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**OCEANA GOLD (NEW ZEALAND) LIMITED
MACRAES OPERATION
MACRAES PHASE 4
MTI AND SP11A TECHNICAL REPORT**

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EXECUTIVE SUMMARY

Oceana Gold (New Zealand) Limited (OGNZL) is proposing the Macraes Phase 4 (MP4) Project to extend the life of the Macraes Operation. This report assesses the geotechnical and dam safety effects of mining Innes Mills Open Pit (IM) Stage 11 and 12 (IM11 and IM12), IM Stage 13 North and South (IM13 North and IM13 South), and expanding Golden Point Underground (GPUG), on the Mixed Tailings Impoundment (MTI) and Southern Pit Option 11A (SP11A) Tailings Storage Facility (TSF). The assessment of SP11A includes the Southern Option 10 (SP10) TSF and Innes Mills Backfill Embankment (IMBE) which form part of the SP11A dam system.

To enable mining of IM13, approximately 27.8 Mt of tailings will be hydraulically removed from SP11A and relocated to Frasers Tailings Storage Facility (FTSF), followed by deconstruction of SP10 embankment and IMBE. Approximately 38.4 Mt of tailings will also be removed from MTI, together with the upstream embankment between 548 and 515 mRL, before mining of IM13 North. The final MTI tailings surface will have an average elevation of approximately 512 mRL.

At closure, MTI will remain as a downstream constructed TSF with a crest elevation of 515 mRL. The remaining tailings will be capped, rehabilitated and graded towards the closure spillway at the western abutment at approximately 509 mRL. SP11A embankment will remain and be lowered to 520 mRL and reprofiled, with a closure spillway at approximately 473 mRL, forming the northern boundary of the Innes Mills Pit Lake.

MTI, SP11A and IMBE are High PIC dams during operation, while MTI and the modified SP11A embankment are expected to become Medium and Low PIC dams respectively in closure.

MTI and SP11A are currently stable and meet the standards-based stability criteria set out in the New Zealand Dam Safety Guidelines (NZDSG). The interaction between the TSFs and MP4 mining will be managed using a performance based, risk informed approach supported by dam safety controls, also set out in the New Zealand Dam Safety Guidelines (NZDSG).

During hydraulic mining and operation, each facility will maintain sufficient storage for the 72-hour PMP, including climate change allowance, with at least 1 m additional freeboard.

The principal dam safety risks relate to mining induced embankment deformation, saturation and instability of the upstream raises during hydraulic mining, loss of freeboard, and piping or internal erosion. Key controls include removal of the upstream embankments of MTI, locating hydraulic mining sumps and ponds away from the upstream raises, careful control of jetting water and launder grades, developing flood freeboard storage before each stage of dam embankment deconstruction and real-time monitoring of deformation combined with traffic management on Macraes Road.

Further geotechnical investigations, detailed design and formal peer review will be required to support applications for Building Consents. A Tailings Removal and Dam Deconstruction Management Plan will be used to manage the operational aspects of the removal of tailings, including triggers and hold points that allow mining to progress from one stage to the next, supported by updates to the existing dam safety documentation. Subject to these measures being developed and implemented, the identified geotechnical and dam safety effects of MP4 can be managed to protect life and the environment.

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**OCEANA GOLD (NEW ZEALAND) LIMITED
MACRAES OPERATION
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1.0 INTRODUCTION

1.1. Overview

Oceana Gold (New Zealand) Limited (OGNZL) is proposing an extension to their Macraes Operation. The Macraes Phase Four (MP4) project seeks to extend the consented mine life and is being progressed under the Fast Track Approvals Act 2024 (FTAA).

OGNZL currently undertakes open pit and underground gold mining operations at the Macraes Operation located at Golden Point Road, Macraes Flat, East Otago. As part of their ongoing operations, OGNZL continually review the remaining life of the Macraes Operation in light of updated knowledge of the gold resource and the economics of mining.

Reflecting recent exploration success and optimisation work, together with higher gold prices, the Macraes Phase Four Project (MP4 or the Project) seeks to extend the life of mining at the Macraes Operation to 2039. The Project, which will enable ongoing gold production at a rate of approximately 130,000 ounces per annum is identified as a Listed Project in Schedule 2 of the Fast-track Approvals Act 2024 (FTAA) as a project of national significance.

To support the development of the substantive application for the Project, OGNZL has engaged Engineering Geology Limited (EGL) to assess the Project's potential effects on existing tailings storage facilities (TSF) at the Macraes Operation and, where necessary, identify appropriate management and operation measures to address any such effects.

This report presents the assessment of geotechnical and dam safety effects of MP4 on the existing tailings storage facilities (TSFs) at the Macraes Operation.

EGL has prepared a separate report for the design of Frasers Tailings Storage Facility (FTSF) Stage 3 (Ref. 1).

1.2. Macraes Operation

The Macraes Operation is located at Macraes Flat in East Otago, inland from Palmerston, as shown in the appended locality plan in Figure A1. Gold and scheelite were initially produced from underground mining between the 1890s and 1920s. Modern operations commenced in 1990 as an open pit mine and subsequently expanded to include underground mining.

An overview of the current mine site layout is shown in Figure 1 below. Various open pits and underground operations over the last 36 years have targeted gold mineralisation within and around the Hyde-Macraes Shear Zone (HMSZ). These mining areas include (from north to south) Coronation and Coronation North Open Pits, Deepdell North Open Pit, Golden Point Open Pit and Golden Point Underground (GPUG), Round Hill Open Pit, Southern Open Pit, Innes Mills Open Pit (IMOP), Frasers Open Pit (FROP), and Golden Bar Open Pit.

The current operation is underpinned by open pit mining at Innes Mills and Coronation North, and underground mining at Golden Point. Currently consented mining operations include IMOP Stages 7, 8, 9 and 10 (IM7, IM8, IM9, and IM10), GPUG, and Coronation North Open Pit Stage 5 (CN5) (see Figure 1 below).

OGNZL currently manages four TSFs, listed below in order of development:

- Mixed Tailings Impoundment (MTI)
- Southern Pit Option 11A Tailings Storage Facility (SP11A)
- Top Tipperary Tailings Storage Facility (TTTSF)
- Frasers Tailings Storage Facility (FTSF).

The TSF locations are shown on Figures 1 below, and in appended Figures A1 and A2.

The SP11A dam system includes the Southern Pit Option 10 (SP10) TSF and Innes Mills Backfill Embankment (IMBE). SP10 is located at the southern end of the SP11A and is currently covered by the SP11A tailings. IMBE is located between SP11A and IMOP and impounds SP11A tailings to the north.

Historically, tailings were deposited into MTI, and then MTI and SP11A. These facilities were initially raised using downstream construction methods and later transitioned to upstream construction. Upstream construction required alternating deposition between facilities to allow consolidation of tailings and dissipation of pore pressures. MTI and SP11A are now in the active closure phase and have not been actively operated since 2013.

Primary tailings deposition moved to TTTSF from 2013 to 2025. Since 2025 primary tailings discharge has moved to FTSF. FTSF is an in-pit TSF formed by construction of the Frasers Backfill (FRBF) Embankment between FROP and IMOP. FTSF is the current active TSF and is located within the mined-out FROP. Tailings are primarily discharged to FTSF, with TTTSF acting as a secondary storage facility. The TTTSF embankment has reached its final crest elevation. Tailings discharge to TTTSF are to profile the tailings surface, and any embankment works are to progress to closure of the TSF.

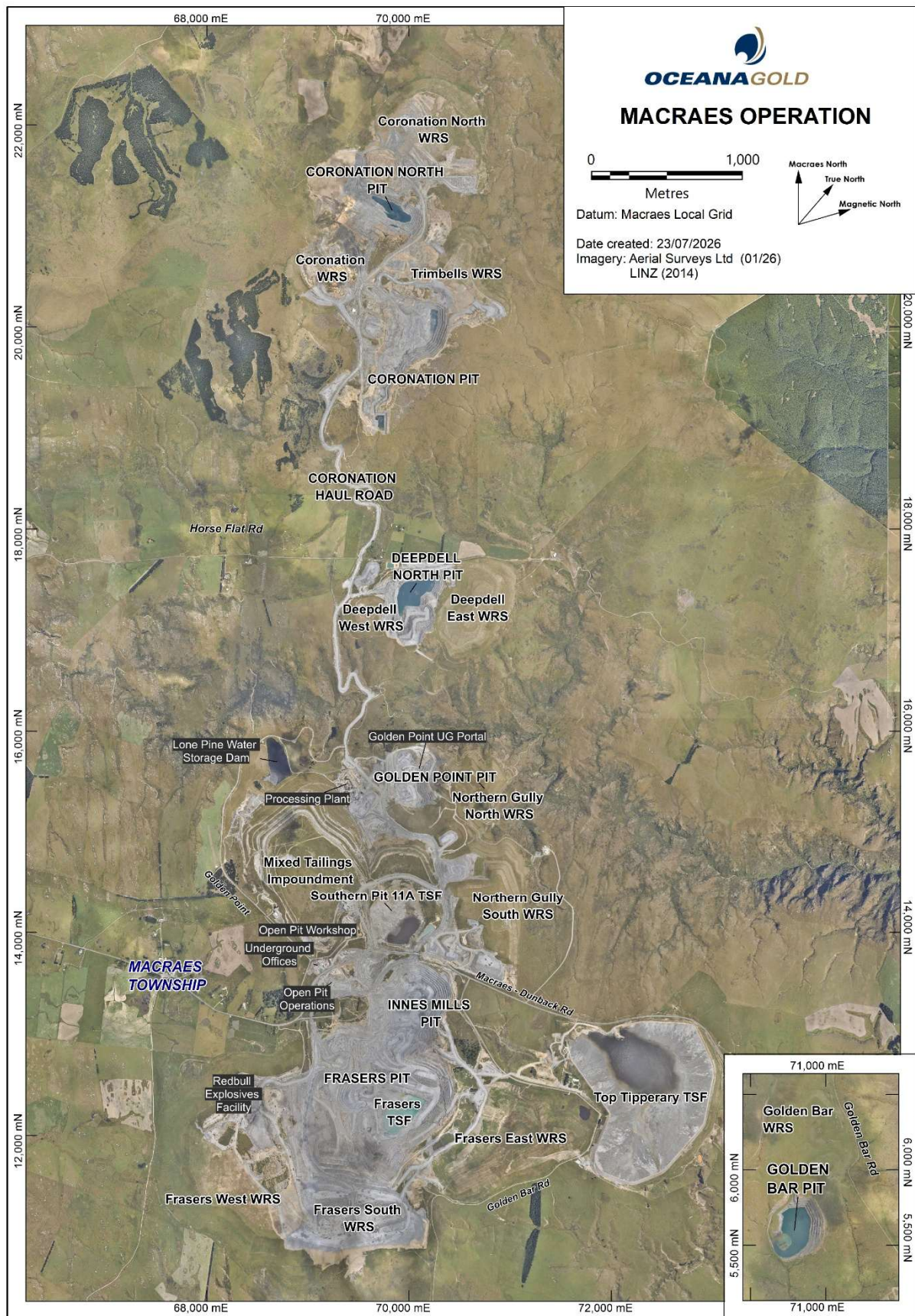


Figure 1: Existing site layout at the Macraes Operation 2025

1.3. Proposed MP4 Mining and Tailings Storage

The proposed mining and tailings storage for MP4 is shown in Figure 2. MP4 proposes to mine IM11, IM12 and IM13 (South and North), Golden Bar Open Pit Stage 2, Coronation Pit and Coronation North Pit, and GPUG.

IM11 and IM12 pits increases the size of the open pit south of IMBE and Macraes Road. IM13 mines through IMBE to the previous Southern Open Pit area now beneath SP11A. To enable access to IM13, tailings currently stored in the SP11A will be relocated by hydraulic mining, and the SP10 embankment and the IMBE will be deconstructed. The SP11A embankment will remain in part requiring modification in operation and closure.

Mining of IM13 is below and downslope of the eastern side of MTI. The mining effects on MTI will require the relocation of tailings behind the upstream lifts of the MTI. This is an approximate 33 m reduction in MTI crest height.

GPUG extension is proposed and extends underground mining below the north-eastern footprint of the SP11A embankment.

As part of the MP4, further development of FTSF (Stage 3) is proposed to provide additional tailings storage capacity to support the extended life of mine. Hydraulically mined tailings from SP11A and MTI will be deposited into the FTSF impoundment. Embankment materials from SP11A, SP10, IMBE and MTI, which have been in contact with tailings, will be placed in FRBF embankment or within FTSF impoundment.

Various rock backfills and increases to rock stacks are proposed. Those that relate to MTI and SP11A are Golden Point Backfill (GPBF), and IMBF within IM13.

1.4. Scope of this Report

The scope of this report relates specifically to the assessment of the following proposed activities that affect MTI and SP11A (including IMBE and SP10):

- 1) Extension of IMOP to IM 11 and 12;
- 2) SP11A tailings relocation by hydraulic mining;
- 3) SP10 embankment deconstruction;
- 4) IMBE embankment deconstruction;
- 5) MTI tailings relocation by hydraulic mining;
- 6) MTI partial deconstruction;
- 7) IMOP mining within Southern Pit (IM13-North and IM13-South);
- 8) GPUG mine extension;
- 9) GPBF;
- 10) Mine closure plans including Innes Mills Pit Lake, SP11A closure embankment/spillway, and MTI closure.

This report has been prepared to support a resource consent application under the FTAA for the works described above.

The proposed works under MP4 FTAA for Coronation and Coronation North Pits, and Golden Bar do not interact with TSFs, and therefore these activities are not discussed in this report.

TTTSF is not assessed to be affected by mining activities proposed under MP4, and is only discussed in the following sections in the context of its impact on other TSFs in operation and in closure.

The feasibility and geotechnical effects assessment of the pits and underground mining has been carried out by Pells Sullivan Meynink (PSM). The feasibility and technical design for hydraulic relocation of tailings from SP11A and MTI has been carried out by Agilitus Pty Ltd (Agilitus). Groundwater and water balance assessments have been carried out by GHD Limited (GHD).

The detailed design and geotechnical assessment of proposed works for MTI, SP11A, SP10 and IMBE will be carried out following the resource consent approval under the FTAA. Detailed design documentation will be prepared to support the required Building Consent applications.

Richard Davidson of RRD (Senior Principal Engineer), acting as peer reviewer for MP4 TSF aspects for OGNZL, visited the Macraes Operation from 21 – 25 April, 2026 to carry out a site visit and a preliminary review of the proposed MP4 Project. His review includes the work covered by this technical report.

1.5. Overview of effects considered

The following potential effects on existing TSFs (MTI and SP10/SP11A) due the proposed MP4 mining activities are considered within this report:

1. Mining in IM11 and IM12 will expand the north wall of IMOP and influence deep-seated movement of Innes Mills West Wall (IMWW):
 - a. This affects the stability of Innes Mills Backfill Embankment (IMBE), which impounds SP10/SP11A to the south.
 - b. The effect will be offset by construction of FTSF Stage 3 embankment and Innes Mills Backfill which will buttress the IMWW movement.
2. Relocation of SP11A and SP10 tailings by hydraulic mining will:
 - a. Affect the stability of the SP11A upstream lift embankments during the hydraulic mining process.
 - b. Affect the stability of a portion of common embankment and rock abutment between MTI and SP11A.
 - c. Affect the stability of the Southern Pit as tailings are removed, due to potential relaxation or creep, and pore pressure dissipation of the pit walls.
 - d. Remove the retention of tailings behind SP11A, IMBE, and SP10 embankments.
3. Expansion of IMOP to the north (IM13), following removal of SP10/SP11A tailings and realignment of Macraes Road,
 - a. Removes IMBE embankment and any potential dam function.
 - b. Affects the stability of the west wall (of IM13, Southern Pit area) which is also the abutment and foundation for part of MTI. This potentially affects the stability of MTI, including the upstream lifts at the front of the facility.

4. Expansion of GPUG to the south beneath Round Hill and the SP11A embankment could:
 - a. Affects the stability of the SP11A embankment
 - b. Affects the integrity of the SP11A embankment due to subsidence settlements and residual voids within the foundation rock mass.
5. Partial relocation of MTI tailings by hydraulic mining will:
 - a. Affect the stability of the MTI upstream lift embankments during the hydraulic mining process.
 - b. Improve the stability of the portion of common embankment and rock abutment between MTI and SP11A.
6. Golden Point Backfill will:
 - a. Reduce the ongoing creep movement on the Footwall Fault towards Golden Point Pit and improve the long-term integrity and stability of the MTI in closure.
7. Innes Mills Closure Lake, remaining SP11A embankment, and spillway and outlet channel will:
 - a. Create very wide low PIC dam, which will remain in perpetuity.
 - b. This will require minor maintenance activities.
 - c. Buttress the rock abutment of MTI.
8. The closure MTI tailings storage facility will:
 - a. Leave a dry capped downstream construction (type) tailings storage facility as a landform in perpetuity
 - b. Leave a High PIC dam while site is operational.
 - c. Leave a Medium PIC dam in closure, which will remain in perpetuity.
 - d. This will require minor maintenance activities.
 - e. This will require ongoing dam safety monitoring, at a much reduced frequency than in operation.
 - f. A dam safety assurance programme (or dam safety management system) and ongoing certification.

These effects will be managed by design, operation, maintenance, to the New Zealand Dam Safety Guidelines (NZDSG), under the requirements of the Building Act (2004) (Ref. 2) and the Building (Dam Safety) Regulations (2022) (Ref. 3).

1.6. Site Grid

All plan grids and references to the site are based on mine north which is approximately 45 degrees anti-clockwise from true north.

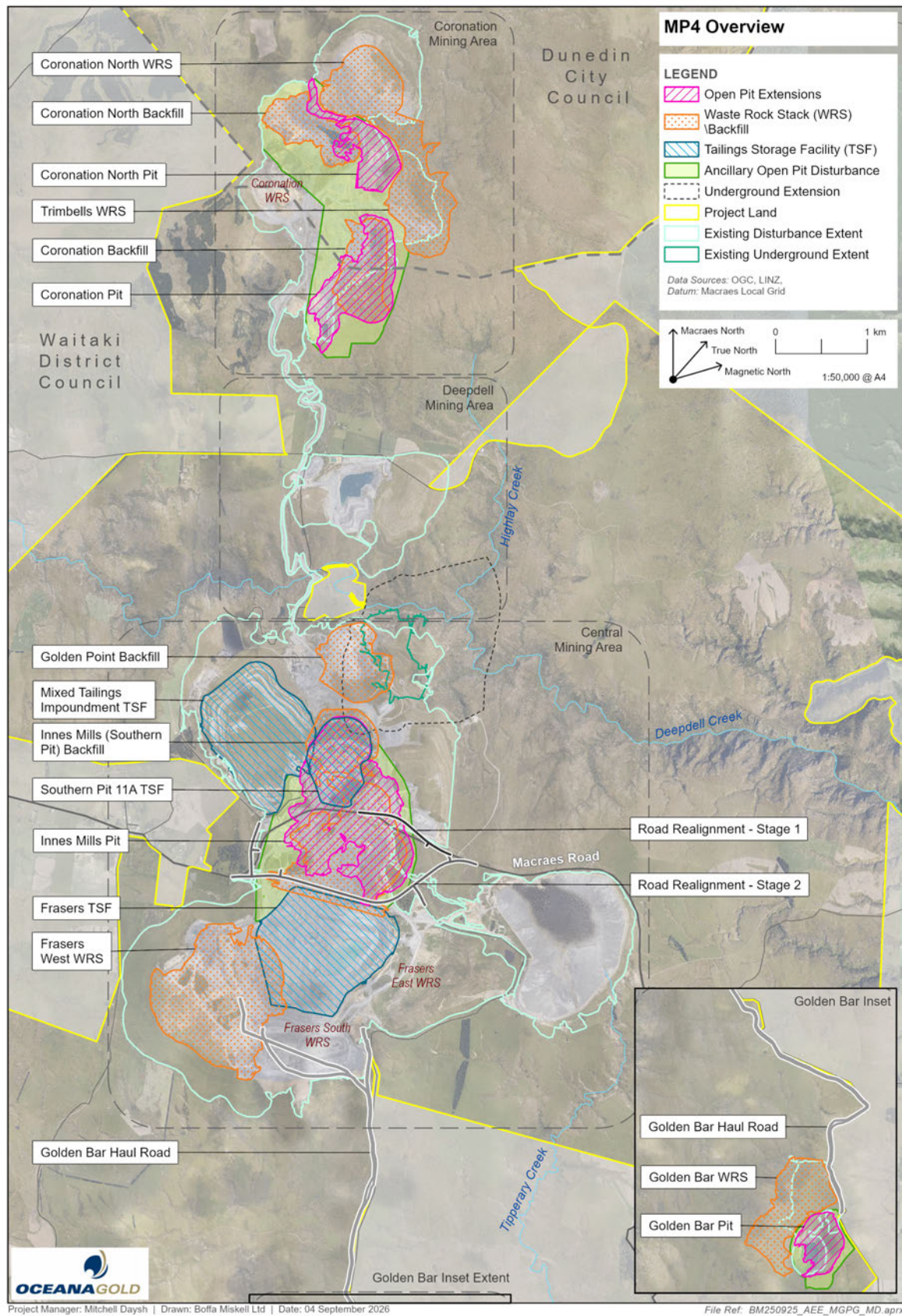


Figure 2: MP4 Overview Plan

2.0 SITE CONDITIONS

2.1. Climate

Climate Setting

The Macraes Operation is in the lower South Island of New Zealand at approximately 500 to 600 m above sea level. New Zealand lies in the mid-latitude zone of westerly winds, in the path of a succession of anticyclones, which move eastwards (Ref. 4). The presence of the Southern Alps extending the length of the South Island has a major effect on the climate of the Otago region, producing distinct contrasts from west to east (Ref. 5). Mean annual rainfall in the South Island ranges from as little as 300 mm in parts of Central Otago to over 8000 mm in the Southern Alps (Ref. 4). The Macraes Operation is approximately 220 km east of the bottom of the Southern Alps (Fiordland), east of the driest region of Central Otago, and 30 km from the east coastline. It is well away from areas with the highest rainfall and is generally a drier area with extended periods of little or no rain (Ref. 4).

Rainfall

Rainfall at Macraes Operation is recorded at three locations, Glendale, Golden Point, and Deepdell with a record mean annual rainfall between 518 and 659 mm (Ref. 5). The Glendale Station Site is located at the northwest upstream end of the TTTSF and has a mean annual rainfall of 634 mm, with a maximum and minimum annual rainfall of 950 mm (recorded 1986) and 395 mm (recorded in 1998). Records at the Glendale Station date from 1959 to 2013. The Golden Point Station, which has been monitored from 1991 to 2022, recorded a mean annual rainfall depth of 665 mm, with a maximum and minimum of 1034 and 414 mm, respectively (Ref. 6).

High intensity rainfall events are estimated from historical data and climate models by the National Institute of Water and Atmospheric Research (NIWA). Table 8 and Table 9 summarise the results based on historical records and climate change scenarios for Representative Concentration Pathway (RCP) 8.5 for 2031 to 2050 and 2081 to 2100 at the Glendale Station Site. Based on historical records the 2, 10, 100, 250 Average Recurrence Interval (ARI) 72-hour rainfall depths are 62, 103, 171, and 200 mm.

Climate Change Effect on Rainfall Depth

For the period of 2031 to 2050, climate change scenario RCP 8.5 estimates the 2, 10, 100, and 250 ARI 72-hour rainfall depths are 64, 108, 181, and 212 mm. This is an increase of 3 to 6 % over historical records. For the period of 2081 to 2100, climate change scenario RCP 8.5 estimates the 2, 10, 100, 250 ARI 72-hour rainfall depths are 70, 120, 201, and 236 mm. This is an increase of 13 to 18 %.

Probable Maximum Precipitation

The New Zealand Dam Safety Guidelines (NZDSG) require the consideration of Probable Maximum Precipitation (PMP) in the assessment of Inflow Design Flood for high Potential Impact Classification (PIC) dams. Using Thompson and Tomlinson (Ref. 7) the 72-hour duration PMP depth at Macraes is assessed as 761 mm, with no adjustment for climate change effects. With adjustment for climate change for the operational phase of the project the PMP depth is 806 mm (72 hour), and for the closure phase of the project it is 898 mm (72 hour).

2.2. Geology and Ground Conditions

Regional Geology

The basement rock in Central and East Otago comprises Otago schist. The Otago schist is primarily composed of psammitic and pelitic grey schist derived from metamorphism of Mesozoic age sandstone and mudstone. In the area of Macraes Flat, the rocks have been metamorphosed to greenschist metamorphic facies, giving a strongly foliated fabric of dark grey micaceous and light grey quartz-rich laminations.

From previous geotechnical investigations and mining operations on site, it is apparent that the prominent geological structures at the Macraes Operation include a well-developed schistosity with two dominant fault sets. The schistosity, which generally has a low eastern dip in the project area, has been folded by north-trending folds to produce a series of anticlines and synclines.

The major set of faults has an eastern trend. They exhibit Miocene age (approx. 5 to 23 million years BP) tectonic deformations and are related to the formation of the Alpine Fault. This deformation has faulted and folded the surface within Central and East Otago to produce the present-day basin and range topography. The major east trending fault in the area is the Macraes Fault (Billy's Ridge Fault) that is exposed in the wall of Frasers Pit and has been identified by Golder to lie within the TTTSF site on the north side of the Macraes-Dunback Road.

The second set of faults has a northern trend, and the most significant of these is the Hyde-Macraes Shear Zone. The Hyde-Macraes Shear Zone (HMSZ) comprises a mineralised shear zone which has been mapped for at least 25 km by OGNZL geologists. The HMSZ represents the principal gold bearing ore body exploited by OGNZL and generally strikes north and dips at about 15° to the east. Tectonic displacement associated with the HMSZ is inferred to be in the order of hundreds of metres, with this movement initiating some 120 to 150 million years ago. The ore-schist zone of the HMSZ consists of predominantly pelite and semipelite, but includes blocks of psammite, typically well foliated and containing mineralised quartz veins.

The base of the HMSZ comprises up to several metres of grey breccia and clay gouge and is defined by the Footwall Fault which is orientated approximately concordant with the dip of the HMSZ. The Footwall Fault daylights under the MTI TSF and is inferred to underlie the SP11A and SP10 TSF at about 100m depth below foundation level.

Site Geology

The rock underlying the MTI, SP10 and SP11A TSFs consists of unweathered to slightly weathered weak to moderately strong psammitic to semi-psammitic schist down to a depth of at least 30 to 40 m, before encountering semi pelite and pelite schist.

The major faults in the immediate vicinity of Innes Mills Pit, Southern Pit and adjacent the TSFs are shown in appended Figure 03 and discussed below.

Joints and Foliation

In 1990 GCNZ Consultants carried out mapping of the ground over the area of the proposed MTI TSF (Ref. 8 & 9), which at that stage was west of the Footwall Fault outcrop (refer appended Figure A3). The mapping showed that the schist foliation dips west to southwest at 10° to 20°. Over the northern portion of the mapped area are a set of shears and joints which strike north-northwest to south-southeast and dip to the east at between 30° and 85°. Minor joint sets strike northeast to southwest and dip southeast at between 75° and 90°.

Mapping for the SP10 TSF (Ref. 10) shows that schist foliation has a low north east dip and the joints are generally steeply dipping with variable strikes. The dip of the schist foliation therefore changes across the Footwall Fault and the dip observed at SP10 TSF is consistent with that observed elsewhere east of the Footwall Fault within the Macraes Operation.

Shears and Faults

Detailed mapping of the schist beneath the MTI TSF by GCNZ Consultants (Ref. 8 & 9), west of the Footwall Fault, noted several faults and shear zones over the northern area striking north-west to south-east and dipping to the south and north-east at between 35° and 75°. Foliation shears were observed, orientated parallel and sub parallel to foliation, dipping west to south-west at 5° to 35°. GCNZ Consultants did not specifically refer to the Footwall Fault in their investigation. It outcrops on the eastern side of the current MTI TSF (refer Figure A3) and strikes north-south dipping to the east at a similar angle to the HMSZ.

Within the SP10 and SP11A TSF area there are two large faults which trend north-south as shown in Figure A3. The faults dip at 60° to the east but only the Northern Gully Fault was exposed on the eastern wall of the Southern Pit. The other fault, Battery Creek Fault, is inferred to pass under the existing SP10 Embankment. Sets of faults, gouges and crushed/shear zones generally strike north to south with sets dipping to the east or west with widths varying up to 3 m. The east dipping set has an average dip of 60° and the west dipping set has an average dip of 40°. Most of the larger shears and faults are infilled with clay gouge and sheared rock.

During previous mining of Round Hill and Golden Point Pits (refer Section 11.1) movement of the western pit slope occurred on the Footwall Fault. The movement resulted in upward (heave) deformation of the rock in the bottom of the pits in the region of the easterly dipping Northern Gully and Battery Creek Faults. In between these faults and the Footwall Fault are westerly dipping discontinuities, referred to as “ramp shears” which are not fully developed through the rock. It is inferred that the deformation occurs in a complicated fashion involving both the easterly dipping faults and westerly dipping ramp shears.

The Macraes Fault crosses the Innes Mills and Frasers Pits, and TTTSF. It offsets the HMSZ by about 250 m, in a reverse sense. This deformation has been accommodated by a number of faults, both parallel to foliation and cutting across foliation.

2.3. Groundwater Conditions

Groundwater levels are currently highly modified by open pit and underground mining excavations, causing a local drawdown of groundwater in the pit walls. As tailings are discharged in FTSF the groundwater table will rise back towards the original groundwater profile.

3.0 EXISTING TAILING STORAGE FACILITIES

3.1. General Overview

The existing TSFs are shown in appended Figure A1, A2 and A3. The outline of SP10 TSF is shown dashed (in Figure A3) as it has subsequently been covered over by the tailings in the SP11A TSF.

The Flotation and Concentrate TSFs were the first TSFs constructed on site. Construction of the embankments commenced in 1990 with the first tailings discharged in 1991. Initially flotation and concentrate tailings were stored separately. Subsequently they were mixed and only the embankment that formed the Flotation TSF continued to be raised. It was renamed as the Mixed Tailing Impoundment (MTI). Concentrate tailings stored in the Concentrate TSF were removed and reprocessed and the TSF was subsequently infilled and overtopped by mixed tailings as the MTI was raised. The MTI TSF was progressively raised using downstream construction embankments until it was not practical to raise the TSF further (embankment crest at 515 mRL) due to space restrictions of the downstream shoulder. The embankment was then changed to upstream construction over the higher northern and western portion of the embankment. The full height of the MTI crest has a building consent to 548 mRL.

To allow a resting period for MTI, and construction of the upstream embankments, it was necessary to construct a second TSF.

SP10 was the second TSF established on site, with construction of the embankment commencing November 2001 and tailings first discharged to it in February 2002. The tailings discharge was cycled back to MTI in May 2003 then again to SP10 in May 2004 when SP10 was filled to design capacity (embankment crest at RL525). The SP10 embankment was constructed full height using downstream construction.

A third TSF embankment, SP11A, was constructed north of SP10 TSF and tailings first discharged to it in March 2006 to allow further upstream construction on the MTI TSF. Initially the tailings were impounded between the SP11A and SP10 embankments then in 2007 the tailings reached the crest level of the SP10 Embankment and extended over it. A small cut was made through the crest of the embankment to assist with tailings management. The current level of the SP11A Embankment crest is 544 mRL. The tailings level above SP10 embankment crest is lower at approximately 542 mRL, which means that approximately 17 m depth of tailings is covering the SP10 TSF crest (embankment crest level at RL525). The SP11A Embankment comprises downstream construction to 530 mRL with two upstream embankment lifts to RL544. It was filled to capacity in 2012.

Tailings in SP10 (above 495 mRL), and SP11A are impounded to the south by IMBE. For much of its life, the IMBE had a substantial buttress of rockfill comprising the

Innes Mills Backfill, which was placed within the original mined-out Innes Mills Pit (stages IM1 to IM4). The start of Innes Mills Pit Backfill placement dates back to around 1997. With the progressive removal of the original Innes Mills Pit Backfill and extension of the Innes Mills Pit (IM7), the IMBE has been created. IMBE is now considered a large dam as defined in the Building Act 2004 and the Otago Regional Council accepted its certification as a High PIC dam in 2026. IMBE retains tailings of SP11A preventing release to Innes Mills Pit, with the primary Population at Risk (in the context of a PIC assessment), being the working population in the pit and Macraes Road users.

TTTSF is the fourth TSF at Macraes and is a fully ex-pit facility located about 2km east of Innes Mills. Construction of the embankment commenced in 2012, with tailings first discharged in October 2013. The TTTSF embankment has now reached its final design crest elevation of 570 mRL and no further raises are proposed. TTTSF is not directly influenced by the MP4 mine plan.

FTSF is the current active TSF at Macraes, with TTTSF operating as a back-up. FTSF is an in-pit facility formed by constructing FRBF between Frasers and Innes Mills Pits. Construction of FRBF Embankment Stage 1 commenced in 2024, with a target crest level of 450 mRL. Tailings deposition began in early 2025. FRBF Stage 2 was consented in late 2025 with a target crest level of 480 mRL. As of May 2026, FRBF has been built to about 374 mRL and tailings are at around 350 mRL.

3.2. Mixed Tailings Impoundment TSF

MTI is a conventional slurry tailings facility. The embankment comprises an earth/rockfill structure formed using open pit waste rock. The Process Plant and ROM pad are located below the northeastern side of MTI as indicated in the appended Figure A2.

Tailings from Macraes Operation originally consisted of two types, concentrate and flotation that were originally produced in the ratio of 1:10, and 1:30 from 1998 onwards. Initially these tailings were stored in separate impoundments. MTI was named 'Flotation Tailings Dam' with a separate 'Concentrate Impoundment Dam' (Concentrate Dam) located upstream of the MTI with maximum embankment height of 521 mRL as indicated in Figure A16. The wool shed water storage dam (Water Dam) was located upstream of the Concentrate Dam. In 1993, a mixed tailings strategy was adopted with all tailings pumped to the Mixed Tailings Impoundment. This strategy was continued until mid-1998 when concentrate tailings were again stored in the Concentrate Dam. The addition of a Pressure Oxidation system in the Process Plant in 1999 allowed progressive re-processing of the concentrate tailings and mixing with the flotation tailings. Most of the concentrate tailings were removed and the Concentrate Dam was subsequently infilled and covered by tailings of the MTI.

The MTI embankment was raised to 515 mRL using downstream construction and above this level five upstream embankment lifts have been built to achieve the current embankment crest level of 548 mRL. The exception is near the eastern abutment and southwest side of the embankment where downstream construction has been continued to full height. MTI shares a central rock abutment with SP11A TSF.

The crest levels of the five main upstream lifts are 520.5, 527, 533, 539 and 545 mRL (later raised to 548 mRL). The 520.5, 527, and 533 mRL upstream raises are

immediately upstream of the crest of the downstream embankment. The 539 and 548 mRL upstream raise embankments are set back over the tailings and includes local toe berms on the tailings. A toe berm is also present on the 515 mRL downstream embankment with a crest up to 526 mRL.

The embankments are zoned with a low permeability zone (Zone A, A1, and A3), compacted rockfill zone (Zone B, B1), and general end tipped rockfill zone (Zone C, and C1). Subsurface drains are located within the foundation, embankment, and tailings to collect seepage.

A typical section through the highest embankment (northern section) and drainage positions are shown in Figure A5.

Tailings have been discharged sub-aerially into the impoundment from the northern portion of the embankment (i.e. around the extent of upstream raising). A large tailings beach was established with the decant water ponding in the southern portion of the impoundment, away from upstream embankments. Water is decanted from the pond and pumped back to the Process Plant.

Above the ROM pad area, the MTI embankment is sited over the Footwall Fault which is the base surface of the HMSZ. The MTI has previously been subject to deformations from the movement of the hanging wall rock mass above the Footwall Fault. Movement on the Footwall Fault first occurred in 1996 in response to mining in Round Hill Pit. Movement slowed to a residual creep on backfilling of Round Hill Pit in 1998. It was remobilised with the mining of Golden Point Pit in 1999. Movement slowed again on partial backfill of Golden Point Pit in 2001.

A 5 to 6 m thick layer of waste rock was over part of the tailings in 2016. This rock filled in the low point in the centre of the tailings surface and caused some heave of the tailings profile locally around the rockfill. This heave, along with settlement at the northern end of MTI, has affected the fall on the tailings from the front to the back of MTI. Concurrently, settlement of the embankment crest has occurred, and its elevation has reduced to 546.9 mRL in some areas by 2023. This means surface water can pond at the front of MTI after heavy rainfall. A continuous wave bund was constructed and completed in 2023 to manage freeboard requirements. The wave bund constructed provides a continuous bund to 548.6 mRL and is a temporary dam safety measure intended to contain temporary emergency ponding. It is planned to commence removal of the waste rock in 2026.

3.3. Southern Pit Option 10 TSF

The SP10 Embankment comprises an earth/rockfill structure. The embankment was raised full height to 525 mRL using downstream construction. A plan and section of the embankment is shown in the appended Figure A9 and A10.

The west and east extents of the SP10 tailings impoundment are formed by the mined in-situ rock of the previous Southern Pit. The southern side of the tailings impoundment is formed by the Innes Mills Backfill. The SP10 embankment is currently buried beneath the southern area of the existing SP11A embankment and the impounded SP11A tailings.

The embankment includes a low permeability upstream zone (Zone A) with drains for collecting tailings seepage. When the SP11A TSF was constructed the SP10 drain

outlets were connected into the tailings seepage collection drains for the SP11A TSF. The drains have therefore continued to drain the tailings within the SP10 TSF, including the SP11A tailings which have subsequently covered over the SP10 TSF.

The downstream and upstream faces are defined as the northern and southern faces. The embankment has an upstream slope of 1V:1.5H from the base to 505 mRL, and an upstream slope of 1V:1H from the 505 mRL to 525 mRL. The embankment downstream slope is 1V:1.5H with a 6 m set back on the 525 mRL crest.

The tailings were discharged sub-aerially into the impoundment from the embankment. A tailings beach was established with the decant water ponding in the southern side of the impoundment. The total recorded dry tonnes of tailings discharged into SP10 is 9.24 Mt. The tailings occupy a volume of approximately 6.6 Mm³ with an average dry density of 1.4 t/m³.

The design of SP10 is described in more detail in the design reports (Ref. 10 and 11).

3.4. Innes Mills Backfill Embankment

The IMBE was not initially constructed as a dam and comprised the backfill of Innes Mills stages IM1 to IM4 which commenced in 1997. The IMBE was formed through consented mining activities which involved the subsequent removal of the original Innes Mills Pit Backfill and extension of the Innes Mills Pit. This has altered the profile of the SP11A stable slope and created the IMBE.

The IMBE is founded on the mined in situ rock surface, which has a low point at approximately 495 mRL. The northern end of TSF SP11A is formed by the SP11A embankment. The southern end is formed by the IMBE. It comprises an earth and rockfill embankment to 544 mRL. The Macraes Road embankment is situated on top of IMBE with its crest level at 564 mRL.

The location of the IMBE and Macraes Road Embankment, and a cross section are presented in Figures A3, A11 and A12. The current profile of the Innes Mills Pit is shown as IM8 below in Figure 3. IMBE is situated on the rock ridge between the previous Southern Pit and the current Innes Mills Pit. Innes Mills Pit is currently undergoing active mining.

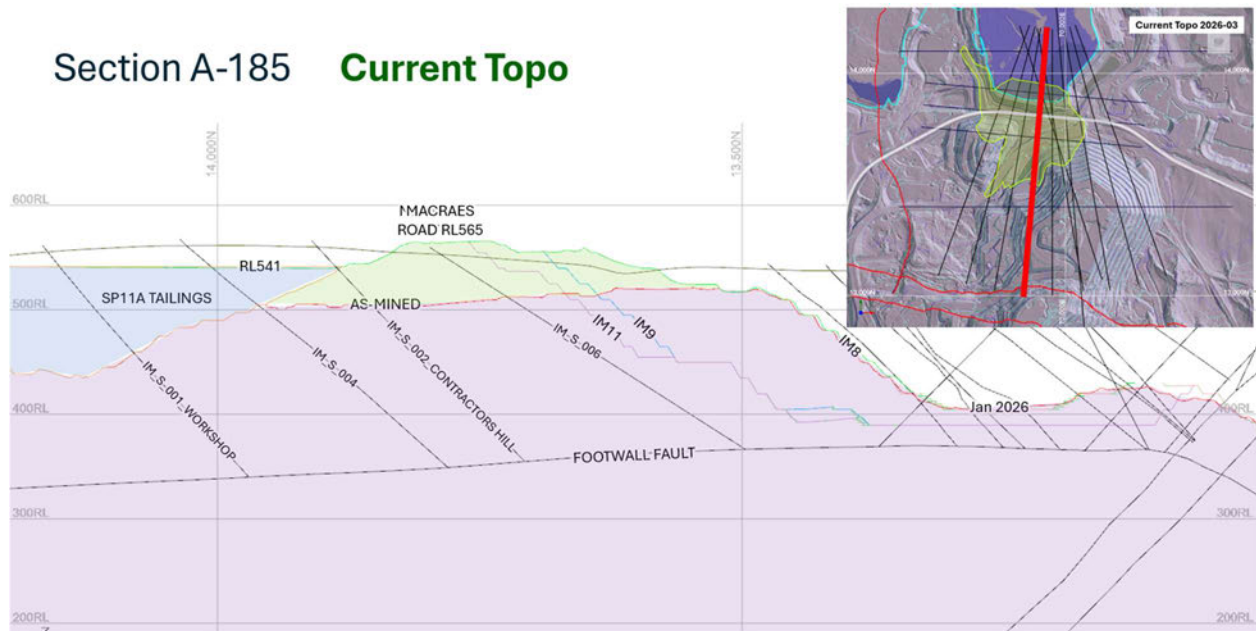


Figure 3: Typical Cross Section Through IMBE

Following the placement of Innes Mills Backfill commencing in 1997, IMBE was raised in 2.5 m lifts to accommodate the Macraes Road diversion that was necessary to allow the FROP development. The Macraes Road was realigned over the eastern side of the IMBE to allow mining of Frasers Pit in about 2003. The Macraes Road was realigned over the full length of the IMBE in 2021.

The northern side of the IMBE was lined with a 6 m wide low permeability earthfill zone (Zone A1) up to 525 mRL to allow placement of tailings in Southern Pit when the SP10 tailings embankment was constructed in 2002/2003. Zone A1 was subsequently extended up to 544 mRL in conjunction with the construction and raising of SP11A.

By the time tailings were impounded up to the base of the embankment (about RL 495 m) backfilling of the original IM Pit had commenced. Backfilling of the IM Pit up to near the crest of the IM Backfill was substantially complete by 2006 and it remained as such until 2016 when mining of IM Pit recommenced. Initially a small pit was excavated southwest of the IMBE.

Mining of the IM7 commenced in about 2024 and this has initiated movement on the pit west wall. EGL were made aware of this movement by OGNZL in September 2025, and subsequently EGL advised that IMBE meets the definition of a large dam under the Building Act. OGNZL has been receiving further advice on this matter and are managing it as if it were a constructed embankment. In February 2026 ORC accepted the certification of IMBE as a high PIC dam. Mining has had a minor effect to date on IMBE, causing minor settlement and hair line longitudinal cracks. Water in the SP11A operating pond has been minimised since the end of 2025 to prevent water from being in direct contact with the IMBE.

Figures 4 and 5 show the MTI, SP10 and IMBE in 2002.



Figure 4: Mine site aerial in 2002



Figure 5: Aerial photo showing SP10 Zone A being placed at the upstream toe of the SP10 embankment in 2002

3.5. Southern Pit Option 11A TSF

The existing SP11A Embankment comprises an earth/rockfill structure. The embankment was raised to 530 mRL using downstream construction and above this level are two upstream embankment lifts to 537 mRL and 544 mRL. The exception is at the eastern and western abutments where downstream embankment construction has been adopted to full height. A plan of the embankment is shown in Figure A3 and A7, and a typical section through the highest northern area of the embankment is shown in Figure A8.

The downstream embankment to 530 mRL has an overall downstream slope of 1V:2H and an upstream slope of 1V:1.5H to 515 mRL, and 1V:1V from 515 to 530 mRL.

The upstream embankment to 537 mRL has a downstream slope of 1V:3H with a 5 m set back on the 530 mRL crest.

The upstream embankment to 544 mRL has a downstream slope of 1V:3H and is set back by 9 m from the 537 mRL crest. The embankments are zoned with a low permeability upstream zone (Zone A1 and A3) and provisions for collecting tailings seepage.

An extensive network of subsurface drainage is installed beneath the tailings impoundment and embankment to intercept and control seepage from the tailings and embankment. When the embankment was raised to 537 mRL an extensive rockfill mattress drain was formed out over the tailings and this is shown in Figure A8 at 530 mRL. All the drains discharge via gravity to the downstream seepage collection system.

The tailings are discharged sub-aerially into the impoundment from the northern embankment. A tailings beach has been established with the decant water ponding on the southern side of the impoundment. Water is decanted from the pond and pumped back to the Process Plant where it is used for processing.

Capping of the northern third of SP11A tailings with rehabilitation material was undertaken, and a haul road was constructed across the SP11A tailings in 2019.

4.0 CURRENTLY CONSENTED MINE PLAN

4.1. Innes Mills Open Pits

The current pit, IM8, is located south of Macraes Road and SP11A as shown in Figure 6 below.

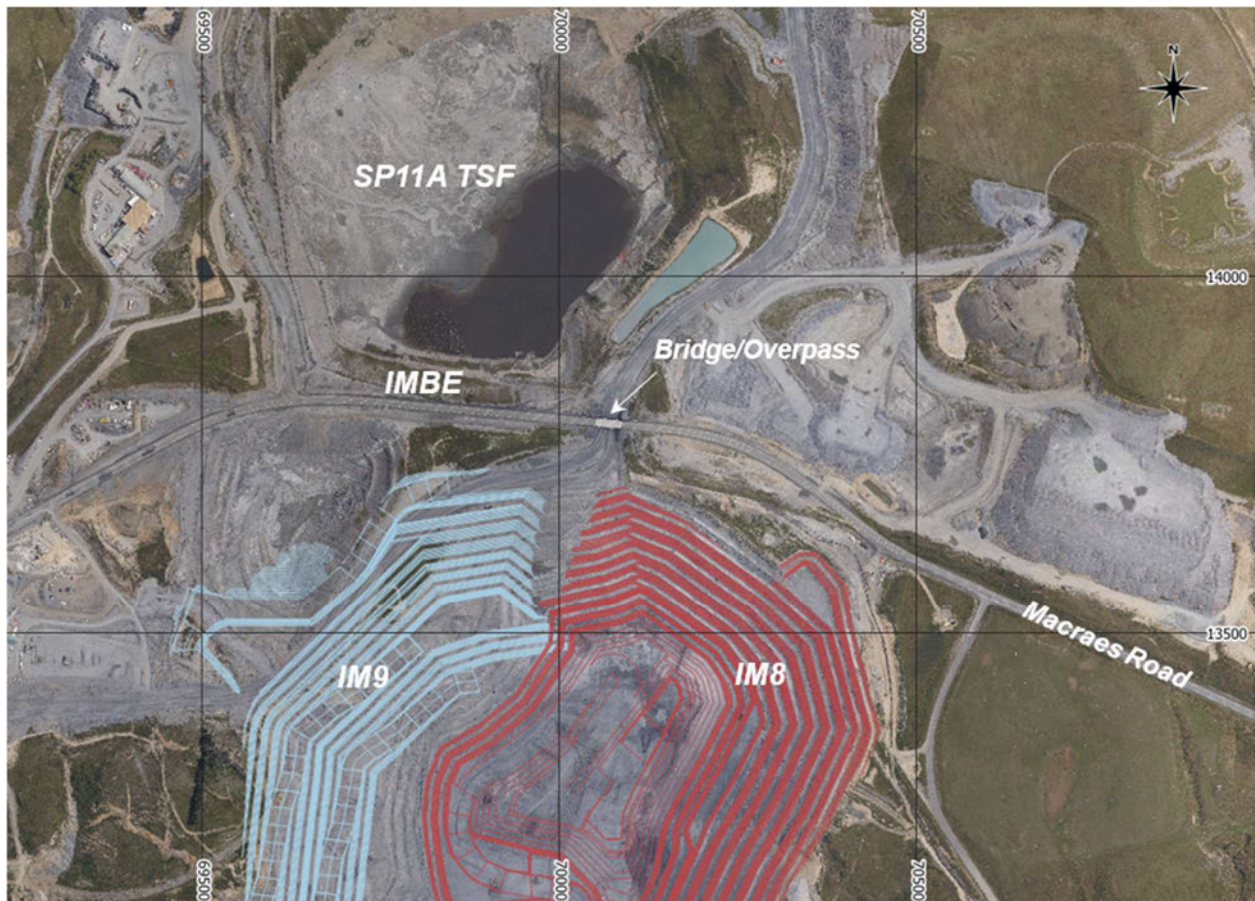


Figure 6: Overview of IM8 and IM9

Currently consented mining activities in the Innes Mills area include the completion of stages IM8, 9 and 10. Resource Consents have been approved for these pit stages as part of CCP1 and CCP2, with tailings going to FTSF Stage 1 and Stage 2.

IM 8 is due to be completed by the end of Q2 2027 and IM 9 and IM 10 are due to be completed by the end of 2027 depending on appropriate management of movement.

Mining of IM7 initiated movement of the west wall (IMWW) in mid-2024. InSAR monitoring indicates the IMWW general direction of movement is towards the base of Innes Mills Pit (southwest direction). The area of main IMWW movement is around 30 Ha, with an additional fringe area of around 40 Ha to the north and west that is creeping in response to the main area of movement. Figure 7 shows current deformation monitoring associated with the West Wall movement. The latest InSAR monitoring in July 2026 indicates deformations along the crest of IMBE are approximately 250 to 500 mm. On the upstream face of IMBE, where the tailings rest against the Zone A lining, the deformations are up to 250 mm. The rate of movement accelerated as the IM Pit was initially expanded in late 2025; however, this has been at a slow rate and the movement velocity has now settled at a steady rate.

Previous modelling and assessment by PSM indicates west wall and north wall deformation is occurring on a combination of the Footwall Fault and other orthogonal faults. The basal sliding surface is a combination of the Footwall Fault and north - south trending faults that dip to the west. This is further discussed in Section 11.7

PSM modelling of existing LOM (IM7, IM8, IM9 and IM10) indicates displacements in the order of 1,000 to 2,000 mm on the crest of IMBE and 200 to 1,500 mm at the

tailings contact with the Zone A. PSM notes their model's ability to reliably predict displacement magnitudes under near-failure or post-failure conditions is inherently limited. Therefore, the model's emphasis has been more towards understanding relative displacement trends, deformation patterns, and spatial distribution of strains to evaluate predicted movement mechanisms, potential failure modes and likely extent of potential instability.

Stability of IMBE is further discussed in Section 11.0.

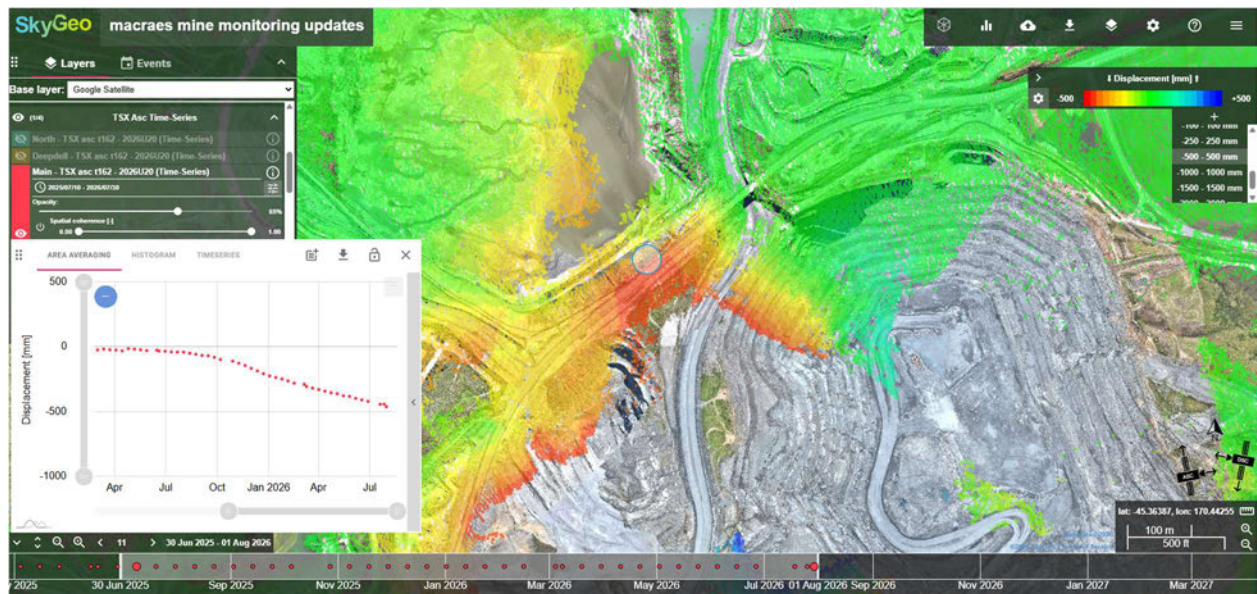


Figure 7: Heat map of ground displacement in vicinity of IM Pit, MTI and SP11A. Velocity of displacement is shown as generally constant since Q3 2025

4.2. Golden Point Underground

GPUG has been progressively developed since 2020. The consented GPUG does not currently extend underneath SP11A.

4.3. Coronation North Open Pit

Coronation North Stage 5 (CN5) is located 8km north of Innes Mills and does not interact with TSFs.

5.0 MP4 MINING PLAN

5.1. Overview and Mining Production Schedule

MP4 will involve further mining of Innes Mills Pit (IM 11 and IM 12) and Southern Pit (IM 13 North and IM 13 South). Further development of the GPUG mine is proposed and its envelope will potentially extend below the northeastern footprint of the SP11A embankment.

Appended Figures A37, A38 and A39 show the plan view of the closure IM pit shell, and MTI and SP11A tailings levels at various stages of hydraulic mining.

Appended Figure A40 supplied by PSM shows the extent of MP4 Innes Mills Pit extensions. Note for the purposes of this report, IM 13 North and IM 13 South are separated at 14,300 mN. The IM backfill extents are shown in appended Figure A41.

Figure 8 below shows an overview of the proposed IM mining stages as for MP4, relative to MTI, SP11A and Macraes Road.

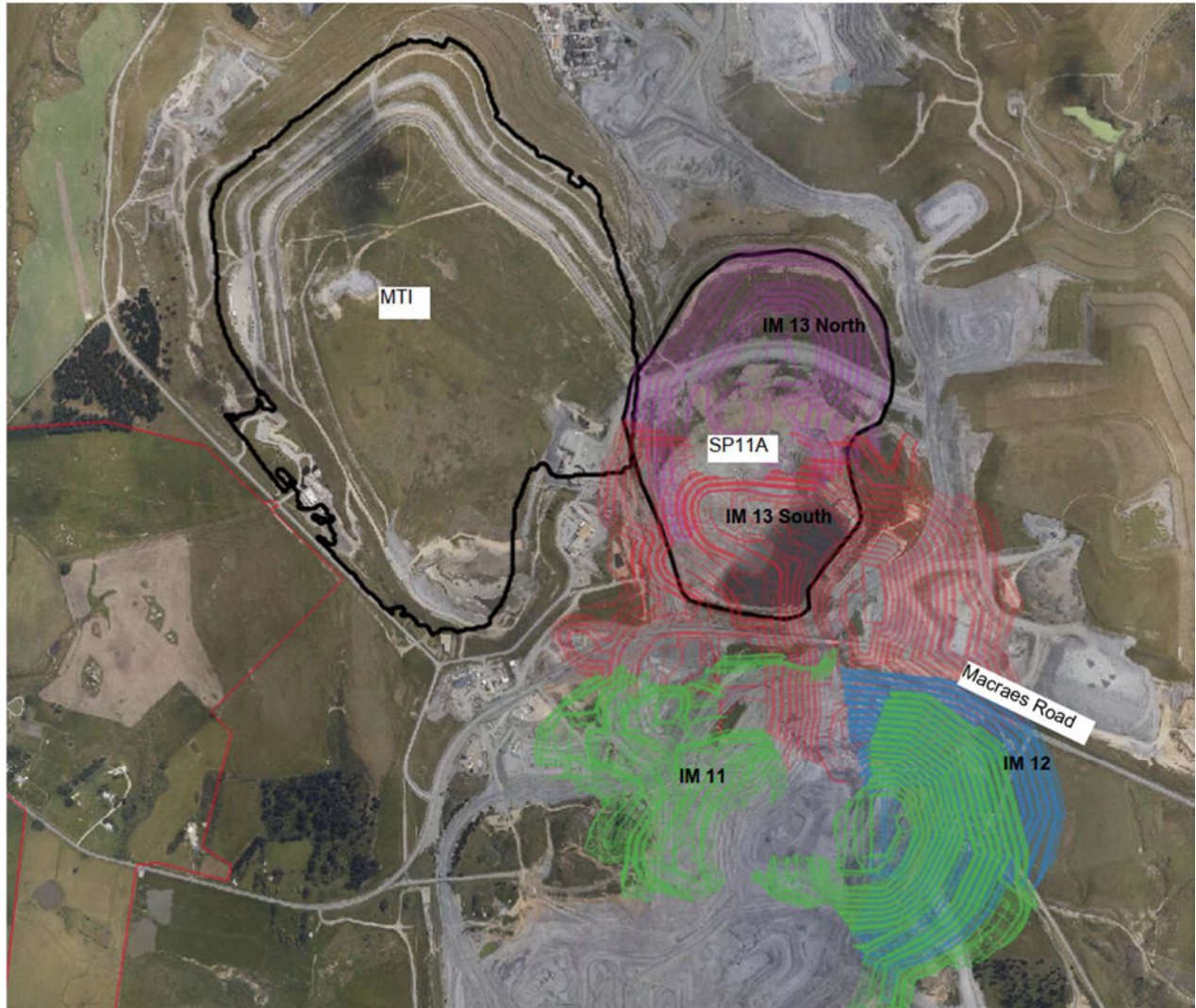


Figure 8: Overview of Proposed IM Mining Stages for MP4

The mining of IM 11 and 12 as part of MP4 will begin following the completion of the currently consented Stage 8, 9 and 10 mining.

Hydraulic mining of tailings from SP11A and the deconstruction of SP10 and IMBE embankments need to take place before further mining to allow access to the IM13 North and South footprint within Southern Pit, below SP11A.

The project proposes IM13-South mining takes place before IM13-North mining and backfill placed in Innes Mills Backfill 2 (IMBF2), which is located in the IM13-North pit area.

Once IM13-South mining is completed, waste rock from IMBF2 will be moved to the IM13-South Pit, which will be named Innes Mills Backfill 3 (IMBF3). This will allow access to the IM 13 North footprint.

MTI upstream lifts need to be removed prior to notable deformations of the abutment and foundations due to pit mining as they could affect stability of the TSF. This requires the staged removal of the top 33 m of upstream tailings lifts during IM13-South mining. MTI upstream tailings removal needs to take place before commencement of mining of IM13-North to mitigate risk of deformations affecting MTI. The Project proposes the start of remining of tailings from MTI towards the end stages of SP11A remining in approximately 2032.

Table 1 below summarises the proposed mining and hydraulic mining schedules.

Table 1: Summary of Innes Mills Pit Mining Stages and Interaction with SP11A, MTI Remining

	Year	Pit Mining and Underground Stage Description	MTI and SP11A Tailings Level ¹
Currently Consented	2026	IM 8, IM 9	Both facilities full height SP11A 542, MTI 545
	2027	IM 8, IM 9, IM 10 GPUG mining adjacent to SP11A embankment	Both facilities full height SP11A 542, MTI 545
MP4	2028	IM 11, IM 12 GPUG mining adjacent to SP11A embankment	SP11A hydraulic mining SP11A 542 to 528 mRL MTI 545 – Full height
	2029	IM 11, IM 12	SP11A/SP10 528 to 512 mRL MTI 545 – Full height
	2030	IM 11, IM 12	SP11A/SP10 512 to 496 mRL MTI 545 – Full height
	2031	IM 11, IM 12, IM 13 South	SP11A/SP10 496 to 464 mRL MTI 545 – Full height
	2032	IM 12, IM 13 South	SP11A hydraulic mining approaches completion. MTI hydraulic mining begins. SP11A/SP10 464 to 418 mRL MTI 545 to 539 mRL
	2033	IM 13 South	SP11A hydraulic mining completed MTI 539 to 530 mRL
	2034	IM 13 South	MTI 539 to 530 mRL then MTI 530 to 521 mRL
	2035	IM 13 South	MTI 530 to 521 mRL
	2036	IM 13 South, IM Backfill Relocation (IMBF 3)	MTI 521 to 512 mRL ²
	2037	IM Backfill Relocation (IMBF 3), IM 13 North	MTI hydraulic mining completed MTI tailings 512 mRL ² behind downstream embankment
	2038	IM 13 North	MTI tailings 512 mRL ² behind downstream embankment
	2039	-	MTI capped and closed
	Closure		

1: Based on Agilitus Pre Feasibility Study Programme, (Ref. 12)

2: Average tailings level. The proposed closure tailings surface of MTI slopes from approximately 514.5 to 509 mRL from east to west towards the closure spillway outlet.

5.2. Innes Mills Mining

The Innes Mills Pit stages IM11 and IM12 extends the currently consented pits to the east and west, as shown in Figure A40. This mining has the potential to affect the stability of IMBE and MTI.

IM13-North and IM13-South extends into and below the Southern Pit footprint. This is adjacent to MTI and SP11A embankment and has the potential to affect MTI and SP11A stability.

IMBE and SP10 will be decommissioned and deconstructed prior to the start of IM13 mining, and therefore this stage will not affect IMBE and SP10.

The effects of IM Pit mining on TSF stability are further discussed in Section 11.0.

Tailings from IM 11, IM12, IM13-North and IM13-South will be discharged to FTSF Stage 2 and Stage 3. Waste rock from IM 11 and IM12 will be placed in the FRBF and adjacent waste rock stacks (Locates indicated in Figure A2).

Waste rock from IM 13-South will be placed into IMBF2, which will then be removed to IMBF3 prior to IM13-North mining commencement. Waste rock from IM13-North will be placed into IMBF3.

5.3. Golden Point Underground Expansion

The GPUG Expansion as part of MP4 extends under SP11A. The effects on the stability and integrity of the SP11A embankment in operation and in closure are discussed in Section 11.0.

5.4. Hydraulic Mining of SP11A

SP11A contains approximately 27.8 Mt of tailings. These tailings are proposed to be hydraulically mined to enable the mining of Southern Pit (IM 13 North and South). This process will involve removing tailings using high pressure water, which are then transported as slurry via a system of in-dam launders (trenches) and drains to a collection sump with a pontoon mounted pump. Tailings will then be relocated to FTSF via pumping of slurry.

Any tailings contaminated capping or embankment material will be deposited into FTSF either as tailings facing construction material or deposited within the impoundment. Clean material will go to WRS.

Hydraulic Mining Configuration

Hydraulic mining will be undertaken in flitches, comprising 6 to 9 m high benches. At the start of each flitch, a 6 m deep sump with pontoon will be established and launders (trenches) graded at 1V:150H to drain into the sump. A main launder must be developed first to establish the initial void required for subsequent mining blocks to drain into.

The haul road across SP11A will be deconstructed before remining commences. The IMBE and SP10 embankments will be mechanically deconstructed in stages that

generally coincides with the lowering of tailings. Figure 9 shows the general arrangement of SP11A, SP10 and IMBE embankments.

Surface Water

Collection sumps will be located away from upstream embankments to prevent water ponding and saturating these embankments and the tailings beneath them i.e. in the middle of the impoundment area against the western rock ridge.



Figure 9: Section through 69,900 mE at SP11A, SP10 and IMBE

Hydraulic Mining Rate

Hydraulic mining will take place at a proposed rate of 1200 t/hr as a base case, reducing to 450 t/hr towards the end of hydraulic mining due to space constraints at the base of the pit. The hydraulic remining will operate 24 hr per day.

Refer to the Agilitus report for further details of hydraulic mining (Ref. 12).

5.5. Hydraulic Mining of MTI

The upstream raises from crest level 548 mRL to 515 mRL are proposed to be deconstructed, and tailings surface level reduced to an average level of 512 mRL to allow sufficient freeboard. This equates to the removal of approximately 33 m or 38.4 Mt of tailings (i.e. average tailings level of 545 mRL to 512 mRL). The purpose of removing the upstream raises and associated tailings at MTI is to reduce risk of deformation and breach of the MTI embankment during the mining of IM13-North and the risk of tailings flowing into the pit.

These tailings are proposed to be hydraulically mined using the same process as the SP11A remining, as described in Section 5.4 above. Remining of MTI will commence towards the end of SP11A remining, when equipment can be deployed to the adjacent TSF.

Any tailings contaminated capping or embankment material will be deposited into FTSF either as tailings facing construction material or deposited within the impoundment. Clean material will go to WRS.

Hydraulic Mining Configuration

Similar to SP11A, hydraulic mining will be undertaken in flitches.

Tailings in the MTI are up to approximately 150 m deep towards the north, decreasing to approximately 10 m towards the south. Refer to Figure 10 for an isopach showing approximate tailings depth across MTI. As hydraulic mining approaches 512 mRL, the operation will expose the natural rock of the original ground profile at the southern extents of MTI, and the dam crest of the buried Concentrate Impoundment Dam and Water Storage Dam. Sumps, pontoons and launders will be repositioned to avoid or minimise excavation into rock while maintaining required falls.

The MTI upstream embankments, Concentrate Dam embankment and Water Storage Dam embankments will be mechanically deconstructed in stages that coincide with the lowering of tailings.

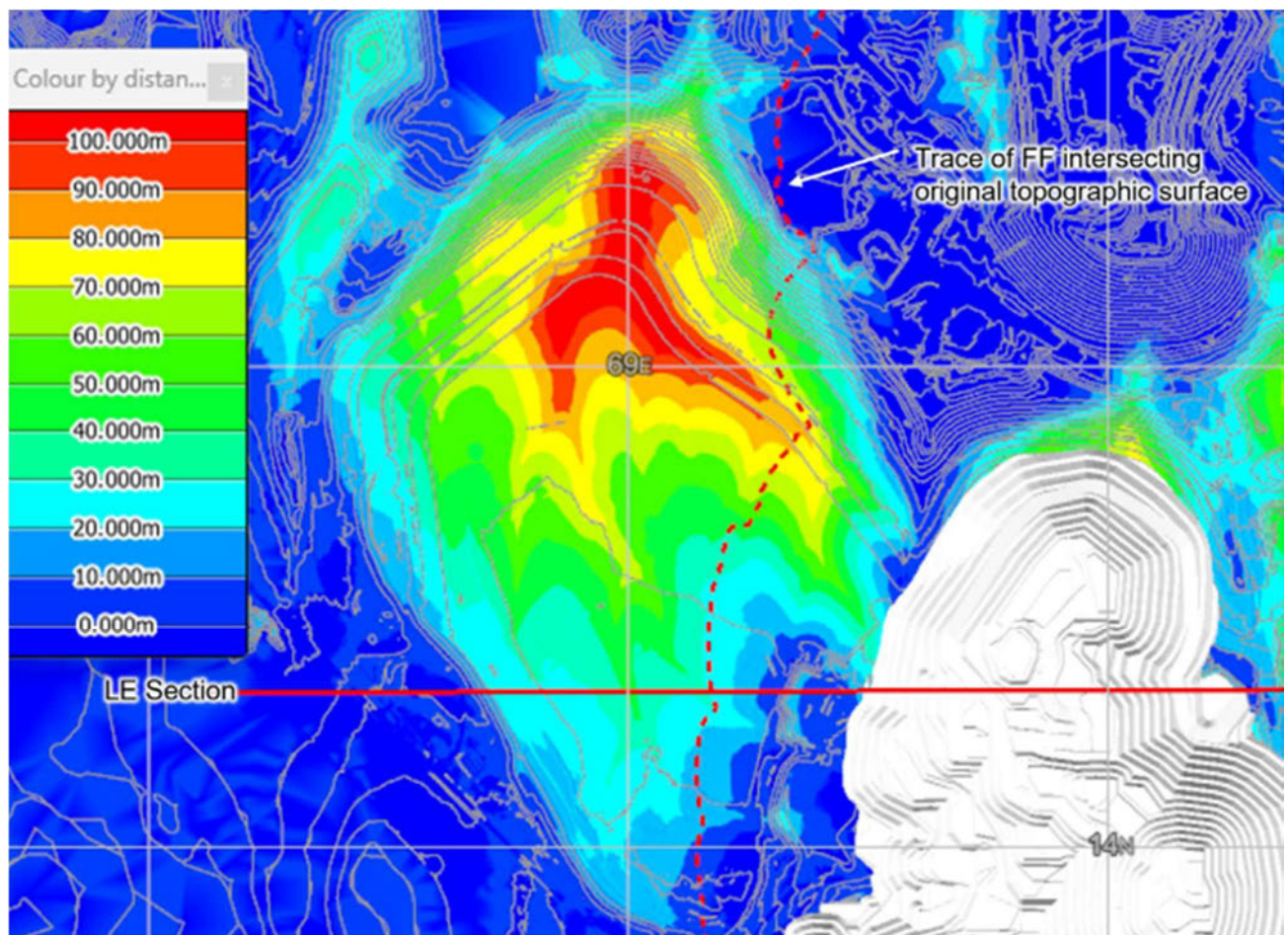


Figure 10: Isopach showing approximate thickness of MTI Tailings

Surface Water

Collection sumps will be located away from upstream embankments to prevent water ponding and saturating these embankments and the tailings beneath them.

Remining Rate

Hydraulic mining will take place at a proposed rate of 1200 t/hr as a base case. The hydraulic remining will operate 24 hr per day.

Refer to the Agilitus report for further details of hydraulic mining (Ref. 12).

6.0 PROPOSED TAILINGS STORAGE FACILITY

6.1. MTI 515 mRL

At the completion of MP4 activities, MTI will partially remain as a downstream constructed TSF with a crest level of 515 mRL, following relocation of tailings impounded by the upstream raises. There is no intention to store tailings in MTI in the future as part of the MP4 project.

6.2. Frasers TSF Stage 3

The proposed FTSF Stage 3 provides storage capacity for the relocated tailings from SP11A and MTI, and the tailings resulting from pit and underground mining scheduled under MP4. FRBF Embankment will be raised to a maximum crest height of 520 mRL to provide this storage capacity.

Tailings contaminated capping or embankment material from the deconstruction of SP11A and MTI will also be deposited into FTSF.

Proposed FTSF Stage 3 allows tailings to be deposited above 450 m RL and the raising of the crest from 480 mRL to a maximum embankment elevation of 520 mRL.

7.0 SITE CLOSURE AT THE COMPLETION OF MP4

7.1. MTI

The proposed rehabilitation and closure strategy for MTI involves construction of a dry cover (dry cap) which will allow the area to be rehabilitated and returned to the pre-mining land use with the minimum potential for adverse environmental effects. An outlet will be constructed on the western side of MTI to discharge surface water to an existing drainage channel along Golden Point Road, into Lone Pine Reservoir as shown in Figure A27.

The removal of the upstream lifts of MTI will expose the original ground surface at the southern portion of the facility. In preparation for closure, residual tailings overlying exposed ground at the southern extent of MTI will be mechanically removed. This includes removal of tailings deposited into local excavations for borrow material near the existing workshop. If tailings within these local excavations are too deep to be practically removed, the installation of dry capping can be considered as an alternative rehabilitation measure.

Tailings remaining in the northern portion of the facility will be retained by the downstream embankment.

In closure, the southern portion of MTI will require dry capping as the ground surface has been previously exposed to tailings and is potentially contaminated. The northern portion of MTI contains tailings and therefore requires dry capping to manage dust and erosion. Closure capping is proposed to comprise a minimum of 300 mm thick brown rock, overlain by a minimum of 200 mm topsoil to allow rehabilitation of the TSF

surface. Specific consideration must be given to protection from the surface water runoff from the gullies from the southern portion of MTI in closure.

The closure dry cap will be shaped such that surface water will fall towards the closure outlet, comprising a spillway cut into rock at the western embankment. Minor earthworks in the form of 5 to 15 m of fill below the western embankment is required to direct water to an existing drainage channel to the west of the stockpile located south of Lone Pine. The closure spillway outlet will be designed to pass the Inflow Design Flood (IDF) based on a 1 in 10,000 AEP flood event adjusted for long-term climate change. For the purposes of this application, the MTI closure spillway outlet has been sized to pass the PMP.

For the purpose of closure spillway assessment, the closure capped tailings surface has been assumed to fall from 514.5 mRL at the northeastern side of MTI, to approximately 509 mRL at the western side of MTI, at a 1V:170H gradient.

7.2. SP11A Embankment

The proposed rehabilitation and closure strategy for SP11A involves establishing a low PIC water dam through reprofiling of the SP11A embankment, and construction of an outlet channel in rock as indicated in Figures A18 and A42. The outlet will discharge to an earth lined channel, west of Golden Point Backfill, and flow to Deepdell Creek. Rock armour will be required for erosion protection along steeper channel sections.

The SP11A embankment will remain in closure. The upper 15 m (530 to 515 mRL) of the upstream slope is at 1V:1H which achieves sufficient stability with tailings impounded against the embankment but requires reprofiling in closure. The crest will be reduced to 520 mRL and the remaining upstream face reprofiled to 1V:1.5H. The upstream face is compacted Zone A material (i.e. weathered brown rock). This slope will require topsoiling for closure. The SP11A embankment is assessed to impound a maximum height of up to approximately 15 m of water in closure under flood conditions.

The upstream cut off drain and tailings underdrains will be disestablished and collector pipes sealed in preparation for Innes Mills Lake water impoundment behind the embankment. As the outlet drains pass through Zone B material, sealing of drains would include plugging at the upstream end and grouting through Zone A1.

A cut will be made to the embankment to create a closure spillway. Specific consideration must be given to the protection of the Zone A1 core and chimney drain where cuts are through these areas. The spillway outlet channel will comprise a concrete weir cut in rock at an invert of approximately 473 mRL and will be designed to pass the IDF. This allows pit lake water quality to be managed through selective pumping and treatment as necessary, with the outlet channel functioning to pass water during extreme flood events only.

Refer to appended Figures A18 to A26 for details of the SP11A closure arrangement.

Water balance modelling undertaken by GHD indicates that a pit lake will form within IM Pit following closure. An excerpt of the model output is included in Figure 11 below. Pit lake levels are assessed to rise immediately in the post-closure period,

reaching approximately 400 to 410 mRL within 5 years. Thereafter, lake levels are expected to increase more gradually, reaching 440 mRL at 20 years post-closure. Over the longer term, IM Lake levels are assessed to stabilise at approximately 465 to 475 mRL after 50 to 70 years.

The elevation of the natural schist rock at the SP11A embankment is approximately 460 mRL. Once the IM Pit lake levels exceed 4 m above natural rock level (approximately 464 mRL post-closure), a large dam will form as the SP11A embankment impounds more than 4 m of water. This is expected to occur between 40 and greater than 50 years post closure.

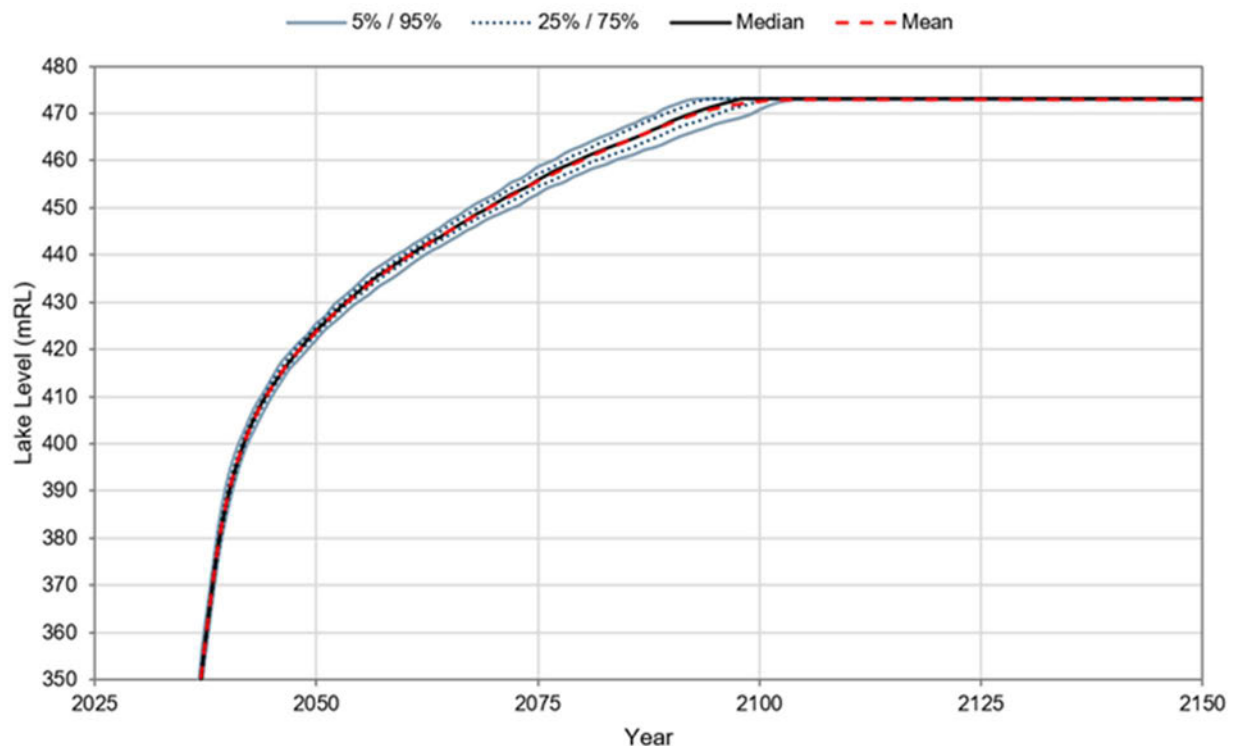


Figure 11: Excerpt GHD water balance model results (Ref 6).

7.3. Frasers TSF and TTTSF

The proposed rehabilitation and closure strategy for FTSF Stage 3 and TTTSF involves construction of a dry cover (dry cap) both with an outlet to the west which will flow to the northern branch of the Waikouaiti River.

Refer to the FTSF Technical Report for further details (Ref. 1).

8.0 NATURAL HAZARDS

The effects of natural hazards on the proposed MP4 works have been considered in the context of the existing TSFs and incorporated into the design criteria where relevant.

Flood

The main flood channels within the project site are in the vicinity of Deepdell Creek. Otherwise, IM, Fraser, Golden Point areas are on a catchment divide, and top of the catchment for North Branch of Waikouaiti.

Refer to GHD's report (Ref. 6) for further information on surface water.

Seismic

Bradley Seismic Limited was engaged to undertake a probabilistic seismic hazard analysis for the Macraes Operation site in 2021 (Ref. 13). The National Seismic Hazard Model (NSHM22) has subsequently been updated in 2022 (Ref. 14) with several differences, including a revised earthquake rupture forecast (source) model. It is recommended that the NSHM22 spectra be used.

In 2010 a detailed investigation was undertaken of the northern segment of the Billy's Ridge Fault, known as the Macraes Fault, by Golder (Ref. 15). The Macraes Fault is adjacent to the Macraes Operation. The surface expression of the Macraes Fault is very subdued compared to the other fault structures that have reported tectonic movement during the Holocene period (last 10,000 years). Golder (Ref. 15) were able to conclude, based on trenching and soil dating techniques, that the Macraes Fault has not ruptured to the ground surface during the last 11,500 years and that there was no evidence of any late Quaternary deformation. On this basis, the annual exceedance probability of rupture of the Macraes Fault is significantly lower than 1/10,000 (0.0001).

Within the Macraes Operation, typical near-surface shear wave velocities (5 to 30 mbgl) have been recorded that range between 1,000 to 2,000 m/s.

Landslide

Generally, the regional topography is free of notable landslide features. However, there is a historic landslide feature associated with the Footwall Fault down to Deepdell Creek. This was not initially identified during mine planning and subsequent movement observed in mine operation has highlighted this feature. The landslide hazard at the Macraes Operation is primarily mining related, and is not associated with the historic Deepdell landslide feature.

9.0 POTENTIAL IMPACT CLASSIFICATION

The New Zealand Dam Safety Guidelines (NZDSG, Ref. 16) provides recommendations for the design, construction, and operation of dams which are dependent on the PIC of the dam. There are three classes of PIC: Low, Medium, and High. The PIC of a dam reflects the potential consequences of a failure (potential failure mode) on people, property, infrastructure, and the environment. Assessment of the PIC considers various factors including Population at Risk (PAR), Potential Loss of Life, damage to houses, infrastructure, environment, and community recovery time.

The term "potential failure mode" does not indicate a deficiency in facility safety, and the hypothetical failure breach scenario used for the assessment of PIC does not correlate with the probability of the dam failing or experiencing a dam safety incident.

Dam Breach and PIC classification assessments (Ref. 17) have been undertaken for MTI, SP11A, IMBE, TTTSF and FTSF. The assessments of PIC align with the requirements in the Building (Dam Safety) Regulations 2022 and are summarised in Table 2 below.

Table 2: Summary of PIC for Existing and Proposed TSFs

Dam	PIC In Operation	PIC In Closure*
MTI TSF	High	Medium
SP11A Embankment	High	Low**
SP11A – IMBE	High	N/A Deconstructed
FTSF Stage 3	High	High

*Initial assessment. To be reviewed at closure and thereafter as required by relevant legislation.

**SP11A Embankment will be modified in closure.

The key populations at risk for each TSF are summarised below.

MTI: Workers at the Process Plant, GPUG, administration building and road users of Golden Point Road

SP11A: Workers at the Process Plant, GPUG, Golden Point Pit

IMBE: Workers in Innes Mills Pit and road users of Macraes Road

FTSF Stage 3: Workers in Innes Mills Pit and road users of Macraes Road

A potential breach from MTI and SP11A can result in run out flows of tailings and retained water reaching Deepdell Creek. Most tailings would settle out immediately downstream but water and some entrained tailings could flow into the Shag River. The population downstream of Deepdell Creek are primarily recreational users as the area is remote and there is no permanent population. Deepdell Creek flows into the Shag River, and along the Shag River are residential dwellings and road crossings.

The hypothetical breach scenario for FTSF Stage 3, upstream of SP11A, is into Innes Mills Pit and will be contained by the SP11A embankment in operation. In closure, the SP11A embankment will be lowered to 473 mRL at the outlet channel over rock. A hypothetical breach of FTSF in closure would pass through the outlet channel and flow into Deepdell Creek and the Shag River. The dam breach assessment of SP11A as a result of a breach of FTSF in closure is included in the FTSF Stage 3 technical report (Ref. 1).

10.0 DESIGN CRITERIA AND RISK MANAGEMENT

10.1. Dam Design Criteria Overview

New Zealand and International Guidelines

Dam design criteria under MP4 has been informed by relevant New Zealand and International guidelines and standards applicable to dam safety and tailings storage facilities.

Key guidelines and standards include:

- NZDSG 2024 (Ref. 16);
- Global Industry Standard on Tailings Management (GISTM) (Ref. 18); and
- ICOLD Bulletin 194 (Ref. 19).

These documents provide the framework for the design, construction, operation, and closure of the facility, including requirements relating to stability, seismic performance, flood management, monitoring, and risk management.

The NZDSG is adopted as the primary reference for establishing design criteria and performance expectations for the facility and is the basis for an alternative solution to the Building Code and to comply with the statutory obligations under the New Zealand Building Act 2004. The NZDSG refers to GISTM and ICOLD Bulletin 194.

In addition, OGNZL is committed to managing TSFs in alignment with the recommendations set out in the *Global Industry Standard for Tailings Management* (GISTM).

Standards-Based and Risk-Informed Approaches

NZDSG Module 3, Section 1.2.1 states:

“The Designer needs to recognise that not all elements of dam structures requiring design are adequately covered by design manuals or standards. The Designer is required to assess all realistic risks by considering all potential failure modes and demonstrate how the design incorporates defensive measures to eliminate or minimise associated risks. For design of rehabilitation works for existing dams, consideration can be given to reducing risk to ‘As Low As Reasonably Practicable’ (ALARP)”

“The design of new dams should involve the use of modern accepted practices that reflect the latest knowledge and technology. New dams will typically incorporate appropriately conservative and prescriptive design criteria, and/or accepted solutions, with a focus on resiliency and future proofing. In contrast, the assessment of existing dams must acknowledge that the past design of older dams may not align with modern accepted practice. For older dams that do not meet or exceed modern design criteria, or for situations where modern design criteria cannot be practically achieved, the assessment of existing dams may involve evaluation against performance criteria and a risk-informed decision-making approach.”

Section 6 of the NZDSG, Module 3, describes two approaches to establishing dam performance criteria: a standards-based approach, and a performance criteria and risk-informed decision-making approach. Performance based design is an evolution of the observational method where a design is monitored, reviewed, and adjusted during construction based on actual field performance.

During operation mining below existing TSFs and remining of tailings will require a performance criteria and risk-informed decision making (RIDM) approach in accordance with NZDSG for stability. This is because the mining situation (interacting with the TSFs) at Macraes Operation does not fit a standards-based approach.

Design for freeboard and stability for the closure of MTI and SP11A will be undertaken using a standards-based approach in accordance with NZDSG.

Design criteria recommended within NZDSG are dependent on the PIC of the dam. A **High PIC classification** has been used in developing design standards and criteria for the embankments of existing or proposed new TSFs in operation, per Section 9.0 above.

Details of the adopted design and performance criteria are summarised in the sections below.

10.2. Stability Criteria

Overview

The mining environment and ground conditions at Macraes Operation results in notable deformation of pit walls, primarily controlled by the non-active Footwall Fault geological structure. Deep-seated pit slope foundation failure modes typically involve structurally-controlled complex block or wedge sliding by shear on the Footwall Fault and/or other pre-sheared surfaces with residual strength characteristics. The resulting low-velocity creep-style ground movement that may affect a dam foundation often has an inherently low risk of rapid catastrophic failure; however, special considerations are required in relation to more brittle failure embankment modes involving liquefaction and internal erosion. This situation is managed using a performance criteria and RIDM approach.

In this context, calculated FoS values for areas adjacent to the pit face fall below standard based targets. However, the deformations that result are limited in extent and self-stabilising when considering the low angle of the basal shear surface and the residual strength on the Footwall Fault interface and the increased drainage associated with deformation of the rock mass. Stability improves as movement slows through stress redistribution and coming to rest at a flatter, more stable slope geometry.

Where TSFs interact with mining around the Footwall Fault, assessments adopt a performance criteria and RIDM approach that considers the mechanism, extent, and consequences of potential failure, and includes the assessment of extreme flood and seismic events. Some deformation of the pit walls and foundation of the TSF embankments may occur, which can be managed safely using this approach and is considered to be consistent with NZDSG. Where deformation are too large and present unacceptable risks to the environment or life, the tailings storage facilities will be relocated.

10.3. Freeboard

Existing TSFs at Macraes Operation operate as fully contained, no release facilities with no dedicated spillway. All supernatant (decant) water managed onsite is contained within the mine circuit water. Sufficient storage volume will be allowed for on the TSFs during hydraulic mining of the tailings to manage all operational pond water requirements plus the Inflow Design Flood (IDF) with additional freeboard.

The freeboard criteria in NZDSG have been adopted. They are summarised in the appended Table 3. This includes freeboard requirements for the following conditions:

1. Maximum Normal Reservoir Level (MNRL) under operating condition
2. Maximum Reservoir Level (MRL) during the Inflow Design Flood (IDF) event
3. Maximum Normal Reservoir Level (MNRL) post-earthquake event

A 1.0 m freeboard is required in accordance with NZDSG recommendations for a tailings dam.

Estimates of wave run-up and wind set-up are based on procedures recommended in Fell et al (Ref. 20). Wave run-up has been estimated for the highest 10 % of waves (R10%).

10.4. Inflow Design Flood (IDF)

Climate Change Adjustment

The allowance for climate change effect on inflow design flood is based on the increases in high intensity rainfall estimates published by NIWA's High Intensity Rainfall Database Version 4 for Climate Change Scenario Representative Concentration Pathway 8.5.

For a 1 in 250-year event the NIWA modelling indicates that, for a 72-hour storm duration, rainfall is projected to increase relative to historical records by:

- 6% during the 2031 to 2050 period, assumed to be representative of the operational phase; and
- 18% during the 2081 to 2100 period, assumed to be representative of the closure phase.

Modelling for climate change events rarer than a 1 in 250-year event are under development in New Zealand but have not yet been adopted by the dam industry in New Zealand. For this project the relative 1 in 250-year increases to rainfall depths have been applied to the PMP estimates.

In Operation – Existing TSFs

The IDF in operation for existing TSFs has been taken as the equivalent of the 72-hour PMF (Probable Maximum Flood, i.e. PMP) event which is estimated to be **761 mm** using Thompson and Tomlinson (Ref. 7), with no adjustment for climate change.

In Operation – Existing TSFs Undergoing Modification

The IDF in operation for existing TSFs that are proposed to be modified, i.e. through remining, has been taken as the equivalent of the 72-hour PMF (Probable Maximum Flood, i.e. PMP) event with climate change adjustment. This is estimated to be **806 mm** using Thompson and Tomlinson (Ref. 7).

In Closure

The IDF in closure for spillway outlet structures has been taken as the equivalent of the 72-hour PMF (Probable Maximum Flood, i.e. PMP) event which is estimated to be **898 mm** using Thompson and Tomlinson (Ref. 7), with climate change adjustment.

Channels conveying TSF outlet flows to receiving water bodies have been designed to accommodate the peak flow associated with a 1-in-1,000-year event across all storm durations.

10.5. Earthquake Design Criteria

The NZDSG require consideration of two earthquake loading conditions, and the effects of an aftershock.

The Operational Basis Earthquake (OBE) is the earthquake for which a dam, appurtenant structures and mechanical, electrical, power, control, and communication equipment that fulfils a dam safety critical function is designed to remain operational, with any damage being minor and readily repairable following the event. It shall be taken as earthquake ground motion with an average return period of 150 years.

The Safety Evaluation Earthquake (SEE) is the earthquake that would result in the most severe ground motion which a dam and appurtenant structures must be able to endure without uncontrolled release of the reservoir. It shall be taken equal to the 84th percentile level of the ground motion associated with the Maximum Credible Earthquake (MCE) but need not be greater than ground motion with an average return period of 10,000-years.

An aftershock one magnitude less than the main rupture is also considered.

Design earthquake ground motions have been based on a site-specific seismic hazard study (Ref. 13) based on the New Zealand National Seismic Hazard Model (NSHM22, Ref. 14).

11.0 STABILITY ASSESSMENT

11.1. Stability Assessment Methodology

The stability assessment considers interactions between existing TSFs and mining activities. A performance-based, risk-informed decision-making approach is adopted. This method involves the assessment of Potential Failure Modes to identify critical and credible failure modes and possible mitigations and controls.

Critical failure modes identified through the assessment of Potential Failure Modes are subsequently evaluated through a quantitative risk assessment, which estimates the likelihood and consequences of the PFM both with and without mitigations and controls.

Stability modelling informs the selection of likelihoods for each scenario.

The approach taken is that it must be demonstrated that the mitigations and controls can result in dam safety risks that are assessed to be tolerable, before an activity is considered acceptable to proceed. In this project the Low As Reasonably Practical

(ALARP) principle has been applied to some risks. Further details of this approach is provided in Section 14.2 and recommended controls and mitigation measures described in Section 14.3.

11.2. Footwall Fault and Deformation of MTI

This section describes the past and current stability situation at Macraes, including past movement, controlling mechanisms, and monitoring, measures and controls.

Movement on the HMSZ first occurred in 1996 in response to mining in Round Hill Pit, and has subsequently been observed during mining of Golden Point Pit, Innes Mills Pit and Frasers Pit. Movement on the HMSZ generally manifests on the western pit wall (West Wall), which moves as a block towards the pit being actively mined. The mechanism driving West Wall movement is complex, with no particular structure acting as a release to ease block sliding.

PSM's review of past pit instability and monitoring data noted West Wall movement has tended to be correlated to the extent of mining (strike, offset to Footwall Fault) and responds to drainage (reduction), backfilling (reduction) and peak rainfall (increase).

Activated movement has been recorded up to 150 m away from the edge of the pit.

The MTI runs the full length of the proposed IM13 mining and the eastern side overlies the Footwall Fault. Any movement on the Footwall Fault beneath MTI is likely to cause deformation at the MTI embankments. Previous deformation of the MTI embankment occurred during the mining of Round Hill movement, which stopped following the cessation of mining and backfilling of Round Hill. Movement on the Footwall Fault was reactivated in November 1999 in response to the commencement of mining in Golden Point Pit. Mining of Golden Point Pit ceased in June 2002 and shortly after, as backfilling progressed, movement on the Footwall Fault ceased.

The MTI embankment has performed as expected as the tailings are well drained due to their sandy and permeable nature along the upstream side of the embankment, the underdrainage beneath the tailings, as well as pump wells located both within the tailings and in the abutment. The downstream embankment (crest RL515) incorporates a chimney drain on the eastern abutment that functions as a filter to prevent migration of tailings should cracking of the embankment occur and/or high seepage gradients develop. Recent monitoring has indicated pore pressures have dropped within the tailings after tailings deposition ceased and the level of saturation of tailings is quite low on the eastern side of MTI.

11.3. Macraes Mining Methods

This section summarises the risk-based approach based on past mining experience and demonstration of effective past management.

Existing controls for West Wall movement due to mining include the use of:

- Open pit planning
 - Footwall Fault Offset, which limits open pit extents to above this offset

- Stop-start approach, stopping mining when deformations and or velocity reach trigger levels, and recommencing once movement subsides.
- Use of Trigger Action Response Plans (TARPs), Ground Control Management Plans (GCMPs) which includes:
 - Live monitoring of ground deformation magnitude, velocity and acceleration through radar, supplemented by InSAR and survey of deformation prisms
 - Rainfall monitoring
 - Groundwater level monitoring
 - Groundwater drainage

11.4. PSM Modelling

PSM has carried out 3D numerical stability modelling using 3DEC software to support our assessment of mining IM Pit stages IM11 to IM13 proposed under MP4. The focus of this work is to assess the potential for mining-induced pits slope deformation, and in particular the potential for foundation movement beneath IMBE and MTI associated with these stages. The results of these analyses are appended to the PSM Open Pits Report PSM71-363R (Ref 21). The results of the PSM analyses are discussed in relevant sections below.

11.5. Existing MTI

The existing MTI is stable and meets standards-based factors for recommended by the NZDSG. Drain down of water in the tailings has reduced the phreatic surface since operation which has improved the stability situation with time.

There is minor long-term creep of an isolated section of the MTI embankment foundation above the existing ROM Pad. This is associated with movements of the rock foundation over the footwall fault to the Golden Point Pit. Infilling of the Golden Point Pit will likely result in this creep reducing to a minor amount at closure.

11.6. Existing SP11A

The existing SP11A is stable and meets standards-based factors of safety recommended by the NZDSG. Drain down of water in the tailings has reduced the phreatic surface since operation which has improved the stability situation with time.

11.7. Existing IMBE and IM11 and IM12 Pit Mining

IMBE is a very wide embankment located on a rock saddle between IMOP and Southern Pits. Macraes Road is located on top of this embankment.

Mining of IMOP is causing some deformation of IMBE back to the tailings. IMBE is contained within the mining environment. The stability of IMBE for subsequent mining stages will be assessed using a performance based, risk informed decision making (RIDM) approach.

Management of the stability will require:

- Detailed geotechnical assessment of the stability and deformation of each stage of pit mining
- Potential failure modes and effects assessment and identification of critical controls
- Quantitative risk assessment for key potential failure modes
- Trigger action response plans to implement the controls
- Update and review of the 3D stability model as mining progresses.
- Monitoring including piezometers, deformation prisms, inclinometers, radar, InSAR and GNSS units.
- Specific documentation of monitoring and TARPs will be provided in a management plan for the IMBE.

Detailed documentation for geotechnical stability will require building consent and peer review under the Building Act 2004. This management of IMBE is to be incorporated into the Operations Maintenance and Surveillance (OMS) Manual.

11.8. SP11A Hydraulic Mining

The deconstruction of the SP11A embankment down to 520 mRL will comprise the removal of the tailings within the impoundment. At the same time the embankment crest will be kept sufficiently above the tailings to ensure that the stormwater runoff can be contained within the SP11A impoundment with an adequate freeboard. The stability of the embankment is therefore not considered to be a significant issue as the embankment crest will always be above the tailings. Initial deconstruction of the two upstream embankments will have to be carried out with care to ensure that the excavation of the tailings does not result in upstream failure of the embankment (i.e. failure towards the tailings area).

The tailings will be removed by a combination of excavation and transport by trucks where the tailings are dry and hydraulic mining where the tailings are too weak to mechanically excavate. Geometric controls will be required to prevent water from storm events encroaching and affecting the stability of the upstream embankments. Provided the tailings removal does not extend significantly below the foundation level of the individual upstream embankments, prior to commencement of their removal, and the level of tailings saturation is managed the stability of the upstream embankments should not be a significant issue.

Hydraulic mining of SP11A for stability will require controls for stability. This will include:

- Detailed design of the staging of the hydraulic mining including geotechnical stability assessment
- Location of sumps away from upstream lifts
- Staging of hydraulic mining and removal of embankment areas to maintain freeboard
- Good practice in the implementation of hydraulic mining face, launders, sumps and pumps
- Stability of SP10 embankment considering differential levels of tailings on each side of the embankment.
- Monitoring for saturation of the upstream lift profile.

Stability during hydraulic mining will be considered as part of detailed design and be part of the documentation to support application for a Building Consent. The design will require peer review as part of the Building Consent process.

11.9. SP11A and MTI embankment and abutment

The central shared embankment and abutment of MTI and SP11A is just north of the Workshop. SP11A upstream embankments will be removed down to 520 mRL ahead of removal of tailings and upstream embankments in MTI. The remaining MTI embankments and exposed rock in the foundations and abutment will be inspected to identify any defects and to confirm stability. Specific ground investigation of the rock foundation in this area is required to confirm geotechnical stability. It is recommended that high-quality geotechnical boreholes with detailed logging are required with acoustic televiewer (ATV) and optical televiewer (OTV). Monitoring including deformation prisms, GNSS units, and inclinometers are likely required in this area.

Stability of the SP11A and MTI embankment and shared abutment will be considered as part of detailed design and be part of the documentation to support application for a Building Consent. The design will require peer review as part of the Building Consent process.

11.10. MTI Hydraulic Mining

Hydraulic mining of MTI can potentially affect the stability of the upstream embankments if the excavation profile is too steep and hydraulic mining results in high levels of saturation of the tailings. Controls will be necessary to ensure stability.. They will include:

- Use of dry mining (mechanical excavation and transport by trucks) as far as practical to minimise saturating the tailings in the immediate vicinity of the upstream embankments
- Detailed design of the staging of the hydraulic mining including the geometry of the excavations and geotechnical stability assessment
- Location of sumps away from upstream lifts
- Staging of hydraulic mining and removal of embankment areas to maintain freeboard
- Good practice in the implementation of hydraulic mining face, launders, sumps and pumps
- Monitoring for saturation of the tailings in the vicinity of the upstream embankments

Stability of the MTI embankment will be considered as part of detailed design and be part of the documentation to support application for a Building Consent. The design will require peer review as part of the Building Consent process.

11.11. MTI While Mining IM13 South

The initial stages of IM13-South mining are assessed to result in minor deformations of the eastern side of the MTI (Refer PSM report, Ref 21). The MTI tailings and upstream embankments will be progressively lowered during mining of IM-13 South.

As the mining of IM13-South progresses deformation will extend north to the upstream lifts of MTI. At the same time the tailings may have some increase in saturation due to the hydraulic mining process. Detailed assessment of the staging and geotechnical stability of the upstream lifts is required. This will be considered as part of detailed design and be part of the documentation to support application for a Building Consent. The design will require peer review as part of the Building Consent process.

11.12. MTI While Mining IM13 North

Deformation modelling by PSM (Ref. 21) indicate that mining of IM13-North results in greater displacements in the area underlying the MTI upstream lifts. Given the hydraulic mining will result in some increase in saturation of this profile it is currently assumed for the Project that the upstream lifts on MTI will need to be fully removed prior to IM13-North mining. Effects on the remaining downstream construction embankment will be assessed as part of detailed design and be part of the documentation to support application for a Building Consent. The design will require peer review as part of the Building Consent process.

11.13. GPUG Ground Subsidence Effects on SP11A

The Golden Point Underground (GPUG) mine will be extended beneath the SP11A embankment as part of MP4. An assessment of the potential for subsidence of the ground beneath SP11A is required if mining occurs while tailings are retained behind the embankment and is also required as part of the assessment to convert SP11A embankment to a water storage dam as part of the closure plan. The potential for cracking, piping, and instability of the embankment and effects on the integrity of the underlying foundations needs to be assessed. Mining affecting the foundations and integrity of a dam requires a Building Consent. The design will require peer review as part of the Building Consent process.

11.14. SP11A Embankment Dam in Closure

The SP11A embankment will be converted to a water storage dam in closure. It will impound water to a depth of approximately 15 to 20 m. This dam is assessed to be Low PIC. The existing SP11A embankment will need to be assessed as a water storage dam and take into consideration the risks associated with extension of GPUG beneath it. Underground workings will need to be backfilled to prevent subsidence, foundations beneath the dam may require grouting, and some modifications to the embankment may be necessary. These issues will be assessed as part of detailed design and be part of the documentation to support application for a Building Consent. The design will require peer review as part of the Building Consent process. The potential for breach of the embankment in perpetuity is considered low. The risk of piping is considered very low due to the wide width of the embankment that will remain at the proposed level of water retention and the zoning of the embankment and presence of a chimney drain filter..

IM Pit slope stability needs to be assessed for passive closure.

12.0 FREEBOARD ASSESSMENT

TSF freeboard assessments have been undertaken for the existing SP11A and MTI dams and for critical interim stages during hydraulic mining. Refer to appended Tables 11 and 12 for a summary of freeboard assessments.

12.1. SP11A Existing

The existing SP11A meets freeboard requirements. Until commencement of hydraulic remining, the design IDF has been assessed based on the 72-hour probably maximum precipitation event, with no climate change adjustment. The adopted 72-hour PMP rainfall depth is 761 mm.

The PMF run-off volume is estimated at 446,000 m³, and the current maximum operation pond volume is 130,000 m³, although this is currently maintained as a low as practicable to manage effects on the IMBE.

The freeboard required above the level of flood resulting from a PMP event is 1 m.

12.2. MTI Existing

The existing MTI dam meets freeboard requirements with a wave bund (that was constructed on top of the existing RL548 upstream embankment) and the planned removal of the waste rock above tailings. Until commencement of hydraulic remining, the design IDF has been assessed based on the 72-hour probable maximum precipitation event, with no climate change adjustment. The adopted 72-hour PMP rainfall depth is 761 mm.

The PMF run-off volume is estimated at 609,300 m³, and the current maximum decant pond volume is 40,000 m³, although this is currently maintained as a low as practicable.

The freeboard required above the level of flood resulting from a PMP event is 1 m.

12.3. SP11A During Hydraulic Mining of Tailings and Embankment Deconstruction

Sufficient freeboard must be maintained during mining of tailings and embankment deconstruction. This can be achieved through staging embankment deconstruction to follow removal of tailings.

The design IDF has been assessed based on the 72-hour probable maximum precipitation event, with a climate change adjustment for the operational period. The adopted 72-hour rainfall depth is 806 mm.

The SP11A catchment increases with the removal of the upstream embankments, then stays relatively consistent throughout removal of tailings.

Prior to the removal of upstream embankments, sufficient storage for the IDF will be developed within the impoundment to ensure freeboard is maintained at the lowest level of the embankment crest at any time. This can be achieved by preferentially

lowering the level of the tailings in areas away from the embankment crest so the IDF can be stored at the southern side of the impoundment before deconstruction of each upstream embankment.

Tailings relocation will proceed to below the foundations of the IMBE before this embankment can be fully removed, while ensuring sufficient freeboard remains.

Mining of IM Pit Stage 13 will connect the Southern Pit impoundment with the IM Pit. At this point, the IDF will be fully contained within Southern Pit and IM Pit in operation.

The PMF run-off volume during removal of tailings from SP11A is estimated at 530,000 m³ (assessed at 530 mRL). The decant pond and associated pumping system will be removed once hydraulic mining commences. If necessary, portable pumps can be used to remove excess water from large rainfall events.

As the hydraulic tailings relocation progresses, the pit will become narrower and the flood rise associated with the PMF will increase.

The freeboard required above the level of flood resulting from a PMP event is 1 m.

The required freeboard (i.e. storage depth below embankment) when the SP11A embankment is at 530 mRL has been assessed as 2.3 m.

The required freeboard (i.e. storage depth below embankment) when the IMBE is removed down to 495 mRL has been assessed as 4.2 m.

12.4. MTI During Hydraulic Mining of Tailings and Embankment Deconstruction

Sufficient freeboard must be maintained during hydraulic mining of tailings from the MTI and embankment deconstruction. This can be achieved through staging embankment deconstruction to follow removal of tailings.

The design IDF has been assessed based on the 72-hour probable maximum precipitation event, with a climate change adjustment for the operational period. The adopted 72-hour rainfall depth is 806 mm.

The MTI catchment size increases with the removal of the upstream embankments, therefore the greatest PMF volume is assessed at the final crest level of 515 mRL.

The maximum PMF run-off volume during removal of tailings is estimated at 981,550 m³. The existing decant pond will be drawn down before hydraulic mining commences, with water managed through the hydraulic mining water management system and portable pumps if necessary.

Prior to the removal of each upstream embankment, sufficient storage for IDF must be developed within the impoundment to ensure freeboard is maintained at the lowest level of the embankment crest at any time. This can be achieved by preferentially lowering tailings level in areas away from the embankment crest so the IDF can be stored towards the southern side of the impoundment before deconstruction of each upstream embankment.

As hydraulic mining progresses, the original ground surface at the southern end of MTI will be exposed, which falls towards the northern side of MTI. This will be considered in the planning the staging of hydraulic mining to ensure freeboard can be maintained at all times.

The freeboard required above the level of flood resulting from a PMP event is 1 m. The total freeboard requirement (i.e. storage depth above tailings surface) at the completion of removal of tailings is estimated to be 5.4 m from the lowest tailings elevation.

The assessed freeboard for the concept closure surface (average tailings level 512 mRL, falling from 514.5 to 509 mRL) is 6.1 m from the lowest tailings elevation.

12.5. SP11A Closure

A closure outlet spillway is proposed for SP11A at 473 mRL. This spillway will be sized to pass the PMP and will incorporate allowance for climate change.

12.6. MTI Closure

A closure spillway is proposed for MTI at approximately 509 mRL. This spillway will be sized to pass the PMP and will incorporate allowance for climate change.

13.0 SP11A PIPING ASSESSMENT

SP11A impounds water under closure conditions; therefore, a preliminary piping assessment has been undertaken for the SP11A closure embankment.

Under normal rainfall conditions, water level against the closure embankment will be limited by the elevation of the closure spillway outlet at 473 mRL, approximately 13 to 23 m above the natural schist rock level. The existing SP11A embankment chimney drain which is present to 480 mRL will be retained in closure. Temporary increases in reservoir water level above this level may occur during extreme storm events but will be managed by the closure spillway arrangement.

The existing SP11A embankment chimney drain, which extends to 480 mRL, will be retained in closure. This is expected to act as a filter to prevent piping through the central core of the embankment (Zone A1).

A detailed assessment of piping risk will be required at the detailed design stage to confirm the piping potential failure mode through the SP11A closure embankment, along the underdrain outlet pipe, and through defects in the foundation is adequately mitigated, ensuring the long-term stability of the embankment and allowing for successful closure in perpetuity.

14.0 POTENTIAL FAILURE MODES AND MITIGATIONS

14.1. General

A potential failure mode (PFM) is defined as a specific chain of events or set of circumstances that could result in the uncontrolled release of all or part of the contents of a reservoir. The identification and assessment of potential failure modes for a dam is an important part of the design process for dams and is recommended by the NZDSG. The failure modes that are identified are not failures that are expected to occur but are hypothetical failures that could occur if appropriate design, construction, monitoring, and surveillance methods were not followed. By adopting appropriate design and construction methods, the risk of these failures is reduced to a very low and acceptable level.

A preliminary review of potential failure modes has been undertaken for the following:

- Hydraulic mining of SP11A (including IM12 effects on IMBE),
- Hydraulic mining of MTI,
- Mining down dip of Footwall Fault at MTI, and
- SP11A Embankment in Closure.

Following the assessment of PFMs, critical failure modes were selected for a further quantitative risk assessment (QRA) to support and inform the RIDM approach to TSF design. Details of this assessment is included in Appendix B.

A further detailed review will be undertaken in the Detailed Design stage. Potential failure modes that have been identified are summarised in the appended Tables 6 to 9 along with details of design mitigations and proposed dam safety monitoring.

These potential failure modes are summarised broadly below.

Hydraulic Mining of SP11A

Ten (10) PFMs were considered and discussed:

- Upstream Embankment failure due to hydraulic remining causing re-saturation of the upstream raises, leading to static liquefaction and flow failure and release of tailings to the north into the Process Plant and/or Golden Point underground. (HMSP11-PFM1)
- IMBE failure due to IM Pit mining causing geotechnical instability of the IM Northwall and IMBE resulting in release of tailings into IM 10 Pit. (HMSP11-PFM2)
- SP10 Embankment failure due to removal of tailings upstream (South) of SP10 causing geotechnical instability of the SP10 embankment and tailings breaching southward into Southern Pit (IM13 – South) (HMSP11-PFM3)
- SP11A Embankment failure due to extreme rainfall during hydraulic mining causing flood to overtop the embankment leading to erosion of the embankment and release of tailings. (HMSP11-PFM4)
- SP11A Upstream Embankment failure due to earthquake induced liquefaction causing geotechnical instability, leading to release of tailings to the north into Process Plant and/or Golden Point Underground. (HMSP11-PFM5)
- Piping through SP10 embankment due to pond water against the embankment leading to release of tailings into IM13 North Pit. (HMSP11-PFM6)

- Embankment failure due to pit wall collapse/landslide into the embankment during hydraulic mining causing overtopping of embankment, leading to release to tailings into pit. (HMSP11-PFM7)
- Embankment failure due to pit wall collapse/landslide into the embankment during hydraulic mining causing geotechnical instability of embankment, leading to release to tailings into pit. (HMSP11-PFM8)
- Embankment failure due to underground mining causing block caving and settlement of the embankment crest resulting in overtopping of embankment and release of tailings either into IM13 South or to the north into Process Plant and/or Golden Point Underground. (HMSP11-PFM9)
- Upstream embankment failure due to underground mining causing block caving and settlement leading to static liquefaction, flow failure and release to tailings to the north into the Process Plant and/or Golden Point underground. (HMSP11-PFM10)
- Upstream embankment failure by slumping into the impoundment due to hydraulic mining resulting in loss of freeboard and overtopping in subsequent storm event. (HMSP11-PFM11)

Hydraulic Mining of MTI

Three (3) PFMs were considered and discussed:

- Upstream Embankment failure due to hydraulic remining causing re-saturation of the upstream raises, leading to static liquefaction and flow failure and release to tailings to the north into the Process Plant. (HMMTI-PFM1)
- Embankment failure due to extreme rainfall during remining causing flood to overtop the embankment leading to erosion of the embankment and release of tailings. (HMMTI-PFM2)
- Upstream Embankment failure due to earthquake induced liquefaction causing geotechnical instability, leading to release of tailings to the north into Process Plant and Golden Point Underground (HMMTI-PFM3)

Mining Downdip of Footwall Fault at MTI

Five (5) PFMs were considered and discussed:

- Embankment failure due to IM Pit mining causing geotechnical instability of the IM Northwall and/or Westwall while MTI upstream raises are still in place. Resulting in release of tailings into IM Pit. (MMTI-PFM1)
- Embankment failure due to IM Pit mining causing geotechnical instability of the IM Northwall and/or Westwall while MTI upstream raises are still in place. Resulting in release of tailings into Process Plant, Golden Point Underground and Deepdell Creek. (MMTI-PFM2)
- Failure of upstream embankment on northeastern end of MTI due to mining of IM Pit causing cracking of embankment leading to piping through the embankment and release of tailings. (MMTI-PFM3)
- Embankment failure due to rising IM Pit Lake levels causing geotechnical instability of the IM Westwall, leading to geotechnical instability of MTI eastern embankment and release of tailings into IM Pit. (MMTI-PFM4)
- Embankment failure due to rising IM Pit Lake levels causing geotechnical instability of the IM Westwall, leading to geotechnical instability of MTI eastern embankment and release of tailings into environment. (MMTI-PFM5)

SP11A Embankment in Closure

Eight (8) PFMs were considered and discussed:

- Embankment failure due to incorrect assumptions used in water balance model leading to closure pit lake levels being higher than designed and overtopping of embankment and erosion causing release of water into environment. (SP11AC-PFM1)
- Piping through embankment due to water impounded against the embankment, or earthquake induced piping, or long term settlement induced piping, leading to release of water into environment. (SP11AC-PFM2, 5 and 7)
- Embankment failure due to pit wall collapse/landslide into the embankment caused by rise in pit lake levels leading to overtopping of embankment and release of water into the environment. (SP11AC-PFM3)
- Embankment failure due to earthquake induced geotechnical instability, leading to release of water into environment. (SP11AC-PFM4)
- Embankment failure, due to unknown weakness in foundation, or settlement due to GPUG or poor construction QA/QC, causing geotechnical instability, leading to release of water into environment. (SP11AC-PFM6)
- Internal erosion along underdrain outlets leading to piping failure and breach of embankment and release of water into environment. (SP11AC-PFM8)

Outcomes of the PFM assessment include recommendations on design, construction and closure mitigations measures. Principal design mitigations measures include:

1. Maintaining appropriate setbacks between hydraulic mining sumps and pontoons and the upstream embankments. Hydraulic mining launders will be arranged to drain away from the upstream embankments to avoid re-saturation of the upstream raises.
2. Maintaining the required freeboard throughout remining. Freeboard assessments will account for the staged tailings and embankment geometry, operating pond and sump volumes, and runoff and direct rainfall from the design PMP event.
3. Remining tailings upstream and downstream of the SP10 embankment concurrently, so that SP10 remains continuously buttressed. Ponding against SP10 will be avoided and setbacks will be maintained between the embankment and the hydraulic mining pontoon.
4. Assessing and controlling the temporary slopes and batters formed by hydraulic mining, including appropriate batter angles and setbacks. The stability of adjacent pit walls will also be assessed, with waste rock buttressing provided where practicable following remining.
5. Assessing the seismic performance of the embankments using liquefied strengths and reduced tailings stiffness. The embankments are required to meet the adopted deformation and stability performance criteria.
6. Undertaking three-dimensional stability analyses of the interaction between IM Pit mining, the pit walls and MTI. IM mining will be staged so that it does not result in significant displacement until the MTI upstream raises have been removed. The required mining offsets will be determined through a risk-informed decision-making process that considers the stability analyses, previous pit performance and current monitoring data (covered in the next section).

7. Managing the interaction between IM Pit mining and IMBE through further development of the existing risk management framework. This will include groundwater and seepage monitoring, InSAR and ground-based radar monitoring, and implementation of a TARP with defined start-stop mining criteria.
8. Assessing the effects of Golden Point Underground mining on SP11A and limiting the mining extent where required. Mining beneath the SP11A embankment will not proceed until the upstream embankments have been deconstructed.
9. Limiting the closure lake level through the SP11A closure spillway. Closure stability assessments will consider the saturated pit walls and the shared MTI and SP11A abutment under the design closure lake conditions.
10. Assessing the potential for piping, seismic instability, long-term settlement and settlement-induced cracking of the SP11A closure embankment. Buttressing or additional lining will be provided where required. The existing chimney drain will be retained and the underdrain outlets will be sealed using a specifically designed procedure to reduce the potential for internal erosion.

These controls will be supported by visual inspections and monitoring of embankment and pit wall deformation, piezometric levels, seepage flows, pond levels and available freeboard. The controls, monitoring requirements, trigger levels and response actions will be incorporated into the TRDD Management Plan, relevant TARPs and the Closure Manual. The potential failure modes assessment should be reviewed and updated through detailed design and as the remaining sequence, pit performance and monitoring data are refined.

Further recommendations have been developed from the QRA which is detailed in the sections below.

14.2. Quantitative Risk Assessment

A quantitative risk assessment (QRA) has been undertaken as part of the stability assessment of interactions between existing TSFs and mining activities. The outcomes of the QRA inform the mining controls and risk management approach. Full details of this assessment are contained in Appendix B.

The methodology of the QRA involves:

- Prioritise the risk-driving PFMs by undertaking a qualitative risk screening,
- Develop event trees for the main risk-driving PFMs,
- Assign likelihoods and consequences of the various branches of the event trees and reference supporting information,
- Assess life risk for each PFM, calculate total life risk and compare against societal risk tolerability limits,
- Identify risk reduction measures and review against as low as reasonably practical (ALARP) principle, and
- Develop recommendations for risk reduction or mitigation measures.

Four critical PFMs selected for assessment as part of the QRA are:

- HMSP11-PFM2
- MMTI-PFM1

- MMTI-PFM2
- MMTI-PFM3

A total of 10 event trees have been developed from the 4 PFMs selected.

The consequences considered in this QRA is the potential loss of life (PLL), both to the public and to workers within Macraes Operation. Other potential consequences such as social, business and financial consequences do not form part of this assessment.

The limit of tolerability adopted is based on loss of life (F-N plot) for existing dams as presented in the ANCOLD guidelines (Ref. 22)

14.3. QRA Outcomes and Recommendations

The 10 event tree scenarios generally plot below the ANCOLD limit of tolerability line with appropriate controls.

While the proposed controls result in annual probability of failure and PLL for all PFM scenarios to be below the ANCOLD limit of tolerability line, ALARP conditions must also be met.

Reduction of risk to ALARP can be demonstrated by taking all reasonable steps that are practical to reduce risks. This includes during TSF planning, design, monitoring, management, and also through elimination or avoidance of risk.

The QRA demonstrates some failure mechanisms are very close to the limit of tolerability, especially IMBE failure due to IM Pit mining causing geotechnical instability of the IM North-wall and/or West-wall. Therefore, the following controls and mitigation measures are recommended to reduce risks to ALARP. This is a non-exhaustive list and additional risk reduction and mitigations measures should be considered at every stage of design and operation.

Effective control surface water to avoid re-saturation of the tailings, including:

1. Re-locate MTI hydraulic mining decant pond to the south and west, away from the Footwall Fault, or maintain storage freeboard on MTI such that water does not approach north eastern upstream embankment under a PMP flood event (per Tree 6.2)
2. Dry mining of areas of MTI adjacent to the upstream embankments to avoid introducing water through hydraulic mining
3. Relocation of Process Plant Turkeys Nest above SP11A
4. Minimising TSF operating ponds to lowest practicable levels, or relocate operating ponds to be set back from anticipated embankment movement

Adopt additional monitoring and/or traffic management controls:

5. Implement additional site monitoring for Macraes Road, including real-time radar, inclinometer, fibre optics, and piezometers. Develop Trigger Action Response Plans (TARPs) linked to traffic management of Macraes Road. The assessment of tolerability for Tree 4.1 assumes full traffic management TARPs are adopted and 24 hr surveillance of road movement is implemented.

6. Adopt automatic real-time warning systems for motorists and pit workers that are linked to monitoring stations (to address residual risks under Trees 4.1 and 4.2).

Improve displacement model reliability:

7. Calibrate 3D stability models used for displacement assessments and proactively review and update models throughout operation.

Eliminate risk of upstream embankment instability where practicable:

8. The base case adopted in the assessment assumes adherence to proposed project sequencing. Where practical, OGNZL should consider earlier removal of MTI upstream embankments.

Other measures that would eliminate the risk, however are likely not economically viable (and therefore do not meet ALARP), include:

1. Relocation of Macraes Road away from IMBE before the commencement of IM11 and IM12 mining.
2. Closing the Golden Point Underground.
3. Relocating the Process Plant.
4. Conclude mining within Golden Point pit.

The QRA should be updated in detailed design to reflect any changes to scenarios or controls.

15.0 RISK MANAGEMENT

A preliminary stability assessment for MTI and SP11A has been undertaken using a risk informed approach. A performance-based risk management process is proposed to manage the risks associated with stability of MTI and SP11A during mining associated with MP4. This approach is proposed for operation, decommissioning and closure phases.

A MP4 Innes Mills Mining, Tailings Removal and Dam Deconstruction (TRDD) Management Plan is recommended to ensure the safe removal of tailings and upstream raises. The TRDD Management Plan should set out:

- The staging required to safely remove tailings and upstream raises for MTI, SP11A and complete IM 11, IM 12 and IM 13 mining; and
- Assessments that are required to be completed prior to commencement of each stage.

The TRDD covers the operational aspects of mining activities as part of MP4 and removal of tailings, including triggers and hold points that allow mining to progress from one stage to the next. Where relevant, the TRDD Management Plan should reference existing dam safety documents that support the management of the MP4 mining interaction with TSFs. This includes relevant sections from the Operation, Maintenance and Surveillance Manuals, Emergency Actions Plans, Ground Control Management Plan, TARPs etc.

OGNZL has an existing, established risk management process. The TRDD Management Plan should be incorporated into OGNZL's existing risk management framework.

16.0 RECOMMENDED INVESTIGATIONS

EGL recommends geotechnical investigation in the form of borehole investigations at the abutment junction between SP11A and MTI to confirm there are no hidden fault structures that could influence stability.

Additional investigations of tailings profile are also recommended to inform detailed design of the hydraulic mining at MTI and SP11A.

Investigations will be scoped in the detailed design stage for MTI and SP11A.

17.0 DETAILED DESIGN CONSIDERATIONS

Detailed design is required to support applications for building consents for alterations to large dams.

Design criteria and decommissioning design criteria will be established in accordance with NZDSG.

Key items to be considered in the detailed design stage for each facility are summarised below. This list is not exhaustive and should be reviewed in the context of the specific TSF alteration scenario.

MTI and SP11A

- Detailed review and update of potential failure modes, and quantitative risk assessment informing performance-based RIDM design approach.
- Specific stability assessments:
 - Removal of upstream embankments
 - Embankment stability between MTI and SP11A
- Assessment of drawdown recovery from flood
- Assessment of interim freeboard requirements during hydraulic mining
- Closure spillway design
- Scoping of additional instrumentation and updates to existing monitoring and instrumentation

Specific to SP11A-IMBE

- Settlement of SP11A embankment and cracking potential due to GPUG
- Piping assessment

Considerations for hydraulic mining is separately covered in the section below.

18.0 HYDRAULIC MINING DAM SAFETY CONSIDERATIONS

Dam safety risks associated with the hydraulic mining of SP11A and MTI must be adequately considered during the detailed design and implementation phases of the hydraulic mining works.

A notable dam safety risk is that hydraulic mining saturates the upstream lifts causes liquefaction (static or seismic induced) leading to TSF failure to the environment outside the footprint of MTI. Appropriate mitigations and controls for dam safety are therefore required.

Hydraulic mining must be accomplished with effective control of jetting water to avoid re-saturation of the tailings. This requires very careful grade control and sump management.

Detailed assessment of stability of the upstream lifts is required for the removal of tailings from a dam safety perspective. This should include the detailed assessment of the hydraulic mining decant pond pontoon position and its effect on stability. Lower risk pontoon locations may be possible and should be considered under an ALARP approach.

The decant pond during hydraulic mining should be kept as far away from the upstream lifts as possible to minimise saturation of the upstream raised profile during normal hydraulic mining and to mitigate the pond flooding the area above the upstream lifts in the event of an extreme flood. Decant pond location should be reviewed in detailed design.

Staging of hydraulic mining should consider dam safety stability risks. EGL recommends that the rear (south) of the facilities are always brought down ahead of the front (north) from as much as practical. This means water in a flood always gathers at the rear away from the upstream lifts and is important to maintain upstream raise stability.

SP10 embankment has a low permeability Zone A on its front face. Hydraulic pressures cannot be allowed to build up within the SP10 embankment fill to a level higher than the tailings upstream, otherwise this may result in failure of the upstream slope of this embankment. Therefore, tailings on the north and south side of SP10 embankment should be brought down in sync, which is the current planned sequence.

MTI and SP11A upstream fill embankments constructed for raising the dam shall be left in place until tailings are removed behind each lift. This provides flood protection and containment in case of internal slumps of the batters.

Dry mining of a certain width of the upstream raise profile at the front of MTI for the section above the Process Plant should be considered in detailed design as part of an ALARP approach.

CPTs within SP11A and MTI are recommended to inform the detailed design of hydraulic mining to further characterise tailings. Tailings liquefaction strengths should be reviewed during detailed design to utilise the most current understanding.

At the completion of hydraulic mining of MTI, the launders will naturally grade toward the pontoon sump locations. For closure, the MTI dry cap must be shaped to direct surface water toward the outlet at the western embankment. To achieve this, the final tailings surface will be contoured either mechanically or through hydraulic mining to provide a gradient falling towards the spillway outlet, while minimising the volume of rock required for the cap. This methodology will be further developed in detailed design.

19.0 CONSTRUCTION CONSIDERATIONS AND RECOMMENDATIONS

Construction staging is a key consideration for the works proposed on MTI and SP11A. Staging must allow for adequate stability, freeboard and other dam safety controls to be continuously maintained throughout construction works. Staging should also take into

account the timing of decommissioning works for infrastructure such as decant pumping systems to avoid interruption to operation.

Construction Control and Management – TSF Embankments

TSF embankment construction and decommissioning should be undertaken by experienced personnel, comprising a combination of the mining fleet and civil construction fleet (or sub-contractor). They should be under the direct supervision of OGNZL technical staff, which include engineering, survey, and civil testing experience.

The TSF Designer should review the construction monitoring, checking against the design drawings and specification. Construction monitoring should include control testing of fill placed in the embankment and undertake regular visual inspections.

Construction Control and Management – Hydraulic Mining

EGL recommends hydraulic mining be undertaken by personnel with experience in hydraulic mining of tailings. They should be under the direct supervision of OGNZL technical staff, with support and oversight from the hydraulic mining Designer.

Erosion and Sediment Control, Dust Management

An Erosion and Sediment Control Report has been prepared for MP4. Work areas associated with MTI and SP11A alterations remain within existing areas of disturbance. New activities within these areas will be assessed as part of a site-specific erosion and sediment control plan.

Dust management will be undertaken throughout construction. Hydraulic mining will expose tailings surfaces. Areas with active hydraulic mining will remain wet. In areas where active hydraulic mining is not in place, dust should be controlled by spraying dry surfaces with water. Dust management must consider dam safety implications of creating saturated tailings against upstream embankments. The Designer should review dust management plans of TSF works.

Water will also be required to condition exposed earthfill and this will assist in reducing the potential for dust.

Quality Control and Assurance

A Quality Programme/Plan will be developed that will detail Quality Assurance and Quality Control procedures including testing to demonstrate compliance with the design (Specifications and Drawings). It will also set out the organisation and reporting structure, roles and responsibilities for staff involved in construction, and documentation and reporting requirements.

Regular surveys of the embankment will be undertaken to ensure works are correctly set out.

20.0 OPERATION CONSIDERATIONS AND RECOMMENDATIONS

The management of TSF infrastructure during hydraulic mining and decommissioning works is a key operation consideration. Management of decant ponds, pumping structure and staging during hydraulic mining is required avoid interruption to operation.

Specific recommendations include:

- Management of freeboard and decant ponds per Section 12.0 and Section 18.0
- Management of stability per Section 11.0.
- Mitigations and controls as outcomes of the QRA, per Section 14.3.
- If staging changes from those assumed in this report, reassessment of stability and effects may be required.

21.0 SURVEILLANCE AND MONITORING RECOMMENDATIONS

The scoping of potential additional instrumentation and updates to existing monitoring and instrumentation triggers is required as part of detailed design to ensure TSF related activities under MP4 are adequately managed.

The scoping of required instrumentation should include:

- The definition of the type of monitoring required for each element
- Monitoring of pit floor movements including deformation, pore water pressures (some of which already covered under existing)
- Define required inclinometers, shape arrays, GNSS units, deformation markers
- Piezometers
- Seepage monitoring
- Schedule of Visual inspections

22.0 REHABILITATION CONSIDERATIONS AND RECOMMENDATIONS

22.1. General and Objective

The proposed rehabilitation and closure strategy for MTI and SP11A is to return the land to the pre-mining land use. The objectives of the rehabilitation and closure of the tailings impoundment are:

- Developing an acceptable post-closure land use.
- Developing acceptable post-closure surface water controls using surface drains and a spillway at the western abutment.
- Providing acceptable, stable, post-closure landforms.
- Ensuring the secure disposal of the tailings in a manner which minimises the risk of release of potential contaminants into the environment in the longer term; and
- Allow the eventual termination of all monitoring and maintenance procedures when environmental risks are assessed to be negligible.

22.2. Rehabilitation of Tailings Impoundment

The final tailings surface of MTI will be capped and vegetated. The proposed capping profile is shown in Figure A27. Surface water runoff on MTI will drain towards the spillway outlet at the western side of MTI. The spillway will be excavated down to rock with the associated channel following the natural ground slope towards Lone Pine (Figure 25).

The SP11A embankment will impound water of the IM Pit, forming a pit lake in closure. A closure outlet will be formed in rock at approximately 473 mRL as described in Section 7.

22.3. Rehabilitation of Tailings Embankment

The downstream shoulders of MTI and SP11A embankments were progressively rehabilitated as it was raised.

SP11A embankment may require additional rehabilitation and vegetation following reprofiling of the embankment in closure.

The vegetation of the embankment will proceed as follows:

- Smooth and compact surface to reduce voids and prevent the loss of rooting medium volume into the waste rock
- Establish plant growth layer
- Spread stockpiled topsoil over the surface
- Fertilise
- Seed with pasture species

22.4. Final Tailings Hydraulic Mining Sequence

An assessment of the post-closure consolidation of the tailings for MTI will be undertaken after hydraulic mining is complete. Some mechanical tailings reprofiling may be required in localised areas where it is not possible or practical for hydraulic mining to achieve the appropriate fall towards the closure spillway location.

Tailings will be fully removed from the SP11A impoundment.

22.5. Covering Strategy

Following the completion of hydraulic mining of MTI, the tailings impoundment will be covered and rehabilitated to the final planned landform. The objectives of this cover are:

- To allow for subsequent settling of the tailings.
- To provide a surface that can be revegetated for the purposes of establishing post-closure land use.

This cover will be constructed as follows:

- Disestablishment and stabilisation of the final hydraulic mining pontoon pond areas, which may consist of saturated slimes, with a veneer of waste rock as required.
- Overfilling with waste rock any areas in which significant settlement due to tailings consolidation is anticipated.
- Grading of the surface of the tailings impoundment with the waste rock to promote stormwater runoff and the construction of stormwater drainage channels and outlet structures.

- Ensuring that waste rock covers the highest levels of the tailings to a minimum depth such that tailings moisture content will not be significantly affected by evapotranspiration (i.e., the evaporative zone depth).
- Spreading a layer of topsoil, and weathered schist over the surface of the waste rock as a rooting medium.
- Proceeding with cultivation as outlined above for the downstream batter of the embankment.

22.6. Post Closure Spillway Design and Surface Drains

A post closure spillway designs for MTI and SP11A are shown in plan in Figures A18 and A27. This is a further development of the previous closure spillway design concepts for MTI and SP11A, which did not allow for the relocation of tailings.

22.7. Seepage Collected in Subsurface Drains

Seepage collected in subsurface drains will be pumped back to Innes Mills Pit Lake in closure. Refer to GHD's report (Ref. 6) for further detail of seepage water treatment in closure.

22.8. Closure Manual

The Closure Manual sets out design objectives and practical measures which will leave the MTI and SP11A in a long-term safe and stable condition that will require minimal maintenance and expenditure, that will not pose a risk to human health and safety, will not pose an unacceptable environmental risk, and is left with sustainable land use and water use that meets stakeholder and community objectives and supports a sustainable ecology.

A Closure Manual will be required for MTI and SP11A in preparation for closure.

23.0 DAM SAFETY MANAGEMENT

23.1. General

Water and tailings storage dams constitute a potential danger to people, property and environment located downstream and requires the management of dam safety to ensure dams are maintained in a safe condition to protect life, property and the environment downstream, and to avoid severe economic loss or loss of facility to the public.

The Building (Dam Safety) Regulations 2022 requires dam owners to submit a PIC assessment for all large dams to the Regional Authority (Otago Regional Council) within three months after the dam is commissioned.

A Dam Safety Assurance Programme (DSAP) is required under the Building Act 2004 and Building Regulations 2022 for Medium or High PIC dams, to be established 1 year following PIC certification. Thereafter, an annual dam compliance certificate is required. The NZDSG provides guidance for developing a Dam Safety Management System (DSMS) that meets the regulatory requirements for a DSAP.

MTI, SP11A, IMBE and TTTSF have been certified as High PIC dams in 2024. A DSAP for MTI, SP11A and TTTSF has been submitted to the Regional Authority in 2025. An update to the DSAP will be undertaken in 2026 to include the IMBE.

23.2. Operations, Maintenance and Surveillance

There are existing Operations, Maintenance and Surveillance (OMS) Manuals for the MTI, SP11A, FTSF and TTTSF. The OMS Manuals cover the operation and maintenance requirements for the dam. They also detail the requirements for monitoring and surveillance. This involves monitoring of deformations and piezometric levels at critical locations, seepage flows, and pond water levels and comparing against expectations. If thresholds are reached this triggers actions that must be undertaken to ensure dam safety is not compromised. The controls and trigger action response plans (TARPS) are included in the OMS Manual.

The most important activities of the dam surveillance program are the frequent and regular inspections for abnormalities or deterioration in conditions and the recording, collection, analysis and evaluation of monitoring data. Surveillance also includes regular dam safety reviews. The NZDSG recommend Intermediate Dam Safety Review (IDSR) at one-year intervals, special investigations after unusual events such as major earthquakes or flood events and Comprehensive Dam Safety Review (CDSR) on a 5-yearly basis, for Medium to High PIC dams. IDSRs are CDSRs are also requirements of the Building (Dam Safety) Regulations 2022.

The OMS manuals for the embankments associated with the TSFs will be reviewed and updated ahead of construction. are to be updated if there are significant changes to the operating, maintenance or surveillance requirements for the dam.

The OMS manuals will be reviewed annually as part of the compliance certification process for high PIC dams. The IMBE will be incorporated into the SP11A OMS Manual.

23.3. Emergency Preparedness and Action Plan

There is an existing Emergency Action Plan (EAP) which covers MTI, SP11A, FTSF and TTTSF. The EAP describes the procedures, responsibilities, and actions in emergency conditions. The purpose of the EAP is to provide a pre-determined plan of actions to be implemented if a safety emergency develops and guidance on preparedness for such scenarios.

All Medium and High PIC dams are to have emergency response procedures in place to manage and reduce the consequences associated with failure. The NZDSG provide guidance for preparing an EAP specific to dam safety.

The EAPs are to be reviewed and updated if there are significant changes to the dams.

The EAPs will be updated for the proposed alternations to existing TSFs once these works are implemented.

The EAP will be reviewed annually as part of the compliance certification process for High PIC dams. The IMBE will be incorporated into the site-wide TSF EAP.

24.0 BUILDING CONSENTS

Building consents are required for the construction, alteration or deconstruction of structures classified as large dams. This applies to all existing TSFs. Required Building Consents include:

- Alteration of IMBE from IM 11 and IM 12 mining
- Deconstruction of SP10, IMBE, Concentrate Dam and water storage dam embankments
- Deconstruction of MTI upstream lifts down to 515 mRL
- Partial deconstruction of Concentrate dam
- Partial deconstruction of SP11A down to 520mRL and reconfiguration as a water storage dam
- MTI Closure

Detailed design of the above activities is required to support the building consent process. A formal peer review is also required for the investigation, design and construction of High PIC dams as described under the NZDSG.

The building consent strategy should consider the operation of TSFs as they are being constructed or deconstructed and the duration till closure. Possible approaches include consenting individual stages of construction, or including all stages under a single consent and providing annual Producer Statements.

Existing TSFs are required to comply with the Building (Dam Safety) Regulations 2022 which took effect in 2024.

25.0 RESOURCE CONSENT RISKS AND MITIGATIONS

Measures for mitigating potential adverse effects of MP4 on the existing TSFs and associated dams are a combination of design, operation and surveillance and monitoring features as summarised below.

Measures for mitigating potential adverse effects of MP4 on the existing TSFs and associated dams are a combination of design, operation and surveillance and monitoring features as summarised below.

1. The existing TSFs at Macraes Operation have been designed and operated in accordance with the NZDSG (Ref. 16). They have provided safe containment of tailings for up to over 35 years.
2. Alterations to existing TSFs at Macraes Operation as a result of MP4 will comply with relevant legislation including the Building Act and the Building (Dam Safety) Regulations 2022. The alterations will require obtaining a Building Consent for relevant stages of alteration. A separate Building Consent application will be required for closure.

3. Hazards associated with earthquakes have been based on a site-specific seismic hazard study. Design has considered extreme rainfall events based on latest practice including allowance for climate change effects.
4. Potential dam safety risks associated with the remining of tailings at SP11A and MTI, and deconstruction of MTI, SP11A, SP10 and IMBE embankments will be minimised by designing, constructing, operating, and closing the facility in accordance with the NZDSG (Ref. 16).
5. The main design risks are stability of the existing TSFs during hydraulic mining, deconstruction, internal erosion from seepage or piping, and stability when subjected to design earthquake ground motions and extreme rainfall events. These risks can be mitigated through control of construction staging, monitoring and surveillance, and enacting a MP4 Innes Mills Mining, Tailings Removal and Dam Deconstruction (TRDD) Management Plan.
6. A TRDDP Management Plan will be prepared for IM 11, IM 12 and IM 13 mining and interaction with MTI and IMBE. This Management Plan will set out the staging and assessments required to safely remove tailings and upstream raises associated with MTI and SP11A, including triggers and hold points that allow mining to progress from one stage to the next.
7. The risks associated with inadequate design will be mitigated by using a dam Designer with appropriate experience. The NZDSG requires the design of High PIC dams to be subject to peer review. A peer reviewer with High PIC dam experience will be engaged to review the design for Building Consent.
8. Potential dam foundation movement instability risks have been assessed through a performance based, risk-informed decision making (RIDM) approach. This has included a review of existing geotechnical investigations, construction records, supporting stability analyses by PSM, and a Quantitative Risk Assessment.
9. An important part of the RIDM process is the implementation of controls to ensure that performance expectations are met, and actions are taken if they are not. This involves monitoring of deformations and piezometric levels at critical locations, and seepage flows and pond water levels and comparing against expectations. If thresholds are reached this triggers actions that must be undertaken to ensure dam safety is not compromised. The controls and trigger action response plans (TARPS) are incorporated into the OMS Manual and referenced in the TRDDP.
10. The existing TSF embankments are constructed from earthfill and rockfill materials which are durable and have good strength and performance when subject to earthquake ground motions. Residual (lowest shear strength after large movements) strengths have been assumed for critical basal sliding surfaces in the foundations.
11. Deformations of the TSFs are expected to occur as a result of mining associated with MP4. The expected deformations of the TSFs can be managed to ensure life safety. The results of the QRA indicate risks generally fall below the ANCOLD tolerability level for existing dams and are considered to meet ALARP criteria with appropriate controls.
12. The risks associated with poor construction will be mitigated through using experienced personnel. The mining of pits, deconstruction of MTI, SP11A, SP10

and IMBE, and recontouring and capping of tailings surface in MTI will be undertaken primarily by OGNZL personnel. OGNZL has three decades of experience in the construction of similar High PIC dams. On-site construction will be managed by competent supervisors with experience in the construction of similar High PIC dams.

13. The risks associated with poor construction will be mitigated using a Contractor with experience in the remining of TSFs and deconstruction of similar Medium or High PIC dams. On-site construction will be managed by a representative of the Contractor with experience in the construction of similar Medium or High PIC dams. The construction work will be supervised and managed by OceanaGold. They employ specialists for these roles.
14. The review and scoping of potential additional instrumentation and updates to existing monitoring and instrumentation triggers is required prior to commencement of hydraulic mining and embankment deconstruction. Trigger and alert levels will be defined and incorporated in the OMS Manual.
15. Effective existing erosion and sediment controls are already in place on-site to manage construction activities. Site specific erosion and sediment control plans will be updated to be in place prior to MP4 works.
16. Dust will be controlled on the tailings primarily through spraying dry surfaces with water.
17. Potential dam safety risks will be mitigated by adopting a dam safety management system (Section 23.0). This is to ensure the TSFs are maintained in a safe condition to protect life, property, and the environment downstream.
18. The TSF Emergency Action Plans are to be updated for MP4, setting out emergency preparedness and action procedures to manage and reduce the consequences associated with dam safety incidents including potential failure.

26.0 CONCLUSION

Potential geotechnical and dam safety risks and effects relating to proposed changes to existing TSFs have been assessed. Additional design mitigations and controls are proposed to manage residual dam safety risks.

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Tables

Table 3: Summary of Design Criteria

Design Parameter	Design Criteria
Flood Protection and Freeboard Crest Freeboard at Maximum Normal Reservoir Level (MNRL) under operating condition Crest Freeboard at Maximum Reservoir Level (MRL) with the Inflow Design Flood (IDF) Crest Freeboard at Maximum Normal Reservoir Level (MNRL) post-Safety Evaluation Earthquake event with aftershock	Wind set-up and wave run-up for the highest 10% of waves caused by a sustained wind speed, which is dependent on the fetch, with an AEP greater than 1 in 100 72-hour PMP (IDF) plus the greater of a) 1m freeboard or b) the sum of wind set-up and wave run-up for the highest 10% of waves caused by a sustained wind speed, which is dependent on the fetch, with an AEP of 1 in 10 For all sections allow for seismic settlement of embankment crest. Wind set-up and wave run-up for the highest 10% of waves caused by a sustained wind speed, which is dependent on the fetch, with an AEP greater than 1 in 10.
Earthquake OBE SEE Aftershock Stability – In Operation <i>Static and Seismic</i>	1 in 150 AEP 1 in 10,000 AEP for High PIC dam Earthquake of one magnitude less than the SEE within one day of the SEE Performance based criteria informed by results of scenario specific risk assessment
Stability – In Closure <i>Static</i> Peak Drained (Long Term) Peak Undrained (Short Term) Residual Undrained (Short Term, e.g., post-earthquake, static liquefaction) <i>Seismic</i> OBE SEE and Aftershock following SEE	Limit Equilibrium FoS ≥ 1.5 Limit Equilibrium FoS ≥ 1.5 Limit Equilibrium FoS ≥ 1.2 Minor deformations are acceptable provided the dam remains functional and the resulting damage is easily repairable Some deformation and damage to the embankment is permitted but the contents retained by the embankment should not be released.

Table 4: ASSESSMENT OF POTENTIAL FAILURES MODES: HYDRAULIC MINING OF SP11A

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
HMSP11-PFM1	Hydraulic mining	Upstream Embankment failure due to hydraulic remining causing re-saturation of the upstream raises, leading to static liquefaction and flow failure and release of tailings to the north into the Process Plant and/or Golden Point underground.	Maintain setback distance between embankment and sumps/pontoons used for hydraulic mining. Hydraulic mining launders are to drain away from the upstream embankments.	Visual inspections and monitoring of piezometric levels in the embankment, foundation and embankment. Monitoring of seepage collection for early detection of any increases in seepage flow. Implement TRDD Management Plan
HMSP11-PFM2	IM Pit mining	IMBE failure due to IM Pit mining causing geotechnical instability of the IM North-wall and/or West-wall and IMBE resulting in release of tailings into IM Pit (Stages IM11 and IM12).	Undertake assessment of stability of IMBE due to IM Pit mining using calibrated parameters shows no large-scale or rapid movement is expected. Separate FMEA undertaken for IMBE in March 2026. Undertake monitoring including groundwater seepage, InSAR, ground radar survey. Implement TARP and determine start-stop mining criteria.	Undertake radar pit wall monitoring and implement TARP for monitoring movement rates. Implement TRDD Management Plan
HMSP11-PFM3	Hydraulic mining of tailings upstream of SP10 Embankment	SP10 Embankment failure due to removal of tailings upstream (South) of SP10 causing geotechnical instability of the SP10 embankment and tailings	Hydraulically mine tailings upstream and downstream of SP10 concurrently, ensuring that SP10 remains continuously buttressed by tailings during the works.	Visual inspections and monitoring of SP10 embankment deformation.

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
		breaching southward into Southern Pit (IM13 – South)		Implement TRDD Management Plan
HMSP11-PFM4	Heavy Rainfall	SP11A Embankment failure due to extreme rainfall during remining causing flood to overtop the embankment leading to erosion of the embankment and release of tailings.	Maintain freeboard during hydraulic mining. The assessment of freeboard takes into account the staging of tailings mining, normal operating decant pond and sump volumes, and runoff and direct rainfall from the design PMP rainfall event. The design crest level of the embankment must include 1 m freeboard above the level of water in the decant pond following a PMP rainfall event.	Visual inspections and monitoring of embankment deformation, monitoring of the decant pond volume and level relative to embankment crest level.
HMSP11-PFM5	Seismic	SP11A Upstream Embankment failure due to earthquake induced liquefaction causing geotechnical instability, leading to release of tailings to the north into Process Plant and/or Golden Point Underground.	The embankment is designed assuming liquefied strengths and reduced stiffness of the tailings. The deformations and FoS must meet acceptable performance requirements. Existing analysis confirms that the embankment core will maintain its integrity and will not lead to release of impoundment.	Visual inspections and monitoring of embankment deformation.
HMSP11-PFM6	Water management	Piping through SP10 embankment due to pond water against the embankment leading to release of tailings into IM13 North Pit.	Remine tailings upstream and downstream of SP10 concurrently, ensuring that SP10 remains continuously buttressed by tailings during the works.	Visual inspections and monitoring of the decant pond volume and level relative to embankment crest level.

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
			Maintain setback distance between pontoon and SP10 embankment.	Implement TRDD Management Plan
HMSP11-PFM7	Landslide	Embankment failure due to pit wall collapse/landslide into the embankment during remining causing overtopping of embankment, leading to release to tailings into pit.	Pit walls will be assessed for stability. The deformations and FoS must meet acceptable performance requirements. Where possible, pit wall will be buttressed with waste rock following hydraulic mining.	Visual inspections and monitoring of embankment and pit wall deformation.
HMSP11-PFM8	Landslide	Embankment failure due to pit wall collapse/landslide into the embankment during remining causing geotechnical instability of embankment, leading to release to tailings into pit.	Pit walls will be assessed for stability. The deformations and FoS must meet acceptable performance requirements.	Visual inspections and monitoring of embankment and pit wall deformation.
HMSP11-PFM9	Underground mining	Embankment failure due to underground mining causing block caving and settlement of the embankment crest resulting in overtopping of embankment and release of tailings either into IM13 South or to the north into Process Plant and/or Golden Point Underground.	Assess effects of settlement due to underground mining and limit mining extents if necessary. Stage GPUG mining such that it does not proceed underneath SP11A embankment until after upstream embankments have been deconstructed.	Implement TRDD Management Plan Visual inspections and monitoring of embankments.

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
HMSP11-PFM10	Underground mining	Upstream embankment failure due to underground mining causing block caving and settlement leading to static liquefaction, flow failure and release to tailings to the north into the Process Plant and/or Golden Point underground.	Confirm removal of upstream embankments before GPUG expansion.	Implement TRDD Management Plan Visual inspections and monitoring of embankments.
HMSP11-PFM11	Hydraulic mining	Upstream embankment failure by slumping into the impoundment due to hydraulic mining resulting in loss of freeboard and overtopping in subsequent storm event.	Assess stability of batters created by hydraulic mining and put in place controls for appropriate slope angles and set-backs.	Implement TRDD Management Plan Visual inspections and monitoring of embankments.

TABLE 5: ASSESSMENT OF POTENTIAL FAILURES MODES: HYDRAULIC MINING OF MTI

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
HMMTI-PFM1	Hydraulic remining	Upstream Embankment failure due to hydraulic remining causing re-saturation of the upstream raises, leading to static liquefaction and flow failure and release to tailings to the north into the Process Plant.	Maintain setback distance between embankment and sumps/pontoons used for hydraulic mining. Hydraulic mining launders are to drain away from upstream embankments.	Visual inspections and monitoring of piezometric levels in the embankment, foundation and embankment. Monitoring of seepage collection for early detection of any increases in seepage flow.

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
HMMTI-PFM2	Heavy Rainfall	Embankment failure due to extreme rainfall during remining causing flood to overtop the embankment leading to erosion of the embankment and release of tailings.	Maintain freeboard during remining. The assessment of freeboard takes into account the staging of tailings remining, normal operating decant pond volumes, and runoff and direct rainfall from the design PMP rainfall event.	Visual inspections and monitoring of embankment deformation, monitoring of the decant pond volume and level relative to embankment crest level.
HMMTI-PFM3	Seismic	Upstream Embankment failure due to earthquake induced liquefaction causing geotechnical instability, leading to release of tailings to the north into Process Plant and Golden Point Underground	The embankment is designed assuming liquefied strengths and reduced stiffness of the tailings. The deformations must meet acceptable performance requirements. The dynamic analysis confirms that the embankment core will maintain its integrity and will not lead to release of impoundment.	Visual inspections and monitoring of embankment deformation.

TABLE 6: ASSESSMENT OF POTENTIAL FAILURES MODES: MINING DOWNDIP FF, MTI

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
MMTI-PFM1	IM Pit mining	Embankment failure due to IM Pit mining causing geotechnical instability of the IM Northwall and/or Westwall while MTI upstream raises are still in place. Resulting in release of tailings into IM Pit.	Undertake 3D stability analyses of pit mining and response from MTI. Stage IM mining such that it does not encroach beneath MTI until upstream raises are removed. Extents of mining offset from MTI to be informed by RIDM process which takes into account stability analyses, past performance and up-to-date monitoring data.	Visual inspections and monitoring of embankment deformation. Implement TRDD Management Plan

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
MMTI-PFM2	IM Pit mining	Embankment failure due to IM Pit mining causing geotechnical instability of the IM Northwall and/or Westwall while MTI upstream raises are still in place. Resulting in release of tailings into Process Plant, Golden Point Underground and Deepdell Creek.	Undertake 3D stability analyses of pit mining and response from MTI. Stage IM mining such that it does not encroach beneath MTI until upstream raises are removed. Extents of mining offset from MTI to be informed by RIDM process which takes into account stability analyses, past performance and up-to-date monitoring data.	Visual inspections and monitoring of embankment deformation. Implement TRDD Management Plan
MMTI-PFM3	IM Pit mining	Failure of upstream embankment on north eastern end of MTI due to mining of IM Pit causing cracking of embankment leading to piping through the embankment and release of tailings.	Undertake 3D stability analyses of pit mining and response from MTI. Stage IM mining such that it does not encroach beneath MTI until upstream raises are removed. Extents of mining offset from MTI to be informed by RIDM process which takes into account stability analyses, past performance and up-to-date monitoring data. Stage hydraulic mining such that surface water does not pond against upstream raises. Locate decant pond away from upstream raises.	Visual inspections and monitoring of embankment deformation. Implement TRDD Management Plan

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
MMTI-PFM4	IM Closure pit lake levels	Embankment failure due to rising IM Pit Lake levels causing geotechnical instability of the IM Westwall, leading to geotechnical instability of MTI eastern embankment and release of tailings into IM Pit.	Undertake 3D stability analyses of pit stability and shared MTI, SP11A abutment in closure once saturated by closure lake. Limit closure lake level by cutting closure spillway outlet for SP11A.	Visual inspections and monitoring of embankment deformation. Implement Closure Manual.
MMTI-PFM5	IM Closure pit lake levels	Embankment failure due to rising IM Pit Lake levels causing geotechnical instability of the IM Westwall, leading to geotechnical instability of MTI eastern embankment and release of tailings into environment.	Undertake 3D stability analyses of pit stability and shared MTI, SP11A abutment in closure once saturated by closure lake. Limit closure lake level by cutting closure spillway outlet for SP11A.	Visual inspections and monitoring of embankment deformation. Implement Closure Manual.

TABLE 7: ASSESSMENT OF POTENTIAL FAILURES MODES: SP11A EMBANKMENT DAM CLOSURE

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
SP11AC-PFM1	Water management	Embankment failure due to incorrect assumptions used in water balance model leading to closure pit lake levels being higher than designed and overtopping of embankment and erosion causing release of water into environment.	Limit closure lake level by cutting closure spillway outlet for SP11A.	Visual inspections and monitoring of embankment deformation. Implement Closure Manual.

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
SP11AC-PFM2	Water management	Piping through embankment due to water impounded against the embankment leading to release of water into environment.	Assess piping risk and consider buttress or additional lining if required. Retain chimney drain in SP11A closure embankment. Limit closure lake level by cutting closure spillway outlet for SP11A.	Visual inspections and monitoring of embankment deformation and seepage. Implement Closure Manual.
SP11AC-PFM3	Landslide	Embankment failure due to pit wall collapse/landslide into the embankment caused by rise in pit lake levels leading to overtopping of embankment and release of water into the environment.	Undertake 3D stability analyses of pit stability in closure once saturated by closure lake. Limit closure lake level by cutting closure spillway outlet for SP11A.	Visual inspections and monitoring of embankment deformation. Implement Closure Manual.
SP11AC-PFM4	Seismic	Embankment failure due to earthquake induced geotechnical instability, leading to release of water into environment.	Assess stability risk under earthquake conditions and consider buttress if required. Limit closure lake level by cutting closure spillway outlet for SP11A.	Visual inspections and monitoring of embankment deformation. Implement Closure Manual.
SP11AC-PFM5	Seismic	Embankment failure due to earthquake induced piping through embankment, leading to release of water into environment.	Assess piping risk and consider buttress or additional lining if required. Retain chimney drain in SP11A closure embankment. Limit closure lake level by cutting closure spillway outlet for SP11A.	Visual inspections and monitoring of embankment deformation and seepage. Implement Closure Manual.

Failure Mode	Initiating Hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
SP11AC-PFM6	Inadequate strength in Design or poor Construction	Embankment failure, due to unknown weakness in foundation, or settlement due to GPUG or poor construction QA/QC, causing geotechnical instability, leading to release of water into environment.	Assess stability risk due to sudden settlement of the embankment and consider buttress if required. Limit closure lake level by cutting closure spillway outlet for SP11A.	Visual inspections and monitoring of embankment deformation and settlement. Implement Closure Manual.
SP11AC-PFM7	Long term settlement	Embankment failure due to cracks induced by long term settlement causing piping through embankment, leading to release of water into environment.	Assess piping risk assuming formation of cracks is possible and consider buttress or additional lining if required. Retain chimney drain in SP11A closure embankment.	Visual inspections and monitoring of embankment deformation and seepage. Implement Closure Manual.
SP11AC-PFM8	Water management and normal operation	Internal erosion along underdrain outlets leading to piping failure and breach of embankment and release of water into environment.	Design outlet sealing procedure to reduce risk of internal erosion at outlets.	Visual inspections and monitoring of embankment deformation and seepage. Implement Closure Manual.

Table 8: High Intensity Rainfall Database (HIRDS V4) Historical and 2031 to 2050

Sitename: GLENDALE STATION

Site ID: I50341

Coordinate system: ZGD1949; Longitude: 170.475; Latitude: -45.364

Rainfall depths (mm): Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	3.57	5.24	6.57	9.65	14	24.1	32.4	41.6	50.4	54.7	57.2	58.6
2	0.5	4.07	5.96	7.46	10.9	15.8	27.1	36.4	46.6	56.4	61.2	63.9	65.5
5	0.2	5.94	8.65	10.8	15.7	22.6	38.3	51.1	65	78.1	84.4	87.9	89.9
10	0.1	7.49	10.9	13.5	19.6	28.1	47.3	62.7	79.5	95.1	103	107	109
20	0.05	9.23	13.3	16.5	23.9	34.1	57	75.3	95	113	122	126	129
30	0.033	10.3	14.9	18.4	26.6	37.8	63	83.1	105	124	134	138	141
40	0.025	11.2	16	19.9	28.6	40.6	67.5	88.9	112	133	142	147	150
50	0.02	11.8	17	21	30.2	42.8	71.1	93.4	117	139	149	154	157
60	0.017	12.4	17.8	22	31.5	44.7	74	97.2	122	144	155	160	163
80	0.013	13.3	19.1	23.5	33.7	47.7	78.8	103	129	153	164	169	172
100	0.01	14	20.1	24.8	35.5	50.1	82.6	108	135	160	171	176	179
250	0.004	17.3	24.5	30.2	43	60.4	98.7	129	160	188	200	206	209

Rainfall depths (mm): Climate Change Scenario Model RCP8.5 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	3.93	5.77	7.24	10.6	15.3	26	34.6	44	52.9	57.1	59.5	60.9
2	0.5	4.49	6.58	8.24	12.1	17.4	29.4	39	49.5	59.4	64.1	66.7	68.2
5	0.2	6.59	9.59	12	17.4	25	41.7	55.1	69.3	82.6	88.9	92.2	94
10	0.1	8.33	12.1	15	21.8	31.1	51.6	67.8	84.9	101	108	112	114
20	0.05	10.3	14.8	18.4	26.6	37.8	62.3	81.5	102	120	129	133	135
30	0.033	11.5	16.6	20.6	29.6	42	69	90	112	132	141	146	148
40	0.025	12.4	17.9	22.1	31.8	45.1	74	96.3	120	141	150	155	158
50	0.02	13.2	18.9	23.4	33.7	47.6	77.9	101	126	148	158	163	165
60	0.017	13.8	19.8	24.5	35.2	49.6	81.2	106	131	153	164	169	171
80	0.013	14.9	21.3	26.3	37.6	53	86.5	112	139	163	173	178	181
100	0.01	15.7	22.4	27.7	39.6	55.7	90.7	117	145	170	181	186	189
250	0.004	19.3	27.4	33.7	47.9	67.1	108	140	172	200	212	218	220

Ref. <https://hirds.niwa.co.nz/>

Table 9: High Intensity Rainfall Database (HIRDS V4) 2081 to 2100

Sitenname: GLENDALE STATION

Site ID: I50341

Coordinate system: NZGD1949; Longitude: 170.475; Latitude: -45.364

Rainfall depths (mm) :: RCP8.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	4.67	6.85	8.59	12.6	18.1	29.9	39.1	49.1	57.9	61.9	64.1	65.4
2	0.5	5.35	7.83	9.81	14.4	20.6	34	44.4	55.3	65.3	69.9	72.3	73.6
5	0.2	7.9	11.5	14.4	20.9	29.8	48.7	63.2	78.1	91.6	97.9	101	102
10	0.1	10	14.5	18.1	26.2	37.2	60.4	78.1	96.1	112	120	123	125
20	0.05	12.4	17.9	22.2	32.1	45.3	73.3	94.1	115	134	142	147	148
30	0.033	13.9	20	24.8	35.8	50.4	81.2	104	127	148	157	161	163
40	0.025	15	21.6	26.8	38.5	54.1	87.2	112	136	157	167	171	173
50	0.02	16	22.9	28.3	40.7	57.2	91.8	117	143	166	175	180	181
60	0.017	16.7	24	29.6	42.5	59.7	95.8	122	149	172	182	186	188
80	0.013	18	25.7	31.8	45.6	63.9	102	130	158	182	193	197	199
100	0.01	19	27.1	33.5	47.9	67.1	107	136	165	191	201	206	208
250	0.004	23.3	33.1	40.8	58	80.8	128	162	195	224	236	241	242

Table 10: Probable Maximum Precipitation Estimation

PMP estimation based on Thompson and Tomlinson (1995)			
72-hour PMP	761	mm	PMP Rainfall depth Unadjusted for Climate Change
Adopted PMP for Operational Phase: 72-hour PMP projected for RCP8.5 (2031-2050)	806	mm	Percentage of increase based on 1/250 AEP RCP8.5 for the period 2031-2050.
Adopted PMP for Operational Phase: 72-hour PMP projected for RCP8.5 (2081-2100)	898	mm	Percentage of increase based on 1/250 AEP RCP8.5 for the period 2081-2100.

TABLE 11 Summary of Embankment Freeboard - MTI

Parameter	Normal Conditions	IDF	Post-Earthquake
Existing Condition – No Waste Rock Stack ⁵			
Embankment as-built crest level (RL)	548	548	548
Flood Rise (m)	Nil	1.67 ⁽¹⁾	Nil
Required Freeboard	Wind set up and wave run up for the highest 10% of waves under 1 in 100 AEP	a) 1.0m or b) wind set up and wave run up for the highest 10% of waves under 1 in 10 AEP	Wind set up and wave run up for the highest 10% of waves under 1 in 100 AEP
	0.42	1.00	0.42
SEE Seismically Induced Earthquake Settlement (m)	-	-	0.23 to 0.47
Required Freeboard (m)		2.67 (including operating pond)	
Available Freeboard (m) ⁽²⁾	2.88		
At completion of hydraulic mining			
Embankment as-built crest level (RL)	515	515	515
Flood Rise (m)	Nil	4.33 ⁽³⁾	Nil
Required Freeboard	Wind set up and wave run up for the highest 10% of waves under 1 in 100 AEP	a) 1.0m or b) wind set up and wave run up for the highest 10% of waves under 1 in 10 AEP	Wind set up and wave run up for the highest 10% of waves under 1 in 100 AEP
	No operating pond	1.00	No operating pond
SEE Seismically Induced Earthquake Settlement (m)	-	-	~0.23 to 0.47
Required Freeboard (m)		5.33 (critical)	
Available Freeboard (m) ⁽⁴⁾		6.20	

Notes:

1. IDF is 72-hour PMP in for existing conditions (761 mm). The catchment is 91.5 ha. Total runoff is 609,288 m³, maximum operating pond volume 40,000 m³.

2. Assessment of freeboard at all times during operation should be based on actual tailings surface and measured decant pond water level.
3. IDF is 72-hour PMP in operation, with allowance for climate change (806 mm). The catchment is 133 ha. Total runoff is 981,523 m³. Flood rise is taken from the lowest tailings level, approximately 508.8 mRL.
4. The available freeboard is based on the closure tailings surface profile with a 1V in 170H slope, lowest tailings level 508.8 mRL in the west, rising to 514.5 mRL at the eastern embankment.
5. Existing freeboard is assessed based on the removal of waste rock from top of MTI, due to take place in 2026.

TABLE 12 Summary of Embankment Freeboard – SP11A and IMBE

Parameter	Normal Conditions	IDF	Post-Earthquake
Existing Condition			
Embankment as-built crest level (RL)	544	544	544
Flood Rise (m)	Nil	1.38 ⁽¹⁾	Nil
Required Freeboard	Wind set up and wave run up for the highest 10% of waves under 1 in 100 AEP	a) 1.0m or b) wind set up and wave run up for the highest 10% of waves under 1 in 10 AEP	Wind set up and wave run up for the highest 10% of waves under 1 in 100 AEP
	0.46	1.00	~0.46 (TBC)
SEE Seismically Induced Earthquake Settlement (m)	-	-	0.19
Required Freeboard (m)		2.38 (including operating pond)	0.65
Available Freeboard (m) ⁽²⁾	4.47		
Interim stage of hydraulic mining – removal of SP11A upstream embankments completed			
Embankment as-built crest level (RL)	530	530	530
Flood Rise (m)	Nil	1.24 ⁽³⁾	Nil
Required Freeboard	Wind set up and wave run up for the highest 10% of waves under 1 in 100 AEP	a) 1.0m or b) wind set up and wave run up for the highest 10% of waves under 1 in 10 AEP	Wind set up and wave run up for the highest 10% of waves under 1 in 100 AEP
	No operating pond	1.00	No operating pond

SEE Seismically Induced Earthquake Settlement (m)	-	-	0.19
Required Freeboard (m)		2.24 (Critical)	
Available Freeboard (m) ⁽⁴⁾	To be managed during hydraulic mining to achieve at minimum required freeboard		
Interim stage of hydraulic mining – IMBE fully deconstructed			
Embankment as-built crest level (RL)	495	495	495
Flood Rise (m)	Nil	3.18 ⁽³⁾	Nil
Required Freeboard	Wind set up and wave run up for the highest 10% of waves under 1 in 100 AEP	a) 1.0m or b) wind set up and wave run up for the highest 10% of waves under 1 in 10 AEP	Wind set up and wave run up for the highest 10% of waves under 1 in 100 AEP
	No operating pond	1.00	No operating pond
SEE Seismically Induced Earthquake Settlement (m)	-	-	0.19
Required Freeboard (m)		4.18 (critical)	
Available Freeboard (m) ⁽⁴⁾	To be managed during hydraulic mining to achieve at minimum required freeboard		

Notes:

1. IDF is 72-hour PMP in for existing conditions (761 mm). The catchment is 64.6 ha. Total runoff is 446,000 m³, Maximum operating pond volume 130,000 m³.
2. Assessment of freeboard at all times during operation should be based on actual tailings surface and measured decant pond water level.
3. IDF is 72-hour PMP in operation, with allowance for climate change (806 mm). The catchment is 71.9 ha. Total runoff is 530,000 m³.
4. The available freeboard is based on an assumed level tailings surface profile with no slope. This is to be confirmed following detailed design of hydraulic mining.
5. SEE Seismically Induced Earthquake Settlement was assessed in the Design raise to RL544. *Southern Pit Option 11a Raise Embankment to RL544 – Design Report*. Total vertical shear displacement during SEE is estimated to be approximately 0.2m

APPENDIX A

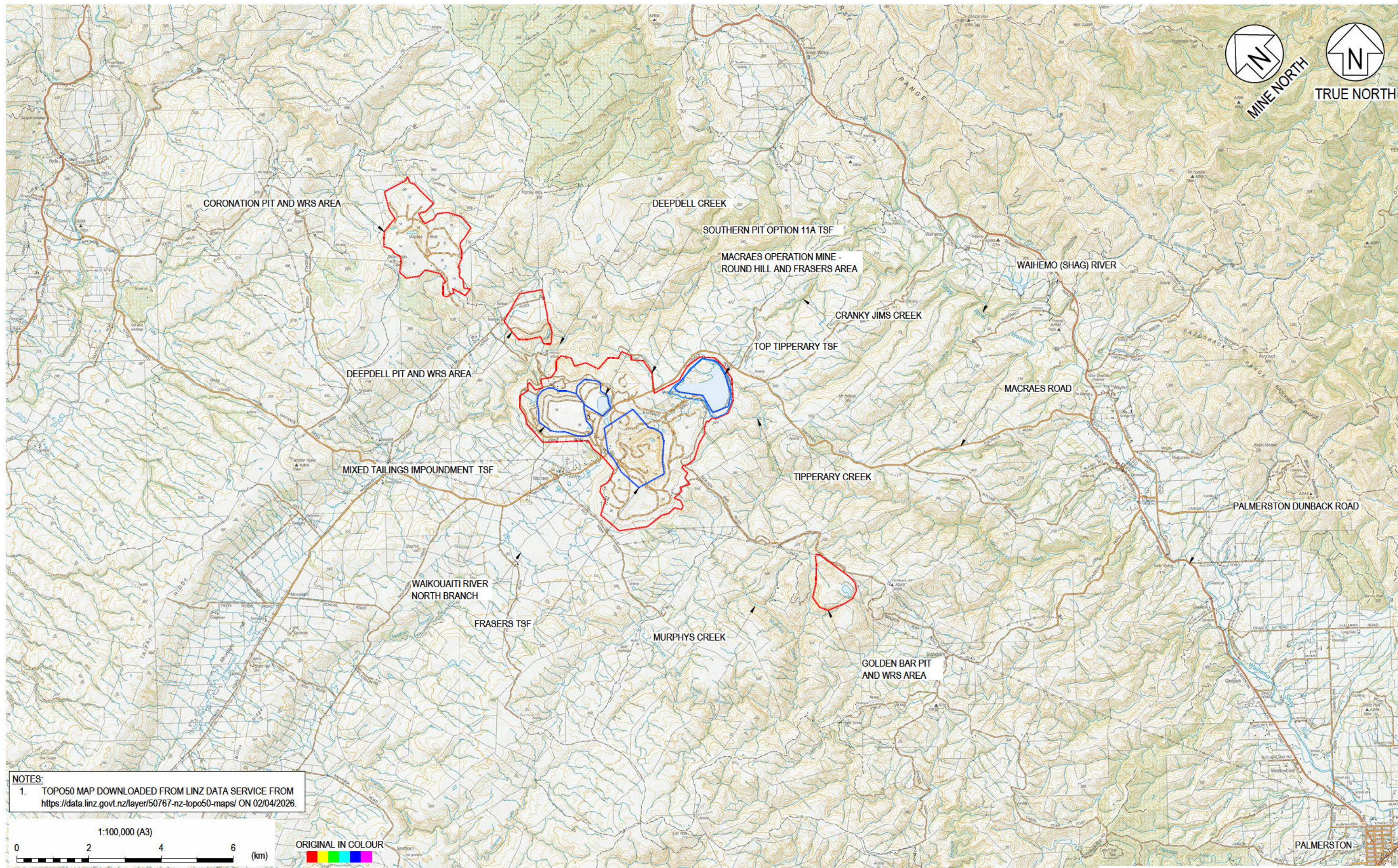


FIGURE 1

MACRAES PHASE 4 FAST TRACK APPROVALS ACT
TAILINGS STORAGE FACILITY
STAGE 3
LOCALITY PLAN

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CHECKED	E.T.	04/21/2026	10092	1:100,000	A

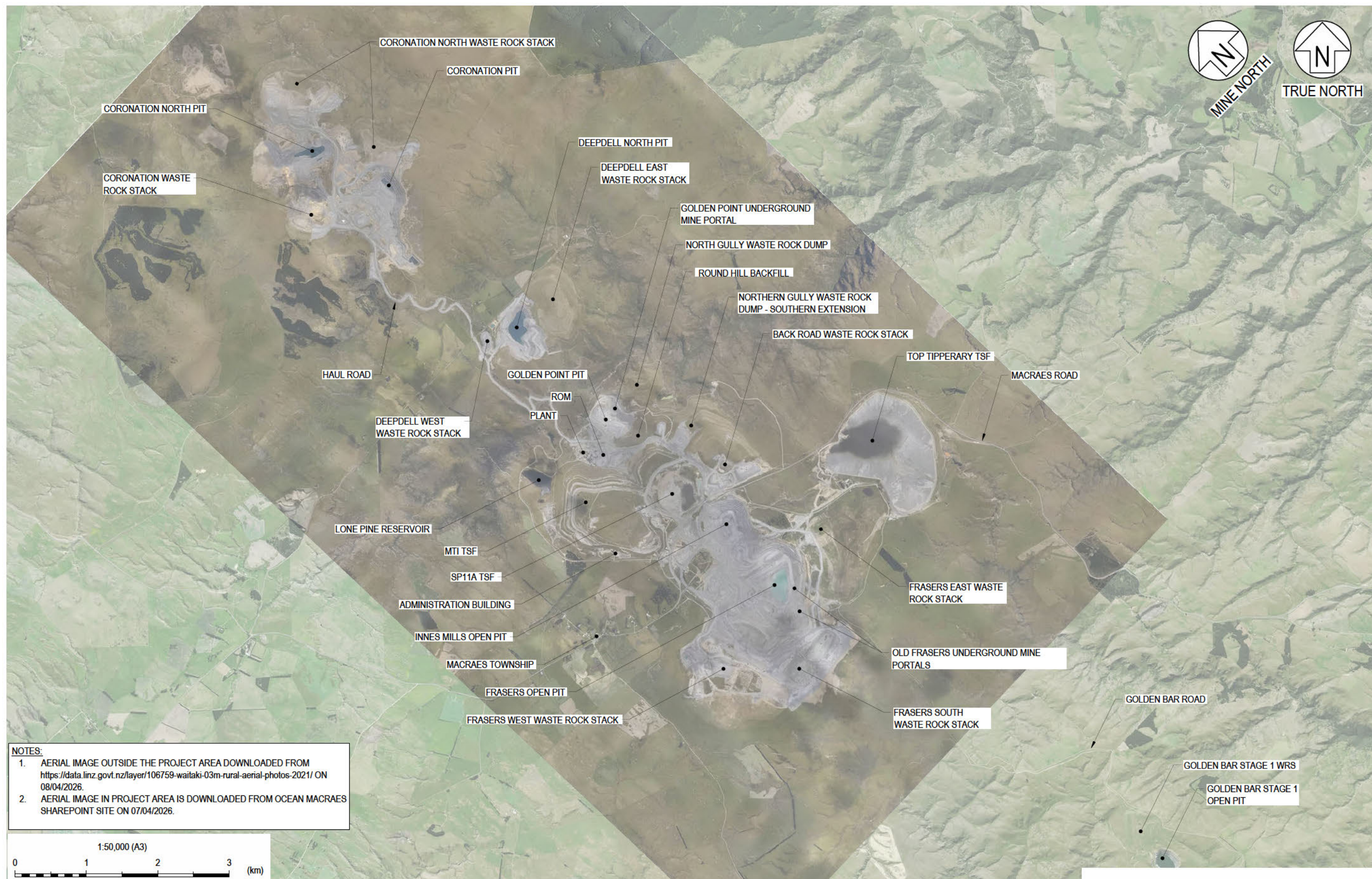


FIGURE 02

MACRAES PHASE 4 FAST TRACK APPROVALS ACT
FRASERS TAILINGS STORAGE FACILITY
STAGE 3
EXISTING SITE LAYOUT PLAN

DRAWN	R.M.	DATE	JOB No	SCALE (A3)	REV.
CHECKED	E.T.	08/04/2026	10092	1:50,000	B

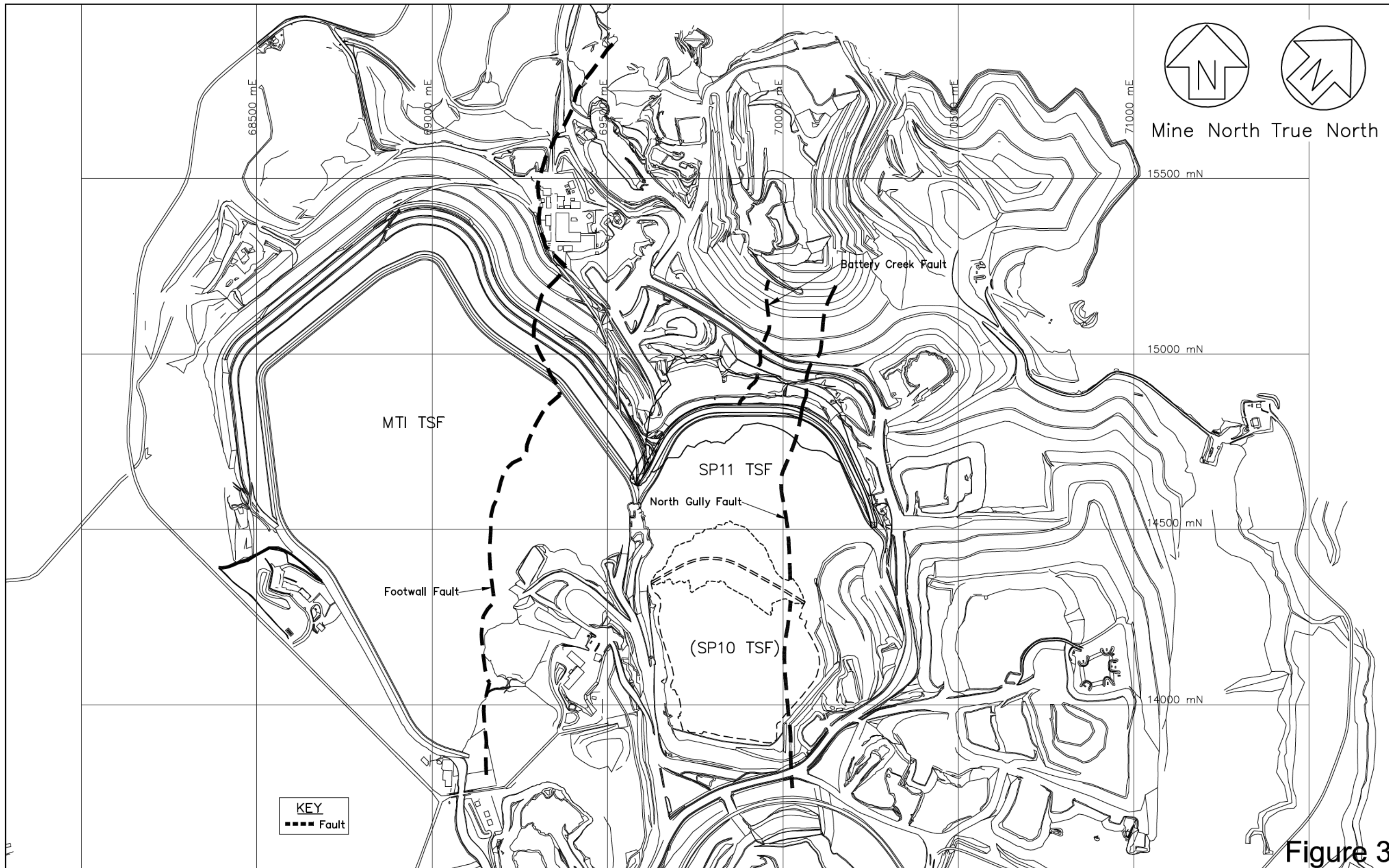
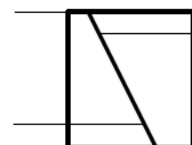


Figure 3



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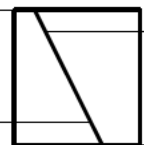
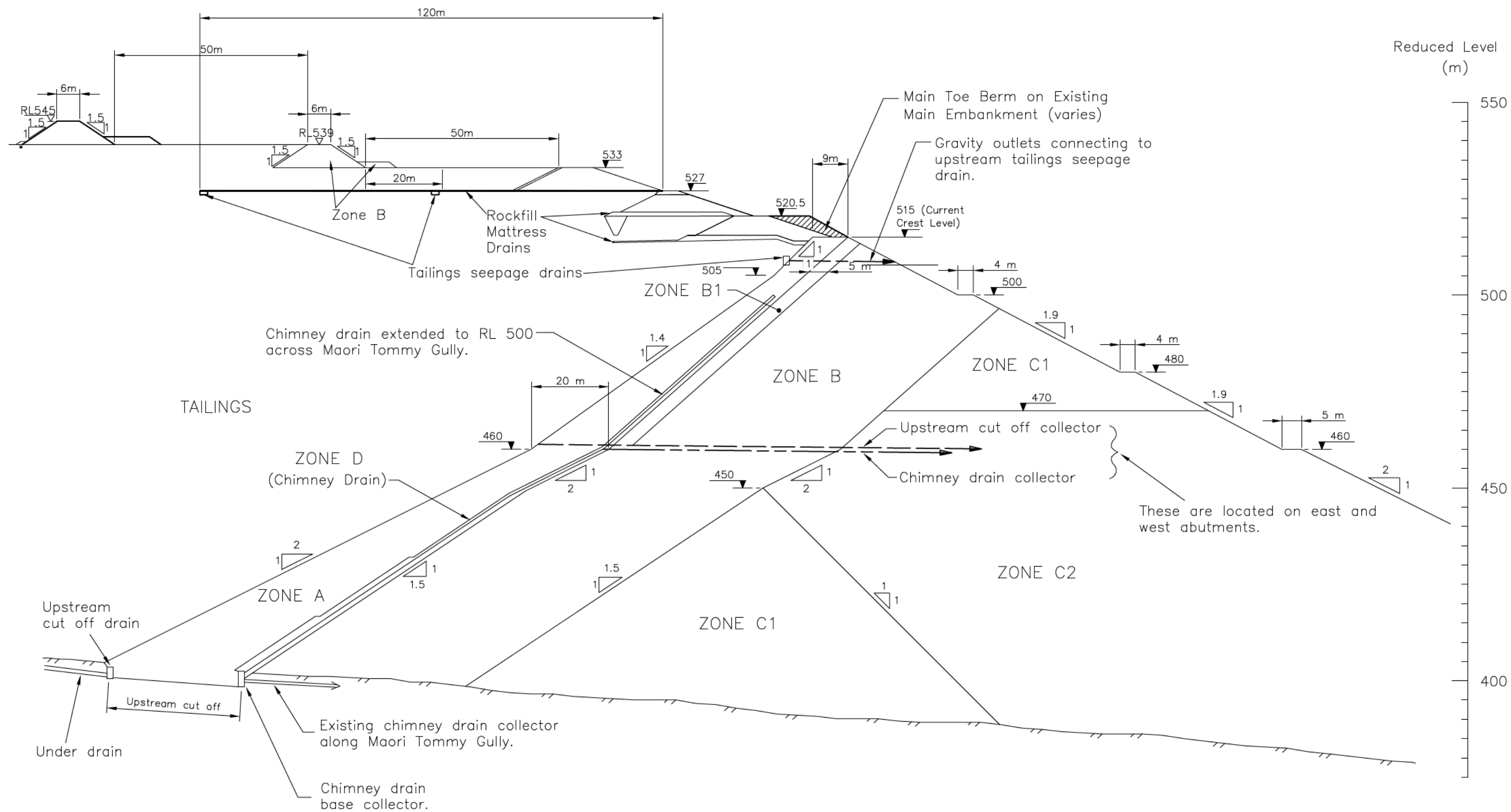
Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany
Ph (09)486-2546, Fax (09)486-2556

OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Round Hill - Southern Pit
Fault Locality Plan

Drawing No. 6786-Figure 3
Date: 8 Mar 2011
Drawn: DM/BL
Scale: 1:10000 (@A3)
Filename: 6786-Figure 3.dwg



Figure A4

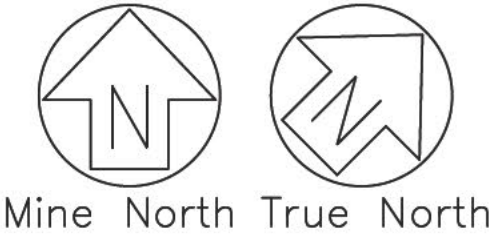
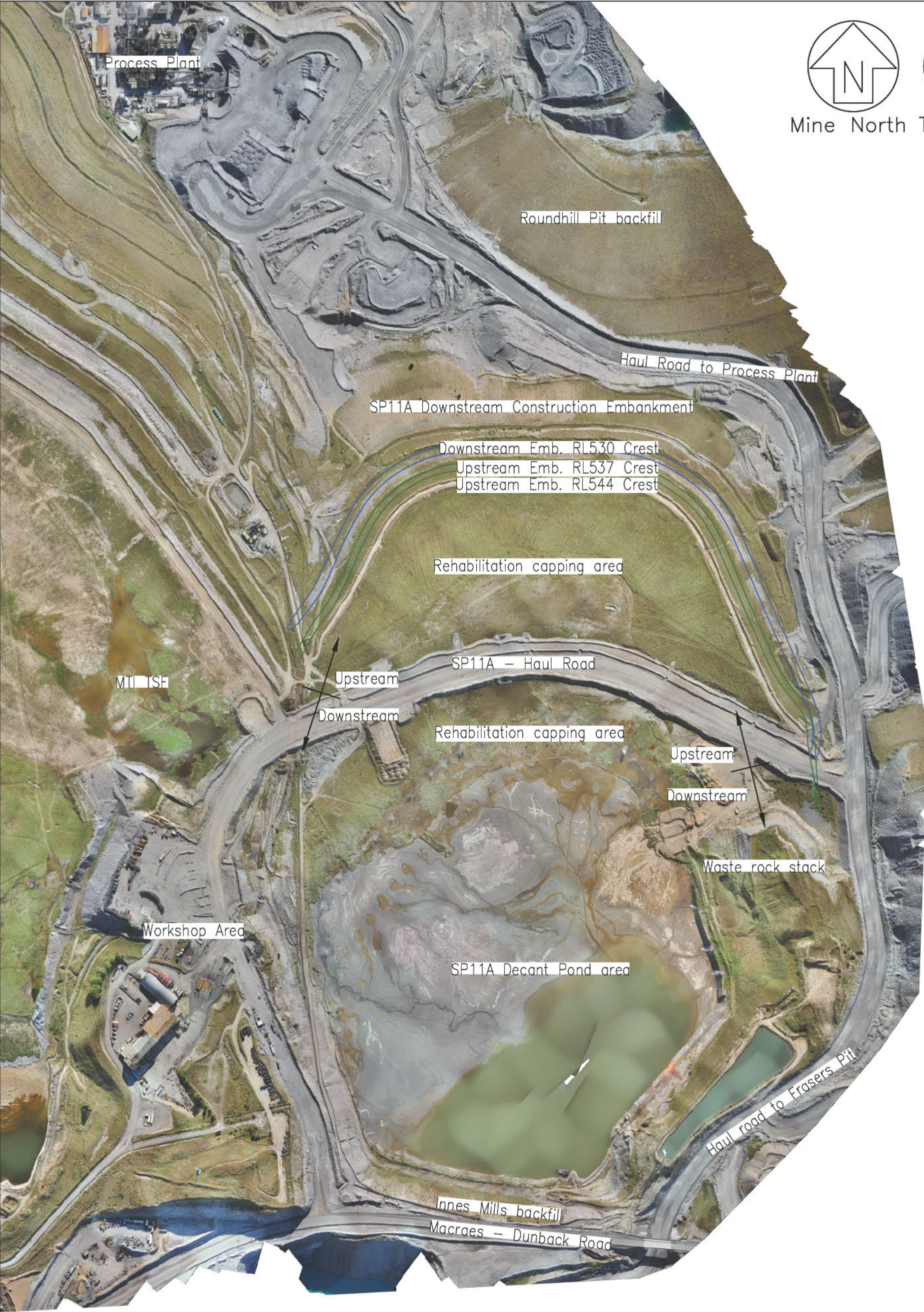


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OCEANA GOLD LIMITED
Macraes Gold Operation
Mixed Tailings Embankment RL545
Typical Cross Section through Embankment

Drawing No. 6961-A
Date: 29 April 2013
Drawn: BL
Scale: 1:1000 (@A3)
Filename: 6961-A.dwg



Note : Aerial OGNZL-15/06/2022

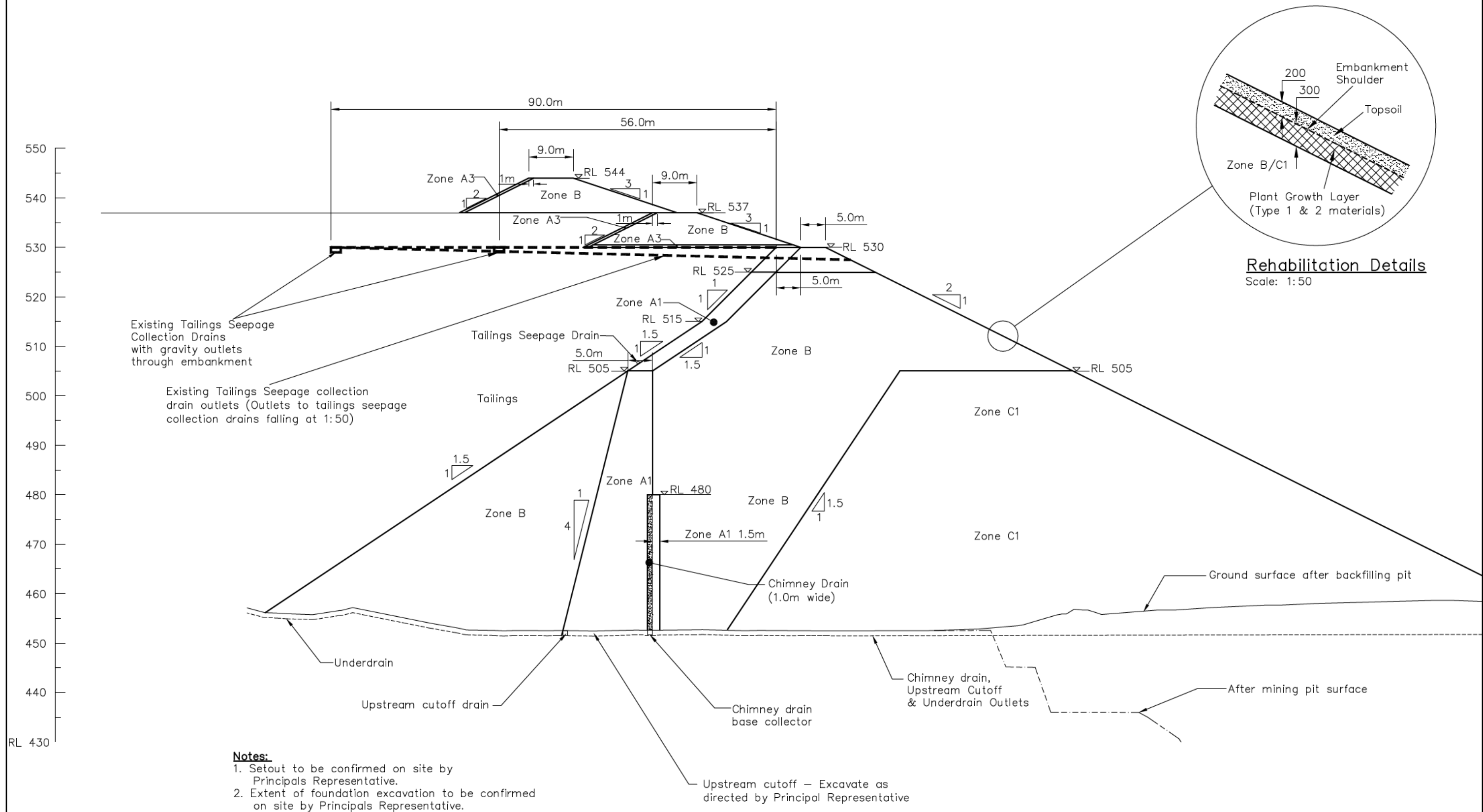
Figure 4



Engineering Geology Ltd
+64 9 486 2546
info@egl.co.nz
Unit 7C, 331 Rosedale Road, Albany, Auckland
PO Box 301054, Albany, Auckland 0752
www.egl.co.nz

OCEANA GOLD (NEW ZEALAND) LIMITED
MACRAES OPERATION
SOUTHERN PIT OPTION 11A TSF
SITE LAYOUT PLAN

Drawing No. Fig4
Date: Oct 2022
Drawn: E.T.
Scale: 1:5,000(@A3)
Filename: SP11A_Plan.dwg



Southern Pit Option 11A Typical Section 1
02
Scale 1:750

Figure 4

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ENGINEERING GEOLOGY LTD
Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany, NZ
Ph +64-9-4862546, Fax +64-9-4862556

Preliminary Issue

Signed:

Date:

Tender Issue

Signed:

Date:

Construction Issue

Signed:

Date:

No.

BY

DATE

REVISION

CHECKED

APPROV.

DRAWN

PROJECT APPR.

BY

DATE

DESIGN APPR.

DESIGNED

CHECKED

DRAWN

PROJECT: MACRAES GOLD PROJECT

AREA: Southern Pit (Option 11A)

CONSULTANT DRAWING No.

JOB NUMBER:

6793

ORIGINAL SCALE:

As shown

SIZE:

A3

TITLE

Southern Pit – Option 11A
Tailings Embankment
Typical Section

DRAWING No.

6793–Figure 4

REV.

No.

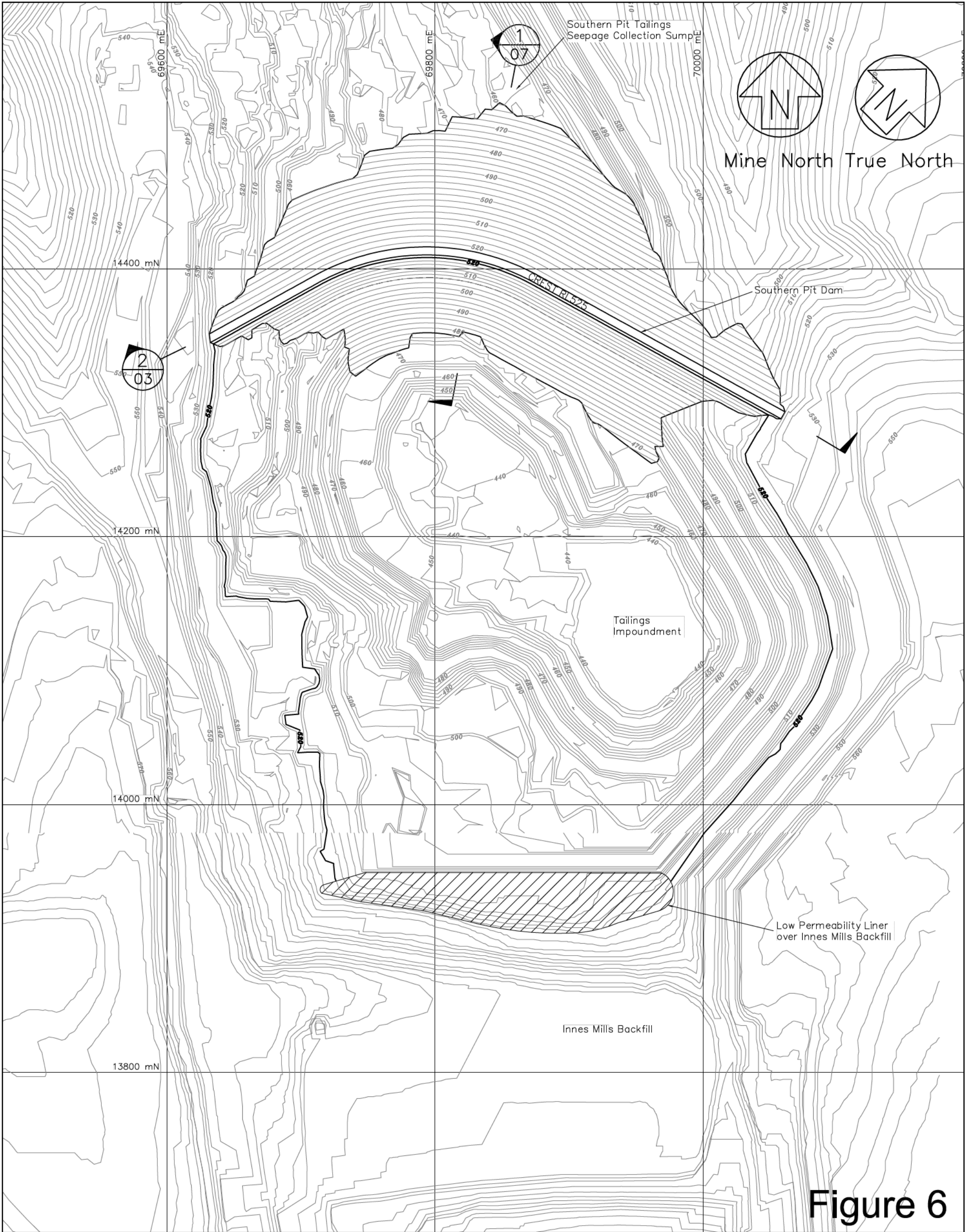


Figure 6

GRDMacraes macraes GOLD PROJECT	PREPARED BY: ENGINEERING GEOLOGY LTD Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany, NZ Ph +64-9-4862546, Fax +64-9-4862556										Preliminary Issue		Signed:	Date:	
											Tender Issue		Signed:	Date:	
											Construction Issue		Signed:	Date:	
COPYRIGHT © This drawing remains the property of GRD MACRAES LIMITED and may not be copied in any way without prior written approval from GRD MACRAES LIMITED							PROJECT APPR.	BY	DATE	PROJECT: MACRAES GOLD PROJECT			TITLE		
							DESIGN APPR.	TM	25-05-01	AREA: Southern Pit (Option 10)			Southern Pit Tailings Storage, Final Embankment Crest RL522 Layout Plan		
							DESIGNED	TM	25-05-01	CONSULTANT DRAWING No.4089-10D-01a.dwg					
	A	ES	25-06-01	Preliminary			TM	TM	CHECKED	TM	25-05-01	JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.
	No.	BY	DATE	REVISION			CHECKED	APPROV.	DRAWN	ES	25-06-01	4089	1:1500	A1	4089-10D-01
														REV. No. A	

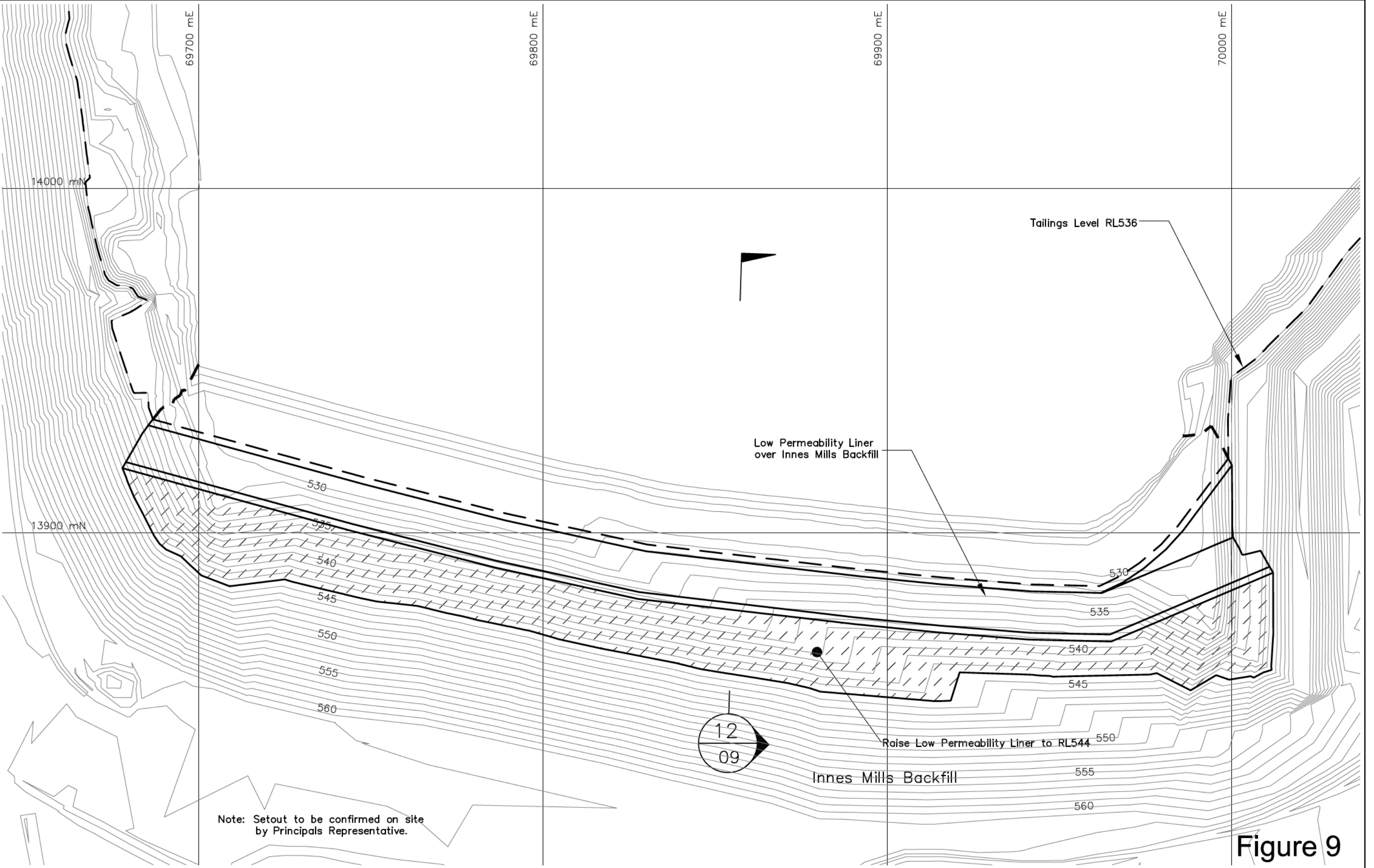


Figure 9

COPYRIGHT © This drawing remains the property of OCEANA GOLD LTD and may not be copied in any way without prior written approval from OCEANA GOLD LTD	OCEANA GOLD	 macraes GOLD OPERATION	PREPARED BY:										PROJECT APPR.		BY	DATE	PROJECT: MACRAES GOLD PROJECT			TITLE Southern Pit – Option 11A Raise to RL544 Innes Mills Backfill Plan				
					ENGINEERING GEOLOGY LTD Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany, NZ Ph +64-9-4862546, Fax +64-9-4862556								DESIGN APPR.		JY	Jun 10	AREA: Southern Pit (Option 11A)							
			Preliminary Issue		Signed:		Date:								DESIGNED		JY	Jun 10	CONSULTANT DRAWING No. 6793-08.dwg					
			Tender Issue		Signed:		Date:		A DM 23-3-11		Innes Mills liner to RL544		JY JY		CHECKED		JY	Jun 10	JOB NUMBER:		ORIGINAL SCALE:	SIZE:	DRAWING No. 6793-08	REV. No. A
			Construction Issue		Signed:		Date:		No.		BY	DATE	REVISION	CHECKED	APPROV.	DRAWN	BL	Jun 10	6793		1:1000			

Notes: 1. Surface of existing trimmed slope to be inspected and approved by Principals Representative prior to placement of Zone A1 fill. Surface should be well graded with no open voids and be tightly compacted. Where necessary Zone B fill shall be placed to achieve uniform profile prior to placement of Zone A1. Zone B fill shall contain high proportion of fines so as to be filter compatible with Zone A1.

2. Setout for extent of fill to be confirmed on site by Principals Representative.

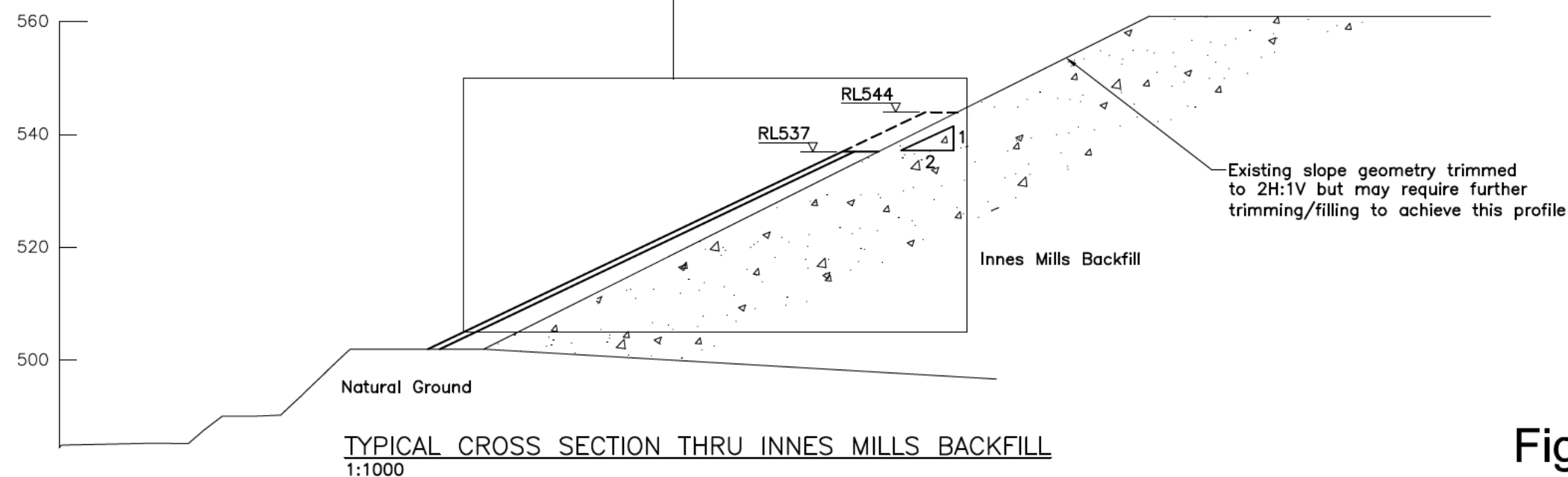
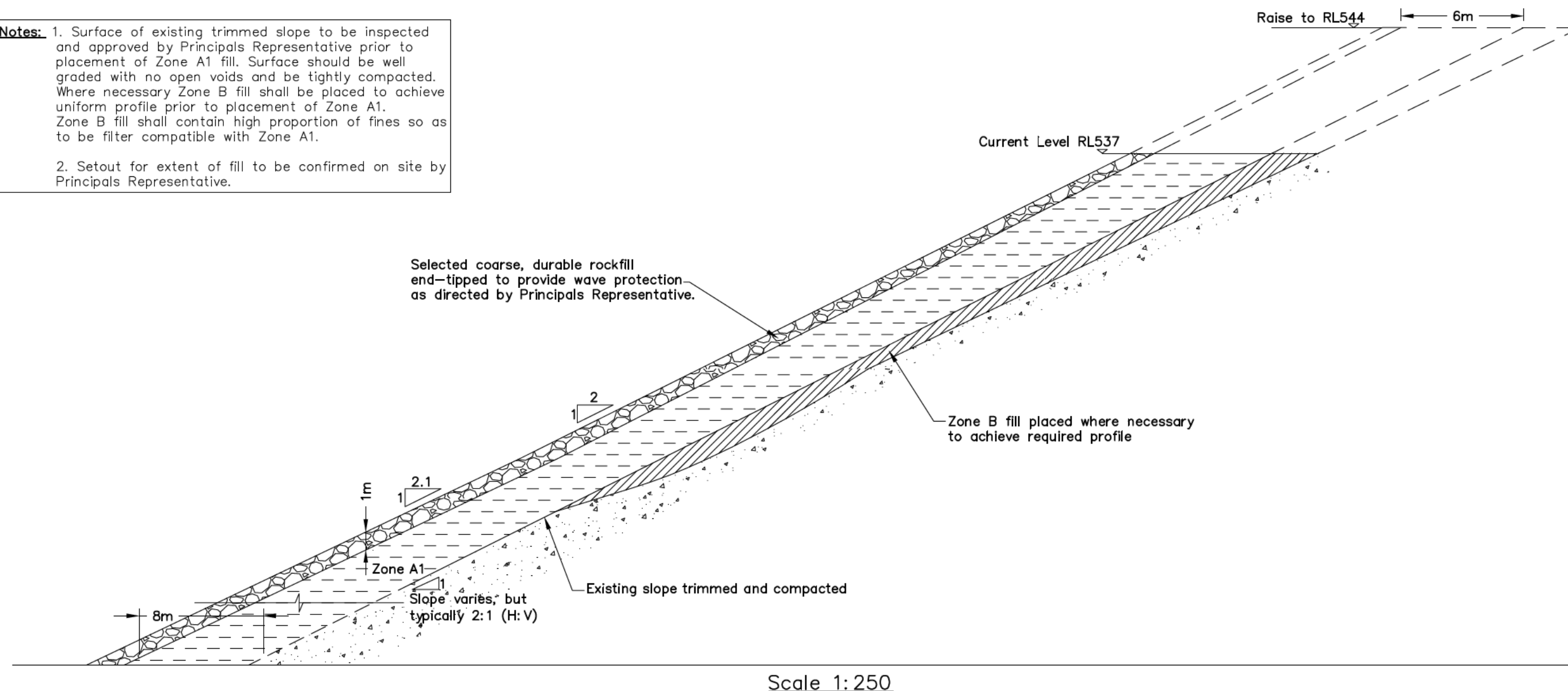


Figure 10

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OCEANA GOLD



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Preliminary Issue	Signed:	Date:			
Tender Issue	Signed:	Date:			
Construction Issue	Signed:	Date:			

No.	BY	DATE	REVISION	CHECKED	APPROV.	DRAWN	BL	Jun 10
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PROJECT APPR.	BY	DATE
DESIGN APPR.	JY	Jun 10
DESIGNED	JY	Jun 10
CHECKED	JY	Jun 10
DRAWN	BL	Jun 10

PROJECT: MACRAES GOLD PROJECT		
AREA: Southern Pit (Option 11A)		
CONSULTANT DRAWING No. 6793-09.dwg		
JOB NUMBER:	ORIGINAL SCALE:	SIZE:
6793	As shown	A3

TITLE		Southern Pit Option – 11A Raise to RL537 Innes Mills Backfill Typical Section	DRAWING No. 6793-09	REV No.

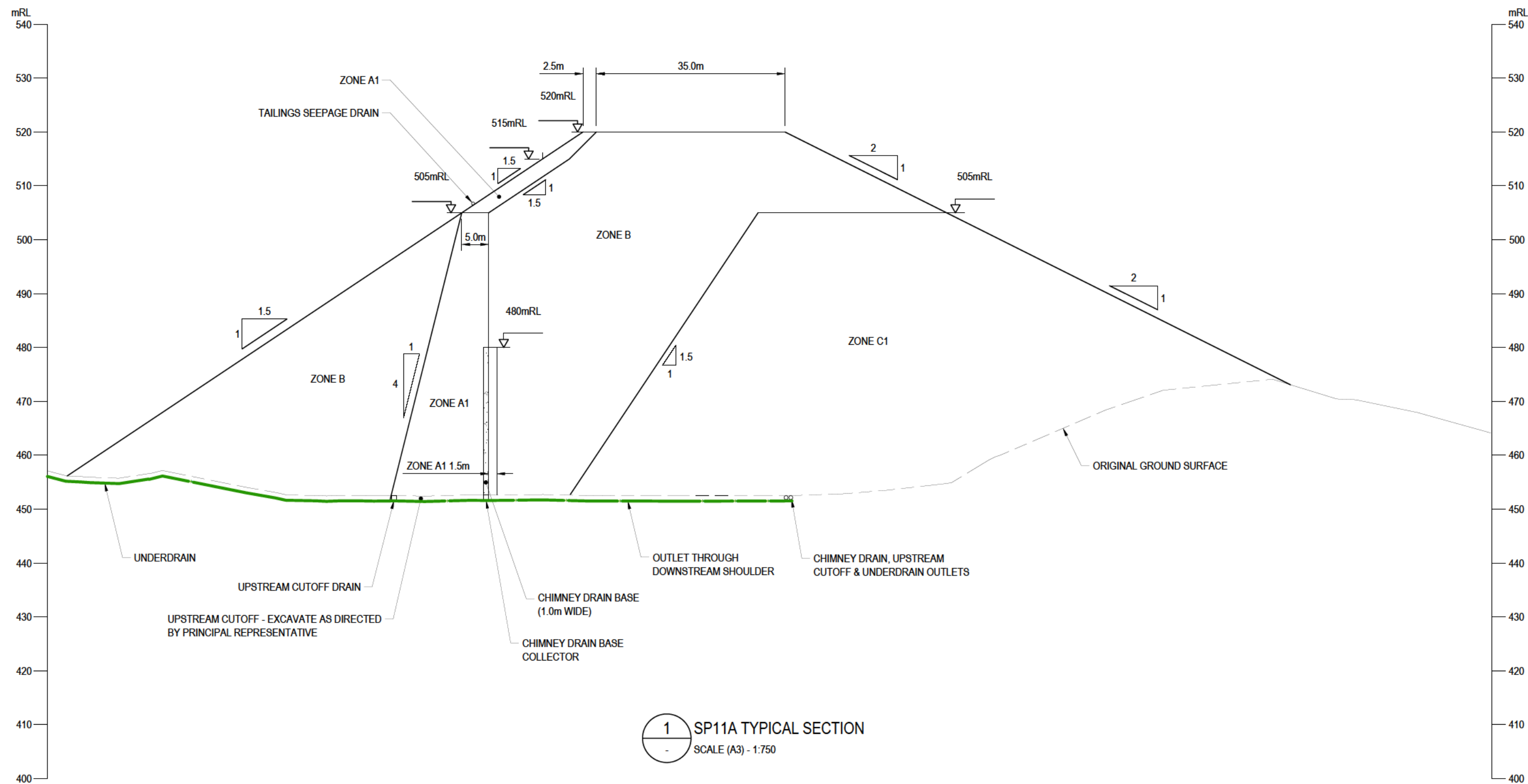
FIGURE A13 REMOVED



PRINTED: 2026-06-21 15:04:28

C:\1265\Bata\EGC\STAMP4_FTA_14\CAD\FIG20260508_MTI\SP11A_Technical Report\10092-FIG-A14.dwg

NOT FOR CONSTRUCTION **FIGURE A14**



NOTES:
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.



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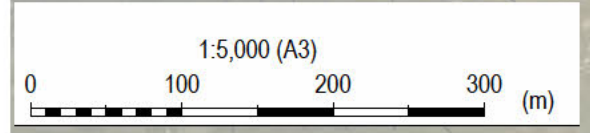
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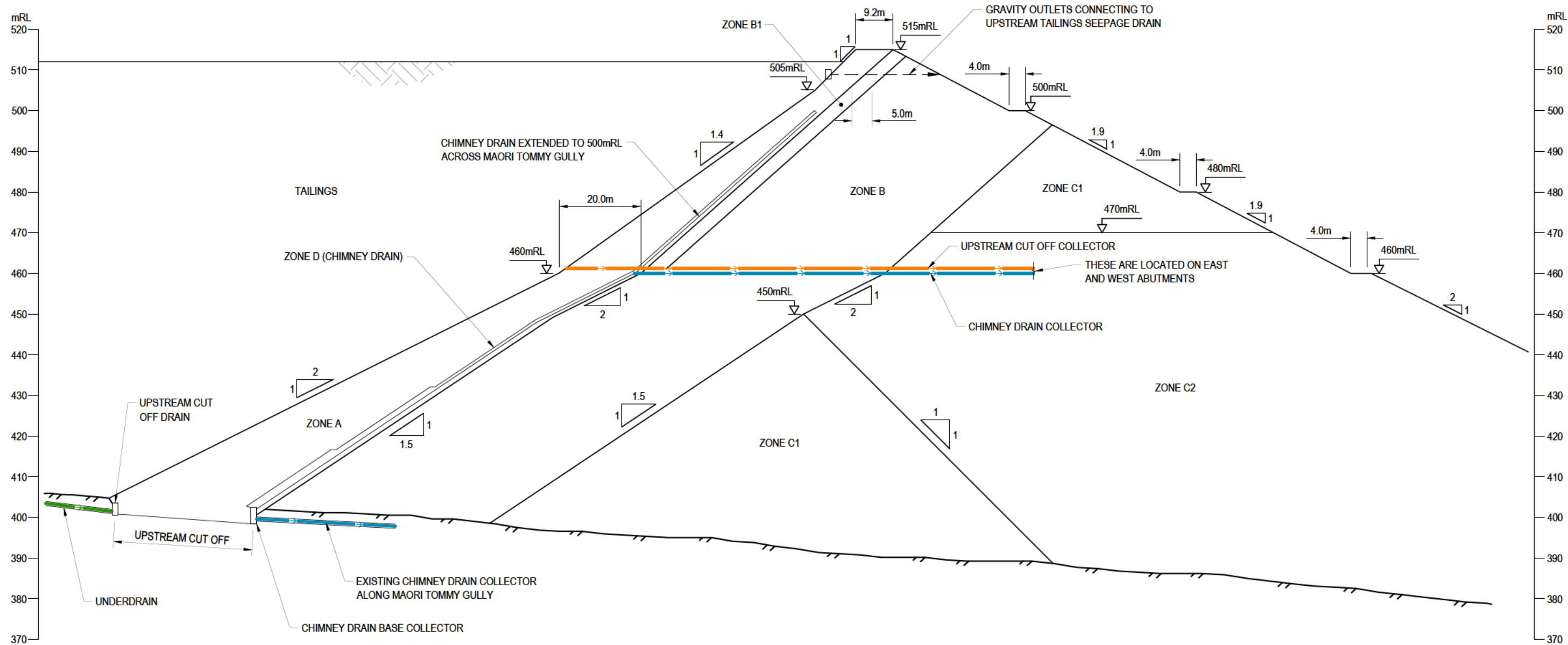
— 510 — EXISTING CONTOURS 5.0m INTERVAL

- - - - - EXISTING CONTOURS 1.0m INTERVAL

- · - · - · - PROPOSED CONTOURS 1.0m INTERVAL

- NOTES:**
1. AERIAL IMAGE IN PROJECT AREA IS DOWNLOADED FROM OCEANA MACRAES SHAREPOINT SITE ON 07/04/2026.
 2. HORIZONTAL COORDINATES IN MACRAES MINE GRID.
 3. VERTICAL DATUM IS MACRAES MINE DATUM.





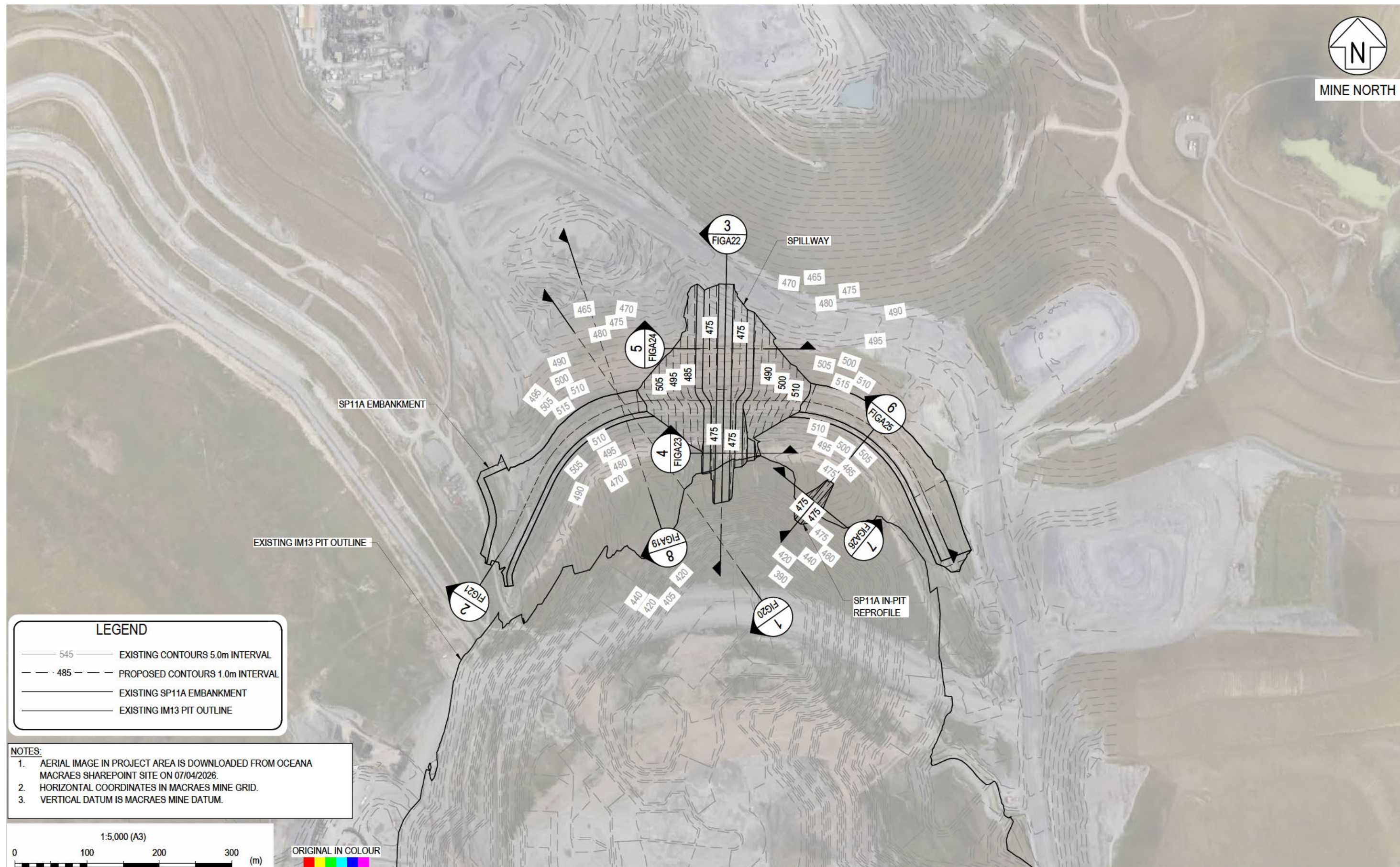
2 MTI POST HYDRAULIC MINING TYPICAL SECTION
SCALE (A3) - 1:1000

NOTES:
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.



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FIGURE A17

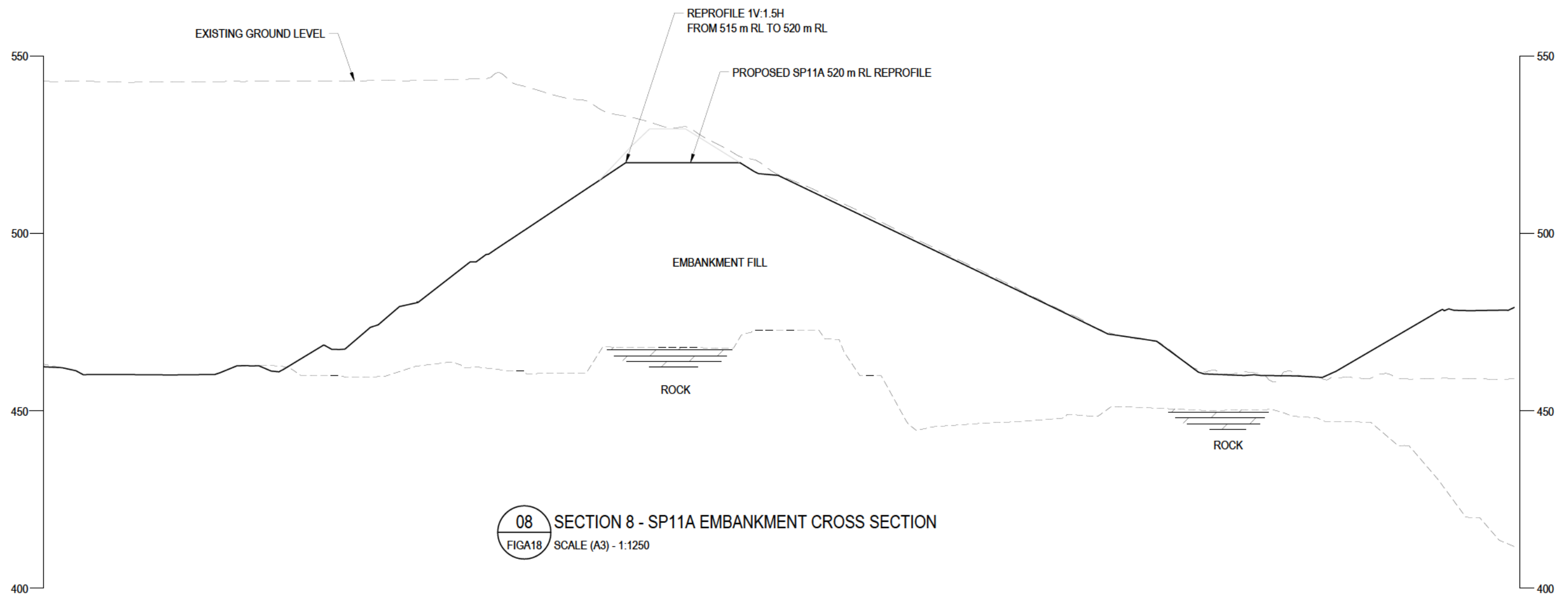


NOT FOR CONSTRUCTION

FIGURE A18

MACRAES PHASE 4 FAST TRACK APPROVAL
PROPOSED SP11A
CLOSURE ARRANGEMENT

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CHECKED	J.Z.	1/05/2026	10092	1:5000	A



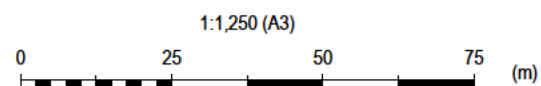
08 SECTION 8 - SP11A EMBANKMENT CROSS SECTION
FIGA18 SCALE (A3) - 1:1250

LEGEND

- EXISTING GROUND LEVEL
- SP11 530 mRL EMBANKMENT
- PROPOSED SP11 520mRL REPROFILE

NOTES:

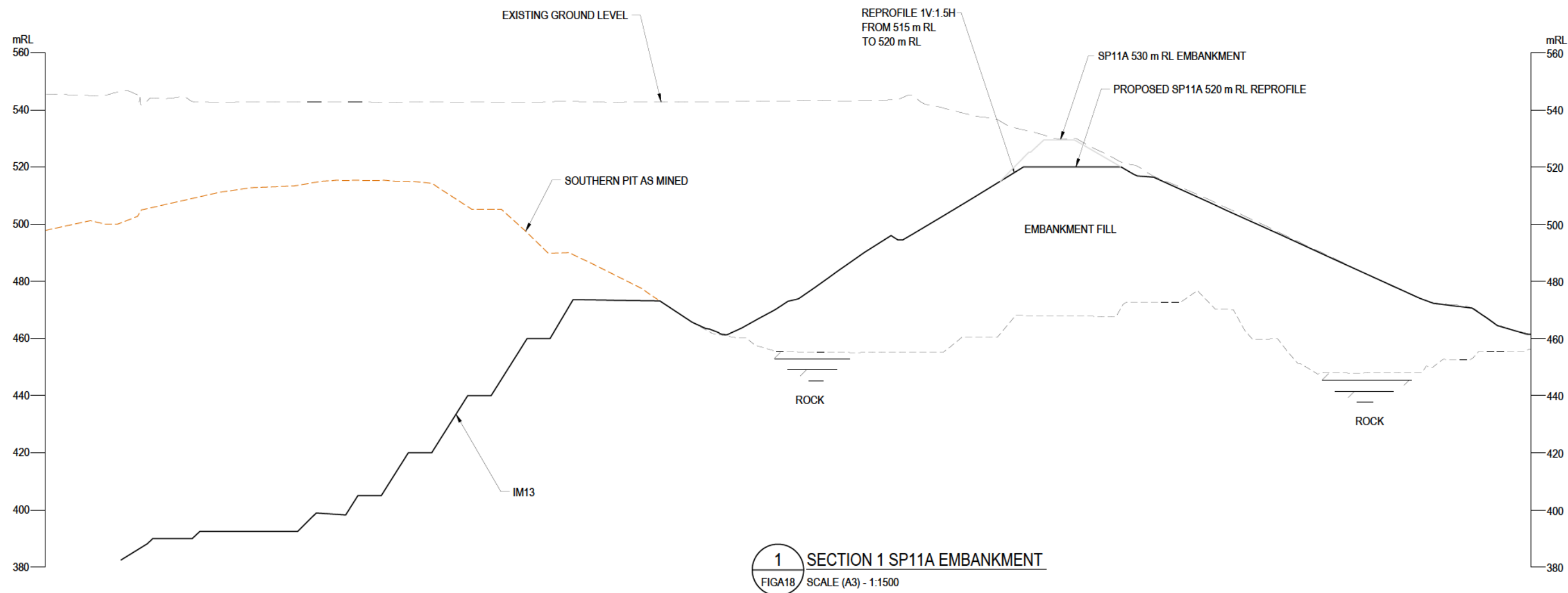
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.



ORIGINAL IN COLOUR

NOT FOR CONSTRUCTION

FIGURE A19



LEGEND

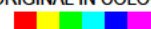
- EXISTING GROUND LEVEL
- SP11A RL530 EMBANKMENT
- IM13
- PROPOSED SP11A 520 mRL REPROFILE

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.

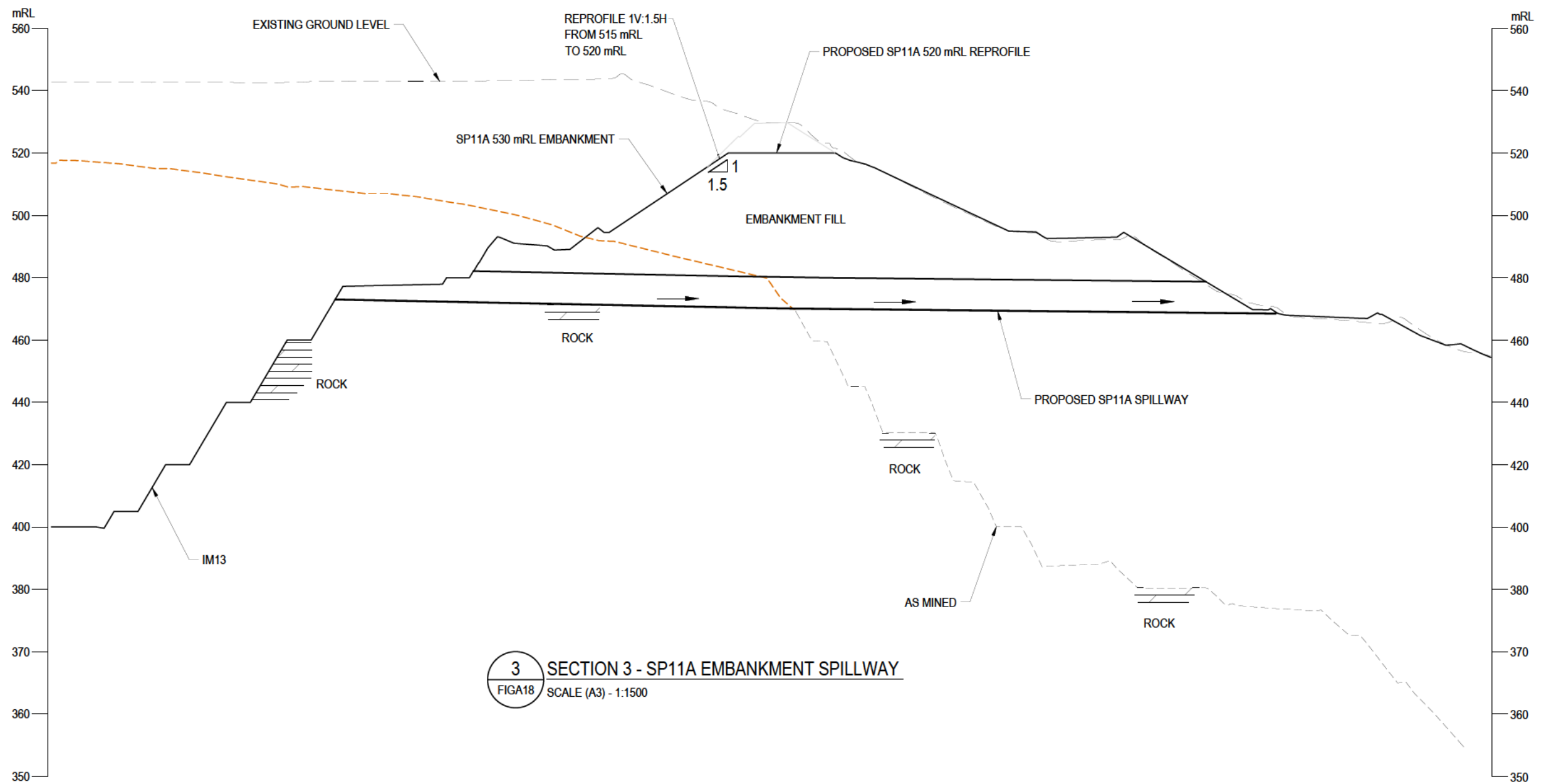


ORIGINAL IN COLOUR



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FIGURE A20



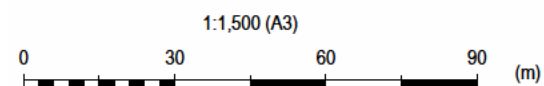
3 SECTION 3 - SP11A EMBANKMENT SPILLWAY
FIGA18 SCALE (A3) - 1:1500

LEGEND

- EXISTING GROUND LEVEL
- SP11A RL530 EMBANKMENT
- IM13
- PROPOSED SP11A 520 m RL REPROFILE
- AS MINED

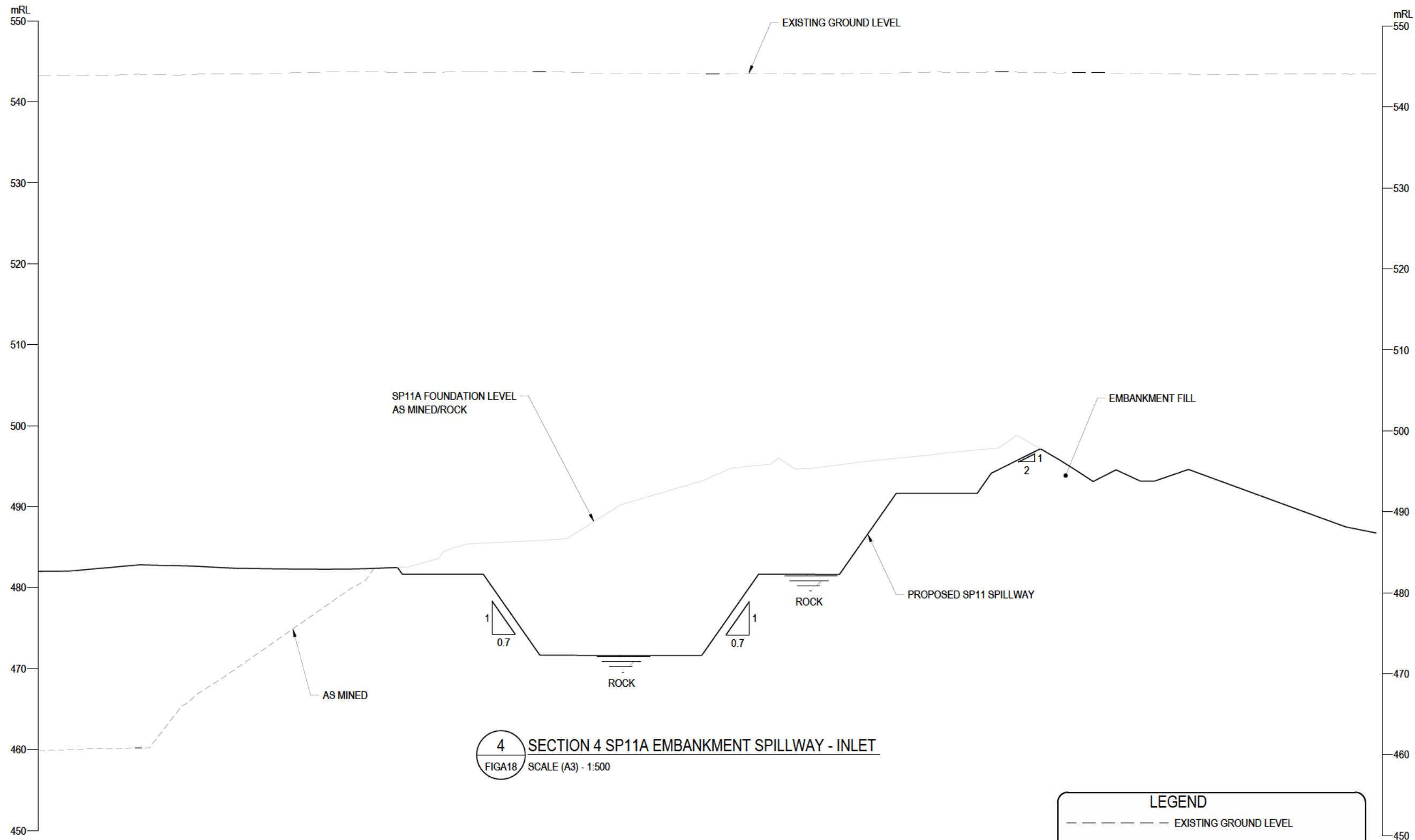
NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.



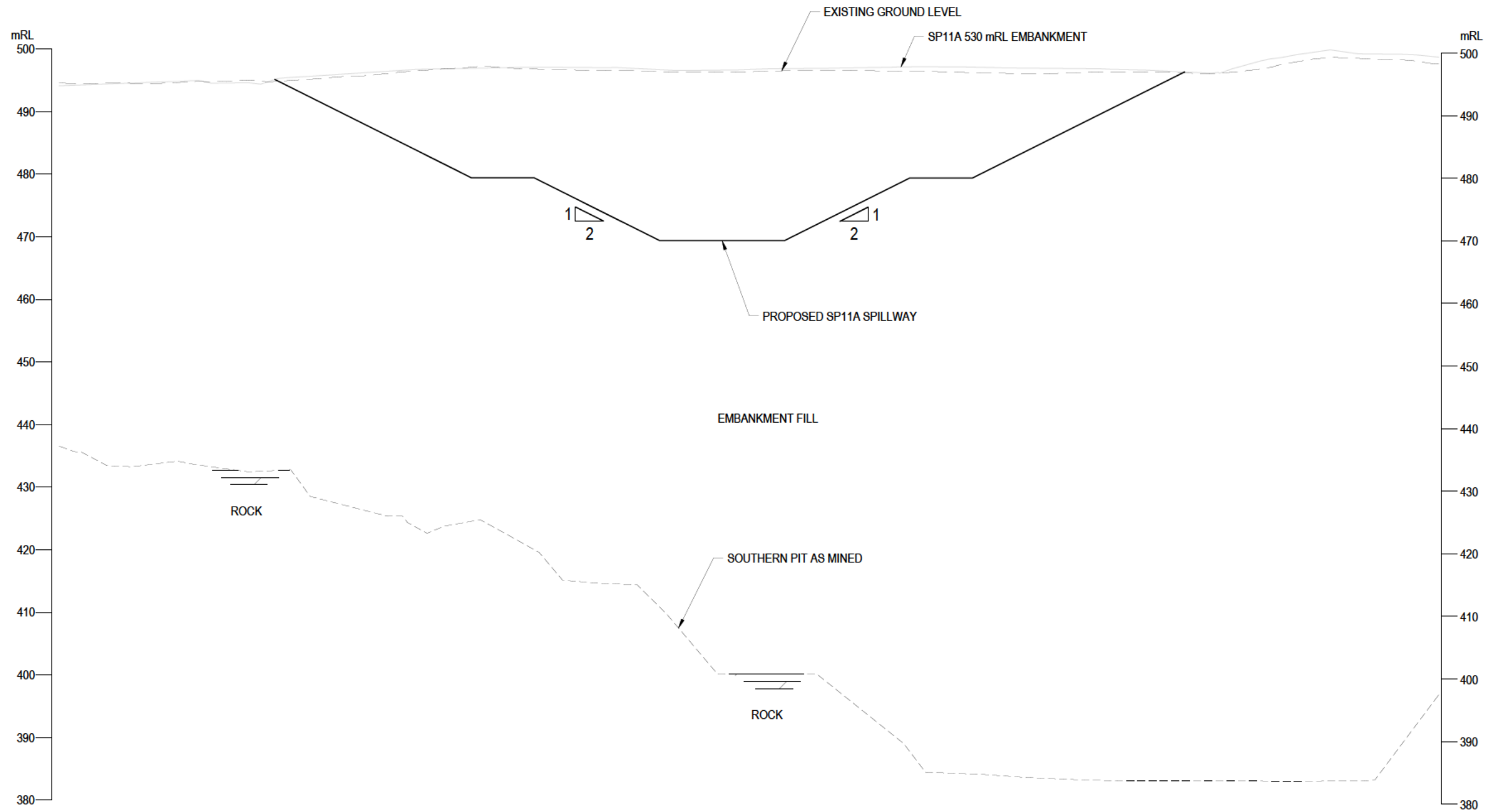
NOT FOR CONSTRUCTION

FIGURE A22



NOT FOR CONSTRUCTION

FIGURE A23



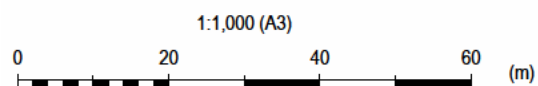
5 SECTION 5 - SP11A EMBANKMENT SPILLWAY - OUTLET
FIG18 SCALE (A3) - 1:750

LEGEND

- EXISTING GROUND LEVEL
- AS MINED
- SP11A 530 m RL EMBANKMENT
- PROPOSED SP11A SPILLWAY

NOTES:

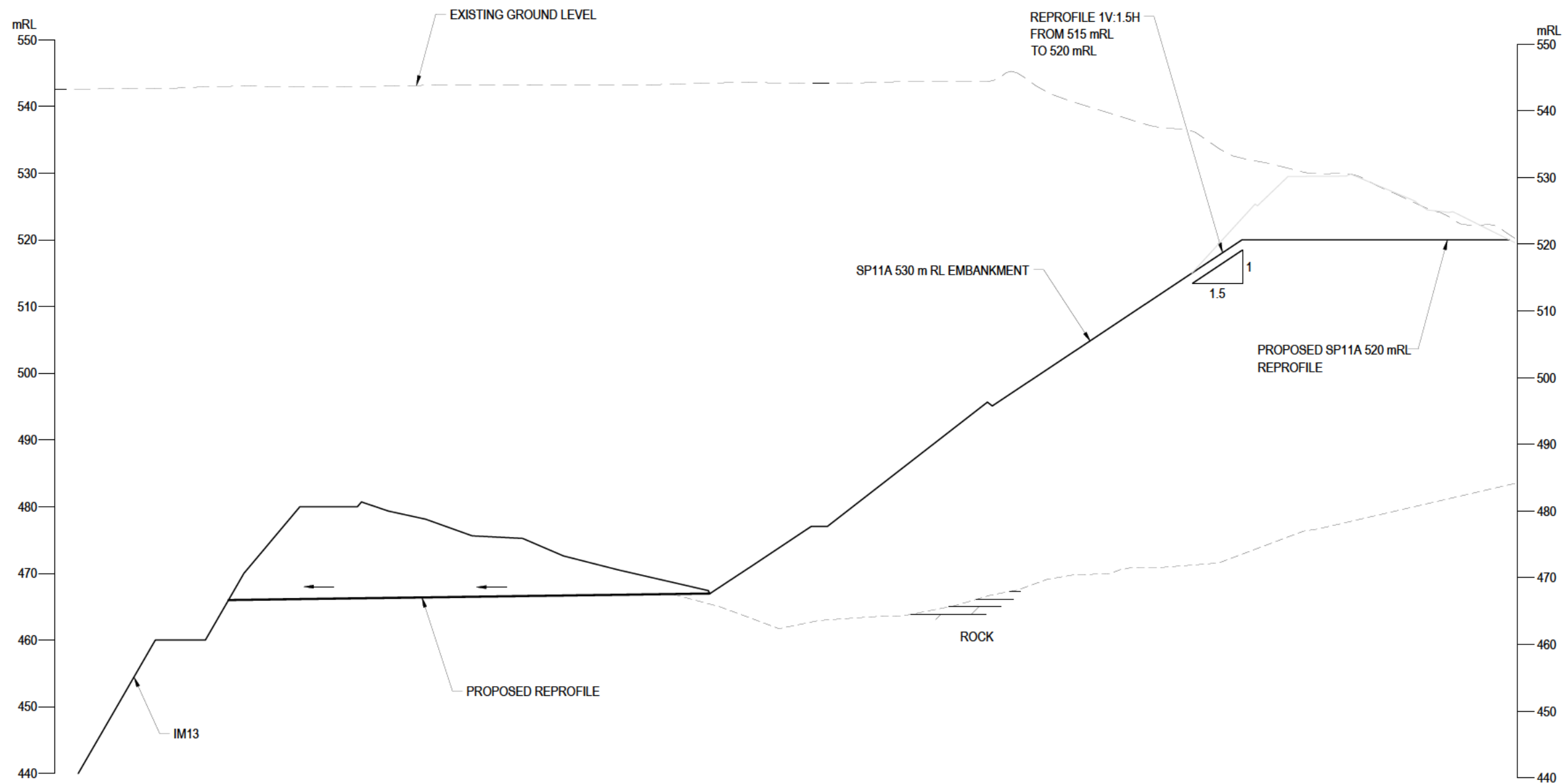
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.



ORIGINAL IN COLOUR

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FIGURE A24



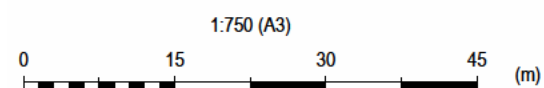
6 SECTION 6
FIGA18 SCALE (A3) - 1:750

LEGEND

- EXISTING GROUND LEVEL
- ... AS MINED
- SP11A 530 m RL EMBANKMENT
- PROPOSED REPROFILE
- IM13

NOTES:

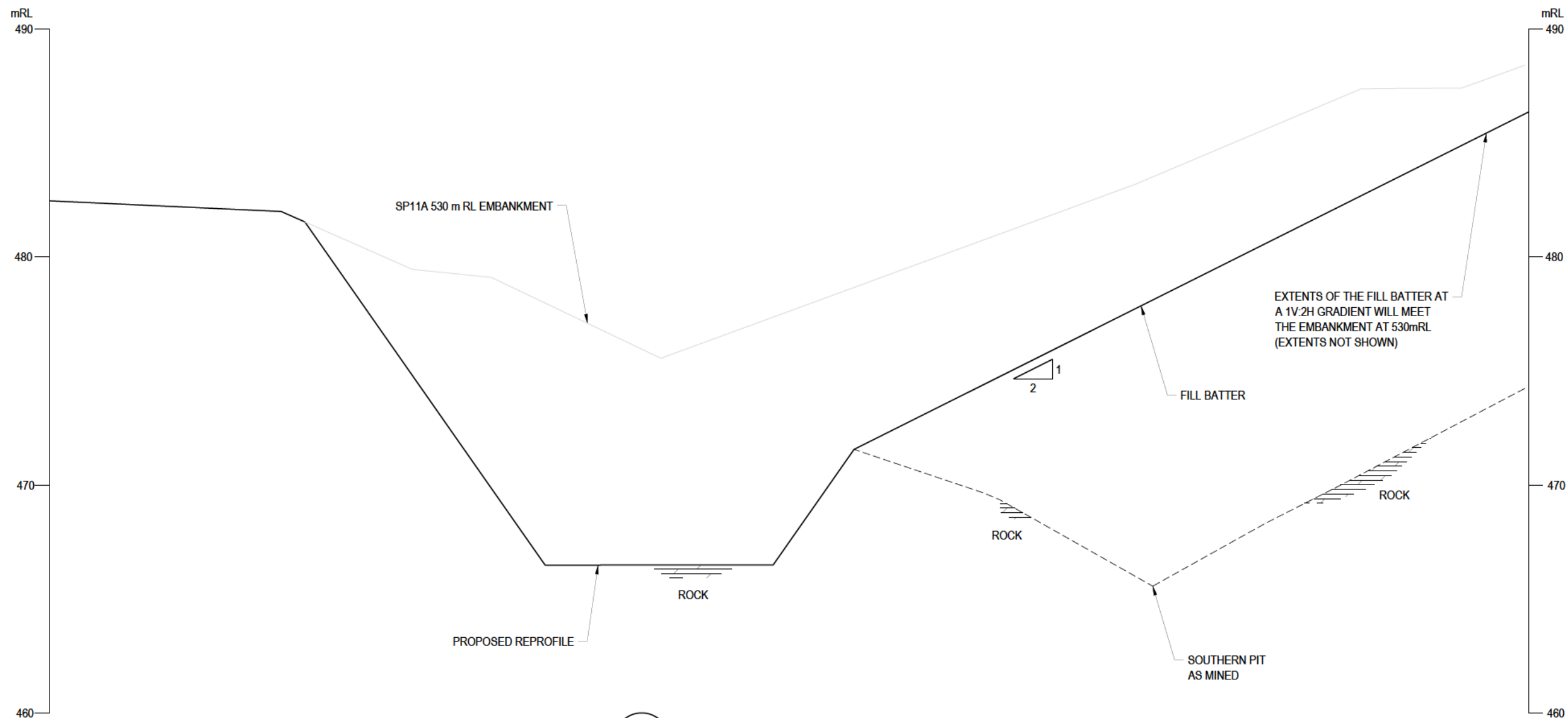
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.



ORIGINAL IN COLOUR

NOT FOR CONSTRUCTION

FIGURE A25



7 SECTION 7 - SP11A PIT REPROFILE CROSS SECTION
 FIGA18 SCALE (A3) - 1:200

LEGEND

- AS MINED
- SP11A 530 mRL EMBANKMENT
- PROPOSED REPROFILE

- NOTES:**
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
 2. VERTICAL DATUM IS MACRAES MINE DATUM.



NOT FOR CONSTRUCTION **FIGURE A26**



LEGEND

- 510 — EXISTING CONTOURS 5.0m INTERVAL
- - - - - EXISTING CONTOURS 1.0m INTERVAL
- - - 510 - - - PROPOSED CONTOURS 1.0m INTERVAL

NOTES:

1. AERIAL IMAGE IN PROJECT AREA IS DOWNLOADED FROM OCEANA MACRAES SHAREPOINT SITE ON 07/04/2026.
2. HORIZONTAL COORDINATES IN MACRAES MINE GRID.
3. VERTICAL DATUM IS MACRAES MINE DATUM.

1:5,000 (A3)

0 100 200 300 (m)

ORIGINAL IN COLOUR

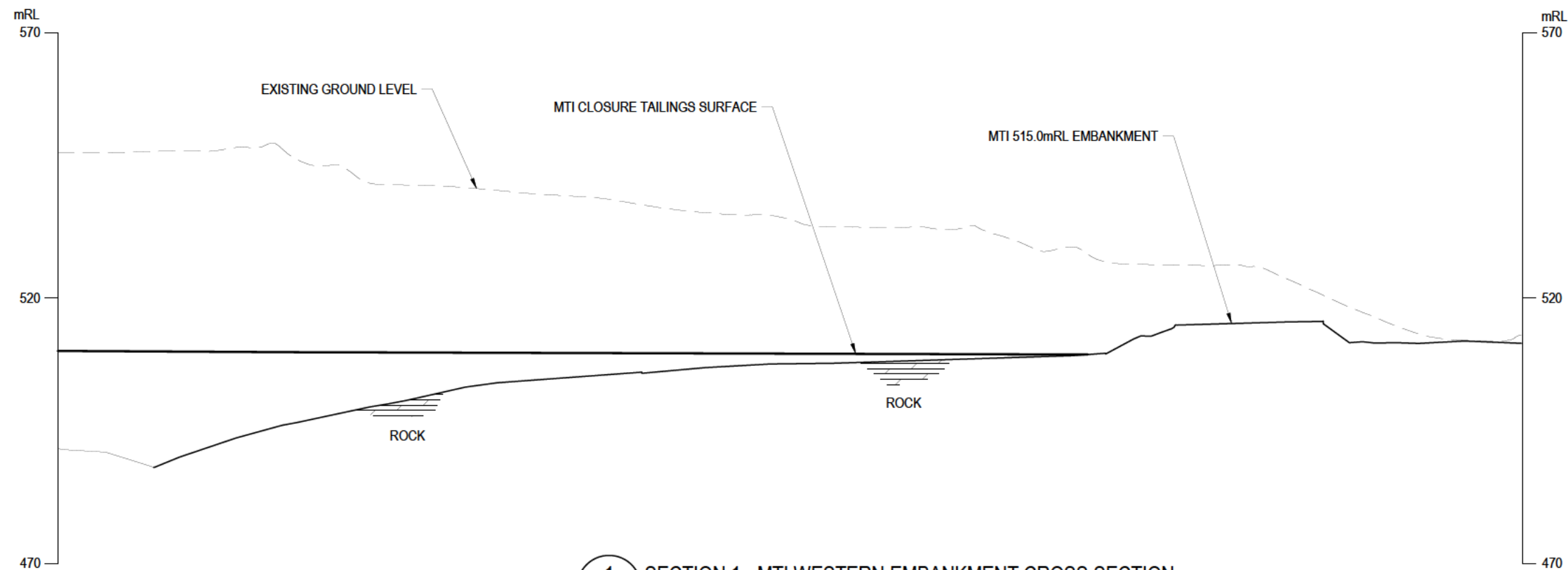


NOT FOR CONSTRUCTION **FIGURE A27**

MACRAES PHASE 4 FAST TRACK APPROVAL
MTI EMBANKMENT CLOSURE LAYOUT PLAN

DRAWN	R.M.	DATE	JOB No	SCALE (A3)	REV.
CHECKED	J.Z.	21/05/2026	10092	1:5000	A

PRINTED: 2026-06-21 15:06:17 C:\1268\Bata\EG\ST\NWP4_FTA_14\CAD\Fig20260508 MTI SP11A Technical Report\10092-FigA27.dwg



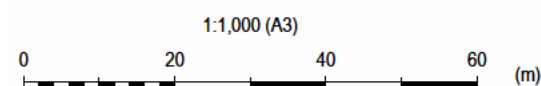
1 SECTION 1 - MTI WESTERN EMBANKMENT CROSS SECTION
FIGA27 SCALE (A3) - 1:1000

LEGEND

- EXISTING GROUND LEVEL
- AS MINED
- MTI 515.0mRL EMBANKMENT AND BASE
- MTI CLOSURE TAILINGS SURFACE

NOTES:

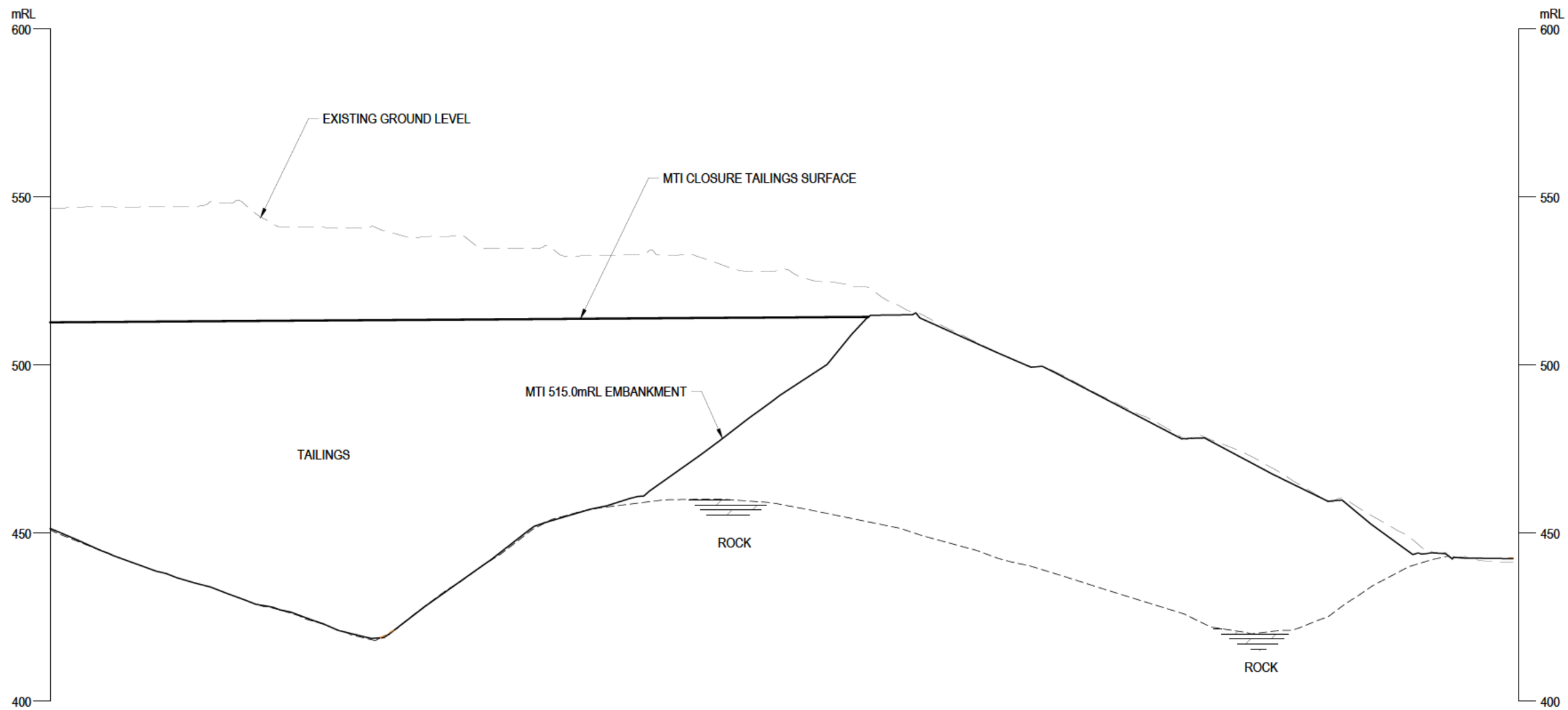
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.



ORIGINAL IN COLOUR

NOT FOR CONSTRUCTION

FIGURE A28



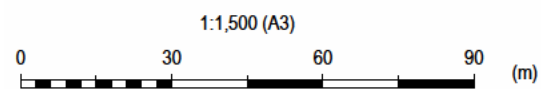
2 SECTION 2 - MTI EASTERN EMBANKMENT CROSS SECTION
FIGA27 SCALE (A3) - 1:1500

LEGEND

- EXISTING GROUND LEVEL
- AS MINED
- MTI 515.0mRL EMBANKMENT
- MTI CLOSURE TAILINGS SURFACE

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.

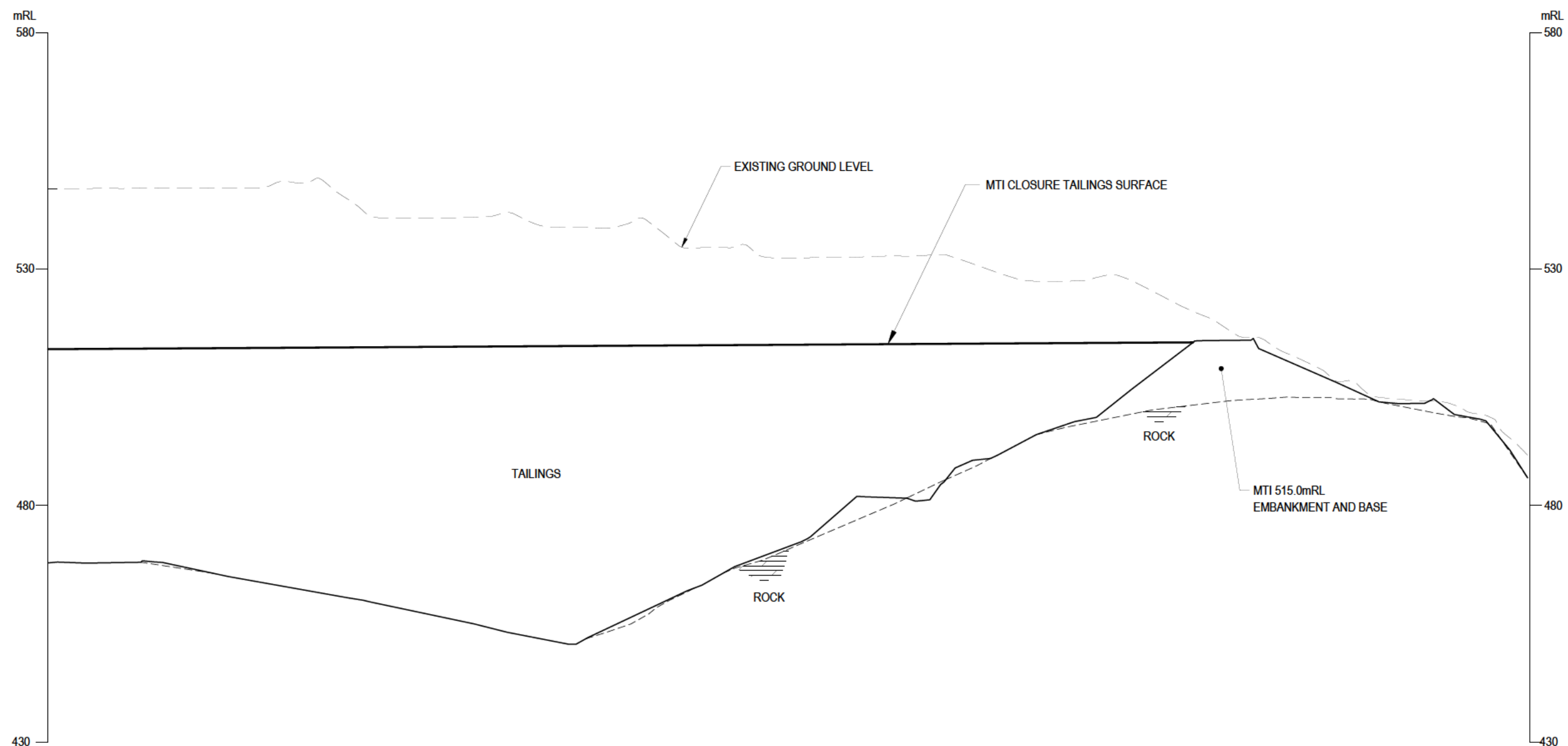


ORIGINAL IN COLOUR



NOT FOR CONSTRUCTION

FIGURE A29



3 SECTION 3 - MTI EASTERN EMBANKMENT CROSS SECTION
FIGA27 SCALE (A3) - 1:1000

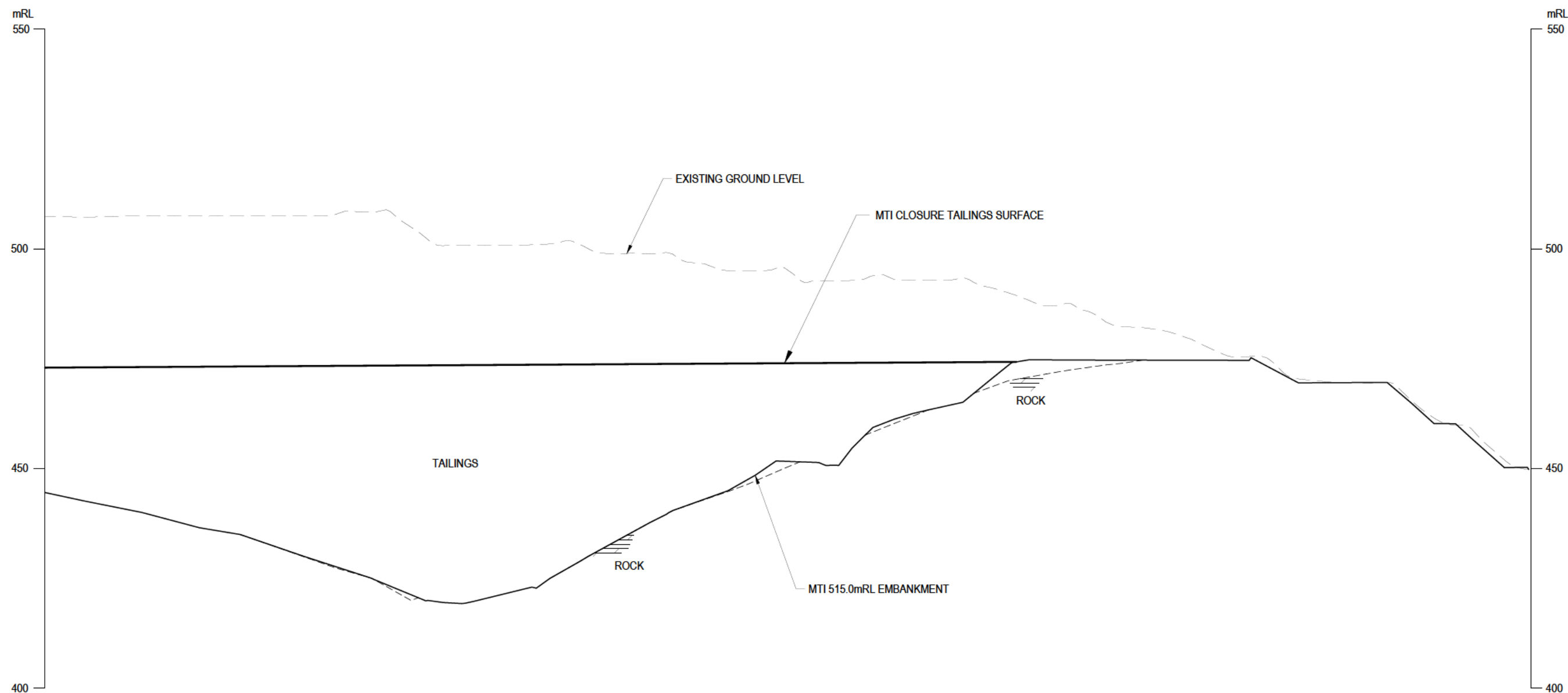
LEGEND	
---	EXISTING GROUND LEVEL
---	AS MINED
---	MTI 515.0mRL EMBANKMENT
---	MTI CLOSURE TAILINGS SURFACE

- NOTES:
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
 2. VERTICAL DATUM IS MACRAES MINE DATUM.



NOT FOR CONSTRUCTION

FIGURE A30



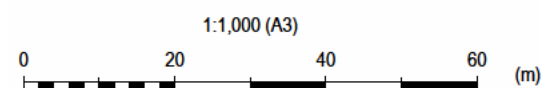
4 SECTION 4 - MTI EASTERN EMBANKMENT CROSS SECTION
FIGA27 SCALE (A3) - 1:1000

LEGEND

- EXISTING GROUND LEVEL
- AS MINED
- MTI 515.0mRL EMBANKMENT
- MTI CLOSURE TAILINGS SURFACE

NOTES:

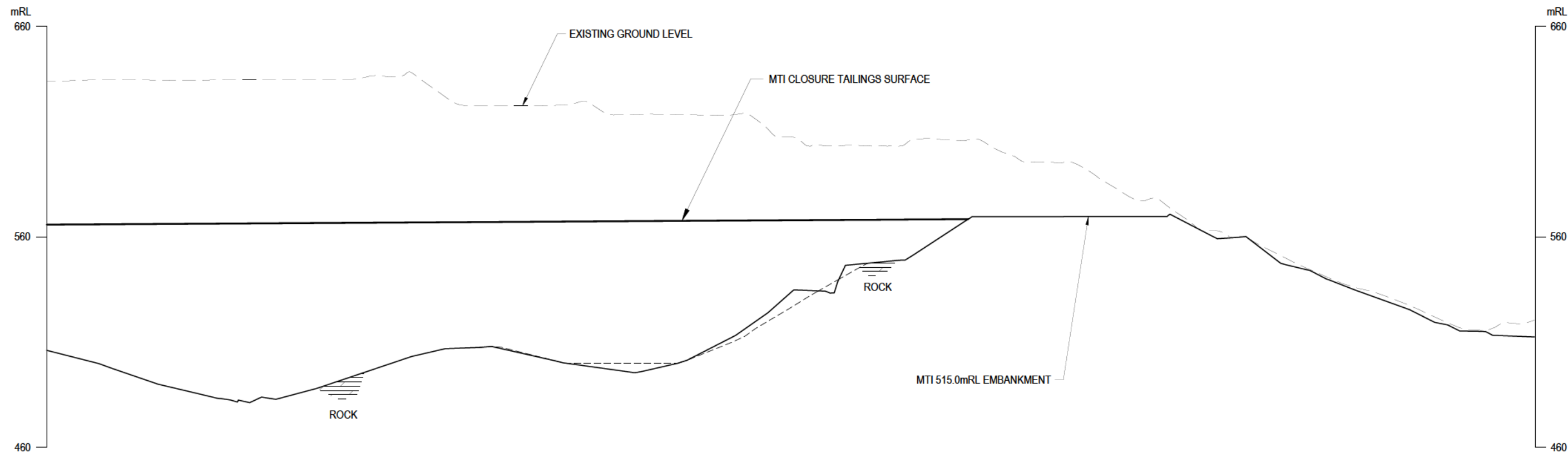
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.



ORIGINAL IN COLOUR

NOT FOR CONSTRUCTION

FIGURE A31



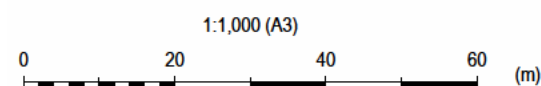
5 SECTION 5 - EASTERN EMBANKMENT CROSS SECTION
FIGA27 SCALE (A3) - 1:1000

LEGEND

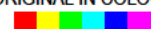
- EXISTING GROUND LEVEL
- AS MINED
- MTI 515.0mRL EMBANKMENT
- MTI CLOSURE TAILINGS SURFACE

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.

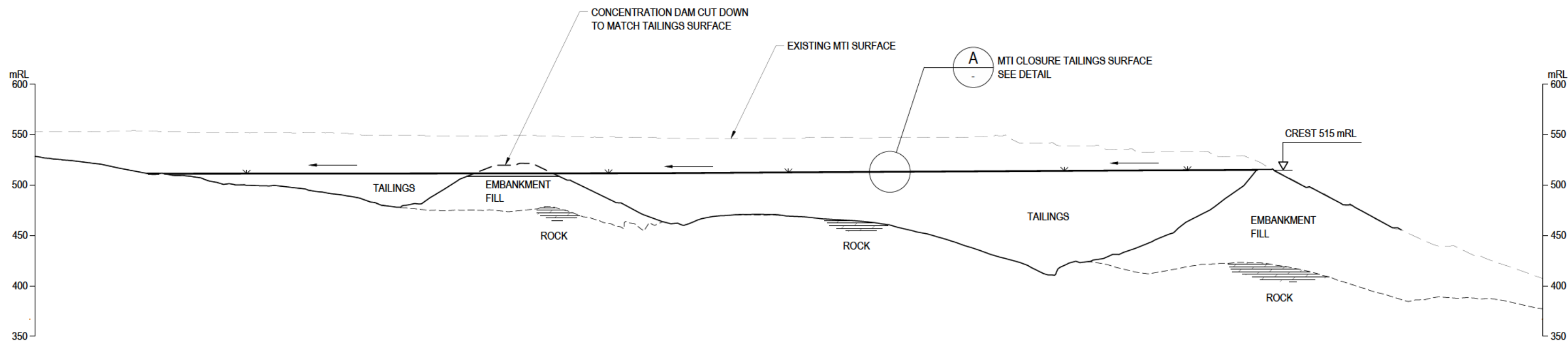


ORIGINAL IN COLOUR



NOT FOR CONSTRUCTION

FIGURE A32



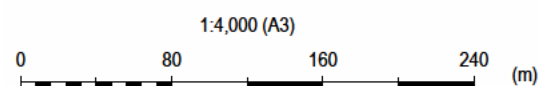
7 SECTION 7 - MTI EMBANKMENT CLOSURE LONG SECTION NORTH TO SOUTH
FIGA27 SCALE (A3) - 1:4000

LEGEND

- EXISTING GROUND LEVEL
- AS MINED 28/02/2026
- MTI 515.0mRL EMBANKMENT
- MTI CLOSURE TAILINGS SURFACE

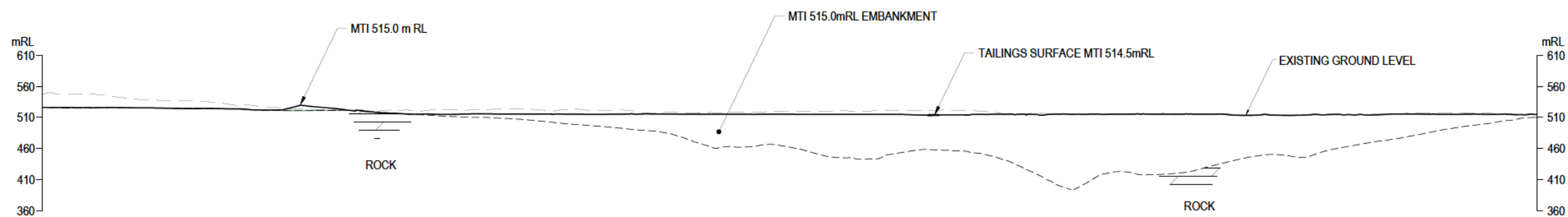
NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.



ORIGINAL IN COLOUR

NOT FOR CONSTRUCTION **FIGURE A34**



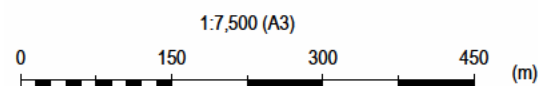
8 SECTION 8 - MTI EMBANKMENT LONG SECTION
FIGA27 SCALE (A3) - 1:7500

LEGEND

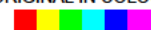
- EXISTING GROUND LEVEL
- AS MINED
- MTI 515.0 m RL EMBANKMENT
- TAILINGS SURFACE MTI 514.5 m RL

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. VERTICAL DATUM IS MACRAES MINE DATUM.

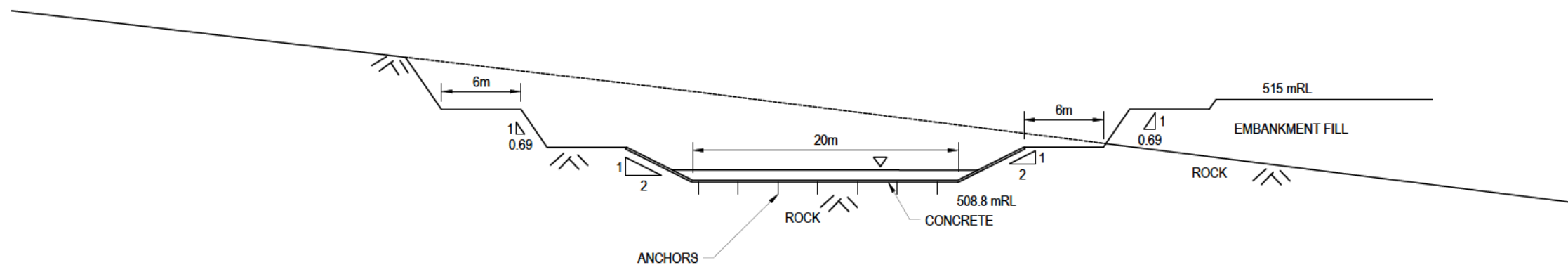


ORIGINAL IN COLOUR

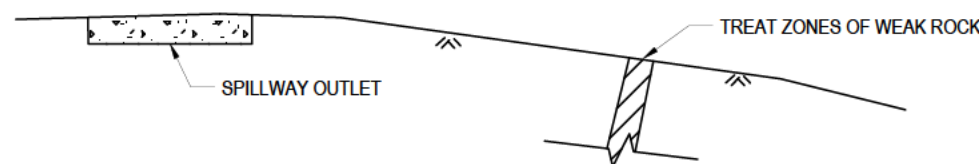


NOT FOR CONSTRUCTION

FIGURE A35

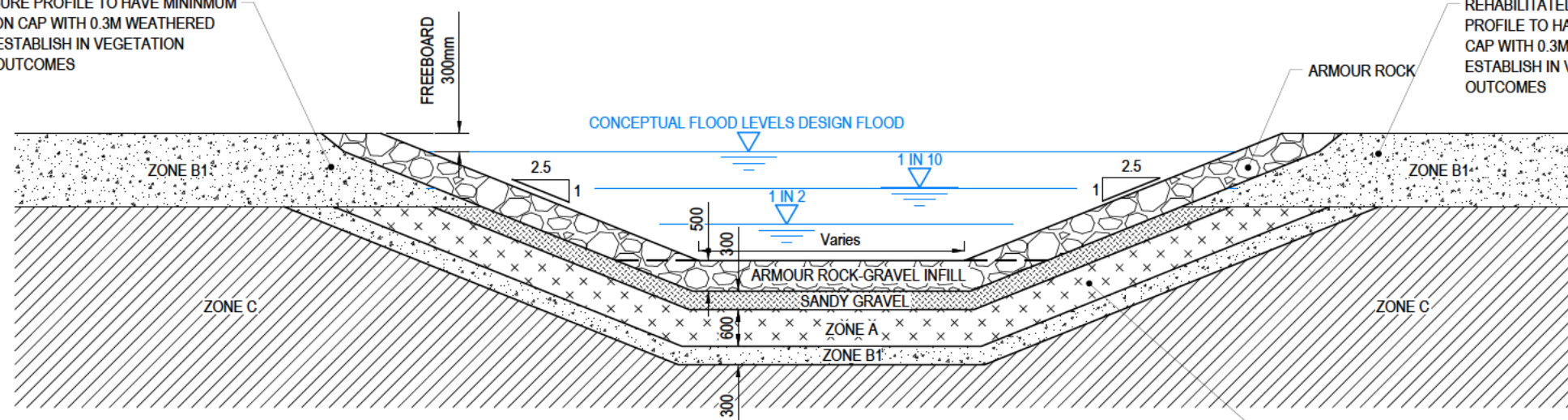


1 CLOSURE SPILLWAY INLET WEIR CROSS-SECTION
SCALE (A3) - NTS



A SPILLWAY - DETAIL FOR WEAK ROCK
SCALE (A3) - NTS

REHABILITATED SURFACE IN CLOSURE PROFILE TO HAVE MINIMUM 1 TO 50 FALL TO STREAM DIVERSION CAP WITH 0.3M WEATHERED BROWN ROCK AND 0.2M TOPSOIL ESTABLISH IN VEGETATION MEETING ECOLOGICAL CLOSURE OUTCOMES



REHABILITATED SURFACE IN CLOSURE PROFILE TO HAVE MINIMUM 1 TO 50 FALL TO STREAM DIVERSION CAP WITH 0.3M WEATHERED BROWN ROCK AND 0.2M TOPSOIL ESTABLISH IN VEGETATION MEETING ECOLOGICAL CLOSURE OUTCOMES

B OUTLET CHANNEL OVER GULLY INFILL
SCALE (A3) - NTS

NOTES:
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.

ORIGINAL IN COLOUR



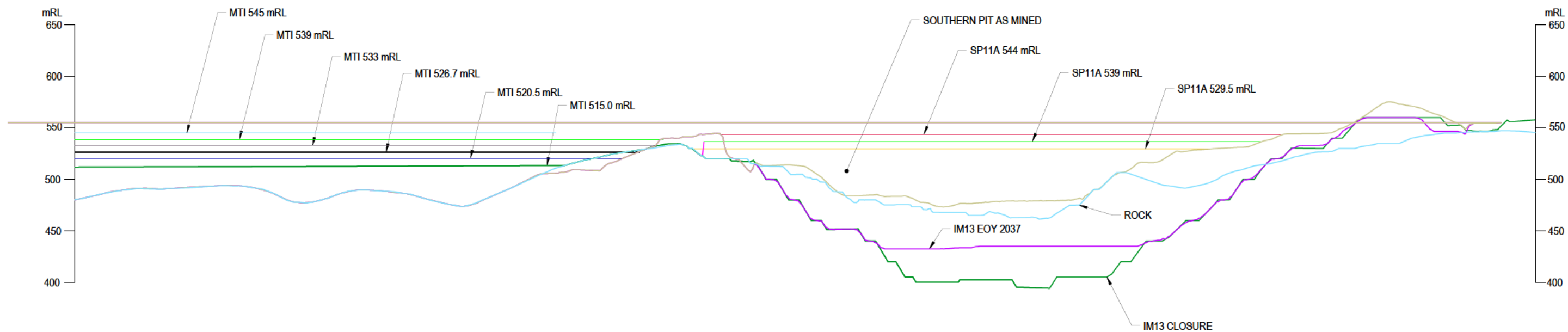
MINE NORTH

NOT FOR CONSTRUCTION

FIGURE 37

MACRAES PHASE 4 FAST TRACK APPROVAL
MTI AND SP11A EMBANKMENT
CLOSURE ARRANGEMENT

DRAWN	R.M.	DATE	JOB No	SCALE (A3)	REV.
CHECKED	J.Z.	06/26/2026	10092	1:10,000	A



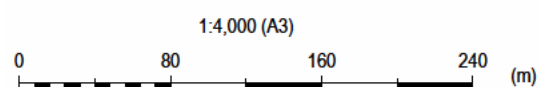
1 SECTION - MTI AND IM13 CROSS SECTION
A37 SCALE (A3) - 1:4000

LEGEND

MTI 545 mRL
MTI 539 mRL
MTI 533 mRL
MTI 526.7 mRL
MTI 520.5 mRL
MTI 515.0 mRL
SP11A 544 mRL
SP11A 539 mRL
SP11A 529.5 mRL
SOUTHERN PIT AS MINED
ROCK LEVEL
IM13 EOY 2037
IM13 CLOSURE

NOTES:

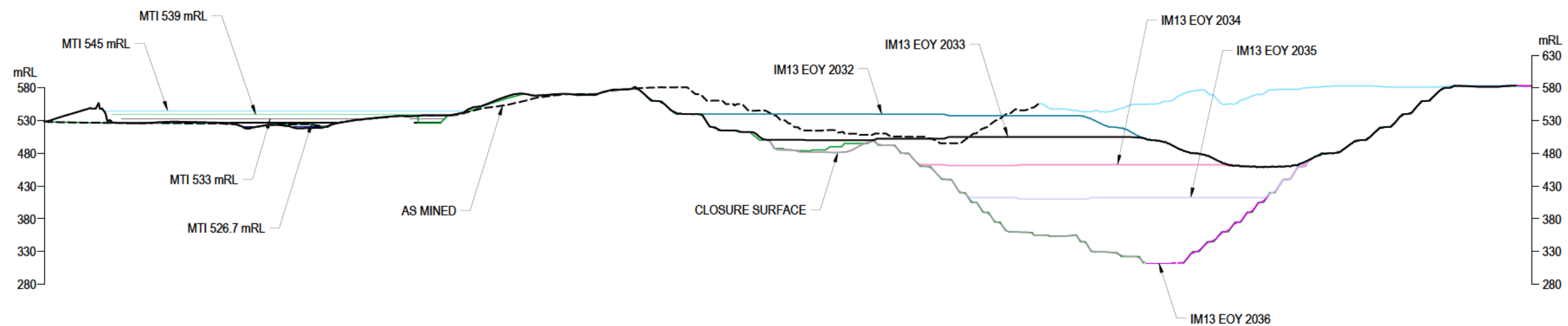
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.



ORIGINAL IN COLOUR

NOT FOR CONSTRUCTION

FIGURE A38



2 SECTION - MTI AND IM13 CROSS SECTION
A38 SCALE (A3) - 1:7500

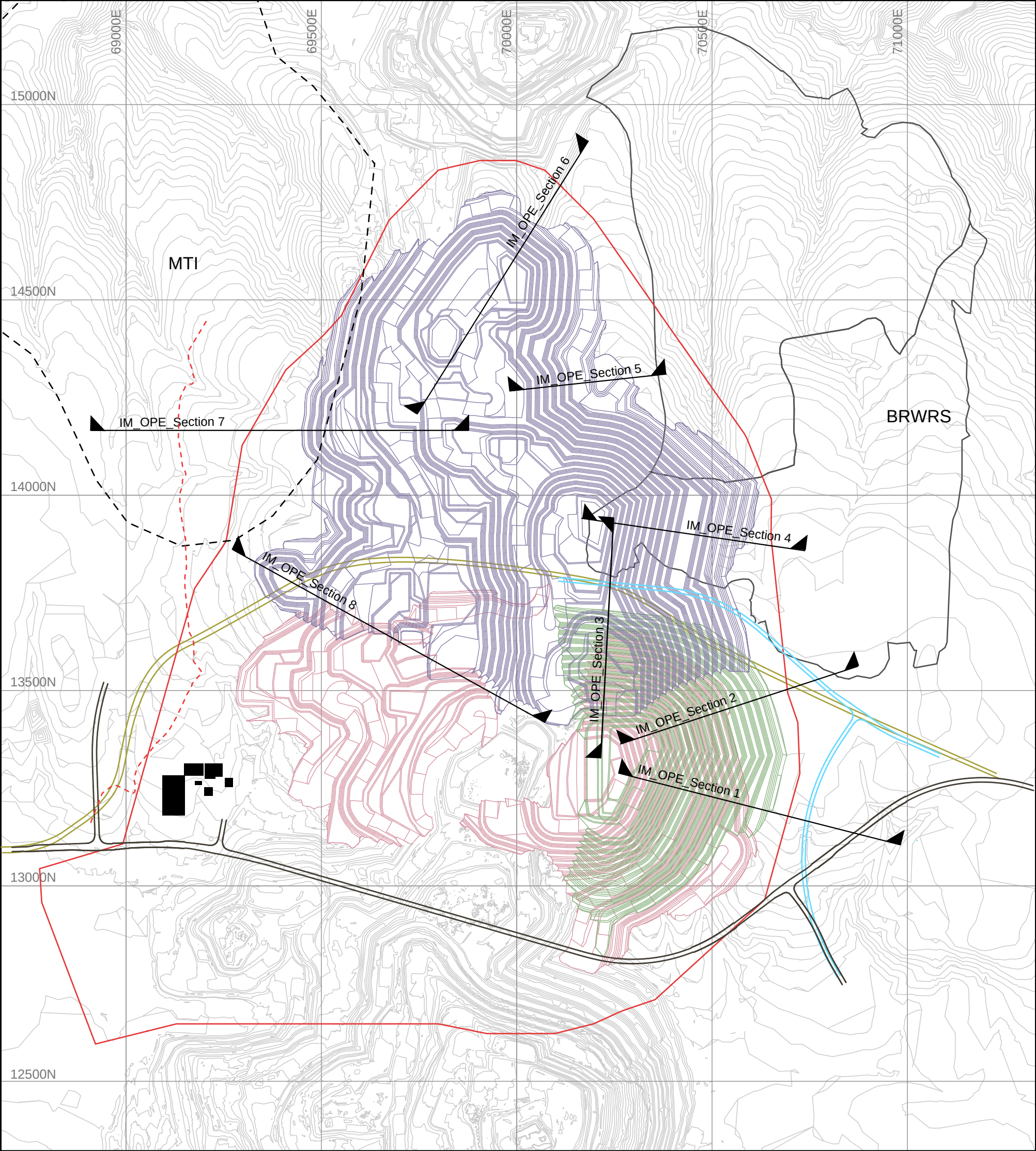
LEGEND	
—	MTI 545 mRL
—	MTI 539 mRL
—	MTI 533 mRL
—	MTI 526.7 mRL
—	IM13 EOY 2032
—	IM13 EOY 2033
—	IM13 EOY 2034
—	IM13 EOY 2035
—	IM13 EOY 2036
---	AS MINED
—	CLOSURE SURFACE

NOTES:
1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.



NOT FOR CONSTRUCTION

FIGURE 39



LEGEND

-  As-mined Surface (*site_as_mined_251106*)

 Open Pit Workshop (*260211_Workshop_Buildings*)

 Innes Mills Stage 11 (*IM11_251117*)

 Innes Mills Stage 12 (*IM12_250505*)

 Innes Mills Stage 13 (*IM13_260302*)
-  As-built Waste Rock Stack Footprint (*Feb_2024*)

 Mixed Tailings Impoundment Boundary

 Stability Cross Svection

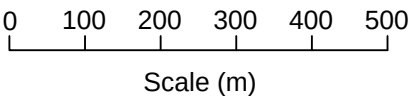
 Current Macraes Road

 Macraes Road Realignment Stage 1 (*STAGE 1 3D STRINGS AND SURFACE*)

 Macraes Road Realignment Stage 2 (*3D DESIGN STAGE 2*)

 Open Pit Disturbance Boundary (*250811_IM_MP4FAST_PIT_POLYGON_2025_LINE*)
-  FF surface expression

 Maximum pit lake level at closure - 489 mRL

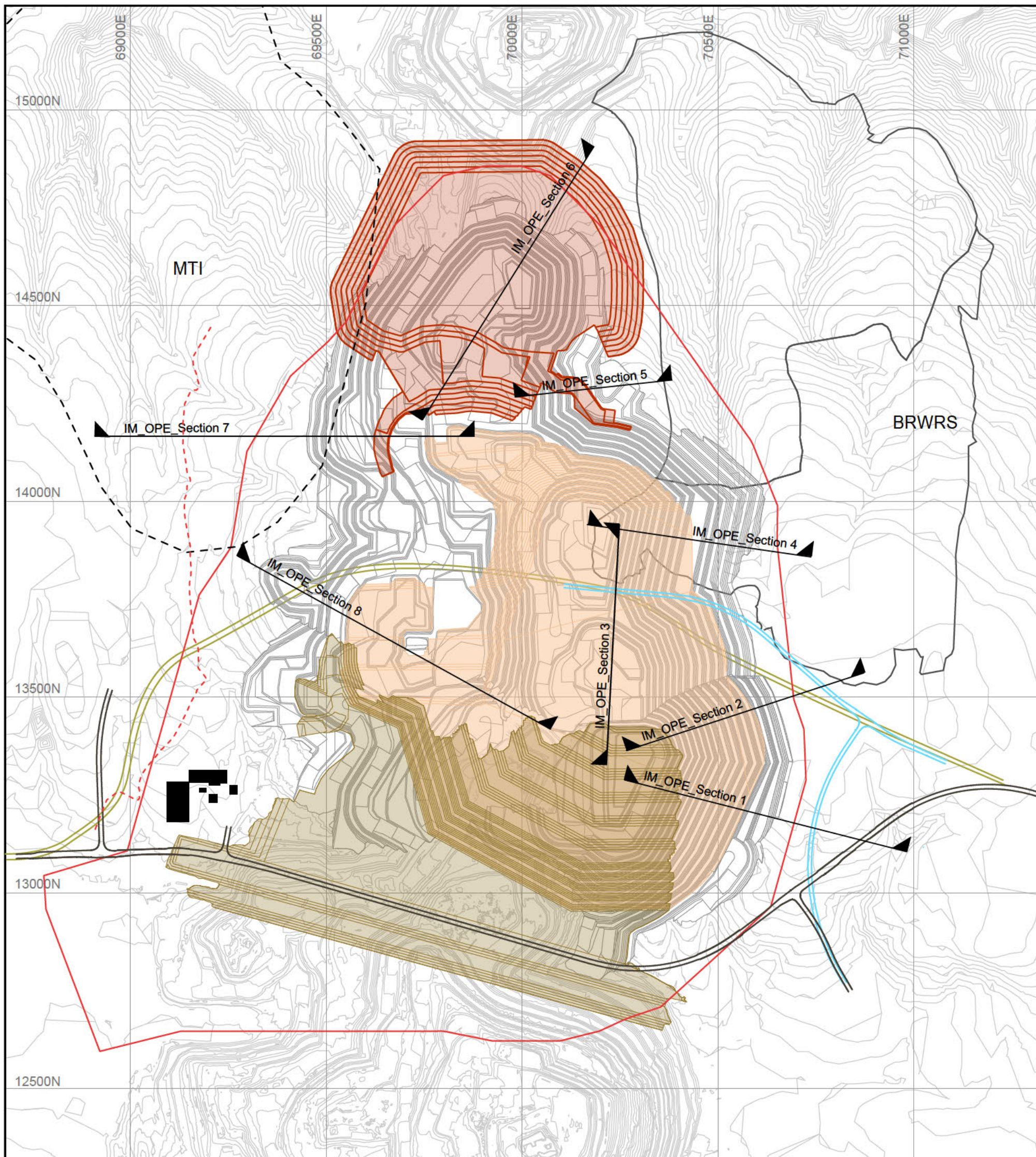


OceanaGold (New Zealand) Limited
Macraes Phase Four Project
Open Pit Extensions

INNES MILLS
CROSS SECTION LOCATIONS

PSM71-363R

Figure 3



LEGEND

- | | | |
|--|--|---|
| As-mined Surface (<i>site_as_mined_251106</i>) | As-built Waste Rock Stack Footprint (<i>Feb_2024</i>) | FF surface expression |
| Open Pit Workshop (<i>260211_Workshop_Buildings</i>) | Mixed Tailings Impoundment Boundary | Maximum pit lake level at closure - 489 mRL |
| MP4 Proposed Pit Shells | Stability Cross Svection | |
| Innes Mills Backfill 1 (<i>IMBF1_260205</i>) | Current Macraes Road | |
| Innes Mills Backfill 2 (<i>IMBF2_251202</i>) | Macraes Road Realignment Stage 1 (<i>STAGE 1 3D STRINGS AND SURFACE</i>) | |
| Innes Mills Backfill 3 (<i>IMBF3_251202</i>) | Macraes Road Realignment Stage 2 (<i>3D DESIGN STAGE 2</i>) | |
| | Open Pit Disturbance Boundary (<i>250811_IM_MP4FAST_PIT_POLYGON_2025_LINE</i>) | |

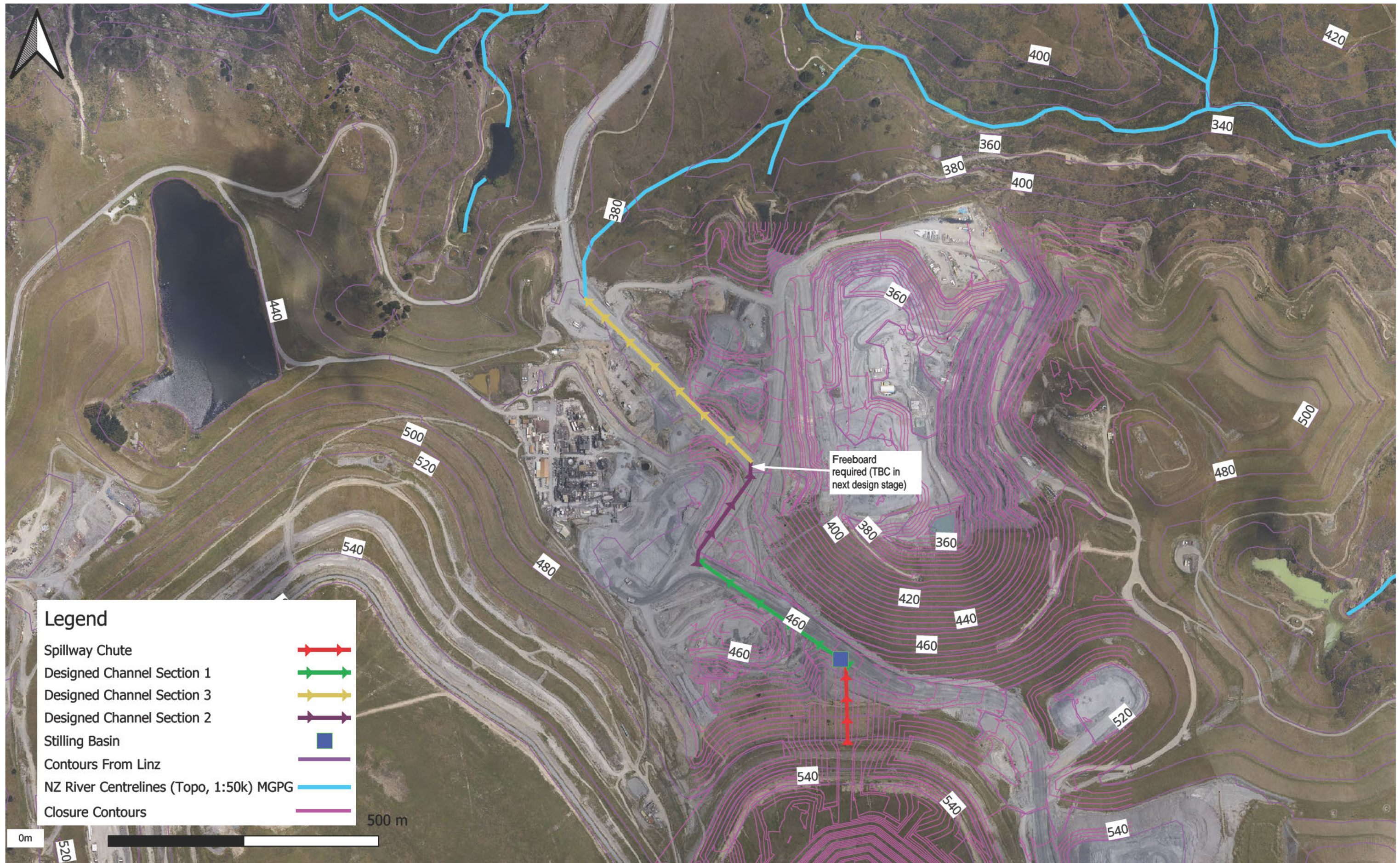
0 100 200 300 400 500
Scale (m)



OceanaGold (New Zealand) Limited
Macraes Phase Four Project
Open Pit Extensions
INNES MILLS
IN-PIT BACKFILLS & SECTION LOCATIONS

PSM71-363R

Figure 4



APPENDIX B
MACRAES MP4 MTI AND SP11A QUANTITATIVE RISK ASSESSMENT

1.0 INTRODUCTION

Oceana Gold (New Zealand) Limited (OGNZL) is proposing an extension to their Macraes Operation. The Macraes Phase Four (MP4) project seeks to extend the consented mine life for at least 10 years and is being progressed under the Fast Track Approvals Act 2024 (FTAA).

A Quantitative Risk Assessment (QRA) has been undertaken by Engineering Geology Limited (EGL) to support and inform the risk-informed decision making (RIDM) approach for the Mixed Tailings Impoundment (MTI), Southern Pit Option 11A (SP11A) and Innes Mills Backfill Embankment (IMBE) Tailings Storage Facilities (TSF) for the proposed interaction with mining of IM12 and IM13 Pits.

This Appendix outlines the methodology, inputs, assumptions and results of the QRA for effects on existing TSFs due to the MP4 proposal. Four Potential Failure Modes (PFMs) have been assessed as part of this QRA.

This document should be read in conjunction with its parent report.

2.0 SITE SETTING AND PROJECT DESCRIPTION

OGNZL currently manages four TSFs, listed below in order of development:

- Mixed Tailings Impoundment (MTI)
- Southern Pit Option 11A Tailings Storage Facility (SP11A), including the IMBE
- Top Tipperary Tailings Storage Facility (TTTSF)
- Frasers Tailings Storage Facility (FTSF)

The current Macraes Operation is underpinned by open pit mining at Innes Mills and Coronation North, and underground mining at Golden Point. MP4 proposes to mine IM11, IM12 and IM13 (South and North), Golden Bar Open Pit Stage 2, Coronation Pit and Coronation North Pit, and GPUG.

The IM Pit works will affect the existing TSFs; MTI, SP11A and IMBE.

IM11 and IM12 pits increases the size of the open pit south of IMBE and Macraes Road. IM13 mines through IMBE to the previous Southern Open Pit area now beneath SP11A. To enable access to IM13, tailings currently stored in the SP11A will be relocated by hydraulic mining, and the SP10 embankment and the IMBE will be deconstructed. The SP11A embankment will remain in part requiring modification in operation and closure.

Mining of IM13 is below and downslope of the eastern side of MTI. To address potential mining effects on MTI, the project proposes the relocation of tailings behind the upstream lifts of the MTI. This is an approximate 33 m reduction in MTI crest height.

A detailed overview of the Macraes Operation and the MP4 scope, including the proposed mining staging, is provided in the parent report.

3.0 QRA PURPOSE

- Identify critical risk mitigation controls required for MTI, SP11A and IMBE stability during the proposed MP4 works,
- Identify potential risk reduction measures, for MTI, SP11A and IMBE during the proposed MP4 works,
- Identify risks which require further work to assess during detailed design, and
- Report recommendations.

The above will inform the RIDM approach to the dam safety management and design of MTI, SP11A and IMBE for the proposed IM11, 12 and IM13 mining stages as part of MP4.

EGL notes this QRA only assesses the risk to loss of life. Other potential consequences such as social, business and financial consequences are not part of this assessment.

4.0 RISK MANAGEMENT APPROACH

4.1. Dam Safety Risk Framework

As defined by FEMA (Ref. 1), dam safety management using risk to inform decisions involves three distinct components. These components each having their own purpose and function, are:

- Risk analysis
- Risk assessment
- Risk management

Risk Analysis is the first step of the Dam Safety Risk Framework. In the context of the MP4, this stage involves a preliminary qualitative assessment of PFMs to identify credible and critical failure modes, along with potential mitigation measures and controls. The outcomes of this assessment and list of PFMs are summarised in Section 14 of the parent report. The identified PFMs are then screened to determine critical failure modes, which are subsequently subject to quantitative risk estimation.

Risk assessment follows the risk analysis and is the process of evaluating the outcomes of the risk analysis against the risk tolerability criteria. The outcome of the risk assessment are recommendations to inform dam safety decision making.

Risk management is the overarching activity of incorporating the recommendations from the risk analysis and risk assessment to into dam safety management. Risk management through the use of a management plan is discussed in Section 15 of the parent report.

4.2. QRA Methodology and Risk Estimation

The methodology of the QRA is:

- Prioritise the risk-driving PFMs by undertaking a qualitative risk screening,
- Develop event trees for the main risk-driving PFMs,
- Assign likelihoods and consequences of the various branches of the event trees and reference supporting information,
- Assess life risk for each PFM, calculate total life risk and compare against societal risk tolerability limits,

- Identify risk reduction measures and review against as low as reasonably practical (ALARP) principle, and
- Develop recommendations for risk reduction or mitigation measures.

Four (4) PFMs from the preliminary qualitative risk assessment were identified as credible and critical failure modes (i.e. risk-driving PFMs) for further quantitative risk estimation.

Risk estimation is then undertaken through the development of 9 event trees to evaluate the key risk drivers associated with each potential failure mode, including loading frequencies (such as earthquakes and floods) and the probability of the dam and its components responding in a particular manner. The event trees trace the progression from the initiating event through a sequence of conditional outcomes to dam failure and the resulting consequences, including potential loss of life.

The estimated risk to loss of life is then evaluated against the risk tolerability criteria to determine whether it is acceptable. For the PFMs that either do not meet, or are close to exceeding, the tolerability criteria, additional mitigation measures and controls are identified and assessed. An additional event tree was subsequently developed for these PFMs to incorporate the proposed mitigation measures and controls, enabling an assessment of their effectiveness in reducing risk to a tolerable level.

A total of 10 event trees were evaluated as part of this QRA.

Where multiple potential loss of life (PLL) possibilities are present in the final branch of an event tree, the PLL is assessed as a weighted average life loss when compared to the risk tolerability criteria.

4.3. Risk Tolerability Criteria

For the purposes of this QRA, the limit of tolerability adopted is based on loss of life (F-N plot) for existing dams as presented in the ANCOLD guidelines (2022, Ref. 2), shown in Figure 1a below.

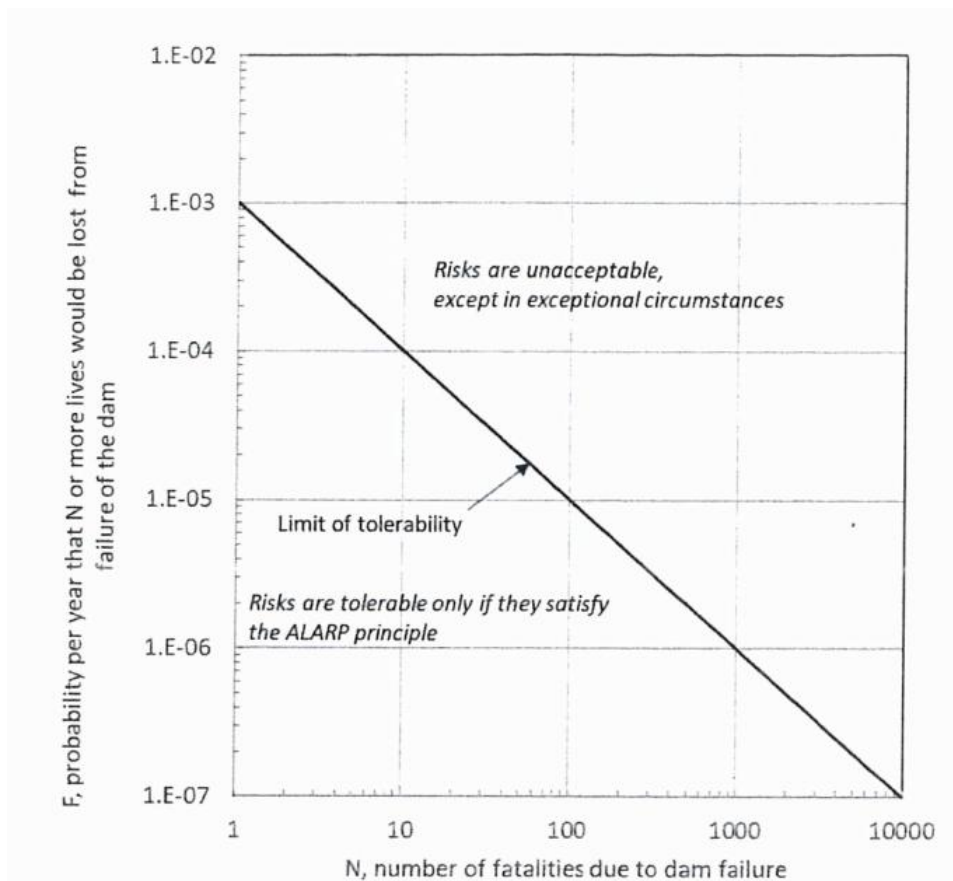


Figure 7.4 – ANCOLD Societal Risk Guideline: Existing Dams

Figure 1a: Excerpt from ANCOLD 2022. Societal Risk Guideline for Existing Dams

In addition to achieving risk tolerability, GISTM (Ref. 3) and ANCOLD both recommend that the principle of As Low As Reasonably Practicable (ALARP) is achieved. Risks are considered to be ALARP if reduced to the extent that the sacrifice (i.e., cost, time) in implementing further risk reduction is grossly disproportionate to the level of risk reduction achieved.

ANCOLD (Ref. 2) guidance recommends the ALARP principle be applied indefinitely below the limit of tolerability as the primary basis for determining the tolerable risk.

FERC (Ref. 6) provides recommendations for defining a boundary line between where risks are intolerable unless ALARP conditions are satisfied and risks are generally tolerable. The FERC boundaries are presented below in Figure 1b.

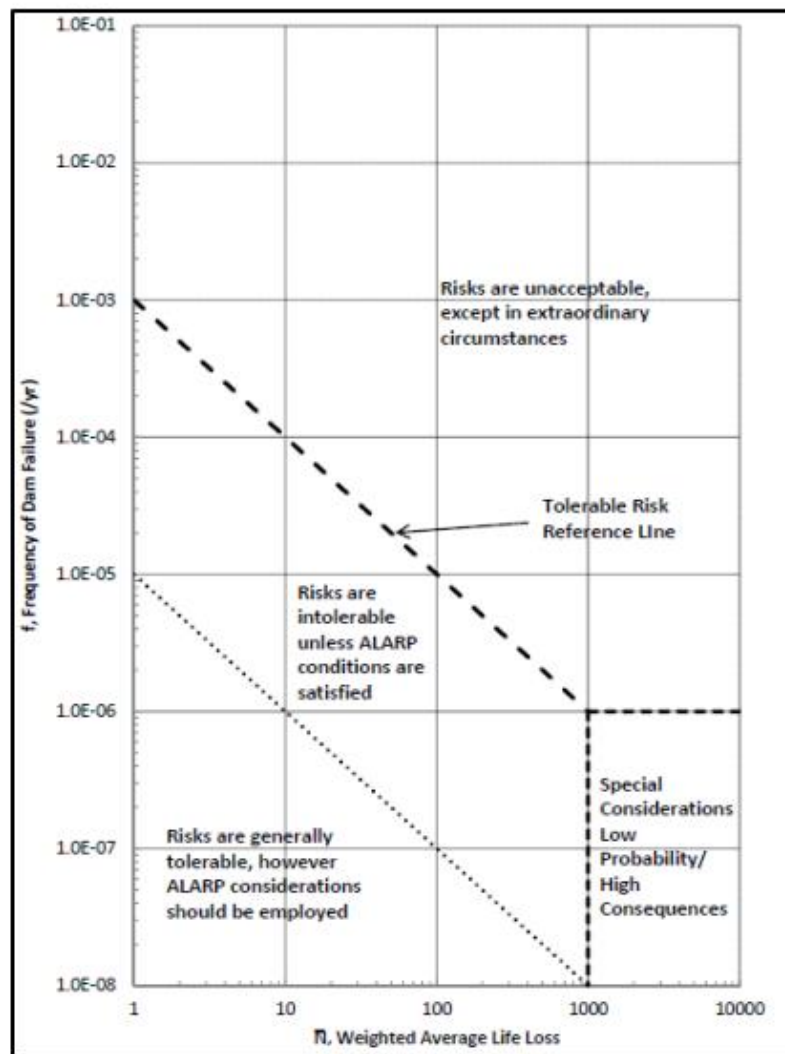


Figure 1b: Excerpt from FERC (Ref. 6), Figure 3-3.

5.0 PFM RISK REGISTER

A preliminary review of potential failure modes was undertaken for the following MP4 stages:

- Hydraulic mining of SP11A (including IM12 effects on IMBE),
- Hydraulic mining of MTI,
- Mining down dip of Footwall Fault at MTI, and
- SP11A Embankment in Closure.

27 PFMs were assessed to be credible and are summarised in Section 14 of the parent report. These PFMs were screened qualitatively based on likelihood of occurrence. Four critical PFMs were subsequently selected for assessment as part of the QRA:

- IMBE failure due to IM Pit mining causing geotechnical instability of the IM North-wall and/or West-wall and IMBE resulting in release of tailings into IM Pit (Stages IM11 and IM12). (HMSP11-PFM2)
- Embankment failure due to IM Pit mining causing geotechnical instability of the IM North Wall and/or West Wall while MTI upstream raises are still in place. Resulting in release of tailings into IM Pit, or into the Process Plant, Golden Point Underground and Deepdell Creek. (MMTI-PFM1 and 2)

- Failure of upstream embankment on north eastern end of MTI due to mining of IM Pit causing cracking of embankment leading to piping through the embankment and release of tailings. (MMTI-PFM3)

6.0 QUANTITATIVE RISK ASSESSMENT

6.1. Scenarios Assessed

The following event trees were developed for each critical PFM scenario. Note previously event trees were developed internally for mining activities, and therefore event trees of MP4 related activities commence at '3'. The locations of the assumed failure mechanism are presented in the figure below.

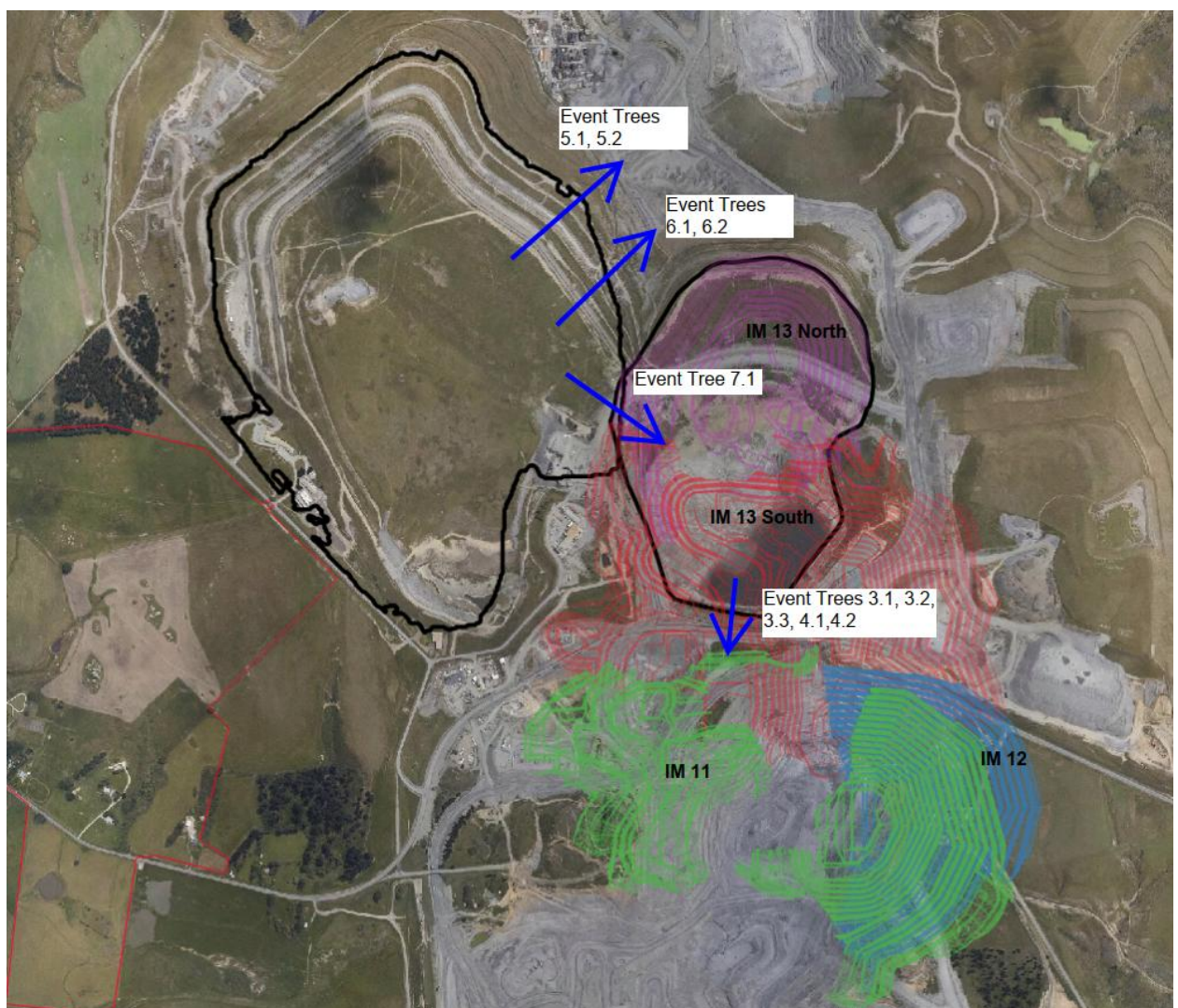


Figure 1c: Summary assumed failure locations for Event Trees

Table 1: Summary of Event Trees

PFM ID	Description	Event Tree ID	Event Tree Description
HMSP11-PFM2	IMBE failure due to IM Pit mining causing geotechnical instability of the IM North-wall and/or West-wall and IMBE resulting in release of tailings into IM Pit (Stages 11 and 12).	Tree 3.1 PFM: IM12 Mining Effect (Piping) Normal	Failure mode: Piping Operating condition: Normal Population at risk (PAR): Travellers on Macraes Road Controls: Daily road visual inspection This scenario assumes piping is initiated by movement/transverse cracking of IMBE caused IM12 under normal operating conditions. The assessed displacement magnitude from outputs of PSM's 3D model and projected movement from EGL's review of recent InSAR monitoring was used as the base case for Branch 1 (i.e. 3 to 5 m of displacement). Piping failure is assumed to be induced by fluid flow through transverse cracks from the operating pond to the downstream face in Branch 2. Transverse cracks are assumed to propagate from the foundation of IMBE. The failure mechanism leading to risk of loss to life for travellers on Macraes road is the formation of sinkholes or embankment instability due to piping of the embankment, with no successful intervention before people encounter the hazard on Macraes Road.
		Tree 3.2 PFM: IM12 Mining Effect (Piping) Flood	Failure mode: Piping Operating condition: Normal and Flood PAR: Travellers on Macraes Road Controls: Daily road visual inspection Tree 3.2 assumes piping is initiated by movement/transverse cracking of IMBE caused IM12 under normal and flood operating conditions. This tree is largely similar to Tree 3.1, with the addition of flood scenarios that increases risk to

PFM ID	Description	Event Tree ID	Event Tree Description
			piping causing sinkholes or instability to Macraes Road due to rise in water in the operating pond. Branches 2 and 3 of Tree 3.1 are combined into Branch 3 for Tree 3.2, under the heading 'probability of sinkhole development or instability arising from piping'. This branch is assessed using a sub-branch that considers the return interval of different flood scenarios.
		Tree 3.3 PFM: IM12 Mining Effect (Piping) Seismic	Failure mode: Piping Operating condition: Normal and Seismic PAR: Travellers on Macraes Road Controls: Daily road visual inspection Tree 3.3 assumes piping is initiated by movement/transverse cracking of IMBE caused IM12 under normal (less than 1 in 150-year AEP event) and great AEP seismic conditions. This tree is largely similar to Tree 3.1, with the addition of seismic scenarios to Branch 1 that increases likelihood of transverse crack formation and magnitude of crack formation on the IMBE, which is summarised in Branch 2. The likelihoods of fluid flowing through transverse cracks are also increased due to seismic events, as summarised in Branch 3.
		Tree 4.1 PFM: IM12 Mining Effect on Road (Slope Instability)	Failure mode: Embankment Instability Operating condition: Normal PAR: Travellers on Macraes Road Controls: 24-hr Automated Road Monitoring and alert systems This scenario assumes that a rapid stability failure of the IMBE embankment and rock ridge is initiated by mining of IM12 under normal operating conditions. If displacements are within the design expectations based on PSM 3D stability assessment the pit walls, this failure mechanism is not expected to occur. The assessed likelihood of rapid movement (Branch 1) being initiated (i.e. outside of design expectation) is based on EGL's understanding of historical West Wall

PFM ID	Description	Event Tree ID	Event Tree Description
			movement rates, for which 1 case of rapid movement was recorded in the previous 2 decades of operation. The assessment of the likelihood of impact from rapid movement affecting travellers on Macraes Road assumes that full traffic management TARPs are implemented and that 24-hour monitoring of ground movement is maintained. Under these conditions, OGNZL would be able to provide advance warning and, in most circumstances, close Macraes Road to travellers before hazardous movement affects the roadway. EGL notes this failure mechanism is largely mining controlled and is not significantly influenced by dam safety controls.
		Tree 4.2 PFM: IM12 Mining Effect on Pit (Slope Instability)	Failure mode: Embankment Instability Operating condition: Normal PAR: Workers in IM Pit Controls: Existing mining controls, including continuous radar pit monitoring Tree 4.2 assumes that a rapid stability failure of the IMBE embankment and IM Pit North Wall is initiated by mining of IM12 under normal operating conditions. This event tree is largely the same as Tree 4.1; however, the likelihood of the hazard associated with rapid movement (Branch 2) is assessed against a PAR of workers within the IM Pit. It would require substantially larger movement of the IMBE and failure of the IM Pit north wall to impact workers of the IM Pit. EGL notes this failure mechanism is largely mining controlled and is not significantly influenced by dam safety controls.
MMTI-PFM1	Embankment failure due to IM Pit mining causing geotechnical instability of the IM	Tree 7.1 PFM: IM13 Mining Slope Instability into IM13 Pit	Failure mode: Embankment Instability Operating condition: Normal PAR: Workers in IM Pit

PFM ID	Description	Event Tree ID	Event Tree Description
	North Wall and/or West Wall while MTI upstream raises are still in place. Resulting in release of tailings into IM Pit (Stage IM13)		Controls/MTI status: Hydraulic mining may not yet removed upstream embankments. Existing mining controls apply. This scenario assumes that a rapid stability failure of the MTI embankment and rock ridge between MTI and the IM 13 South Pit. This stability failure is initiated by mining of IM13 South pit or IM13 North pit under normal operating conditions. This event tree is largely the same as Tree 4.1. If displacements are within the design expectations based on PSM 3D stability assessment the pit walls, this failure mechanism is not expected to occur. EGL notes this failure mechanism is largely mining controlled and is not significantly influenced by dam safety controls.
MMTI-PFM2	Embankment failure due to IM Pit mining causing geotechnical instability of the IM North Wall and/or West Wall while MTI upstream raises are still in place. Resulting in release of tailings into the Process Plant, Golden Point Underground and Deepdell Creek.	Tree 5.1 PFM: IM13 mining causes static liquefaction failure of Section J through M upstream lifts Normal	Failure mode: Embankment Instability Operating condition: Normal PAR: Workers in Process Plant, GPUG and GP Pit (averaged across Sections J through M) MTI status: Hydraulic mining has not yet removed upstream embankments The failure mechanism for Tree 5.1 is assumed to be initiated by displacement at the eastern embankment of MTI due to mining of IM13 South, leading to static liquefaction and flow failure. The critical stage is assessed to be when upstream embankments remain, which is prior to the mining of IM 13 North. Branch 1 considers whether the eastern embankment displacement is within design expectations (i.e. within the displacement magnitudes of the outputs of the PSM 3D model, i.e. ~1 m, if the base case mining sequence is adhered to). Displacements not within the design expectations, or displacements due to uncontrolled mining sequence is assumed to be 2 to 10x greater in magnitude (i.e. ~2 to 10 m).

PFM ID	Description	Event Tree ID	Event Tree Description
			The likelihood of flow failure is based on outputs of the existing MTI stability assessment of the eastern embankment sections, which considers liquefied tailings strength scenarios. Successful intervention to avoid loss to life is considered to be unlikely due to the rapid nature of this failure mechanism.
		Tree 5.2 PFM: IM13 mining causes liquefaction failure of Section J through M upstream lifts Normal & Seismic	Failure mode: Embankment Instability Operating condition: Normal and Seismic PAR: Workers in Process Plant, GPUG and GP Pit (averaged across Sections J through M) MTI status: Hydraulic mining has not yet removed upstream embankments. Controls: Adherence to existing site evacuation procedure for earthquakes. This event tree is similar to Tree 5.1; however, it takes into consideration seismic events. Liquefaction triggering likelihood increases with greater return interval events, and is based on outputs of the existing MTI stability assessment which includes a liquefaction triggering assessment. Successful intervention to avoid loss to life is considered to be slightly more likely than Tree 5.1 as the PAR would be evacuated immediately in the event of an earthquake.
MMTI-PFM3	Failure of upstream embankment on north eastern end of MTI due to mining of IM Pit causing cracking of embankment leading to piping	Tree 6.1 PFM: IM13 mining causes cracking of upstream lifts or downstream embankment and results in piping failure under flood conditions in the area of east of section M (no control on	Failure mode: Piping Operating condition: Normal and Flood PAR: Workers in GPUG and GP Pit (Section M) MTI status: Hydraulic mining has not yet removed upstream embankments. Controls: Hydraulic mining pontoon sump assumed to be at location of pre-feasibility study, adjacent to the MTI eastern embankment

PFM ID	Description	Event Tree ID	Event Tree Description
	through the embankment and release of tailings.	location of hydraulic mining pontoon)	The failure mechanism considered is piping underneath upstream embankments, initiated by movement/transverse cracking at the eastern embankment of MTI due to mining of IM13 South, leading to subsidence of the upstream embankments and overtopping. The critical stage is assessed to be when upstream embankments remain, which is prior to the mining of IM 13 North. This scenario assumes surface water of MTI will be directed to the hydraulic mining sump location, which comes into contact or close to the upstream embankment during a flood event. Branch 1 considers whether the eastern embankment displacement is within design expectations (i.e. within the displacement magnitudes of the outputs of the PSM 3D model, i.e. ~1 m, if the base case mining sequence is adhered to). Displacements not within the design expectations, or displacements due to uncontrolled mining sequence is assumed to be 2 to 10x greater in magnitude (i.e. up to 10 m). Branches 3 and 4 considers the likelihood of subsidence causing instability and overtopping based on the flood return interval. Intervention is unlikely to be successful in the normal operating case as the area is not assumed to be monitored daily. As the flood return interval increases, there is more likely to be active monitoring of the MTI flood condition and therefore the likelihood of unsuccessful intervention to prevent loss to life is slightly reduced. Overtopping of the eastern embankment is assessed to be plausible only near Section M, where the proposed hydraulic mining sump is to be located. Therefore the PAR considers workers in GP Pit and GPUG.
		Tree 6.2 PFM: IM13 mining causes cracking of upstream lifts or downstream	Failure mode: Piping Operating condition: Normal and Flood PAR: Workers in GPUG and GP Pit (Section M)

PFM ID	Description	Event Tree ID	Event Tree Description
		embankment and results in piping failure under flood conditions in the area of east of section M (Setback location of hydraulic mining pontoon)	MTI status: Hydraulic mining may not yet removed upstream embankments. Controls: Hydraulic mining pontoon and sump assumed to be located away from MTI upstream embankments such that a PMP event does not result in water ponding against eastern upstream embankment. This scenario is equivalent to Tree 6.1; however, it assumes the hydraulic mining sump is located in the southern and western extents of MTI away from the upstream embankments. This decreases the likelihood of surface water in contact with the upstream embankments under flood conditions. Particularly Sections J to M.

6.2. Inputs and Assumptions

Risk estimation for this QRA is based on EGL's understanding of the design and construction, annual performance monitoring and recent work related to PFMs including:

1. Limit equilibrium post-earthquake stability Factors of Safety (FOS) for existing MTI stability, undertaken by EGL (Appendix F and G, MTI Stability Report – DRAFT)
2. 3D modelling of IM Pit stages undertaken by PSM (PSM Open Pit Report PSM71-363R. Ref. 4)
3. Estimation of different flood levels on MTI, undertaken by EGL
4. MTI Dam Breach assessment undertaken by EGL in 2024, which also contains the survey of the Population at Risk (PAR) onsite (Ref. 5)
5. InSAR monitoring data reviewed in July and August 2026
6. MTI Liquefaction Triggering Assessment, which evaluates the percentage of liquefaction triggering in relation to different return interval EQs, undertaken by EGL (Appendix C, MTI Stability Report – DRAFT)
7. Dynamic time history analysis using the constitutive model PM4 Sand for MTI, which assesses rise in phreatic surface after EQ, undertaken by EGL (Appendix E, MTI Stability Report – DRAFT)

PSM's 3D model output of magnitude of displacement has been adopted as the base 'design' case for all event trees. Where applicable, this base case was supplemented by InSAR monitoring results and linearly projected movements from current rate of movement.

Displacements greater than PSM's model have also been considered to account for uncertainty in modelling.

Project mining sequence has been assumed for Trees 5 and 6, i.e. removal of MTI upstream embankments prior to the commencement of IM13 North mining. This is presented in Section 5 of the parent report.

6.3. Assessment of Potential Consequences

The consequences considered in this QRA is the PLL, both to the public and to workers within Macraes Operation.

PAR used to determine PLL is largely based on the dam breach assessment undertaken for the MTI and SP11A in 2024.

7.0 QRA OUTCOMES

The appended Figures 2 and 3 contain summary plots of the annual probability of failure and PLL for each event tree, compared against the risk tolerability criteria.

The scenarios generally plot below the ANCOLD limit of tolerability line, except for Tree 6.1. Additional controls were therefore considered as part of Tree 6.2 and the annual probability of failure re-assessed. Tree 4.1 plots very close to the limit of tolerability and additional controls are required to achieve ALARP, as set out in the section below.

EGL notes the failure mechanism for trees 4.1, 4.2 and 7.1 is largely mining controlled and is not greatly influenced by dam safety controls.

8.0 ALARP CONSIDERATION AND RECOMMENDED MITIGATIONS AND CONTROLS

While the proposed controls result in annual probability of failure and PLL for all PFM scenarios to be below the ANCOLD limit of tolerability line, ALARP conditions must also be met.

Reduction of risk to ALARP can be demonstrated by taking all reasonable steps that are practical to reduce risks. This includes during TSF planning, design, monitoring, management, and also through elimination or avoidance of risk.

The QRA demonstrates some failure mechanisms are very close to the limit of tolerability, especially IMBE failure due to IM Pit mining causing geotechnical instability of the IM North-wall and/or West-wall. Therefore, the following controls and mitigation measures are recommended to reduce risks to ALARP. This is a non-exhaustive list and additional risk reduction and mitigations measures should be considered at every stage of design and operation.

Effective control surface water to avoid re-saturation of the tailings, including:

1. Re-locate MTI hydraulic mining decant pond to the south and west, away from the Footwall Fault, or maintain storage freeboard on MTI such that water does not approach north eastern upstream embankment under a PMP flood event (per Tree 6.2)
2. Dry mining of areas of MTI adjacent to the upstream embankments to avoid introducing water through hydraulic mining
3. Relocation of Process Plant Turkeys Nest above SP11A
4. Minimising TSF operating ponds to lowest practicable levels, or relocate operating ponds to be set back from anticipated embankment movement

Adopt additional monitoring and/or traffic management controls:

5. Implement additional site monitoring for Macraes Road, including real-time radar, inclinometer, fibre optics, and piezometers. Develop Trigger Action Response Plans (TARPs) linked to traffic management of Macraes Road. The assessment of tolerability for Tree 4.1 assumes full traffic management TARPs are adopted and 24 hr surveillance of road movement is implemented.
6. Adopt automatic real-time warning systems for motorists and pit workers that are linked to monitoring stations (to address residual risks under Trees 4.1 and 4.2).

Improve displacement model reliability:

7. Calibrate 3D stability models used for displacement assessments and proactively review and update models throughout operation.

Eliminate risk of upstream embankment instability where practicable:

8. The base case adopted in the assessment assumes adherence to proposed project sequencing. Where practical, OGNZL should consider earlier removal of MTI upstream embankments.

Other measures that would eliminate the risk, however are likely not economically viable (and therefore do not meet ALARP), include:

1. Relocation of Macraes Road away from IMBE before the commencement of IM11 and IM12 mining.
2. Closing the Golden Point Underground.
3. Relocating the Process Plant.
4. Conclude mining within Golden Point pit.

9.0 DOCUMENT CONTROL

Document Prepared By: Julie Zou and Sophia Zhou

Document Reviewed By: Eric Torvelainen

Document Approved for issue on behalf of EGL By: Eric Torvelainen

Revision 0 issued 21 August 2026

Attachments:

Summary of Population at Risk
Event Trees

10.0 REFERENCES

1. Federal Emergency Management Agency (FEMA). '*Federal Guidelines for Dam Safety Risk Management*', FEMA P-1025, January 2015.
2. Australian National Committee on Large Dams (ANCOLD). (2022). '*ANCOLD Guidelines on Risk Assessment*', July 2022.
3. International Council on Mining & Metals (ICMM). (2020). '*Global Industry Standard on Tailings Management (GISTM)*', August 2020.
4. PSM Pty Ltd. (2026). *Macraes Phase Four Project, Open Pit Extensions - Geotechnical Stability*. PSM Ref: PSM71-363R
5. Engineering Geology Ltd. (2025). Macraes Operation, *Mixed Tailings Impoundment and Southern Pit Option 11A Tailings Storage Facilities Dam Breach and Potential Impact Classification Assessment*. EGL Ref. 8266
6. Federal Energy Regulatory Commission (2016) *Risk-Informed Decision Making Guidelines, Chapter 3, Risk Assessment* <https://cms.ferc.gov/sites/default/files/2020-04/chapter-3.pdf>

Event Tree Summary

Tree 3.1 PFM: IM12 Mining Effect (Piping) Normal

Tree 3.2 PFM: IM12 Mining Effect (Piping) Flood

Tree 3.3 PFM: IM12 Mining Effect (Piping) Seismic

Tree 4.1 PFM: IM12 Mining Effect on Road (Slope Instability)

Tree 4.2 PFM: IM12 Mining Effect in Pit (Slope Instability)

Tree 5.1 PFM: IM13 mining causes static liquefaction failure of Section J through M
upstream lifts Normal

Tree 5.2 PFM: IM13 mining causes static liquefaction failure of Section J through M
upstream lifts Normal & Seismic

Tree 6.1 PFM: IM13 mining causes cracking of upstream lifts or downstream embankment
and results in piping failure under flood conditions in the area of east of section M
(no control on location of hydraulic mining pontoon)

Tree 6.2 PMF: IM13 mining causes cracking of upstream lifts or downstream embankment
and results in piping failure under flood conditions in the area of east of section M
(Setback location of hydraulic mining pontoon)

Tree 7.1 PMF: IM13 Mining Slope Instability into IM13 Pit

Table 2. Summary of Annual Probability of Failure for the event tree caused by IM12 Mining

MTI PFM	PLL	Annual Probability of Failure
Tree 3.1	1.2	1.85E-07
Tree 3.2	1.2	2.89E-06
Tree 3.3	1.2	3.00E-07
Tree 4.1	1.4	7.46E-04
Tree 4.2	2.3	1.50E-04

Table 3. Summary of Annual Probability of Failure for the event tree caused by IM13 Mining

MTI PFM	PLL	Annual Probability of Failure
Tree 5.1	40	1.08E-07
Tree 5.2	40	4.03E-07
Tree 6.1	28	8.32E-05
Tree 6.2	28	1.10E-06
Tree 7.1	2.3	1.50E-04

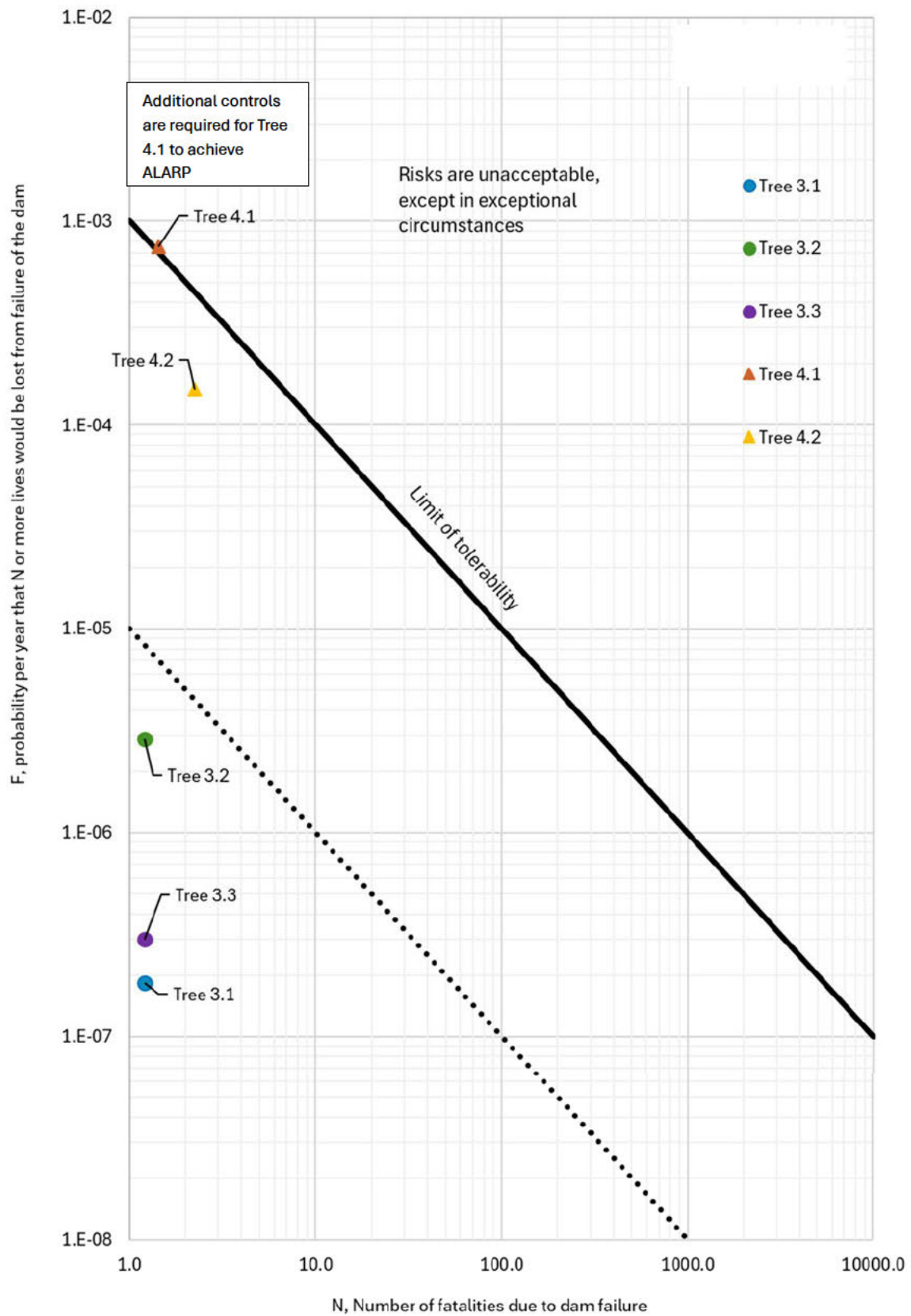


Figure 2. Societal risk assessment for IM12 Mining.

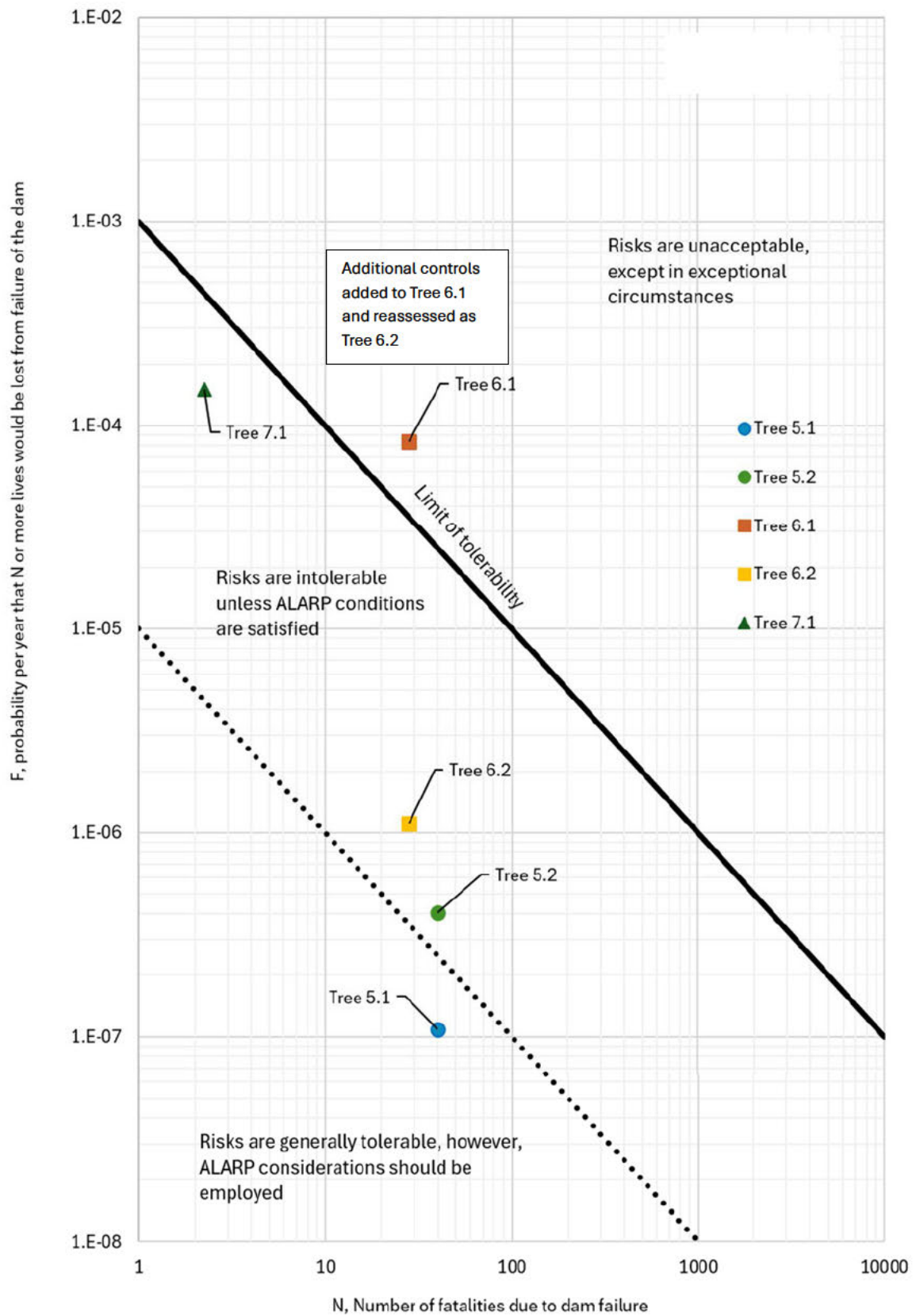
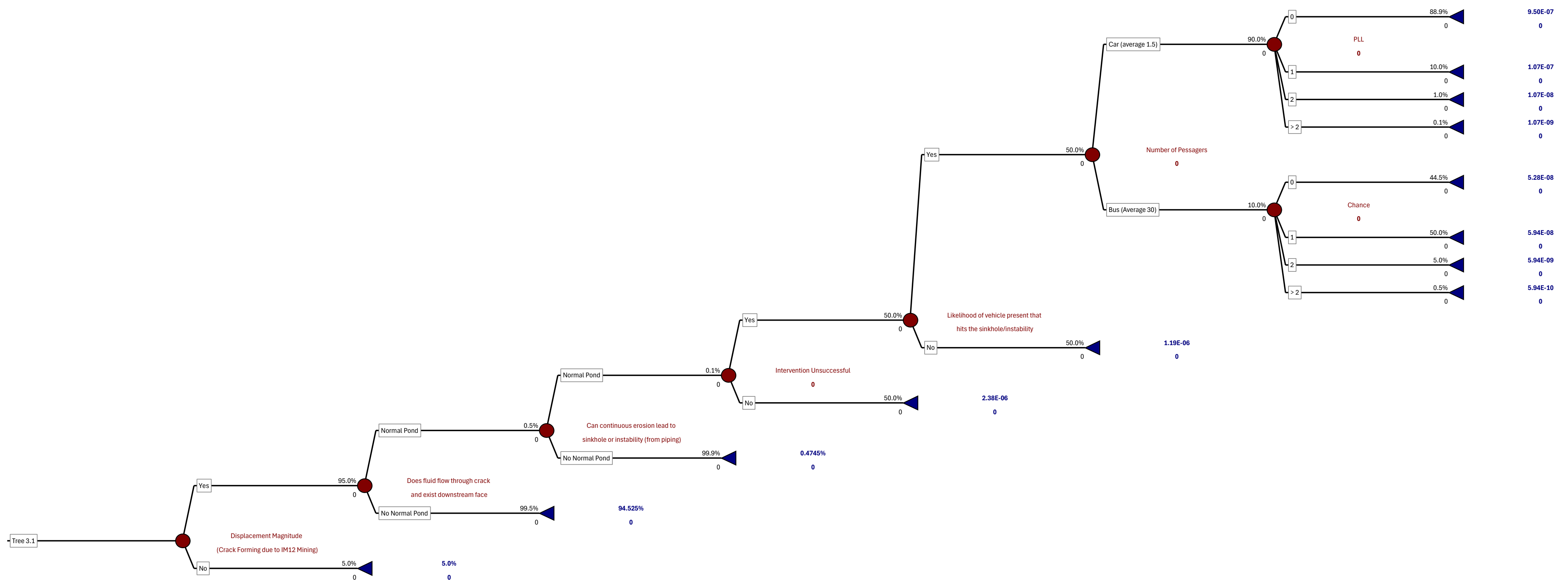


Figure 3. Societal risk assessment for IM12 Mining.

2	1%
> 2	0.1%
0	45%
1	50%
2	5%
> 2	0.5%

Annual Probability	1.85E-07
1 in	5,418,953

Category	Percentage
Chance	0
0	44.5%
0	50.0%
0	5.0%

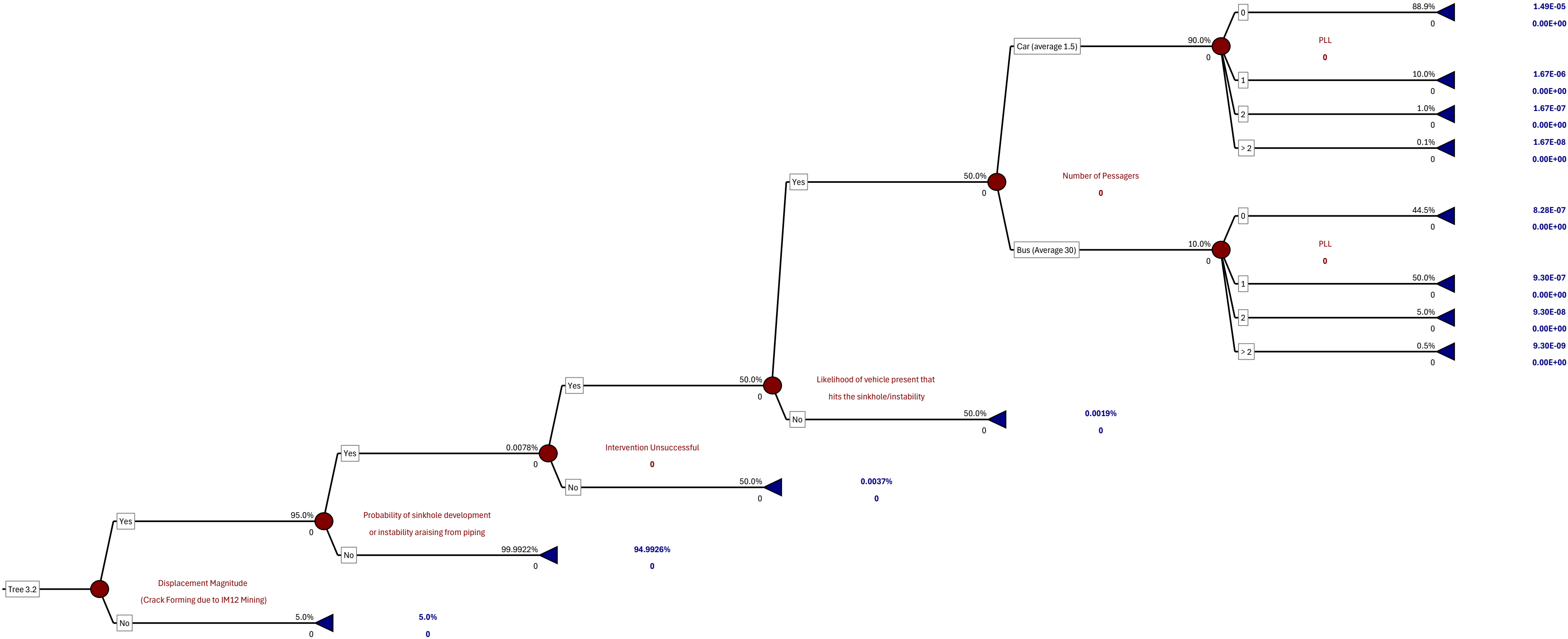


Displacement Magnitude (Crack Forming due to IM12 Mining)	Probability of sinkhole development or instability arising from piping	Intervention Unsuccessful	Likelihood of vehicle present that hits the sinkhole/instability	Number of Passagers	PLL	Probability of Damage
Yes	Yes	Yes	Yes	Car (average 1.5)	0	2.89E-06
95%	7.83375E-05	50%	50%	90%	89%	
No	No	No	No	Bus (Average 30)	1	
5%	1.00E+00	50%	50%	10%	10%	
					2	
					1%	
					> 2	
					0.1%	
					0	
					45%	
					1	
					50%	
					2	
					5%	
					> 2	
					0.5%	

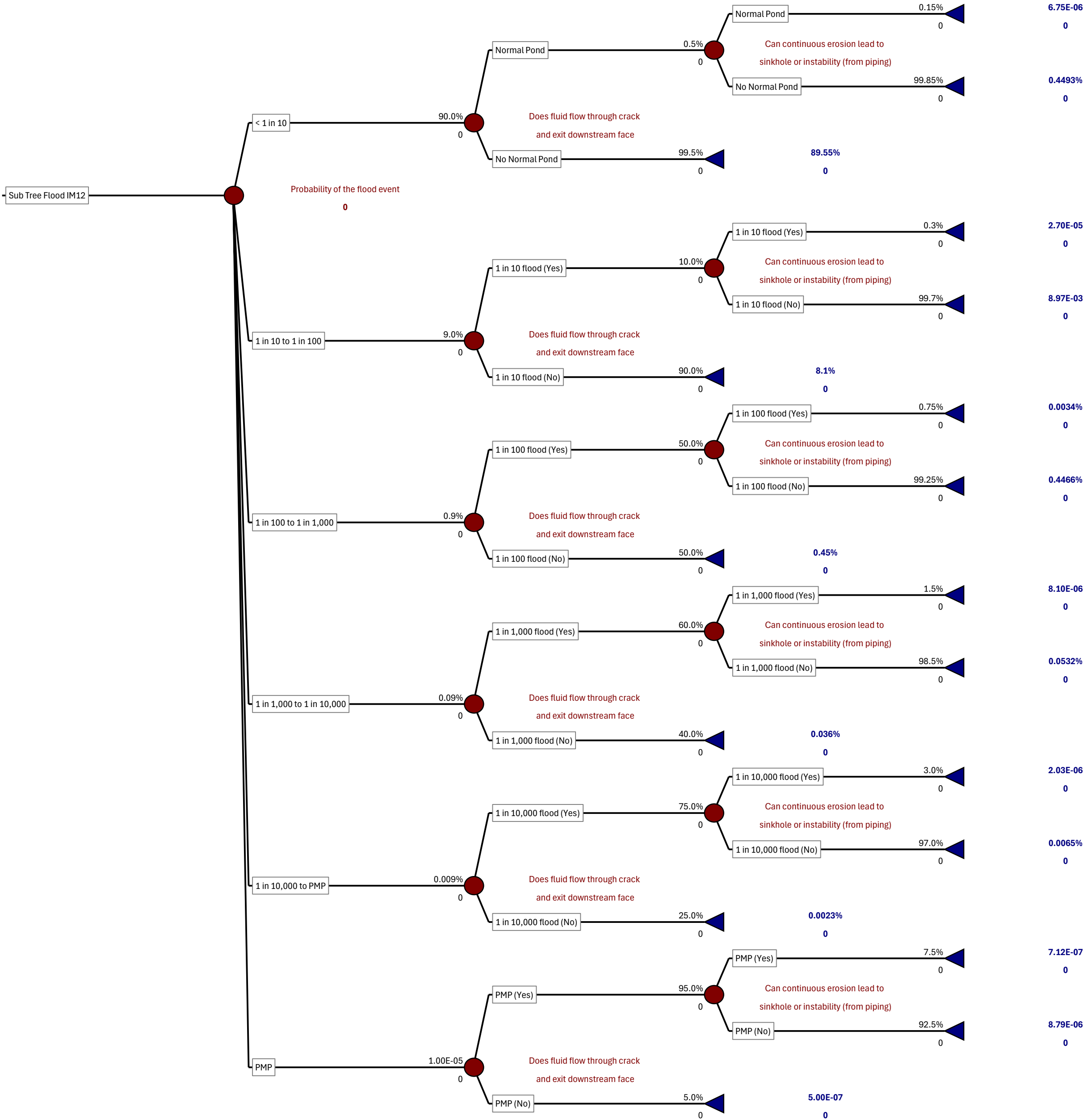
Tree 3.2 PFM: IM12 Mining Effect (Piping) Flood

Annual Probability
1 in
2.89E-06
345,872

Displacement Magnitude (Crack Forming due to IM12 Mining)	Probability of sinkhole development or instability arising from piping	Intervention Unsuccessful	Likelihood of vehicle present that hits the sinkhole/instability	Number of Passagers	PLL	Probability
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Probability of the flood event	Does fluid flow through crack and exit downstream face	Can continuous erosion lead to sinkhole or instability (from piping)	Probability of sinkhole development or instability arising from piping
< 1 in 10	Normal Pond	Normal Pond	6.75E-06
90.000%	0.5%	0.15%	
	No Normal Pond	No Normal Pond	
	100%	99.85%	
1 in 10 to 1 in 100	1 in 10 flood (Yes)	1 in 10 flood (Yes)	2.70E-05
9%	10%	0.30%	
	1 in 10 flood (No)	1 in 10 flood (No)	
	90%	99.7%	
1 in 100 to 1 in 1,000	1 in 100 flood (Yes)	1 in 100 flood (Yes)	3.38E-05
0.9%	50%	0.75%	
	1 in 100 flood (No)	1 in 100 flood (No)	
	50%	99.3%	
1 in 1,000 to 1 in 10,000	1 in 1,000 flood (Yes)	1 in 1,000 flood (Yes)	8.10E-06
0.09%	60%	1.5%	
	1 in 1,000 flood (No)	1 in 1,000 flood (No)	
	40%	98.5%	
1 in 10,000 to PMP	1 in 10,000 flood (Yes)	1 in 10,000 flood (Yes)	2.03E-06
0.009%	75%	3.0%	
	1 in 10,000 flood (No)	1 in 10,000 flood (No)	
	25%	97.0%	
PMP	PMP (Yes)	PMP (Yes)	7.12E-07
0.001%	95%	7.5%	
	PMP (No)	PMP (No)	
	5%	92.5%	
Probability			7.83E-05
Probability of the flood event	Does fluid flow through crack and exit downstream face	Can continuous erosion lead to sinkhole or instability (from piping)	Probability of sinkhole development or instability arising from piping

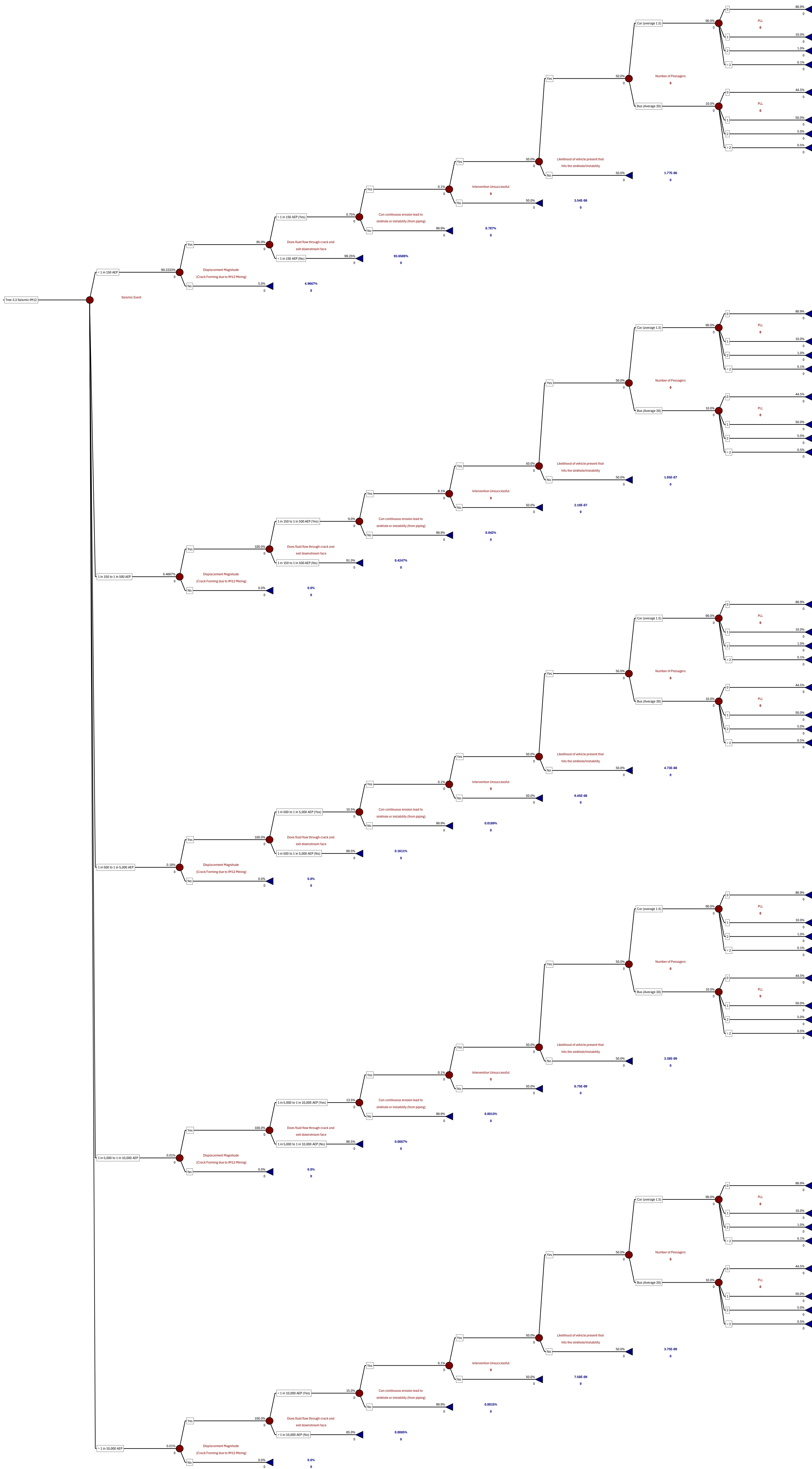


Seismic Event	Displacement Magnitude (Crack Forming due to M12 Mining)	Does fluid flow through crack and exit downstream face	Can continuous erosion lead to sinkhole or instability (from piping)	Intervention Unsuccessful	Likelihood of vehicle present that hits the sinkhole/instability	Number of Passengers	PLL	Probability of Damage
< 1 in 150 AEP	Yes	< 1 in 150 AEP (Yes)	Yes	Yes	Yes	Car (Average 1.5)	0	2.75E-07
9.93E-01	0.95%	0.75%	0.1%	50%	50%	Bus (Average 30)	80%	1.63E-08
	No	< 1 in 150 AEP (No)	No	No	No		10%	
	0%	90%	99.9%	50%	50%		0	7.34E-09
1 in 150 to 1 in 500 AEP	Yes	1 in 150 to 1 in 500 AEP (Yes)					2	
4.67E-03	100%	9.0%					3	5.24E-10
	No	1 in 150 to 1 in 500 AEP (No)					0	
	0%	93%					0	5.83E-10
1 in 500 to 1 in 5,000 AEP		1 in 500 to 1 in 5,000 AEP (Yes)					0	
1.80E-03		10.5%					45%	
		1 in 500 to 1 in 5,000 AEP (No)					0	
		90%					50%	
1 in 5,000 to 1 in 10,000 AEP		1 in 5,000 to 1 in 10,000 AEP (Yes)					2	
1.00E-04		13.5%					5%	
		1 in 5,000 to 1 in 10,000 AEP (No)					0	
		87%					0.5%	
> 1 in 10,000 AEP		> 1 in 10,000 AEP (Yes)					0	
1.00E-04		15%					0	
		> 1 in 10,000 AEP (No)					0	
		85%					0	

Tree 3.3 PFM IM12 Mining Effect (Piping) Seismic

Annual Probability
1 in
3.00E-07
3.00E-06

Seismic Event	Displacement Magnitude (Crack Forming due to M12 Mining)	Does fluid flow through crack and exit downstream face	Can continuous erosion lead to sinkhole or instability (from piping)	Intervention Unsuccessful	Likelihood of vehicle present that hits the sinkhole/instability	Number of Passengers	PLL	Probability
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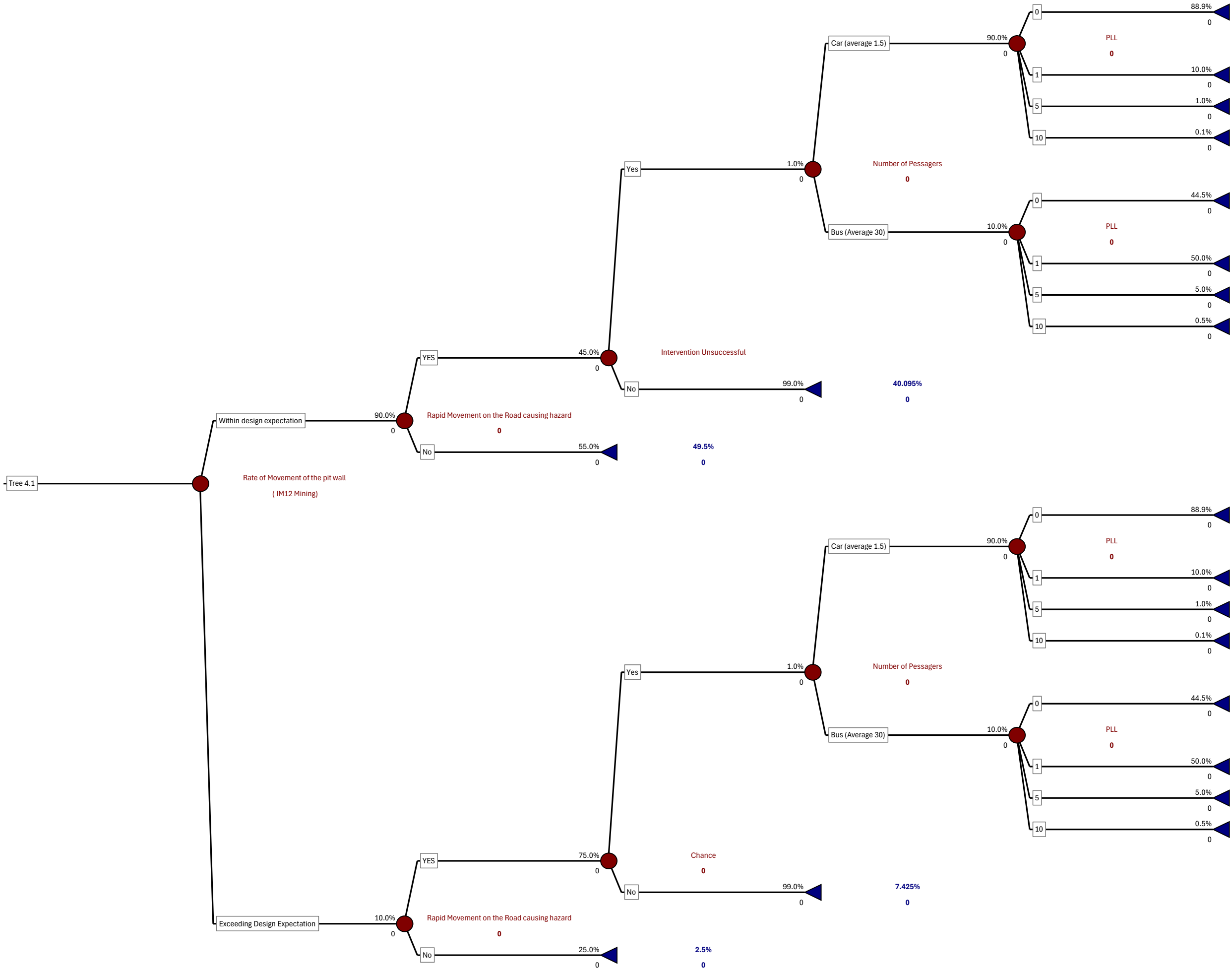


Rate of Movement of the pit wall (IM12 Mining)	Rapid Movement on the Road causing hazard	Intervention Unsuccessful	Number of Passagers	PLL	Probability of Damage
Within design expectation	YES	Yes	Car (average 1.5)	0	3.42E-03
90%	45%	1%	90%	88.9%	
	No	No		1	5.67E-04
	55%	99%		10%	
Exceeding Design Expectation	YES	Yes		5	5.67E-05
10%	75%	1%		1	
	No	No		10	5.67E-06
	25%	99%		0.1%	
			Bus (Average 30)	0	6.33E-04
			10%	44.5%	
				1	1.05E-04
				50%	
				5	1.05E-05
				5%	
				10	1.05E-06
				0.5%	

Tree 4.1 PFM: IM12 Mining Effect on Road (Slope Instability)

Annual Probability1 in7.46E-041,341

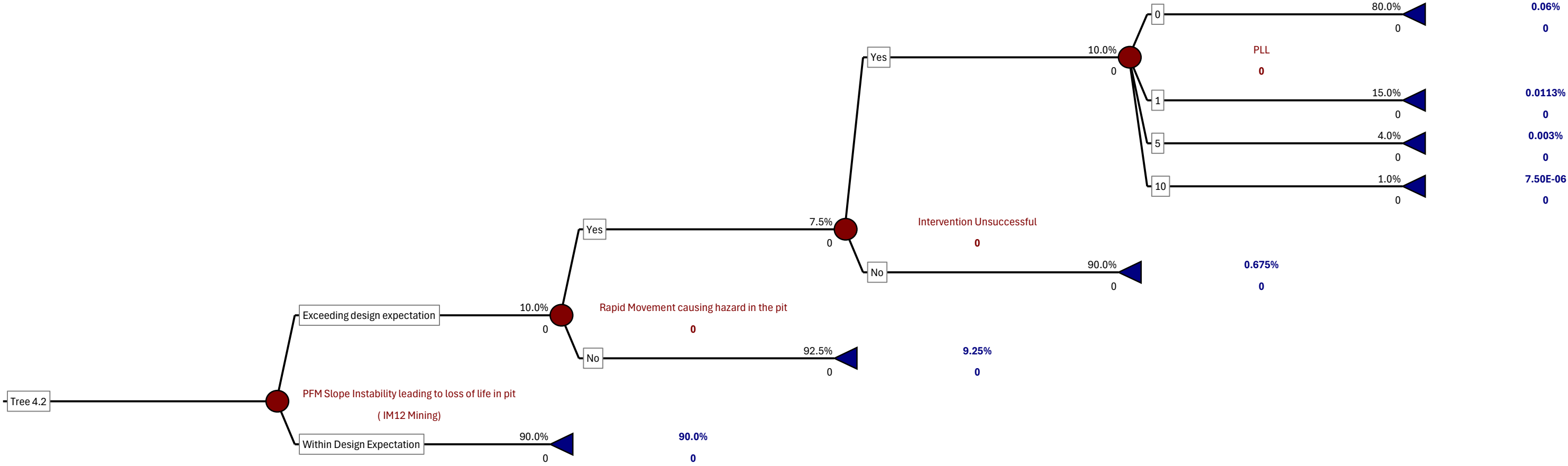
Rate of Movement of the pit wall (IM12 Mining)	Rapid Movement on the Road causing hazard	Intervention Unsuccessful	Number of Passagers	PLL	Probability
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PFM Slope Instability leading to loss of life in pit (IM12 Mining)	Rapid Movement causing hazard in the pit	Intervention Unsuccessful	PLL	Probability of Damage
Exceeding design expectation	Yes	Yes	0	6.00E-04
10%	7.5%	10%	80.0%	
	No	No	1	1.13E-04
	93%	90%	15%	
Within Design Expectation			5	3.00E-05
90%			4%	
			10	7.50E-06
			1.0%	
Annual Probability				1.50E-04
1 in				6,667

Tree 4.2 PFM: IM12 Mining Effect in Pit (Slope Instability)

PFM Slope Instability leading to loss of life in pit (IM12 Mining)	Rapid Movement causing hazard in the pit	Intervention Unsuccessful	PLL	Probability
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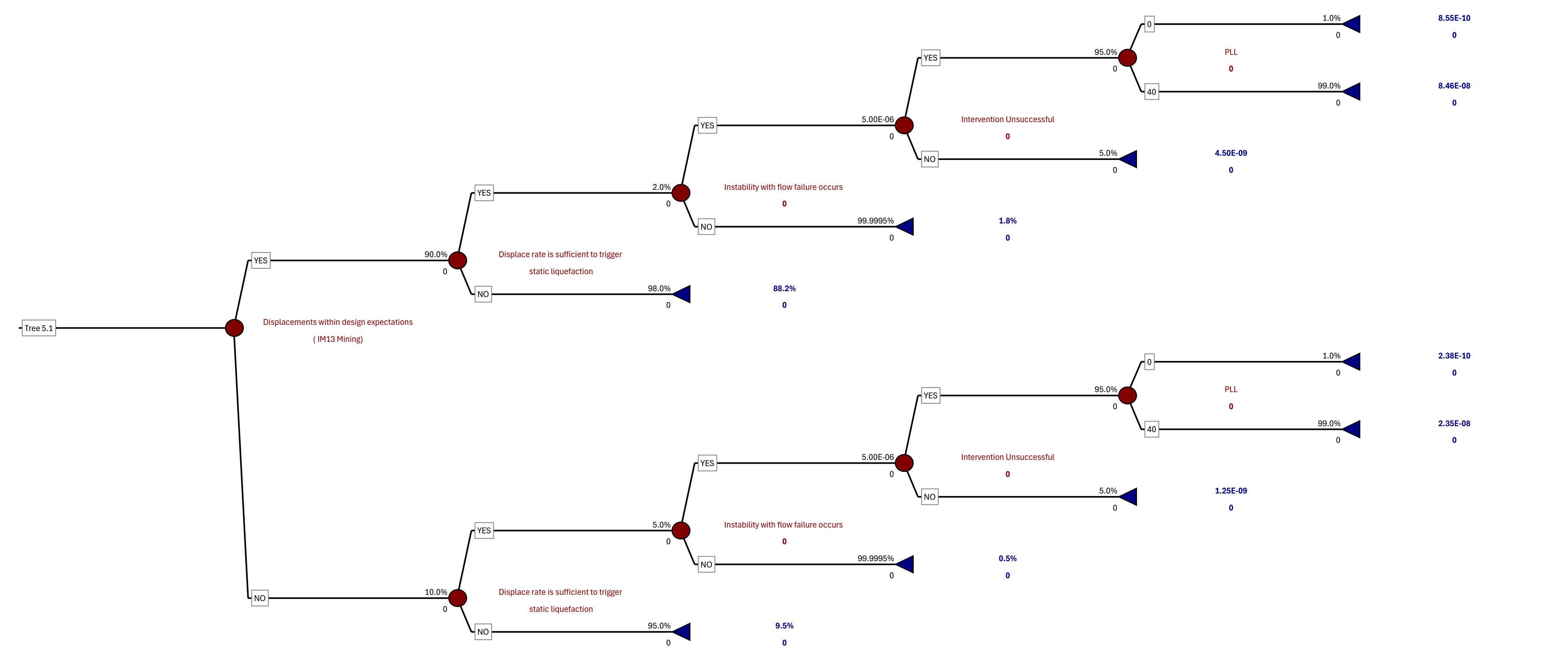


Displacements within design expectations (IM13 Mining)	Displace rate is sufficient to trigger static liquefaction	Instability with flow failure occurs	Intervention Unsuccessful	PLL	Probability of Damage
YES	YES	YES	YES	0	8.46E-08
90%	2%	5.00E-06	95%	1%	
	NO	NO	NO	40	
	98%	1.00E+00	5%	99%	2.35E-08
NO	YES				
10%	5%				
	NO				
	95%				

Tree 5.1 PMF: IM13 mining causes static liquefaction failure of Section J through M upstream lifts Normal

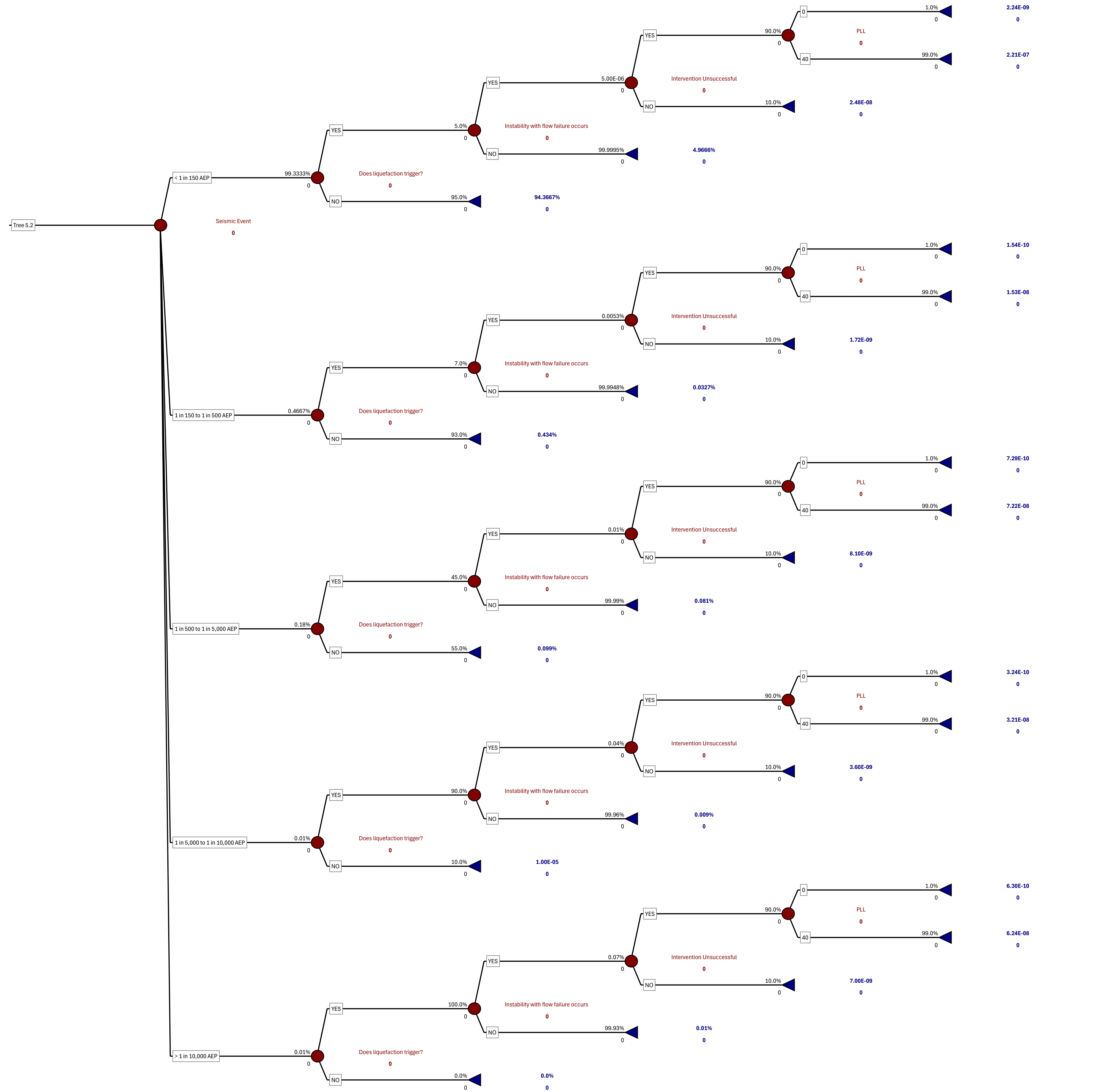
Annual Probability1 in1.08E-079,245,776

Displacements within design expectations (IM13 Mining)	Displace rate is sufficient to trigger static liquefaction	Instability with flow failure occurs	Intervention Unsuccessful	PLL	Probability
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Seismic Event	Does liquefaction trigger?	Instability with flow failure occurs	Intervention Unsuccessful	PLL	Probability of Damage
< 1 in 150 AEP	YES	YES	YES	0	2.21E-07
9.93E-01	5%	5.00E-06	90%	1.0%	
	NO	NO	NO	40	
	95%	1.00E+00	10%	99%	
1 in 150 to 1 in 500 AEP	YES	YES			1.53E-08
4.67E-03	7%	5.25E-05			
	NO	NO			
	93%	1.00E+00			
1 in 500 to 1 in 5,000 AEP	YES	YES			7.22E-08
1.80E-03	45%	1.00E-04			
	NO	NO			
	55%	1.00E+00			
1 in 5,000 to 1 in 10,000 AEP	YES	YES			3.21E-08
1.00E-04	90%	4.00E-04			
	NO	NO			
	10%	1.00E+00			
> 1 in 10,000 AEP	YES	YES			6.24E-08
1.00E-04	100%	7.00E-04			
	NO	NO			
	0%	9.99E-01			

Tree 5.2 PMF: IM13 mining causes static liquefaction failure of Section J through M upstream lifts Normal & Seismic					Annual Probability 1 in	4.03E-07 2,480,388
Seismic Event	Does liquefaction trigger?	Instability with flow failure occurs	Intervention Unsuccessful	PLL	Probability	



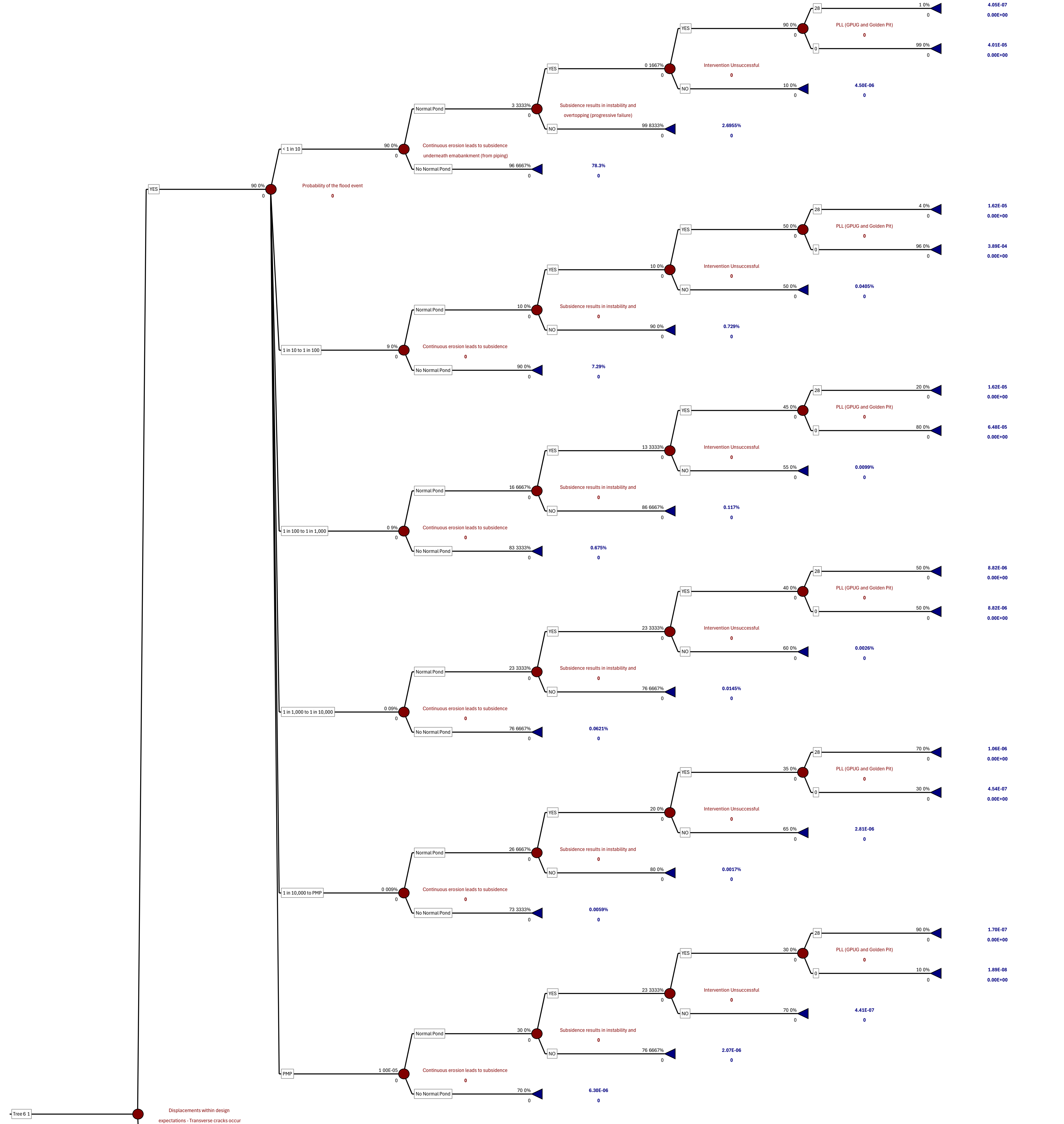
Displacements within design expectations - Transverse cracks occur	Probability of the flood event	Continuous erosion leads to piping and subsidence underneath emabankment (from piping)	Subsidence results in instability and overtopping (progressive failure)	Intervention to protect life unsuccessful	PLL (GPUG and Golden Pit)	Probability of Damage
YES	< 1 in 10	Normal Pond	YES	YES	28	4.05E-07
90%	90.000%	3.3%	0.2%	90%	1.0%	
		No Normal Pond	NO	NO	0	
		96.7%	100%	10%	99.0%	
1 in 10 to 1 in 100	1 in 10 flood (Yes)	1 in 10 flood (Yes)	YES	YES	28	1.62E-05
9%	10.0%	10.0%	10.0%	50%	4.0%	
		1 in 10 flood (No)	NO	NO	0	
		90.0%	90%	50%	96.0%	
1 in 100 to 1 in 1,000	1 in 100 flood (Yes)	1 in 100 flood (Yes)	YES	YES	28	1.62E-05
0.9%	16.7%	13.3%	45%	20.0%		
		1 in 100 flood (No)	NO	NO	0	
		83.3%	87%	55%	80.0%	
1 in 1,000 to 1 in 10,000	1 in 1,000 flood (Yes)	1 in 1,000 flood (Yes)	YES	YES	28	8.82E-06
0.09%	23.3%	23.3%	40%	50.0%		
		1 in 1,000 flood (No)	NO	NO	0	
		76.7%	77%	60%	50.0%	
1 in 10,000 to PMP	1 in 10,000 flood (Yes)	1 in 10,000 flood (Yes)	YES	YES	28	1.06E-06
0.009%	26.7%	20.0%	35%	70.0%		
		1 in 10,000 flood (No)	NO	NO	0	
		73.3%	80%	65%	30.0%	
PMP	PMP (Yes)	PMP (Yes)	YES	YES	28	1.70E-07
0.001%	30.0%	23.3%	30%	90.0%		
		PMP (No)	NO	NO	0	
		70.0%	77%	70%	10.0%	
NO	< 1 in 10	Normal Pond	YES			4.05E-07
10%	90.000%	10.0%	0.5%			
		No Normal Pond	NO			
		90.0%	100%			
1 in 10 to 1 in 100	1 in 10 flood (Yes)	1 in 10 flood (Yes)	YES			0.0016%
9%	30.0%	30%				
		1 in 10 flood (No)	NO			
		70.0%	70%			
1 in 100 to 1 in 1,000	1 in 100 flood (Yes)	1 in 100 flood (Yes)	YES			1.62E-05
0.9%	50.0%	40%				
		1 in 100 flood (No)	NO			
		50.0%	60%			
1 in 1,000 to 1 in 10,000	1 in 1,000 flood (Yes)	1 in 1,000 flood (Yes)	YES			6.30E-06
0.09%	70.0%	50%				
		1 in 1,000 flood (No)	NO			
		30.0%	50%			
1 in 10,000 to PMP	1 in 10,000 flood (Yes)	1 in 10,000 flood (Yes)	YES			1.06E-06
0.009%	80.0%	60%				
		1 in 10,000 flood (No)	NO			
		20.0%	40%			
PMP	PMP (Yes)	PMP (Yes)	YES			1.70E-07
0.001%	90.0%	70%				
		PMP (No)	NO			
		10.0%	30%			

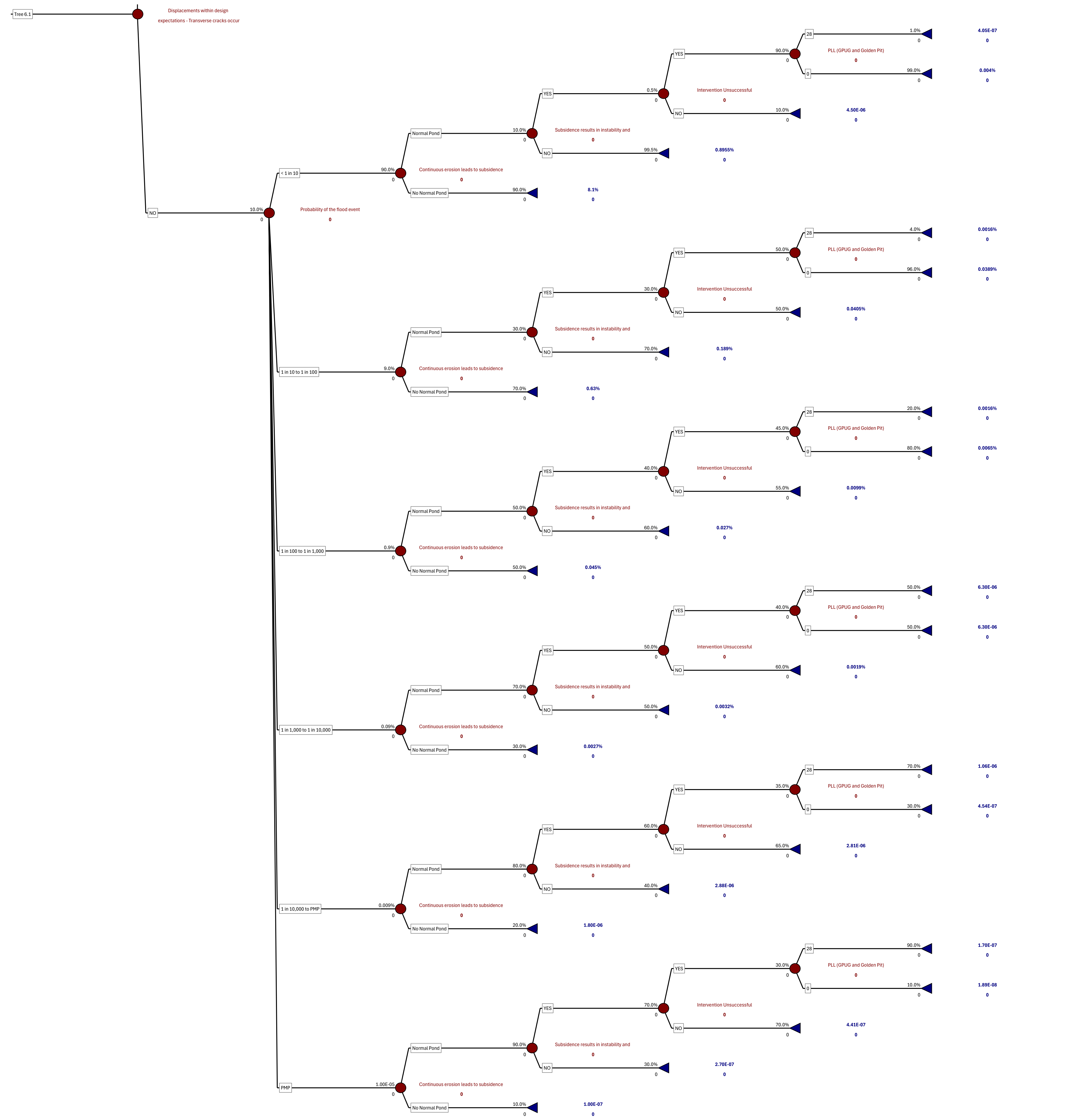
Tree 6.1 PMF: IM13 mining causes cracking of upstream lifts or downstream embankment and results in piping failure under flood conditions in the area of east of section M (no control on location of hydraulic mining pontoon)

Annual Probability 0.0083%

1 in 12,021

Displacements within design expectations - Transverse cracks occur	Probability of the flood event	Continuous erosion leads to subsidence underneath emabankment (from piping)	Subsidence results in instability and overtopping (progressive failure)	Intervention Unsuccessful	PLL (GPUG and Golden Pit)	Probability
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Displacements within design expectations - Transverse cracks occur	Probability of the flood event	Continuous erosion leads to subsidence underneath emabankment (from piping)	Subsidence results in instability and overtopping (progressive failure)	Intervention Unsuccessful	PLL (GPUG and Golden Pit)	Probability of Damage
YES	< 1 in 10	Normal Pond	YES	YES	28	0.0%
90%	90.000%	0.1%	0.5%	90%	0.0%	
NO		No Normal Pond	NO	NO	0	
10%		99.9%	100%	10%	100.0%	
	1 in 10 to 1 in 100	1 in 10 flood (Yes)	YES	YES	28	1.51E-07
	9%	0.2%	3%	70%	4.0%	
		1 in 10 flood (No)	NO	NO	0	
		99.8%	97%	30%	96.0%	
	1 in 100 to 1 in 1,000	1 in 100 flood (Yes)	YES	YES	28	4.50E-07
	0.9%	0.5%	10%	50%	20.0%	
		1 in 100 flood (No)	NO	NO	0	
		99.5%	90%	50%	80.0%	
	1 in 1,000 to 1 in 10,000	1 in 1,000 flood (Yes)	YES	YES	28	2.25E-07
	0.09%	1.0%	10%	50%	50.0%	
		1 in 1,000 flood (No)	NO	NO	0	
		99.0%	90%	50%	50.0%	
	1 in 10,000 to PMP	1 in 10,000 flood (Yes)	YES	YES	28	2.25E-07
	0.009%	5.0%	10%	50%	100.0%	
		1 in 10,000 flood (No)	NO	NO	0	
		95.0%	90%	50%	0.0%	
	PMP	PMP (Yes)	YES	YES	28	5.00E-08
	0.001%	10.0%	10%	50%	100.0%	
		PMP (No)	NO	NO	0	
		90.0%	90%	50%	0.0%	

Tree 6.2 PMF: IM13 mining causes cracking of upstream lifts or downstream embankment and results in piping failure under flood conditions in the area of east of section M (Setback location of hydraulic mining pontoon)

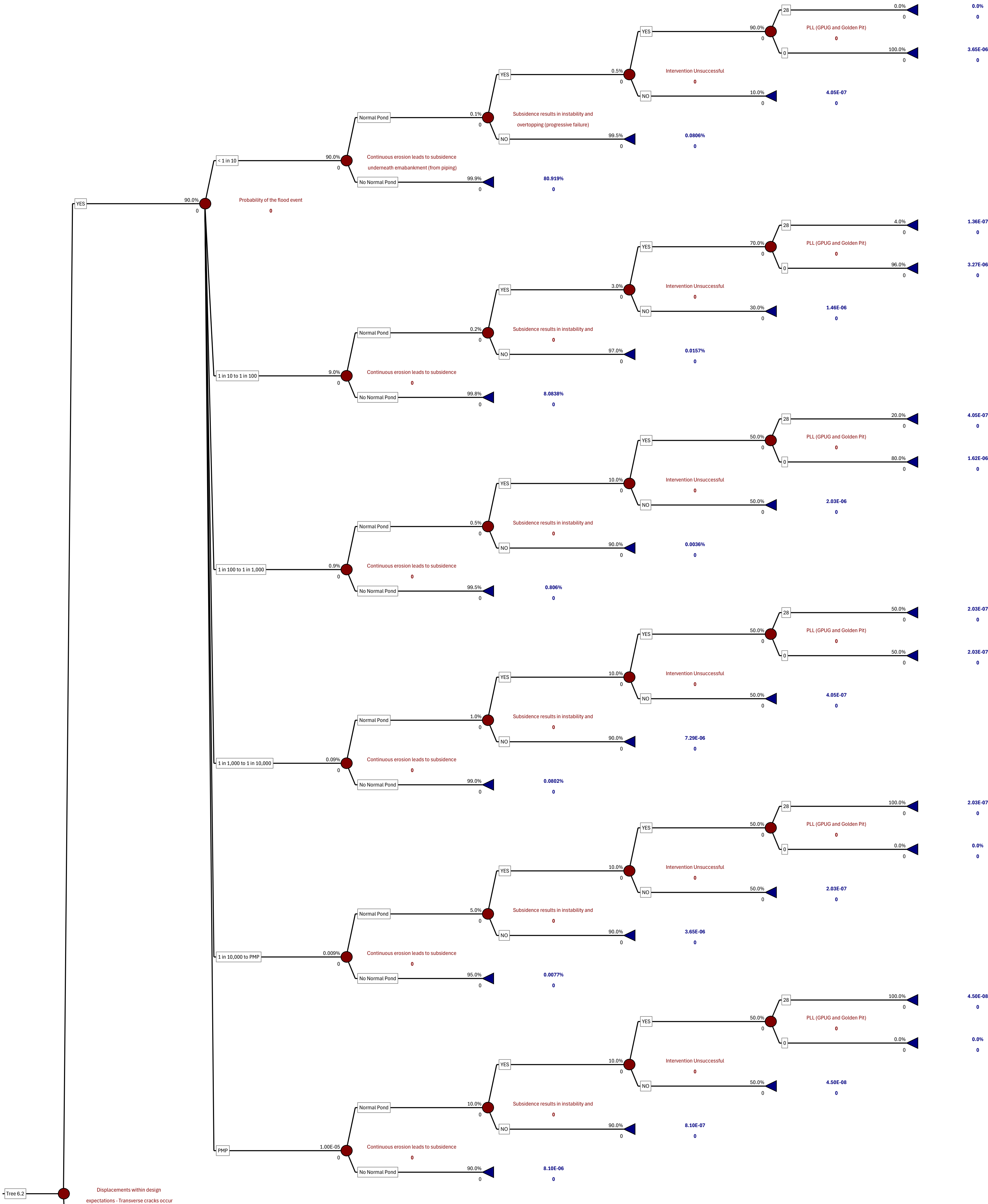
Annual Probability

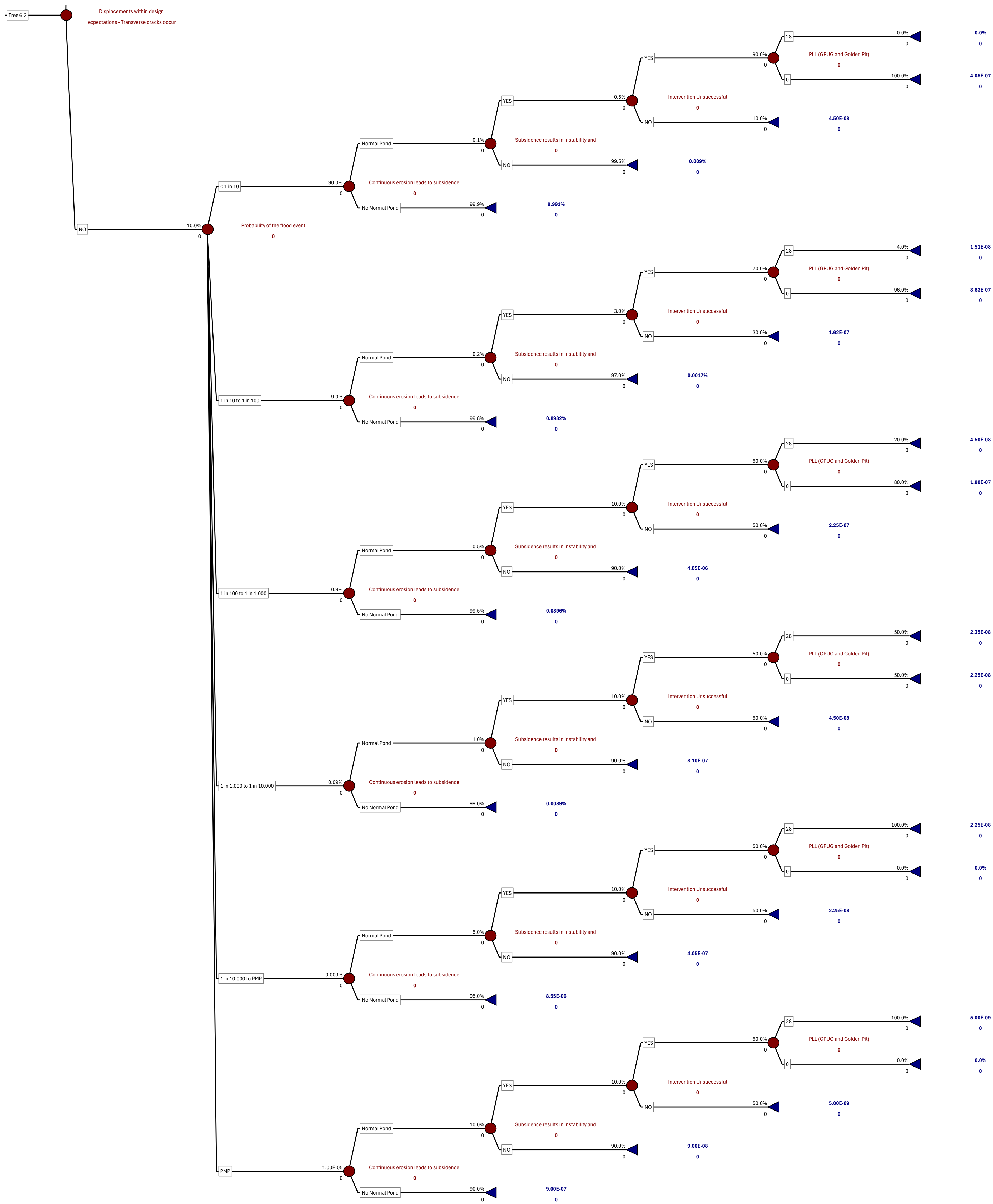
1 in

1.10E-06

908,100

Displacements within design expectations - Transverse cracks occur	Probability of the flood event	Continuous erosion leads to subsidence underneath emabankment (from piping)	Subsidence results in instability and overtopping (progressive failure)	Intervention Unsuccessful	PLL (GPUG and Golden Pit)	Probability
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PFM Slope Instability leading to loss of life in pit (MIT failure into IM13 Mining)	Rapid Movement causing hazard in the pit	Intervention Unsuccessful	PLL	Probability of Damage
Exceeding design expectation	YES	Yes	0	6.00E-04
10%	7.5%	10%	80.0%	
	No	No	1	1.13E-04
	92.5%	90%	15%	
Within Design Expectation			5	3.00E-05
90%			4%	
			10	7.50E-06
			1.0%	
Annual Probability				1.50E-04
1 in				6,667

Tree 7.1 PMF: IM13 Mining Slope Instability into IM13 Pit

PFM Slope Instability leading to loss of life in pit (MIT failure into IM13 Mining)	Rapid Movement causing hazard in the pit	Intervention Unsuccessful	PLL	Probability
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