# Appendix B3

# Annual Review of Slope Performance

2015 ANNUAL REVIEW REPORT

**November 28, 2015**

# MEADOWBANK MINE

# ANNUAL REVIEW OF PIT SLOPE PERFORMANCE (2015)

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# Executive Summary


An annual site visit to inspect the performance of the pit walls of the open pits at Agnico Eagle Mines Ltd.'s (AEM) Meadowbank Mine was carried out by CJ Clayton Mine Geotechnical Services Ltd. (CJC) during the period 10 September 2015 to 22 September 2015. The following serves to summarise the key observations and associated recommended actions from the annual inspection. A detailed summary of recommended actions is presented in Section 9.

## PORTAGE PIT

The Portage Pit is subdivided into 5 pits, labelled A through E from north to south.

### Pit A

At the time of the site visit the Pit A platform was inactive. Since the 2014 site visit the pit has only been deepened by a single bench from 5053 mRL to 5046 mRL. The west, north and east walls of the pit continue to perform well. There are no significant geotechnical concerns for Pit A.

Visual monitoring should continue as part of regular geotechnical inspections.

### Pit B

Mining of Pit B is complete and it continues to be backfilled as a waste rock dump. Access to the pit is limited as the main ramp on the west wall has been closed. There are no significant geotechnical concerns for Pit B. There was no indication of dump instability associated with the Pit B dump.

Visual monitoring should continue as part of regular geotechnical inspections.

### Pits C and D

Mining is complete at both pits and they are backfilled as waste rock dumps. Access was limited. The dumps are performing adequately, and no tension cracks were observed in the crest areas, where access was possible. There are no significant concerns for Pits C and D.

It was not possible to inspect an area of the Dump D crest which was observed in 2014 to have tension cracks. However, the dump face and toe were observed to show no indications of instability.

Visual monitoring should continue as part of regular geotechnical inspections.

### Pit E

At the time of the site visit the floor platform elevation at Pit E3 was at 5039 mRL. There are 7 benches remaining to be mined at Pit E3, to a final planned elevation of 4983 mRL, with a target completion of Q3 2017.

There are no significant geotechnical concerns for Pit E3 east and west wall. The east wall is developed within permafrost, which provides additional strength and stability to the rock mass. The west wall has limited areas developed in permafrost; some seepage faces are noted and the presence of water may contribute to bench scale instability especially where ultramafic rock is present. Shear structure within the ultramafic dips into the wall creating a top release plane for bench scale wedge failures. Visual monitoring should continue as part of regular geotechnical inspections.

The Pit E3 south wall has experienced significant instability, and AEM are currently developing a plan to mitigate the instability and manage risk. The area has been designated no entry until remedial measures are undertaken to stabilize and monitor the wall, including slope depressurization, crest unloading, and installation of additional slope monitoring installation. The mechanism of failure is well understood, and the contributing factors are the complex geology and structure, the absence of permafrost and the presence of groundwater. The engineering geology model and stability analyses indicate the failure behind the crest will be limited to the depth of the ultramafic rock and will not extend back to the dewatering dike. AEM are in the process of designing a program to stabilize the slope, and to install additional instrumentation such as piezometers, TDR cables, and thermistors. Monitoring of the slope using the GroundProbe radar is currently the most effective method for managing risk. Monitoring should continue with diligence, and vigilance.

### Pit E West Wall Ramp

The Pit E3 ramp is situated on the west wall of the pit, and descends to the south into the pit. Several areas of potential instability were noted in the benches of the ramp. A rock fall containment berm along the west side of the ramp is being used to effectively manage the risk of rock falls from the areas of potential instability. The ultramafic rock below the ramp is strongly sheared, but is currently performing well. The rock fall containment berm should be maintained along the ramp. The ultramafic rock should continue to be scaled carefully, and operators instructed to avoid over-excavating which could lead to instability.

Visual monitoring should continue as part of regular geotechnical inspections.

### Pit E3 Pushback South and East Wall

In general, the bench performance of the pushback areas is satisfactory, although bench crests tend to be ragged with some over-break, and areas where structure has been undercut. The relatively good performance of the walls is attributable in part to the iron formation and volcanic rock forming significant proportions of the wall, and the presence of permafrost with associated absence of water.

Visual monitoring should continue as part of regular geotechnical inspections.

## GOOSE PIT

Mining has been completed at Goose pit to a final floor elevation of 4997 mRL. The Goose pit slopes continue to perform adequately. Waste rock has been end-dumped into the northwest corner of the pit near the access ramp entry, using the pit as a short-haul dump. A pit lake has formed, and is at an elevation of 5031.18 mRL (15 October 2015). During the inspection a series of tension cracks were identified on the waste rock dump platform. This area is now classified as no entry, and a rock fill berm has been placed to prevent access. The dump may be reactivated in the future. Prior to reactivation an inspection of the dump should be carried out, and an appropriate action plan developed.

Visual monitoring of both the pit and the waste dump should continue as part of regular site geotechnical inspections.

### Slope Monitoring Instrumentation

There have been no significant changes to the TDR or thermistor response patterns. With the exception of piezometer tip PZ4c in GPIT-14, pressure heads have remained constant. Tip PZ4c exhibited a sudden pressure rise in 2013 followed by a gradual reduction in pressure to steady-state conditions; a similar pressure increase has been noted in 2015 but there are insufficient data yet to determine if the trend in gradual pressure reduction will also be repeated. This presents no risk to pit slope or waste dump stability, but should be reviewed again next year.

# VAULT PIT

Mining of the Vault Pit has advanced significantly since the 2014 inspection, providing the first opportunity to evaluate the performance of the pit slopes. In general, the pit slopes are performing as anticipated, and there are currently no significant geotechnical concerns for the current conditions.

AEM has carried out mapping using Lidar scan images to digitize structure and compare with the orientations used to develop the optimized wall configurations (2013), complying with a recommendation from the 2014 inspection. The structural orientations from the mapping are generally consistent with the orientations used in the design study.

An inflow along the east wall was in response to the wall pushback into a talik beneath the former Vault Lake, and to the lake area being managed with a relatively high water surface at 5134.1 mRL. As noted in the 2014 inspection report, any push back of the east-southeast high wall should include a re-evaluation of the slope stability as the optimized design (2013) assumed the wall would remain frozen (with the exception of the upper bench). A push-back of the east high wall will place it in the unfrozen talik beneath Vault Lake, and may change the conditions for the stability of the slope.

## Footwall (Vault Grid West Wall)

The wall is being mined as a series of single benches (7m high) to create a footwall slope. There are no significant geotechnical concerns noted, and no evidence of large scale (overall slope) instability for the footwall slope.

The slope follows the inclination of the ore which is inclined to the east, parallel with foliation and stratigraphy. Bench faces are pre-sheared at steep angles but break back to the orientation of the foliation and stratigraphy. The low benches are being used to effectively manage the undercutting of the east dipping stratigraphy by minimizing potential failure volumes.

An area at the south end of the wall exhibits an increased density of continuous joint and fault features intersecting to form wedges. However, the plunge of these wedges is shallow, on the order of 30 degrees, and roughly parallel to the dip of the overall slope angle.

An area of seepage adjacent to the ramp may be derived from a hydraulic connection to east-west and north-south structures connecting with the talik beneath the dewatered Vault Lake. If increased raveling is noted, it may be necessary to construct bumper berms in this area

## Southwest Wall (Vault Grid South Wall)

The stratigraphy intersects the south wall at right angles. There are no significant geotechnical concerns noted, and no evidence of large scale (overall slope) instability for the slope. The stratigraphy intersects the south wall at right angles. Pre-shearing of the walls has been effective for developing steep bench faces, although these can be blocky in appearance. The benches are being appropriately cleaned and scaled. Continue visual monitoring as part of regular site geotechnical inspections.

## East Wall (Vault Grid East Wall)

The east wall (grid east) is being developed as a two-phase pushback. Phase 1 had been completed to a floor elevation of approximately 5081 mRL at the time of the site inspection, while Phase 2 had not been significantly developed since the 2014 inspection. There are no significant geotechnical concerns noted, and no evidence of large scale (overall slope) instability for the slope.

The Phase 1 east wall is a temporary wall and has been developed using bulk blasting. Bench performance is generally good despite bulk blasting. Care should be exercised while operating beneath the temporary benches, and light vehicle traffic and personnel must maintain a safe setback distance from the temporary bench faces. Visual monitoring should continue as part of the regular geotechnical inspections.

Phase 2 is a final wall and is being developed using pre-shear blasting methods. There has been no significant advancement of the Phase 2 pit from the 2014 inspection. An inflow of water to the Vault pit along the east wall through the ring road occurred on 16 September 2015. This was reviewed and determined to be a response to pushback of the wall to intersect the talik beneath former Vault Lake, and also to operation of Vault Lake at an elevation of 5134 mRL, approximately 4 m higher than the downstream side of the ring road. The following recommendations were made:

- Lower the water level in Vault Lake to reduce inflows through the ring road.
- If settlement of the ring road is noted, use road rock fill material to bring back to grade. Monitor for the development of tension cracks within the road surface. Restrict access on the downstream side of the ring road in the immediate area of the seepage.
- Continue visual monitoring of the inflows as part of regular site geotechnical inspections.
- Review inflow observations during the next annual pit inspection, and compare observations to thermal model predictions from 2013 optimization study (Golder 2013).
- If significant inflows continue to be observed during 2016 summer thaw period, install piezometers and thermistor behind the wall, record observed conditions, and compare with predicted conditions.
- If observed conditions are not consistent with the predicted conditions it may be necessary to review the optimized slope stability in the context of new data.

## Vault Grid North Wall

The Vault north wall (grid north) transitions from the west wall to the east wall. There is a sump near the base of the wall at the northwest corner. A wedge in the northwest corner is associated with seepage along its base. If the wedge were to fail, it could compromise the haul road at the crest. A stability assessment should be made, and bolting of the wedge should be considered. Light vehicle traffic and personnel should maintain a safe setback distance from the temporary bench faces. The water lines crossing the wedge should be moved. Continue visual monitoring as part of regular site geotechnical inspections.

# Study Limitations

CJ Clayton Mine Geotechnical Services Ltd (CJC) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

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**APPENDICES**

# 1.0 INTRODUCTION

CJ Clayton Mine Geotechnical Services Ltd (CJC) was retained by Agnico Eagle Mines Ltd (AEM) to complete an annual inspection of the pit slope performance at the Meadowbank Mine, as a requirement under the water licensing agreement for the project. The first annual inspection was completed for the Portage Pit in 2010. In 2012, the Goose Pit was added to the annual inspections, followed by the addition of the Vault Pit in 2014.

The site visit was completed during the period 10 September 2015 to 22 September 2015, and included the inspection of general bench and wall performance of Portage Pits A through E, the Goose Pit, and the Vault Pit. This report summarizes the inspection carried out for the pits and describes observations made during the site visit of the performance of the various pit slopes. Where possible the observations are related to the engineering geological model for the project in order to test assumptions made during the development of the slope design criteria as part of the feasibility level engineering design for the pits. Available instrumentation data for the Goose Pit were reviewed as part of the site visit, and are presented in Appendix A.

Mining at Portage Pits B, C, and D has been completed and these pits are currently being backfilled as short-haul waste dumps. Mining at Goose Pit has also been completed and the north end of the pit used to dump waste rock to stabilize weak ultramafic rock exposed in the north pit wall during mining. The Goose Pit ramp is closed and the pit is no longer accessible. The Vault Pit has been advanced significantly since 2014.

# 2.0 CURRENT MINE STATUS

## 2.1 Portage Pit

The Portage Pit consists of five pits, identified as Pits A through E, from north to south. The general pit plan is shown on Figure 1. Mining at Pit A was not active at the time of the site visit; however, the pit is in the process of being dewatered to recommence mining in 2015. At the time of the site visit the Portage Pit was being actively mined at Pit E3, at the south end. Pits B, C, and D continue to be used as short-haul waste rock dumps. The current and planned dump crest elevations are shown in the following table.

*Table 2-1: Pit dump platform elevations*

| Pit Dump | Platform Elevation During Inspection (mRL) | Planned Final Platform Elevation (mRL) |
|---|---|---|
| B | 5126.5 | 5145 |
| C | 5127 | 5145 |
| D | 5127 | 5142 |

The extents of the Portage Pits at the time of the site visit are shown in the following figure.

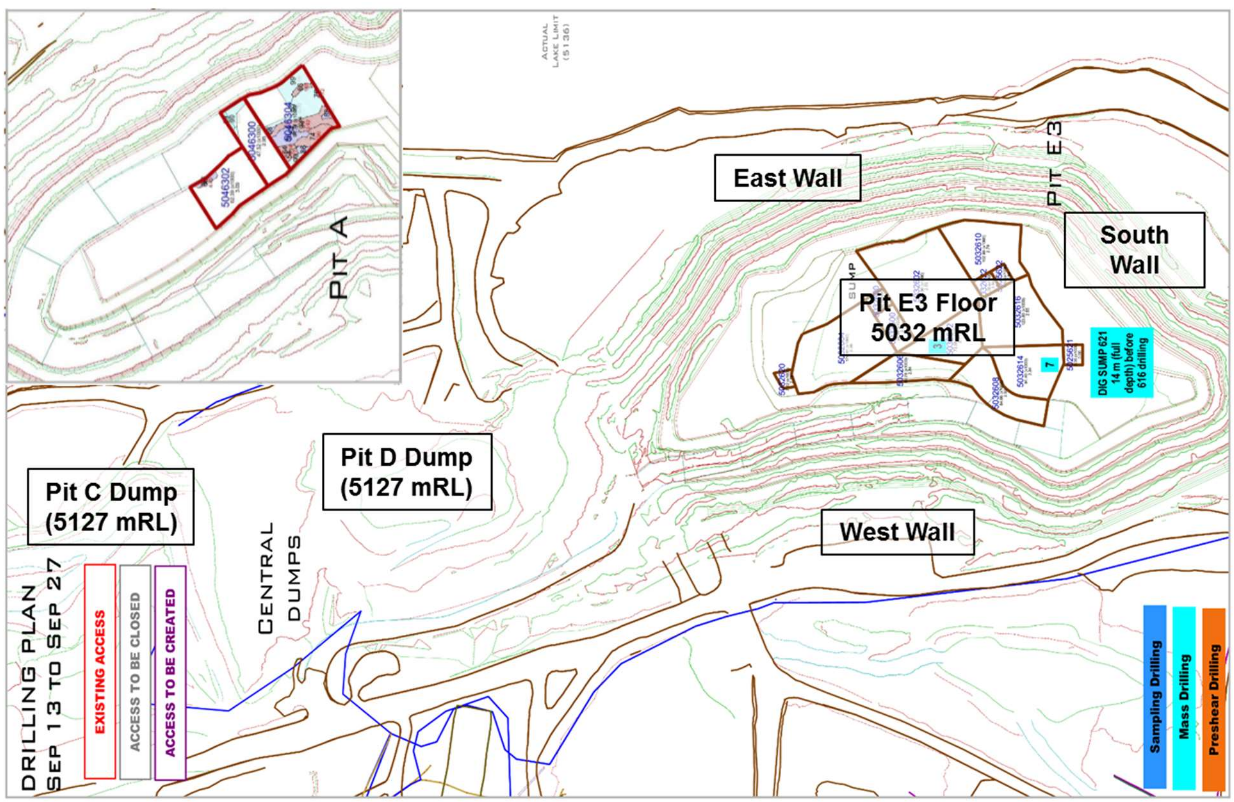



*Figure 2-1: Portage pit north end (Pit A) and south end (Pit E3) at time of 2015 site visit*

## 2.2 Goose Pit

During final mining of the pit in 2014 a number of rock falls occurred on the west and northwest walls of the pit, and activities were suspended until wall stabilization could be completed. The rock falls were associated with adversely oriented structure within weak ultramafic rock. Mining has been completed at Goose Pit to a final floor elevation of 4997 mRL. A pit lake has formed, and is at an elevation of 5031.18 mRL (15 October 2015). Following completion of mining, waste rock was end-dumped from the northwest pit crest ramp entry as a short-haul dump. The platform elevation of the Goose Pit dump is at 5125 mRL. Tension cracks are visible extending across the dump platform. The pit is no longer accessible.

The extent of the Goose Pit at the time of the site visit is shown in the following Figure 2-2.

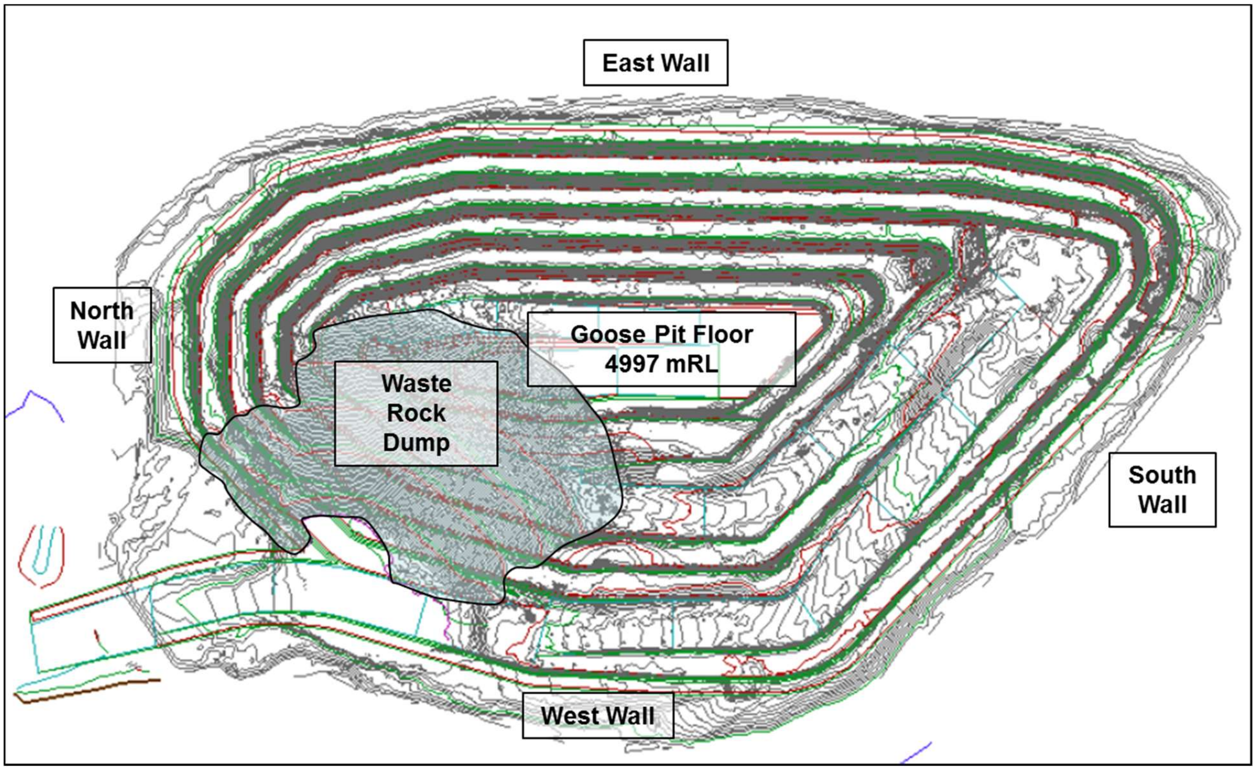



*Figure 2-2: Goose pit at time of the 2015 site visit*

## 2.3 Vault Pit

Mining of Phase 1 of Vault Pit has advanced considerably since 2014. At the time of the site visit the floor elevation of the Phase 1 pit was at 5081 mRL and Phase 2 at 5130 mRL. Drilling and blasting for the Phase 2 push-back has commenced in the crest area of the Phase 1 pit. Some water inflows to Vault Pit have been encountered, most recently during the site visit, and from the east wall crest area of the Phase 2 push-back. These inflows are related to the intersection of the pit walls with talik beneath dewatered lakes, and can be addressed through appropriate water management planning.

The extent of the Vault Pit at the time of the site visit is shown in the following figure.

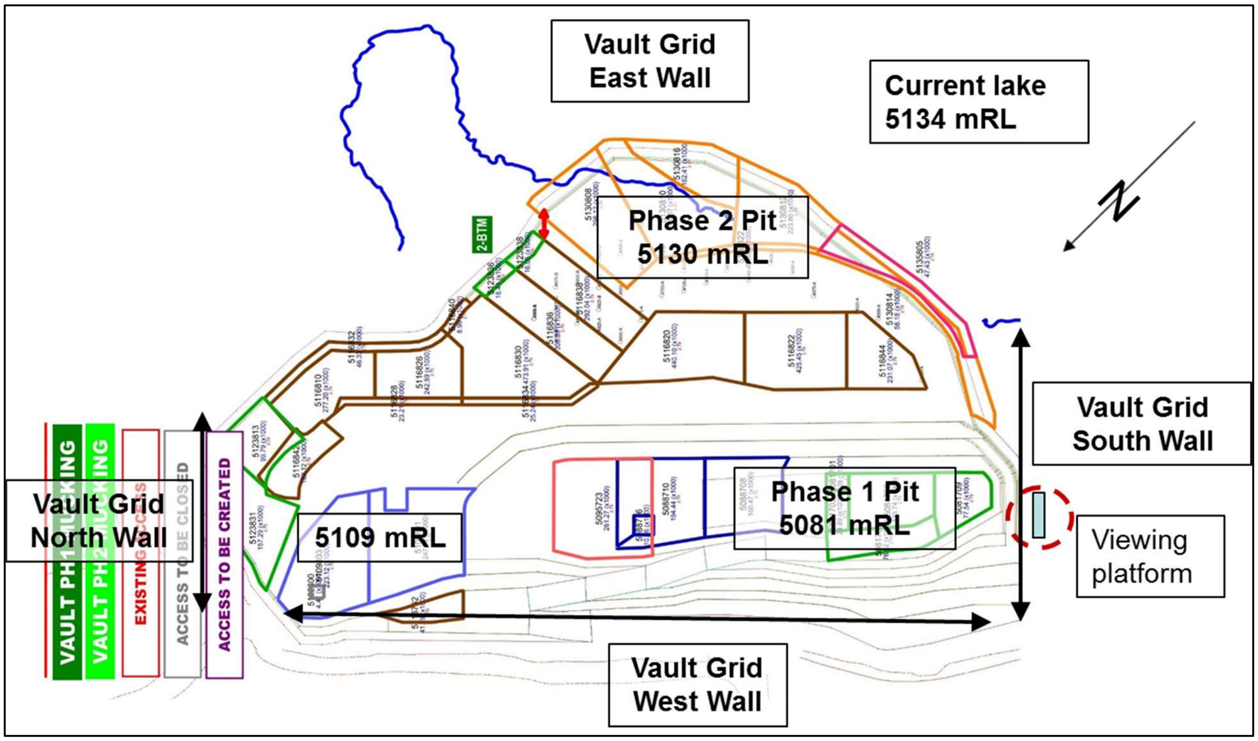



*Figure 2-3: Vault pit at time of 2015 site visit*

## 2.4 Life of Mine Schedule

The current Life of Mine schedule for the various pits at the site was provided by AEM, and is summarized in the following table.

*Table 2-2: Life of Mine Schedule for Meadowbank Mine (Ref. AEM, September 2015)*

| Pit | Current Floor Elevation (mRL) | Final Floor Elevation (mRL) | Benches Remaining | Planned Completion Date |
|---|---|---|---|---|
| A Ultimate | 5046 | 5004 | 15 | Q1 2018 |
| B | Backfilling | | | Complete |
| C | Backfilling | | | Complete |
| D | Backfilling | | | Complete |
| E Ultimate | 5032 | 4983 | 7 | Q3 2017 |
| Goose | Backfilling | | | Complete |
| Vault Phase 1 | 5088 | 5081 | 1 | Q1 2016 |
| Vault Ultimate | 5123 | 4955 | 24 | Q3 2018 |

# 3.0 MINE SITE ENGINEERING GEOLOGY MODELS

The supracrustal stratigraphy of the mine area consists of ultramafic volcanic, felsic to intermediate volcaniclastic, and/or greywacke, interbedded magnetite-chert iron formations and associated pelitic schists, and quartzite. The bulk of the gold mineralization in the deposit is contained within the iron formations, with the exception of the Vault Deposit where gold is associated with sericite schist.

## 3.1 Portage Deposit

The Portage Deposit area has undergone a series of regional deformation events resulting in typical 'dome and basin' fold structures. The dominant structural feature of the Portage Deposit is a gently to steeply inclined tightly folded north/south trending anticline which has resulted in the iron formation, interbedded volcaniclastic and metasedimentary rocks being folded around a core of ultramafic volcanic rock. Bedding-parallel foliation associated with the east-west deformational events is pervasive throughout the deposit area, and has formed the basis for much of the pit slope design criteria. Foliation surfaces tend to be slightly altered with occasional coatings and can be associated with slickensiding and shearing. In general, the foliation and stratigraphy dip to the west at variable inclinations from horizontal to sub-vertical. Locally the foliation orientations can vary considerably, particularly adjacent to major fault zones.

During the site visit, refinement of the Portage engineering geology model was completed to better understand wall stability problems at the south end of Pit E3 South Wall. AEM geologists report that up to 4 deformational events have been interpreted in the project area, resulting in very complex fold patterns and rock structure. This is particularly evident at the south end of the Portage Pit, in Pit E3, where superposition of fold events has imparted a complexity to the rock mass that has led to recent wall multi-bench scale instability. The refinements to the model are based on a review of available data including the geological block model, limited geotechnical drilling data, hydrogeological data from instrumentation installed in the Bay Goose dewatering dike, rock fall reporting, radar data, site observations and mapping. Key model refinements include the following interpretations:

- Pit E3 South Wall is comprised of ultramafic rock;
- The rock is strongly serpentinized, and has a high mineralogical component of talc. Talc absorbs water resulting in volumetric expansion;
- The south wall is connected hydraulically to Third Portage Lake, and is saturated to ground surface;
- The south wall stratigraphy is more complexly folded than elsewhere in the Portage Pit, and the interference patterns a minimum of 3 deformational events (east-west, and north-south compression, and overturning.
- The complex folding has resulted in tight isoclinal folding of the ultramafic rock plunging to the northwest and southeast into and out of the slope, with associated northwest to southeast trending, west dipping, fold axial planes which may be coincident with faulting and shearing along these surfaces;
- A zone of weaker, often sheared and faulted, ultramafic rock ranging from perhaps 1 to 5 m and averaging about 3 m is observed in the footwall of the ultramafic rock, between about 5 and 15 m from the footwall contact of the ultramafic with underlying iron formation. The presence and continuity of this shear zone has been confirmed by field observations of its occurrence in the west wall of Pit E3 where it is inclined steeply westward at around 65 degrees, trending southeast across the floor of the pit to the south wall where its orientation changes to relatively flat lying, trending east-west and dipping into the south wall at its base. For clarity this will be referred to as the Footwall Shear Zone, FSZ as it occurs near the lower contact with iron

formation. Where the FSZ is observed at the base of the south wall it is observed to have water flowing from it. No estimates of flow rates have been made.

- Tight isoclinal folding of the ultramafic units within fold nose areas has resulted in a significant deterioration of rock quality. This is apparent from a review of core photographs, and is consistent with observations of behaviour of the ultramafic in the south wall of the pit. Based on the review of core photographs as the distance from the fold noses increases, the quality of the ultramafic rock improves, through the core of the folds.

## 3.2 Goose Deposit

The Goose Deposit is a steeply dipping, stratiform gold bearing iron formation that is part of a sequence of Achaean ultramafic and mafic flow sequences, volcaniclastic sediments, felsic to intermediate flows and tuffs, and sediments. The ultramafic rocks are variably altered and contain serpentine, chlorite, actinolite, and talc. Through the central core of the deposit, the stratigraphy trends northward and southward from Goose Island and dips at steep angles, generally greater than about 55$^o$ to 60$^o$ to the west. Axial planar and bedding-parallel foliation, which is pervasive throughout the rock mass, occurs commonly as healed fractures rather than open fractures within the rock. Axial plane bedding-parallel ductile shearing are common due to intense regional deformation events. This shearing is most commonly associated with weaker lithologic units, such as the ultramafic rock.

## 3.3 Vault Deposit

The Vault Deposit area is underlain by a sequence of intermediate volcanic rock that has been altered by sericite, chlorite, and silica. The stratigraphy is consistently inclined south-southeast between approximately 20$^o$ and 30$^o$.

The pit area is generally underlain by permafrost, with the exceptions of the east pit wall where it is pushed back into the former Vault Lake, and sections of the north pit wall which will also intersect an arm of Vault Lake. Within the pit footprint area is a smaller lake which has been drained. Both Vault Lake, and the smaller lake, will be underlain by talik (unfrozen ground) and water inflows can be expected where the pit wall may intersect the taliks. During the site visit water inflows occurred over a narrow area of the east pit crest resulting from water flow from the partially drained Vault Lake at elevation 5134 mRL through the ring road to the Phase 2 platform at 5130 mRL.

The stratigraphy and foliation are the most significant structural characteristic at the Vault Deposit area. The foliation is continuous and closely spaced, whereas joint sets are generally discontinuous and terminate within the rock mass or at other intersecting joint sets.

## 3.4 Tectonic and Structural Features

### 3.4.1 Portage Pit

Historically, the main tectonic features within the Portage and Goose Pit areas are the Second Portage Lake Fault and the Bay Fault. More recent wall instability associated with the south wall of Pit E3 has been recognized and appears to be related to shearing of the ultramafic rock exposed in this wall and subsequent folding of the weaker stratigraphy into adverse orientations relative to the wall.

The Second Portage Lake Fault is interpreted to trend northwest-southeast, parallel to the axis of Second Portage Lake, dipping at approximately 70 degrees to the southwest. The fault has been identified to intersect the east and west walls of the Portage Pit.

The Bay Fault trends south through the Portage Pit, and may be responsible for shearing of the ultramafic units at the south end of Pit E3, and beneath the Pit E3 ramp. Intense polyphase deformation at the south end of Pit E3 has resulted in folding and re-folding of sheared ultramafic rock, leading to instability of the south wall.

### 3.4.2 Goose Pit

The Bay Fault extends south to intersect the Goose Pit, and is visible in the north and south walls of the pit. The fault trends south from the pit to intersect the Bay-Goose Dike approximately at Chainage 31+625 along the centreline. Water in-flows to the pit along the Bay Fault in the south wall have been noted during previous site visits.

A shallow west dipping sheared stratigraphic contact intersects the upper west wall of the Goose Pit, and is the source of significant water inflows to the pit during mining. The contact is inclined at a shallow angle between about 20 and 30 degrees to the west, striking in a north-south direction. The contact extends south from the pit, passing beneath the dewatering dike approximately at Chainage 31+925. Water is observed to flow along this contact, and the feature is interpreted to be hydraulically connected to Third Portage Lake. At the downstream toe of the dewatering dike, along the projection of the contact trace, seepage has previously been observed. In the pit area, the contact is intersected by east-west steeply to vertically dipping faults and joints which provide a mechanism for east-west flow of water behind the south and west pit walls and into the pit. During winter an ice curtain forms on the west wall.

### 3.4.3 Vault Pit

Faulting in the Vault area generally takes the form of moderate to high angle, east and south dipping fault zones. In general, the east dipping fault features are inclined at approximately 70 degrees, while the south dipping features are inclined at approximately 55 degrees. These faults either will intersect the pit walls at high angles, or will dip into the pit walls. Potential wedges formed by the intersection of these through-going continuous features will plunge into the south and southeast pit wall at angles of about 50 degrees. Planar failures will be a factor for south and southwest facing walls where the south dipping faults intersect the wall. Major fault structures in the area are considered continuous, and may therefore influence pit slope stability at both an overall slope and bench scale. However, these faults are very widely spaced, about 30 m to 100 m based on previous surface mapping interpretation and as such the risk of a kinematically feasible planar failure is reduced.

# 4.0 PORTAGE PITS A AND B INSPECTION

At the time of the site visit the Pit A platform was inactive. Since the 2014 site visit the pit has only been deepened by a single bench from 5053 mRL to 5046 mRL. Mining in Pit A was suspended in 2014 and a small pit lake has formed in the base of the pit. It is planned to recommence mining of Pit A in 2016. Mining at Pit B has been completed, and the pit is being backfilled.

The inspection consisted primarily of observations made from the crest area, and from the base of the pit. The west ramp access has been blocked and access to the base of the pit is by the east wall ramp. The pit lake prevents access to the north, northwest, and northeast wall areas of Pit A.

## 4.1 Pits A and B Overview

A view of Pits A and B at the time of the site visit is shown in the following photographs.

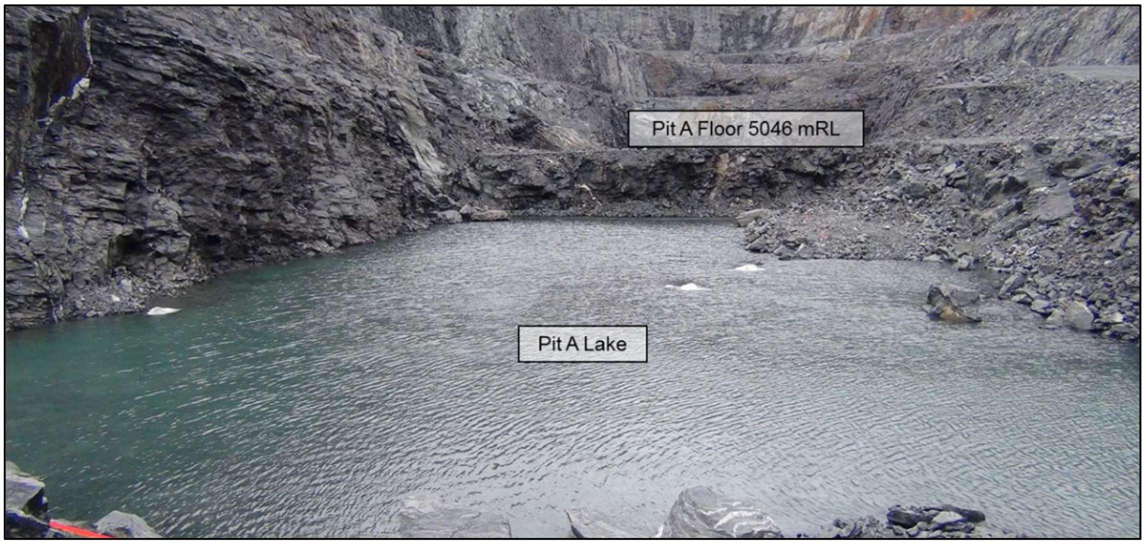

*Photograph 4-1: Pits A and B looking north from east crest*


*Photograph 4-2: Pits A and B looking north from west crest*

Mining of Pit B has been completed and it continues to be backfilled as a waste rock dump.

## 4.2 Pit A Inspection

Pit A is at the north end of the Portage Pit, and includes the northwest through northeast end walls of the pit. There are 15 benches remaining to be mined in Pit A to a final floor elevation of 5004 mRL, planned for Q1 2018. A portion of the west wall of Pit A will be mined as a push-back. At the time of the inspection, a small lake at the base of Pit A had formed and will be drained before mining commences again, shown in Photograph 4-3.

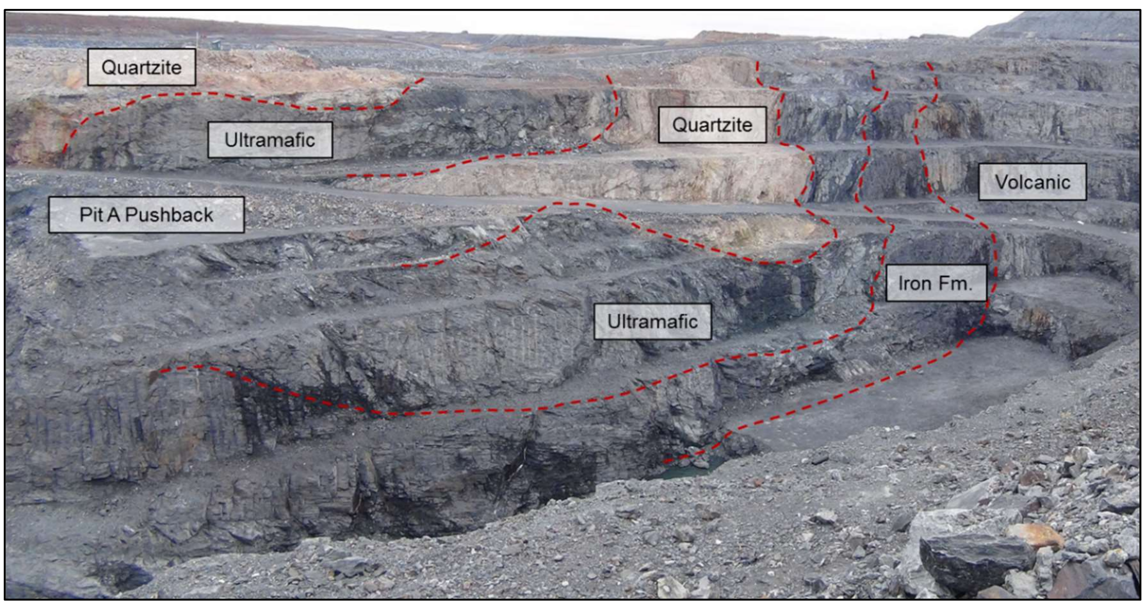



*Photograph 4-3: Pit A Lake*

The west, north and east pit walls of Pit A were inspected from the east, north, and west pit crest. In general, the walls of Pit A continue to perform satisfactorily.

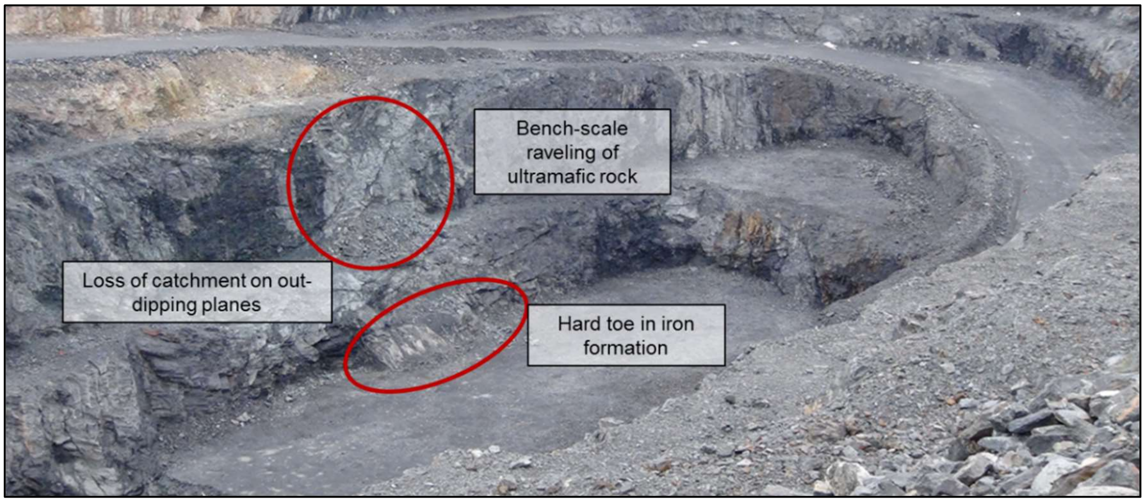
### 4.2.1 Pit A West Wall

The following Photograph 4-4 shows the west through north wall of Pit A at the time of the inspection.




*Photograph 4-4: Pit A west wall*

The west wall bench face angles are excavated steeper than designed, however wide catch benches are used to manage the overall slope angle within the design criteria. The benches continue to perform well and as with the 2014 inspection there is very little accumulation of material on the catchment, and crest loss is minimal. An area of instability of the lower west wall identified during the 2014 inspection continues to ravel, and some new material has accumulated at the toe of the slope (shown in Photograph 4-5). A hard toe in iron formation remains at the base of the slope, exposing out-dipping planes. Poor quality ultramafic rock exposed in the bench above continues to ravel with exposure to air and moisture, along adversely oriented joint structure. This has resulted in loss of catchment. This is a localized occurrence and not indicative of larger scale instability, hence can be managed through mucking as necessary. AEM plan to mine the Pit A pushback beginning with the upper benches, and progressing downwards. Consequently, no personnel or machinery will be working beneath this area.



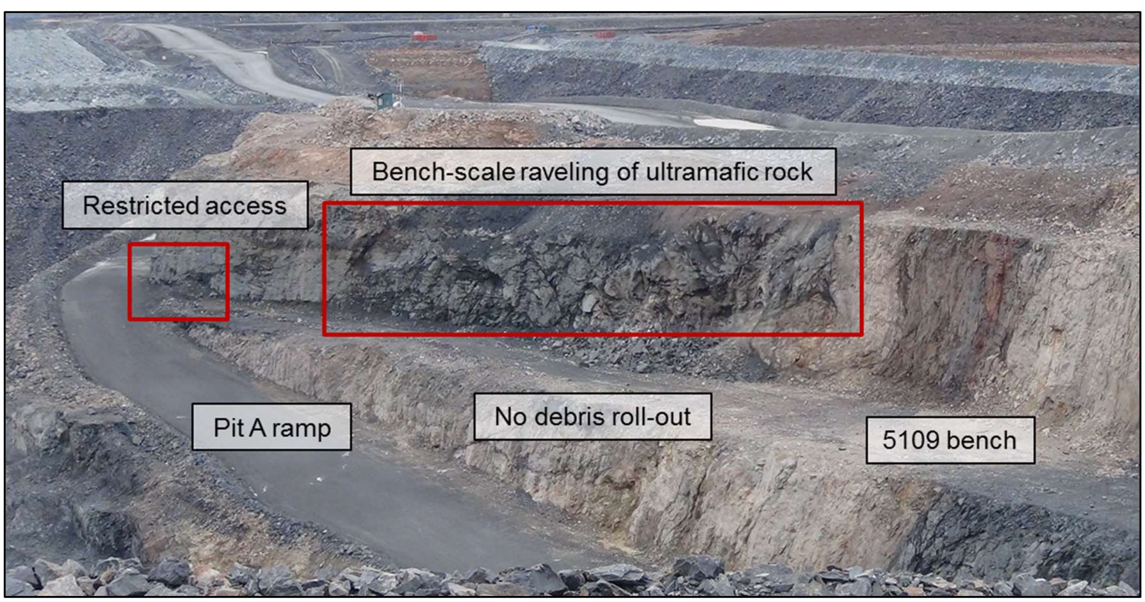

*Photograph 4-5: Pit A lower west wall raveling*

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

### 4.2.2 5109 Bench Instability

A rock fall event from 2012 along the west wall of Pit A continues to be monitored. The location is shown on the following figure and photograph.




*Photograph 4-6: Pit A 5109 bench instability*

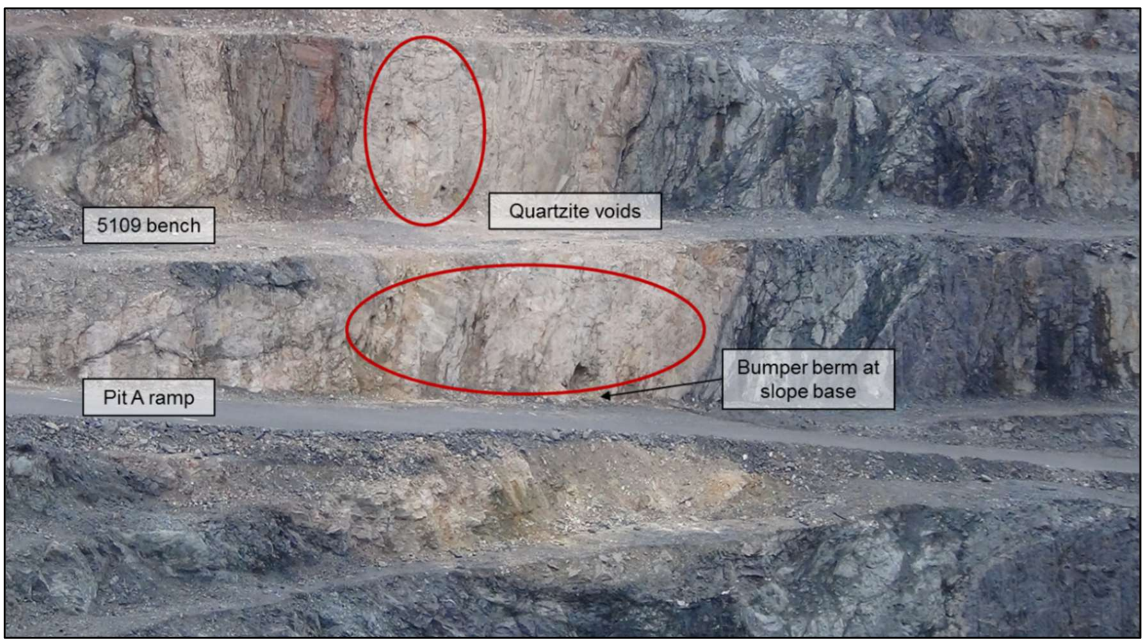
The bench-scale instability is a result of complex folding and shearing of the ultramafic rock in this area resulting in planar structure dipping towards the pit. Bench-scale raveling of material has occurred in the past, hence this area continues to be monitored as it is located above the access ramp. Previous recommendations to restrict access to this area have been implemented, including raising of the berm height at the bench entry point. During the inspection no additional accumulation of material was noted at the toe of the slope. Since Pit A is planned to be re-opened and traffic will again travel the ramp, this section should be closely monitored at the beginning, and visual monitoring of this area should be part of the regular site geotechnical inspections.

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.
- Closely monitor this area when Pit A and the ramp are re-activated.

### 4.2.3 Pit A West Wall Voids

The quartzite stratigraphy observed in the Pit A west wall along the ramp contains several large voids identified during previous inspections. Previous recommendations for managing local instability associated with the voids have been implemented, including the construction of a bumper berm to contain material that may continue to ravel.




*Photograph 4-7: Voids in quartzite above Pit A west ramp*

While it was not possible to access the ramp during the site inspection, it was observed from a distance that the bench continues to perform adequately. Since this ramp is planned to be put back into service, this area should form part of regular site inspections.

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

### 4.2.4 Pit A North to Northeast Wall

The north through northeast walls of Pit A continue to perform adequately. Very little accumulation of loose or raveling material on the catch benches was noted during the site visit.

*Photograph 4-8: Pit A north to northeast wall*

There are no significant geotechnical concerns for this wall. The following actions are recommended:

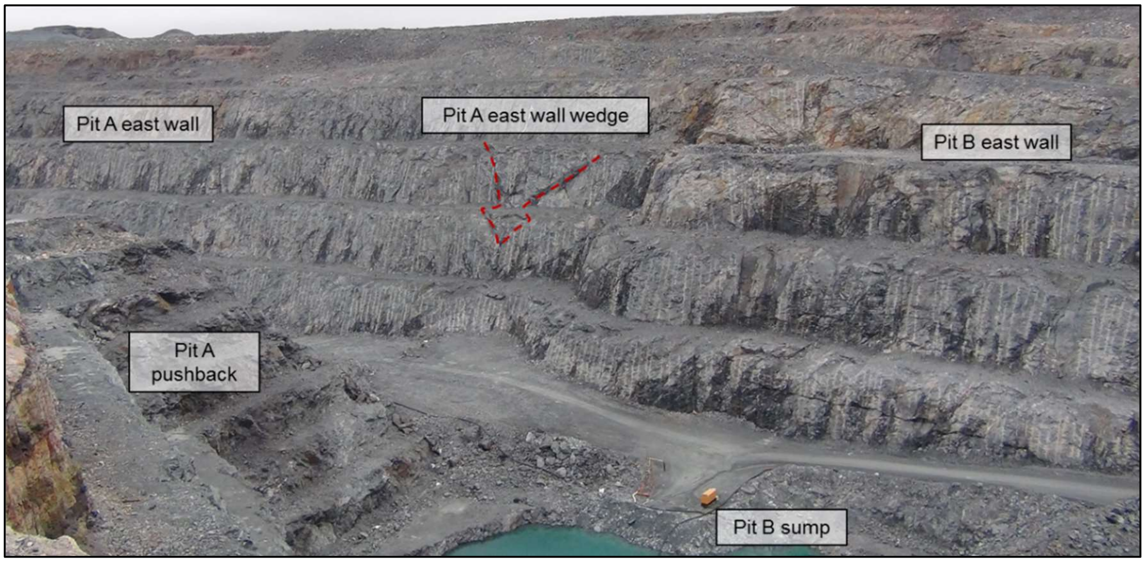
- Continue visual monitoring as part of regular site geotechnical inspections.

### 4.2.5 Pit A East Wall

The east wall of Pit A continues to perform adequately. It is well scaled, with steep bench face angles, and minimal accumulations of material on the catch benches.

*Photograph 4-9: Pit A east wall performance*

During the 2014 site visit a large wedge was identified on the east wall of Pit A, shown in the following Photograph 4-10.




*Photograph 4-10: Pit A east wall wedge*

Recommendations made following the 2014 site visit included completing a Lidar scan of the wedge followed by a kinematic assessment of the potential for sliding of the wedge. AEM have completed this analysis, and the results are presented in the figure below.

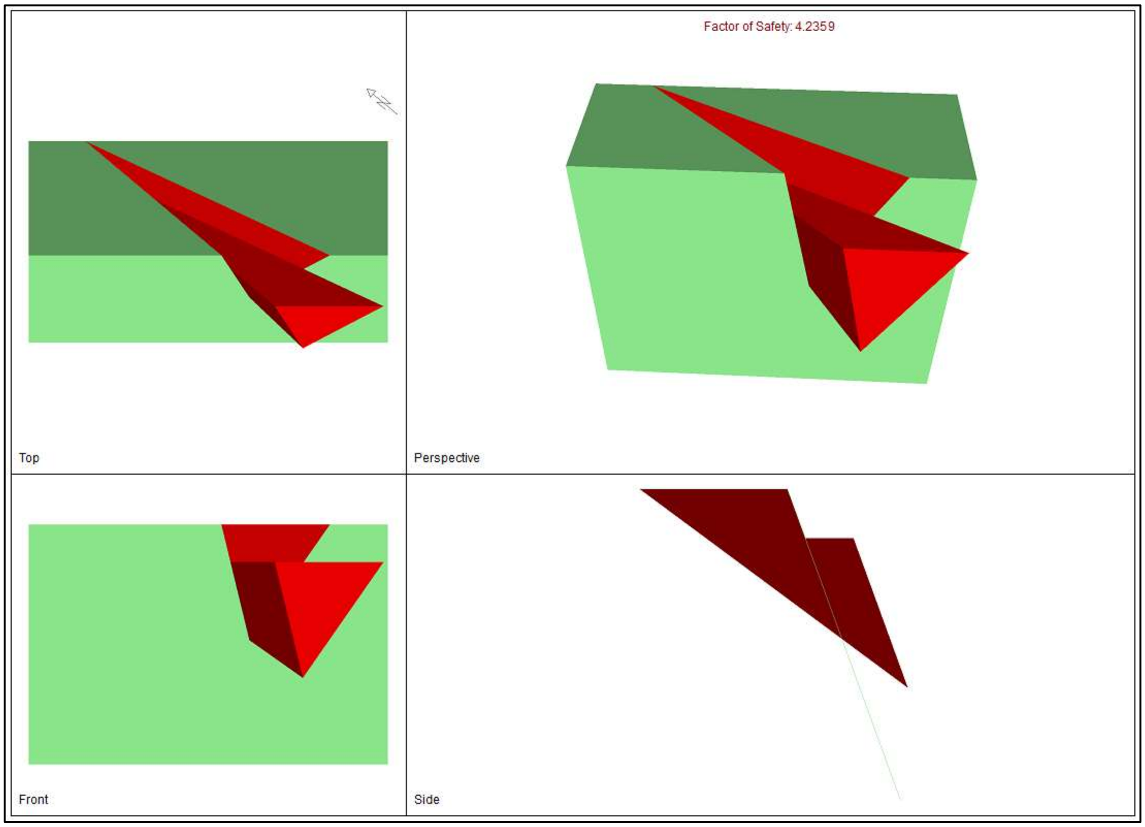



*Figure 4-1: Pit A SWEDGE analysis*

The weight of the wedge is estimated by SWEDGE to be 418 tonnes. There is no seepage noted on the wall, and so the analysis was carried out appropriately without water pressure, and using frictional strength of 30 degrees with no cohesive strength. Based on the analysis the factor of safety associated with this wedge is greater than 4. Since Pit A will be re-opened this area should continue to be visually monitored as part of regular inspections.

There are no significant geotechnical concerns for this wall. The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

### 4.2.6 Pit A East Wall Ramp Tension Cracks

In 2011 AEM observed tension cracks at the crest of the east wall ramp. The area has been inspected as part of the 2011 through 2014 pit slope performance reviews, and again during the 2015 site visit. There is no indication that the tension cracks observed in 2011 are indicative of a larger scale failure, and this specific inspection can be removed from future site visits.

The following actions are recommended:

- No further actions required.

## 4.3 Portage Pit B Inspection

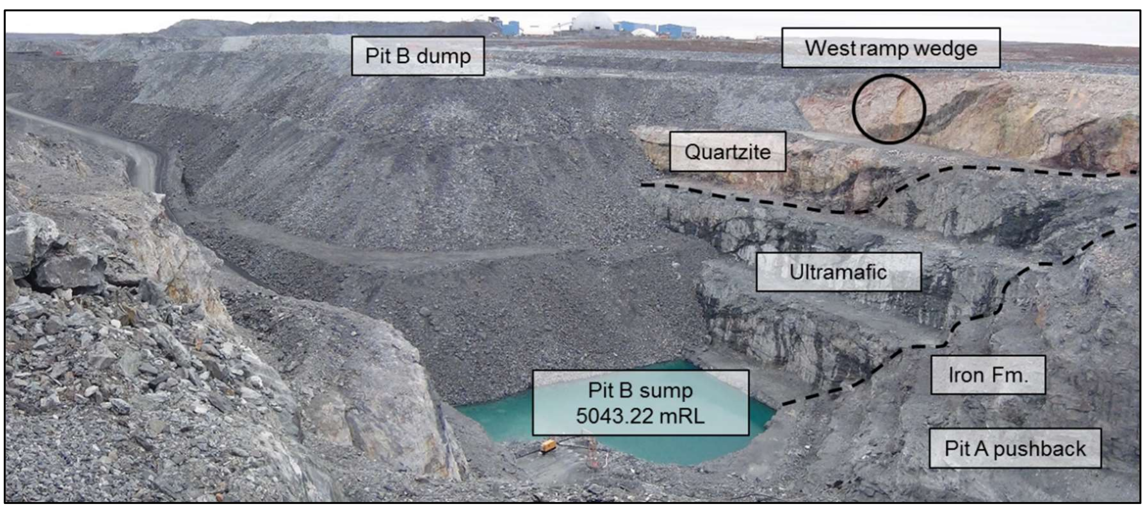
Pit B extends south from Pit A. Mining of Pit B is complete, and it is being backfilled as a waste rock dump.


*Photograph 4-11: Looking south at Pit B dump in foreground and Pit C dump in background*

### 4.3.1 Pit B West Wall

The west wall of Pit B is performing adequately, exposing quartzite in the upper benches overlying ultramafic rock, and iron formation. There is no access to the west wall of the pit, and access to the base of the pit is gained by the east ramp which also provides access to Pit A.

The west wall performance is shown in the following photograph.




*Photograph 4-12: Pit B west wall performance*

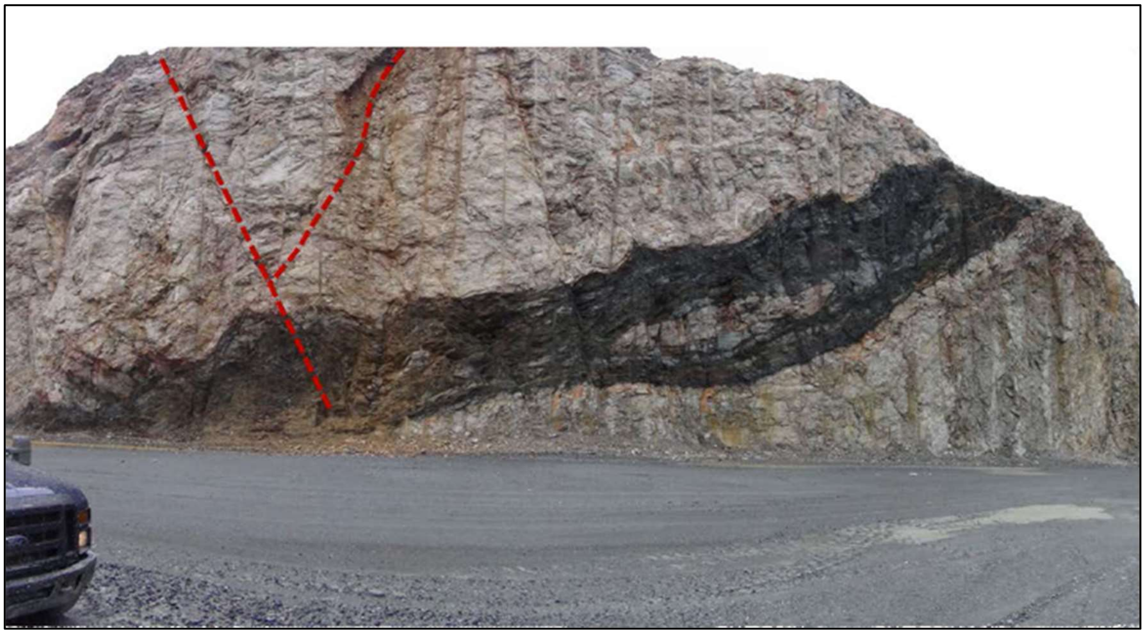
There is no evidence of large-scale instability for the west wall of Pit B.

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

### 4.3.2 Pit B West Ramp Wedge

During the 2014 inspection a wedge immediately above the west ramp access to the pit was identified, and is shown in Photograph 4-12, and in Photograph 4-13 below from the 2014 inspection.



*Photograph 4-13: Pit B west ramp wedge (Reference: Golder 2014)*

As the wedge is immediately adjacent to the ramp, and there was observed evidence of smaller failed wedges locally having similar orientation to this wedge, it was recommended that a small bumper berm be constructed as a precaution.

Currently, access to the west ramp is closed. When Pit A is re-opened, the west ramp will again be in service; however, AEM have indicated this portion of the ramp will not be part of the ramp re-activation.

- Continue visual monitoring as part of regular site geotechnical inspections.

### 4.3.3 Pit B East Wall

The east wall of Pit B was inspected from several viewpoints as well as from within the pit. The wall continues to perform satisfactorily. Benches are generally clean with little accumulation of material.

*Photograph 4-14: Pit B east wall performance*

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

### 4.3.4 Pit B Dump

During the time of the site visit, the crest elevation of the Pit B dump was at 5126.5 mRL. The planned final crest elevation will be 5142 mRL. The dump is being constructed as a dump and doze operation. The following photographs show the performance of the dump platform.

*Photograph 4-15: Pit B dump platform*


*Photograph 4-16: Pit B dump*

Only limited areas of the crest were accessible, but no tension cracks or indications of subsidence or settlement were noted during the inspection; no bulging of the dump toe or dump face was observed.

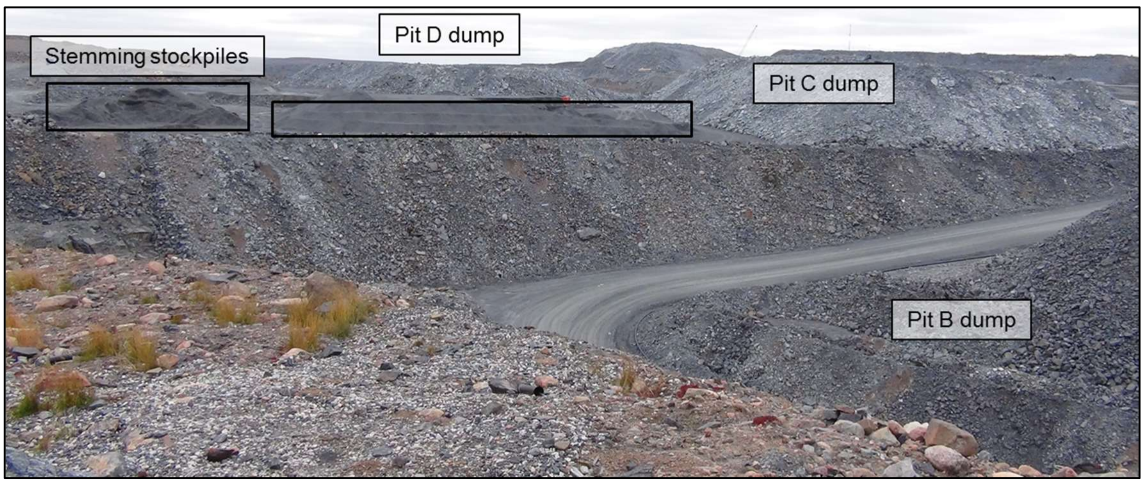
The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

# 5.0 PORTAGE PITS C AND D INSPECTION

Pits C and D extend south from Pit B to form the central dump of the Portage Pit. Mining is complete at both pits and they are being backfilled as waste rock dumps. At the time of the site visit the Pit C main platform elevation was at 5127 mRL, with a planned final elevation of 5145 mRL. The Pit D main platform elevation was at 5127 mRL. It is understood that portions of Dumps B, C, and D will remain at 5127 mRL, while specific areas will be raised to final elevations of 5142 mRL.

A photograph looking south at the waste rock dumps in Pit C and Pit D is shown below.




*Photograph 5-1: Pit C and Pit D waste rock dumps looking south*

The west and east pit walls of Pit C are buttressed by waste rock and no longer present any significant geotechnical hazard. The main dump platform for Pit C is used for storing stockpiles of stemming material. The Pit C dump is performing adequately. There were no tension cracks observed in the crest area, and no bulging of the face or toe areas was noted at the time of the inspection.


*Photograph 5-2: Pit D waste rock dump, looking north from Pit E3*

During the 2014 inspection some tension cracks of limited extent were noted in the south crest area of the Pit D dump. An attempt was made to re-visit this area during the 2015 site visit but access was no longer possible. No evidence of instability was observed on the south face and toe area of the Pit D dump.

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

# 6.0 PORTAGE PIT E INSPECTION

At the time of the site visit the floor platform elevation at Pit E3 was at 5039 mRL. There are 7 benches remaining to be mined at Pit E3, to a final planned elevation of 4983 mRL, with a target completion of Q3 2017.

The Pit E3 east wall continues to perform well. The west wall has localized bench-scale instability associated with the weaker ultramafic rock exposed at the base of the wall, and adverse structure (shearing in the ultramafic rock) inclined into the walls and resulting in overhangs.

The Pit E3 south wall has experienced multiple bench-scale failures of the ultramafic rock. The most recent failure occurred on 21 September 2015. There have been no rock falls since, and this is attributable in part to the arrival of winter. The area has been designated no entry until remedial measures are undertaken to stabilize the wall.

## 6.1 Pit E3 East Wall

The Pit E3 east wall is excavated in good quality intermediate volcanic. The main structural control for the east wall is a steeply west dipping foliation plane. Bench face angles have been excavated generally parallel to this dominant structure, and the bench and overall wall performance continues to be satisfactory. Final benches have been cleaned and scaled appropriately. Occasional bench-scale rock falls have occurred in association with local undercutting of wedge and plane geometries; however the material from these local failures has been retained on the catchment benches.

*Figure 6-1: East wall showing good bench and wall performance*

Local areas of out-dipping planes have been encountered in the lower benches, and where identified have been scaled back resulting in some crest loss and associated loss of catchment. However, this action is appropriate locally as it results in a more stable bench face by removing the risk of adverse structure failing at a later time.


*Figure 6-2: Example of catchment loss from scaling to out-dipping plane*

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.
- Continue to scale and clean final benches.

## 6.2 Pit E3 South Wall

Pit E3 south wall exposes primarily ultramafic rock, with iron formation and volcanic rock on its eastern edge. The ultramafic rock is poor quality. The wall has experienced considerable instability since approximately June of 2015, resulting in substantial rock falls and wall instability. A series of bench and multi-bench scale wall failures within the ultramafic rock exposed in the south wall have occurred resulting in a talus slope of the failed material.

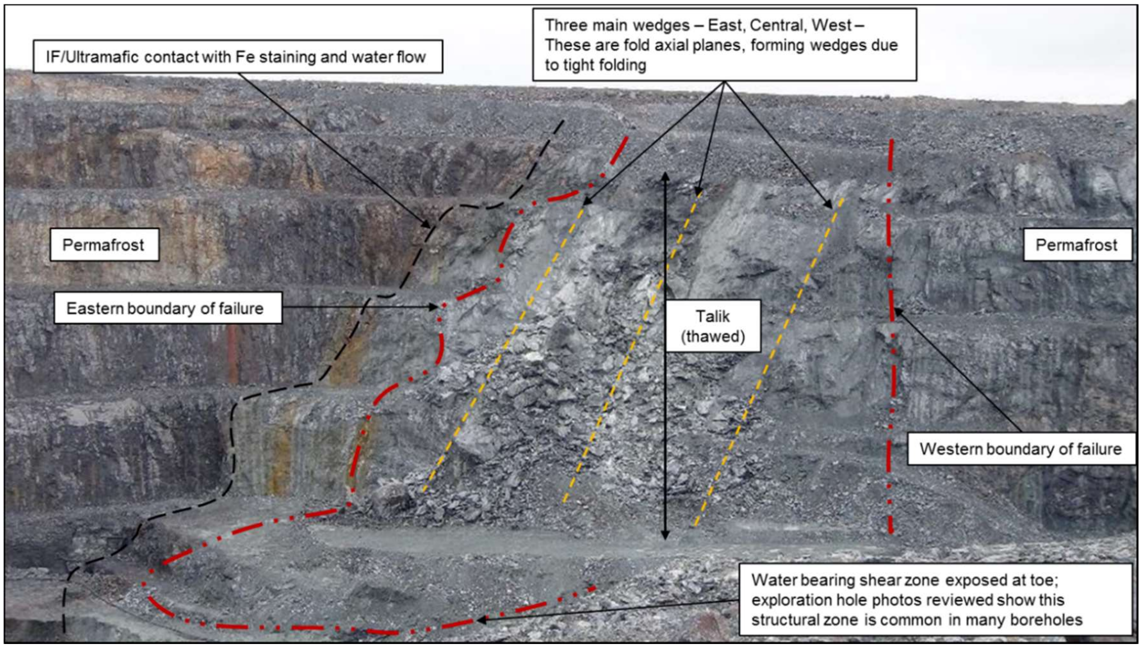
AEM have appropriately documented each failure, and have reported these to the Mines Inspector. AEM have also taken the appropriate steps to identify this area of the pit as a 'high risk' area, with no activity permitted immediately below the wall. A GroundProbe radar system has been purchased and monitors the wall continuously; the radar has been successful in identifying the potential failures, allowing AEM to communicate this information to operators. It has been recommended that the radar system be augmented by regular monitoring of the remaining prisms on the face, when possible (there are difficulties in monitoring the prisms during winter). An appropriate response plan is in place, and AEM have taken further steps to investigate the instability, update the hydrogeological model, complete additional stability analyses, and develop a mitigation strategy for the wall, including slope depressurization, crest unloading, and installation of slope monitoring instrumentation (TDR cables, piezometers, and thermistors). The annual site visit was extended to allow the collection of additional information, including a review of dewatering dike instrumentation, geological logs, core photographs, and the geological block model. Additional structural interpretation was carried out using Lidar radar scans and computer software which allowed mapping of additional structural features safely.

The following photograph shows the south wall.


*Photograph 6-1: Pit E3 south wall*

Many of the benches on the wall have been lost and there are substantial areas having no catchment over several benches. Groundwater seepage is noted in the bench faces, up to ground surface. The seepage suggests a hydraulic connection with Third Portage Lake, which is located behind the dewatering dikes constructed behind this wall. The ultramafic rock is absent of permafrost in the area of the failure, as the area was originally lake-bottom and so talik conditions persist. The ultramafic rock to the east and west of the failure area is in permafrost, is absent of groundwater, and is performing adequately. The crest of the south wall has been used to store waste rock, and the waste rock slope face has been advanced to the edge of the pit crest.

The geology of the south end of Portage Pit is structurally complex, characterized by at least two separate phases of large-scale folding of the stratigraphy, and as many as four separate phases of folding. There is little in the way of oriented geotechnical borehole data behind the wall, however the geological block model is reasonably accurate relative to observed bedrock in the wall. Historically, a fold hinge line and fault zone has been projected approximately through this area, and this appears to contribute significantly to the bench-scale instability. The large-scale multi-phase deformation of the stratigraphy has resulted in strain accommodation predominantly within the weak ultramafic rock, contributing to its poor rock quality, and exacerbated by the structural trend through the wall. This has also resulted in the development of a shear zone within the ultramafic rock, and occurring generally within 10 to 20 m of the contact between ultramafic and underlying iron formation and volcanic rock.




*Photograph 6-2: Pit E3 south wall controls governing instability*

The orientation of the main stratigraphic boundaries, and the layer-parallel foliation developed as part of the major fold events, are the primary controls on bench-scale and overall slope stability, and so an understanding of the fold patterns relative to the south wall is of primary importance in assessing the slope stability. Previous studies (2007) identified that the foliation and stratigraphy at the south end of the Portage Pit is reoriented to an east-west direction, dipping to the north.

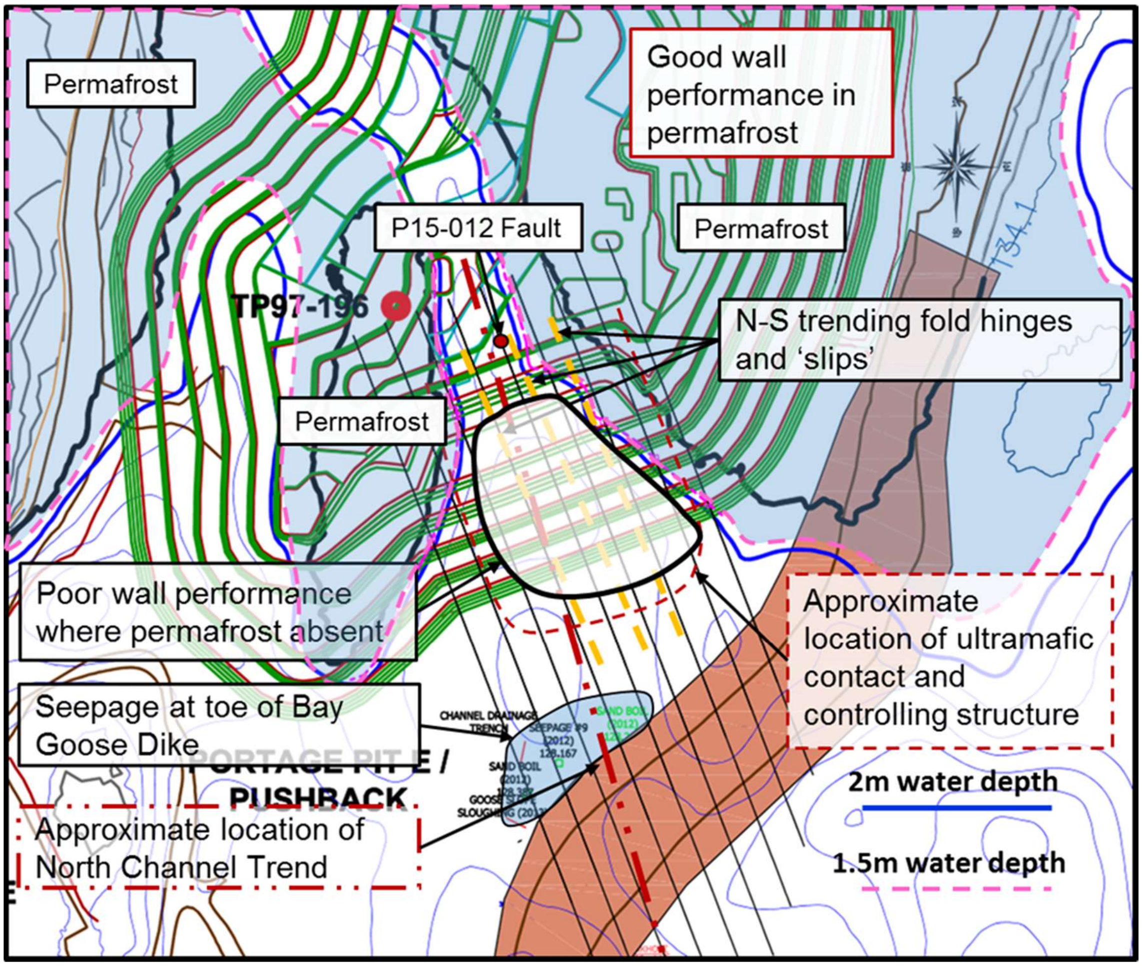



*Figure 6-3: Pit E3 south wall performance relative to permafrost location*

There are two potential scales of failure to be addressed in relation to the stability of the south wall: the first is bench, or multi-bench kinematic instability associated with the tight isoclinal folding forming large wedges; the second is larger scale deep-seated circular type failure associated with the geometry and orientation of the ultramafic rock and shear zone.

The potential for the failure to extend back to the dewatering dike and affect the integrity of the dike has been investigated. The engineering geology model and stability analyses suggests that failure behind the crest will be limited to the depth of the ultramafic contact with the iron formation, and will not extend back to the dewatering dike.

The contributing factors to the instability are now well known, comprising:

- Geology and Rock Quality
  - The ultramafic rock forming the south wall is weak (average unconfined compressive strength of 32 MPa), with relatively low rock mass quality.
  - The ultramafic rock is serpentinized, having a significant component of the mineral talc.

  - The presence of talc significantly reduces the frictional strength along discontinuities (foliation and joint surfaces) and of sheared inter-unit contacts. Its presence also contributes to the strength reduction of the rock mass.
  - The ability of talc to absorb water contributes to further weakening of the rock mass.
- Rock Structure
  - Complex polyphase deformation of stratigraphy has formed 'dome and basin' fold patterns at the south end of Pit E3, leading to re-orientation of the structure and stratigraphy to adverse orientations relative to the orientation of the south wall. The geometry that is developed is bowl shaped, inclined out of the wall.
  - North-south trending structures (slips) parallel to fold hinge lines trend into the south wall, affecting the rock mass quality and hydraulically connecting the wall to Third Portage Lake.
  - Tight isoclinal folding of the foliation about fold axial planes formed by the north-south trending structures has resulted in multi-bench scale wedges plunging out of the wall at angles undercut by the bench face and inter-ramp slope angles, resulting in multi-bench scale failure.
- Hydrogeology and Permafrost Conditions
  - The area of instability of the south wall of Pit E3 is within talik (unfrozen ground), geometrically wedged between permafrost boundaries to the east (pre-mining Third Portage Peninsula) and west (pre-mining Bay Zone Island). The performance of the rock slopes within permafrost is adequate in comparison with the area of instability of the south wall where permafrost is absent.
  - The area is hydraulically connected to Third Portage Lake by structures that trend into the wall. This results in groundwater pressures present behind the rock slope.
  - The groundwater pressures contribute to both overall slope instability, and the multi-bench scale instability.

The following actions are recommended:

- Continue to restrict access to the area immediately below the slope instability.
- Continue radar monitoring of this area and implementation of response plan.
- Continue monitoring of prisms while possible.
- Develop a plan to install slope monitoring instrumentation, including piezometers and TDR cables.
- Develop a plan to depressurize the slope and unload the crest area to complete mitigation of this area.

Prior to recommencement of mining below this wall, and following the efforts to depressurize and unload the slope, a re-evaluation of the slope stability based on the achieved results of the mitigation should be undertaken.

## 6.3 Pit E3 West Wall

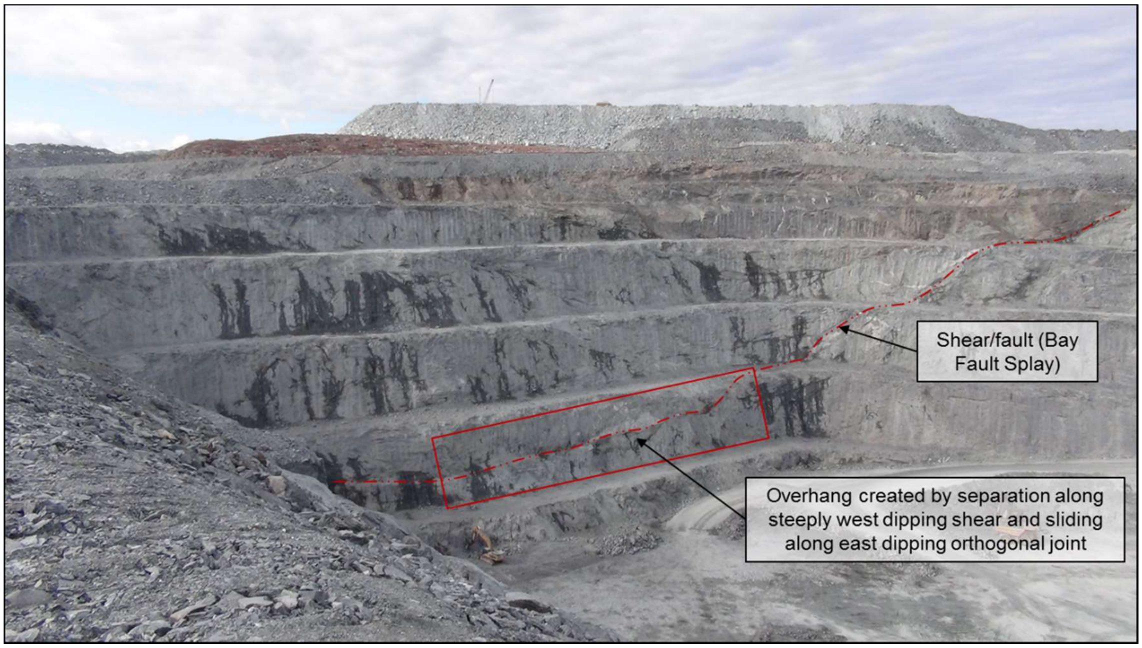
The Pit E3 west wall exposes predominantly quartzite, iron formation and intermediate volcanic rock in the upper benches of the wall, overlying ultramafic rock in the lower benches. Ultramafic rock is exposed for a significant portion of the ramp as it descends into the pit. The west wall has been advanced to the south to form a narrow slot at the southwest end of the pit.

Currently the performance of the west wall benches is satisfactory, particularly in the upper benches excavated in the stronger rock types. The bench face angles are steep, with wide catch benches, and these are adequate for retaining small material that has failed.

*Photograph 6-3: Pit E3 west wall upper benches*

Seepage faces are common along fracture planes exposed in the bench faces, and will likely form ice curtains during the winter. While stable through the winter, these areas may be prone to increased raveling and bench scale failure during the spring thaw. Additional care will be needed during spring thaw to identify potentially unstable areas of the pit wall.

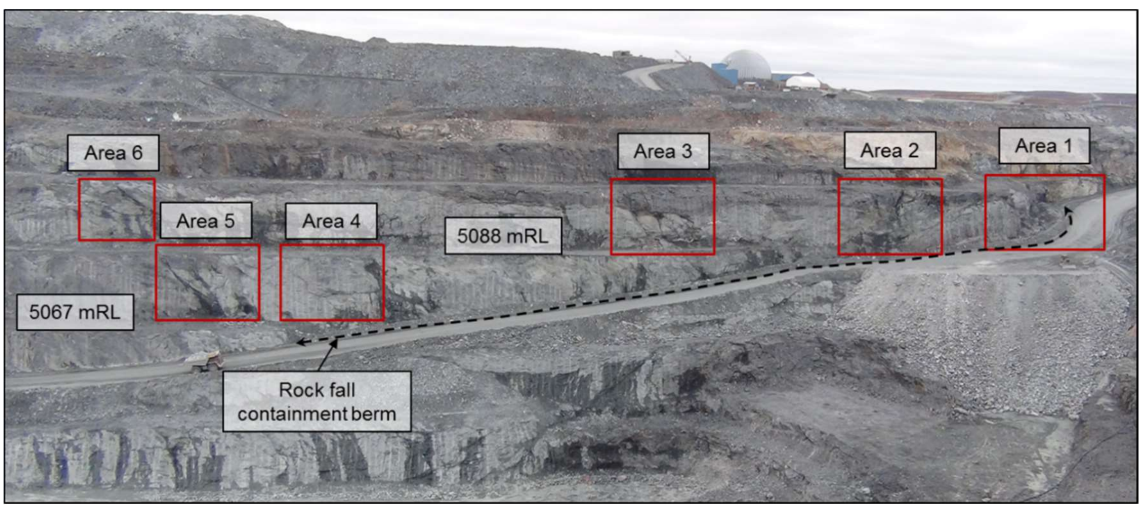
At the south end of the west wall, the contact of the ultramafic rock and overlying intermediate volcanic rock is inclined into the wall, which is beneficial for overall slope stability, but results in bench-scale instability of the underlying ultramafic rock. Local rock falls have occurred as the ultramafic rock separates from the overlying volcanic contact, followed by sliding along the steeply east dipping orthogonal joint set. This instability is exacerbated by the presence of shear zones within the ultramafic rock, which are inclined steeply into the west wall. The area of the overhang has been cleaned well, as has the bench beneath it. As this area of the pit continues to be mined down, continuing raveling of ultramafic rock can be expected. However, this material is expected to collect on the catch benches.




*Photograph 6-4: Pit E3 west wall lower benches*

## 6.4 Pit E3 West Wall Ramp

The Pit E3 ramp is situated on the west wall of the pit, and descends to the south into the pit. Several areas of potential instability were noted in the benches of the ramp. These are shown in the following photograph.




*Photograph 6-5: Pit E3 west wall ramp areas of potential instability*

A rock fall containment berm has been constructed along the west edge of the ramp, below the areas of potential instability, continues to provide adequate catchment for rock falls that have occurred. As the ramp descends south along the west wall into the base of Pit E3, it becomes single lane to accommodate the width of the containment berm adjacent to the bench.

### 6.4.1 Ramp Areas 1 and 2

The ramp passes beneath an area of wall that was problematic during the 2014 site visit (Area 1 and Area 2). The area of wall is associated with a fault zone – possibly the Bay Fault or a splay off that fault trend - trending through this area of the pit. This fault, or shear, is several metres wide, and steeply dipping to the west.

*Photograph 6-6: Pit E3 Ramp Area 1 above ramp - Bay Fault or splay*

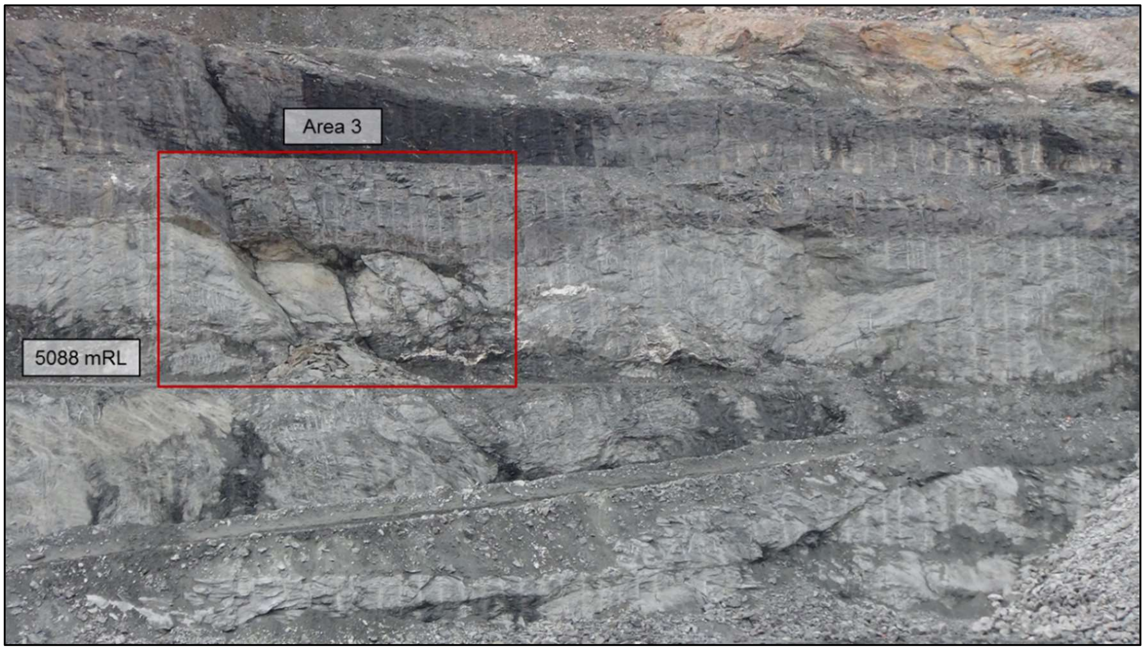

*Photograph 6-7: Pit E3 Ramp Areas 1 and 2 - Bay Fault or splay*

The following actions are recommended:

- Maintain the rock fall containment berm on the ramp
- Continue visual monitoring as part of regular site geotechnical inspections.

### 6.4.2 Ramp Area 3

Area 3 is defined by the contact between ultramafic rock and overlying volcanic rock inclined into the slope which forms a top release surface for a wedge formed within the ultramafic rock. Material has collected on the 5088 bench at the toe of the wedge, having raveled from the contact area. The combination of the 5088 mRL bench, and the containment berm on the ramp is adequately managing the potential for rock fall in this area.




*Photograph 6-8: Pit E3 Ramp Area 3 wedge*

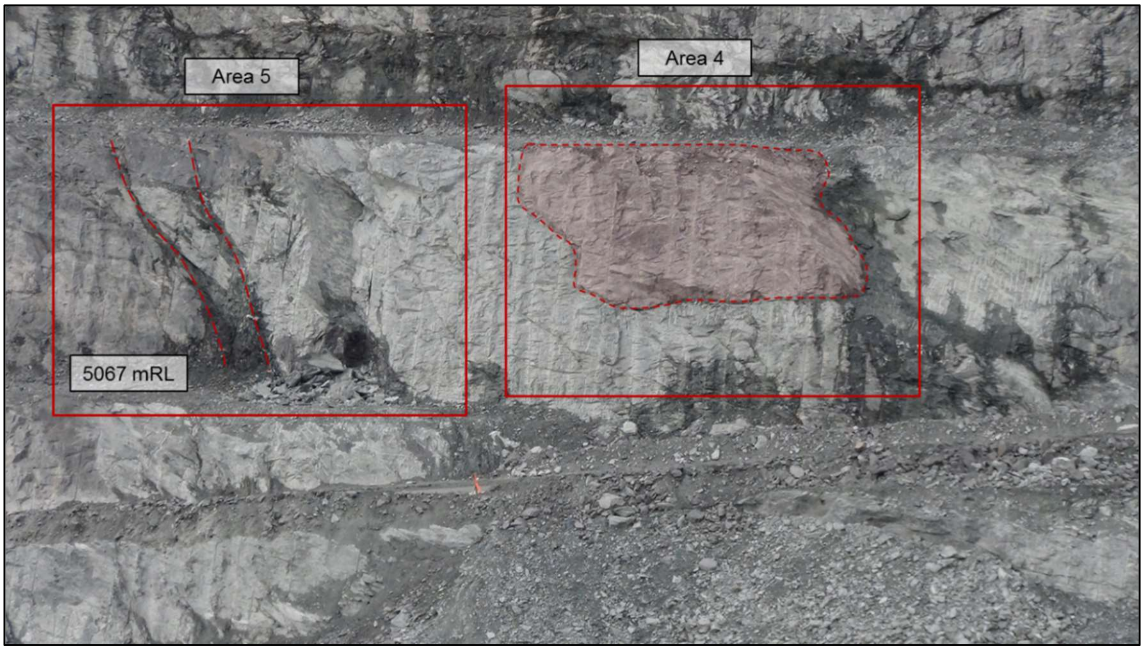
The following actions are recommended:

- Maintain the rock fall containment berm on the ramp
- Continue visual monitoring as part of regular site geotechnical inspections.

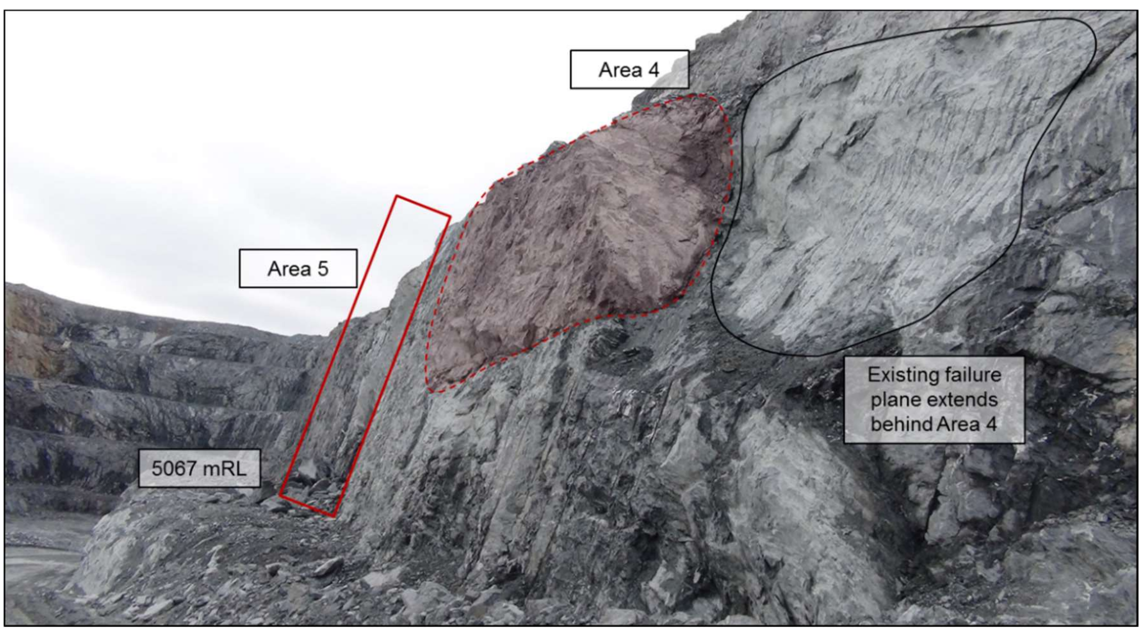
### 6.4.3 Ramp Areas 4 and 5

Area 4 is a potential planar failure formed by a steep east dipping sliding plane undercut by the bench face. The sliding plane is exposed adjacent to Area 4 on a portion of wall that was scaled down. The plane extends behind Area 4, and daylights in the bench face. While it is possible Area 4 could be either scaled down, or supported by bolting, the rock fall containment berm extends along the ramp beneath the rock block to manage the risk associated with the potential failure of this material.

Area 5 is defined by a series of closely spaced bench-scale joints trending into the wall, and forming steeply plunging wedges. Some material has already failed on to the 5067 mRL bench. On-going raveling of material can be expected from this area. However, the steeply plunging orientation of the wedges will result in relatively small volume of material which will be managed by the 5067 mRL catch bench.




*Photograph 6-9: Pit E3 Ramp Areas 4 and 5*



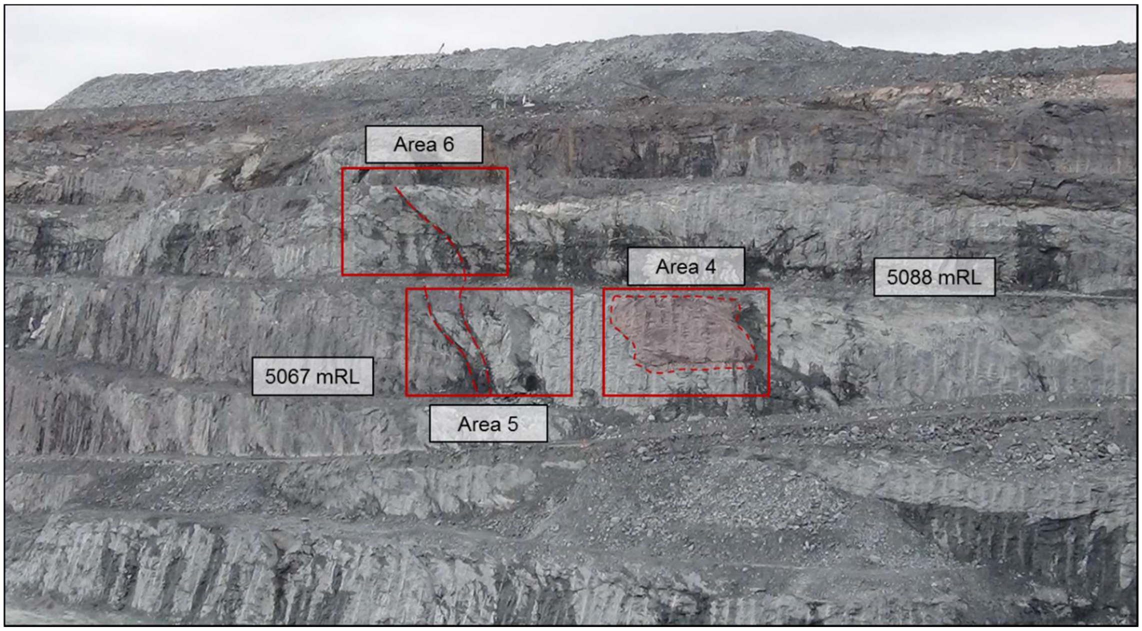

*Photograph 6-10: Pit E3 Ramp Areas 4 and 5 viewed from the ramp*

The following actions are recommended:

- Maintain the rock fall containment berm on the ramp.
- Continue visual monitoring as part of regular site geotechnical inspections.

### 6.4.4 Ramp Area 6

Area 6 is located above the 5088 mRL bench, and is a vertical extension of the closely spaced jointing of Area 5. These are steeply north dipping shear joints, which intersect the volcanic rock. The close spacing and continuous nature of these joints may result in increased raveling of material particularly during freshet and spring thaw. The 5088 and 5067 mRL benches should provide sufficient catchment for material that ravels from these areas.




*Photograph 6-11: Pit E3 Ramp Area 6*

The following actions are recommended:

- Maintain the rock fall containment berm on the ramp.
- Continue visual monitoring as part of regular site geotechnical inspections.

## 6.5 West Wall Ramp – South End

As the West Wall Ramp continues to descend into the pit to the south past Areas 5 and 6, the quality of the ultramafic rock improves as does the bench performance. This is seen in the following photograph.

*Photograph 6-12: Pit E3 west wall ramp south end*

The following actions are recommended:

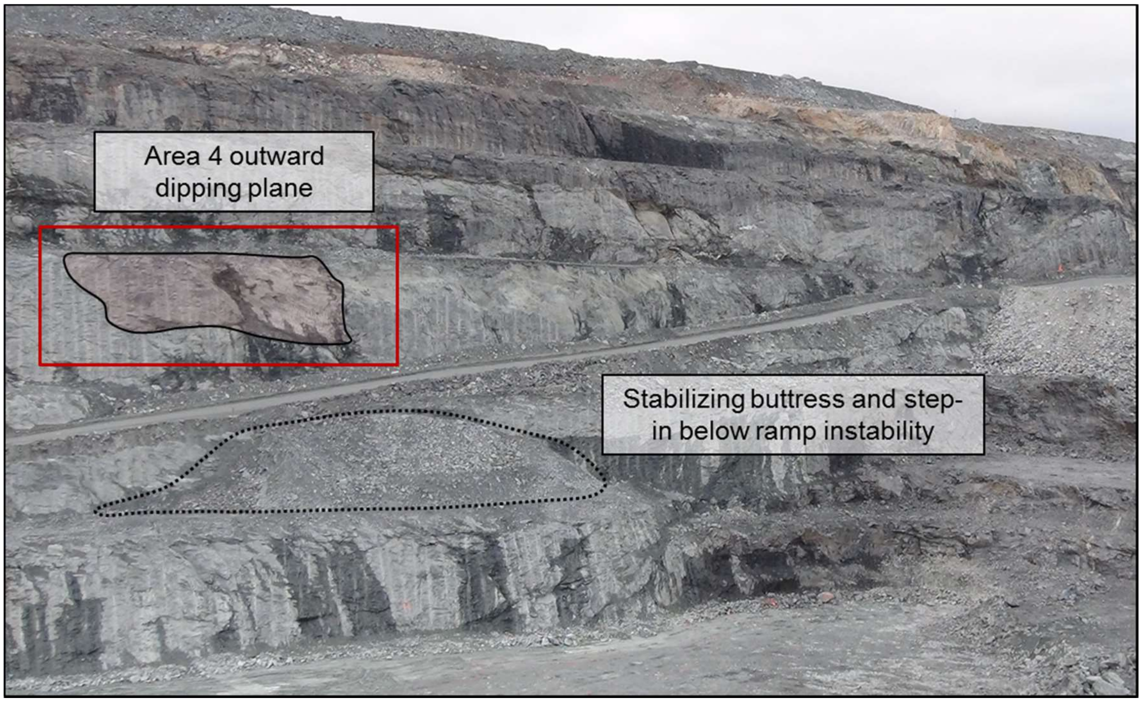
- Continue visual monitoring as part of regular site geotechnical inspections.

### 6.5.1 West Wall Ramp – Lower Wall Ramp Buttress

AEM identified some ramp instability associated with the lower wall ultramafic rock of the benches below the ramp. To mitigate this, the pit design was modified in this area to allow a step-in of the bench below the ramp, and the construction of a counter-balancing rock fill berm to stabilize the ramp. The performance of the buttress and ramp appear to be adequate to manage this instability.

It is possible that the instability of the ramp in this area is associated with the Area 4 outward dipping structure. Ramp Area 4 is immediately adjacent to the ramp on the up-slope side, while the ramp area requiring buttressing occurs immediately adjacent on the down-slope side. This is shown in photograph (Photograph 6-13). Inspection of the bench face below the buttress does not reveal parallel features, although it is possible the Area 4 plane may be encountered as this wall is deepened, and this should be watched for.

Sheared foliation is observed which dips into the wall at shallow angles, and it should be expected that this structure will create a top release surface for material to separate from and ravel as the pit is deepened. The ultramafic rock should be carefully scaled, and the operators instructed not to over-excavate in this material.




*Photograph 6-13: Pit E3 west wall ramp buttress and step-in*

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.
- Exercise care when scaling the ultramafic rock walls, and instruct operators not to over-excavate.

### 6.5.2 Pit E3 Pushback South and East Wall

In order to mine out a small pushback area, the west wall has been extended further south forming a narrow mining slot with a west wall, south wall and east wall. The west wall continues to be comprised of the south trending stratigraphy of quartzite, iron formation, intermediate volcanic and ultramafic rock. The south wall has a small radius and transitions rapidly into a short east wall. The upper benches of the south wall are comprised of ultramafic, intermediate volcanic and quartzite, transitioning down into iron formation. The east wall is comprised of iron formation, transitioning into ultramafic rock to the east as the wall orientation change back to the north dipping south wall. The pushback is primarily within permafrost.

In general, the bench performance of the slot area is satisfactory, although bench crests tend to be ragged and have suffered some over-break. The relatively good performance of the walls in the pushback area is attributed in part to the iron formation and volcanic rock forming significant components of the wall, and the presence of permafrost which removes the impact of groundwater on rock quality and stability, and increases the overall rock mass strength.

The topmost bench of the south wall of the slot reveals an adversely oriented, continuous planar structure dipping to the northeast at a moderate angle which was scaled out during mining. As the east wall of the pushback transitions into the Pit E3 south wall, continuous north dipping joint planes result in catchment loss where these have been undercut by bench face angles. This was noted during the 2014 inspection. These areas have been scaled during mining, and appear to be performing well despite the loss of catchment.

*Photograph 6-14: Pit E3 south slot pushback looking south*

*Photograph 6-15: Pit E3 pushback east wall showing local planar failure along continuous north dipping surfaces*

The following actions are recommended:

- Continue careful scaling and bench cleaning as the pushback is deepened.
- Instruct operators not to over-excavate.
- Continue visual monitoring as part of regular site geotechnical inspections.

# 7.0 GOOSE PIT INSPECTION

Mining has been completed at Goose Pit to a final floor elevation of 4997 mRL. Waste rock has been end-dumped into the northwest corner of the pit near the access ramp entry, using the pit as a short-haul dump. A pit lake has formed, and is at an elevation of 5031.18 mRL (15 October 2015).

The inspection of the Goose Pit comprised a series of stops around the crest of the pit for an overview of the current conditions. The pit is closed, and the access ramp has been blocked. In addition to the observations made during the site visit, data from thermistor and TDR instrumentation were reviewed.

## 7.1 Goose Pit East Wall

The east wall of the Goose Pit was excavated predominantly in intermediate volcanic rock and iron formation. The stratigraphy is inclined steeply at a consistent angle to the west. Consequently steep bench faces were achievable with the use of careful pre-shear blasting.

The following photograph shows the east pit wall looking north. There has been very little loss of catchment over time, and very little accumulation of material on the benches.

*Photograph 7-1: Goose Pit east wall performance looking north*

The east wall continues to perform satisfactorily and there are no immediate geotechnical concerns.

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

### 7.1.1 TDR Cables, Thermistors, and Piezometers

As part of the site inspection, the instrumentation data from TDR cables, thermistors, and piezometers installed in the east pit wall were reviewed. A location plan for the instrumentation is shown in the following figure, and the data are presented in Appendix A.

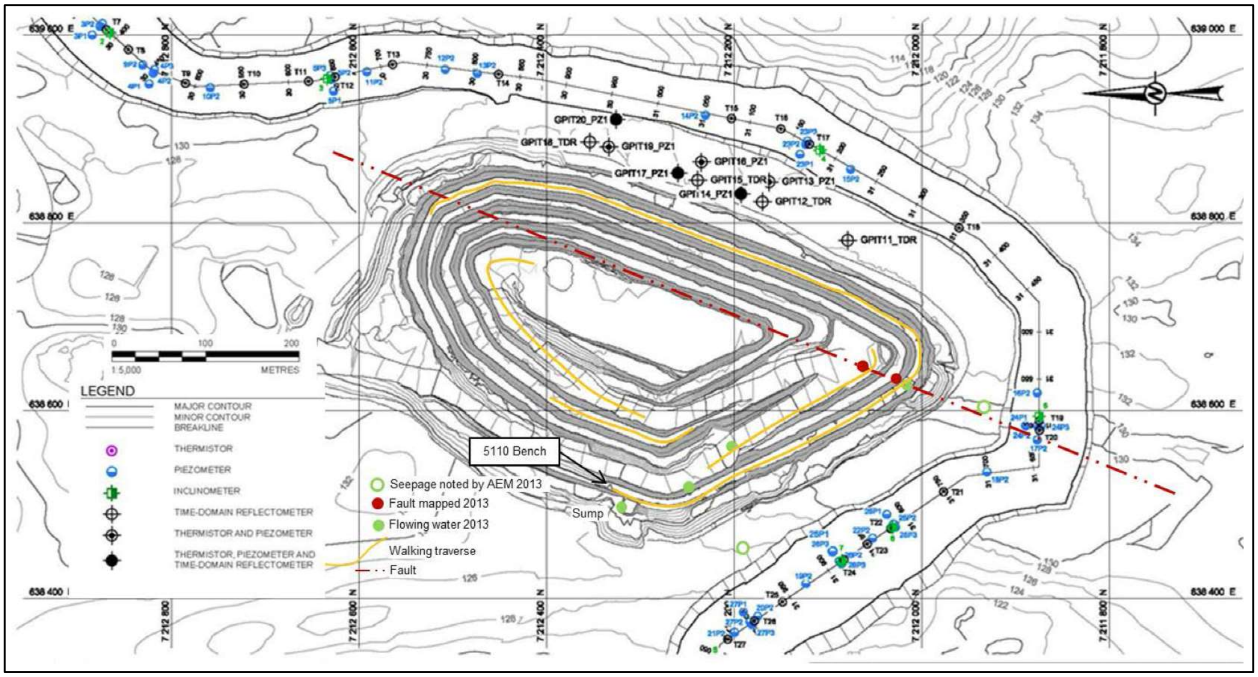



*Figure 7-1: Goose Pit location of instrumentation*

### 7.1.2 TDR Cables

Seven Time Domain Reflectometry (TDR) cables were installed in geotechnical boreholes drilled behind the east wall of the Goose pit in 2013 to monitor slope movement. A review of the data indicates no slope displacement. There is no noticeable change in the TDR cable signatures from 2014. The response for TDR GPIT-14 is erratic, suggesting it is damaged.

### 7.1.3 Thermistors

Thermistors were installed in 6 geotechnical boreholes drilled behind the east wall in 2013. The data indicate generally steady-state conditions have been reached. The upper thermistor beads, installed above the depth of zero annual amplitude, show the annual temperature fluctuations in response to seasonal temperature changes.

### 7.1.4 Piezometers

Piezometers were installed in 6 geotechnical boreholes drilled behind the east wall in 2013. A review of the data indicates constant hydraulic heads at the elevations the piezometer tips have been installed, and no noticeable change from 2014. The exception is piezometer tip PZ4c in GPIT-14 which showed a rapid increase in hydraulic head from about 4970 m to about 5070 m around October 2013 over a period of 1 to 2 months, followed by a gentle decline in head back to 4970 m over a period of approximately one year. This pattern has repeated in 2015, with an increase in head from approximately 4970 m to approximately 5099 m over a period of 2 months, beginning in July. The current pressure head for this piezometer tip is approximately 5099 m. This currently presents no risk to pit slope stability, but the data should be reviewed again next year to determine if this pattern repeats.

## 7.2 Goose Pit South Wall

The south wall of the Goose pit is comprised of iron formation and intermediate volcanic rock in the east, transitioning through a sequence of ultramafic rock, quartzite, and iron formation. The most prominent structural feature is the Bay Fault which intersects the south wall of the pit, within the ultramafic rock. The various lithological units are shown in the following photographs.

*Photograph 7-2: Goose Pit south wall performance*

The bench-scale and overall wall performance of the south wall continue to be satisfactory. There is no evidence of additional instability from the 2014 inspection.

There are no significant geotechnical concerns noted. The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

## 7.3 Goose Pit West Wall

The upper west wall of the Goose Pit is comprised of mixed sedimentary and volcaniclastic rocks at the crest, overlying quartzite. The lower benches of the pit expose poor quality ultramafic rock. The stratigraphic contacts dip at moderate angles to the west, into the pit wall. The ultramafic rock is characterized by relatively closely spaced sheared joints or foliation, dipping at steep angles to the east. Where these are undercut by bench face angles, local failures occur. The quality of the ultramafic rock degrades with exposure to air and water.

Steeply dipping east-west trending faults and joints connect to a north-south sheared contact within the mixed sediment units, providing a hydraulic connection to Third Portage Lake, and allowing water to flow towards the pit. Water reports to a sump on the 5110 bench. Although it was not possible to gain access to the 5110 bench during the inspection, remote observations suggest no change to the flow rate reporting to the sump. The rock immediately below the sheared contact remains saturated, and water continues to seep from the face above the ramp, as well as from the bench faces below the ramp. During mining, the presence of water contributed significantly to bench scale failures on the lower west wall, as well as the wall in the northwest corner of the pit which is comprised entirely of ultramafic. Water flowing to the pit also resulted in the formation of an ice curtain on the west wall, covering the ultramafic rock, below the contact with the quartzite.

Much of the west wall of the pit is now covered by a waste rock dump which conceals or partially conceals many of the instabilities noted during the 2014 inspection, and now acts to buttress those instabilities. As such, there is no evidence of additional instability since the 2014 inspection.

*Photograph 7-3: Goose Pit west wall performance*

There are no significant geotechnical concerns noted, and no evidence of large scale (overall slope) instability for the west wall of the closed pit.

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

### 7.3.1 Goose Pit Waste Rock Dump

The Goose Pit has been used as a short-haul waste rock dump. Waste rock has been dumped from the crest area and ramp entry at the northwest end of the pit. The dump platform is at elevation 5125 mRL; the dump toe extends into the pit lake, and across the pit floor to the east wall, at the north end of the pit. Currently, there is no active dumping.

*Photograph 7-4: Goose Pit waste rock dump (photograph courtesy of AEM)*

Safety candles have been placed at the entry to the dump crest to warn against entry to this area.

A series of large tension cracks were noted on the dump platform, between 10 m and 20 m back from the dump crest. The tension cracks are curvilinear and extend the full width of the dump platform. There is up to approximately 30 cm of vertical displacement across the cracks and lateral separation, or opening.

*Photograph 7-5: Goose Pit dump crest*

*Photograph 7-6: Goose Pit dump tension cracks*

During the inspection it was agreed with AEM that a temporary rock fill berm would be constructed to prevent access to the dump crest. It is understood that dumping of waste rock into the Goose Pit may be considered in the future as part of the longer term mine plan. Prior to active dumping in this area a detailed dump inspection should be carried out, and an action plan developed that might include frequent inspections of the crest area, and the installation of instrumentation.

The following actions are recommended:

- Continue with no active dumping from the dump crest for the current conditions.
- If the dump is to be reactivated, carry out a dump inspection and develop an action plan for inspections and monitoring.
- Maintain the rock fill berm to restrict access to the dump crest.
- Continue visual monitoring as part of regular site geotechnical inspections.

## 7.4 Goose Pit Northwest through Northeast Walls (North End-Wall)

The northwest through northeast (north end-wall) walls of the Goose Pit exposes the stratigraphic sequence of the deposit, from ultramafic rock in the west, through intermediate volcanic, and then iron formation in the east. The stratigraphic trend and dominant foliation is perpendicular to the wall, dipping at about 60 degrees to the west. The wall also exposes the Bay Fault, and associated splays. During mining of the pit in 2014, the combination of faulting, foliation and joint orientation, and shearing in the poor quality ultramafic rock led to significant bench-scale failures of the northwest pit wall.

Since the completion of mining of the Goose Pit in 2015, the waste rock dump has been developed at the northwest end of the pit. The dump has covered many of the previous areas of instability, such as the area identified in 2014 as the Northwest Wedge Instability (Golder, 2014). Seepage is still noted on the north end-wall in association with the main structural features intersecting the wall, and the seepage face is notably higher in the wall than during the 2014 inspection. Seepage from this wall could be related to release of water stored within the talik exposed by this wall, or could be an indication of a hydraulic connection with Third Portage Lake. This structural zone trends north, and may intersect the Bay-Goose dewatering dike over a short segment. It is possible this structural zone also intersects the south wall of Pit E3, in the area of the current instability.

The following photograph illustrates the geology and seepage daylighting in the north end-wall face.

*Photograph 7-7: Goose Pit north end wall*

There are no significant geotechnical concerns noted, and no evidence of large scale (overall slope) instability for the north end-wall of the closed pit.

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

# 8.0 VAULT PIT INSPECTION

Mining of the Vault Pit has advanced significantly since the 2014 inspection. At the time of the site visit, the Phase 1 pit had been excavated to 5081 mRL, and drilling for blasting of the Phase 2 push back had started on the 5130 mRL platform. Figure 8-1 shows the extents of the Vault Pit at the time of the site visit.

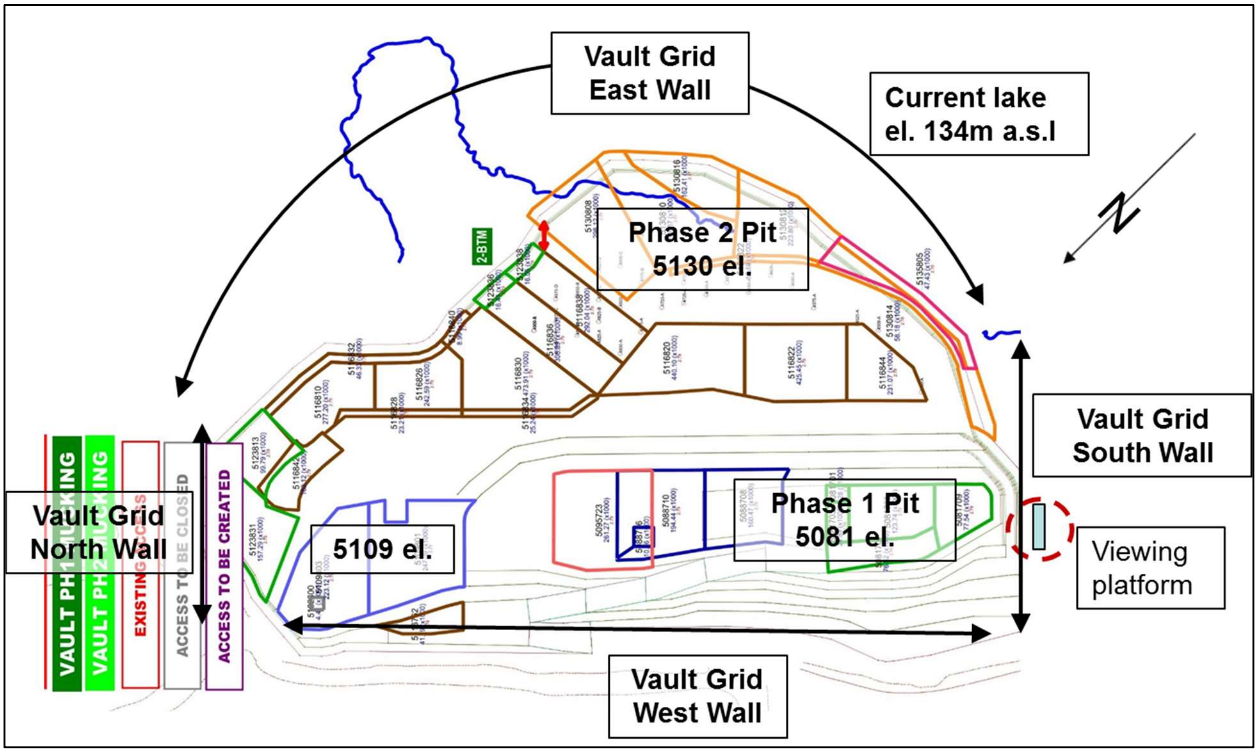



*Figure 8-1: Extents of Vault Pit at time of inspection*

## 8.1 Vault Pit – General Design Criteria

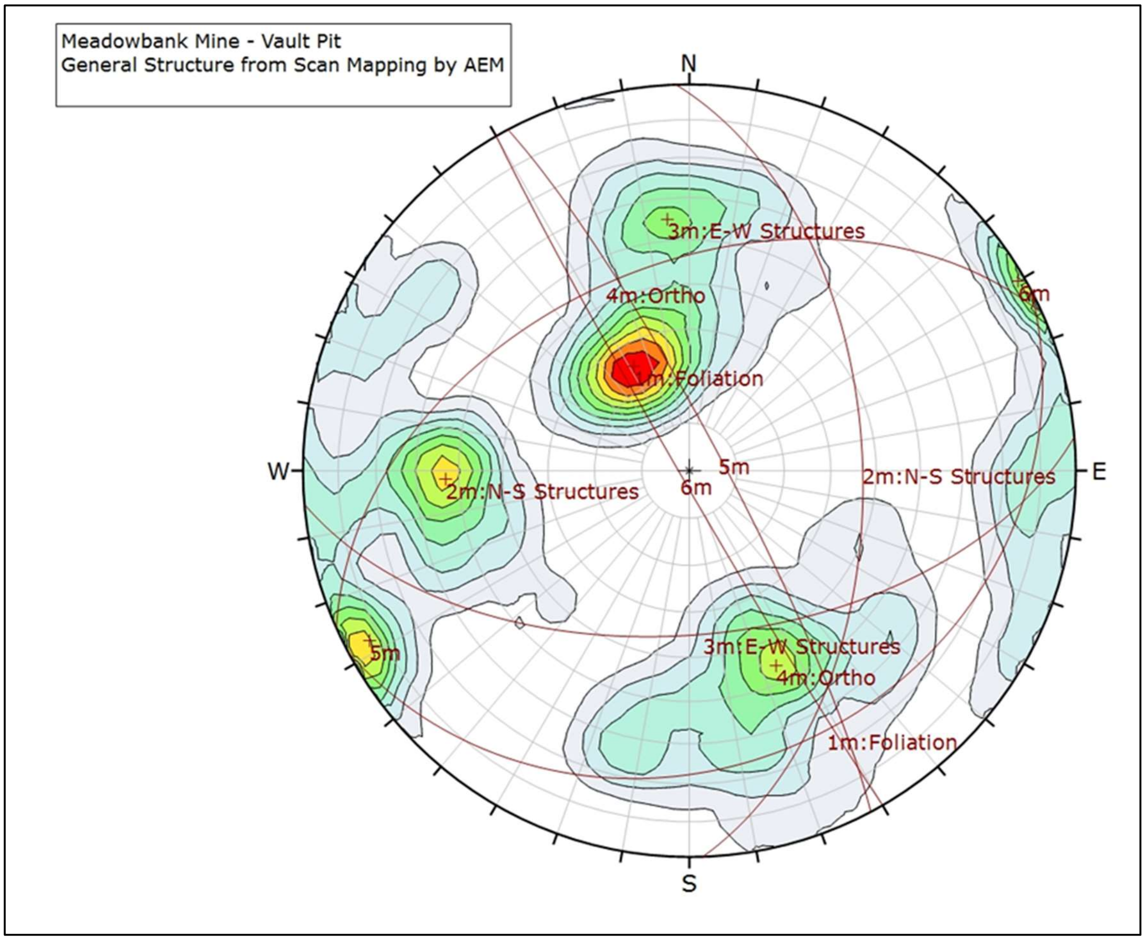
The slope designs currently implemented at the Vault Pit are described in the following table.

*Table 8-1: Vault Pit Current Slope Design Practice*

| Component | Vault Grid West | Vault Grid North | Vault Grid East | Vault Grid South |
|---|---|---|---|---|
| Bench Height (m) | 7 | 21 | 21 | 21 |
| Bench Face Angle (deg) | 88 | 75 | 75 | 75 |
| Catch Bench Width (m) | 10.5 | 10.5 | 10.5 | 10.5 |
| Inter-Ramp Angle (deg) | 33 (Footwall Slope) | 52.5 | 52.5 | 52.5 |
| Overall Slope Angle (deg) | 25 | N/A | N/A | N/A |

The slope design criteria currently in practice at the Vault Pit are consistent with the design criteria recommended in the slope optimization study (Golder, 2013). Catch benches are designed slightly wider than recommended by Golder (2013) resulting in slightly shallower inter-ramp angles.

AEM carried out additional structural mapping using a Lidar scanner and compared the data to the orientation data used in the feasibility design. The general structure is consistent with structural orientation data used in the feasibility design, and is shown below based on the scan data provided by AEM.




*Stereonet 1: Vault general structure based on AEM scan*

## 8.2 General Observations

During the site visit access to certain areas of the pit was limited due to active mining. Nevertheless, observations have been made on the overall performance of the benches in the pit in areas that could not be visited directly. The following Figure 8-2 shows areas of the pit that were visited directly.

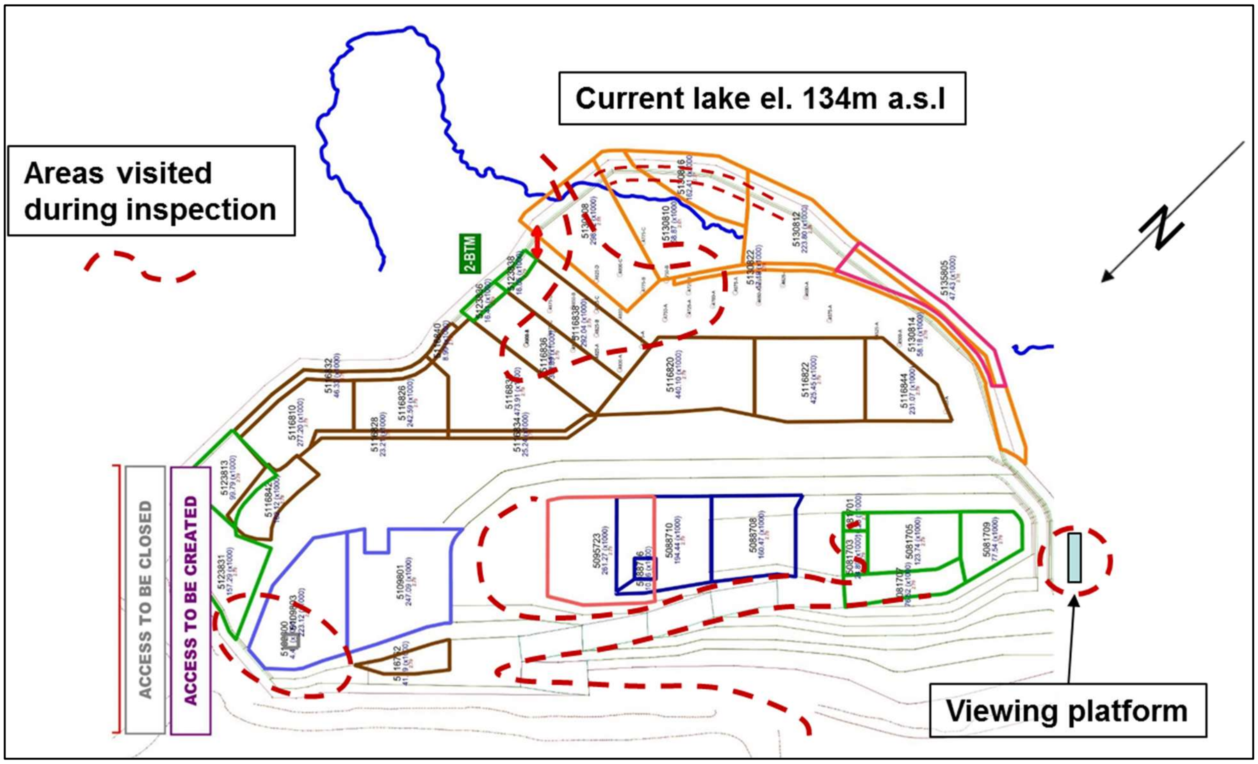



*Figure 8-2: Vault Pit areas visited during inspection*

In general terms, the pit walls of the Vault Pit are performing as expected. The Phase 1 Pit walls are currently bulk blasted, resulting in a generally ragged and blocky condition which is to be expected. The Phase 2 pit walls are pre-sheared, resulting in less damage, although many areas remain blocky. This is due to the thinly foliated and sericitic rock, which is susceptible to fracturing when blasted. The foliation and general stratigraphy dip at relatively shallow angles averaging 22 degrees, but varying from about 10 degrees to as high as 40 degrees.

### 8.2.1 Water Inflows and Seepage

Water inflows and seepage were noted in a number of areas of the pit. The locations are shown on the figure below. These are generally related to the dewatering of Vault Lake, and to the current lake level. These are discussed in relevant sections below.

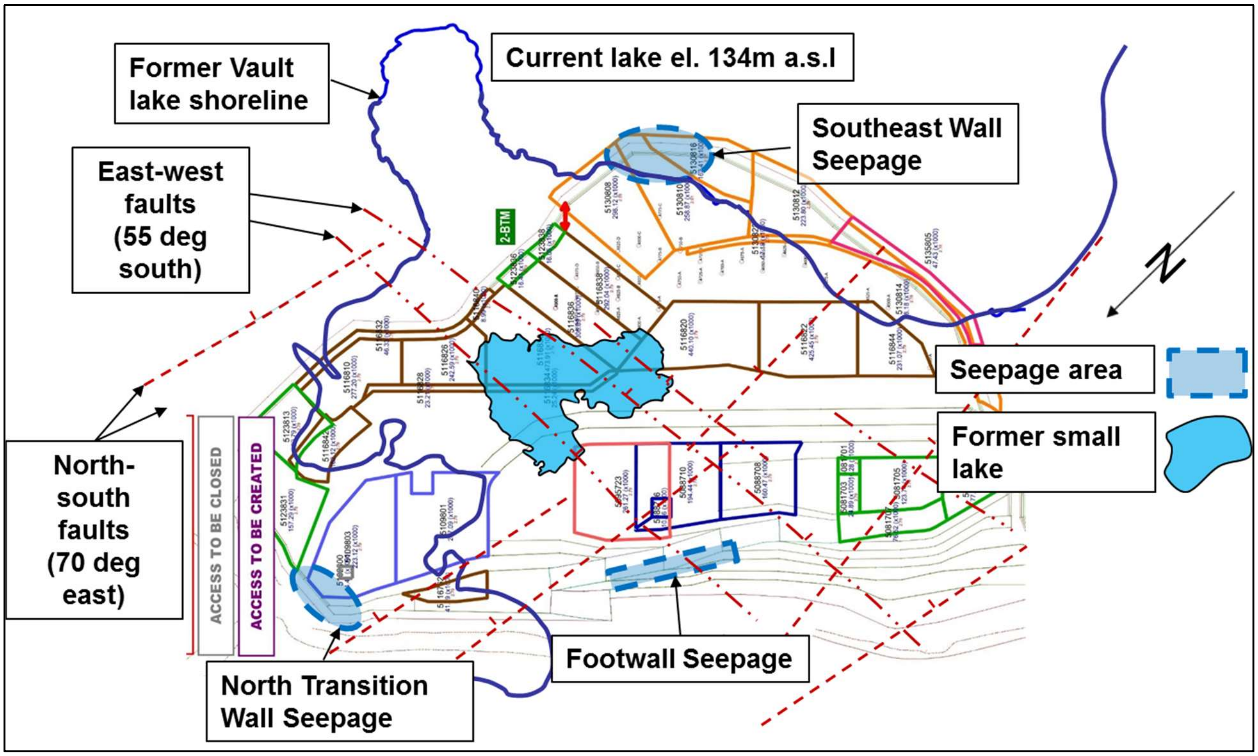


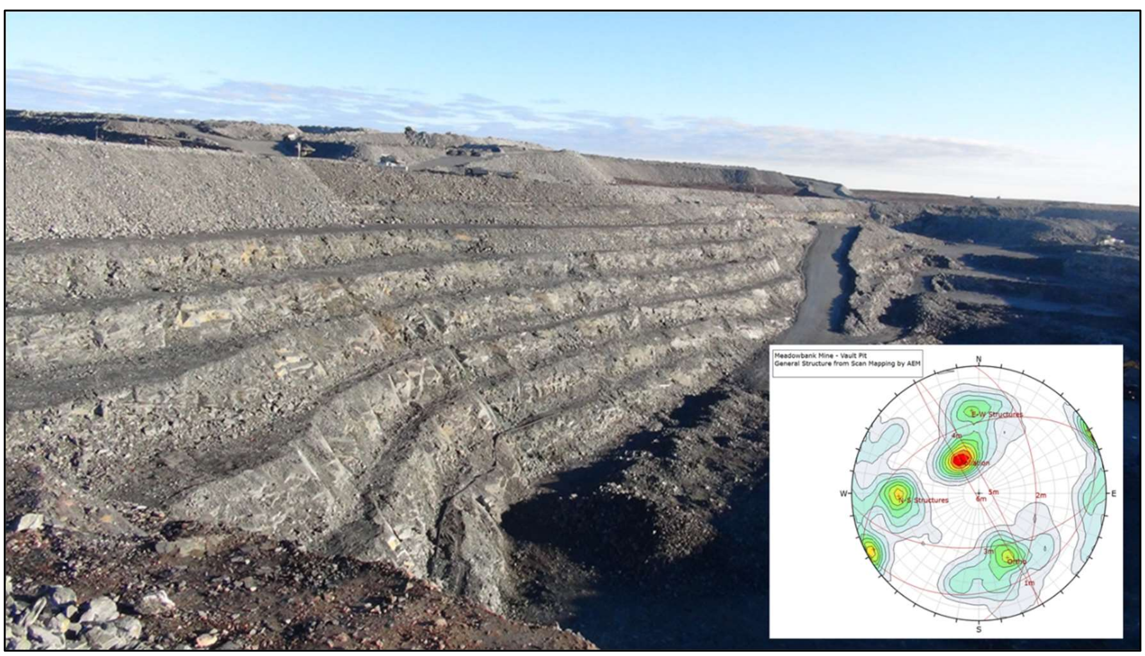

*Figure 8-3: Vault Pit seepage and pit inflows*

## 8.3 Footwall (Vault Grid West Wall)

The west wall (grid west) of the Vault is being mined as a series of single-benches (7m high) to create a footwall slope. The deposit dips at relatively shallow angles to the east (grid east), parallel to the foliation and stratigraphy. The average inclination is 22 degrees, but ranges from as shallow as 10 degrees to as steep as 40 degrees. Bench faces are pre-sheared at steep angles, and generally break back, or are scaled back, to the orientation of the foliation. Consequently there are some benches with considerable loss of catchment. This was anticipated during the design process, hence restricting benching to single benches to allow for this catchment loss. Within this Design Sector, average back break was estimated in the optimization study to be 1.3 m, with maximum back break of approximately 3 m (Golder, 2013). Observations of current performance are consistent with the predicted back break distances.

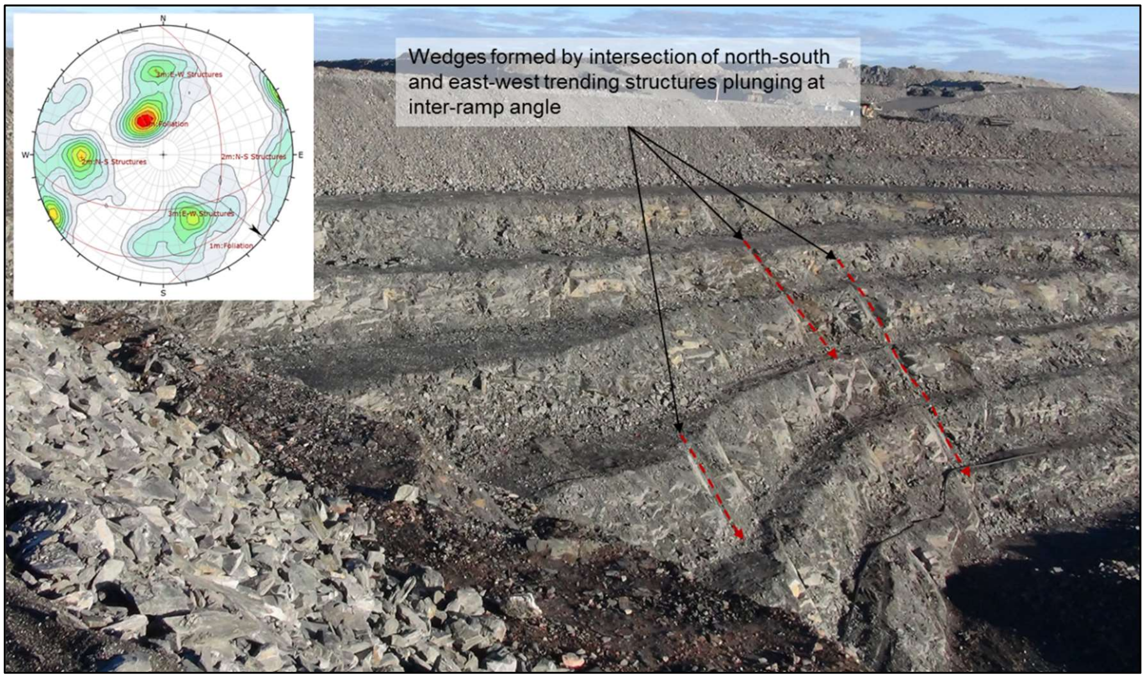
*Photograph 8-1: Vault Pit grid west footwall slope*

The inter-ramp slope angle is shallow at 33 degrees, and so the likelihood of larger scale multiple bench failures of significant volume is low. While there is catchment loss resulting from crest break-back, the benches are performing well. AEM report that operators have been instructed not to over-dig in order to minimize catchment loss.




*Photograph 8-2: Vault Pit grid west footwall slope, south end*

At the south end of the wall a series of closely spaced continuous fault structures trend into the wall at high angles. These are part of the east-west trending family of faults and sub-parallel joints which dip to the south at about 55 degrees. These features form narrow wedges with north-south trending faults and sub-parallel joints. The plunge of these wedges ranges from about 30 degrees to about 60 degrees, and where undercut by the inter-ramp angle have formed multiple bench features. These features are narrow and widely spaced, and because of the shallow inter-ramp angle result in only raveling of limited extent is observed.




*Photograph 8-3: Vault Pit grid west footwall slope south end wedges*

There are no significant geotechnical concerns noted, and no evidence of large scale (overall slope) instability for the footwall slope.

- Continue visual monitoring as part of regular site geotechnical inspections.

### 8.3.1 Footwall Seepage

An area of seepage adjacent to the ramp was observed. The seepage appears to be concordant with the foliation, and may be derived from hydraulic connection by the major east-west and north-south structures to talik beneath the dewatered Vault Lake. Currently, the seepage does not appear to be affecting the bench-scale stability of the rock above the ramp, but it is possible that with time some increased raveling of material will occur. This area should continue to be monitored as part of regularly scheduled geotechnical inspections, and a bumper berm developed if necessary. It is possible that over time this area will fully drain.

*Photograph 8-4: Vault Pit grid west wall seepage*

The presence of water will increase the susceptibility of this area above the ramp to continue to ravel over time. However the volume of material that may be dislodged is expected to be relatively small, and the use of bumper berms at the toe of the slope to redirect traffic and to prevent vehicles stopping in this area will be effective.

- Use bumper berms on ramp to manage material raveling from slope.

## 8.4 Southwest Wall (Vault Grid South Wall)

The southwest wall (grid south) intersects the stratigraphy and foliation perpendicular to their trend. The gently dipping structure can be seen clearly in the wall, as shown in the following photographs.

*Photograph 8-5: Vault Pit grid south wall transition*

*Photograph 8-6: Vault Pit grid south wall structure*

Pre-shearing of the walls has been effective for developing steep and final bench face angles. Although the bench faces are blocky in appearance, half-barrels from the drill holes are visible, and there is little accumulation of debris on the benches. While it was not possible to gain access for a bench traverse, observations of the two upper benches shown in the photograph below indicate these to have been cleaned well.

*Photograph 8-7: Vault Pit grid south wall upper catch benches*

There are no significant bench-scale geotechnical concerns noted for the grid south wall, and no evidence of large scale (overall slope) instability.

The following actions are recommended:

- Continue visual monitoring as part of regular site geotechnical inspections.

## 8.5 East Wall (Vault Grid East Wall)

The east wall (grid east) is being developed as a two-phase pushback. Phase 1 had been completed to a floor elevation of approximately 5081 mRL at the time of the site inspection, while Phase 2 had been developed to approximately 5130 mRL with drilling and blasting planned to start mining down on the pushback. The Phase 1 east wall is a temporary wall and has been developed using bulk blasting, while Phase 2 is a final wall and is being developed using pre-shear blasting methods.

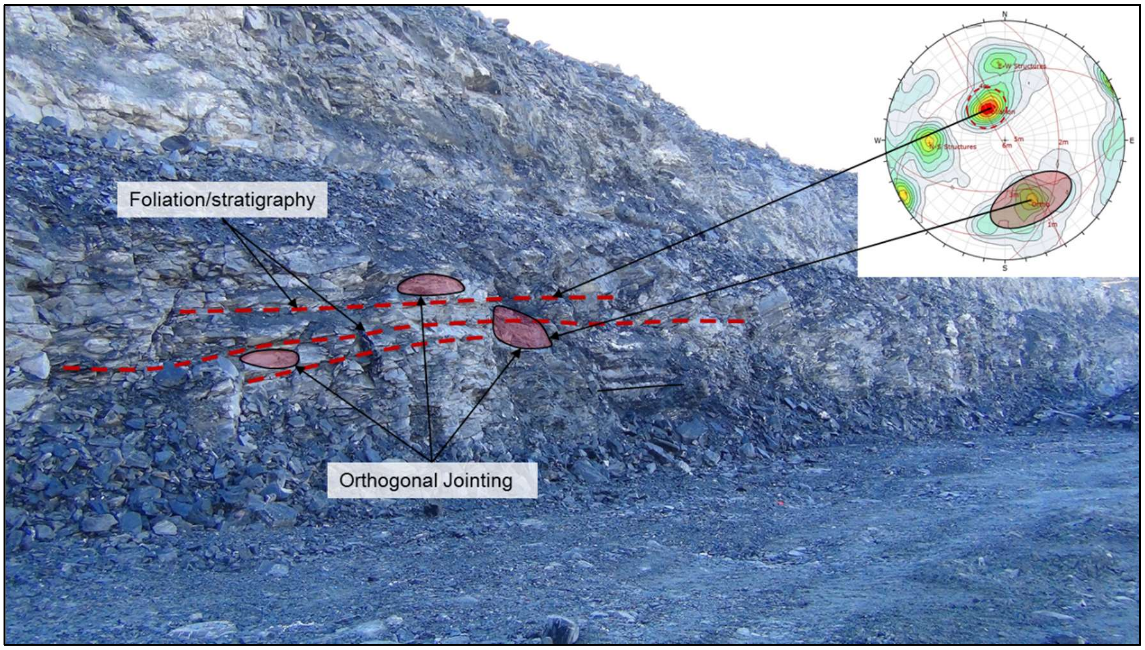
### 8.5.1 Phase 1 Pit East Wall (Grid East)

The following photograph shows the Phase 1 east wall development, looking northeast from the viewing platform.

*Photograph 8-8: Vault Pit Phase 1 east wall performance*

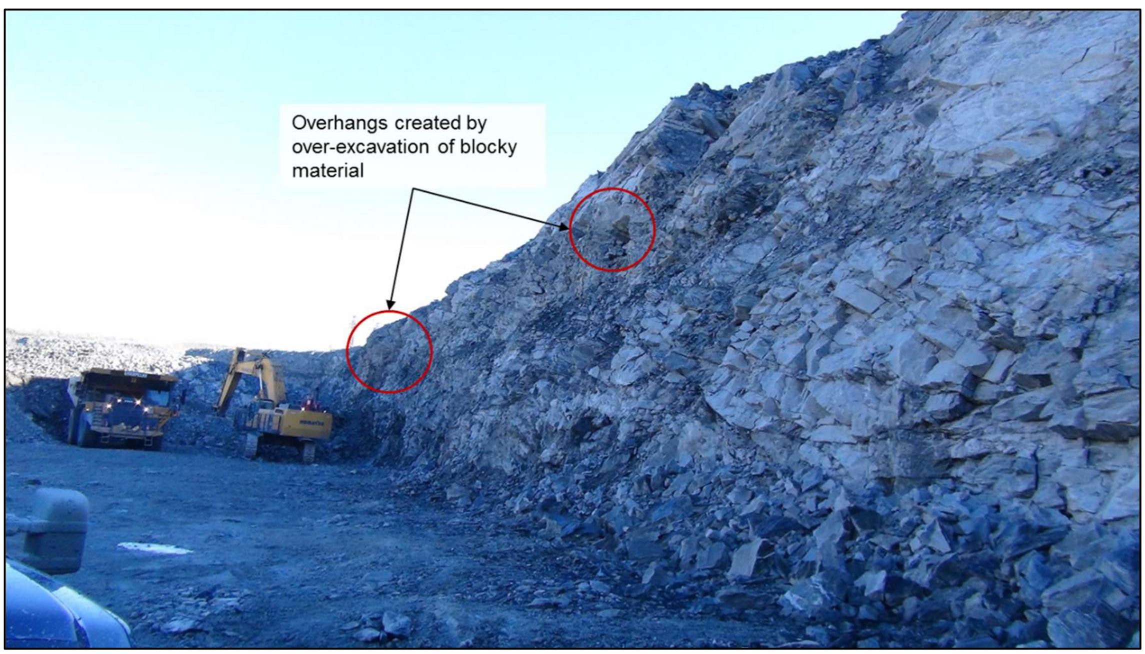
Although bulk blasting has been used to develop these walls, the bench face performance is relatively good, but blocky in appearance. There is very little crest loss and very little accumulation of debris on the benches. The debris that is observed on the benches in Photograph 8-8 is from spill-over of windrowed material along the crest of the bench above to develop a temporary safety berm.

The blocky nature of the benches results from the closely spaced foliation dipping into the wall, joint surfaces inclined out of the wall, and northwest-southeast trending joint sets. These are shown in the following photograph.




*Photograph 8-9: Vault Pit Phase 1 east wall structure*

The temporary benches are being scaled appropriately. In some instances over-excavation of the bench face has resulted in the creation of overhangs. Care should be exercised while operating beneath the temporary bench faces, and there should be no access to the face by personnel or light vehicles.




*Photograph 8-10: Vault Pit Phase 1 east wall overhangs*

There are no significant bench-scale geotechnical concerns noted for Phase 1 east wall, and no evidence of large scale (overall slope) instability.

The following actions are recommended:

- Light vehicle traffic and personnel should maintain a safe setback distance from the temporary bench faces.
- Continue visual monitoring as part of regular site geotechnical inspections.

### 8.5.2 Phase 2 Pit East Wall (Grid East)

At the time of the site visit the Phase 2 pit had not been advanced significantly from the 2014 inspection, and much of the exposed pit area consisted of bench cut in till, the ring road and thermal capping. Rock outcrop that is exposed is strongly fractured, and the till/bedrock interface forms an undulating and uneven surface around the edge of the pit.

*Photograph 8-11: Vault Pit Phase 2 5130 platform looking southeast*

### 8.5.3 Phase 2 Pit 5130 Seepage East Wall (Grid East)

On 16 September 2015, AEM reported an inflow of water on the 5130 bench, at the toe of the ring road and till slope. The level of water in the partially dewatered Vault Lake on the upstream side of the ring road was at 5134 mRL, resulting in a 4m head differential between the upstream and downstream side of the ring road.

The location of the inflow is shown in the following figure.

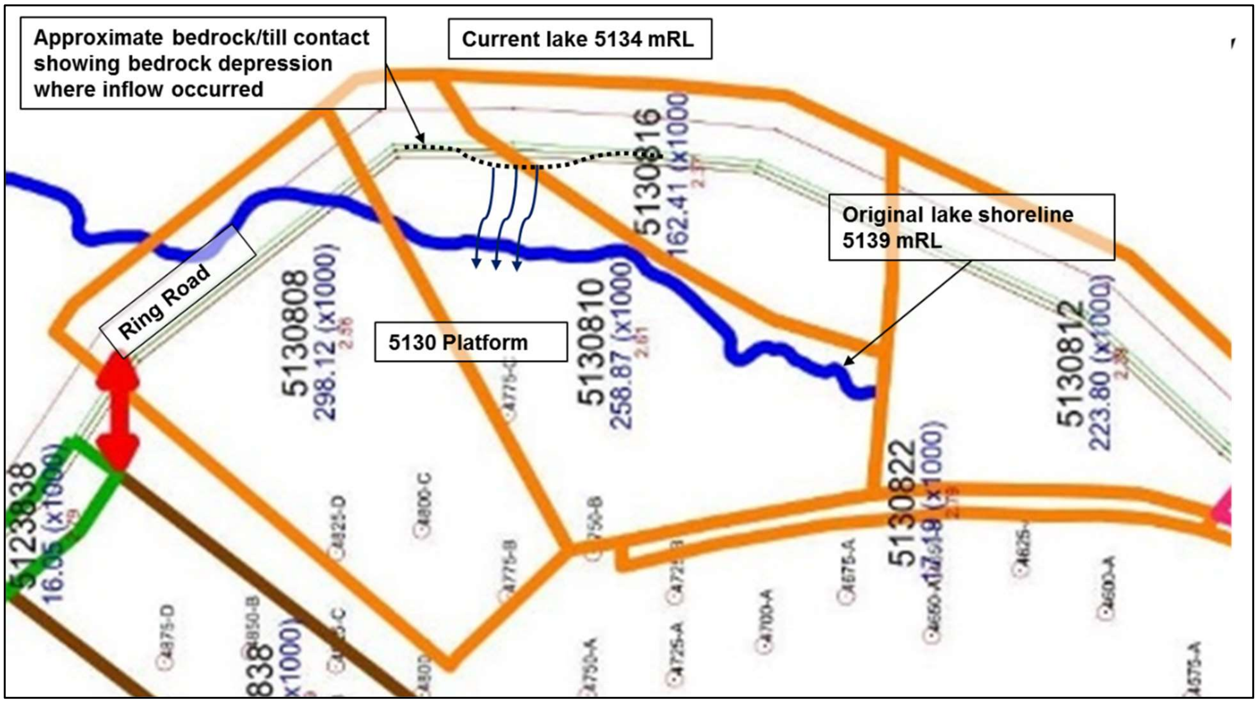



*Figure 8-4: Vault Pit inflow location on 5130 bench, grid east wall*

The following photographs show the inflow area on the downstream side of the ring road, and the lake level on the upstream side of the ring road.

*Photograph 8-12: Vault Pit flowing water from seepage face on downstream side of ring road (5130 mRL)*

*Photograph 8-13: Vault Lake on upstream side of ring road (5134 mRL)*

A review of the area indicated that the seepage was associated with a bedrock depression exposed in the till material of the ring road. The bedrock depression allowed a hydraulic connection to be formed with the partially dewatered Vault Lake so that water could flow through the depression and through the coarse rock fill used for construction of the ring road. Water flowing through the rock fill was clear, and so there was no indication that till material underlying the ring road was being eroded, which could potentially lead to instability. The rock fill overlying the till is relatively thin, as is the till. Even if erosion of the till were to occur, overall instability of the ring road is unlikely due to the relatively thin till profile. Some settlement of the ring road in this area was noted, and this can be remedied by hauling and dumping additional rock fill material to bring the ring road back up to grade.

Thermal modeling carried out during the 2013 optimization study noted that if this part of the pit were pushed back to intersect the talik beneath Vault Lake, then inflows to the pit are to be expected (Golder 2013). This is shown by the following steady state thermal figure from the 2013 report, which shows the east pit crest intersecting the talik beneath Vault Lake during initial mining of the pit in this area. Currently, the inflows to the pit that occurred on 16 September 2015 are consistent with the predictions of the thermal modeling.

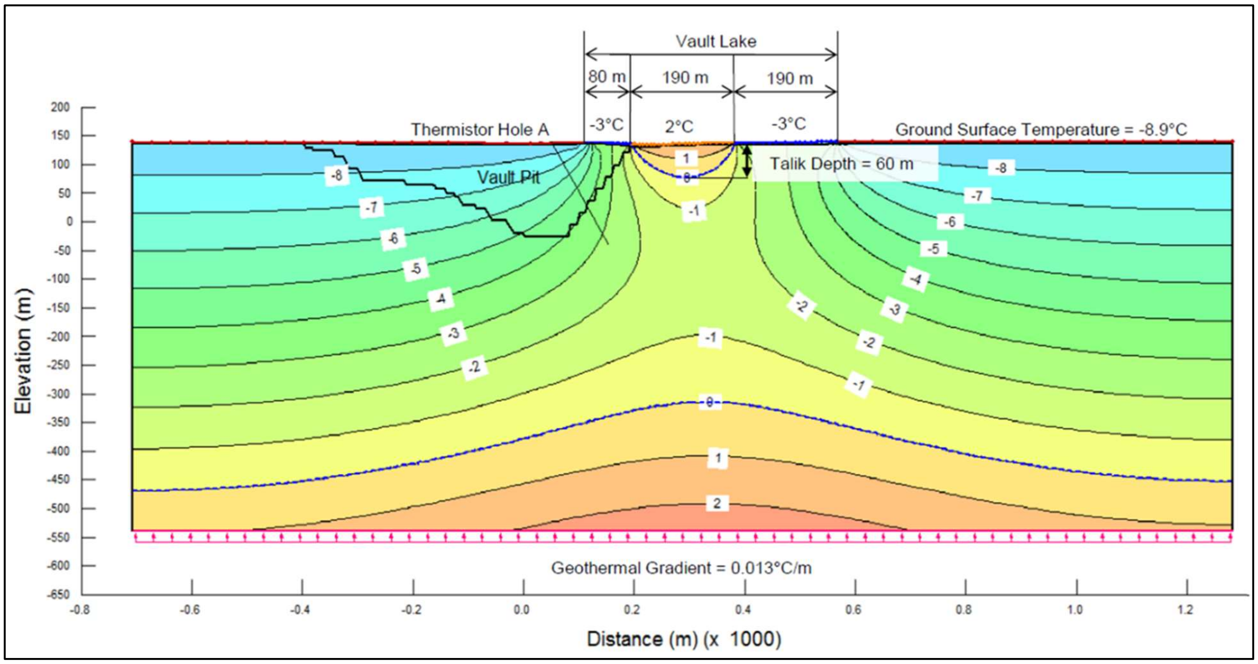



*Figure 8-5: Vault Pit steady state thermal model (Ref: Golder 2013)*

The thermal modeling also predicts that over time, permafrost will develop into the talik area, eventually preventing further inflows (after the first full bench has been excavated). It is important that AEM monitor this condition next year to confirm the observed seepage behaviour remains consistent with the predictions of the thermal model. The optimized slope design criteria and the slope stability relies on the predictions that the development of permafrost and continued isolation of the talik will act as a barrier to groundwater, so that no groundwater pressures will exist behind the wall.

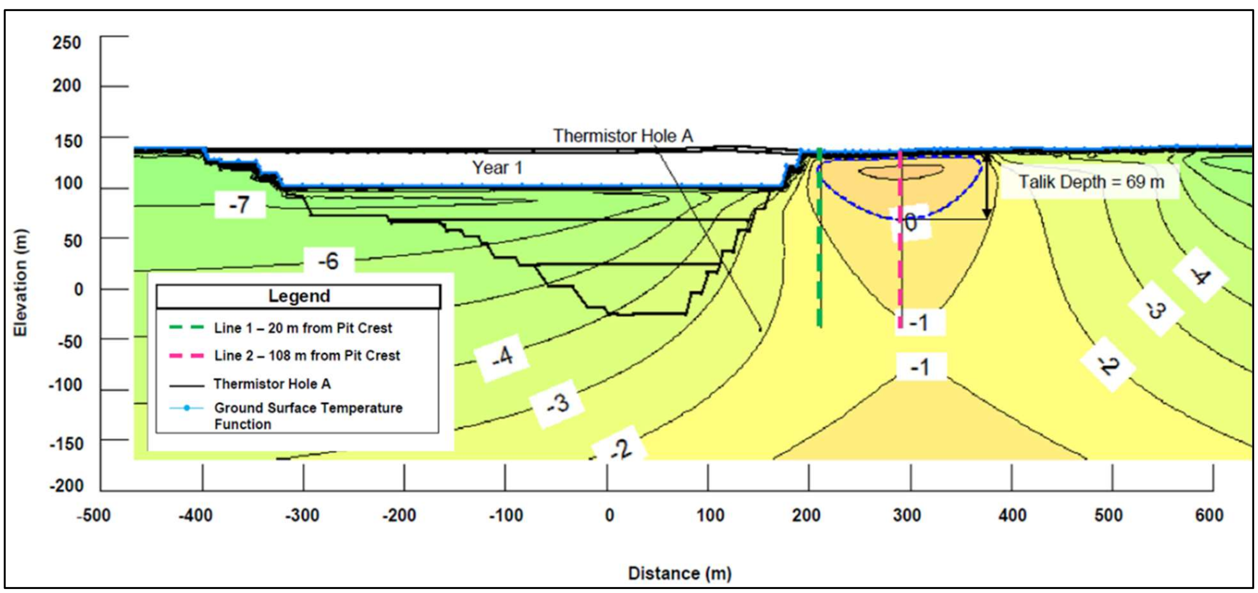



*Figure 8-6: Vault Pit transient thermal model, Year 1 (Ref: Golder 2013)*

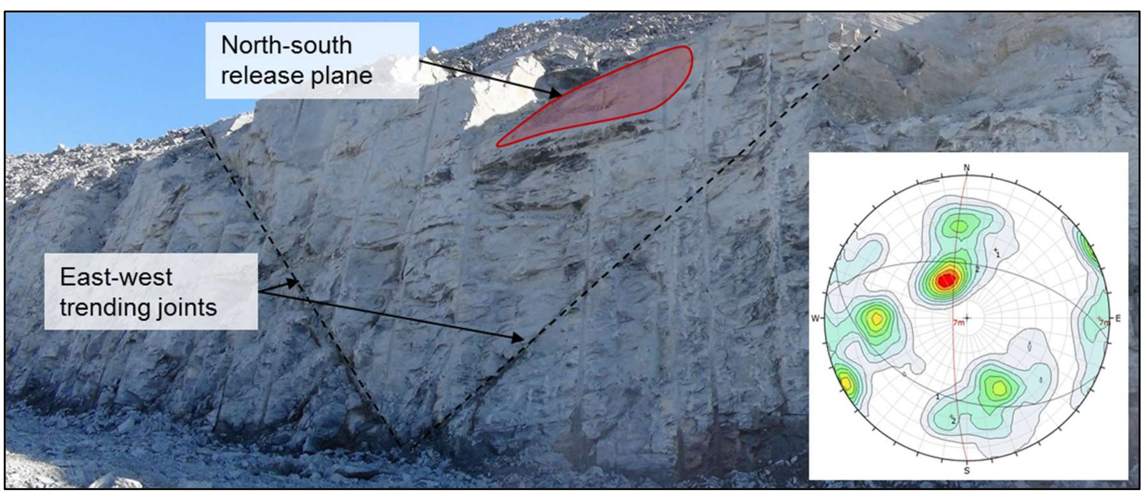
The wall should be observed generally to be dry. If significant seepage is observed from the wall at various bench levels during next year's thaw period, combined thermistor and piezometer tips should be installed behind the wall to define the thermal and groundwater pressure conditions, and compare these to model predictions.

The following actions are recommended.

- Lower the water level in Vault Lake to reduce inflows through the ring road.
- If settlement of the ring road is noted, use road rock fill material to bring back to grade. Monitor for the development of tension cracks within the road surface. Restrict access on the downstream side of the ring road in the immediate area of the seepage.
- Continue visual monitoring of the inflows as part of regular site geotechnical inspections.
- Review inflow observations during the next annual pit inspection, and compare observations to thermal model predictions from 2013 optimization study (Golder 2013).
- If significant inflows continue to be observed during 2016 summer thaw period, install piezometers and thermistor behind the wall, record observed conditions, and compare with predicted conditions.
- If observed conditions are not consistent with the predicted conditions it may be necessary to review the optimized slope stability in the context of new data.

### 8.5.4 Phase 2 East Wall (Grid East) Wedge

A large wedge was observed at the north end of the east wall on the 5109 platform. The wedge is formed by intersecting east-west trending structures which are inclined to the north and south, as shown in the following photograph.




*Photograph 8-14: Vault Pit Phase 2 grid east wall wedge*

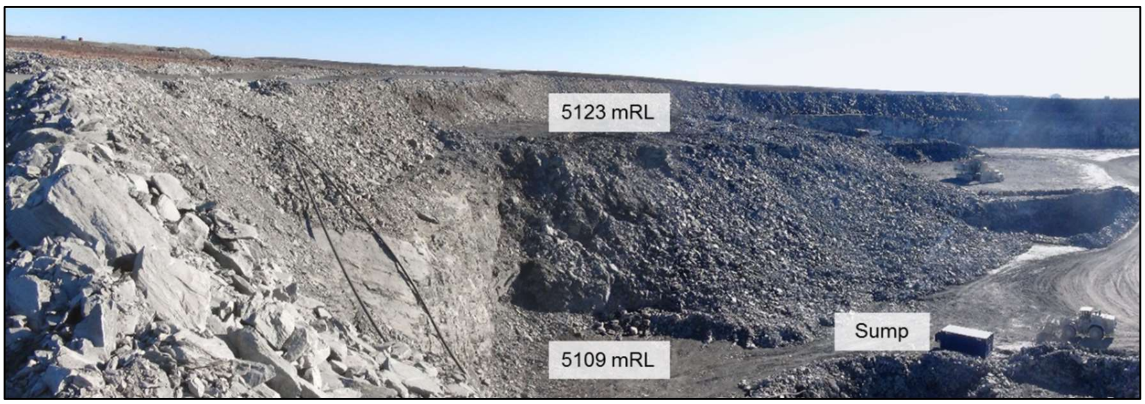
The plunge of these wedges is shallow, less than 10 degrees. Consequently it is not anticipated that these will present bench-scale or multiple bench scale stability issues as the pit is developed. Nevertheless, as the pit continues to be mined, these should continue to be monitored for changes in orientation. The presence of steeply west dipping back release planes could also present the risk of smaller scale planar failures and so light vehicle traffic and personnel should maintain a safe setback distance from the bench faces.

The following actions are recommended:

- Light vehicle traffic and personnel should maintain a safe setback distance from the temporary bench faces.
- Continue visual monitoring as part of regular site geotechnical inspections.

## 8.6 Vault Grid North Wall

The Vault north wall (grid north) transitions from the west wall to the east wall. At the time of the site visit the pit floor at the north end of the pit was at 5109 mRL, and mucking of the 5123 bench was underway. There is a sump near the base of the wall at the northwest corner.




*Photograph 8-15: Vault Pit north transition wall*

### 8.6.1 North Transition Wall Seepage

Seepage was noted along a south dipping joint feature in the bench face near the sump.

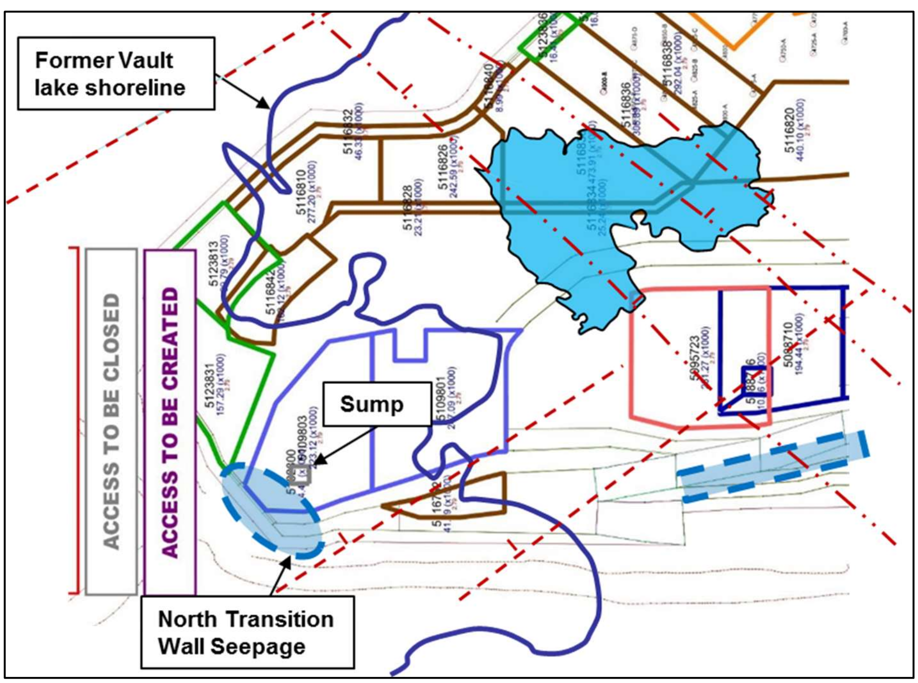



*Figure 8-7: Vault Pit north transition wall seepage*

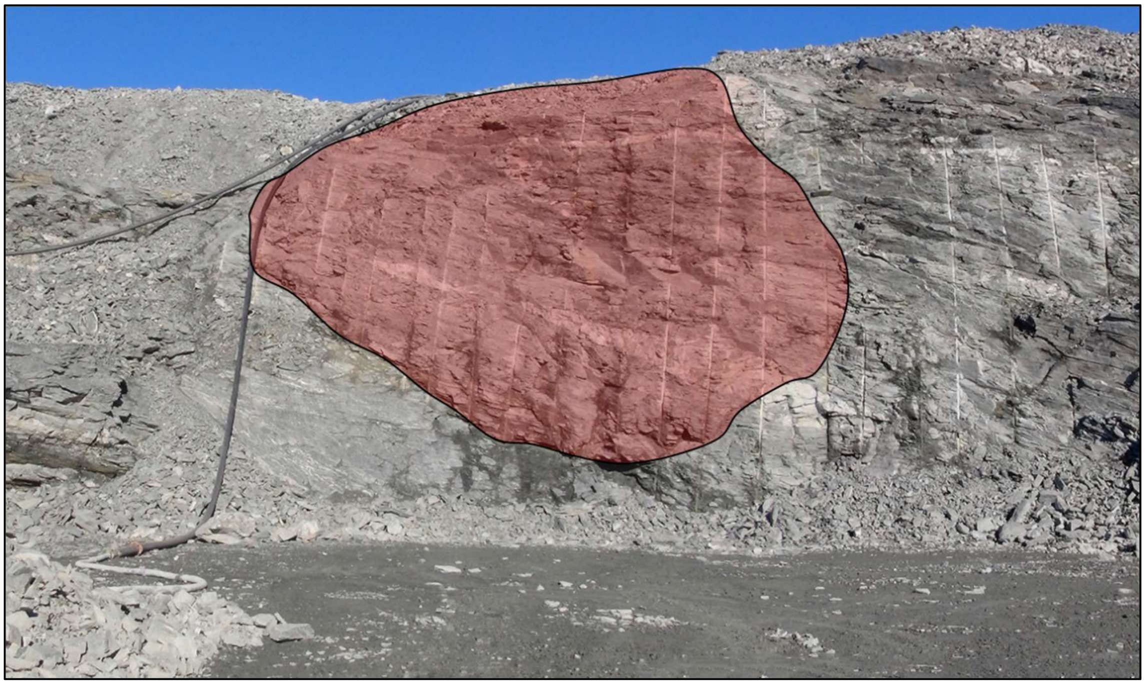
*Photograph 8-16: Vault Pit north transition wall seepage near sump*

While it is not immediately clear the source of the water, the northwest end of the pit is developed in the former lake bed of the dewatered Vault Lake. Furthermore, a water management pond – Pond A – is located to the north of the haul road which separates Pond A from the seepage area. Pond A is shown in the following photograph.

*Photograph 8-17: Vault Pit Pond A water management pond*

It is possible the seepage source is release of water stored in the talik beneath Vault Lake, or potentially seepage from Pond A. However, flows are low and are not likely to result in the formation of significant ice.

There is a wedge formed by the joint plane along which seepage is occurring, and other joint planes trending into the rock face. The proximity of the haul road to the bench crest in this area, and the geometry of the potential back release plane is such that if this wedge were to fail a section of the haul road could be compromised.



*Photograph 8-18: Vault Pit north transition wall wedge*

The geometry of the back release plane is such that this wedge could be supported by bolting, and this should be considered. In the interim, a bumper berm should be placed at the base of the wedge to maintain traffic or personnel at a safe setback distance. Water lines from the sump should be moved so that if failure were to occur it would not compromise the effectiveness of the water management system.

The following actions are recommended:

- Light vehicle traffic and personnel should maintain a safe setback distance from the temporary bench faces.
- Move water lines away from wedge area.
- Consider bolting.
- Continue visual monitoring as part of regular site geotechnical inspections.

# 9.0 SUMMARY OF KEY OBSERVATIONS AND RECOMMENDATIONS

## 9.1 Portage Pit

The Portage Pit is subdivided into 5 pits, labelled A through E from north to south.

### 9.1.1 Pit A

At the time of the site visit the Pit A platform was inactive. Since the 2014 site visit the pit has only been deepened by a single bench from 5053 mRL to 5046 mRL. The west, north and east walls of the pit continue to perform well. There are no significant geotechnical concerns for Pit A.

The following is a summary of the inspection and associated action items:

- West Wall
  - The west wall continues to perform adequately. There are no significant geotechnical concerns for the west wall.
- A small bumper berm may be required to contain rock that may ravel from poor quality ultramafic rock on 5051 mRL bench.
  - The 5109 mRL bench instability noted during previous inspections has shown no indication of increased instability.
  - Continue visual monitoring of areas of potential instability as part of regular site geotechnical investigations.
- North Wall
  - The north wall continues to perform adequately. There are no significant geotechnical concerns for the north wall.
  - Continue visual monitoring as part of regular site geotechnical inspections.
- East Wall
  - The east wall continues to perform adequately. There are no significant geotechnical concerns for the east wall.
  - The wedge in the east wall identified during the 2014 inspection shows no sign of instability. A wedge stability analysis carried out by AEM is consistent with field observations.
  - Continue visual monitoring as part of regular site geotechnical inspections.
- East Wall Ramp Tension Cracks
  - Tension cracks were observed at the crest of the east wall ramp of 2011 and this area has continued to be monitored as part of the annual inspections.
  - After annual observation for 4 years, there is no indication these are indicative of any larger scale instability and this specific area of inspection can be removed from future annual inspections.

### 9.1.2 Pit B

Mining of Pit B is complete and it continues to be backfilled as a waste rock dump. Access to the pit is limited as the main ramp on the west wall has been closed. There are no significant geotechnical concerns for Pit B.

The following is a summary of the inspection and associated action items:

- West Wall
  - The west wall continues to perform adequately. There are no significant geotechnical concerns for the west wall.
  - Continue visual monitoring of areas of potential instability as part of regular site geotechnical investigations.
- East Wall
  - The east wall continues to perform adequately. There are no significant geotechnical concerns for the east wall.
  - Continue visual monitoring as part of regular site geotechnical inspections.
- Pit B Dump
  - The dump is performing adequately, and no tension cracks were observed in the crest area.
  - Continue visual monitoring of areas of potential instability as part of regular site geotechnical investigations.

### 9.1.3 Pits C and D

Mining is complete at both pits and they are backfilled as waste rock dumps. Access was limited. There are no significant concerns for Pits C and D.

The following is a summary of the inspection and associated action items:

- The dumps are performing adequately, and no tension cracks were observed in the crest areas, where access was possible.
- It was not possible to inspect an area of the Dump D crest which was observed in 2014 to have tension cracks. However, the dump face and toe were observed to show no indications of instability.
- Continue visual monitoring of areas of potential instability as part of regular site geotechnical investigations.

### 9.1.4 Pit E

At the time of the site visit the floor platform elevation at Pit E3 was at 5039 mRL. There are 7 benches remaining to be mined at Pit E3, to a final planned elevation of 4983 mRL, with a target completion of Q3 2017. There are no significant geotechnical concerns for Pit E3 east and west wall. Pit E3 south wall has experienced significant instability, and AEM are currently developing a plan to mitigate the instability and manage risk.

- East Wall

  - The east wall continues to perform well. The wall is predominantly within permafrost. There are no significant geotechnical concerns for the east wall.
  - Continue visual monitoring as part of regular site geotechnical inspections.
  - Continue to scale and clean final benches.
- South Wall
  - The south wall has experienced multiple bench-scale failures of the ultramafic rock.
  - The area has been designated no entry until remedial measures are undertaken to stabilize and monitor the wall, including slope depressurization, crest unloading, and installation of additional slope monitoring installation.
  - The mechanism of failure is well understood, and the contributing factors are the complex geology and structure, the absence of permafrost and the presence of groundwater.
  - The engineering geology model and stability analyses indicate the failure behind the crest will be limited to the depth of the ultramafic rock and will not extend back to the dewatering dike.
  - AEM are in the process of designing a program to stabilize the slope, and to install additional instrumentation such as piezometers, TDR cables, and thermistors.
  - Monitoring of the slope using the GroundProbe radar is currently the most effective method for managing risk. Monitoring should continue with diligence, and vigilance.
- West Wall
  - The upper benches of the west wall are performing adequately, although there has been some crest and catchment loss in areas where the orthogonal joint set dips out of the slope and is undercut by the steep bench faces.
  - The lower benches of the west wall exhibit localized bench-scale instability associated with the weaker ultramafic rock exposed at the base of the wall, and adverse structure (shearing within the ultramafic rock) inclined into the walls and resulting in overhangs associated with the outward dipping orthogonal set.
  - The areas of the wall within permafrost perform better than those areas that are in thawed ground. Seepage faces occur where the ground is thawed and these areas may exhibit instability during spring thaw.
  - Continue visual monitoring as part of regular site geotechnical inspections.

### 9.1.5 Pit E West Wall Ramp

The Pit E3 ramp is situated on the west wall of the pit, and descends to the south into the pit. Several areas of potential instability were noted in the benches of the ramp. A rock fall containment berm along the west side of the ramp is being used to effectively manage the risk of rock falls from the areas of potential instability. The ultramafic rock below the ramp is strongly sheared, but is currently performing well.

- Maintain the rock fall containment berm on the ramp.

- Continue to carefully scale the ultramafic rock below the ramp, and instruct operators not to over-excavate.
- Continue visual monitoring as part of regular site geotechnical inspections.

### 9.1.6 Pit E3 Pushback South and East Wall

In general, the bench performance of the pushback areas is satisfactory, although bench crests tend to be ragged with some over-break, and areas where structure has been undercut. The relatively good performance of the walls is attributable in part to the iron formation and volcanic rock forming significant proportions of the wall, and the presence of permafrost.

The following actions are recommended:

- Continue careful scaling and bench cleaning as the pushback is deepened.
- Instruct operators not to over-excavate.
- Continue visual monitoring as part of regular site geotechnical inspections.

## 9.2 Goose Pit

Mining has been completed at Goose pit to a final floor elevation of 4997 mRL. Waste rock has been end-dumped into the northwest corner of the pit near the access ramp entry, using the pit as a short-haul dump. A pit lake has formed, and is at an elevation of 5031.18 mRL (15 October 2015).

There are no significant geotechnical concerns relating to the pit slopes in Goose pit; however tension cracks on the Goose waste rock dump platform were noted. The following is a summary of the inspection and associated action items:

- The Goose pit slopes continue to perform adequately.
- During the inspection a series of tension cracks were identified on the waste rock dump platform. This area is now classified as no entry, and a rock fill berm is in place to prevent access.
- If the dump is to be reactivated, an inspection should first be undertaken, followed by the development of an action plan which might include increased frequency of inspections, and monitoring and instrumentation.
- Continue visual monitoring of both the pit and the waste dump as part of regular site geotechnical inspections.

### 9.2.1 Slope Monitoring Instrumentation

There have been no significant changes to the TDR or thermistor response patterns. With the exception of piezometer tip PZ4c in GPIT-14, pressure heads have remained constant. Tip PZ4c exhibited a sudden pressure rise in 2013 followed by a gradual reduction in pressure to steady-state conditions; a similar pressure increase has been noted in 2015 but there are insufficient data yet to determine if the trend in gradual pressure reduction will also be repeated. This presents no risk to pit slope or waste dump stability at this time, but should be reviewed again next year.

## 9.3 Vault Pit

Mining of the Vault Pit has advanced significantly since the 2014 inspection, providing the first opportunity to evaluate the performance of the pit slopes. In general, the pit slopes are performing as anticipated, and there are currently no significant geotechnical concerns.

AEM has carried out mapping using Lidar scan images to digitize structure and compare with the orientations used to develop the optimized wall configurations (2013), complying with a recommendation from the 2014 inspection. The structural orientations from the mapping are generally consistent with the orientations used in the design study.

Water inflows and seepage were noted in a number of areas of the pit. An inflow along the east wall was in response to the wall pushback into a talik beneath the former Vault Lake, and to the lake area being managed with a relatively high water surface at 5134.1 mRL. As noted in the 2014 inspection report, any push-back of the east-southeast highwall should include a re-evaluation of the slope stability as the optimized design (2013) assumed the wall to remain frozen (with the exception of the upper bench). A push-back of the highwall will place it in the unfrozen talik beneath Vault Lake, and may change the conditions for the stability of the slope.

### 9.3.1 Footwall (Vault Grid West Wall)

The wall is being mined as a series of single benches (7m high) to create a footwall slope. The slope follows the inclination of the ore which is inclined to the east, parallel with foliation and stratigraphy.

There are no significant geotechnical concerns noted, and no evidence of large scale (overall slope) instability for the footwall slope. The following is a summary of the inspection and associated action items:

- The low benches are used to manage undercutting of the east dipping stratigraphy, and minimize potential failure volumes.
- Bench faces are pre-sheared at steep angles but break back to the orientation of the foliation and stratigraphy. The shallow slope and low bench heights allow wedge failures to be effectively managed.
- An area of seepage adjacent to the ramp may be derived from a hydraulic connection to east-west and north-south structures connecting with the talik beneath the dewatered Vault Lake. If increased raveling is noted, it may be necessary to construct bumper berms in this area
- Continue visual monitoring as part of regular site geotechnical inspections.

### 9.3.2 Southwest Wall (Vault Grid South Wall)

The stratigraphy intersects the south wall at right angles. There are no significant geotechnical concerns noted, and no evidence of large scale (overall slope) instability for the slope.

The following is a summary of the inspection and associated action items:

- The stratigraphy intersects the south wall at right angles.
- Pre-shearing of the walls has been effective for developing steep bench faces, although these can be blocky in appearance.
- The benches are being appropriately cleaned and scaled.
- Continue visual monitoring as part of regular site geotechnical inspections.

### 9.3.3 East Wall (Vault Grid East Wall)

The east wall (grid east) is being developed as a two-phase pushback. Phase 1 had been completed to a floor elevation of approximately 5081 mRL at the time of the site inspection, while Phase 2 had not been significantly developed since the 2014 inspection. There are no significant geotechnical concerns noted, and no evidence of large scale (overall slope) instability for the slope. The following is a summary of the inspection and associated action items:

- The Phase 1 east wall is a temporary wall and has been developed using bulk blasting.
  - Bench performance is good despite bulk blasting, although blocky in appearance.
  - Exercise care while operating beneath the temporary benches.
  - Light vehicle traffic and personnel should maintain a safe setback distance from temporary bench faces.
  - Continue visual monitoring as part of regular site geotechnical inspections.
- Phase 2 is a final wall and is being developed using pre-shear blasting methods.
  - There has been no significant advancement of the Phase 2 pit from the 2014 inspection.
  - An inflow of water to the Vault pit along the east wall through the ring road occurred on 16 September 2015.
  - This was reviewed and determined to be a response to pushback of the wall to intersect the talik beneath former Vault Lake, and also to operation of Vault Lake at an elevation of 5134 mRL, approximately 4 m higher than the downstream side of the ring road.
  - Lower the water level in Vault Lake to reduce inflows through the ring road.
  - If settlement of the ring road is noted, use road rock fill material to bring back to grade. Monitor for the development of tension cracks within the road surface. Restrict access on the downstream side of the ring road in the immediate area of the seepage.
  - Continue visual monitoring of the inflows as part of regular site geotechnical inspections.
  - Review inflow observations during the next annual pit inspection, and compare observations to thermal model predictions from 2013 optimization study (Golder 2013).
  - If significant inflows continue to be observed during 2016 summer thaw period, install piezometers and thermistor behind the wall, record observed conditions, and compare with predicted conditions.
  - If observed conditions are not consistent with the predicted conditions it may be necessary to review the optimized slope stability in the context of new data.
- A large wedge was observed on the north of the east wall.
  - The plunge of the wedge is shallow, less than 10 degrees, and so it is not expected that this wedge will result in slope instability.
  - Light vehicle traffic and personnel should maintain a safe setback distance from the temporary bench faces.
  - Continue visual monitoring as part of regular site geotechnical inspections.

### 9.3.4 Vault Grid North Wall

The Vault north wall (grid north) transitions from the west wall to the east wall. There is a sump near the base of the wall at the northwest corner.

- A wedge in the northwest corner is associated with seepage along its base.
  - If the wedge were to fail, it could compromise the haul road at the crest.
  - Light vehicle traffic and personnel should maintain a safe setback distance from the temporary bench faces.
  - Move water lines away from wedge area.
  - Consider bolting.
- Continue visual monitoring as part of regular site geotechnical inspections.

## 9.4 Geotechnical Mapping and Surveying

Geotechnical and structural information should continue to be collected form all operational pits. This is most efficiently and safely accomplished using the Lidar scanner coupled with processing using MapTek software. Any areas that may potentially pose risk of instability should be surveyed, and assessed.

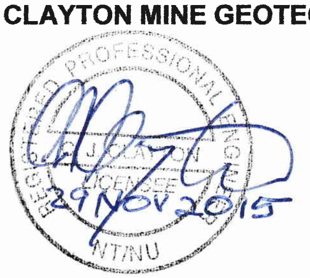
Areas of seepage in the pits should be surveyed and compiled into the overall site geotechnical management plan.

# 10.0 CLOSURE

The reader is referred to the Study Limitations which precede the text and forms an integral part of this report.

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

**CJ CLAYTON MINE GEOTECHNICAL SERVICES LTD.**




Cameron Clayton, P.Eng., P.Geo. (BC, NU, NT)
Principal Engineer
CJC/cjc

\\sp3\users\cameron\desktop\projects\2015-01_annualslopeinspection\documents\reporting\rpt001-pn2015-01_2015pitinspection_final.docx

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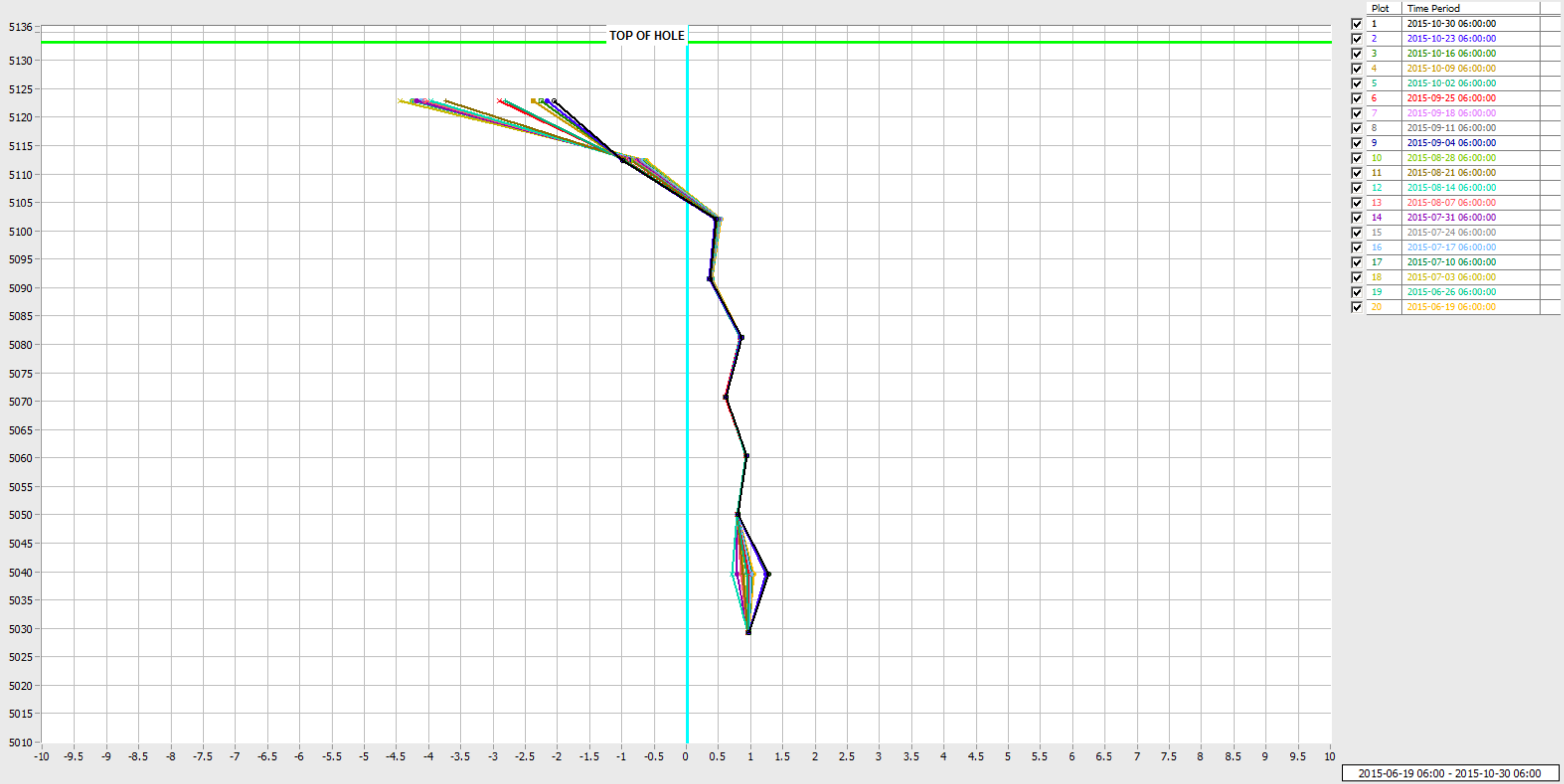
# APPENDIX A

## 2015 Goose Pit Thermistor, TDR, and Piezometer Data

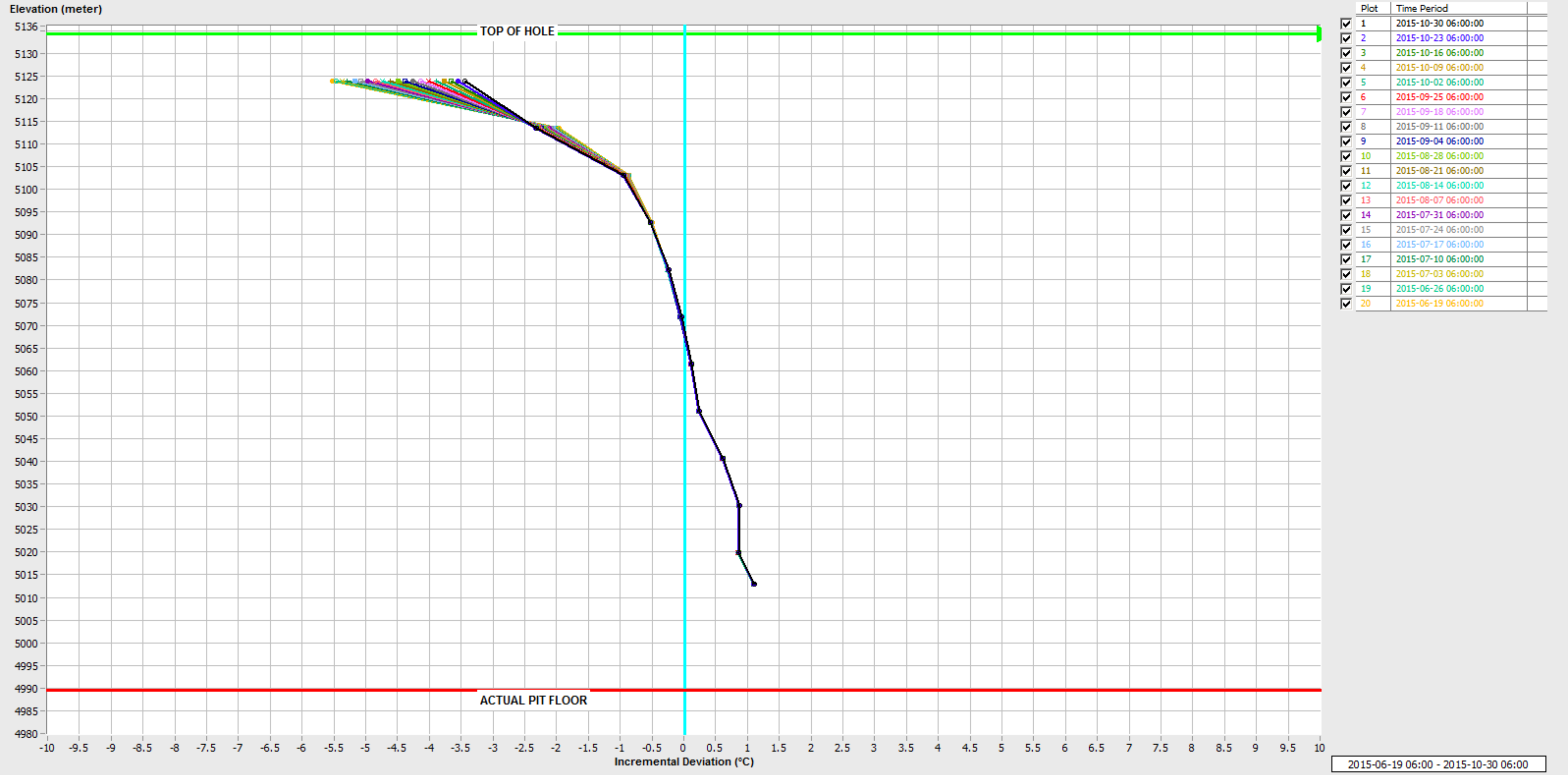
# Appendix A-1
# 2015 Goose Pit Thermistor Data

## GPIT13 Temp Profile



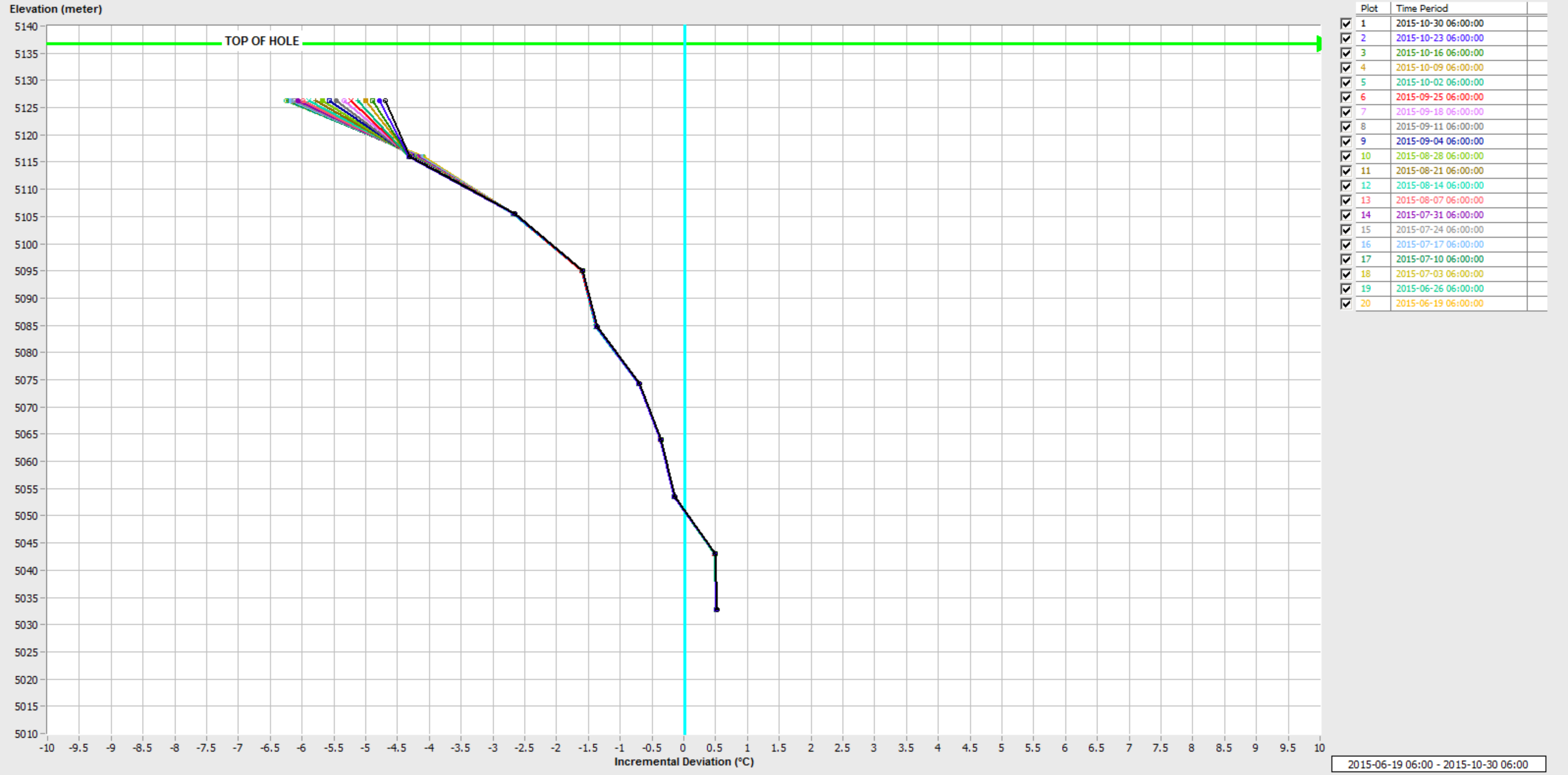

GPIT14 Temp Profile
Elevation (meter)
TOP OF HOLE
ACTUAL PIT FLOOR
Incremental Deviation (°C)
Plot
Time Period
1 2015-10-30 06:00:00
2 2015-10-23 06:00:00
3 2015-10-16 06:00:00
4 2015-10-09 06:00:00
5 2015-10-02 06:00:00
6 2015-09-25 06:00:00
7 2015-09-18 06:00:00
8 2015-09-11 06:00:00
9 2015-09-04 06:00:00
10 2015-08-28 06:00:00
11 2015-08-21 06:00:00
12 2015-08-14 06:00:00
13 2015-08-07 06:00:00
14 2015-07-31 06:00:00
15 2015-07-24 06:00:00
16 2015-07-17 06:00:00
17 2015-07-10 06:00:00
18 2015-07-03 06:00:00
19 2015-06-26 06:00:00
20 2015-06-19 06:00:00
2015-06-19 06:00 - 2015-10-30 06:00
Copyright © Vista Engineering 2004-11

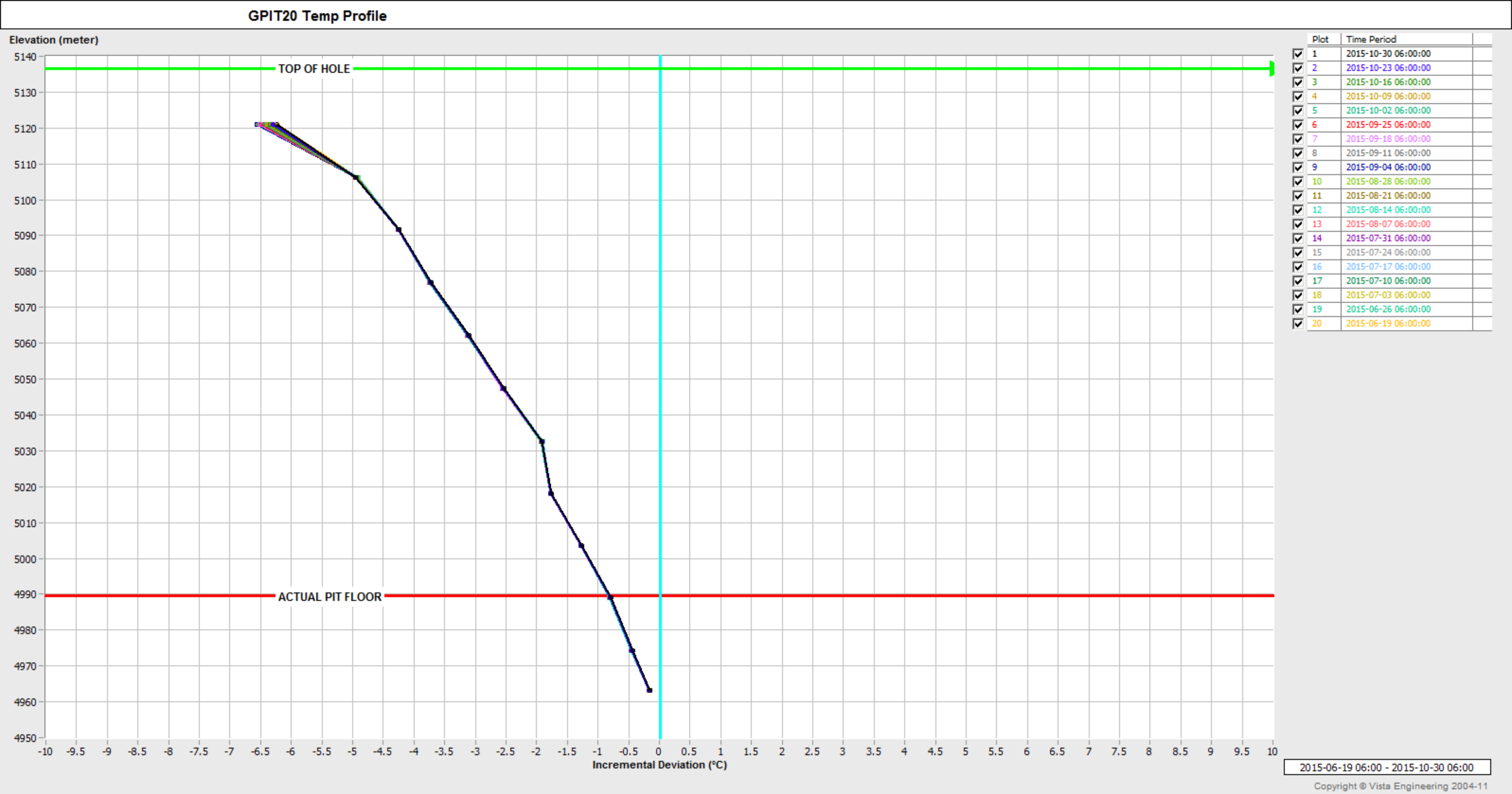
# GPIT16 Temp Profile



## GPIT17 Temp Profile

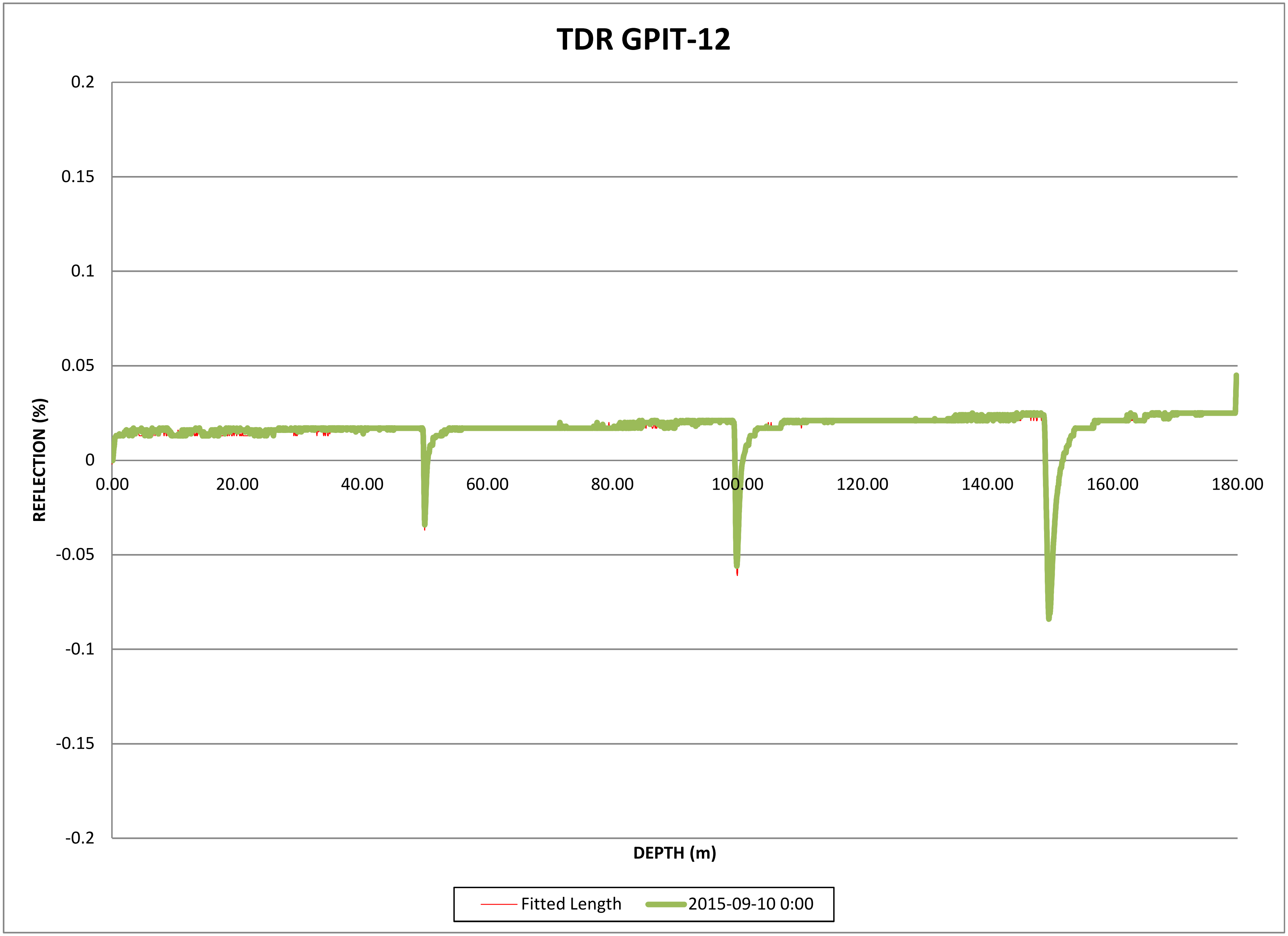
# GPIT19 Temp Profile



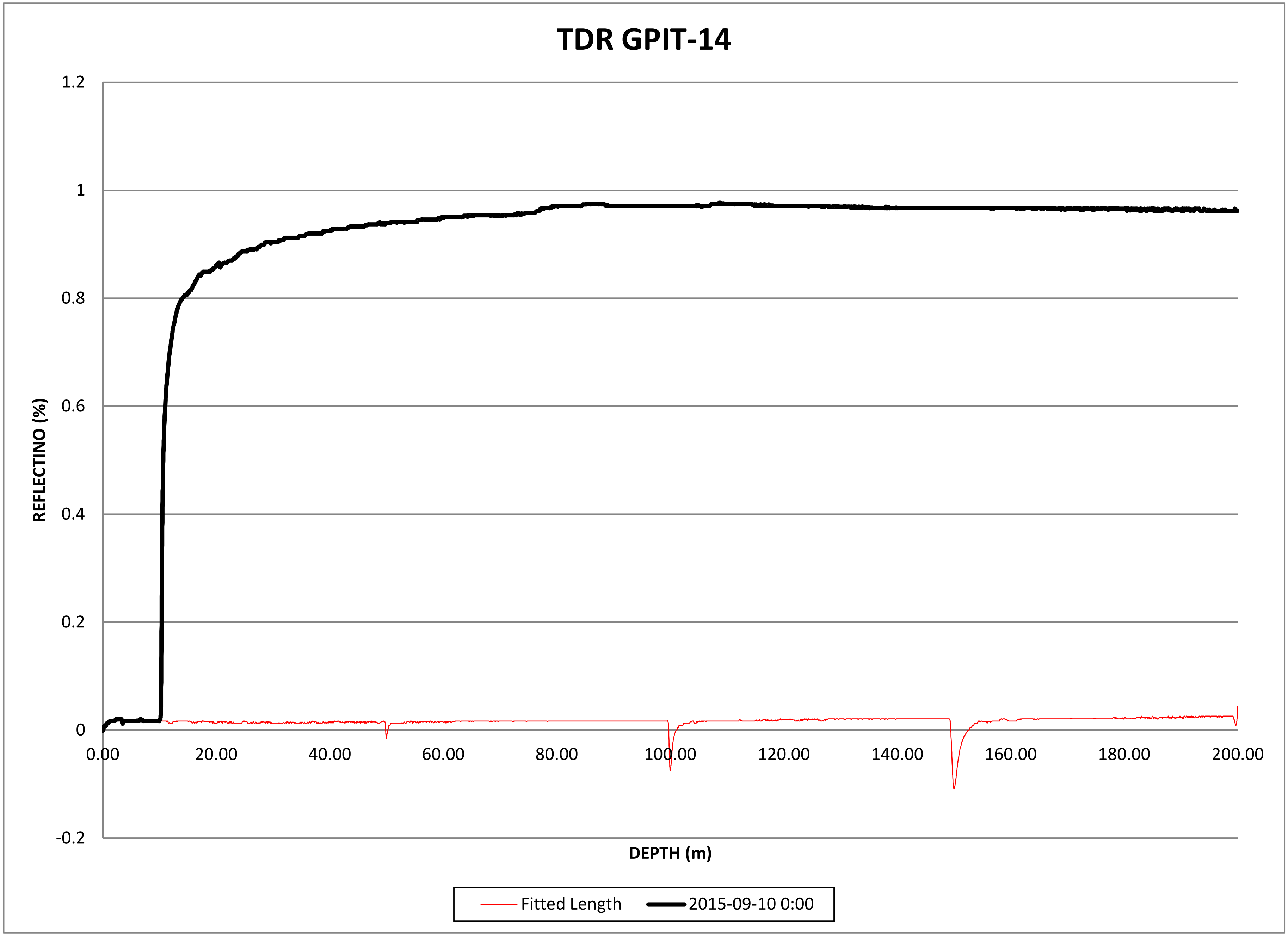

GPIT20 Temp Profile
Elevation (meter)
5140
5130
5120
5110
5100
5090
5080
5070
5060
5050
5040
5030
5020
5010
5000
4990
4980
4970
4960
4950
TOP OF HOLE
ACTUAL PIT FLOOR
-10 -9.5 -9 -8.5 -8 -7.5 -7 -6.5 -6 -5.5 -5 -4.5 -4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10
Incremental Deviation (°C)
Plot Time Period
1 2015-10-30 06:00:00
2 2015-10-23 06:00:00
3 2015-10-16 06:00:00
4 2015-10-09 06:00:00
5 2015-10-02 06:00:00
6 2015-09-25 06:00:00
7 2015-09-18 06:00:00
8 2015-09-11 06:00:00
9 2015-09-04 06:00:00
10 2015-08-28 06:00:00
11 2015-08-21 06:00:00
12 2015-08-14 06:00:00
13 2015-08-07 06:00:00
14 2015-07-31 06:00:00
15 2015-07-24 06:00:00
16 2015-07-17 06:00:00
17 2015-07-10 06:00:00
18 2015-07-03 06:00:00
19 2015-06-26 06:00:00
20 2015-06-19 06:00:00
2015-06-19 06:00 - 2015-10-30 06:00
Copyright © Vista Engineering 2004-11

# Appendix A-2
# 2015 Goose Pit TDR Data

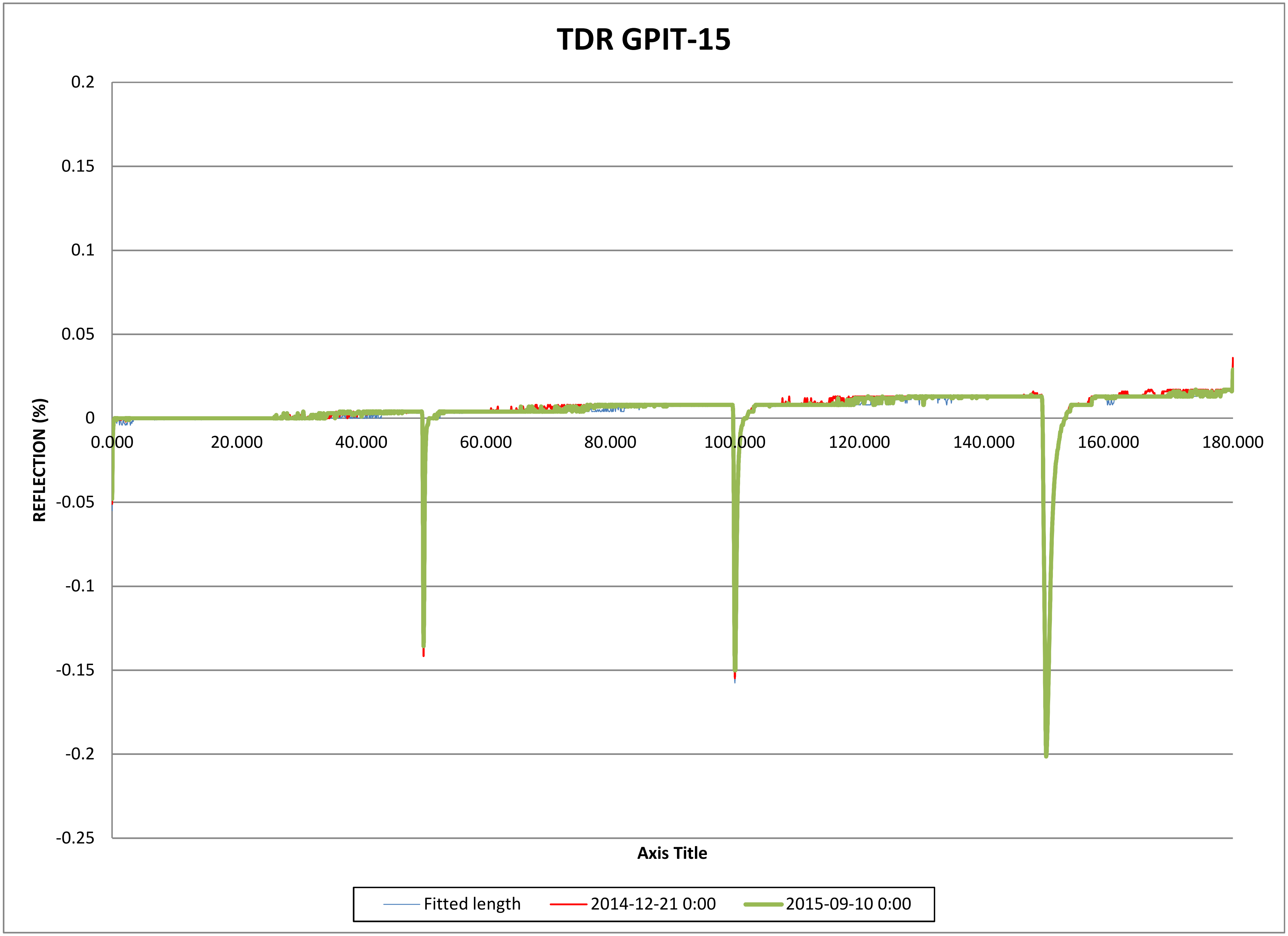

TDR GPIT-11
Fitted length
2015-09-10 0:00
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00



TDR GPIT-12
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
REFLECTION (%)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
DEPTH (m)
Fitted Length
2015-09-10 0:00



TDR GPIT-14
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
REFLECTINO (%)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
DEPTH (m)
Fitted Length
2015-09-10 0:00



TDR GPIT-15
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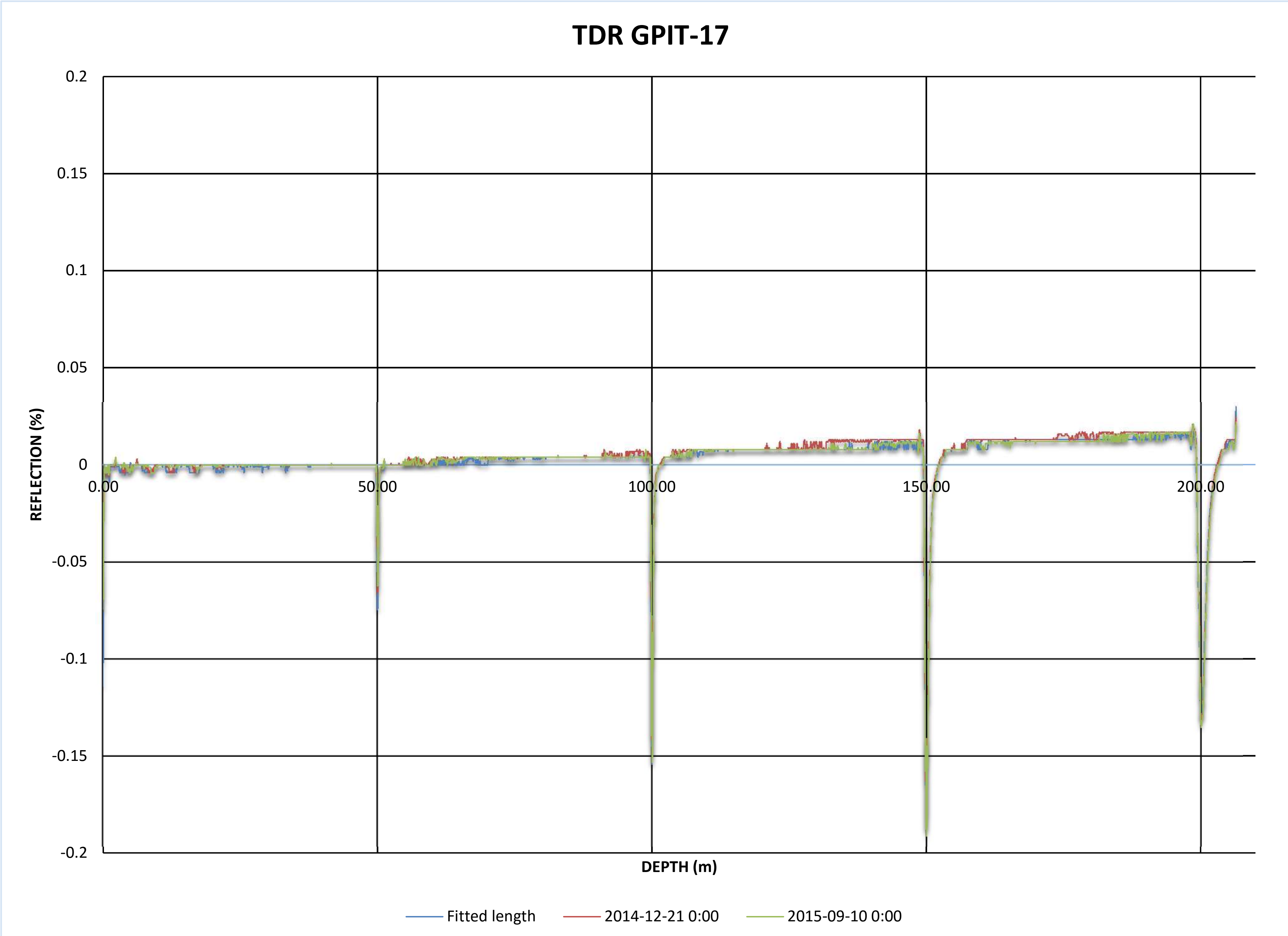
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
REFLECTION (%)
0.000
20.000
40.000
60.000
80.000
100.000
120.000
140.000
160.000
180.000
Axis Title
Fitted length
2014-12-21 0:00
2015-09-10 0:00



TDR GPIT-17
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0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
REFLECTION (%)
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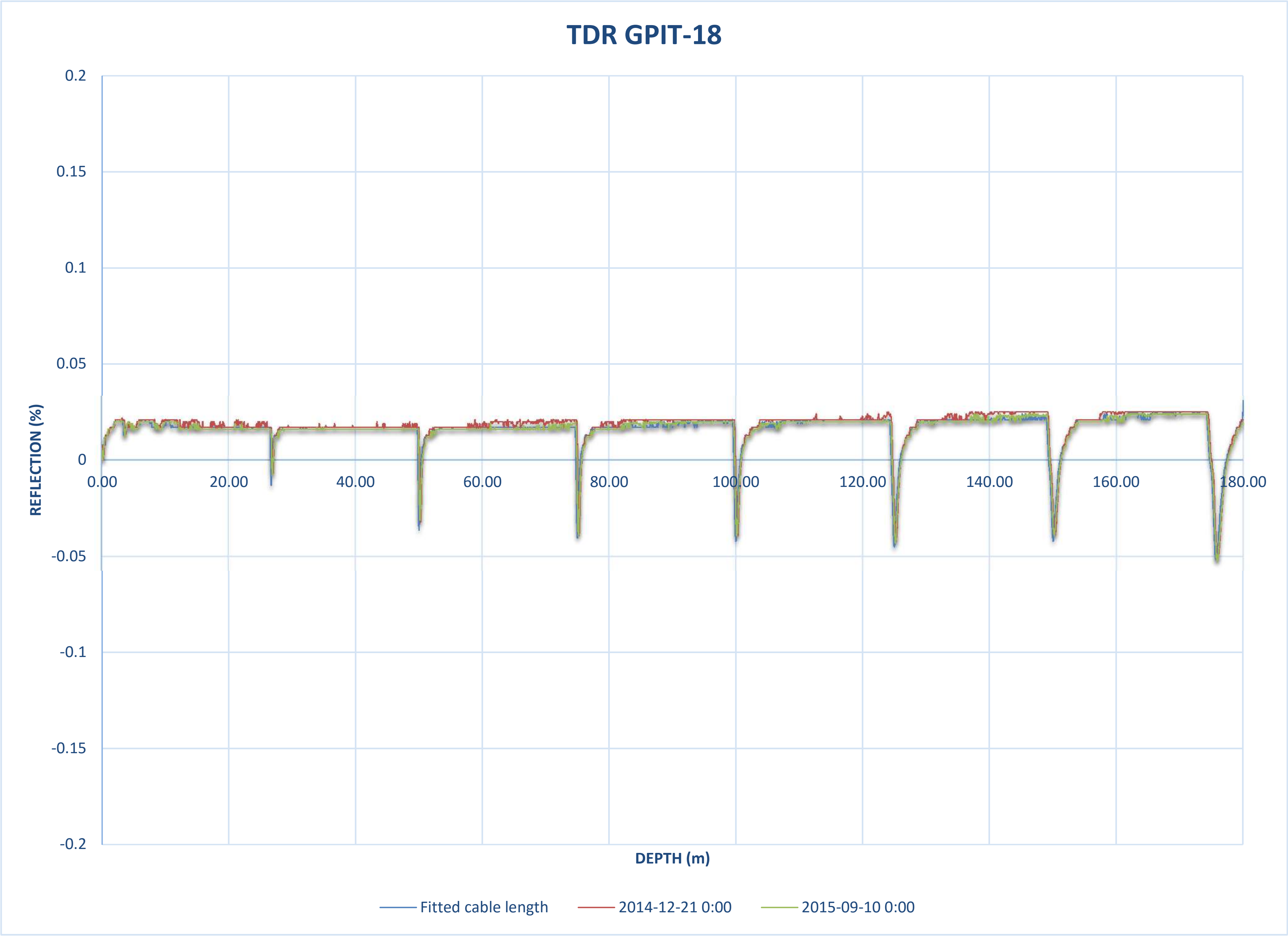
50.00
100.00
150.00
200.00
DEPTH (m)
Fitted length
2014-12-21 0:00
2015-09-10 0:00


TDR GPIT-18
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0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
REFLECTION (%)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
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DEPTH (m)
Fitted cable length
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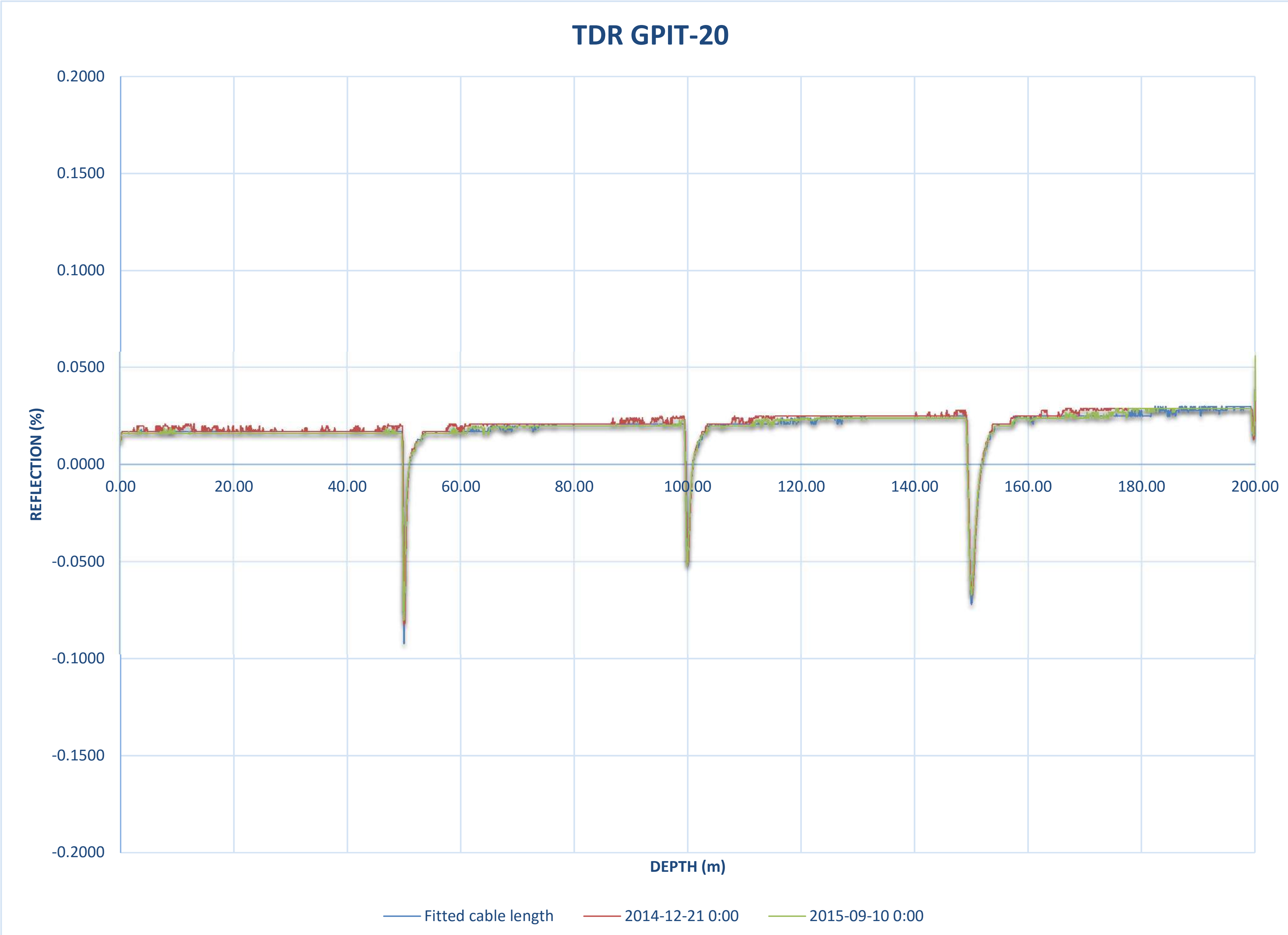
2015-09-10 0:00


TDR GPIT-20
0.2000
0.1500
0.1000
0.0500
0.0000
-0.0500
-0.1000
-0.1500
-0.2000
REFLECTION (%)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
DEPTH (m)
Fitted cable length
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2015-09-10 0:00

# Appendix A-3
# 2015 Goose Pit Piezometer Data

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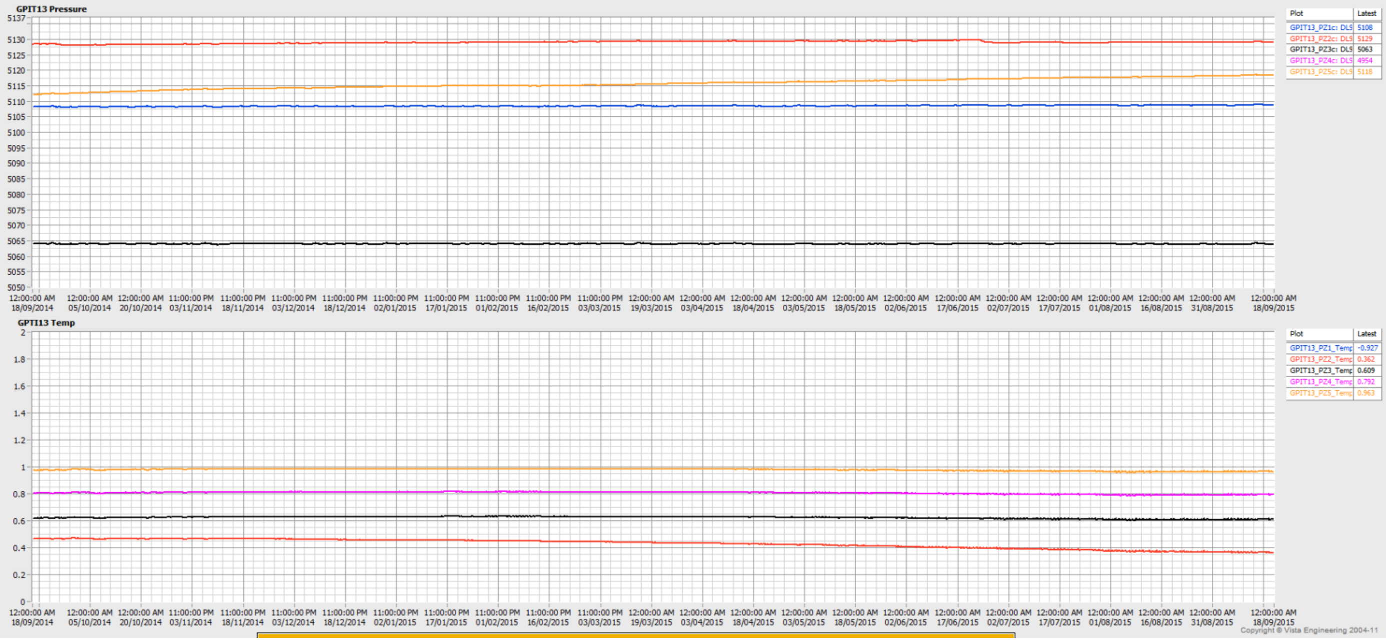
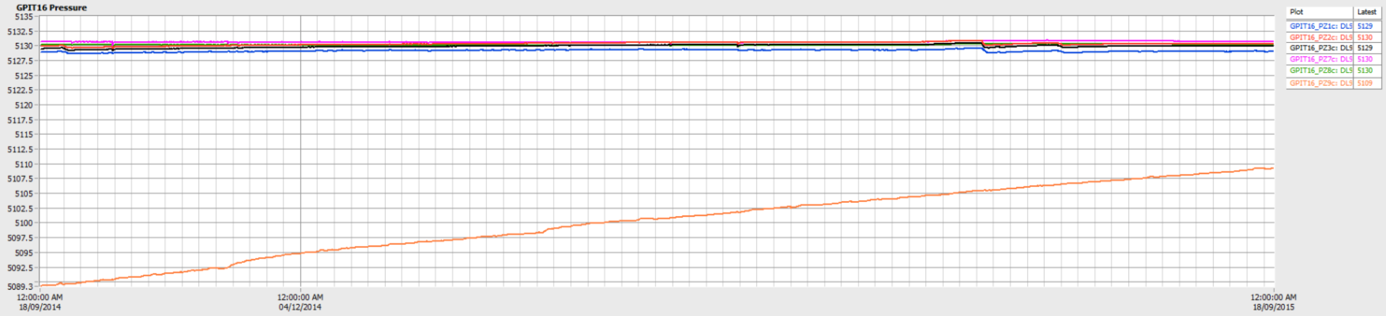


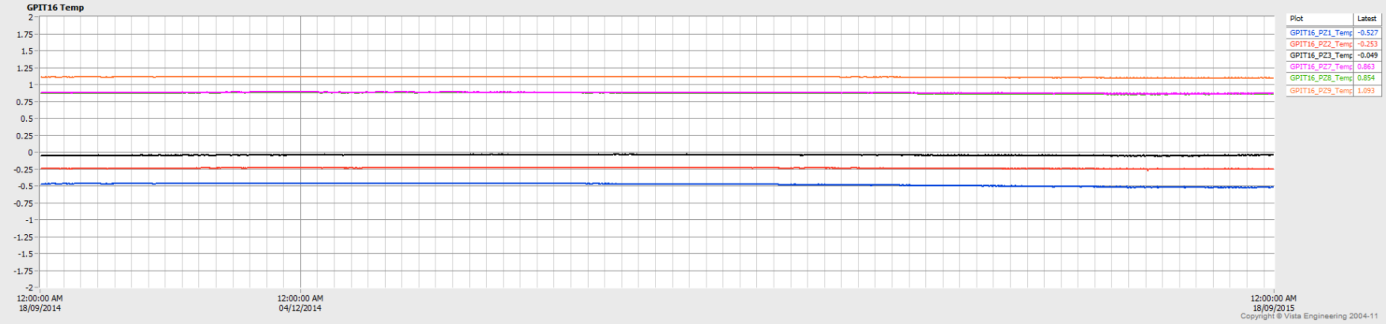
03 - GPIT Piezometer: GPIT14

03 - GPIT Piezometer: GPIT16

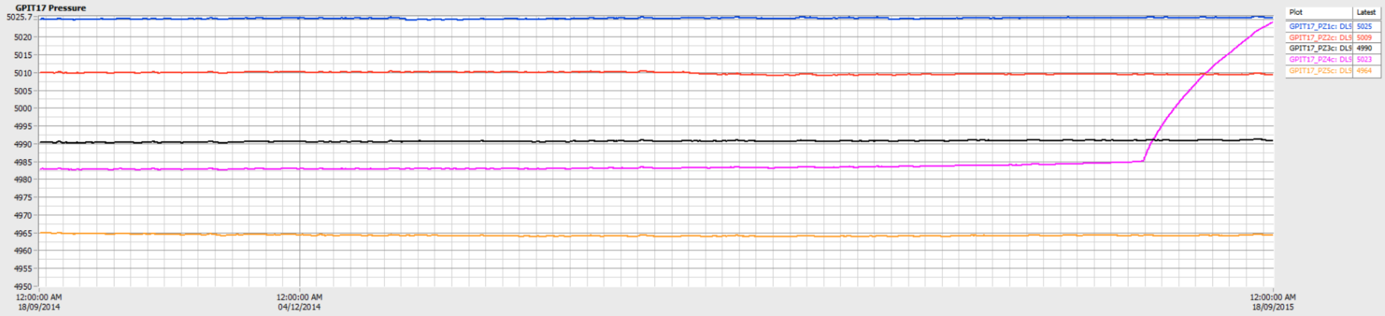
GPIT16 Pressure

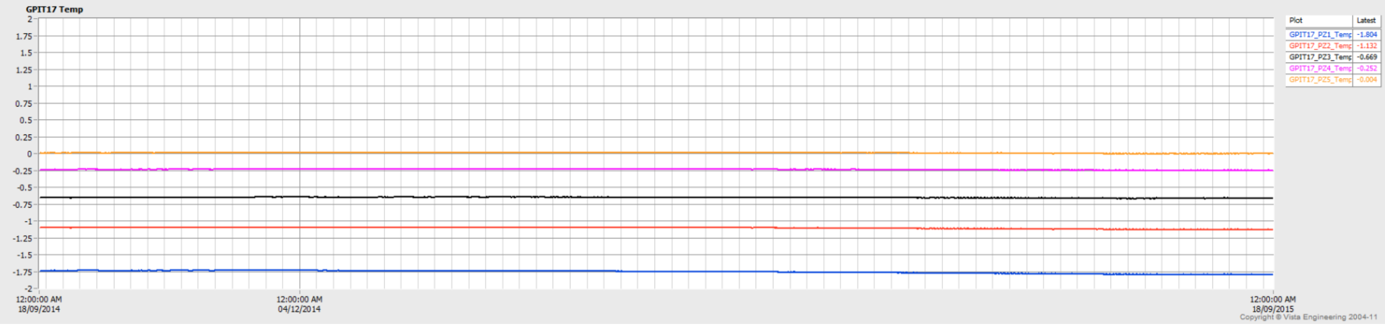



GPIT16 Temp

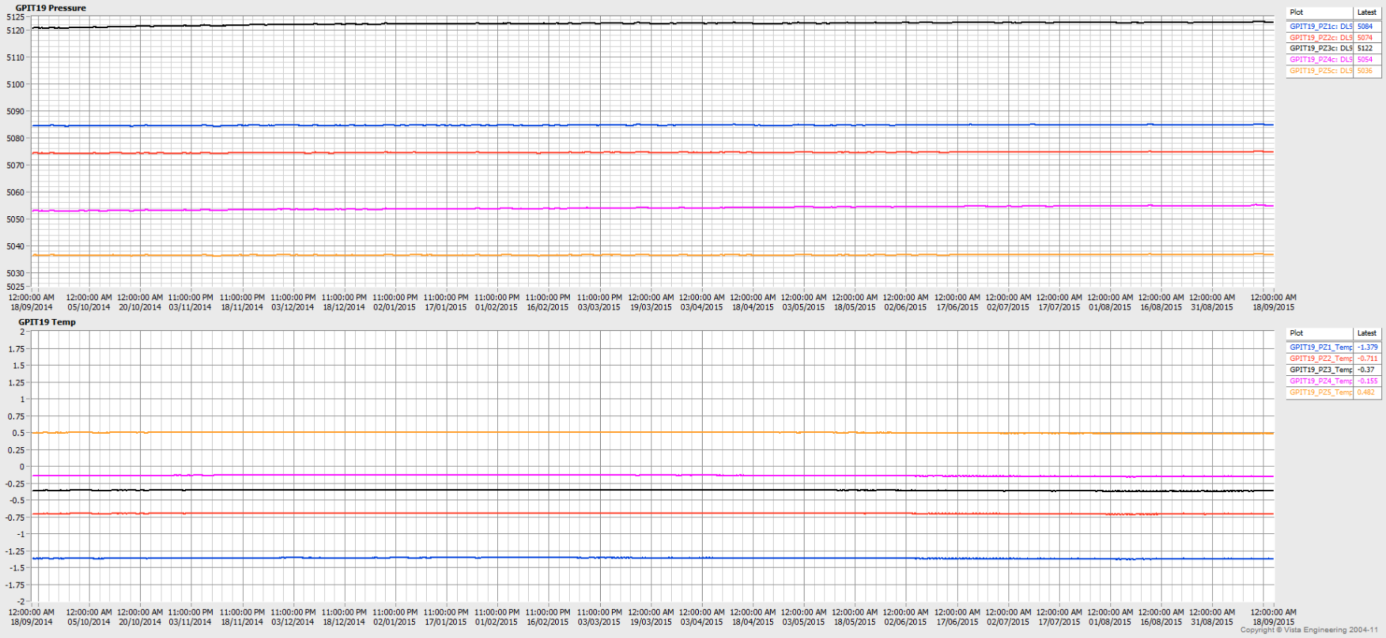


03 - GPIT Piezometer: GPIT17

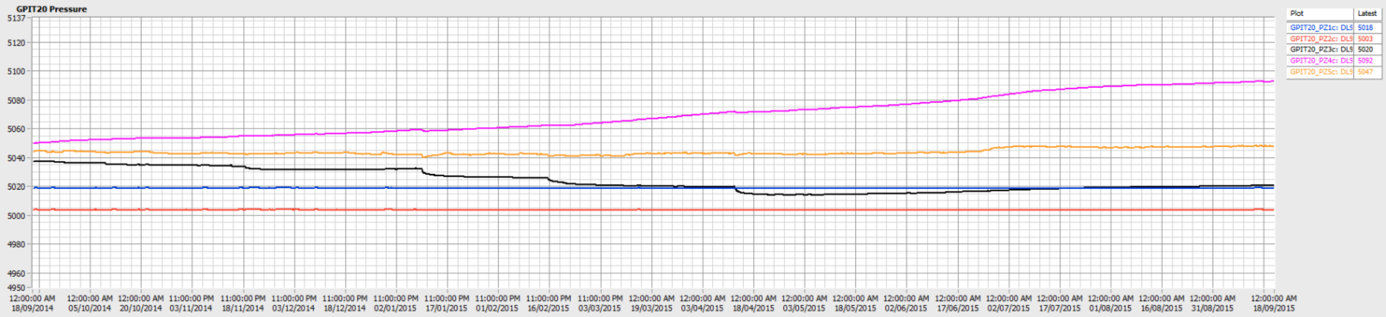


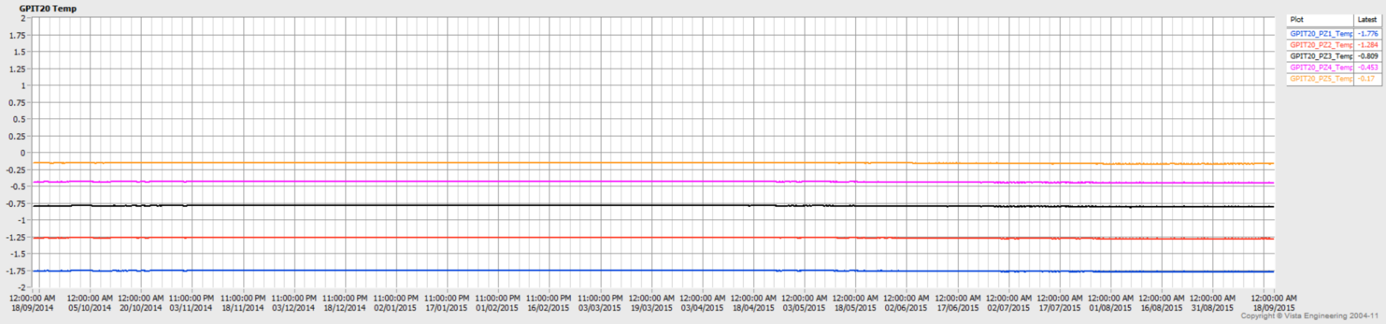



03 - GPIT Piezometer: GPIT19



03 - GPIT Piezometer: GPIT20



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