Appendix 65

Whale Tail Open Pit - 2020 Annual Inspection

October 19, 2020

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Dear Frederick,

RE: Amaruq Mine - Whale Tail Open Pit - 2019 Annual Inspection

1.0 INTRODUCTION

Agnico Eagle Mines Limited (AEM) operates the Amaruq Mine, in Nunavut, Canada. The mine is 150 km northwest of Baker Lake and 50 km northwest of AEM's Meadowbank Mine. The mine currently consists of the Whale Tail open pit, which entered commercial production in September 2019, and an exploration ramp. Knight Piésold Ltd. (KP) has been providing geomechanical support for the mine since 2015, including providing recommendations on the slope geometry for the Whale Tail open pit.

Mr. Ben Peacock, P.Eng., of KP completed a site visit from August 27 to September 3, 2020 in order to inspect the Whale Tail open pit and the nearby Attenuation Pond 5 (AP5) that is excavated in rock. The results of the inspection are summarized in this letter and detailed in Appendix A.

The mine received an order from the Workers' Safety & Compensation Commission (WSCC) mine inspector (WSCC, 2020) regarding a series of bench-scale failures in the Komatiite in the north wall of the Whale Tail open pit. This letter includes a summary of the current understanding of the failure mechanism and recommendations to reduce the occurrence of similar failures in the future.

2.0 INSPECTION RESULTS

2.1 GENERAL

The Whale Tail open pit was inspected by Ben Peacock of KP and Vincent Duranleau (Geotechnical Technician) of AEM on August 28 and on September 1. Christian Tremblay (Geotechnical Engineer) of AEM also participated in the September 1 inspection. Observations made during the site visit were grouped according to the following four headings at AEM's request:

- **Priority 1 (P1) -** A high priority or structural safety issue considered immediately dangerous to life, health or the environment. Also includes issues with a significant risk of regulatory enforcement.
- **Priority 2 (P2) -** An issue that, if not corrected, could plausibly result in a structural safety issue leading to injury, environmental impact or significant regulatory enforcement. Also includes repeated deficiencies that demonstrate a systematic breakdown of procedures.
- **Priority 3 (P3) -** Single occurrences of deficiencies or non-conformances that in isolation are unlikely to result in structural safety issues. Also includes recommendations for pro-active measures important to the validation of the open pit slope design.

- **Priority 4 (P4) -** Opportunity for improvement, for example to meet industry best practices.

The observations and associated recommendations were reviewed with AEM during the site visit.

2.2 PRIORITY 1 OBSERVATIONS

No P1 observations were made during the inspection.

2.3 PRIORITY 2 OBSERVATIONS

The following P2 observations were made:

1. **Phase 1 North Wall** – The design of the north wall of the Phase 1 pit should be revised to reduce the frequency of the bench-scale failures in the Komatiite. This is discussed in further detail later in this letter.
2. **Frozen Muck on East Wall** – Most of the upper east wall of the open pit was originally excavated as a separate excavation known as Quarry 1. Waste material was end dumped into a portion of Quarry 1 early in the mine life and froze. This frozen material now covers a portion of the final bench face and is progressively ravelling as it thaws. The mine is periodically scraping the face to remove the thawed material and the material will either be completely removed or covered with waste rock to act as a buttress and thermal cap. Access to the area was not physically restricted at the time of the inspection, though a berm was later installed. The berm should remain in place until the frozen material is removed or capped.
3. **Access below East Wall** – The southern portion of the east wall was one of the earliest walls excavated as part of Quarry 1. The benches were established without pre-shear blasting and the bench performance was controlled by planar failures in the Diorite. There is a significant amount of loose rock on the wall and limited catch bench width, both of which contribute to a rockfall hazard. It is understood that regular access to this area is not required until the Phase 3 expansion and that the wall will be re-established with pre-shear blasting at that time. Measures should be implemented to restrict access to the Quarry 1 area (e.g. the construction of a berm) until the wall is re-established or the rockfall hazard mitigated.
4. **Southwest Wall Rockfall Hazard** – In general, scaling of the bench faces appears to be well done and it is clear that AEM focusses on this aspect of slope management. However, loose material from the construction of the ramp was observed along the crest of the southwest wall. The material represents a rockfall hazard and should be removed.

2.4 PRIORITY 3 OBSERVATIONS

The following P3 observations were made:

1. **Southeast Wall Overburden** – Lakebed sediments are present at the crest of a portion of the upper southeast wall, near the ramp. The overburden represents a hazard for any activities directly below this bench, especially in the summer months when the active layer thaws. Access below the affected portion of the bench is currently prevented by a berm and it is understood that the wall is planned to be pushed back within the next year. The Nunavut Mine Health and Safety Act (2011) requires a minimum offset of 2 m between the toe of the overburden and the crest of the bench. Access below the bench should

continue to be restricted until the overburden is either excavated back at least 2 m from the current crest or the wall is pushed back, including the excavation and/or thermal capping of the overburden.

2. **Northwest Wall Oxidized Greywacke** – A zone of oxidized greywacke is present in the northwest wall, within the footprint of what was the western lobe of Whale Tail Lake. This zone is associated with reduced rock mass quality and much tighter joint spacing, which has resulted in ravelling. The rockfall risk is currently mitigated by the catch benches, but the risk could increase over time as material accumulates on the catch benches. The performance of this zone should continue to be monitored. The mine should evaluate the incorporation of rockfall mitigation measures into the design of this sector if the zone extends deeper than another bench.
3. **Wall Performance Review** – AEM has committed to reviewing the performance of the open pit slopes every four months. A review has not yet been completed and should be undertaken and documented. The review should include any slope failures, a comparison of the planned and achieved slope geometry, as well as a comparison of the collected geomechanical data to the design basis for the open pit slope geometry recommendations. This is a new commitment for the mine and was initiated in August, 2020.
4. **Blasting Trials** – The blast design is not currently varied to account for different lithologies or the orientation of the foliation. Based on visual assessments, the performance of the walls varies significantly based on these considerations. Increased overbreak and blast damage was observed in the Komatiite and underbreak was observed in the Greywacke in the Southwest wall where the foliation dips into the face. It is recommended that blasting trials be completed to refine the blasting practices used for different lithologies and to consider the influence of structure.

2.5 PRIORITY 4 OBSERVATIONS

The following P4 observations were made:

1. **Geotechnical Inspection Frequency** – Formal visual geotechnical inspections of the open pit are completed twice a month. Additional inspections are completed on an ad hoc basis. It is recommended that a procedure be developed to adjust the frequency of the geotechnical inspections of particular areas based on the observed slope performance (e.g., if a deformation rate is exceeded) and the risk associated with a particular slope.
2. **Geotechnical Inspection Photos** – Photos are taken as part of the inspections. It is recommended that a series of standard photos (i.e. similar perspectives) be incorporated into the formal inspections to facilitate the tracking of changes in the slope performance over longer time periods. This is most important for the slopes that are not covered by the Slope Stability Radar (SSR).
3. **Geotechnical Inspection Follow-up** – The mitigation and follow-up actions recommended during the geotechnical inspections are not always completed within the specified time frame. There should be a process in place to re-assess the suitability of the recommendation if the original timeframe is not met. If the mitigation measures recommended for an identified hazard will not be completed in the near-term (e.g. if the area is not an active mining area) then access to that area should be prevented.
4. **Geotechnical Hazard Maps** – Hazard maps for the open pit slopes are issued after each inspection, documenting the observed hazards and recommended mitigation measures. While the maps are an

effective tool, they primarily consider hazard rather than risk. Risk considers both the likelihood that a hazard occurs and the consequences of that hazard occurring. The maps form the basis for AEM's risk-based Work Close to Pit Wall procedure, which is a key process used by the mine to manage geotechnical risk. There is a potential disconnect between the risk-based procedure and the hazard map. It is recommended that the mine periodically complete a risk assessment based on the hazard map and account for the mitigating measures in place. This will help identify areas requiring additional mitigation. The maps should include all interim benches that are greater than 7 m in height. Consider developing a Trigger Action Response Plan (TARP) to assist with the categorization of common hazards.

5. **Rock Fall Database** – Rock falls are documented in a database along with key characteristics (e.g. rock type, failure mode, discontinuity orientation, tonnage, etc.). This is an important practice. It is recommended that the database be expanded to document the failure geometry (depth and height), relevant blasting parameters (e.g. whether the bench was pre-sheared) and whether a radar alarm was triggered. These data should be collected for all documented failures (to the extent possible) to facilitate back-analyses and a review of possible trends.
6. **Geomechanical Software** – The geotechnical staff have access to a comprehensive suite of geomechanical design software produced by Rocscience Inc., including DIPS, RocFall, Swedge, RocPlane, Slide and RS2. These software programs are several versions out of date, preventing staff from using some of the most powerful features. It is recommended that the mine update DIPS, RocPlane, Swedge and RocFall.
7. **Ground Control Management Plan** – Several opportunities to improve the Ground Control Management Plan (GCMP) were identified during the site visit and discussed with the geotechnical staff. These include adding a brief overview of the deposit geology and mine plan and clarifying several points (e.g. the collected geomechanical data should be compared to the design basis for the open pit in addition to looking for trends). An inspection requirement for areas identified as potentially unstable or of particular concern should also be defined.

3.0 ADDITIONAL CONSIDERATIONS

Several additional considerations were discussed during the site visit. These considerations are not associated with specific follow-up actions but are important to the successful operation of the mine.

- The current mine plan includes establishing the upper portion of the west, northwest, north and east walls of the open pit in their final configuration early in the mine life. This limits the opportunity to refine blasting practices and to consider adjustments to the slope design based on the performance of the interim slopes. This puts a premium on the proper implementation and validation of the bench and inter-ramp slope design.
- The three-month mine plan was reviewed from a geotechnical perspective. The review is summarized in Appendix A. The majority of the comments focus on managing the Komatiite in the north and northwest walls of the Phase 1 open pit as well as opportunities to validate the current geotechnical design of the open pit.
- The ultimate extents of the south wall of the open pit are in close proximity to the attenuation pond planned to the south of the open pit. This has been discussed in detail in previous studies by KP (2019)

and is expected to increase both the likelihood and the magnitude of ice formation on the south wall. AEM has installed instrumentation between the open pit and the attenuation pond to better understand the seepage encountered in the open pit. It is understood that additional instrumentation and follow-up studies are planned. This work is important as possible mitigation measures will need to be evaluated prior to the Phase 3 pushback of the south wall.

- AEM is actively documenting the bench performance and conducting geotechnical mapping to improve the characterization of the deposit rock masses. This work is important as the collected data are required for evaluating and refining the open pit slope design.

4.0 PERFORMANCE OF THE KOMATIITE IN THE PHASE 1 OPEN PIT

4.1 GENERAL

Between June 6 and July 8, 2020, ten bench-scale failures occurred along a bench in the north wall of the Phase 1 open pit. The failures occurred within the Komatiite and ranged in scale from less than 150 tonnes to approximately 1,100 tonnes. Examples are included in Appendix A. These failures resulted in an order from the mine inspector to:

"Prepare an independent report assessing the causes of the recent ground falls, providing recommendations to reduce the occurrence of failures in the future, and providing clear recommendations to ensure worker protection from these events. (WSCC, 2020)"

Note that the bench that experienced the failures was mined out by AEM as a precautionary measure prior to KP's site visit. As a result, the assessment of the failures described in this letter was based on the photos and laser scans provided by AEM as well as the current understanding of the rock mass and its expected behaviour.

4.2 CAUSE OF FAILURE

A review of the failures was completed during the site visit and concluded that they were planar and wedge failures on foliation dipping at a shallower angle than the Bench Face Angle (BFA) of 65°. In several cases, an undulation in the foliation results in it forming both sides of the wedge. The dip of the failure plane for six of the failures was measured using a Maptek laser scanner and typically ranged from 55 to 60°, with one plane having a dip of 50°. These dips are within the expected range for the foliation in this area.

In one instance, a brittle structure in the Komatiite may have contributed to an initial failure on June 23 that undercut the bench face. The face then failed back to the foliation six days later.

The geometry of the north wall of the Phase 1 open pit was based on the recommendations developed by KP for Design Sector A1 of the final open pit configuration (KP 2019). Those recommendations consisted of a 65° BFA, 10.5 m bench width and 21 m bench height. Design Sector A1 strikes at approximately 070° (all orientations in mine grid) whereas the north wall strikes at 090°. This rotation in the orientation of the wall resulted in it becoming sub-parallel to the foliation and increased the likelihood of planar failures on the foliation. The slope geometry was not adjusted to reflect this change.

4.3 RECOMMENDATIONS TO REDUCE THE OCCURRENCE OF SIMILAR FAILURES

Several options for reducing the occurrence of similar failures were discussed with AEM during the site visit. A decision was made to revise the slope geometry for the north wall of the Phase 1 open pit.

Design Sector B1 strikes at approximately 100°, parallel to the foliation, and is more applicable to the design of the north wall of the Phase 1 open pit than Design Sector A1. The slope geometry recommendations developed by KP for Design Sector B1 are based on the expectation that the bench face can be reliably established at 55°, which is consistent with the actual performance of the north wall.

As an interim measure, a modified version of the slope geometry recommendations for Design Sector B1 will be applied to all new benches on the north wall of the Phase 1 open pit. The recommendations have been updated to reflect the mine's ability to drill the pre-shear holes at 55° rather than the previously considered limit of 65°. As a precautionary measure, a design bench width of 10.5 m will be used instead of the 8 m minimum to increase the distance between the workforce and the bench face during drilling and loading. The resulting slope geometry consists of a 55° BFA, 10.5 m bench width and 21 m bench height, reducing the IRA of the north wall from 43° to 40°. This measure is expected to reduce, though not eliminate, the bench-scale failures in the Komatiite in the north wall of the Phase 1 open pit. AEM has committed to conducting stability analyses for the revised slope geometry and KP will review the results.

4.4 RECOMMENDATIONS TO PROTECT WORKERS

The primary measure for reducing the risk to mine personnel is implementing the revised bench geometry. A combination of visual inspections and Maptek scans should be used to document the performance of the benches. The collected data should be reviewed regularly to validate the suitability of the modified slope design.

The inspections and monitoring identified six of the ten failures in advance. Regular visual inspections by the geotechnical staff and the SSR should continue to be used to identify potential instabilities. Appropriate mitigation measures (e.g. defining exclusion zones and constructing berms to prevent access and to limit the runout distance of rockfall) can then be identified and implemented to protect mine personnel.

5.0 REFERENCES

Knight Piésold Ltd. (KP), 2019. *6112-E-132-004-REP-003_R0 Whale Tail Open Pit Slope Geometry Recommendations.* April 24. North Bay, Ontario. Ref. No. NB101-622/19-1, Rev 0.

Mine Health and Safety Act, 2011. *Consolidation of Mine Health and Safety Regulations.* Government of Northwest Territories and Nunavut. R-125-95, Section 1.137.

Workers' Safety & Compensation Commission (WSCC), 2020. *Inspection Report*. Reference: Inspection # 2020-VM-02224.

6.0 CLOSING

We trust this letter meets your present needs. Please do not hesitate to contact us should you require anything further.

Knight Piésold CONSULTING

Yours truly,
Knight Piésold Ltd.

REGISTERED PROFESSIONAL ENGINEER
B.D. PEACOCK
LICENSEE
Oct 19, 2020
NT/NU

Prepared: Ben Peacock, P.Eng.
Senior Engineer

Reviewed: Robert A. Mercer, Ph.D., P.Eng.
Managing Principal

Approval that this document adheres to the Knight Piésold Quality System:

Attachments:

Appendix A Amaruq Project - Whale Tail Open Pit - 2020 Annual Inspection

/bp

PERMIT TO PRACTICE
KNIGHT PIESOLD LTD.
Signature
Date Oct 19/2020
PERMIT NUMBER: P 547
The Association of Professional Engineers, Geologists and Geophysicists of NWT/NU

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APPENDIX A

Amaruq Project - Whale Tail Open Pit - 2020 Annual Inspection

(Pages A-1 to A-58)

Amaruq Project – Whale Tail Open Pit

2020 Annual Inspection

August 27 to September 3, 2020

Outline

- Introduction
- Observed Slope Performance
- Slope Design Discussion
- Monitoring and Inspections
- Other Considerations
- Review of Three-Month Plan

Introduction

Introduction

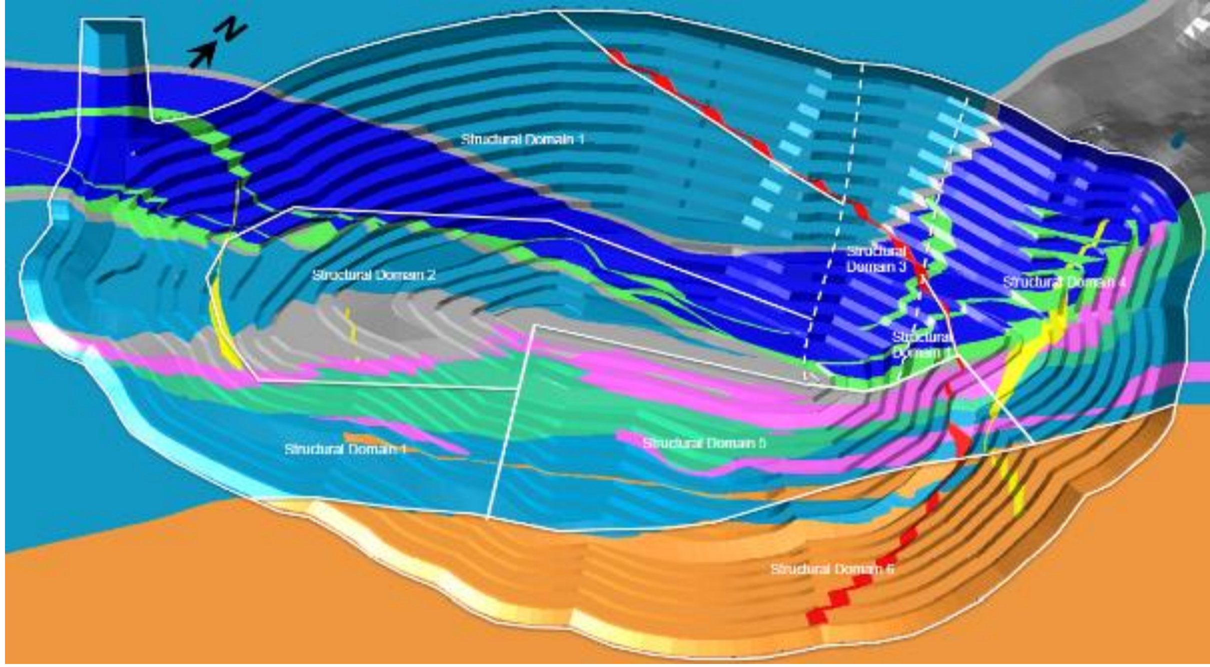
General

- Agnico Eagle Mines (AEM) is developing the Amaruq Deposit in Nunavut.
- Amaruq consists of the Whale Tail and IVR deposits. The deposits are planned to be mined using a combination of open pit and underground mining methods. The Whale Tail Open Pit entered commercial production in 2019.
- Knight Piésold (KP) has been providing geomechanical support for Amaruq since 2016, including a 2018 feasibility design for the Whale Tail Open Pit, a 2019 feasibility design for the IVR Open Pit, and several design studies for the underground mine.
- KP completed the 2019 annual inspection of the Whale Tail Open Pit and was retained by AEM to complete the 2020 annual inspection. The inspection was completed during a site visit from August 27 to September 3, 2020. The inspection is summarized in this presentation.

Introduction

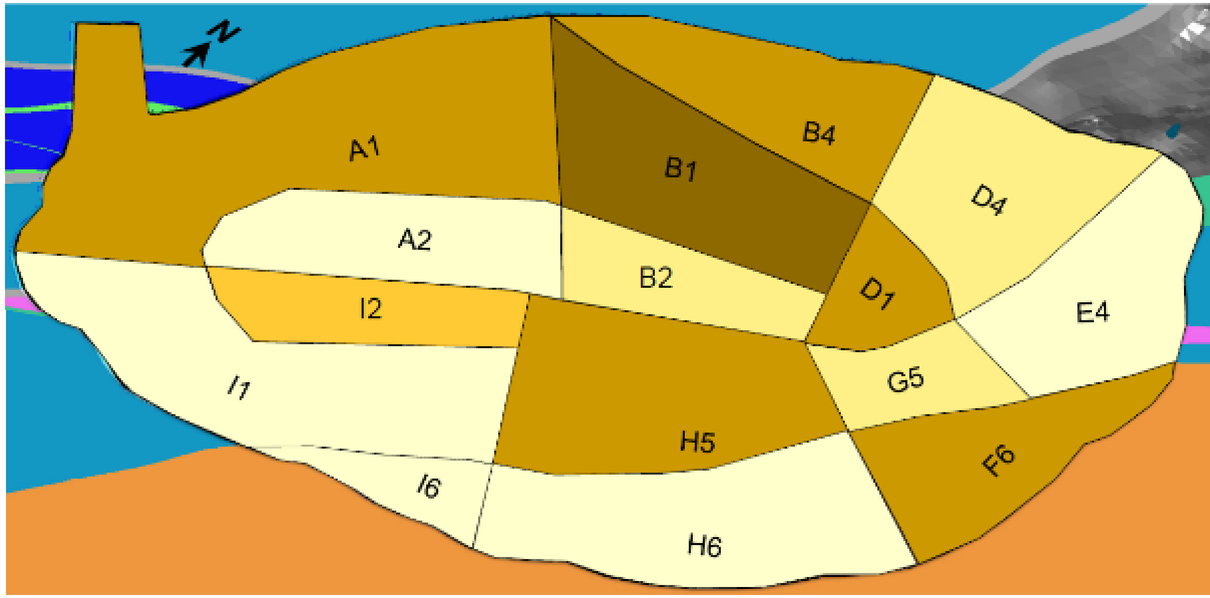
Overview

- The WHL-001-010F design is shown at right for reference. Note that this design is outdated, and the WHL-001-011C is the most recent design.
- The Structural Domains (which control the achievable slope geometry in many cases) are shown at upper right along with the lithologies expected in the final open pit walls.
- The design sectors and the Feasibility Study slope geometry recommendations are shown at lower right.



LITHOLOGY LEGEND:

GREYWACKE	IRON FORMATION
CHERT	MAFIC VOLCANICS
KOMATIITE - NORTH LIMB	DIORITE
KOMATIITE - SOUTH LIMB	RAMP FAULT



Base Bench Geometry

BASE CASE
BFA: 75°
Bench Width: 10 m
Bench Height: 21 m
IRA: 53°

KOMATIITE
BFA: 75°
Bench Width: 10.5 m
Bench Height: 21 m
IRA: 52°

Bench Geometry Controlled by Bench-Scale Failures

BFA: 65°
Bench Width: 10 m
Bench Height: 21 m
IRA: 47°

BFA: 65°
Bench Width: 10.5 m
Bench Height: 21 m
IRA: 46°

BFA: 65°
Bench Width: 13 m
Bench Height: 21 m
IRA: 43°

Observed Slope Performance

Observed Slope Performance

General

- The Whale Tail open pit was inspected on August 28. Observations made during the inspection are summarized on the following slides.
- The approximate current pit geometry is shown at right. The approximate final crest position (Phase 3) is marked by the dashed yellow line, and the walls inspected are labelled relative to mine north.

Observed Slope Performance

North Wall

- Final wall in the Greywacke, Design Sector B1 / B4.
- Benches generally performing well. The bench performance is often controlled by the dip of the foliation, as expected. Bench face angle is approximately 65°, consistent with design.
- Material was left along the crest of the most recent bench during scaling. This was identified during the August 15 wall inspection and additional scaling has been requested.

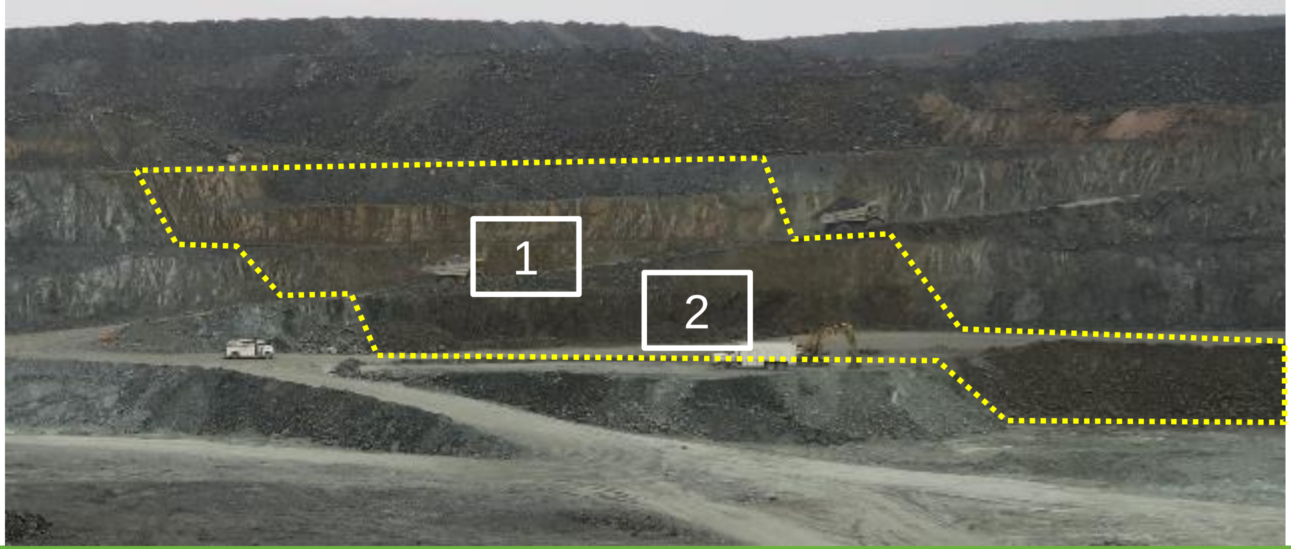
Observed Slope Performance
Northwest Wall Overview

- The upper two benches will form part of the final wall in Design Sector A1. The lowest bench is an interim wall.
- With two exceptions, the wall is generally performing well. These exceptions are discussed in greater detail later in this presentation.
  - The oxidized greywacke was not previously identified during the design of the open pit. It is of lower quality than the greywacke and is generally performing poorly.
  - The interim 7 m high bench in the Komatiite was originally 21 m high and performed poorly over the summer.
- Prior to the inspection, a possible wedge was scaled down in the komatiite (circled in red).

Observed Slope Performance

Northwest Wall – Oxidized Greywacke

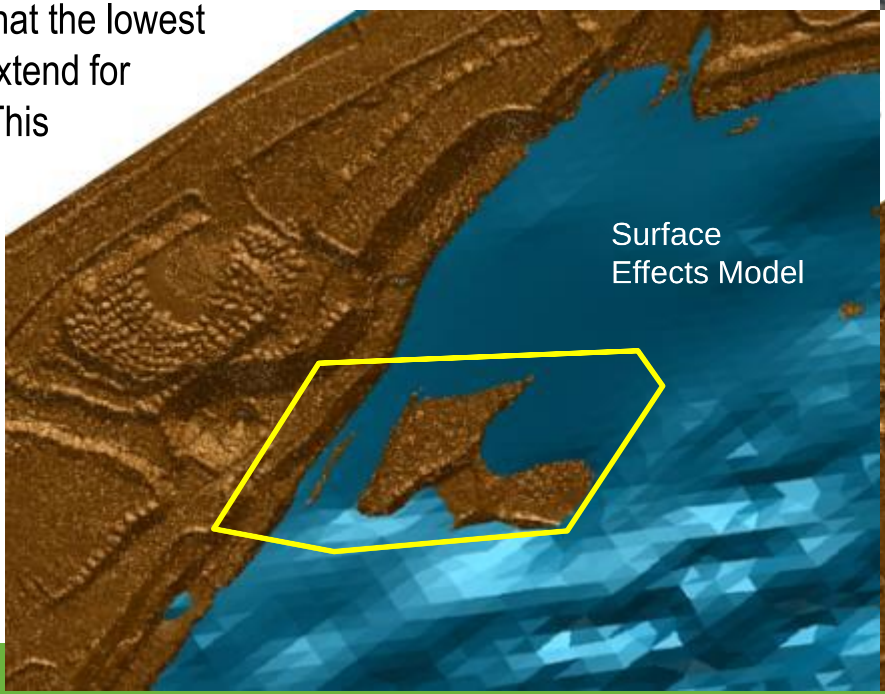
- A large interval of oxidized greywacke is present in the northwest wall.
- This unit is of lower quality than the typical Greywacke encountered. The rock mass is tabular to blocky, with Joint Sets A, C and D present, as well as random structures. The joint spacing, particularly of the foliation (Joint Set A) is at a decimeter scale, which is much tighter than observed elsewhere in the Greywacke. This creates smaller blocks.
- Significant backbreak was observed and on-going ravelling is starting to result in the accumulation of failed material on the benches. Over time, this could result in a loss of catch bench capacity and a rockfall hazard.

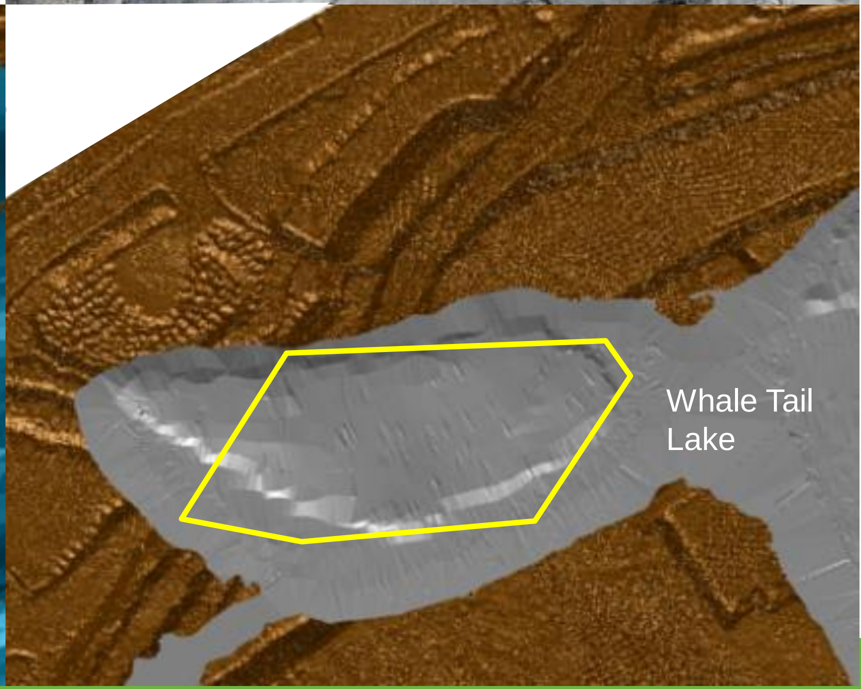


Observed Slope Performance

Northwest Wall – Oxidized Greywacke

- The southern contact of the oxidized greywacke appears to be defined by the contact with the Komatiite. The northern boundary may be gradational.
- The oxidized greywacke appears to be associated with the western lobe of Whale Tail lake (see bathymetry overlain on July pit shell at lower right).
- The area also corresponds to a region of reduced RQD incorporated into a "surface effects" region of the brittle structural model (volume above blue surface in lower left image)
- The brittle structural model suggests that the lowest quality oxidized greywacke will only extend for approximately one more 7 m bench. This should be considered approximate.
- If the oxidized greywacke extends deeper than predicted, it will be necessary to consider how best to manage the rockfall hazard (e.g. increasing bench width directly below this unit).





Observed Slope Performance

Northwest Wall – Komatiite

- This wall was the first significant interval where benches were excavated in the Komatiite, parallel to the foliation of the Komatiite.
- The bench was originally 21 m high but has since been reduced to 7 m as mining has progressed. Partially as a result of these activities, the wall has deteriorated compared to its original state. The current condition is shown in the images below.
- The bench geometry was based on the recommended Bench Face Angle (BFA) of 65° and bench width of 10.5 m.
- The bench was partially established within a brittle structure (below right). The brittle structures within the Komatiite result in the lowest rock mass quality encountered at the deposit. Most, but not all, of these structures have been modelled.

Observed Slope Performance

Northwest Wall – Komatiite

- The bench was established over the winter. Starting in the spring, a series of bench scale wedge failures occurred on the 21 m high bench, peaking in June.
- In total, 10 failures occurred, ranging from approximately 100 to 1,100 tonnes. At least two of these failures were a continuation of earlier failures. The largest failure is shown below.
- The mine inspector issued an order in late July to assess the causes of these failures and to develop a plan to reduce their occurrence. This is discussed further later in this presentation.

Observed Slope Performance

Northwest Wall – Iron Formation

- Benches performing reasonably well. Half barrels present on most places but there has been some ravelling of the crest and face.
- Previous lithology models predicted that Iron Formation would be present in this wall, and the darker material was confirmed to be magnetic during the inspection. However, the most recent lithology model removed the Iron Formation from this area and predicts it to be Komatiite. The lithology should be confirmed with geology.

Observed Slope Performance

West Wall

- Final wall in Design Sector A1 / I1
- Benches performing reasonably well, despite being intersected by multiple brittle structures. This is likely because the wall crosses the structures close to perpendicular, which is a favourable relative orientation.
- A possible wedge was identified on one of the brittle structures in the Komatiite and is shown at right. The bounding structures do not conclusively intersect. The wedge should be monitored as part of the regular inspections.

Observed Slope Performance

Southwest Wall

- Interim wall in the Greywacke in Design Sector I1. The benches are performing well, with half-barrels typically visible.
- The wall has under-broken significantly in some areas (example outlined below) and the blasting practices are being reviewed. As discussed later, it is recommended that the blasting practices vary between lithologies / design sectors to accommodate the wide range of rock mass characteristics.
- Loose material and oversize from construction of the ramp is present along the crest of the most recent bench and should be removed.

Observed Slope Performance

South Wall

- Interim Wall in the Greywacke and Diorite in Design Sector I1.
- The benches are performing well, with half-barrels visible. It is understood that hard toes are a recurring problem along this wall.
- The wall consists of several benches ranging in height from 7 to 21 m, above which there is a 7 m bench of till and fractured bedrock, offset by a 30 to 80 m temporary step-out. The till has slumped along most of the length of the wall but has been contained by the step-out.

Observed Slope Performance

South Wall – Faults/Shears

- Several discrete low angle faults or shears were observed towards the eastern end of the south wall. The shears are centimeters to a few decimeters thick and have not meaningfully affected the bench performance. The shears are not included in the structural model.
- It was not possible to measure the orientation of these structures but they appear to be similar to the expected orientation of the Ramp Fault.

Observed Slope Performance

Lower Southeast Wall

- The area was being mucked during the inspection and access was limited. No specific geotechnical issues were identified.
- Significant groundwater was observed in this area and is discussed further later in this presentation.

Observed Slope Performance

Upper Southeast Wall

- Interim wall in the Diorite and Greywacke in Design Sector E4 / F6.
- The bench is performing reasonably well, with half barrels visible in some areas and variable back-break at the crest.
- Increased back-break was observed in areas where the rock mass becomes blockier and the joint spacing tighter. Experience elsewhere in the pit and underground suggests the Greywacke is blockier along the contact with the Diorite.
- The performance of this bench suggests that relatively intensive scaling will be required for new benches in this sector of the pit.
- Note that this bench is the first 7 m bench so is also influenced by surface effects.

Observed Slope Performance

Upper Southeast Wall

- A sump was established adjacent the ramp in the southeast wall.
- Lakebed sediments are present at the crest of the slope in this area and need to be excavated back either 2 m from the crest and thermal capped or excavated back the full 10 m from the crest.
- The muck was noted to be very blocky, close to being orthogonally jointed.

Observed Slope Performance

East Wall

- Final wall, primarily within the Greywacke, in Design Sector E4.
- This wall formed part of Quarry 1. Early in the mine life, waste was end dumped into this portion of Quarry 1 and subsequently froze. Frozen muck now covers the bench face and is progressively ravelling as it thaws.
- It is understood that the mine intends to scrape back the muck as far as practical and then build a buttress and thermal cap over the remaining muck.
- The area should be bermed off until the muck has been buttressed/capped or excavated. This was done during the site visit.

Observed Slope Performance

East Wall

- Interim wall in the Diorite in Design Sector F6.
- Wall was originally developed as part of Quarry 1 without pre-shear and the achievable bench geometry has been controlled by planar failure. There is a large amount of failed material on the slope. Access to the area should be restricted.
- This wall will be re-established with pre-shear for the final pit wall. The recommended bench geometry for this sector accounts for the expected planar failures.

Observed Slope Performance

Northeast Wall

- Final wall in the Komatiite in Design Sector D4, 14 m in height.
- The upper 7 m bench has broken back to the foliation, while the lower 7 m bench has held at the design bench face angle of 75° (steeper than the foliation). The reason for this is not currently known. Possible causes include variation in scaling practices, blasting practices, discontinuity strength, etc.
- The dip of the foliation is estimated to be approximately 45 to 50° (to be confirmed). The foliation was expected to have an average dip of between 55 and 60° in this sector.

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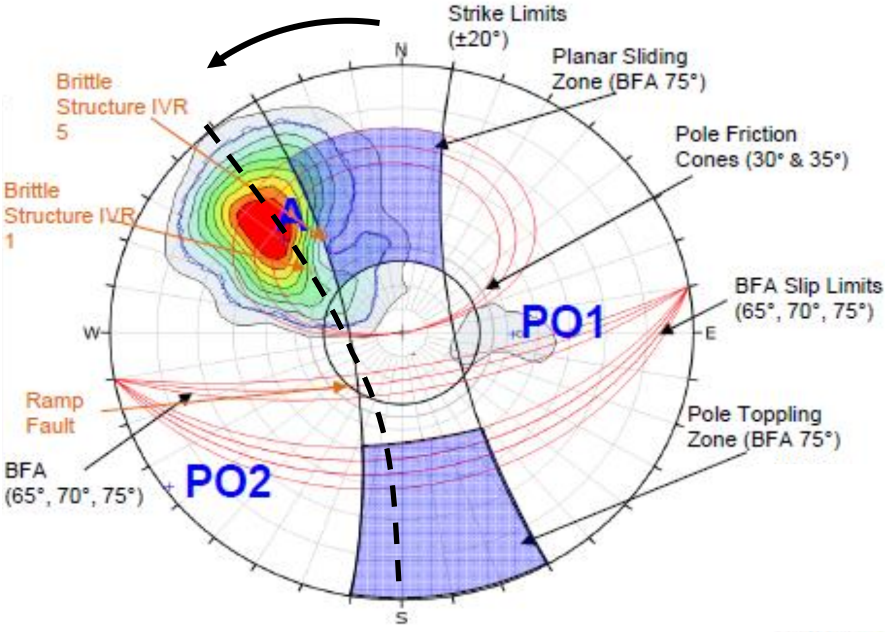
Observed Slope Performance

Northeast Wall

- The performance of this bench is important, because the achievable slope geometry in this sector (D4) is very sensitive to the relative azimuth of the bench face and the foliation.
- The recommended bench geometry is based on the expectation that the bench face is not parallel to the foliation. The recommendations were developed using the 10F pit design (analysis shown at right). In the current 11C pit design, sector D4 strikes 10° closer to the strike of the foliation, increasing the potential for planar failure (represented by dashed line overlain on figure at right).
- If the benches frequently fail back to the foliation in this sector, the recommended bench geometry will need to be revised (BFA reduced or bench width increased).
- Conversely, if the benches reliably achieve BFAs steeper than the foliation, there may be an opportunity to steepen the slope in other sectors with similar conditions.
- The bench has not yet been scanned with the Maptek (system is being calibrated). It is important that this bench be scanned so that the foliation orientation and bench back-break can be confirmed.



Observed Slope Performance

AP5

- Attenuation Pond 5 is located to the east of the Whale Tail Open Pit.
- The pond is largely flooded and a detailed inspection could not be completed.
- No stability concerns were identified in the exposed slopes. A protection berm is in place adjacent the access ramp to the pumping system.

Slope Design Discussion

Slope Design Discussion

General

- The open pit is in the early stages of mining. The current benches provide an opportunity to improve our understanding of the deposit rock masses and how benches established within them will perform. There is also more flexibility to refine the slope design at this stage in the mine life.

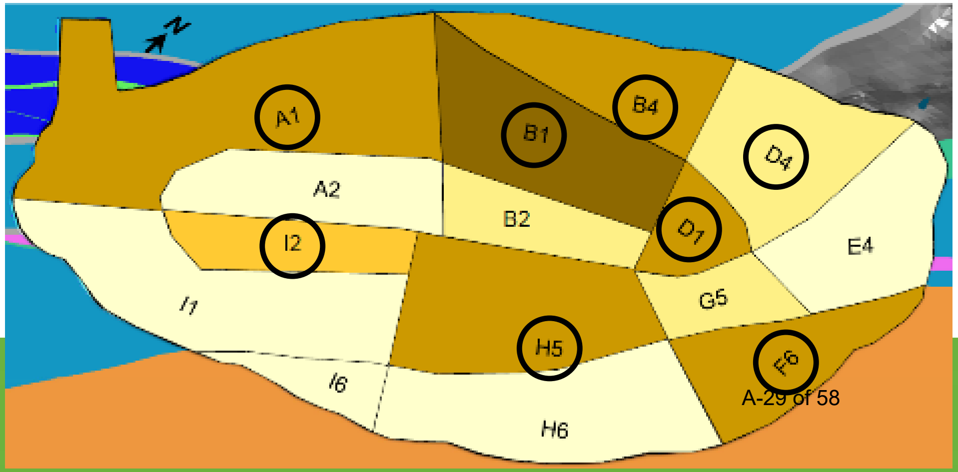
- The geomechanical design recommendations for the open pit were primarily based on data from drill core. While numerous geomechanical drillholes were completed, drilling ultimately only allows us to characterize a small sample of the deposit rock masses. The exposures in the open pit provide an invaluable opportunity to verify the rock mass characteristics on which the slope design is based.

- The current mine plan calls for establishing some of the final West, North and East walls as mining advances. Establishing the final walls early in the mine life makes the proper implementation and verification of the bench and inter-ramp slope design a critical consideration. This limits the opportunity to refine blasting practices and to consider adjustments to the slope design. It also means that the mine will have to live with any failures or unaddressed hazards for the duration of the mine life.

Slope Design Discussion

Design Verification (Reminder from Sept, 2019 Inspection)

- The bench designs in eight design sectors (circled below) are limited by the potential for planar failure on the foliation. Several of these sectors (e.g. A1, B1 and H5) have a strong effect on open pit economics. As the bench face is expected to fail to the foliation, the achievable bench geometry is sensitive to the dip of the foliation. The orientation of the foliation should be tracked (e.g. using the Maptek or mapping). If the average dip of the foliation deviates significantly from the feasibility study structural domains, the slope design should be revisited.
- The base case bench designs incorporate a minimum allowance for back break of 2.5 m in the Komatiite and 2 m in the other domains based on the performance of the benches at Meadowbank. This allowance has been applied to design sectors where the bench width is not strongly limited by kinematic failures. The back break in these sectors should be tracked by comparing the planned vs actual slope geometry (e.g. by using the Maptek). If it differs significantly form these values, the design should be revisited.
- Blast design can have a strong influence on bench performance. The design will need to vary between some of the lithologies (e.g. Komatiite vs Diorite), and pre-shear blasting will be needed for the final walls. Interim pit walls provide an opportunity to refine the blast design and determine what provides the best results for the performance of the final walls. Backbreak can be used as one of the metrics for comparing designs.



Base Bench Geometry

BASE CASE
BFA: 75°
Bench Width: 10 m
Bench Height: 21 m
IRA: 53°

KOMATIITE
BFA: 75°
Bench Width: 10.5 m
Bench Height: 21 m
IRA: 52°

Bench Geometry Controlled by Bench-Scale Failures

BFA: 65°
Bench Width: 10 m
Bench Height: 21 m
IRA: 47°

BFA: 65°
Bench Width: 10.5 m
Bench Height: 21 m
IRA: 46°

BFA: 65°
Bench Width: 13 m
Bench Height: 21 m
IRA: 43°

Slope Design Discussion

Data Collection and Review

- Geomechanical mapping was recently completed by both AEM and KP to verify the rock mass characteristics on which the slope design is based. Mapping should continue to be completed, with the objective of confirming:
  - The orientation, persistence and large-scale roughness of the foliation
  - The prominence, spacing and orientation of other joint sets that could result in wedge failures
  - The rock mass quality of the various lithologies, particularly the Komatiite
  - The position, orientation, thickness and characteristics of the faults, particularly the Brittle Structures
- The mine has started to document back-break of the benches and the data are currently being reviewed. These data can be used to refine both the bench design and the blast design.
- Failures are tracked in a database along with relevant characteristics (e.g. rock type, discontinuity orientation, etc). These characteristics have not been recorded for all rockfalls and the database would benefit from also tracking the failure geometry (e.g., depth and height), blasting parameters (e.g. whether bench was pre-sheared) and whether a radar alarm was triggered. These data are valuable for back analyses and identifying trends.
- Note that the GCMP includes a commitment to document and review the slope performance every four months. This has not yet been done.
- It is important that the collected data are compared to key design inputs and action taken if there are significant discrepancies.

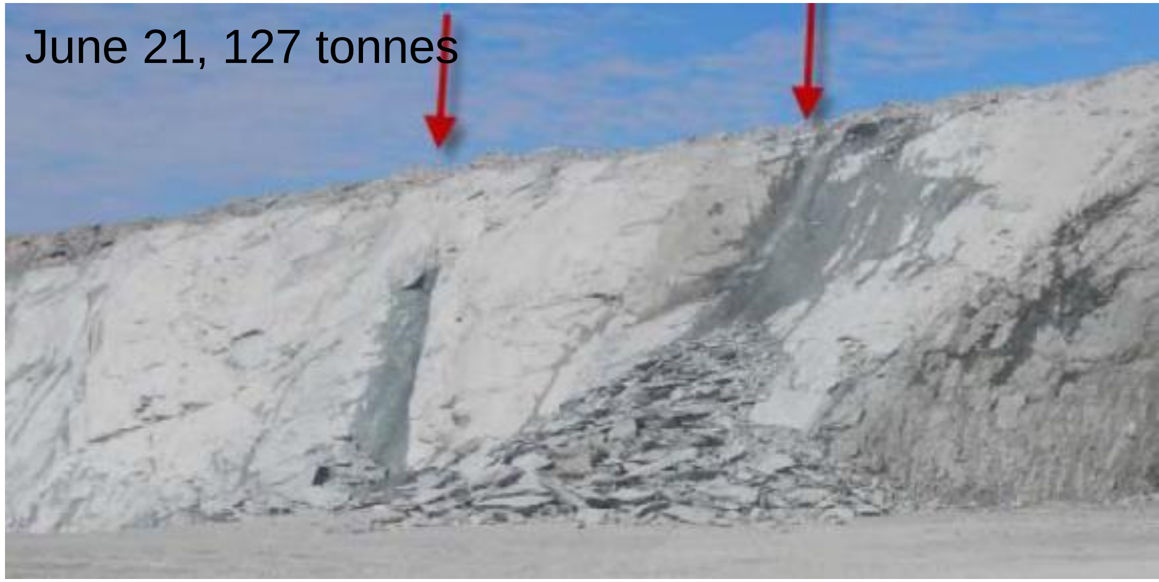
Slope Design Discussion

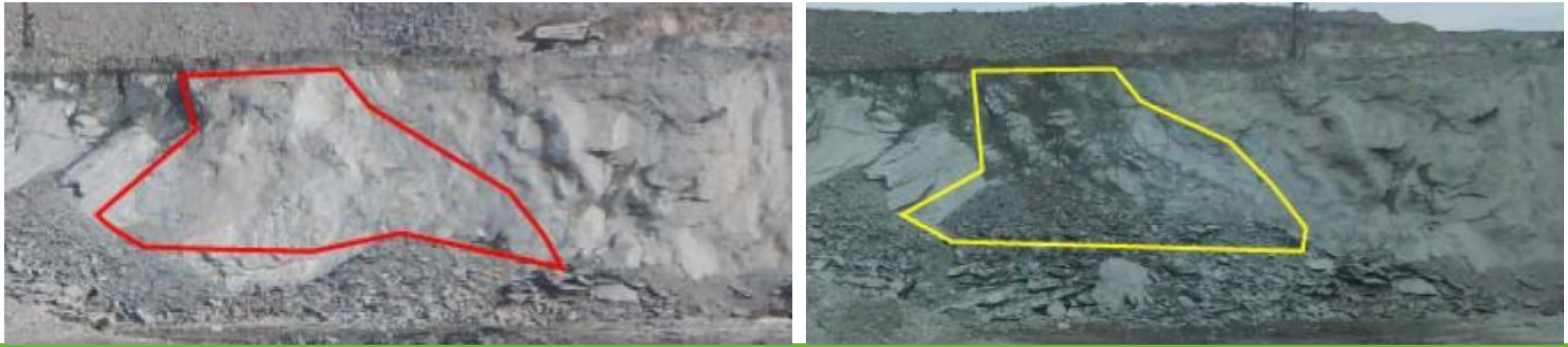
Performance of the Komatiite

- To date, the benches have generally performed well. The exception is the Komatiite, particularly in the lowest bench of the northwest wall. This bench forms part of the Phase 1 interim pit. The bench was established parallel to the strike of foliation and was partially within a brittle structure. A series of bench-scale failures occurred along this bench.
- Note that the benches were established in the winter and are understood to have performed well until the spring thaw, when the failures occurred.
- The failure mechanism has not yet been evaluated in detail but appears to consist primarily of both planar and wedge failures on the foliation, where the foliation is dipping at a shallower angle than the bench face. In some cases, an undulation in the foliation may form both sides of the wedge. In at least one instance, the brittle structure appears to be a contributing factor.
- The mine inspector issued an order in late July to assess the causes of these failures and develop a plan to reduce their occurrence.
- Examples of the failures that occurred in the Komatiite in the lowest bench of the northwest wall are shown on the subsequent slides.

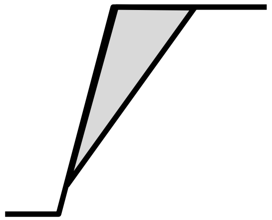
Slope Design Discussion

Performance of the Komatiite





June 22, 254 tonnes
Before & After



Slope Design Discussion

Performance of the Komatiite

June 23, 942 tonnes

June 29, 659 tonnes
Continuation of original failure

Slope Design Discussion

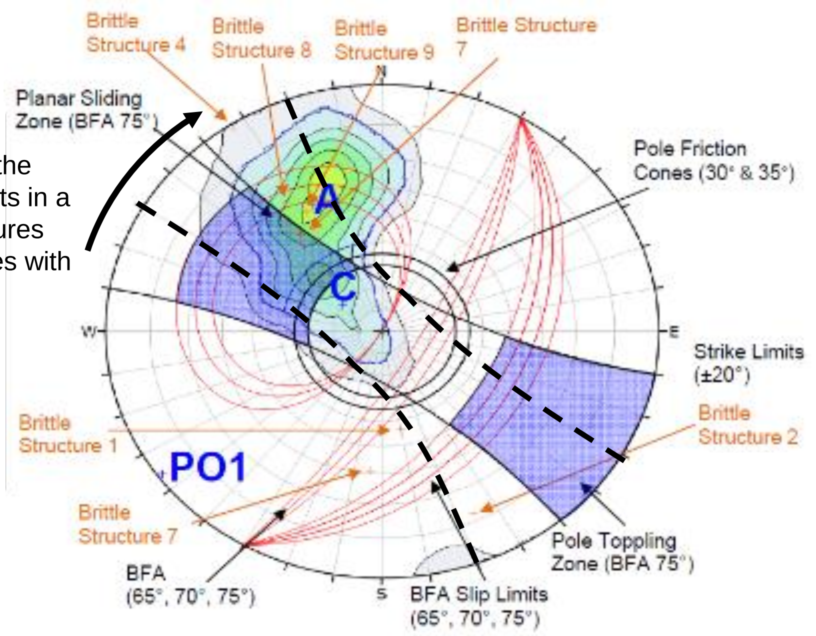
Performance of the Komatiite

June 28, 1122 tonnes

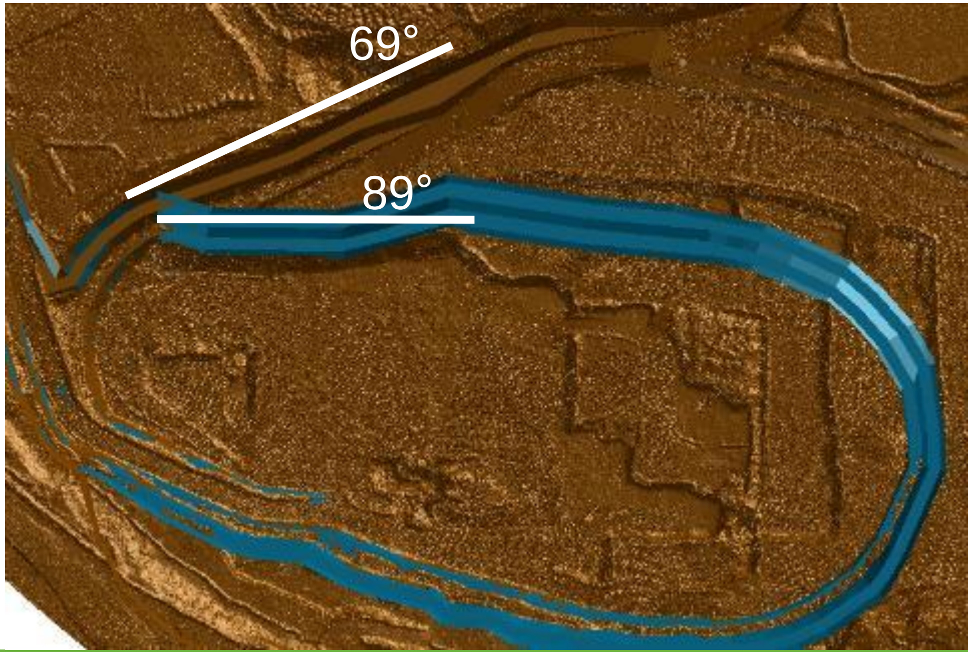
Slope Design Discussion

Performance of the Komatiite

Clockwise rotation in the pit wall orientation from the Phase 3 to the Phase 1 wall configuration results in a predicted increase in planar failures (the planar sliding zone coincides with the foliation).



- In this particular design sector (A1), the average dip of the foliation was expected to be 60°.
- The Maptek scans of the failures suggest that they typically occurred on foliation dipping between 55 and 60°, slightly shallower than the BFA. In one instance the dip was 50°.
- This is the immediate cause of the failures. However, a significant contributing factor is the relative strike of the pit wall and the foliation.
- The slope recommendations (BFA of 65°, width of 10.5 m, IRA of 46°) applied to the Phase 1 bench in the komatiite were originally developed for the final Phase 3 wall. There is a significant difference in the orientation of those walls in design sector A1:
  - The Phase 3 wall has a strike of 69° (mine grid), crossing the foliation at an oblique angle which is favourable.
  - The Phase 1 wall has a strike of 89°, parallel to the foliation which is unfavourable
- The strike of the Phase 1 wall is closer to that of design sector B1 than A1. The slope recommendations for design sector B1 were based on the expectation that the slope would fail back to 55°, which is largely consistent with the actual performance of this wall.
- This is an important reminder that the slope recommendations are linked to the wall orientation of the sectors they were developed for.



Slope Design Discussion

Adjustments to Slope Design

- Several options to reduce the occurrence of bench-scale planar failures in the Komatiite in the north wall of Phase 1 were discussed. The selected option was to revise the design of the Phase 1 north wall to use a modified version of the slope recommendations for Design Sector B1. The modifications are described below.
  - **Reduced BFA:** At the time of the design study, the recommended BFA was limited to a minimum of 65° due to restrictions with the pre-shear drill. The bench width was increased to accommodate these failures and maintain an 8 m minimum width. A limitation of this approach is that the mine has very limited control over when the bench face fails back to the foliation. The mine has confirmed that the pre-shear can be drilled at dips as shallow as 55°. The BFA will be reduced to 55° so that it is closer to the dip of the foliation. This is expected to reduce but not eliminate the planar failures in the Komatiite, due to variation in the orientation of the foliation. As a result, there will still be a need to identify and manage failures (e.g. with exclusion zones).
  - **Bench Width:** A bench width of 13 m is recommended for Design Sector B1 to accommodate the expected back-break from 65° to 55°. Establishing the BFA at 55° reduces the expected back break. Maintaining the same IRA would result in an 8 m bench width. A bench width of 10.5 m is recommended in order to help maintain an 8 m minimum bench width and to increase the distance between the workforce and the bench face.
- AEM will complete stability analyses to confirm these recommendations and KP will review. In the interim, a BFA of 55° and a bench width of 10.5 m can be used for planning purposes.
- Any approach should be trialled, ideally on an interim wall, before wide-spread adoption. The performance of the revised bench geometry should be carefully monitored. If the benches do not perform as expected, the design should be revised.
- In all cases, avoid developing benches for Phase 1 and 2 along the brittle structures in the Komatiite. It will not be possible to avoid them for every bench due to the number of structures, but this should still be an objective.

Slope Design Discussion

Adjustments to Slope Design

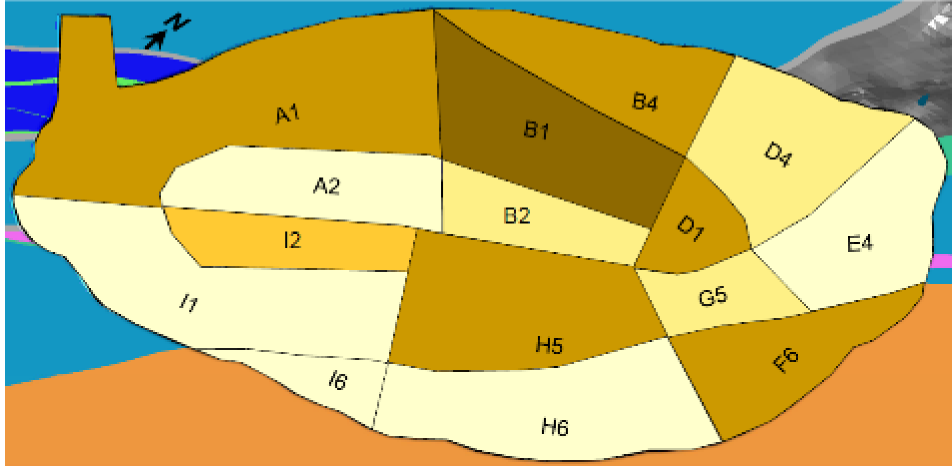
- It is important to note that the objective here is to reduce the frequency of the failures, not prevent them. Some failures will still occur due to the variability in the orientation of the foliation, particularly within the Komatiite.

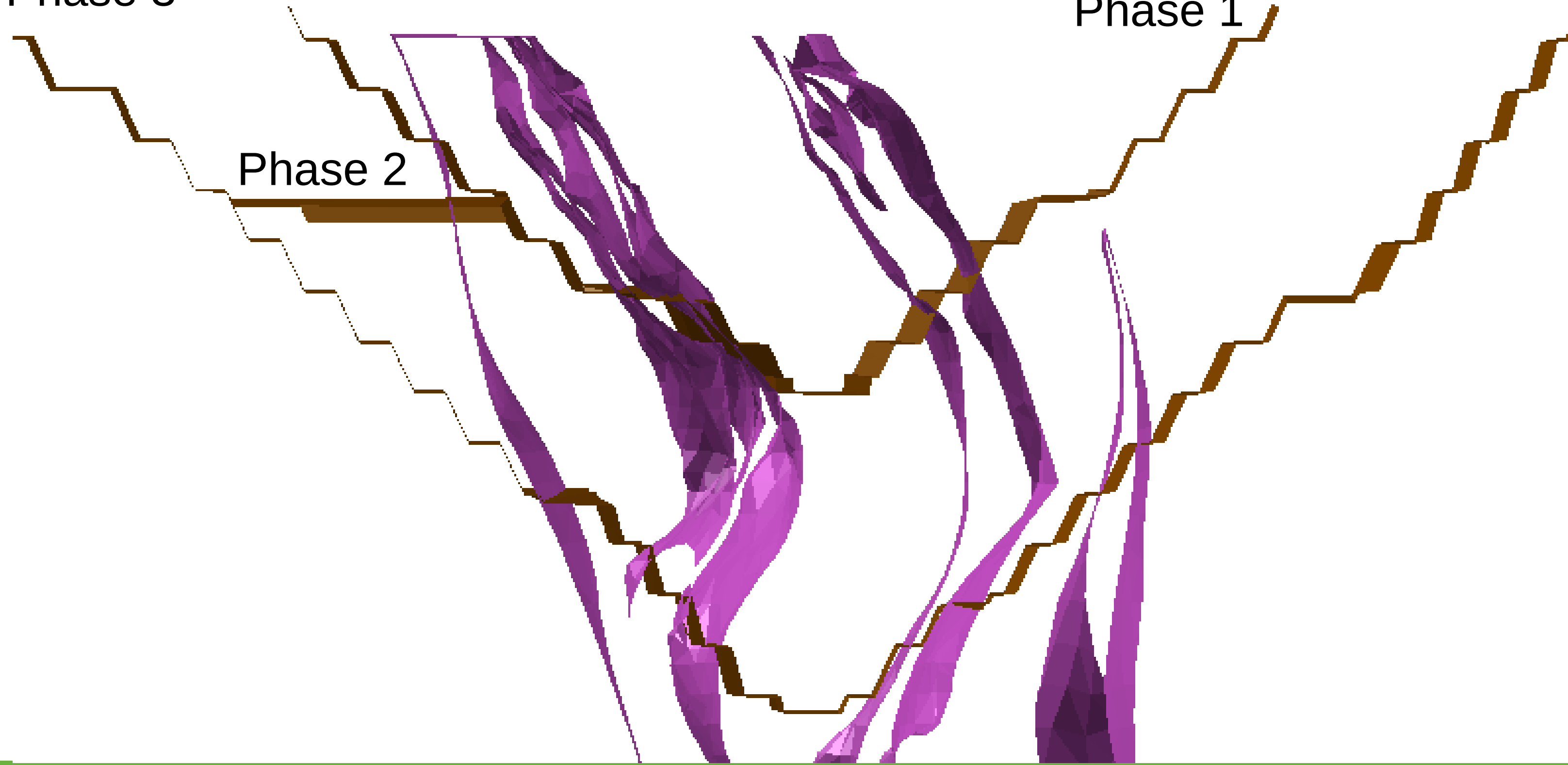
- An example of the local variation in the dip of the foliation encountered over a 21 m bench in the komatiite is shown at right.

Slope Design Discussion

Future Considerations

- The orientation of the Komatiite and the foliation is expected to rotate with depth, becoming more favourable for the performance of the north wall (though it will continue to require careful consideration).
- As a result, the large exposure of Komatiite in the north wall of Phase 1 & 2 is of greater concern than the exposures in the Phase 3 (final) pit.
- The potential for mining out the Komatiite in Phase 1 was discussed but it is understood that this is not economically feasible.





Monitoring and Inspections

Monitoring and Inspections

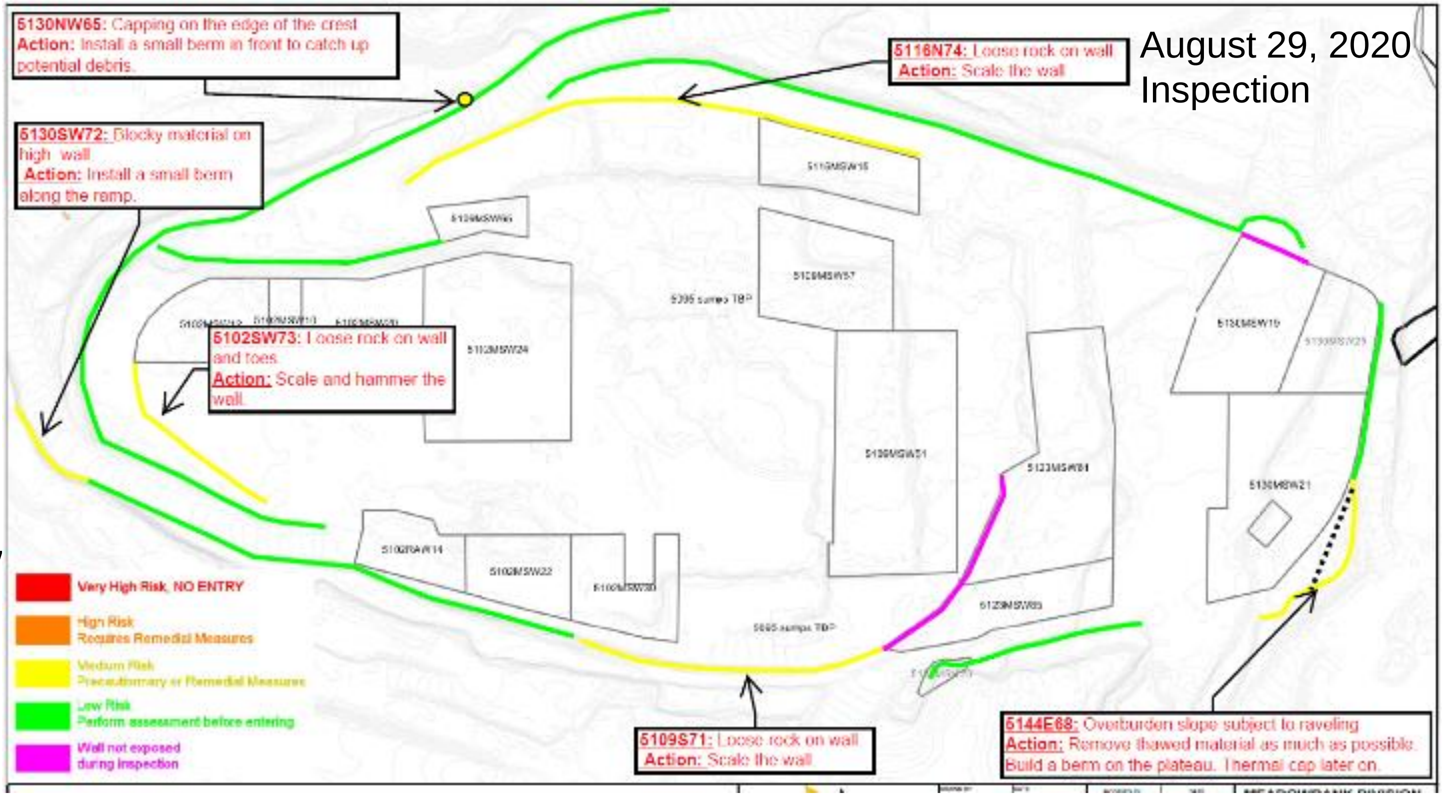
Inspections

- Formal visual inspections are completed by the geotechnical team twice a month and a summary report and map issued. Additional inspections are completed every few days.
- A selection of the inspection reports were reviewed and the following discussed:
  - Taking a series of standard photos from the same positions each visit allows changes to be tracked over time. This is in addition to the regular day-to-day photos.
  - Some of the follow-up actions were not completed by the due date. Clearly, this will happen from time to time. However, in these cases it is important to ensure that access has been prevented to the area and that the wall hasn't deteriorated further and that the original recommendation is still valid.
- The mine tracks areas requiring remediation in a database. They are closed out as the work is completed. Verifying that the required work has been completed is an important practice.
- While there are frequent visual inspections, there should be a formal mechanism in place to increase the frequency of inspections in the event that an instability is observed or, for example, particular deformation limits are observed.
- If the mitigation measures recommended for a hazard won't be completed in the near term (e.g. the area is not an active mining area) then access to that area should be prevented (e.g. with a berm). The hazard and required mitigation measures should be documented for future reference but do not necessarily need to be shown on the hazard map.

Monitoring and Inspections

Hazard / Risk Assessment

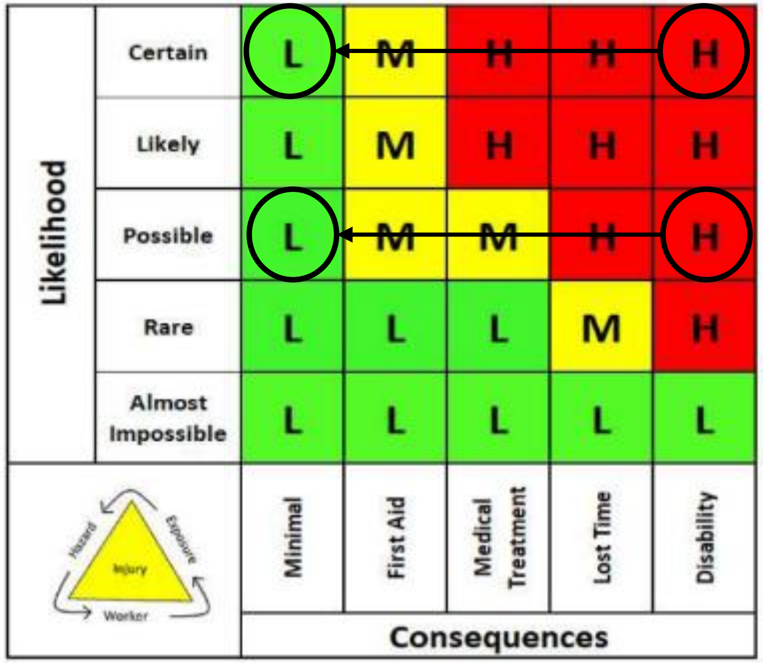
- The wall inspection maps produced by the geotechnical team primarily document unmitigated hazards and the required mitigation work. In this regard, they are an effective tool.
- The maps also form the basis for the risk-based wall approach procedure, which is a key process used at the mine to manage geotechnical risk. As such, it is important that there is a mechanism in place to identify risks rather than just hazards.
- A risk assessment would allow the mine to better identify those sectors where ground control hazards are most likely to pose a health and safety risk to personnel or pose a significant economic risk to the mine.
- Note that the wall inspections do not typically include interim benches as they are typically obscured by muck. Benches that are > 7 m in height should be included.
- Having a TARP or examples of the conditions associated with each risk category would help ensure consistency in the application of the risk ratings.



Risk = The Likelihood of a Hazard Occurring x The Consequences if the Hazard Occurs

Monitoring and Inspections

Example Risk Assessment



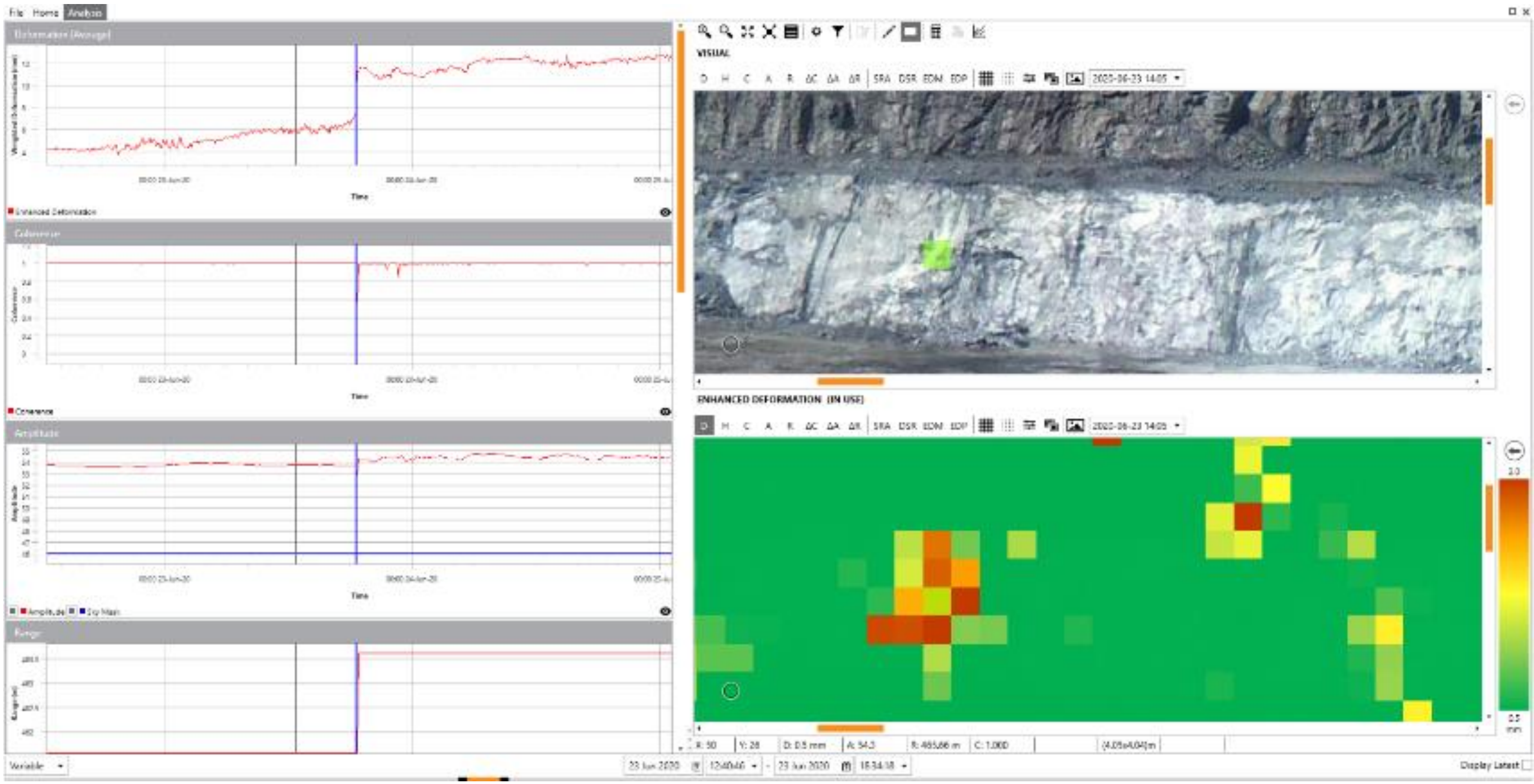
- An example risk assessment is shown below using a generic risk matrix. Operations typically require the residual risk to be Low. Note that this assessment focussed on health and safety and other factors may govern (e.g., loss of a ramp would have high financial consequences).
- It is recommended that a similar approach be used to create a risk map based on the existing wall inspection map. The risk map can then be used to identify and guide risk mitigation efforts (e.g. regular visual inspections, focus of SSR, rockfall berms, etc.).
- Any assessment should be based on AEM's or the site's risk matrix.
- Note that similar risk assessments can be used as part of reviews of the 3MR or annual mine plans to identify areas of particular geotechnical concern and support the planning process.

Hazard	Uncontrolled			With Controls in Place		
	Likelihood	Consequences	Risk	Likelihood	Consequences	Risk
Multi-Bench Scale Failure	Possible	Disability / Fatality	High	Possible	Minimal (Radar monitoring allows creation of exclusion zone)	Low
Rockfall	Certain	Disability / Fatality	High	Certain	Minimal (Rockfall berm in place)	Low

Monitoring and Inspections

Slope Stability Radar

- A GroundProbe slope stability radar is installed on the south wall of the open pit, covering the north wall.
- A second radar has been purchased and is being brought to site.
- The SSR has been able to forecast 5 of the 10 bench scale failures that have occurred since it was installed (example from June 23, 2020 shown at right). However, 2 of the missed failures were obscured by equipment or muck.

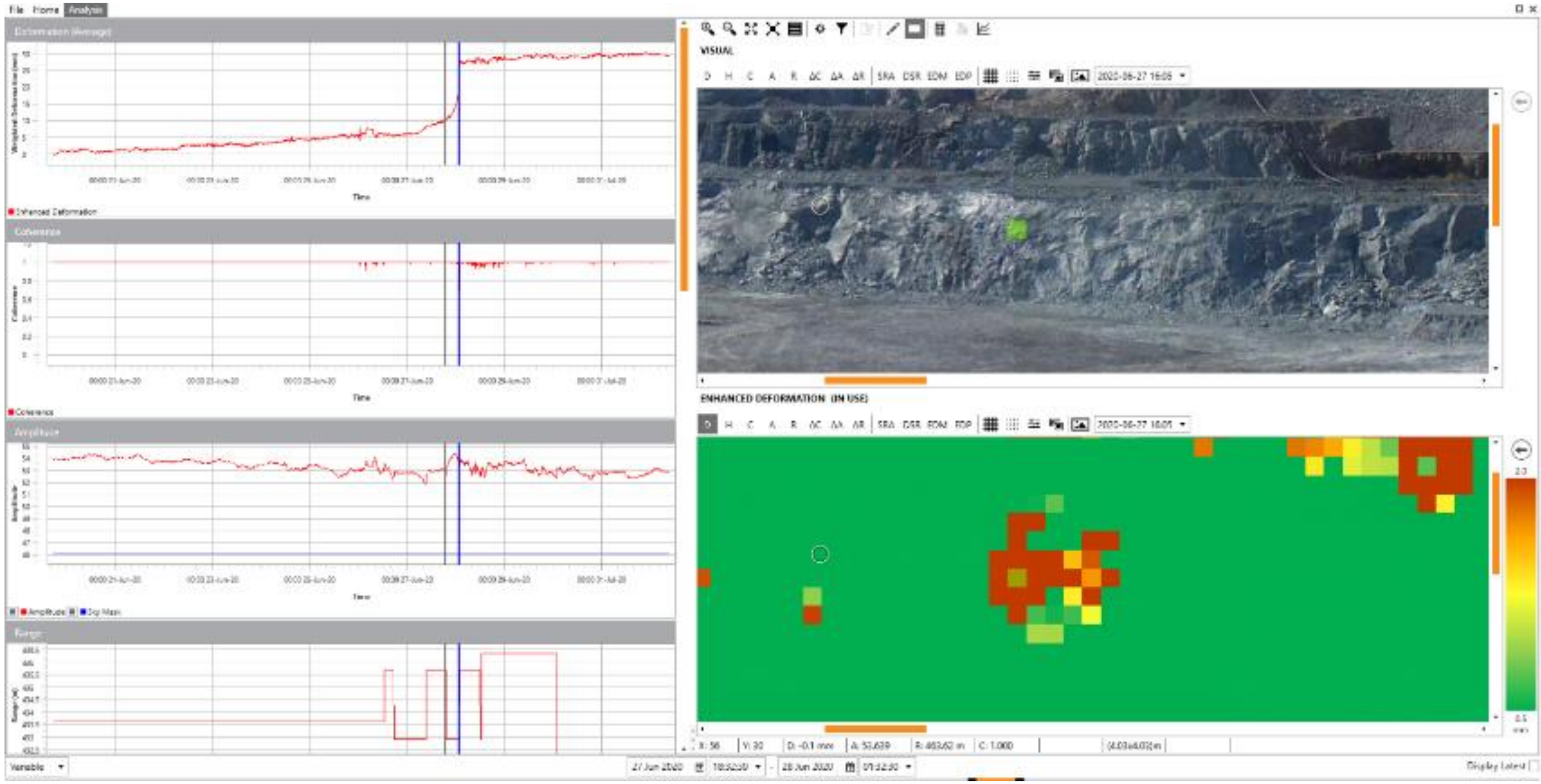


Monitoring and Inspections

Slope Stability Radar

- The SSR is not always able to predict the bench scale failures that have occurred at the mine. This is primarily a function of the scale of the failure relative to the resolution of the radar, and how rapidly they occur.

- For example, the SSR predicted the June 29 failure (which was a continuation of the June 23 failure) only a few hours in advance and might not have triggered an alarm.



Monitoring and Inspections

Slope Stability Radar

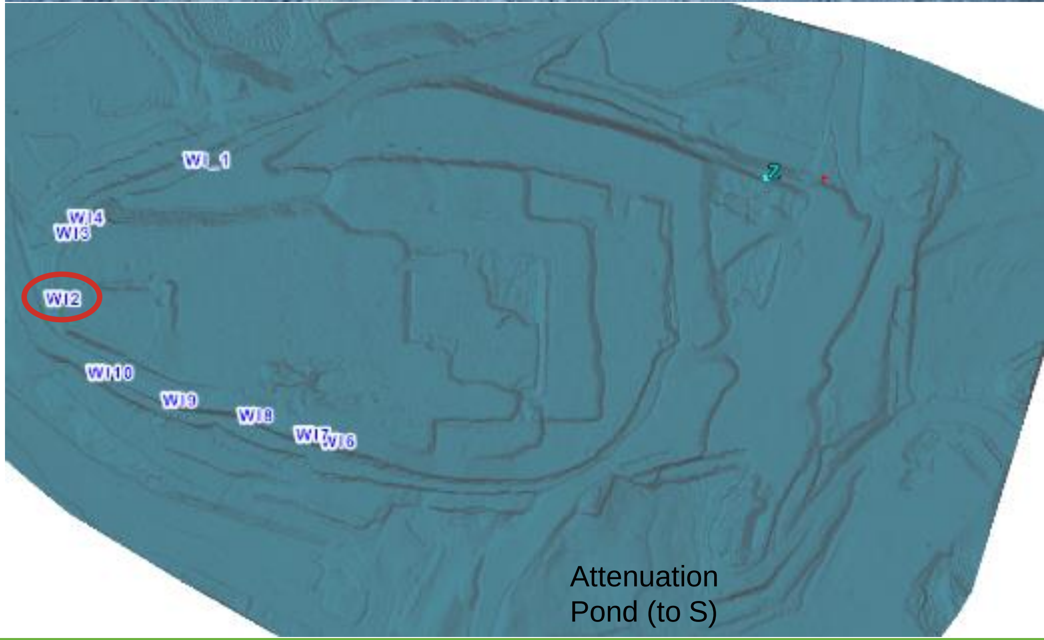
- While the SSR is a very valuable and effective tool, it is best suited to larger-scale failures and cannot always detect bench scale failures, especially if they are small and/or brittle failures. This highlights the importance of the on-going visual inspections.
- The effectiveness of the system can be increased by keeping the SSR close to the wall being monitored and orienting it as close as perpendicular to the wall as possible. With the acquisition of a second unit, the mine has the ability to use one SSR strategically (e.g. covering the north wall) and to use the other tactically (e.g. focussing on a key area such as a large exposure of komatiite while mining is in the area).

Other Considerations

Other Considerations

Groundwater

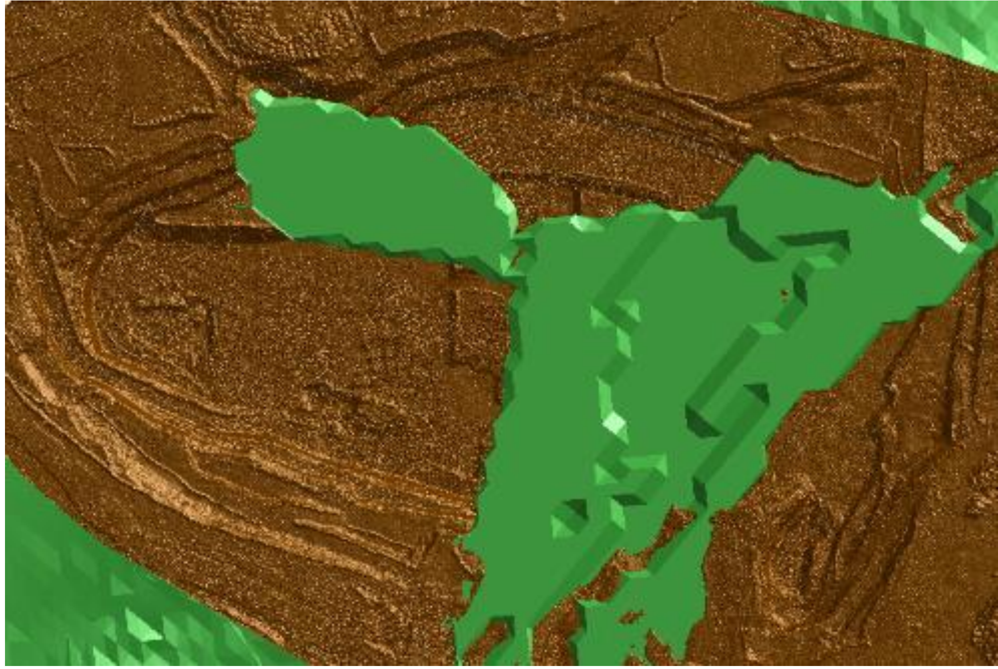
- Seeps have been observed in the west and southwest walls of the open pit. The vast majority of the seeps manifest as damp or wet patches on the wall rather than flowing water.
- The most prominent seep is Water Inflow #2 (shown at upper right and circled on the plan at lower right). At the time of the inspection, seepage was flowing down the wall from multiple points. The majority of the seepage appeared to be associated with sub-horizontal joints. The total flow rate was difficult to gauge but is likely a few litres / second. The seepage was suspected to increase in flow due to rain over the course of the site visit, but this was not possible to confirm.
- The source of the seeps is unclear. With the exception of Water Inflow #1 in the northwest wall, these seeps are not located below the former Whale Tail Lake or within predicted talik / cryopeg (see next slide). The seeps predominantly appear in the middle of the face and are not obviously linked to flow along the overburden / bedrock contact. The seepage may be occurring through a zone of blast damage behind the wall.
- The flow at Water Inflow #2 is expected to form an ice wall over the winter. The seep is located above the planned ramp for the Phase 1 pit and the risk of an ice fall will need to be managed.



Other Considerations

Groundwater

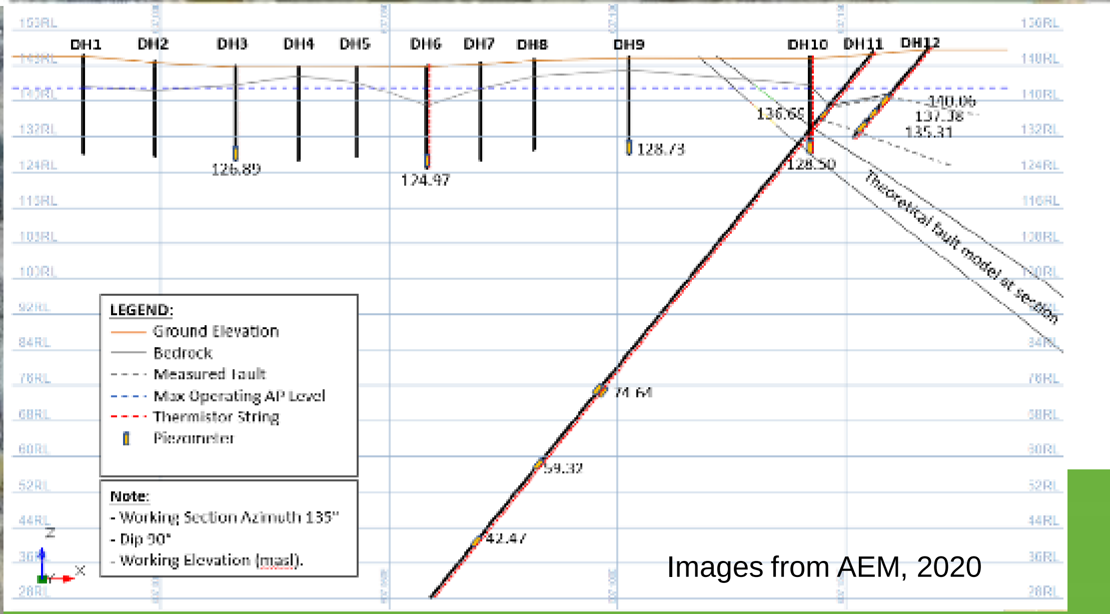
- While seeps have not been observed to date in the south/southeast walls, a significant accumulation of groundwater has been noted in the floor of the pit and the drillers report water when drilling in the area approximately outlined in yellow.
- During the visit, a driller also reported water filling his holes and then freezing in the area outlined in white.
- The areas where groundwater is accumulating in drillholes or on the pit floor agree well with the extents of the talik/cryopeg predicted by the thermal model (Cryopeg predicted by Scenario 2 shown at upper right in green). The source of the water is discussed on the next slide.



Other Considerations

Groundwater

- AEM installed a series of piezometers and thermistors along the planned crest of the ultimate pit where it will be adjacent the attenuation pond and the lakebed of Whale Tail lake. The objective was to determine if the pond was the source of the water in the floor of the pit.
- The results suggest that water is flowing from the attenuation pond towards the open pit within the near-surface bedrock, as well as deeper fractured zones. There is a rapid response observed in the instruments (both piezometers and thermistors) when the water level in the attenuation pond rises (shown on next slide).
- Additional sensors are planned to better define the flow path to the open pit; this is encouraged.
- No evidence of flow along the Ramp Fault was observed in the instrumentation.



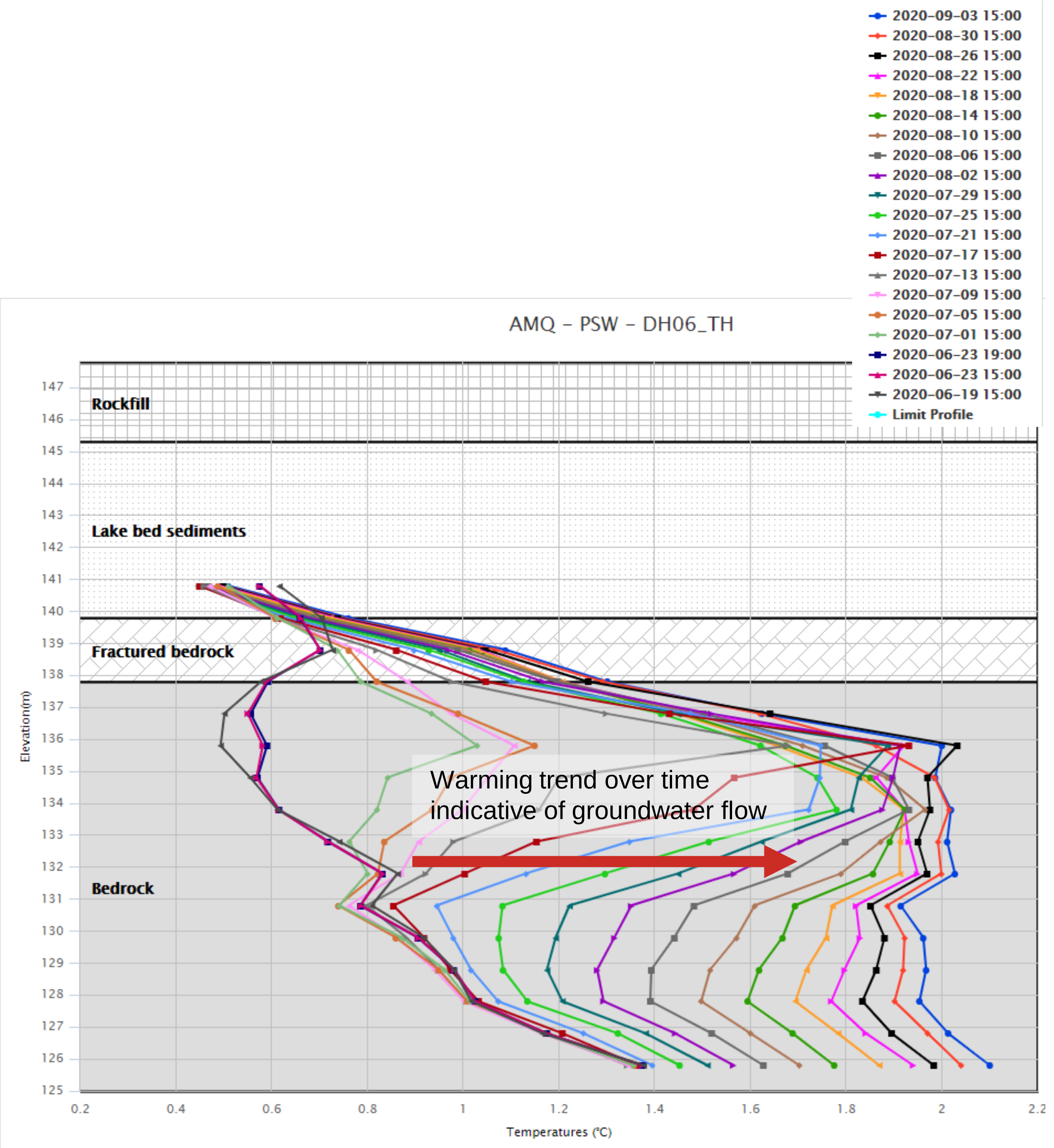
Images from AEM, 2020

Knight Piésold CONSULTING

Other Considerations

Groundwater

- The talik/cryopeg is predicted to extend approximately 100 to 150 m below surface in the south wall of the open pit. It is expected that groundwater will continue to enter the pit within the talik/cryopeg as mining progresses.
- As the open pit deepens, the groundwater will eventually manifest as seepage in the wall rather than in the floor of the open pit. This may not occur until the floor of the pit passes below the base of the talik/cryopeg but could occur earlier due to a change in the rock mass characteristics (e.g. the rock mass quality in the diorite is expected to improve at approximately 80 m below surface).
- Seepage from the pit wall is expected to result in the formation of ice walls that will pose an ice fall hazard, particularly in the spring.
- The groundwater flow into the open pit should continue to be studied so that mitigation measures can be assessed prior to the pushback of the south wall to its final configuration in Phase 3.



Other Considerations

GCMP and Geomechanical Software

Ground Control Management Plan (GCMP)

- A GCMP was recently developed for Amaruq. It is a clear concise document and is reviewed annually. The following observations stem from reading the GCMP in preparation for this visit:
  - Consider adding a one- or two-page overview of the deposit geology and mine plan, including key information such as the ultimate pit dimensions, approximate mine life, major lithologies, etc.
  - (5.2.1.1) Recommend adding an inspection requirement for areas of identified as potentially unstable / of particular concern
  - (5.3.2) Recommend clarifying that the collected data should be compared to the design basis for the open pit in addition to looking for trends
  - (5.4.1) Recommend noting that crack meters and extensometers have not been installed to date

Geomechanical Software

- The mine has a full suite of Rocscience software (DIPS, RocPlane, Swedge, RocFall, Slide, RS2). However, the programs are outdated by several versions, preventing the team from using some of the more powerful features of these programs.
- It is recommended that the mine update DIPS, RocPlane, Swedge and RocFall. Switching to Rocscience's Maintenance program could facilitate future budgeting and ensure the programs remain up to date.

Review of Three-Month Plan

Review of Three-Month Plan

General

The monthly plans for the open pit for September, October and November were reviewed from a geotechnical perspective. The plans will most likely change, but the objective was to identify key risks and opportunities. The review is summarized on the following slides.

Several general design considerations discussed during the previous site visit are repeated below as a reminder:

- Establishing the final walls early in the mine life puts a premium on the proper implementation and validation of the bench and inter-ramp slope design. This limits the opportunity to refine blasting practices and to consider adjustments to the slope design based on the performance of the interim slopes.
- Good communication between the geotechnical team and the planners and geologists is important.
- Regular review of, and feedback on, interim designs by the geotechnical team is important. For example, identifying issues such as: brittle structures immediately behind interim walls, establishing interim walls within the Komatiite, awkward geometry, etc.

Review of Three-Month Plan

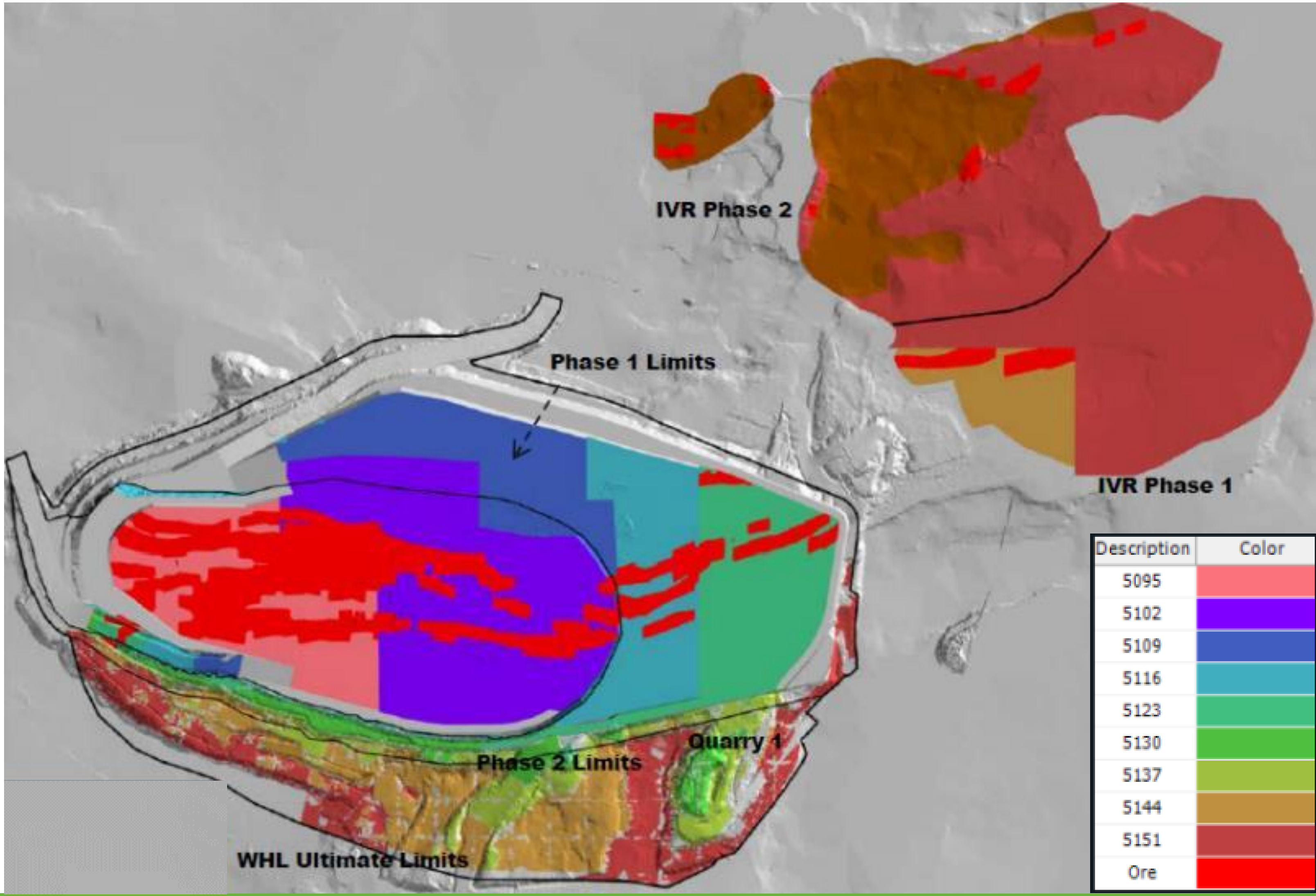
Design Sign-Off

- Regular review of, and feedback on, interim designs by the geotechnical team is important. Ground control factors requiring consideration include:
  - The structural domain(s) involved, including the presence of adverse structure and whether the conditions deviate from expectations
  - The rock mass quality domains involved, including the presence of weak units (Komatiite and overburden) and whether the conditions deviate from expectations
  - The relative orientation of the pit wall and the foliation
  - Whether the proposed design is consistent with the slope geometry recommendations (bench scale and inter-ramp scale)
  - Whether the slope geometry recommendations are applicable (see first three points). Is a specific analysis required (by the mine or a consultant)?
  - Possible interactions with faults (e.g. will a fault intersect or lie directly behind the slope)
  - Possible interactions with existing or predicted slope instabilities
  - Possible interactions with talik or surface water (e.g. the formation of an ice wall or potential for significant inflows)
  - The creation of adverse slope geometry (e.g. a nose)
  - Potential impacts on and of nearby infrastructure (e.g. ramp, roads at pit crest, attenuation pond, etc.)
  - Is instrumentation or a specific monitoring plan required?
- It is understood that the geotechnical team provide input on regular design considerations such as the drill polygons / layouts and are incorporated into the sign-off process. This is a good practice.

Review of Three-Month Plan

September

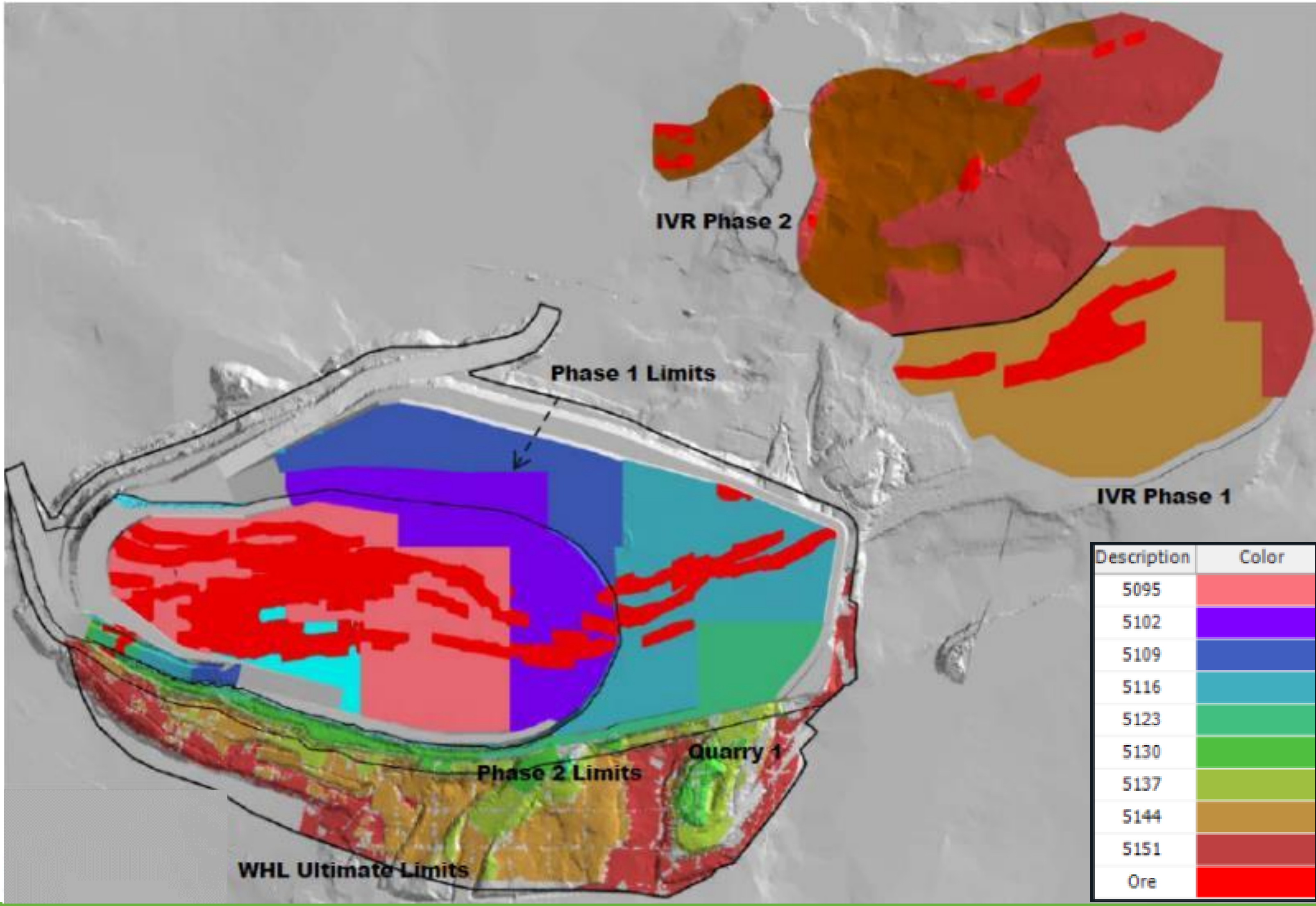
- Deepening Phase 1
- Management of the Komatiite in the north wall of Phase 1 is expected to be an on-going consideration.
- As Phase 1 is advanced to the southeast, it will be important to review the performance of the South Wall and the encountered rock mass structure. This is the first major opportunity to see if Structural Domain 5 extends as far north as Phase 1 and, if so, to better define its extents.
- Stripping of IVR Phase 1 begins.



Review of Three-Month Plan

October

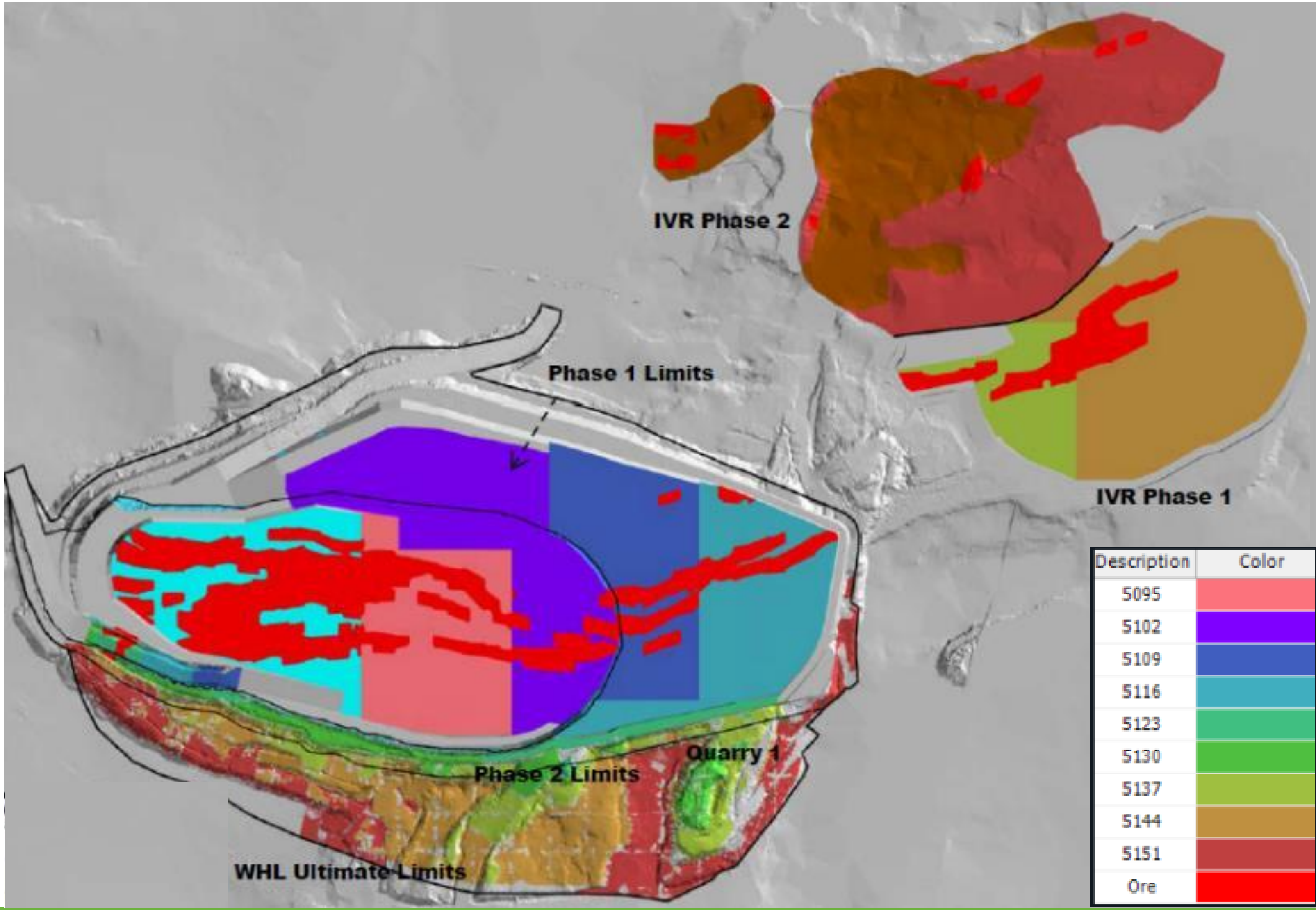
- Continuing to deepen Phase 1 and expanding to the northeast within Phase 2 at Whale Tail.
- Management of the Komatiite in the north wall of Phase 1 is expected to be an on-going consideration.
- It will be important to monitor the performance of the benches on the northeast corner of Phase 2 (Design Sector D4)
- It will be important to continue to monitor groundwater inflows to the open pit as Phase 1 deepens.
- Excavation of the initial benches in IVR Phase 1 continues. This provides an opportunity to review the rock mass characteristics and bench performance.



Review of Three-Month Plan

November

- Expanding Phase 2 to the North and East.
- Management of the Komatiite in the north wall of Phase 1 is expected to be an on-going consideration.
- The push back to the north reduces the exposure of Komatiite in the Phase 1 north wall and is favourable.
- Continued mining in the north and southeast of Phase 2 provides new opportunities to confirm the position of the Ramp Fault.
- Excavation of the initial benches in IVR Phase 1 continues. This provides an opportunity to review the rock mass characteristics and bench performance. The footwall (north wall) of the pit is of particular concern due to the expected presence of several faults and brittle structures.




THANK
YOU