

Appendix 27

Whale Tail 2019 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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1 INTRODUCTION

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

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

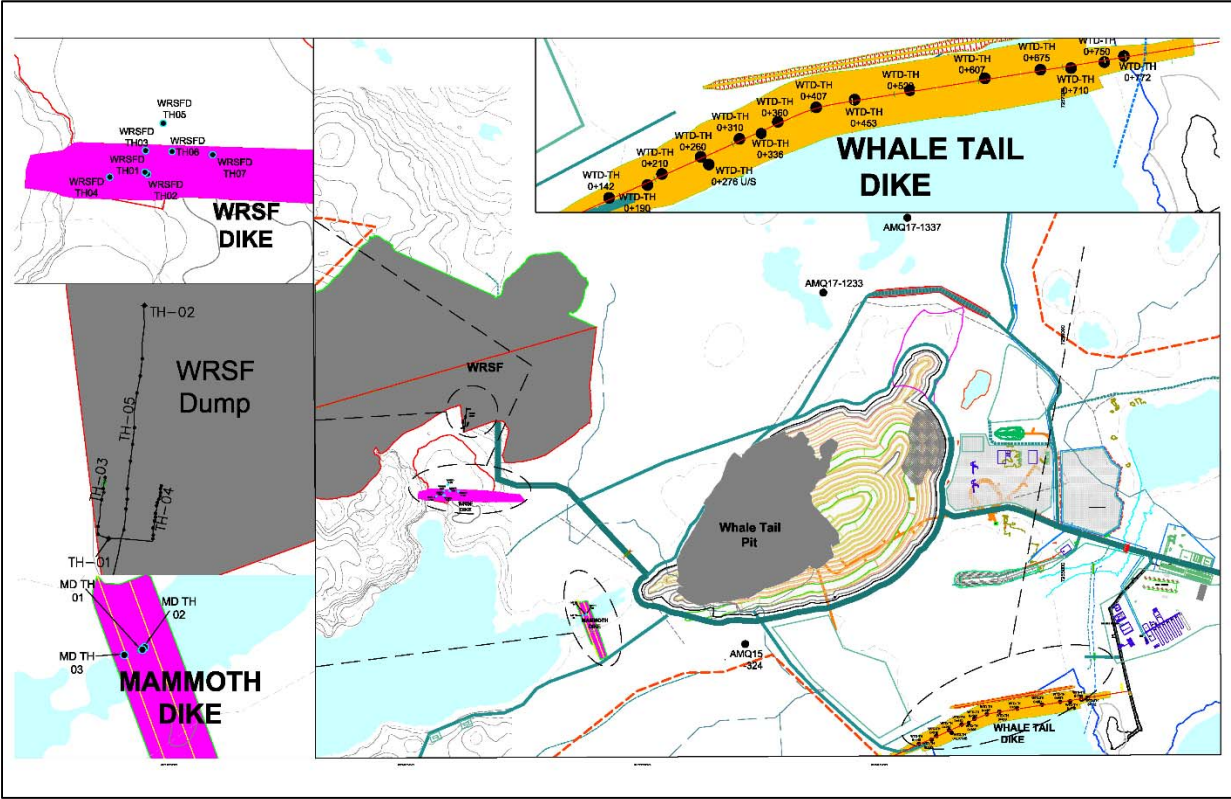


Table 1: Summary of Active Thermistors within the Project Site

Name	Area	Easting (X)	Northing (Y)	Elevation (Z)	Azimuth	Dip	Installed	Active (Y) or (N)
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	605428.59	7255566.21	153.63		-90	2019	Y
<i>WRSF TH06</i>	WRSF Dike	605435.56	7255544.29	155.35		-90	2019	Y
<i>WRSF TH07</i>	WRSF Dike	605466.94	7255541.78	155.13		-90	2019	Y

3 THERMAL MONITORING RESULT

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

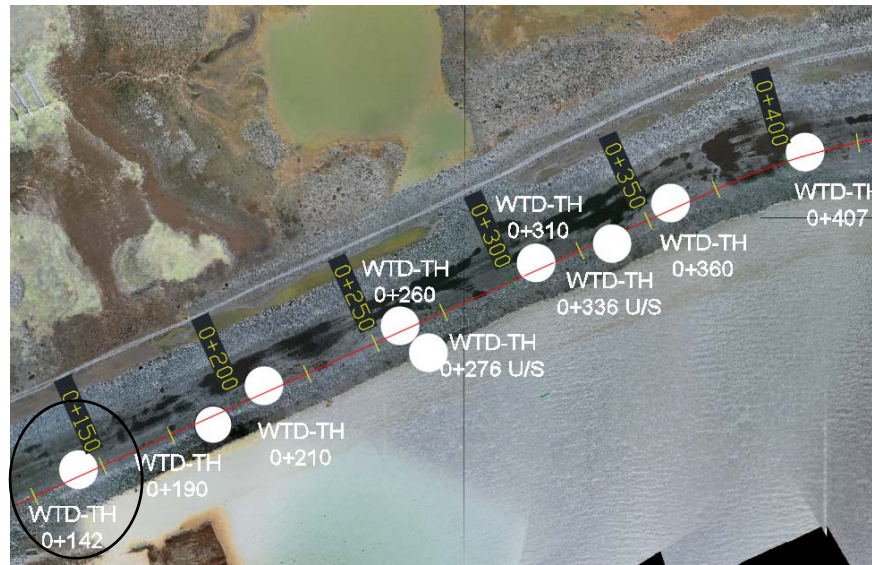
The thermistor currently installed near the pit area are following the expected trend and are not showing any impact on the surrounding permafrost.

3.4 WHALE TAIL LAKE SHORE

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

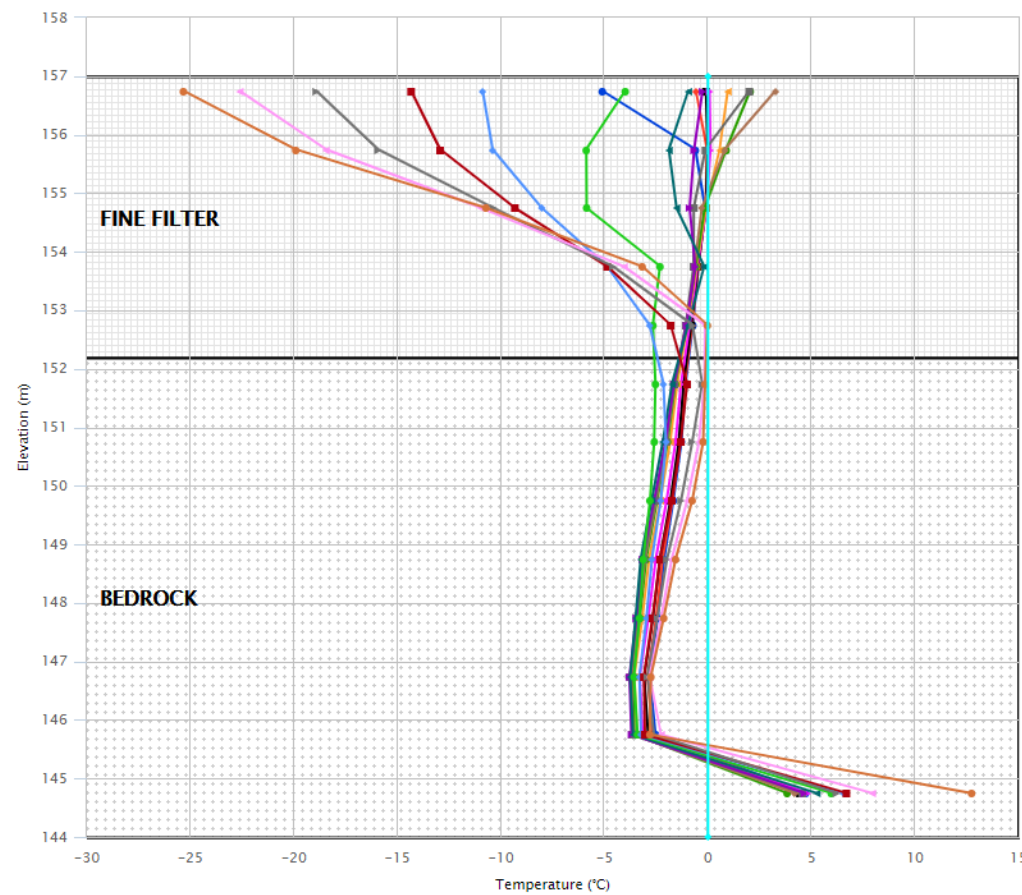
APPENDIX A – THERMAL MONITORING DATA

WTD-TH 0+142



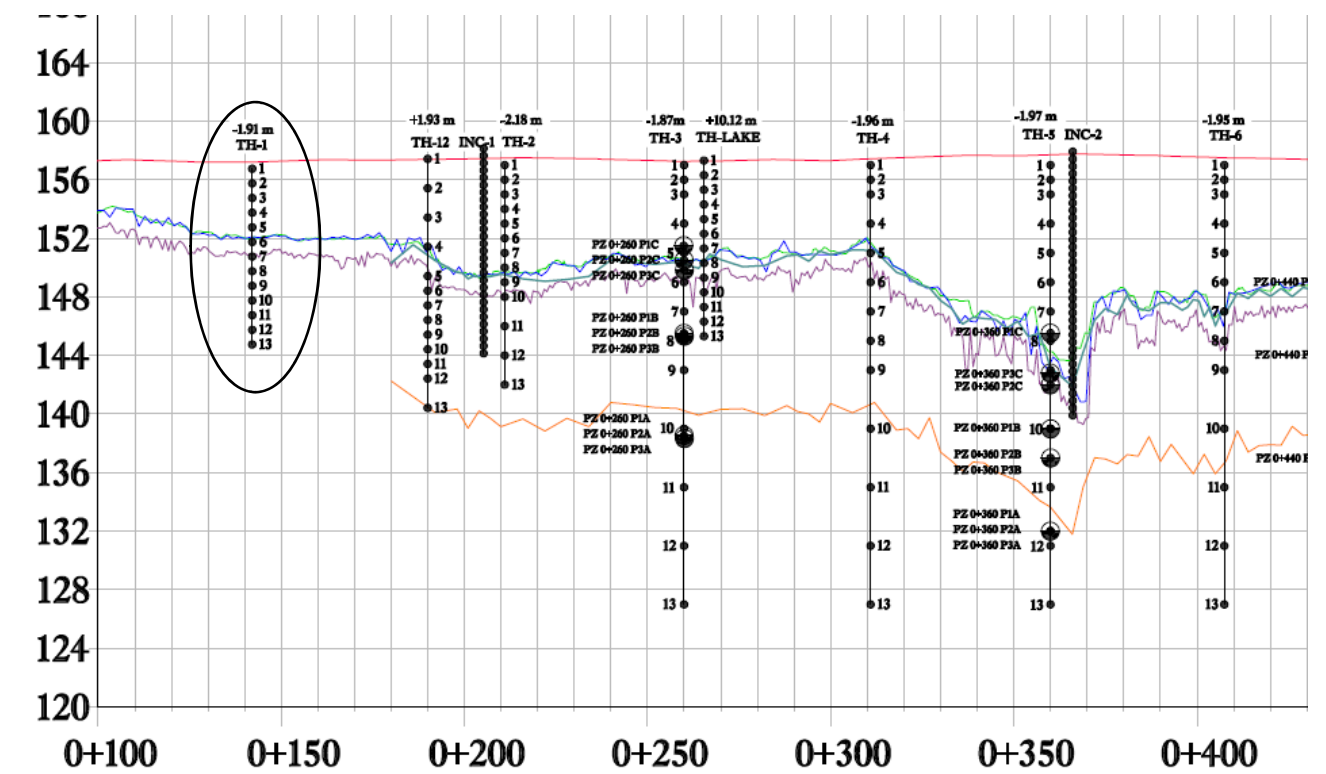
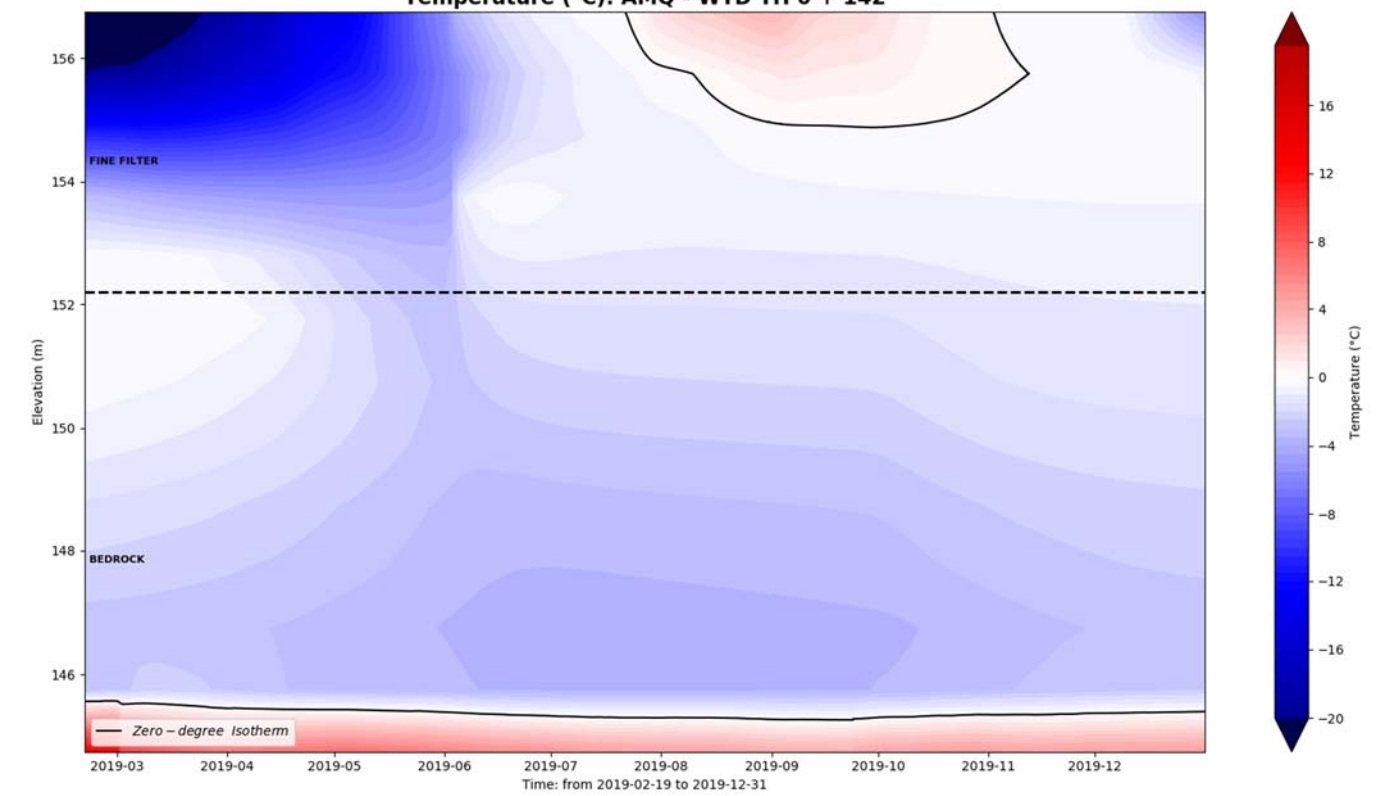
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Significant capacitive effect Bead #12 and #13

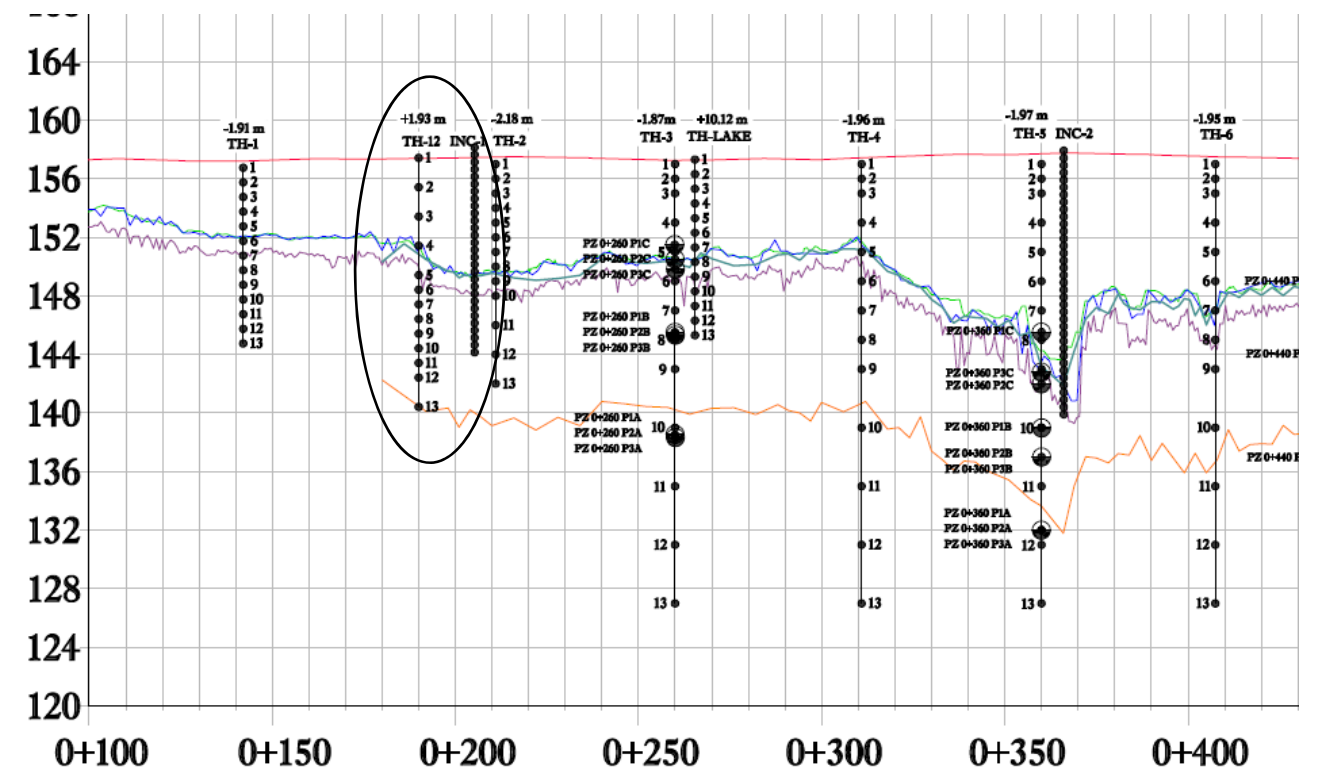
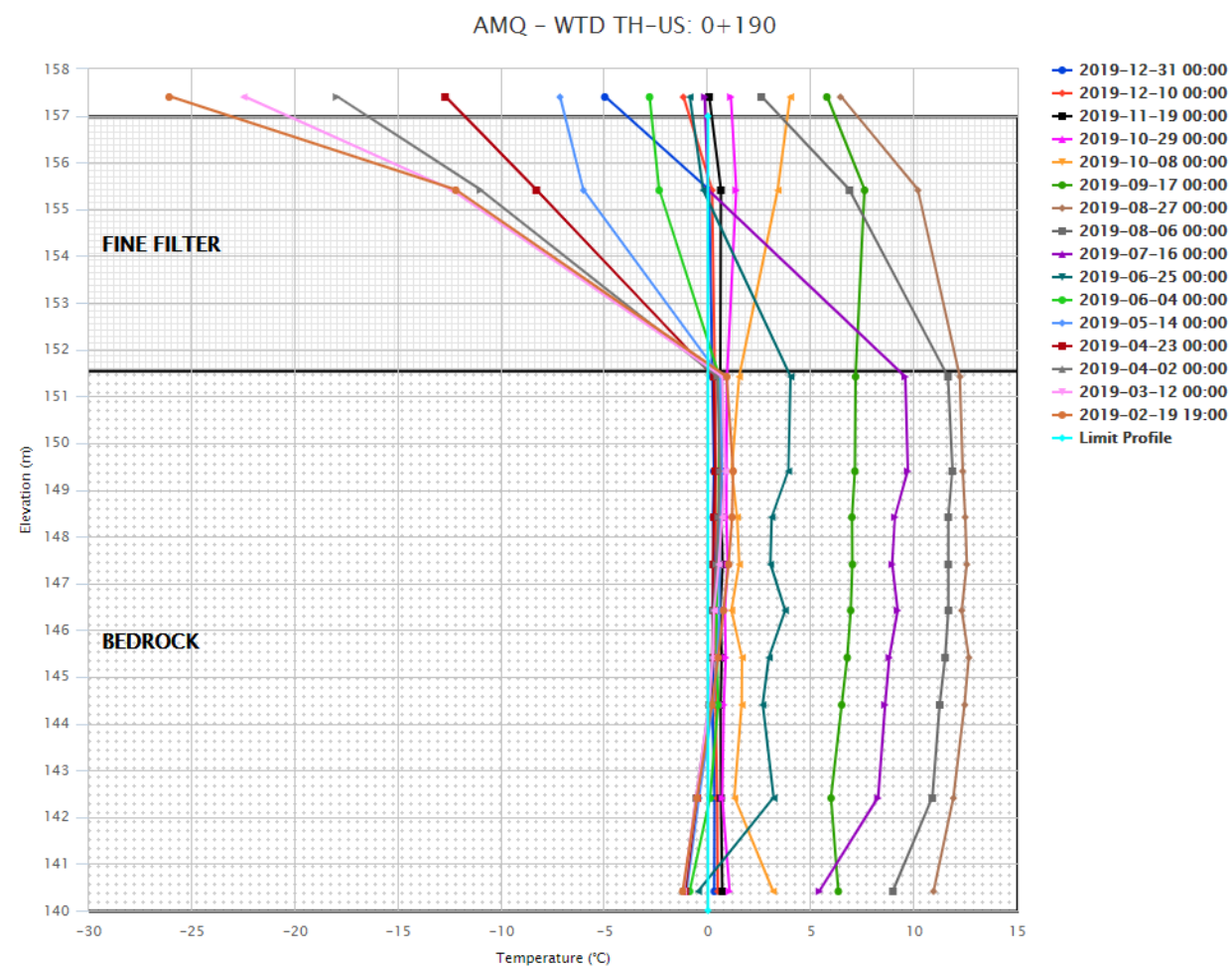
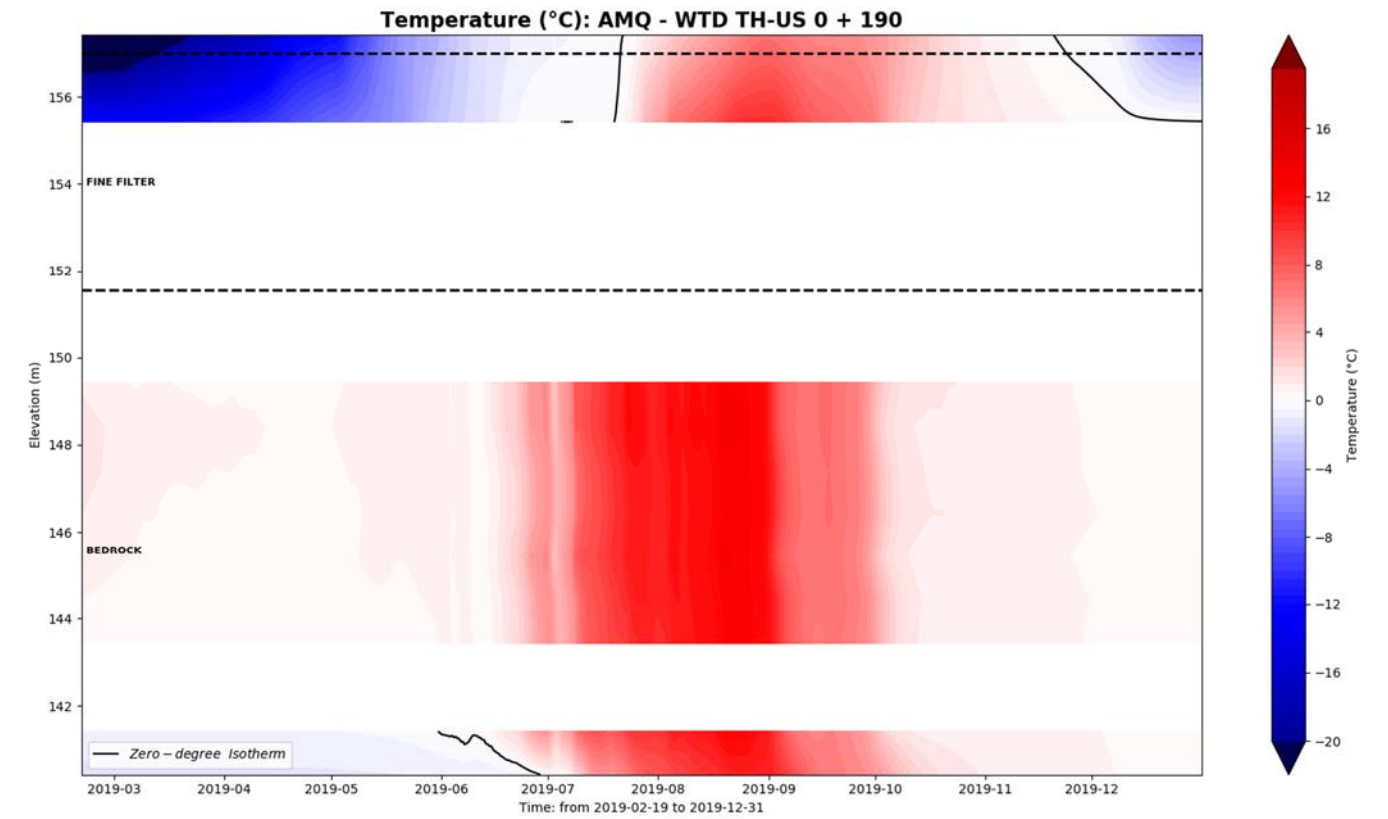
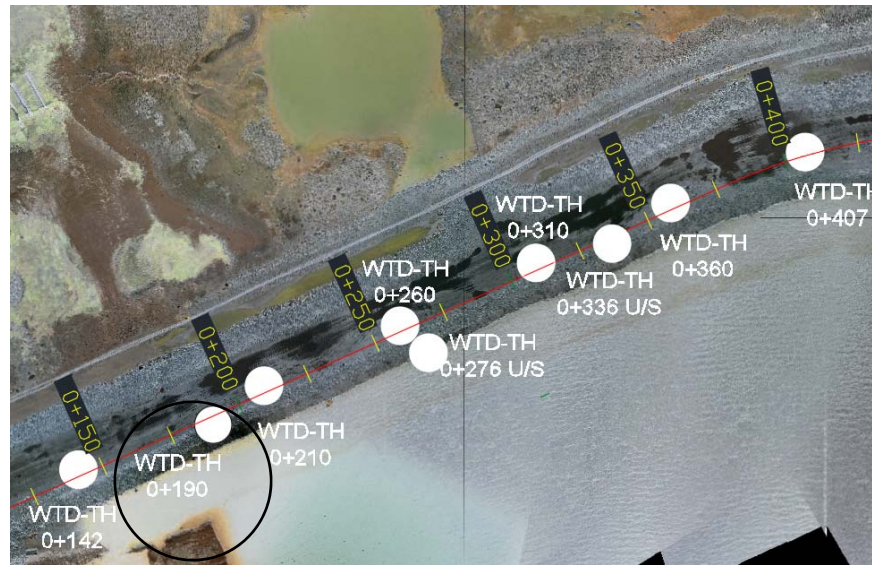


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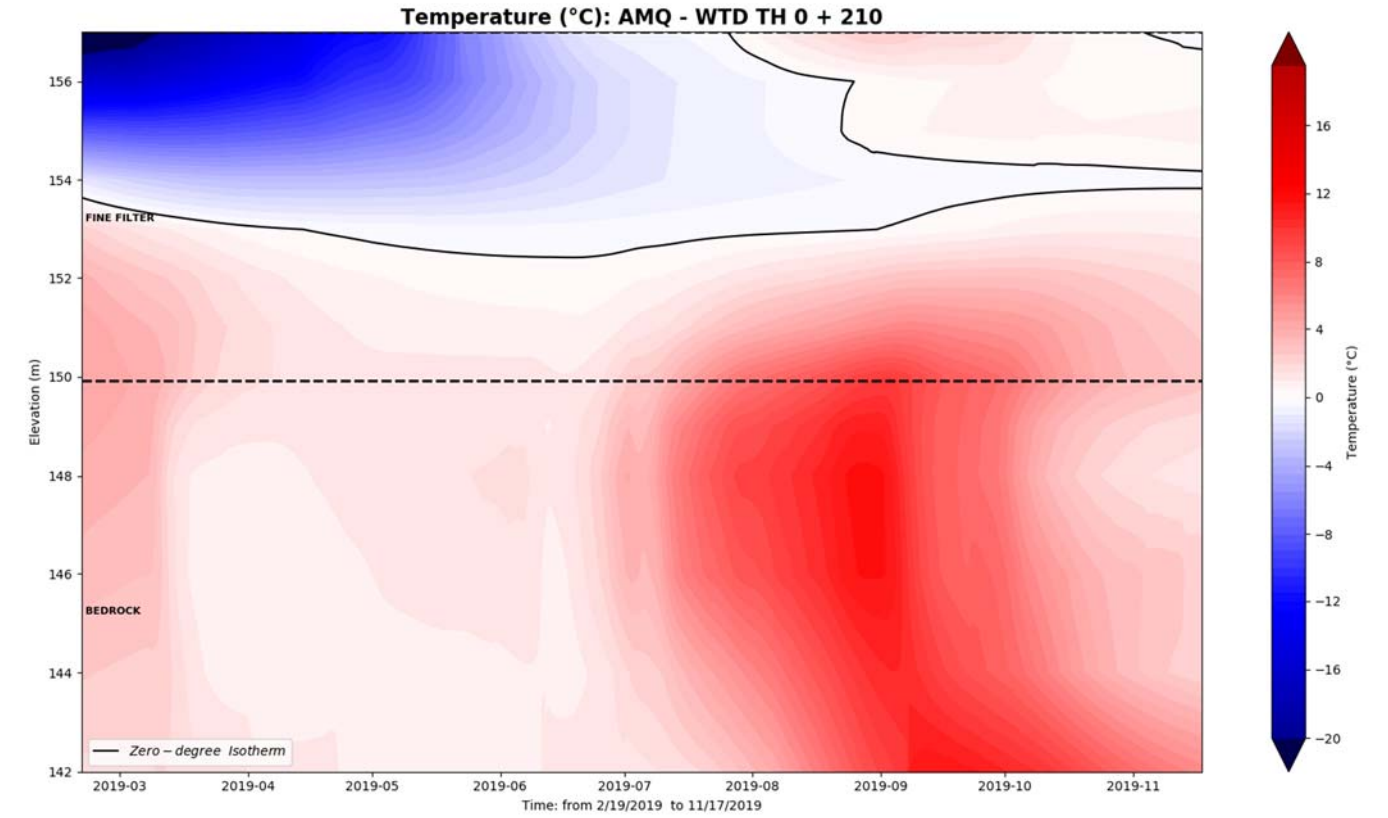
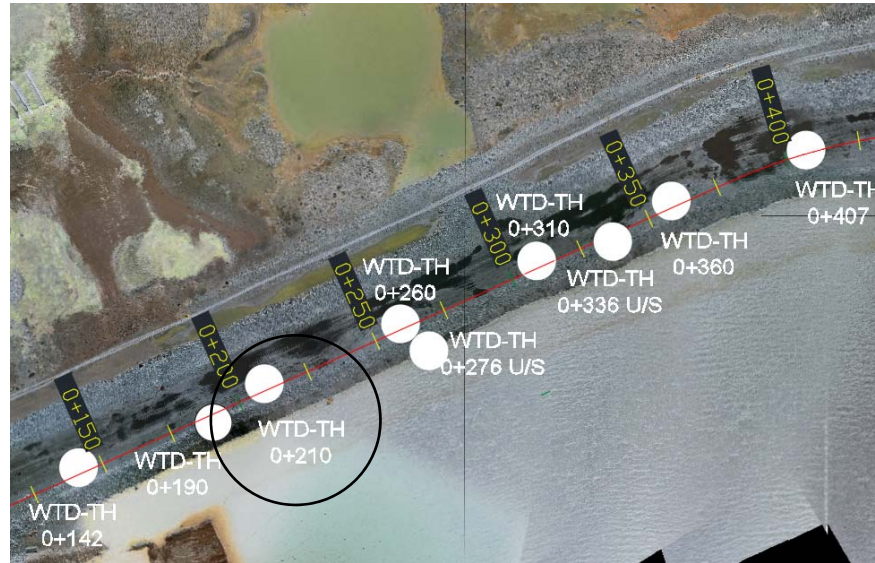
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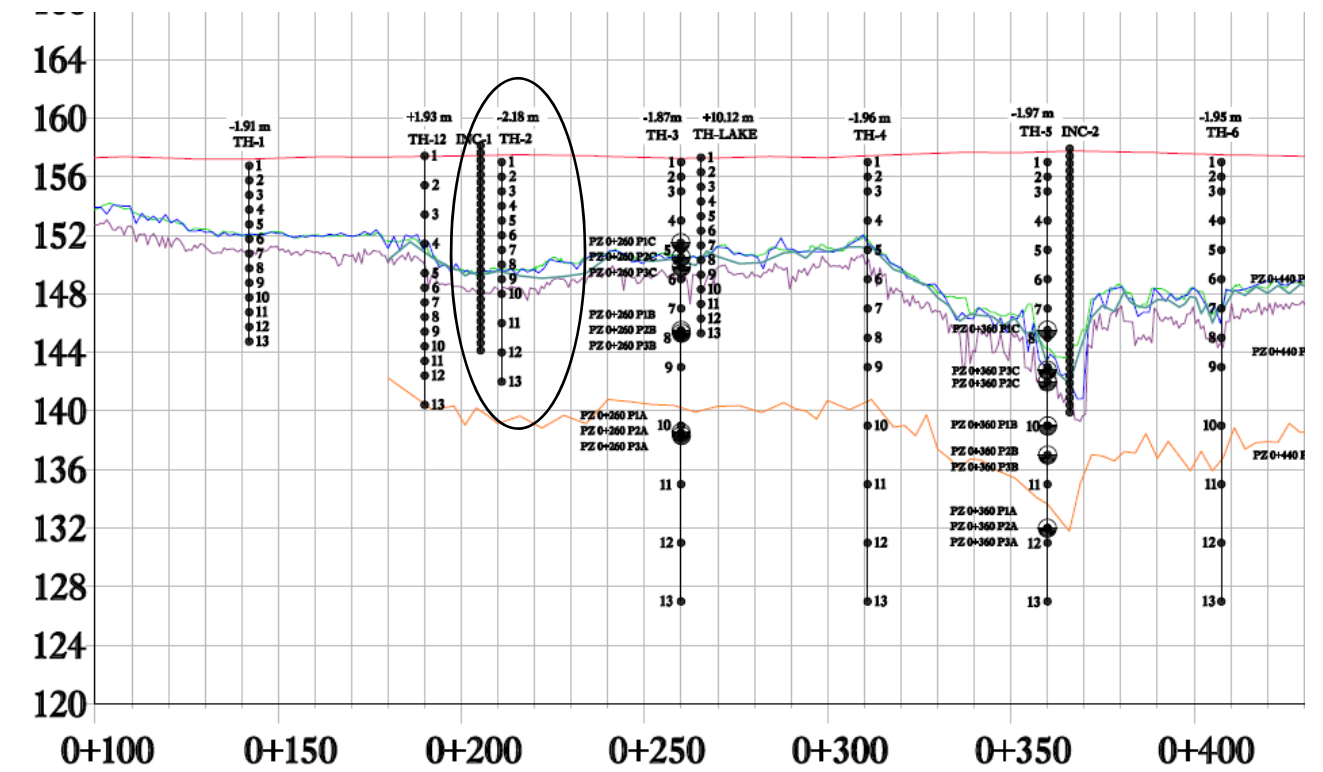
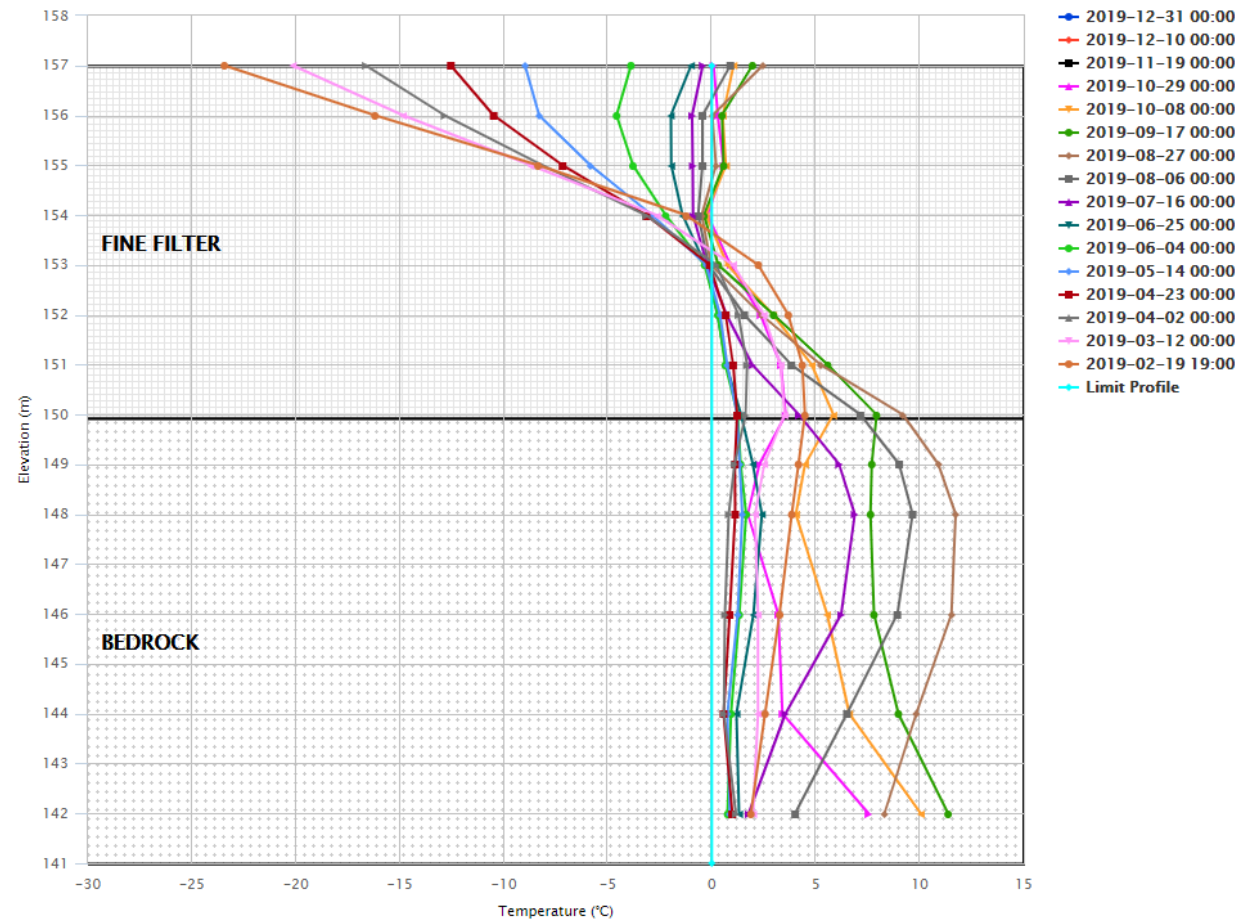
WTD-TH 0+190 U/S



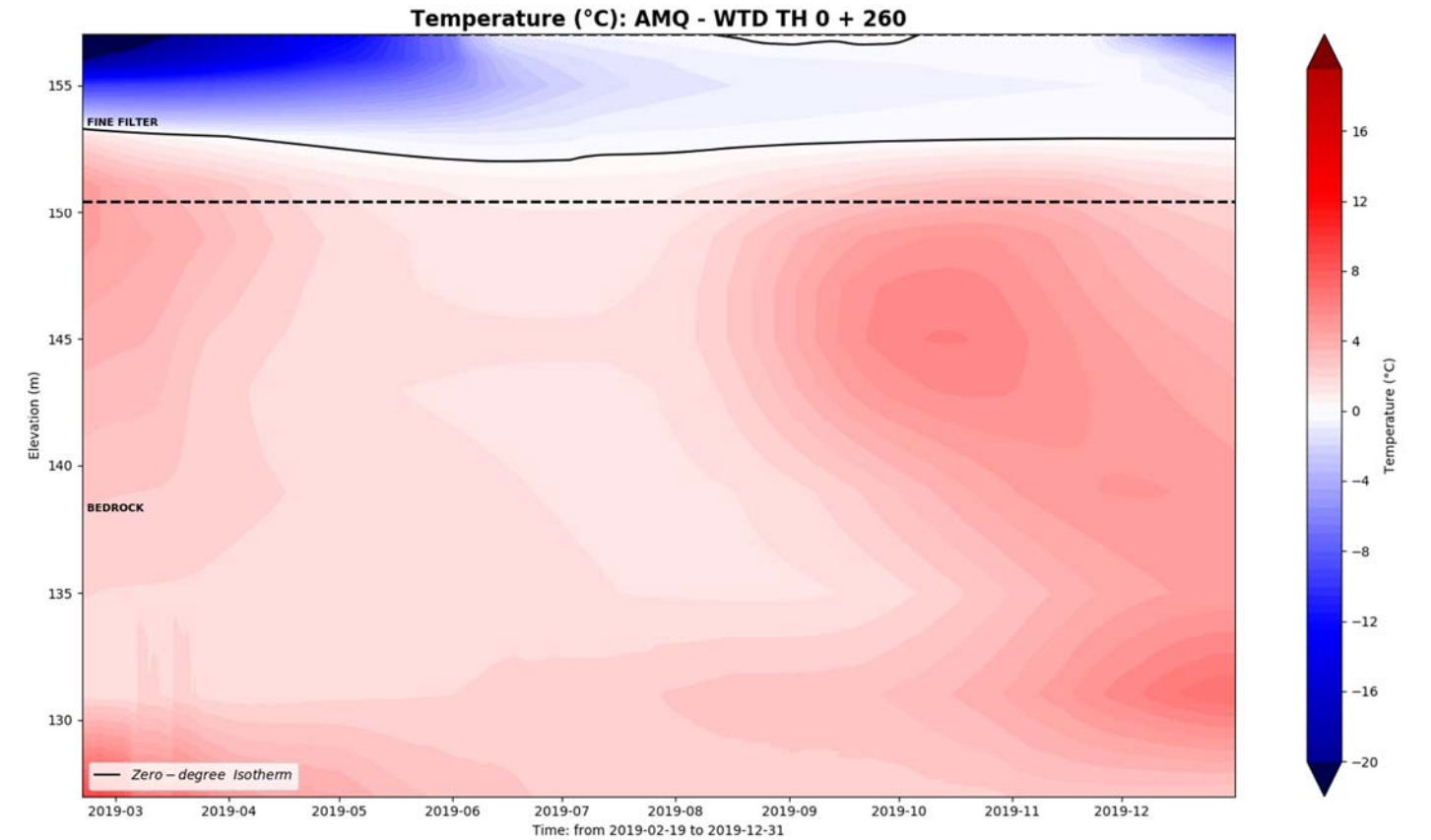
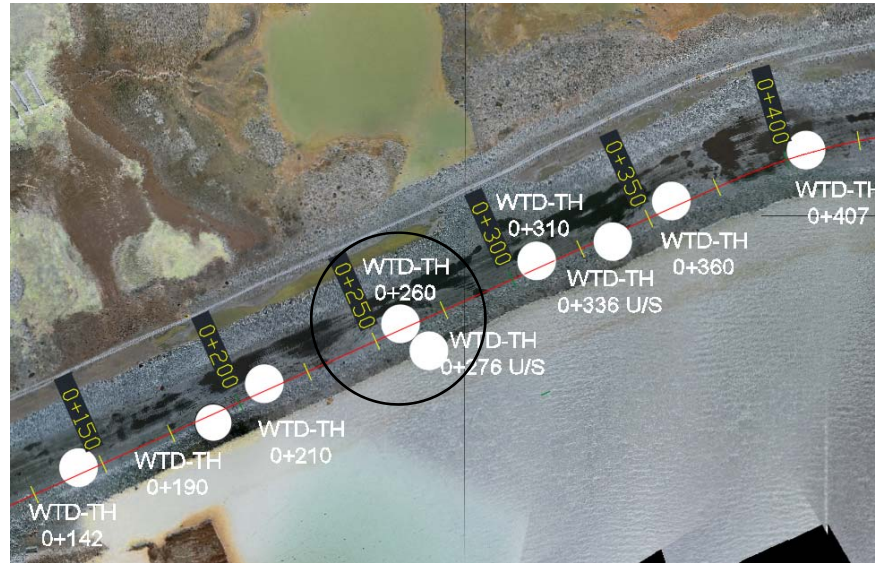
WTD-TH 0+210



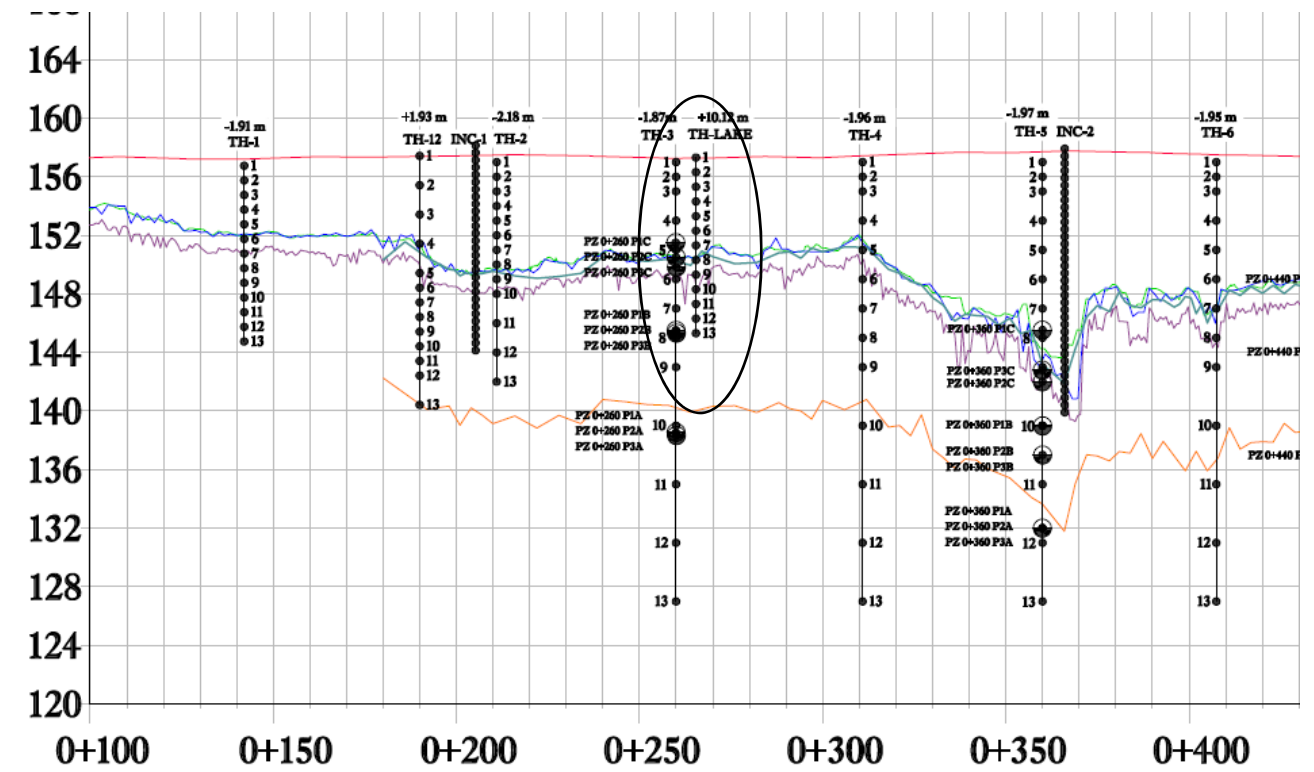
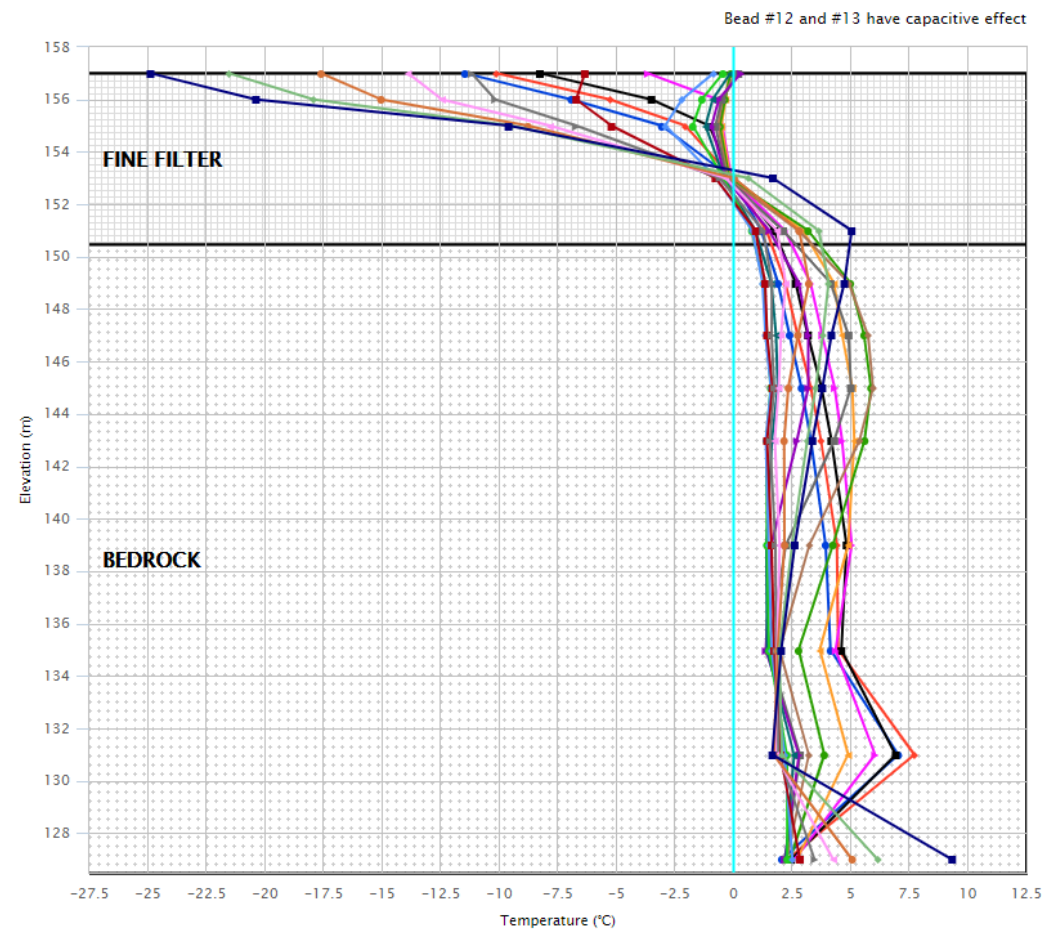
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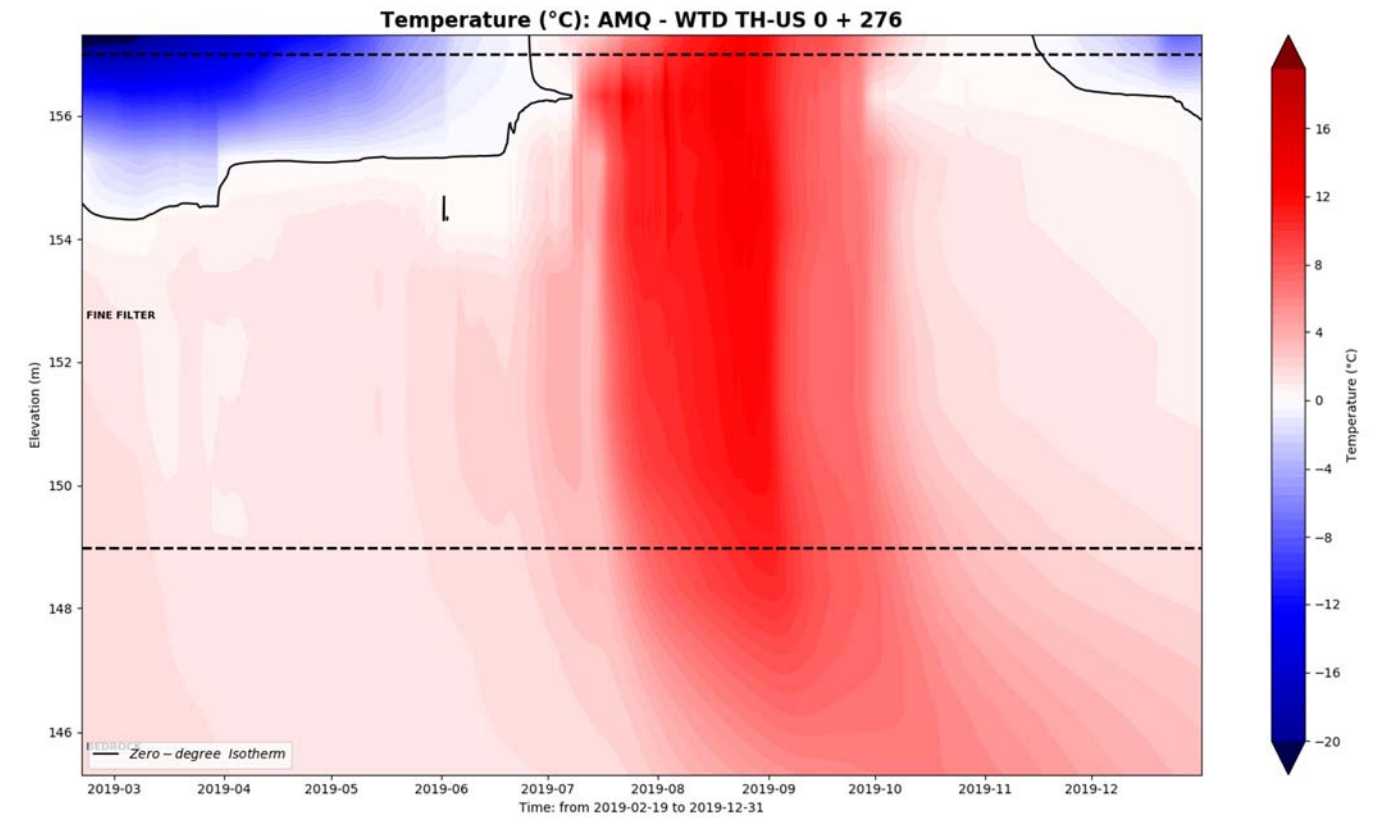
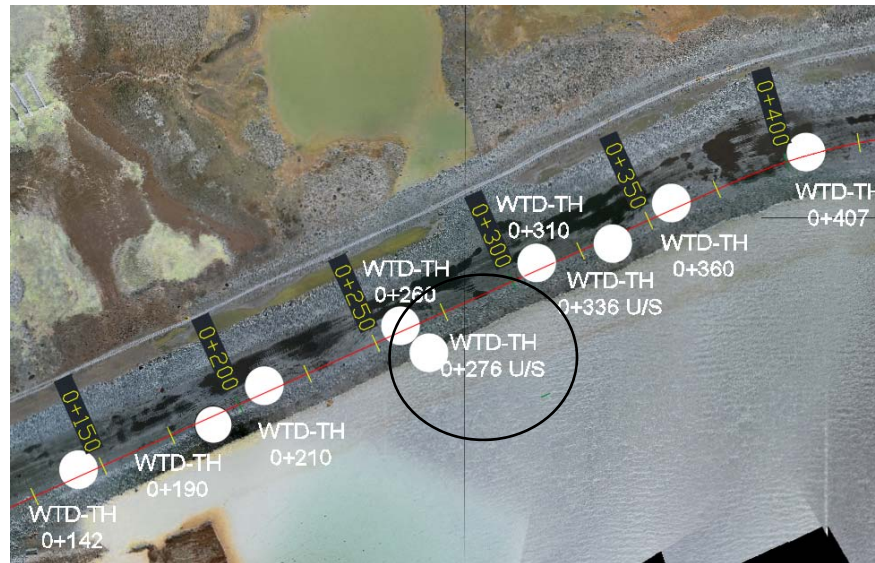
WTD-TH 0+260



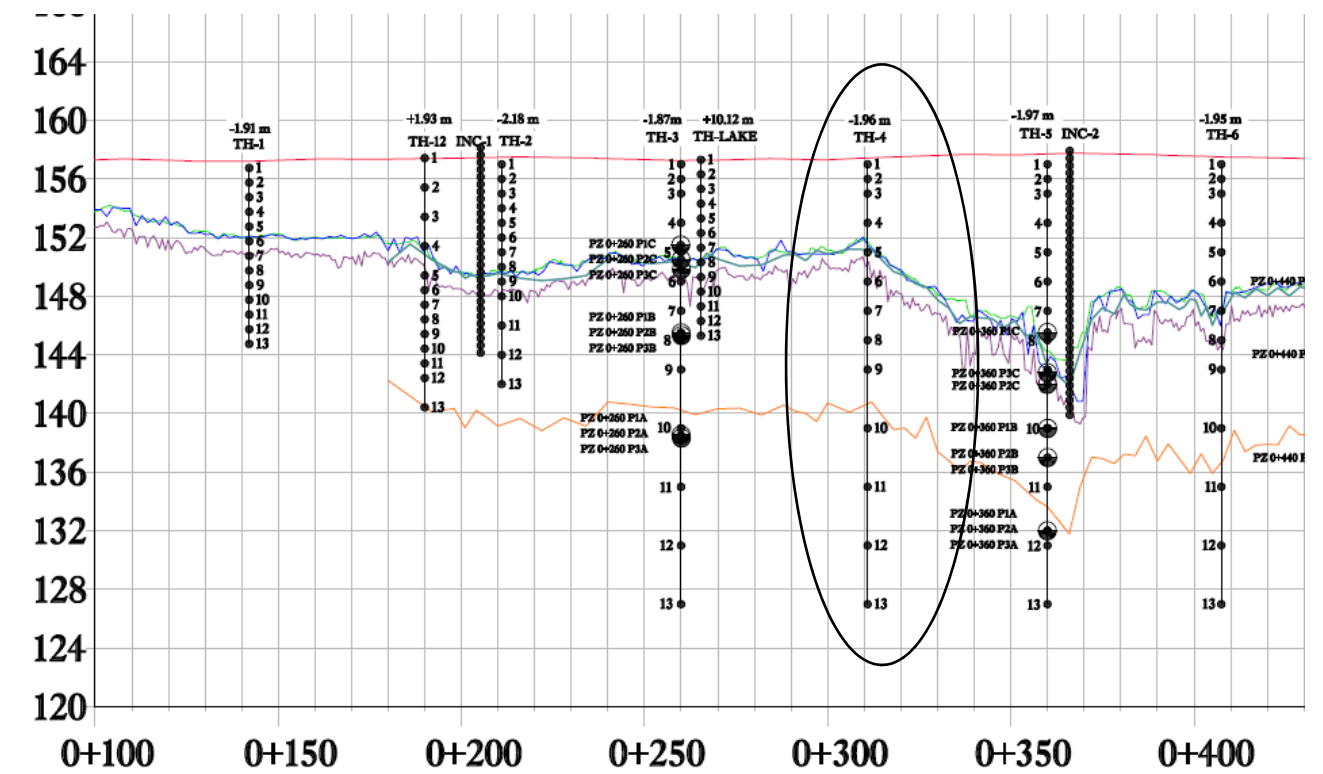
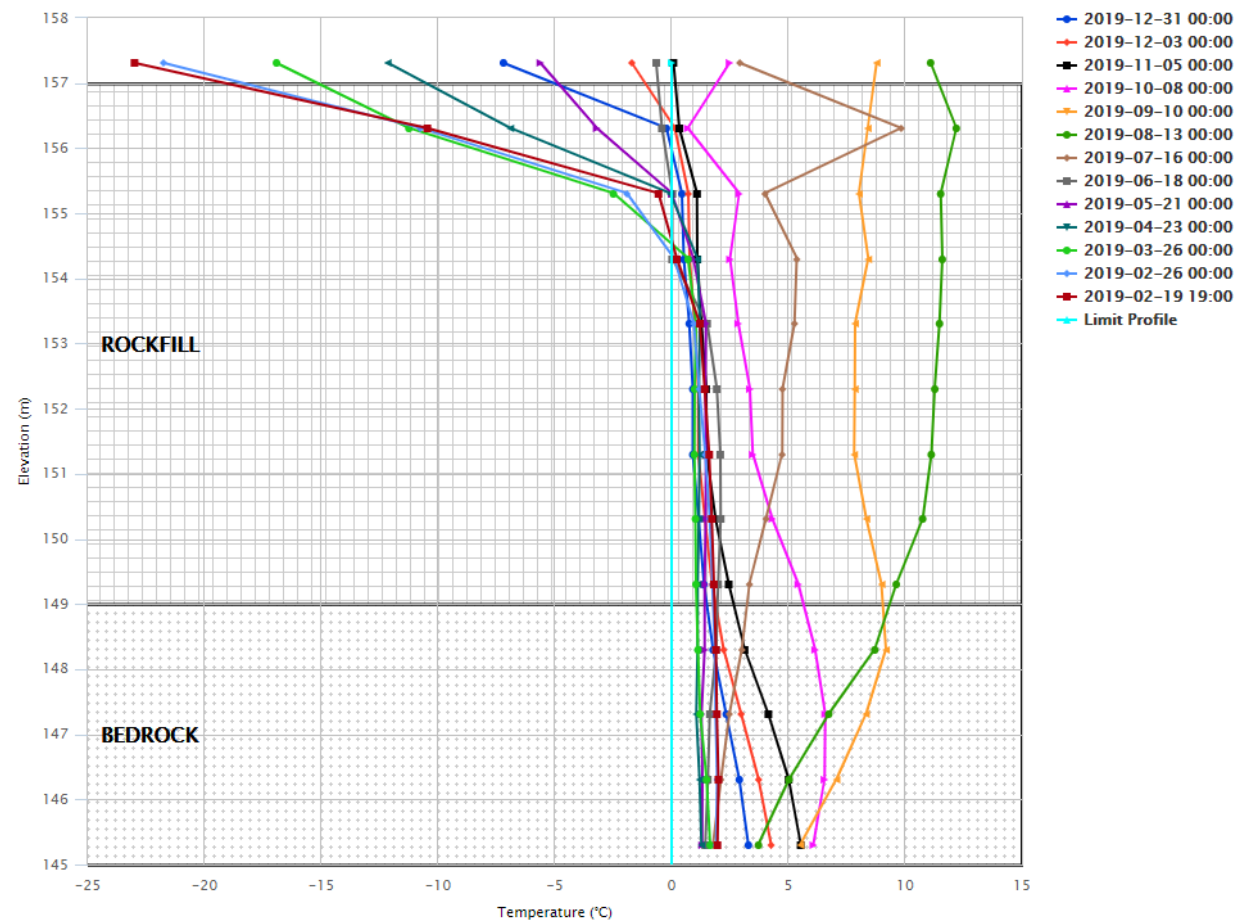
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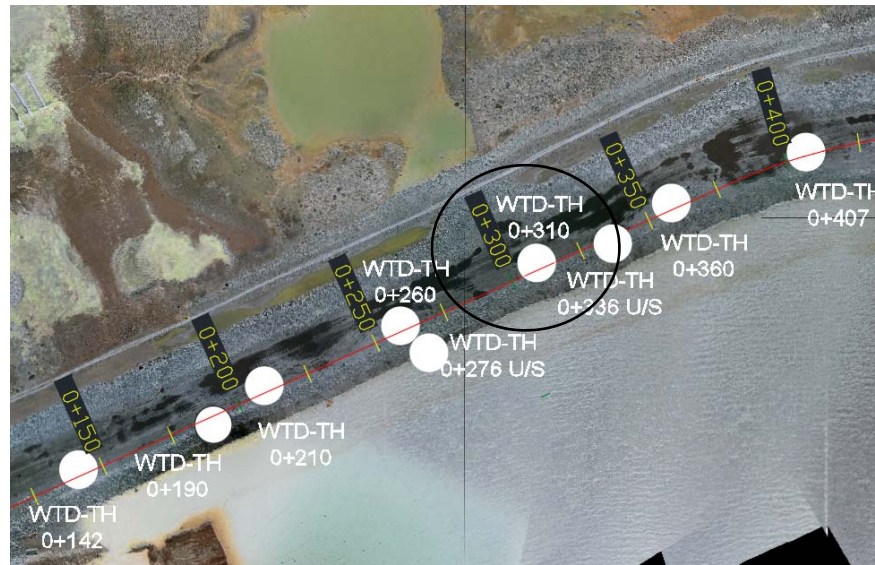
WTD-TH 0+276 U/S



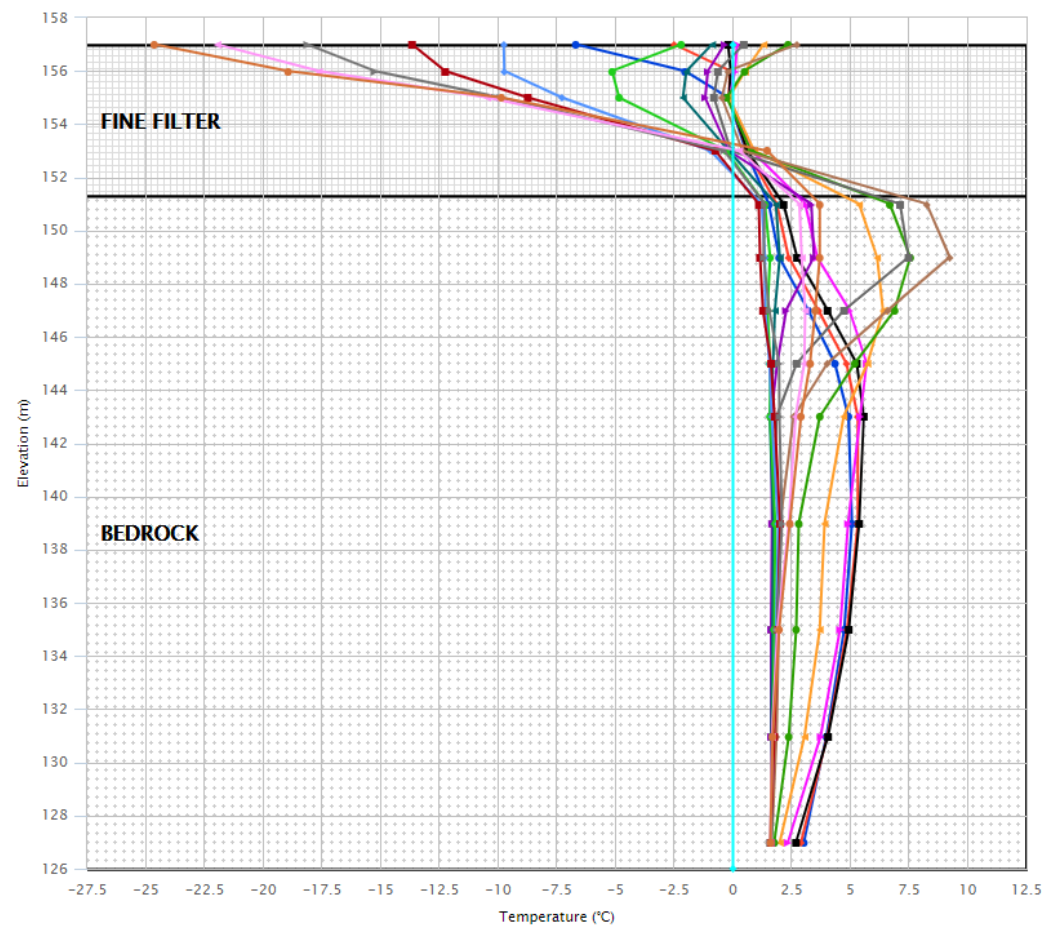
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WTD-TH 0+310

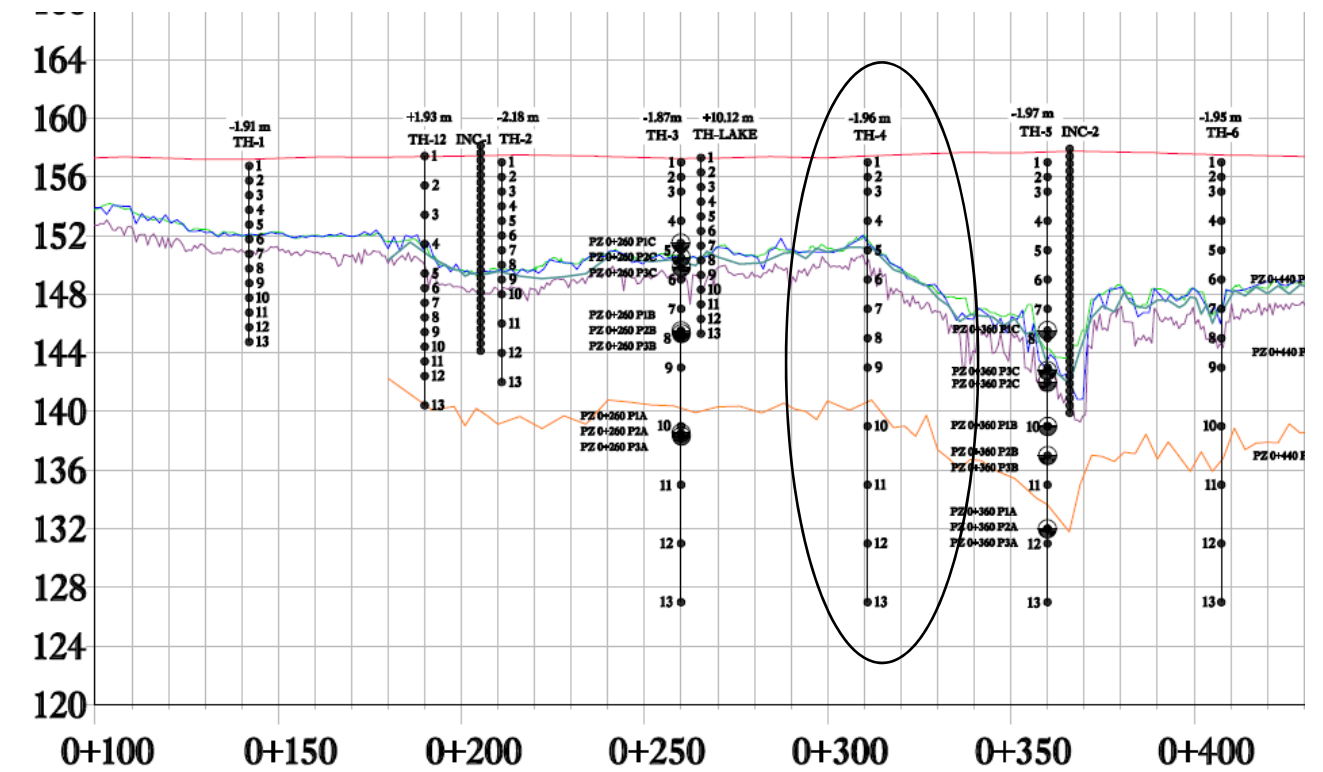
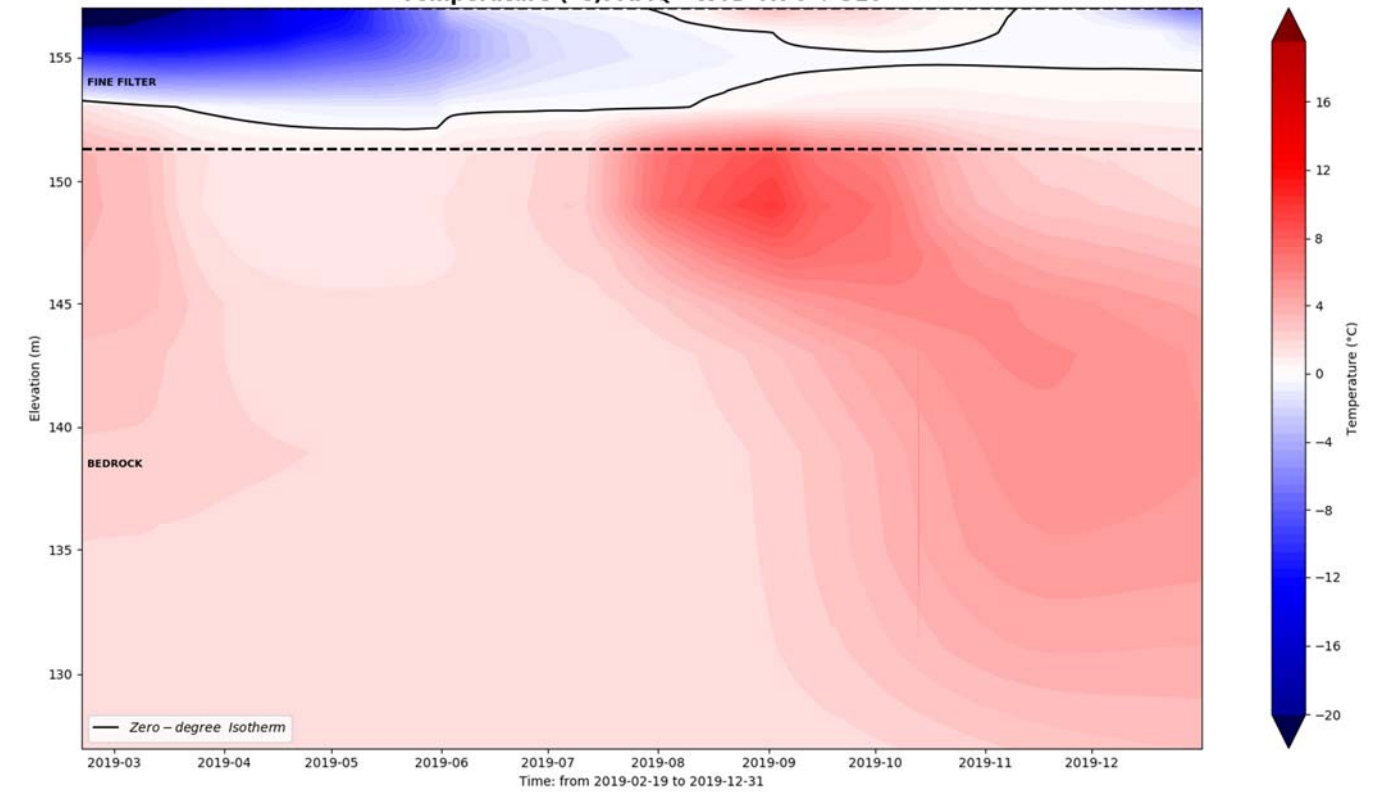


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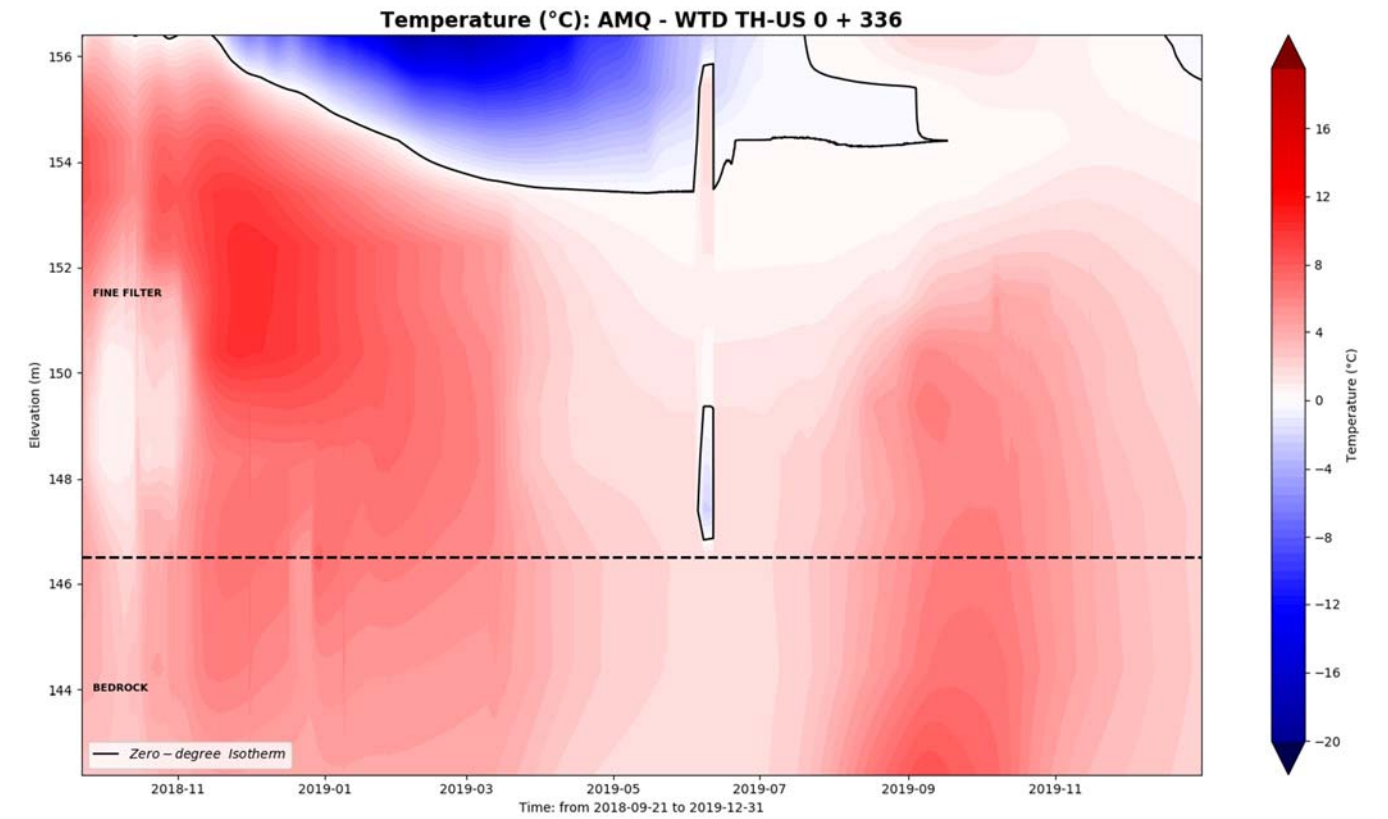
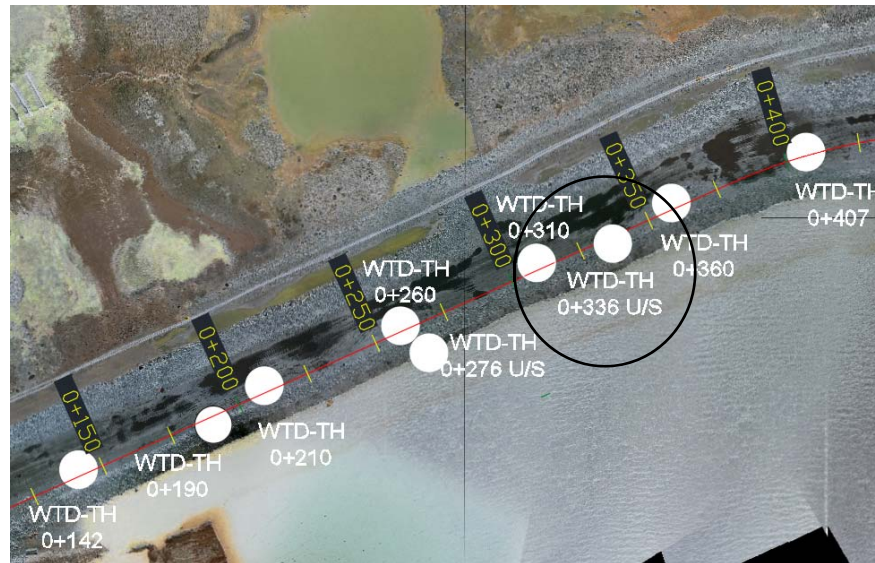


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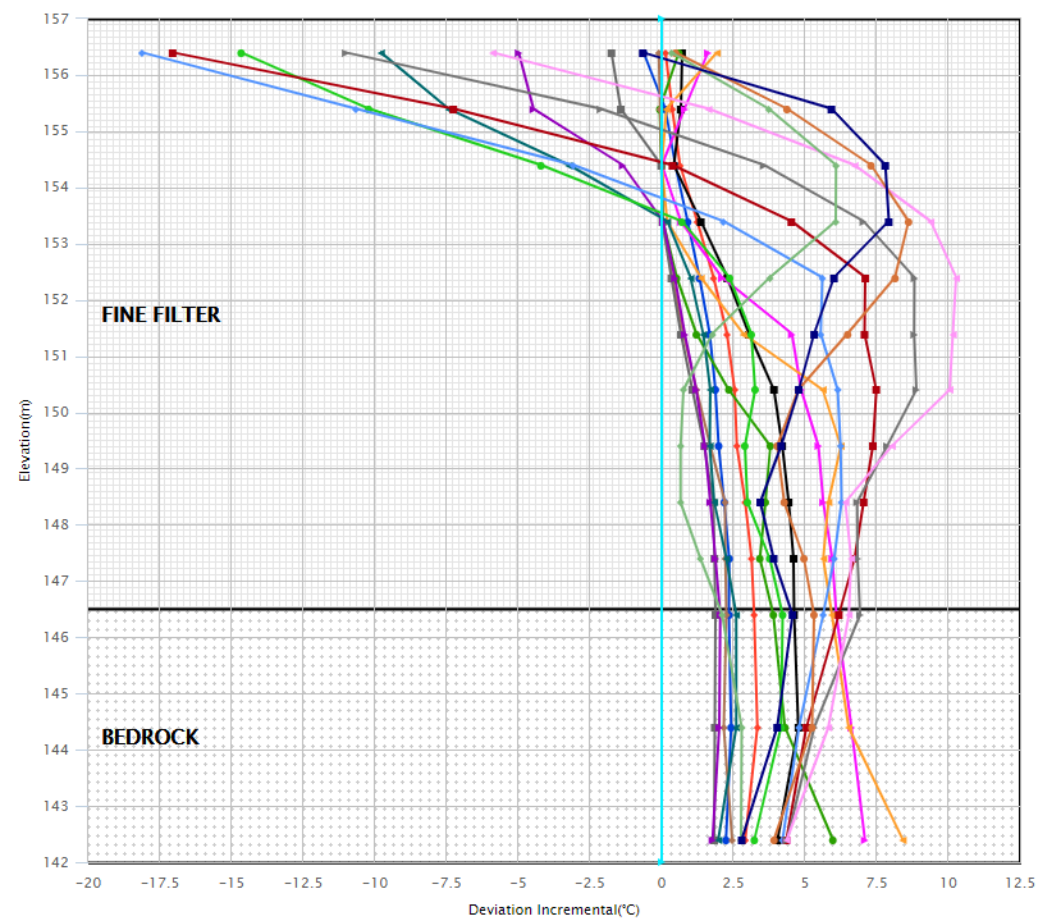
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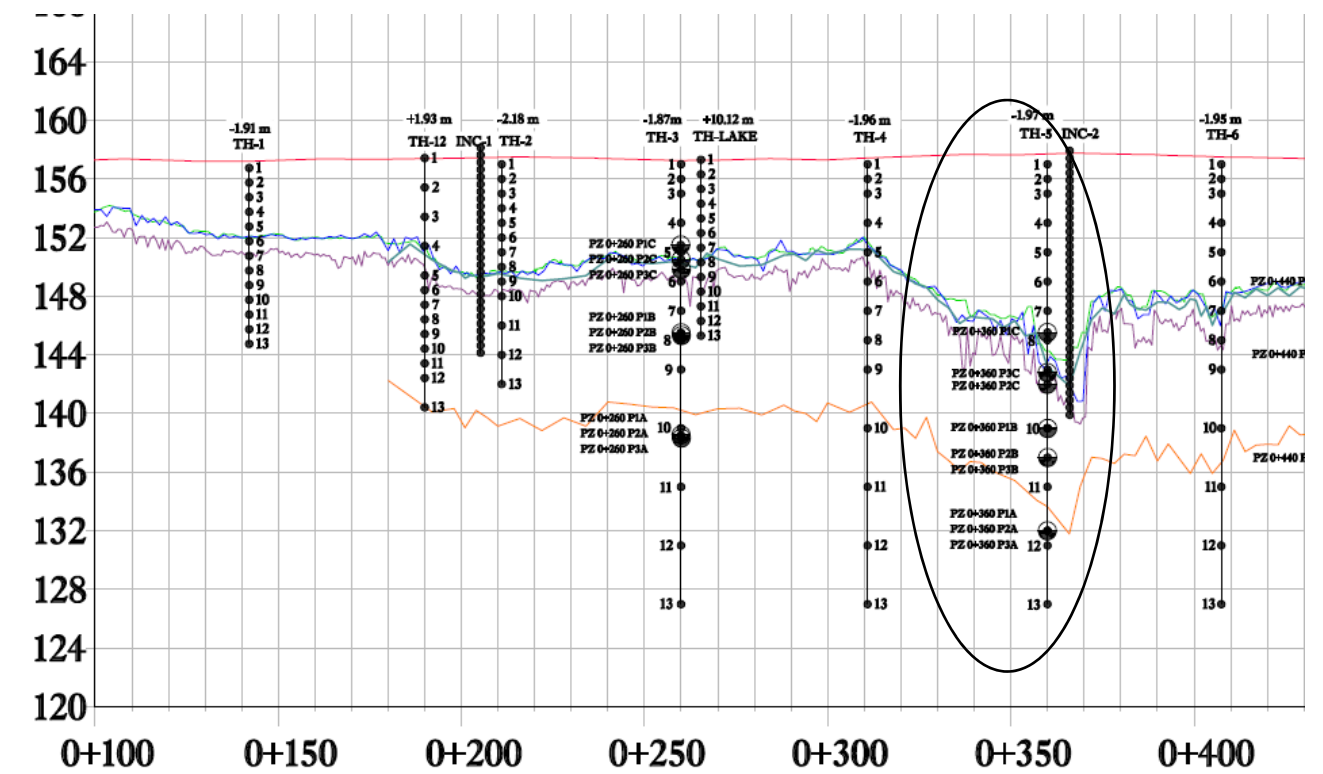
WTD-TH 0+336 U/S



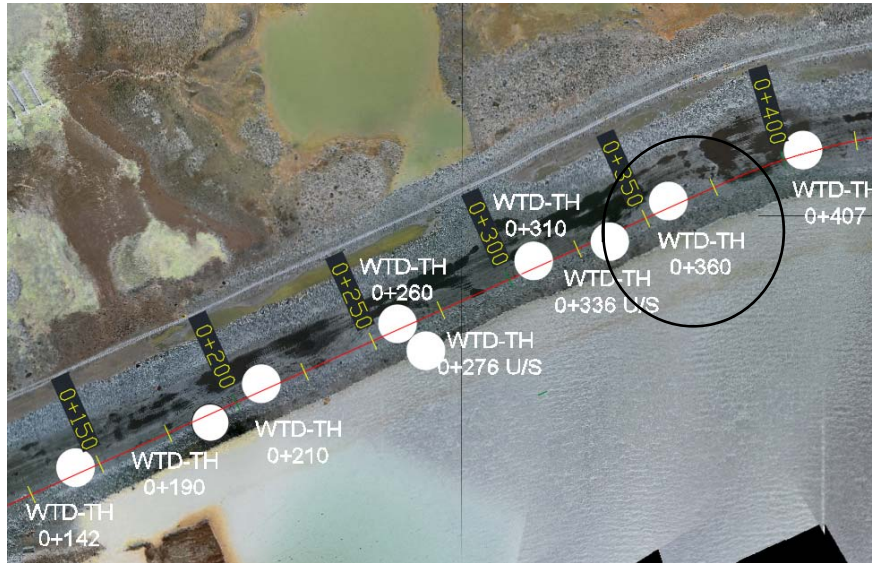
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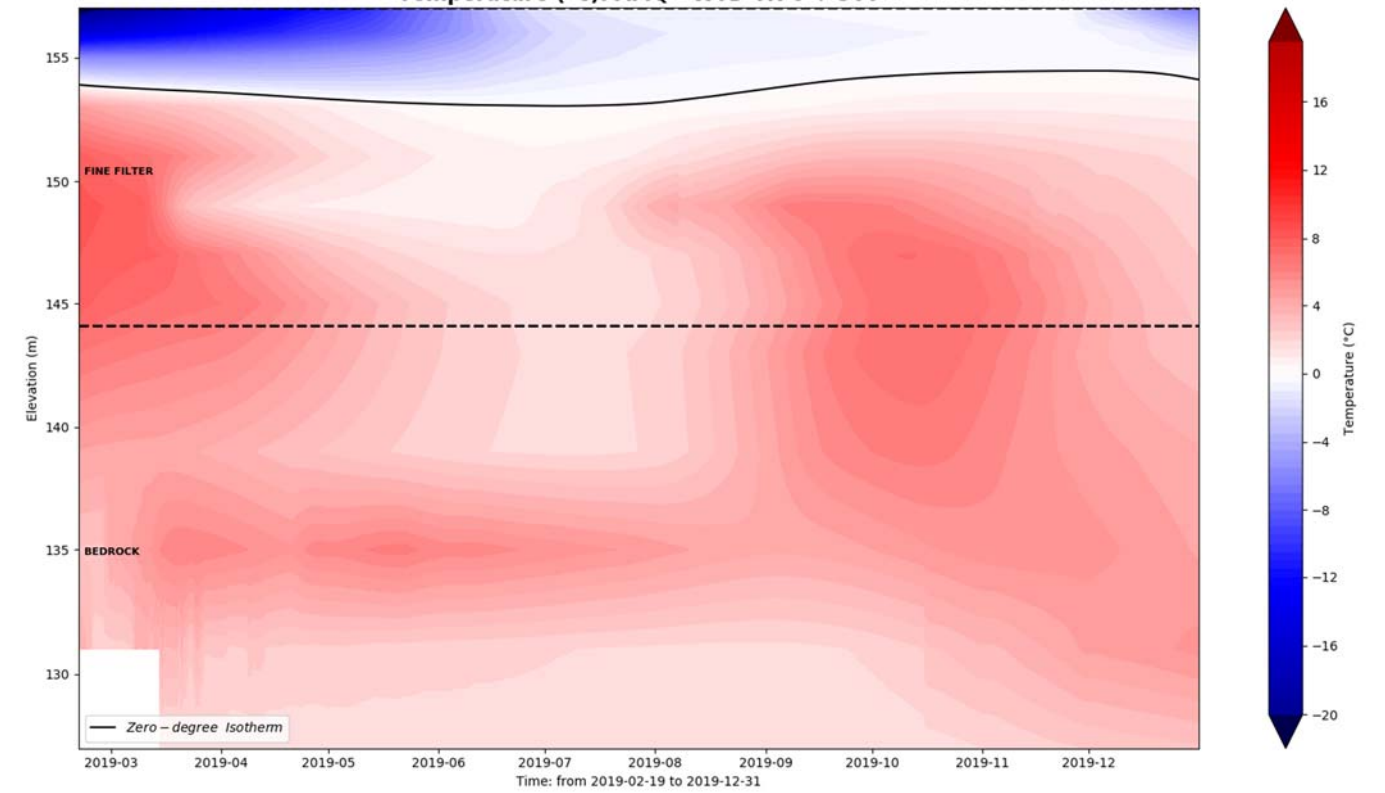
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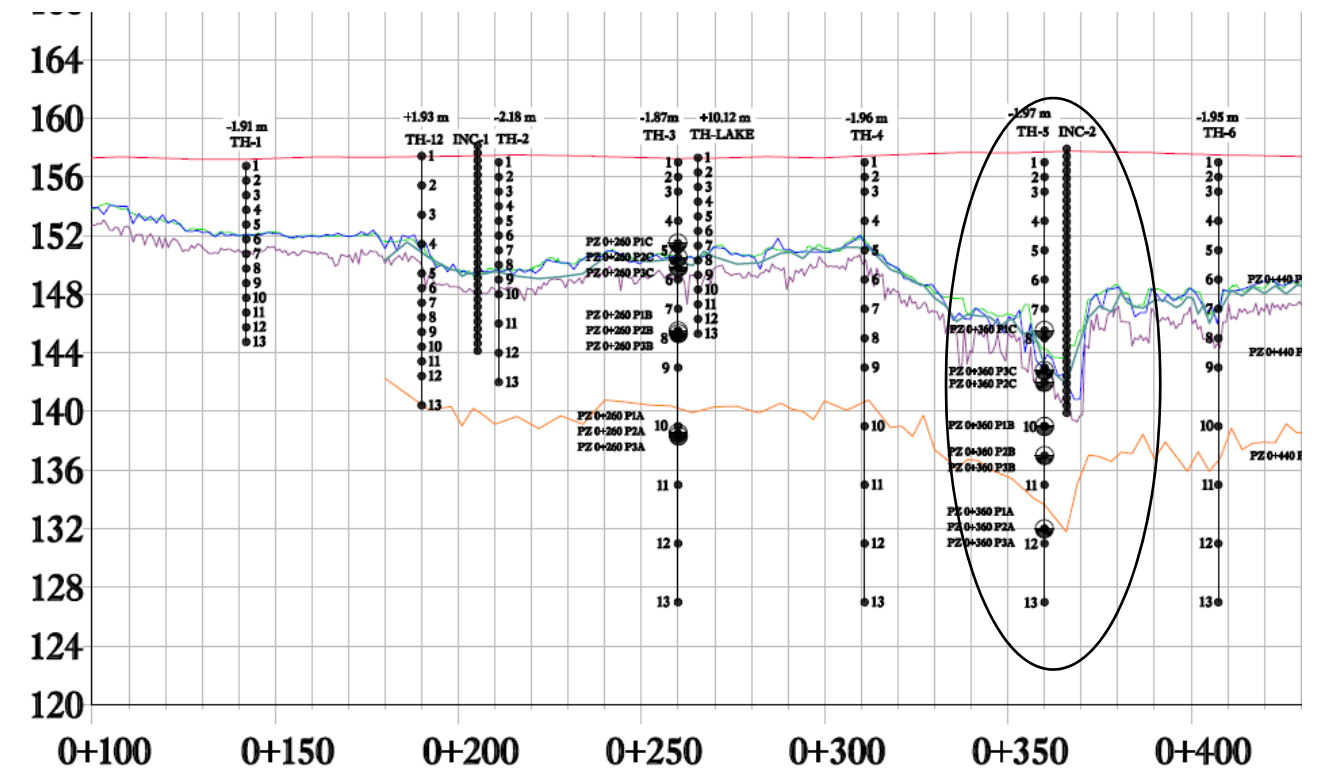
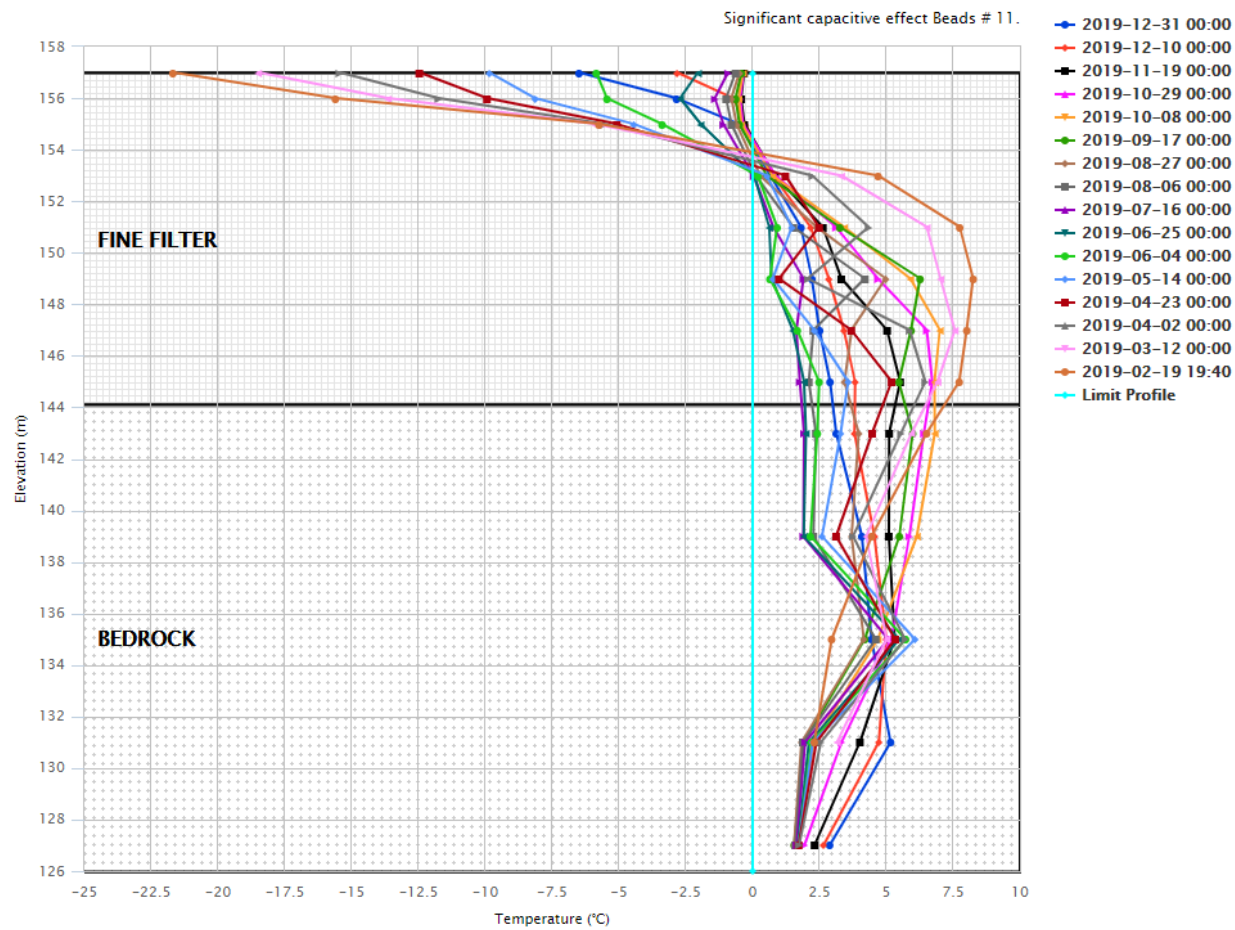
WTD-TH 0+360



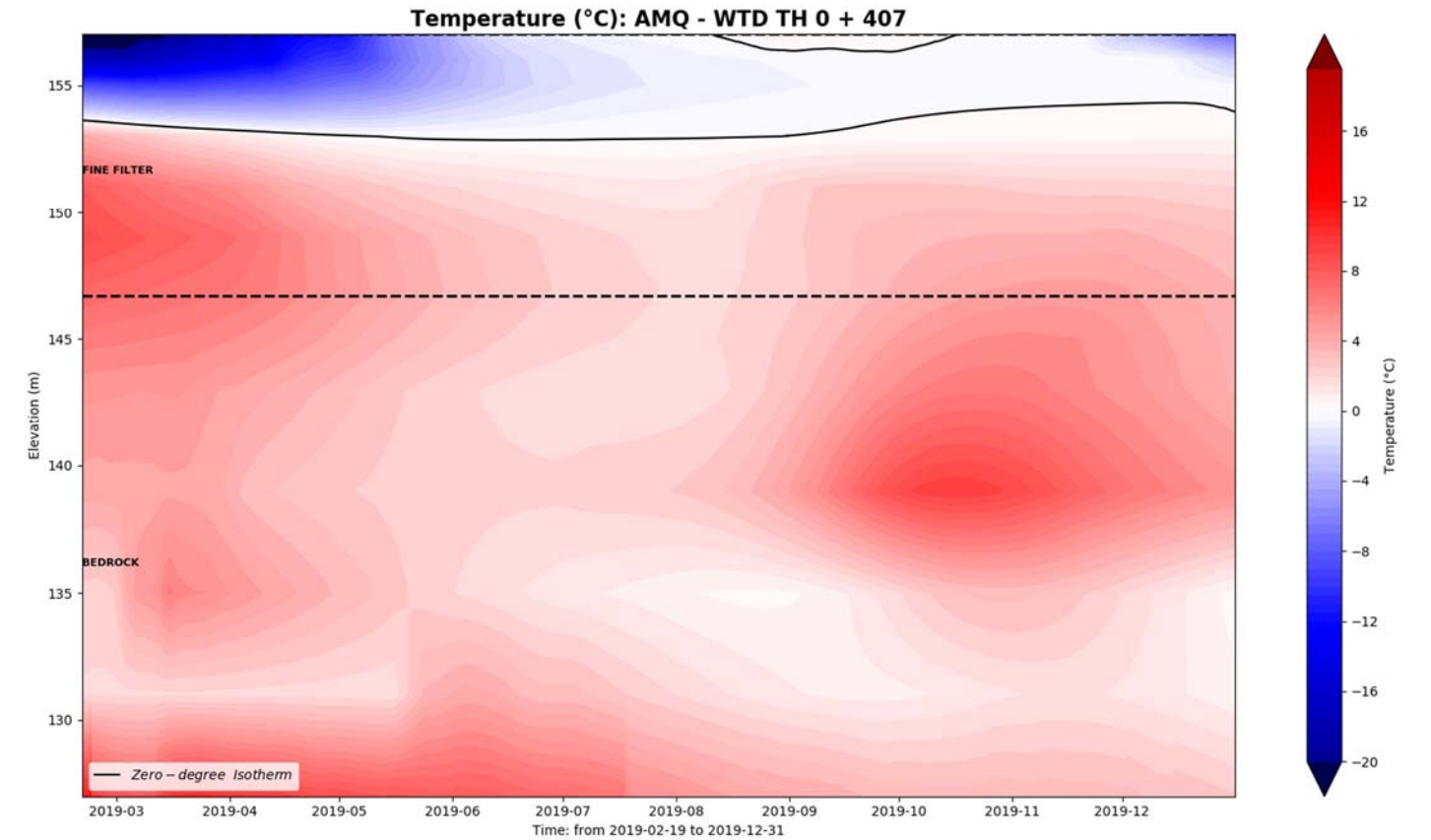
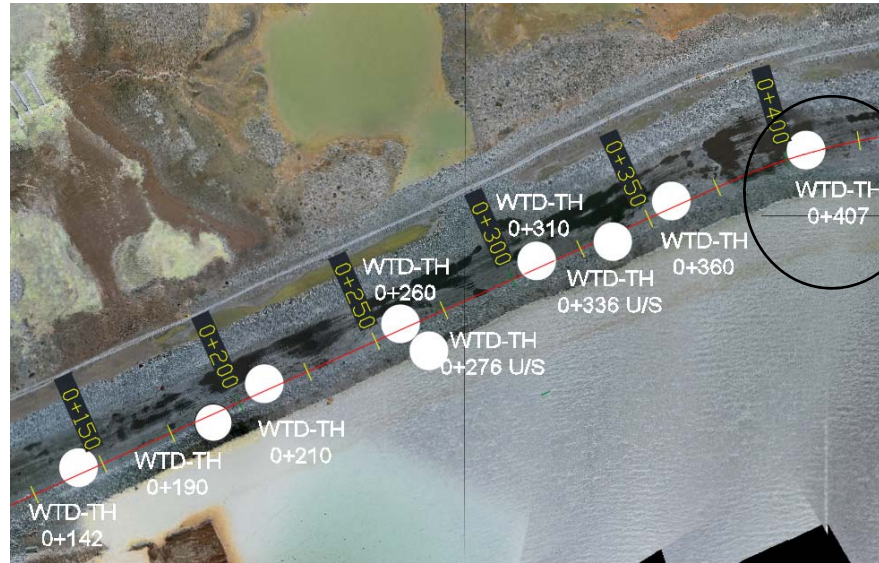
Temperature (°C): AMQ - WTD TH 0 + 360



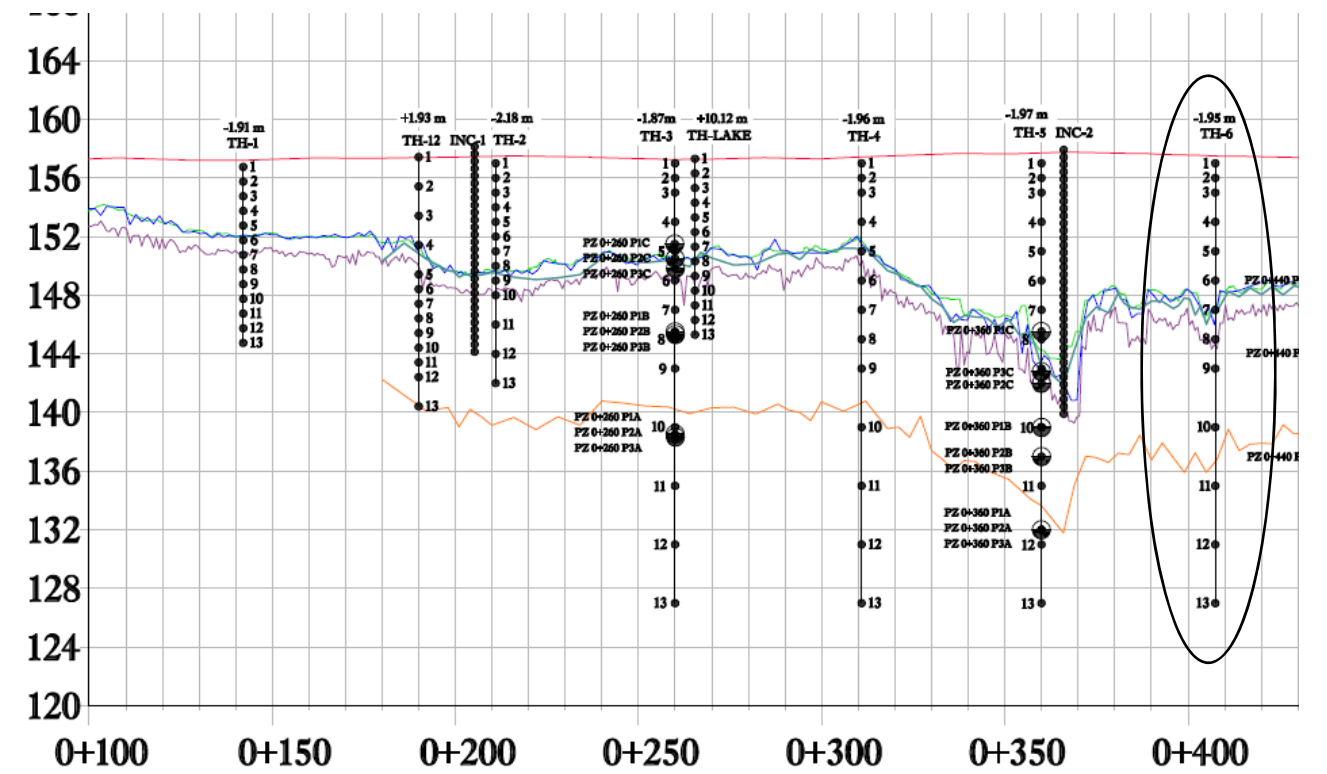
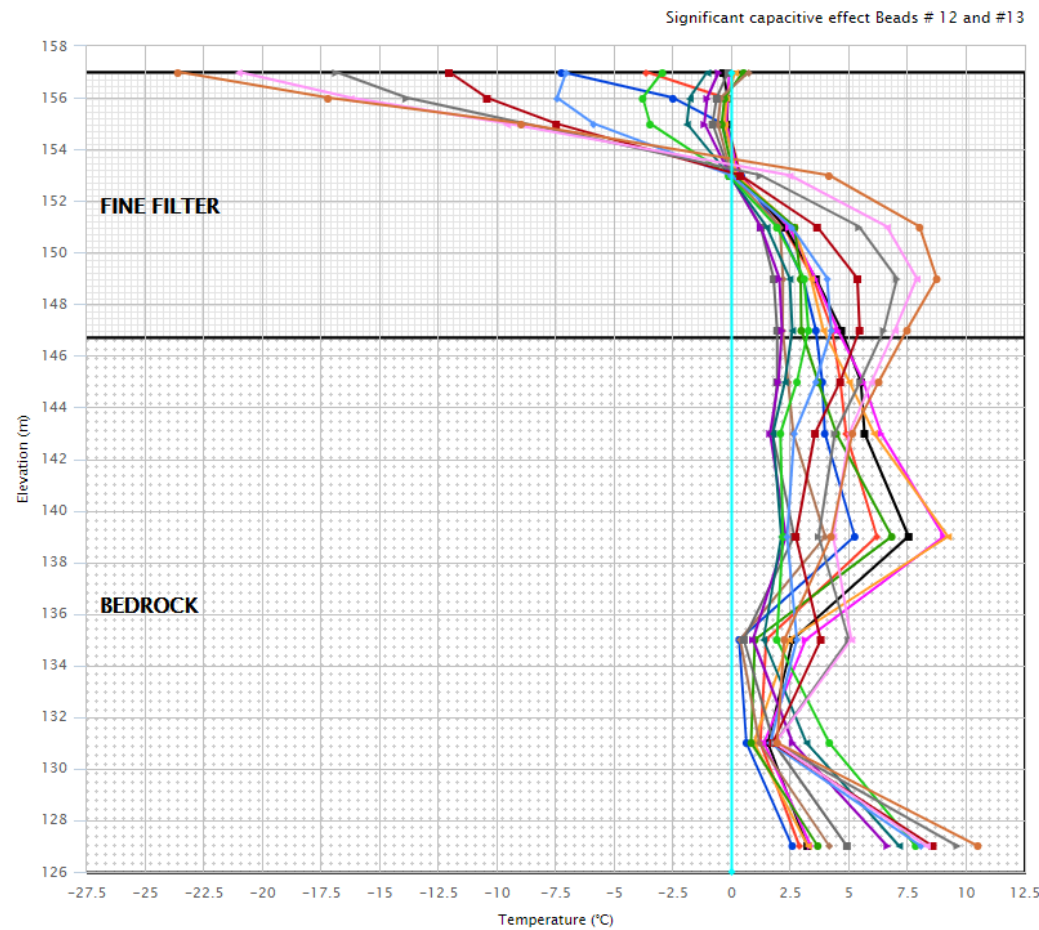
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WTD-TH 0+407



AMQ - WTD TH: 0+407

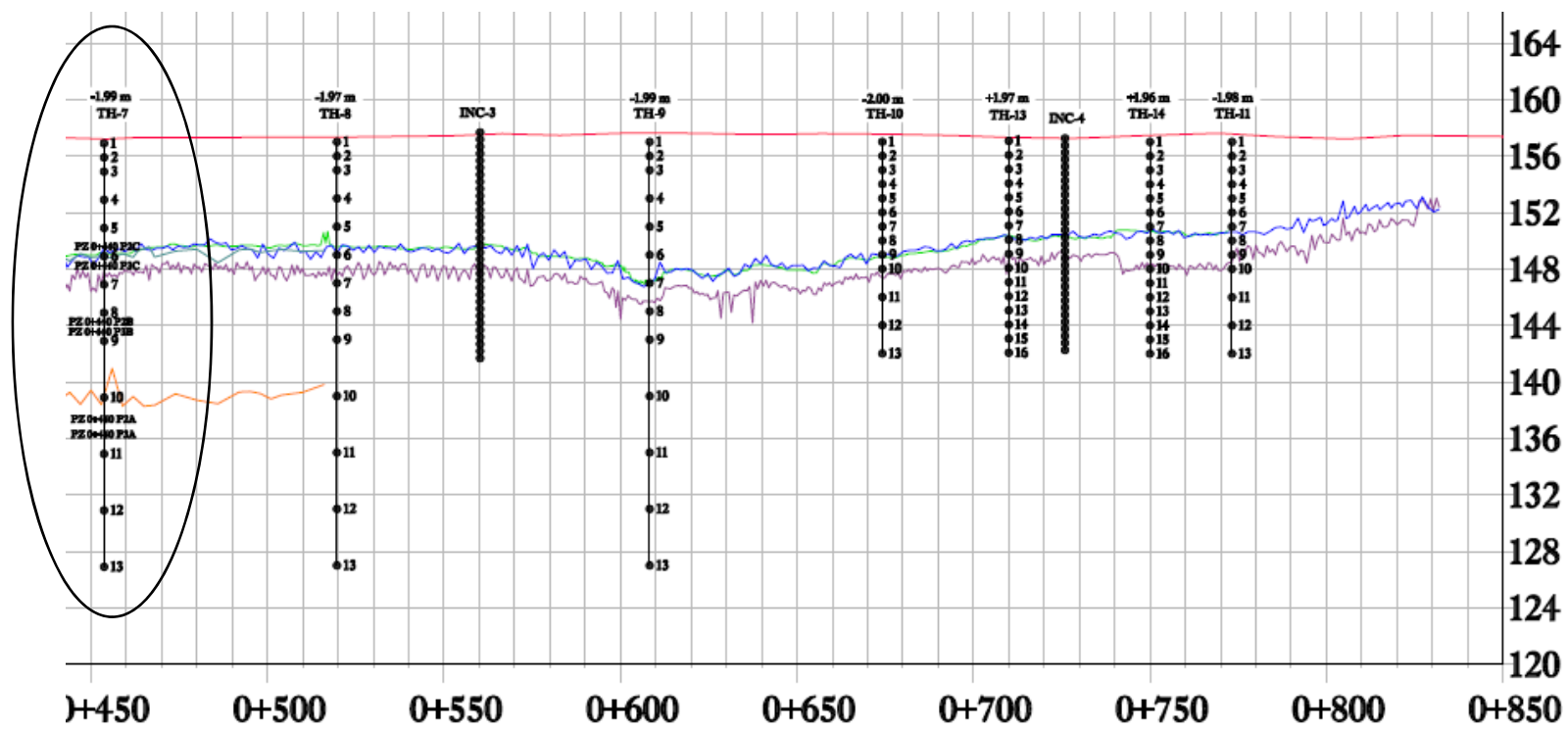
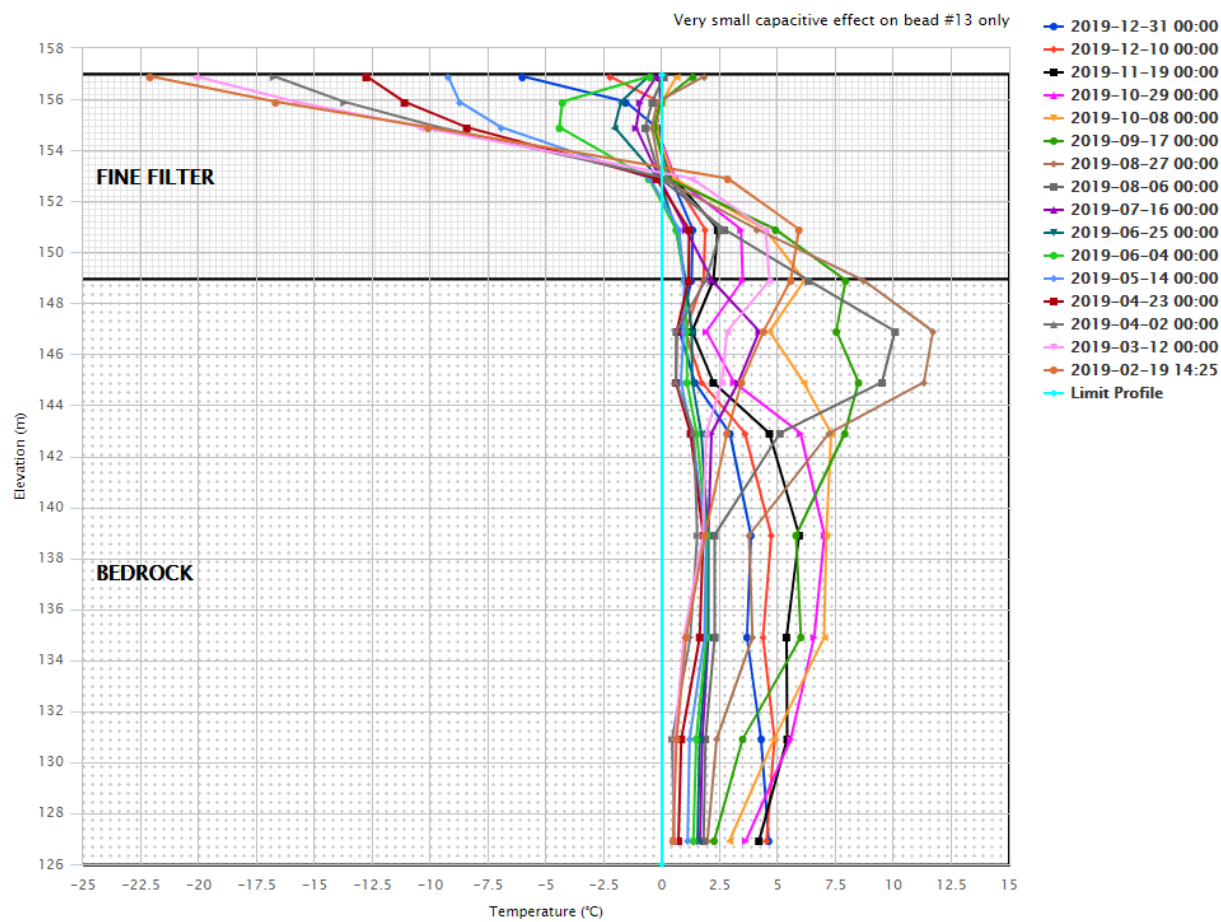
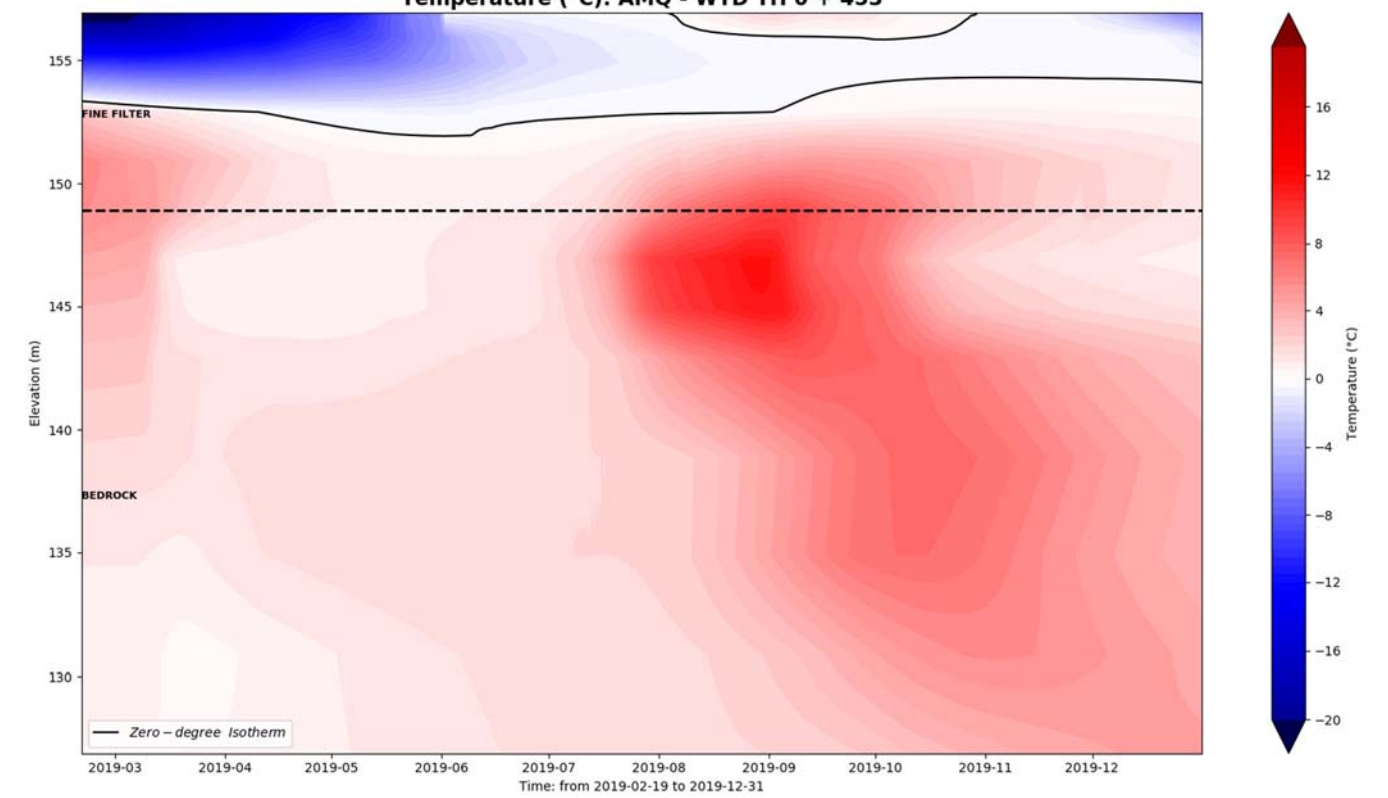


WTD-TH 0+453



AMQ - WTD TH: 0+453

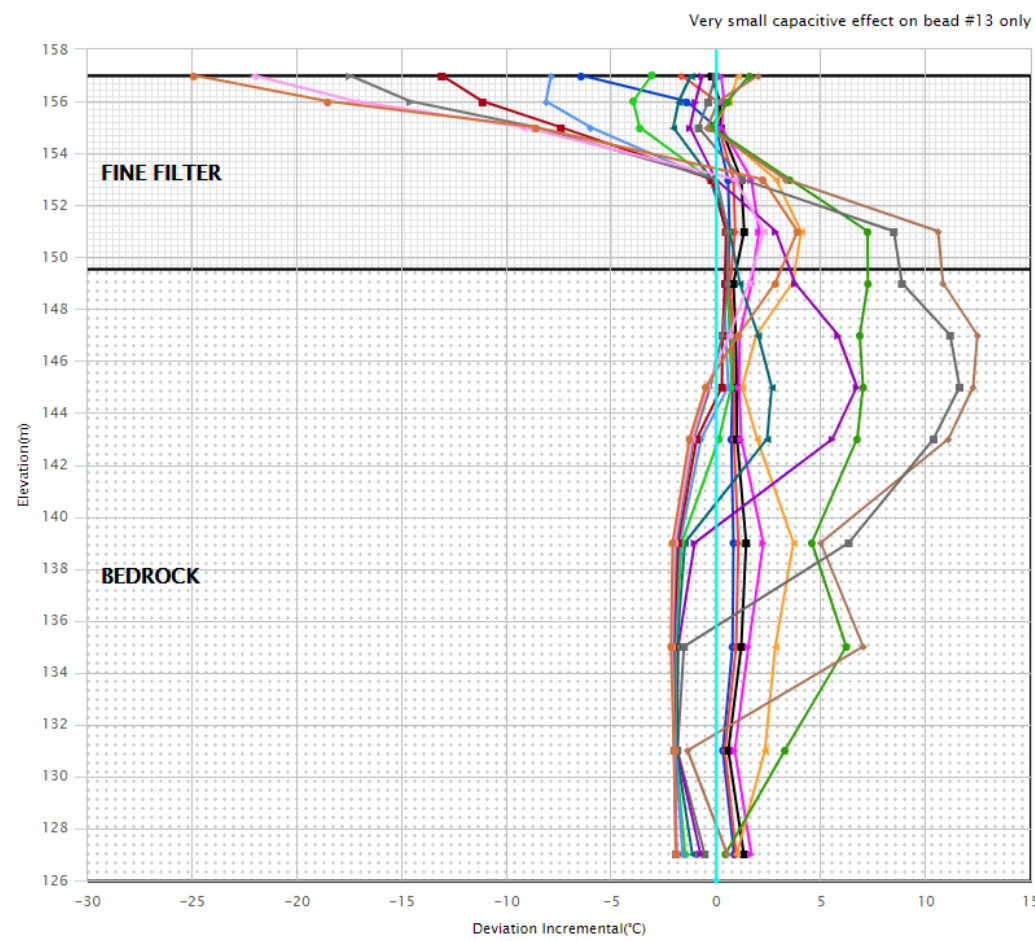
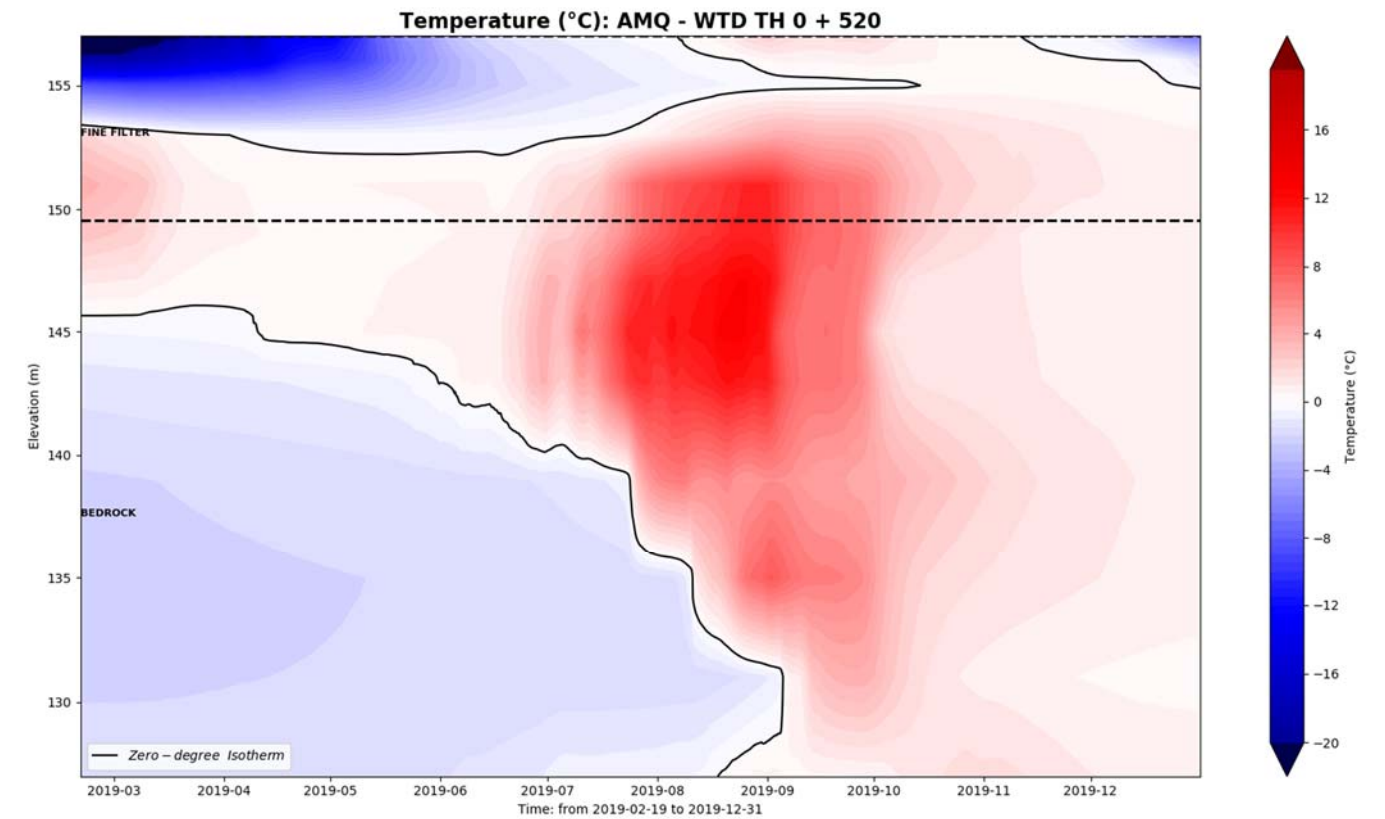
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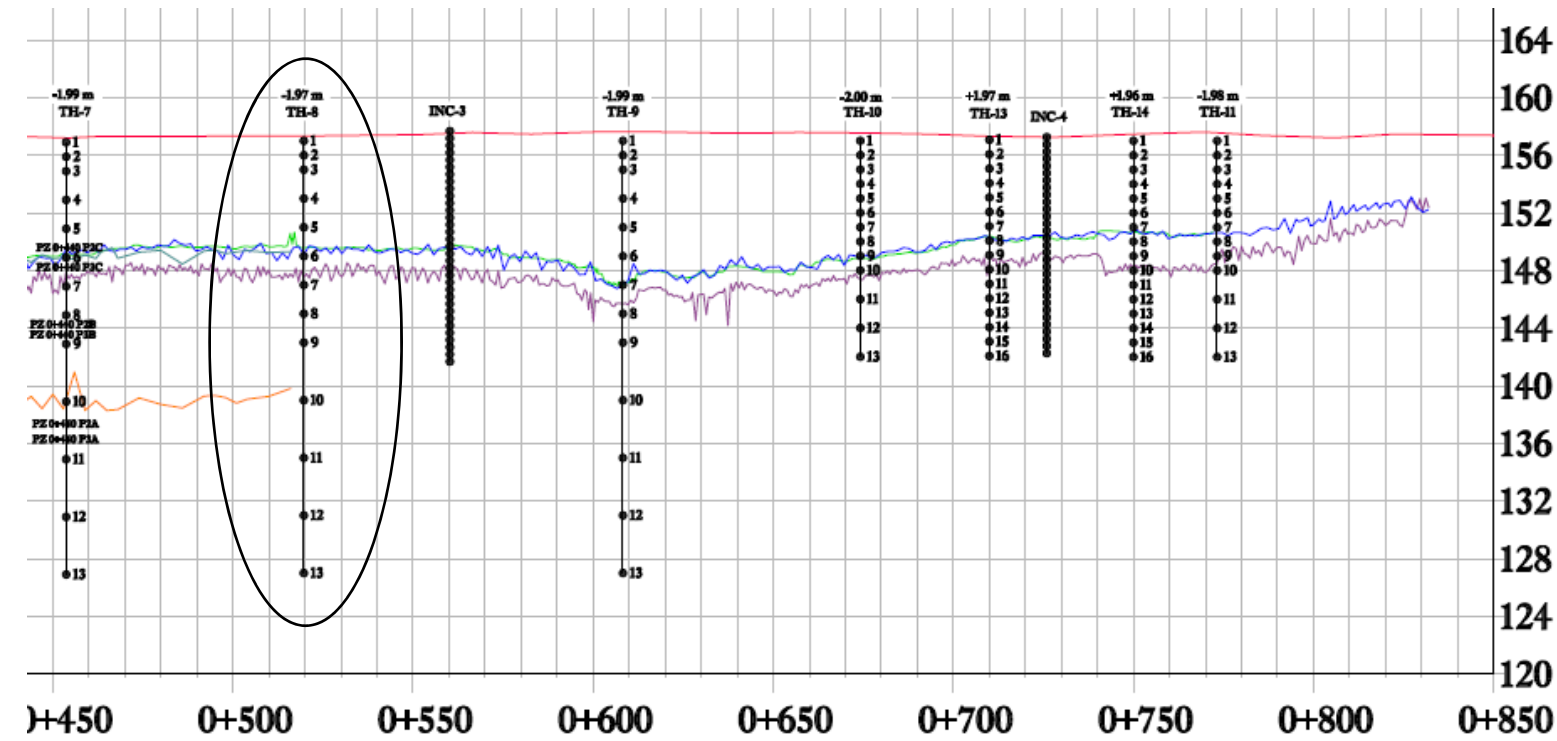
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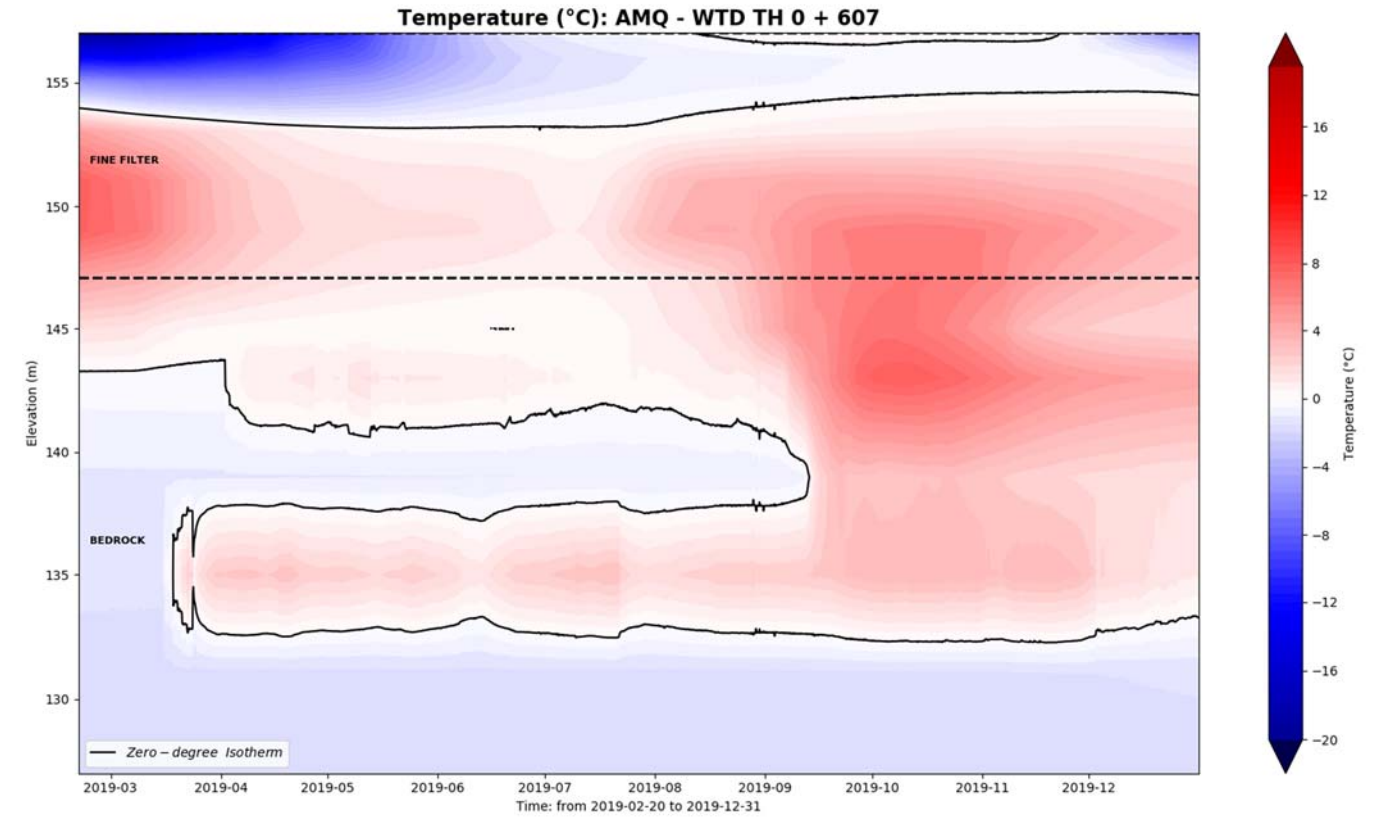
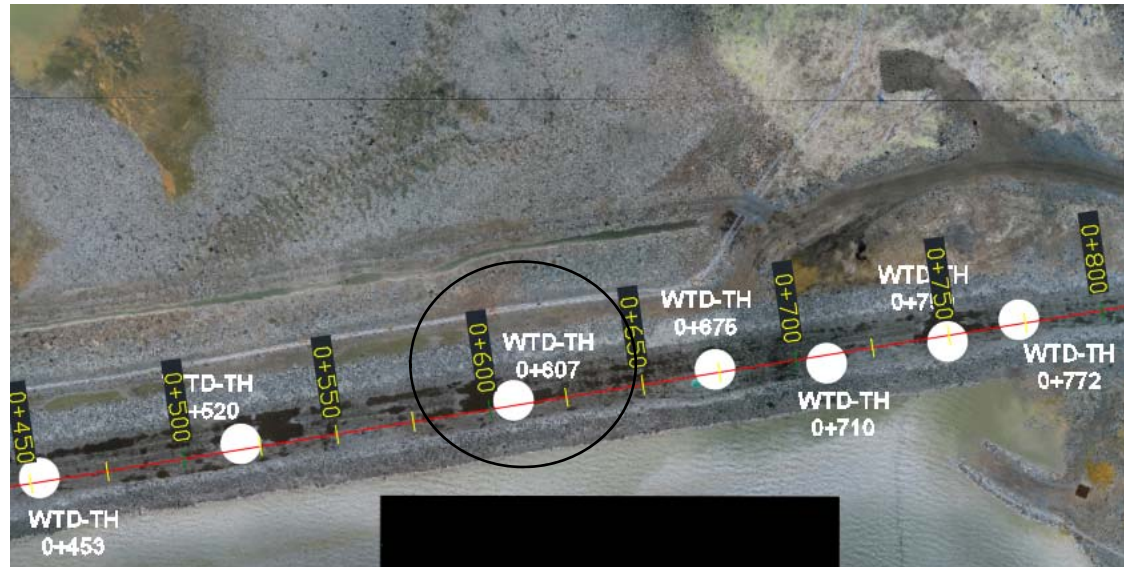
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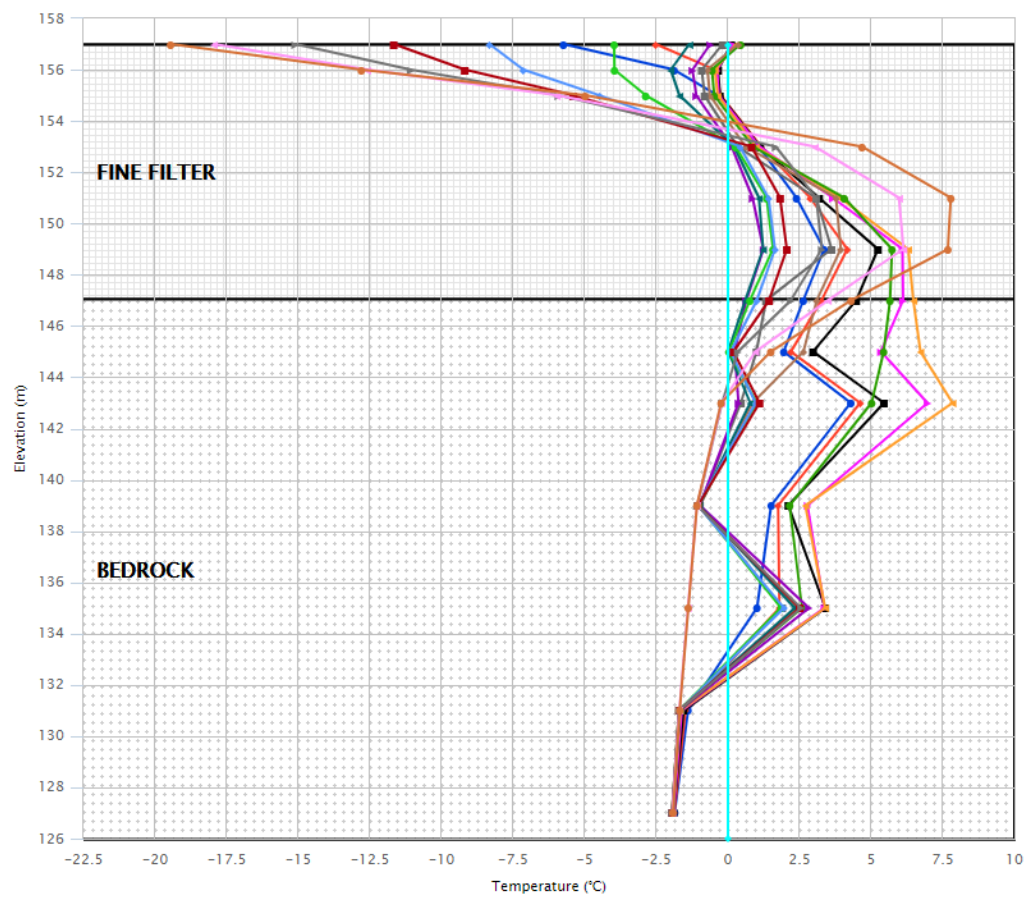


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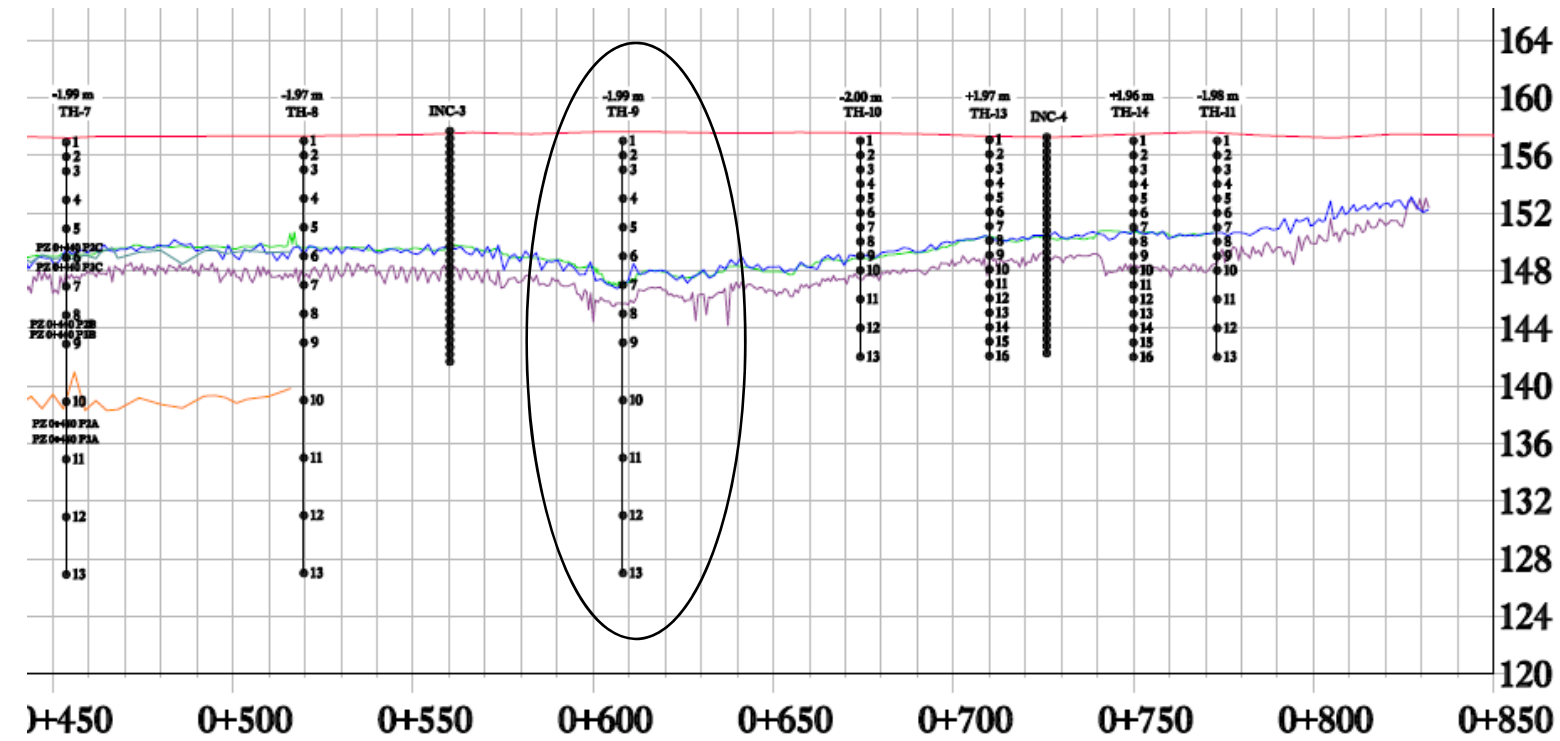


AMQ - WTD TH: 0+607

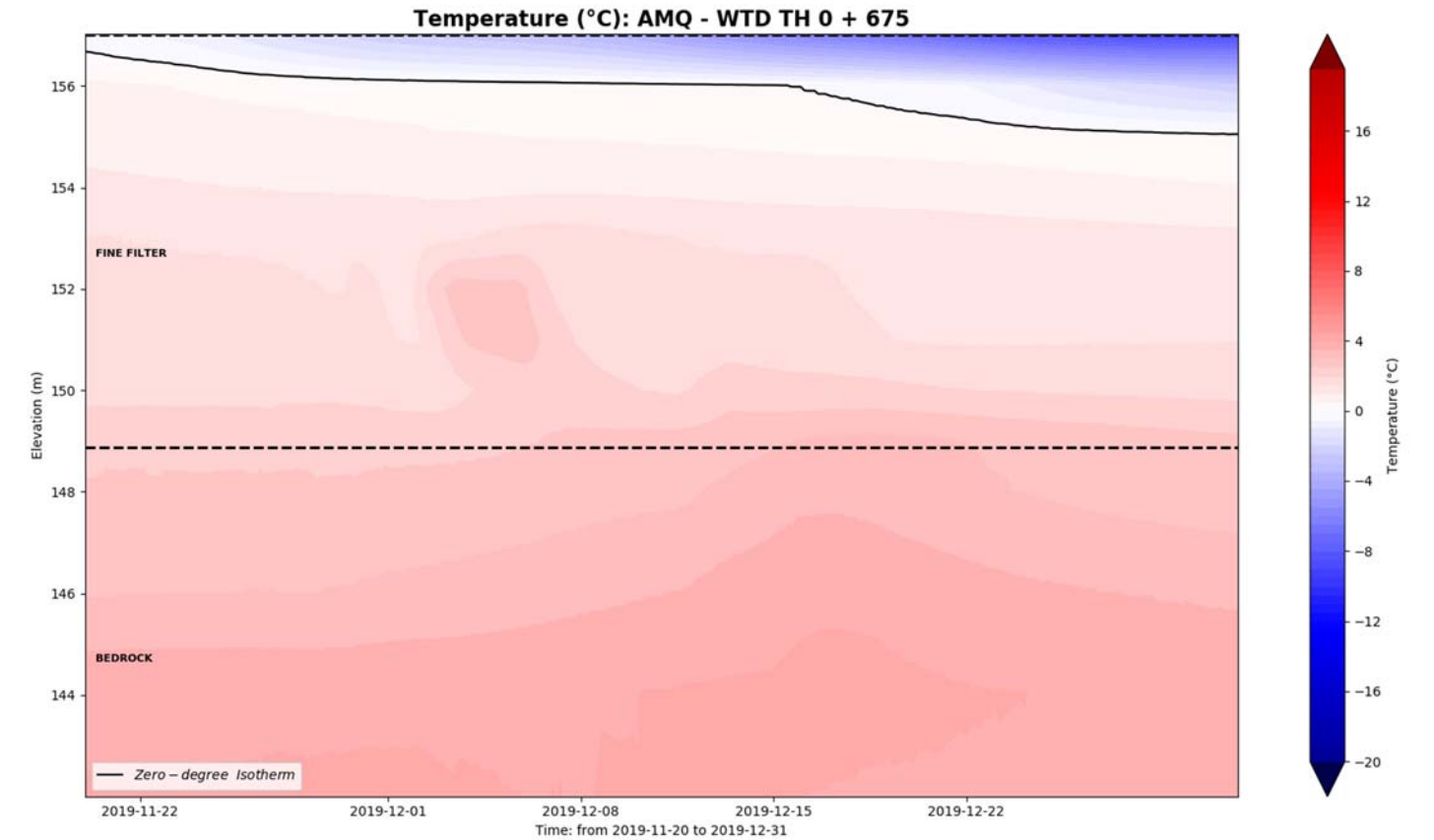
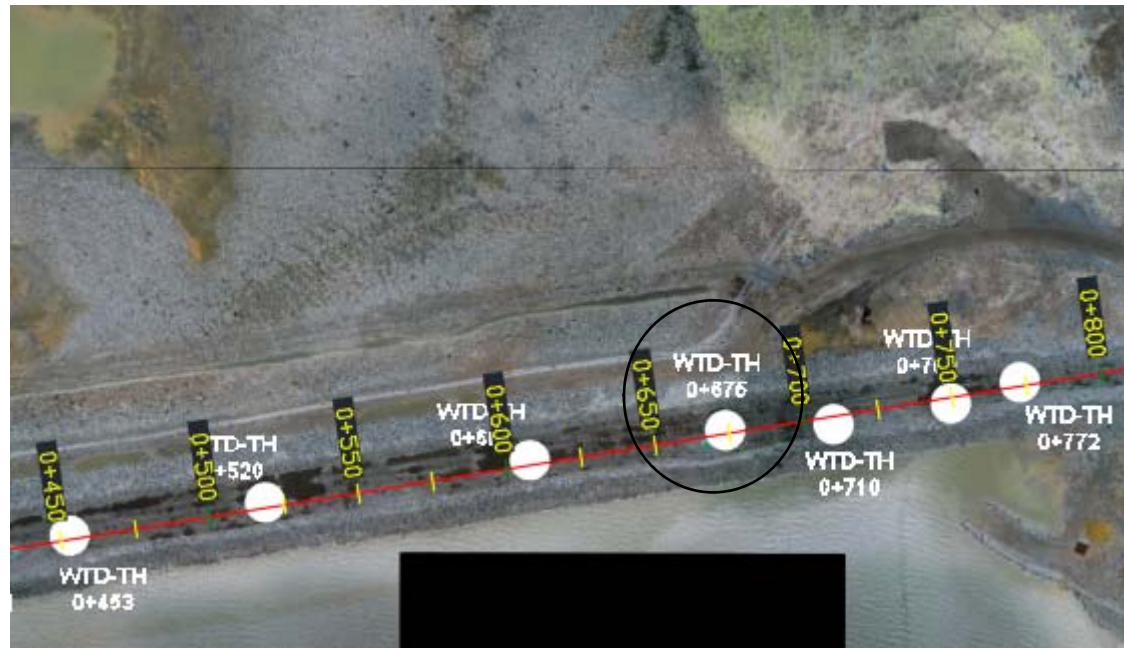
Significant capacitive effect Beads # 9 and #11. Bd #4, #6 and #7 have small effect.



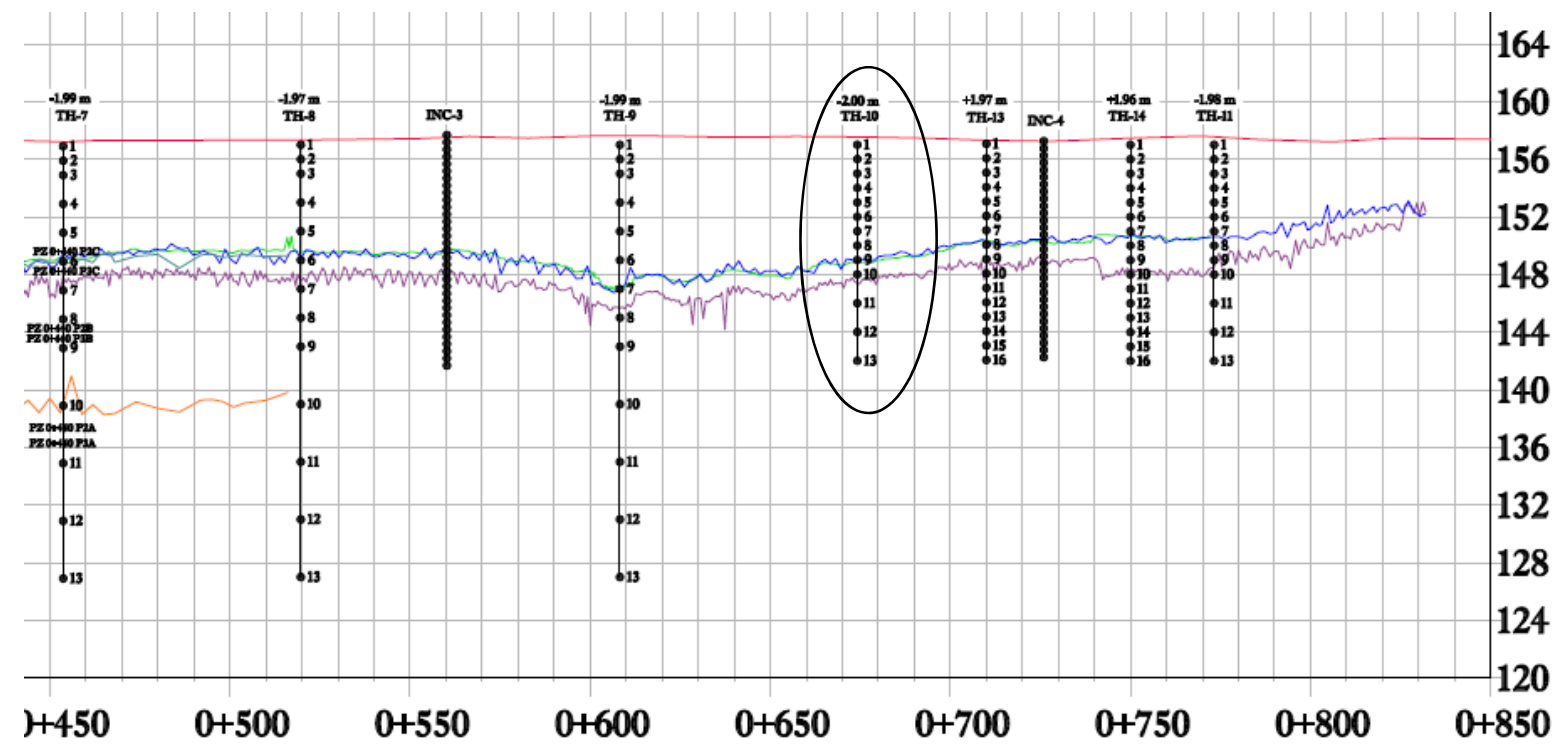
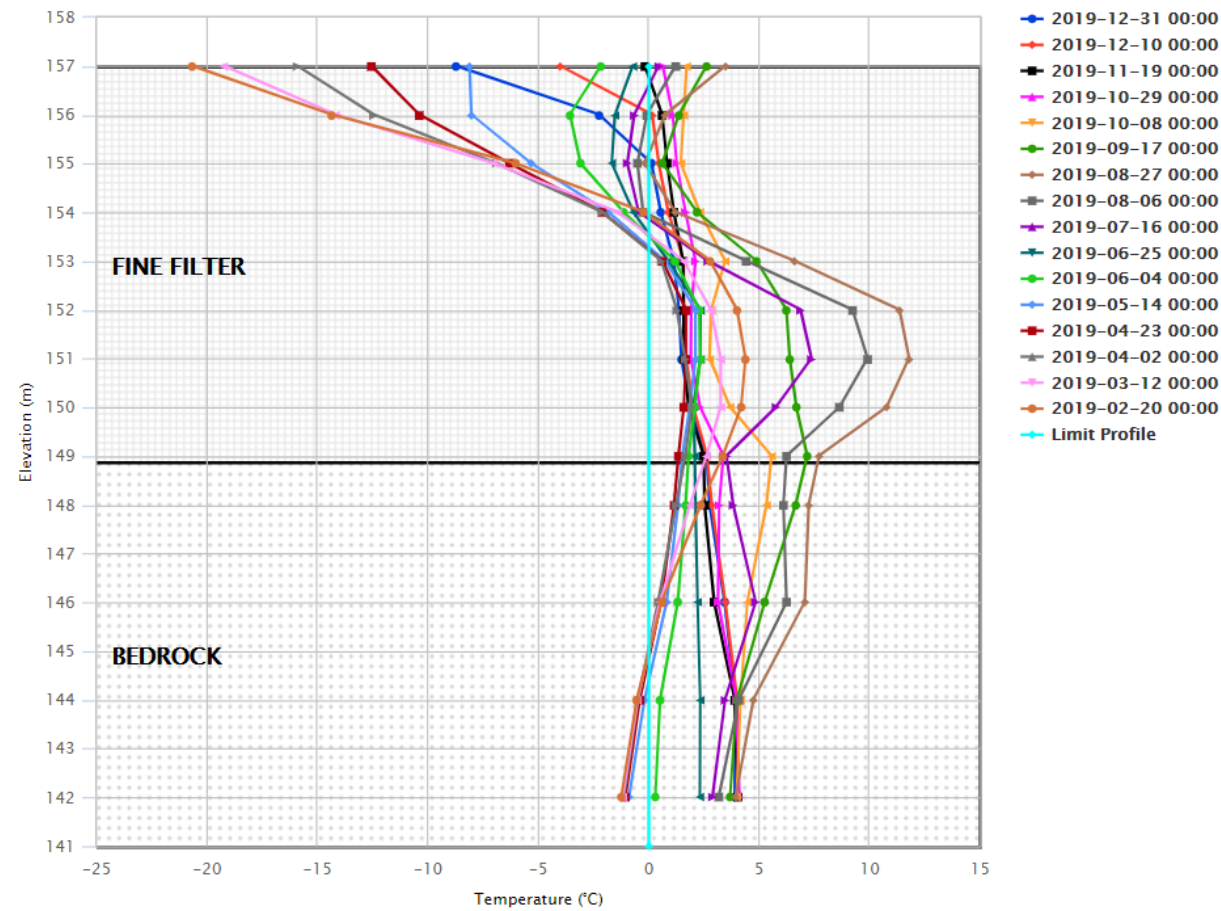
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-04-23 00:00
- 2019-04-02 00:00
- 2019-03-12 00:00
- 2019-02-20 00:00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



WTD-TH 0+675



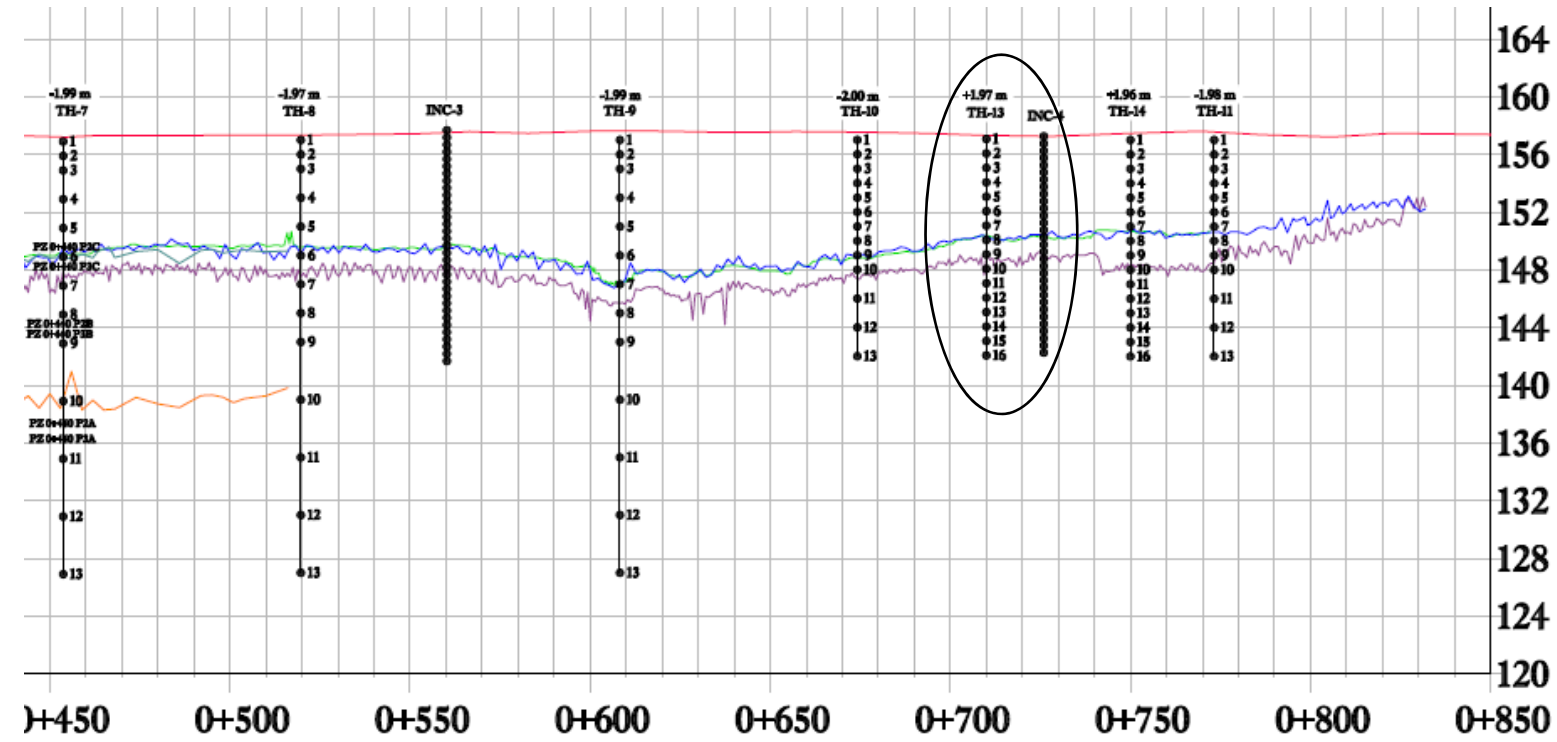
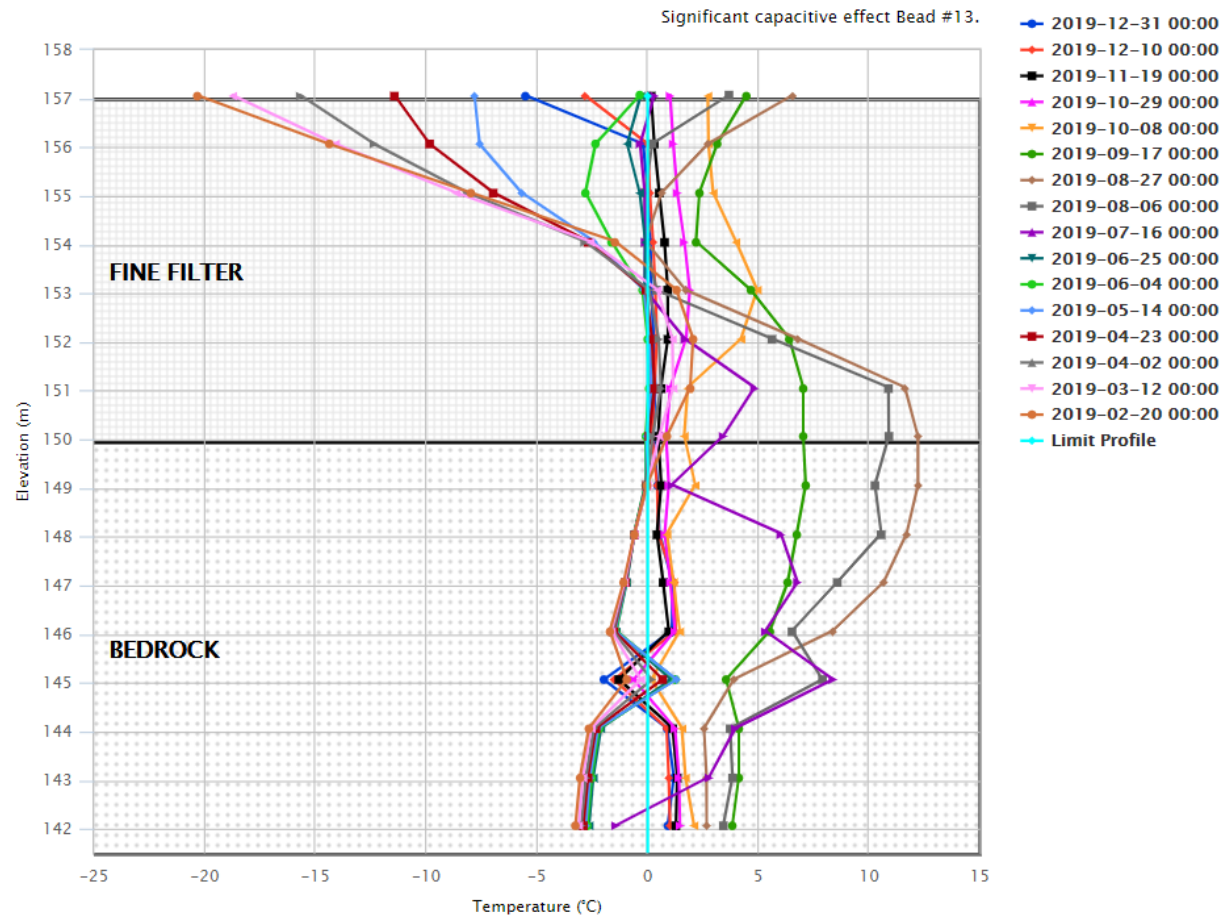
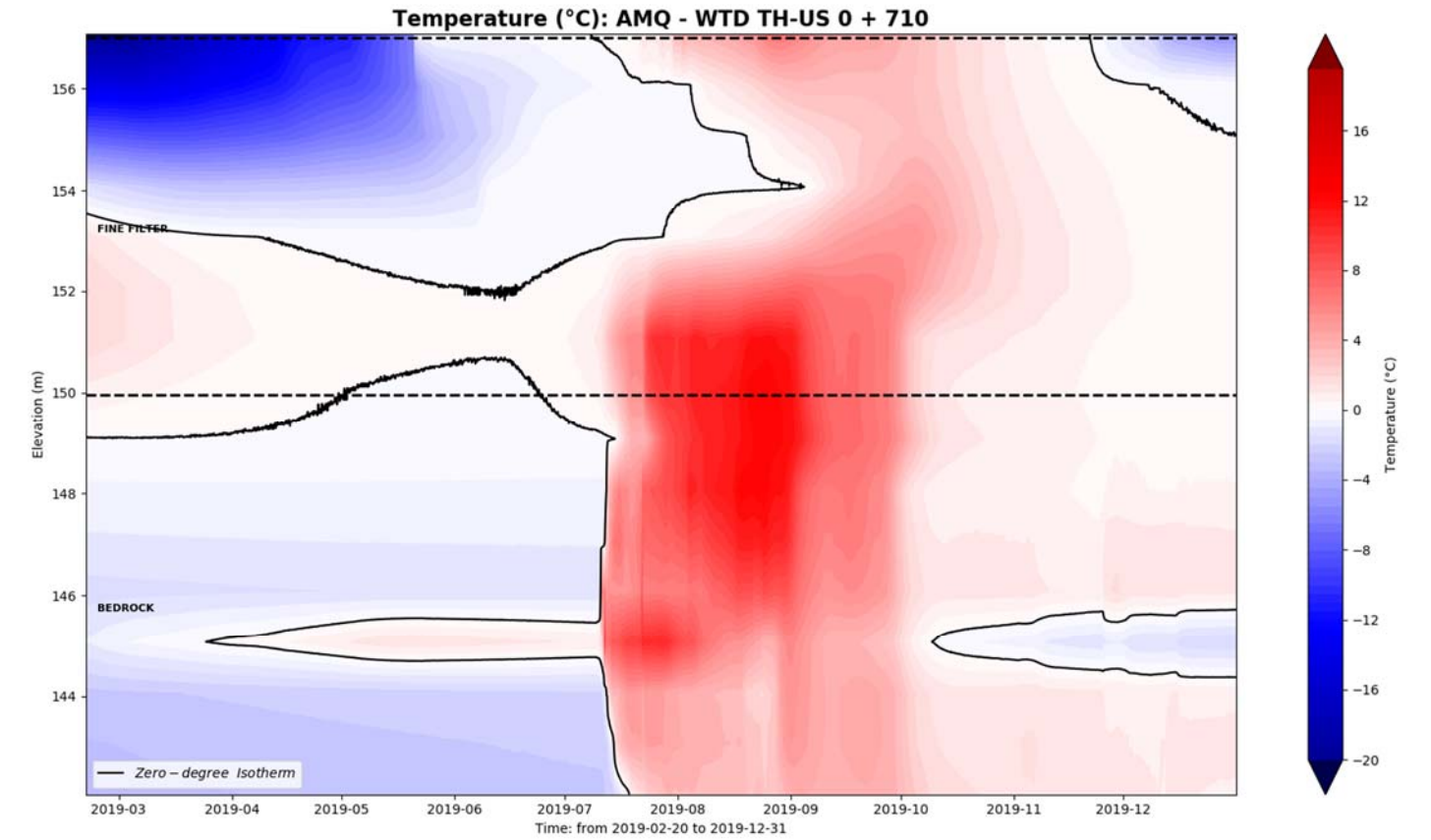
AMQ - WTD TH: 0+675



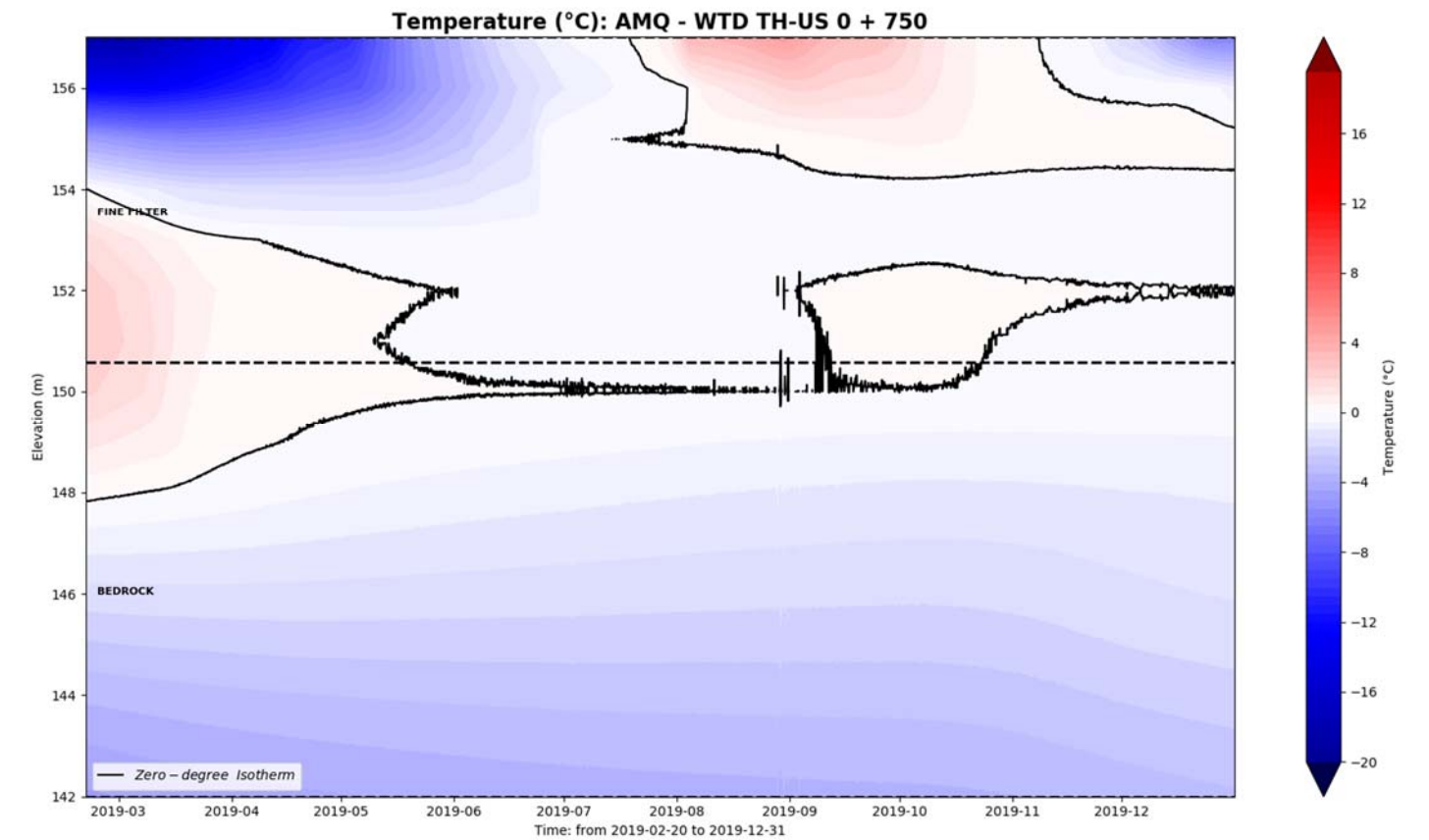
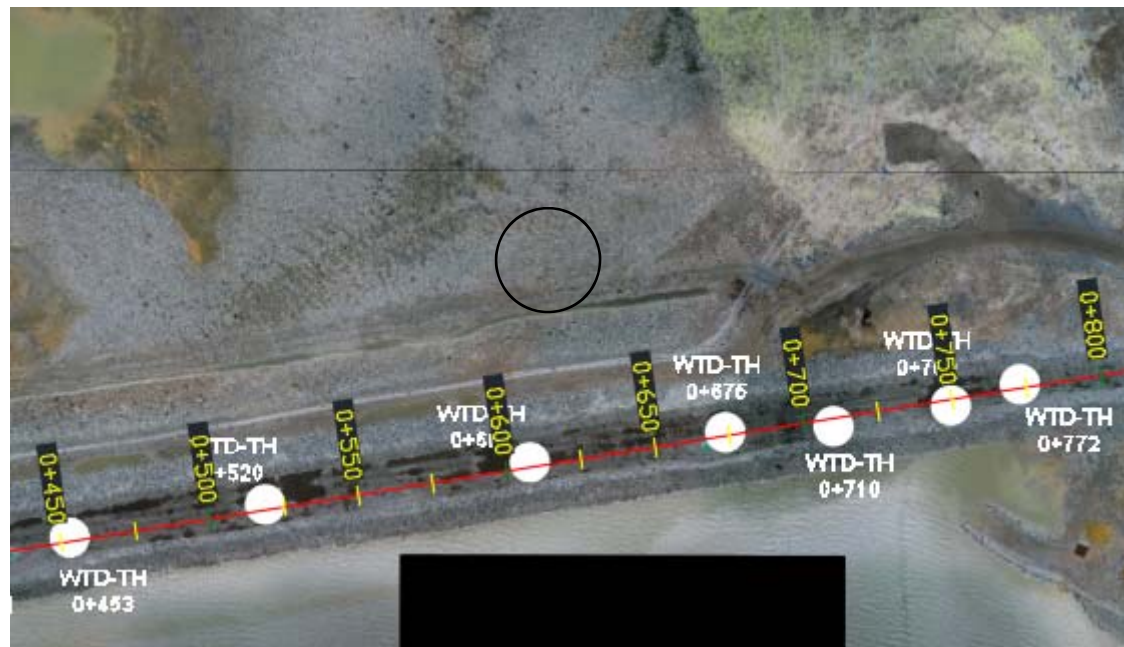
WTD-TH 0+710 U/S



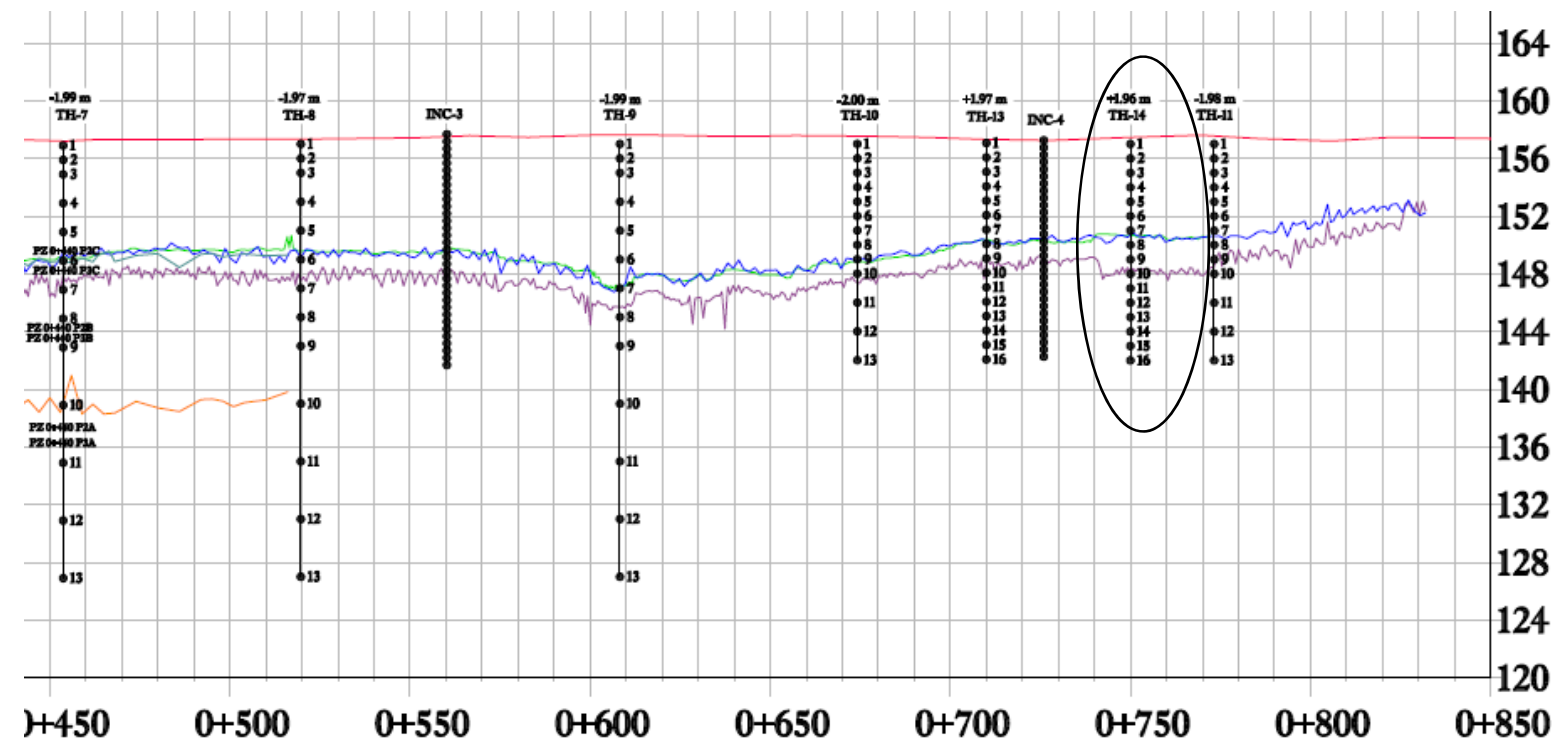
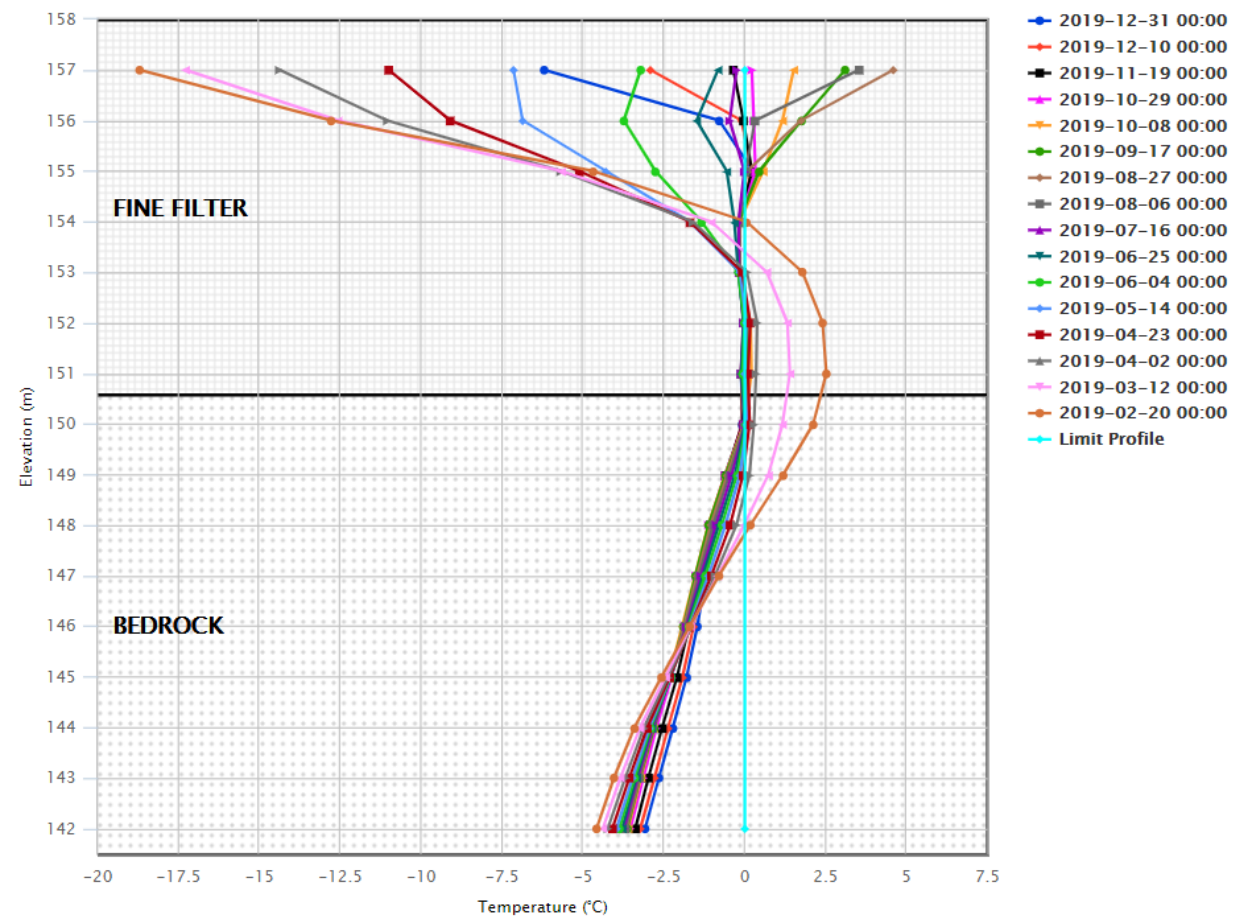
AMQ – WTD TH-US: 0+710



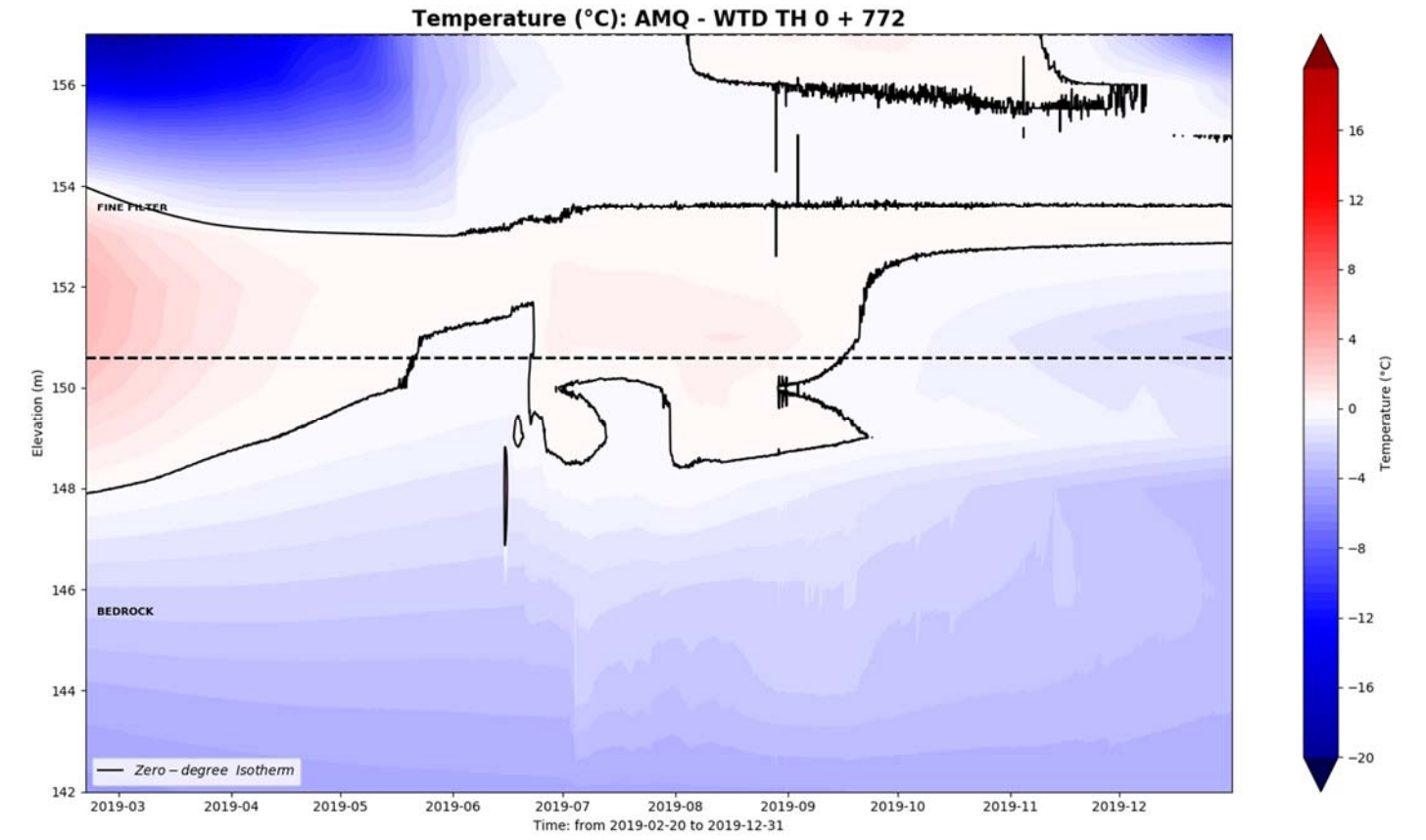
WTD-TH 0+750



AMQ - WTD TH-US: 0+750

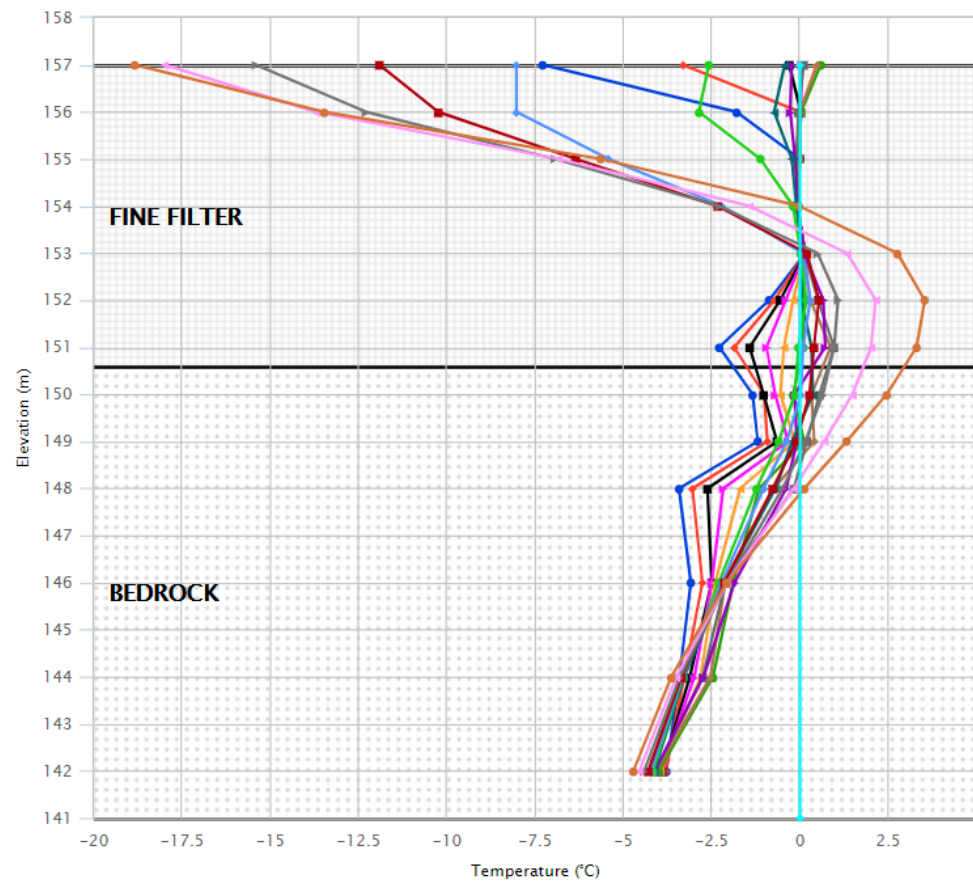


WTD-TH 0+772 U/S

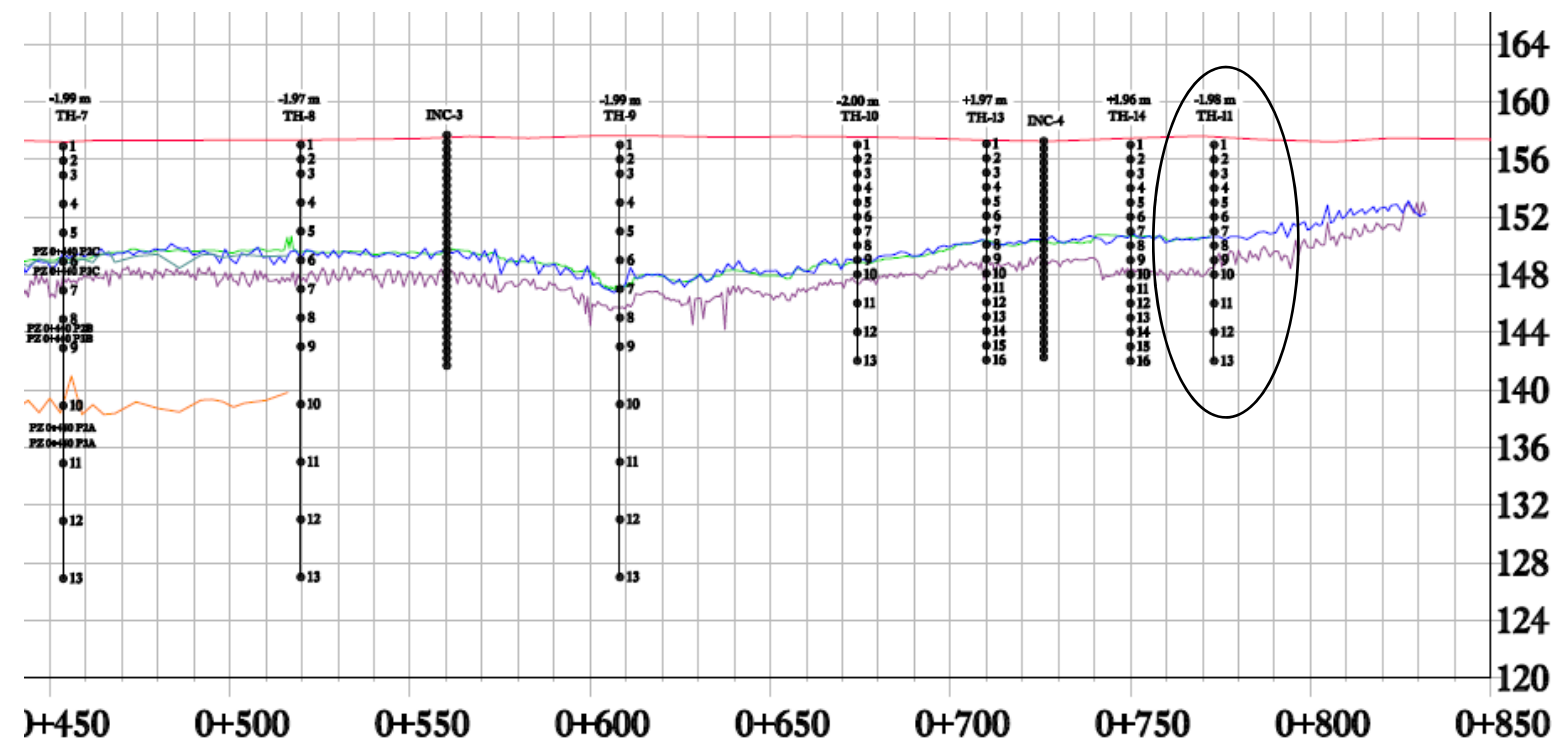


AMQ – WTD TH: 0+772

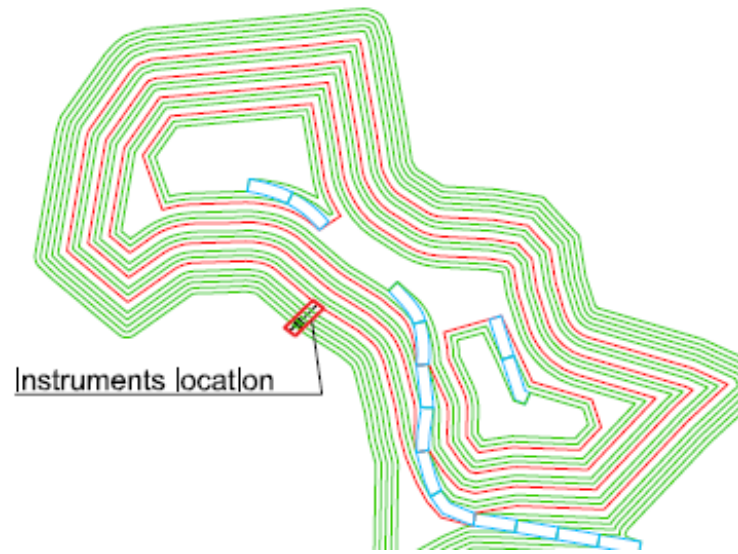
Mostly all beads have capacitive effect. Beads # 1, #2, #4 and #13 still good.



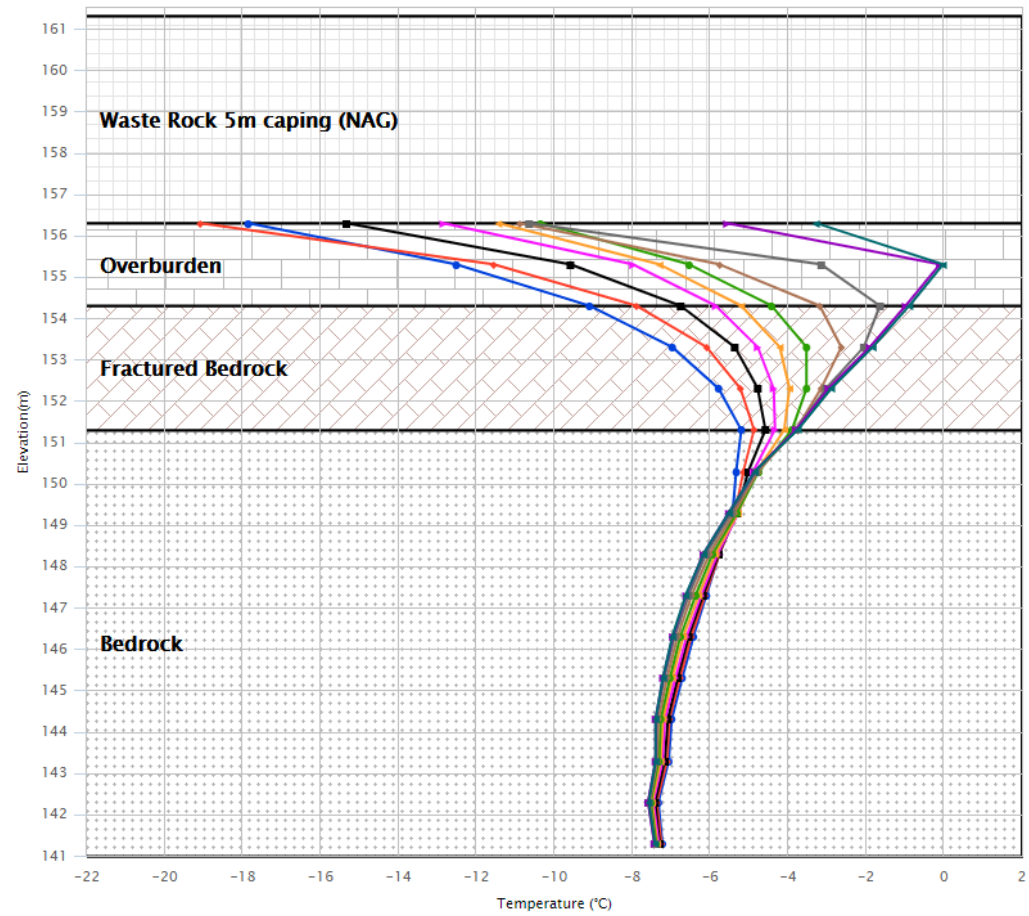
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-04-23 00:00
- 2019-04-02 00:00
- 2019-03-12 00:00
- 2019-02-20 00:00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



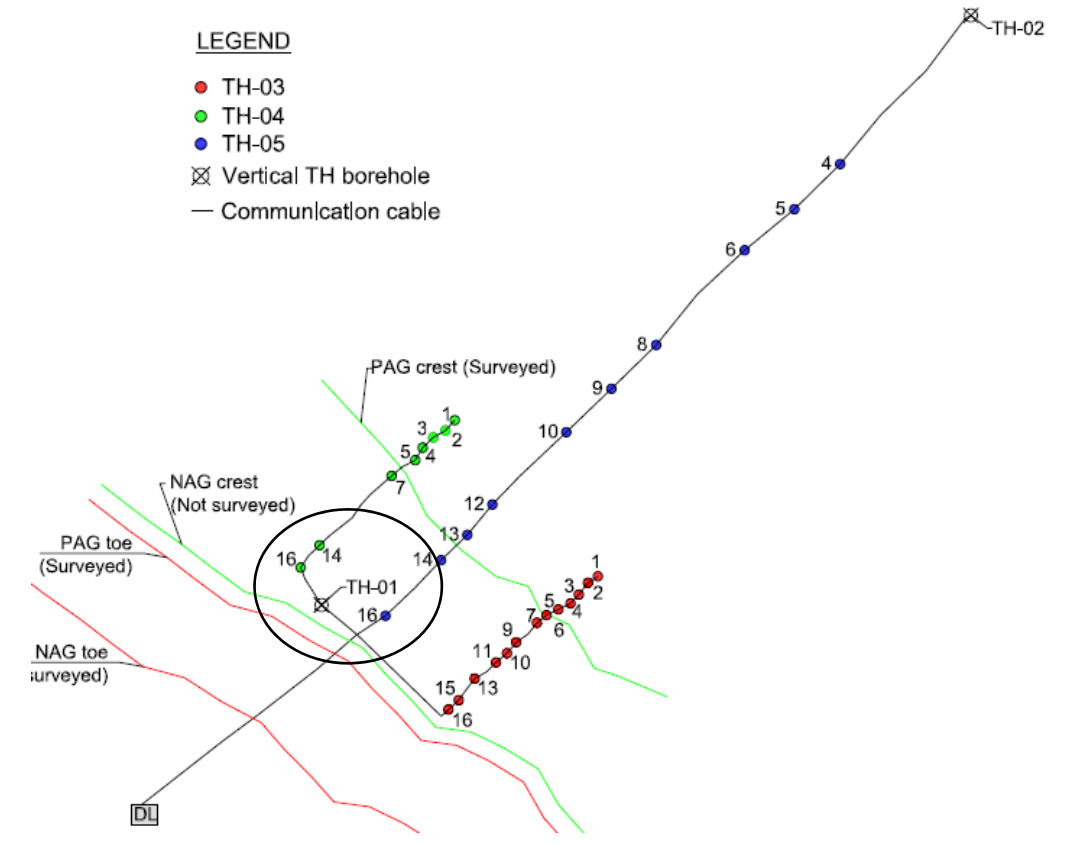
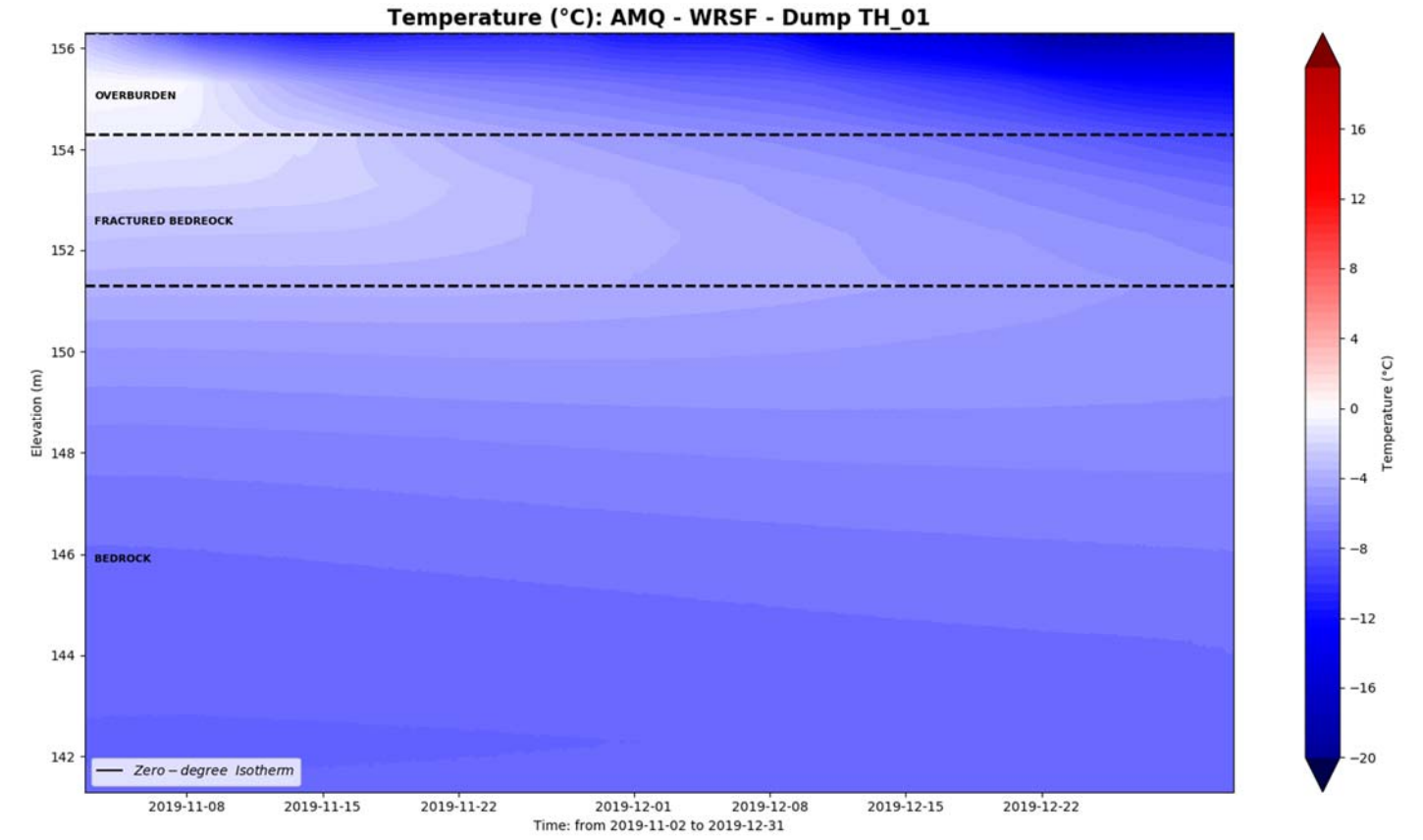
WRSF Th01



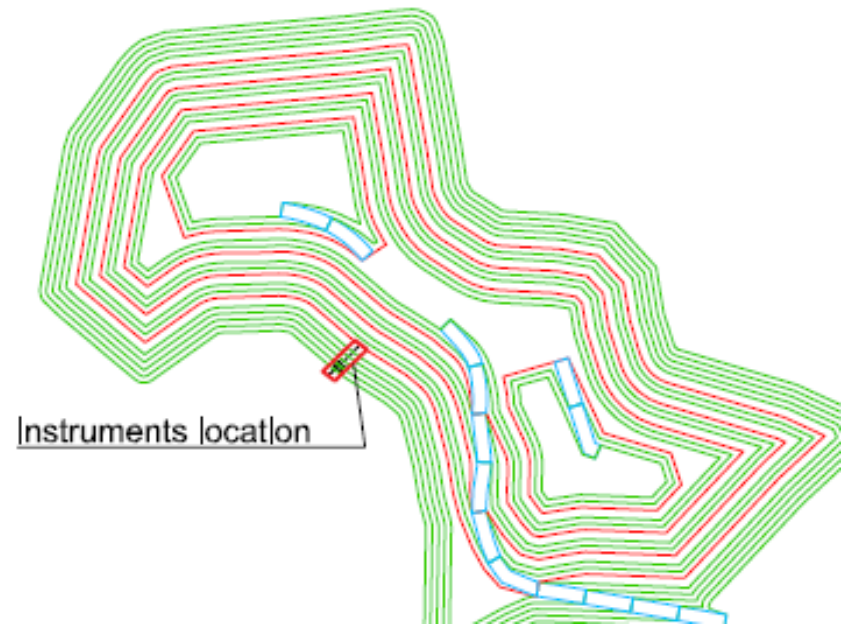
AMQ - WRSF - Dump TH_01



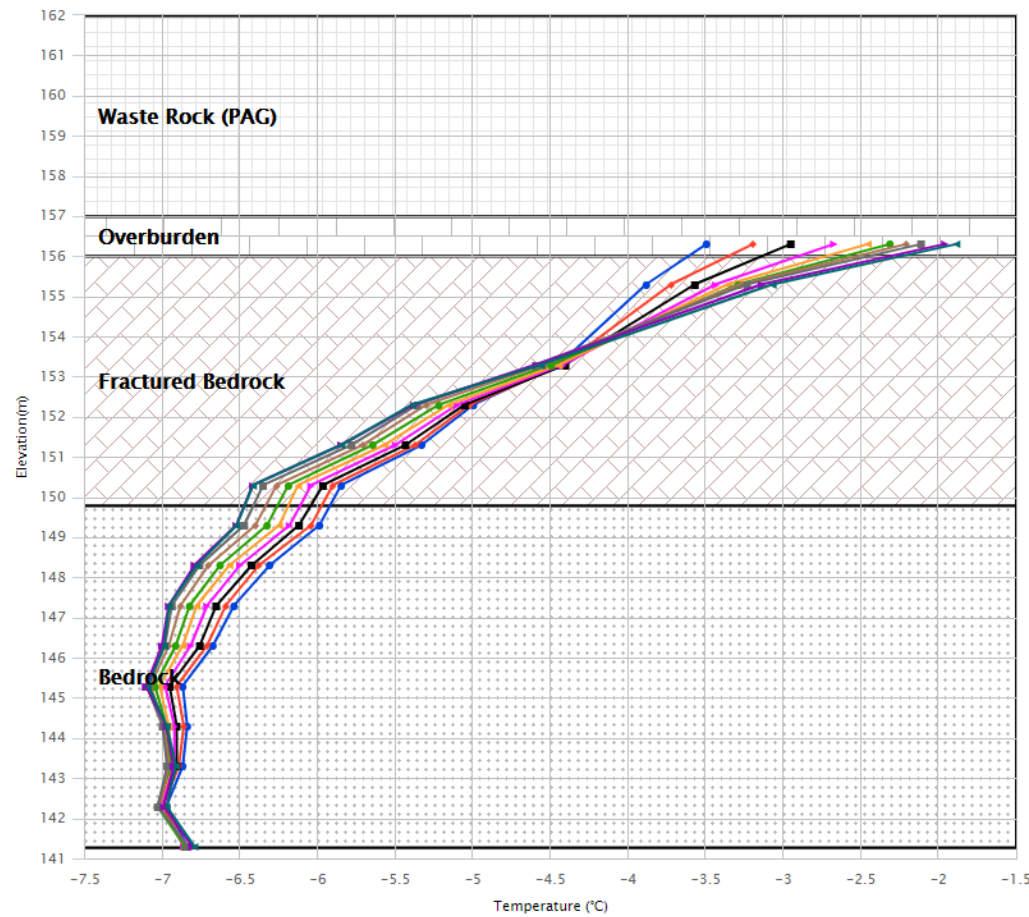
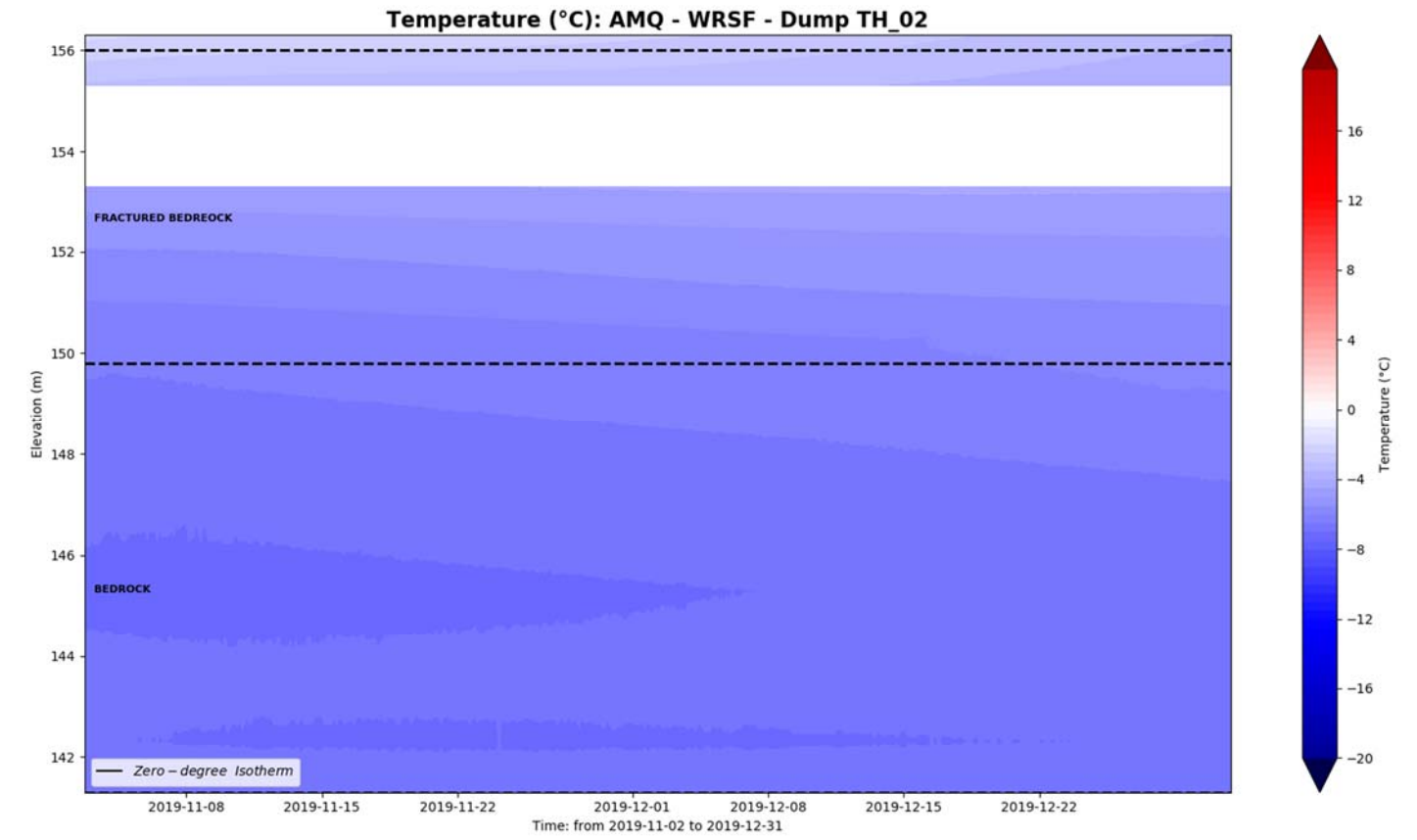
- 2019-12-31 00:00
- 2019-12-24 00:00
- 2019-12-17 00:00
- 2019-12-10 00:00
- 2019-12-03 00:00
- 2019-11-26 00:00
- 2019-11-19 00:00
- 2019-11-12 00:00
- 2019-11-05 00:00
- 2019-11-02 18:00



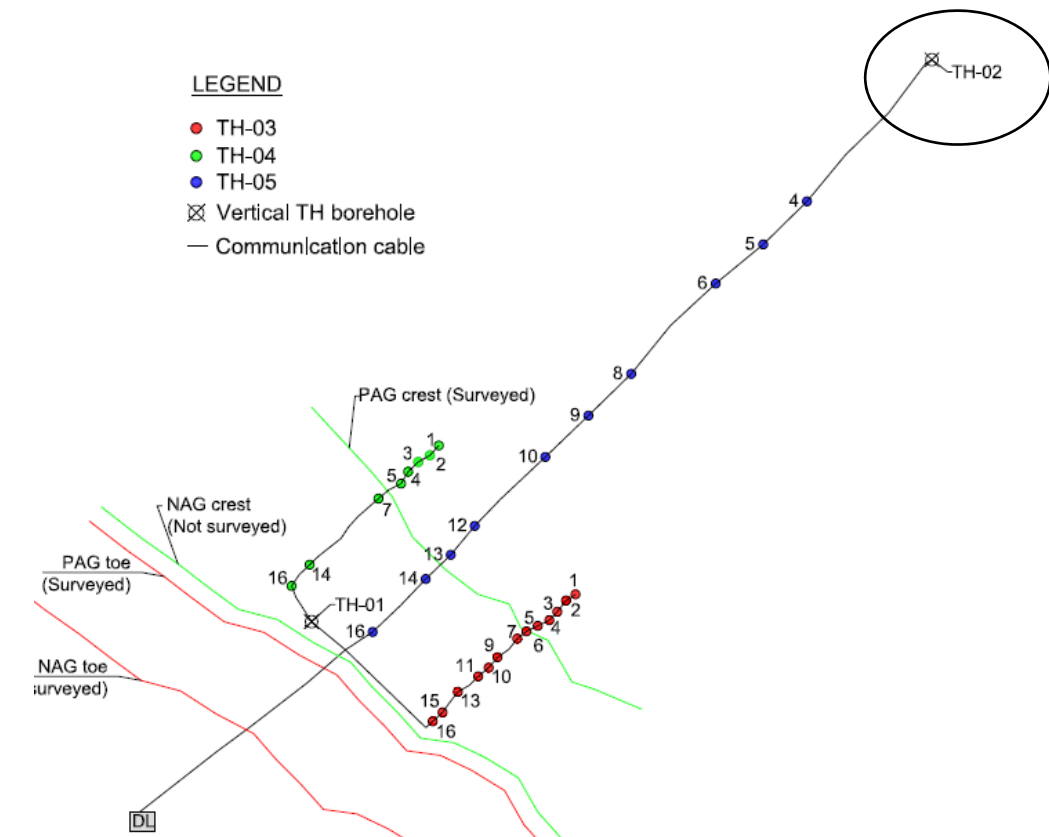
WRSF TH02



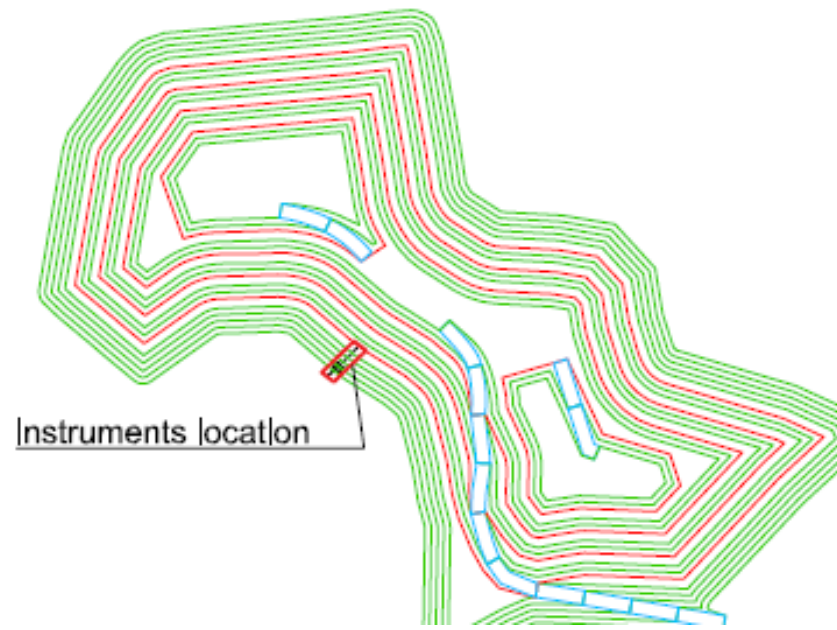
AMQ - WRSF - Dump TH_02



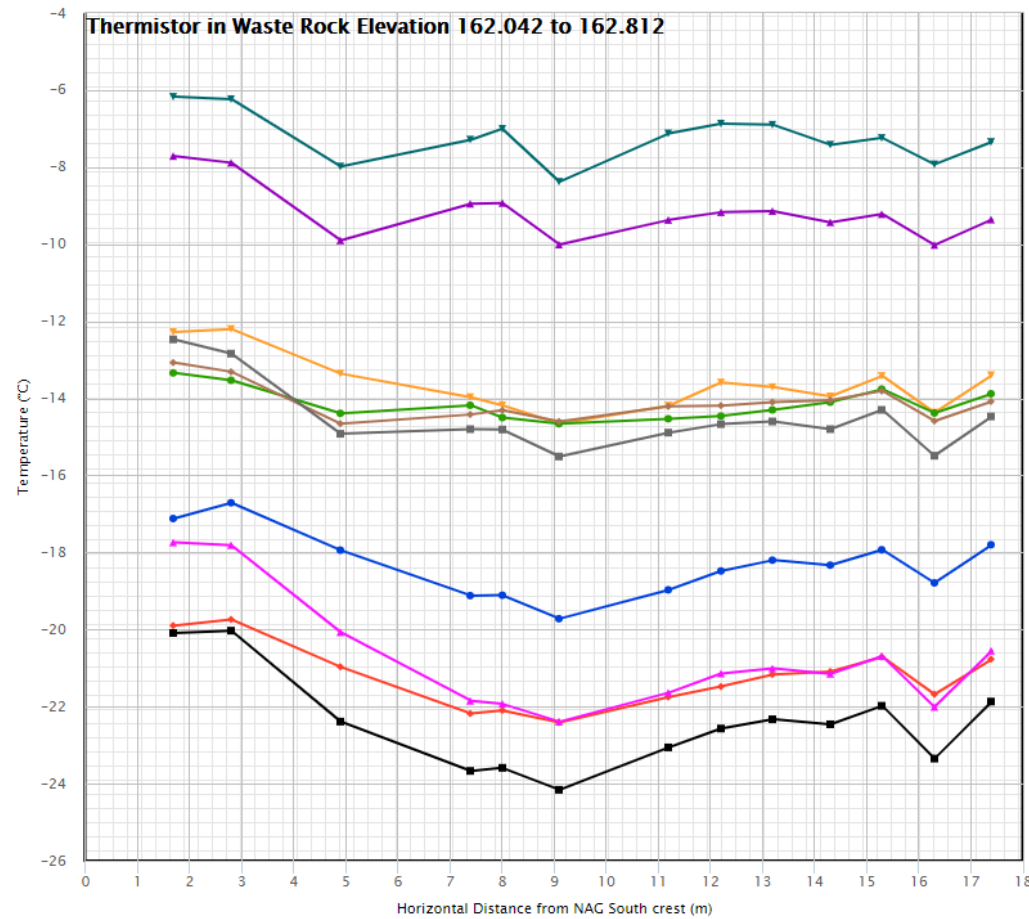
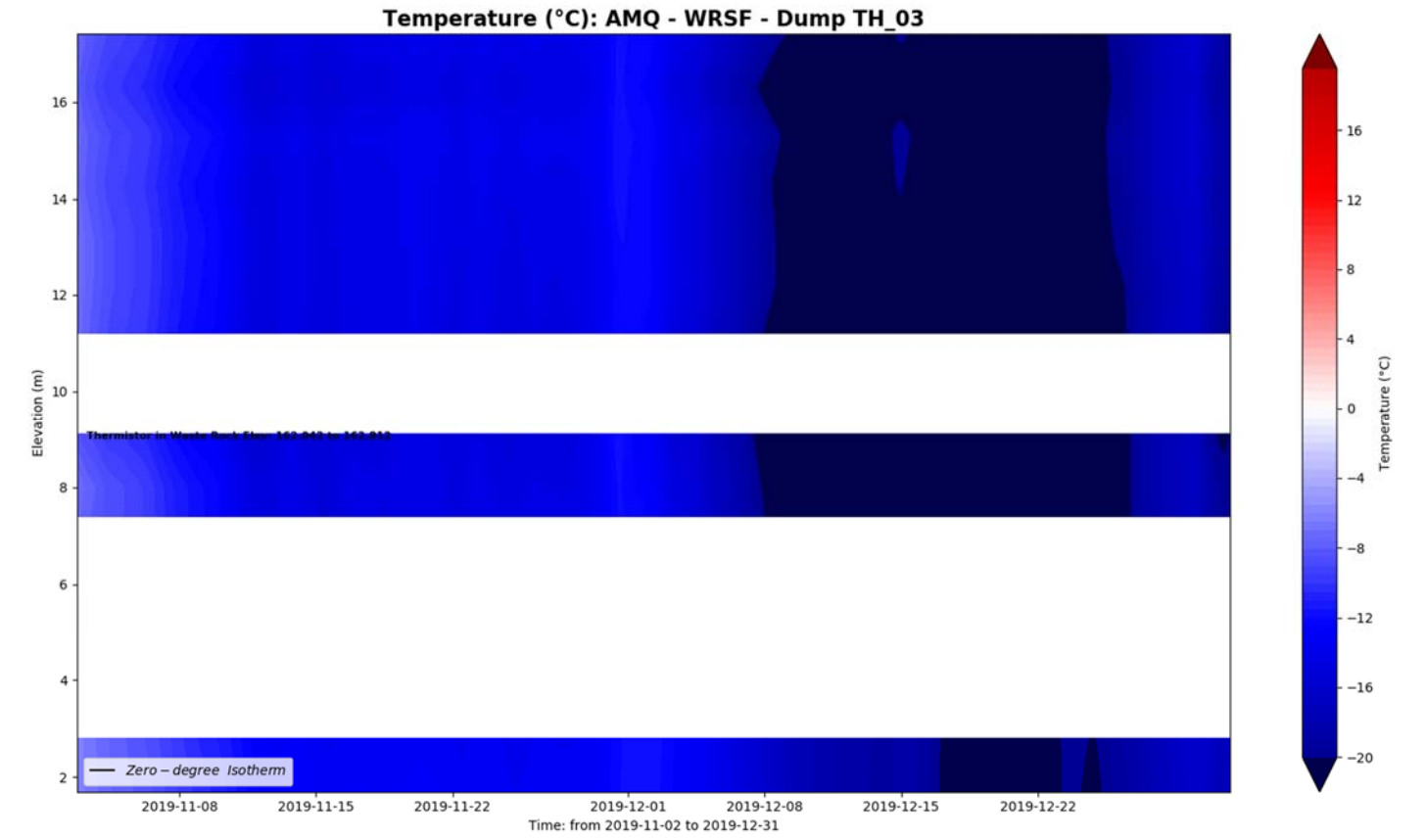
- 2019-12-31 00:00
- 2019-12-24 00:00
- 2019-12-17 00:00
- 2019-12-10 00:00
- 2019-12-03 00:00
- 2019-11-26 00:00
- 2019-11-19 00:00
- 2019-11-12 00:00
- 2019-11-05 00:00
- 2019-11-02 18:00



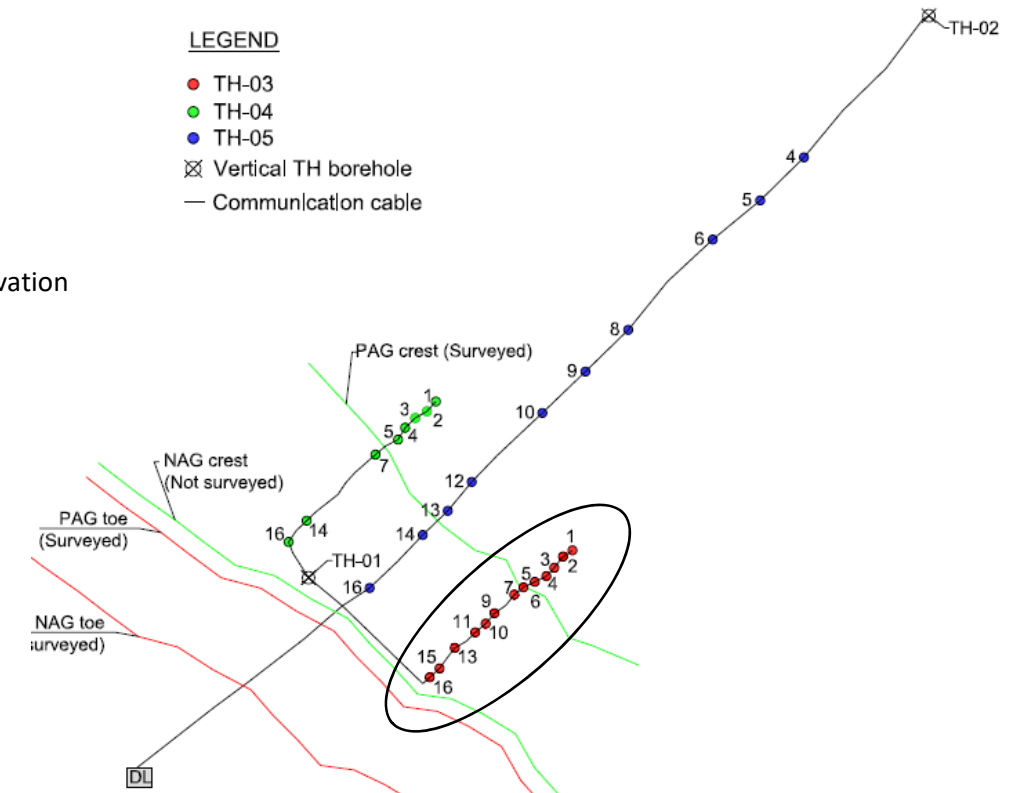
WRSF TH03



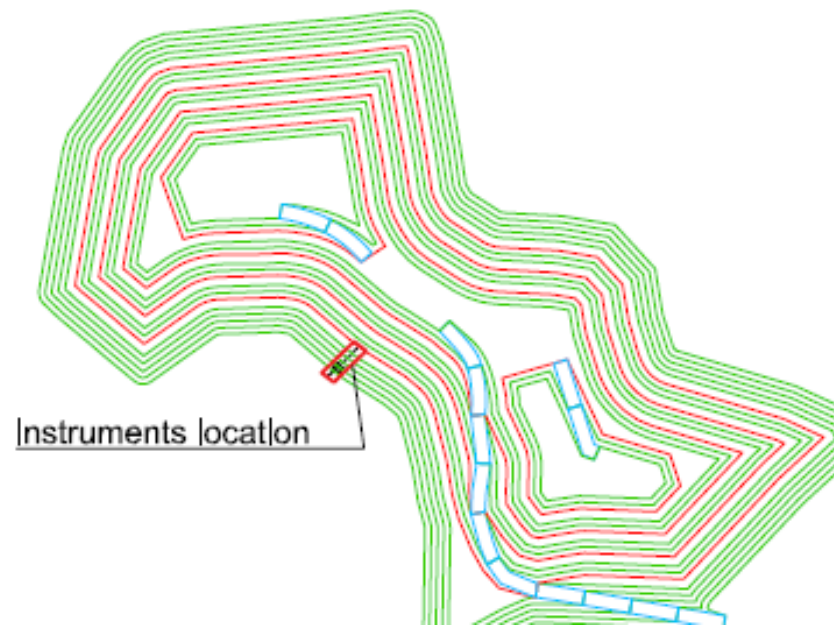
AMQ - WRSF - Dump TH_03



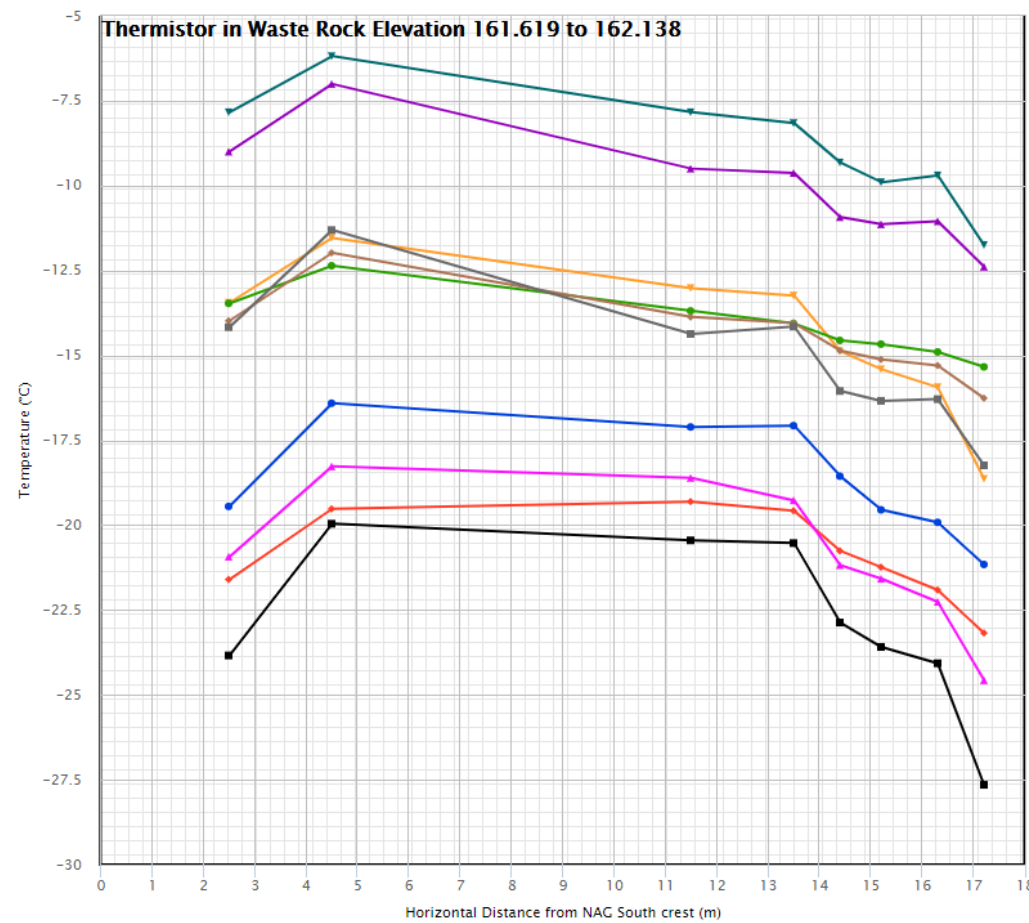
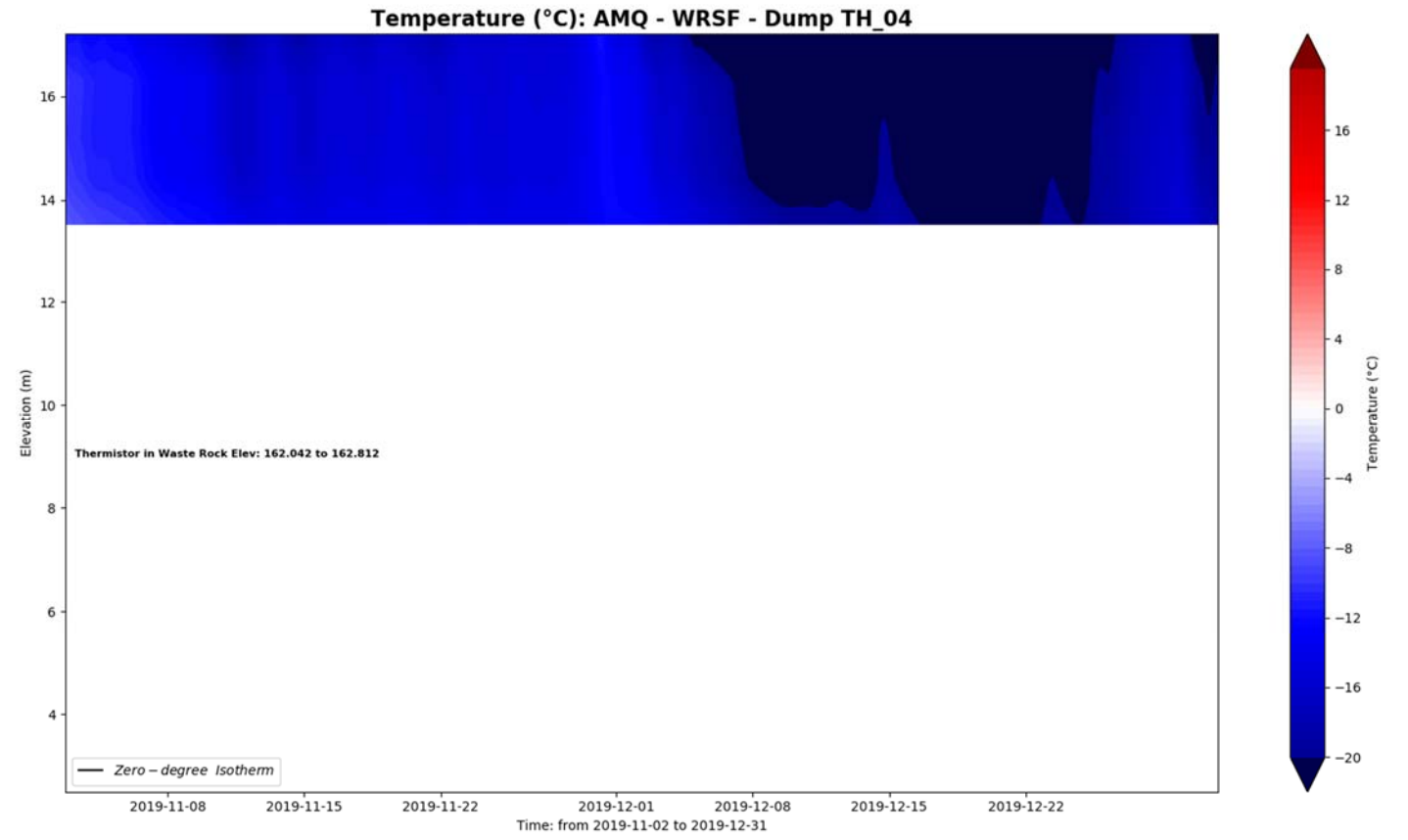
Thermistor in Waste Rock Elevation 162.042 to 162.81



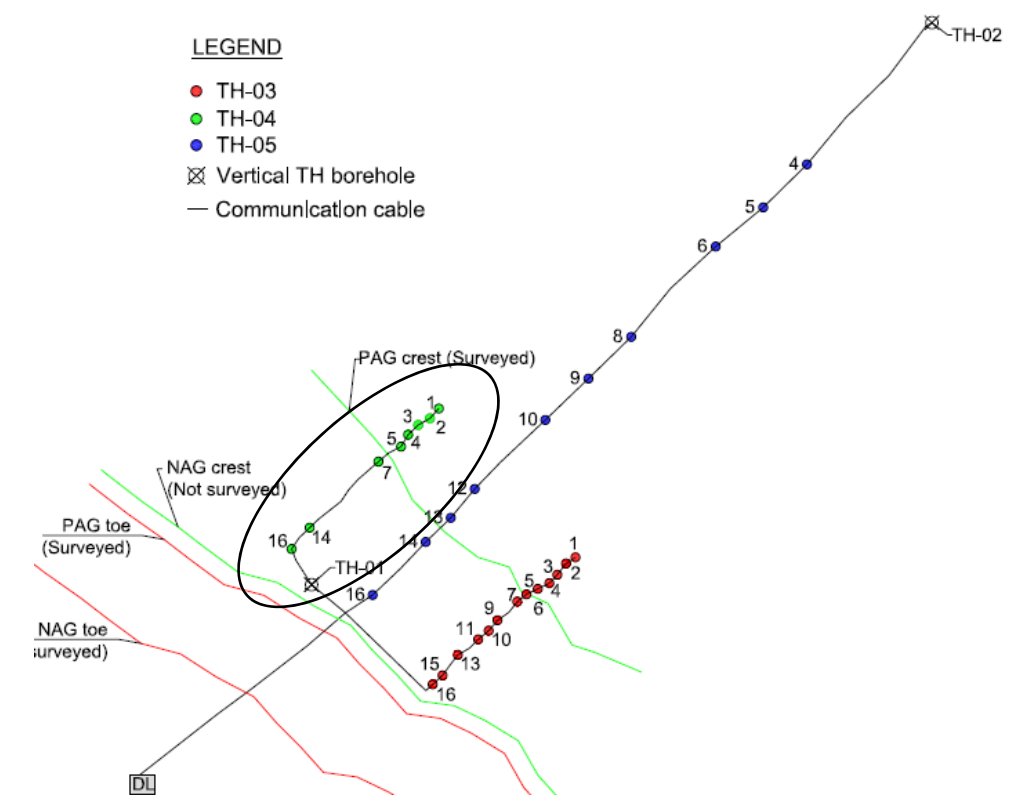
WRSF TH04



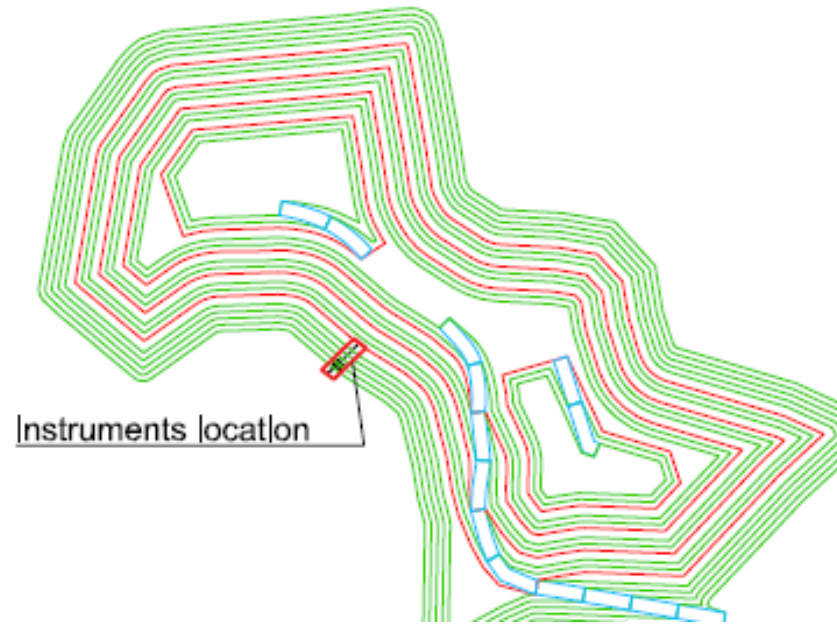
AMQ - WRSF - Dump TH_04



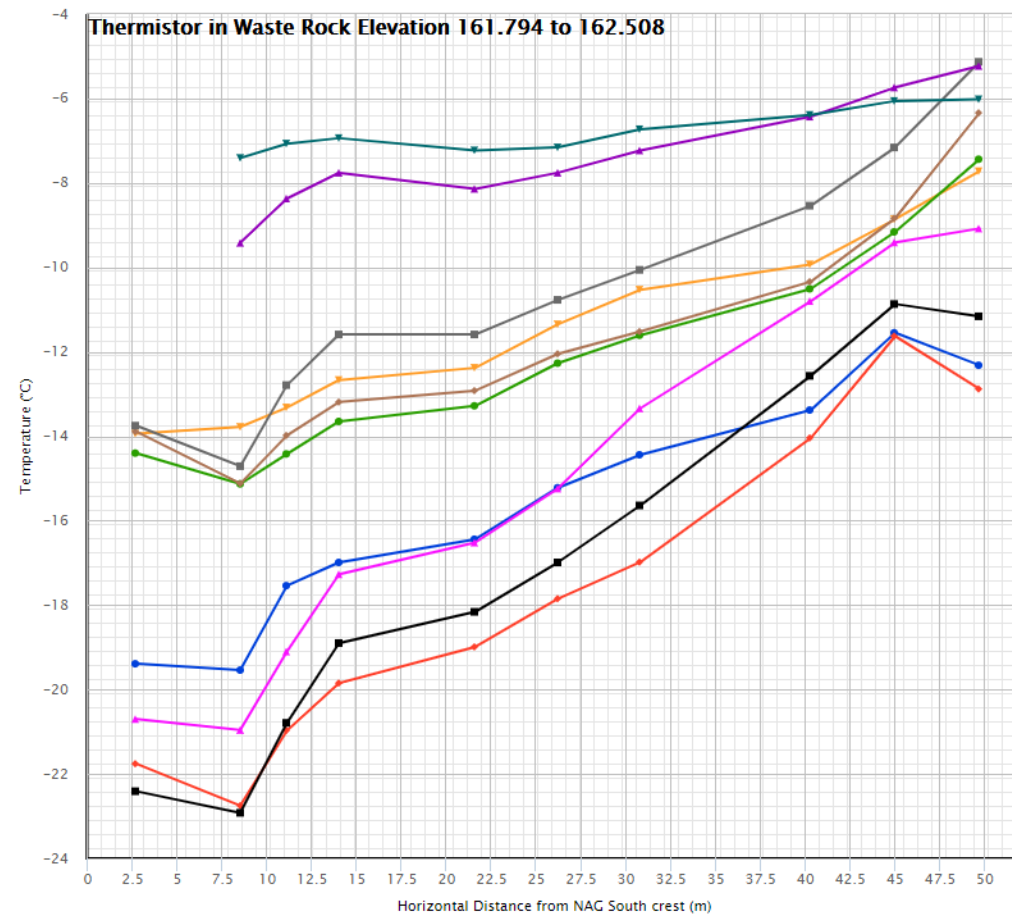
Thermistor in Waste Rock Elevation 161.619 to 162.138



WRSF TH05

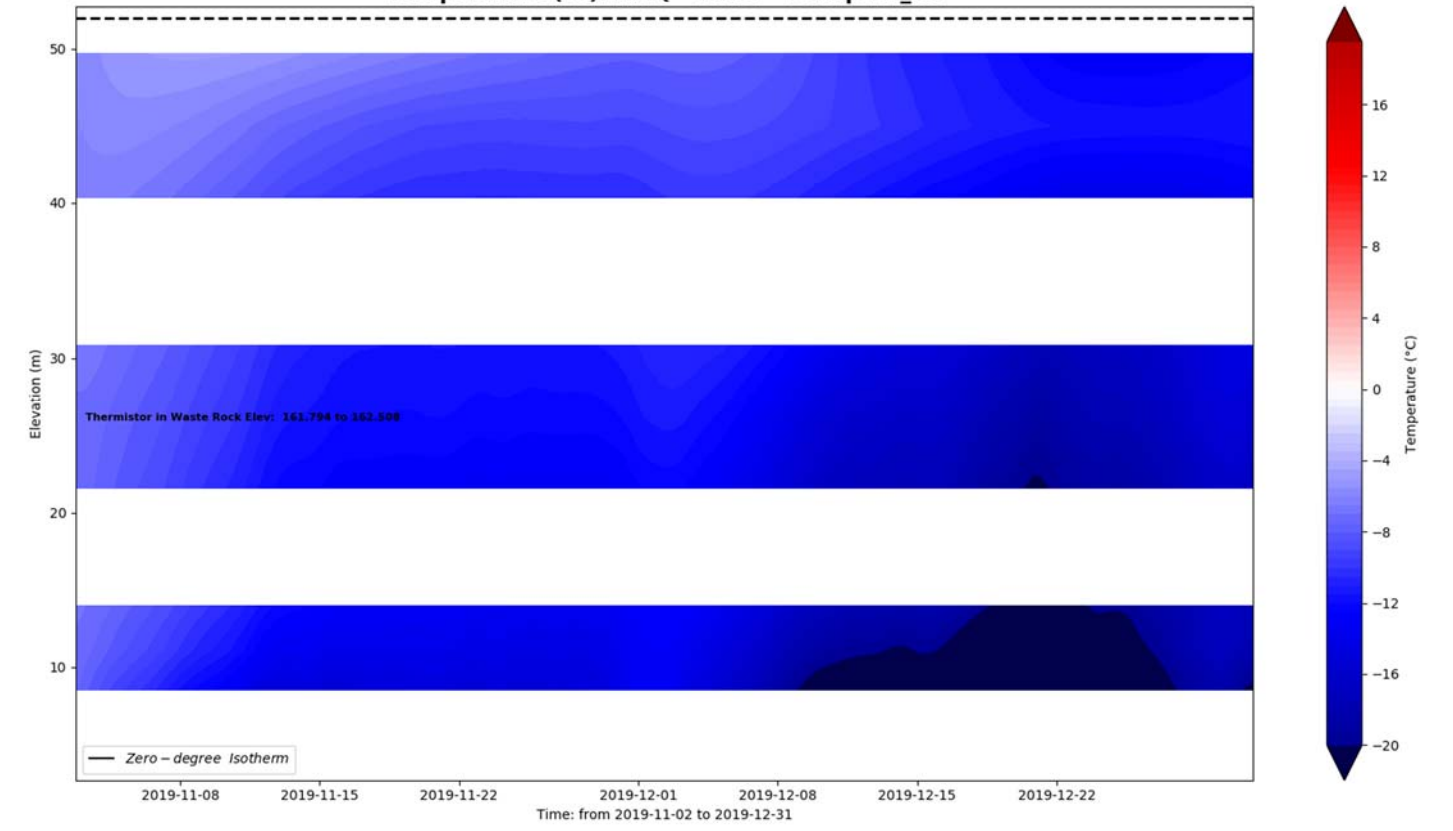


AMQ - WRSF - Dump TH_05



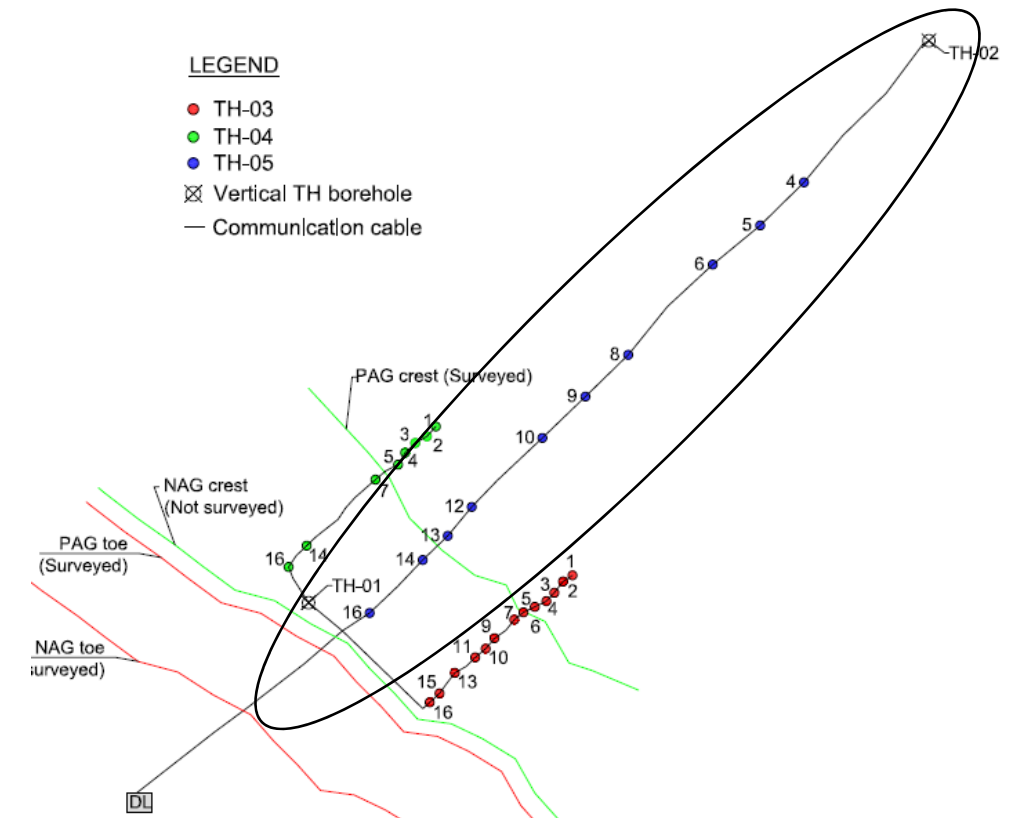
Thermistor in Waste Rock Elevation
161.794 to 162.508

Temperature (°C): AMQ - WRSF - Dump TH_05



LEGEND

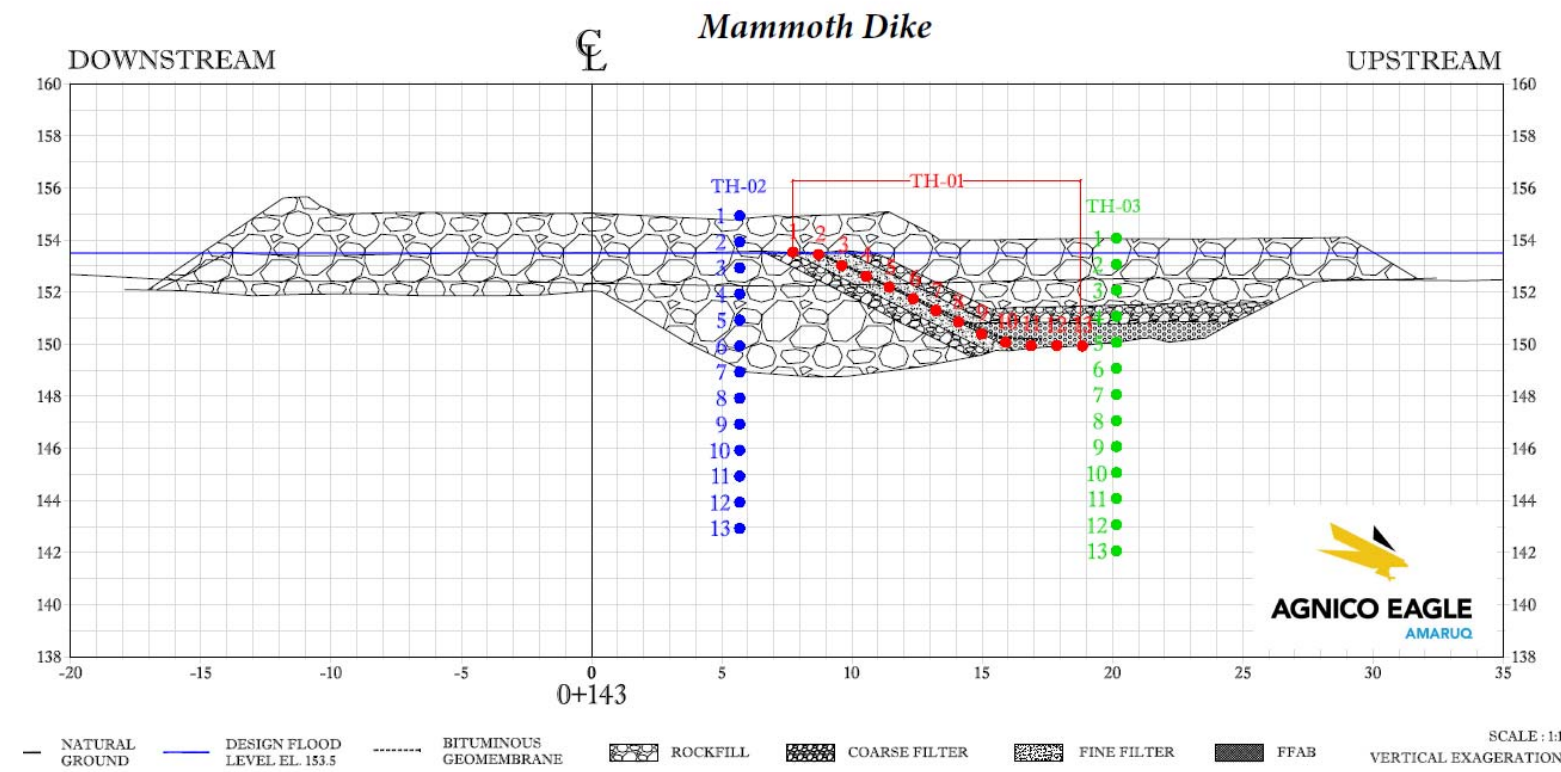
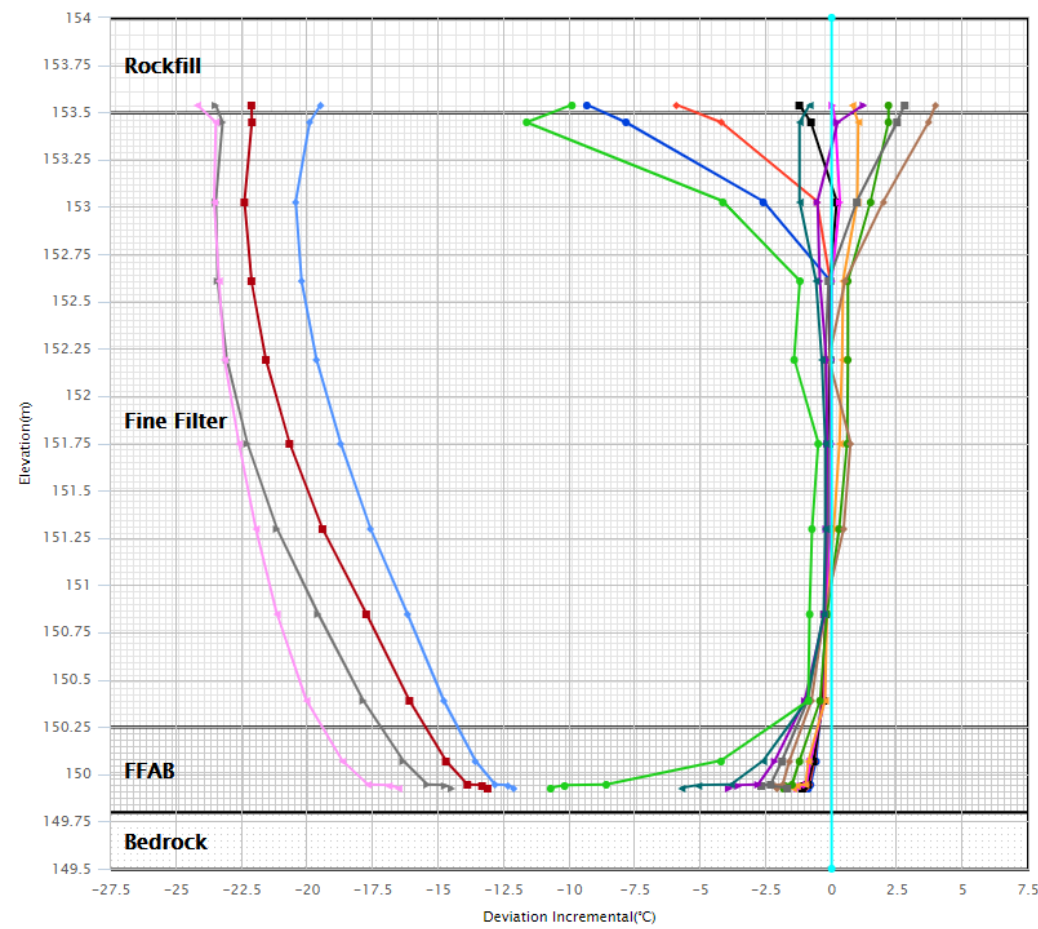
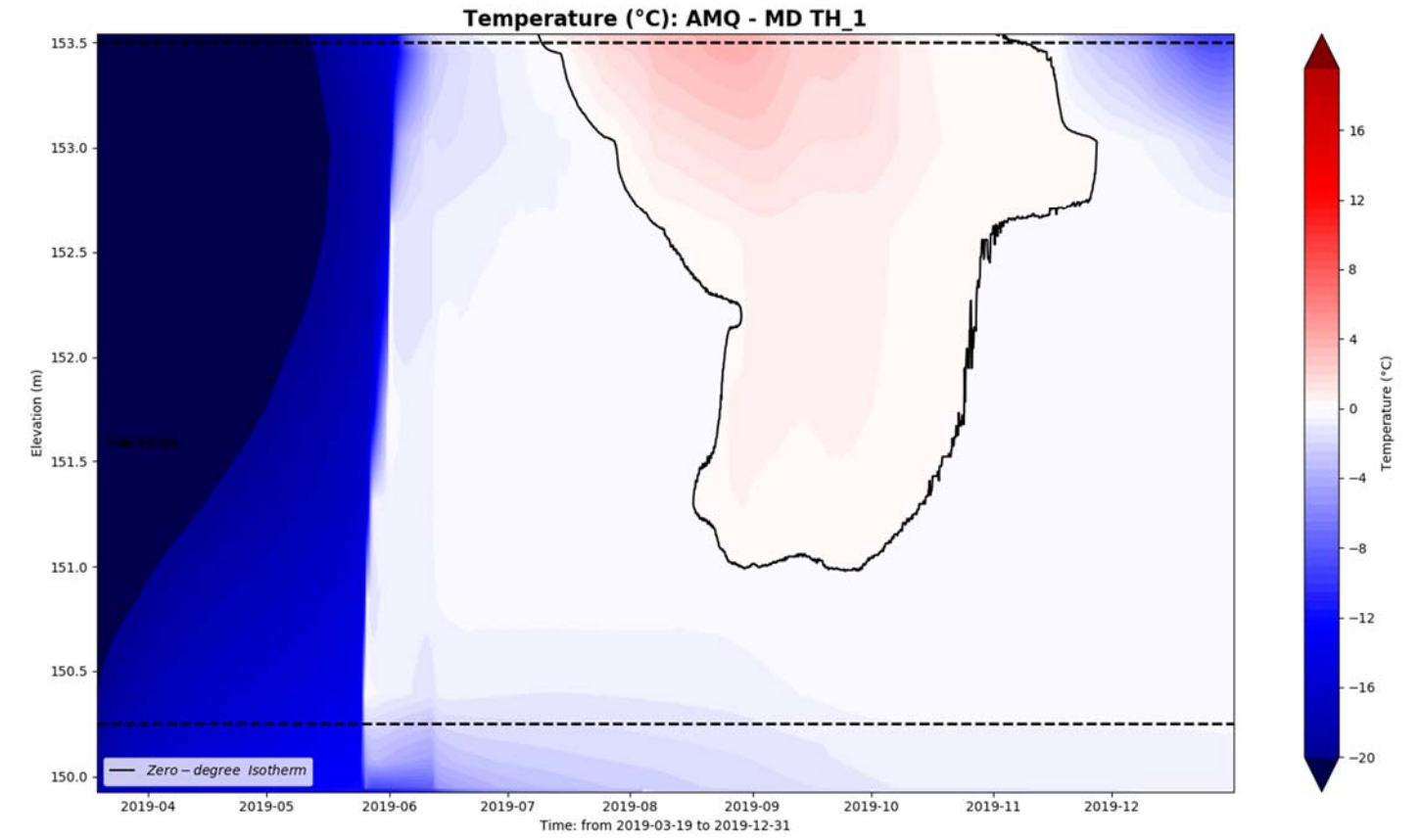
- TH-03
- TH-04
- TH-05
- ⊗ Vertical TH borehole
- Communication cable



MD TH01

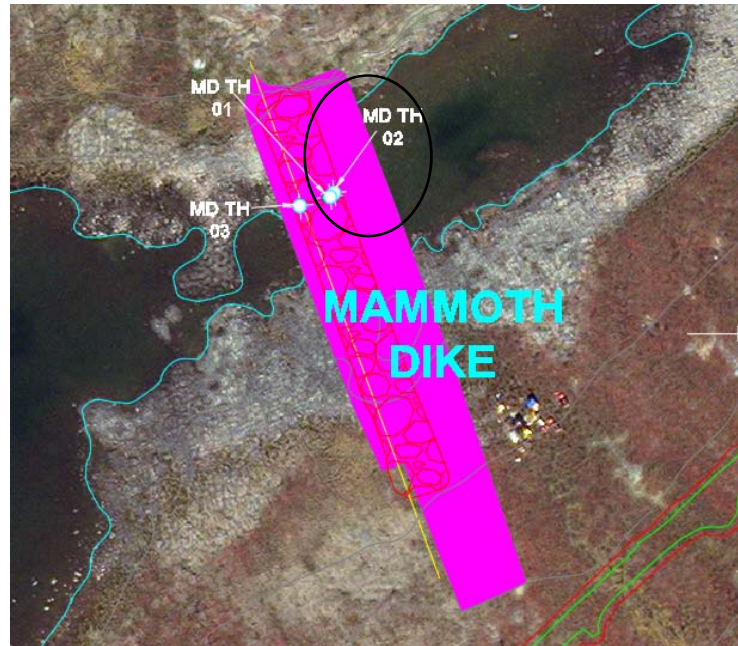


AMQ - MD TH_01

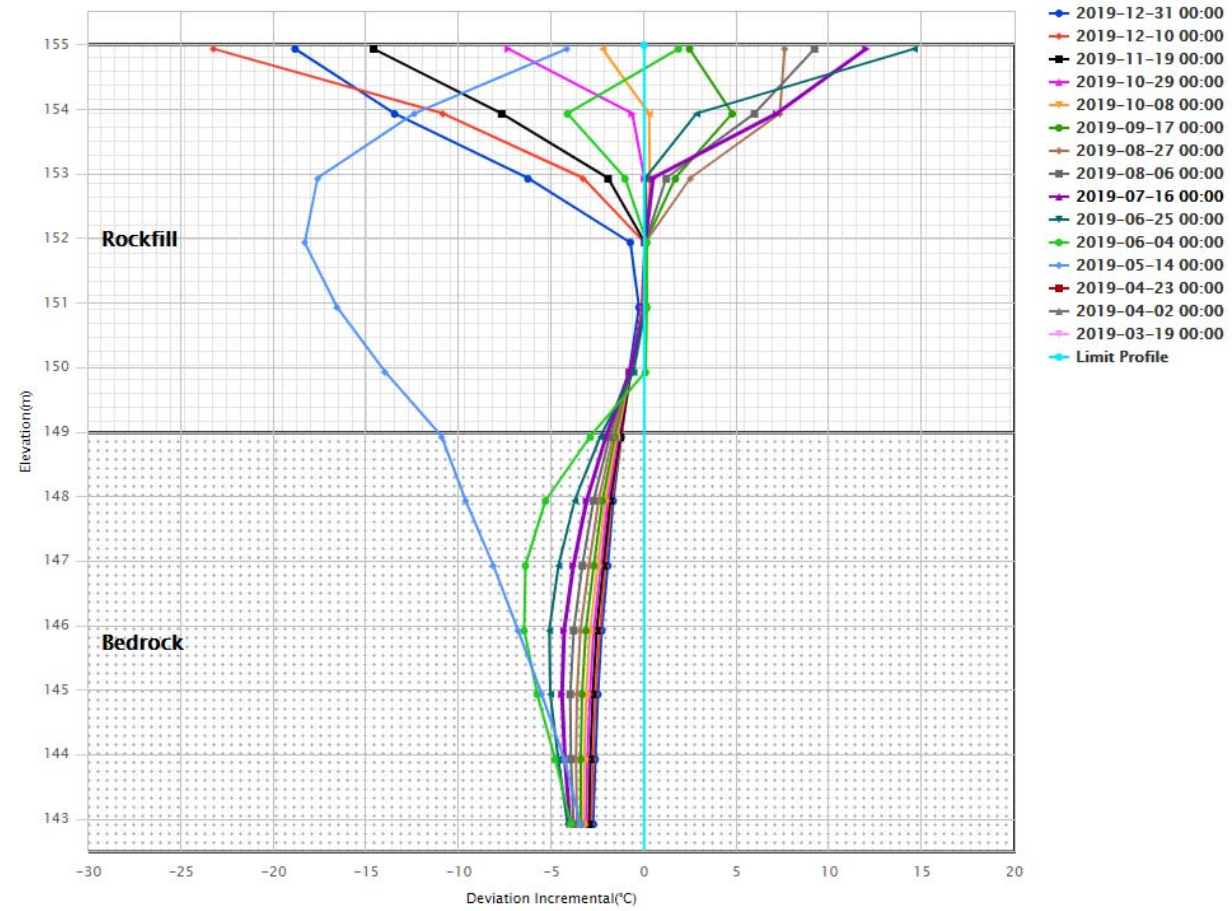


SCALE: 1:15
VERTICAL EXAGGERATION:

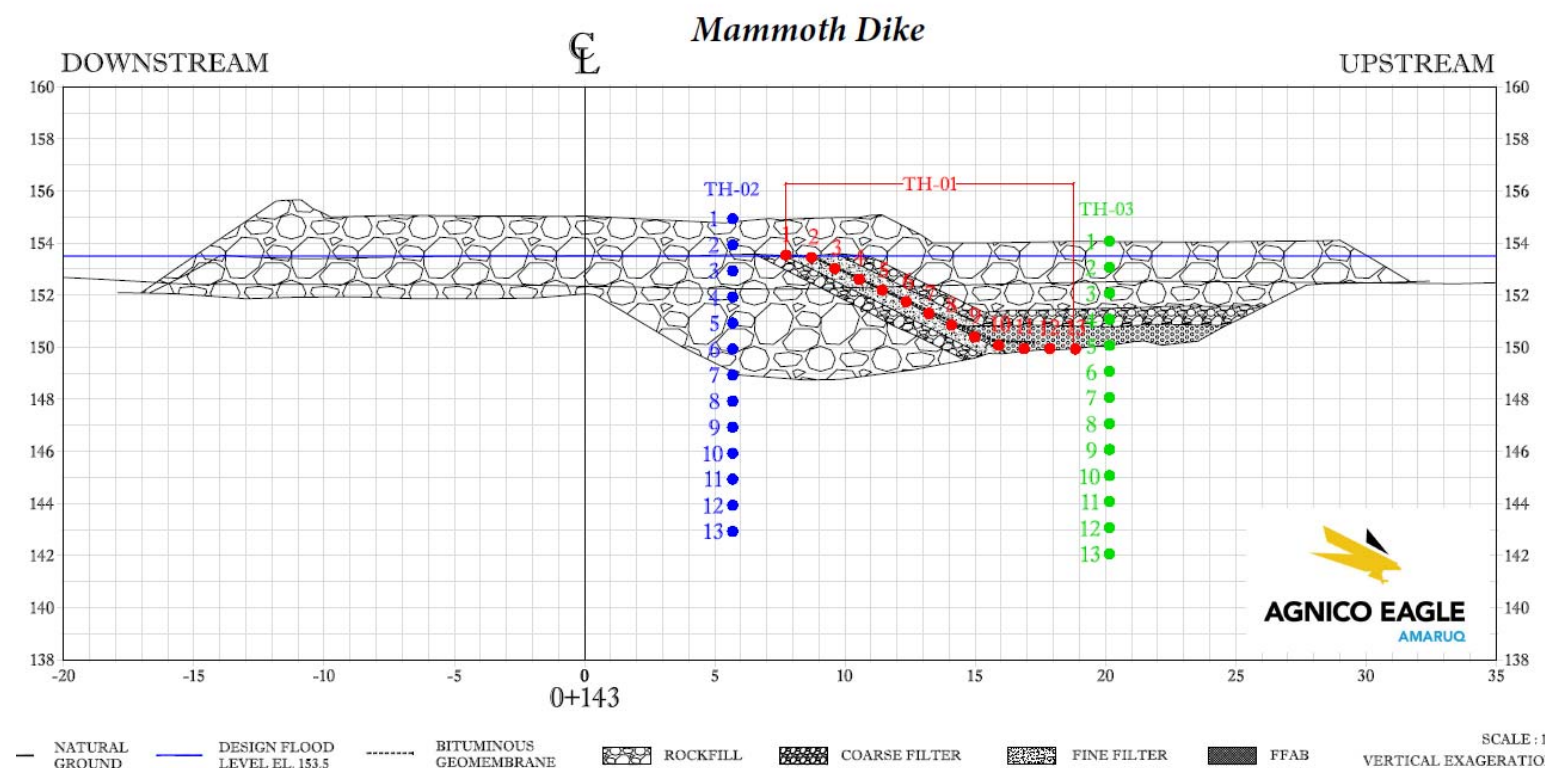
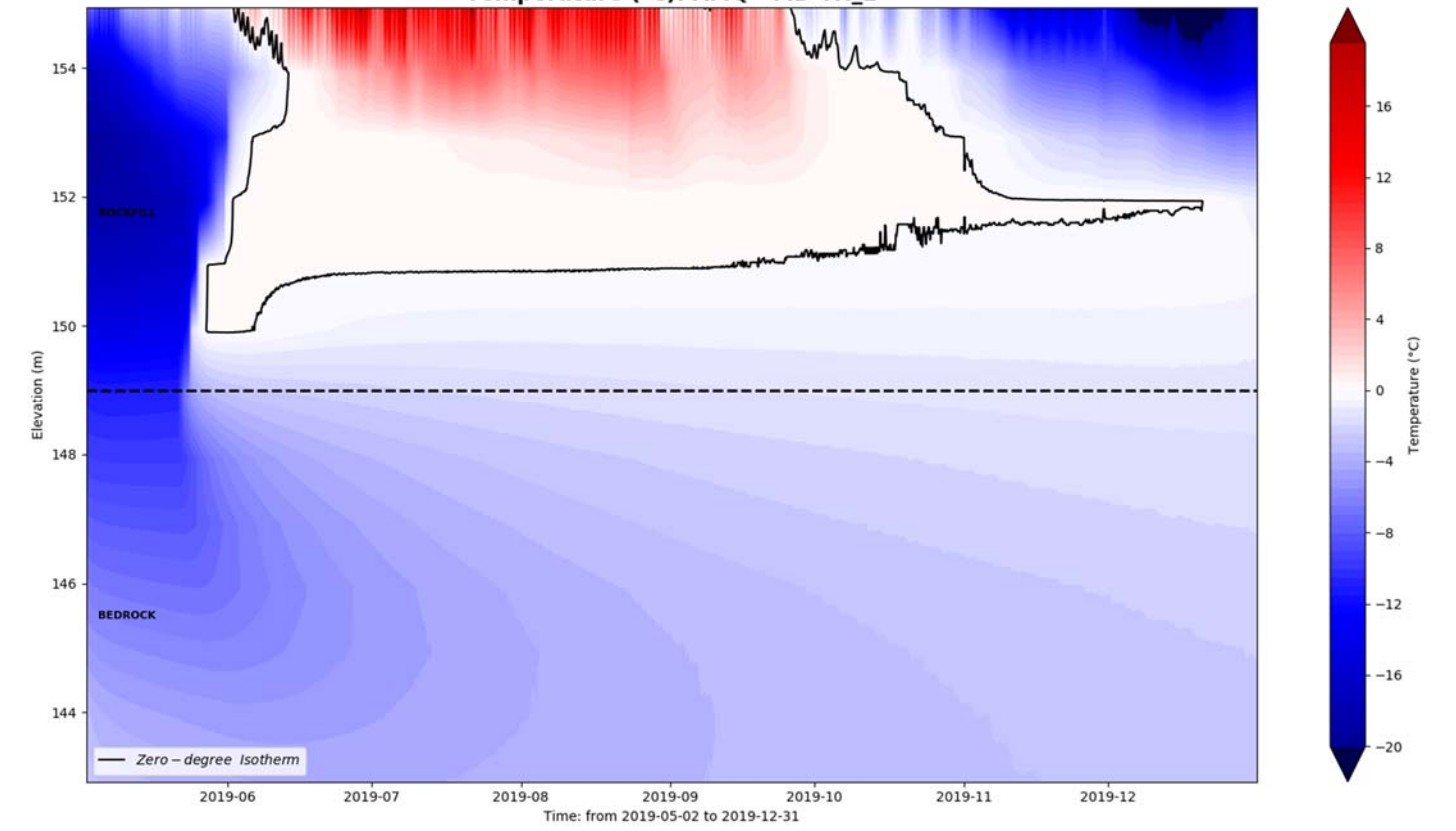
MD TH02



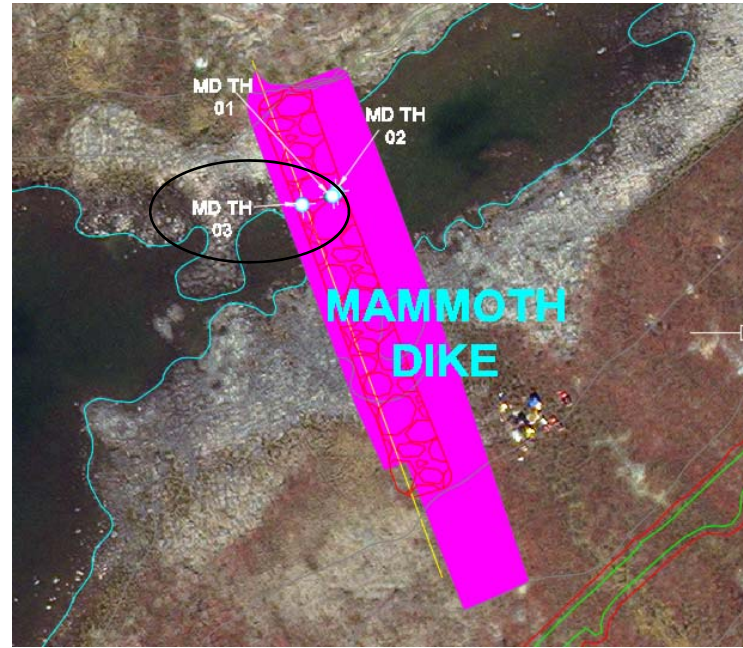
AMQ - MD TH_02



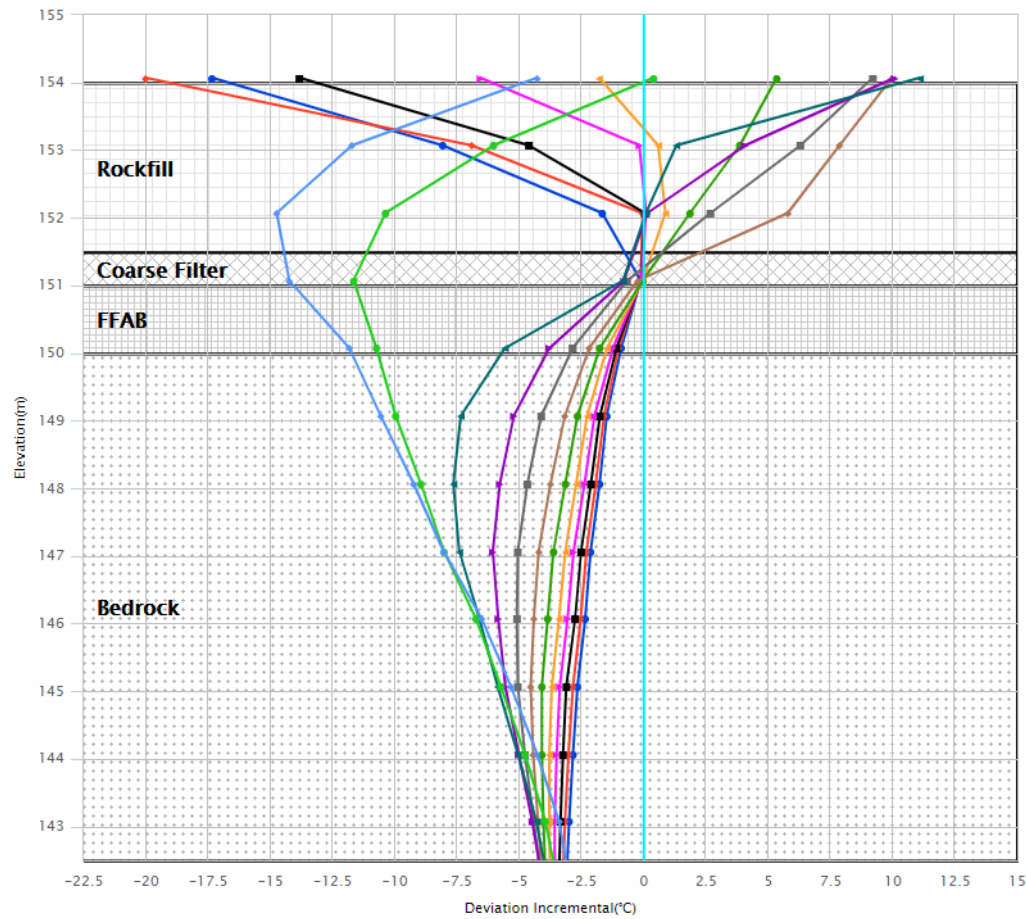
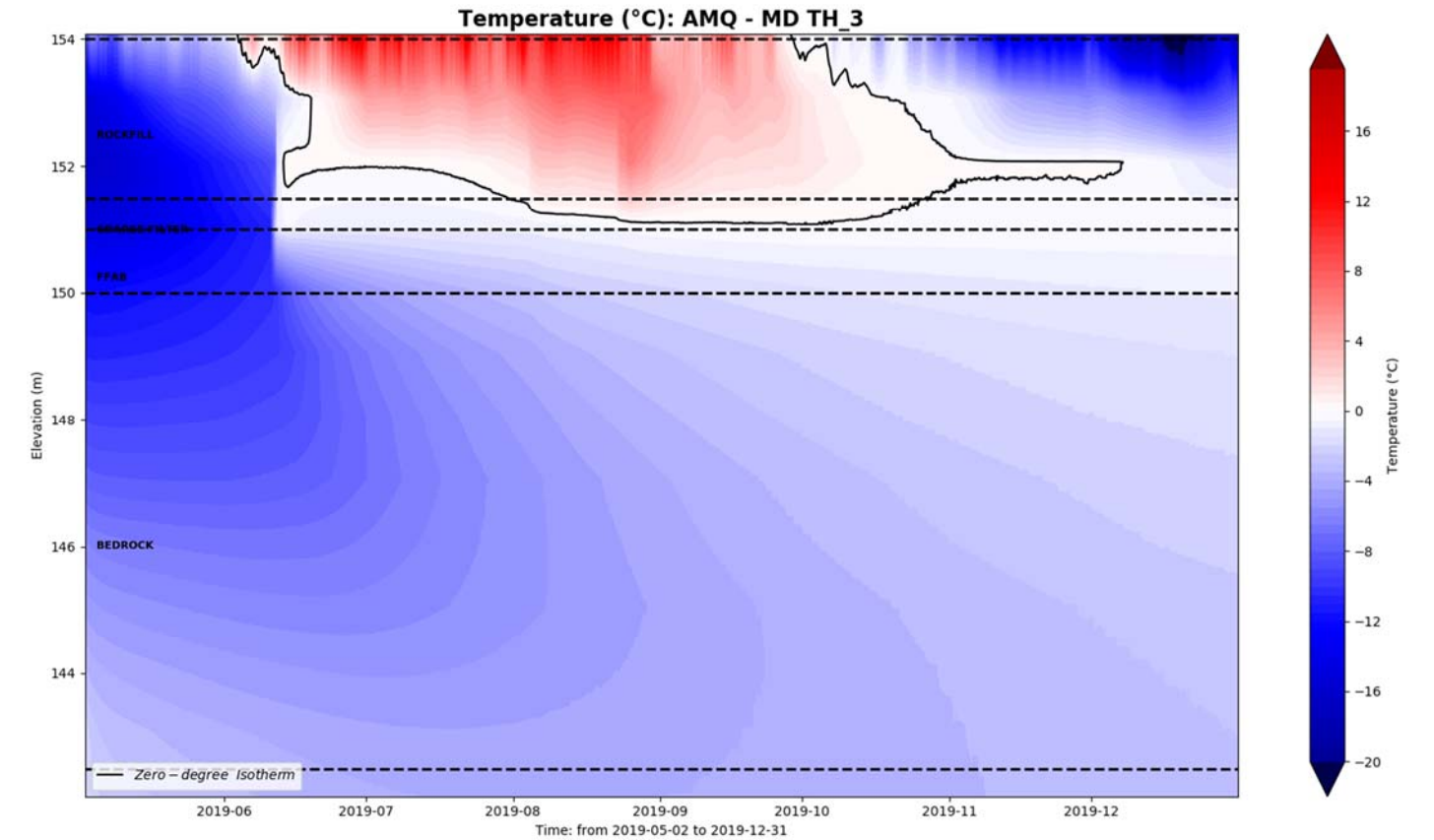
Temperature (°C): AMQ - MD TH_2



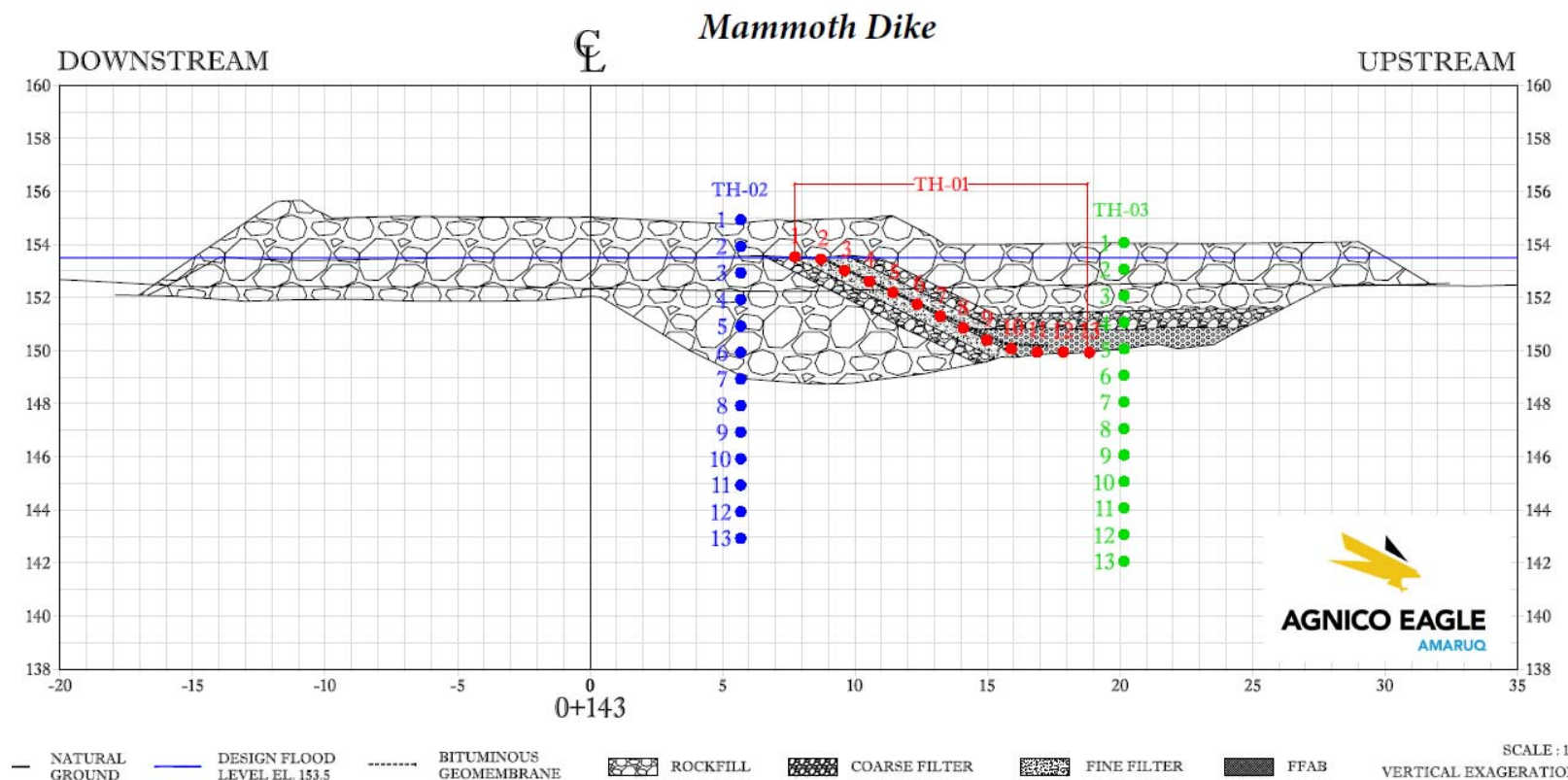
MD TH03



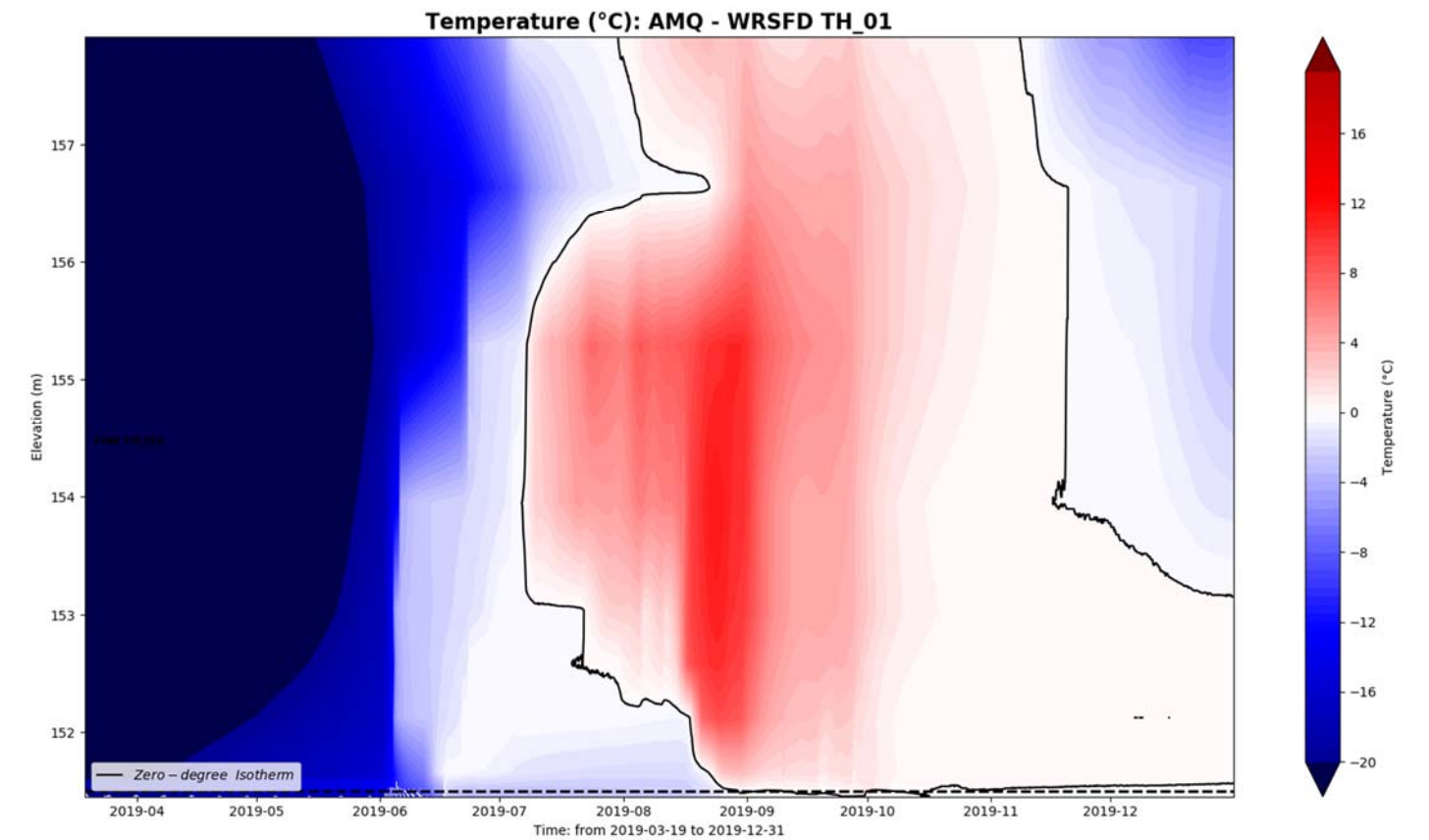
AMQ - MD TH_03



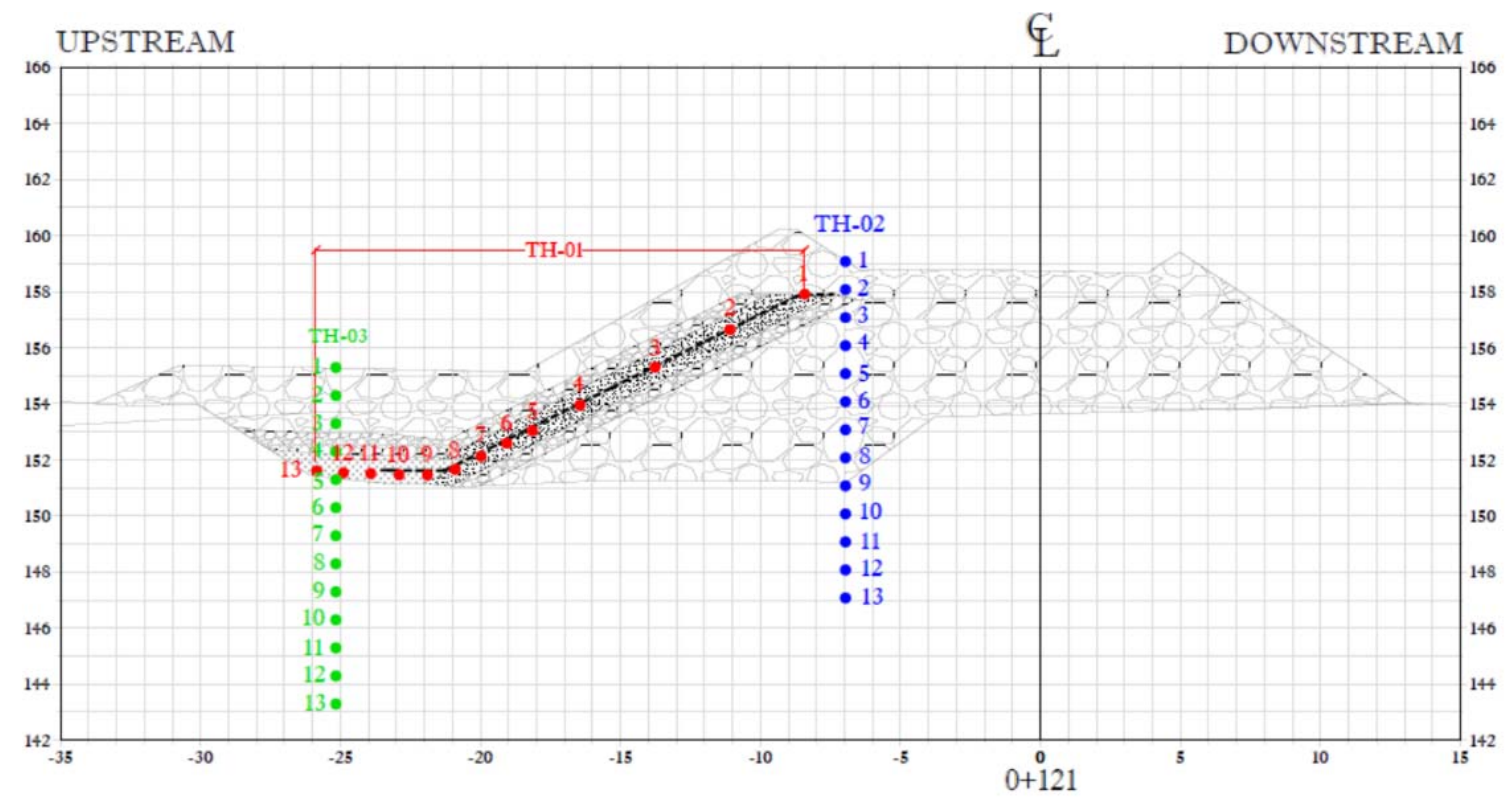
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-04-23 00:00
- 2019-04-02 00:00
- 2019-03-19 00:00
- Limit Profile



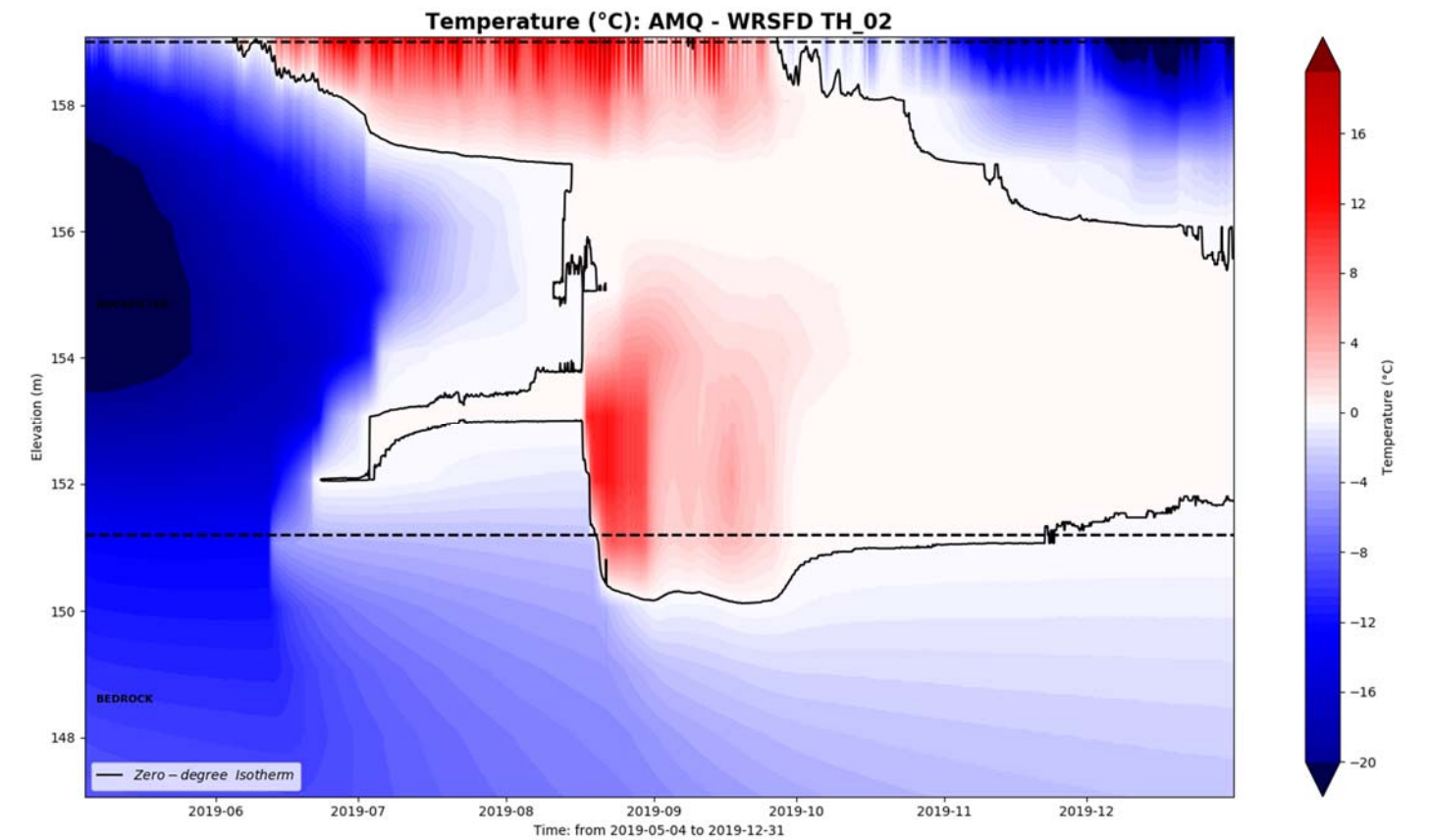
WRSFD TH01



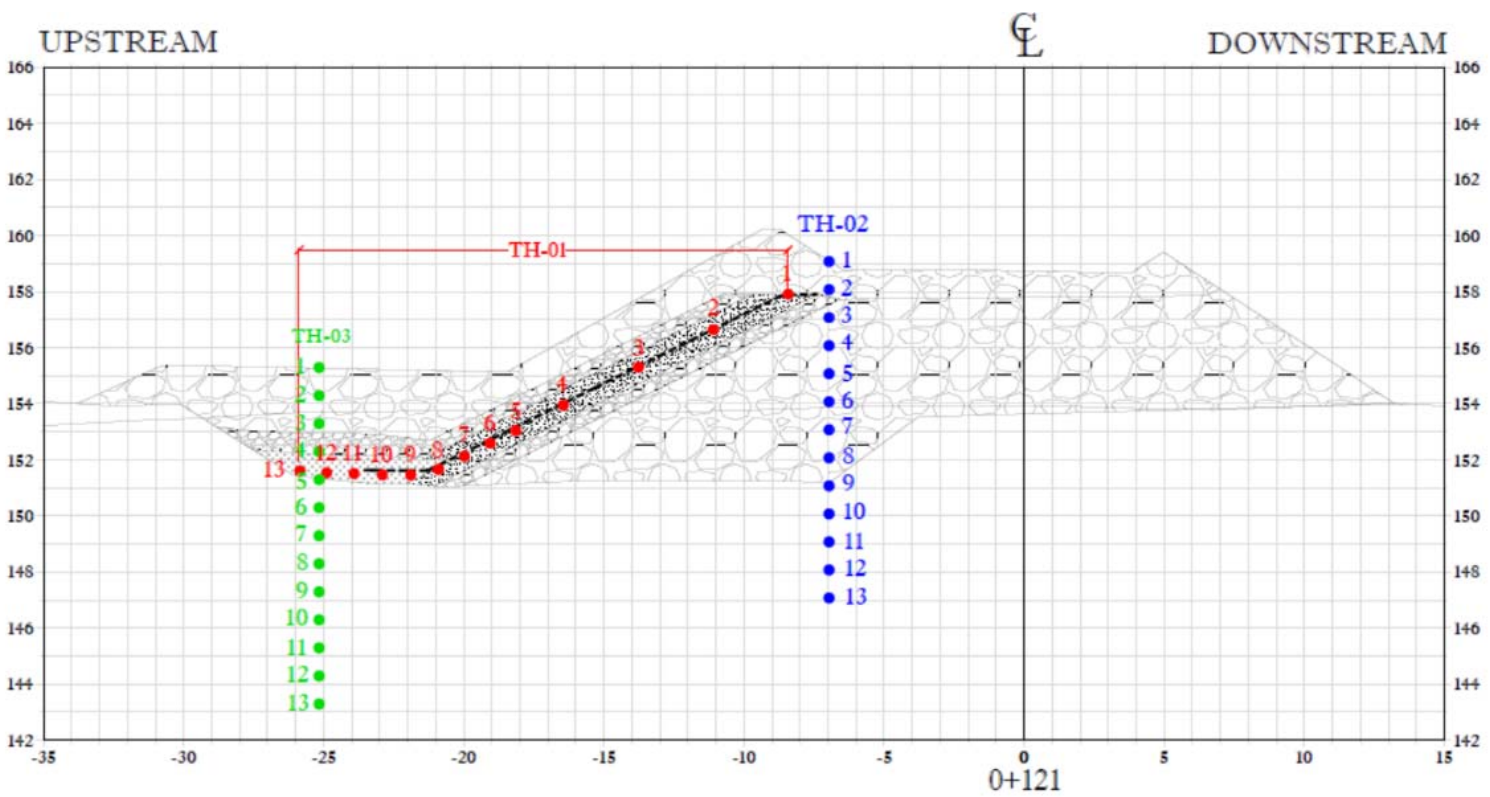
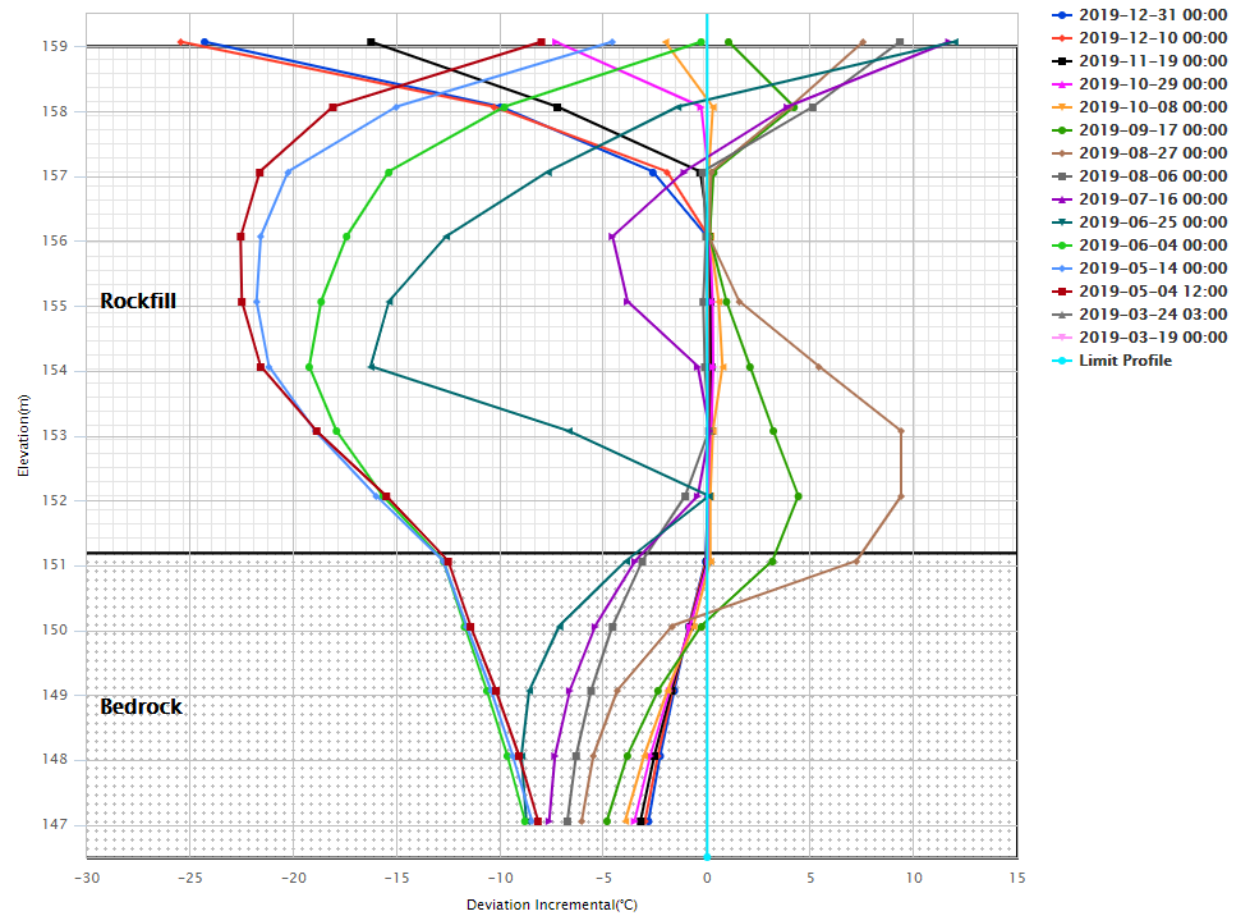
AMQ - WRSFD TH_01



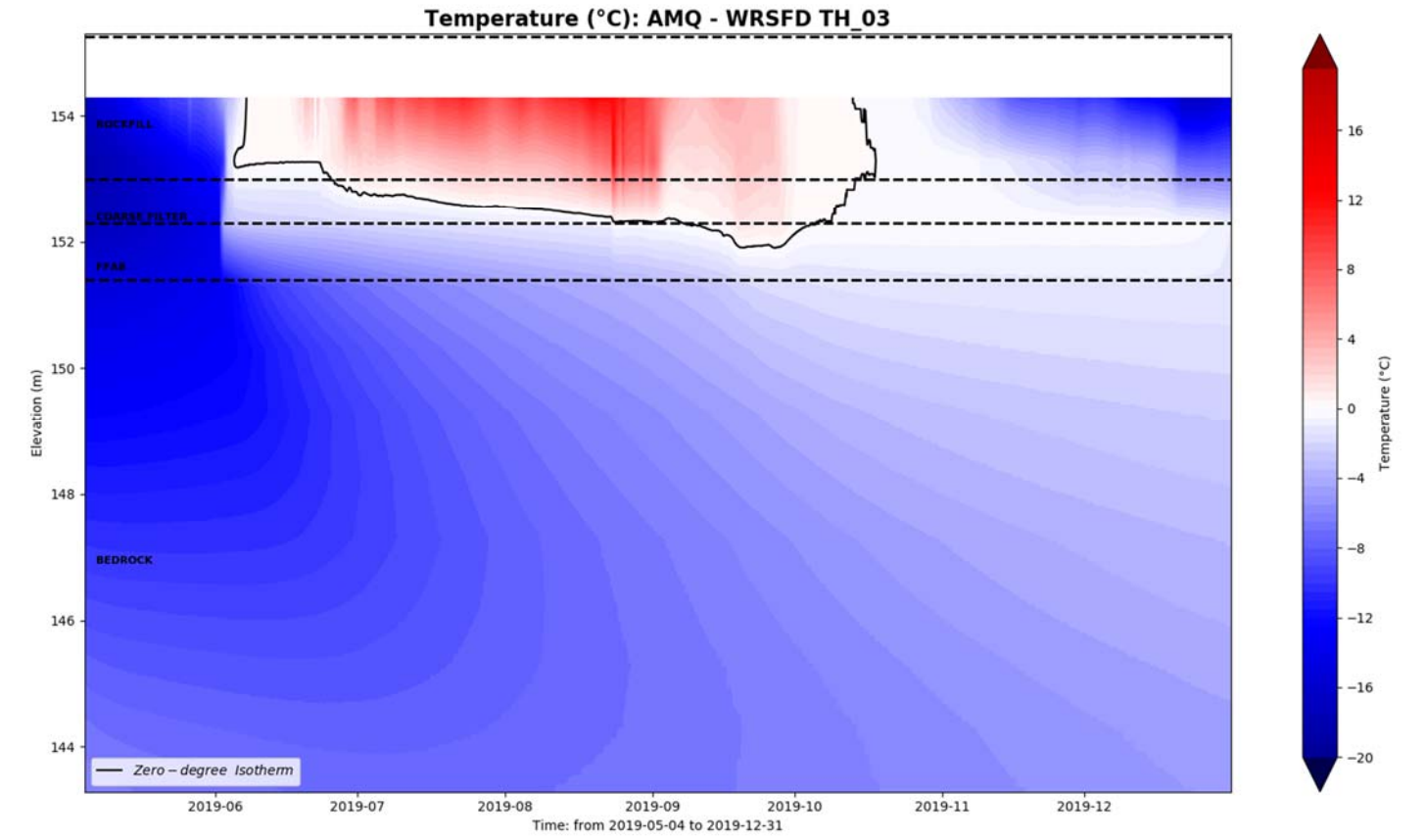
WRSFD TH02



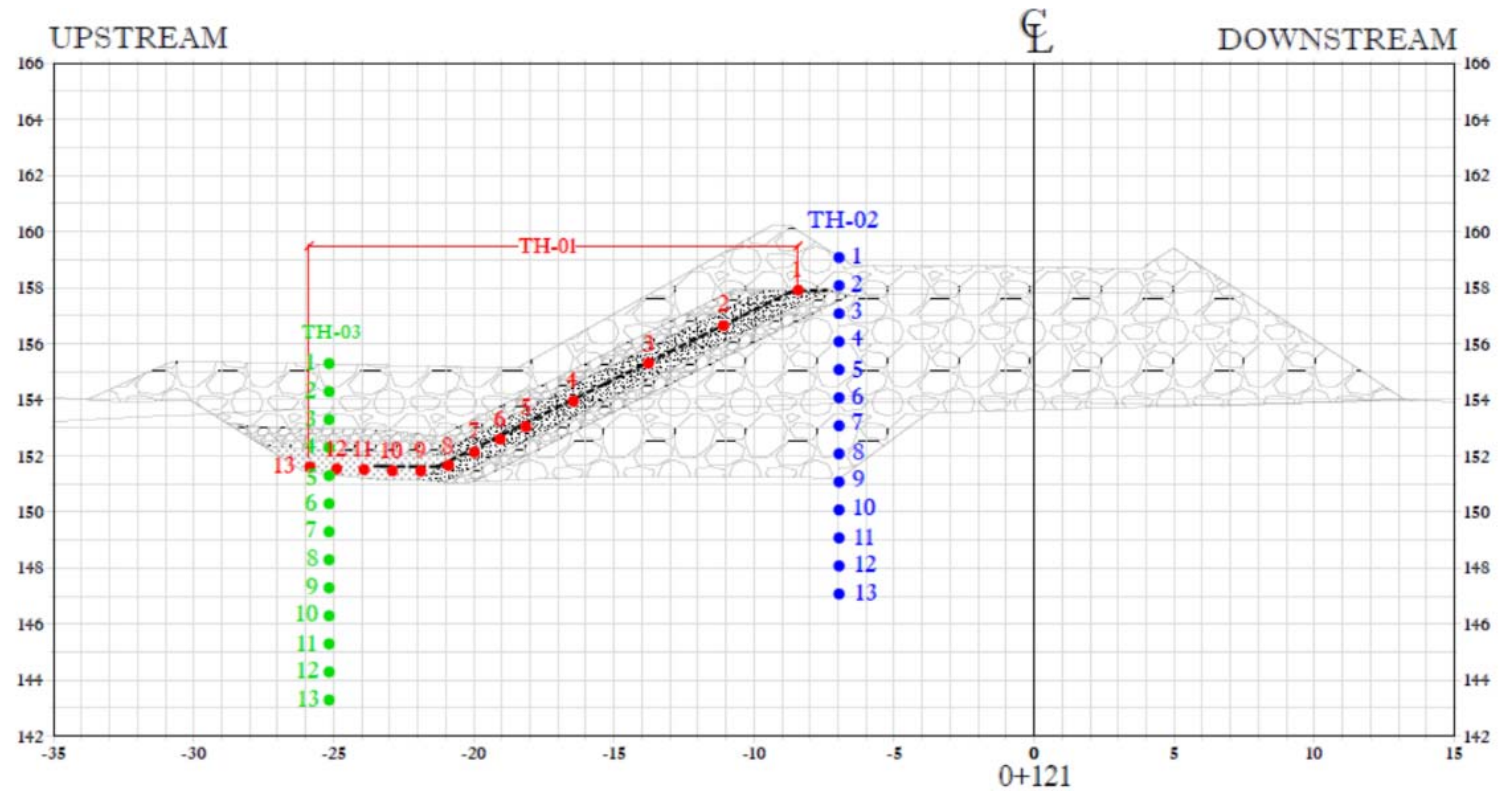
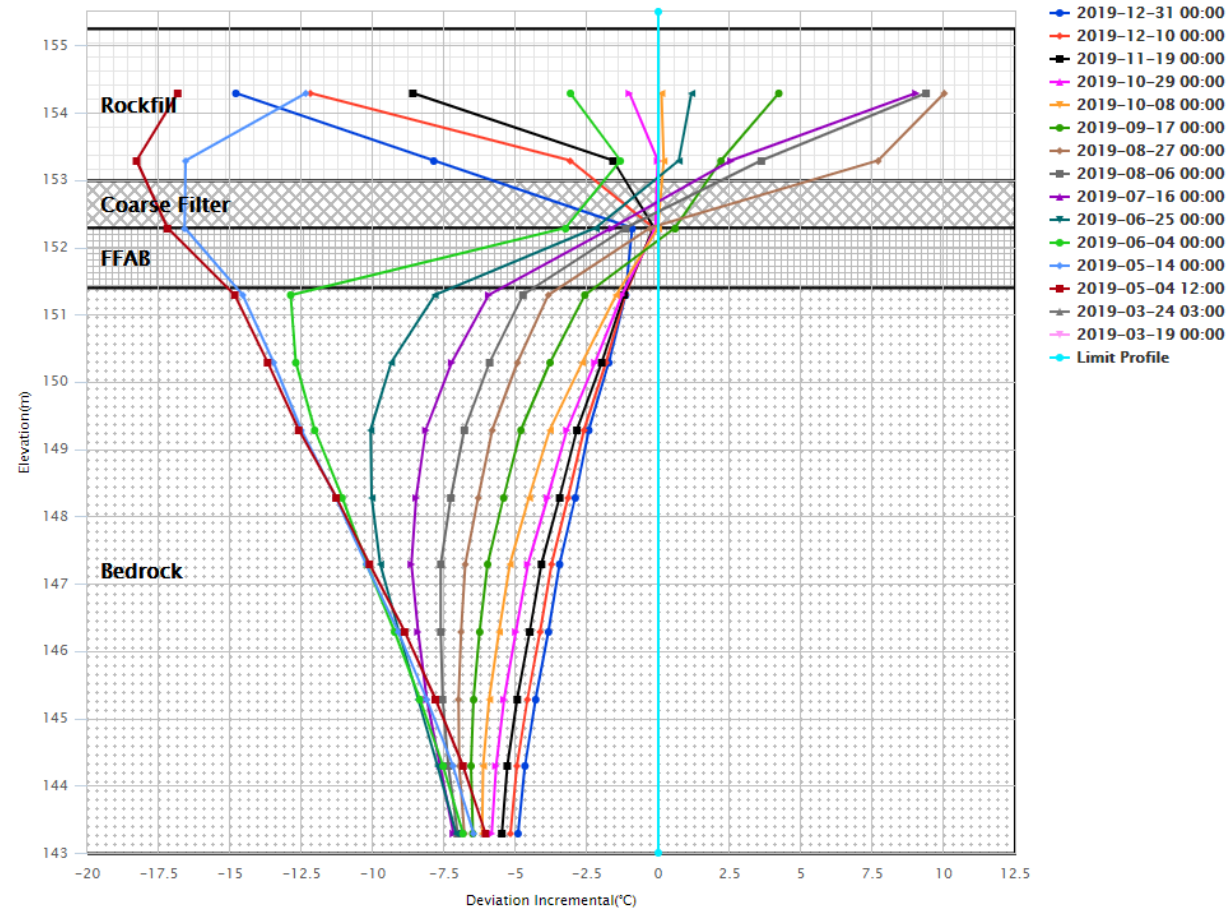
AMQ - WRSFD TH_02



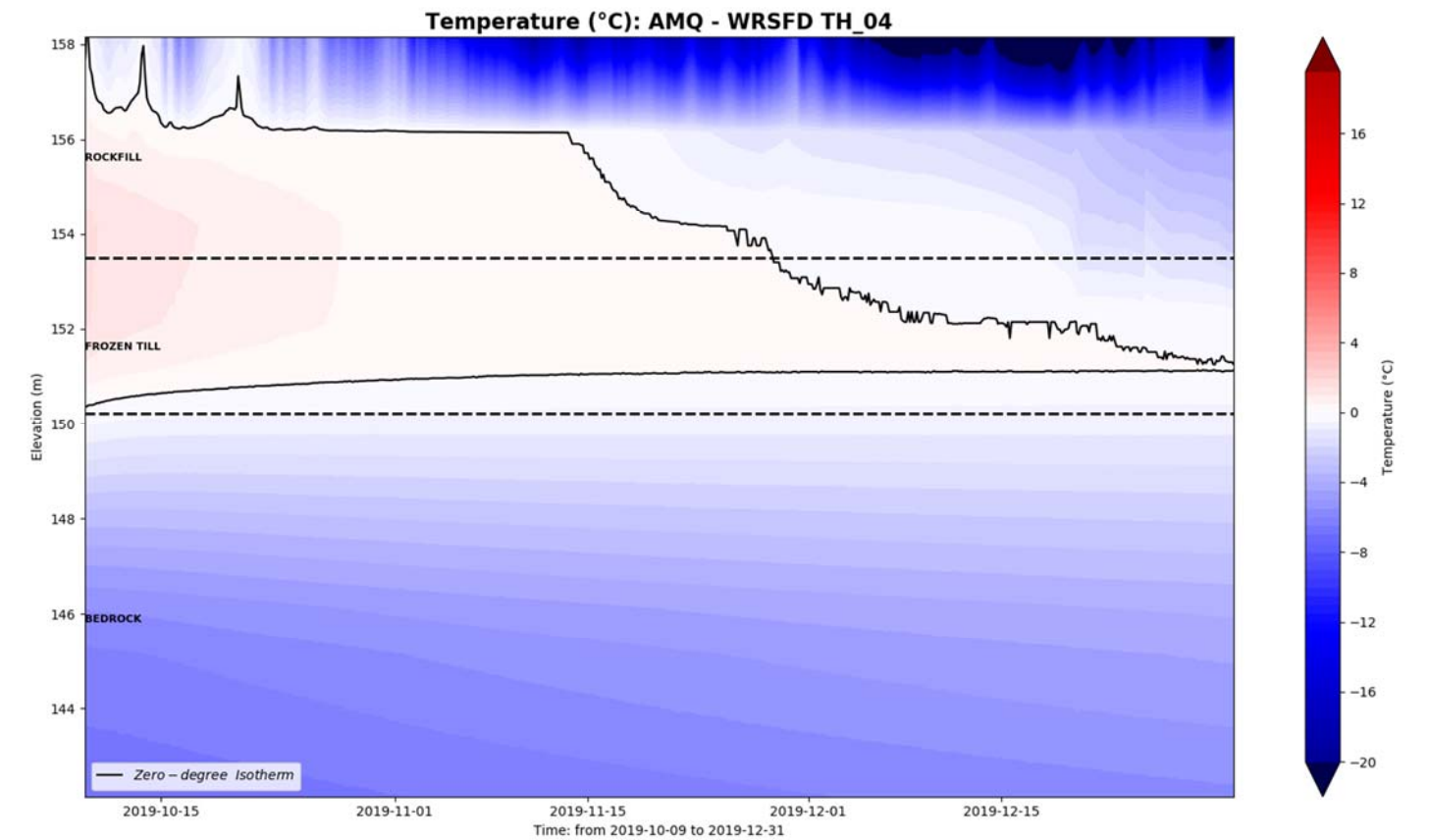
WRSFD TH03



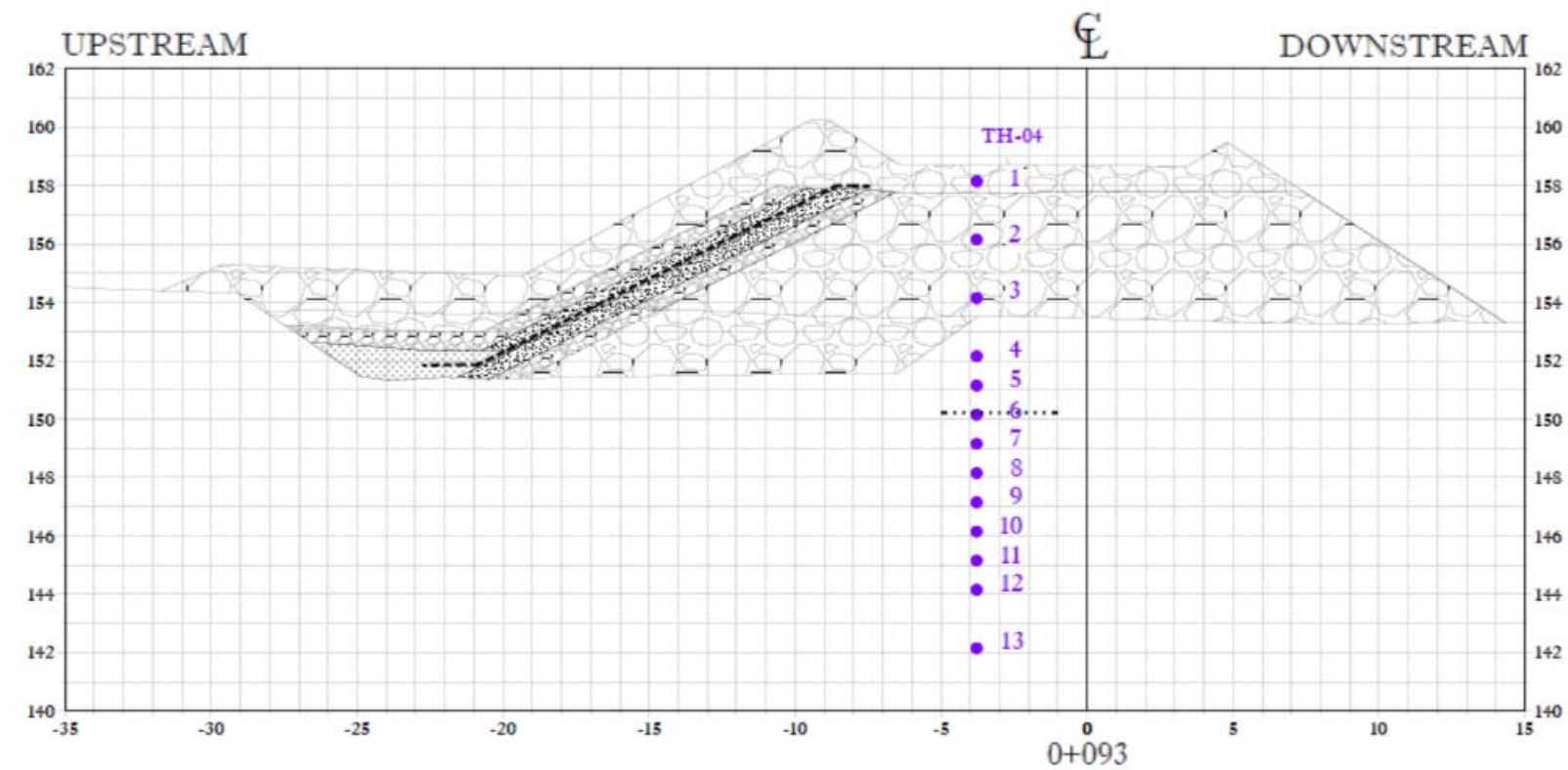
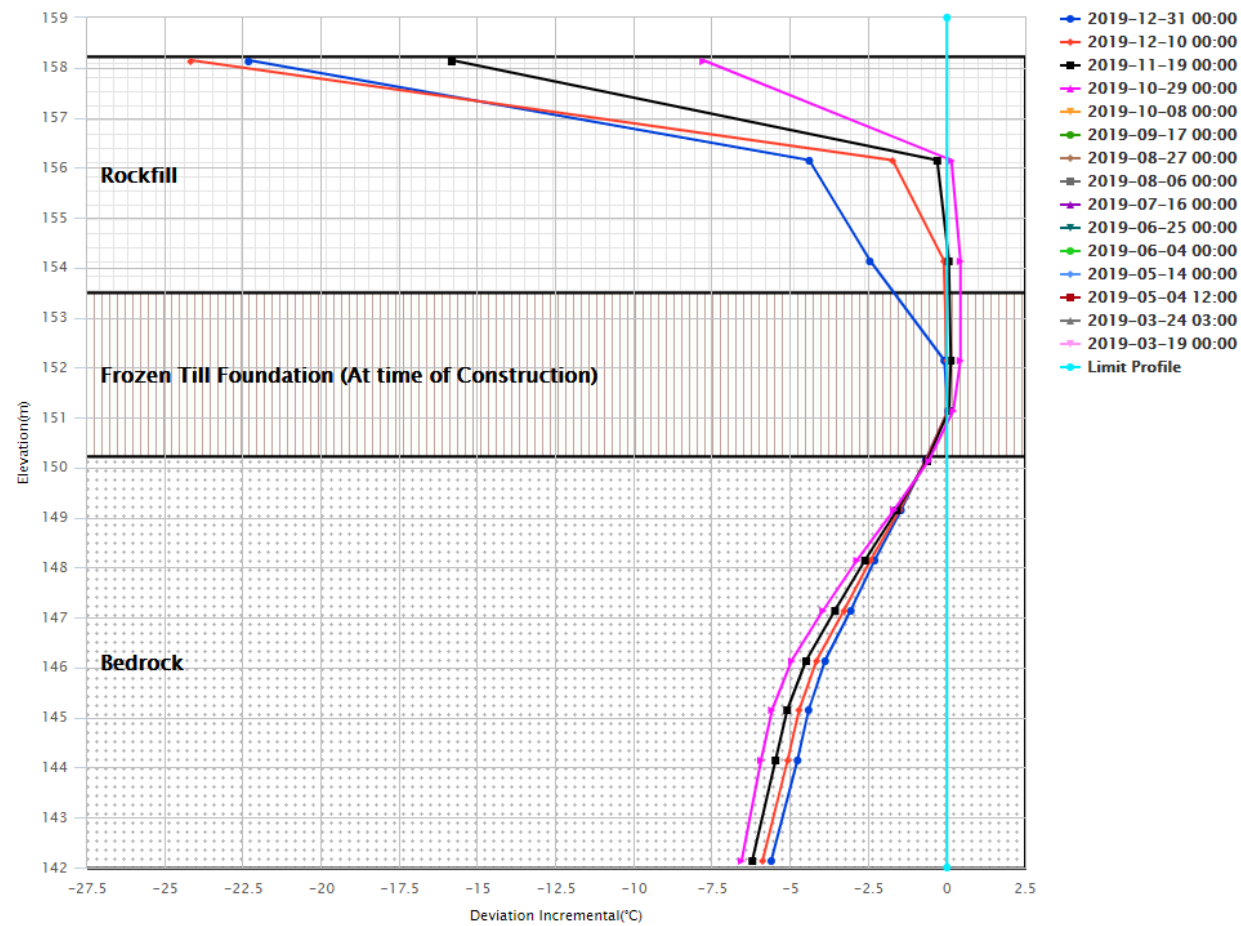
AMQ - WRSFD TH_03



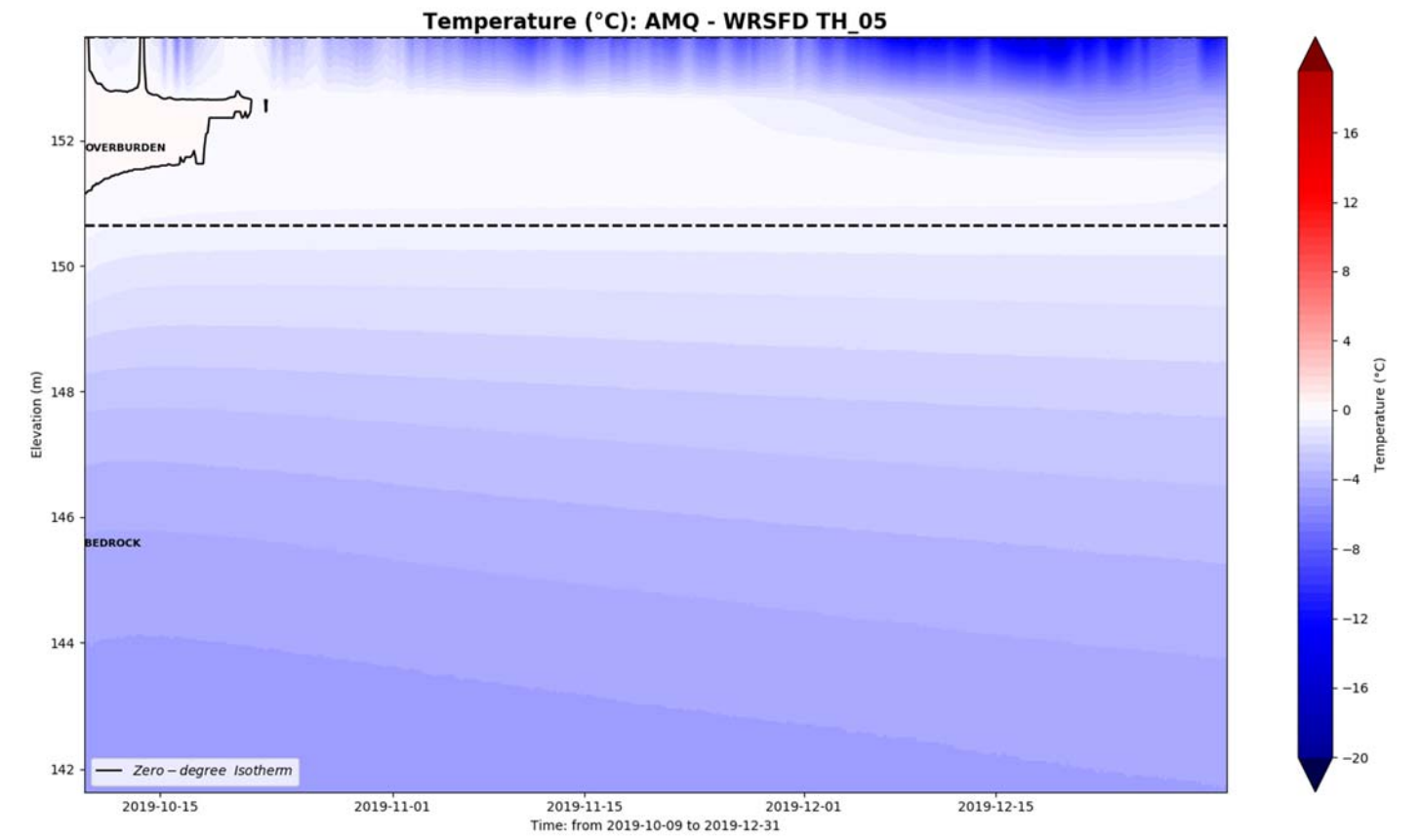
WRSFD TH04



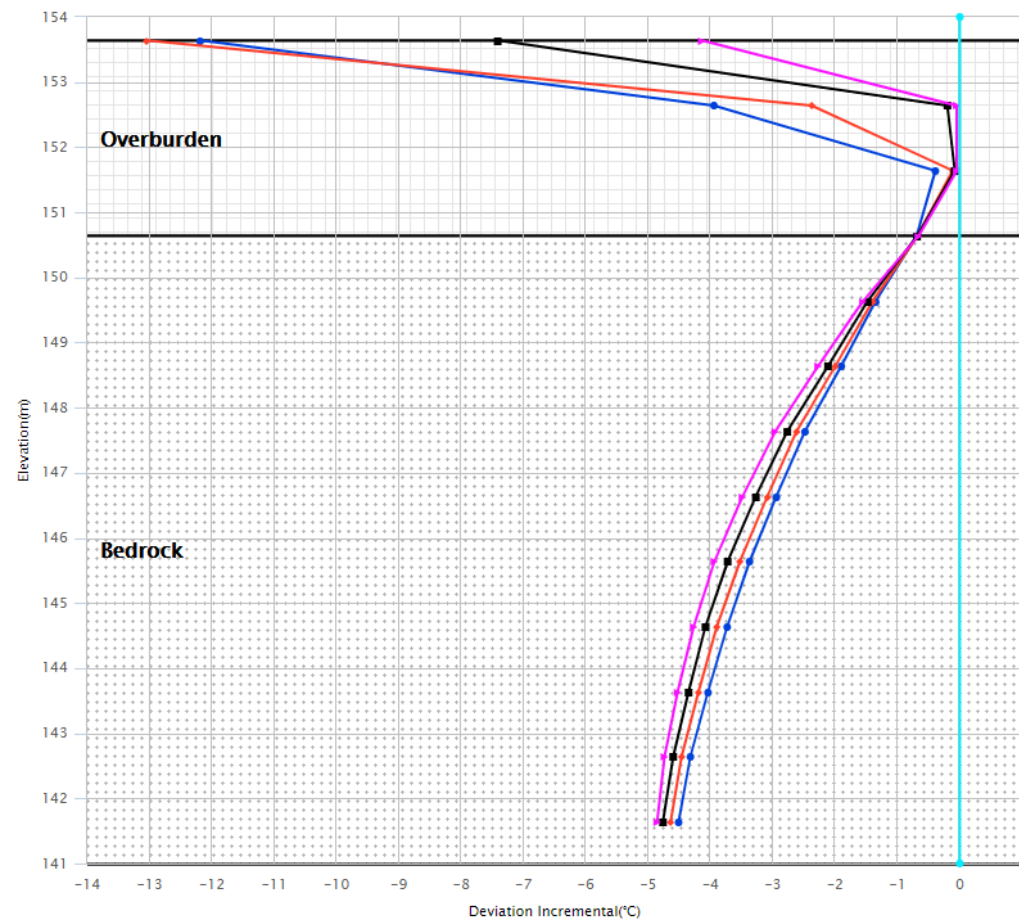
AMQ - WRSFD TH_04



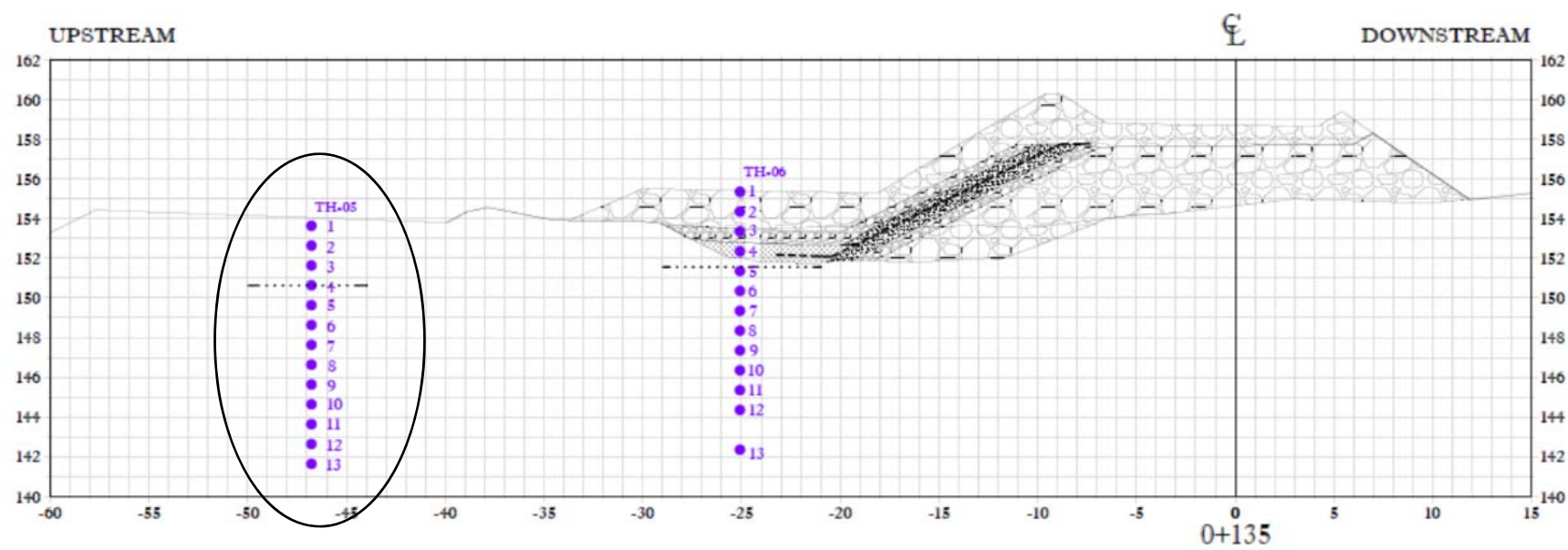
WRSFD TH05



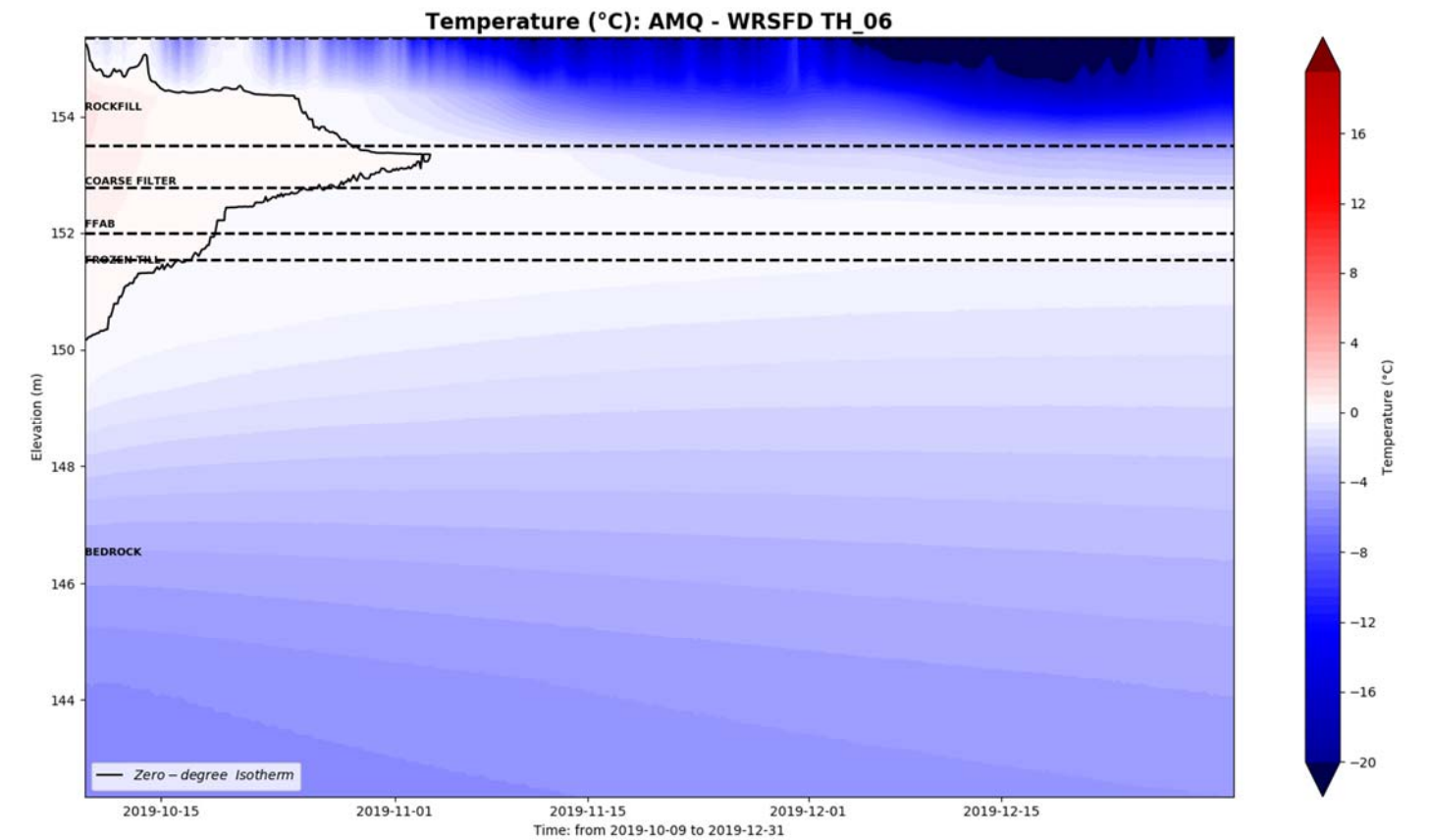
AMQ - WRSFD TH_05



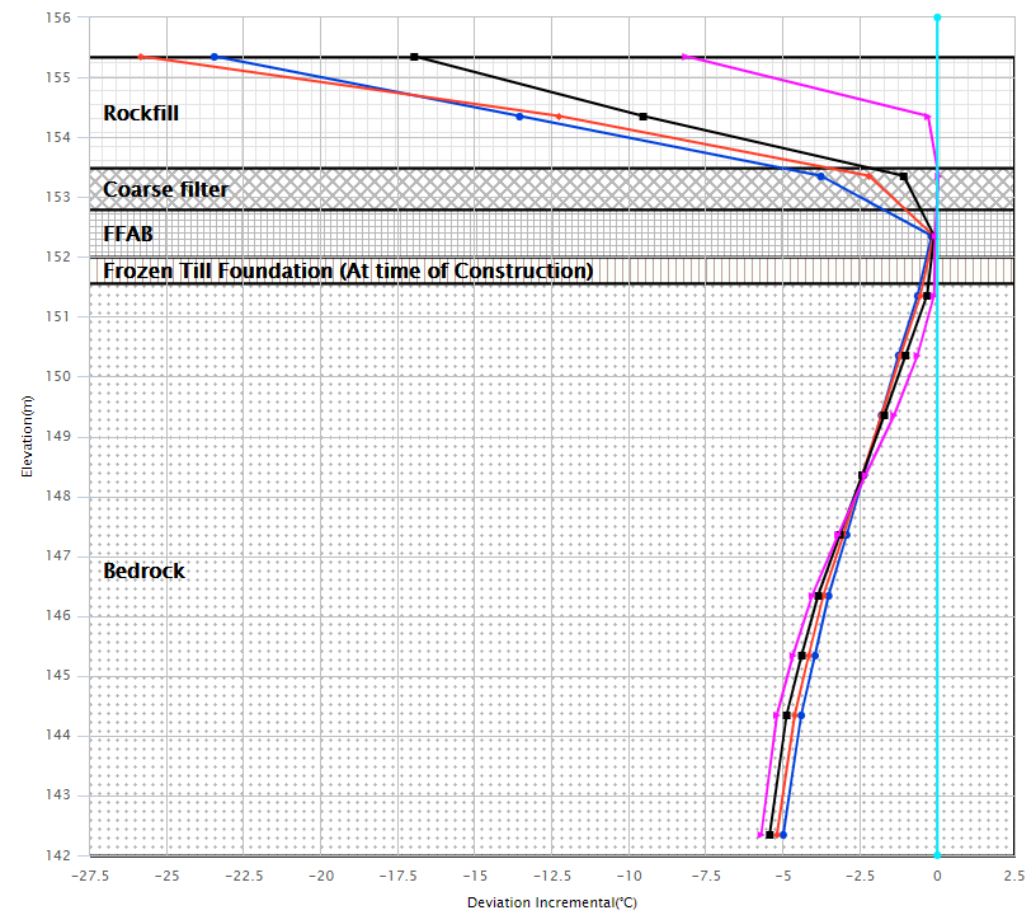
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-05-04 12:00
- 2019-03-24 03:00
- 2019-03-19 00:00
- Limit Profile



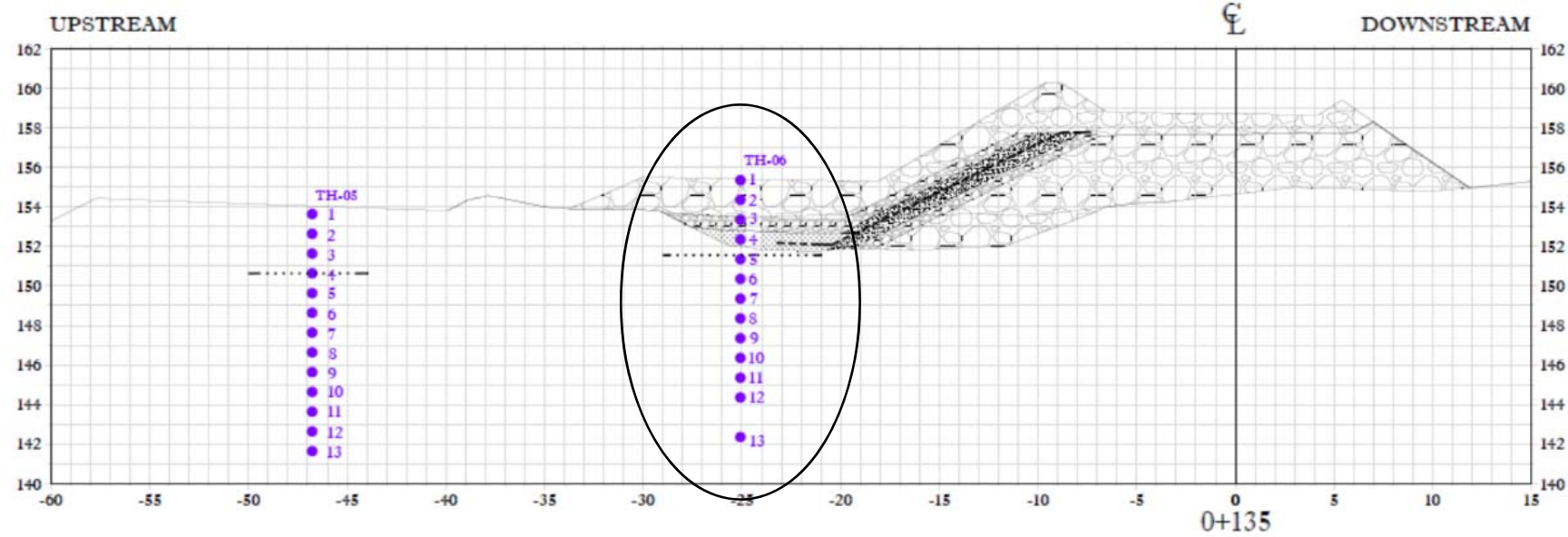
WRSFD TH06



AMQ - WRSFD TH_06



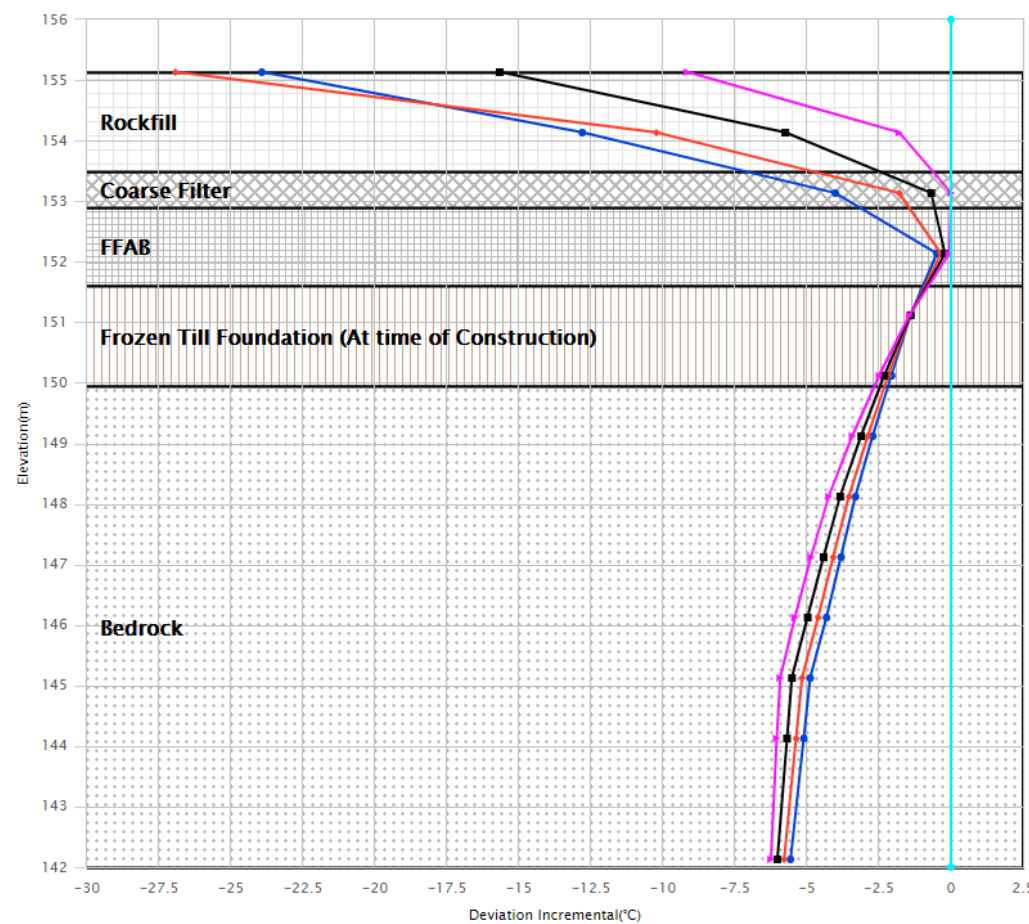
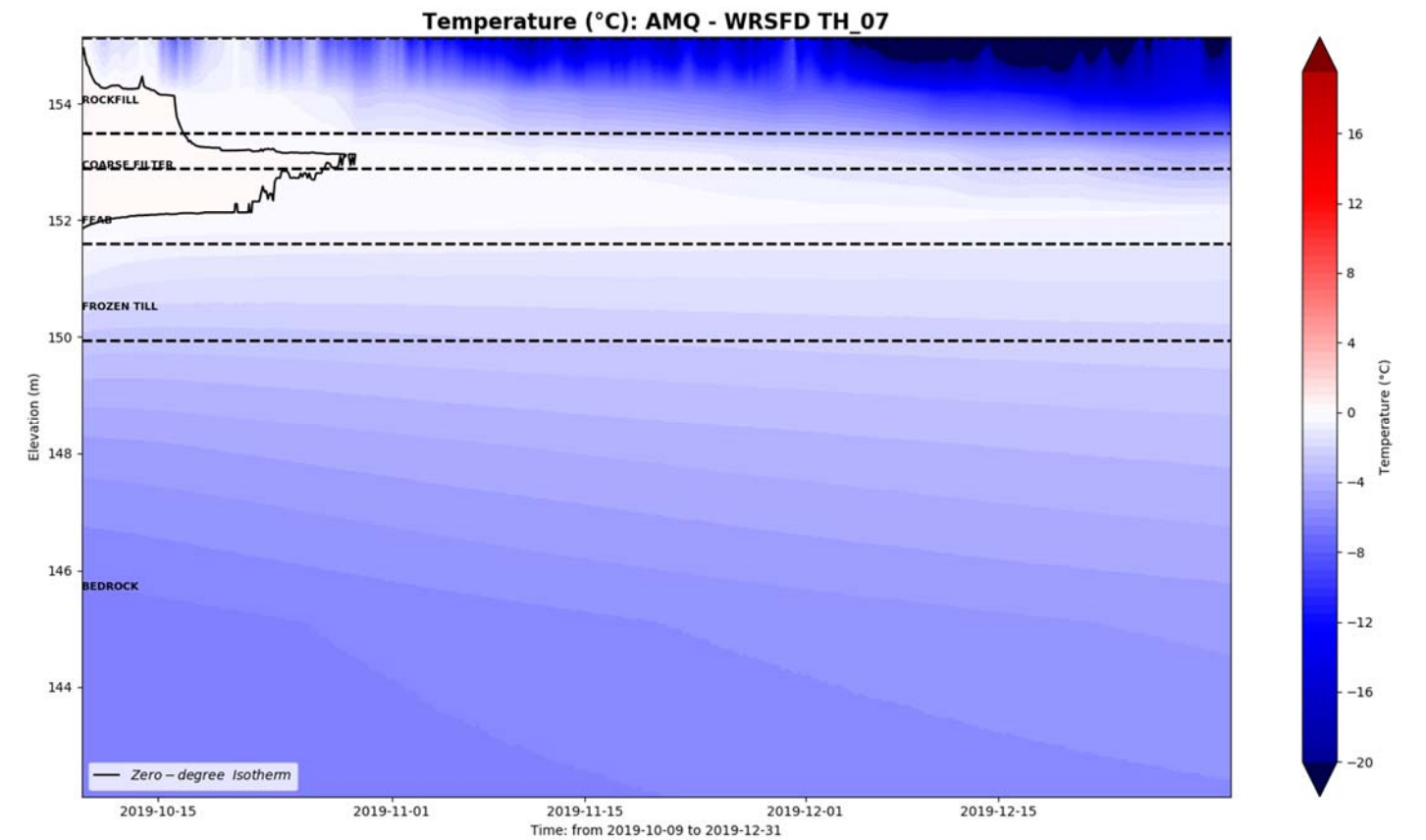
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-05-04 12:00
- 2019-03-24 03:00
- 2019-03-19 00:00
- Limit Profile



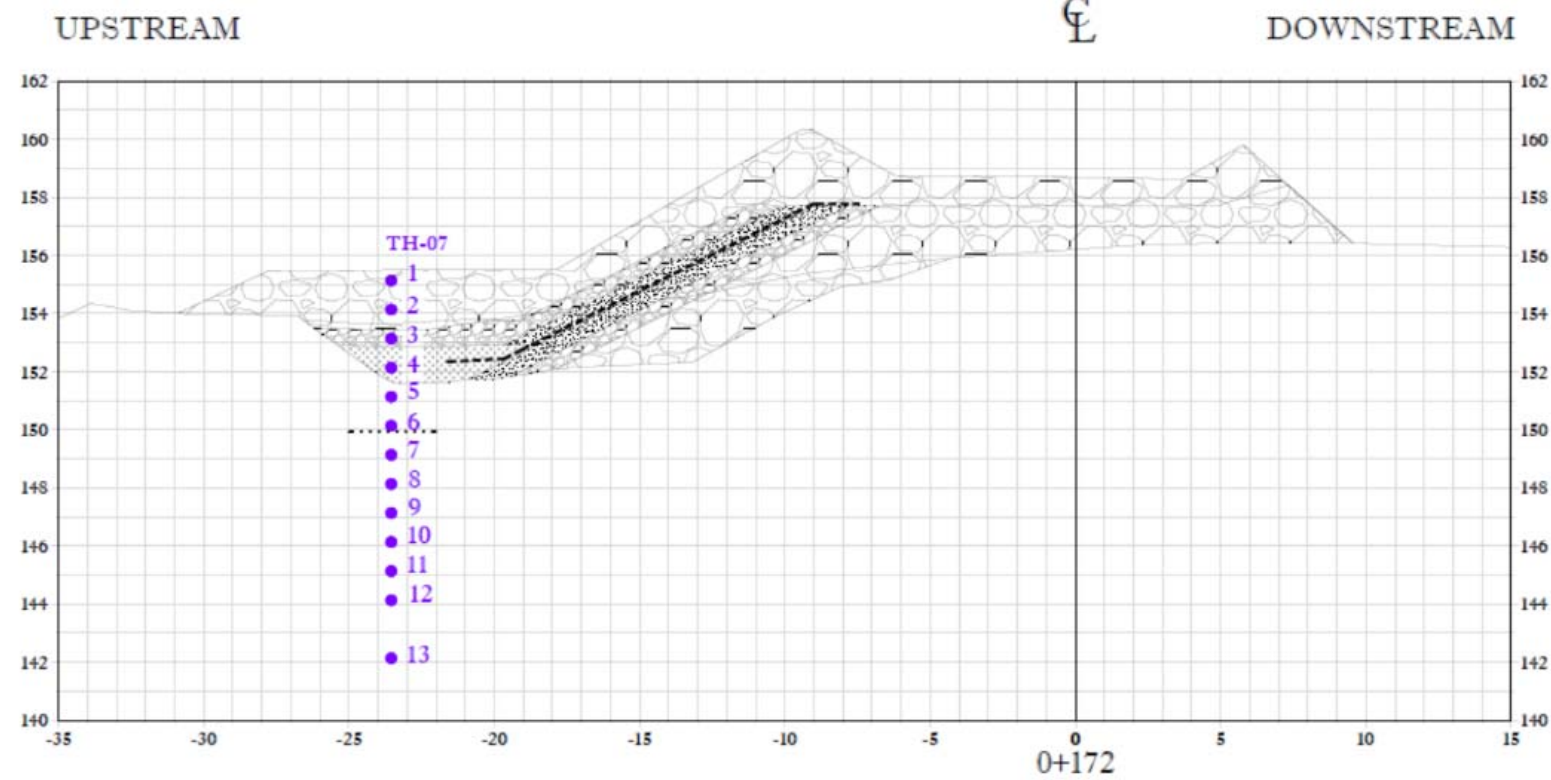
WRSFD TH07



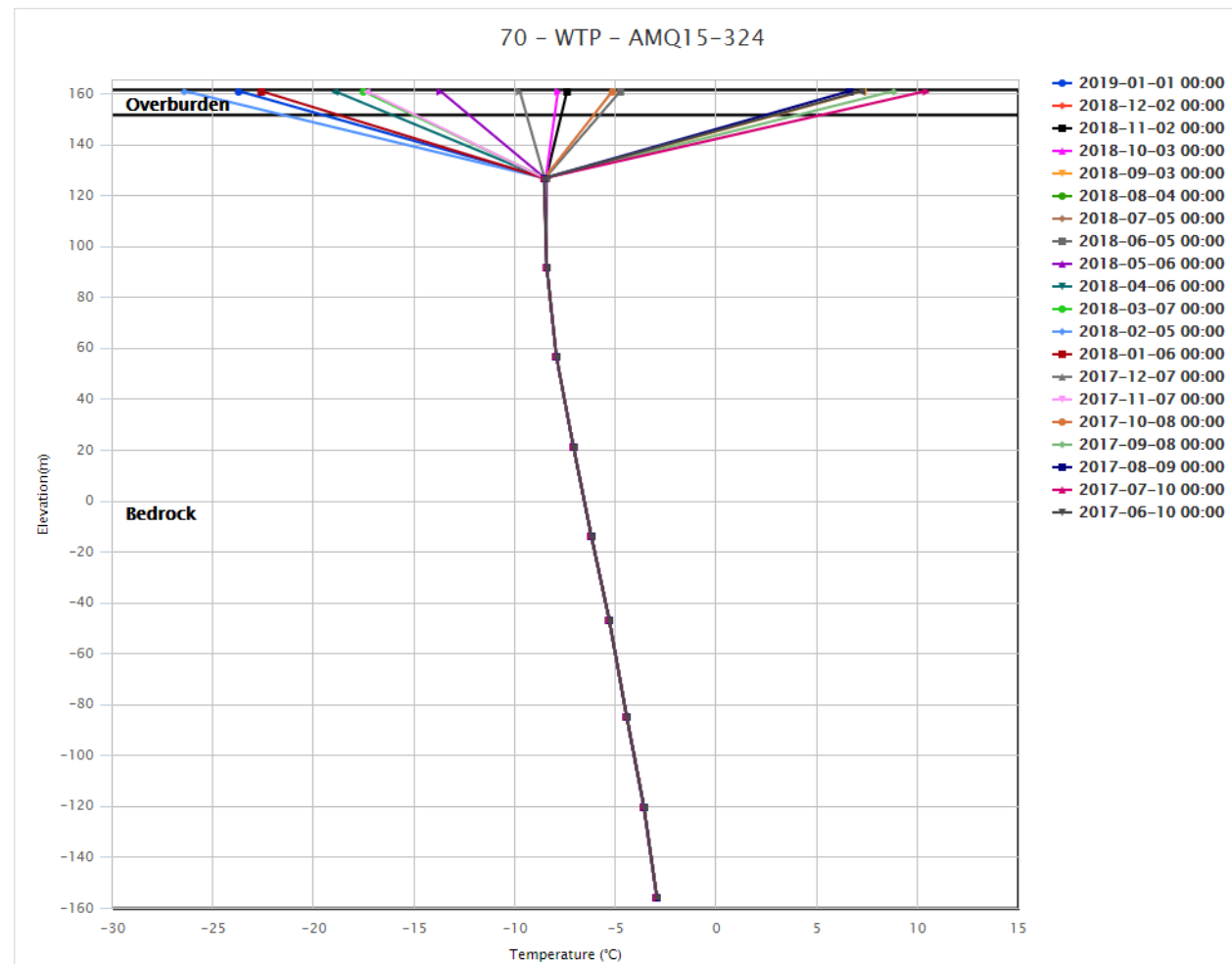
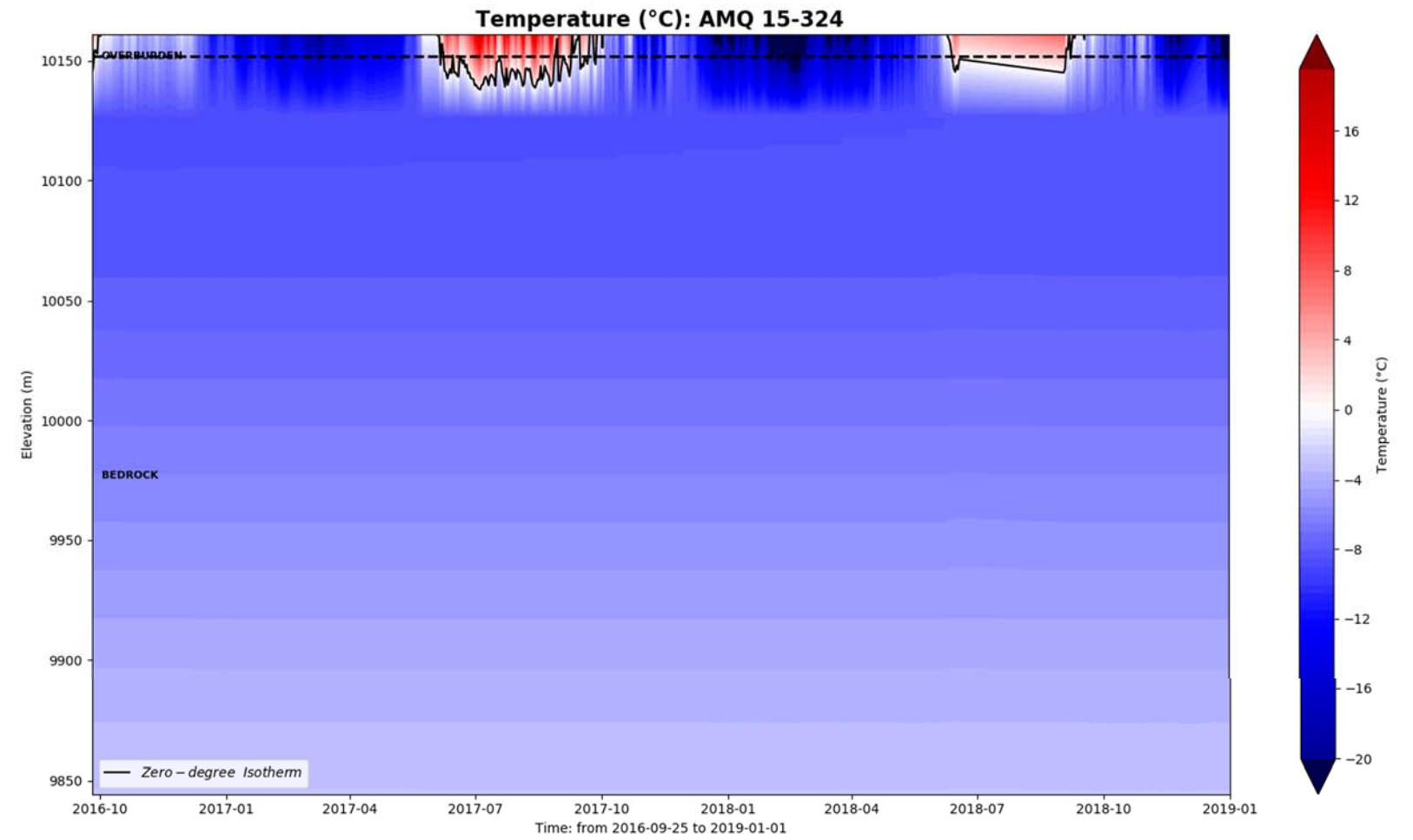
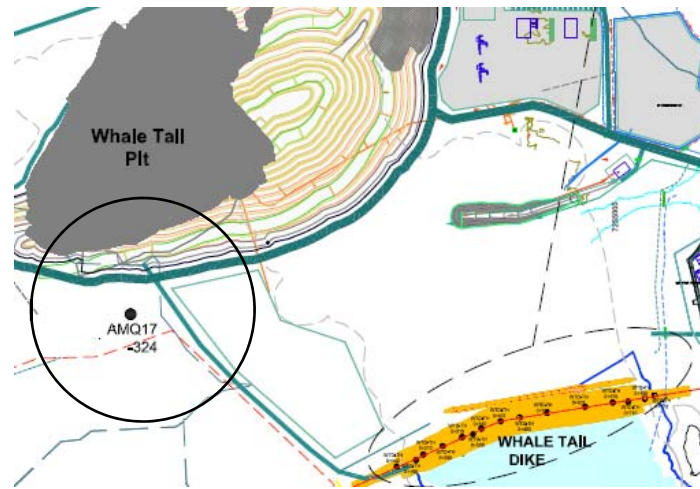
AMQ - WRSFD TH_07



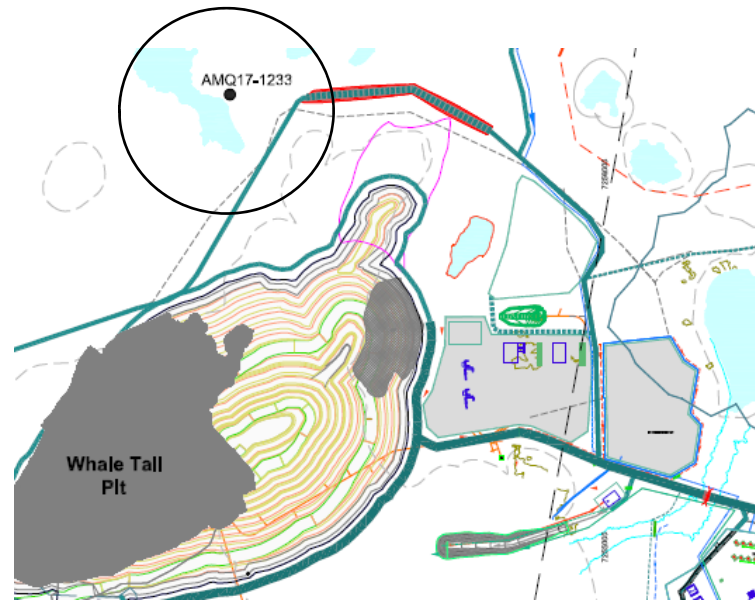
- 2019-12-31 00:00
- 2019-12-10 00:00
- 2019-11-19 00:00
- 2019-10-29 00:00
- 2019-10-08 00:00
- 2019-09-17 00:00
- 2019-08-27 00:00
- 2019-08-06 00:00
- 2019-07-16 00:00
- 2019-06-25 00:00
- 2019-06-04 00:00
- 2019-05-14 00:00
- 2019-05-04 12:00
- 2019-03-24 03:00
- 2019-03-19 00:00
- Limit Profile



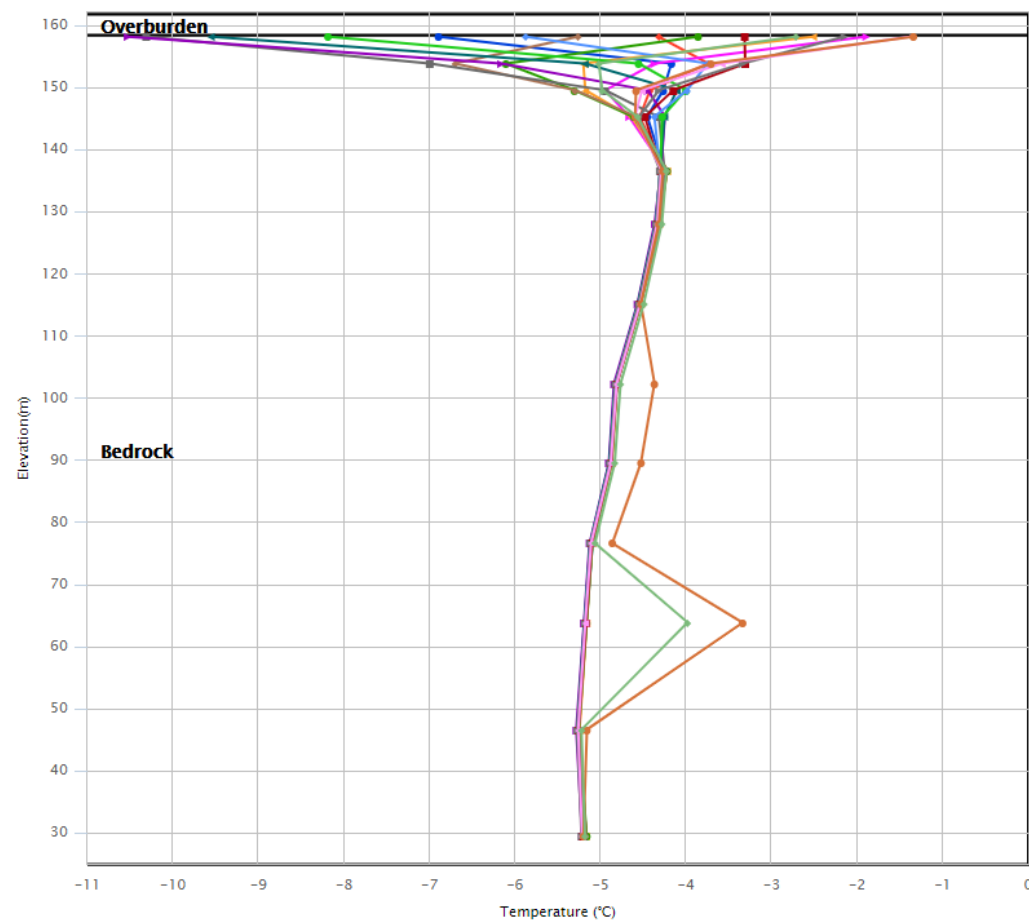
AMQ 15-324



AMQ 17-1233

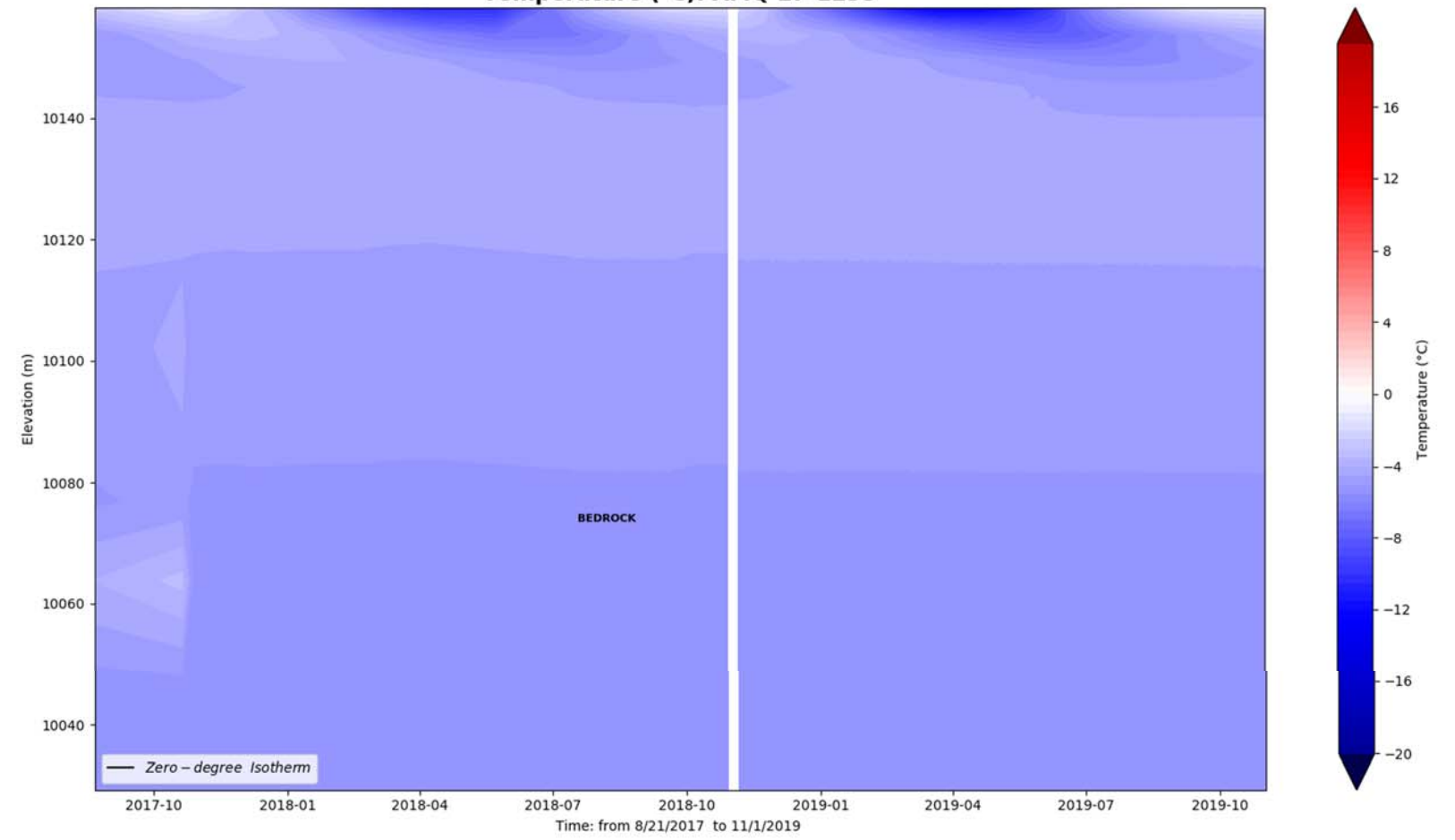


70 - IVR - AMQ17-1233

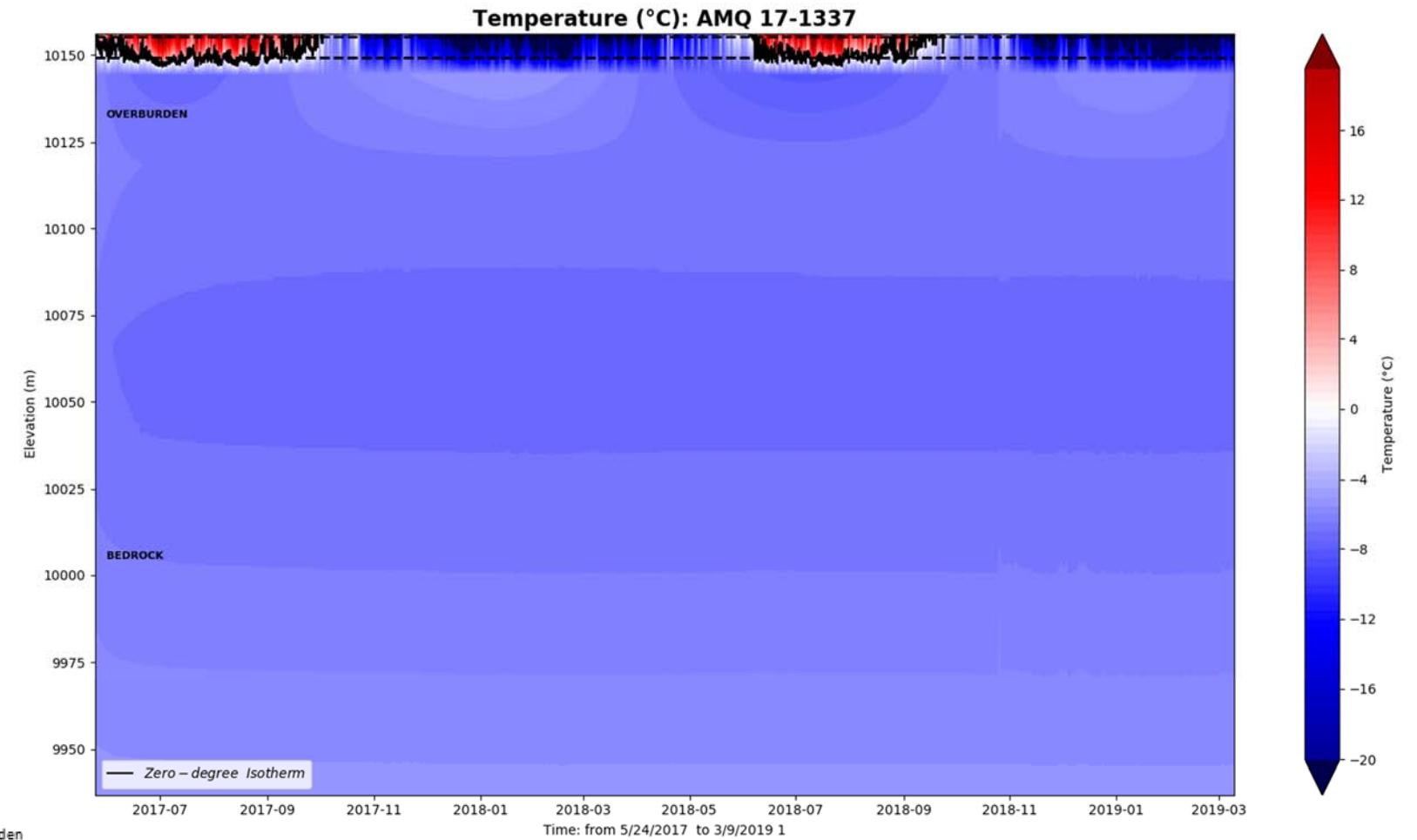
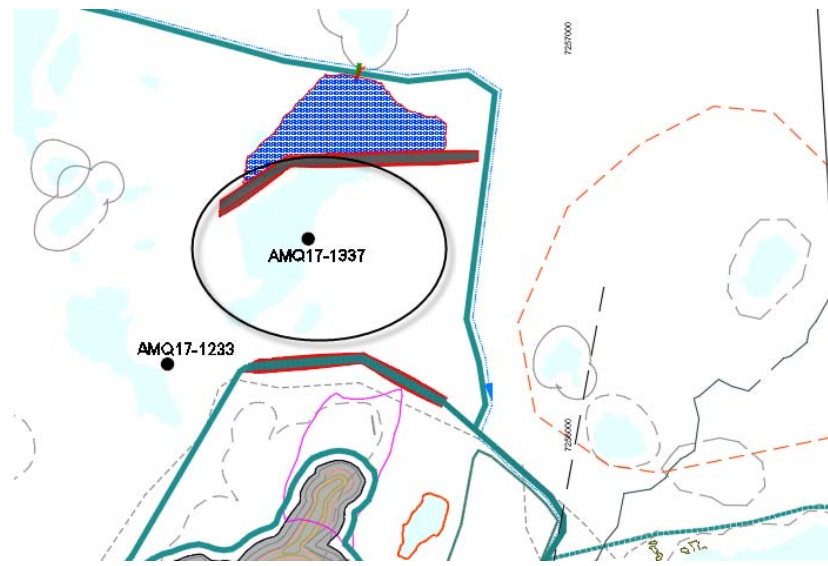


- 2019-01-01 15:00
- 2018-12-02 15:00
- 2018-11-05 15:00
- 2018-10-06 11:00
- 2018-09-03 15:00
- 2018-08-04 15:00
- 2018-07-15 14:03
- 2018-05-24 14:15
- 2018-04-08 10:40
- 2018-03-07 10:10
- 2018-02-16 11:30
- 2018-01-15 11:10
- 2017-12-10 10:45
- 2017-11-20 12:10
- 2017-10-28 10:15
- 2017-10-20 10:15
- 2017-08-21 15:15

Temperature (°C): AMQ 17-1233



AMQ 17-1337



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

