

Appendix 17.4-C

*Tailings Storage Facility Conceptual Closure Plan
Alternatives Assessment*

AJAX PROJECT

**Environmental Assessment Certificate Application / Environmental Impact Statement
for a Comprehensive Study**

Tailings Storage Facility Conceptual Closure Plan Alternatives Assessment

Submitted to:
KGHM Ajax Mining Inc.

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EXECUTIVE SUMMARY

KGHM Ajax Mining Inc. (KAM) retained Norwest Corporation (Norwest) to complete a high level closure alternatives assessment of the Tailings Storage Facility (TSF) for the Ajax Project. The surface area of the TSF at closure is approximately 582 hectares. This area will be reclaimed to satisfy key closure objectives outlined in this document in an effort to transform the TSF into an integrated component of the surrounding ecosystem. This report presents the results of the conceptual closure alternatives assessment for unthickened tailings that include design criteria, trade-off advantages and disadvantages, Rough Order of Magnitude (ROM) quantities and associated costs for each option. The quantities were developed from topographic information provided by KAM using 3D MineSight modelling software. The closure cover and cross-sections were developed as surfaces and built into the topography. Costs were developed using these quantities and applying unit rates from previous cost estimate studies completed in 2014 (Norwest, 2014 and Knight Piésold Ltd, 2014). This alternatives assessment was completed for comparative purposes only to evaluate the Best Available Technology (BAT) at closure for the Ajax Project. The results of this study are conservative, as KAM is moving to a thickened tailings strategy using 60% solids content tailings material based on the results from a recent trade off study of BAT for tailings disposal (Norwest, 2015). The higher initial solids content and lower segregation potential associated with thickened tailings placement are expected to reduce the challenges and costs to achieve the dry closure option (Option 2) described in this report.

The Ajax mine is a copper-gold project located near Kamloops, British Columbia. The resource will be developed as an open pit over a 23 year mine life. The slurry tailings will be deposited and managed in a TSF located south of the open pit. The TSF has been designed to contain a total storage volume of approximately 315Mm³ of tailings material and approximately 7Mm³ of water. Four zoned earth-rockfill dams will be constructed to provide containment to an elevation of 1,060m. Tailings will be discharged from the north, west and south embankments that will result in a supernatant pond toward the southeast corner of the facility which will be drawn down to 2Mm³ at the end of mine life. Prior to closure of the TSF, the supernatant water will be pumped into the pit to expedite the establishment of a pit lake. The removal of the supernatant pond will allow the surficial layer of high fines tailings beneath to desiccate and form a crust. The tailings mass beneath the crust is expected to be a very weak saturated material that will create challenges during reclamation and closure. Consolidation and settlement testing of high fines tailings based on site specific tailings samples has recently been completed (Knight Piésold, 2015). Preliminary review shows the results confirm the current estimate for the range of subsidence within the high fines zone expected to form at the base of the supernatant pond. As the detailed tailings placement plan is developed, it is expected the footprint of the post-operation high fines zone may be refined, therefore volumetric estimates for closure materials should be reviewed at that time.

Three conceptual closure options were evaluated for this study:

- Option 1: The tailings will be covered with an earth fill cover except for a pond/wetland area at the location of the final supernatant pond. This option includes an engineered channel at the abutment of the east embankment to manage surface water from the TSF into the open pit. This closure option will have an uncovered tailings wetland in perpetuity.
- Option 2: The entire tailings surface will be covered and recontoured with an earth fill cover to minimize ingress of surface water and to pass runoff (upon meeting water quality requirements) into an engineered channel towards the south of the TSF and into Humphrey Creek. This dry closure option will be designed to minimize ponded water within the TSF footprint and infiltration into the tailings in perpetuity.
- Option 3: The entire tailings surface will be covered and recontoured with an earth fill cover to minimize ingress of surface water and to pass runoff through a spillway along the abutment of the east embankment (similar to Option 1) and into the open pit. This dry closure option will be designed to minimize any ponded water within the TSF footprint and infiltration into the tailings in perpetuity. There are two tailings management plans considered to meet this dry closure option:
 - Option 3a: Use the current tailings management plan (used for Option 1 and 2) with a sloped beach to the south and use construction materials to regrade and recontour the surface to promote positive drainage towards an engineered channel located near the east embankment.
 - Option 3b: Revise the tailings deposition plan so that the beaches are sloping towards the spillway along the abutment of the east embankment to minimize construction costs. Details on the practicality of establishing this tailings management plan were not covered in this study.

A summary of the closure alternatives assessment is as follows:

- The lowest cost closure design concept is Option 1. This option is estimated to be approximately \$95M or \$165,000/ha. The lower cost is attributed to the material savings achieved by leaving the high fines tailings and weaker tailings under a shallow water cover.
- The most complex design concept is Option 3a/b.
 - Option 3a is the highest closure cost option. This option is estimated to be approximately \$631M or \$1,080,000/ha. The high cost is attributed to the significant

volume of material (approximately 156Mm³ of mine rock) required to reslope the reclamation cover towards the east embankment.

- Option 3b is estimated to be approximately \$105M or \$180,000/ha. This dry closure option is similar in cost to Option 1 (approximately 11% higher). However, this option carries more geotechnical and tailings management risks. The revised tailings management plan assumes that tailings will be discharged along the west and south of the facility to develop beaches at 1 to 2% slopes in order to push the supernatant pond towards the east embankment. The practicality of this depositional plan is uncertain and it is unclear if it is feasible. In addition, a supernatant pond close to the embankment is not consistent with standard tailings dam operating practice. Standard practice would dictate that the supernatant pond should be some distance from the dyke in order to minimize risks associated with seepage and stability.
- Option 2 is estimated to be approximately \$105M or \$180,000/ha. This dry closure option is similar in cost to Option 3b but is expected to have lower risks associated with tailings management. This option does not require significant material to regrade the earth fill cover over the tailings surface for positive drainage (as required in Option 3a). Option 2 also takes advantage of the natural elevation loss of the tailings beach towards the south of the TSF.
- The assumed costs to develop each channel design concept are similar, with both options costing approximately \$4M (or roughly 4% of the total cost with the exception of Option 3a at less than 1%). Lacking detailed information of the foundation materials within these areas, the same unit rate was applied to the estimated cut volumes. Fill volumes for the channel over the east embankment were estimated to be 70,000m³ of till and 630,000m³ of mine rock.
- Both channel design options are expected to be challenging to construct:
 - The proposed channel over the abutment of the east embankment (for Option 1 and 3a/b) has steep gradients that will require energy dissipation design features, potential rock cuts and channel lining over fill zones to convey water from the TSF into the mined out pit. The costs associated with these detailed design features were not evaluated for this study.
 - The proposed engineered channel (for Option 2) requires a significant excavation up to 40m in depth to convey runoff from the TSF into Humphrey Creek. It was assumed that this channel could maintain 1H:1V overall slopes. Stability assessment of the channel side slopes was not evaluated in this study given the limited data. Stability investigations and flattening these side slopes or any additional benching could increase the estimated price provided in this document.

The cost of each option (\$CDN/ha) are summarized in the table below.

Option	Cost (\$CDN / Hectare)
1	\$165,000/ha
2	\$180,000/ha
3a	\$1,080,000/ha
3b	\$180,000/ha

Norwest recommends Option 2 as the reclamation and closure strategy (Best Available Technology (BAT)) for the Ajax project based on the evaluation of the above listed closure options. Key advantages of Option 2 are as follows:

- Reduced uncertainty in achieving required tailings deposition plan (similar to Option 1 and 3a with 3b having the highest level of uncertainty).
- No ponded water at closure (similar to Option 3a and 3b with Option 1 having a pond). A stagnant pond at closure results in a concentration of contaminants remaining in the pond as water evaporates. Ponded water also results in increased infiltration through the base of the pond which leads to an increase in contact seepage water and an expected corresponding reduction in discharge water quality.
- Land is returned to a terrestrial landscape, as close as practical to pre-mining conditions (similar to Option 3a and 3b whereas Option 1 has the pond of contact water).
- The terrestrial landscape closure option has the added benefit of lower embankment stability risks during the post-closure period as no water is impounded. Therefore, the risks and costs associated with long-term maintenance and monitoring of these embankment structures are eliminated.

The key challenge associated with Option 2 would be the development of the channel to connect the covered TSF area to Humphrey Creek and potential reinforcement of the creek's natural channel. Although the size of the cut, side slope configuration, and amount of channel protection will need to be further defined, these are not expected to be technically challenging and are outweighed by the operational and long-term environmental benefits listed above.

1 INTRODUCTION

1.1 Project Description

The Ajax mine is a copper-gold project located near Kamloops, British Columbia. The resource will be developed as an open pit over a 23 year mine life. Tailings will be discharged from the north, west and south embankments that will result in a supernatant pond toward the southeast corner of the facility.

The method of tailings deposition (spigotting from perimeter) is expected to result in beaches with approximately 1 to 2% slopes. During deposition, larger particles will naturally settle out of the tailings slurry closer to the discharge locations. Over the mine life, fine tailings will be displaced by the coarser, denser beach material and the fines will accumulate in the area of the supernatant water pond. Prior to closure of the TSF, a portion or all of the supernatant water will be pumped into the pit. This will expedite the establishment of a pit lake and also reduce the volume of long-term ponded water on the TSF.

1.2 Scope of Work

This conceptual closure alternatives assessment includes the following:

- Basis of design and assumptions.
- Description of each closure option that includes cover design specifications and high level water management structures to direct runoff away from the TSF and into the open pit or natural drainage of Humphrey Creek.
- A trade-off comparison of quantities, costing, and the advantages and disadvantages of each closure option.

The result of this closure alternatives assessment is a recommendation of the option identified as Best Available Technology (BAT) for the Ajax project.

2 BASIS OF DESIGN

2.1 Closure Design Objectives

The overall TSF closure design strategy is to produce a walk-away closure condition with the facility decommissioned and reclaimed.

The primary closure objectives of the TSF are to:

- Facilitate progressive reclamation to the extent practical, in order to provide early mitigation of impacts from the project, reduce environmental exposure times for potentially reactive materials and to decrease final closure activities;
- Provide a sound environmental closure design that meets acceptable extractive industries best practice measures and minimizes environmental risks including re-establishment of a functioning ecosystem and protecting air quality;
- Address and decrease public safety concerns following closure;
- Preserve groundwater and surface water quality downstream of the TSF;
- Ensure the long term stability and integrity of the TSF embankments; and
- Integrate the TSF into the surrounding landscape and restore the natural appearance of the site to return the land to the pre-mining use and level of productivity.

In order to help facilitate these closure objectives, monitoring of geotechnical stability and environmental factors will be conducted until all governing parameters have met acceptable closure criteria.

2.2 Design Basis and Operating Criteria

- The basis of design for the closure alternatives assessment study was developed based on engineering studies provided by KAM (Knight Piésold Ltd, 2014).
- TSF and water management facilities are located on KAM claims.
- TSF storage capacity for 315Mm³ of unthickened tailings.
- TSF dam classification “EXTREME” as per the Canadian Dam Association (CDA) guidelines (CDA 2007).
- Long-term mean annual precipitation estimated to be 336mm.

- Mean annual lake evaporation rate estimated to be 565mm.
- Conventional unthickened tailings disposal with a slurry solids content of 32% by weight.
- Assumed dry tailings density of 1.4 tonnes/m³.
- Inflow Design Flood (IDF) is the Probable Maximum Flood (PMF) = 2.6 Mm³.
- There is sufficient freeboard to accommodate the IDF above the maximum supernatant pond elevation at each dam construction stage, plus a two meter allowance for wave run-up protection.
- Slurry tailings will be discharged from the embankment crests to establish a uniform 1 to 2% beach slope with an operating supernatant pond, away from the embankments, towards the center and southeast corner of the facility. Coarser and heavier particles will settle out of the tailings slurry close to the discharge locations and will displace the finer tailings which will concentrate in the area of the supernatant pond.
- The supernatant pond will be drawn down to 2Mm³ at the end of production. The supernatant water is pumped into the pit to allow the upper zone of high fines tailings to desiccate prior to placement of capping materials. The loose, saturated high fines tailings beneath the supernatant pond are assumed to settle over time due to loading from the earth fill cover. Knight Piésold Ltd. has completed consolidation modelling (2015) based on laboratory test results of site specific tailings material. That report indicates that post-closure consolidation of the deposited tailings will occur over an extended period and the magnitude of settlement of the tailings will vary depending upon its size distribution and initial placement condition (sub-aerial or sub-aqueous). Settlement estimates in the range of 1m (coarse beach area) to 10m (high fines pond basin) were predicted.
- Earth fill materials used to cap and cover the tailings surface will include:
 - Mine rock sourced from the South Mine Rock Storage Facility (SMRSF), which will include blended Non Potential Acid Generating (non-PAG) and PAG that is net neutral material, on the tailings surface. The mine rock will increase bearing capacity in order facilitate trafficable access for construction equipment.
 - Low permeability glacial till from local borrow sources to minimize water infiltration into the tailings deposit.
 - Topsoil and vegetation to match the surrounding landscape and transform the TSF into an integrated component of the existing ecosystem.

- The cover system has been designed based on guidance from the Mine Environment Neutral Drainage (MEND) Program and will use construction materials stockpiled during mine development and operations. Emphasis has been placed on optimizing the amount of capping materials necessary to complete the closure objectives of the TSF.
- Table 1 summarizes the capping materials for the earth fill reclamation closure cover. Figure 1 shows a conceptual plan view of the TSF at the end of mine life (Year 23) and a simplified cross section of the proposed cover system.

Table 1
Reclamation Cover – Capping Material Thickness

Capping Materials	Thickness of Capping Layer
Topsoil	0.35m
Till	0.65m
Mine Rock	Minimum ¹ 1m

1. The high fines tailings beneath the supernatant pond are expected to settle due to mine rock loading for dry closure options and will require a thicker rock capping layer.

- Runoff and/or flood events will be directed away from the facility to an engineered channel to Humphrey Creek or to the open pit. Two preliminary channel concepts were developed to establish high level quantities and costs for this study. Detailed engineering is required to prove the viability of these designs during the detailed design phase of the project.

3 TSF CLOSURE ALTERNATIVES ASSESSMENT

Three closure options were evaluated in this alternatives assessment and are discussed below. Each option includes details on the cover design specifications and associated engineered structures to manage runoff and/or flood events, advantages and disadvantages, estimated quantities and associated costs.

The quantities developed for this study were based on topographic information provided by KAM using 3D MineSight modelling software. The footprints and cross-sections were developed as surfaces and built into the topography. Costs were developed based on previous cost estimate studies completed in 2014 (Norwest, 2014 and Knight Piésold Ltd, 2014). Wherever possible, updated unit costs were developed and used for this study.

3.1 Option 1: Small Pond/Wetland and Discharge to Open Pit

Option 1 includes a dry cover over the tailings beaches and a pond/wetland over the high fines tailings area where the final supernatant pond was located. Flood events exceeding the design criteria will be managed through an engineered channel near the east embankment. Further details on Option 1 are described below. Figure 2 shows a conceptual layout of closure Option 1.

Closure Cover Development:

General aspects of the TSF closure design for Option 1 include:

- The tailings management plan will be designed and operated to keep the supernatant pond away from the embankments and towards the southeast corner of the facility.
- At the end of production, the supernatant pond will be pumped into the mine pit prior to TSF reclamation and closure activities to expedite the establishment of the pit lake. The high fines tailings beneath the supernatant pond are not pumped into the pit but are allowed to desiccate to increase their bearing capacity prior to placement of capping materials.
- The competent tailings outside the footprint of the supernatant pond will be reclaimed to the maximum practicable extent. Mine rock will be end dumped and spread over the competent tailings beaches using a dozer at a one meter thick lift up to the perimeter of the softer tailings (beneath the supernatant pond) where a trafficable surface cannot be maintained.

- A low permeability glacial till layer (approximately 0.65m thick) will be placed on top of the mine rock layer to minimize water infiltration into the tailings deposit.
- A growth medium or topsoil will be placed above the till to promote vegetation growth in order to return the area to the natural pre-mining conditions of the surrounding ecosystem.
- An engineered channel near the east embankment is included in the design to manage and direct any flood volumes that exceed a storage volume of 57Mm³ into the open pit. Based on the preliminary water balance provided by KAM, a pond storing 57Mm³ would not likely accumulate after closure because the average evaporation rates are typically higher than precipitation. There is the potential for small localized seasonal wetland/pond features to form during the spring freshet due to differential settlement of the underlying tailings.

Estimated Quantities and Costs:

Table 2 provides a summary of quantities and costs of each cover material for Option 1. Total cost to develop Option 1 is approximately \$95M. This cost is comprised of approximately \$91M for reclamation cover materials and \$4M for the engineered channel.

Table 2
Option 1: Reclamation Materials and Estimated Costs

Material Type	Thickness/Area	Quantity ¹	Costs ² (\$Million CDN)
Mine Rock	1m	5,310,000m ³	\$19M
Till	0.65m	3,450,000m ³	\$47M
Topsoil	0.35m	1,860,000m ³	\$24M
Re-Vegetation	N/A	531ha	\$1M
Channel - Excavation	N/A	170,000m ³	\$1M
Channel - Fill	N/A	700,000m ³	\$3M
TOTAL			\$95M

1. Quantities are based on topographic information provided by KAM using 3D MineSight modelling software.
2. All costs are in Canadian dollars. Unit rates were developed from previous KAM studies completed in 2014.
3. Above costs do not include indirect costs or contingency.

Advantages and Disadvantages:

Advantages of TSF closure Option 1 include:

- Requires significantly less cover material over the tailings beach than the dry reclamation cover systems because the high fines tailings area is left under a shallow water cover.
- Easier to construct than the other two options because a cover system is only required over the more competent tailings beach.
- The long term impacts of consolidation within the softer deposits causing surface deformation have little impact on the long term efficacy of this closure option.
- Recontouring of the TSF is not required.
- Modifications to existing water courses are not required.
- Part of the existing surface water management infrastructure can be used to convey water discharged through the engineered channel into the pit.

Disadvantages of TSF closure Option 1 include:

- Surface water ingress into the tailings deposit is not prevented as the lower permeable till layer does not cover the softer tailings sediments beneath the supernatant pond. A stagnant pond at closure results in a concentration of contaminants remaining in the pond as water evaporates. Pondered water also results in increased infiltration through the base of the pond which leads to an increase in contact seepage water and an expected corresponding reduction in discharge water quality.
- The uncapped area of softer sediments will consolidate over a much longer period of time, compared with dry closure options that provide loading on these sediments that decreases the consolidation time.
- The area of soft sediments may pose a threat to both animal and human land users and may require additional provisions to secure the area.
- Land use will be impaired over the area of the soft sediments and will not be returned to the pre-mine level of usage.
- The engineered channel over the east embankment will be challenging to construct due to the steep slopes, rock cuts, channel lining and energy dissipation measures needed to convey water from the TSF into the pit.
- If the long term water balance changes and water begins to accumulate in the area of the TSF, the entire surface of the TSF would be covered in water before excess water is routed down the engineered channel towards the pit.

3.2 Option 2: Dry Closure with Discharge to Humphrey Creek

Option 2 includes a dry cover over the entire tailings surface. The surface of the TSF will be recontoured with an earth fill cover to minimize ingress of surface water and to pass runoff (after meeting water quality requirements) into an engineered channel towards the south of the TSF and into Humphrey Creek. This dry closure option will prevent water ponding on the reclaimed TSF surface to promote a dry cover in perpetuity. Figure 3 shows a conceptual layout of closure Option 2.

Closure Cover Development:

General aspects of the TSF closure design for Option 2 include:

- The tailings management plan will be designed and operated to keep the supernatant pond away from the embankments and towards the southeast corner of the facility.
- At the end of production, the supernatant pond will be pumped into the mine pit prior to TSF reclamation and closure activities in order to expedite the establishment of the pit lake. The high fines tailings beneath the supernatant pond are not pumped into the pit but allowed to desiccate to increase their density and bearing capacity prior to placement of capping materials.
- Mine rock will be end dumped and spread over the entire tailings surface using a dozer in a one meter thick lift (over competent tailings) and increasing in lift thickness over the softer tailings to establish a trafficable surface. The loose, saturated high fines tailings beneath the supernatant pond will settle over time due to loading. Consolidation and settlement testing of high fines tailings based on site specific tailings samples was recently completed (Knight Piésold, 2015). Preliminary review shows the results confirm the current estimate for the range of subsidence within the high fines zone expected to form at the base of the supernatant pond. As the detailed tailings placement plan is developed, it is expected the footprint of the post-operation high fines zone may be refined, therefore volumetric estimates for closure materials should be reviewed at that time.
- A low permeability glacial till will be placed approximately 0.65m thick above the mine rock unit to minimize water infiltration into the tailings deposit.
- A growth medium or topsoil will be placed above the till to promote vegetation growth to return the area to the natural pre-mining conditions of the surrounding ecosystem.

- An engineered channel will take surface water flows (upon meeting the water quality requirements) at the south end of the pond into the Humphrey Creek drainage.

Estimated Quantities and Costs:

Table 3 provides a summary of quantities and costs of each cover material for Option 2. The total cost to develop Option 2 is approximately \$105M. This cost is comprised of approximately \$101M for reclamation cover materials and \$4M for the engineered channel.

Table 3
Option 2 Reclamation Materials and Estimated Costs

Material	Thickness/Area	Quantity ¹	Costs ² (\$Million CDN)
Mine Rock ³	1m	5,970,000m ³	\$21M
Till	0.65m	3,780,000m ³	\$52M
Topsoil	0.35m	2,040,000m ³	\$27M
Re-Vegetation	N/A	582ha	\$1M
Channel - Excavation ⁴	N/A	1,000,000m ³	\$4M
TOTAL			\$105M

1. Quantities are based on topographic information provided by KAM using 3D MineSight modelling software.
2. All costs are in Canadian dollars. Unit rates were developed from previous KAM studies completed in 2014.
3. Mine rock volumes increase in the area of high fines tailings zone beneath the supernatant pond due to settlement from loading.
4. Material from channel excavation can be used as cover material, partially offsetting the cost of channel development. The savings from this partial offset have not been included in this assessment.
5. Above costs do not include indirect costs or contingency.

Advantages and Disadvantages:

Advantages of TSF closure Option 2 include:

- Confidence (based on experience) in achieving the required tailings deposition.
- Hazards associated with a pond of standing water or uncapped tailings area are mitigated.
- The low permeable till cap layer isolates surface water from the tailings and minimizes infiltration into the tailings deposit.

- Improved discharge water quality is expected due to the elimination of a standing pond and reduced infiltration.
- Entire TSF area is returned to a terrestrial landscape, as close as practical to pre-mining conditions.
- The terrestrial landscape closure option has the added benefit of lower embankment stability risks during the post-closure period as no water is impounded. Therefore, the risks and costs associated with long-term maintenance and monitoring of these embankment structures are eliminated.

Disadvantages of TSF closure Option 2 include:

- Development of a channel to connect the covered TSF area to Humphrey Creek. The current estimate includes an excavation up to 40m deep. It should be noted that the cost associated with developing this channel can be partially offset by using the excavated materials during cover construction.
- Potential reinforcement of the Humphrey Creek natural channel (as it would be required to manage flow from an increased catchment area).
- If the quality of the discharge water is a concern, an engineered wetland or other mitigation options may be required to remove contaminants before surface water can be discharged into Humphrey Creek.

3.3 Option 3a/b Dry Closure with Discharge to the Open Pit

Option 3a/b includes a dry closure cover over the tailings surface. Both options will prevent water ponding on the reclaimed TSF surface to promote a dry cover in perpetuity. Figure 4 shows a conceptual layout of closure Option 3.

Option 3a/b assumes two different tailings management plans:

- Option 3a maintains the current tailings deposition plan that establishes sloped beaches to the south and a supernatant pond away from the embankments. The surface of the TSF is regraded and recontoured to promote positive drainage towards an engineered channel located near the east embankment (similar to Option 1) using mine rock to lift the south end of the TSF.
- Option 3b considers an alternate tailings deposition plan that develops sloped beaches to the east and establishes a supernatant pond near the east embankment. This tailings deposition plan is currently at a conceptual level only. There is

uncertainty that the development of sloped beaches to the east is practical over the mine life.

Closure Cover Development:

General aspects of the TSF closure Option 3a/b include:

- At the end of production, the supernatant pond will be pumped into the mine pit prior to TSF reclamation and closure activities to expedite the establishment of the pit lake. The high fines tailings beneath the supernatant pond are not pumped into the pit but allowed to desiccate to increase their bearing capacity prior to placement of capping materials.
- Mine rock will be end dumped and spread over the entire tailings surface using a dozer in a one meter thick lift (over competent tailings) and increasing in lift thickness over the softer tailings to establish a trafficable surface. The loose, saturated high fines tailings beneath the supernatant pond will settle over time due to loading. Consolidation and settlement of the high fines tailings beneath the TSF pond has been predicted based on laboratory consolidation tests of site specific tailings samples (Knight Piésold, 2015). Preliminary review shows the results confirm the current estimate for the range of subsidence within the high fines zone expected to form at the base of the supernatant pond. As the detailed tailings placement plan is developed, it is expected the footprint of the post-operation high fines zone may be refined, therefore volumetric estimates for closure materials should be reviewed at that time.
- A low permeability glacial till will be placed approximately 0.65m thick above the mine rock unit to minimize water infiltration into the tailings deposit.
- A growth medium or topsoil will be placed above the till to promote vegetation growth to return the area to the natural pre-mining conditions of the surrounding ecosystem.
- An engineered channel will take excess surface water flows over the east embankment and into the mined out pit. In order to facilitate this closure option, the final tailings surface will slope towards the northeast of the facility and will be covered and regraded/recontoured to maintain positive drainage towards the east embankment.

Estimated Quantities and Costs:

Table 4 provides a summary of quantities and costs of each cover material for Option 3a/b. Total cost to develop Option 3a is approximately \$631M. This cost is comprised of approximately \$627M for reclamation cover materials and \$4M for the engineered channel. Total cost to develop Option 3b is approximately \$105M. The cost is comprised of approximately \$101M for reclamation cover materials and \$4M for the engineered channel.

Table 4
Option 3a/b: Reclamation Materials and Estimated Costs

Material	Thickness/Area	Option 3a Quantity ¹	Option 3a Costs ² (\$Million CDN)	Option 3a Quantity ¹	Option 3b Costs ² (\$Million CDN)
Mine Rock ³	1m	156,200,000m ³	\$547M	5,970,000	\$21M
Till	0.65m	3,780,000m ³	\$52M	3,780,000m ³	\$52M
Topsoil	0.35m	2,040,000m ³	\$27M	2,040,000m ³	\$27M
Re-Vegetation	N/A	582ha	\$1M	582ha	\$1M
Channel - Excavation	N/A	170,000m ³	\$1M	170,000m ³	\$1M
Channel - Fill	N/A	700,000m ³	\$3M	700,000m ³	\$3M
TOTAL 3a			\$631M	TOTAL 3b	\$105M

1. Quantities are based on topographic information provided by KAM using 3D MineSight modelling software.
2. All costs are in Canadian dollars. Unit rates were developed from previous KAM studies completed in 2014.
3. Mine rock volume increases approximately 20% in the area of the high fines tailings zone beneath the supernatant pond due to settlement from loading.
4. Above costs do not include indirect costs or contingency.

Advantages and Disadvantages:

Advantages of TSF closure Option 3a/b include:

- The low permeable till cap layer isolates surface water from the tailings and minimizes infiltration into the tailings deposit.
- Water quality is not a concern as all runoff water is routed into the pit.
- The entire TSF area will be returned to the pre-mine land usage.

Disadvantages of TSF closure Option 3a/b include:

- The engineered channel over the east embankment will be challenging to construct due to the steep slopes, rock cuts, channel lining and energy dissipation measures needed to convey water from the TSF into the pit.

- There are seepage and stability risks associated with locating the supernatant pond in close proximity to the east embankment for Option 3b. These geotechnical issues have not been evaluated for this study.
- Option 3a requires handling of a significant volume of mine rock (much larger than any other option considered).
- There is uncertainty that the tailings deposition plan for Option 3b is practical over the life of the mine (developing beaches from the east).

3.4 Cost Comparison of Closure Options

The results indicate that:

- The lowest closure design concept is Option 1. This option is estimated to be approximately \$95M or \$165,000/ha. The lower cost is attributed to the material savings achieved by leaving the loose saturated high fines tailings under a shallow water cover.
- The highest closure design concept is Option 3a. This option is estimated to be approximately \$631M or \$1.1M/ha. There is a significant cost (\$547M) required to regrade and recontour the cover over the tailings surface to direct runoff to the east embankment.
- Option 2 is \$105M or \$180,000/ha and it does not require significant material to regrade the tailings surface to allow positive drainage. This option takes advantage of the natural elevation loss of the tailings beach towards the south of the TSF. However, there is a significant excavation required (up to 40m in depth) to convey runoff flows into Humphrey Creek.
- The costs for the two high level channel design options are similar. Detailed engineering has not been undertaken as part of this study and actual costs associated with these structures may not be reflected in this preliminary estimate.

Table 5 provides a summary of the cost for each closure option evaluated in this study. The total cost does not include indirect costs or contingency.

Table 5
Closure Option Cost Summary

Description	Unit	TSF Closure Option #1			TSF Closure Option #2			TSF Closure Option #3a			TSF Closure Option #3b						
		Unit Rate	Quantity	Cost	Unit Rate	Quantity	Cost	Unit Rate	Quantity	Cost	Unit Rate	Quantity	Cost				
		(\$/unit)	(unit)	(\$Million CAD)	(\$/unit)	(unit)	(\$Million CAD)	(\$/unit)	(unit)	(\$Million CAD)	(\$/unit)	(unit)	(\$Million CAD)				
Mine Rock (1m) ²	m ³	\$ 3.50	5,310,000	\$19M	\$ 3.50	5,970,000	\$21M	\$ 3.50	156,200,000	\$547M	\$ 3.50	5,970,000	\$21M				
Till (0.65m) ²	m ³	\$ 13.67	3,450,000	\$47M	\$ 13.67	3,780,000	\$52M	\$ 13.67	3,780,000	\$52M	\$ 13.67	3,780,000	\$52M				
Tops oil (0.35m) ³	m ³	\$ 13.00	1,860,000	\$24M	\$ 13.00	2,040,000	\$27M	\$ 13.00	2,040,000	\$27M	\$ 13.00	2,040,000	\$27M				
Channel - General Cut ⁴	m ³	\$ 4.00	170,000	\$1M	\$ 4.00	960,000	\$4M	\$ 4.00	170,000	\$1M	\$ 4.00	170,000	\$1M				
Channel - General Fill ⁵	m ³	\$ 4.52	700,000	\$3M	\$ 4.52	0	\$0M	\$ 4.52	700,000	\$3M	\$ 4.52	700,000	\$3M				
Re-Vegetation ⁶	ha	\$1,000.00	531	\$1M	\$1,000.00	582	\$1M	\$1,000.00	582	\$1M	\$1,000.00	582	\$1M				
			Option #1 Total Cost⁷	\$95M				Option #2 Total Cost⁷	\$105M			Option #3a Total Cost⁷	\$631M			Option #3b Total Cost⁷	\$105M

Notes:

1. Unit rate from Norwest Life of Mine Cost Estimate Review - Tailings and Water Management Structures (Dec 10,2014)
2. Unit rate from Norwest Life of Mine Cost Estimate Review - Tailings and Water Management Structures (Dec 10,2014).
3. Unit rate from KPL Closure Plan Alternatives Assessment #VA101-246/26-6
4. Unit rate from Norwest Life of Mine Cost Estimate Review - Tailings and Water Management Structures (Dec 10,2014)
5. Unit rate from KPL Closure Plan Alternatives Assessment #VA101-246/26-6
6. Unit rate is an aggregate of the till and waste rock unit rates as required to complete the channel fill.
7. Contingency has not been included in these estimates.

4 TRADE-OFF COMPARISON

4.1 Trade-off Discussion

A high level TSF reclamation closure alternatives assessment was completed for the Ajax Project. Three options were developed for this study:

- **Option 1:** A small wetland with discharge to the open pit. This closure concept was designed with an earth fill cover over the competent tailings beaches and the softer tailings would be left exposed to form a wetland in perpetuity. There would be no, or very limited, flow-through of water for the wetland (i.e. stagnant conditions) and ponded water quality is expected to be very poor. An engineered channel would be developed along the abutment of the east embankment to direct any runoff from the facility through an engineered channel to the mined out open pit. Due to the sloped beaches to the south, this design concept would store a volume of 57Mm³ (22 times the estimated PMF) before it would reach the engineered channel along the east embankment. A pond volume of this size is unlikely to occur based on the preliminary water balance provided by KAM as the average evaporation is higher than precipitation at this site. Some level of ongoing embankment monitoring and maintenance would be required due to the presence of stored water within the TSF impoundment. Costs for ongoing monitoring and maintenance are not included in this assessment.

Option 1 has the lowest closure cost for reclamation at \$95M or \$165,000/ha. Option 2 and 3b costs are approximately 11% higher than Option 1 while Option 3a costs are approximately 660% higher than Option 1.

- **Option 2:** Dry closure with discharge to Humphrey Creek. This closure concept was designed with an earth fill cover over the entire tailings surface to minimize infiltration from ponding water or runoff. The absence of ponded water will reduce infiltration and eliminating the standing pool of poor quality water should improve discharge water quality. The hazard to people and wildlife of having a pond with a very soft bottom is also removed.

Consolidation and settlement of the high fines zone beneath the TSF pond has been predicted based on laboratory consolidation tests of site specific tailings samples (Knight Piésold, 2015). Preliminary results confirm the current estimate of subsidence within the high fines tailings at the base of the pond.

An engineered channel would be developed at the southeast part of the facility to optimize the natural elevation loss of the tailings beach towards the south of the TSF. The excavation to develop this channel requires cuts up to 40m high. However, this cut

material can be incorporated into the cover construction, thereby reducing the cost impact and the need for additional storage area. A retention pond would be required to ensure the water quality from runoff meets acceptable environmental criteria before discharging to the natural drainage of Humphrey Creek. Costs for this retention pond were not covered in this study.

This option does not require ongoing monitoring and maintenance of the TSF embankments as there is no longer water impounded within the facility.

Option 2 is estimated to be \$105M or \$180,000/ha. The costs are approximately 11% higher than Option 1 due to the additional material required to cover the exposed loose, saturated high fines tailings area beneath the footprint of the supernatant pond.

- **Option 3a/b:** Dry Closure with Discharge to the Open Pit. This closure concept was designed with an earth fill cover over the entire tailings surface to minimize infiltration from ponding water or runoff. Consolidation and settlement of the high fines zone beneath the TSF pond has been predicted based on laboratory consolidation tests of site specific tailings samples (Knight Piésold, 2015). Preliminary review shows the results confirm the current estimate for the range of subsidence within the high fines zone expected to form at the base of the supernatant pond. As the detailed tailings placement plan is developed, it is expected the footprint of the post-operation high fines zone may be refined, therefore volumetric estimates for closure materials should be reviewed at that time.

There are challenges to establish positive drainage from the cover system to the engineered channel that will require modification to the current tailings deposition plan to slope the beaches towards the east embankment or a significant increase in earth fill to raise the south end of the facility (due to sloped beaches towards the south). The additional material for Option 3a results in 660% higher cost and Option 3b 11% higher cost than Option 1. The cost due to a revised tailings management plan was not evaluated for this study.

4.2 Quantitative Trade-off

Each of the options considered has advantages and disadvantages; however, the relative difference is not always large. A qualitative trade-off table, shown below in Table 6, is used for comparison and to provide consideration to the relative advantages and disadvantages. The trade-off table is used as a tool to help guide the selection of BAT for TSF closure at the Ajax Project.

Table 6
Quantitative Trade-off Comparison

Attribute ¹	Option 1	Option 2	Option 3a	Option 3b
Tailings Deposition	10	10	10	1
Ponded Water	1	10	10	10
Water Infiltration	1	10	10	10
Terrestrial Landscape	6	10	10	10
Channel Earthworks	5	1	5	5
Discharge Water Quality	1	8	8	8
Long-term Consolidation	10	8	1	8
Cost	10	9	1	9
TOTAL RANKING POINTS	44	66	55	61
RANKING	4	1	3	2

Notes:

1. Tailings deposition refers to the period during operations. All other attributes are during and after closure.
2. Point scale is 1 to 10 with 10 points representing the most favorable option and 1 the least favorable.
3. Option descriptions:
 - Option 1: Small Pond/Wetland and Discharge to Open Pit.
 - Option 2: Dry Closure with Discharge to Humphrey Creek.
 - Option 3a: Dry Closure with Discharge to Open Pit (contoured using mine rock).
 - Option 3b: Dry Closure with Discharge to Open Pit (contoured using tailings deposition).

4.3 Trade-off Recommendation

Norwest recommends Option 2 as Best Available Technology (BAT) for the Ajax project based on the evaluation of the above listed closure options. Key advantages of Option 2 are as follows:

- Reduced uncertainty in achieving required tailings deposition (similar to Option 1 and 3a with 3b having the highest level of uncertainty).
- No ponded water at closure (similar to Option 3a and 3b with Option 1 having a pond). A stagnant pond at closure could result in an area of concentration of salts or other contaminants as water accumulates and then evaporates seasonally. Ponded water also results in increased infiltration through the base of the pond which leads to an increase in contact seepage water and an expected corresponding reduction in discharge water quality.
- Land is returned to a terrestrial landscape, as close as practical to pre-mining conditions (similar to Option 3a and 3b whereas Option 1 has the pond of contact water).

- The terrestrial landscape closure option has the added benefit of lower embankment stability risks during the post-closure period as no water is impounded. Therefore, the risks and costs associated with long-term maintenance and monitoring of these embankment structures are eliminated.

The key challenge associated with Option 2 would be the development of the channel to connect the covered TSF area to Humphrey Creek and potential reinforcement of the creeks natural channel. Although the size of the cut, side slope configuration, and amount of channel reinforcement will need to be further defined, these are not expected to be technically challenging and are outweighed by the operational and long-term environmental benefits listed above.

It is important to note that the results of this study are conservative, as KAM is moving to a thickened tailings strategy using 60% solids content tailings material based on the results from a recent trade off study of BAT for tailings disposal (Norwest, 2015). The higher initial solids content and lower segregation potential associated with thickened tailings placement are expected to reduce the challenges and costs to achieve the dry closure option for Option 2.

5 CLOSURE

This report has been prepared for KGHM Ajax Mining Inc. to provide a high level closure alternatives assessment for the proposed tailings storage facility at the Ajax Project, located near Kamloops, British Columbia. As mutual protection to KGHM Ajax Mining Inc., the public, and Norwest Corporation, this report and its figures are submitted for exclusive use by KGHM Ajax Mining Inc. We specifically disclaim any responsibility for losses or damages incurred though the use of our work for a purpose other than described in the report. Our report and recommendations should not be reproduced in whole or in part without our express written permission.

June 5, 2015

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Senior Geotechnical Engineer
Norwest Corporation

June 5, 2015

Sean Ennis, P.Eng.
Vice President, Mining
Norwest Corporation

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Norwest Corporation, 2015. ROM Tailings Storage Facility Dry Closure Concept Design. Rev A.

7 ATTACHMENTS

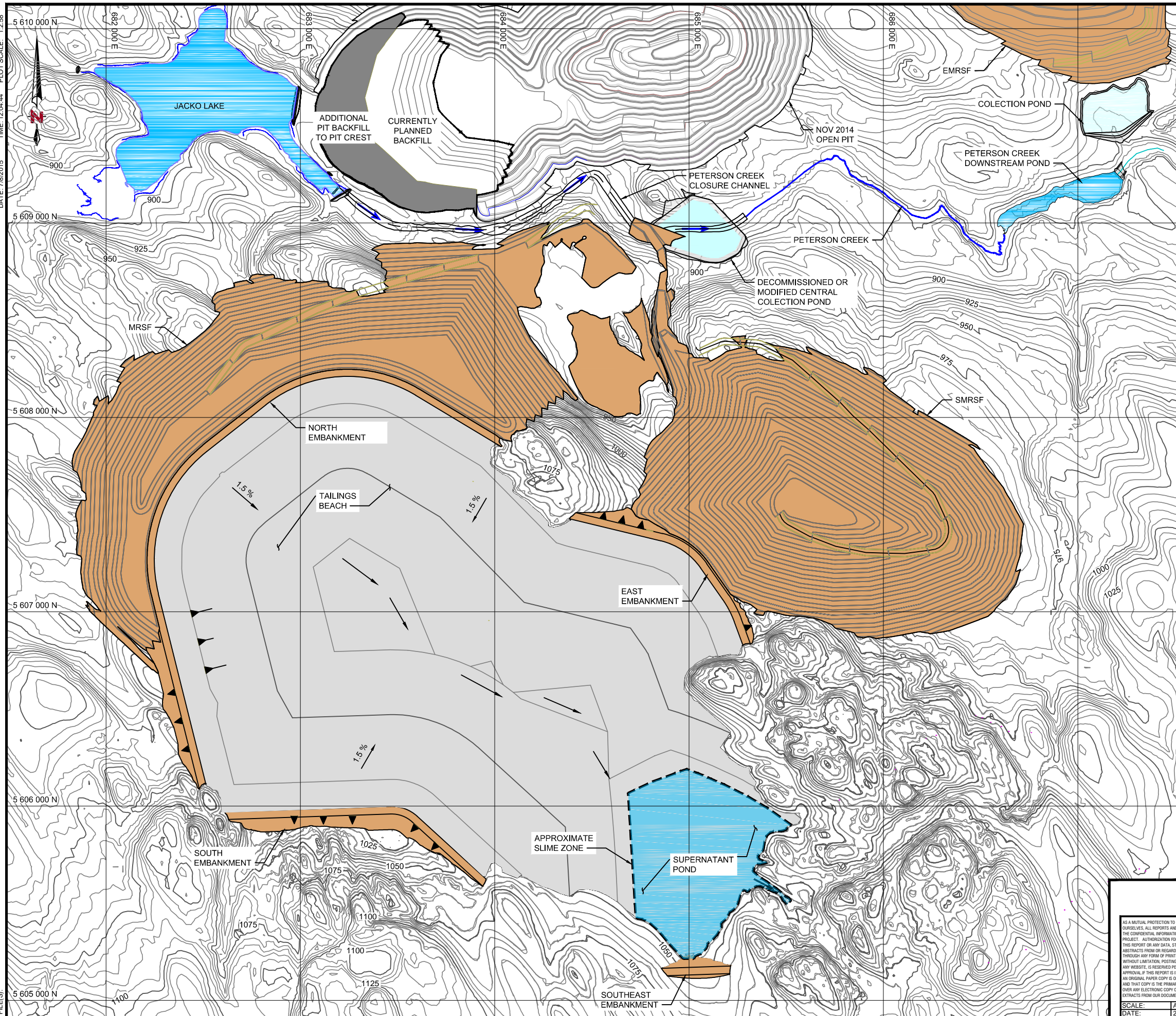
Figure 1 – TSF Conceptual Closure Assessment – General Arrangement Plan

Figure 2 – TSF Conceptual Closure Assessment – Option 1 Wet Closure

Figure 3 – TSF Conceptual Closure Assessment – Option 2 Dry Closure

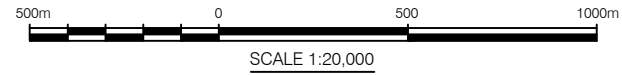
Figure 4 – TSF Conceptual Closure Assessment – Option 3a/b Dry Closure

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REFERENCES:

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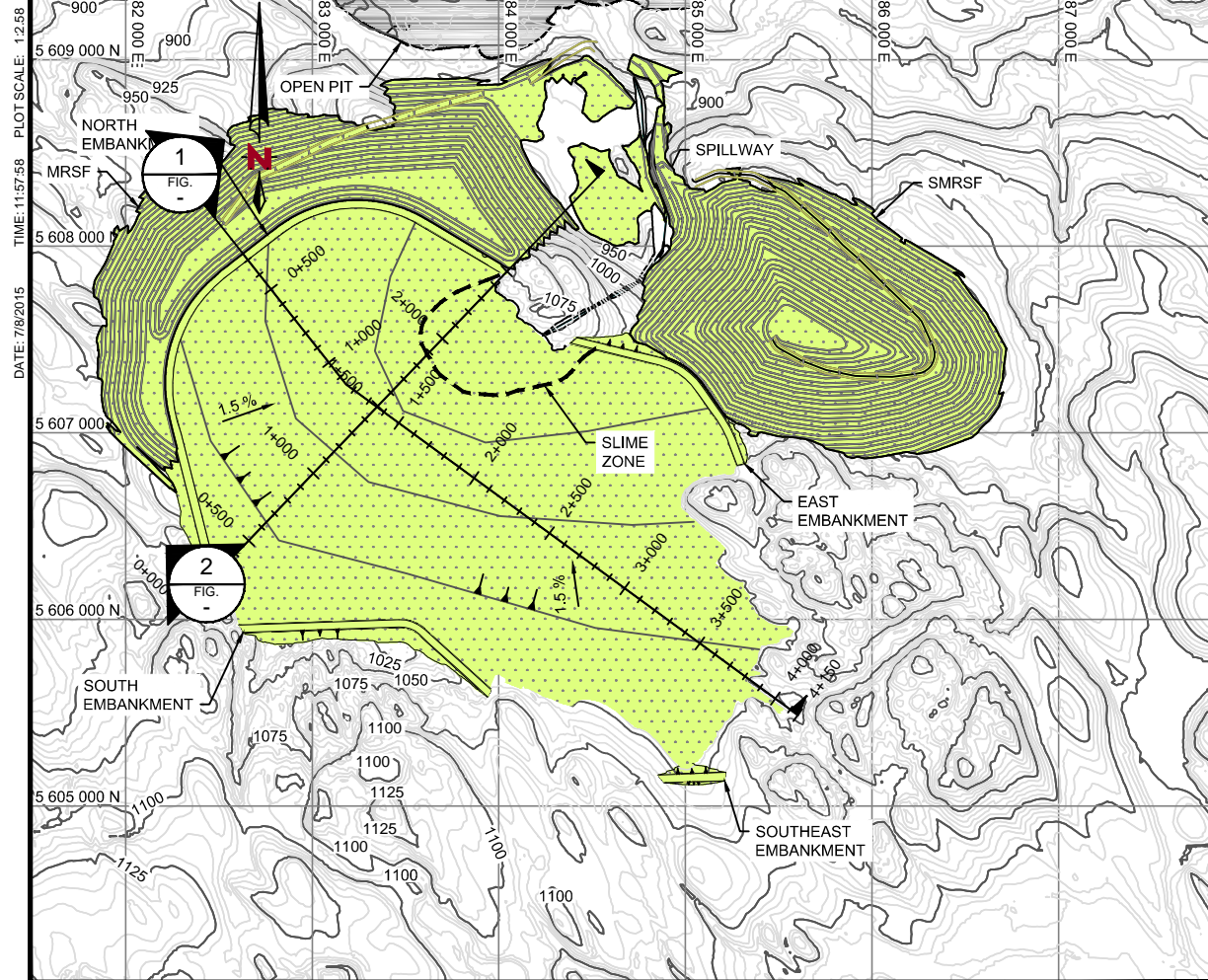


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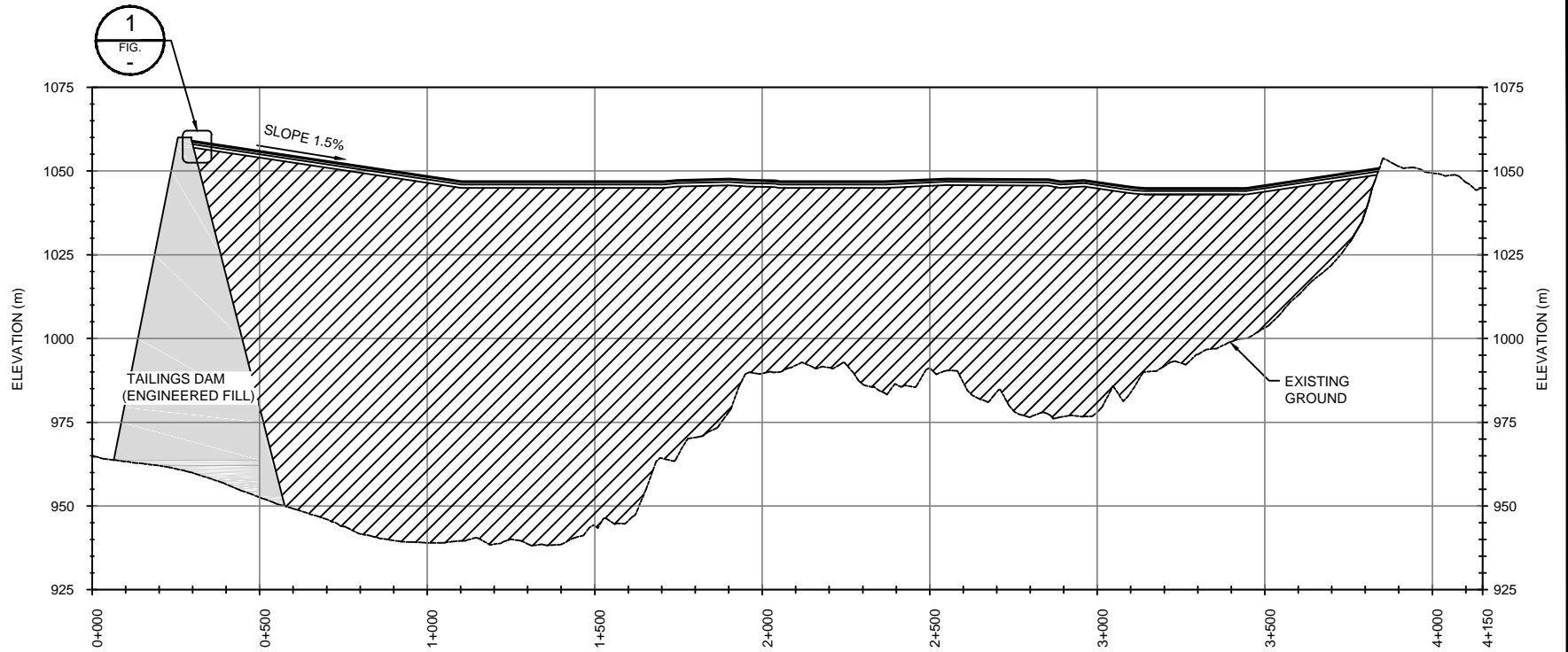
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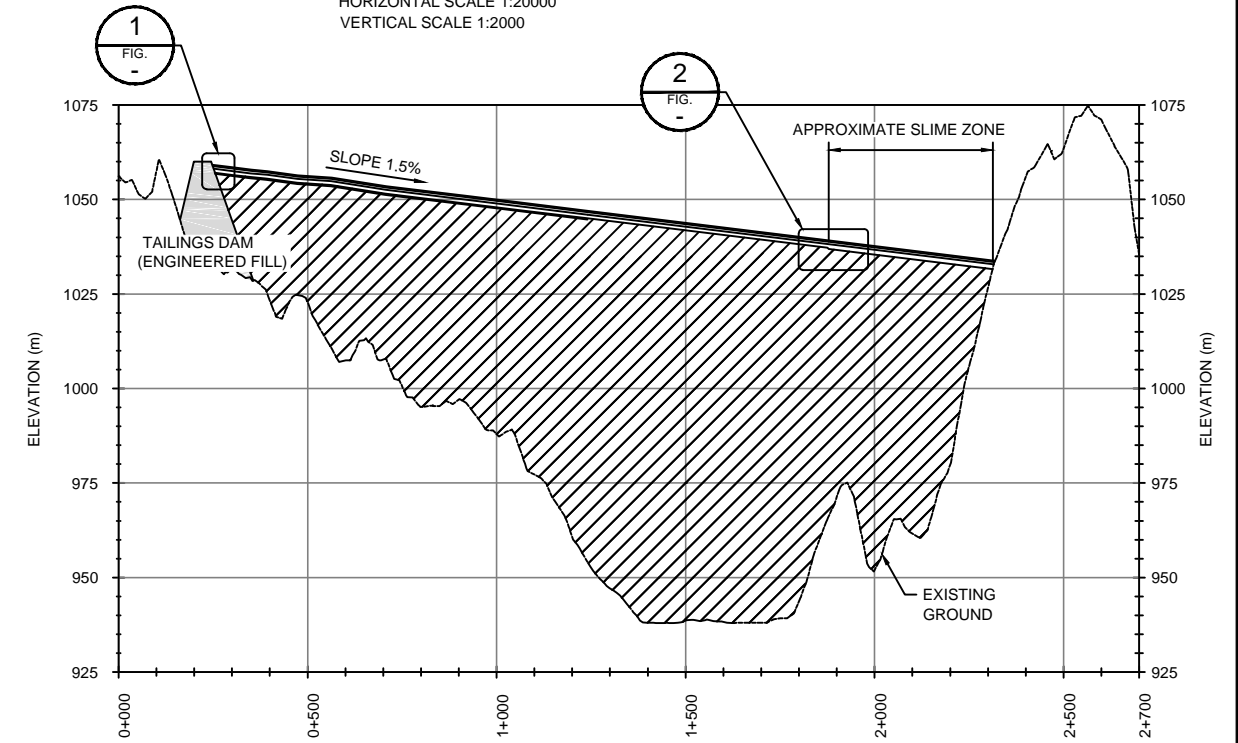
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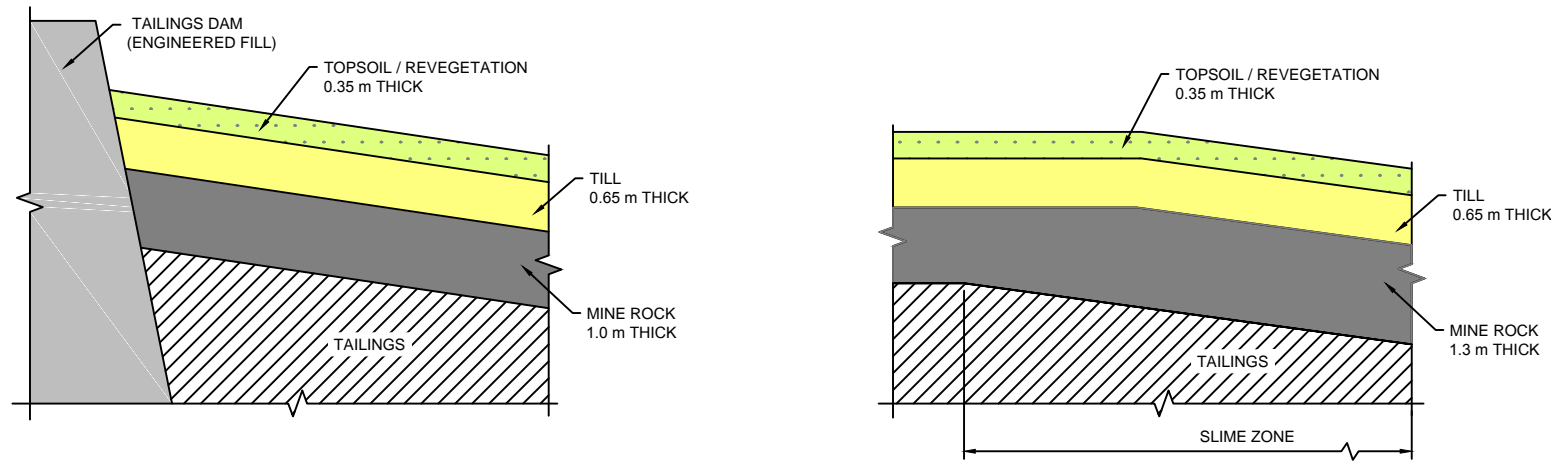
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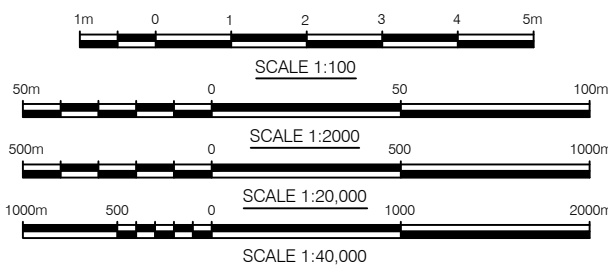
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- TILL
- MINE ROCK
- TAILINGS
- SLIME ZONE

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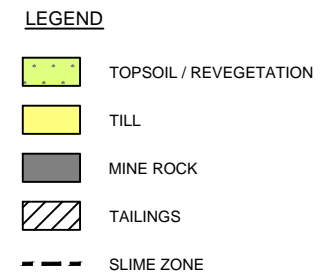
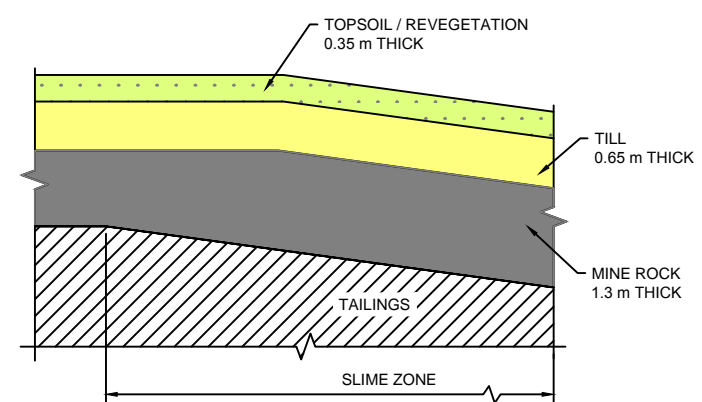
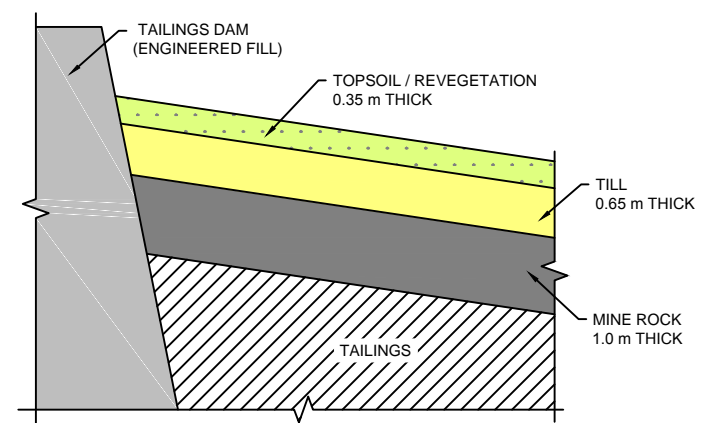
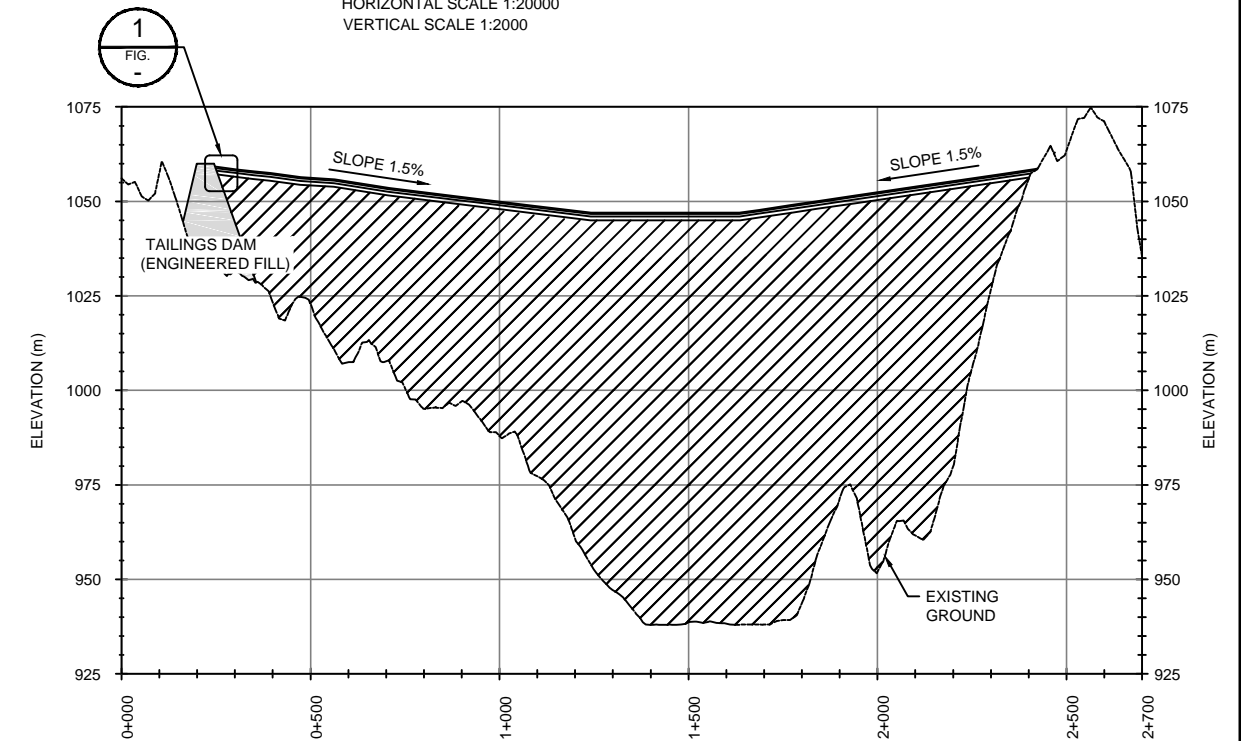
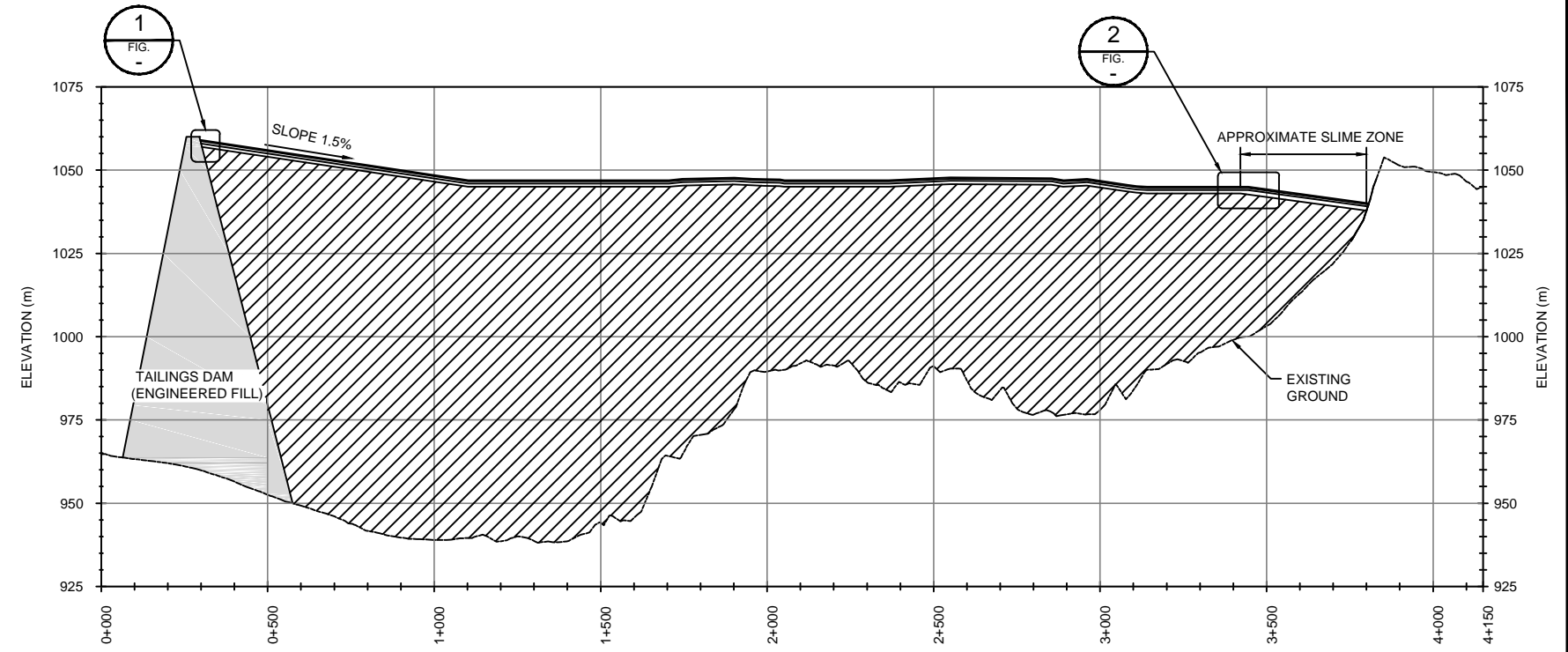
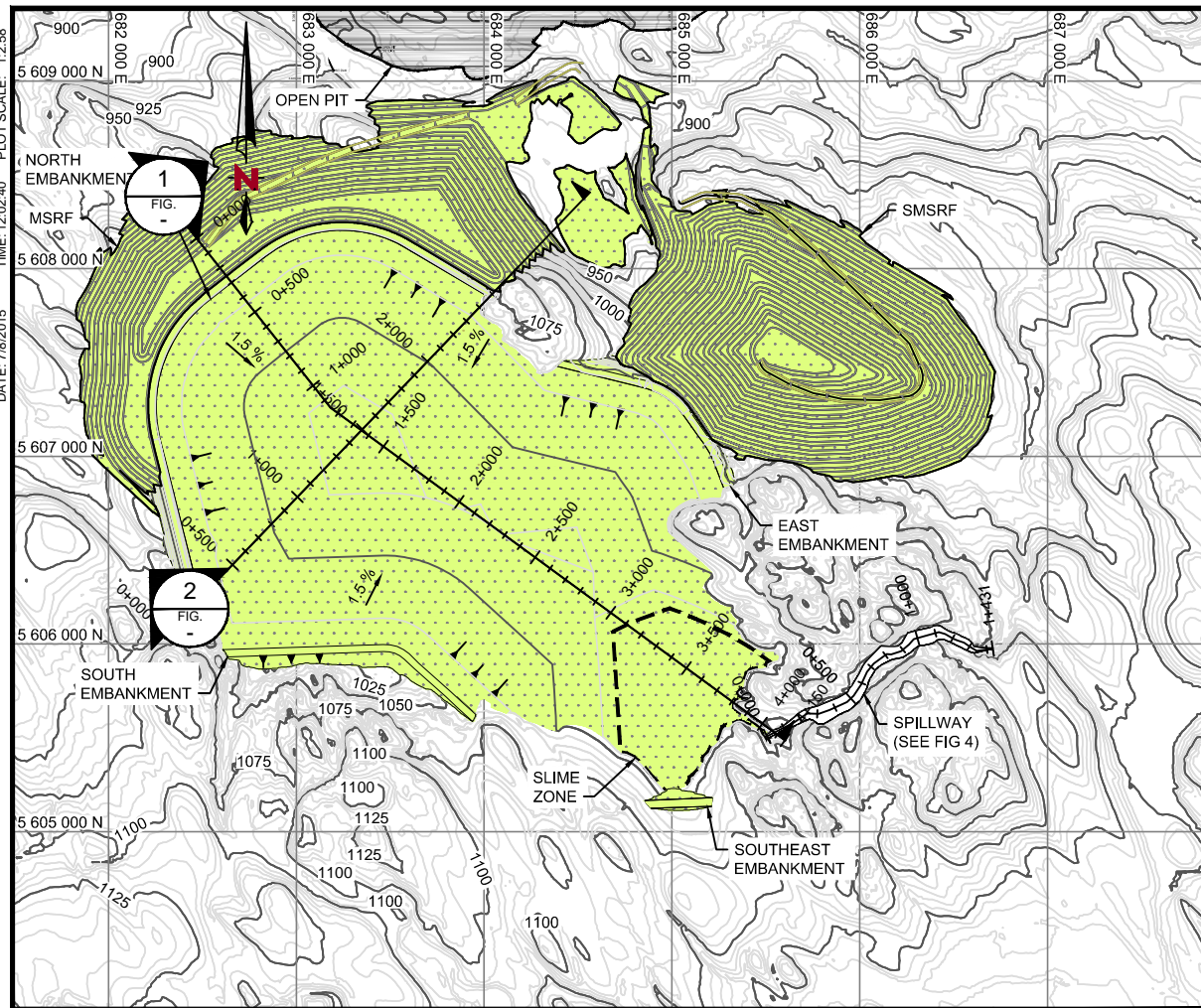


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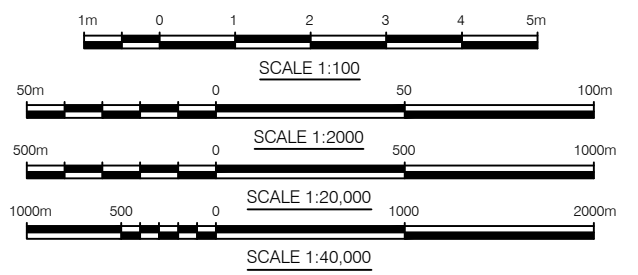
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- REFERENCES:
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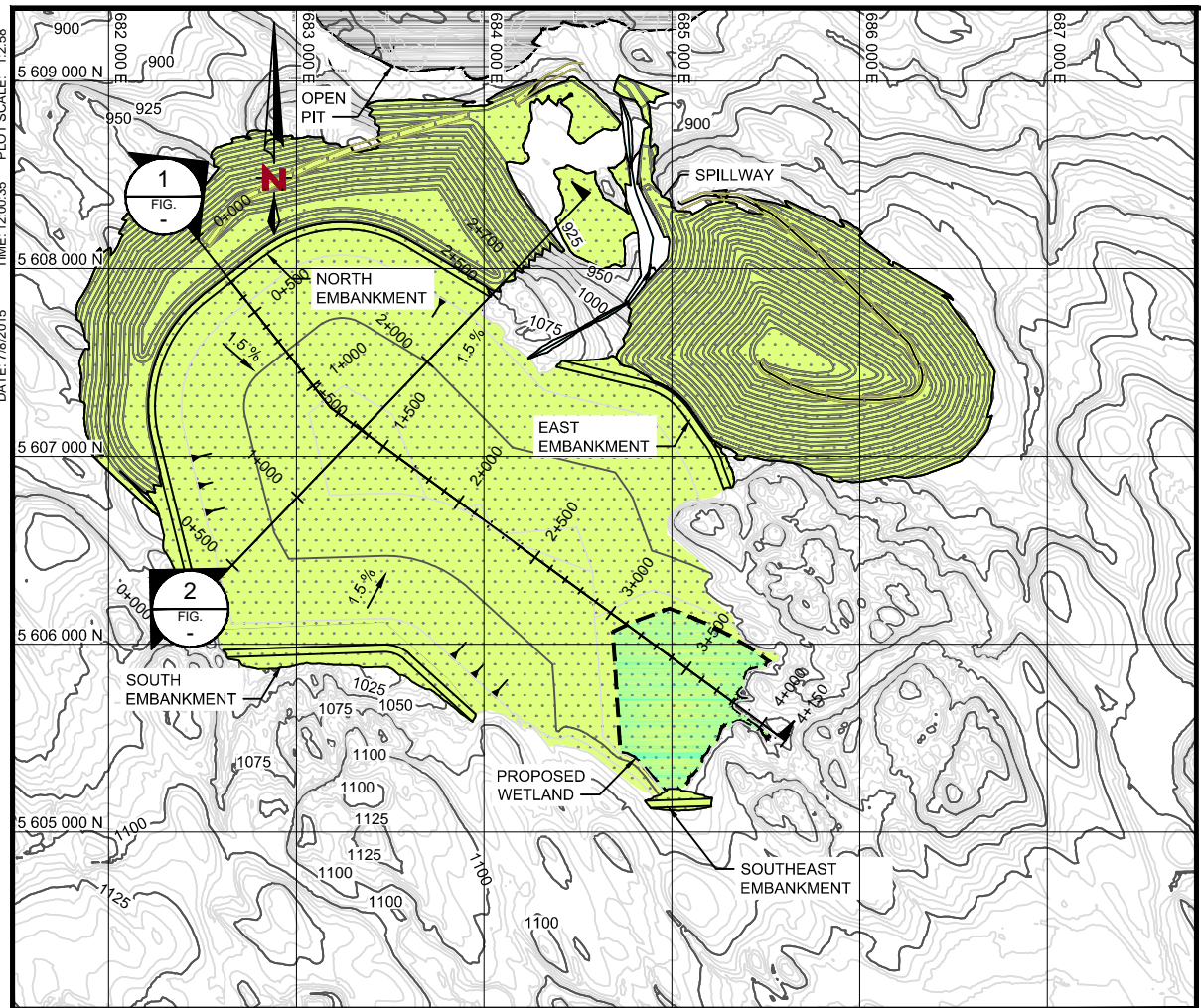


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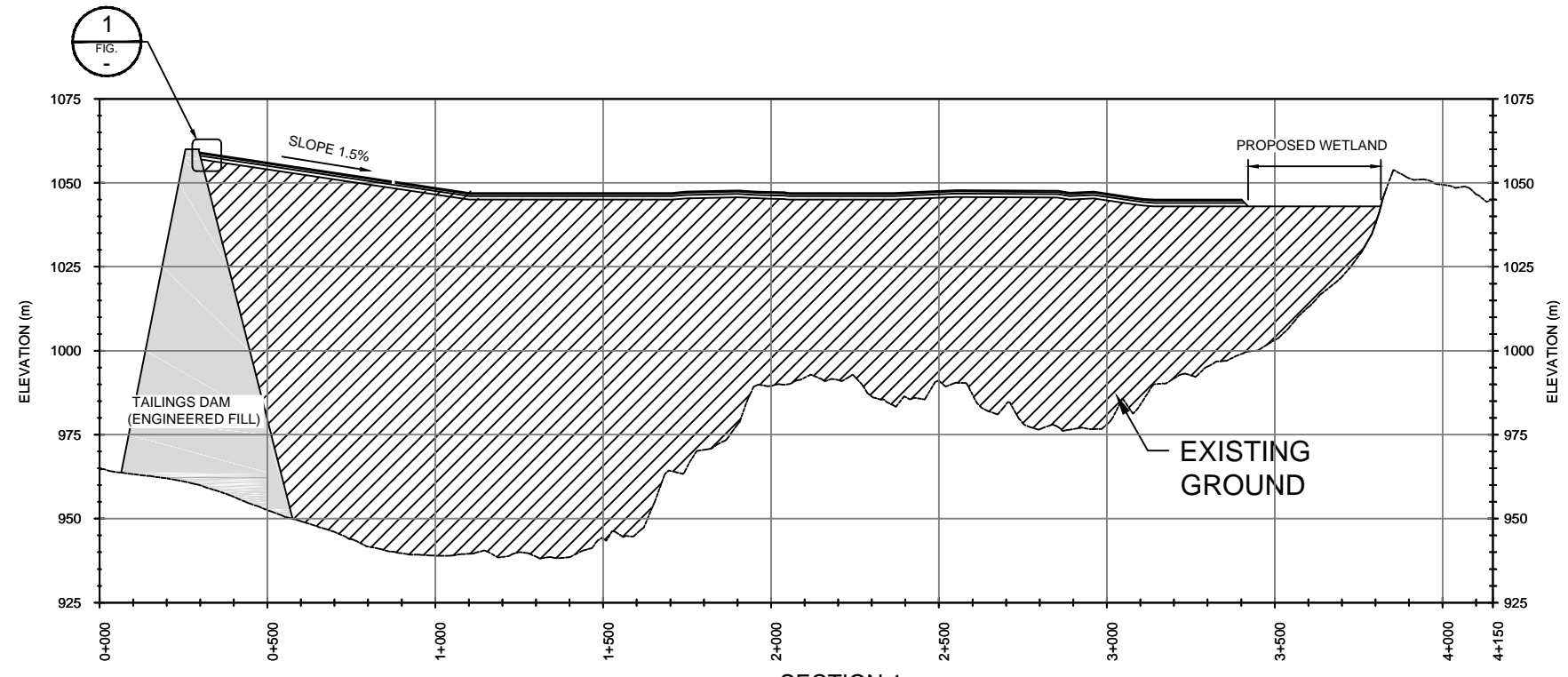
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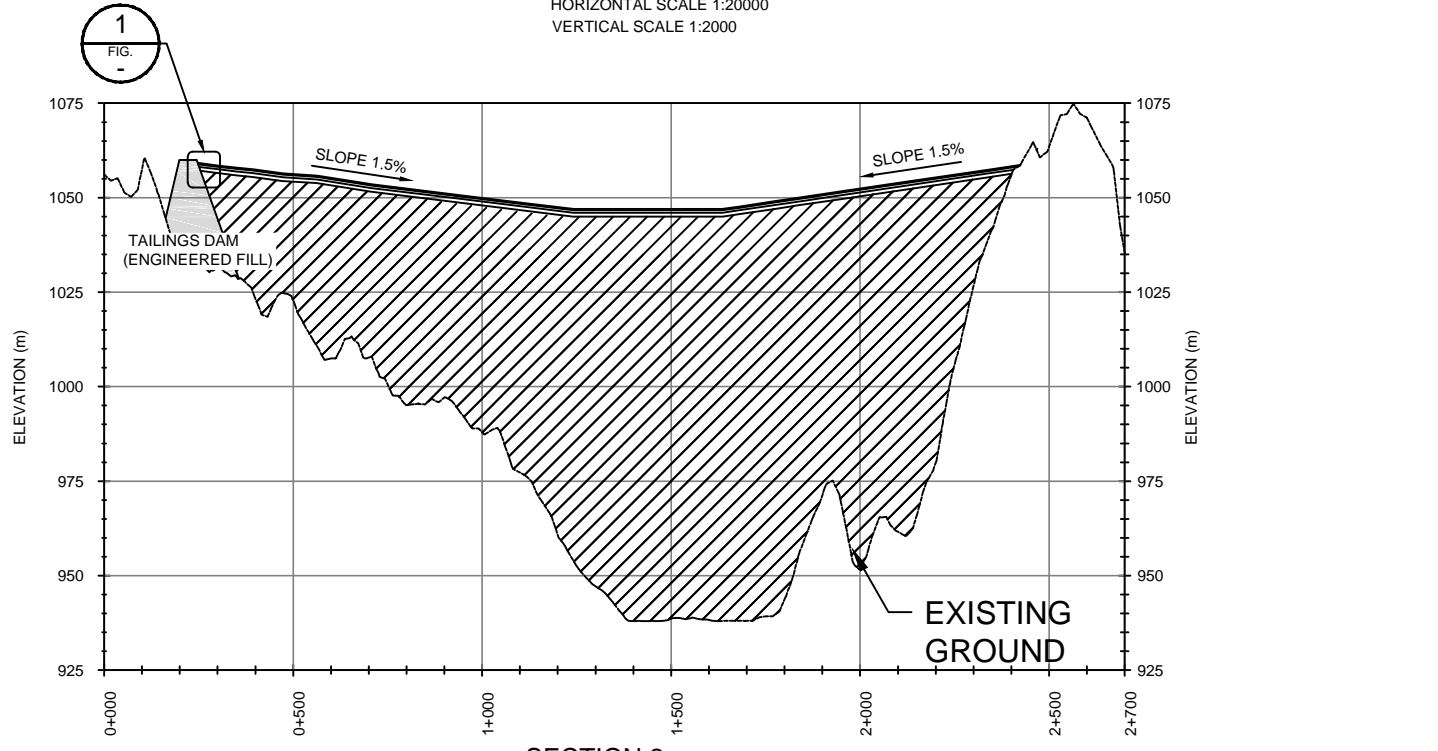
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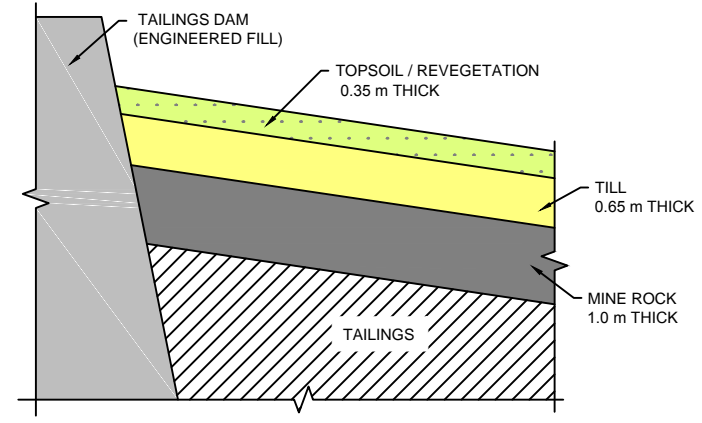
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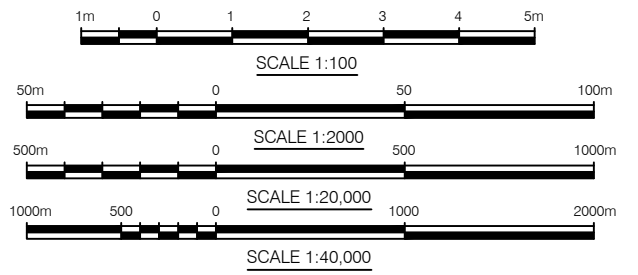


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- TOPSOIL / REVEGETATION
 - TILL
 - MINE ROCK
 - TAILINGS
 - WETLAND
 - SLIME ZONE

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	AJAX PROJECT		
TAILINGS STORAGE FACILITY WETLAND AND DISCHARGE TO OPEN PIT OPTION #1 - PLAN VIEW AND SECTIONS			
NORWEST	PROJECT NO.:	FIG. NO.:	REV.:
	809-6	2	0