH-US: 0+750

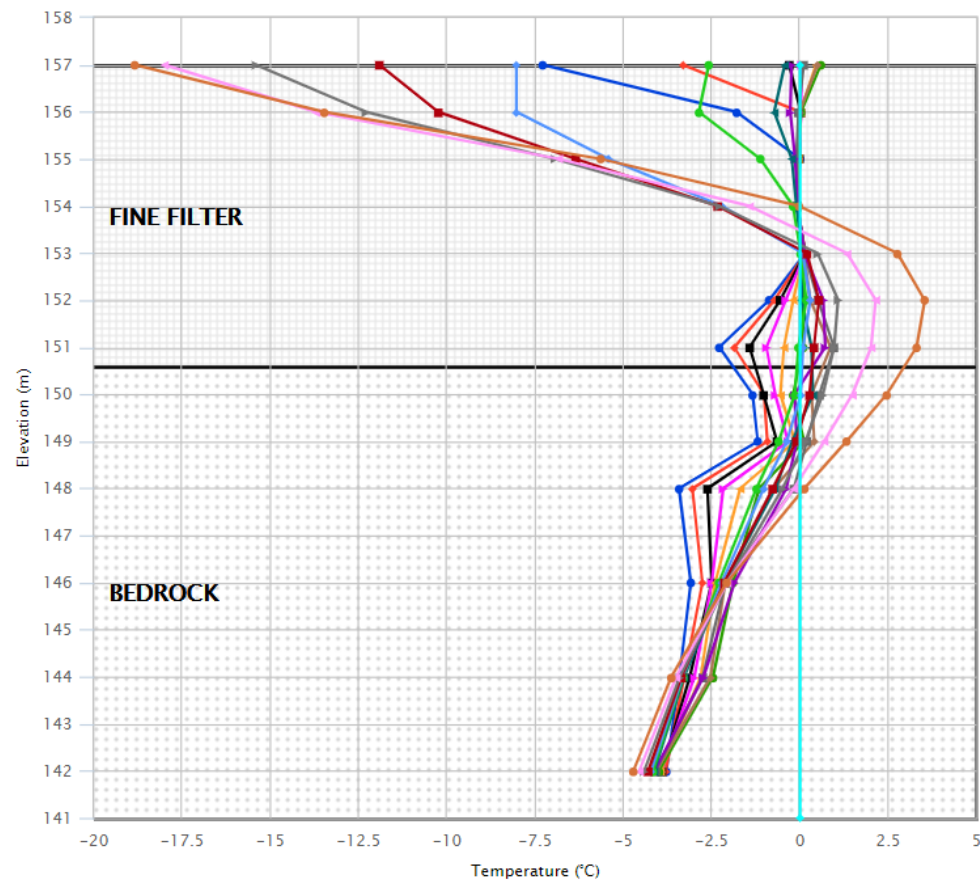


WTD-TH 0+772 U/S

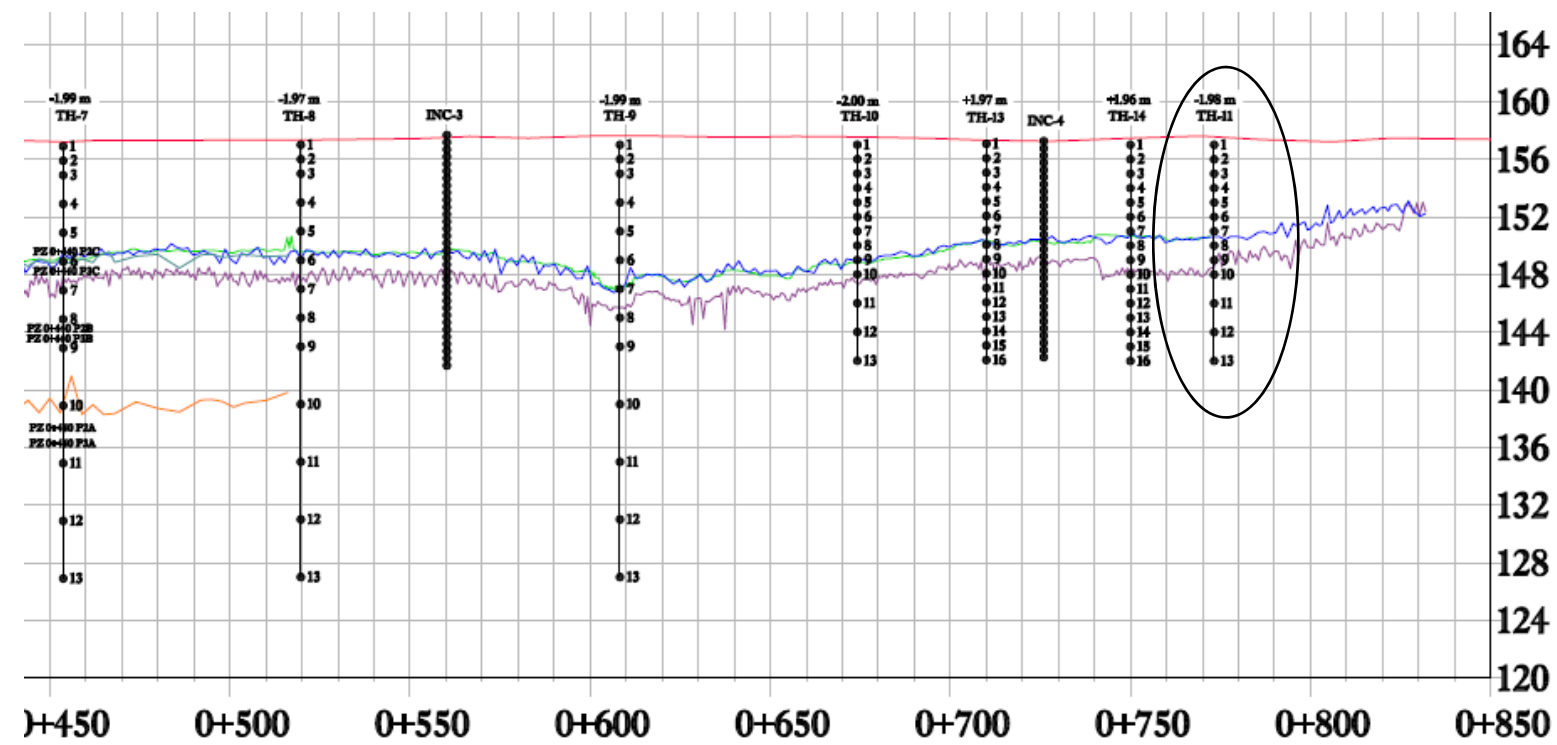


AMQ – WTD TH: 0+772

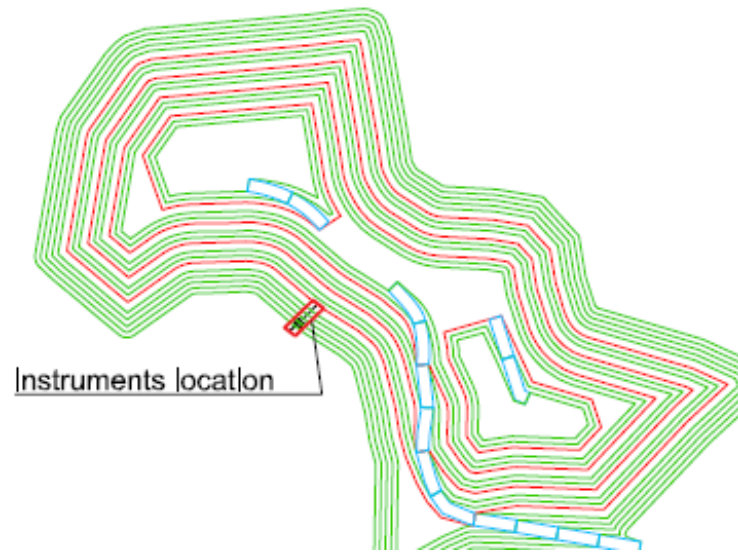
Mostly all beads have capacitive effect. Beads # 1, #2, #4 and #13 still good.



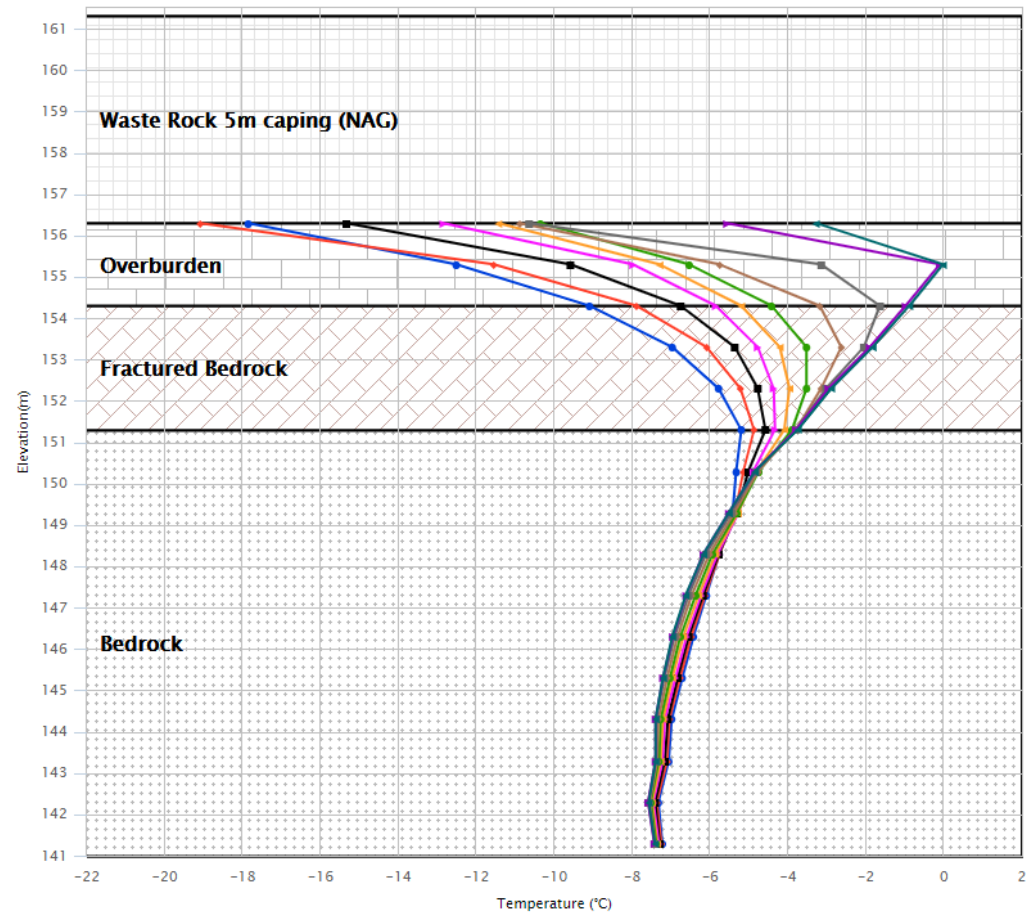
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-04-23 00:00
- 2019-04-02 00:00
- 2019-03-12 00:00
- 2019-02-20 00:00
- Limit Profile



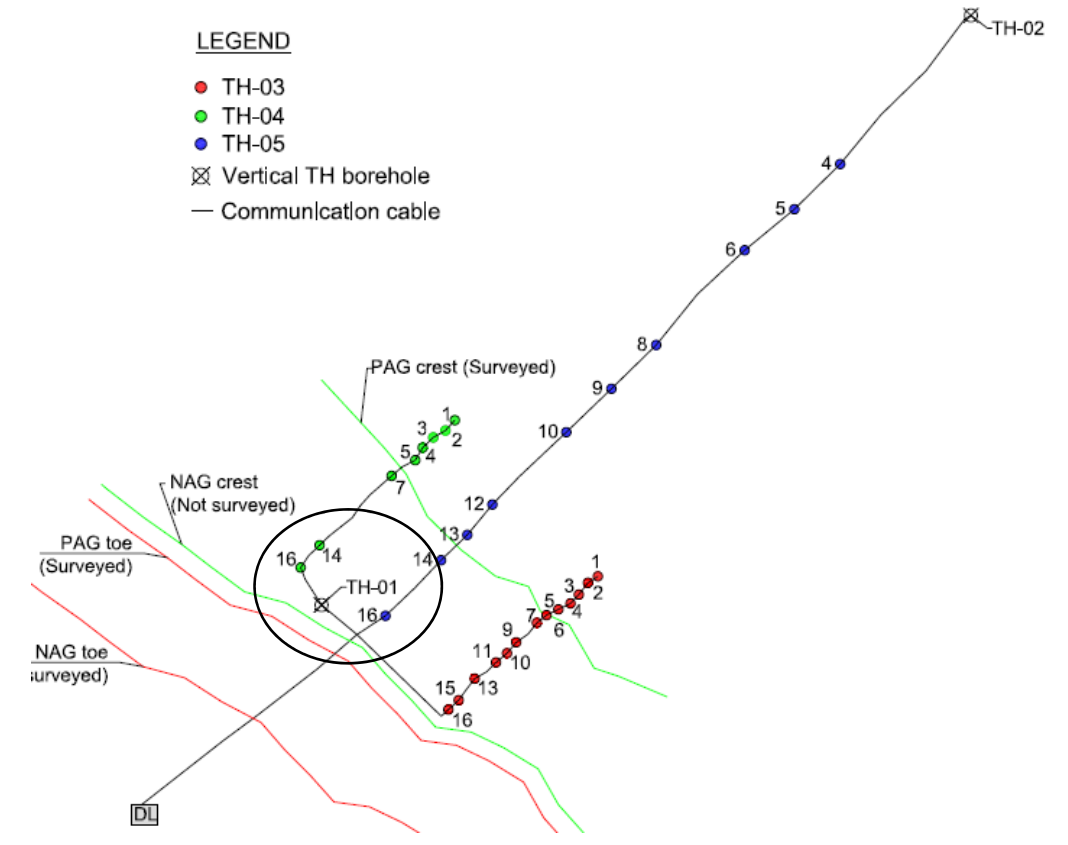
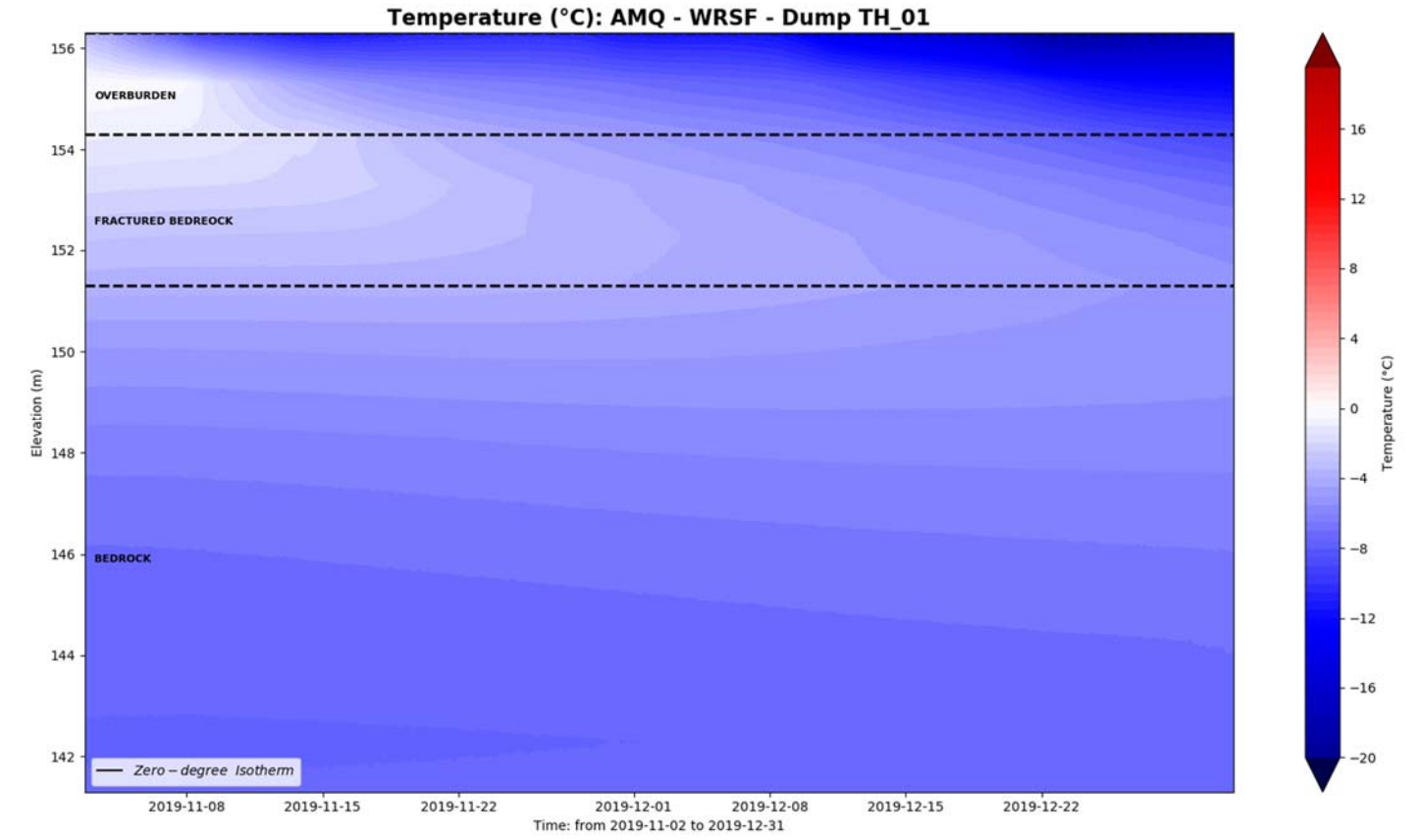
WRSF Th01



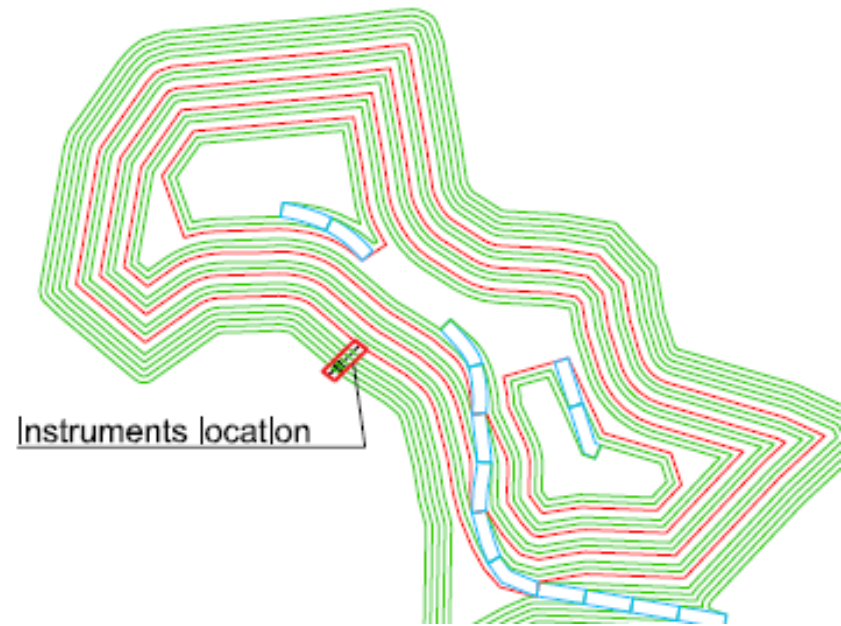
AMQ - WRSF - Dump TH\_01



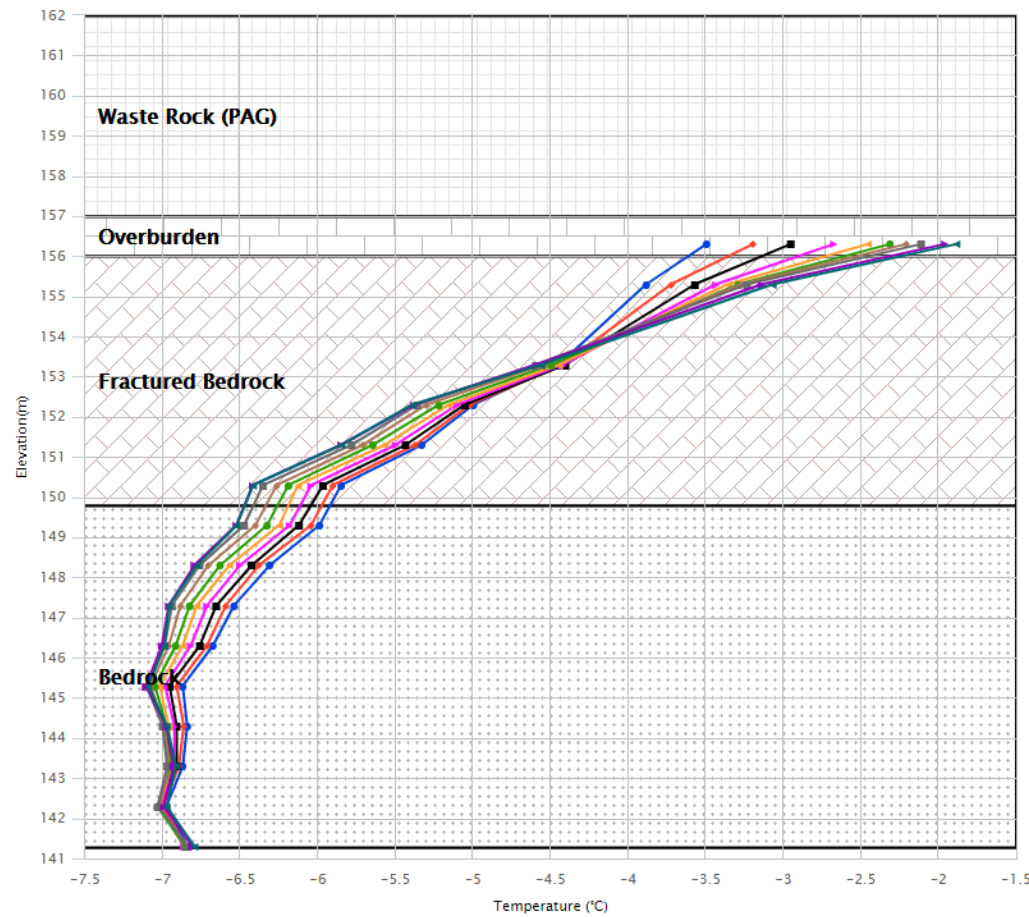
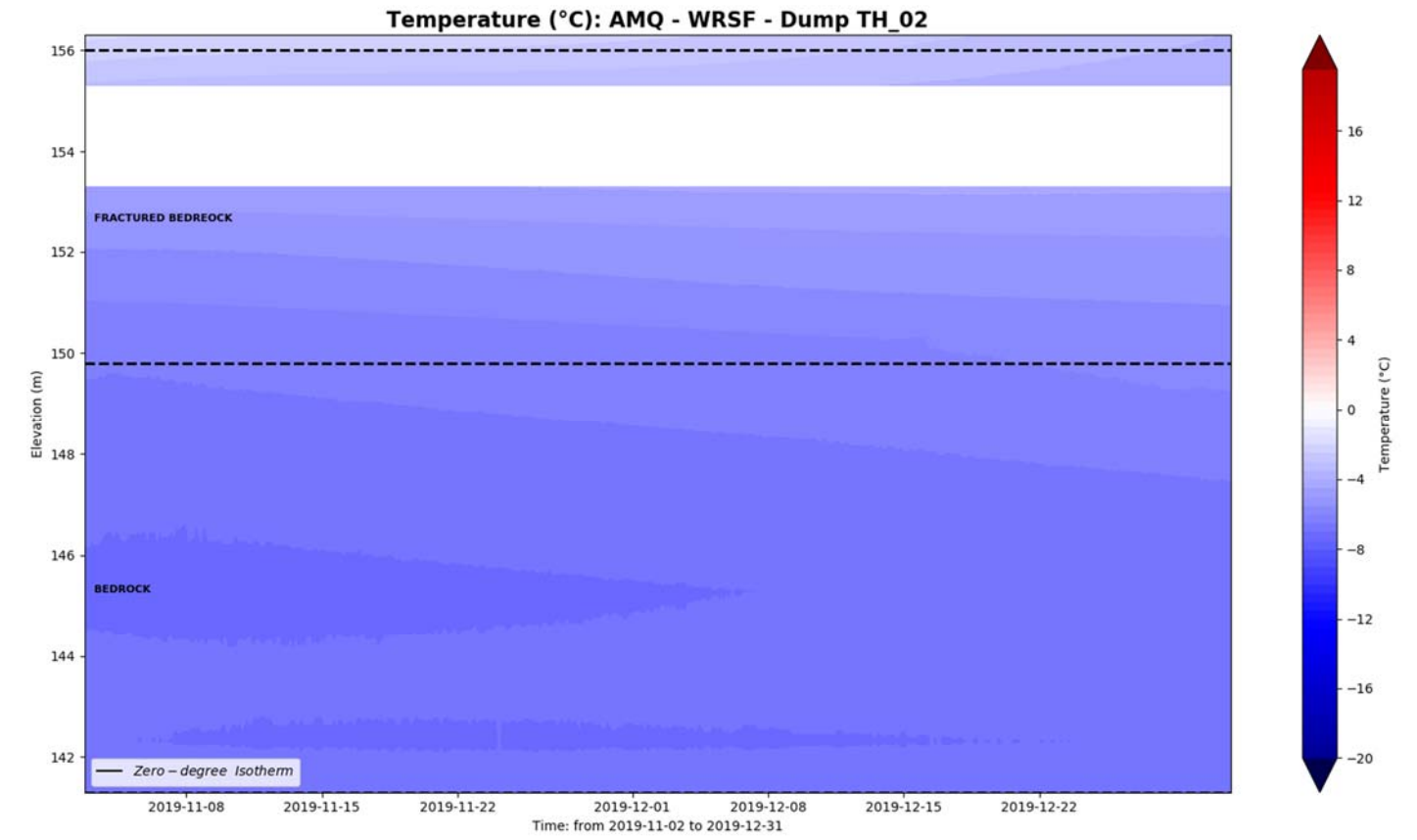
- 2019-12-31 00:00
- 2019-12-24 00:00
- 2019-12-17 00:00
- 2019-12-10 00:00
- 2019-12-03 00:00
- 2019-11-26 00:00
- 2019-11-19 00:00
- 2019-11-12 00:00
- 2019-11-05 00:00
- 2019-11-02 18:00



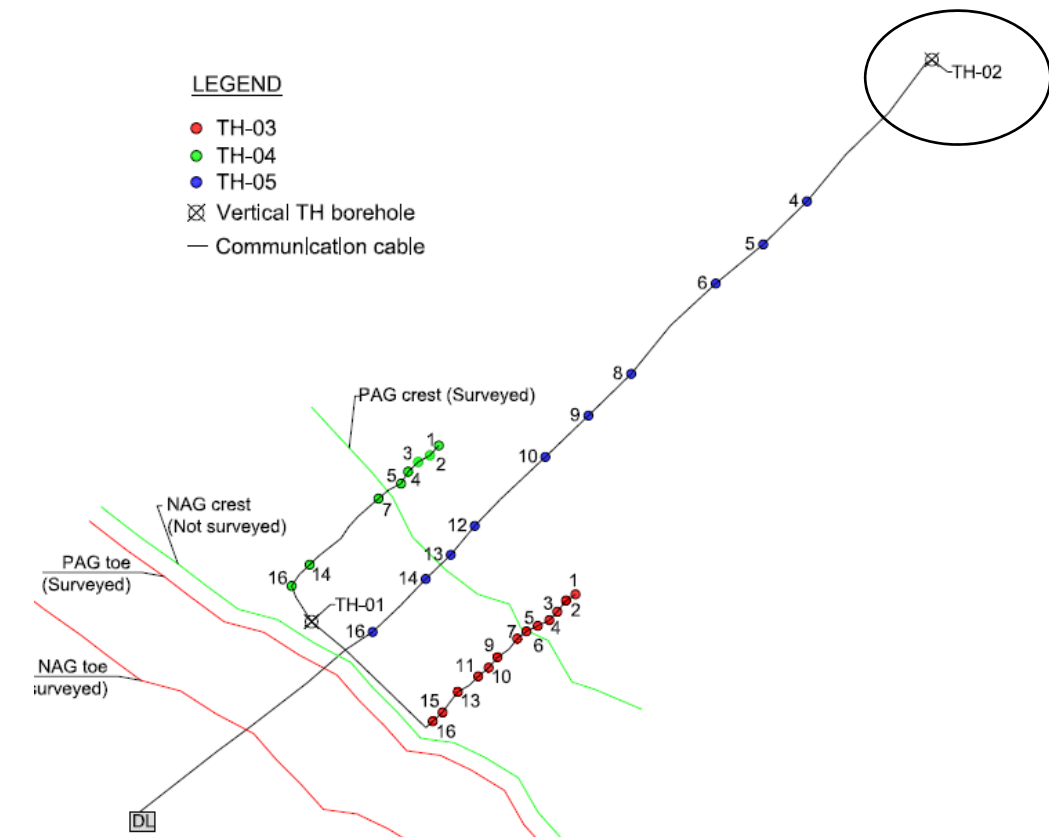
WRSF TH02



AMQ - WRSF - Dump TH\_02

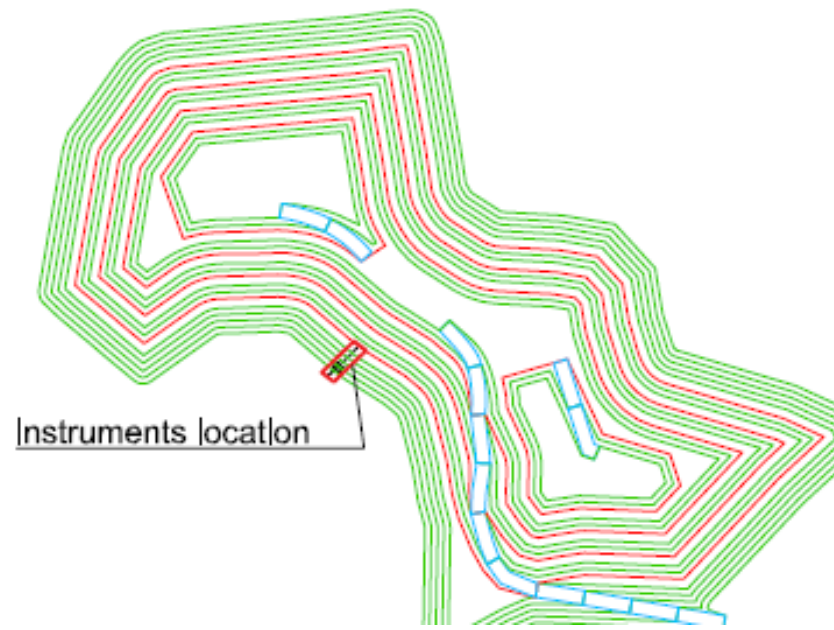


- 2019-12-31 00:00
- 2019-12-24 00:00
- 2019-12-17 00:00
- 2019-12-10 00:00
- 2019-12-03 00:00
- 2019-11-26 00:00
- 2019-11-19 00:00
- 2019-11-12 00:00
- 2019-11-05 00:00
- 2019-11-02 18:00

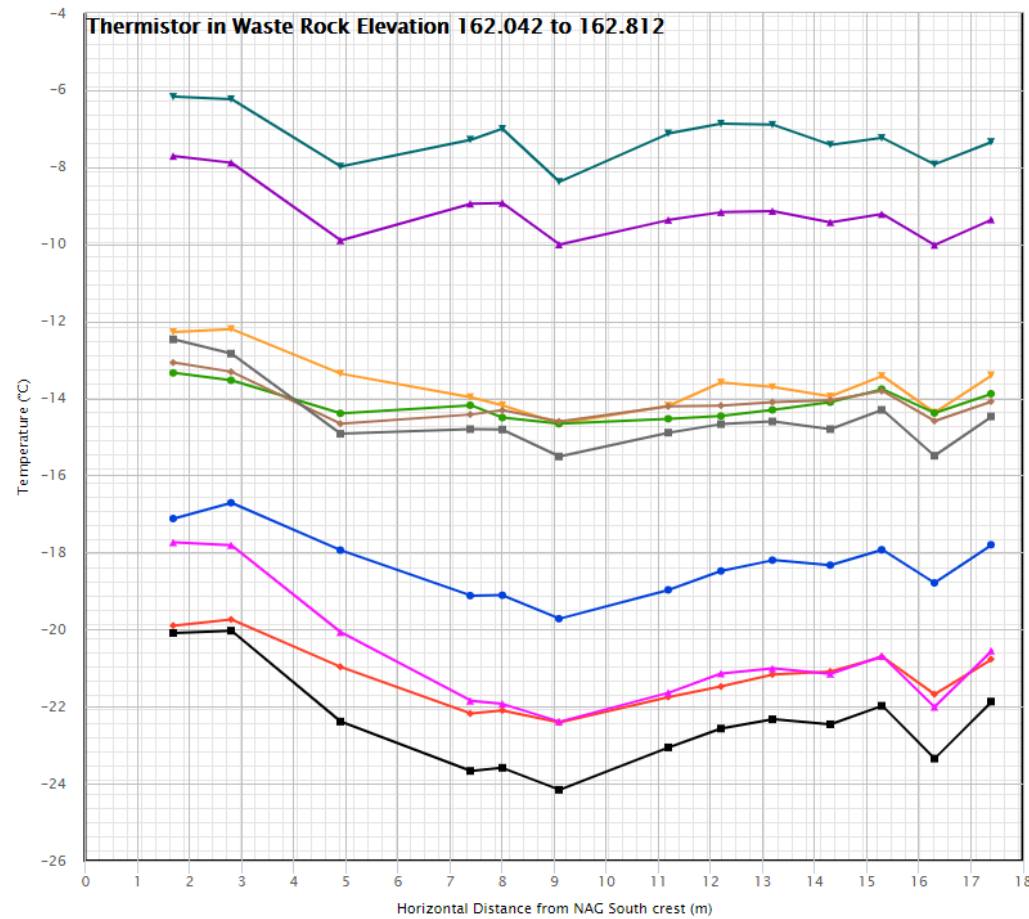
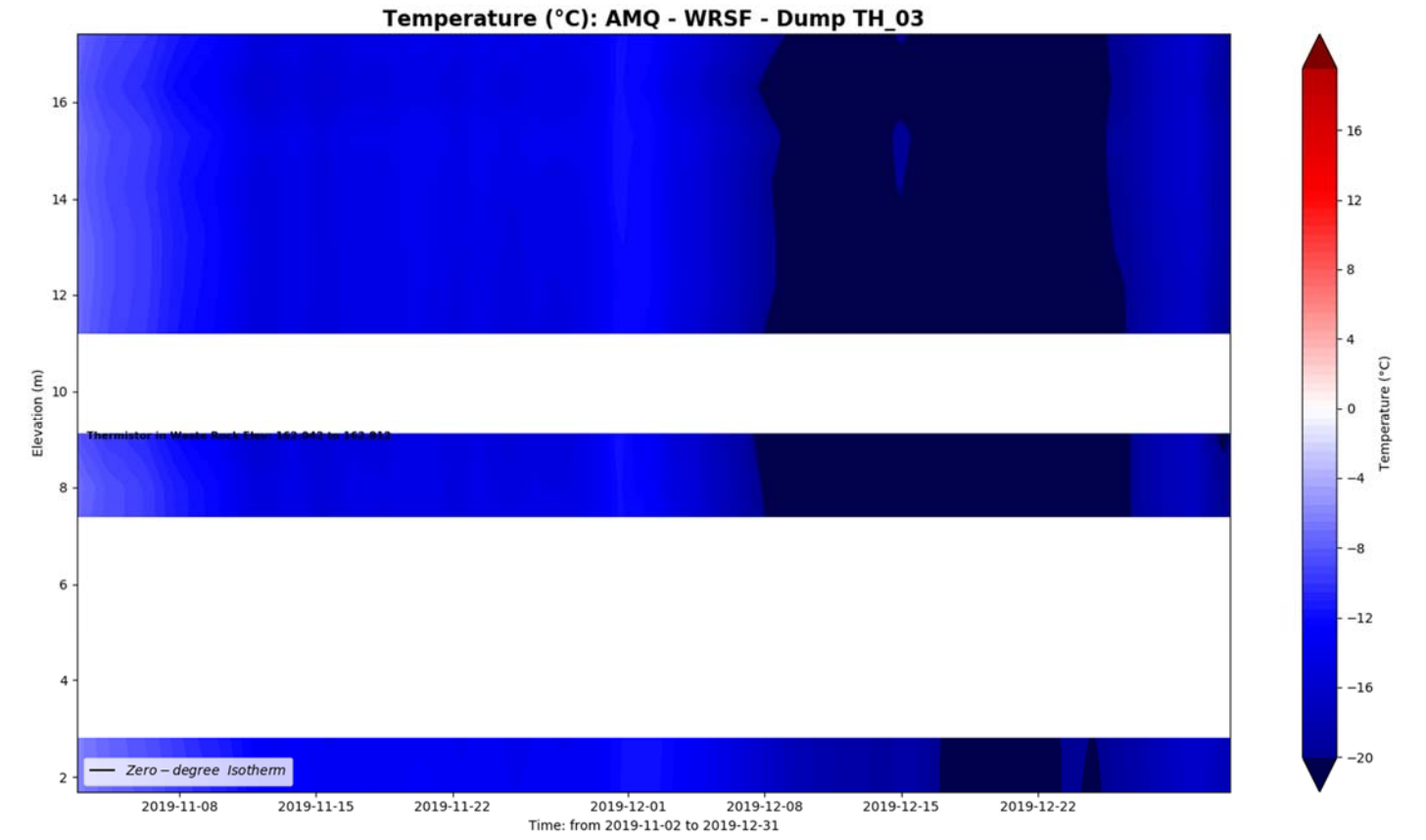




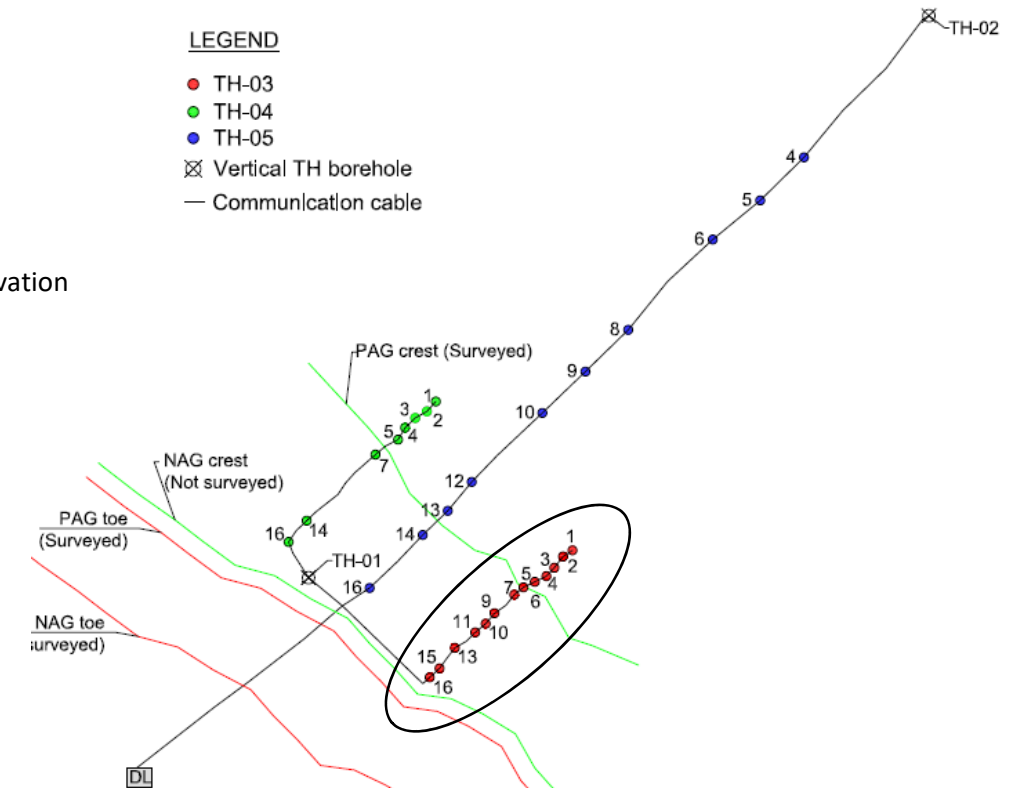
WRSF TH03



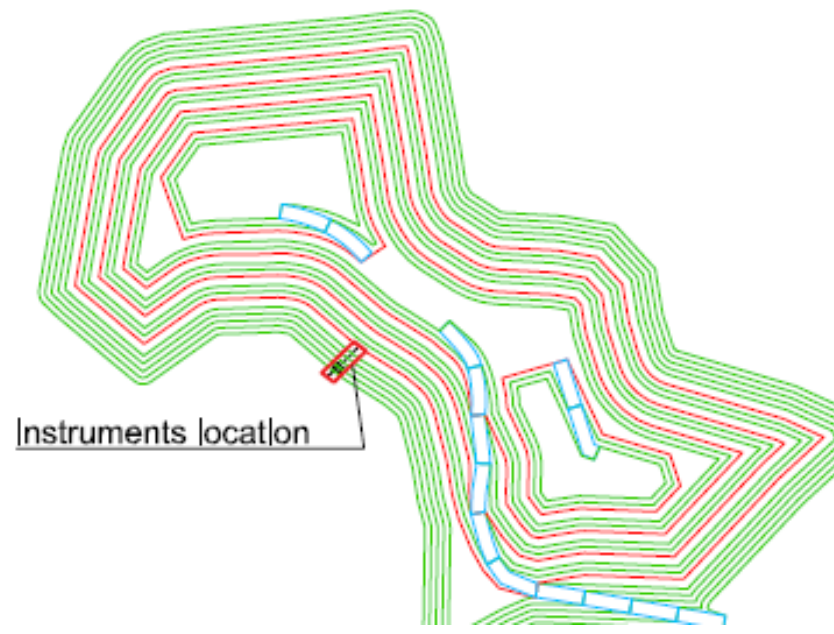
AMQ - WRSF - Dump TH\_03



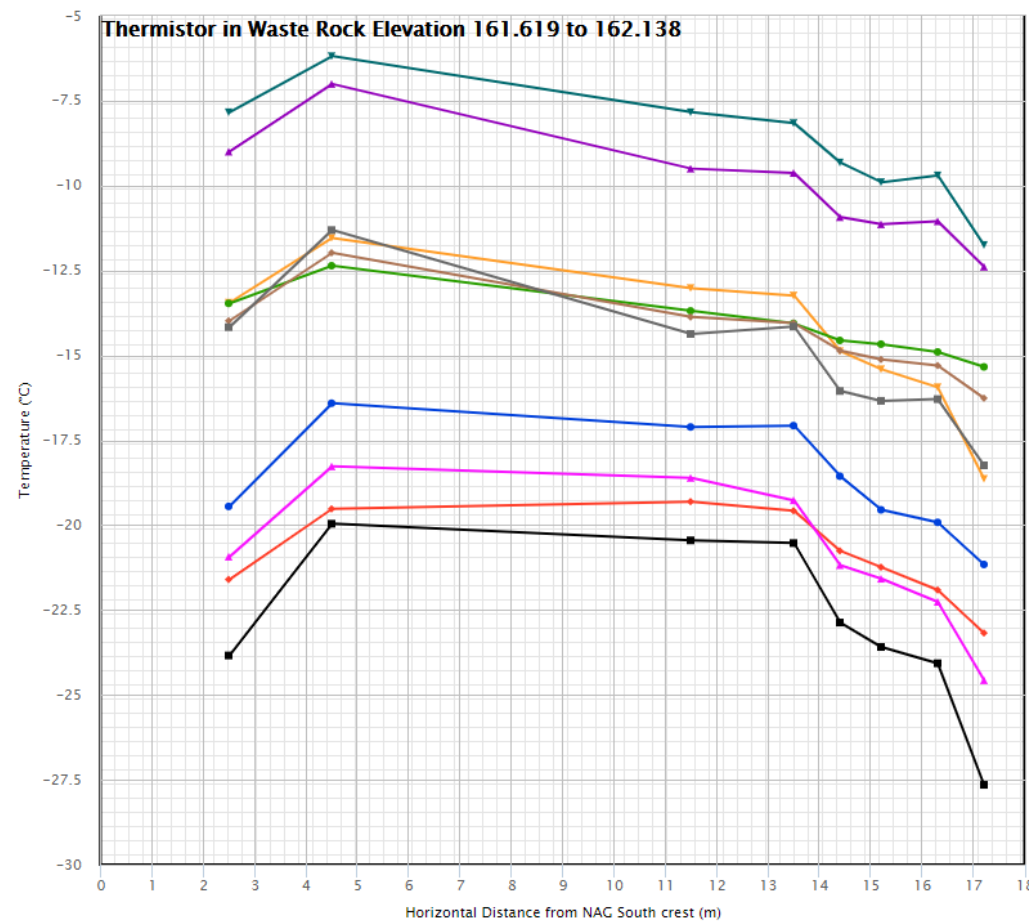
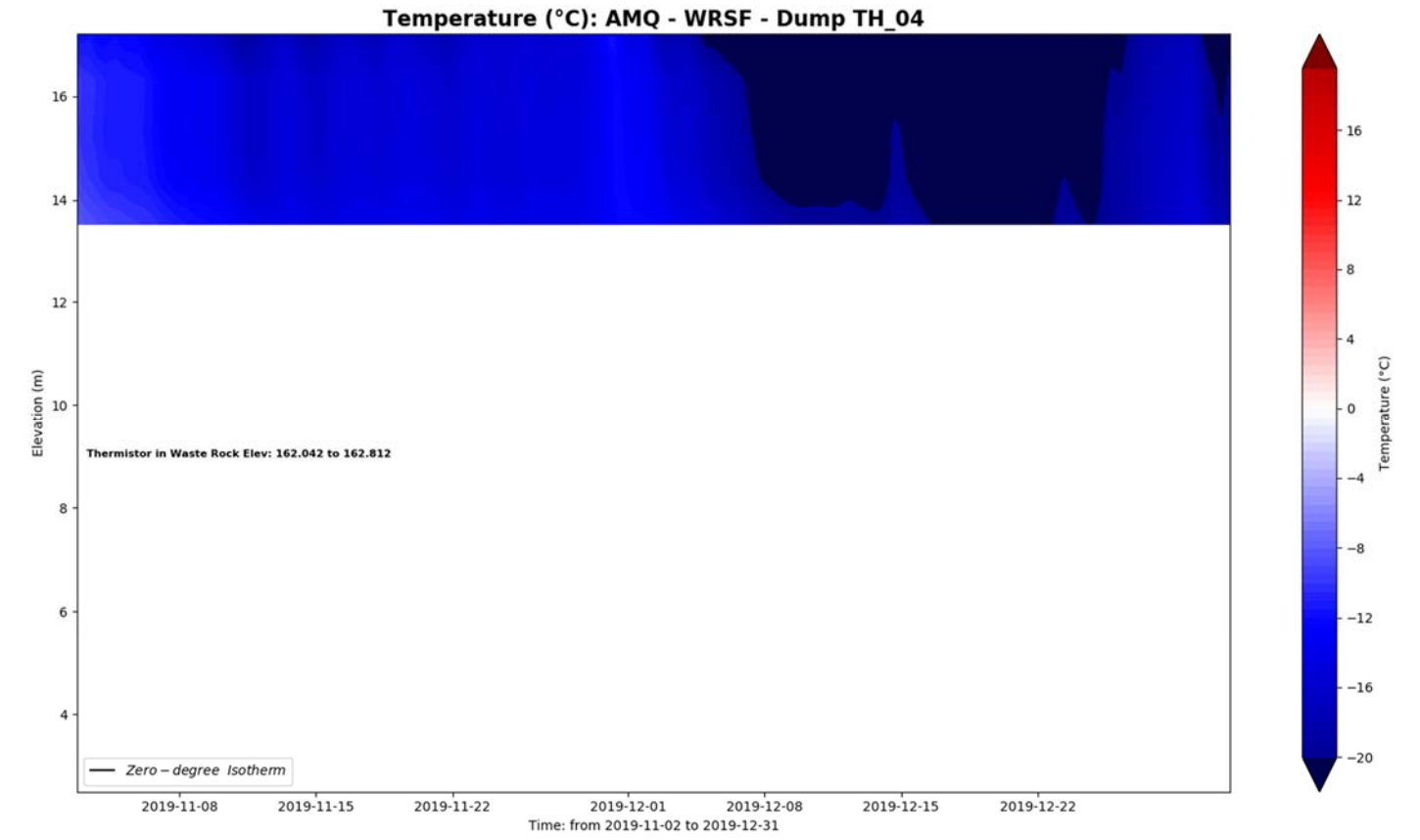
Thermistor in Waste Rock Elevation 162.042 to 162.81



WRSF TH04

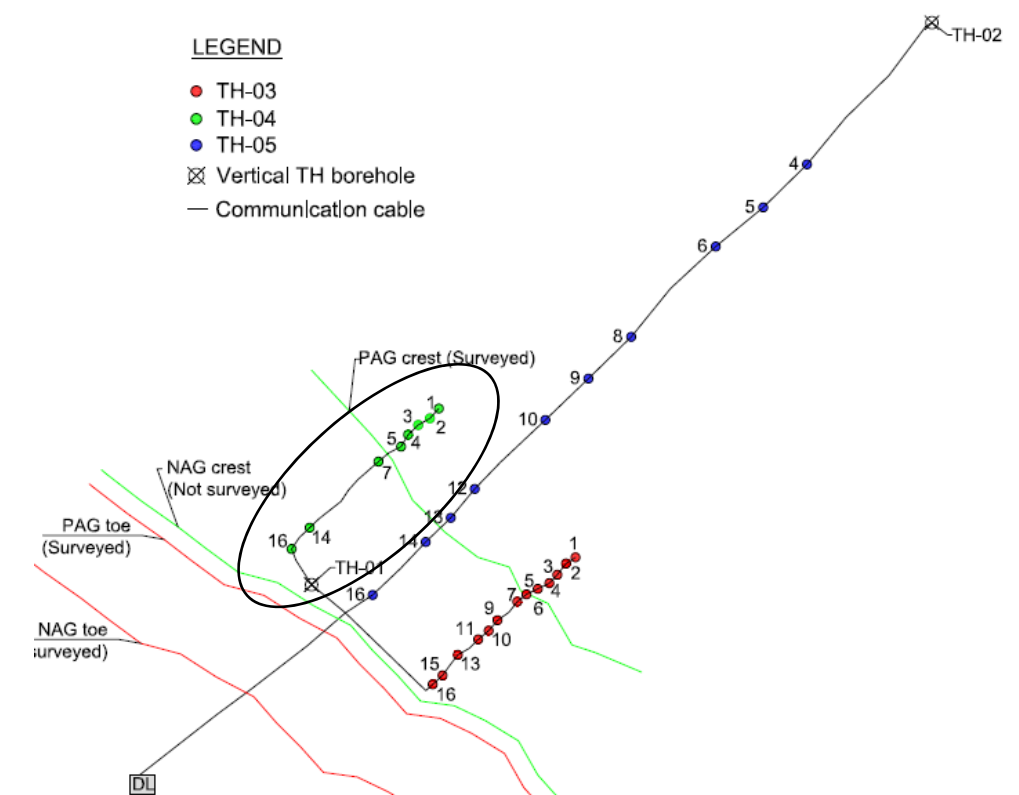


AMQ - WRSF - Dump TH\_04

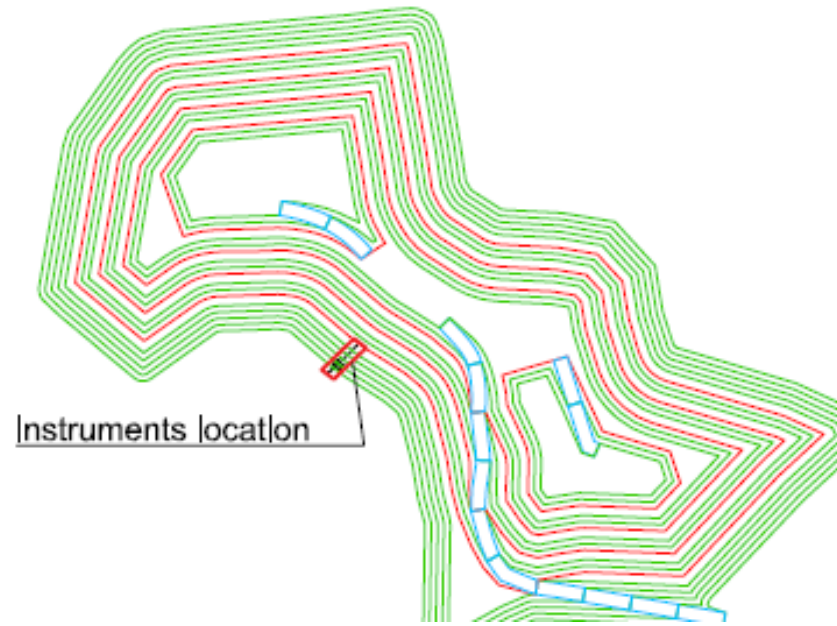


- 2019-12-31 00:00
- 2019-12-24 00:00
- 2019-12-17 00:00
- 2019-12-10 00:00
- 2019-12-03 00:00
- 2019-11-26 00:00
- 2019-11-19 00:00
- 2019-11-12 00:00
- 2019-11-05 00:00
- 2019-11-02 18:00

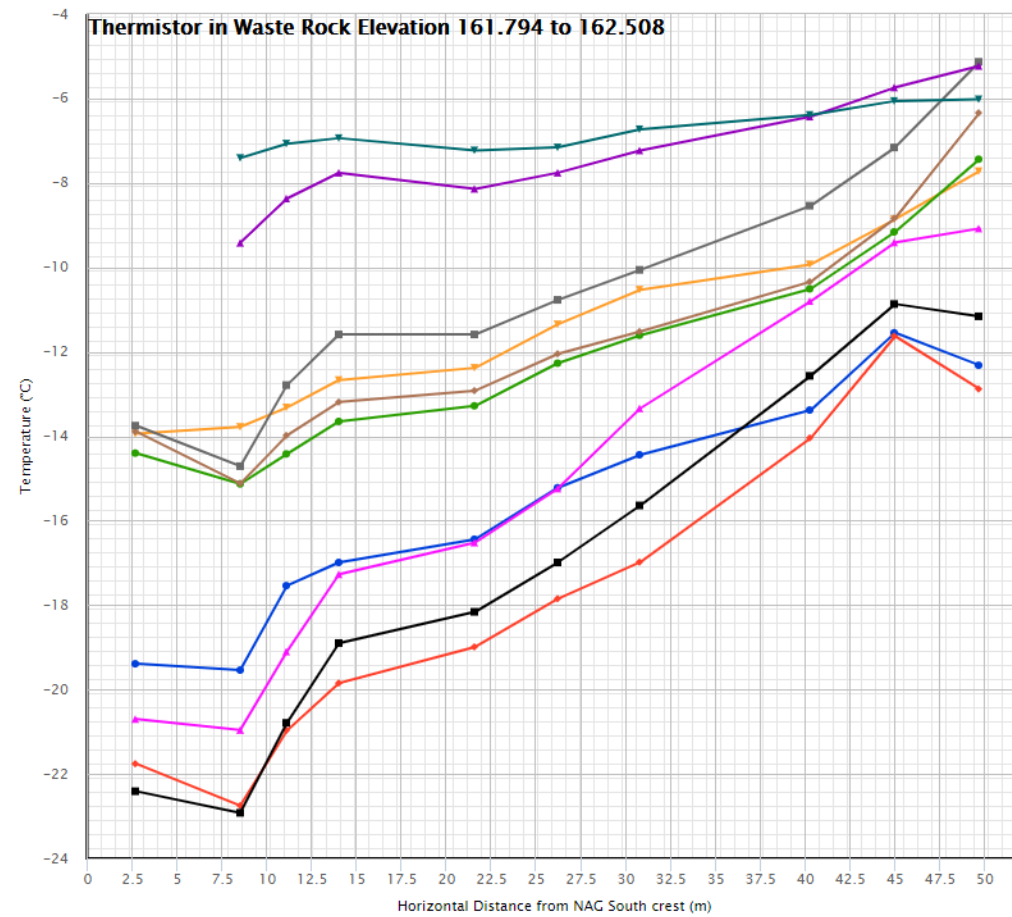
Thermistor in Waste Rock Elevation 161.619 to 162.138



WRSF TH05

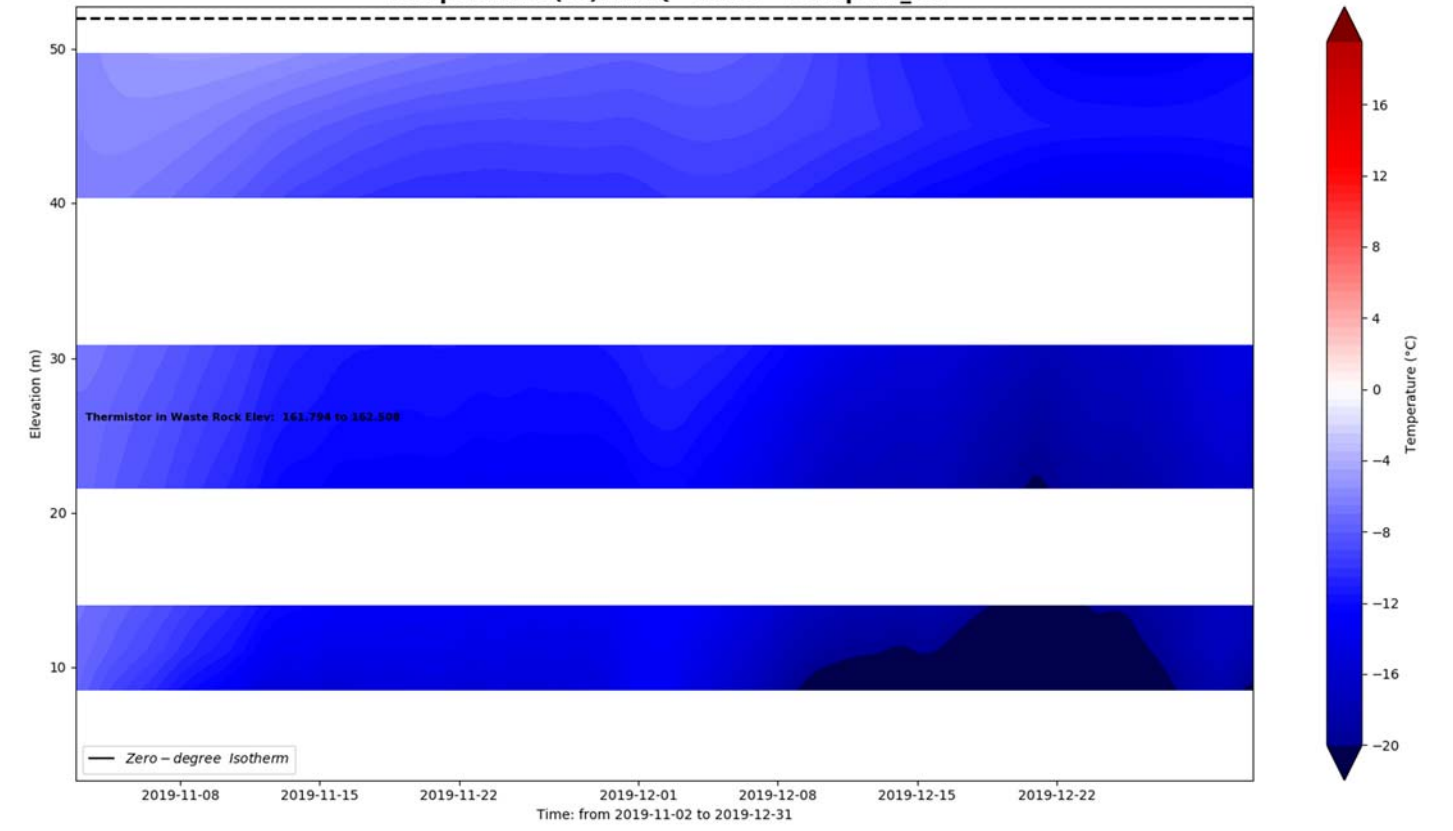


AMQ - WRSF - Dump TH\_05



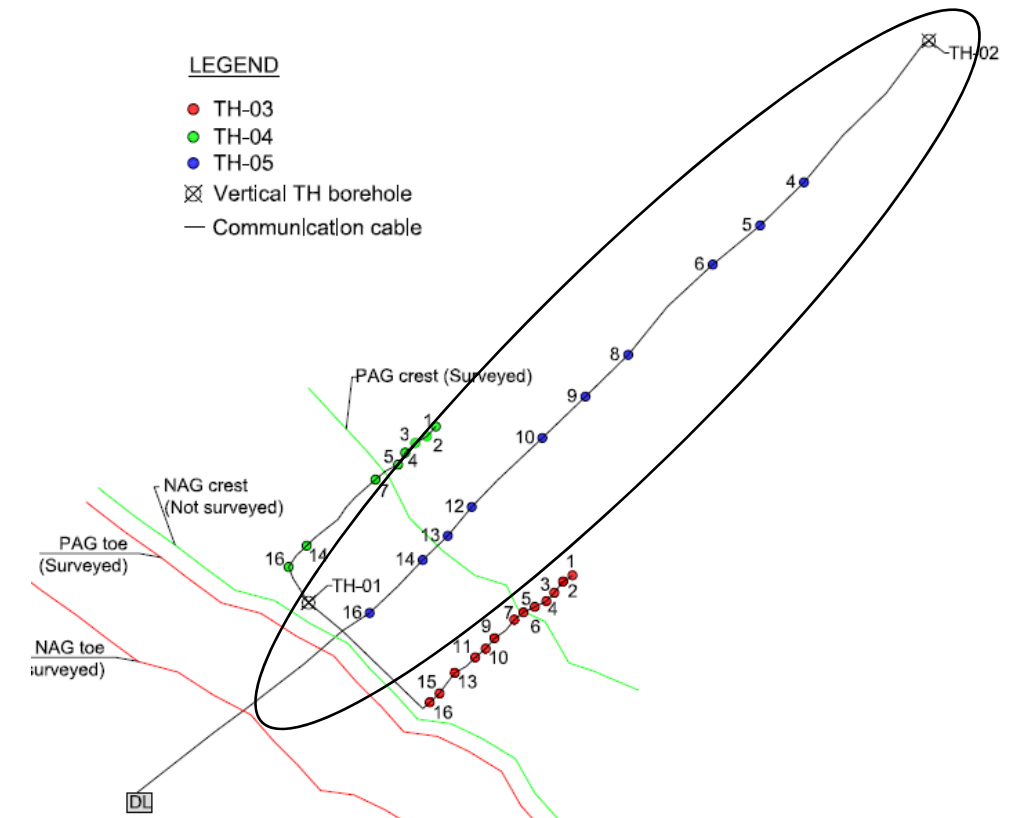
Thermistor in Waste Rock Elevation  
161.794 to 162.508

Temperature (°C): AMQ - WRSF - Dump TH\_05



LEGEND

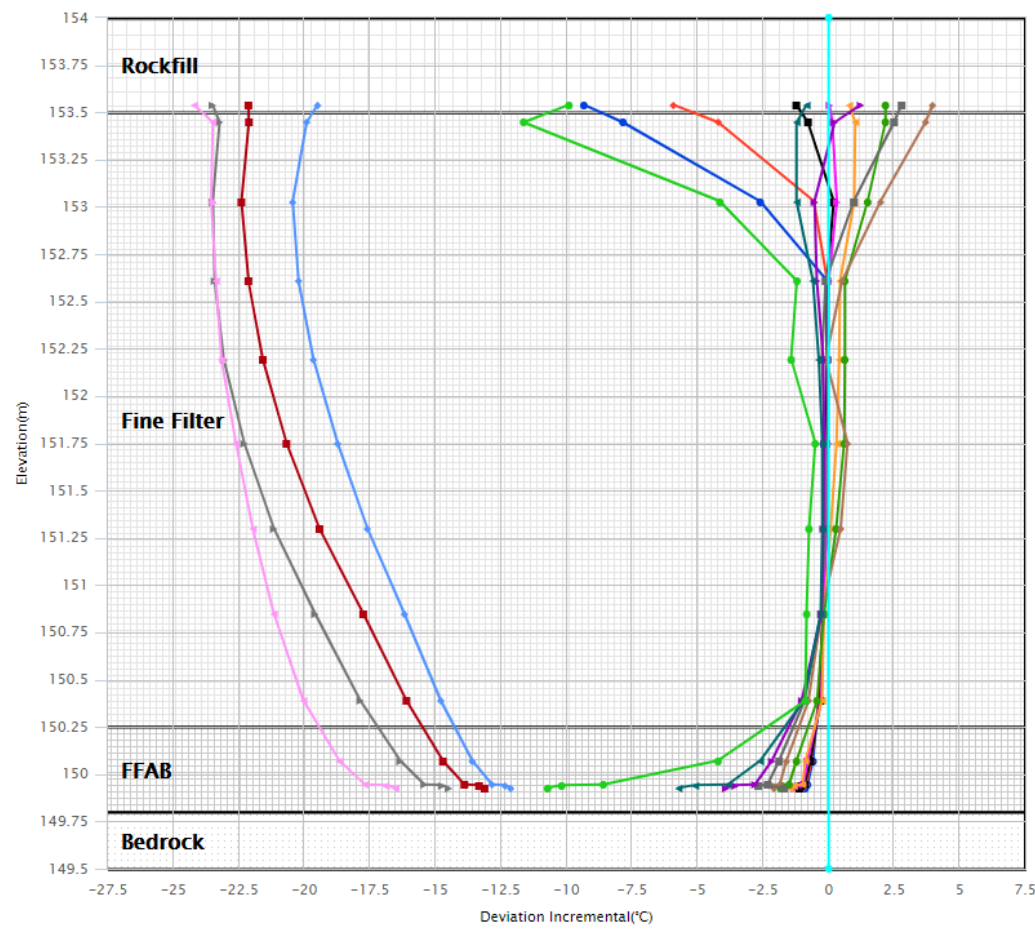
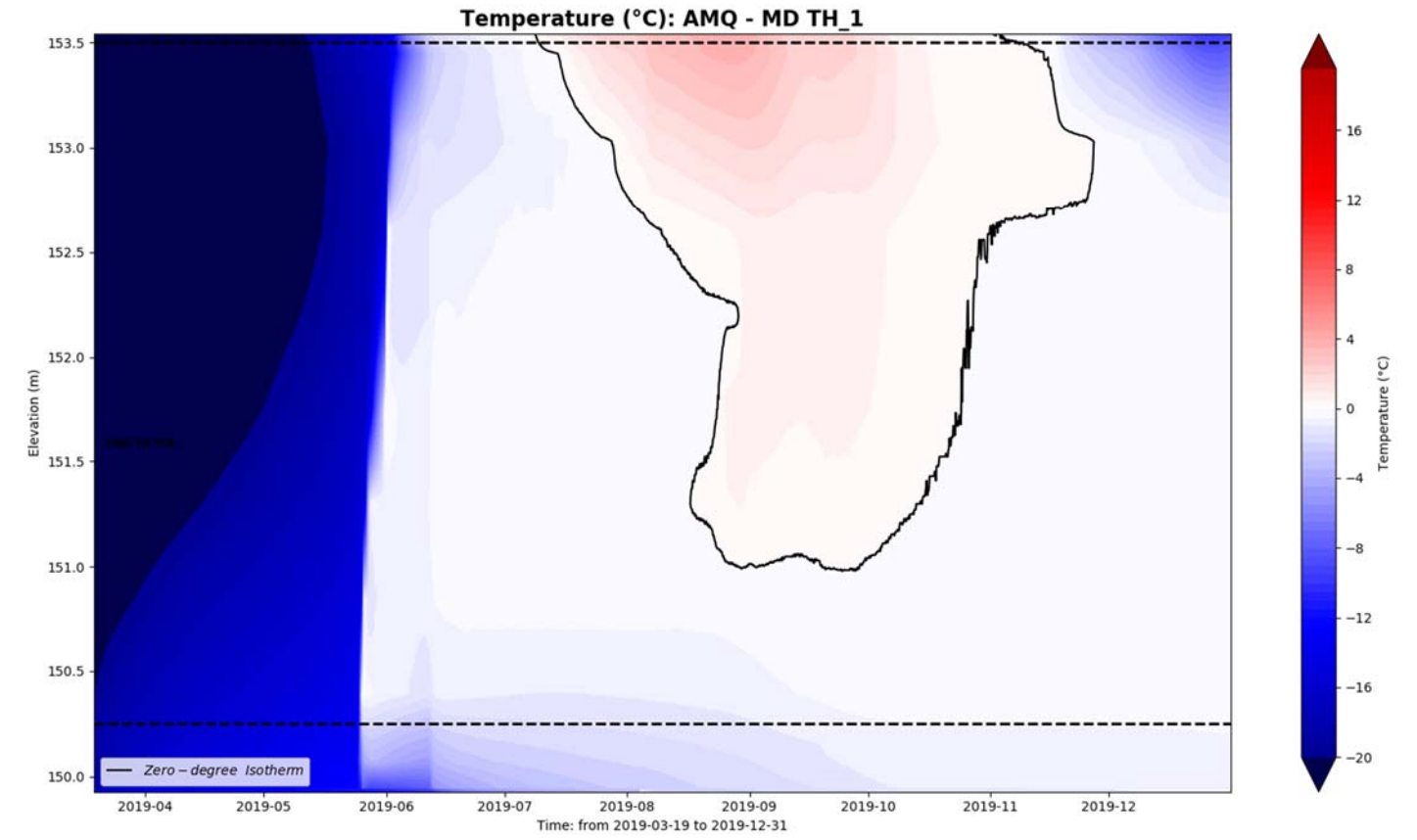
- TH-03
- TH-04
- TH-05
- Vertical TH borehole
- Communication cable



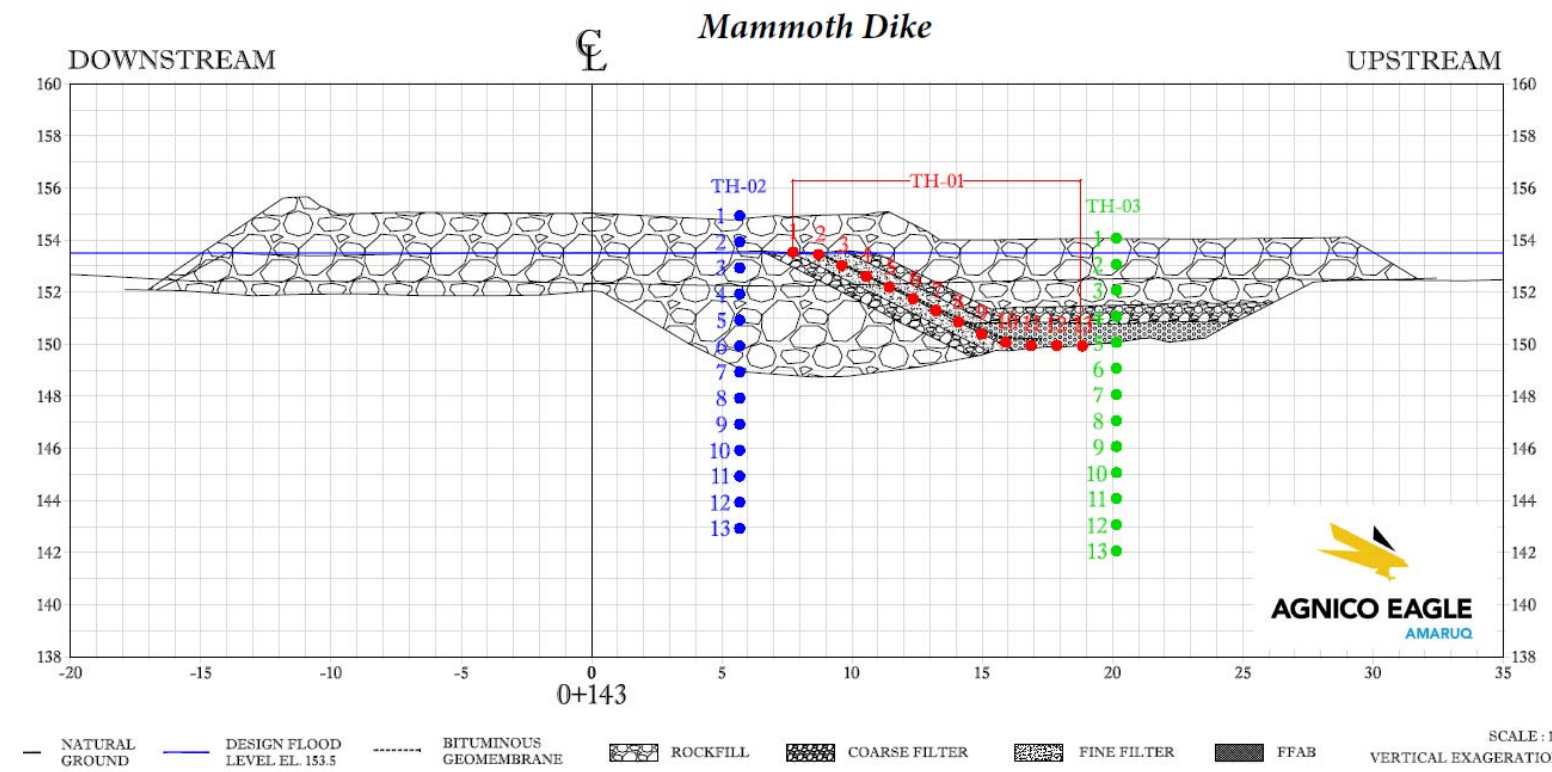
MD TH01



AMQ - MD TH\_01

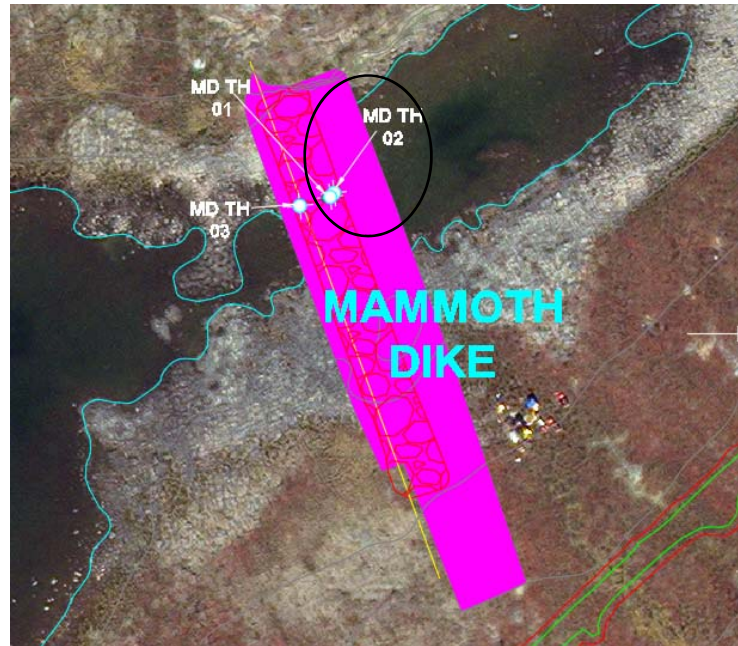


- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
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- 2019-05-14 00:00
- 2019-04-23 00:00
- 2019-04-02 00:00
- 2019-03-19 00:00
- Limit Profile

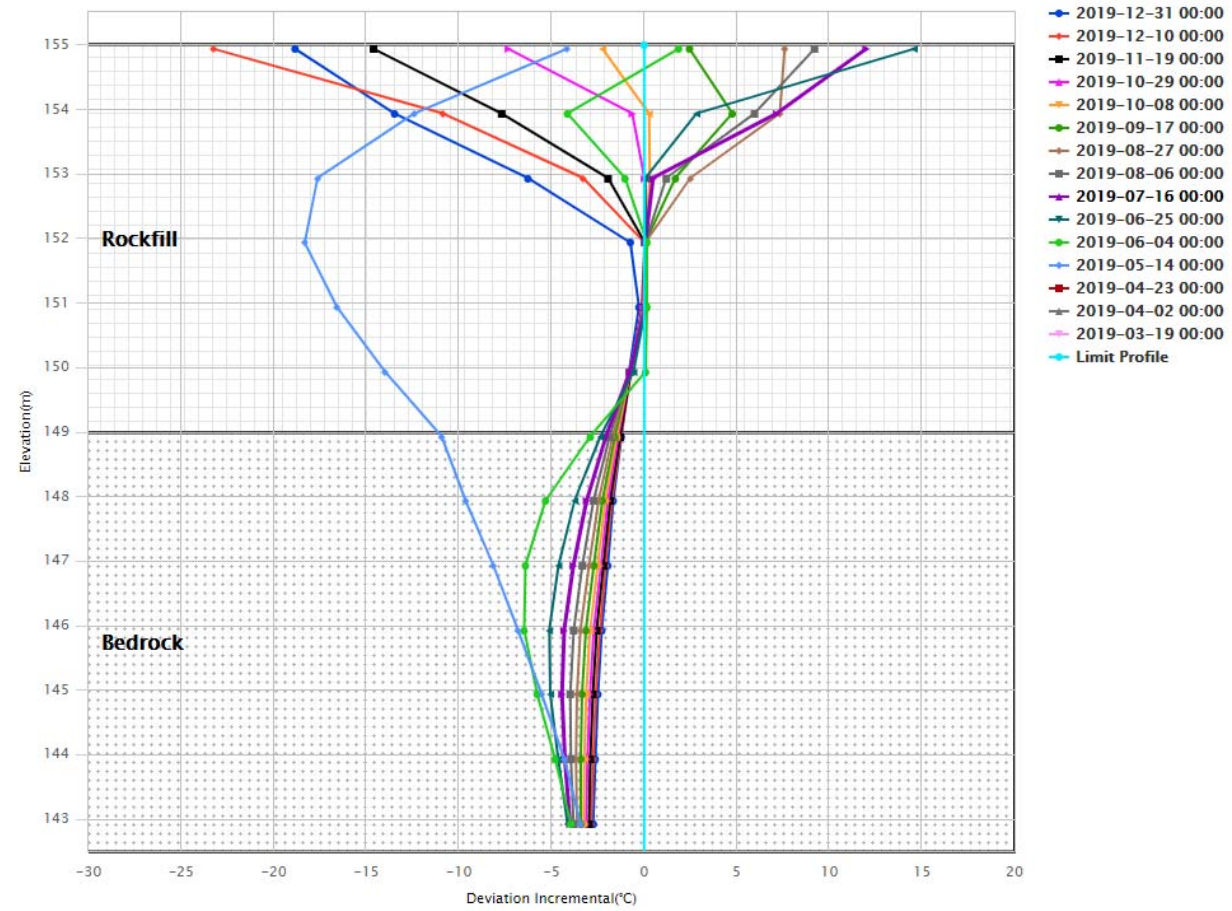


SCALE: 1:15  
VERTICAL EXAGGERATION:

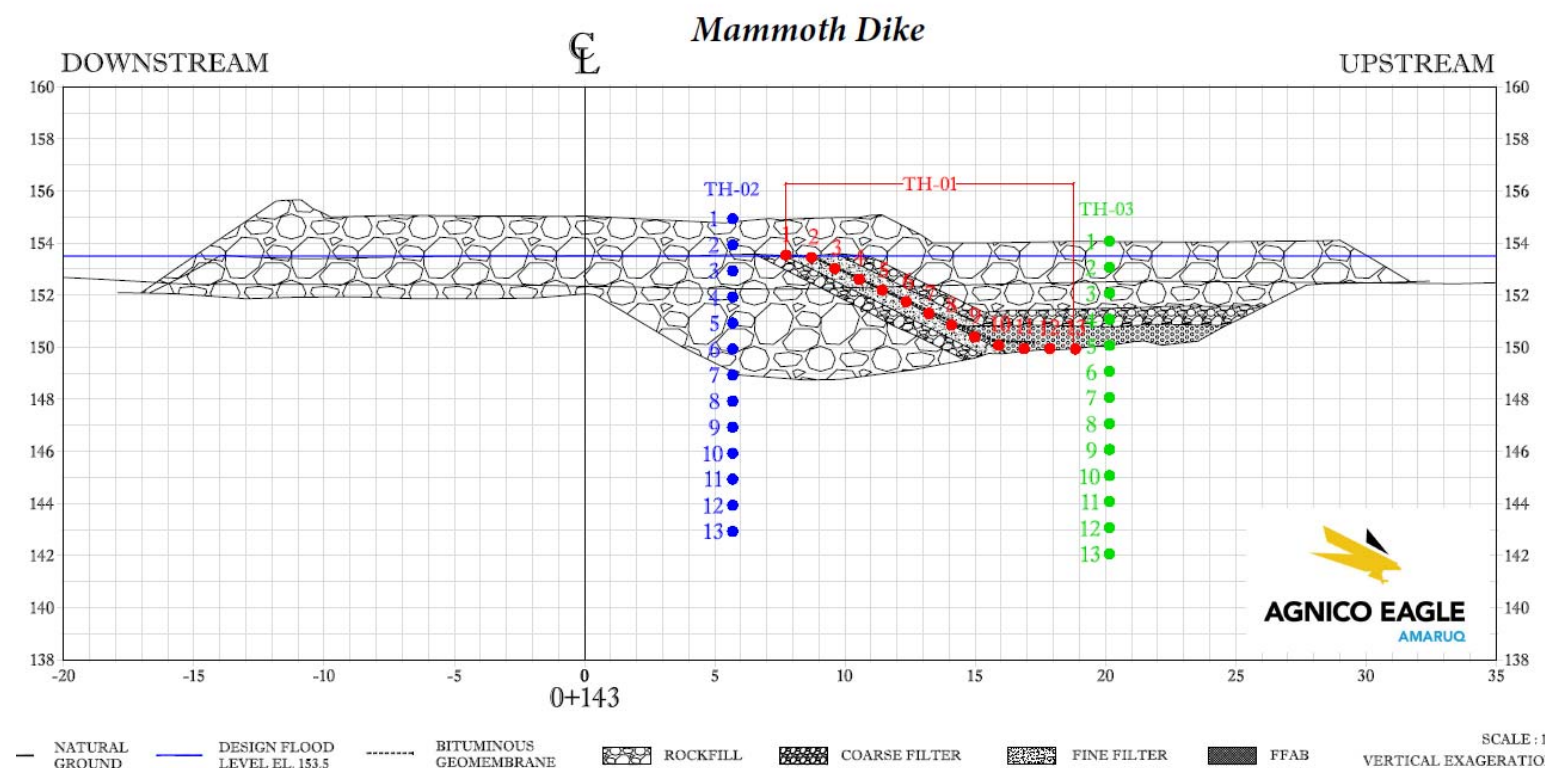
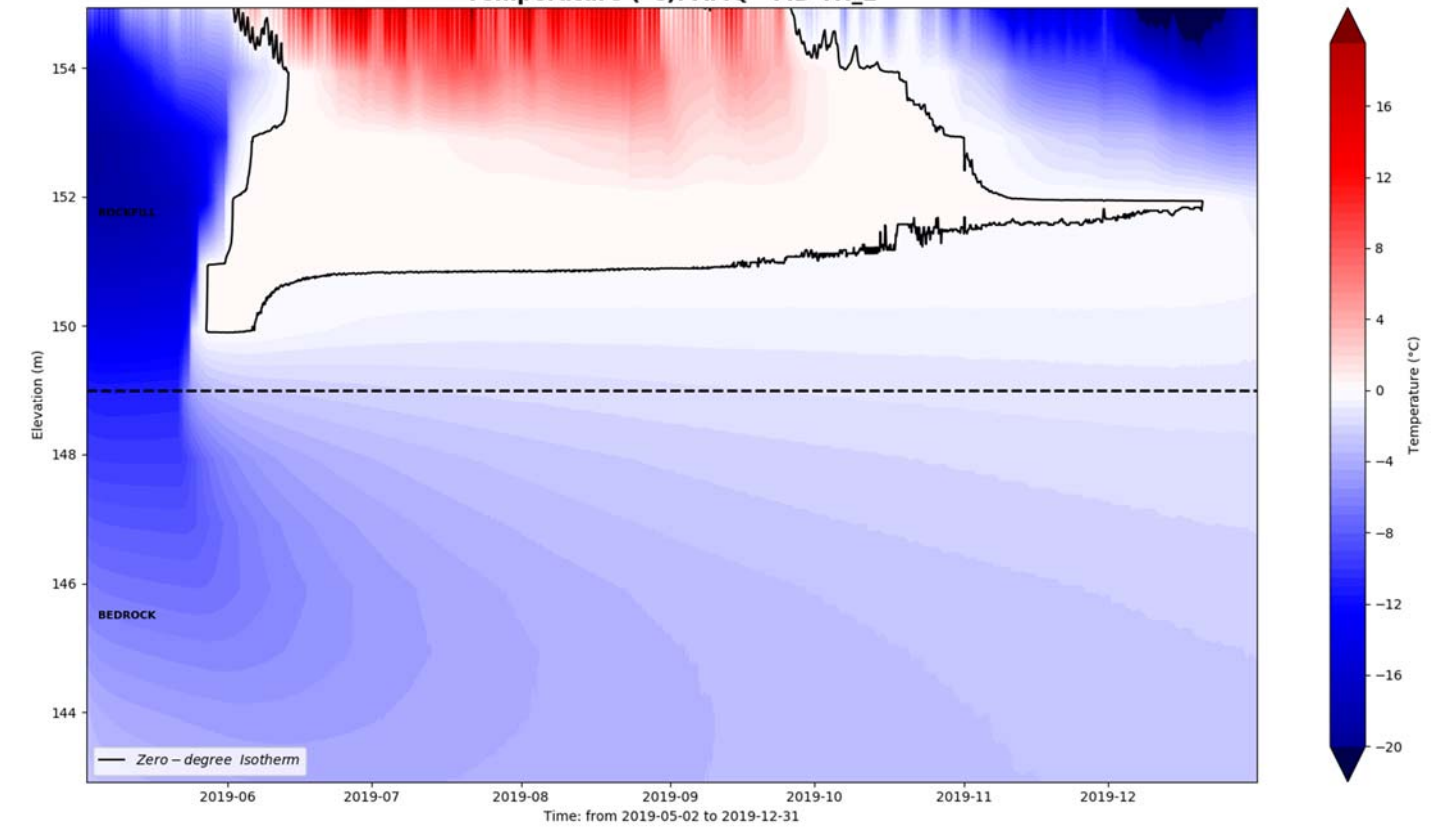
MD TH02



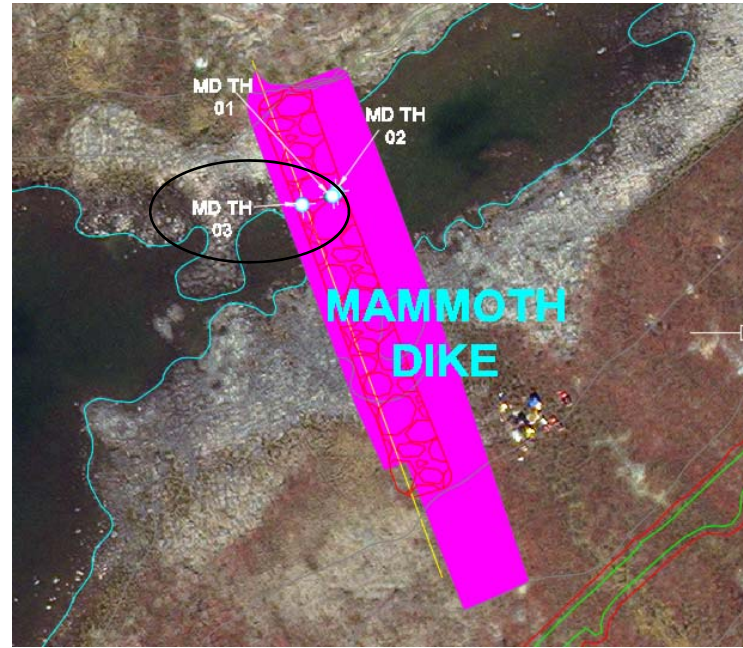
AMQ - MD TH\_02



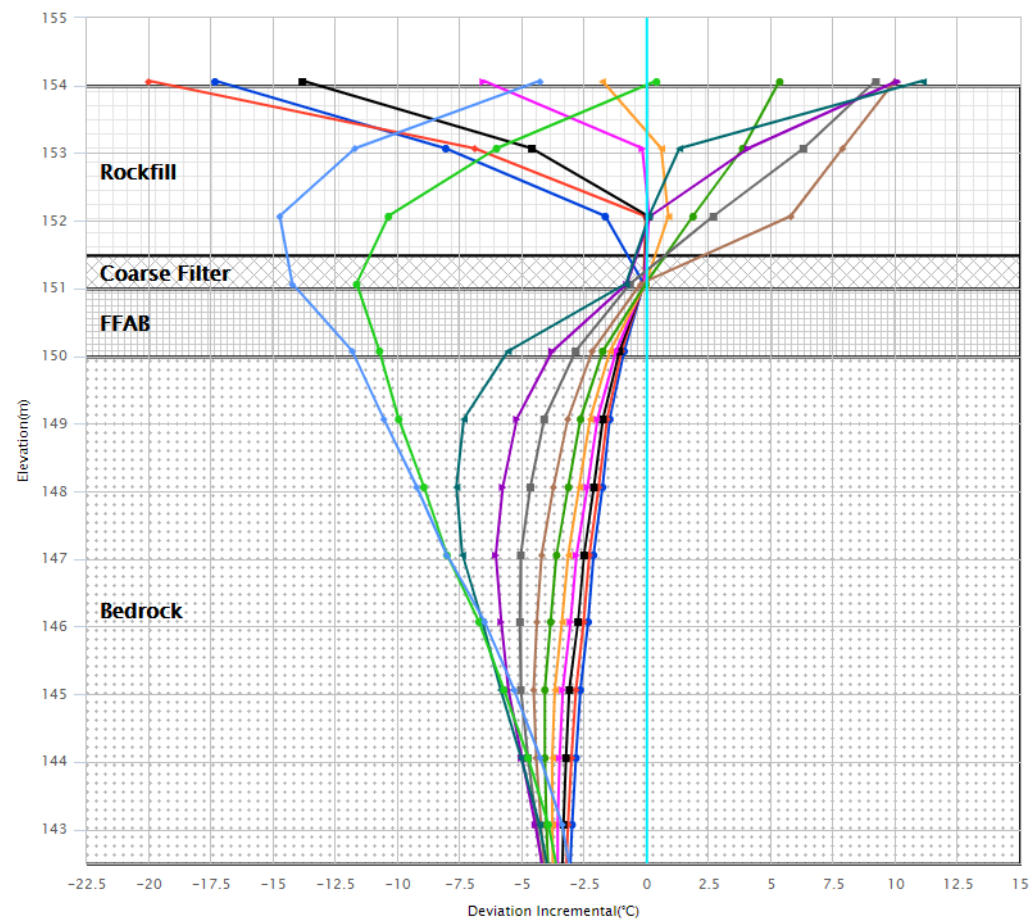
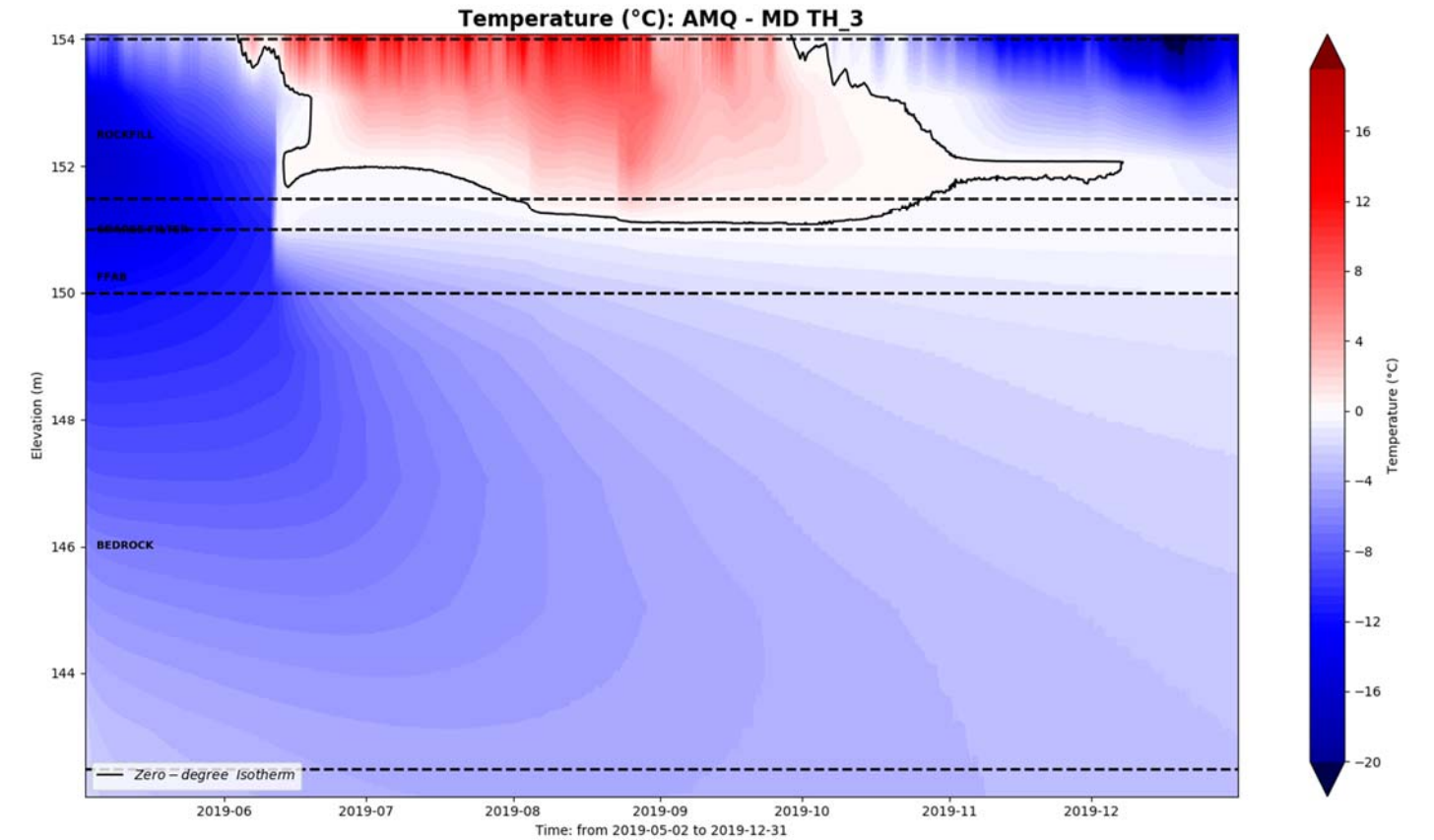
Temperature (°C): AMQ - MD TH\_2



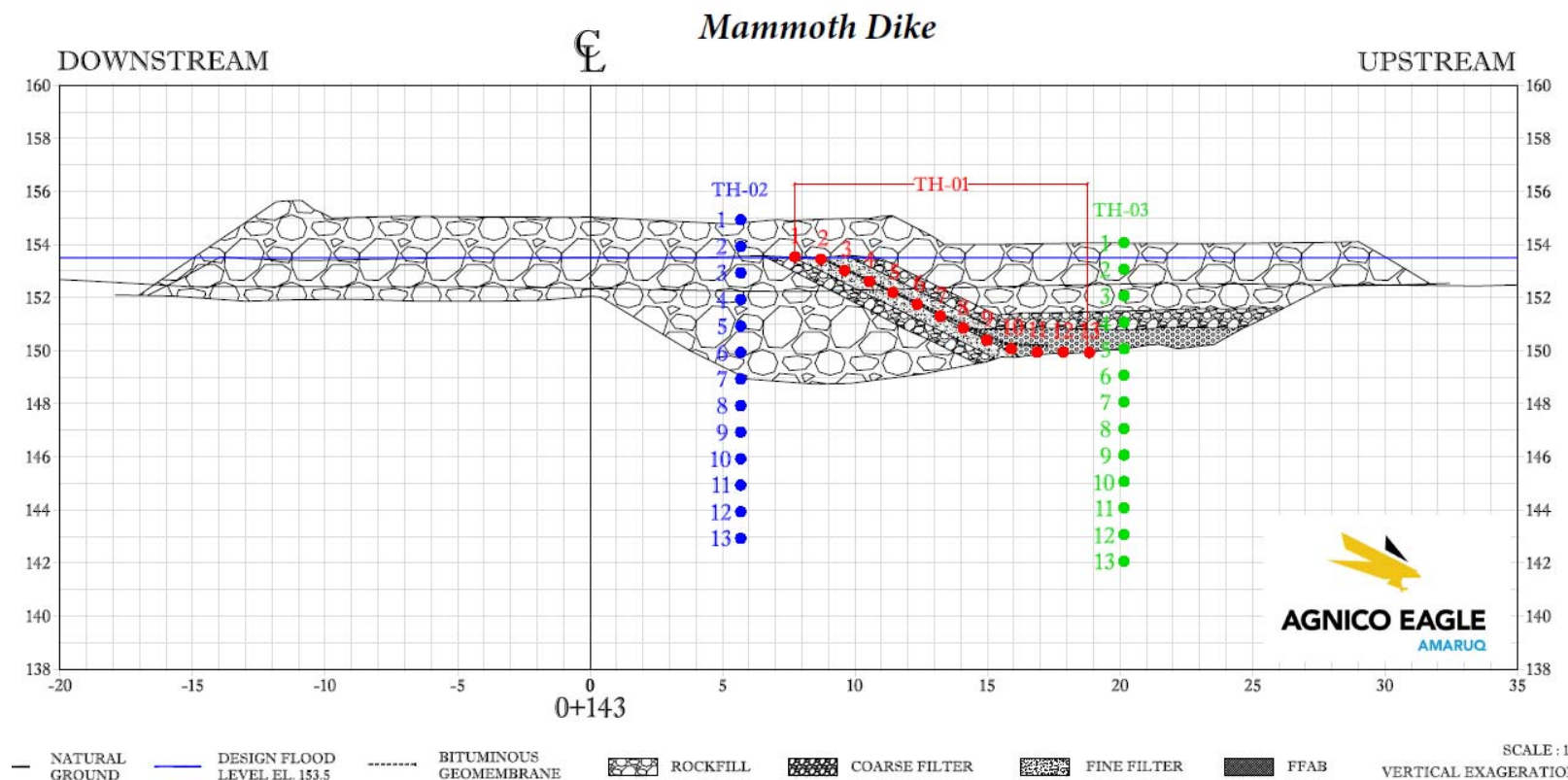
MD TH03



AMQ - MD TH\_03

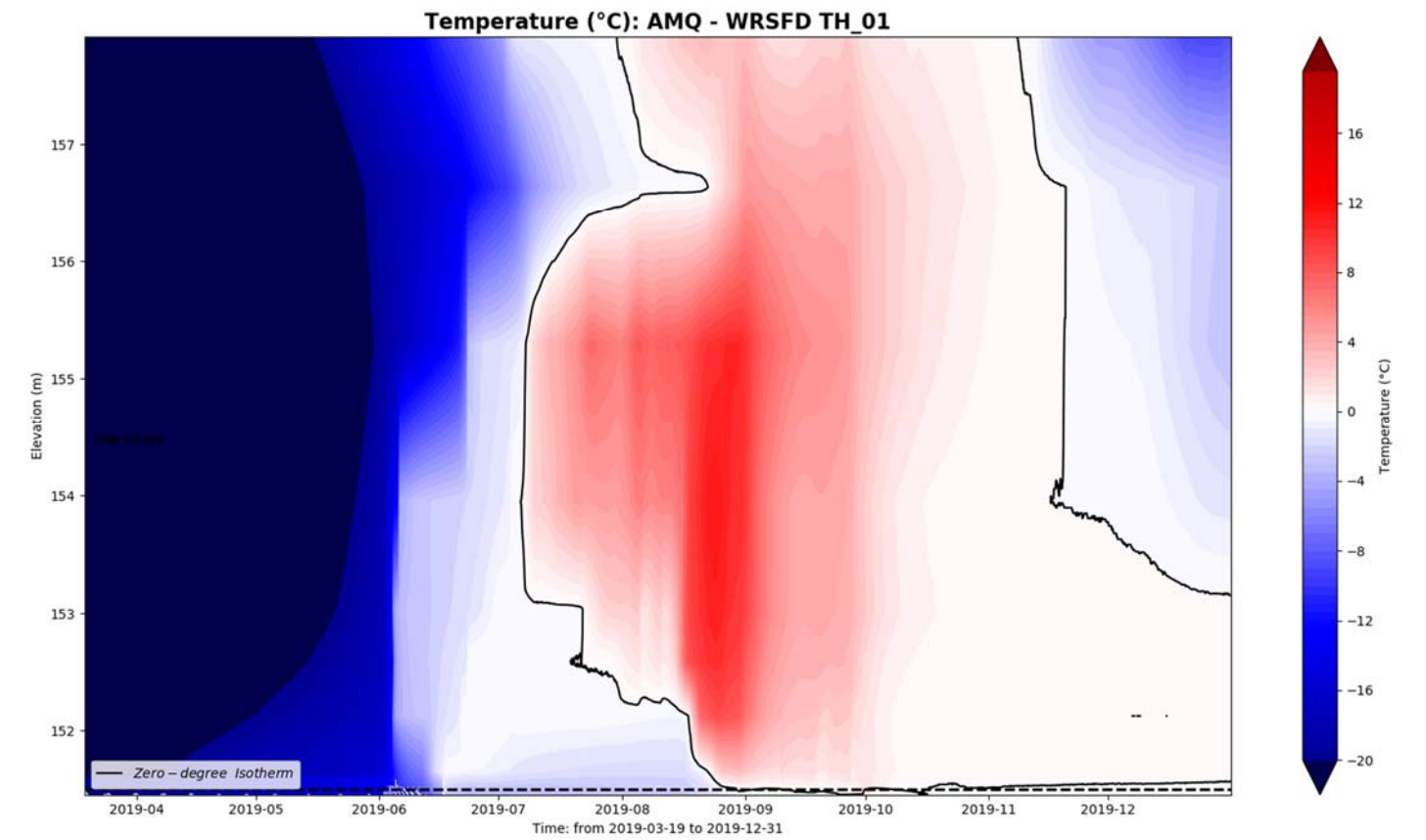


- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-04-23 00:00
- 2019-04-02 00:00
- 2019-03-19 00:00
- Limit Profile

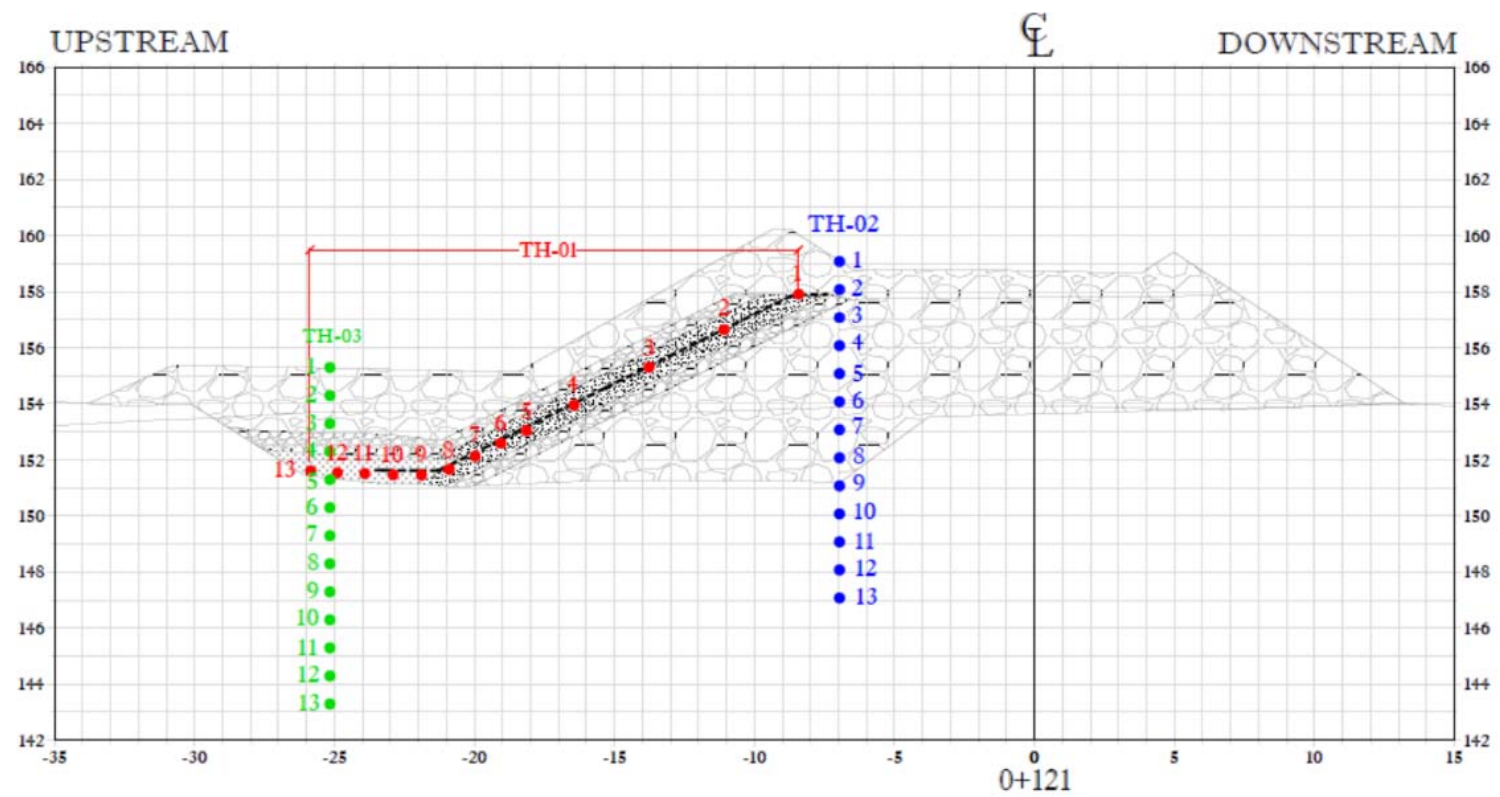
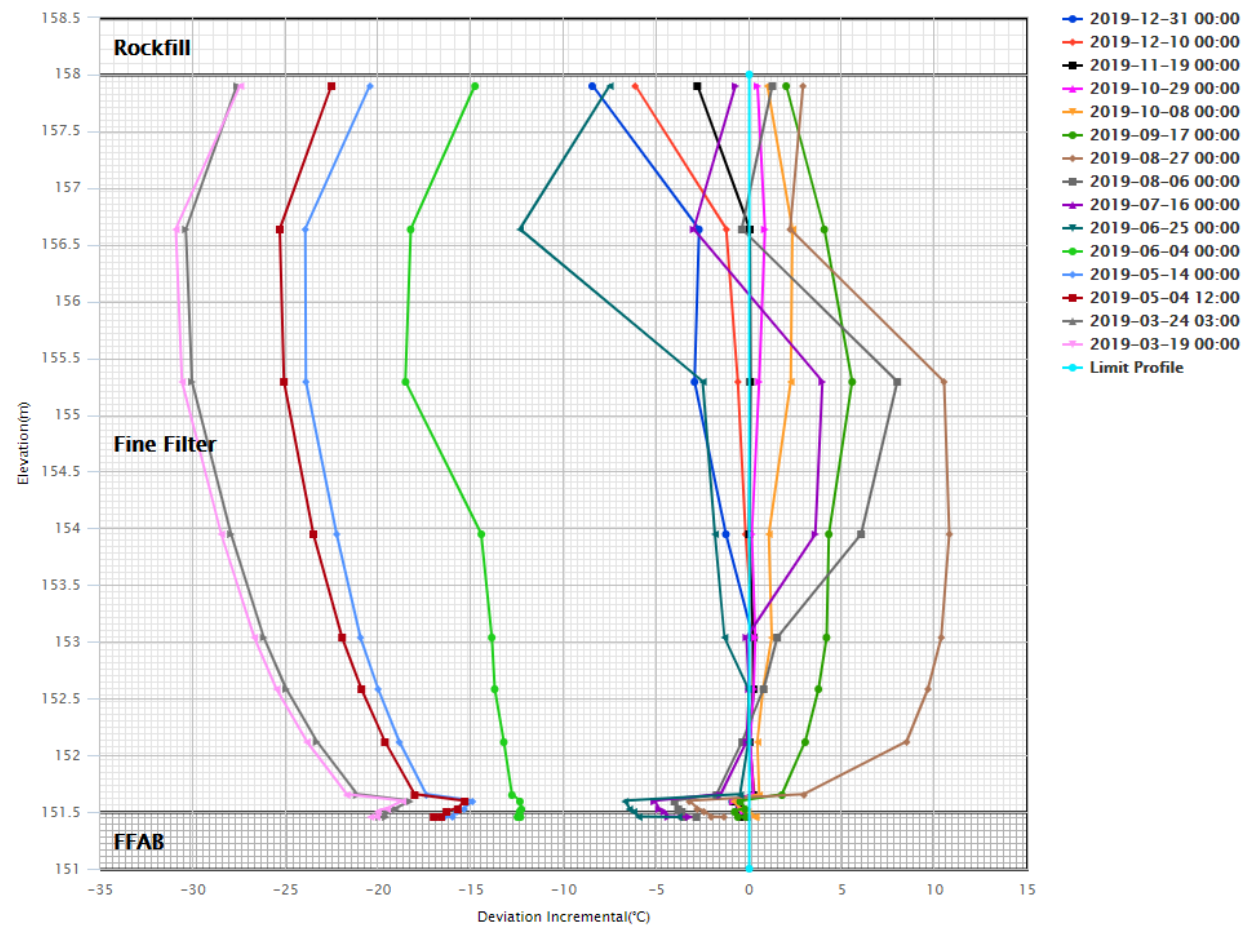


SCALE: 1:15  
VERTICAL EXAGGERATION:

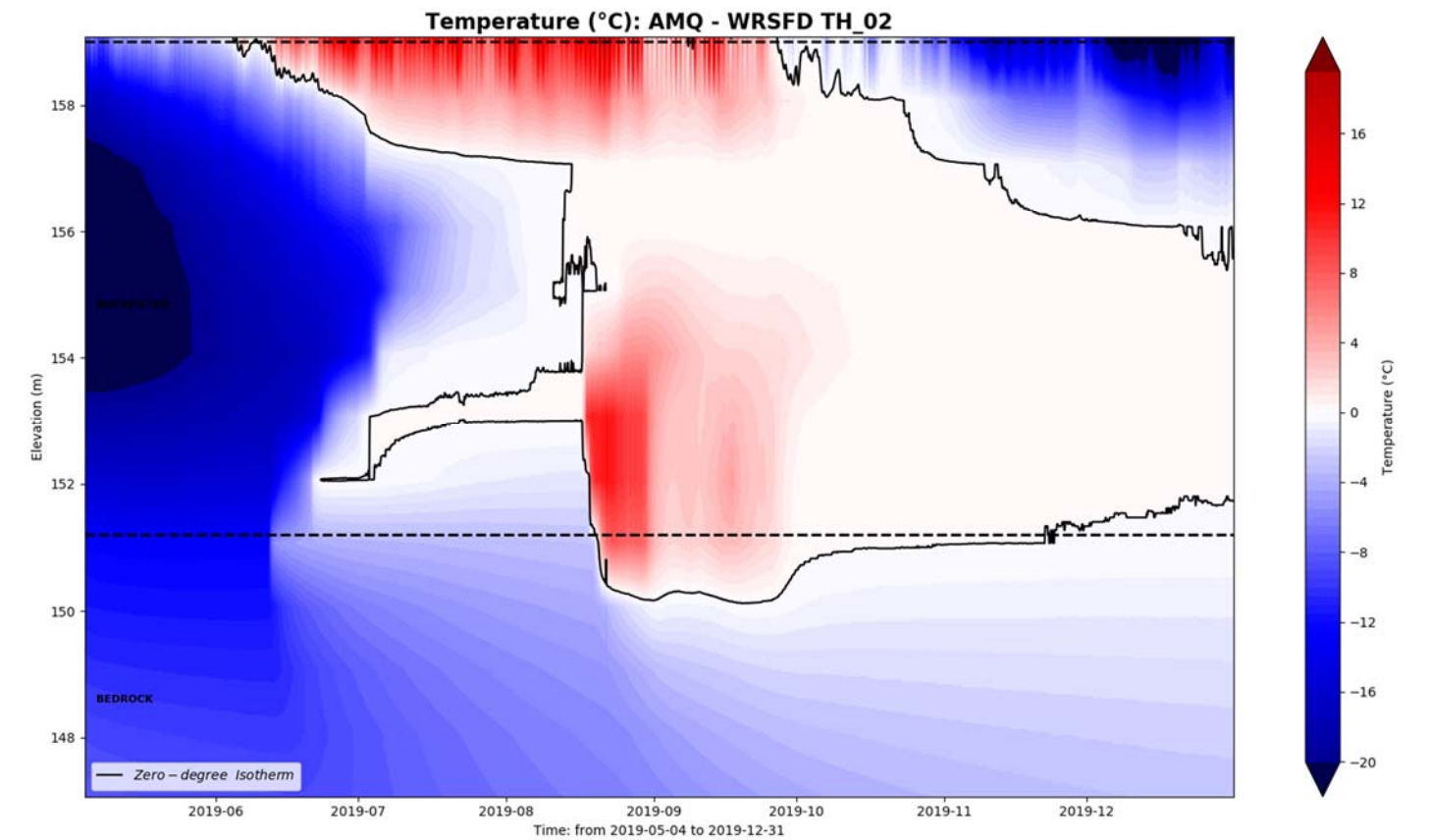
### WRSFD TH01



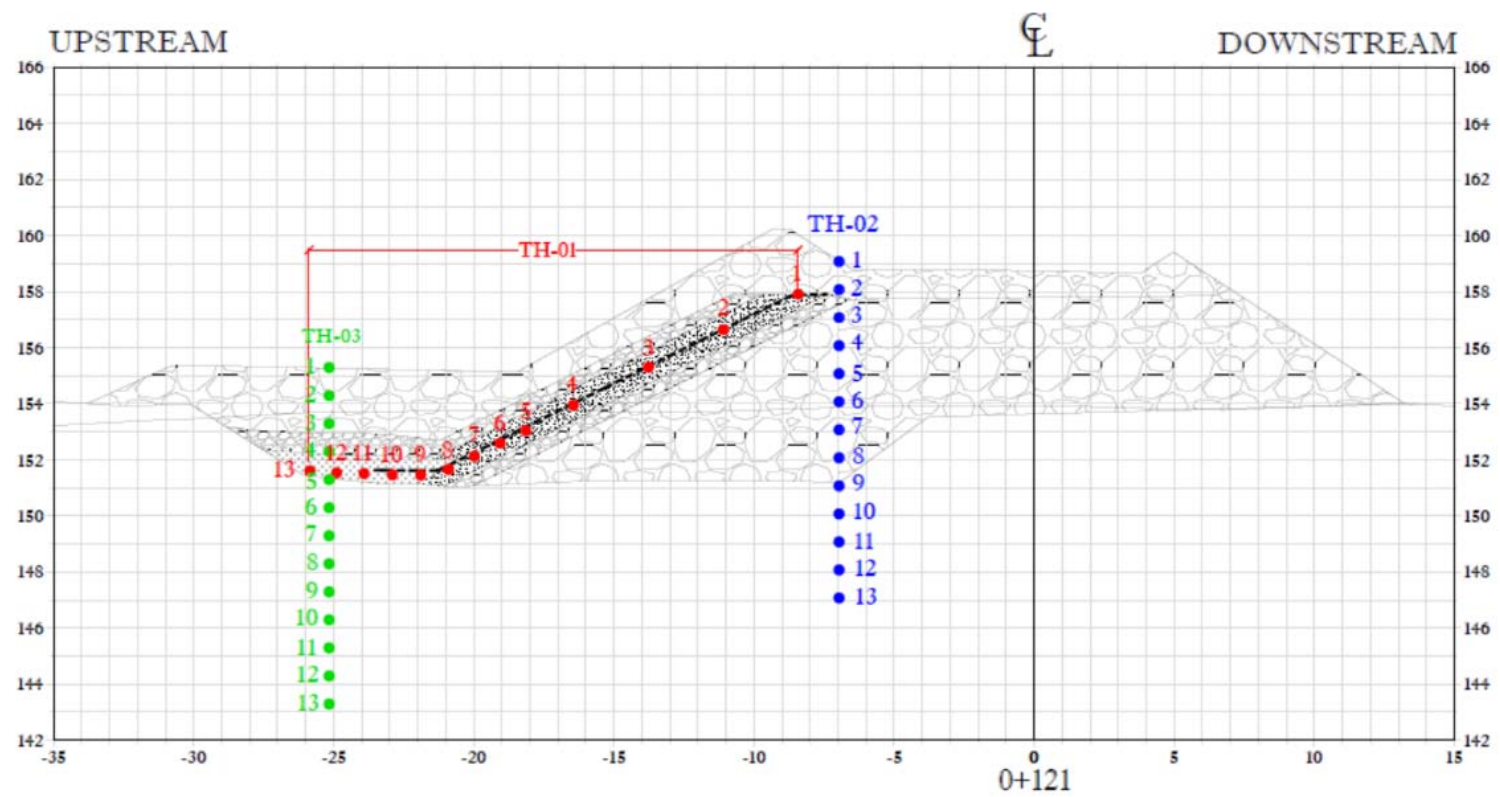
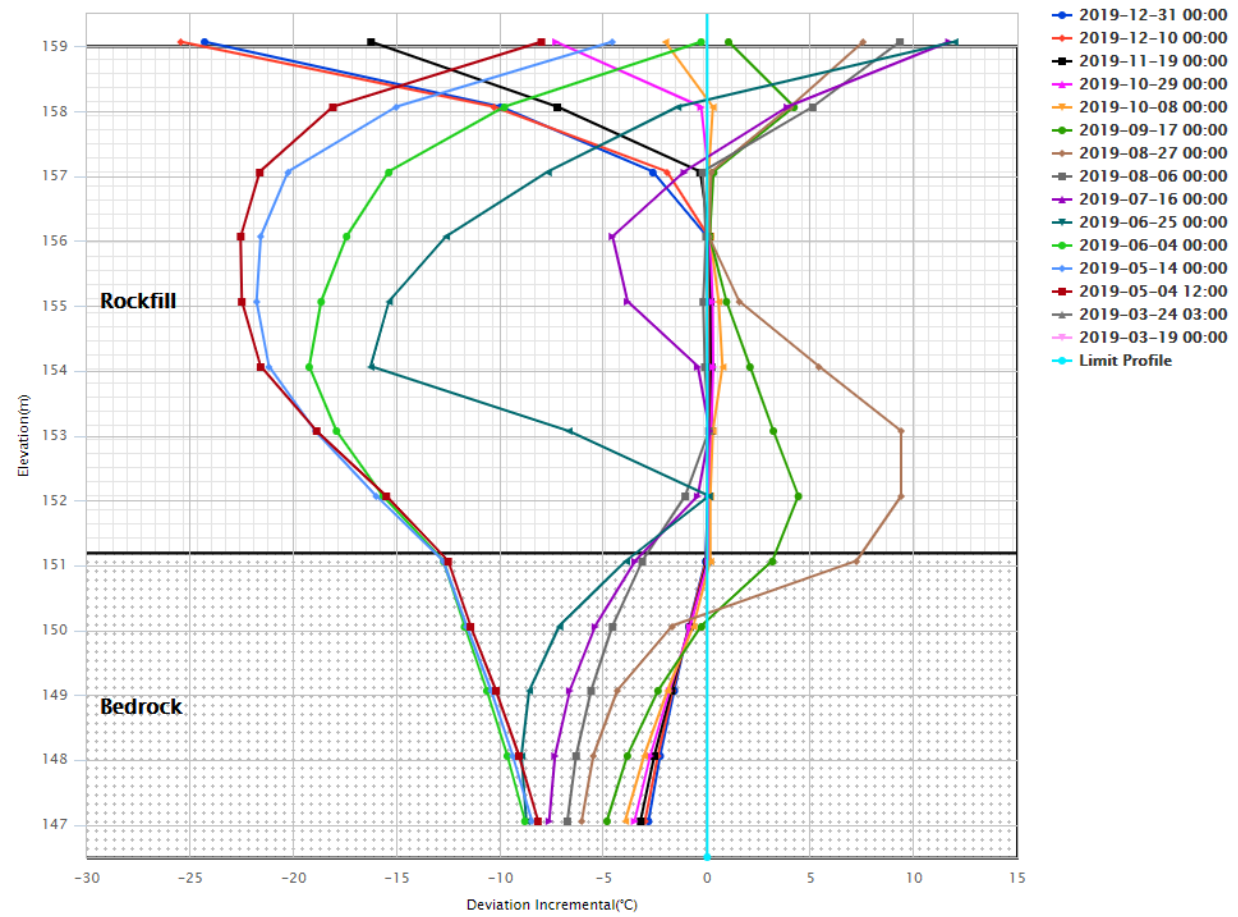
AMQ - WRSFD TH\_01



### WRSFD TH02

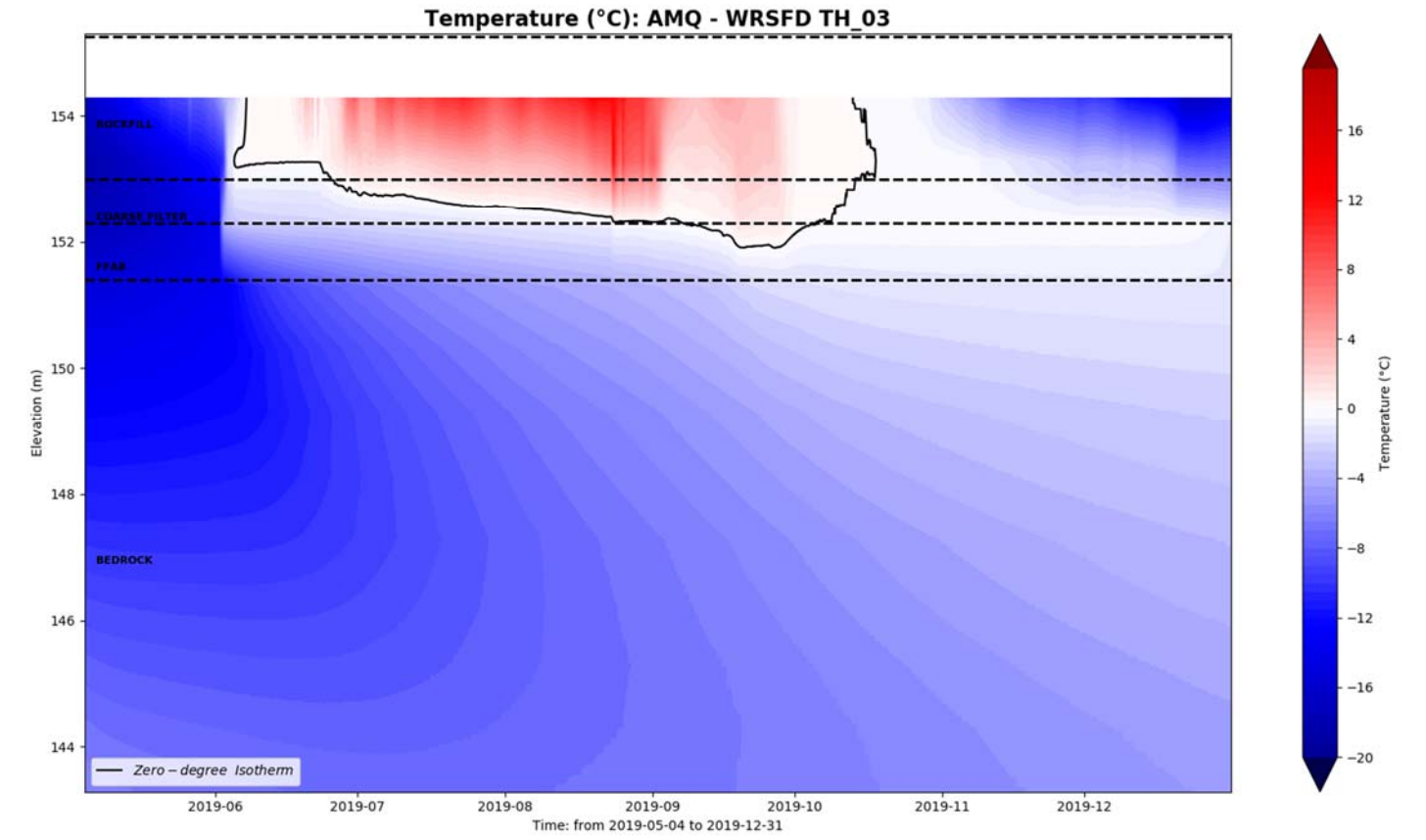


AMQ - WRSFD TH\_02

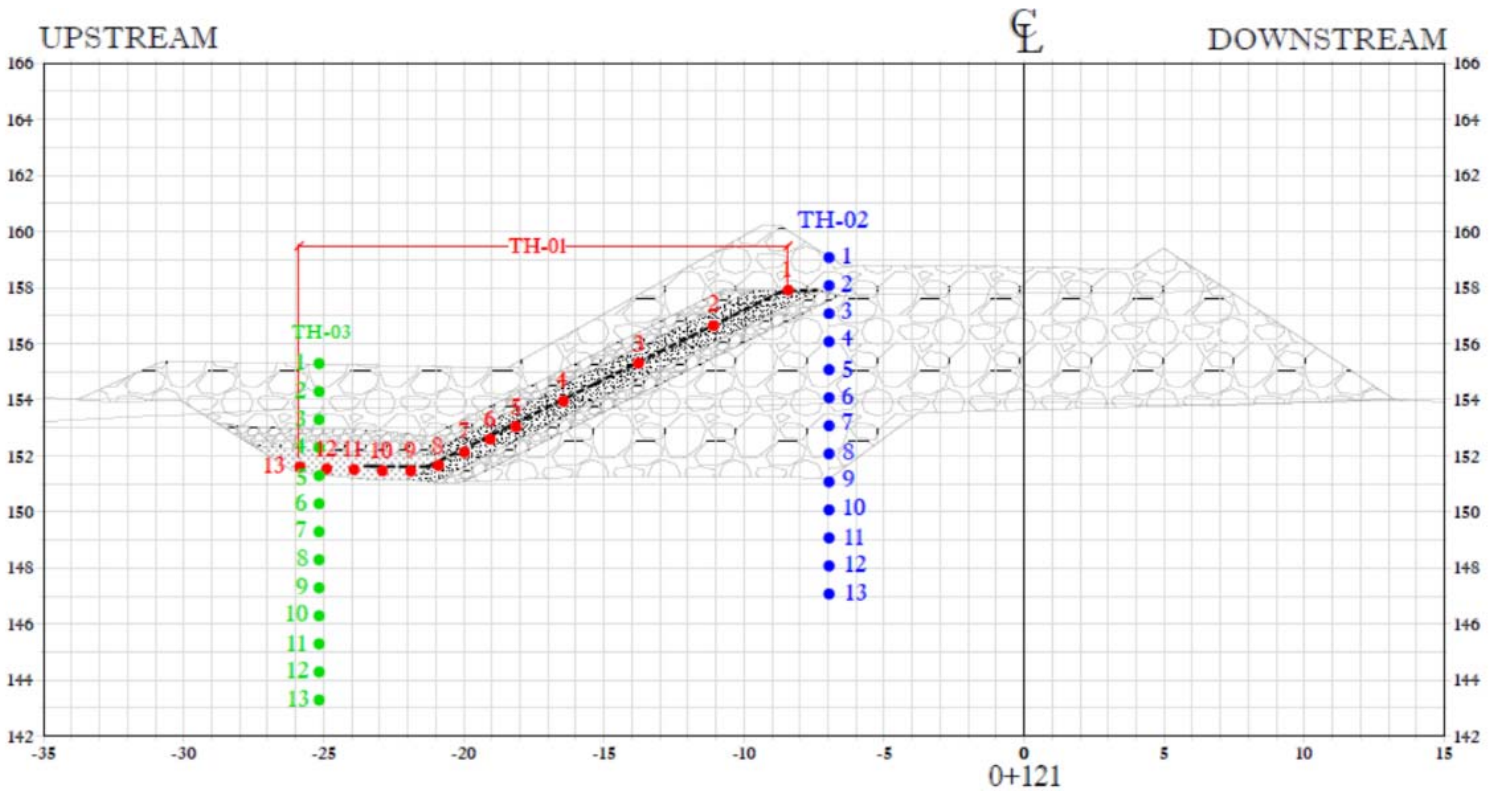
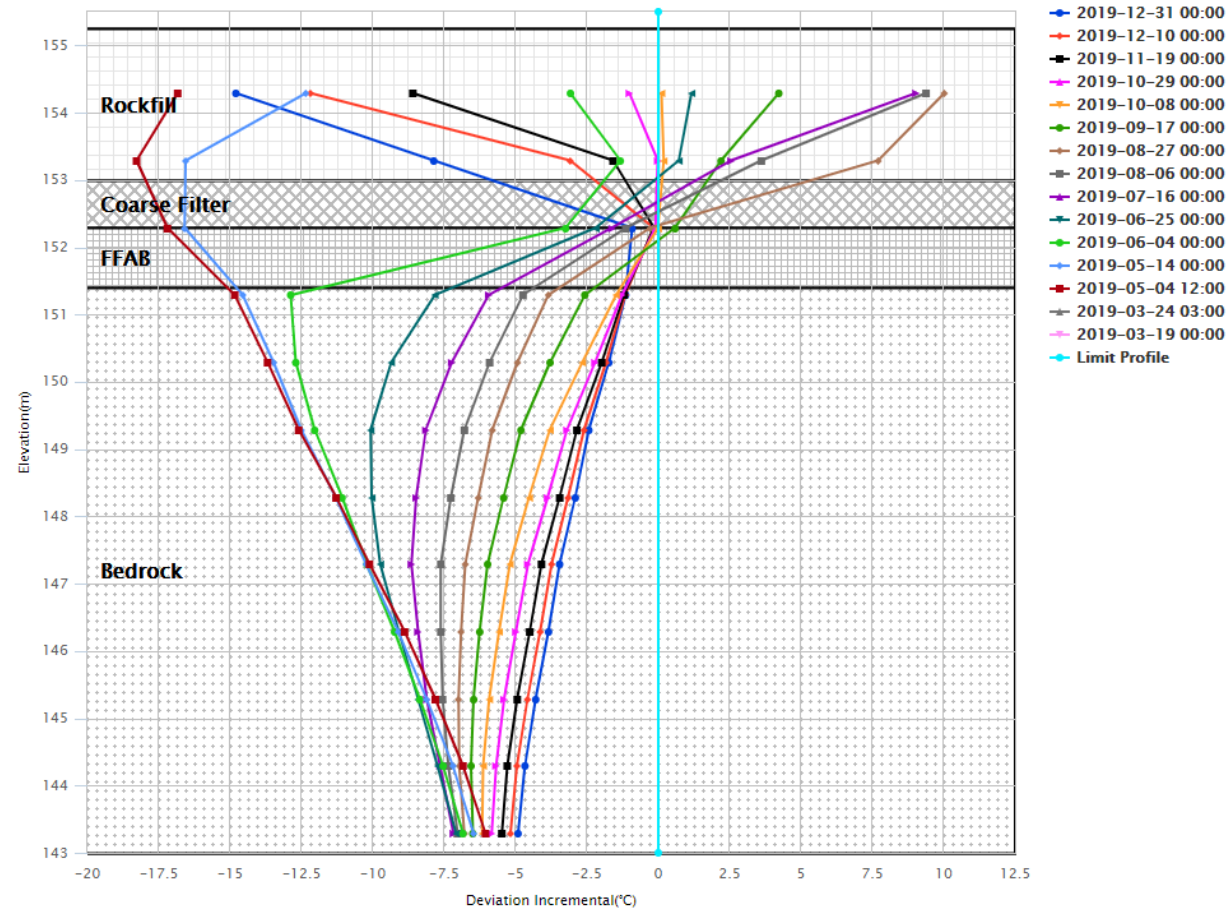




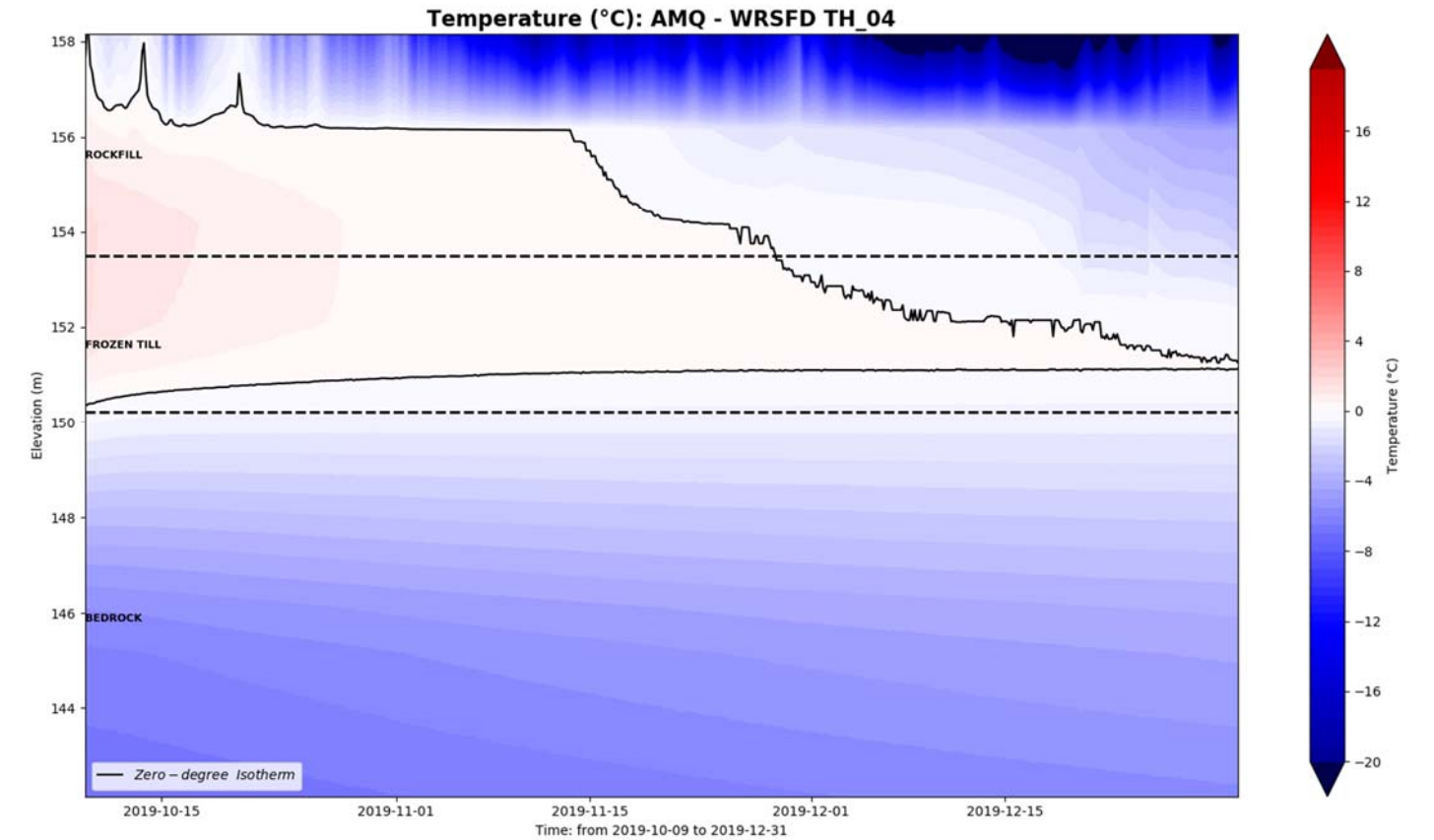
### WRSFD TH03



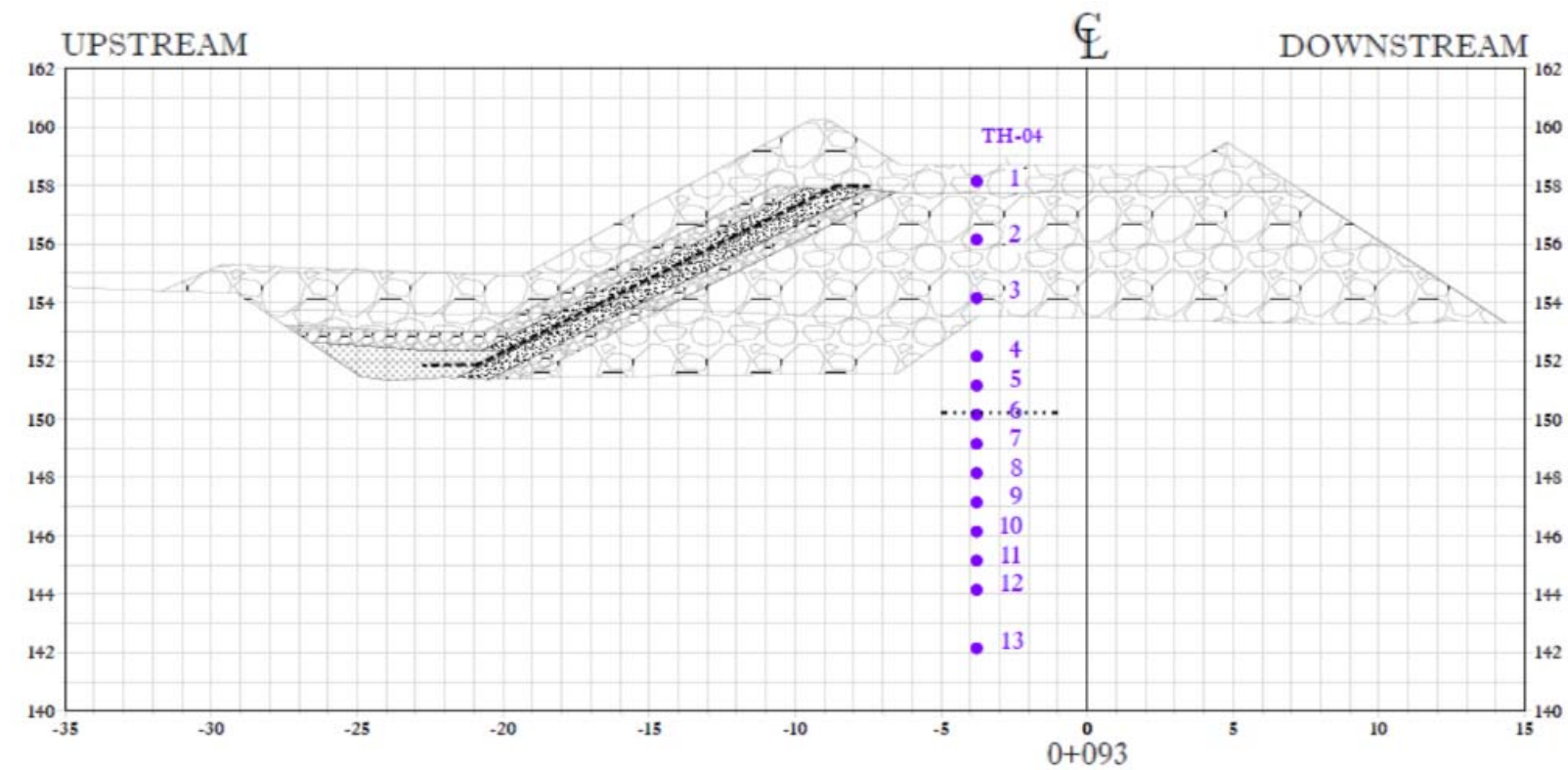
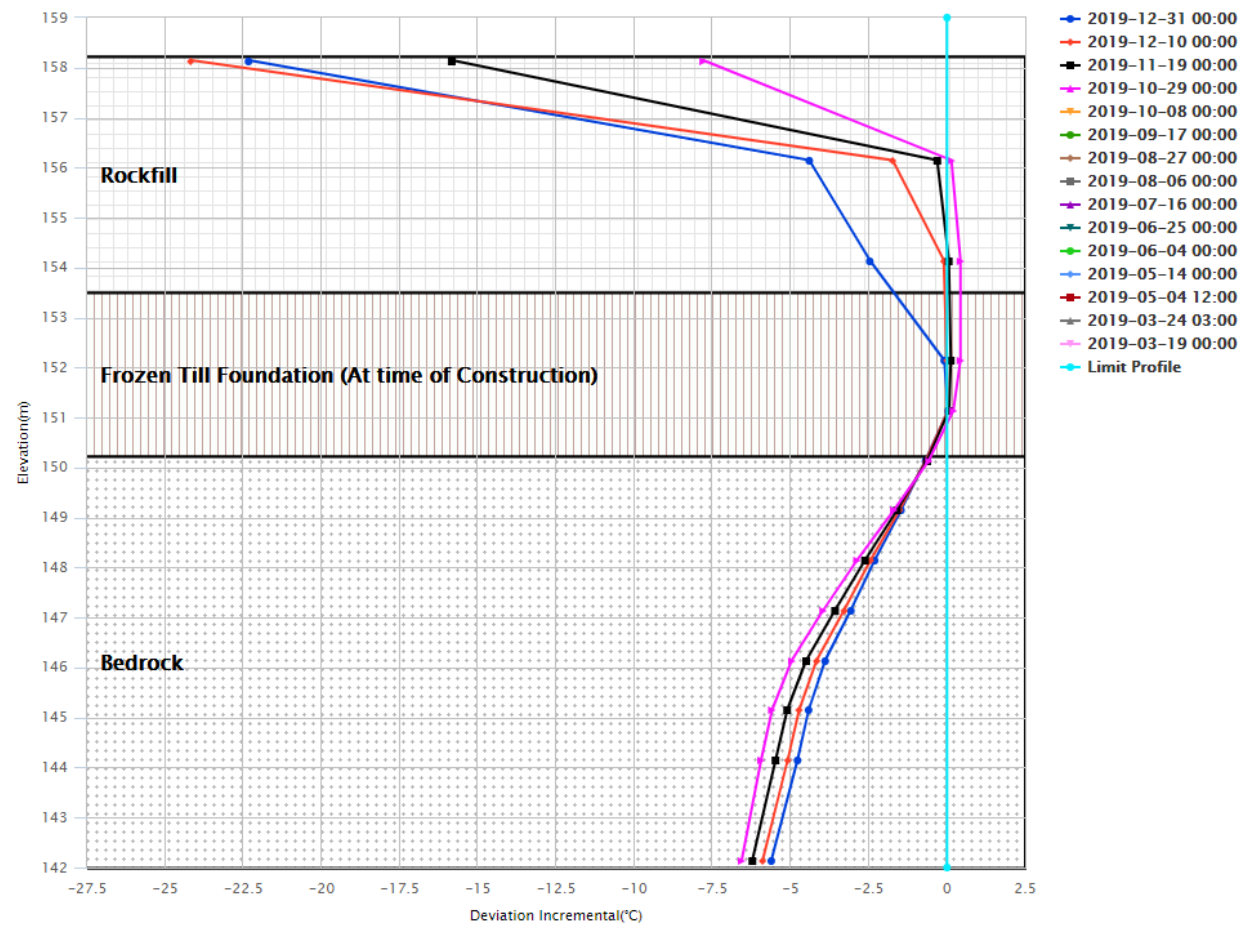
AMQ - WRSFD TH\_03



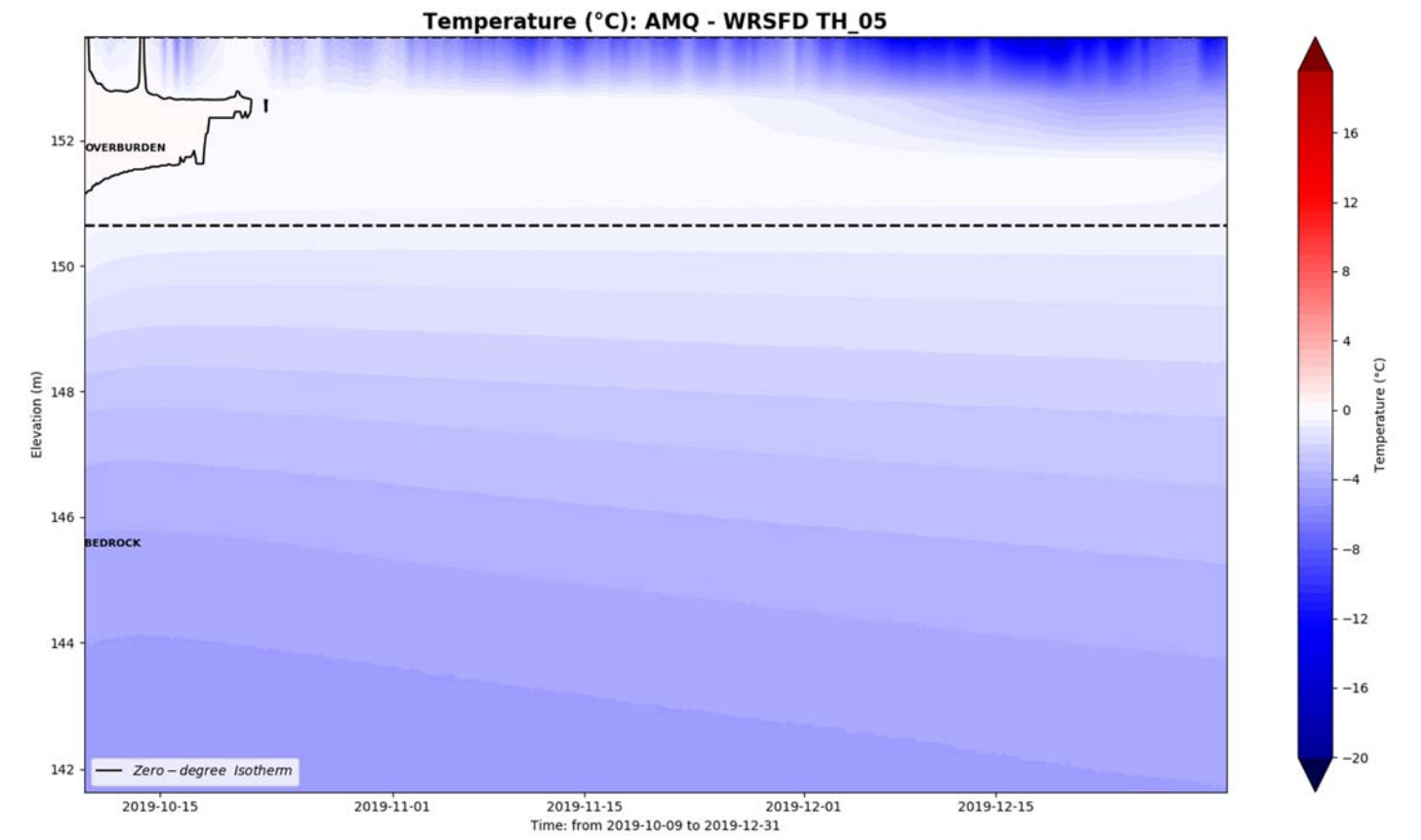
### WRSFD TH04



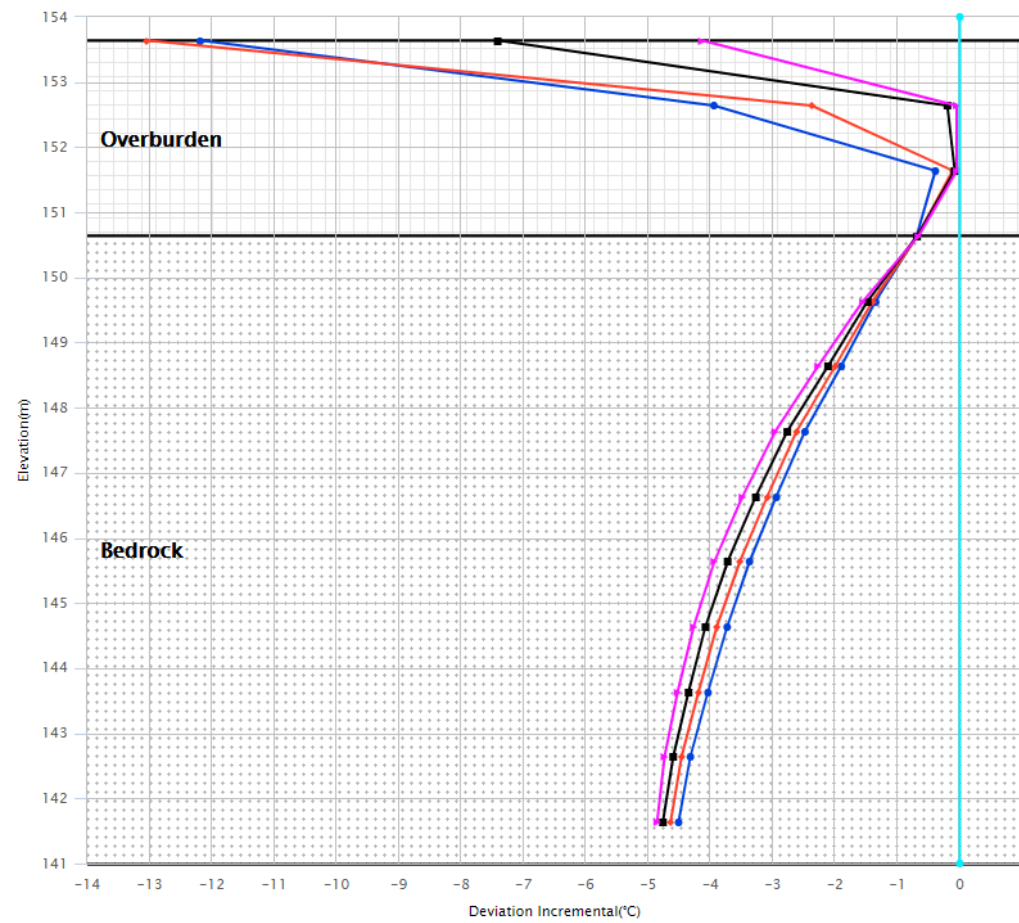
AMQ - WRSFD TH\_04



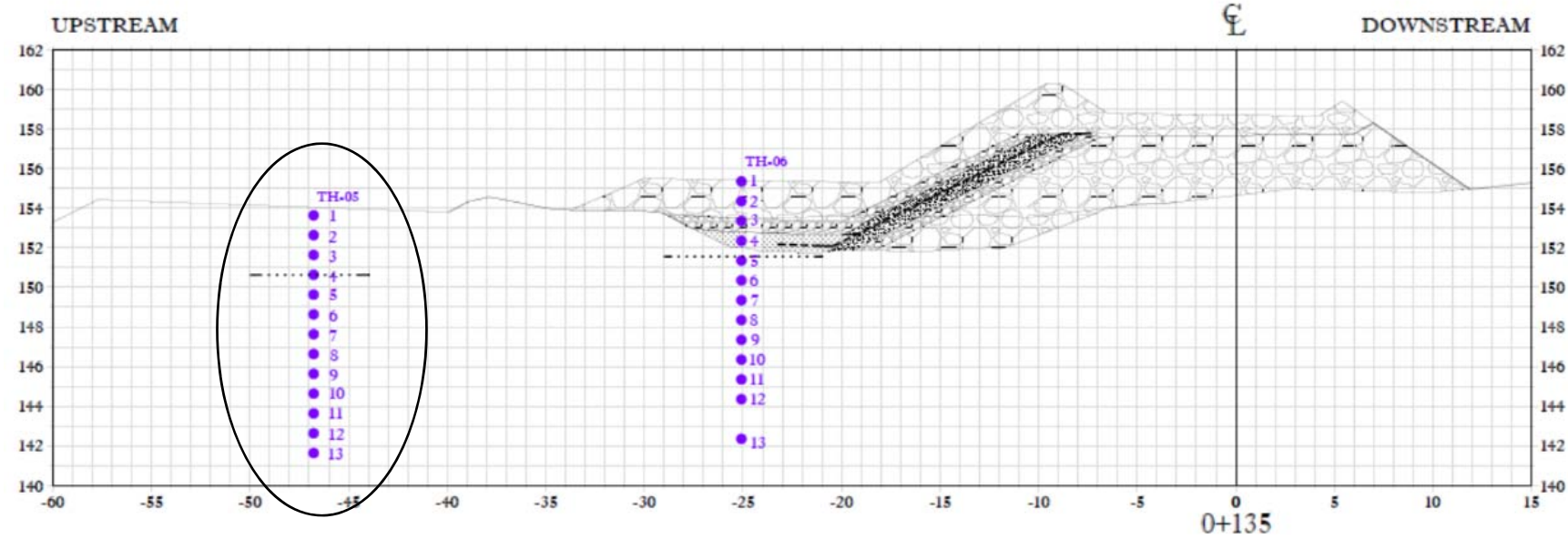
### WRSFD TH05



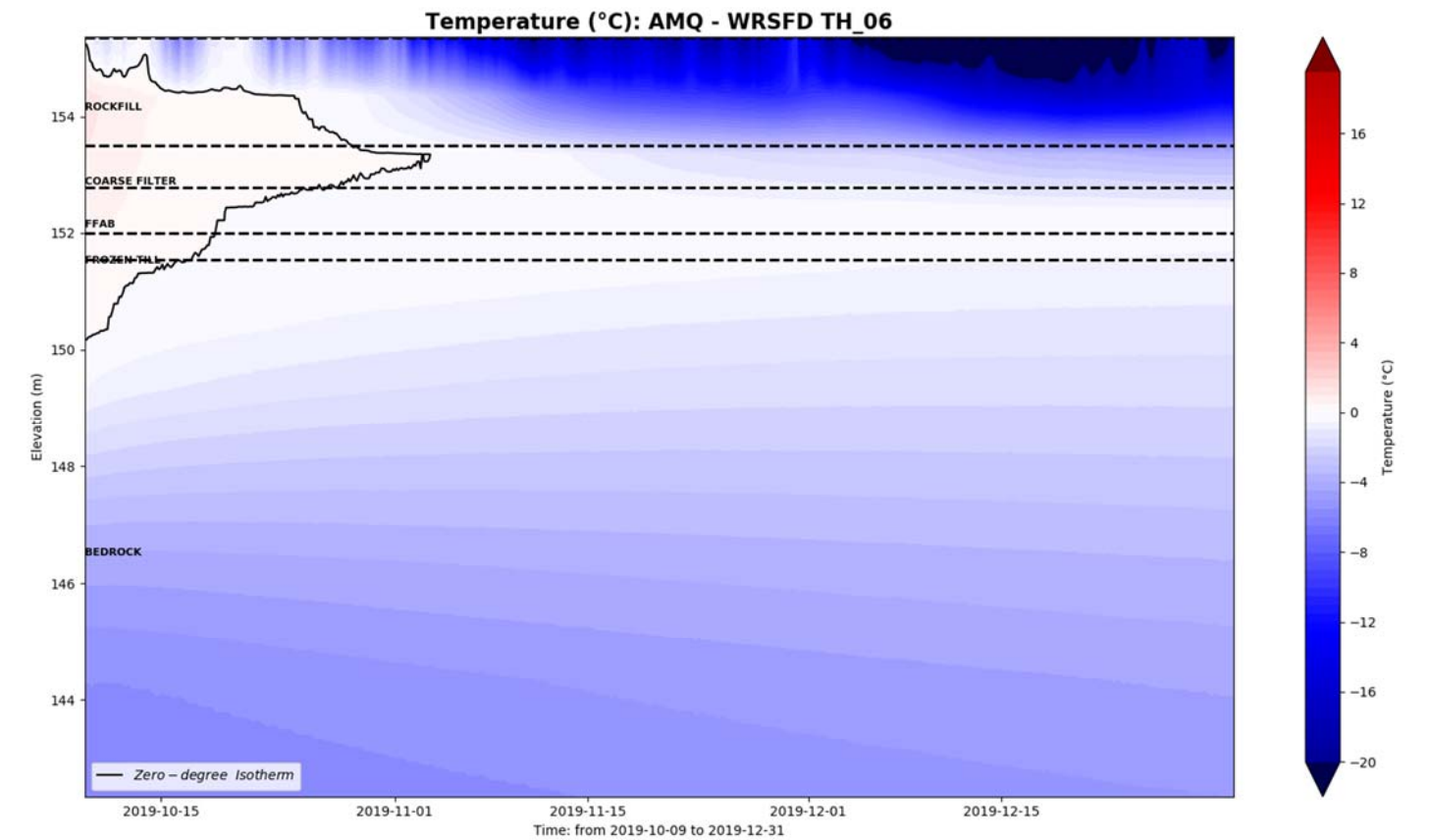
AMQ - WRSFD TH\_05



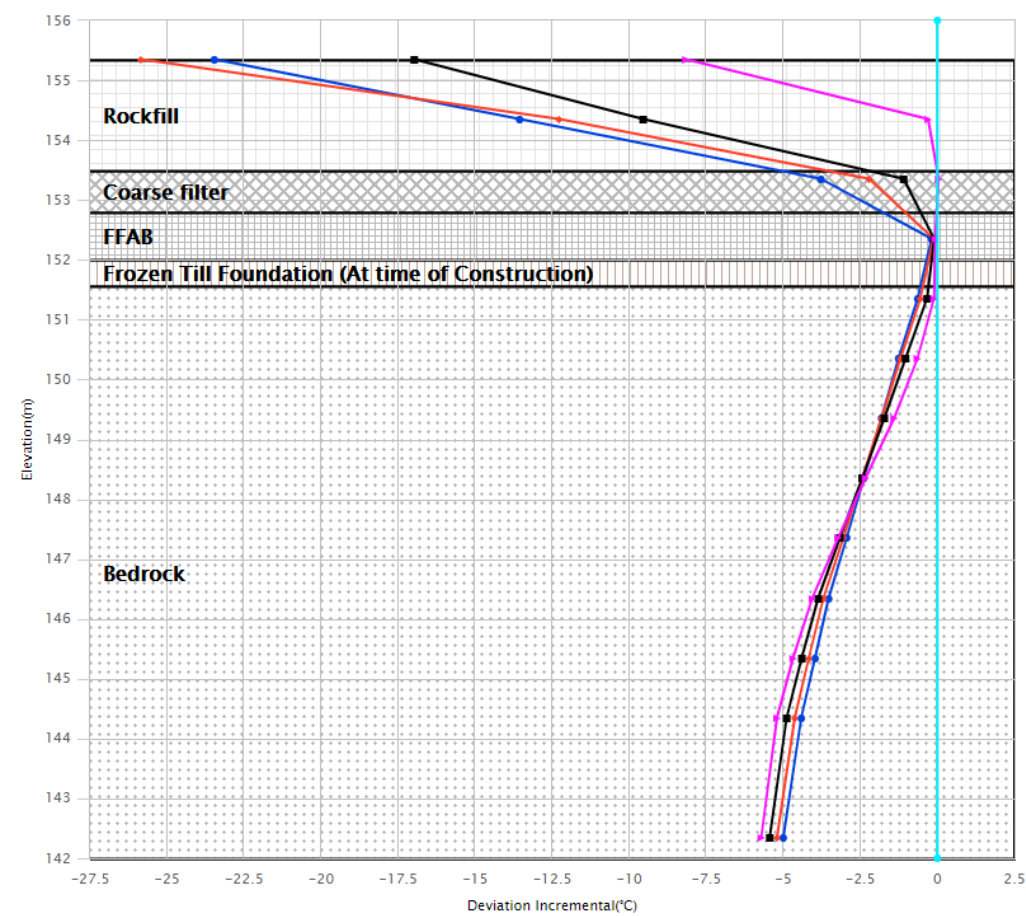
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-05-04 12:00
- 2019-03-24 03:00
- 2019-03-19 00:00
- Limit Profile



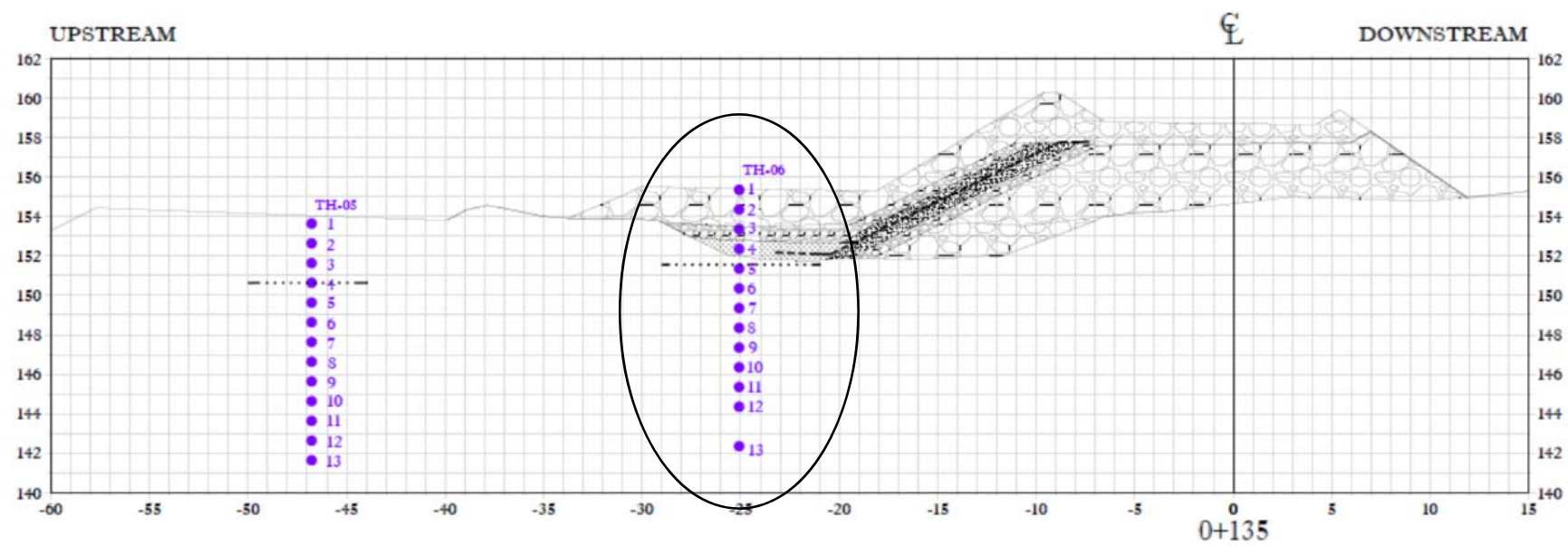
### WRSFD TH06



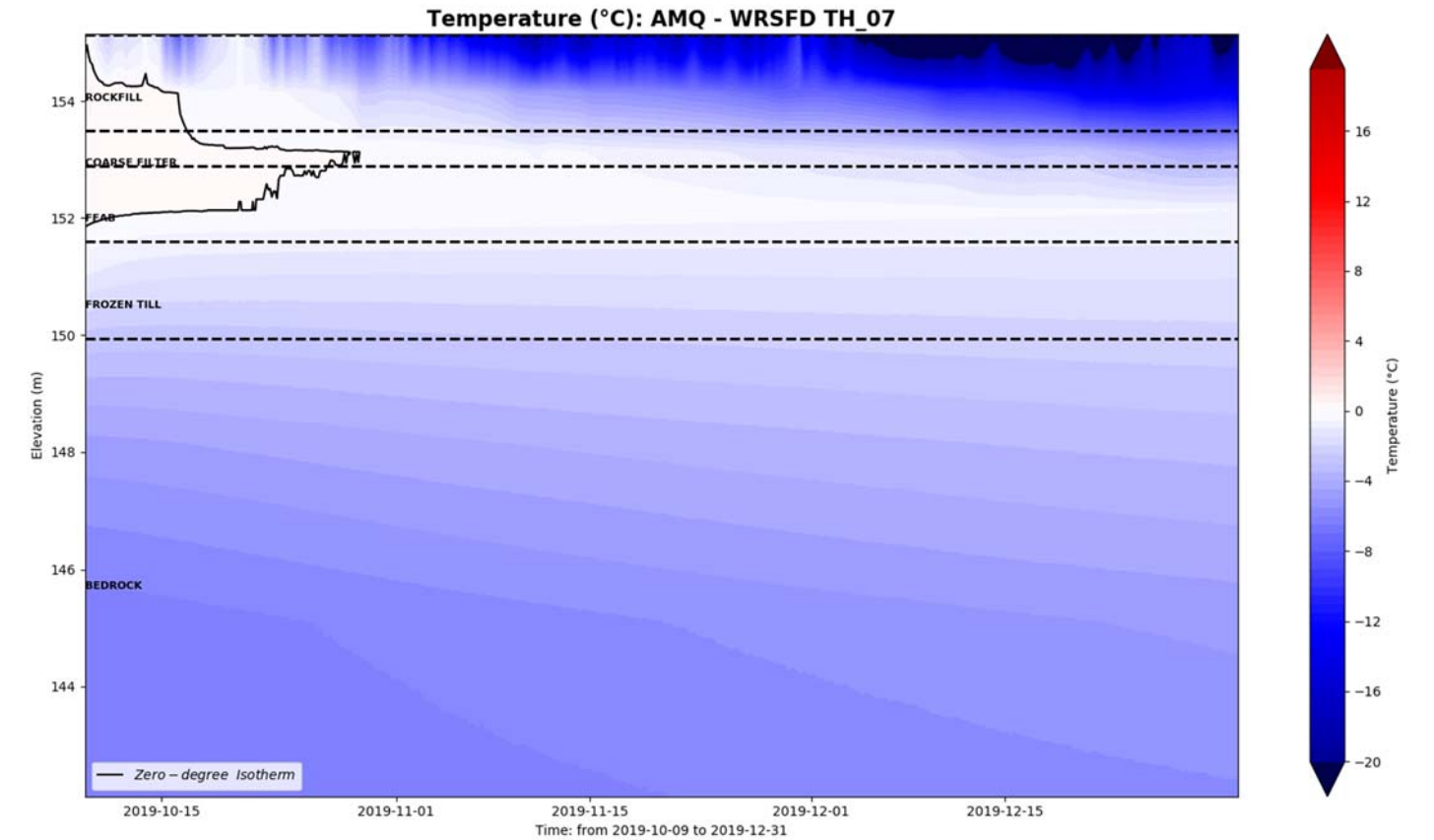
AMQ - WRSFD TH\_06



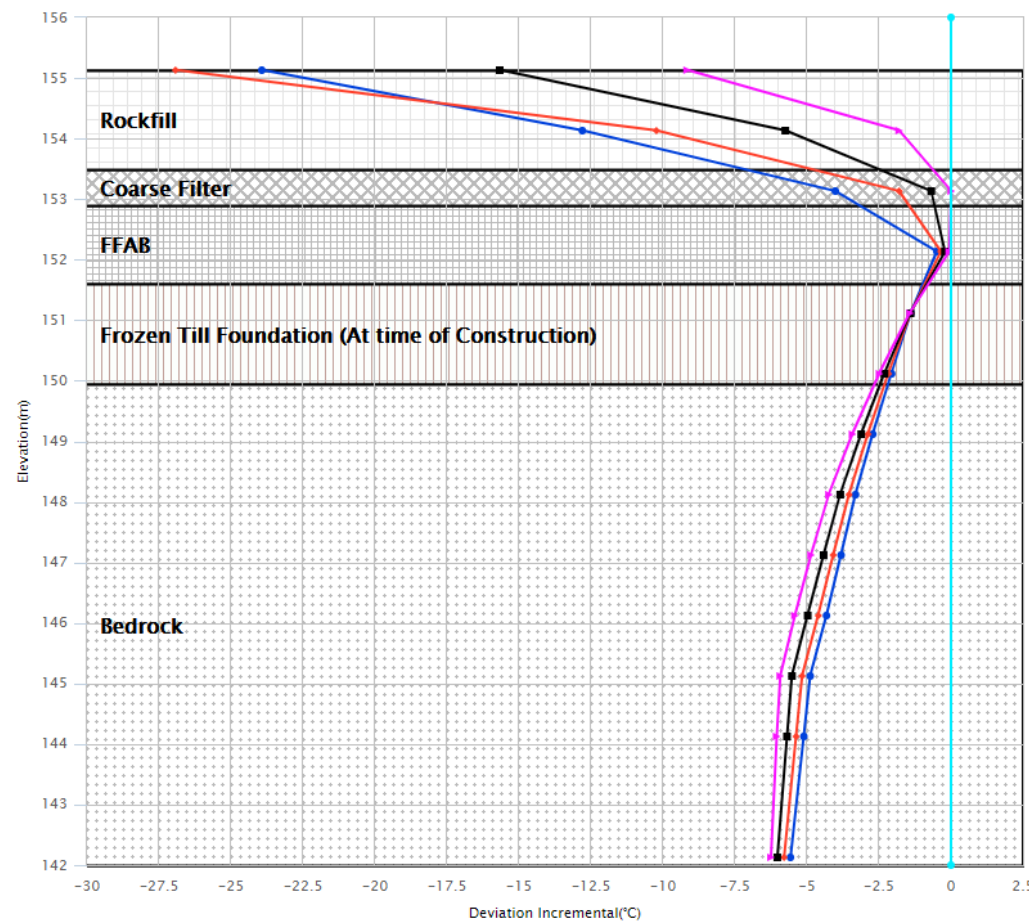
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-05-04 12:00
- 2019-03-24 03:00
- 2019-03-19 00:00
- Limit Profile



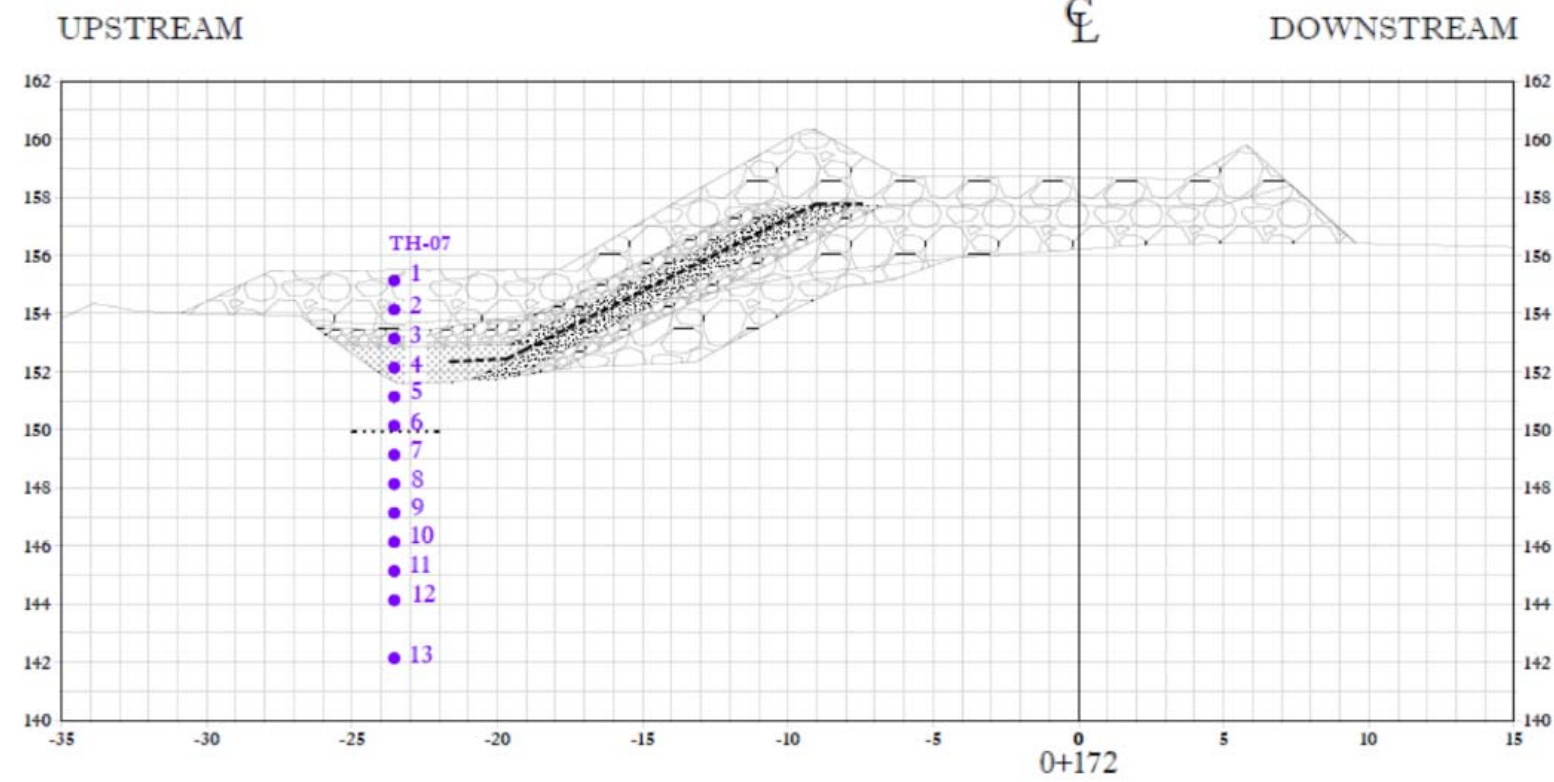
WRSFD TH07



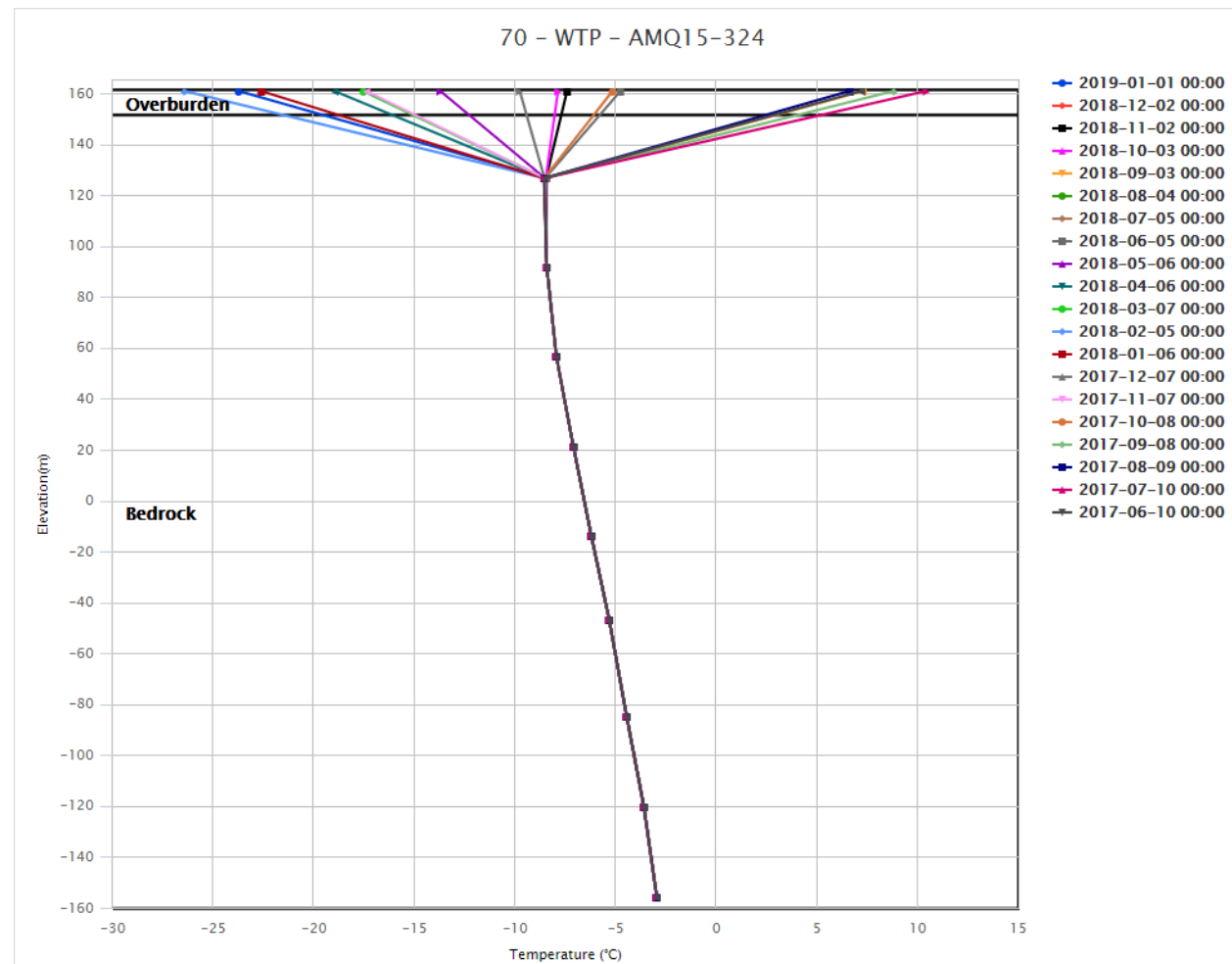
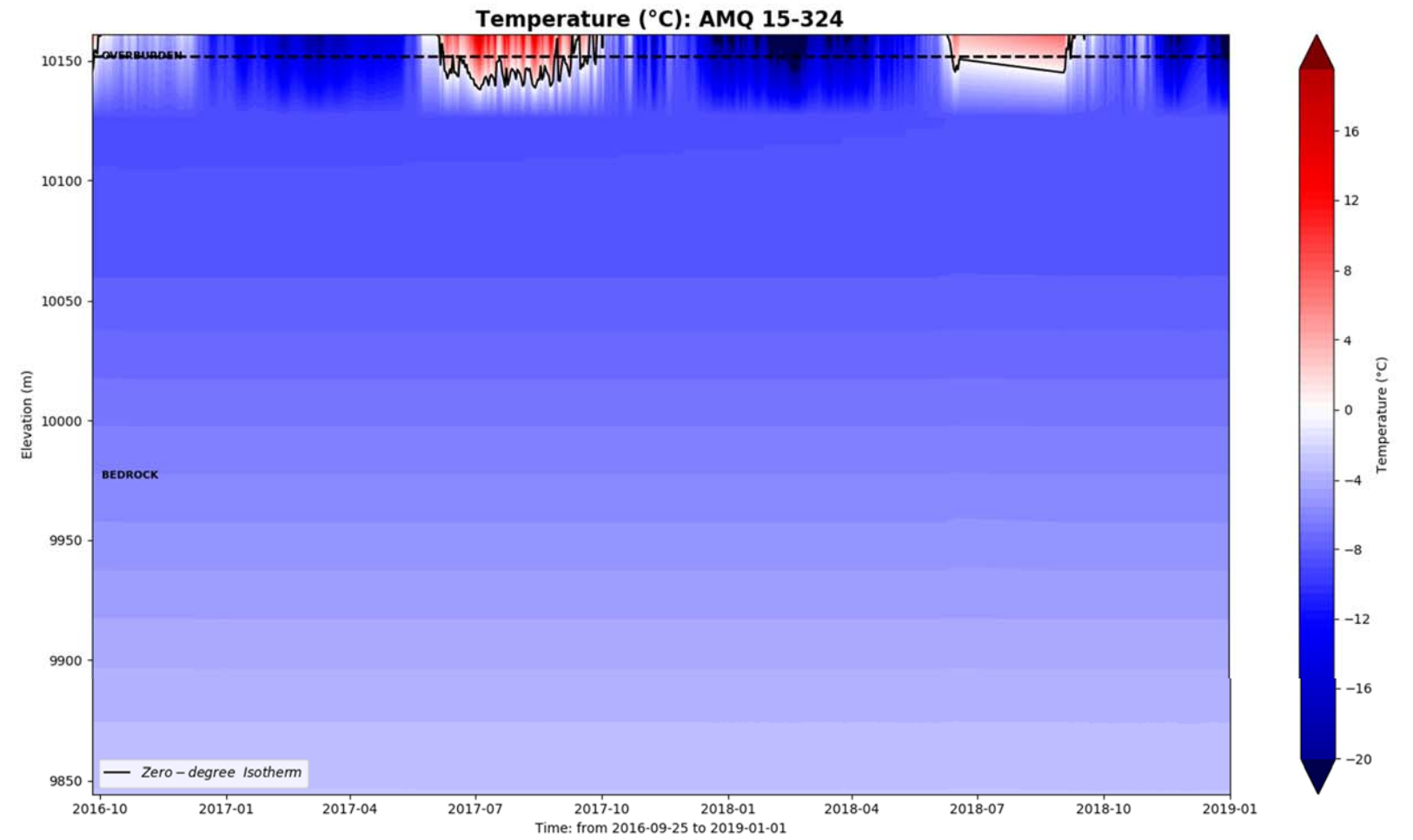
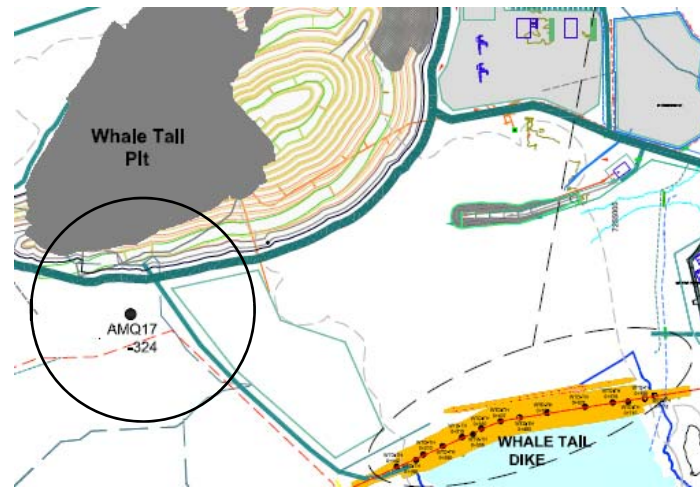
AMQ - WRSFD TH\_07



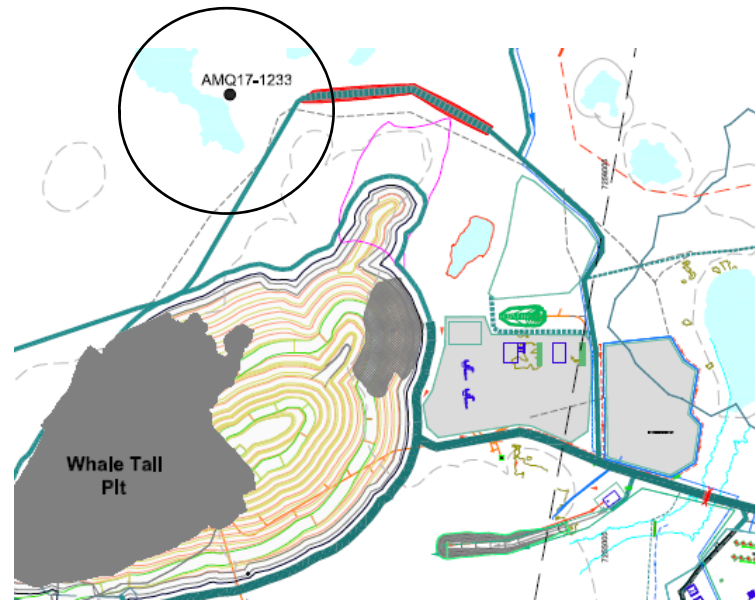
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-05-04 12:00
- 2019-03-24 03:00
- 2019-03-19 00:00
- Limit Profile



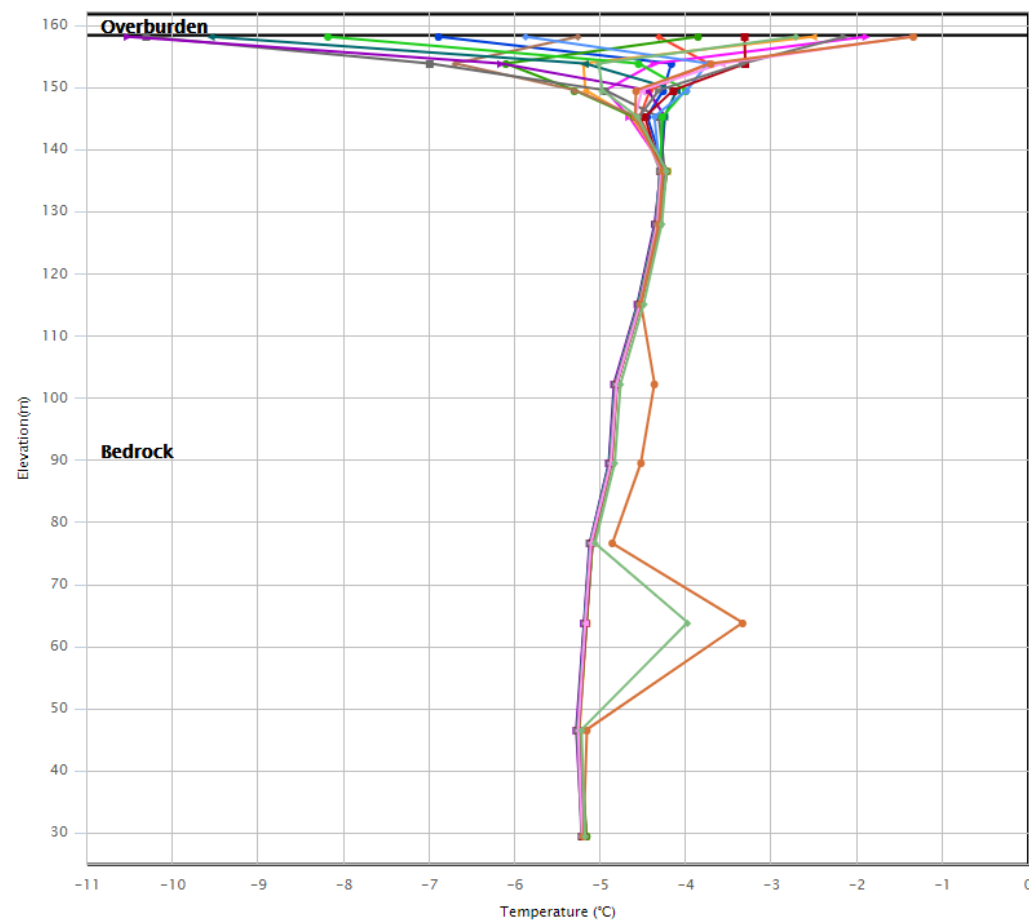
### AMQ 15-324



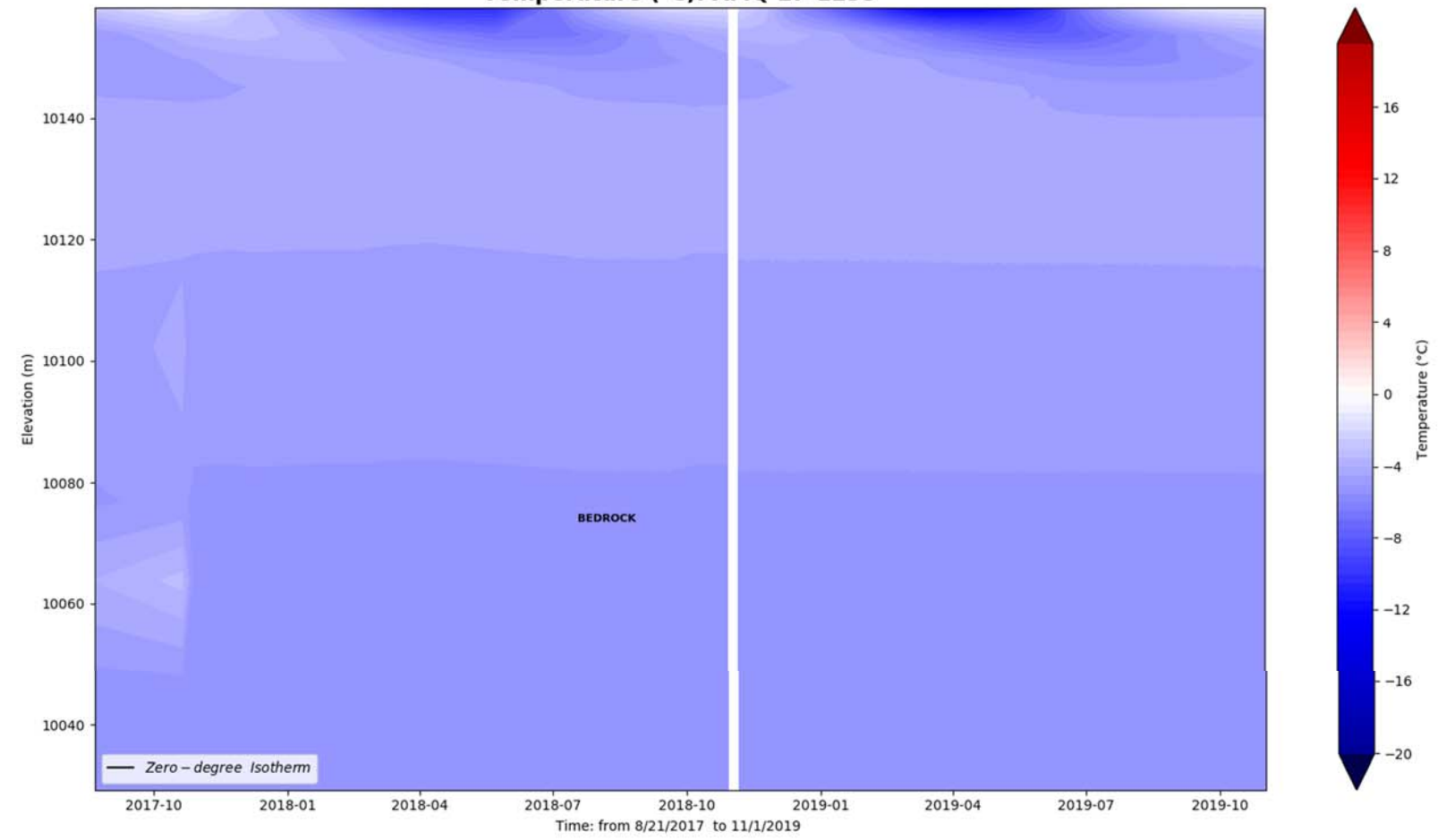
### AMQ 17-1233



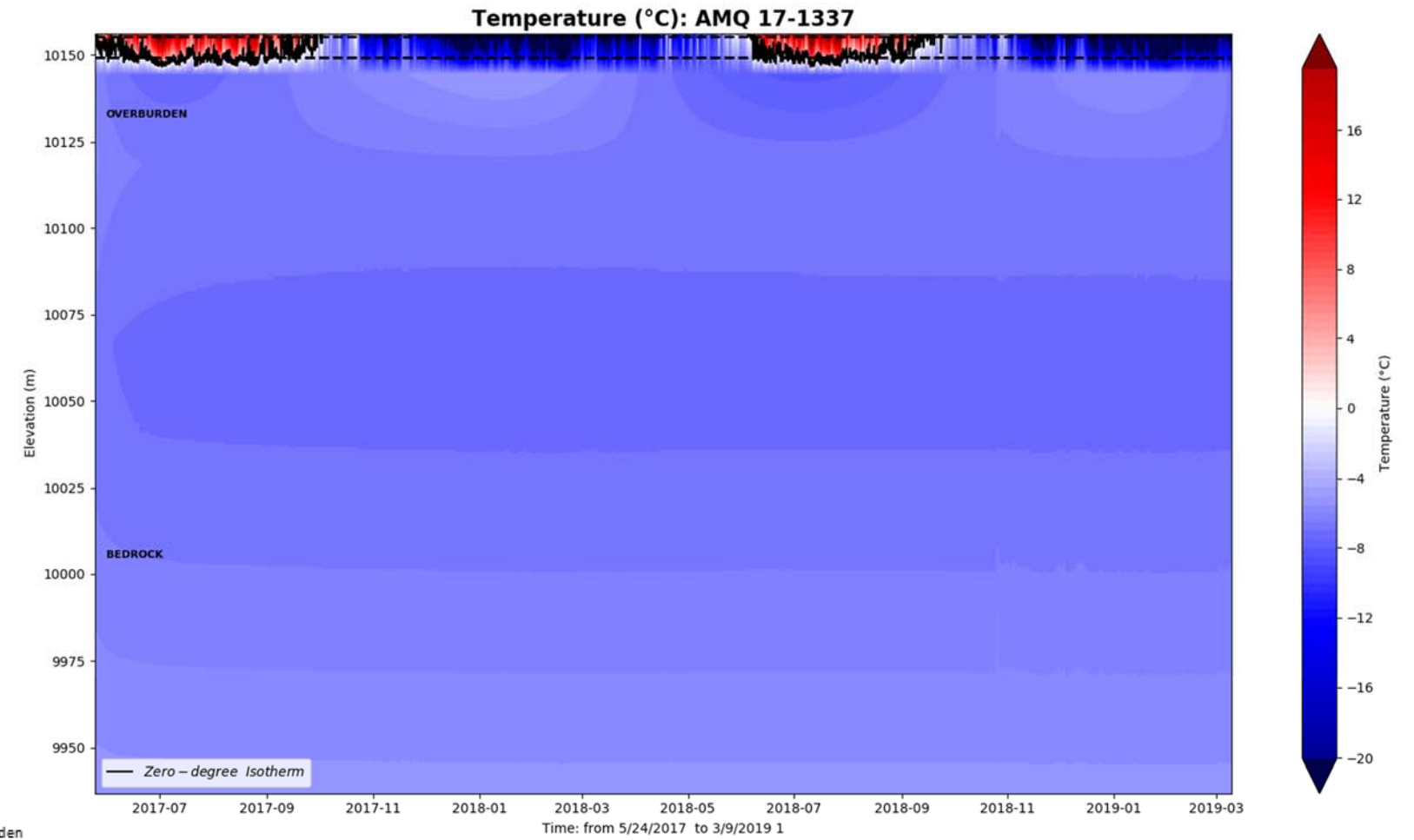
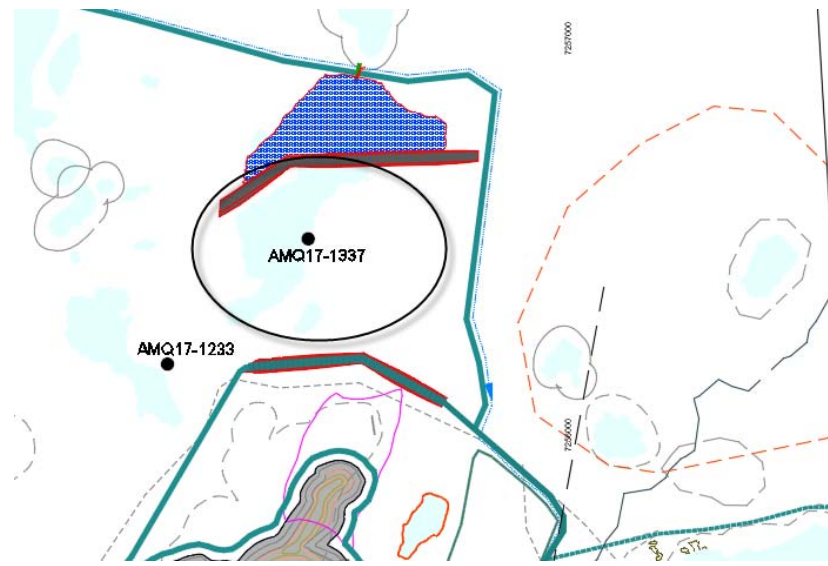
70 - IVR - AMQ17-1233



### Temperature (°C): AMQ 17-1233



### AMQ 17-1337



AMQ17-1337\_IVR Pit - Bead Temperature vs. Elevation - 2017

