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OCEANA GOLD (NEW ZEALAND) LTD
TAILINGS STORAGE AND ROCK DISPOSAL
VOLUME 3
PROPOSED TAILINGS STORAGE FACILITY
STORAGE 3 RL155
TECHNICAL REPORT

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1.0 INTRODUCTION

Engineering Geology Ltd (EGL) has been appointed by OceanaGold (New Zealand) Limited (OGNZL) to undertake a technical report for the proposed Storage 3 Tailing Storage Facility (TSF) for resource consent for the Waihi North Project (WNP). The proposed embankment dam with a crest level to RL155 (RL, Reduced Level in Mine Datum less 1000m) will be achieved using downstream construction methods. A locality plan for WNP is provided in Figure 1.

This technical report has been prepared for seeking consents under the Fast-track Approvals Act and details a preliminary design for the assessment of environmental effects as required under the Resource Management Act 1991. This report is Volume 3 of a 4-part series of reports prepared on the tailings and rock disposal for Waihi North Project (WNP). Volume 1 is an overview of the tailings and rock disposal strategy (Ref. 1), Volume 2 is a technical report on Gladstone Open Pit (GOP) TSF (Ref. 2) and Volume 4 is a technical report on the Northern Rock Stack (Ref. 3). Elsewhere in the project documentation the proposed Storage 3 TSF is referred to in short as ‘TSF3’.

The new Storage 3 TSF is proposed to provide the tailings storage for the WNP in conjunction with the proposed GOP TSF. Storage 3 has been selected and compared against a range of options summarised in the Tailings Storage and Rock Disposal - Natural Hazard and Option Report (Volume 1 – Ref. 1). Design for the construction of Storage 3 will be undertaken in accordance with the recommendations and guidelines of the New Zealand Society on Large Dams (NZSOLD) ‘New Zealand Dam Safety Guidelines’ (NZDSG - Ref. 4). Storage 3 is to be designed as a High Potential Impact Classification (PIC) dam.

2.0 BACKGROUND AND CURRENT SITE FACILITIES

2.1. Location and existing TSFs

There are two existing TSFs at the Waihi Operation, Storage 1A and Storage 2. They are shown in Figure 2 along with other site features. Storage 1A crest is at RL176.4 as of March 2024 and has resource and building consent to be raised to RL182 (Ref. 5).

Storage 3 site was previously investigated as a potential TSF location at the time the Development Site was first investigated, however, preference was given to Storage 2 and 1A locations which are closer to the Process and Water Treatment Plant. The location and the layout of the Waihi operation are shown in Figures 1 and 2. Trevor Matuschka of EGL has been the Project Engineer for the Storage 2 since 1987 and EGL is the Design Engineer of Storage 1A TSF and subsequent modifications.

2.2. Construction and operation

Previously the mine was operated by the Waihi Gold Company Limited, which was owned by Newmont before OGNZL purchased the mine operation. McMahon Contractors Ltd was contracted to undertake construction of Storage 1A from 1 July 1998 to 28 May 2015 when surface mining was halted due to a slip in the Martha Open pit. Since then, construction of the Storage 1A embankment and associated facilities has been undertaken by C&R Developments Limited under the supervision of OGNZL.

Since May 2001 virtually all tailings have been disposed of into Storage 1A and no tailings have been deposited within Storage 2 since July 2005.

2.3. Monitoring and Surveillance

A comprehensive monitoring and surveillance program is in place to enable the performance and condition of Storage 1A and 2 to be assessed. This is documented in the Operations, Maintenance and Surveillance Manual (Ref. 6). The manual was originally developed in accordance with the 2000 version of the New Zealand Dam Safety Guidelines and was updated and re-issued in September 2019 to comply with updates in the 2015 New Zealand Dam Safety Guidelines (Ref. 7). It is scheduled to be updated to comply with the 2024 New Zealand Dam Safety Guidelines (NZDSG - Ref. 4).

Monitoring and surveillance associated with the tailings embankment includes:

- visual inspection on a regular basis;
- measurements of supernatant decant pond water volumes and levels;
- measurements of freeboard;
- measurement of pore pressures within the embankment fill;
- tailings and foundations by pneumatic, standpipe and vibrating wire piezometers;
- measurement of underdrain and toe drain flows;
- deformation monitoring; and
- monitoring of materials and construction standards to ensure that the Contract Specification is adhered to.

The data from the monitoring and surveillance programme are provided to the Designer at regular intervals for review. The data is provided annually to Waikato Regional Council and Hauraki District Council in annual reports and are independently peer reviewed by the Peer Review Panel (PRP) which is engaged by OGNZL as required by the existing resource consent conditions. The annual reports cover structural integrity, geochemistry, groundwater, underdrainage and rehabilitation related to the TSFs. The latest Annual Structural Integrity Reports for Storage 1A and 2 were prepared by EGL in July and September 2024 respectively (Ref. 8 and Ref. 9). OGNZL monitoring and surveillance is documented in the Tailings Storage Facility Monitoring Plan (TSFMP) (Ref. 10).

2.4. Dam Safety Reviews

An essential part of modern dam safety management is the regular review of the performance and safety of a dam. Two types of reviews are recommended by the NZDSG. They are discussed below.

2.4.1. Intermediate Dam Safety Review

Intermediate Dam Safety Reviews (IDSR) are recommended to be conducted annually and are normally conducted by the Design Engineer. The Annual Structural Integrity Report prepared by EGL annually meets the expectations for an IDSR.

2.4.2. Comprehensive Dam Safety Reviews

The NZDSG recommend that a Comprehensive Dam Safety Review (CDSR) be undertaken every 5 years for a High PIC dam. The CDSR must be undertaken by an independent, experienced, and qualified reviewer to meet the requirements of the NZDSG. The CDSR must include a comprehensive independent review of the design, construction, operation and performance of the dam and all the systems and procedures that affect dam safety and compare against current dam safety guidelines, standards and industry practice.

To ensure full compliance with the NZDSG Tony Pickford was engaged by OGNZL to undertake a CDSR. Mr Pickford is a very experienced dam engineer and has undertaken CDSRs for most of the largest dams in New Zealand. He undertook a site inspection in March 2020, interviewed OGNZL staff with responsibilities for dam safety, interviewed the Designer and reviewed all relevant documents. A CDSR report was provided on 12 June 2020 (Ref. 11). Risk assessments are also undertaken as part of comprehensive reviews and a Failure Modes and Effects Analysis workshop was undertaken for the Storage 2 and 1A in August 2018 with a report outlining potential failure modes and mitigations produced (Ref. 12).

3.0 PERFORMANCE TO DATE

The latest annual reports cover the period 1 April 2023 to 31 March 2024 (Ref. 8 and Ref. 9). The pore pressures measured by the piezometers, subsurface drain flow measurements and deformations confirm that the performance of the embankments are within design expectations and meet the conditions of the resource consents. Stability analyses are undertaken annually using the as-built geometry and measured pore pressures. These analyses show that calculated factors of safety exceed the criteria required by the NZDSG, indicating satisfactory performance. Assessments of earthquake deformation also meet the performance criteria recommended by the NZDSG.

The annual reports (Ref. 8 and 9) and Geotechnical PRP report (Ref. 13) confirm that the management and operation of the current TSFs are performing well and providing for safe storage of tailings and minimising any environmental effects on the environment.

Partial closure of Storage 2 has demonstrated effective closure of the TSFs can be achieved with over 15 years of monitoring of closure conditions (Ref. 14). Pond water on top of the tailings is now clean and can be discharged direct to the Ohinemuri River (via. a tributary stream). Both pasture and planted vegetation has been able to be established and maintained effectively on the Storage 2 slopes. Groundwater chemistry from beneath Storage 2 has stabilised with the partial closure of the facility (Refs. 15 and 16).

The dam safety management systems and operational strategies successfully implemented for Storage 1A and 2 will be extended to Storage 3.

4.0 WAIHI NORTH PROJECT AND STORAGE 3 TSF

4.1. Waihi North Project (WNP)

The Waihi North Project adds the Wharekirauponga Underground Mine (WUG) 10km north of Waihi and Gladstone Open Pit (GOP) Mine adjacent to the Process Plant to the existing mining operation at Waihi. This requires new tailings storage to accommodate the increased tailings production. The new tailings storage is to be provided by the proposed new TSFs Storage 3 (this report) and GOP (Ref. 2).

Gladstone Open Pit provides an additional source of overburden material to MOP which can be used for the construction of downstream TSF embankments. Like MOP overburden, material from GOP will be part Non-Acid Forming (NAF) and part Potentially Acid Forming (PAF). Some of the GOP material will have shorter acid generation lag times, compared to MOP, and some of the material will have higher mercury contents.

4.2. Storage 3 - TSF

Storage 3 is to be located approximately 3.5km south-east of the Waihi Township. It is to be formed using a ‘L shaped’ embankment dam which abuts the Storage 1A embankment at its west extent and rising land to the east. Storage 2 is to the west of Storage 1A. The layouts of the TSFs are shown in Figure 3. The impoundment will be created between this embankment and the hills to the north. Storage 3 will be constructed primarily from the overburden material that is excavated as part of the process of obtaining ore from the GOP and MOP. The layout of Storage 3 to RL155 is shown in Drawing 0513 in Appendix A.

The proposed crest height for the embankment is RL155, forming a 46m high embankment above the existing ground at the downstream toe (RL109). The proposed impoundment partially covers the existing East Stockpile area.

While further additional storage is not required for the WNP project described here, the upstream toe position of the embankment is set to allow sufficient space downstream to raise the facility in the future using a downstream embankment profile to a crest level of RL177, or to store excess overburden material from future open pit expansions. However, for this consent, the maximum crest level of this embankment is RL155.

The Storage 3 embankment will be zoned with low permeability liners and capping to provide for secure containment of PAF rock from GOP or MOP. These liners and capping limit oxygen and water ingress, and along with the addition of lime into the material being placed, minimise any acid generation potential. This approach has been successful for Storage 1A and 2. For the material from GOP with a short lag time till acid generation, specific characterisation and placements controls will be applied.

The RL155 crest height provides a total impoundment storage volume of approximately 8,100,000m^3. Allowance will be made to safely manage surface water from extreme storm events on top of the tailings. The volume available for tailings storage is estimated at approximately 6,700,000m^3.

The tailings impoundment will be fully lined with an earth liner. Additionally, a 1.5mm HDPE geomembrane liner is proposed within the tailing's impoundment up to the initial embankment height (RL135) to further minimise tailings seepage. This is over and above what was provided for Storage 1A and 2.

Groundwater and leachate collected in the subsurface drains will be pumped back to the Water Treatment Plant via the perimeter ring main system around Storage 1A and 2, which will be extended to Storage 3. Power will be supplied by extending the existing power line at the Development Site.

Tailings delivery pipelines, water return pipes and power for the decant return will be extended around the back of Storage 1A and Storage 3.

The Storage 3 site is accessible from the Storage 1A site via the Baxter Road Security Gate and Southern Perimeter Road.

Trig Road North is the closest road to Storage 3 and is located 500m to the southeast of the facility.

The haul road (Eastern Haul Road and Northern Haul Road) from the existing conveyor loadout behind Storage 2 and Storage 1A will be extended down the East Stockpile to the Storage 3 site. The conveyor delivers material from the MOP and it is proposed that this will be modified to deliver material from GOP.

The main function of the TSF embankment is to provide secure containment of the tailings. A secondary function is the disposal of PAF mine overburden material from the MOP and GOP. This is necessary as PAF mine overburden material, if exposed to oxygen for a period of time, can oxidise and generate low pH runoff. This can result in the release of heavy metals and poor water quality. Special measures will be incorporated into the design of Storage 3 embankment, as for Storage 1A and 2, to prevent this from happening and ensure that there are no detrimental long-term effects to the environment associated with the disposal of PAF materials. Limitations on where PAF mine overburden material can be used are set. PAF materials are encapsulated in low permeability, Non-Acid Forming (NAF) mine overburden material in specific zones to restrict both oxygen and water entry.

To achieve the design objectives, the embankment will be designed as a zoned structure. The primary functions of the different zones are summarized below:

Zone A	-	Low permeability zone (earth liner) that restricts seepage from mine overburden material into underlying ground
Zone B	-	Low permeability upstream zone that restricts seepage from the tailings
Zones C1 and C2	-	Structural fill zones that provide support to Zone B and provide a transition between the finer grained material in Zone B and the coarser material in Zones D2 and D3
Zones D2 and D3	-	Bulk fill zones with less restrictive requirements than other zones. Zone D2 has a higher strength specification than Zone D3.
Zone E	-	Specified zones for the weakest material
Zone F	-	Structural fill zone on outside shoulder that also provides a transition between the coarser material in Zone D and finer material in Zone G. Also provides a drainage path for leachate.
Zone G	-	Outer sealing layer of the embankment that restricts entry of oxygen and water
Zone H	-	Plant growth layer
Zone I	-	Structural fill forming downstream section of the Perimeter road where it is in fill.

PAF mine overburden material and high mercury (>3.5 mg/kg) is not permitted for use in Zones A, G, H and I. Typical profiles illustrating these zones are discussed in Section 11.

The construction of Storage 3 is expected to commence in advance of MOP and GOP. Therefore, alternative material sources are required for the initial stages of construction of the Storage 3 starter embankment. Three borrow areas located within the Waihi Development Site have been designed to provide a source of NAF Fill.

The depletion of the East Stockpile will also provide a good source of additional fill material for construction of the Storage 3 starter embankment. The materials from the East Stockpile may be PAF or NAF depending on where they are sourced from within the stockpile.

The depletion of the East Stockpile and borrows have been staged to match the sequencing of the Storage 3 starter embankment and associated fill requirements. The local borrow areas will require drill and blast techniques to excavate the majority of the material.

5.0 GEOTECHNICAL INVESTIGATIONS AND SITE GEOLOGY

Extensive geotechnical investigations have been undertaken for Storage 3. They have been undertaken progressively over 25 years in 1994, 1995, 1996, 1997, 2001, 2007, 2009, 2010, 2017, 2018 and 2020. The investigations are documented in the Geotechnical Factual Report (GFR) for the Storage 3 site (Ref. 16). Figures 5 to 9 show the locations of machine drillholes, hand auger boreholes, test pits and Cone Penetration Tests (CPTs) undertaken for Storage 3.

Interpretation of the Storage 3 site geology has the benefit of the deep sterilisation hole (GT020) drilled in 2017. The hole was drilled to 455m at an incline of 50 degrees to horizontal, reaching a vertical depth of 348m, starting from Storage 3 site and extending under the Storage 1A embankment. This deep sterilisation borehole is consistent with the interpreted site geology that has been mapped across the Storage 3 site with other deep boreholes (AP21a to 80m and AP22a 70m).

5.1. Geology Overview

Homunga Rhyolite profiles are encountered in all boreholes across the Storage 3 site and effectively forms the bedrock surface on which the Storage 3 embankment is founded. This bedrock surface is encountered at the surface to variable depths up to 125 m. Underlying this rhyolite profile are deeper dacite and andesite rock units.

Overlying the three rock units are layers of alluvium and ash. The interpretation of these geological units is described in the following sections, generally from the youngest and shallowest to oldest and deepest. These units are further detailed in the GFR (Ref. 16).

5.2. Topsoil

Across the site there is a layer of topsoil, which typically varies in thickness from 0.1m to 0.3m, refer to Figure 10. There are some locations where the thickness of topsoil or organic material is locally thicker, up to 0.7m, likely due to their position near small gully features. All topsoil will need to be stripped from the embankment, collection pond and stockpile footprints and stockpiled for rehabilitation.

5.3. Volcanic Ash

There are three volcanic ash units across the site of which the Waihi Ash unit is the most common. The ash layers are typically found blanketing the hills and are usually absent from lower valley floors. Of the locations where ash was identified, the thickness ranged from minimal to 2.2m, with an average thickness of approximately 1.1m. The thickness and extent of ash across the site is indicated in Figure 11.

The ash soils require careful conditioning to compact to the required specifications. The ash can be used for construction and will either be worked into the Zone A layer beneath the impoundment or embankment, or stockpiled as a source of material for rehabilitation. They could also be used for Zone B as was done for the initial embankment in Storage 1A, however, sufficient NAF material needs to be stockpiled for closure rehabilitation layers.

5.4. Colluvium

Layers of colluvium are typically encountered on the hills. The thickness and extent of colluvium is shown in Figure 12. The colluvium may be encountered below or above the ash layers and consists of ash material mixed with reworked rhyolite materials. The colluvium layers are typically sandy or gravelly silt with some cobble size material. In some locations it may also be slightly clayey. The thickest layer of colluvium encountered was 3.3m thick to the northeast of the site.

5.5. Alluvium

Alluvium is encountered over the floor of the valley and in hillside gullies. Alluvium can also be found on the positive topography at the toe of the steeper hills and is expected to be encountered on the terrace area where the main Storage 3 stockpile is located. The thickness and extent of alluvium is shown in Figure 12.

The alluvium is derived from the erosion of the surrounding rhyolite hills and transportation of material in surface water runoff and streams.

The nature of the alluvium varies across the site from gravelly and sandy, to clayey. There are also some buried organic or peaty layers in the northeast and in the lowest valley floor.

5.6. Rhyolite – Tuff and Lava Flows

An extensive field investigation has been undertaken to determine the extent, depth and nature of the bedrock profile. The deep GT020 borehole encountered rhyolite from 125 m depth up to the surface. The base of the profile is the remnants of lava flows grading upwards into a welded tuff (air fall deposits) closer to the surface. This borehole found the rhyolite unit sits on an epiclastic (volcanic unit of variable material) unit over dacite rock.

Deep boreholes AP21a and AP22a were specifically drilled to prove the rhyolite bedrock profile is competent to depth at the downstream toe of the embankment. AP21a was drilled to a depth of 80 m and AP22a to 70 m. They encountered a competent rhyolite lava flow profile from close to the ground surface to depth. This lava flow profile is part of the rhyolite flows which form the East Ridge. The embankment abuts into it and it is a competent foundation for the embankment. The boreholes indicate that the top surface of the rhyolite is weathered, and it will need to be undercut at the toe of the embankment slopes. Refer to Sections 11.4 and 11.5.

Generally, to the south of the proposed embankment position the rhyolite rock surface deepens and is covered by a complex mix of rhyolite tuffs, pyroclastic flows, gaseous lava flows and reworked rhyolite deposits. Figure 13 shows a site geology plan indicating different tuffs and lava flows. The reworked rhyolite deposits are particularly sensitive to strength loss with notable loading from a large embankment. It is recommended that the embankment avoids these deposits, or they are undercut and replaced with structural fill. A Paleo Gully undercut area is indicated in Drawing 0513 and is further discussed in Section 11.4.

5.7. Dacite – Tuff Breccia

Dacite tuff breccia is observed from 156 m to 191 m vertical depth in the GT020 drillhole below Storage 3. There are no dacite outcrops on the Storage 3 site. Dacite outcrops to the west of Storage 2 along the Ohinemuri River, and east of Storage 3 in cuttings on Trig Road North. Dacite is also present at 16.5 m depth in one localised borehole (WG4) at the southwest extent of Storage 1A on the east side of Collection Pond S3.

5.8. Andesite – Tuff and Lava Flow

Below the dacite, andesite tuff is observed from 191 m to 206 m vertical depth in the GT020 drillhole. From 206 m to the base of the drillhole at 350 m is andesite lava flow.

6.0 SEISMIC HAZARD

Estimates of seismic hazard for the site have been provided by GNS Science in 2007 and 2017 (Ref. 17). The 2017 update incorporated the latest knowledge of the Kerepehi Fault System (Ref. 18) and the Hikurangi Subduction Zone and updated estimates of background seismicity. The tectonic environment and seismic hazard estimates are discussed in more detail in Volume 1 (Ref. 1). The National Seismic Hazard Model (NSHM) was updated in 2022 (Ref. 26). The NSHM numbers are higher, however, do not make a material difference to the assessed performance of the WRS. For consistency, the 2017 study has been applied across the Waihi North Project. In detailed design seismic hazard estimates will be updated. In summary there are no active faults on the Storage 3 site and the nearest known active fault expressed at the surface is the Kerepehi Fault System at 23 km distance.

Peak Ground Acceleration (PGA) values and corresponding average magnitudes at the Storage 3 site (on rock) are as follows:

150-year return period	PGA = 0.10g,	M_w = 6.3
84th percentile level for maximum controlling earthquake:	PGA = 0.23g	M_w =7.3
2,500-year return period	PGA = 0.27g	M_w =6.6
10,000-year return period:	PGA = 0.39g,	M_w = 6.9

Uniform hazard spectra (spectral acceleration) for the probabilistic and deterministic estimates of seismic hazard are shown in Figure 14. The spectra are 5% damped larger horizontal component acceleration spectra for Site Class B rock conditions.

7.0 FLOOD HAZARD

Waihi is subject to regular heavy rainfall events with an annual average rainfall of between 1500 mm to 3100 mm (Ref. 1). The proposed Storage 3 site is away from the main flood hazard area associated with the Ohinemuri River. Flooding from the Ruahorehore Stream is relatively minor and does not pose a notable threat to the proposed TSF site. The catchment above Storage 3 is approximately 50 ha, which is greater than the catchments above Storage 1A and 2. However, runoff can be diverted away with a diversion drain as is done for the existing TSFs. Refer to Section 10 for the design basis for water management.

8.0 POTENTIAL IMPACT CLASSIFICATION (PIC)

Potential Impact Classification (PIC) of a large dam sets appropriate design levels for the dam and guides construction and operational requirements. The PIC of a dam reflects the potential impact a hypothetical dam breach could have on people, property, infrastructure, and environment. Storage 3 will be designed and operated in accordance with modern standards which are set out in the NZDSG. Dams that are designed and operated to these standards have a low and acceptable risk of potential failure, and a breach would be unlikely to occur.

Assessment of the PIC considers various factors including Population at Risk (PAR), Potential Loss of Life (PLL), damage to houses, infrastructure, and environment as well as community recovery time. The assessed PIC sets the design level so the design is appropriately resilient to extreme conditions brought on by natural hazards or unlikely scenarios which may occur.

The PIC of Storage 3 is assessed to be **High** based on a dam breach assessment (Ref. 19) undertaken in accordance with the NZDSG. The dam breach assessment also provides maps for use in emergency planning that is part of the dam safety management system (refer to Section 16.5).

9.0 TAILINGS CHARACTERISTICS

Tailings in Storage 3 will be deposited subaerially via spigots and end pipe discharge on to a tailings beach as is currently undertaken on Storage 1A. Tailings are deposited over short sections on a rotational basis to allow resting and drying. The pond water level is maintained low during operation to expose as large an area of tailings as possible to air-drying. Air-drying has the benefit of achieving higher density and strength. The deposition of tailings onto a beach (subaerial deposition) via spigots promotes segregation of the tailings. The coarsest tailings generally settle out closer to the point of deposition, with the finer fraction (slimes) transported further. The deposition of tailings on a rotational basis results in local variations in tailings characteristics both between spigots and transverse to the embankment crest. Changes in ore characteristics can also affect the characteristics of the tailings.

Samples from boreholes within Storage 2 show that the tailings generally comprise of cohesive low plasticity material (sandy silt, clayey silt) with occasional thin lenses of cohesionless (non-plastic) silty sand material. Lenses rather than layers are inferred from comparison of CPTs on similar sections. Samples of the typical cohesive low plasticity tailings and cohesionless lenses were obtained for testing confirming a low plasticity material.

Pore water pressures measured from CPT dissipation testing in Storage 2 indicated a sub hydrostatic profile within the tailings, which indicates underdrainage is occurring. This increases the consolidation stress and strength of the tailings. Storage 1A and 2 do not have a Zone A base liner within the impoundment. Storage 3 will have a fully lined impoundment (combination of earth and geomembrane liner) so the pore pressure profile will be hydrostatic (unless tailings underdrains are installed). This means it will take longer for the tailings to fully consolidate and will result in lower tailings densities than in Storage 1A and 2 (for the same discharge rate and tailings characteristics). Lower densities mean less tailings stored and greater potential for liquefaction of tailings in the impoundment. However, the proposed downstream embankment will remain stable as it is not dependent on the strength of the tailings for stability.

The tailings at Waihi typically consolidate to a low permeability soil. Laboratory permeability tests undertaken in 2010 and 2017 indicate values from 7×10^{-11} to 6×10^{-9} m/s. However, higher values are indicated through consolidation modelling of the settlement measured in Storage 2. It indicates typical tailings permeabilities in the range from 1×10^{-9} to 1×10^{-7} m/s.

10.0 DESIGN BASIS

10.1. Dam Design Criteria

Guidelines for the design, construction and operation of dams have been produced by the New Zealand Society on Large Dams (NZSOLD), a technical group of Engineering New Zealand. The guidelines are referred to as the New Zealand Dam Safety Guidelines (NZDSG Ref.4). The latest version of the guidelines was published in 2024. It represents current best practice and adherence with the guidelines has become mandatory by Building Consent Authorities, Regional Councils and Territorial Authorities. The NZDSG has a dam classification system that reflects the consequences of failure and includes engineering design advice appropriate to the hazard posed by the dam. A dam's classification is termed its Potential Impact Classification (PIC). There are three classes (Low, Medium and High). A High PIC classification has been used in developing the design standards and criteria for the new TSF. Details of the adopted design criteria are summarised in Table 1.

Table 1: SUMMARY OF PROPOSED DAM DESIGN CRITERIA

Design Parameter	Design Criteria
Flood (In Flow Design Flood)	Runoff from PMP (72 hour) rainfall event
Earthquake	
• OBE	Probabilistic 150 year return period
• SEE	84^{th} percentile level for the CME developed by a deterministic approach and need not exceed the 1 in 10,000 AEP ground motions developed by a probabilistic approach. Aftershock of one magnitude less than the SEE within one day.
• Aftershock	1 in 10,000 AEP ground motions developed by a probabilistic approach. Aftershock of one magnitude less than the SEE within one day.
Stability	
• Static	-End of construction Factor of Safety (FOS)≥1.3 -Long term operational steady state FOS≥1.5 -Long term post closure steady state FOS≥1.5 - Rapid drawdown FOS≥1.3 - Post-earthquake conditions FOS≥ 1.2
• Seismic	OBE: The performance requirement for the OBE is that the dam and appurtenant structures remain functional and that the resulting damage is minor and easily repairable. SEE (incl. Aftershock): The performance requirement for the SEE is that there is no

Design Parameter	Design Criteria
	uncontrolled release of the impounded contents when the dam is subjected to the seismic load imposed by the SEE. Damage to the structure may have occurred.
Freeboard	
• Maximum Normal Reservoir Level	Wind set up and wave runup for the highest 10% of waves caused by a sustained wind speed, which is dependent on the fetch, with an AEP of greater than 1 in 100
• Freeboard at Maximum Reservoir Level during the Inflow Design Flood (IDF)	The greater of a) 1.0m or b) the sum of the wind setup and wave runup for the highest of waves caused by sustained wind speed, which is dependent on the fetch, within an AEP of 1 in 10

The IDF will be taken equal to the 72-hour PMP flood event. This is based on the recommendations in the NZDSG for High PIC dams where the PLL is greater than 10 and is consistent with the design criteria adopted for the existing Storage 1A and 2.

The controlling magnitude earthquake (CME) taken to be an 84th percentile shaking event from a maximum rupture on the Kerepehi Fault System (onshore sections) does not exceed the 1 in 10,000 AEP ground motion developed by a probabilistic approach. In this case under the NZDSG the SEE can be taken to be the 84th percentile for the CME. However, for the design of Storage 3 a second SEE case applying the 1 in 10,000 AEP ground motion has also been applied.

For the proposed dam, the wind set up and wave run up are small due to the small fetch. Under normal operation, the pond water is proposed to be maintained 3.0m below the design crest level. Consequently, the 1st criterion controls for freeboard during the IDF. For this situation the NZDSG recommend a minimum freeboard of 1.0 m above the IDF for TSFs. The current design freeboard for Storage 1A and 2 is 1 m and this is to be adopted for the proposed new Storage 3 TSF.

10.2. Uphill diversion drain sizing

The uphill diversion drain will be sized for a minimum requirement of a 10 year ARI (Average Recurrence Interval) flow, equal to the existing resource consent conditions (RC971307, RC971309, Condition 4).

10.3. Perimeter drain sizing

The perimeter drain will be sized for a minimum requirement of a 10 year ARI flow.

10.4. Embankment permanent surface water collection systems

Surface water drainage systems on the embankments are to be sized for a 100 year ARI flow.

10.5. Collection pond design

The collection ponds will be sized to manage runoff from a 10 year ARI (24 hour storm).

10.6. NAF Stockpile

The NAF stockpile shown in Drawings 0511 to 0513 will reach its maximum size during operation and will be partially depleted before closure. In closure it will be rehabilitated to an engineered landform and pasture or vegetation will be established. It will likely be suitable for farming as the remaining stockpile material will be over consolidated. The proposed design criteria are detailed in Table 2.

Table 2: STORAGE 3 STOCKPILE DESIGN CRITERIA

Design Parameter	Design Criteria
Earthquake loading • OBE • SEE	 Probabilistic 150 year return period Probabilistic 500 year return period
Geotechnical stability • Static	 - Temporary benches in stockpile Factor of Safety (FOS)≥1.2 - Rehabilitated benches in stockpile Factor of Safety (FOS)≥1.5 - Stockpile global stability FOS≥1.5 - Post-earthquake conditions FOS≥ 1.2
• Seismic	OBE: The performance requirement for the OBE is that the stockpile remain functional and that the resulting damage is minor and easily repairable. SEE: The performance requirement for the SEE is that there is no major instability when the stockpile is subjected to the seismic load imposed by the SEE. Damage to the rehabilitated surface and surface drains may have occurred, however, it is readily recoverable.

11.0 DEVELOPMENT OF STORAGE 3 TSF

11.1. Design Concepts

The RL155 crest height provides a total storage volume of approximately 8,100,000 m^3. Allowing for freeboard requirements to store a Probable Maximum Precipitation (PMP) inflow design flood with 1.0m freeboard, the volume available for tailings storage is estimated at approximately 6,700,000 m^3. Depending on the processing rate, discharge regime between TSFs, tailings grind size, and tailings underdrainage, average dry densities in the order of 1.0 to 1.28 t/m^3 can be expected based on experience at Waihi with the existing TSFs. Considering that no underdrainage is proposed for Storage 3 a final average dry density of 1.2 t/m^3 is recommended for design. On this basis the potential tailings storage in Storage 3 is approximately 8 Mt (million tonnes).

The tailings impoundment is to be fully lined with an earthfill liner. The earthfill liner on the upstream face of the embankment is part of the embankment zoning. Additionally, a 1.5 mm HDPE geomembrane liner is proposed within the tailing's impoundment and up to the initial embankment height (RL135) to further minimise tailings seepage.

The Storage 3 embankment is zoned with low permeability liners and capping to provide for secure disposal of PAF overburden material obtained from mining of GOP or MOP4. These liners and capping limit oxygen and water ingress and along with the addition of lime into the material being placed minimises any acid generation potential. This approach has been successful for Storage 1A and 2.

Groundwater beneath the facility will be collected beneath the base earth liner of the impoundment and the embankment through a series of subsurface drains.

Leachate from the material within the embankment will be collected via a series of leachate drains.

Groundwater and leachate collected in the drains will be pumped back to the Water Treatment Plant via the perimeter ring main system around Storage 1A and 2, which will be extended to Storage 3. Power will be supplied by extending the existing power line at the Development Site.

Tailings delivery pipelines, water return pipes and power for the decant return will be extended around the back of Storage 1A and Storage 3.

Clean run-on water from the hills above the TSF will be diverted around the facility to the Ruahorehore Stream. This diversion will be an extension to the existing Southern Uphill Diversion Drain which currently starts behind Storage 1A and runs behind the East Stockpile. This drain is set at a level which allows for future potential raising of Storage 3 to a crest of RL177. The length of the new section of the Southern Uphill Diversion Drain is approximately 2500m.

11.2. Collection Ponds

Dirty surface water run-off prior to the placement of PAF can be managed with typical earthworks erosion controls and sediment controls including Sediment Retention Ponds (SRP). Once PAF is placed dirty water will be diverted to lined collection ponds as is currently done for the Storage 1A and 2 sites. Figure 3 shows the current layout of collection ponds. The ponds are sized to have sufficient capacity to contain runoff in rainfall events up to a 1 in 10 year 24 hour storm, when dilution is effective to ensure that any discharge will have less than minor effects on the receiving environment. Contained water is pumped back to the existing Water Treatment Plant before being discharged to the Ohinemuri River or for use in the Process Plant. The collection ponds are pumped down during and after a storm events~~.~~

Collection Pond S5, which currently provides retention of surface water from the north east part of Storage 1A and East Stockpile, will be buried by Storage 3 works. This pond will be replaced by a new pond at the intersection of the downstream toe of Storage 1A and 3. It will be called Collection Pond S6. Collection Pond S5 currently spills excess water to the Storage 1A Perimeter Drain which flows to Collection Pond S4. Collection Pond S4 has a spillway for excess flow to the Ruahorehore Stream. To separate the discharges to allow for more efficient management of surface water as rehabilitation is completed, Collection Pond S6 will have its own spillway to the Ruahorehore Stream, rather than spilling to S4. A new collection pond is required to manage the additional embankment runoff area from Storage 3. It will be called Collection Pond S7. Its proposed location is the low-lying area at the toe of the Storage 3 embankment which is the natural drainage path for water on the site, and it is immediately adjacent to Collection Pond S6. Collection Ponds S6 and S7 will both be fully lined with a 1.5mm HDPE on a 0.6m thick earthfill liner. A forebay and causeway into the main pond will be features of the ponds that will aid in maintenance, as is used in the existing collection ponds.

A surface water perimeter drain will direct dirty water runoff from the embankment to the collection ponds. These drains will be HDPE lined.

Realignment of 310m of the Ruahorehore Stream is required to make room for Collection Pond S7 and temporary sediment retention ponds indicated on the Drawings 511, 512 and 513 in Appendix A.

The total footprint of Storage 3 TSF, including the extent of the stockpile and uphill diversion drain, is approximately 120ha. Of this area 20ha is already part of the existing footprint of Storage 1A and East Stockpile. The additional footprint is therefore 100ha.

Geotechnical investigations indicate the depth to bedrock on average is greater than that encountered at the Storage 1A and 2 sites. There are limitations on the practical downstream toe position due to the presence of weak and compressible ground that is up to 32m deep and extends beyond the site. The embankment has been positioned to limit the excavation required to rock, while not significantly compromising the capacity of Storage 3. Generally, the downstream toe excavation will be 7 m deep, apart from across the 'Paleo Gully' where it may be up to 20 m deep. Refer to Sections 11.4 and 11.5 and drawings in Appendix A.

This allows any risk from weak or liquefiable soils to be mitigated by removal and placement of structural fill directly on the bedrock. Weak or liquefiable soils only need to be removed at the toe of the embankments to provide stability for the embankment slopes.

11.3. Initial Embankment and Impoundment

The initial (starter) embankment with a crest of RL135 is located over the upstream half of the main embankment footprint and provides the initial tailings storage capacity for the facility. The approximate initial embankment layout is shown in Drawing 511 and the embankment and impoundment profile is shown in cross section in Drawings 516, 517 and 518. The proposed initial embankment profile has a buttress of material at its downstream toe which extends out to an initial downstream toe drain and shear key positioned for the RL145 embankment (Drawing 512, 516 and 517). This profile is currently proposed as it provides for a more efficient development of storage capacity between RL135 to RL145.

The initial embankment abuts Storage 1A at its west extent and the rhyolite hills to the east. The impoundment is then formed against the initial embankment, East Stockpile ignimbrite toe bund and the slopes of the northern hills.

The conditions encountered during the first discharge of tailings are different to the following lifts as no consistent layer of tailings is in place within the impoundment. Deposited tailings at Waihi have a relatively low permeability and this limits the amount of seepage from them. The underlying rock and surficial soil cover also do naturally provide some containment. The existing TSFs do not have a liner over the base of the impoundment and rely on hydraulic containment of the site and the cutoff and associated drain at the upstream toe of the embankment and subsurface drains to intercept and collect groundwater seepage. However, additional controls in the form of a lined impoundment are proposed for Storage 3 as an improvement over the previous facilities to limit seepage into the natural environment, and because the depth to rock for a cutoff is too deep to be practical.

The existing TSFs have performed well. However, the proposed lining of the impoundment while still retaining the upstream cutoff drain provides an additional level of protection during this early stage of deposition and for the long term. As previously mentioned, the tailings consolidate to a low permeability soil over time which will offset any potential deterioration of the HDPE geomembrane. The earth liner (Zone A fill) will remain in perpetuity. The HDPE geomembrane will also limit seepage to the subsurface drains located beneath the liner. Drawings 621 and 622 show drain details.

11.4. Main Embankment West Abutment with Storage 1A

The west side of the Storage 3 embankment abuts Storage 1A. The Storage 1A embankment is constructed of the same bulk material as the Storage 3 embankment and so the two embankment fills can be joined by stripping the outer capping layers, Zones H and G, from the Storage 1A embankment progressively as Storage 3 is raised so Zone D (PAF) material placed in Storage 3 is in contact with the Zone F (PAF) drainage layer of Storage 1A.

The perimeter infrastructure for Storage 1A buried by Storage 3 (i.e., subsurface drain collection sumps/pumps and ring main) will be extended to the toe of Storage 3. The drains flowing to the collection sumps at the toe of Storage 1A that will be buried, will need to be extended through the sumps to a gravity outlet. The drains may need to be raised from the sumps to a level which is practical to construct a gravity outlet. This will have the effect of raising the level of effective drainage provided by the drains. Eventually Storage 3 will buttress the toe of Storage 1A in this area.

11.5. Main Embankment across lower valley floor

A cross section of the main embankment across the lower valley floor is shown in Drawing 516.

Where the main embankment crosses the lower valley floor sensitive redeposited rhyolite soils within a paleo gully constrain the downstream toe position of the embankment. The embankment is positioned so undercut of these sensitive soils is limited to approximately 20 m depth (the sensitive material reaches 34 m depth downstream). The extent of excavation will need to be confirmed during construction. The excavated area will be backfilled with structural fill before the construction of the embankment and drainage systems. This structural fill material will be NAF.

The collection pond for Storage 3 is positioned at the toe of the main embankment in the lower valley floor as this is the practical location to collect runoff by gravity.

11.6. Main Embankment over the toe of east rhyolite ridge

To the east of the paleo gully the ground rises gradually towards the toe of the hills of the east ridge. The positive topography is the surface of a rhyolite lava flow deposit over 80 m deep (Boreholes AP21a and AP22a). The embankment downstream toe is positioned on this rhyolite flow. The downstream toe is to have a 50 m width (minimum) excavation down to rock with a downstream toe drain installed at the upstream extent of the cut. The depth of weathering of the rhyolite surface varies, and the expected depth of cut is between 4 m to 7 m. Further testing of the strength of the material will be required for detailed design to confirm the likely depth of excavation with confirmation during construction. The rhyolite is covered by 2 m to 3 m of ash and this material will be stockpiled and used for construction of the Zone A liner of the impoundment and embankment.

11.7. Main Embankment against east rhyolite ridge

The east rhyolite ridge is a weathered rhyolite flow deposit. It is covered in a surficial layer of colluvium and ash soils. The embankment’s downstream toe sits against the ridge line and eventually wraps across a gully and inside the property boundary to the northeast. The layout is shown on Drawing 510.

As shown in cross section in Drawings 518 and 519, the embankment profile is truncated at its downstream toe with the surface of the Zone A base liner sloping upstream. Seepage through the embankment will therefore flow back towards the upstream toe of the embankment.

11.8. Impoundment against the Northern Slopes

The northern slopes of the impoundment will need to be stripped and reworked to construct an HDPE liner up to RL135 and an earth liner above RL135.

Where possible local surficial soils can be reworked, however, some overburden material may be required to line the full extent of the impoundment.

Local borrow areas (1 - Central and 2 - Eastern) fall within or partially within the impoundment area. The slopes of the local borrows have been designed at 1V:3H with 4m wide berms at 10m vertical spacings. This will enable the earth and HDPE liners to be placed against the final excavated profiles.

Typical profiles are shown in Sections 7 and 8 on Drawing 521.

11.9. Impoundment over East Stockpile

The East Stockpile will be fully depleted with fill used in the construction of the Storage 3 starter embankment. A Zone B earthfill liner with Zone C1 filter layer will be constructed over the East Stockpile depleted surface, with the addition of an HDPE geomembrane up to RL135. The East Stockpile area is currently underlain by a Zone A liner.

11.10. Subsurface Drainage

The subsurface drainage shown on Drawing 620 includes subsoil drains installed up the centre of the gullies, initial embankment upstream cutoff drain and initial toe drain, and a main embankment downstream toe drain. The subsurface drains intercept the groundwater flow immediately beneath the impoundment and the embankment liners to firstly control groundwater seepage during construction and to collect leachate that may seep through the liner.

The drains are formed using drainage metal wrapped in geotextile to provide a filter for finer material. This type of drain has worked satisfactorily with the existing TSFs. A proposed improvement is to replace the geotextile over the top of the drain with a sandy gravel filter (Type A Drainage Metal) placed directly on top of the subsurface drainage metal (Type B Drainage Metal) to provide some redundancy against precipitate forming on the geotextile and clogging. ABS (acrylonitrile-butadiene-styrene) pipes collect the seepage in the drainage metal. ABS pipes are proposed as they have performed well for the existing embankments. In the long term, if the pipes deteriorate or collapse, the gravel surrounding them will still provide drainage. Long term closure stability is not reliant on the drains. For closure design they are assumed to be blocked.

11.11. Impoundment Liner System

For the base of the impoundment a geomembrane liner on top of a 0.6 m Zone A earth liner is proposed as the liner system. This is shown in Detail B in Drawing 517. The Zone A liner will be constructed on surficial soil or rock and over the subsoil drains.

For the embankment up to RL135 a geomembrane liner is proposed over the upstream shoulder low permeability Zone B, as shown on Drawings 517 and 518. Zone B acts as a liner and is approximately 6 to 10m thick. A Zone B liner without geomembrane is proposed above RL135.

The use of a geomembrane liner in addition to the Zone A earth liner provides a more robust design. Refer to Section 13.5.

A Zone A earth liner a minimum of 0.75 m thick is proposed against the northern slopes above RL135, as shown in Section 6 in Drawing 520. Where the slopes are at more gentle grades the Zone A liner will be able to be constructed as a blanket 0.75 m thick. As the slopes steepen the thickness will need to increase to achieve a safe practical working width which is likely to be approximately 5 m to 7 m width.

11.12. Embankment Liner System

The embankment is to be underlain by a 0.75 m thick Zone A earth liner. Previously the Zone A base liner was 1.5m thick beneath the embankment. However, this additional thickness has been shown to provide only minor benefit over 0.75 m thickness. Using a 0.75 m thickness reduces the demand on NAF material, saving it for more critical locations, like capping of the embankments and stockpiles.

11.13. Leachate Collector Drains

Leachate collector drains are installed over the top of the Zone A base liner within the embankment. The drains are constructed from Type C Drainage Material which is a gravelly cobble. Drains are proposed at the downstream toe, extending over the downstream half of the Zone A blanket and up the eastern gully where leachate will collect at the upstream toe, as show in Drawing 626. Details of the drains are shown in Drawing 627.

11.14. Uphill Diversion Drain

The uphill diversion drain is to be constructed before the foundations are stripped, establishing a clean water diversion to minimise the amount of water needing to be treated for sediment during early construction, and once PAF material is being placed, treatment for contaminants.

Previous consents have required the uphill drains to be sized for a 1 in 10 year Average Recurrence Interval (ARI) Event.

Preliminary drainage design has been sized for 1 in 50 year ARI Event. This minimises the water entering the impoundment to assist with water management at the Water Treatment Plant.

11.15. Haul Route B Behind Storage 1A

The Haul Route B (also referred to as the Northern Haul Road) behind Storage 1A (refer Figure 3) will be the haul route for overburden material transported to Storage 3. The road will be extended down the East Stockpile.

11.16. Storage 3 Stockpiles

Three proposed stockpiles are shown on Drawing 511. These are for stockpiling of topsoil and surplus soils from the strength stripping of the Storage 3 foundations. All stockpiles are to be for NAF material only. The rhyolite soils of Storage 3 are expected to be NAF. Allowance for a total stockpile volume of approximately 3,000,000 m^3 has been made.

The stockpiles will require an access road and perimeter drains leading to sediment collection ponds.

The existing East Stockpile will be near full depleted and will require lining as described in Section 11.9.

11.17. Local Borrow Areas

The construction of Storage 3 is expected to commence in advance of MOP and GOP. Therefore, alternative material sources are required for the construction of the Storage 3 starter embankment. Three borrow areas local to the Waihi development site have been designed to provide a source of NAF Fill. Borrow area 1 (Central) is located within the impoundment area directly to the east of the East Stockpile and is expected to provide approximately 260,000m^3 of fill. Borrow Area 2 (Eastern) is located to the northeast of the embankment and falls partially within the impoundment area. Borrow Area 2 (Eastern) has been split into 2 stages, 2A and 2B, which are expected to provide approximately 400,000m^3 and 1,250,000m^3 of fill respectively. The local borrow areas adjacent to TSF3 are shown on drawing 0511-0513.

Borrow Area 3 (Western) is located within the footprint of the Northern Rock Stack and is expected to provide approximately 495,000m^3 of fill. Additional information on this borrow area is provided in the technical report on the Northern Rock Stack (Ref. 3).

The depletion of the East Stockpile will also provide a source of additional fill material for construction of the Storage 3 embankment. These materials may be PAF or NAF depending on where they are sourced from within the stockpile. The full depletion of the East Stockpile is expected to provide approximately 930,000m^3 of fill.

The depletion of the East Stockpile and borrows have been staged to match the sequencing of the Storage 3 embankment raising. The Borrow Areas will require drill and blast techniques to excavate the majority of the material.

11.18. Tailings Storage Capacity and Surface Profile

The elevation storage curve for the proposed Storage 3 design to RL155 is shown in Figure 15. The storage at RL155 is approximately 8,100,000 m^3. Of this volume approximately 6,700,000 m^3 will be available for tailings storage, with the rest required for freeboard and storage of supernatant water and extreme rainfall on top of the tailings.

It is estimated that tailings will be able to be discharged up to 3.1 m below the crest and the normal operating level of the pond water will be typically at least 4.1 m below the crest. The maximum tailings profile and operating water level is controlled by the need to provide storage for the design flood above the tailings with 1 m freeboard. The design flood is the runoff from a 72-hour probable maximum precipitation (PMP) rainfall event. The PMP volume is approximately 840,000 m^3.

The decant water will be pumped to the Process Plant for re-use or to the Water Treatment Plant prior to discharge into the Ohinemuri River. It will be necessary to monitor the decant pond water level to ensure that operating water levels are consistent with design assumptions. It will also be necessary to undertake close monitoring of the tailings profile when it nears the maximum design profile to ensure there is enough storage for the design storm (72-hour PMP) with 1 m freeboard.

Under normal operation the water in the pond is to be kept away from the crest by forming a tailings beach around the embankment extent. This will be managed by discharging tailings from spigots around the embankment crest. This is similar to the current operation on Storage 1A.

11.19. Construction Aspects

Storage 3 will require a series of establishment works before tailings can be discharged. The initial works to establish the initial embankment are expected to take 3 to 4 years depending on the sequencing of the work and weather. Drawings 0511 to 0513 and 0690 in Appendix A illustrate the various stages of works from the starter embankment with crest at RL135 to RL155 closure.

The works include but are not limited to:

- Establishment of initial erosion and sediment controls
- Clearing the site of farm fences and trees etc.
- Fencing the perimeter
- Establishment of an uphill clean water diversion drain and access track
- Diversion of the Ruahorehoe Stream adjacent to the collection ponds
- Establishment of the Storage 3 topsoil and surplus soil stockpiles
- Undercut and backfill of sensitive rhyolite tuff material up to 20 m deep in the ‘Paleo Gully’
- Stripping the site of topsoil
- Targeted stripping of ashes and alluvial soils
- Undercut to rhyolite rock at and construction of the Upstream Cutoff Drain, Initial Toe Drain, and Downstream Toe Drain
- Development of local borrows
- Construction of subsoil drains up the gullies
- Construction of the Zone A Pad
- Construction of the Perimeter Embankment, including Perimeter Access Road, Perimeter Surface Water Drain, Subsurface Drain Collection Sumps and Closure Gravity Outlets
- Construction of the Storage 3 Collection Pond including Decant, Power, Water Return and Closure Gravity Outlet pipes
- Construction of the Leachate Collection Drains and Collection Sumps
- Construction of the Perimeter Collection Sumps, including gravity collector pipes and pumps
- Construction of the Initial embankment
- Construction of the Impoundment Earthfill and Geomembrane Liner up to RL135
- Installation of the Tailings Delivery Pipe and Spigots
- Installation of the Tailings Impoundment Decant, Power and Water Return Pipes.

After the initial embankment is established, raising of the crest and the impoundment lining is a progressive task of fill placement, instrumentation installation, and rehabilitation. Storage 3 and Storage 1A can be constructed independent of each other. Drawings 0512 and 0513 show the progressive development of the embankment up to RL145 and RL155 respectively.

The volume of material to be excavated from the foundations of the embankment is summarised in Table 3. For the preliminary design an initial estimate of fill volumes by NAF, PAF and topsoil and by embankment zonation has been made and is summarised in Table 4 and Table 5. Approximately 2,650,000m^3 of NAF is required. It is estimated that 1,000,000m^3 can be obtained from stripping of the Storage 3 foundations and that 1,650,000m^3 of NAF local borrow area material will be required from local borrow, GOP or MOP. Management of NAF stockpile volumes is required to ensure suitable quantities of ash, alluvium and rhyolite is won from the Storage 3 site prior to the construction of the embankments.

Material required to be sourced offsite from external suppliers, such as drainage metal, sand filter material, rockfill lining, pipes, sumps, concrete, and decants is summarised in Table 6.

An Erosion and Sediment Control Report has been prepared by Southern Skies for Storage 3 (Ref. 20).

Table 3: STORAGE 3 SITE STRIPPING, FOUNDATION UNDERCUT, LOCAL BORROW, AND EAST STOCKPILE VOLUMES

Item	Cut Volume (m^3)
NAF - Foundation Undercut	1,800,000
Local Borrow Area	1,910,000
East Stockpile	930,000
Topsoil	110,000
Total	**4,750,000**

*Cut volumes are preliminary estimates only, actual volumes will vary

Table 4: STORAGE 3 RL155 FILL VOLUMES BY MATERIAL ZONATION

	Fill Volumes (m^3)											
Fill Breakdown	**Zone A**	**Zone B**	**Zone C1**	**Zone C2**	**Zone D**	**Zone F**	**Zone G**	**Zone H**	**Zone I**	**Topsoil**	**General NAF**	**Totals**
Starter Embankment (Crest RL135)	756,000	443,172	207,623	239,696	228,323				629,600	7,300	**131,000**	**2,642,714**
RL145 Embankment	49,000	293,840	97,922	221,318	366,389							**1,028,470**
RL150 Embankment	197,500	138,000	100,000	230,000	1,293,800	486,200	200,000	50,000				**2,695,500**
RL155 Embankment	80,000	54,250		42,000	1,353,000	771,349	257,500	102,500		72,950		**2,733,549**
Closure capping								68,000	136,000			**204,000**
Totals	**1,082,500**	**929,262**	**405,545**	**733,014**	**3,241,512**	**1,257,549**	**457,500**	**220,500**	**765,600**	**80,250**	**131,000**	**9,304,233**

*Fill volumes are preliminary estimates only, actual volumes will vary

Table 5: STORAGE 3 RL155 FILL VOLUMES BY NAF/PAF/TOPSOIL

	Fill Volumes (m^3)			
Fill Breakdown	**NAF**	**PAF**	**Topsoil**	**Totals**
Starter Embankment (Crest RL135)	1,516,600	1,118,814	7,300	**2,642,714**
RL145 Embankment	49,000	979,470	-	**1,028,470**
RL150 Embankment	447,500	2,248,000	-	**2,695,500**
RL155 Embankment	440,000	2,220,599	72,950	**2,733,549**
Closure capping	204,000	-	-	**204,000**
Totals	**2,657,100**	**6,566,883**	**80,250**	**9,304,233**

*Fill volumes are preliminary estimates only, actual volumes will vary

Table 6: STORAGE 3 EXTERNALLY SOURCED MATERIAL QUANTITIES

Item	Quantity*	Units
Drainage metal and filter sand	13,200 to 15,800	m^3
Roading metal	4,800 to 5,800	m^3
Rockfill lining	2400 to 2900	m^3
Geotextile	53,000 to 64,000	m^2
ABS Subsoil Pipes (80 to 150mm dia.)	12,100 to 14,500	m
PE Subsoil Pipes (110mm dia.)	1,000 to 1,200	m
Geomembrane (HDPE)	270,000 to 330,000	m^2
Tailings Underdrains	220,000 to 260,000	m^2
Sumps (i.e. 2.3m dia. manholes)	75 to 90	m
Concrete	360 to 430	m^3
Culverts (1.5m dia.)	70 to 90	m
Collection sys. PVC pipes (225mm dia.)	900 to 1100	m
Decants	2	No.
Embankment surface water PVC pipes	2600 to 3200	m
PE Delivery and Return Pipes	3200 to 3800	m

*Preliminary estimates only, actual volumes will vary

11.20. Closure Plan

The closure plan concepts for Storage 3 are shown in Drawing 0690. The current plan for the closure surface of Storage 3 comprises a perimeter capping layer of ignimbrite rockfill with a 0.5m thick layer of Zone H over the top. The uphill diversion drain along the northern hills will be decommissioned and runoff will be allowed to flow into the impoundment. The eastern section of the drain will remain and form a permanent outlet channel (i.e. spillway) for closure, discharging water to the Ruahorehore Stream. Closure details will be reviewed and advanced and it is recommended they be subject to future approval by Waikato Regional Council and Hauraki District Council.

11.21. Surface Water

Runoff from the ground above Storage 3 is intercepted and diverted by the uphill diversion drain.

Runoff from the Storage 3 site will initially be managed through a series of diversion channels, earth bunds and SRPs. Initially materials onsite will only be NAF. As the initial embankment is constructed over the Zone A base liner PAF material will be placed. At this point the ability to collect PAF runoff is required. This is likely to be done by controlling the downstream perimeter of the site with a perimeter bund (NAF) required for the embankment construction and the Storage 3 Collection Pond S7 which is to have approximately 90,000m^3 storage capacity, be HDPE lined and have pumps to deliver water back to the treatment plant.

Runoff from the downstream shoulder of the Storage 3 embankment is to be collected via benches (grassed at final lift to RL155) at approximately 10m vertical intervals. Water can be conveyed down to the toe of the embankment to a perimeter drain via buried PVC pipes or surface drains. The perimeter drain will then discharge to the Storage 3 Collection Ponds S6 and S7, which is then pumped to the process plant or to the water treatment plant. Once water quality improves water in the collection ponds can be discharged into the Ruahorehore Stream.

The surface runoff pipes or surface drains are likely to be at approximately 200m centres. Pipes are likely to be 220 to 300mm in diameter.

A similar piped surface water system on Storage 1A and 2 has operated without incident throughout the operation of the embankment. The same is expected for Storage 3.

12.0 POTENTIAL FAILURE MODES

The identification and assessment of potential failure modes for a dam is a routine risk assessment exercise done in accordance with the NZDSG. The failure modes that are identified are not failures that are expected to occur. They are hypothetical failures that could occur if appropriate design, construction, monitoring, and surveillance methods were not followed. However, 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 for the proposed Storage 3 has been undertaken. A further detailed review is to be undertaken in detailed design. Potential failure modes that have been identified are summarised in Table 7. The potential failure mechanism is described along with the design mitigation and proposed dam safety monitoring.

Table 7: POTENTIAL FAILURES MODES

Failure Mode	Initiating hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
FM1	Normal operation	Concentrated seepage within or beneath the embankment leads to internal erosion of embankment and high seepage pressure, resulting in piping failure of embankment	Specify Zone B sufficiently wide to have low seepage gradients and very low risk of internal erosion. Supervision of construction and testing of embankment fill to ensure fill complies with specifications. Design water management processes to maintain a tailings beach under normal operating water levels.	Visual inspections and seepage collection and monitoring for early detection of seepage and any increases in flow.
FM2	Normal operation	Weak layer formed during a pause in construction creating potential failure plane and instability.	Specify reworking and testing of the embankment surface prior to placement of new material. Include a visual inspection and approval by Designer	Visual inspections and monitoring of embankment deformation.
FM3	Normal Operation	Weak layer within the embankment creating potential failure plane and instability.	Careful zoning and selection of material used to construct the new embankment with monitoring, testing and certification of the compacted fill.	Visual inspections and monitoring of embankment deformation.
FM4	Heavy Rainfall	Extreme rainfall events cause rise in the decant pond water and overtop the embankment causing erosion on the face and abutments leading to failure of embankment	The maximum decant pond level is limited so that the available air space above to the lowest embankment crest level can accommodate the PMP event with 1.0m freeboard.	Visual Inspections and monitoring of decant pond volume and level relative to embankment crest level.
FM5	Normal Operation	Failure through hidden weak layer in the foundation.	Investigate foundation to depth to determine any potential weak planes. Include any weak planes in analysis.	Installation of inclinometers at toe of embankment prior to fill placement

Failure Mode	Initiating hazard	Potential Failure Mechanism	Design Mitigation	Dam Safety Monitoring
				with regular monitoring to identify the development of excessive shear strain.
FM6	Seismic	Liquefaction (cyclic softening) or settlement of weak soils in the foundations leading to slumping and instability	Positioning of embankment to optimize stability at the toe of downstream embankment. Undercutting of sensitive soils in the Paleo Gully and backfilling with structural fill. (Shear) key cuts into bedrock.	Visual inspections and monitoring of embankment deformation.
FM7	Heavy rainfall	Failure of northern slopes into Storage 3 impoundment causing wave which over tops the crest.	Assess the conditions for landslips and consider inundation scenarios in relation to impoundment.	After very heavy rainfall (1 in 10 year event) undertake inspection of slopes above facility for potential slope instability to identify any new potential instabilities risks.

13.0 DESIGN ASSESSMENT

13.1. Embankment geotechnical stability

Slope stability analyses for the proposed Storage 3 RL155 embankment have been carried out using limit equilibrium methods outlined in Appendix B. The stability design criteria are outlined in Section 10.1. The analyses have been undertaken for operation and closure groundwater levels for the final profile. Two critical cross sections were analysed. These were Section 1 and Section 2 shown in plan view in Drawing 0513 and in cross section in Drawing 0516 and 0517. Section 1 is through the Paleo Gully and Section 2 is through the end of the rhyolite (lava flow) rock ridge that extends from the east abutment, west along the toe of the proposed embankment. Section 1 and Section 2 also represent different situations in terms of ground works for stability, with the Paleo Gully requiring a full undercut and replacement with engineered fill, and Cross Section 2 requiring instead a 50 m wide downstream shear key cut and initial embankment key cut for stability. The stability assessment considered varying slide surfaces, including through the foundations, Zone A base pad liner and within the embankment.

The assessed factor of safety (FOS) values for each loading condition are summarised in Table 8 below. Refer to Appendix B for the calculations and analysis outputs. All NZDSG criteria are meet.

Table 8: SUMMARY OF EMBANKMENT SLOPE STABILITY ANALYSIS

Design case	**FOS required by NZDSG**	**Section 1 FOS**	**Section 2 FOS**
Operational/construction static stability – peak strengths	≥1.5	1.8	1.7
Long term post closure static stability – peak strengths	≥1.5	2.1	2.0
Post-earthquake strength conditions – static stability	≥ 1.2	1.6	1.5
	Required by NZDSG	**Section 2 EQ. Slope Disp.**	**Section 2 EQ. Slope Disp.**
OBE 1 in 150 year Earthquake Slope Displacement Estimate	Minor easily repairable damage	Less than 0.5cm – Negligible	Less than 0.5cm – Negligible
SEE 1 in 10,000 year Earthquake Slope Displacement Estimate	No release of contents	Between 9 and 42 cm –	Between 15 and 65 cm -

The effect of earthquake displacements on freeboard are considered in Section 1.4.

13.2. Embankment seismic shakedown settlements

Seismic induced volumetric shakedown settlements of the fill are estimated to be less than 0.2% (Ref. 51) of the depth of fill when subjected to the 10,000 year ground motion. This is because the embankment is rockfill compacted in 0.25 m to 0.5 m thick layers with an expected SPT-N of 35+ and the CSR is less than 0.4. As an estimate of the maximum potential volumetric shakedown settlement, 0.2% of 46 m is 9.2 cm.

Shakedown volumetric settlement is in addition to any settlement of the crest due to shear displacements considered in Section 13.1. See Section 13.4 for freeboard scenarios.

13.3. Embankment consolidation settlement

Monitored settlements of the installed embankment deformation monitoring points on the finished surfaces indicates fill settlements are small. Most of the settlements of Storage 1A are less than 0.3 % of the depth of embankment fill. On Storage 2 they are up to 0.7%. For Storage 3 a settlement ratio of 0.7% has been applied for an initial assessment resulting in 0.32 m (0.7% x 46 m above rock) post construction.

Both the potential static embankment settlement and potential fill volumetric shakedown settlement are not likely to be critical in the long term. They are easily manageable by setting the level of the closure outlet channel to allow for any potential future settlements.

Section 13.4 considers the effects of embankment settlement regarding freeboard. Any effects are easily managed in design and construction, to prepare the facility for closure.

13.4. Freeboard scenarios

The likely freeboard scenarios are summarised in Table 9. Specific freeboard calculations are undertaken for the different situations in operation and for closure. No scenarios compromise freeboard and risk overtopping.

Initial estimates indicate that for Storage 3, the top of the tails beach will need to be at least 2.9 m below the minimum crest level and the normal operation water level will need to be 4.1 m below the minimum crest level. This allows for storage of the IDF (from a 72 hour PMP) above the maximum normal water operation level, with 1.0 m of freeboard remaining. The current freeboard criteria in the resource consent condition is 1.0 m above the 72 hour PMP level, and it is also the minimum freeboard level under the IDF recommended by the NZDSG.

In closure the outlet channel invert will need to be determined allowing for long term crest settlements and potential earthquake deformations. As set out in Table 9 these settlements are easily managed for the proposed facility.

Table 9: SUMMARY OF EMBANKMENT FREEBOARD SCENARIOS

Parameters	Freeboard Scenarios*				
	Operation			Closure	
	Normal Conditions	Inflow Design Flood during operation	Post SEE Earthquake during operation	Inflow Design Flood after closure[#]	Post SEE Earthquake after closure
Embankment as-built crest level (RL)	155	155	155	155	155
Approximate tailings level against embankment	151.9	151.9	151.9	151.9	151.9
Reservoir/Pond water level (RL)	150.9	154	150.9	153.1*	151.2[&] (estimated closure outlet channel invert)
Static embankment fill settlement (m)	0m	0m	0m	0.7% x 46m = 0.32m	0.7% x 46m = 0.32m
SEE slope displacement related crest settlements affecting freeboard	-	-	0.65m	-	0.65m
SEE fill shakedown related crest settlements	-	-	0.2% x 46m = 0.09m	-	0.2% x 46m = 0.09m
Freeboard without wind, or wave (m)	4.1 m^	1.0 m	3.36 m	1.58m	2.74 m
Wind design event	1 in 100 AEP	1 in 10 AEP	1 in 10 AEP	1 in 10 AEP	1 in 10 AEP
Wave run-up (m)	0.34 m	0.30m	0.30m	0.30m	0.30m
Freeboard allowing for wave run-up (m)	3.76 m	0.7m	3.06m	1.28m	2.44m

*Levels reported for the freeboard scenarios are based on operating experience and expected catchments for Storage 3. Level will vary during operation depending on the tailings surface profile and specific calculations are required to confirm sufficient freeboard is maintained at regular intervals by operational staff. This table is indicative of the likely scenarios.

^Normal operation freeboard is targeted to allow sufficient volume to hold the IDF with 1.0m freeboard remaining, without including wave runup.

[#] Closure scenario assumes an outlet channel at normal water levels which spills clean water to receiving catchment. Outlet channel will need to be sized to pass sufficient volume to limit maximum water level under IDF (72 hour PMP) to maintain freeboard. To be confirmed at closure.

[&] Outlet channel invert level will need to consider tailings coverage with pond water where there is no dry capping. Level estimated. To be confirmed in closure.

13.5. Geomembrane liner performance

OGNZL has undertaken site specific trials of geomembrane performance when exposed to tailings liquor and overburden rock leachate from the existing TSFs (Ref. 21). The trials involved testing of enhanced HDPE and Linear Low Density Polyethylene (LLDPE) liners. LLDPE is more flexible than HDPE and this can be an advantage where large strains are expected. The trials indicated that the enhanced HDPE membrane performed much better in oxidative stress tests when exposed to leachate and tailings liquor samples from Waihi and would have a much longer effective design life. A HDPE liner provides more resistance to chemicals breakdown and has sufficient flexibility to withstand expected differential settlements and expected strains. Consequently, a HDPE geomembrane is recommended. The use of a geomembrane liner provides additional protection against seepage from the tailings into the environment above an earthfill liner alone. Over time the geomembrane becomes redundant to the design performance. Seepage control is provided by the Zone A and B earthfill liners and the consolidation of tailings.

13.6. Groundwater and leachate seepage estimation

Estimates of groundwater and leachate seepage, including flows to the various subsurface drains, are based on seepage models with permeabilities of the different materials determined from insitu and laboratory testing, and also the historic performance of the subsurface drain flow and piezometric levels measured at the existing TSFs.

13.7. Uphill diversion drain sizing

The uphill diversion drains will be sized in accordance with the design criteria in Section 10.2. Design will include freeboard above the design flow to allow for sedimentation, and waves and unusual flow conditions that may occur. The fill and cut slopes associated with the drain will be designed to meet conventional factors of safety and performance for different load conditions. The drain will be constructed from materials that have inherent long-term durability (earth and rock). Armour rock will be used in locations where velocities could result in erosion of bare earth surfaces.

13.8. Perimeter drain sizing

The perimeter drain will be sized in accordance with the design criteria in section 10.3. Design concepts and drain geometry will be similar to the existing perimeter drains. Design will include freeboard above the design flow to allow for sedimentation, and waves and unusual flow conditions that may occur.

13.9. Collection pond sizing

The collection ponds will be sized in accordance with the design criteria in section 10.5. Design concepts and geometry will be similar to the existing collection ponds. The fill and cut slopes associated with the collection ponds will be designed to meet conventional factors of safety and performance for different load conditions.

The ponds will likely have a volume greater than 20,000m^3 and be higher than 4 m and will be classified as large dams by the Building Act, and therefore will require design as per the NZDSG. A dam breach assessment will be required to assign the PIC, which is likely to be low or medium. Design criteria will then be set from this assessment. A design report will need to be prepared for each Collection Pond and submitted for building consent.

13.10. Embankment surface water drainage sizing

The embankment surface water system will be sized in accordance with the design criteria in section 10.4. The design concepts will be the same as for the existing TSFs with a combination of benches that divert runoff to sumps and buried pipes that discharge runoff down the slope into the perimeter drain. In very large rainfall events runoff overflows the benches and flows as sheet flow down the embankment. The embankment will be mostly pasture and it is resistant to erosion from short duration flows.

13.11. Paleo Gully Undercut Settlement Effects on Storage 1A

The potential settlement effects on Storage 1A and Collection Pond S5 as a result of the Paleo Gully excavation dewatering have been considered. GHD (Ref. 22) has undertaken a preliminary groundwater drawdown assessment on a section extending beneath Collection Pond S5 and the Storage 1A embankment. The preliminary predicted groundwater drawdown beneath Collection Pond S5 is approximately 5 m, beneath the toe of Storage 1A the prediction is 4 m, and below the crest of Storage 1A it is 1 m. EGL settlement calculations indicate up to 20 mm of settlement. Settlement of this order would have no noticeable effect on Collection Pond S5 or Storage 1A. Even if greater settlements did result, they would not have a material effect unless they affected the impoundment freeboard. To have a material effect settlement would need to be greater than 100 mm. Even then this could be managed by topping up the embankment crest with construction plant on site. Settlements in the range calculated will not affect the Zone A liner or Zone G capping.

14.0 DRAWINGS

The following Drawings have been prepared for Storage 3 to RL155 for this technical report (Refer to Appendix A).

Drawing No.	Drawing Title
WAI-983-080-DWG-CI-0500	Locality Plan and Index - Storage 3 - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0101	Site Plan - Waste Disposal Area - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0511	Layout Plan - Storage 3 RL135 Embankment - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0512	Layout Plan - Storage 3 RL145 Embankment - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0513	Layout Plan - Storage 3 RL155 Embankment - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0516	Sections - Storage 3 - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0517	Sections - Storage 3 - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0518	Sections - Storage 3 - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0519	Sections - Storage 3 - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0520	Sections - Storage 3 - Tails / Waste Rock 080

Drawing No.	Drawing Title
WAI-983-080-DWG-CI-0541	Sections - Storage 3 - Uphill Diversion - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0556	Sections - Storage 3 Perimeter Bund - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0608	Sections - Storage 3 Collection Pond - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0620	Layout Plan - Storage 3 Subsurface Drain - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0621	Details - Storage 3 Subsurface Drain- Tails / Waste Rock 080
WAI-983-080-DWG-CI-0622	Details - Storage 3 Subsurface Drain- Tails / Waste Rock 080
WAI-983-080-DWG-CI-0626	Layout Plan - Storage 3 Leachate Drain - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0627	Details - Storage 3 Leachate Drain - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0639	Details - Storage 3 Drainage - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0690	Layout Plan - Storage 3 Closure – Tails / Waste Rock 080

15.0 CONSTRUCTION

Construction will be undertaken by an independent Contractor supervised by OGNZL. The NZDSG provide guidance on construction and recommend for High PIC dams that the works be undertaken by a Contractor with experience in similar Medium or High PIC dams and on-site construction should be managed by a representative of the Contractor with experience in the construction of Medium or High PIC dams.

The Contractor shall prepare a Quality Assurance Plan.

This plan shall set out specifically, among the other things that are required under a quality assurance plan, the requirements and obligations for control testing of the Works.

In this regard, and as a minimum, the Quality Assurance Plan shall state:

i. How the Contractor will use the control test results to satisfy that it has met the requirements of the Specification;
ii. Personnel responsible for reviewing and confirming that the requirements of the Specification have been met;
iii. Documentation of test results;
iv. Corrective action procedures.

As-built records of construction will be the responsibility of OGNZL. Records shall include:

i. As-built survey records, of all stripped surfaces prior to placement of fill and all final surfaces
ii. Earthworks quantities
iii. Photographs
iv. Quality control test results including results from tests undertaken by the Independent Testing Authority
v. Construction plant
vi. Notes on any issues that arise during construction

The NZDSG recommend that the Designer has full-time representation for High PIC dams and that the on-site representative should have experience in the design and construction of High PIC dams. This is to ensure the works are undertaken in accordance with the design intent and to determine whether any design changes are necessary because of the actual site conditions. Construction of the Storage 3 does warrant full time Designer representation during parts of the foundation and initial embankment works. Reduced representation may be appropriate during certain (later) stages of construction where dam safety related risks are low. An earthworks specification and schedule of monitoring required will be prepared for detailed design. Monitoring during construction and operation will be undertaken by the Designer and OGNZL.

16.0 DAM SAFETY MANAGEMENT

16.1. General

Water and tailings storage dams constitute a potential danger to people, property and environment located downstream. A dam safety management system is required to ensure the dam is 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 NZDSG (Ref.4) provides guidance for developing appropriate dam safety management systems. A dam safety management program should ensure that:

- The dam is operated with safe procedures;
- A routine preventative maintenance program is in place;
- Effective surveillance and inspection procedures are followed;
- All responsible people are kept informed of the status of the dam through an effective reporting system;
- Any incidents are managed with proper procedures and a clear plan
- Responsibilities for all aspects of the dam safety program are clearly defined;
- A validation or review system exists to check that all aspects of the program are effective; and
- All personnel involved in the program are properly trained in dam safety procedures.

The existing Operations, Maintenance and Surveillance (OMS) Manual for Storage 1A and 2 (Ref. 6) will be updated to include Storage 3 and be consistent with the NZDSG and Global Industry Standards on Tailings Management (GISTM - Ref. 23). It will include surveillance requirements for the dam as well as guidance on management of surveillance records, presentation of data, performance evaluation, and reporting. The most important activities in the dam surveillance program are frequent and regular inspections for abnormalities or deterioration in conditions and the recording, collection, analysis and evaluation of monitoring data.

Existing resource consents for Storage 1A and Storage 2 require a Tailings Storage Facility Monitoring Plan (TSFMP). The TSFMP covers monitoring for structural integrity (dam safety) as well as monitoring for groundwater and environmental effects. The structural integrity monitoring in the TSFMP duplicates the monitoring elements included in the OMS Manual.

An important element of a dam safety management programme is regular dam safety reviews. The regular reviews outlined in Section 2.4 for the existing TSFs will include Storage 3 in future.

The annual inspection report, (prepared by EGL as mentioned in Section 2.3), will also be undertaken for Storage 3 and reviewed by the PRP.

The overall responsibility for dam safety management lies with OGNZL. All personnel involved in dam safety are required to be trained and be familiar with dam safety procedures.

The Building (Dam Safety) Regulations 2022 took effect from 13 May 2024. They are concerned with the safety of existing dams. They require dam owners to submit a PIC assessment for all large dams to the Regional Authority. The PIC assessment must be certified by a Recognised Engineer. If they classify as Medium or High they will require a Dam Safety Assurance Program (DSAP) that will require certification by a Recognised Engineer. Annual certificates will need to be submitted by a Recognised Engineer that certify compliance with the DSAP. The TSFs at Waihi will comply with the proposed Dam Safety Regulations.

16.2. Operation and Water Management

The operation of Storage 1A and 2 is managed by OGNZL. Water on the surface of the TSFs is pumped back to the Process Plant for re-use or to the Water Treatment Plant via pumps, until closure when the water returns to a sufficiently high quality to be direct discharged without treatment. A similar operation will be used for Storage 3.

During operation of Storage 3 a beach will be maintained around the upstream embankment by discharging from spigots. This minimises depth of water that may impound in flood events against the embankment, and during drier periods has the benefit of air drying the tailings surface which results in higher densities and strength in the beach area. This provides for more efficient storage of tailings and also reduces the potential for seepage of pond water through the embankment. The proximity of the decant pond to the embankment will be controlled by selective discharge of tailings from the spigots around the embankment to maintain a consistent beach and pumping of water back to either the Process Plant or Water Treatment Plant to control the water level.

A final tailings closure plan is shown in Drawing 690. It will be necessary during the later stages of tailings discharge to regularly survey the tailings surface to check that the profile is in accordance with closure design requirements including that there is sufficient storage for the design rainfall event and to meet design freeboard requirements.

16.3. Maintenance

Maintenance activities include:

- Weed control and fertilising of pasture and vegetation on the embankment
- Maintenance and testing of the pumps and inspection of the tailings and return water pipelines
- Undertaking repairs due to erosion following heavy rainfall
- Maintenance of vehicle access to and over the embankment crest
- Maintenance of the subsurface drain outlets, flowmeters, seepage collection sumps and pumps and return water pipelines
- Maintenance of surface drainage systems (removal of sediment, localised slips)
- Removal of sediment from the collection ponds and maintenance and repair of the decant pumps

16.4. Surveillance and monitoring

Surveillance (visual inspections) and monitoring is to be undertaken to monitor the performance of Storage 3. The purpose is to allow the performance of Storage 3 to be assessed and reported against design expectations; enable the detection and mitigation of potential deficiencies or adverse trends; and to fulfil legislative and regulatory requirements. Instrumentation for monitoring the performance is summarised below:

i. Piezometers will be installed in the embankment and tailings. They are to be read monthly.
ii. Inclinometers will be installed at the toe of the embankment and be measured monthly.
iii. Deformation monitoring stations on the embankment are to be read at regular lift intervals determined by the Designer or at least annually.
iv. Seepage flows in the various subsurface drains are to be measured weekly.
v. The decant pond water level is to be measured weekly to check that sufficient freeboard is available to meet the resource consent conditions.
vi. Weekly visual inspection of the embankment, decant pond, adjacent areas and the uphill diversion drain.

The OMS Manual and the TSFMP will be updated to include surveillance and monitoring at Storage 3. They will include trigger levels and trigger action response plans and include data evaluation and reporting requirements.

16.5. Emergency Preparedness

All dams should have emergency response procedures in place to manage and reduce the consequences associated with failure. The NZDSG provide guidance for an Emergency Action Plan (EAP) specific to dam safety. The EAP for the existing TSFs (Ref. 24) is to be updated to include Storage 3. This is to be incorporated in the Waihi Operation Emergency Management Plan (EMP Ref. 25) which covers the whole mine site. The EAP describes the procedures, responsibilities and actions in emergency conditions. The purpose of the EAP for Storage 3 is to provide a pre-determined plan of actions to be implemented if a dam safety emergency develops. An EAP is designed to:

1. Minimise the potential for failure should a potential safety emergency arises.
2. Limit the effects of a failure on people, property and the environment if failure cannot be prevented.

An EAP includes the following information:

- Guidance on the identification of emergency conditions and the evaluation and classification of the conditions;
- Guidance on the notification procedure depending on the class of emergency;
- Inundation maps that show the possible extent of flooding in the event of a dam breach. Inundation maps for a dam breach are included in the Dam Breach Study report (Ref. 19);
- Summary of possible emergency conditions and what to look for;
- Summary of actions to prevent failure;
- Contact list for emergency services and downstream property owners that could be affected by a TSF breach;
- Maps showing access to the site;
- Methods of communication in an emergency;
- Sources of materials and updating of EAP, and
- Training.

17.0 BUILDING CODE COMPLIANCE

17.1. General

A Building Consent will be required as a requirement of the New Zealand Building Code before construction can commence. It will be processed by Waikato Regional Council which is accredited by the Ministry of Business, Innovation and Employment (MBIE) as a Building Consent Authority (BCA) for dams in the North Island of New Zealand. The design documentation for the Storage 3 embankment (i.e. Design Report, Drawings and Specifications) will be prepared to provide confirmation that the work will comply with the Building Code. Relevant sections of the Building Code are discussed in the following sections.

17.2. Clause B1-Structure

The requirement of this clause is to ensure that relevant structures can withstand the combination of loads that are likely to occur over its design life. The proposed design will be undertaken in accordance with the NZDSG, New Zealand and Australian standards, and referenced technical publications. A Producer Statement for Design–PS1 for Clause B1 will be provided. The design will need to be independently reviewed because it is a High PIC dam and a Producer Statement for Design Review-PS2 will be provided.

17.3. Clause B2-Durability

The requirement of this clause is to ensure that building materials and construction methods are sufficiently durable with normal maintenance to have a specified design life of 50 years. The embankment is constructed of natural durable materials which are expected to remain in perpetuity. The subsurface drains use durable materials which are expected to meet the 50-year design life. In closure it is assumed that subsurface drainage pipes may block, and the design must meet stability criteria in perpetuity with this assumption. A Producer Statement for Design–PS1 for Clause B2 will be provided.

17.4. Clause E1-Surface Water

The requirement of this clause is to ensure that people and property are protected from surface water flooding. Surface water run-off from the catchment area of Storage 3 is reduced as flood flows are attenuated due to storage in the pond and detention of water in the Collection Ponds and controlled with surface water drainage systems. A Producer Statement for Design–PS1 for Clause E1 will be provided.

17.5. Building (Dam Safety) Regulations 2022

The Building (Dam Safety) Regulations 2022 took effect from 13 May 2024. They are concerned with the safety of existing dams. Storage 3 will need to comply with these regulations once it is commissioned. The regulations do not affect the proposed design or construction.

18.0 RESOURCE CONSENT - POTENTIAL RISKS AND MITIGATION MEASURES

1. Potential risks associated with the proposed dam will be minimised by designing, constructing and operating in accordance with the New Zealand Dam Safety Guidelines (NZDSG - Ref. 4).

2. The risks associated with inadequate design will be mitigated by using a dam Designer with appropriate experience. Engineering Geology Limited will be the Designer which has over 35 years of experience in the design and construction of dams, including High PIC dams and the existing TSF dams at Waihi. 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.

3. The risks associated with construction not being in accordance with the design and not responding to actual site conditions, which may be different to those assumed, will be mitigated by the Designer having representation onsite as recommended by the NZDSG. The Designer will undertake inspections during construction to confirm design assumptions, advise on any design amendments, inspect critical details to ensure they are in accordance with the design and confirm that construction standards meet specified requirements.

4. The risks associated with poor construction will be mitigated using a Contractor with experience in the construction 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.

5. The main design risks are stability of the downstream slope during construction, internal erosion from seepage and stability when subjected to design earthquake ground motions. These risks can be mitigated through proper detailing of liners and embankment zones and full-time monitoring of the liner and drain installation for the Initial embankment. This will be controlled with an Earthworks Specification produced at detailed design.

6. Potential geotechnical risks have been investigated by undertaking comprehensive geotechnical investigations (Ref. 17). These risks are reviewed with site data and inspections during construction as outlined in Point 3 above.

7. The materials for construction of the dam consist of gravelly clayey silt or silty, clayey gravelly soils. These materials have good strength and good performance when subject to earthquake ground motions.

8. Erosion and sediment control plans are being prepared for the works (Ref. 20). The layout of the site allows for effective erosion and sediment control measures to be prepared.

9. Water for construction is available from the existing Collection Ponds and existing Storage 1A and 2 ponds as suitable, and other works onsite.

10. Dust will be controlled by spraying dry surfaces with water. Water will also be required to condition the earthfill and this will assist in reducing the potential for dust.

11. The construction of the Storage 3 starter embankment will require local borrow areas to source soil and rock. Borrow areas located within the Storage 3 site (1 - Central, 2A,

and 2B – Eastern) provide up to 1,910,000 m^3 of NAF soil and rock and are shown in Drawings 0511 to 0513. A large proportion of the rock will require drilling and blasting.

12. Potential dam safety risks will be mitigated by adopting a dam safety management system (see Section 16). This is to ensure the dam is maintained in a safe condition to protect life, property and the environment downstream. Storage 3 requirements will be incorporated in the existing OMS Manual.

13. An Emergency Action Plan is in place for the current TSFs, setting out procedures to manage and reduce the consequences associated with failure. This will be updated for Storage 3 (see Section 16.5).

19.0 PEER REVIEW

Peer review of the detailed design is recommended by the NZDSG and will be required for building consent. The Peer Review Panel will also undertake independent review of the design.

20.0 CONCLUSIONS

This technical report presents the proposed design, construction and operation of the proposed Storage 3 TSF. Storage 3 will be formed by a 46 m high downstream constructed earth and rockfill embankment dam with a proposed crest at RL155. Storage 3 can be developed into a TSF in a similar and safe manner as accomplished for Storage 1A and 2. The preliminary design analyses confirm that the expected performance meets criteria in the NZDSG.

REFERENCES

1. Engineering Geology Ltd (December 2024) 'Oceana Gold (New Zealand) Ltd, Waihi Operation. Waihi North Project, Tailings Storage and Rock Disposal Volume 1. Natural Hazards and Options Assessment Technical Report'. EGL Ref: 9215. Doc ID: WAI-985-000-REP-LC-0007.

2. GHD Pty Ltd (2024). 'Gladstone Pit TSF Design Report'

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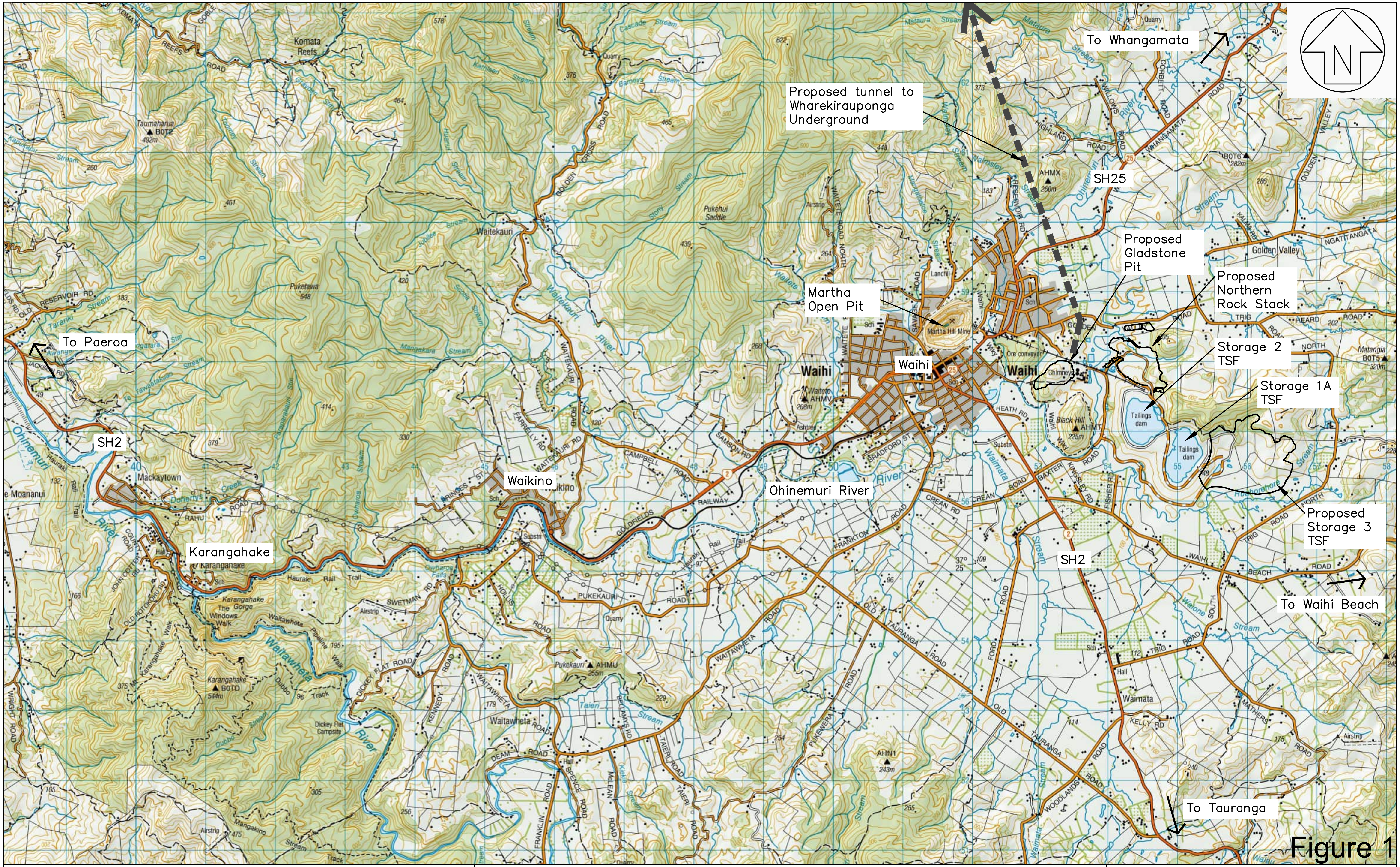
FIGURES



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EGL Geotechnical, Earthquake and Dam Engineers

OCEANA GOLD (NEW ZEALAND) LIMITED - WAIHI
Waihi North Project
Locality Plan

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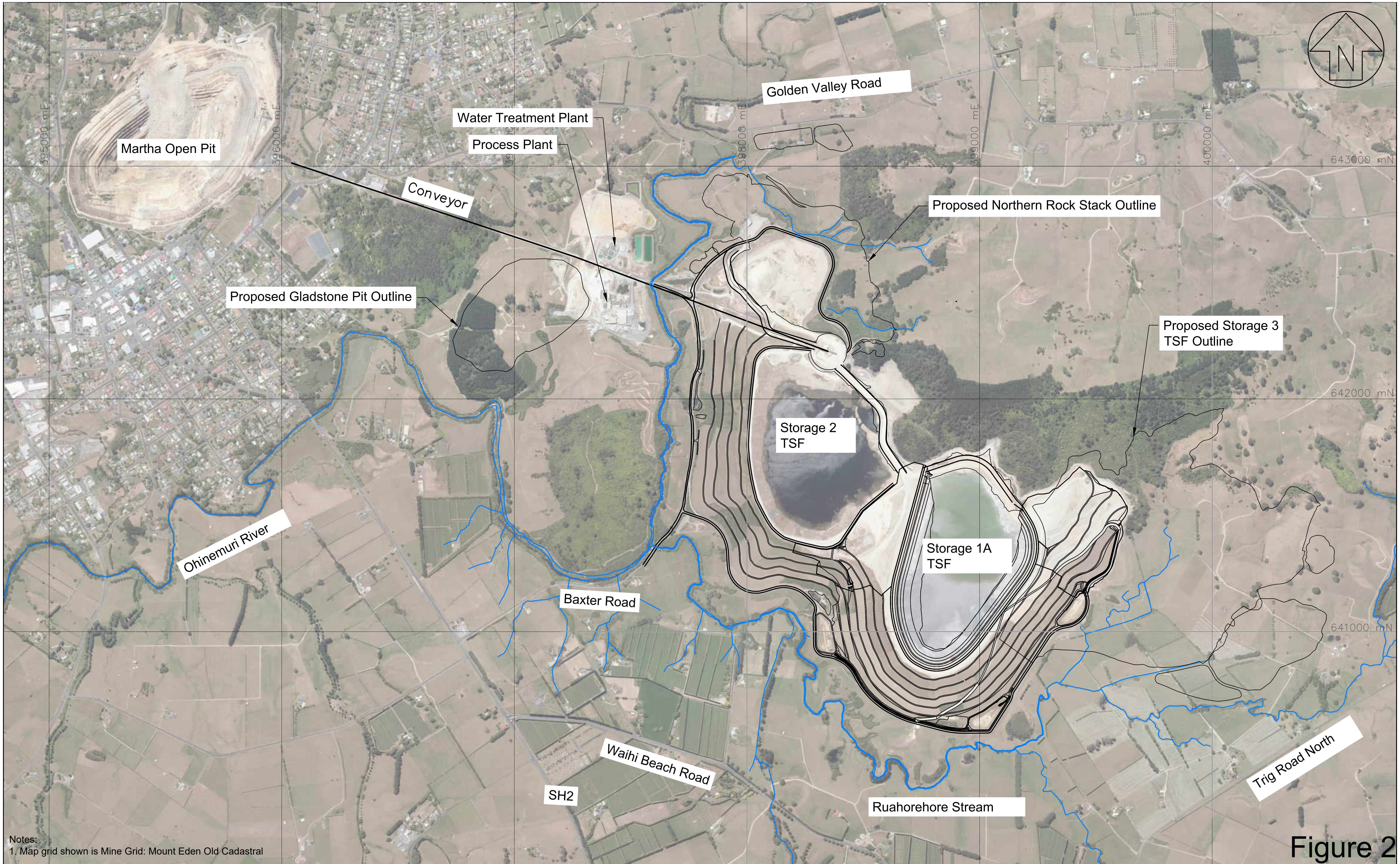

Notes:
1. Map grid shown is Mine Grid: Mount Eden Old Cadastral

Figure 2

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OCEANA GOLD (NEW ZEALAND) LIMITED - WAIHI
WAIHI NORTH PROJECT
Site Layout

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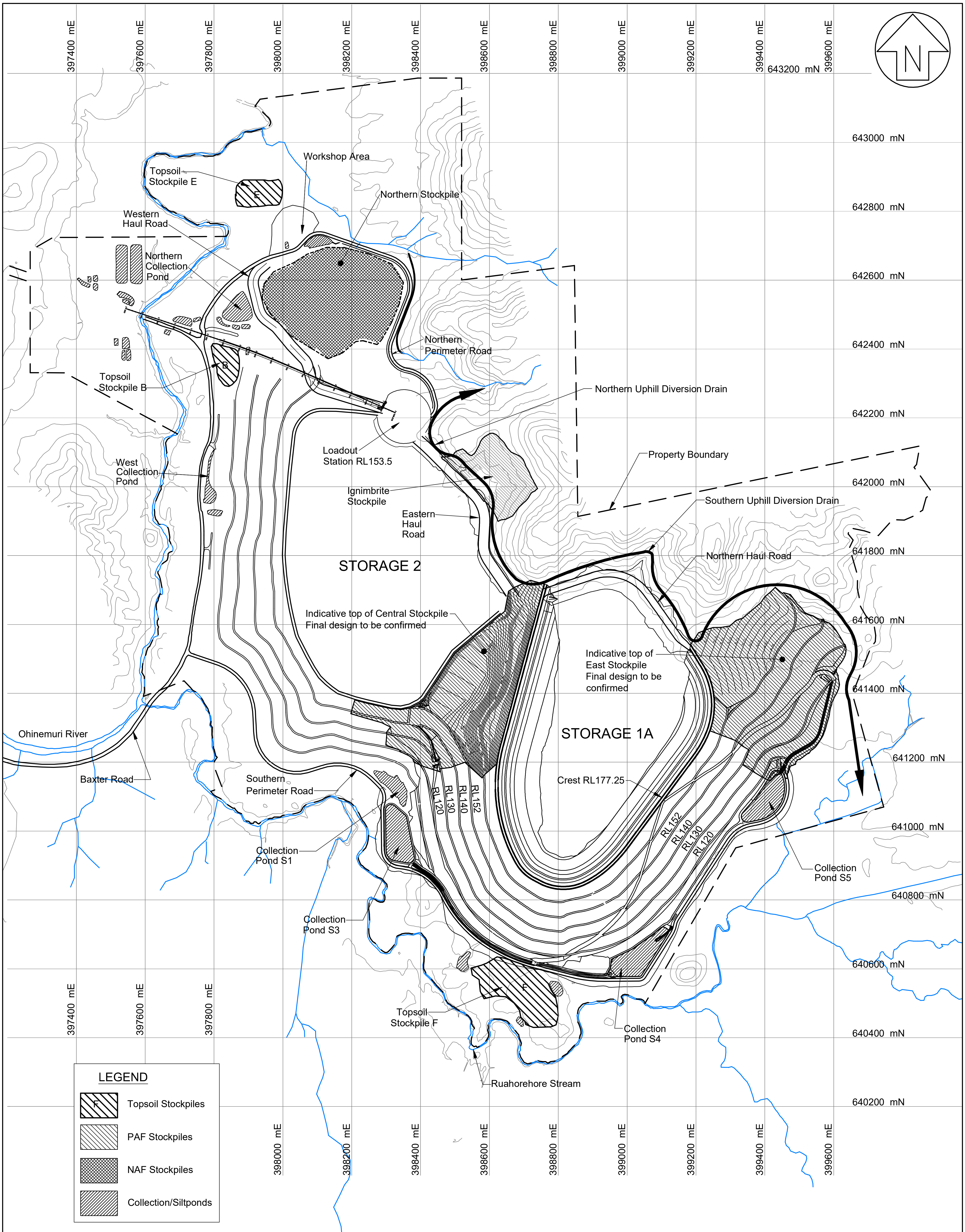

OceanaGold New Zealand Ltd
PO BOX 190, WAIHI, NEW ZEALAND
Telephone +64-7-863-8192
FAX +64-7-863-8924

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

	Signed:	Date:
Preliminary Issue	Signed:	Date:
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date: 24-06-2014

Figure 3

No.	BY	DATE	REVISION	CHECKED	APPROV.
0	PHH	19-6-2014	Construction issue	TM	TM
A	BL	6-12-2013	Tender issue	TM	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	6-12-2013
DESIGNED	TM	18-6-2014
CHECKED	TM	18-6-2014
DRAWN	PHH	18-6-2014

PROJECT: Martha Mine 2014 Contract
AREA: DEVELOPMENT SITE
CONSULTANT DRAWING No. 7604-03-0.dwg

JOB NUMBER:	ORIGINAL SCALE:	SIZE:
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TITLE
Development Site
General Layout

DRAWING No. 7604-03
REV. No. 0

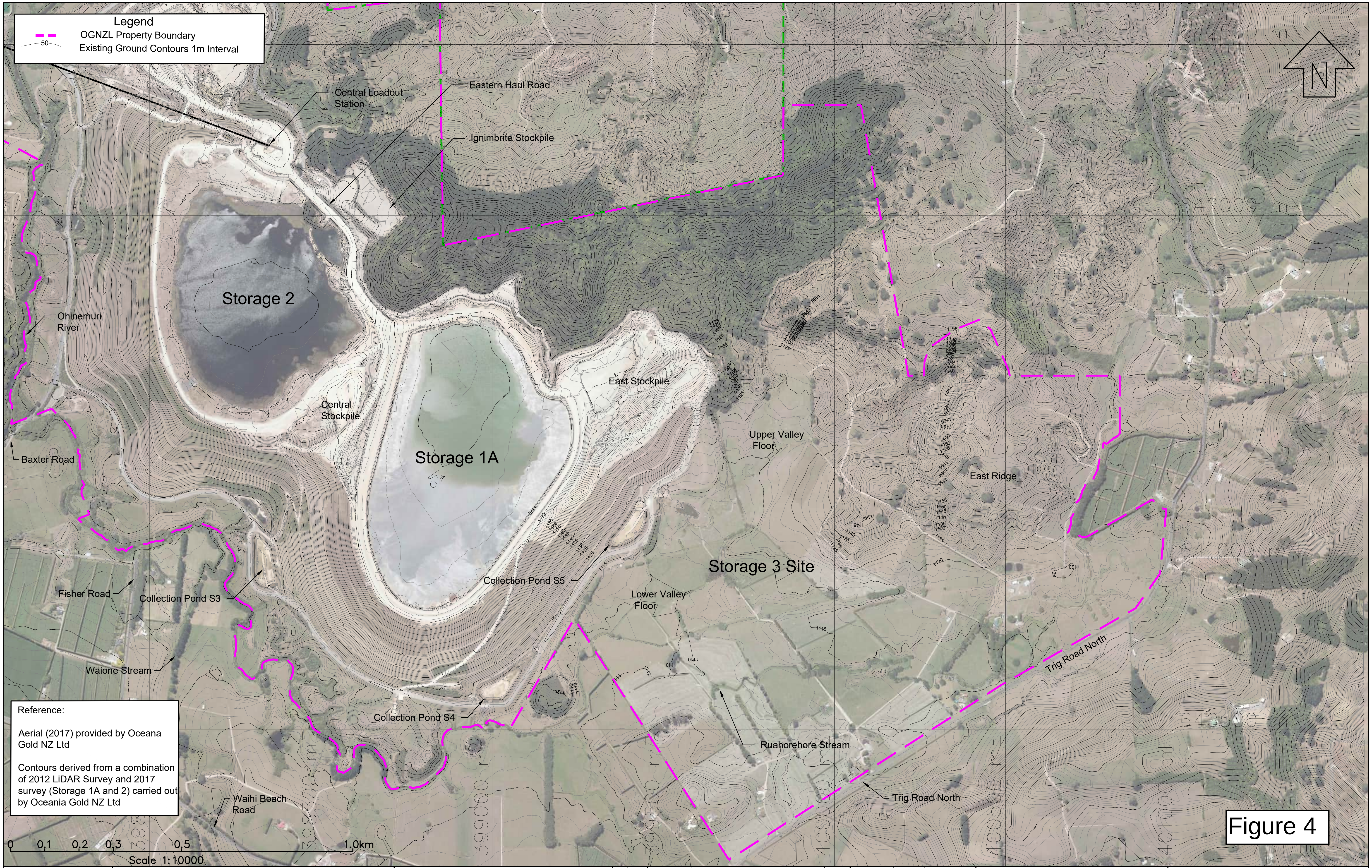

Figure 4

OCEANAGOLD WAIHI OPERATION

EGL Engineering Geology Ltd
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www.egl.co.nz

	Signed:	Date:
Preliminary Issue		
Tender Issue		
Construction Issue		

No.	BY	DATE	REVISION	CHECKED	APPROV.
A	JL	09-09-20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED	ET	09-09-20
CHECKED	ET	09-09-20
DRAWN	JL	09-09-20

PROJECT: General

AREA: DEVELOPMENT SITE

TITLE: Site Plan Waste Disposal Area South Tails / Waste Rock 080

JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.	REV. No.
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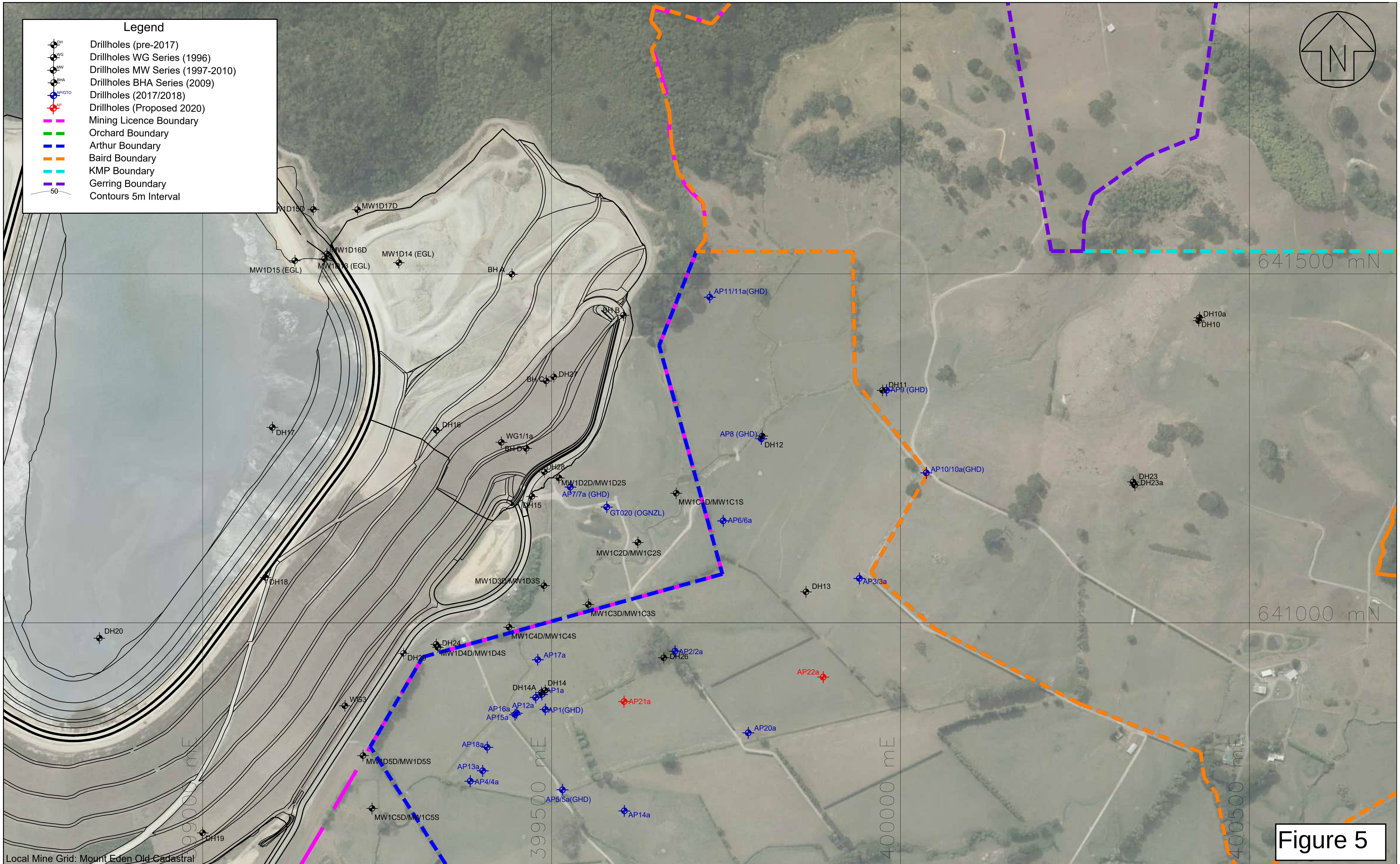

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OCEANA GOLD NZ LIMITED - WAIHI
Drillhole Plan

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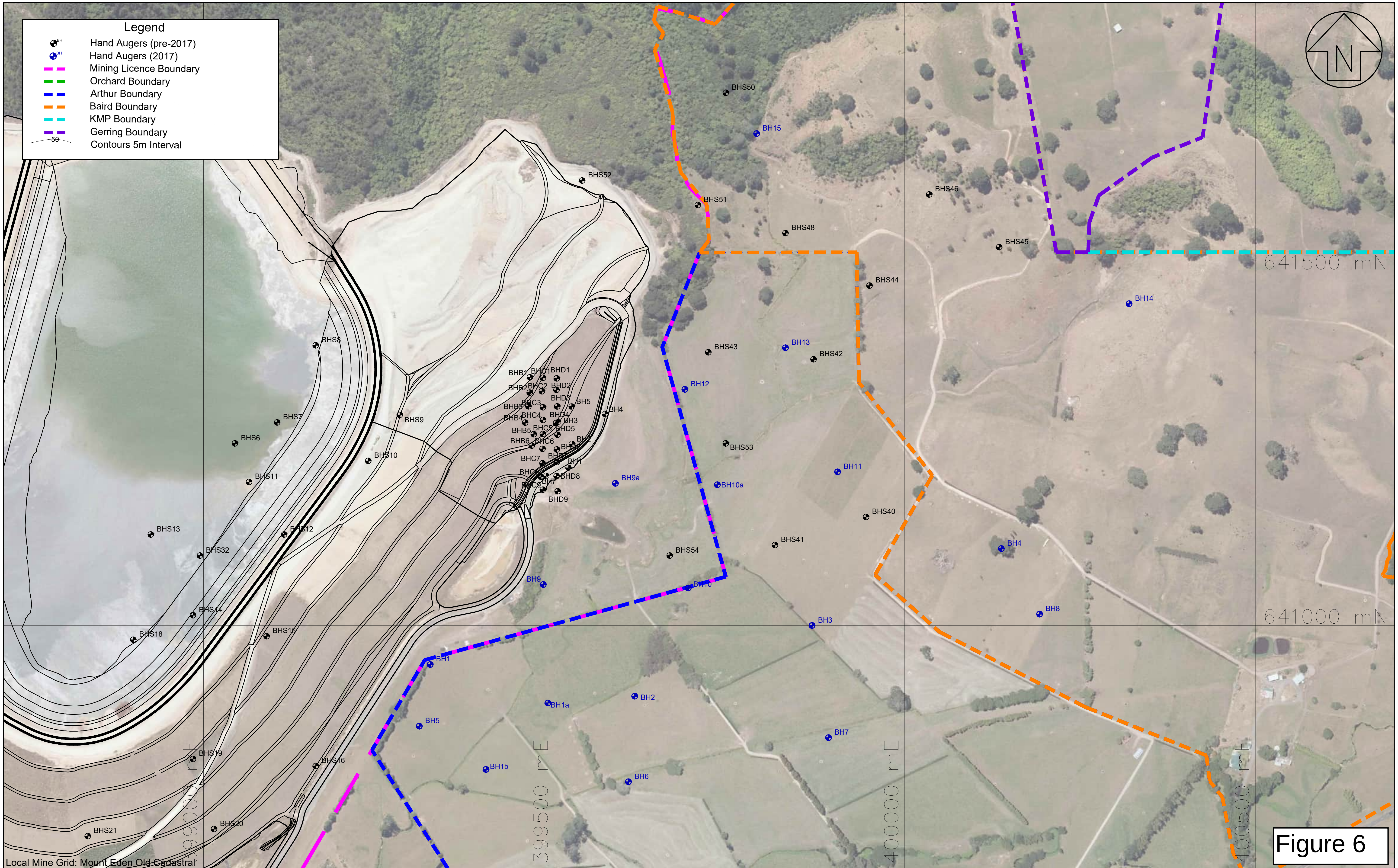

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OCEANA GOLD NZ LIMITED- WAIHI
Storage 3
Hand Auger Location

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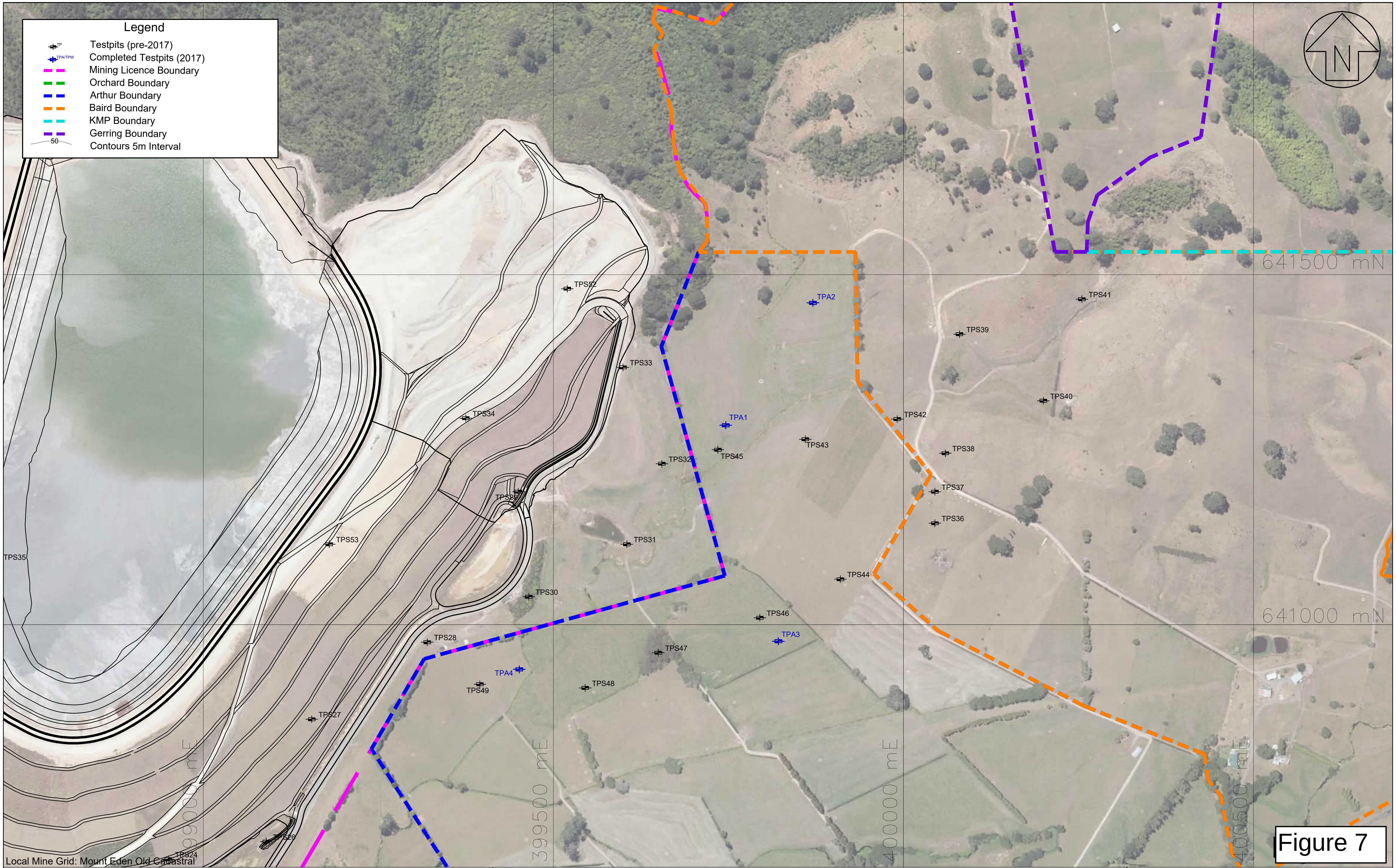

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OCEANA GOLD NZ LIMITED- WAIHI
Storage 3
Testpit Location

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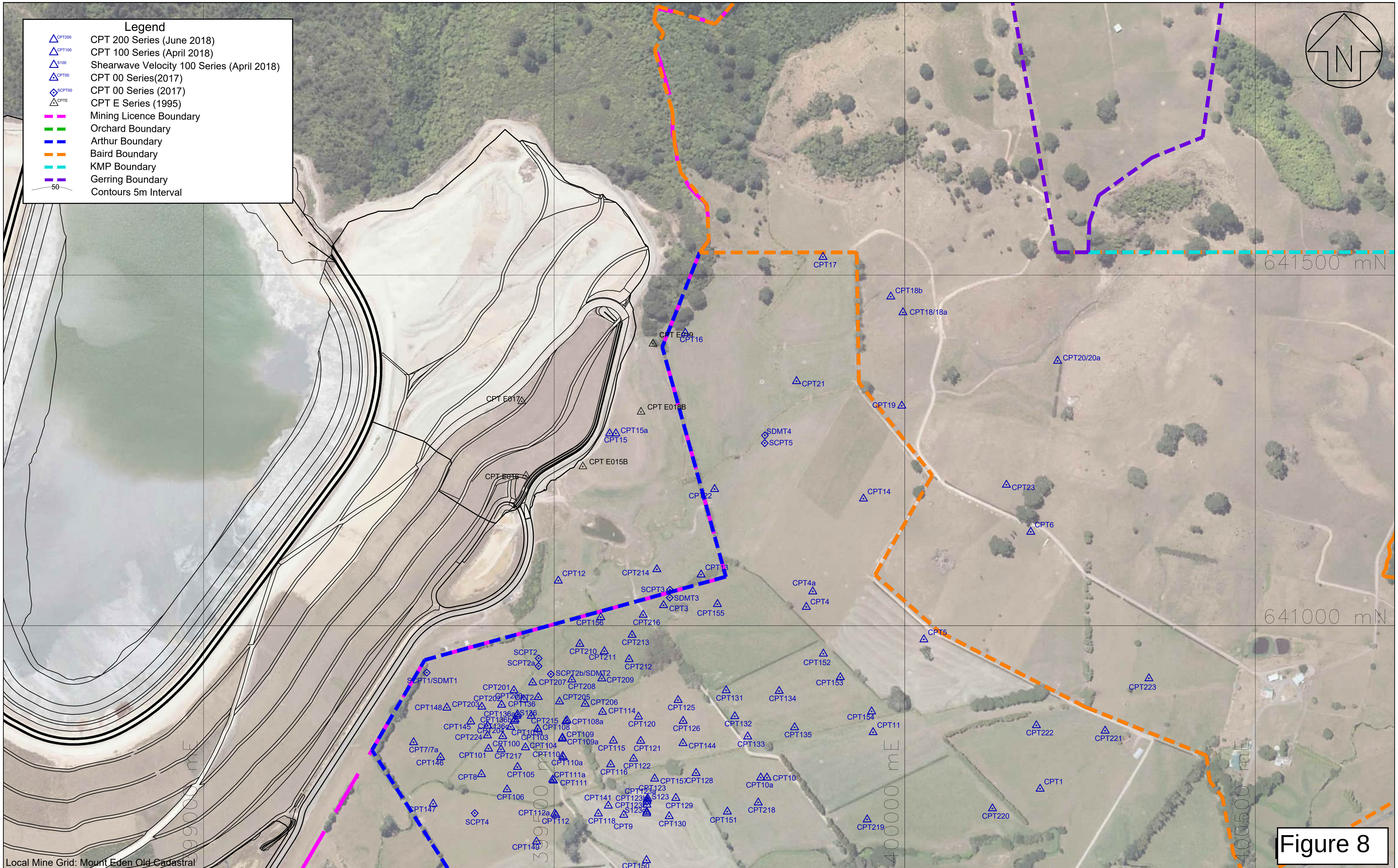

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Storage 3
CPT and Shearwave Velocity Location

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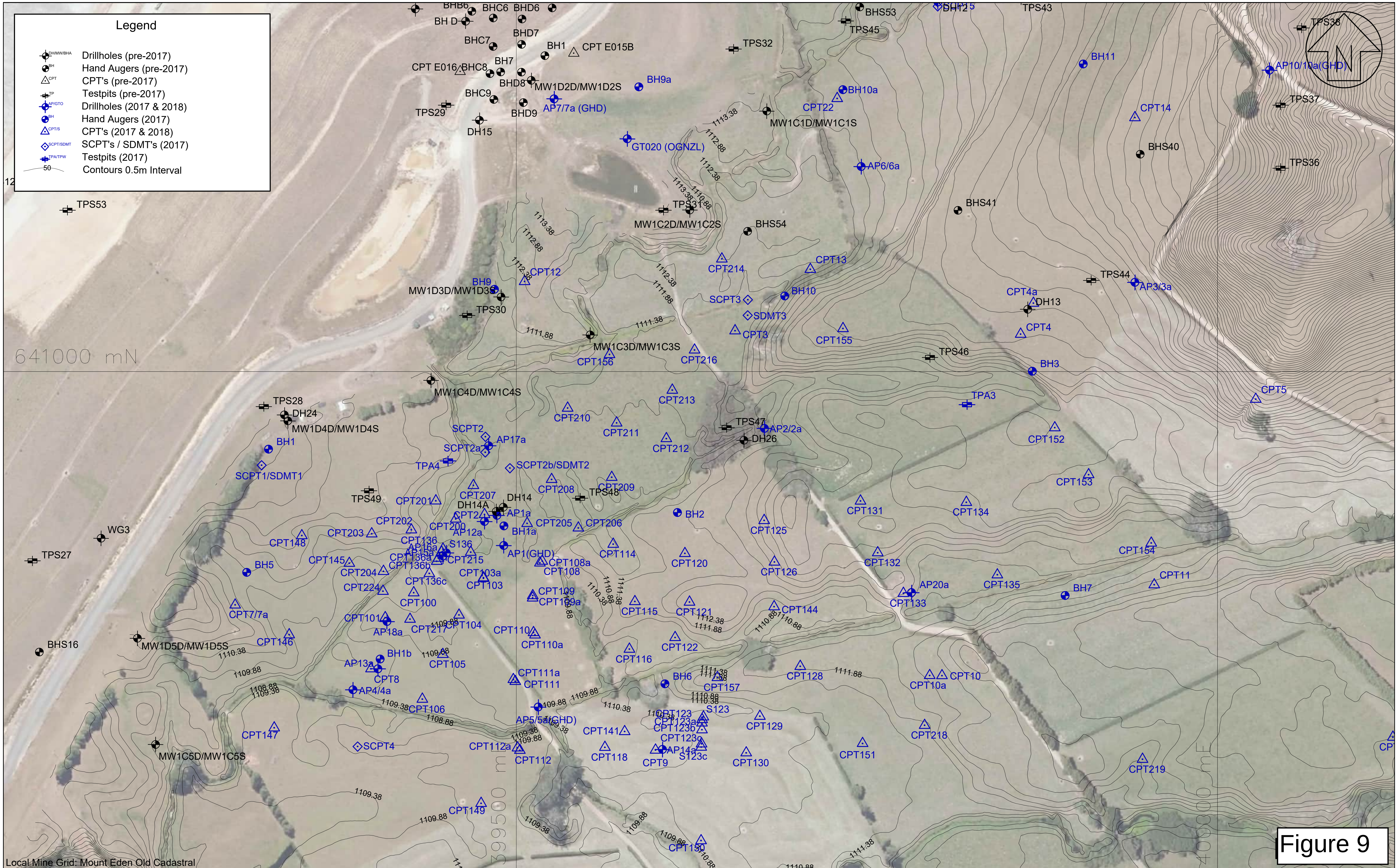

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Storage 3
Geotechnical Investigation Plan- South

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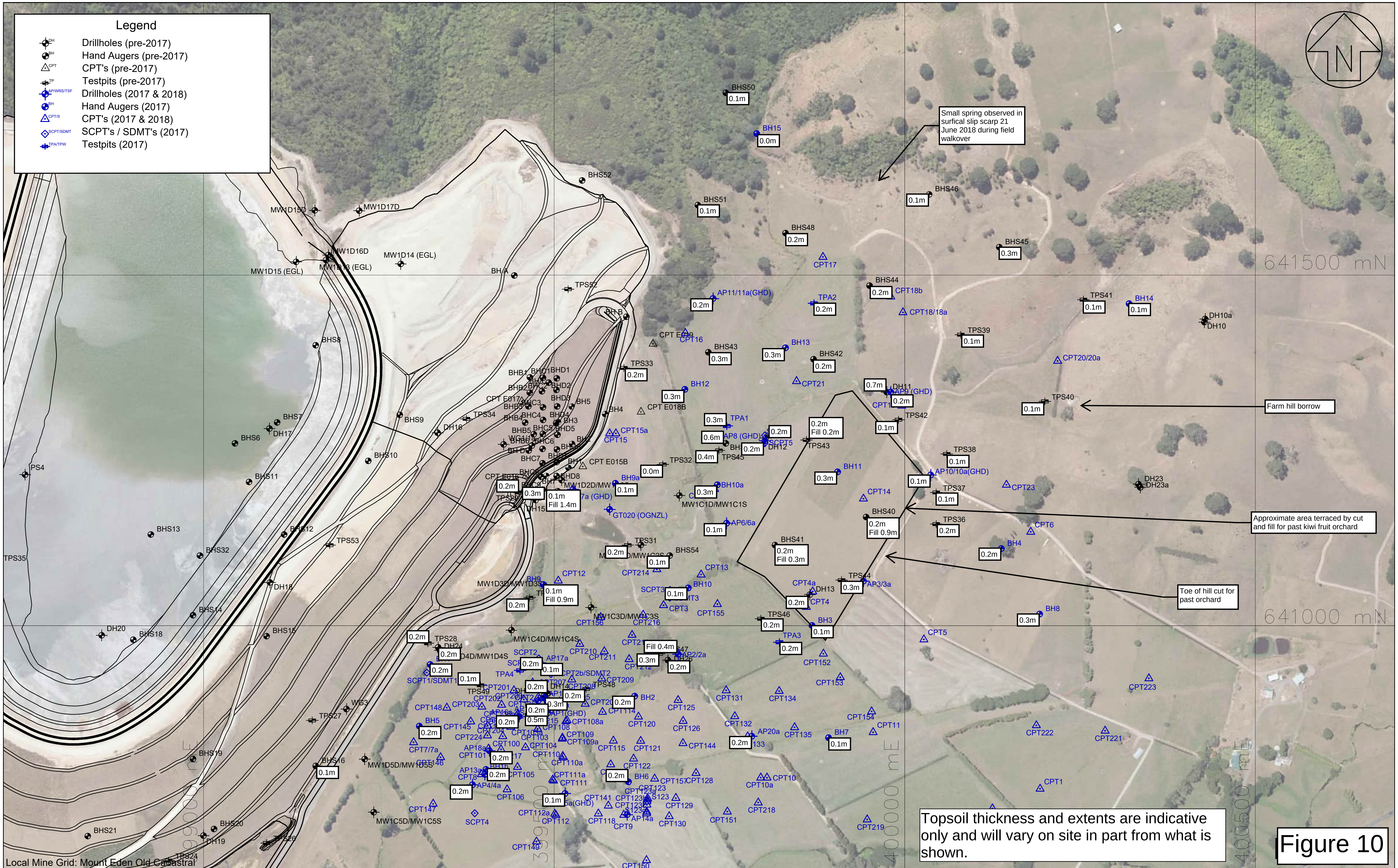

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Storage 3
Thickness of Topsoil Plan

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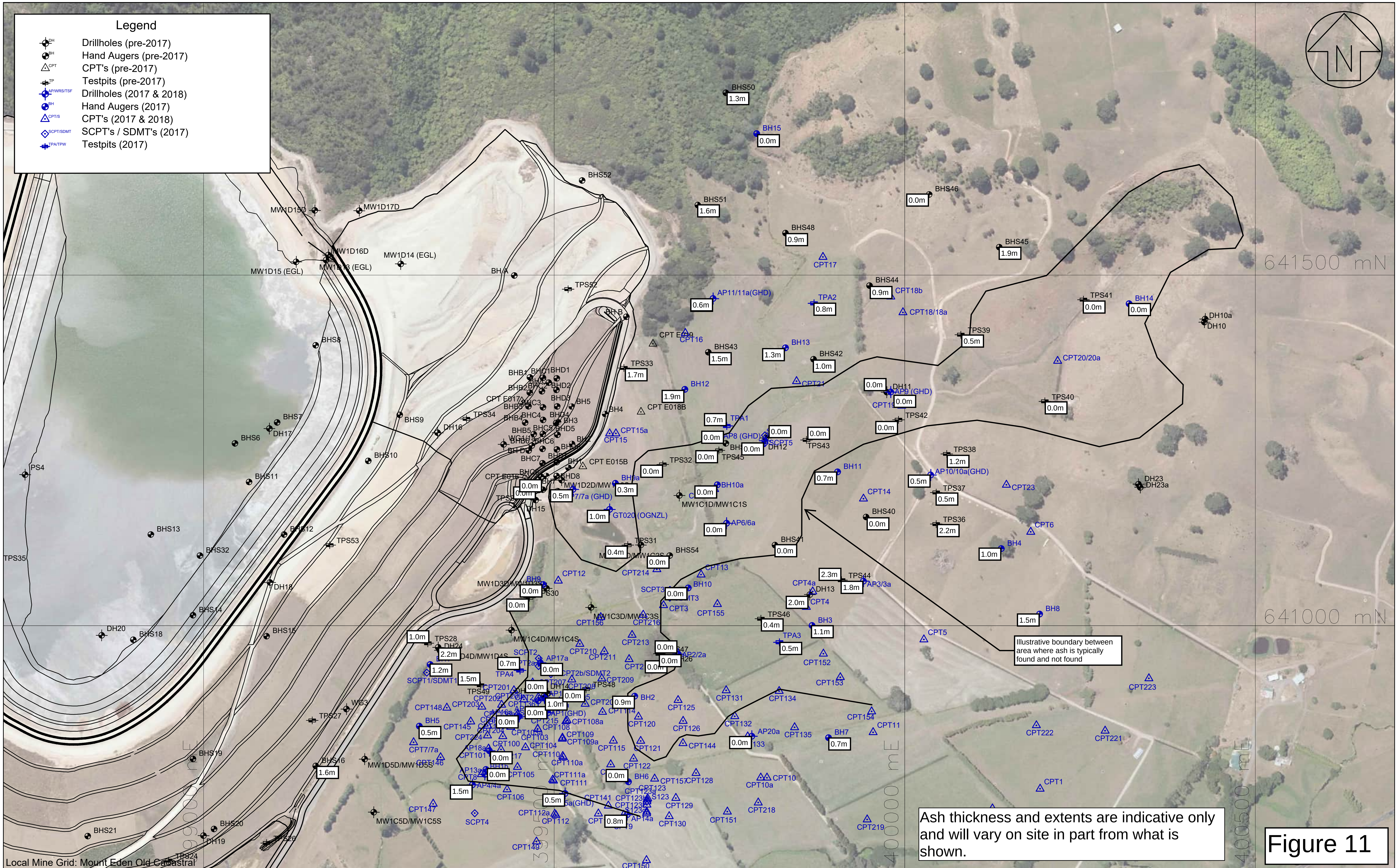

Figure 11

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OCEANA GOLD NZ LIMITED- WAIHI
Storage 3
Thickness of Ash Plan

Drawing No.	8332–Fig10
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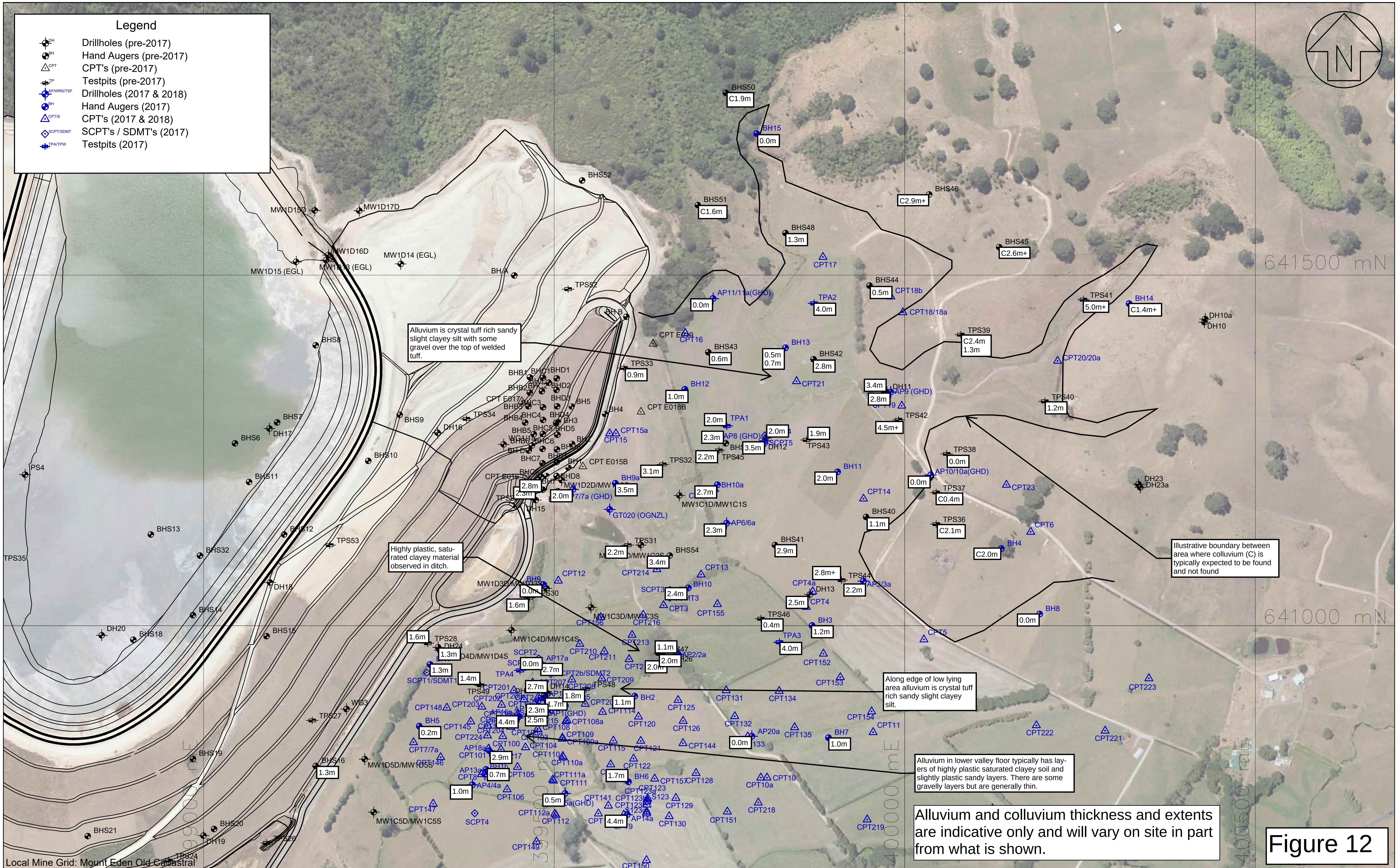

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OCEANA GOLD NZ LIMITED- WAIHI
Storage 3
Thickness of Alluvium Plan

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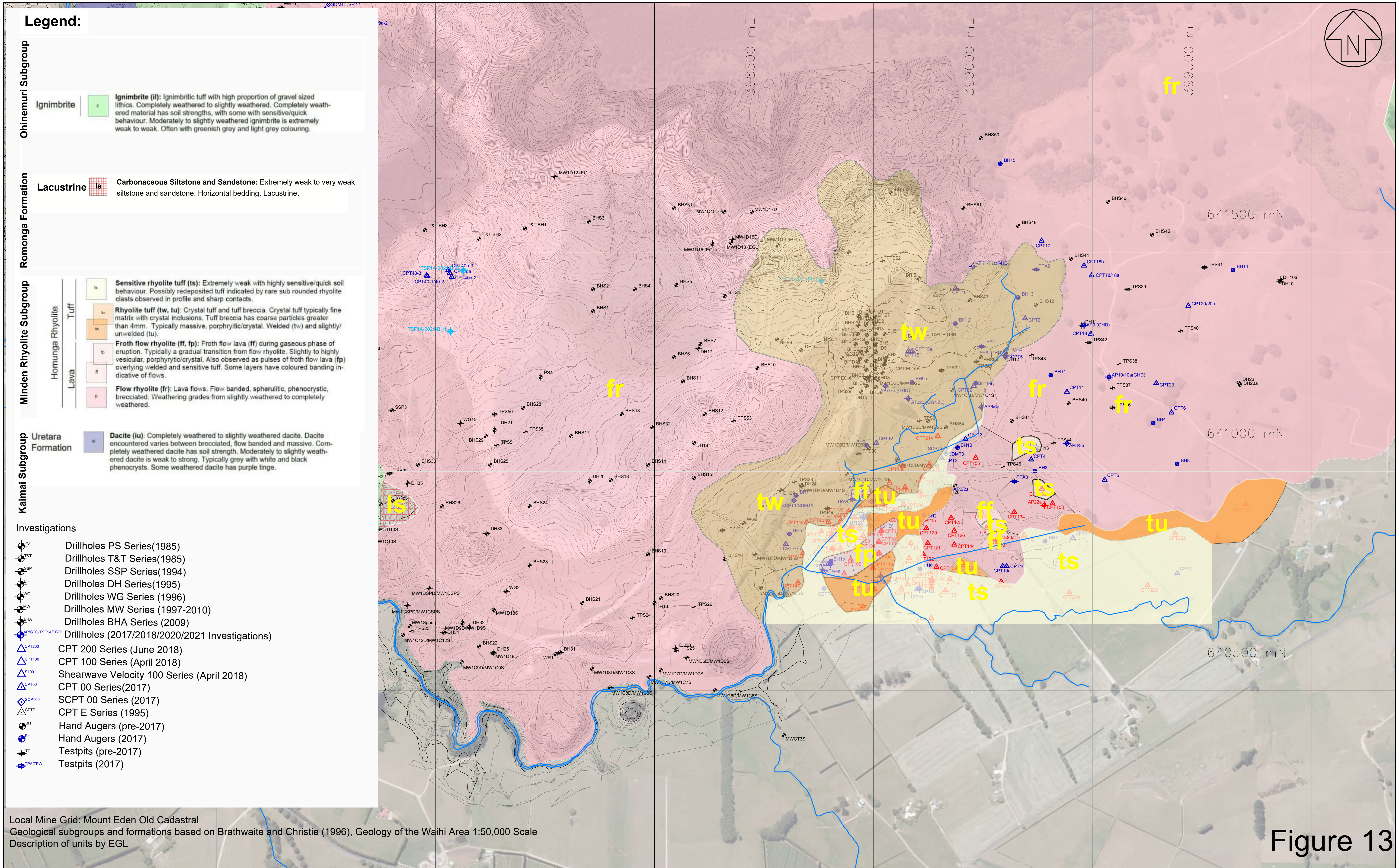

Figure 13

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OCEANA GOLD (NEW ZEALAND) LIMITED - WAIHI
Storage 3
Site Geology Plan

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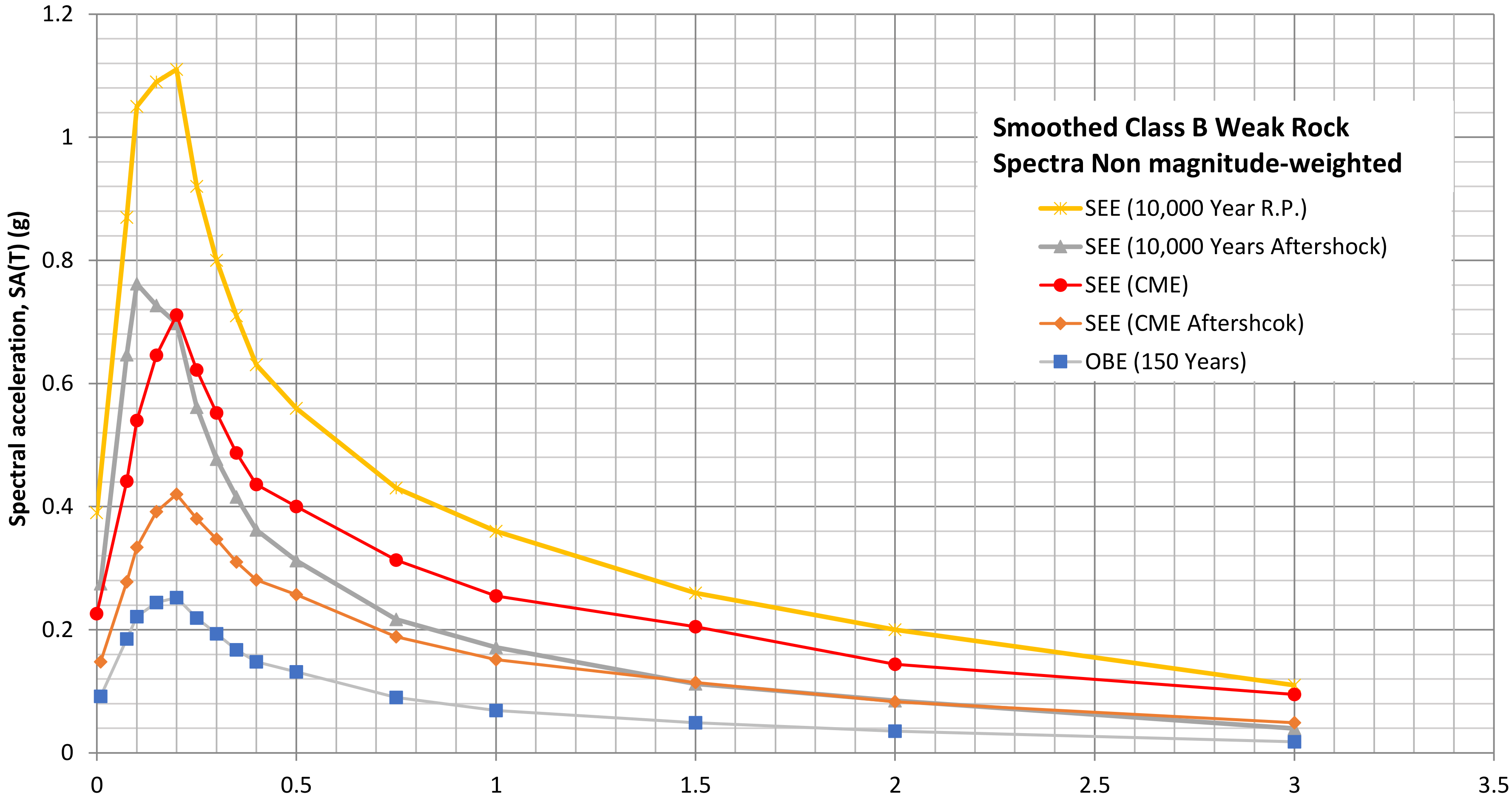

SA(T) is larger component SA_{larger}

Figure 14

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EGL Geotechnical, Earthquake and Dam Engineers

OCEANA GOLD (NEW ZEALAND) LIMITED
WAIHI OPERATION
STORAGE 3 DESIGN SPECTRA Acceleration
Response Spectra (5% Damping)

Ref. No: 8983
Date: Aug 2021
Drawn: YW

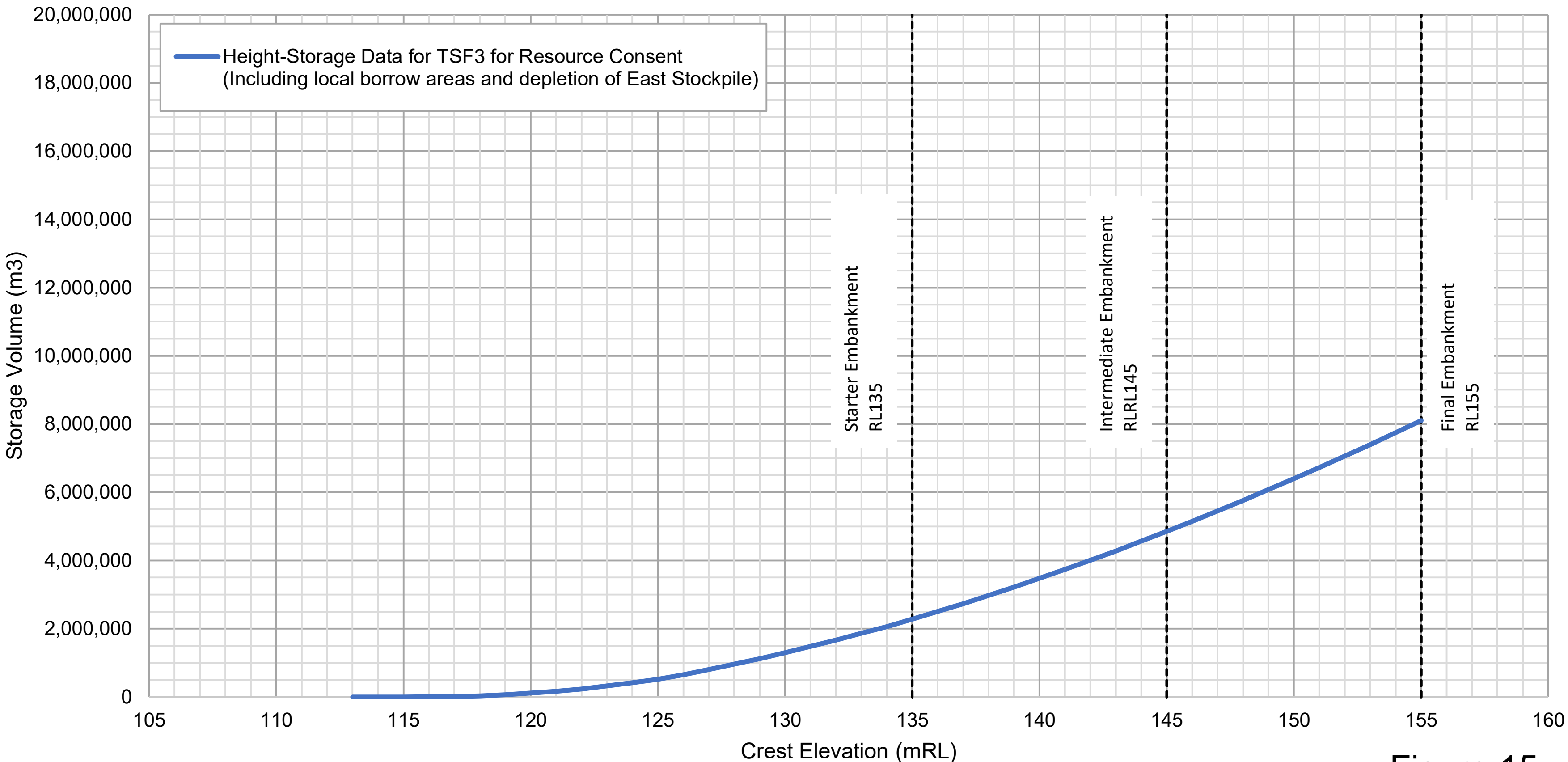

Figure 15

EGL Geotechnical, Earthquake and Dam Engineers 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 WAIHI OPERATION STORAGE 3 DESIGN DECEMBER 2024 ELEVATION - STORAGE	Ref. No: 8983 Date: Dec 2024 Drawn: AH

APPENDIX A
DRAWINGS

EGL
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DRAWING REGISTER AND TRANSMITTAL NOTICE

SHEET 1 OF 1

Client: OCEANA GOLD (NEW ZEALAND) LIMITED

Job No. 8983

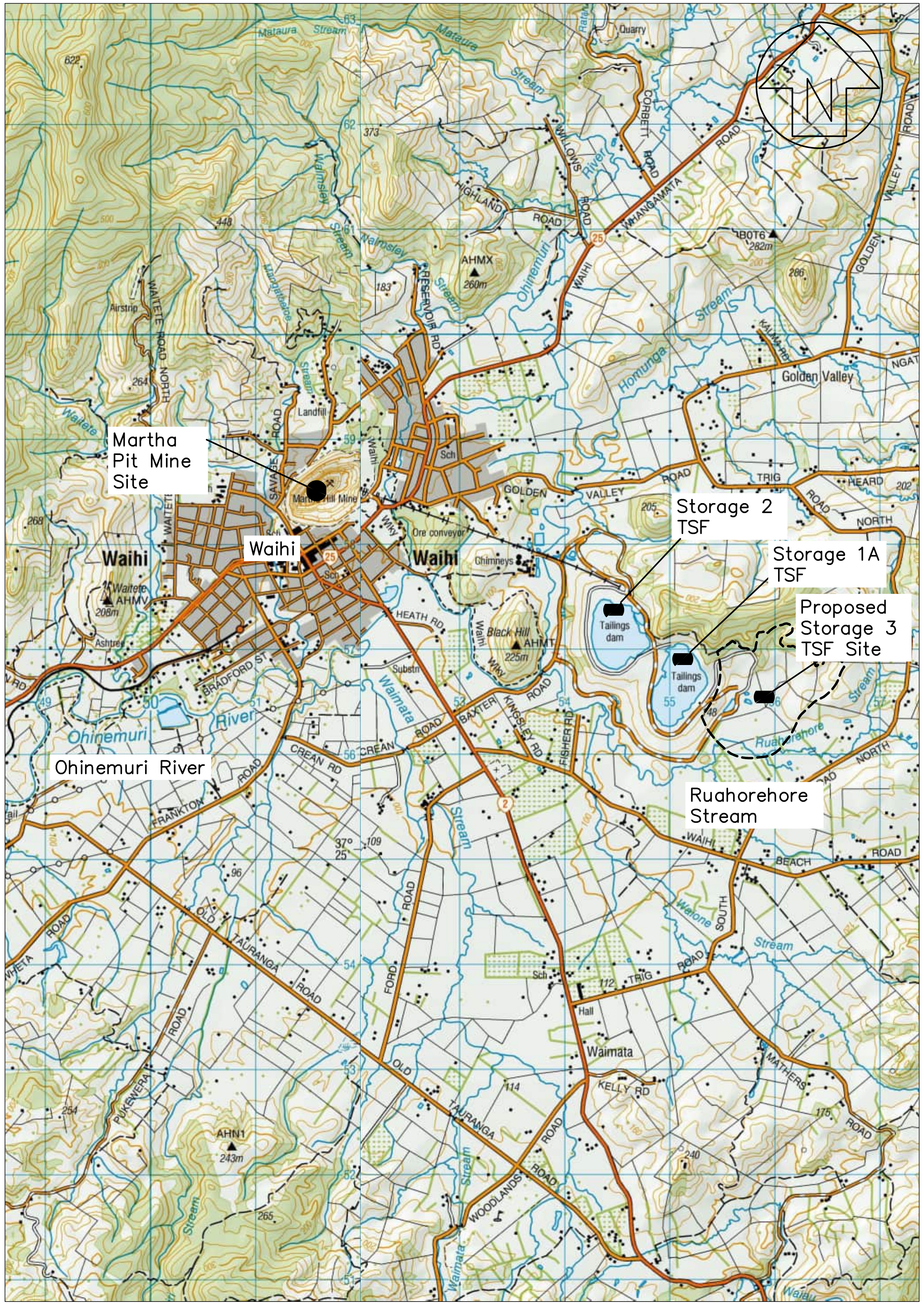
Site/Project: WAIHI NORTH PROJECT-STORAGE 3

Drawing No.	Drawing Title					
	DAY	16	19	04	10	17
	MONTH	07	07	10	12	02
	YEAR	21	21	21	24	25
		Revision				
WAI-983-080-DWG-CI-0500	Locality Plan and Index - Storage 3 - Tails / Waste Rock 080	C		D		
WAI-983-080-DWG-CI-0101	Site Plan - Waste Disposal Area - Tails / Waste Rock 080	B			C	
WAI-983-080-DWG-CI-0511	Layout Plan - Storage 3 RL135 Embankment - Tails / Waste Rock 080	D			E	
WAI-983-080-DWG-CI-0512	Layout Plan - Storage 3 RL145 Embankment - Tails / Waste Rock 080	D			E	
WAI-983-080-DWG-CI-0513	Layout Plan - Storage 3 RL155 Embankment - Tails / Waste Rock 080	C			D	
WAI-983-080-DWG-CI-0516	Sections - Storage 3 - Tails / Waste Rock 080	C			D	
WAI-983-080-DWG-CI-0517	Sections - Storage 3 - Tails / Waste Rock 080	C	D		E	
WAI-983-080-DWG-CI-0518	Sections - Storage 3 - Tails / Waste Rock 080	C	D		E	
WAI-983-080-DWG-CI-0519	Sections - Storage 3 - Tails / Waste Rock 080	C			D	
WAI-983-080-DWG-CI-0520	Sections - Storage 3 - Tails / Waste Rock 080	C			D	
WAI-983-080-DWG-CI-0541	Sections - Storage 3 Uphill Diversion - Tails / Waste Rock 080	B				
WAI-983-080-DWG-CI-0556	Sections - Storage 3 Perimeter Bund - Tails / Waste Rock 080	B				
WAI-983-080-DWG-CI-0608	Sections - Storage 3 Collection Pond - Tails / Waste Rock 080	B				
WAI-983-080-DWG-CI-0620	Layout Plan - Storage 3 Subsurface Drain - Tails / Waste Rock 080	B			C	D
WAI-983-080-DWG-CI-0621	Details - Storage 3 Subsurface Drain- Tails / Waste Rock 080	B				
WAI-983-080-DWG-CI-0622	Details - Storage 3 Subsurface Drain- Tails / Waste Rock 080	B				
WAI-983-080-DWG-CI-0626	Layout Plan - Storage 3 Leachate Drain - Tails / Waste Rock 080	B			C	D
WAI-983-080-DWG-CI-0627	Details - Storage 3 Leachate Drain - Tails / Waste Rock 080	B				
WAI-983-080-DWG-CI-0639	Details - Storage 3 Drainage - Tails / Waste Rock 080	B				
WAI-983-080-DWG-CI-0690	Layout Plan - Storage 3 Closure - Tails / Waste Rock 080			B	C	

Distribution	Reason Of Issue				
OCEANA GOLD (NEW ZEALAND) LIMITED	P	P	P	Y	Y
WAIKATO REGIONAL COUNCIL					Y

I = INFORMATION A = AS BUILT C = CONSTRUCTION T = TENDER P = PRELIMINARY X= PEER REVIEW Y= CONSENT

Oceana Gold (New Zealand) Limited
Waihi



DRAWING INDEX

WAI–983–080–DWG–CI–0500	Locality Plan and Index – Storage 3 – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0101	Site Plan – Development Site South – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0511	Layout Plan – Storage 3 RL135 Embankment – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0512	Layout Plan – Storage 3 RL145 Embankment – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0513	Layout Plan – Storage 3 RL155 Embankment – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0516	Sections – Storage 3 – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0517	Sections – Storage 3 – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0518	Sections – Storage 3 – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0519	Sections – Storage 3 – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0520	Sections – Storage 3 – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0541	Sections – Storage 3 Uphill Diversion – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0556	Sections – Storage 3 Perimeter Bund – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0608	Sections – Storage 3 Collection Pond – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0620	Layout Plan – Storage 3 Subsurface Drain – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0621	Details – Storage 3 Subsurface Drain– Tails / Waste Rock 080
WAI–983–080–DWG–CI–0622	Details – Storage 3 Subsurface Drain– Tails / Waste Rock 080
WAI–983–080–DWG–CI–0626	Layout Plan – Storage 3 Leachate Drain – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0627	Details – Storage 3 Leachate Drain – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0639	Details – Storage 3 Drainage – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0690	Layout Plan – Storage 3 Closure – Tails / Waste Rock 080

OCEANAGOLD WAIHI OPERATION

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www.egl.co.nz

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

No.	BY	DATE	REVISION	CHECKED	APPROV.
D	ET	04–10–21	Closure Plan	ET	TM
C	JL	06–07–21	WNP update	ET	TM
B	JL	27–10–20	Drawing Number Changes	ET	ET
A	JL	09–09–20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	06–07–21
DESIGNED	ET	10–08–20
CHECKED	ET	10–08–20
DRAWN	JL	10–08–20

PROJECT: Storage 3 RL155 TSF

AREA: DEVELOPMENT SITE

JOB NUMBER: 8983

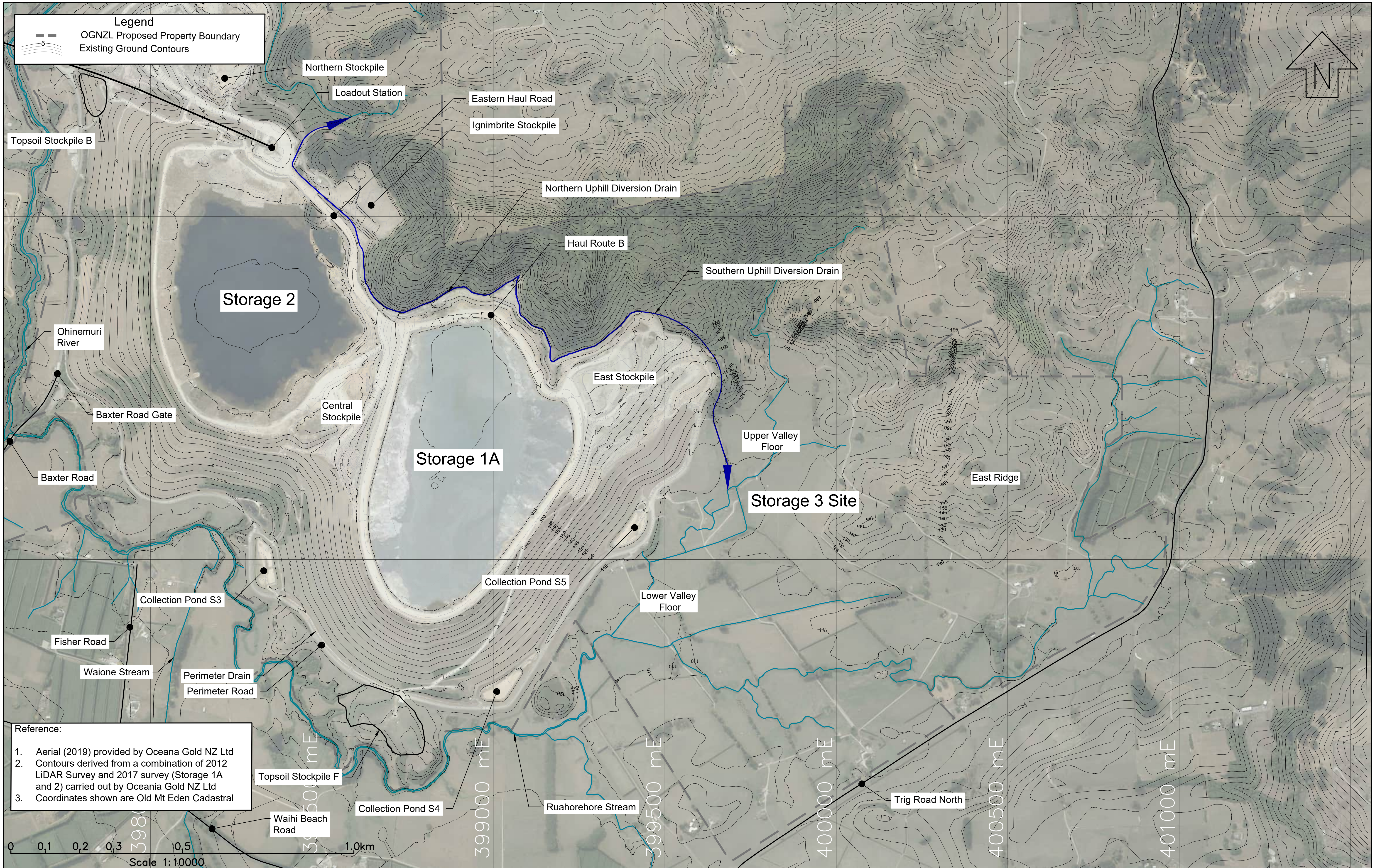
ORIGINAL SCALE: as shown

SIZE: A3

TITLE: Locality Plan and Index Storage 3 Tails / Waste Rock 080

DRAWING No. WAI–983–080–DWG–CI–0500

REV. No. D



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

No.	BY	DATE	REVISION	CHECKED	APPROV.
C	SK	10-12-24	Vertical Datum Added	AH	ET
B	JL	06-07-21	WNP Update	ET	TM
A	JL	09-09-20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	06-07-21
DESIGNED	ET	09-09-20
CHECKED	ET	09-09-20
DRAWN	JL	09-09-20

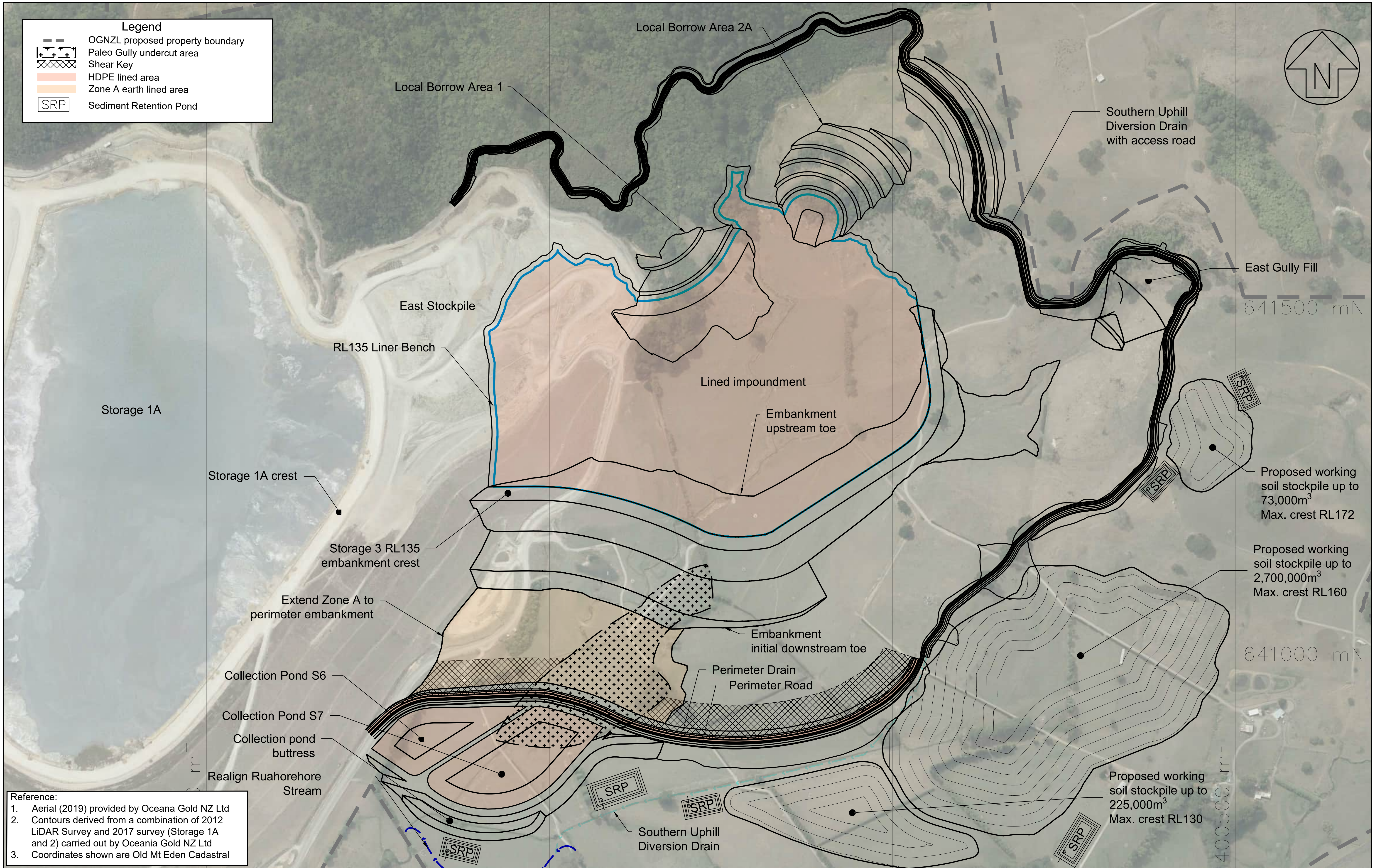
PROJECT: Storage 3 RL155 TSF

AREA: DEVELOPMENT SITE

JOB NUMBER: 8983 | ORIGINAL SCALE: 1:10,000 | SIZE: A3

TITLE
Site and Topography Plan
Development Site South
Tails / Waste Rock 080

DRAWING No. WAI-983-080-DWG-CI-0101 | REV. No. C



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info@egl.co.nz
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PO Box 301054, Albany, Auckland 0752
www.egl.co.nz

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

No.	BY	DATE	REVISION	CHECKED	APPROV.
E	SK	10-12-24	Addition of Borrow Areas	AH	ET
D	JL	06-07-21	WNP Update	ET	TM
C	JL	25-06-21	Preliminary Issue	ET	ET
B	JL	27-10-20	Preliminary Issue	ET	ET
A	JL	09-09-20	Preliminary Issue	ET	ET

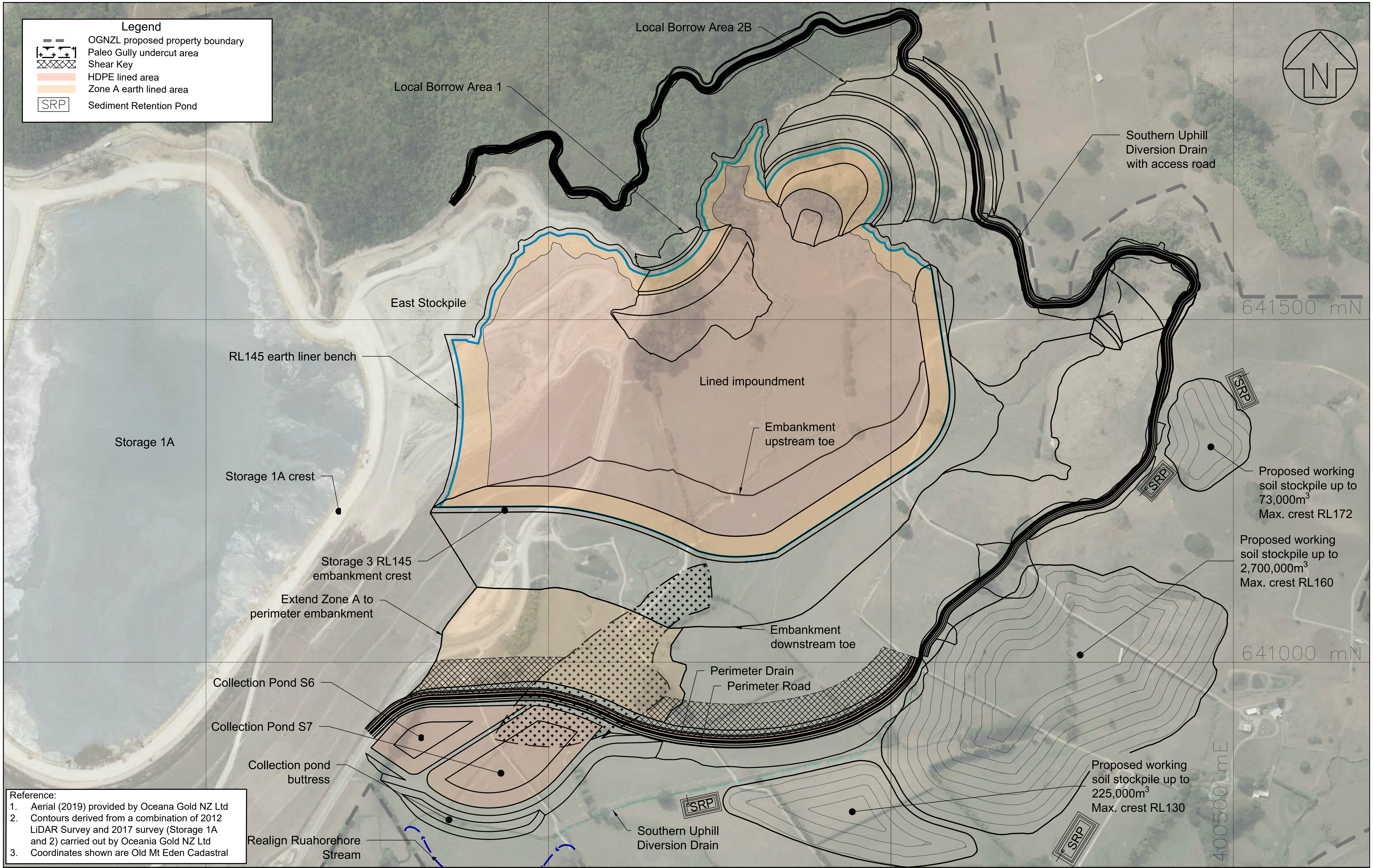
	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	06-07-21
DESIGNED	ET	09-09-20
CHECKED	ET	09-09-20
DRAWN	JL	09-09-20

PROJECT: Storage 3 RL155 TSF
AREA: DEVELOPMENT SITE

JOB NUMBER:	ORIGINAL SCALE:	SIZE:
8983	1:5000	A3

TITLE
Layout Plan
Storage 3 RL135 Embankment
Tails / Waste Rock 080

DRAWING No. WAI-983-080-DWG-CI-0511
REV. No. E



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

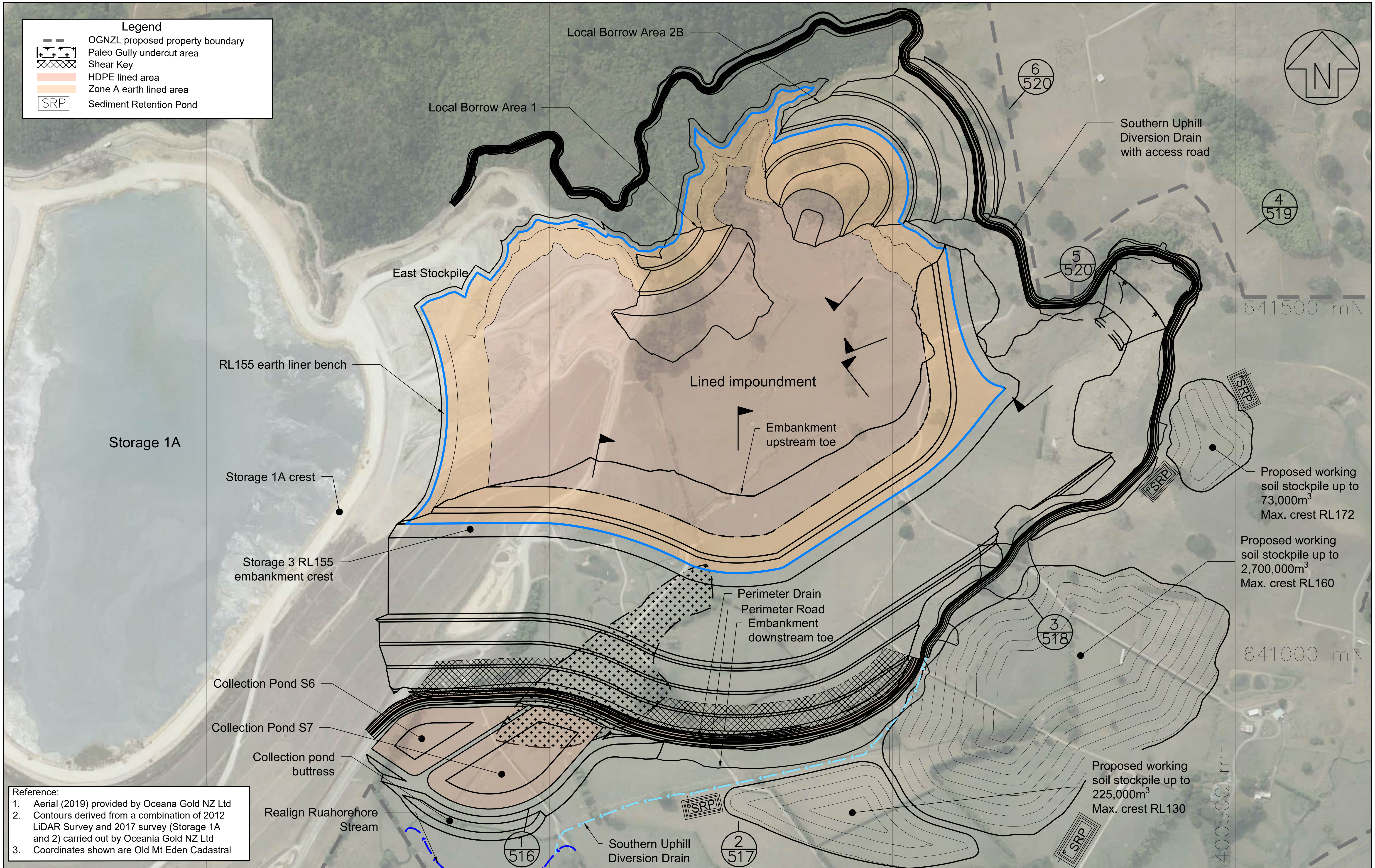
No.	BY	DATE	REVISION	CHECKED	APPROV.
E	SK	10–12–24	Addition of Borrow Areas	AH	ET
D	JL	06–07–21	Downstream cutoff/shear key	ET	TM
C	JL	25–06–21	WNP Project Update	ET	TM
B	JL	27–10–20	Preliminary Issue	ET	ET
A	JL	09–09–20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	06–07–21
DESIGNED	ET	25–06–21
CHECKED	ET	25–06–21
DRAWN	JL	25–06–21

PROJECT: Storage 3 RL155 TSF
AREA: DEVELOPMENT SITE
JOB NUMBER: 8983
ORIGINAL SCALE: 1:5000
SIZE: A3

TITLE
Layout Plan
Storage 3 RL145 Embankment
Tails / Waste Rock 080

DRAWING No. WAI–983–080–DWG–CI–0512
REV. No. E



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

No.	BY	DATE	REVISION	CHECKED	APPROV.
D	SK	10-12-24	Addition of Borrow Areas	AH	ET
C	ET	06-07-21	WNP Update	ET	TM
B	ET	18-06-21	Embankment and Uphill Diversion Drain Update	ET	TM
A	ET	04-05-21	Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	06-07-21
DESIGNED	ET	04-05-2021
CHECKED	ET	04-05-2021
DRAWN	JL	04-05-2021

PROJECT: Storage 3 RL155 TSF

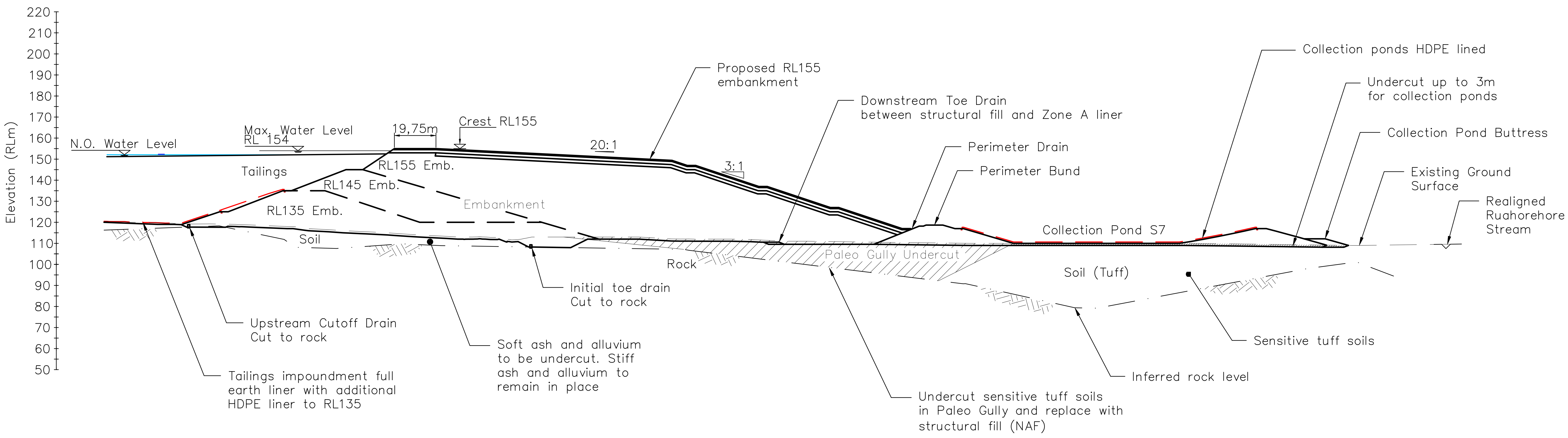
AREA: DEVELOPMENT SITE

JOB NUMBER:	ORIGINAL SCALE:	SIZE:
8983	1:5000	A3

TITLE
Layout Plan
Storage 3 RL155 Embankment
Tails / Waste Rock 080

DRAWING No. WAI-983-080-DWG-CI-0513

REV. No. D



STORAGE 3– EMBANKMENT PROFILE TYPICAL SECTION
PALEO GULLY
scale 1:2000

1
513

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

No.	BY	DATE	REVISION	CHECKED	APPROV.
D	SK	10–12–24	Addition of Borrow Areas	AH	ET
C	ET	05–07–21	WNP Updates	ET	TM
B	JL	27–10–20	Preliminary Issue	ET	ET
A	JL	09–09–20	Preliminary Issue	ET	ET

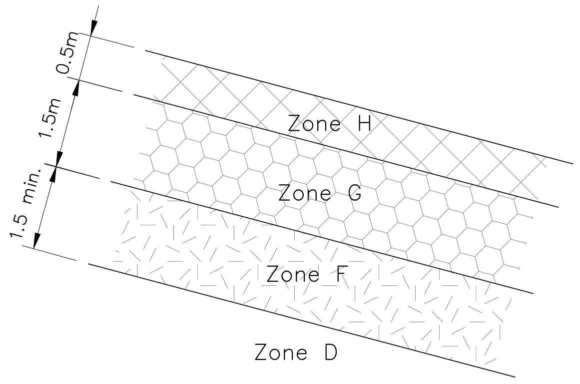
	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 RL155 TSF

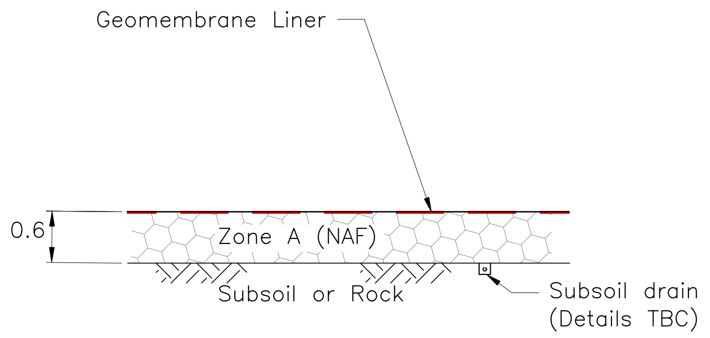
AREA: DEVELOPMENT SITE

TITLE
Sections
Storage 3
Tails / Waste Rock 080

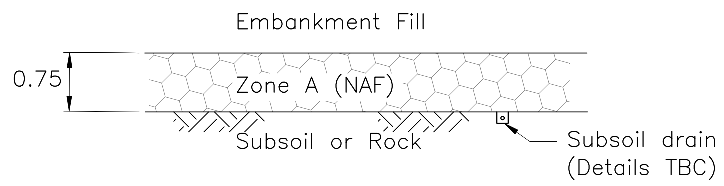
JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.	REV. No.
8983	as shown	A3	WAI–983–080–DWG–CI–0516	D



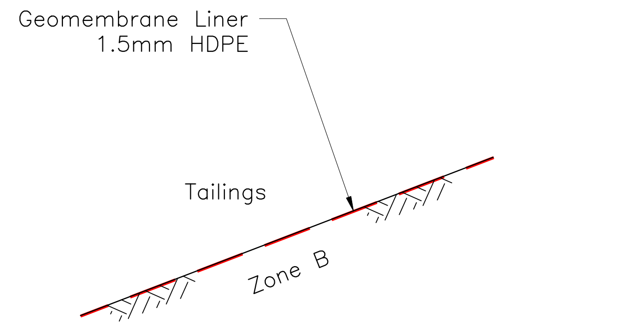
REHABILITATION DETAILS A –
NTS



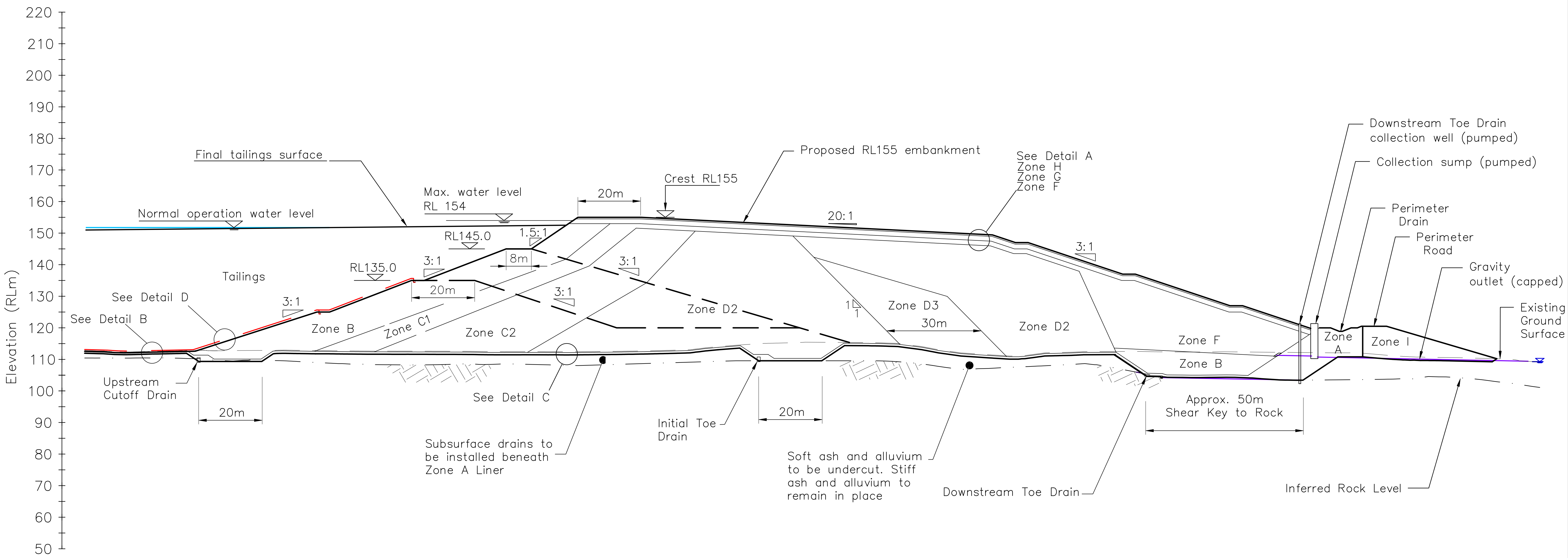
TAILINGS IMPOUNDMENT LINER DETAILS B –
AGAINST GROUND
NTS



ZONE A BASE LINER DETAIL C –
NTS



STARTER EMBANKMENT LINER DETAIL D –
NTS



STORAGE 3– EMBANKMENT PROFILE TYPICAL SECTION SHEAR KEY UNDERCUT 2/513
scale 1:1250

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

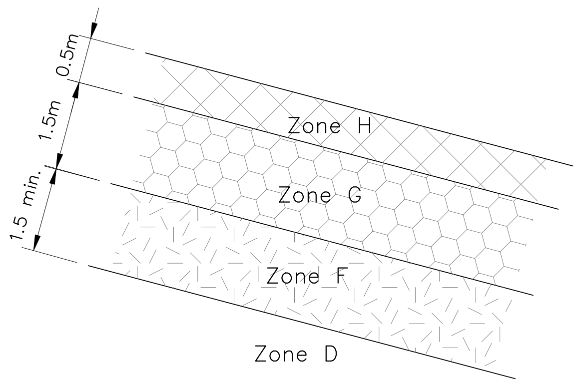
No.	BY	DATE	REVISION	CHECKED	APPROV.
E	SK	10–12–24	Addition of Borrow Areas	AH	ET
D	JL	19–07–21	Removed Tailings Underdrain	ET	TM
C	ET	05–07–21	WNP Updates	ET	TM
B	JL	27–10–20	Preliminary Issue	ET	ET
A	JL	09–09–20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

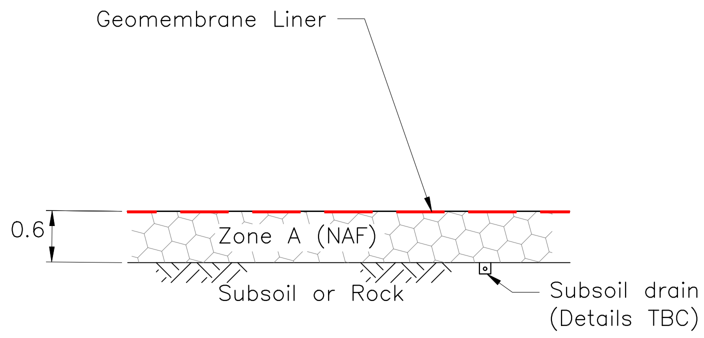
PROJECT: Storage 3 RL155 TSF
AREA: DEVELOPMENT SITE
JOB NUMBER: 8983
ORIGINAL SCALE: as shown
SIZE: A3

TITLE
Sections
Storage 3
Tails / Waste Rock 080

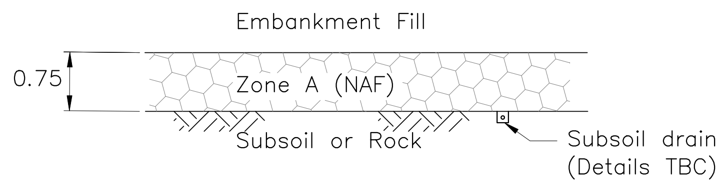
DRAWING No. WAI–983–080–DWG–CI–0517
REV. No. E



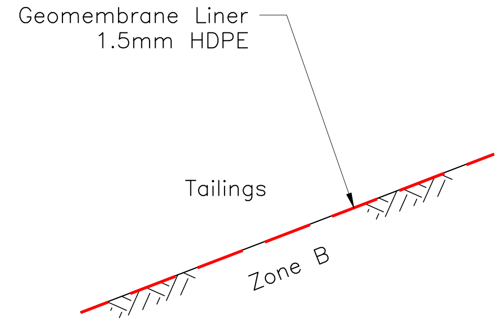
REHABILITATION DETAILS (A/–)
NTS



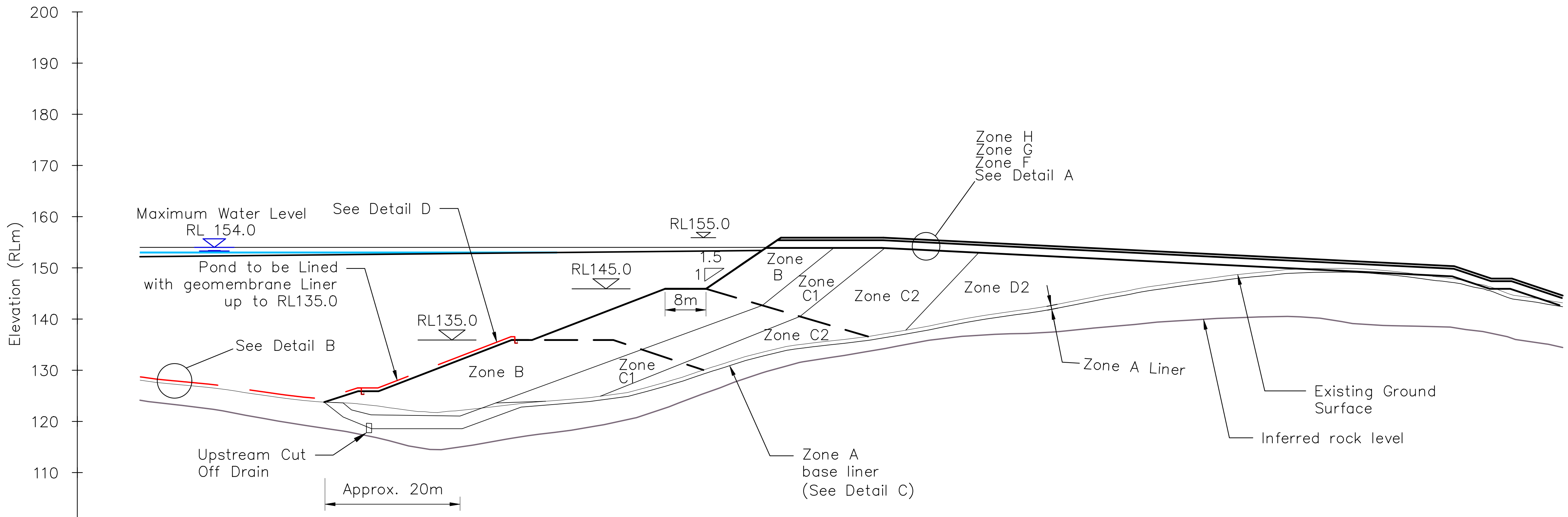
TAILINGS IMPOUNDMENT LINER DETAILS AGAINST GROUND (B/–)
NTS



ZONE A BASE LINER DETAIL (C/–)
NTS



STARTER EMBANKMENT LINER DETAIL (D/–)
NTS



STORAGE 3 – EMBANKMENT PROFILE TYPICAL SOUTHEAST (3/510)
scale 1:1000

Reference:

1. Coordinate Datum: NZGD2000, New Zealand Transverse Mercator (NZTM2000)

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

No.	BY	DATE	REVISION	CHECKED	APPROV.
E	SK	10–12–24	Addition of Borrow Areas	AH	ET
D	JL	19–07–21	Removed Tailings Underdrain	ET	TM
C	JL	06–07–21	WNP Update	ET	TM
B	JL	27–10–20	Preliminary Issue	ET	ET
A	JL	09–09–20	Preliminary Issue	ET	ET

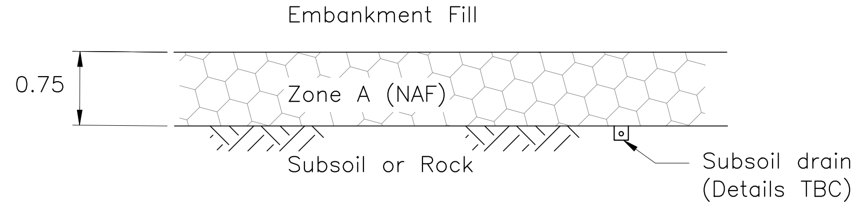
	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 RL155 TSF
AREA: DEVELOPMENT SITE

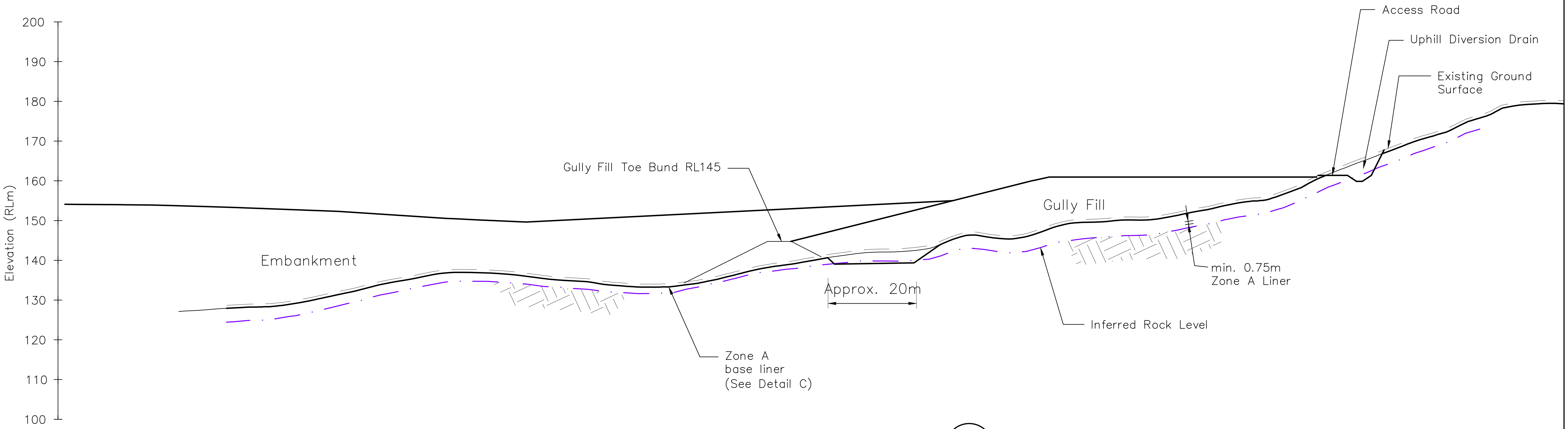
JOB NUMBER:	ORIGINAL SCALE:	SIZE:
8983	as shown	A3

TITLE
Sections
Storage 3
Tails / Waste Rock 080

DRAWING No. WAI–983–080–DWG–CI–0518
REV. No. E



ZONE A BASE LINER DETAIL C –
NTS



STORAGE 3– SECTION THROUGH GULLY 3 510
scale 1:1000

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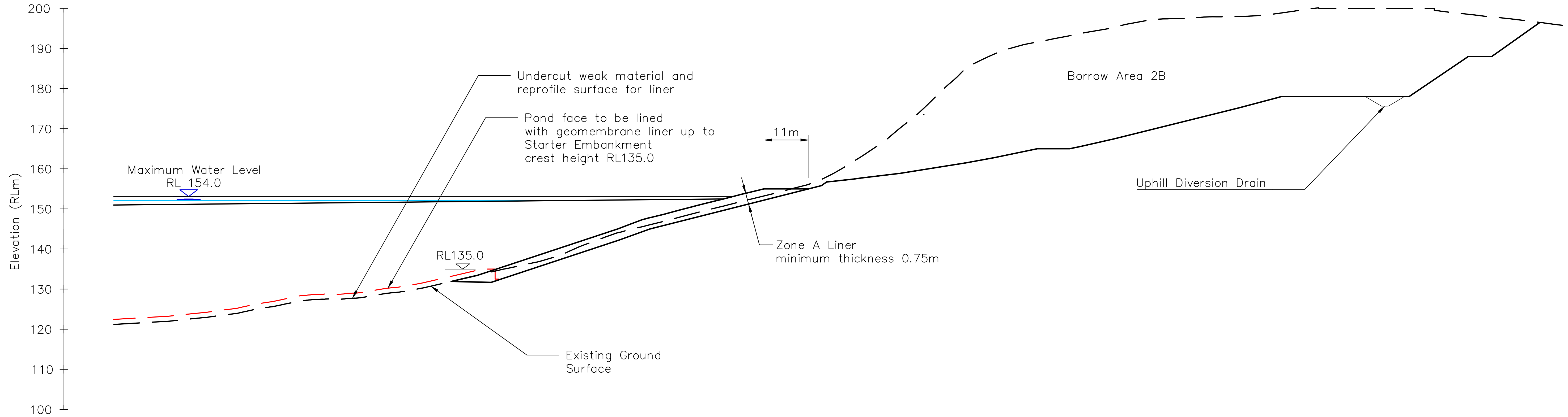
Preliminary Issue	Signed:	Date:
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

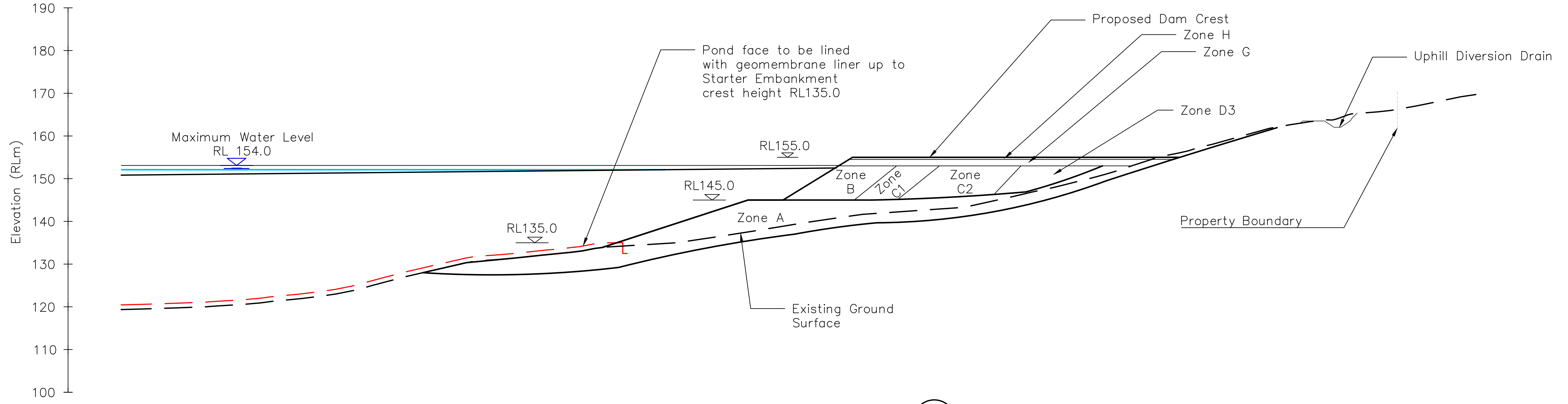
No.	BY	DATE	REVISION	CHECKED	APPROV.
D	SK	10–12–24	Addition of Borrow Areas	AH	ET
C	JL	06–07–21	WNP Update	ET	TM
B	JL	27–10–20	Preliminary Issue	ET	ET
A	JL	14–10–20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 RL155 TSF
AREA: DEVELOPMENT SITE
JOB NUMBER: 8983
ORIGINAL SCALE: as shown
SIZE: A3
TITLE: Sections Storage 3 Tails / Waste Rock 080
DRAWING No. WAI–983–080–DWG–CI–0519
REV. No. D



STORAGE 3– TYPICAL SECTION NORTHERN SLOPE LINING 6/513
scale 1:1000



STORAGE 3– TYPICAL SECTION NORTHERN SLOPE LINING 5/513
scale 1:1000

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

No.	BY	DATE	REVISION	CHECKED	APPROV.
D	SK	10-12-24	Addition of Borrow Areas	AH	ET
C	JL	06-07-21	WNP Update	ET	TM
B	JL	27-10-20	Preliminary Issue	ET	ET
A	JL	09-09-20	Preliminary Issue	ET	ET

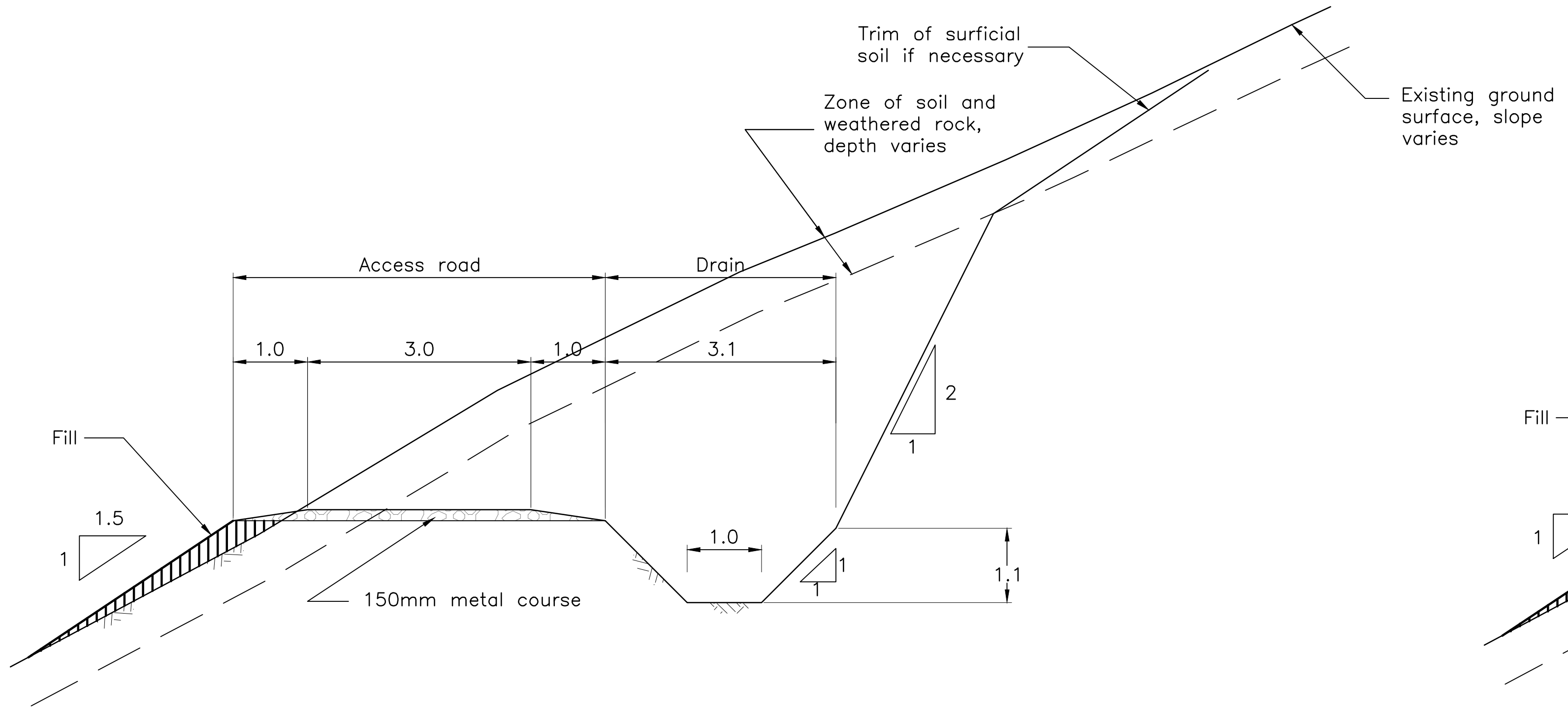
	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 RL155 TSF
AREA: DEVELOPMENT SITE

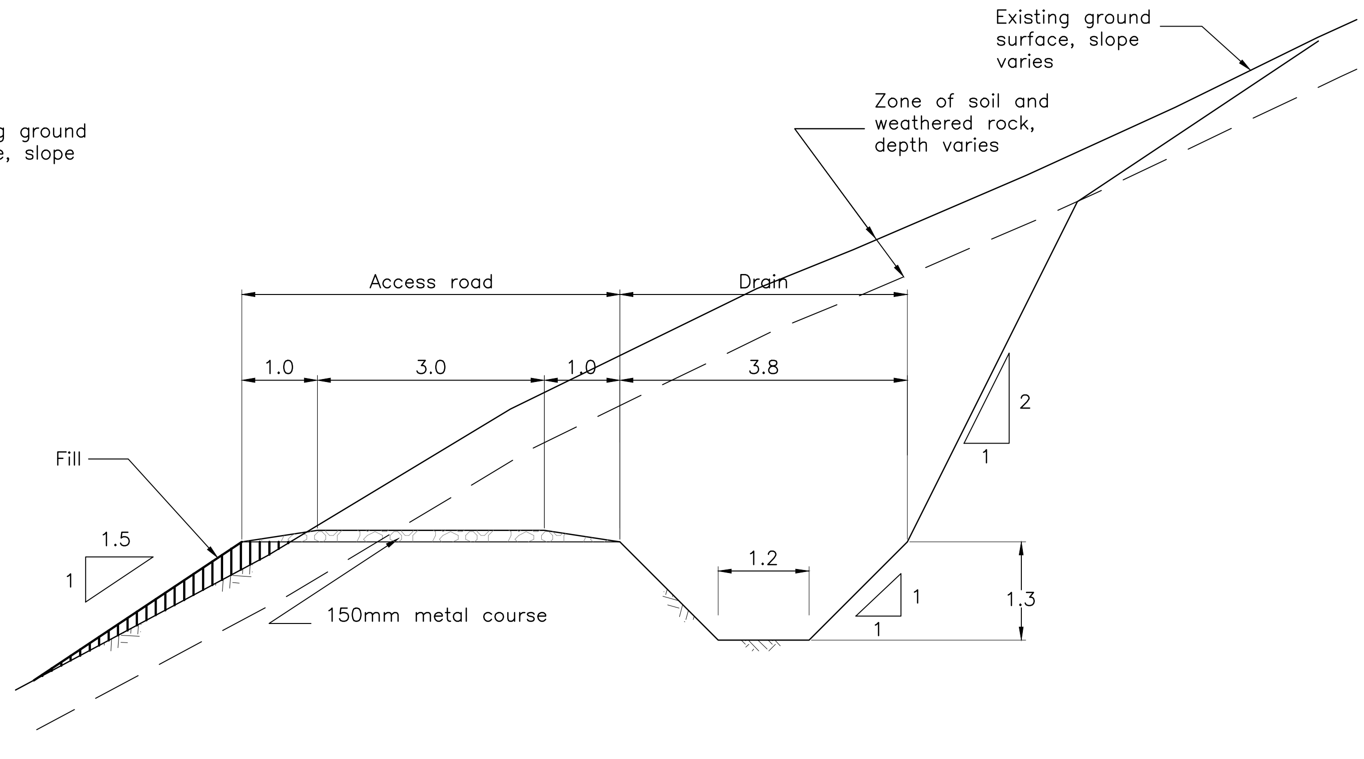
JOB NUMBER:	ORIGINAL SCALE:	SIZE:
8983	as shown	A3

TITLE
Sections
Storage 3
Tails / Waste Rock 080

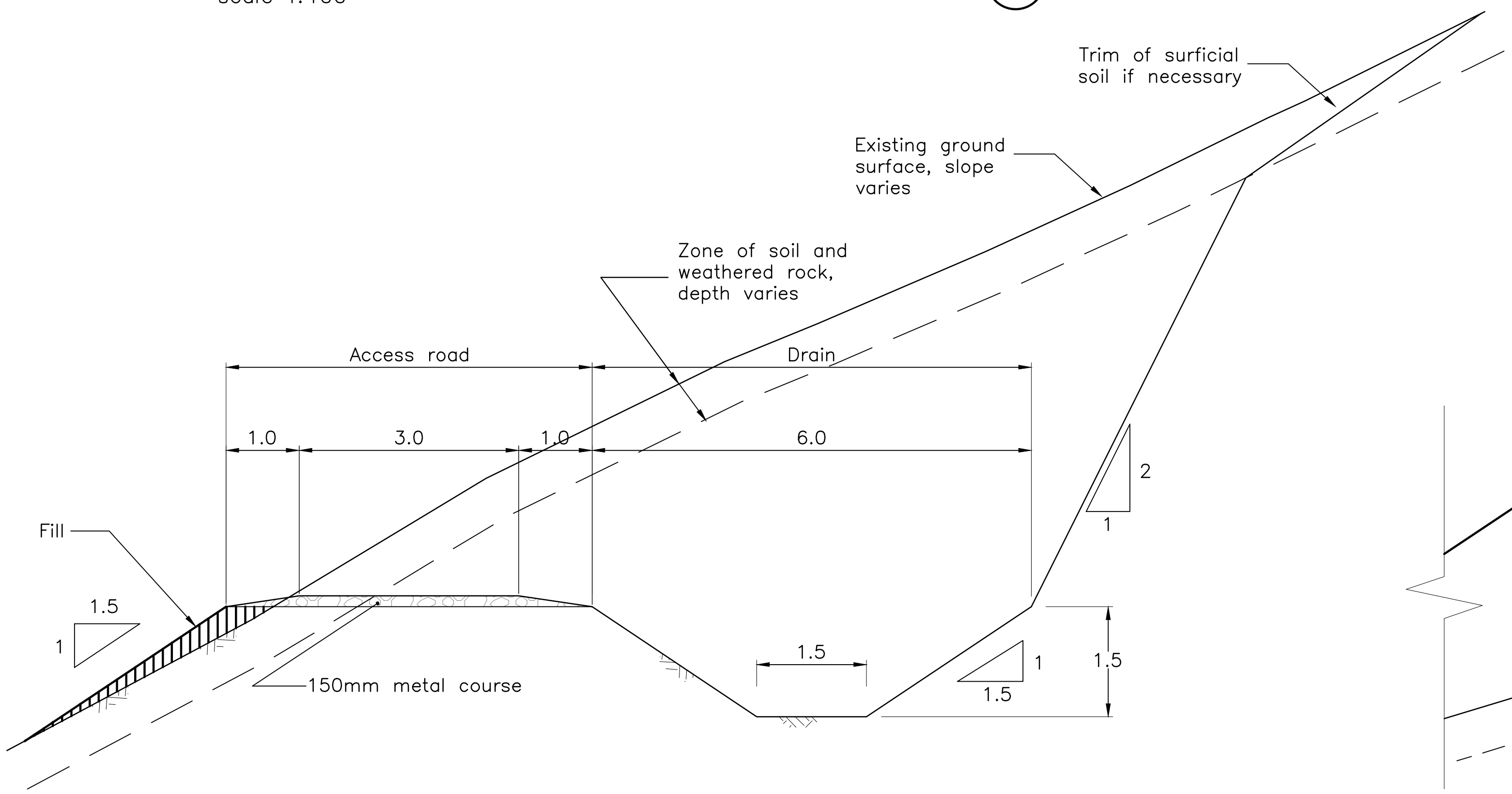
DRAWING No. WAI-983-080-DWG-CI-0520
REV. No. D



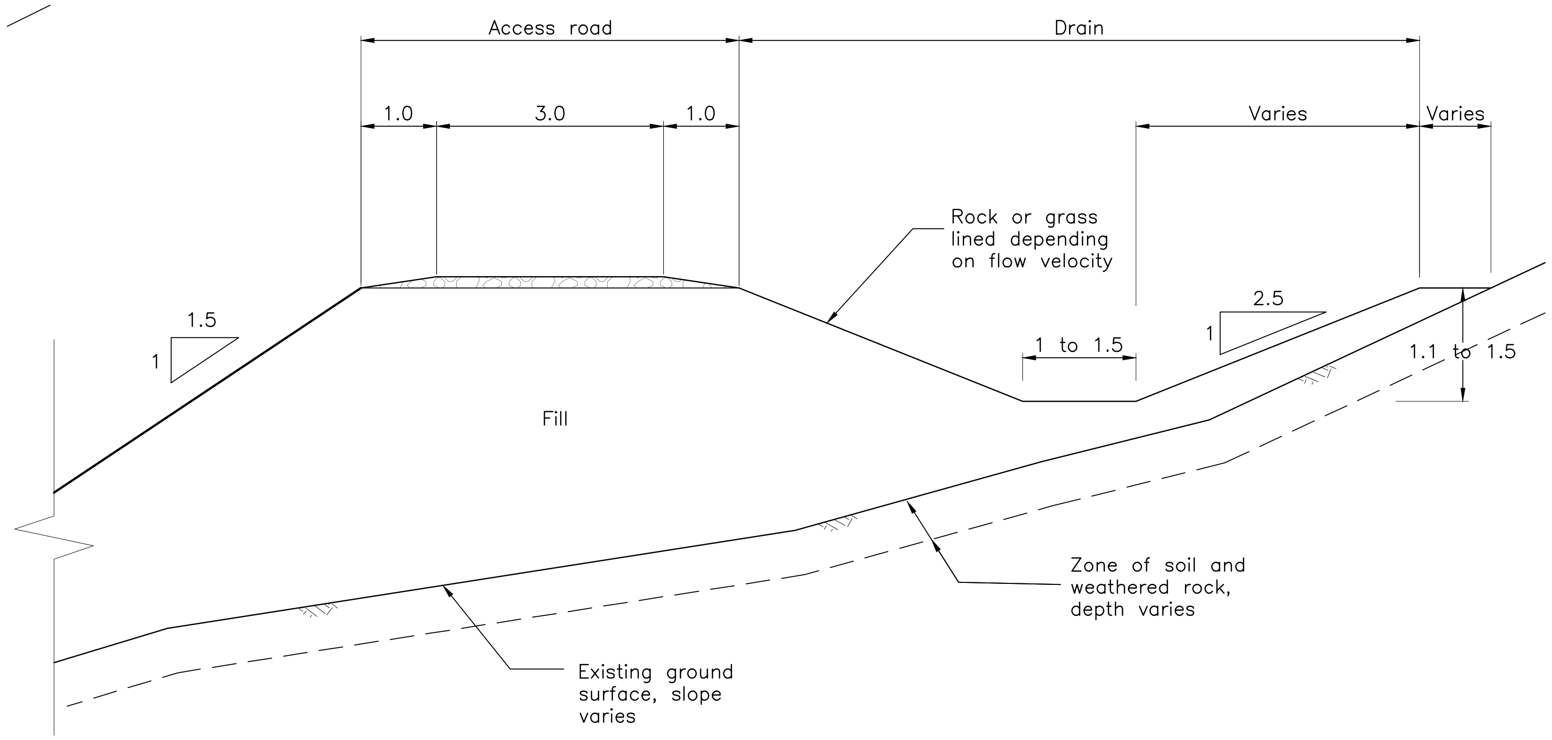
UPHILL DIVERSION DRAIN– TYPE 1– TYPICAL SECTION 9 –
scale 1:100



UPHILL DIVERSION DRAIN– TYPE 2– TYPICAL SECTION 10 –
scale 1:100



UPHILL DIVERSION DRAIN– TYPE 3– TYPICAL SECTION 11 –
scale 1:100



UPHILL DIVERSION DRAIN– FILL– TYPICAL SECTION 12 –
scale 1:100

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

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	JL	06-07-21	WNP Update	ET	TM
A	JL	27-10-20	Preliminary Issue	ET	ET

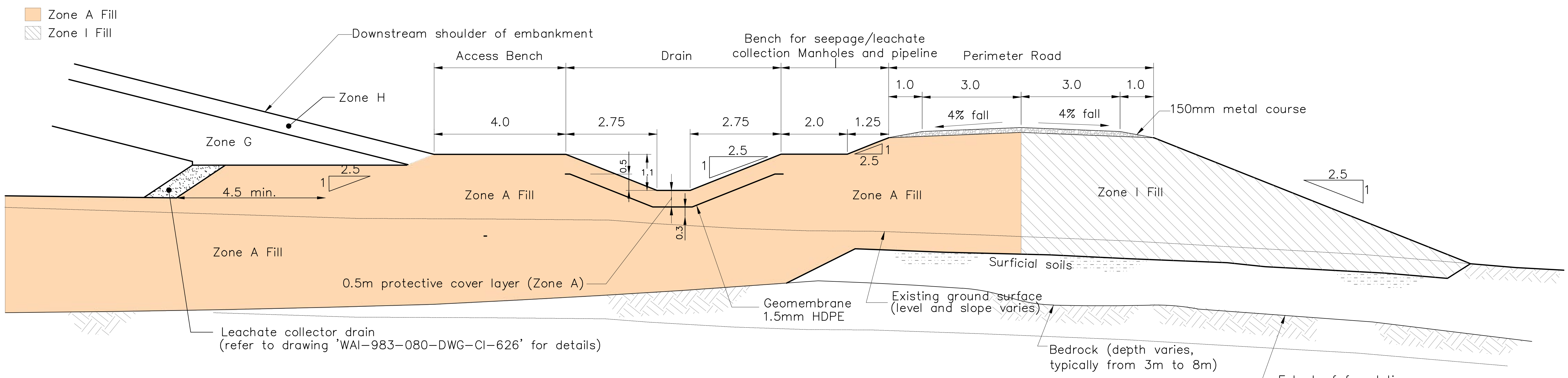
	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 RL155 TSF
AREA: DEVELOPMENT SITE

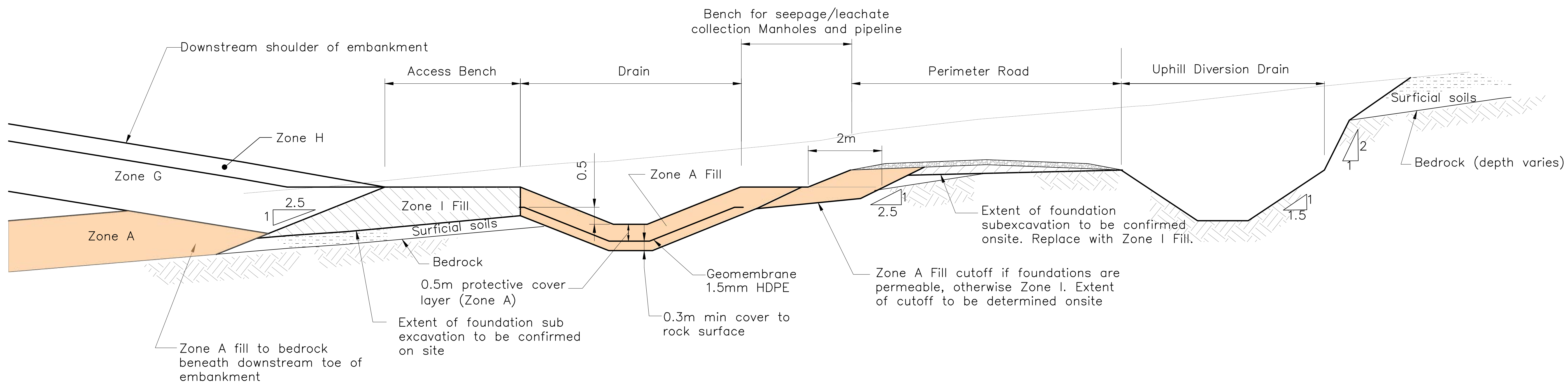
JOB NUMBER:	ORIGINAL SCALE:	SIZE:
8983	as shown	A3

TITLE
Sections
Storage 3 Uphill Diversion
Tails / Waste Rock 080

DRAWING No. WAI-983-080-DWG-CI-0541
REV. No. B



PERIMETER BUND – TYPICAL SECTION IN FILL 13
Scale 1:125 (A3)



PERIMETER BUND – TYPICAL SECTION IN CUT 14
Scale 1:125 (A3)

Note: Refer to 'Typical Section in Fill' for dimensions.

Note: Zone A Fill within 0.3m of the HDPE liner shall not contain rock, stones or sharp objects greater than 20mm size

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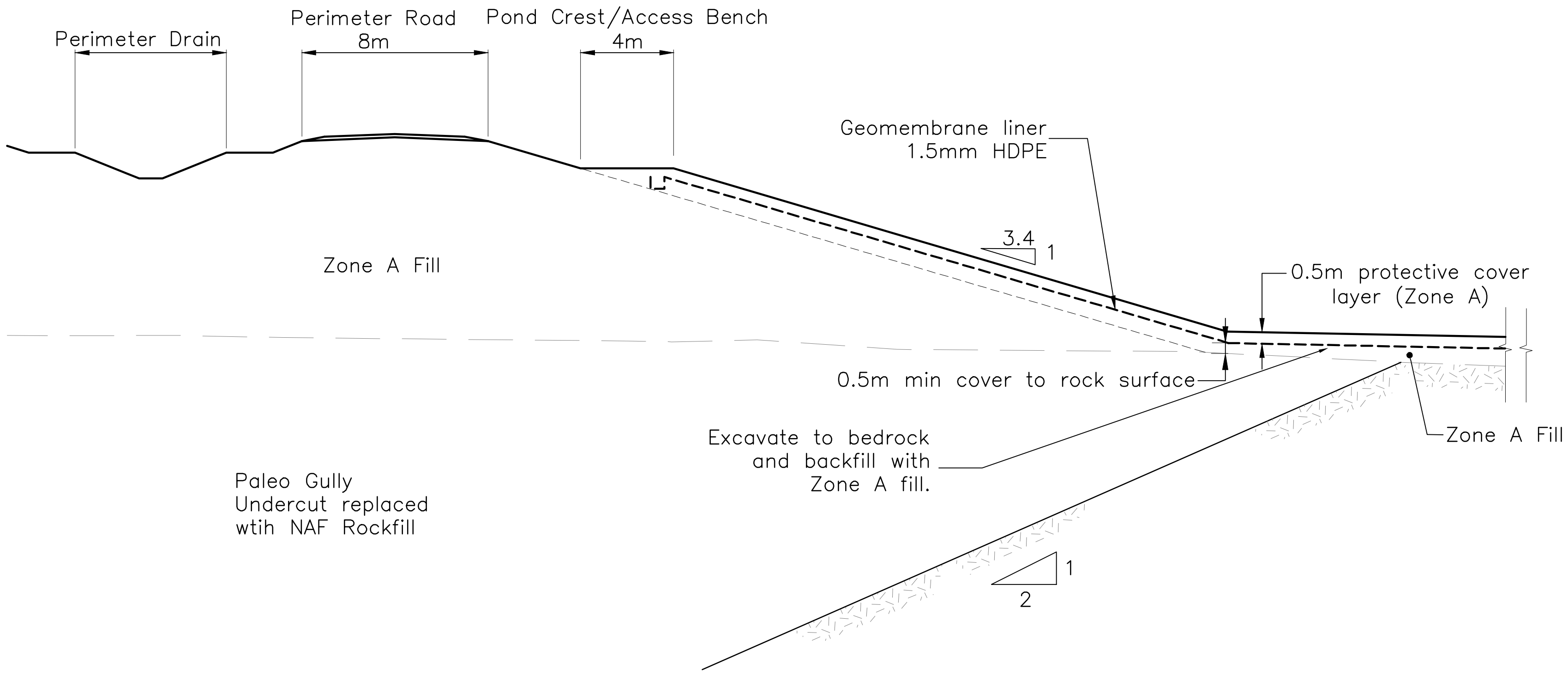
Preliminary Issue	Signed:	Date:		
Tender Issue	Signed:	Date:		
Construction Issue	Signed:	Date:		

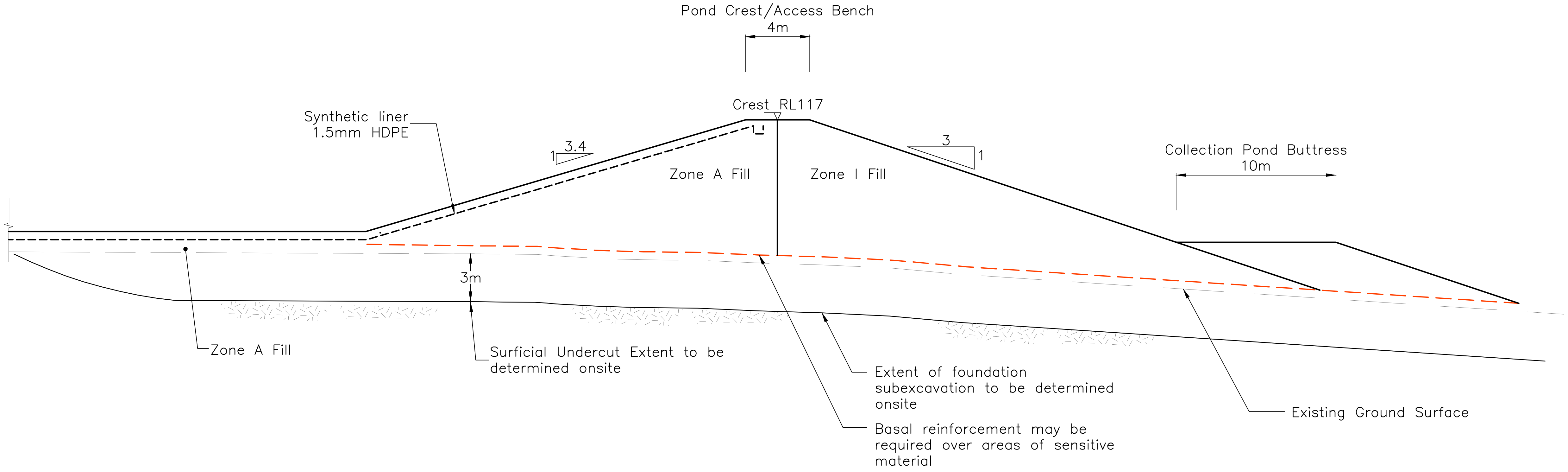
No.	BY	DATE	REVISION	CHECKED	APPROV.
B	JL	06-07-21	WNP Update	ET	TM
A	JL	27-10-20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 RL155 TSF
AREA: DEVELOPMENT SITE
JOB NUMBER: 8983
ORIGINAL SCALE: as shown
SIZE: A3
TITLE: Sections Storage 3 Perimeter Bund Tails / Waste Rock 080
DRAWING No. WAI-983-080-DWG-CI-0556
REV. No. B



COLLECTION POND S6 AND S7– TYPICAL SECTION 15
scale 1:300



Note: Zone A Fill within 0.3m of the HDPE liner shall not contain rock, stones or sharp objects greater than 20mm size

COLLECTION POND S6 AND S7– TYPICAL SECTION 16
scale 1:300

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

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	JL	06–07–21	WNP Update	ET	TM
A	JL	27–10–20	Preliminary Issue	ET	ET

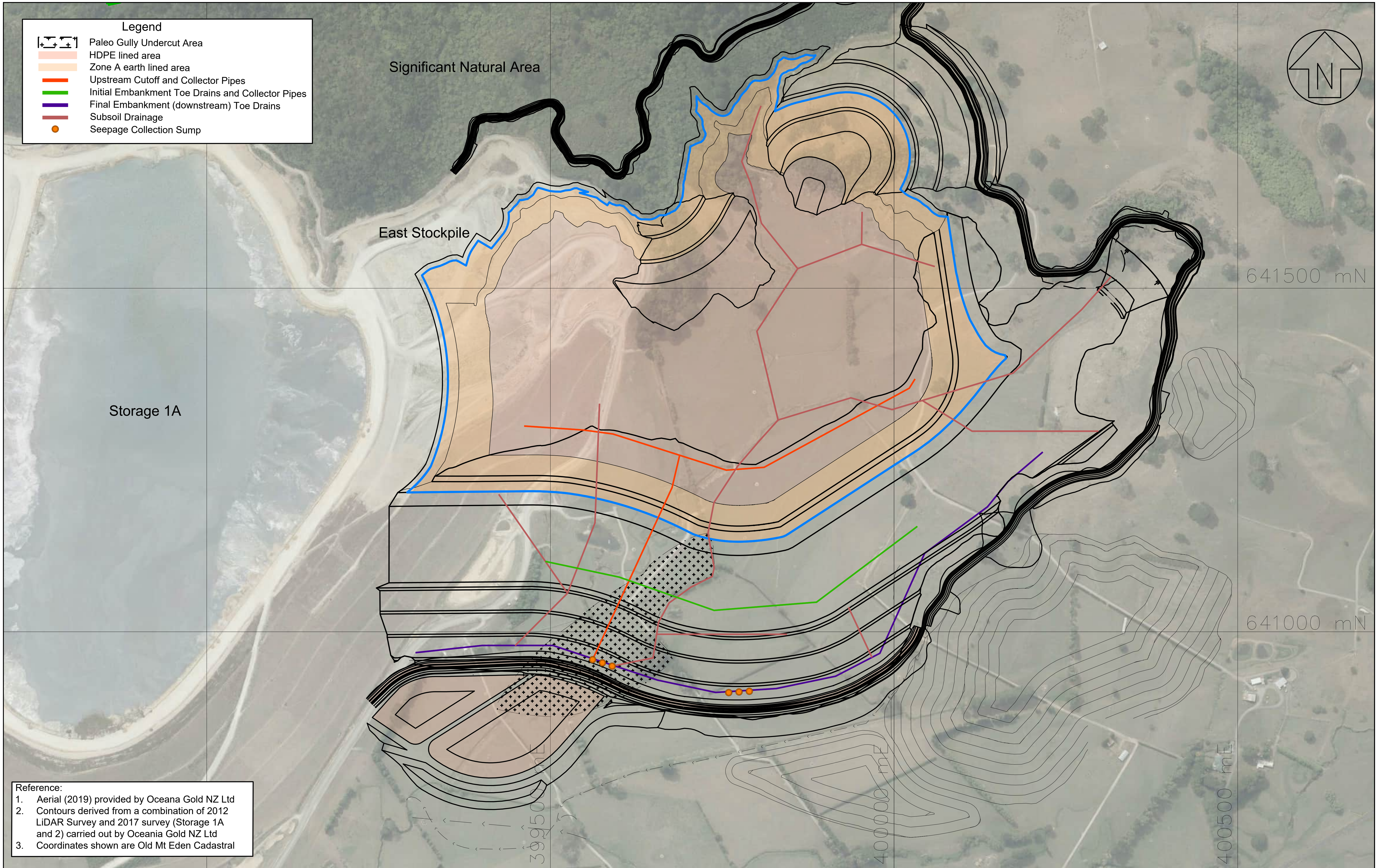
	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 RL155 TSF

AREA: DEVELOPMENT SITE

TITLE: Storage 3 – Collection Pond Typical Section

JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.	REV. No.
8983	as shown	A3	WAI–983–080–DWG–CI–0608	B



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

No.	BY	DATE	REVISION	CHECKED	APPROV.
D	SK	17–02–25	Sump Legend Update	AH	ET
C	SK	10–12–24	Addition of Borrow Areas	AH	ET
B	JL	06–07–21	WNP Update	ET	ET
A	JL	27–10–20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

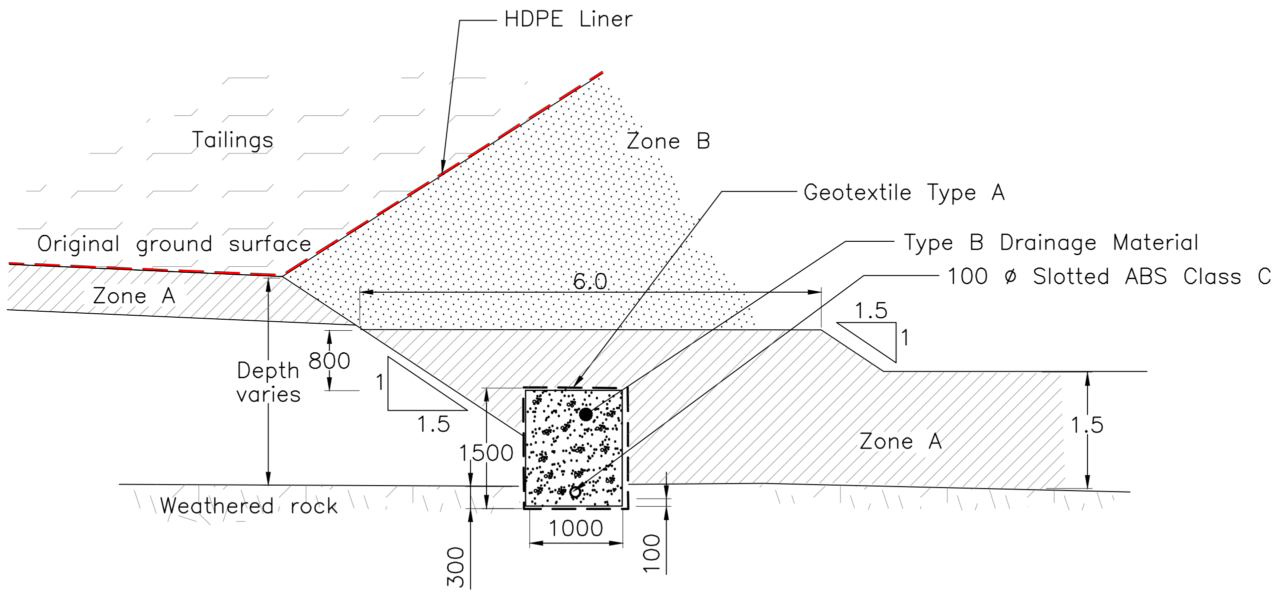
PROJECT: Storage 3 RL155 TSF

AREA: DEVELOPMENT SITE

JOB NUMBER:	ORIGINAL SCALE:	SIZE:
8983	1:5000	A3

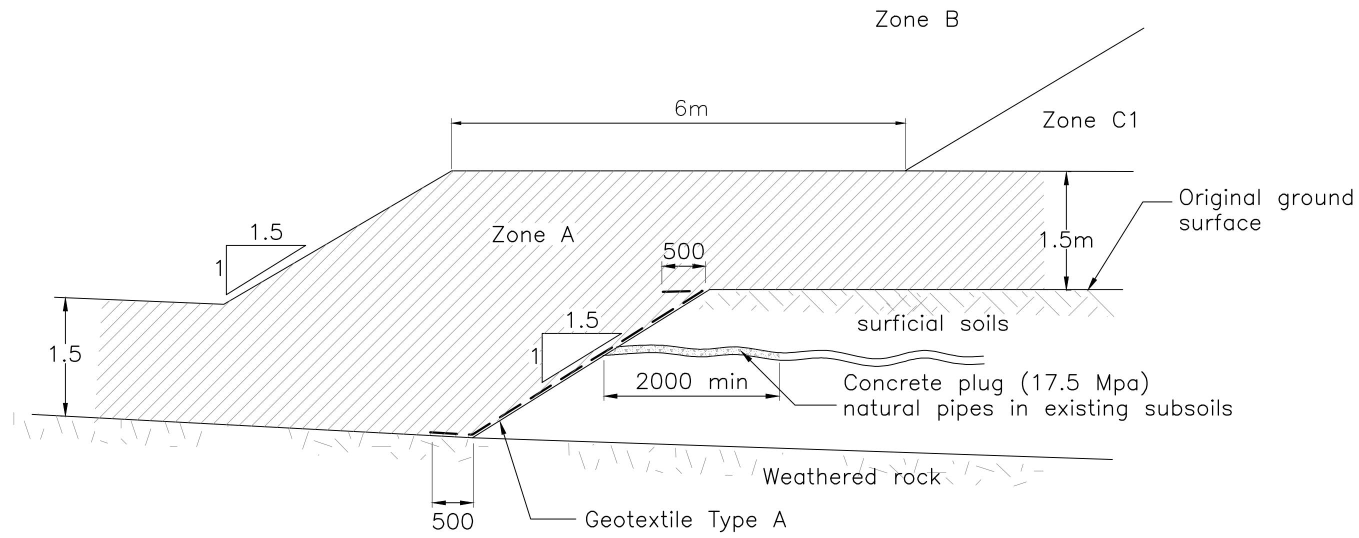
TITLE
Layout Plan
Storage 3 Subsurface Drain
Tails / Waste Rock 080

DRAWING No.	REV. No.
WAI–983–080–DWG–CI–0620	D



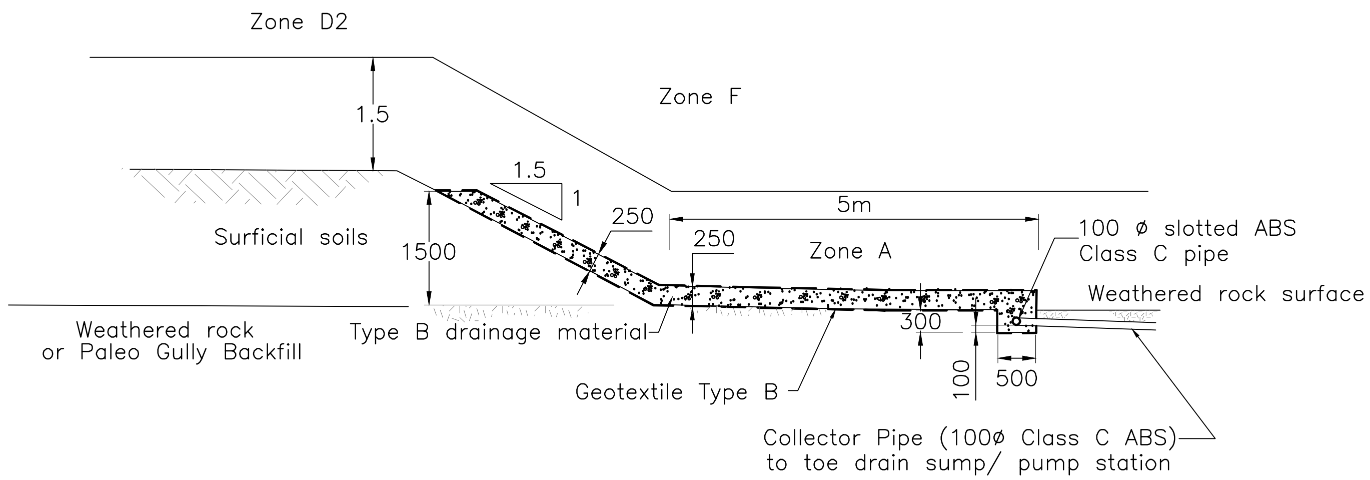
UPSTREAM CUTOFF DRAIN 17 —

Scale 1:100 (A3)



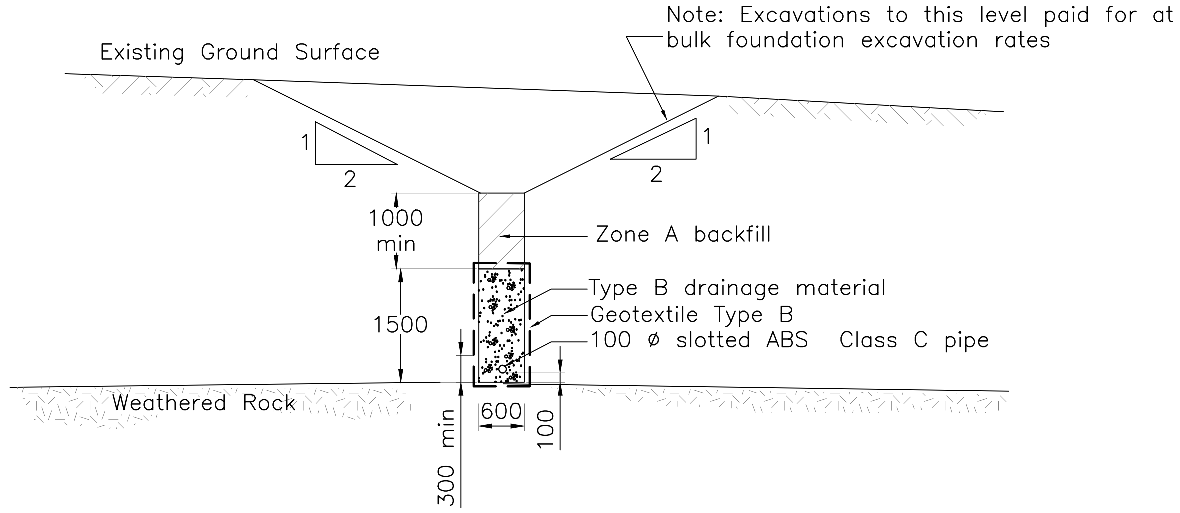
FILTER ZONE 18 —

Scale 1:100 (A3)



TOE DRAIN 19 —

Scale 1:100 (A3)



INITIAL TOE DRAIN 20 —

Scale 1:100 (A3)

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

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	JL	06-07-21	WNP Update	ET	TM
A	JL	27-10-20	Preliminary Issue	ET	ET

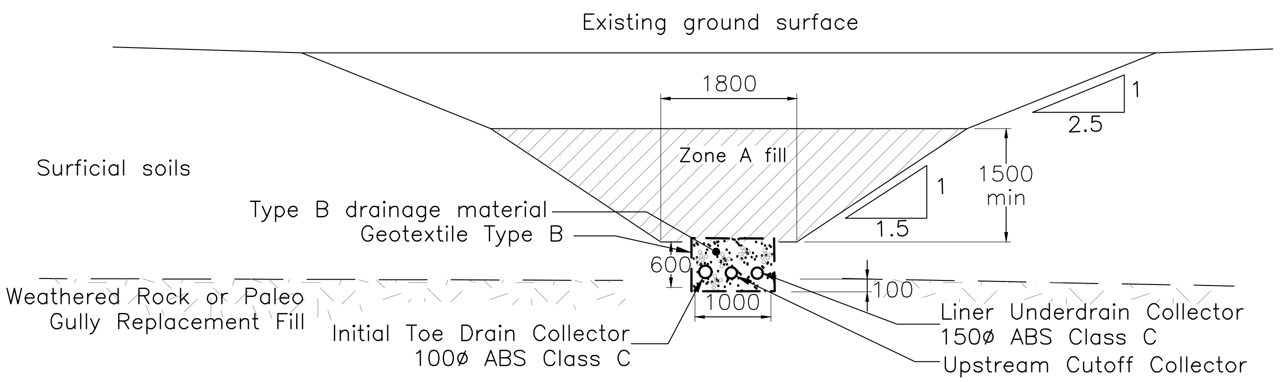
	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 RL155 TSF

AREA: DEVELOPMENT SITE

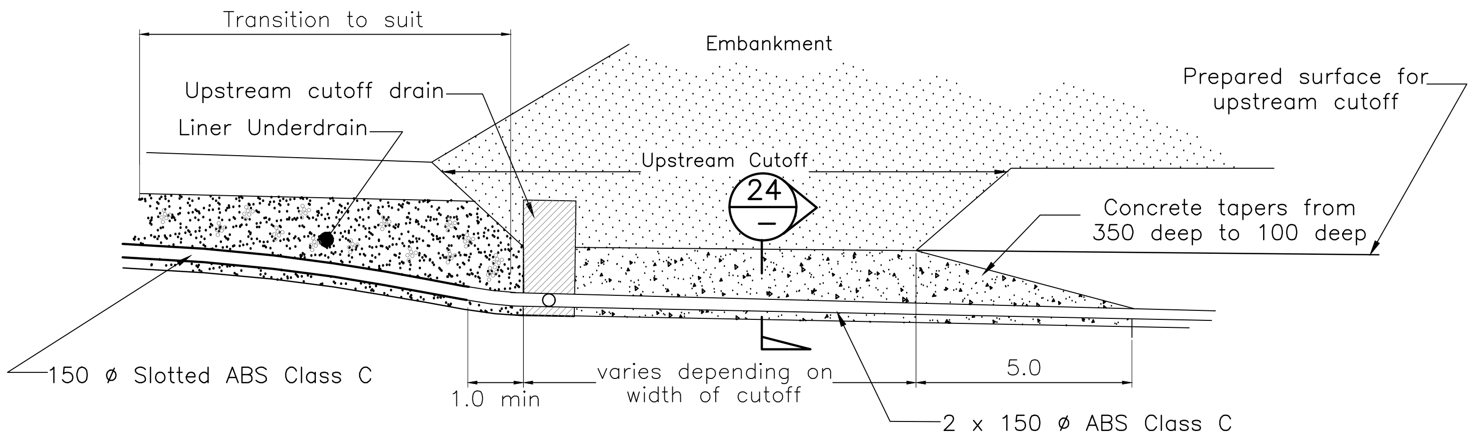
TITLE: Details Storage 3 Subsurface Drain Tails / Waste Rock 080

JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.	REV. No.
8983	as shown	A3	WAI-983-080-DWG-CI-0621	B



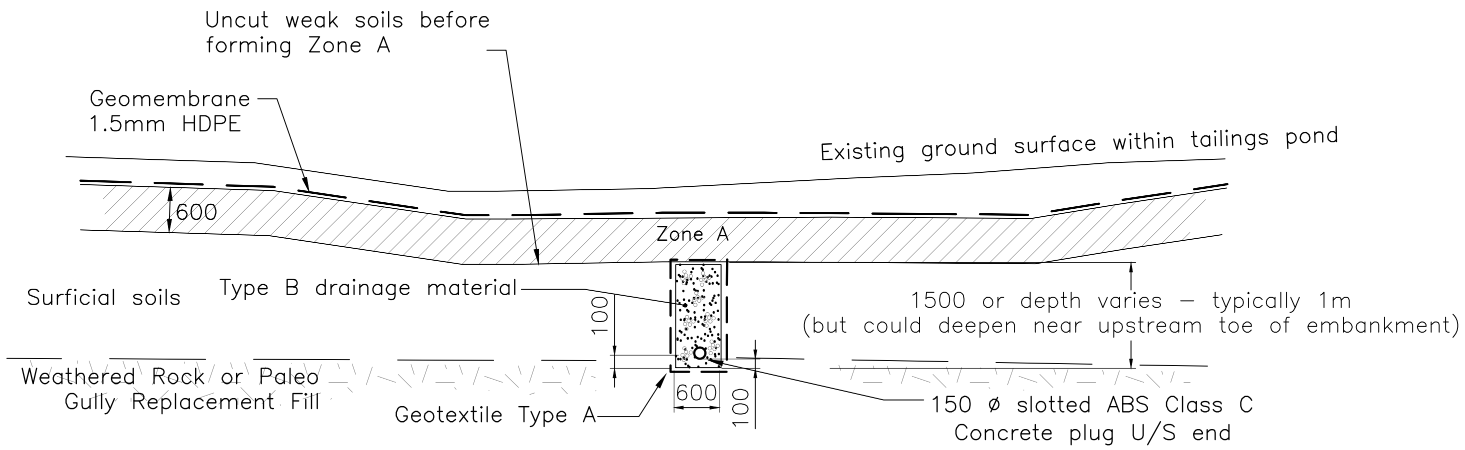
TYPICAL SECTION – LINER UNDERDRAIN AND INITIAL
TOE DRAIN COLLECTOR – DOWNSTREAM OF INITIAL TOE DRAIN
Scale 1:100 (A3)

21
–



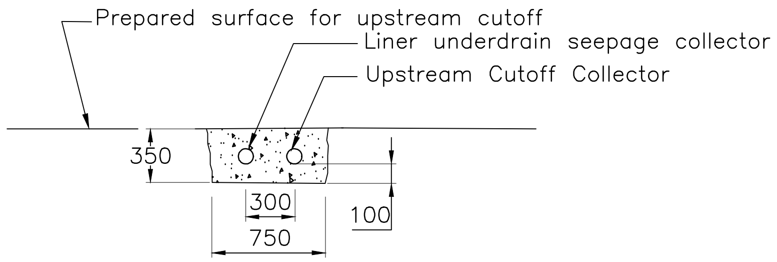
CONCRETE ENCASEMENT AROUND COLLECTOR DRAINS
THROUGH UPSTREAM CUTOFF
Scale 1:100 (A3)

22
–



TYPICAL SECTION – LINER UNDERDRAIN
Scale 1:100 (A3)

23
–



CONCRETE ENCASEMENT AROUND TAILINGS SEEPAGE
COLLECTOR DRAINS– TYPICAL SECTION
Scale 1:50 (A3)

24
–

Notes:
1. Concrete thickness reduces from 350 mm to 100 mm over a 5 m section immediately downstream of upstream cutoff.

2. Expanding agent to be added to concrete to ensure tight contact with rock. Details to be approved by Engineer

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Preliminary Issue		
Tender Issue		
Construction Issue		

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	JL	06-07-21	WNP Update	ET	TM
A	JL	27-10-20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

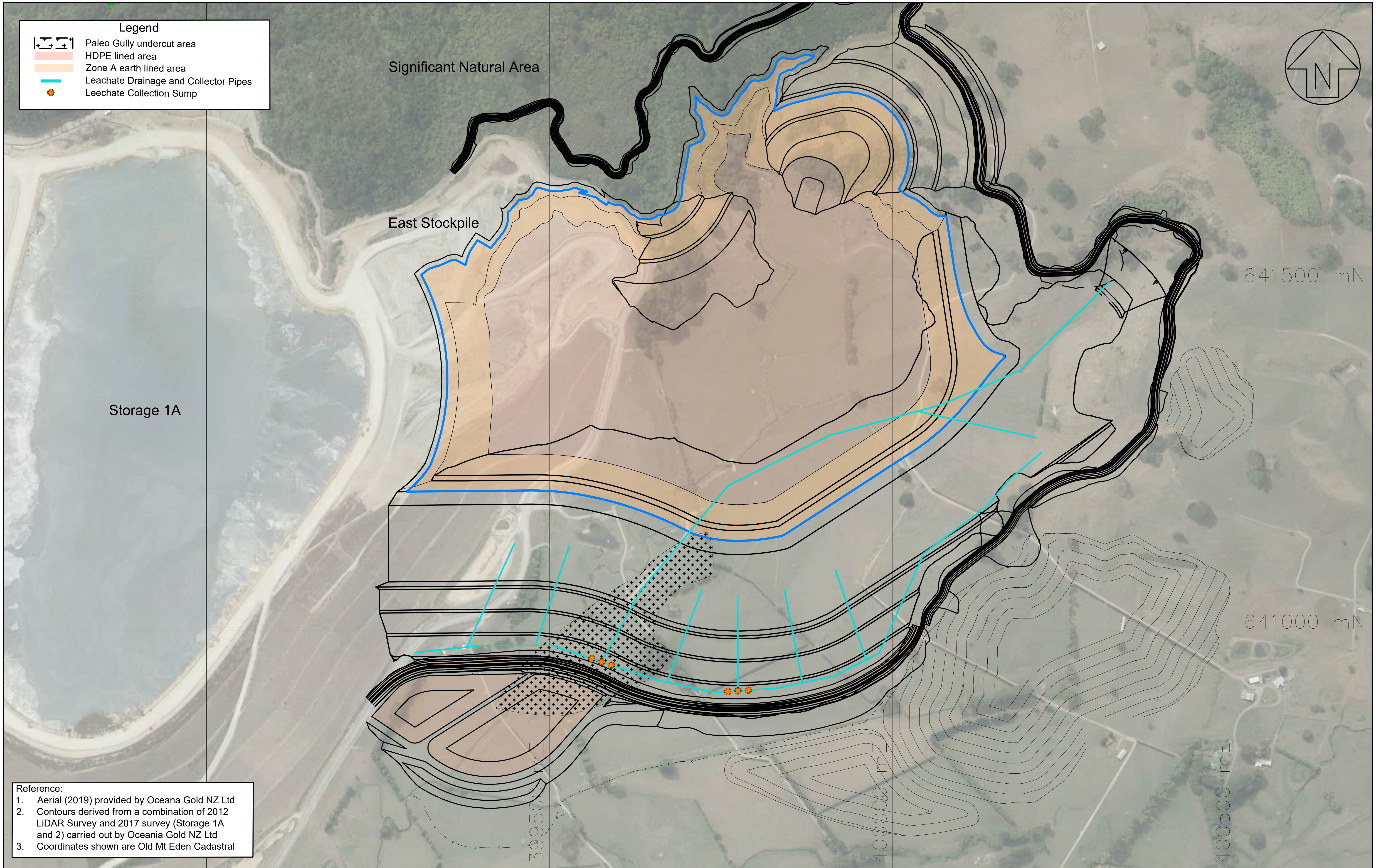
PROJECT: Storage 3 RL155 TSF

AREA: DEVELOPMENT SITE

JOB NUMBER: 8983
ORIGINAL SCALE: as shown
SIZE: A3

TITLE
Details
Storage 3 Subsurface Drain
Tails / Waste Rock 080

DRAWING No. WAI-983-080-DWG-CI-0622
REV. No. B



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

No.	BY	DATE	REVISION	CHECKED	APPROV.
D	SK	17-02-25	Sump Legend Update	AH	ET
C	SK	10-12-24	Addition of Borrow Areas	AH	ET
B	JL	06-07-21	WNP Update	ET	TM
A	JL	27-10-20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 RL155 TSF

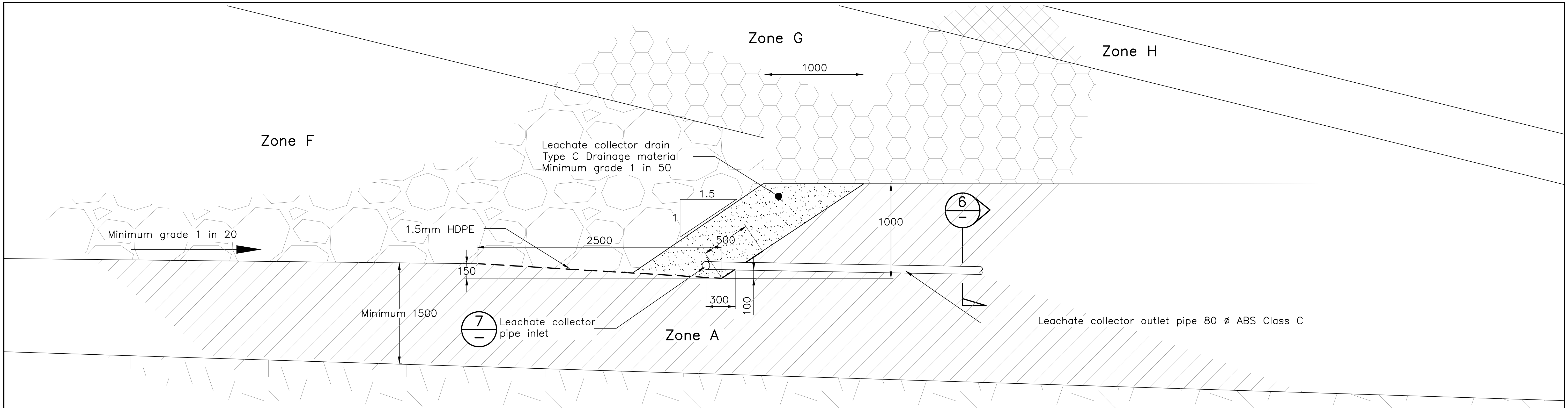
AREA: DEVELOPMENT SITE

JOB NUMBER:	ORIGINAL SCALE:	SIZE:
8983	1:5000	A3

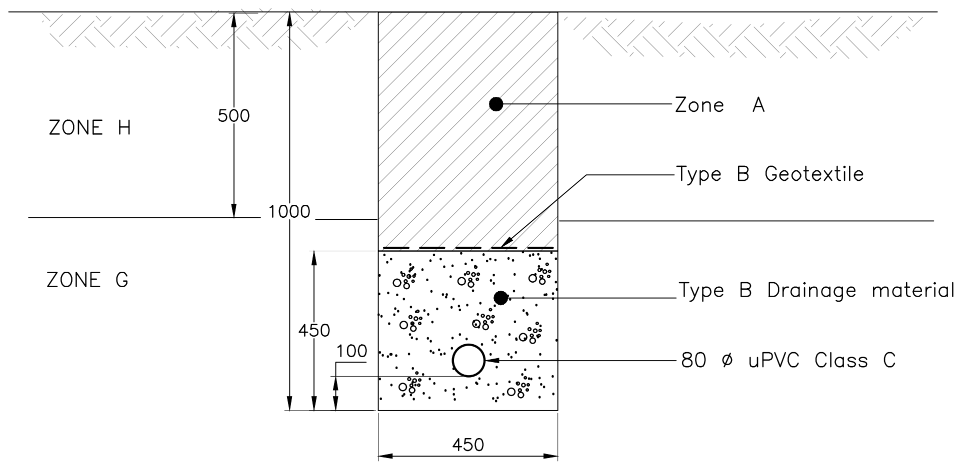
TITLE
Layout Plan
Storage 3 Leachate Drain
Tails / Waste Rock 080

DRAWING No. WAI-983-080-DWG-CI-0626

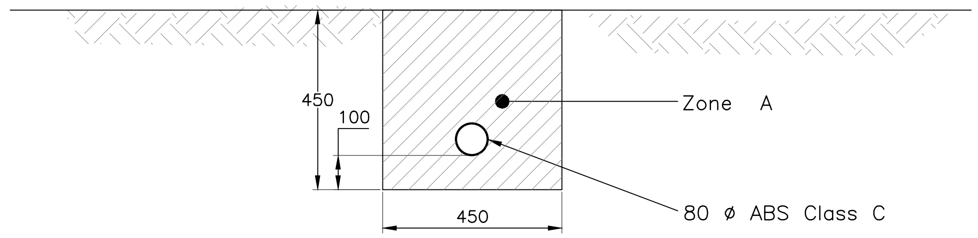
REV. No. D



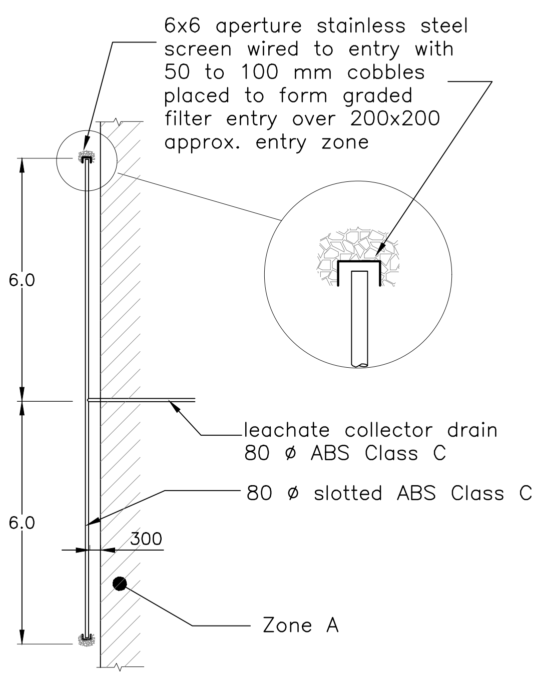
LEACHATE COLLECTION OUTLET (5)
scale 1:40



LEACHATE COLLECTOR OUTLET PIPE WITHIN EMBANKMENT (8)
scale 1:20



LEACHATE COLLECTOR OUTLET PIPE WITHIN EMBANKMENT (7)
scale 1:20



LEACHATE COLLECTOR OUTLET PIPE INLET DETAILS – PLAN VIEW (6)
scale 1:200

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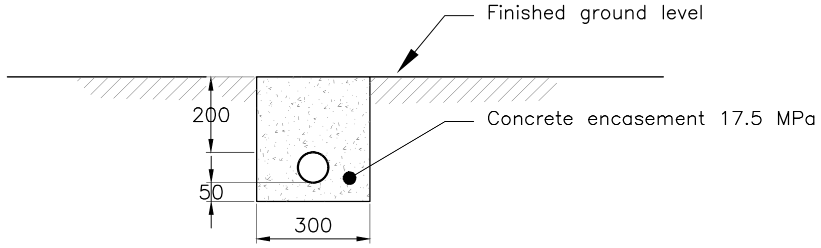
Preliminary Issue	Signed:	Date:
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	JL	06-07-21	WNP Update	ET	TM
A	JL	27-10-20	Preliminary Issue	ET	ET

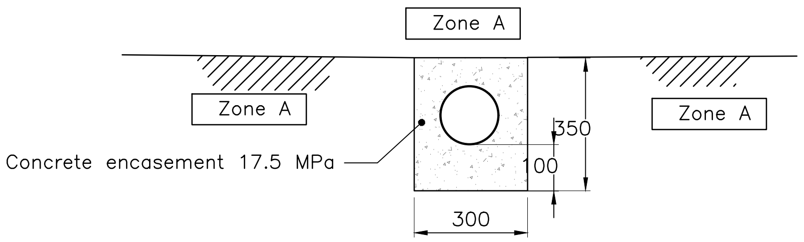
	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 TSF RL155
AREA: DEVELOPMENT SITE
TITLE: Details Storage 3 Leachate Drain Tails / Waste Rock 080

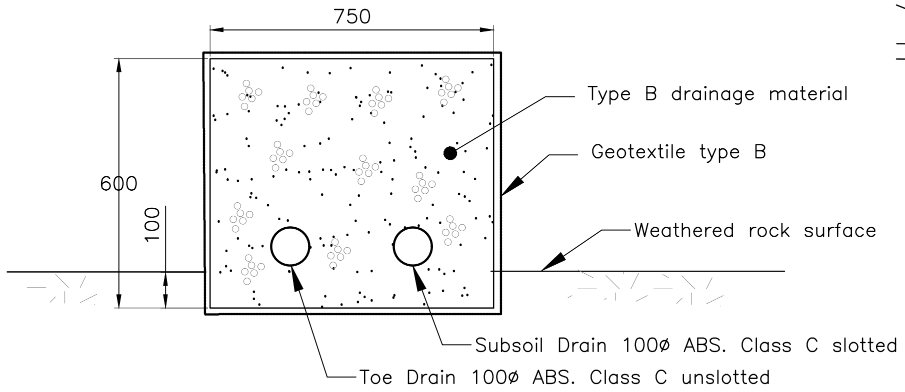
JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.	REV. No.
8983	as shown	A3	WAI-983-080-DWG-CI-0627	B



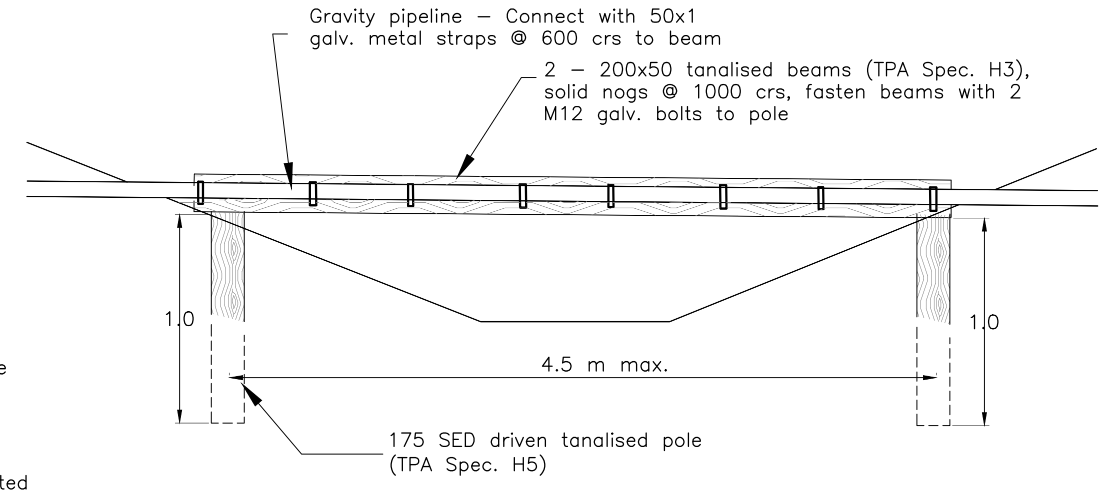
GRAVITY PIPE TYPICAL SECTION 26
Scale 1:20 (A3)



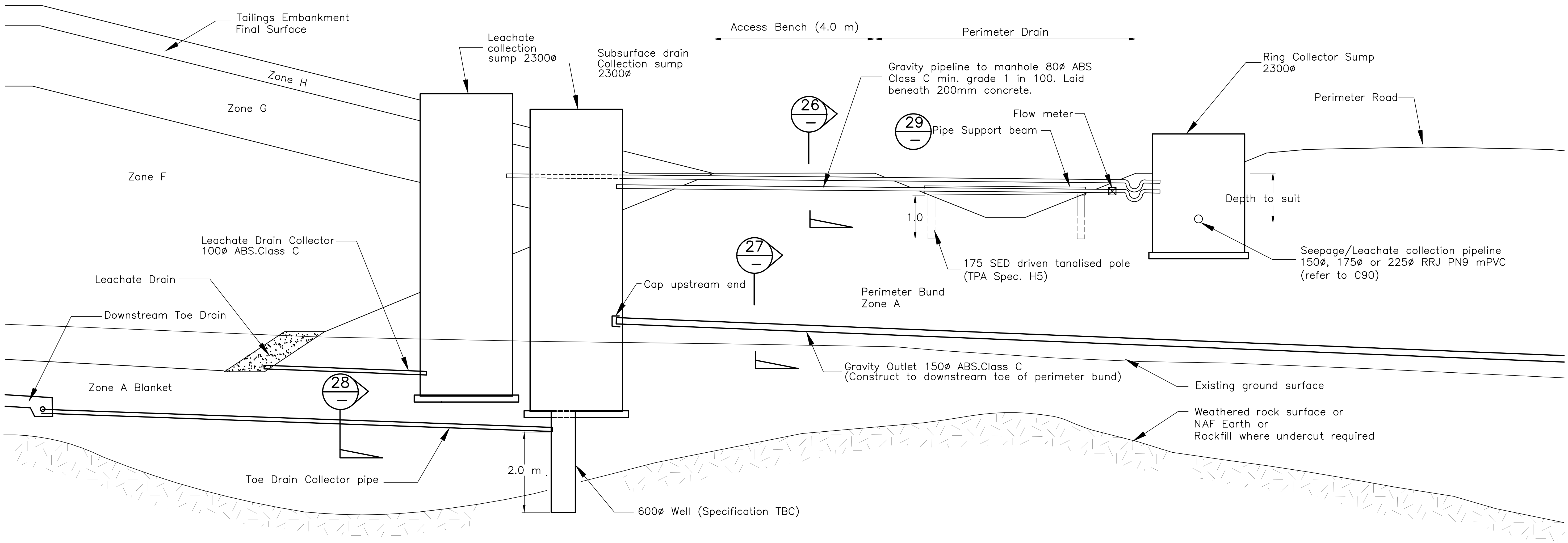
GRAVITY OUTLET TYPICAL SECTION 27
Scale 1:20 (A3)



TOE DRAIN COLLECTOR AND SUBSOIL DRAIN DETAIL 28
Scale 1:20 (A3)



PIPE SUPPORT BEAM DETAILS 29
Scale 1:20 (A3)



DOWNSTREAM TOE DRAIN SUMP AND LEACHATE COLLECTION MANHOLE 25

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	Signed:	Date:
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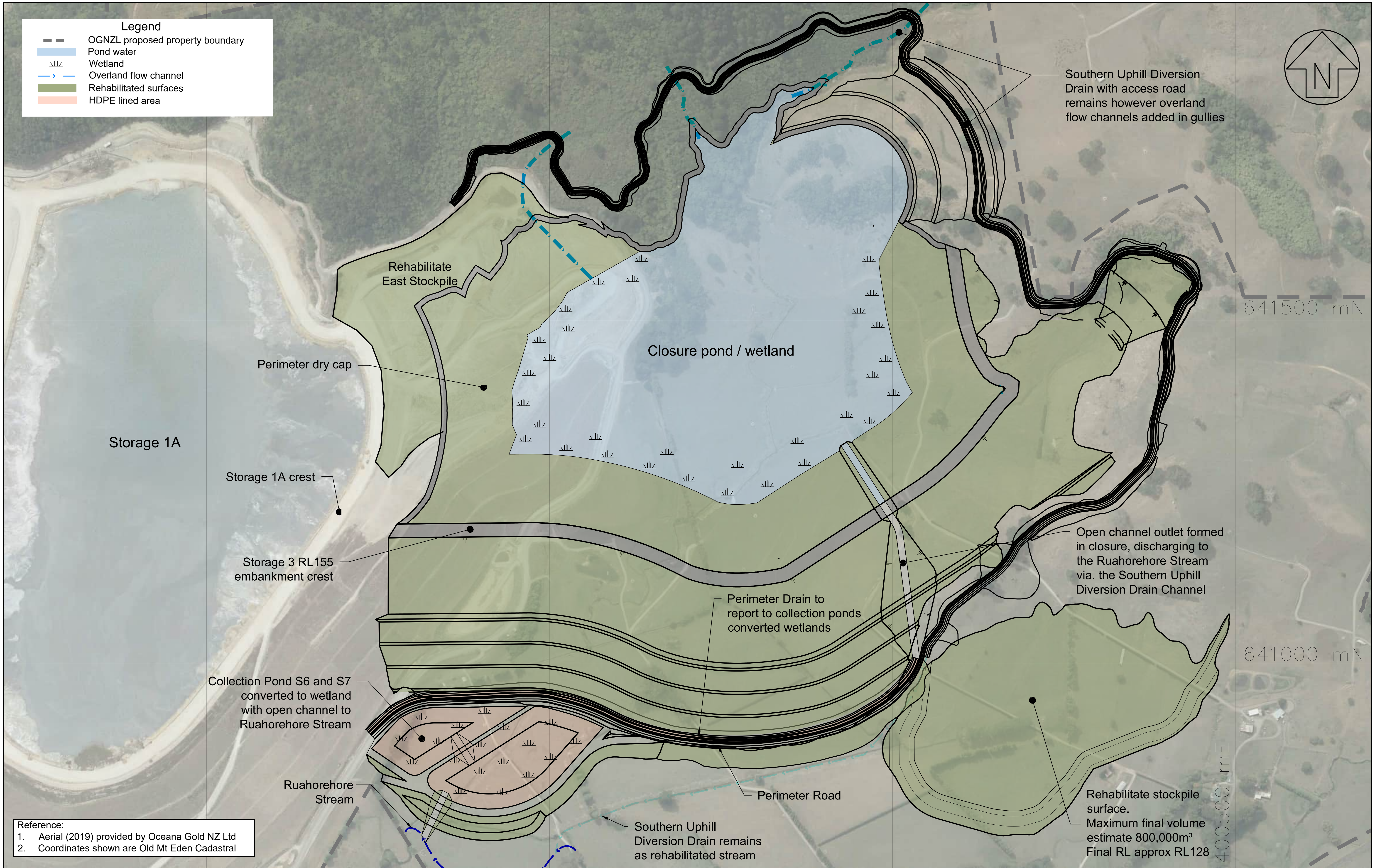
Tender Issue		
Construction Issue		

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	JL	06-07-21	WNP Update	ET	TM
A	JL	27-10-20	Preliminary Issue	ET	ET

	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Storage 3 RL155 TSF
AREA: DEVELOPMENT SITE
JOB NUMBER: 8983
ORIGINAL SCALE: as shown
SIZE: A3
TITLE: Details Storage 3 Drainage Tails / Waste Rock 080
DRAWING No. WAI-983-080-DWG-CI-0639
REV. No. B



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

No.	BY	DATE	REVISION	CHECKED	APPROV.
C	SK	10-12-24	Addition of Borrow Areas	AH	ET
B	ET	04-10-21	Labels and hatching	ET	TM
A	ET	09-08-21	Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	09-08-2021
DESIGNED	ET	04-05-2021
CHECKED	ET	09-08-2021
DRAWN	JL	09-08-2021

PROJECT: Storage 3 RL155 TSF

AREA: DEVELOPMENT SITE

TITLE: Layout Plan Storage 3 Closure Tails / Waste Rock 080

JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.	REV. No.
8983	1:5000	A3	WAI-983-080-DWG-CI-0690	C

APPENDIX B
STABILITY ASSESSMENT

APPENDIX B

EMBANKMENT STABILITY CALCULATIONS

B1. PURPOSE

Assess the proposed profile for geotechnical stability.

B2. OBJECTIVES

1. Select geotechnical strength parameters for each material for the different loading cases. Consider peak drained strengths, peak undrained strengths, residual undrained strengths.
2. Consider operational and long term closure stability cases.
3. Assess stability for Sections 1 and 2 shown in plan on Drawing 0513 and cross section in Drawing 0516 and 0517.
4. Apply Morgenstern and Price stability calculation method with half sine interslice pressure distribution.
5. Review stability against NZDSG criteria for stability.

B3. STABILITY ASSESSMENT

The following strength parameter sets have been selected for Storage 3 stability.

TABLE B1: HOEK ROCK MASS STRENGTH RELATIONSHIP PARAMETERS

Rock	Strength	Structure	Surface Condition	σ_c (MPa)	m_i	m_b/m_i	s	a
Rhyolite	W	blocky/ seamy	Fair	5	16	.12	.001	.5

σ_c – uniaxial compressive strength

TABLE B2: DUNCAN FILL STRENGTH RELATIONSHIP PARAMETERS

Fill	Relative Density Dr	A	B	C	D	Std dev.	Percentile
Duncan Gravel/Cobbles with Cu>4 16%ile	0.85	44	10	7	2	3.1	16%

TABLE B3: STATIC CONDITION – DRAINED STRENGTH PARAMETER SET

Material	γ (kN/m^3)	Strength Parameters		Porewater Pressure	
				Operational	Closure
Zone A/I Fill – Sourced from mine overburden of foundation rock undercut	20.5	c' = 5 kPa	ϕ' = 35 deg	r_u = 0.1	Phreatic^
Zone A/I Fill – Sourced from foundation undercut ash and alluvium	17.5	c' = 3 kPa	ϕ' = 31 deg	r_u = 0.3	Phreatic^
Zone A Fill – Reworked in-situ Ash/Surface CW Rhyolite	17.0	c' = 0 kPa	ϕ' = 26 deg	r_u = 0.3	Phreatic^
Zone B Fill Below RL145	20.5	c' = 3 kPa	ϕ' = 31 deg	r_u = 0.5	Phreatic*
Zone B Fill Above RL145	20.5	c' = 5 kPa	ϕ' = 35 deg	Phreatic*	Phreatic*
Zone C2, F Fill	20.5	Duncan Gravel/Cobbles with Cu > 4 16%ile		r_u = 0.05	Phreatic^
Zone C1 Fill	20.5	c' = 5 kPa	ϕ' = 35 deg	r_u = 0.1	Phreatic^
Zone D2	20.5	c' = 5 kPa	ϕ' = 35 deg	r_u = 0.1	Phreatic^
Zone D3	19.0	c' = 0 kPa	ϕ' = 31 deg	r_u = 0.4	Phreatic^
Zone E	19.0	c' = 0 kPa	ϕ' = 26 deg	r_u = 0.6	Phreatic^
Tails Capping Layer	20.5	c' = 3 kPa	ϕ' = 31 deg	Phreatic^	Phreatic^
Zone G Fill	20.5	c' = 3 kPa	ϕ' = 31 deg	r_u = 0.1	Phreatic^
PG Fill	20.5	Duncan Gravel/Cobbles with Cu > 4 16%ile		r_u = 0.05	Phreatic^
Sensitive Redeposited Rhyolite Tuff Typical SPTN = 0 to 1	16.5	c' = 0 kPa	ϕ' = 37 deg	Phreatic^ plus r_u = 0.1	Phreatic^
CW Rhyolite/Residual Soil UCS <0.5MPa Typical SPTN <8	17.0	c' = 0 kPa	ϕ' = 26 deg	Phreatic^ plus r_u = 0.1	Phreatic^
HW to MW Rhyolite Rock Extremely Weak to Very Weak Rhyolite Rock UCS 0.5MPa to 5MPa	17.5	c' = 5 kPa	ϕ' = 35 deg	Phreatic^	Phreatic^
Weak Rhyolite Rock UCS > 5MPa	18.5	Hoek – W Rhyolite		Phreatic^	Phreatic^
Fresh Tailings	16.0	$Su/\sigma_v' = 0.04$		*Phreatic	*Phreatic
Consolidated Tailings	18.0	$Su/\sigma_v' = 0.13$		*Phreatic	*Phreatic

*Supernatant pond water phreatic surface with a hydrostatic profile
^Embankment/foundation phreatic surface applied with a hydrostatic profile

TABLE B4: STATIC CONDITION – UNDRAINED STRENGTH PARAMETER SET

Material	γ (kN/m^3)	Strength Parameters			Porewater Pressure	
					Operational	Closure
Zone A/I Fill – Sourced from mine overburden of foundation rock undercut	20.5	Su_{min} = 150 kPa, Su/σ_v' = 0.4			r_u = 0.1	Phreatic^
Zone A/I Fill – Sourced from foundation undercut ash and alluvium	17.5	Su_{min} = 80 kPa, Su/σ_v' = 0.35			r_u = 0.3	Phreatic^
Zone A Fill – Reworked in-situ Ash/Surface CW Rhyolite	17.0	Vert. eff. Stress (kPa)	Su (kPa)	Su/σ_v'	r_u = 0.3	Phreatic^
		0	0	-		
		100	46	0.46		
		300	103	0.34		
		600	189	0.32		
		1000	288	0.29		
		2000	460	0.23		
Zone B Fill Below RL145	20.5	c = 10 kPa	ϕ = 18 deg		r_u = 0.5	Phreatic*
Zone B Fill Above RL145	20.5	c = 21 kPa	ϕ = 21 deg		Phreatic*	Phreatic*
Zone C2, F Fill	20.5	Duncan Gravel/Cobbles with Cu > 4 16%ile			r_u = 0.05	Phreatic^
Zone C1 Fill	20.5	c = 21 kPa	ϕ = 21 deg		r_u = 0.1	Phreatic^
Zone D2 Fill	19.5	c' = 5 kPa	ϕ' = 35 deg		r_u = 0.1	Phreatic^
Zone D3	19.0	c = 10 kPa	ϕ = 18 deg		r_u = 0.4	Phreatic^
Zone E	19.0	Su/σ_v' = 0.21			r_u = 0.6	Phreatic^
Tails Capping Layer	20.5	c' = 3 kPa	ϕ' = 31 deg		Phreatic^	Phreatic^
Zone G Fill	20.5	Su = 100 kPa			-	-
PG Fill	20.5	Duncan Gravel/Cobbles with Cu > 4 16%ile			r_u = 0.05	Phreatic^
Sensitive Redeposited Rhyolite Tuff Typical SPTN = 0 to 1	16.5	Su/σ_v' = 0.21			Phreatic^ plus r_u = 0.1	Phreatic^
CW Rhyolite/Residual Soil UCS <0.5MPa SPTN <8	17.0	Vert. eff. Stress (kPa)	Su (kPa)	Su/σ_v'	Phreatic^ plus r_u = 0.1	Phreatic^
		0	0	-		
		100	46	0.46		
		300	103	0.34		
		600	189	0.32		
		1000	288	0.29		
		2000	460	0.23		
HW to MW Rhyolite Rock Extremely Weak to Very Weak Rhyolite Rock UCS 0.5MPa to 20MPa	17.5	c' = 5 kPa	ϕ' = 35 deg		Phreatic^	Phreatic^
Weak Rhyolite Rock	18.5	Hoek – W Rhyolite			Phreatic^	Phreatic^
Fresh Tailings	16.0	Su/σ_v' = 0.04			*Phreatic	*Phreatic
Consolidated Tailings	18.0	Su/σ_v' = 0.13			*Phreatic	*Phreatic

*Supernatant pond water phreatic surface with a hydrostatic profile
^Embankment/foundation phreatic surface applied with a hydrostatic profile

TABLE B5: EARTHQUAKE CONDITION - POST SEISMIC & CO-SEISMIC PARAMETER SET

Material	γ (kN/m^3)	Strength Parameters		Porewater Pressure	
				Operational	Closure
Zone A/I Fill – Sourced from mine overburden of foundation rock undercut	20.5	Su_{min} = 120 kPa, Su/σ_v' = 0.32		r_u = 0.1	Phreatic^
Zone A/I Fill – Sourced from foundation undercut ash and alluvium	17.5	Su_{min} = 50 kPa, Su/σ_v' = 0.28		r_u = 0.3	Phreatic^
Zone A Fill – Reworked in-situ Ash/Surface CW Rhyolite	17.0	Su/σ_v' = 0.23		r_u = 0.3	Phreatic^
Zone B Fill Below RL145	20.5	c = 8 kPa	ϕ = 15 deg	r_u = 0.5	Phreatic*
Zone B Fill Above RL145	20.5	c = 17 kPa	ϕ = 17 deg	Phreatic*	Phreatic*
Zone C2, F Fill	20.5	Duncan Gravel/Cobbles with Cu > 4 16%ile		r_u = 0.05	Phreatic^
Zone C1 Fill	20.5	c = 17 kPa	ϕ = 17 deg	r_u = 0.1	Phreatic^
Zone D2 Fill	19.5	c' = 5 kPa	ϕ' = 35 deg	r_u = 0.1	Phreatic^
Zone D3	19.0	c = 8 kPa	ϕ = 15 deg	r_u = 0.4	Phreatic^
Zone E	19.0	Su/σ_v' = 0.06		r_u = 0.6	Phreatic^
Tails Capping Layer	20.5	c' = 2.4 kPa	ϕ' = 26 deg	Phreatic^	Phreatic^
Zone G Fill	20.5	Su = 80 kPa		-	-
PG Fill	20.5	Duncan Gravel/Cobbles with Cu > 4 16%ile		r_u = 0.05	Phreatic^
Sensitive Redeposited Rhyolite Tuff Typical SPTN = 0 to 1	16.5	Su/σ_v' = 0.15 (20% strain) Su/σ_v' = 0.06 (100% strain)		Phreatic^ plus r_u = 0.1	Phreatic^
Ash/ CW Rhyolite/Residual Soil UCS <0.5MPa SPTN <8	17.0	Su/σ_v' = 0.23		Phreatic^ plus r_u = 0.1	Phreatic^
HW to MW Rock Extremely Weak to Very Weak Rhyolite Rock UCS 0.5MPa to 5MPa	17.5	c' = 5 kPa	ϕ' = 35 deg	Phreatic^	Phreatic^
Weak Rhyolite Rock UCS > 5MPa	18.5	Hoek – W Rhyolite		Phreatic^	Phreatic^
Fresh Tailings	16.0	Su/σ_v' = 0.04		*Phreatic	*Phreatic
Consolidated Tailings	18.0	Su/σ_v' = 0.13		*Phreatic	*Phreatic

*Supernatant pond water phreatic surface with a hydrostatic profile
^Embankment/foundation phreatic surface applied with a hydrostatic profile

The following stability analyses have been run.

TABLE B6: DOWNSTREAM STABILITY ANALYSES – SECTION 1 (PALEO GULLY SECTION)

Stability Analyses	Strength Parameters	Figure	Slide Surface	Result	Comment
Static construction/ operation – peak undrained strength conditions	Main embankment and foundation Combination of drained and undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement. Tailings Residual undrained strengths applied using effective stresses based on hydrostatic porewater pressure profile.	B1	Foundation	FOS=2.17	Above FOS=1.5 recommended by NZDSG
		B2	Zone A	FOS=1.86	Above FOS=1.5 recommended by NZDSG
		B3	Embankment	FOS=2.75	Above FOS=1.5 recommended by NZDSG
Static construction/ operation – peak drained strength conditions	Main embankment and foundation Drained strength parameters applied using effective stresses based on excess porewater pressures due to fill placement. Tailings Drained strength parameters applied using effective stresses based on hydrostatic porewater pressure profile.	B4	Foundation	FOS=2.28	Above FOS=1.5 recommended by NZDSG
		B5	Zone A	FOS=2.40	Above FOS=1.5 recommended by NZDSG
		B6	Embankment	FOS=2.69	Above FOS=1.5 recommended by NZDSG
Static long term – closure drains fail - peak undrained strength conditions	Main embankment and foundation Combination of drained and undrained parameters applied using effective stresses based on long term porewater pressure profile Tailings Residual undrained strengths applied using effective stresses based on hydrostatic porewater pressure profile	B7	Foundation	FOS=2.31	Above FOS=1.5 recommended by NZDSG
		B8	Zone A	FOS=2.12	Above FOS=1.5 recommended by NZDSG
		B9	Embankment	FOS=2.52	Above FOS=1.5 recommended by NZDSG
Static long term – closure drains fail - peak drained strength conditions	Main embankment and foundation Drained strength parameters applied using effective stresses based on long term porewater pressure profile Tailings Drained strength parameters applied using effective stresses based on hydrostatic porewater pressure profile	B10	Foundation	FOS=2.45	Above FOS=1.5 recommended by NZDSG
		B11	Zone A	FOS=2.42	Above FOS=1.5 recommended by NZDSG
		B12	Embankment	FOS=2.48	Above FOS=1.5 recommended by NZDSG
Post-earthquake – Undrained	Main embankment fill Combination of drained and undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement. Tailings Residual undrained strengths applied using effective stresses based on hydrostatic porewater pressure profile	B13	Foundation	FOS=2.11	Above FOS=1.2 recommended by NZDSG
		B14	Zone A	FOS=1.63	Above FOS=1.2 recommended by NZDSG
		B15	Embankment	FOS=2.38	Above FOS=1.2 recommended by NZDSG
OBE embankment response	Main embankment and foundation Combination of drained and undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement. Tailings Residual undrained strengths applied using effective stresses based on hydrostatic porewater pressure profile	B16	Top 1/3rd of embankment k_y = 0.55 g	< 0.5 cm	See Table B15 for seismic parameters used for determining co-seismic deformations
		B17	Top 2/3^{rds} of embankment k_y = 0.45 g	< 0.5 cm	
		B18	Full embankment k_y = 0.12 g	< 0.5 to 0.6 cm	
SEE (CME + aftershock)		B16	Top 1/3rd of embankment k_y = 0.55 g	<0.5 to 2.7 cm	
		B17	Top 2/3^{rds} of embankment k_y = 0.45 g	<0.5 to 2.9 cm	
		B18	Full embankment k_y = 0.12 g	4.3 to 19.9 cm	
SEE (1 in 10,000 year EQ + aftershock)		B16	Top 1/3rd of embankment k_y = 0.55 g	<0.5 to 10.4 cm	
		B17	Top 2/3^{rds} of embankment k_y = 0.45 g	<0.5 to 5.9 cm	
		B18	Full embankment k_y = 0.12 g	9.9 to 41.7 cm	

TABLE B7: DOWNSTREAM STABILITY ANALYSES – SECTION 2 (SHEAR KEY CUT)

Stability Analyses	Strength Parameters	Figure	Slide Surface	Result	Comment
Static construction/ operation – peak undrained strength conditions	<u>Main embankment and foundation</u> Combination of drained and undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement. <u>Tailings</u> Residual undrained strengths applied using effective stresses based on hydrostatic porewater pressure profile.	B19	Foundation	FOS=2.23	Above FOS=1.5 recommended by NZDSG
		B20	Zone A	FOS=1.71	Above FOS=1.5 recommended by NZDSG
		B21	Embankment	FOS=2.11	Above FOS=1.5 recommended by NZDSG
Static construction/ operation – peak drained strength conditions	<u>Main embankment and foundation</u> Drained strength parameters applied using effective stresses based on excess porewater pressures due to fill placement. <u>Tailings</u> Drained strength parameters applied using effective stresses based on hydrostatic porewater pressure profile.	B22	Foundation	FOS=2.29	Above FOS=1.5 recommended by NZDSG
		B23	Zone A	FOS=2.26	Above FOS=1.5 recommended by NZDSG
		B24	Embankment	FOS=2.58	Above FOS=1.5 recommended by NZDSG
Static long term – closure drains fail - peak undrained strength conditions	<u>Main embankment and foundation</u> Combination of drained and undrained parameters applied using effective stresses based on long term porewater pressure profile <u>Tailings</u> Residual undrained strengths applied using effective stresses based on hydrostatic porewater pressure profile	B25	Foundation	FOS=2.20	Above FOS=1.5 recommended by NZDSG
		B26	Zone A	FOS=2.00	Above FOS=1.5 recommended by NZDSG
		B27	Embankment	FOS=2.15	Above FOS=1.5 recommended by NZDSG
Static long term – closure drains fail - peak drained strength conditions	<u>Main embankment and foundation</u> Drained strength parameters applied using effective stresses based on long term porewater pressure profile <u>Tailings</u> Drained strength parameters applied using effective stresses based on hydrostatic porewater pressure profile	B28	Foundation	FOS=2.29	Above FOS=1.5 recommended by NZDSG
		B29	Zone A	FOS=2.53	Above FOS=1.5 recommended by NZDSG
		B30	Embankment	FOS=2.36	Above FOS=1.5 recommended by NZDSG
Post-earthquake – Undrained	<u>Main embankment fill</u> Combination of drained and undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement. <u>Tailings</u> Residual undrained strengths applied using effective stresses based on hydrostatic porewater pressure profile	B31	Foundation	FOS=2.08	Above FOS=1.2 recommended by NZDSG
		B32	Zone A	FOS=1.52	Above FOS=1.2 recommended by NZDSG
		B33	Embankment	FOS=1.80	Above FOS=1.2 recommended by NZDSG
OBE embankment response	<u>Main embankment and foundation</u> Combination of drained and undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement. <u>Tailings</u> Residual undrained strengths applied using effective stresses based on hydrostatic porewater pressure profile	B34	Top $1/3^{rd}$ of embankment $k_y = 0.54$ g	< 0.5 cm	See Table B15 for seismic parameters used for determining co-seismic deformations
		B35	Top $2/3^{rds}$ of embankment $k_y = 0.46$ g	< 0.5 cm	
		B36	Full embankment $k_y = 0.085$ g	< 0.5 to 1.5 cm	
SEE (CME + aftershock)		B34	Top $1/3^{rd}$ of embankment $k_y = 0.54$ g	<0.5 to 3 cm	
		B35	Top $2/3^{rds}$ of embankment $k_y = 0.46$ g	<0.5 to 2.6 cm	
		B36	Full embankment $k_y = 0.085$ g	7.6 to 32.1 cm	
SEE (1 in 10,000 year EQ + aftershock)		B34	Top $1/3^{rd}$ of embankment $k_y = 0.54$ g	<0.5 to 10.9 cm	
		B35	Top $2/3^{rds}$ of embankment $k_y = 0.46$ g	<0.5 to 5.5 cm	
		B36	Full embankment $k_y = 0.085$ g	15.3 to 64.1 cm	

EMBANKMENT CO-SEISMIC DEFORMATION CALCULATIONS

B4. PURPOSE

Estimate the potential co-seismic deviatoric (shear) embankment deformations under earthquake loading for Storage 3 TSF embankment raise to RL155.

B5. OBJECTIVES

1. Select design response spectra and mean moment magnitudes (Mw) for the dam site (Vs30 = 600m/s) for an:
    a. Operational Basis Earthquake - 150 year return period event
    b. Safety Evaluation Earthquake - 84%ile Shaking Intensity from a rupture on the Kerepehi Fault System and aftershock
    c. Safety Evaluation Earthquake - 10,000 year return period event and aftershock
2. Estimate the embankment shearwave velocity profile
3. Estimate the amplification factors (base to crest) for embankment spectral response and topographical effects
4. Estimate the ground motion variation through the embankment
5. Estimate the co-seismic deviatoric deformations induced by earthquake shaking using the Bray and Macedo (2019) calculation method

B6. DESIGN RESPONSE SPECTRA

A seismic hazard study was undertaken by GNS Science in 2017 (Ref. 1) for the Waihi Operation site with a time average shearwave velocity over 30m, Vs30 = 600 m/s, representative of a soft rock site. The GNS study provided probabilistic uniform hazard spectra for the required:

- 150 year return period earthquake event
- 10,000 year return period earthquake event

EGL assessed the spectrum for the aftershock following 10,000 year return period earthquake event.

The GNS study (Ref. 1) also assessed the deterministic spectrum for the required 84%ile rupture on the Kerepehi Fault System. EGL assessed the spectrum for the aftershock on the Kerepehi Fault System.

6.1. Operational Basis Earthquake - 150 year return period earthquake event

The Operational Basis Earthquake probabilistic 150 year return period uniform hazard spectrum is shown in Figure B1 and the associated deaggregation plots are shown in Figure B2, Figure B3, and Figure B4. The mean magnitude of the deaagregated rupture sources for PGA (Peak Ground Acceleration) is provided by GNS (Ref. 1), however, not for SA(0.5s) and SA(1.0s). These have been visually estimated as summarised in Table B8 by EGL for use in estimating co-seismic displacement.

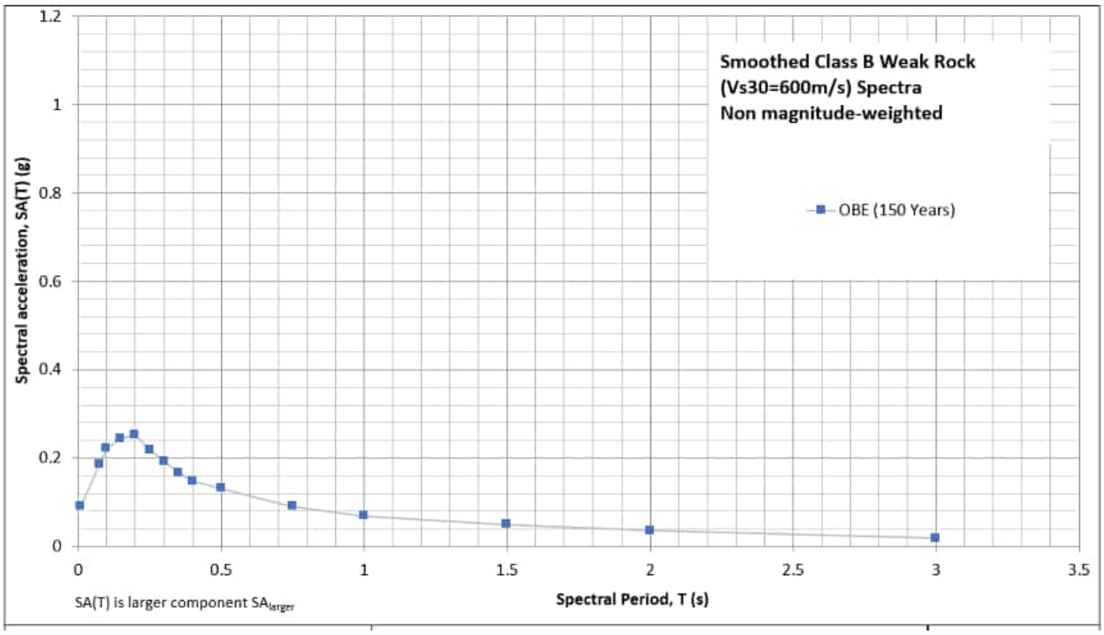


FIGURE B1: OBE 150 YEAR RETURN PERIOD RESPONSE SPECTRUM

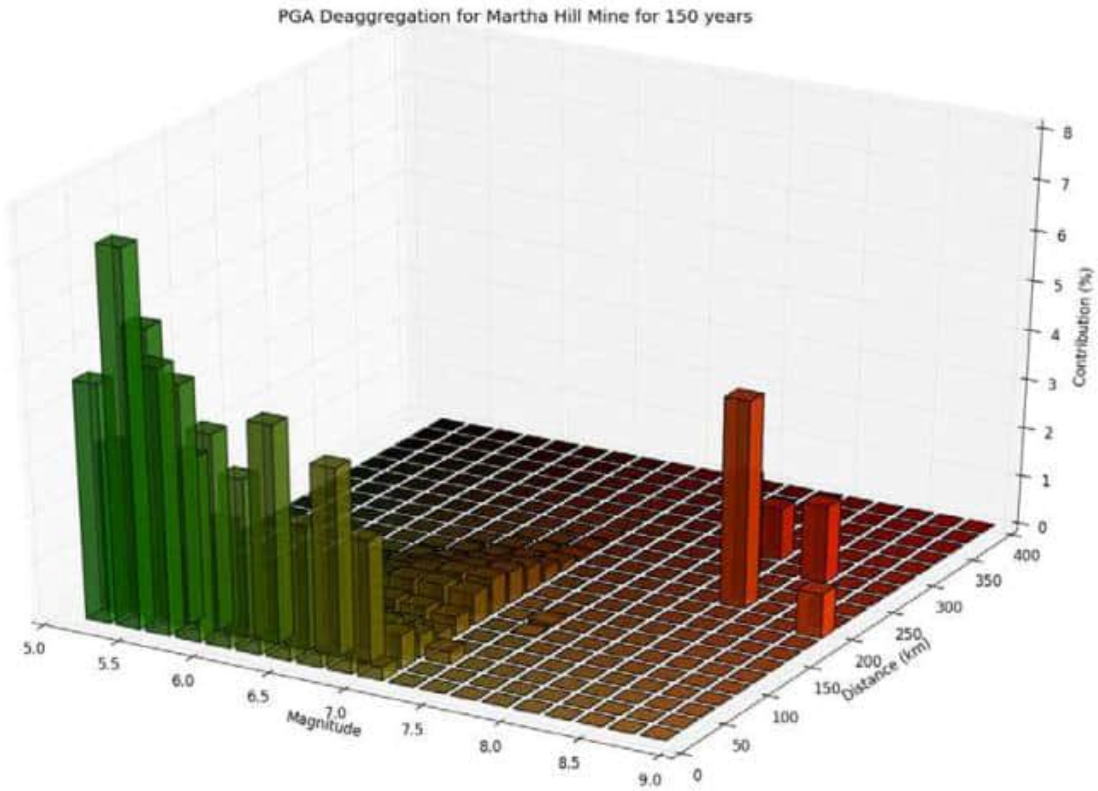


FIGURE B2: NON MAGNITUDE-WEIGHTED 150 YEAR PGA DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

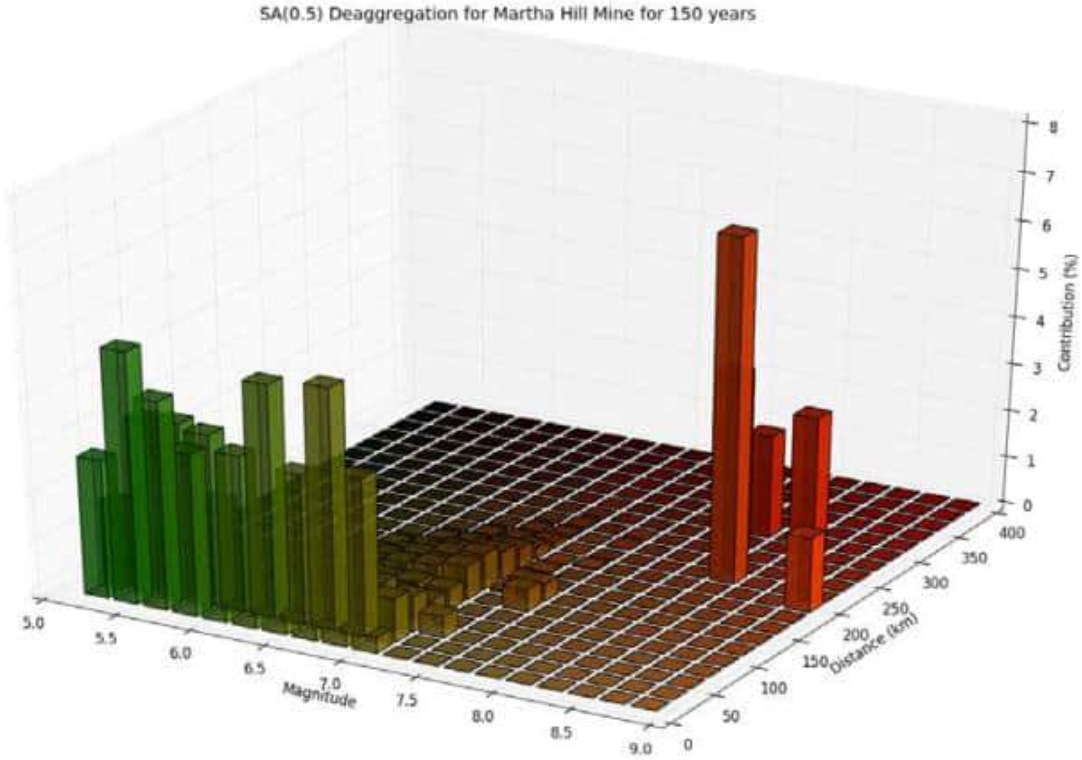


FIGURE B3: NON MAGNITUDE-WEIGHTED 150-YEAR SA (0.5S) DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

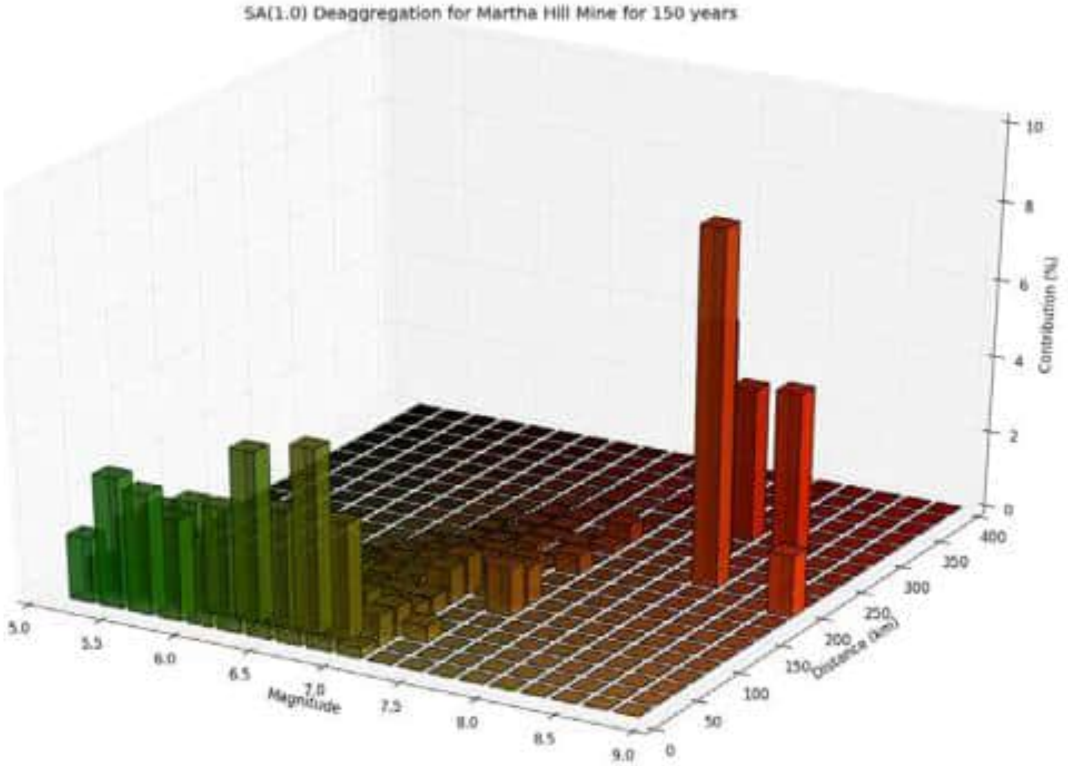


FIGURE B4: NON MAGNITUDE-WEIGHTED 150-YEAR SA (1.0 S) DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

TABLE B8: ESTIMATED MEAN MAGNITUDES FOR 150 YEAR RETURN PERIOD SPECTRAL ACCELERATIONS

Intensity Parameter	Mean Magnitude (Mw)
PGA	6.3
SA(0.5s)	6.4*
SA(1.0s)	6.7*

*Visually estimated from GNS 2017 deaggregation

6.2. Safety Evaluation Earthquake - Kerepehi Fault System earthquake event and aftershock

The deterministic response spectrum for a rupture on the full (onshore) Kerepehi Fault System is shown in Figure B5 as one of the two cases considered under the Safety Evaluation Earthquake criteria. The spectrum shown is for a magnitude 7.3 rupture, for shaking one standard deviation (i.e. 84%ile or epsilon value equal to one)) above the median estimate using McVerry et al. (2006) (Ref. 2) and Bradley (2013) (Ref. 3) ground motion prediction equations. An aftershock of one magnitude less is to be considered with the main rupture for the Safety Evaluation Earthquake when assessing effects. The aftershock spectrum is assessed using the same ground motion prediction equations as for the main rupture, for shaking intensities one standard deviation (epsilon value equal to one) above the median predicted. Table B9 summarises the magnitudes. The Kerepehi Fault System is 21km from the Waihi Operation.

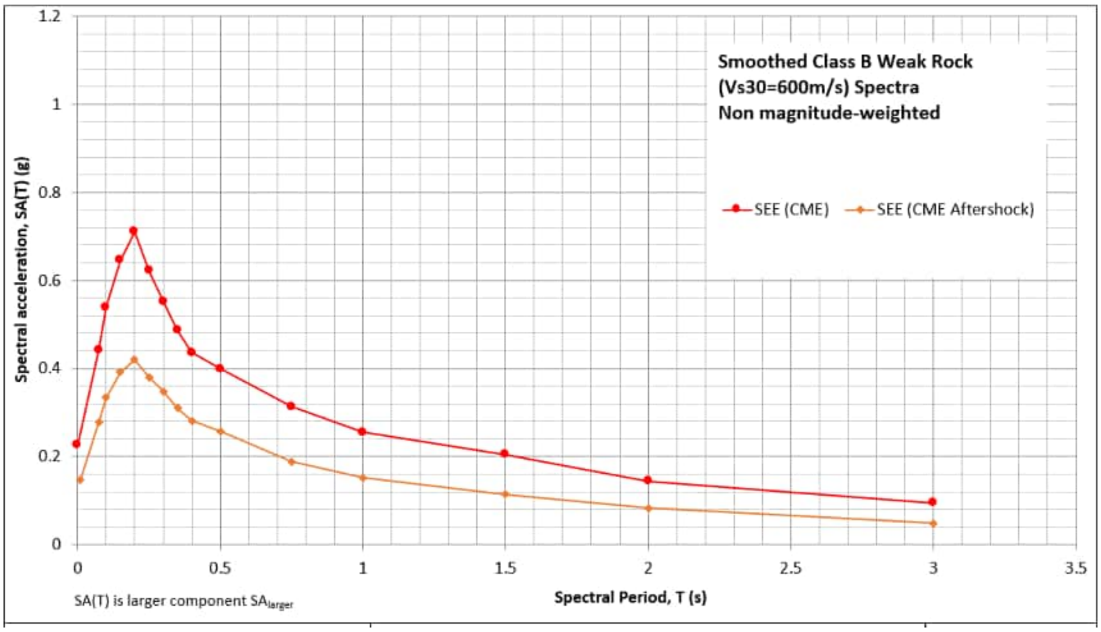


FIGURE B5: SEE KEREPEHI FAULT SYSTEM RUPTURE (84%ILE MOTION) RESPONSE SPECTRA

TABLE B9: ESTIMATED MAGNITUDES FOR THE KEREPEHI FAULT SYSTEM RUPTURE

Rupture Event	Magnitude (Mw)
Main rupture	7.3
Aftershock	6.3*

* Taken as one magnitude less than the main rupture

6.3. Safety Evaluation Earthquake - 10,000 year return period earthquake event and aftershock

The probabilistic 10,000 year return period uniform hazard spectrum is shown in Figure B6 and the associated deaggradation plots are shown in Figure B7, Figure B8, and Figure B9. The probabilistic 10,000 year return period earthquake event is one of two cases considered for the Safety Evaluation Earthquake criteria. The mean magnitude of the deaagregated rupture sources for PGA (Peak Ground Acceleration) is provided by GNS (Ref. 1), however, not for SA(0.5s) and SA(1.0s). These have been visually estimated as summarised in Table B12 by EGL for use in estimating co-seismic displacement. The aftershock spectrum is assessed using the same ground motion prediction equations as for the main rupture. The mean magnitude for the main rupture is selected as Mw7.3, based on a representative period of 0.5s, for the process of calculating the aftershock spectrum. Indicative natural periods and degraded natural periods (1.3T) for the embankment are in Table B10 which informed the selection of 0.5s. Normal faulting and a distance to rupture of 21km was applied in the GMPE and the epsilon values (standard deviations above the median estimate in a log normal distribution) were adjusted to match the 10,000 year spectra and are reported in Table B11. The standard deviations are between 1.15 and 2.01 which represent between 87 to 98%ile motions from a M7.3 at 21km. The rupture parameters apart from epsilon are the same as applied for the Kerepehi Fault System rupture, however, this does not imply that the rupture would be on this fault system as the 10,000 year uniform hazard spectra is made up of many sources, including potential rupture on unknown faults and the subduction zone. The aftershock (uniform hazard) spectrum following a 10,000 year return period rupture was estimated using the same parameters as the main earthquake, however, using one magnitude lower i.e. Mw 6.3.

TABLE B10: ESTIMATES OF EMBANKMENT FUNDMENTAL PERIOD

Section	RL155 Emb. Height Crest to Toe		RL155 Emb. height above rock beneath crest	Time average shear wave velocity, V_{sH} (m/s)	Fundamental period on downstream slope of embankment $T = 2.6H/V_{sH}$	Fundamental period of embankment beneath crest $T = 4.0H/V_{sH}$
	Height to Toe	Description				
1	46 m	Collection Pond S7 pond base to embankment crest.	46m	V_{s46} = 429 m/s	T= 0.28s 1.3T = 0.364	T= 0.43s 1.3T = 0.56s
2	45 m	Toe of Perimeter Bund to embankment crest.	47m	V_{s47} = 431 m/s	T= 0.28s 1.3T = 0.364	T= 0.44s 1.3T = 0.57s

TABLE B11: EPSILION VALUES CALCULATED TO MATCH A MW7.3 NORMAL FAULT RUPTURE TO THE 10,000 YEAR PROBABILISTIC SPECTRA

Period, T(s)	Epsilon calculated
0.01	2.01751
0.075	2.07564
0.1	2.02176
0.15	1.75527
0.2	1.62195
0.25	1.54329
0.3	1.51919
0.35	1.52935
0.4	1.50603
0.5	1.47386
0.75	1.46113
1	1.47490
1.5	1.32827
2	1.40116
3	1.15211

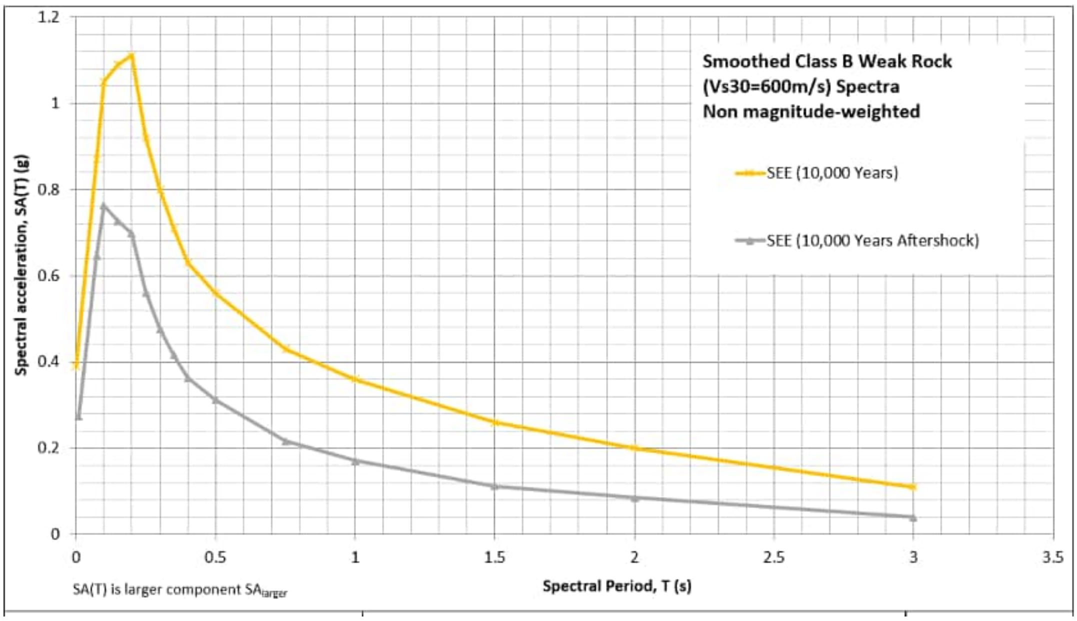


FIGURE B6: SEE 10,000 YEAR RETURN PERIOD RESPONSE SPECTRA

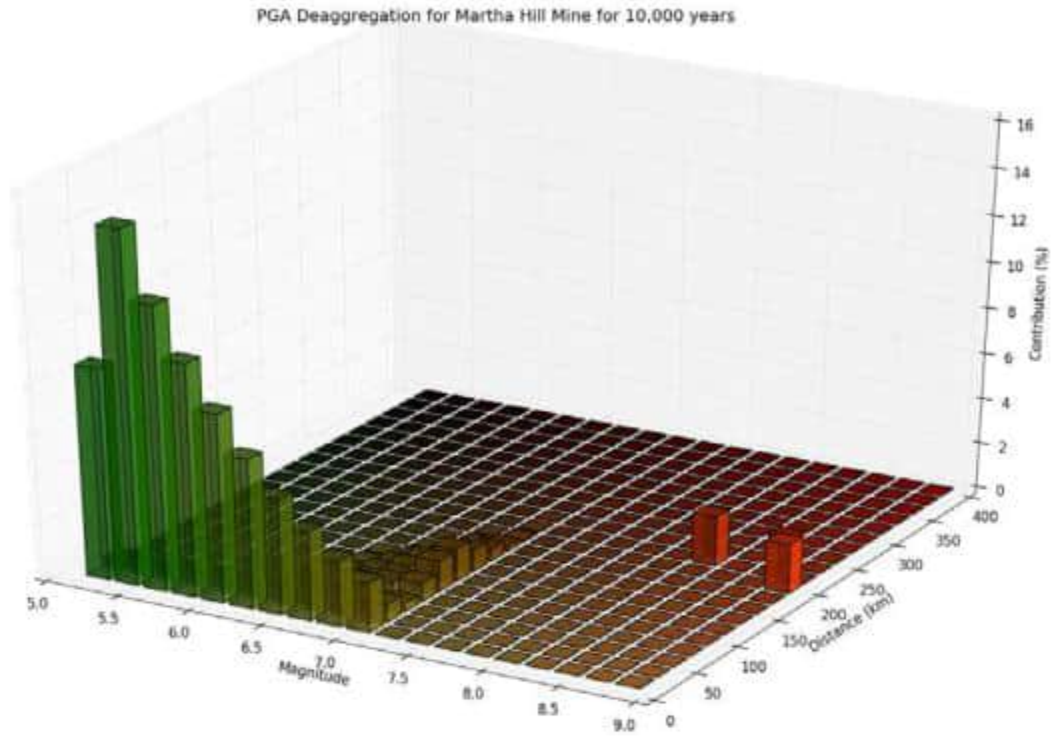


FIGURE B7: NON MAGNITUDE-WEIGHTED 10,000 YEAR PGA DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

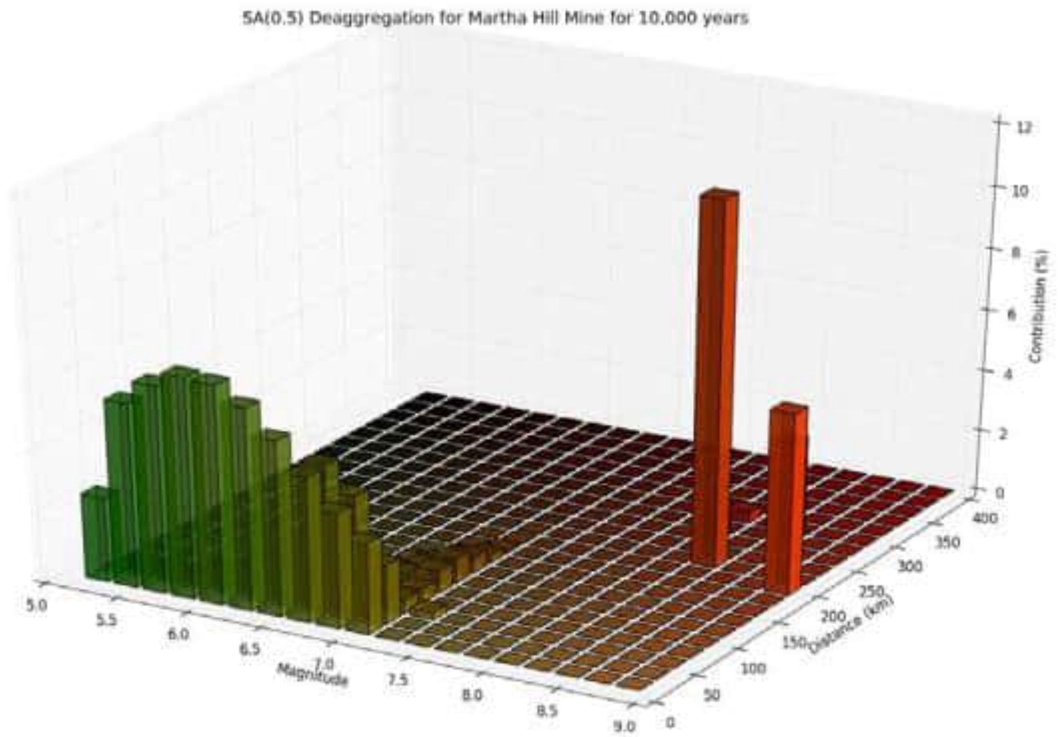


FIGURE B8: NON MAGNITUDE-WEIGHTED 10,000-YEAR SA (0.5S) DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

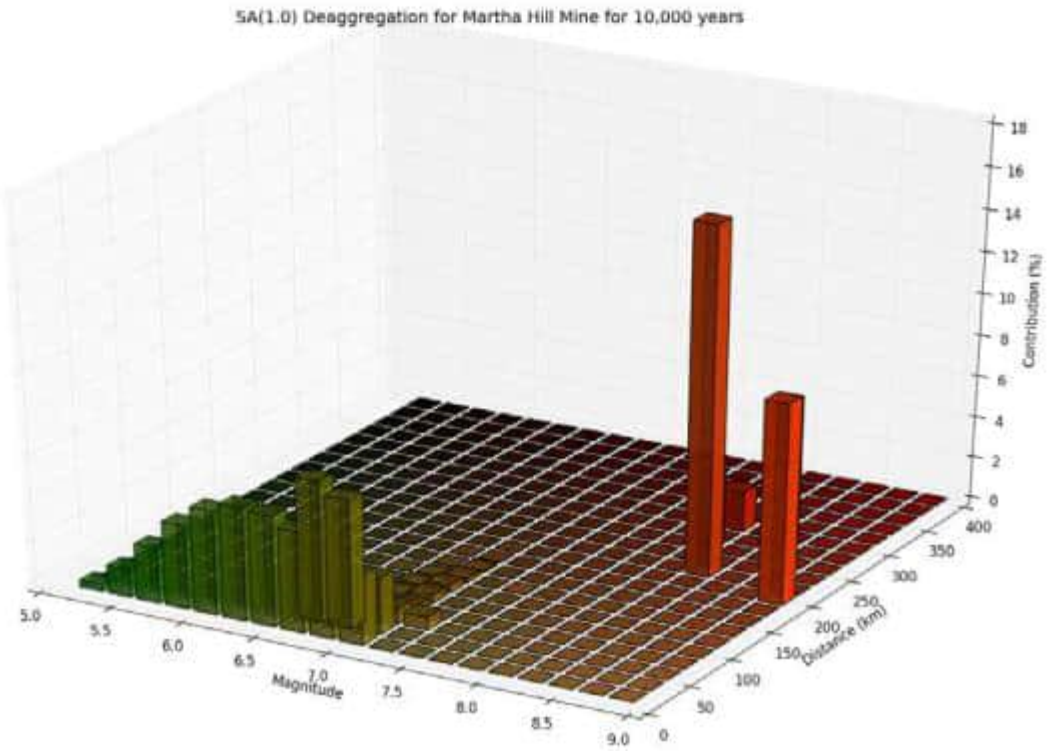


FIGURE B9: NON MAGNITUDE-WEIGHTED 10,000-YEAR SA (1.0 S) DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

TABLE B12: ESTIMATED MEAN MAGNITUDES FOR 10,000 YEAR RETURN PERIOD SPECTRAL ACCELERATIONS

Intensity Parameter	**Mean Magnitude (Mw)**
PGA	6.9
SA(0.5s)	7.3*
SA(1.0s)	7.5*

*Visually estimated from GNS 2017 deaggregation

B7. EMBANKMENT SHEARWAVE VELOCITY PROFILE

Zone C1, C2, D2 form the major proportion of the material within the embankment below the crest and will dominate the embankments response. The material for these zones is likely to be the more rocky overburden material. This material is likely to be crushed and conveyed to the Development Site, and transported and placed by dump truck in the embankment. The layers are placed in 0.25 to 0.5m thick layers and are track rolled with the loaded dump trucks or compacted with a CAT825. Placed in the embankment the material is a predominately a Sandy GRAVEL with some cobbles and silt.

No direct measurement of shearwave velocity of the embankment material has been made. Estimates are based on empirical correlations for gravelly soils and depend on density and effective stress. These zones are drained within the embankment so the effective stress is the total weight of the material above. The gravel fill material is assumed to be a dense gravel with a relative density of Dr=0.85. A total unit weight of 20.5kN/m^3 is used for the gravel fill.

Two empirical relationships for shearwave velocity based on the Pacific Earthquake Engineering Research (PEER) Centre Report 2012/08 (Ref. 4) were applied. The relationships are the result of a review on a wide range of empirical correlations for shearwave velocity including gravels. One is for Holocene age gravels and the other is for Pleistocene age gravels. The empirical curves are plotted for reference in Figure B10 using the site specific parameters for unit weight and relative density. Density is considered through the Standard Penetration Test – N Value, SPT-N, not corrected for overburden (i.e. N_{60}). The target $(N_1)_{60}$ value is determined using the common relationship below with a C_d value of 46 (Ref. 5):

$$D_R = \sqrt{\frac{(N_1)_{60}}{C_d}}$$

The equivalent $(N_1)_{60}$ value is 33 for a relative density of 0.85. Using equation 39 in Idriss and Boulanger (2008) (Ref. 5) for overburden correction, the equivalent N60 profile was developed to then estimate shearwave velocity, V_s. No limit to the maximum value of C_N was applied at shallow depth. The N_{60} profile developed and applied to the V_s reference curves is shown in Figure B10.

A third reference curve for dense gravels (relative density of 0.95) was applied as per Lin et al. (2014) using a shearwave velocity of 312m/s (Ref. 6) with an exponent $n_s = 0.331$. This is shown in Figure B10. This reference curve was used to estimate the Vs profile for embankment in a stepped profile up to a maximum Vs = 600m/s, which was limited as the Vs30 for the underlying rock for the seismic hazard study was 600m/s and the PEER equation 4.102 for Pleistocene Gravels indicates values less than 600m/s. The estimated Vs values with depth are indicated in Table B13.

FIGURE B10: EMBANKMENT SHEARWAVE VELOCITY ESTIMATATION

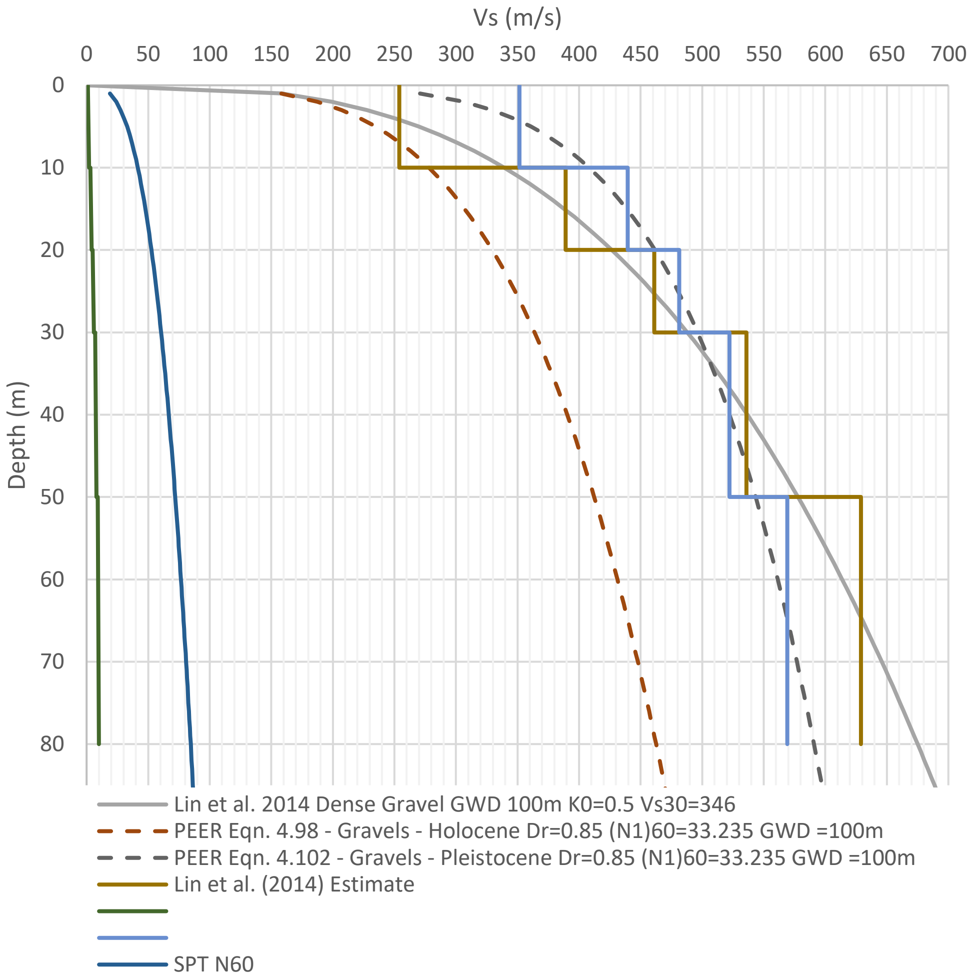


TABLE B13: ESTIMATED SHEARWAVE VELOCITY PROFILE FOR THE EMBANKMENT

Depth	Vs (m/s)	Vs10	Vs20	Vs30	Vs50
0 to 10m	303	303m/s	350m/s	383m/s	514m/s
10 to 20m	414				
20 to 30m	471				
30 to 50m	529				

B8. EMBANKMENT SPECTRAL AND TOPOGRAPHIC AMPLIFICATION FACTORS

Amplification of ground motions from the base of the embankment to the crest are applied for earthquake displacement analyses. The values selected are based on recorded amplification of peak ground acceleration at the crest and base of earth-rockfill dam. The case histories are summarised by Harder (1998) (Ref. 7.) and Yu et al. (2012) (Ref. 8) and are shown in Figure B11 and Figure B12. Included in the dataset is the 86m high Matahina Dam in the Bay of Plenty Region of New Zealand which recorded an amplification ratio of 1.5 for a base peak ground acceleration of approximately 0.26 g, in the Edgecumbe Earthquake. Figure B13 shows the response spectra for the base and the crest. The amplification ratio is close to 1.0 over 0.1 to 0.5 s, however increases to 2 over 0.5 to 0.8 s, and then at approximately 1.1 to 1.3 s it is approximately 3 to 3.5s. The highest spectral amplification likely corresponds with the embankments natural period of resonance and while this amplification was recorded the natural period of any slide masses at the crest would have been much lower and so not experience notable amplification effects.

Recorded events indicate higher amplification ratios for lower shaking intensities where embankment materials are closer to their elastic range and hysteretic damping is lower, and lower amplification rations for higher shaking intensities where embankment materials are further into their non-linear range with greater hysteretic damping. The peak ground accelerations for each of the seismic case are listed below:

- 150-year return period earthquake: PGA = 0.10g
- Kerepehi F.S. Rupture 84%ile PGA = 0.23g
- Kerepehi aftershock 84%ile PGA = 0.16g
- 10,000-year return period earthquake: PGA = 0.39g
- 10,000 year aftershock: PGA = 0.23g

The selected amplification ratios are:

- 150-year return period earthquake: AMP = 3.6
- Kerepehi F.S. Rupture 84%ile AMP = 2.0
- Kerepehi aftershock 84%ile AMP = 2.7
- 10,000-year return period earthquake: AMP = 1.5
- 10,000 year aftershock: AMP = 2.0

The amplification ratios for ground motions from the base of the embankment to the crest selected are indicatively shown on Figure B11 and Figure B12.

FIGURE B11: HARDER (1998) (REF. 7) RECORD OF CREST AND BASE PEAK GROUND ACCELERATIONS

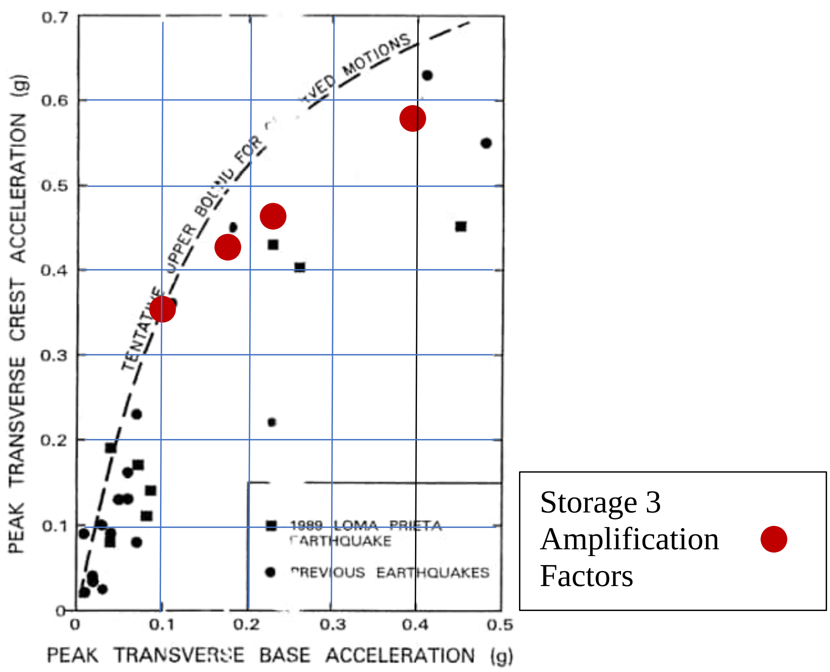


FIGURE B12: YU ET AL. (2012) (REF. 8) RECORD OF CREST AND BASE PEAK GROUND ACCELERATIONS

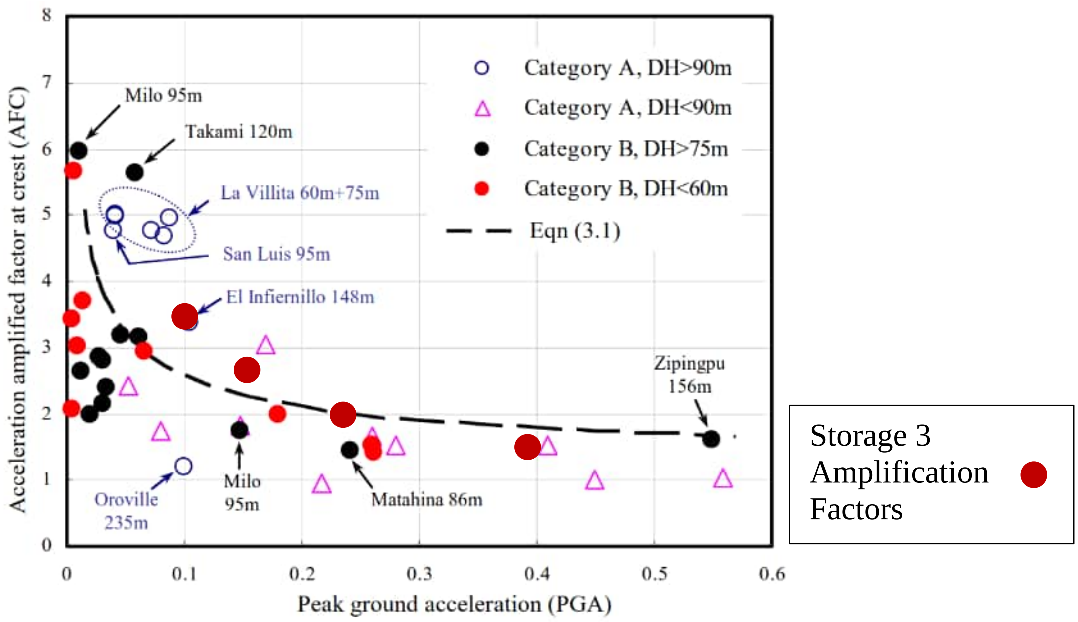


FIGURE B13: RESPONSE SPECTRA RECORDED AT THE BASE AND CREST OF THE MATAHINA DAM IN THE EDGECUMBE EARTHQUAKE

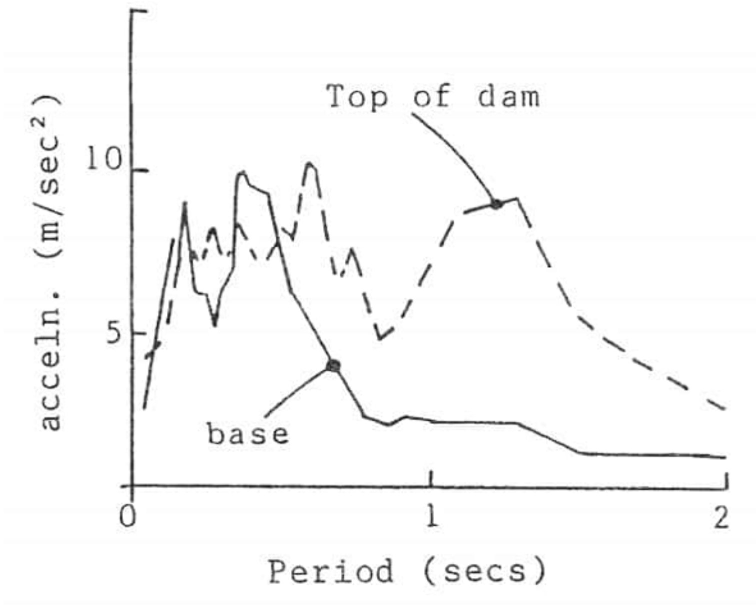


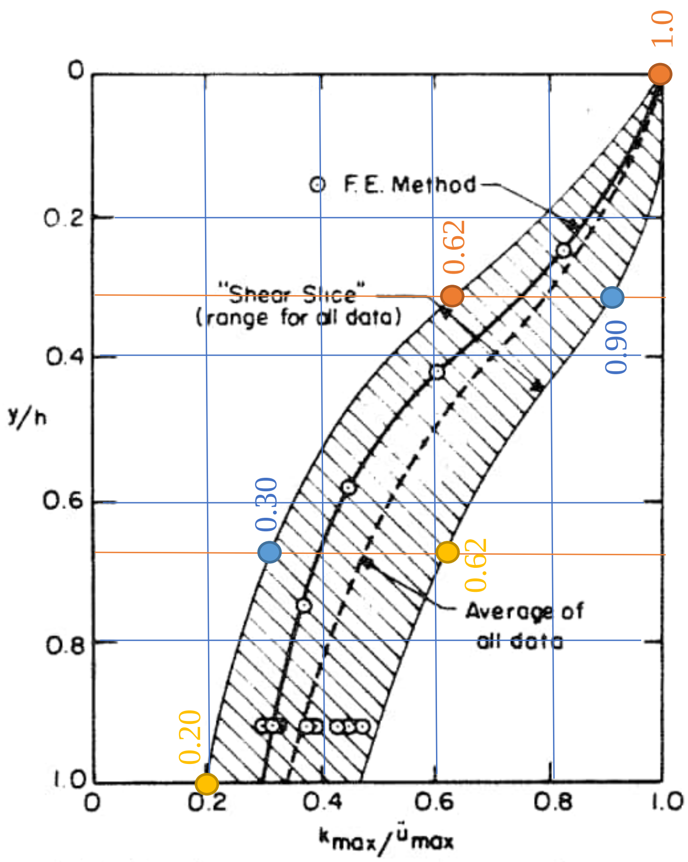
Fig. 2.6 : Response spectra at the crest of the dam

B9. GROUND MOTION INTENSITY VARIATION THROUGH THE EMBANKMENT

Ground motion intensity will increase up the embankment. Different slide masses will experience varying ground motion intensities depending on what portion of the embankment is encompassed by the slide mass. The dynamic response of the embankment is complex with many modes resulting in different parts of the embankment being in and out of phase during an earthquake. Makidisi and Seed (1977) (Ref. 9) summarised work on the variation of the maximum acceleration ratio with depth of sliding mass from the top of embankments. The summary of the work is a range of ratios varying with depth of the sliding mass shown in Figure B14.

For the Storage 3 assessment, a simplified approach has been taken for the application of amplification. Factors have been selected based on which third of the embankment the toe of the slide mass extends too, as summarised in Table B14. For slide masses which are with the top one third of the embankment height the full crest response has been applied. Makdisi and Seed (1977) indicates 0.62 to 1.0 for comparison. For slide masses which encompass the full height of the embankment the ratio is taken as the inverse of the crest amplification ratio selected, so that a slide of the full embankment would be applied the response spectra equal to that at the base of embankment. The ratio ends up being between 0.28 to 0.67. Makdisi and Seed (1977) indicates 0.20 to 0.62 for comparison. For slide masses which extend from the crest to between one third to two thirds of the embankment height the average of the top third and the bottom third has been taken, which results in values between 0.64 to 0.84. Makdisi and Seed (1977) indicates 0.3 to 0.9 for comparison.

FIGURE B14: MAKDISI AND SEED (1977) MAXIMUM ACCELERATION RATIO WITH DEPTH OF SLIDING MASS SUMMARY FIGURE



VARIATION OF "MAXIMUM ACCELERATION RATIO" WITH DEPTH OF SLIDING MASS

TABLE B14: COMPARISON OF MAKDISI AND SEED (1977) MAXIMUM ACCELERATION RATIOS WITH DEPTH OF SLIDING MASS TO VALUES SELECTED FOR STORAGE 3 RL182 CO-SEISMIC DISPLACEMENT ASSESSMENT

y/h	Makidisi and Seed (1977) Range	Selected kmax_slide/kmax_crest for Storage 3 RL182 assessment				
		150 year R.P EQ.	Kerepehi Rupture	Kerepehi A.S.	10,000 year R.P EQ.	10,000 year R.P A.S.
0 to 0.33	0.62 to 1.0	1	1	1	1	1
0.33 to 0.67	0.30 to 0.90	(1+0.28)/2 = 0.64	(1+0.50)/2 = 0.75	(1+0.37)/2 = 0.69	(1+0.67)/2 = 0.84	(1+0.50)/2 = 0.75
0.67 to 1.0	0.20 to 0.62	1/3.6 = 0.28	1/2.0 = 0.50	1/2.7 = 0.37	1/1.5 = 0.67	1/2.0 = 0.50

B10. CO-SEISMIC DEVIATORIC DEFORMATIONS

Co-seismic deviatoric (shear) deformation of slide masses within the embankment are estimated using the method of Bray and Macedo (2019) “Procedure for Estimating Shear-Induced Seismic Slope Displacement for Shallow Crustal Earthquake”. The method is based on a fully coupled 1-dimension idealisation of slide mass response with displacement accumulated on the slide surface when the felt horizontal acceleration exceeds the pseudo-static yield acceleration of the slide mass. Application of this method for Storage 3 RL155 requires assessment of the slide mass, slide mass pseudo-static yield acceleration, and the slide mass fundamental period of resonance. The slide mass pseudo-static yield acceleration requires judgement regarding what is a realistic slide surface as pseudo-static limit equilibrium methods do not consider the complex dynamics of the system. The analysed yield surfaces are include in Appendix B in Figures B09a, B10, B11, B20, B21, B22, B31, B32, B33, B42, B43, B44, US12, US13, US14, US15. The parameter assessed and estimated co-seismic displacements are summarised in Table B15.

Estimation of the period of the slide mass depends on the geometry of the mass. For circular slide masses a relationship of 2.6H/Vs is applied, where H is the overall height of the slide mass and Vs is the average shearwave velocity in the slide mass.

TABLE B15: ESTIMATED CO-SEISMIC SLOPE DEFORMATION CALCULATION INPUTS SECTION 1 AND 2

									OBE					SEE CME Earthquake - Mw=7.3				SEE CME Aftershock - Mw=6.3				SEE 1 in 10,000 year Earthquake					SEE 1 in 10,000 year Earthquake Aftershock – Mw=6.3			
Section	Scenario Direction/ Profile		Slip Surface	Total Height of Slip Surface (m)	Slide mass velocity V_s (m/s)	T_s (s)	$1.3T_s$ (s)	k_y (g)	Sa ($1.3T_s$) (g)	Amp. Ratio	Amp. Sa(1.3Ts)	Mean Mw	Permanent Def. (cm)	Sa ($1.3T_s$)	Amp. Ratio	Amp. Sa(1.3Ts)	Permanent Def. (cm)	Sa ($1.3T_s$)	Amp. Ratio	Amp. Sa(1.3Ts)	Permanent Def.(cm)	Sa ($1.3T_s$)	Amp. Ratio	Amp. Sa(1.3Ts)	Mean Mw	Permanent Def.(cm)	Sa ($1.3T_s$)	Amp. Ratio	Amp. Sa(1.3Ts)	Permanent Def.(cm)
1	DS	Oper.	Top 1/3rd emb.	10	303	0.09	0.11	0.55	0.23	3.6	0.81	6.4	<0.5	0.57	2.0	1.14	<0.5 to 2.2	0.36	2.70	0.97	<0.5 to 0.5	1.06	1.50	1.59	7.3	<0.5 to 7.1	0.75	2.00	1.50	<0.5 to 3.3
1	DS	Oper.	Top 2/3rds emb.	31	383	0.21	0.27	0.45	0.22	2.3	0.50	6.4	<0.5	0.59	1.5	0.89	<0.5 to 2.5	0.37	1.85	0.69	<0.5 to 0.4	0.87	1.25	1.09	7.3	<0.5 to 5.1	0.53	1.5	0.79	<0.5 to 0.8
1	DS	Oper.	Full emb.	46	514	0.23	0.30	0.12	0.20	1	0.20	6.4	<0.5 to 0.6	0.55	1	0.55	3.9 to 16.6	0.35	1.00	0.35	0.4 to 3.3	0.80	1.00	0.80	7.3	8.4 to 35.2	0.47	1.00	0.47	1.5 to 6.5
2	DS	Oper.	Top 1/3rd emb.	10	303	0.09	0.11	0.54	0.23	3.6	0.81	6.4	<0.5	0.57	2.0	1.14	<0.5 to 2.4	0.36	2.70	0.97	<0.5 to 0.6	1.06	1.50	1.59	7.3	<0.5 to 7.5	0.75	2.00	1.50	<0.5 to 3.4
2	DS	Oper.	Top 2/3rds emb.	31	383	0.21	0.27	0.46	0.22	2.3	0.50	6.4	<0.5	0.59	1.5	0.89	<0.5 to 2.3	0.37	1.85	0.69	<0.5 to 0.3	0.87	1.25	1.09	7.3	<0.5 to 4.8	0.53	1.50	0.79	<0.5 to 0.7
2	DS	Oper.	Full emb.	45	514	0.23	0.30	0.09	0.20	1	0.20	6.4	<0.5 to 1.5	0.55	1	0.55	6.3 to 26.3	0.35	1.00	0.35	1.3 to 5.8	0.80	1.00	0.80	7.3	12.8 to 53.5	0.47	1.00	0.47	2.5 to 10.6

B11. REFERENCES

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Tails Fresh	SHANSEP	16						0		0.04	1		No
	Udrnd PG Fill	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)	0				1		No
	Udrnd Rhy. CW	SHANSEP	17						0	Ash/CW Rhy Surface		2	0.1	Yes
	Udrnd Rhy. Hw/Mw	Mohr-Coulomb	17.5		5	35		0				2	0.1	Yes
	Udrnd Rhy. Sen. Tuff.	SHANSEP	16.5						0		0.21	2	0.1	Yes
	Udrnd Rhy. Weak	Shear/Normal Fn.	18.5				Weak Rhyolite	0				2	0.1	Yes
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2	0.3	Yes
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2	0.1	Yes
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5		21	21		0				1		No
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5		10	18		0					0.5	Yes
	Udrnd Zone C1	Mohr-Coulomb	20.5		21	21		0				2	0.3	Yes
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)	0				2	0.05	Yes
	Udrnd Zone D2	Mohr-Coulomb	19.5		5	35		0				2	0.1	Yes
	Udrnd Zone D3	Mohr-Coulomb	19		10	18		0				2	0.4	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2		No

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.167

Factor of Safety
2.167 - 2.267
2.267 - 2.367
≥ 2.367

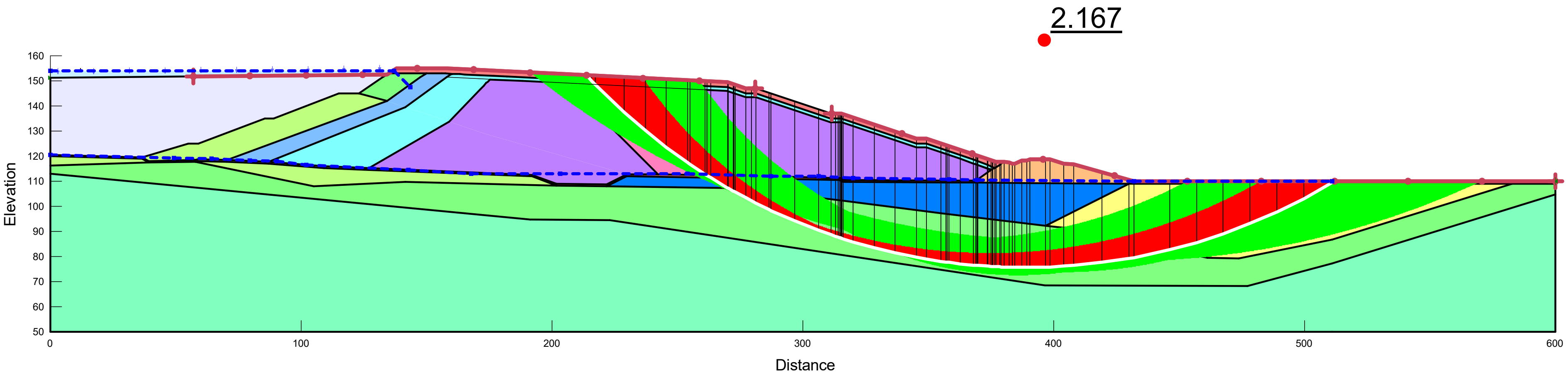

Figure B01-Static-Oper-Peak-Udrnd-Fdn

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TSF3 RL 155 - Section 1

Date: 13/02/2025
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Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 1.856

Factor of Safety
1.856 - 1.956
1.956 - 2.056
≥ 2.056

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)										1		No
	Tails Fresh	SHANSEP	16						0		0.04	1		No
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2	0.3	Yes
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2	0.3	Yes
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5			21	21	0				1		No
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5			10	18	0					0.5	Yes
	Udrnd Zone C1	Mohr-Coulomb	20.5			21	21	0				2	0.3	Yes
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0				2	0.05	Yes
	Udrnd Zone D2	Mohr-Coulomb	19.5			5	35	0				2	0.1	Yes
	Udrnd Zone D3	Mohr-Coulomb	19			10	18	0				2	0.4	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2		No

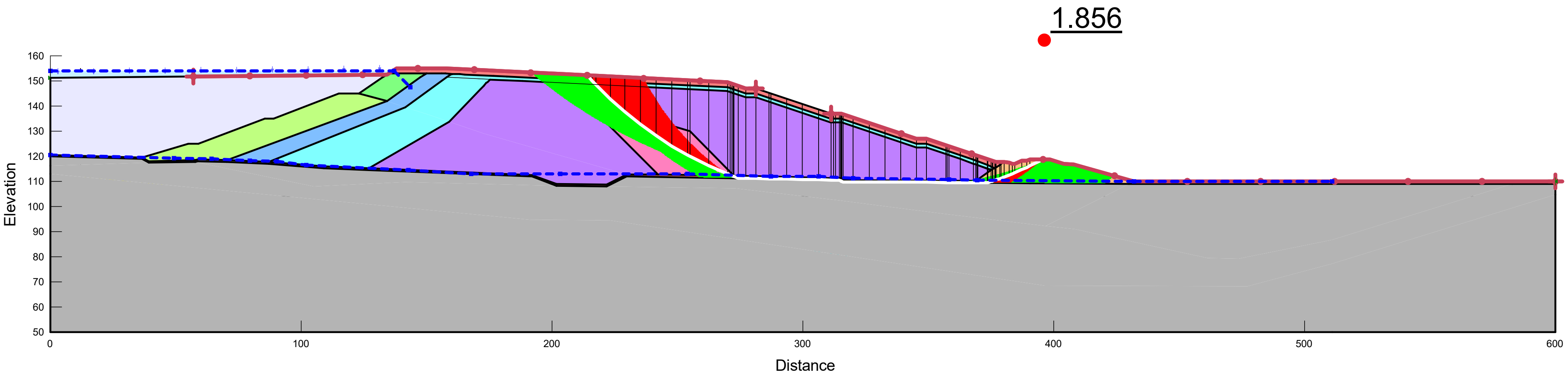

Figure B02-Static-Oper-Peak-Udrnd-ZneA

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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Tails Fresh	SHANSEP	16						0		0.04	1		No
	Udrnd PG Fill	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)	0				1		No
	Udrnd Rhy. CW	SHANSEP	17						0	Ash/CW Rhy Surface		2	0.1	Yes
	Udrnd Rhy. Hw/Mw	Mohr-Coulomb	17.5		5	35		0				2		No
	Udrnd Rhy. Sen. Tuff.	SHANSEP	16.5						0		0.21	2	0.1	Yes
	Udrnd Rhy. Weak	Shear/Normal Fn.	18.5				Weak Rhyolite	0				2		No
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2	0.3	Yes
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2	0.3	Yes
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5		21	21		0				1		No
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5		10	18		0					0.5	Yes
	Udrnd Zone C1	Mohr-Coulomb	20.5		21	21		0				2	0.1	Yes
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)	0				2	0.05	Yes
	Udrnd Zone D2	Mohr-Coulomb	19.5		5	35		0				2	0.1	Yes
	Udrnd Zone D3	Mohr-Coulomb	19		10	18		0				2	0.4	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2		No

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.746

Factor of Safety
2.746 - 2.846
2.846 - 2.946
≥ 2.946

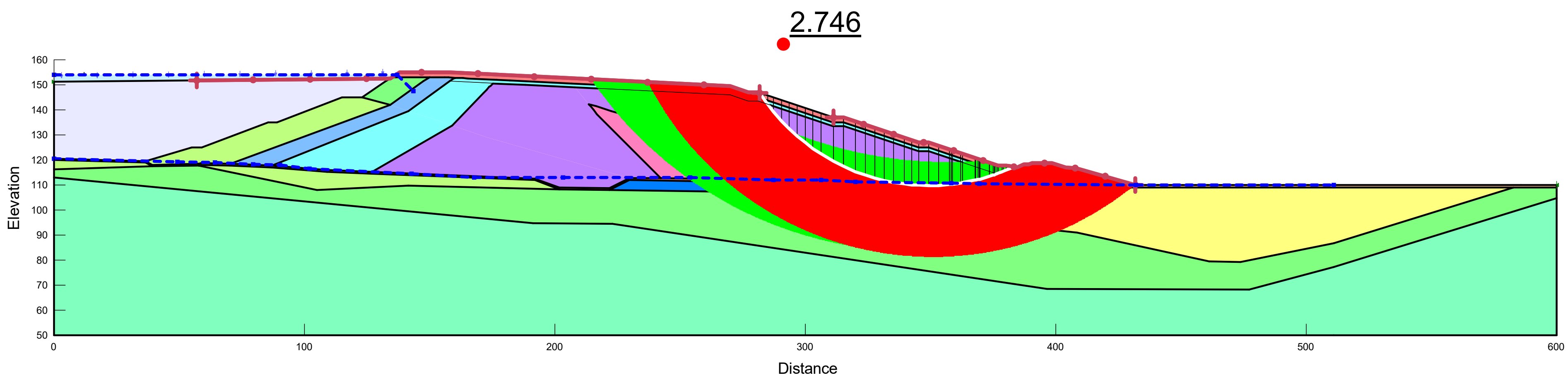

Figure B03-Static-Oper-Peak-Udrnd-Emb

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Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.279

Factor of Safety
2.279 - 2.379
2.379 - 2.479
≥ 2.479

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd PG Fill	Shear/Normal Fn.	20.5					Gravels/Cobbles Dr=0.85 (16%ile)	0	1		No
	Drnd Rhy. CW	Mohr-Coulomb	17			0	26		0	2	0.1	Yes
	Drnd Rhy. HW/MW	Mohr-Coulomb	17.5			5	35		0	2	0.1	Yes
	Drnd Rhy. Sens. Tuff	Mohr-Coulomb	16.5			0	37		0	2	0.1	Yes
	Drnd Rhy. Weak	Shear/Normal Fn.	18.5					Weak Rhyolite	0	2	0.1	Yes
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5			3	31		0	2	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5			5	35		0	2	0.1	Yes
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5			5	35		0	1		No
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5			3	31		0		0.5	Yes
	Drnd Zone C1	Mohr-Coulomb	20.5			21	21		0	2	0.3	Yes
	Drnd Zone C2/F	Shear/Normal Fn.	20.5					Gravels/Cobbles Dr=0.85 (16%ile)	0	2	0.05	Yes
	Drnd Zone D2	Mohr-Coulomb	19.5			5	35		0	2	0.1	Yes
	Drnd Zone D3	Mohr-Coulomb	19			10	18		0	2	0.4	Yes
	Drnd Zone G	Mohr-Coulomb	20.5			3	31		0	2		No
	Tails Fresh	SHANSEP	16	0	0.04					1		No

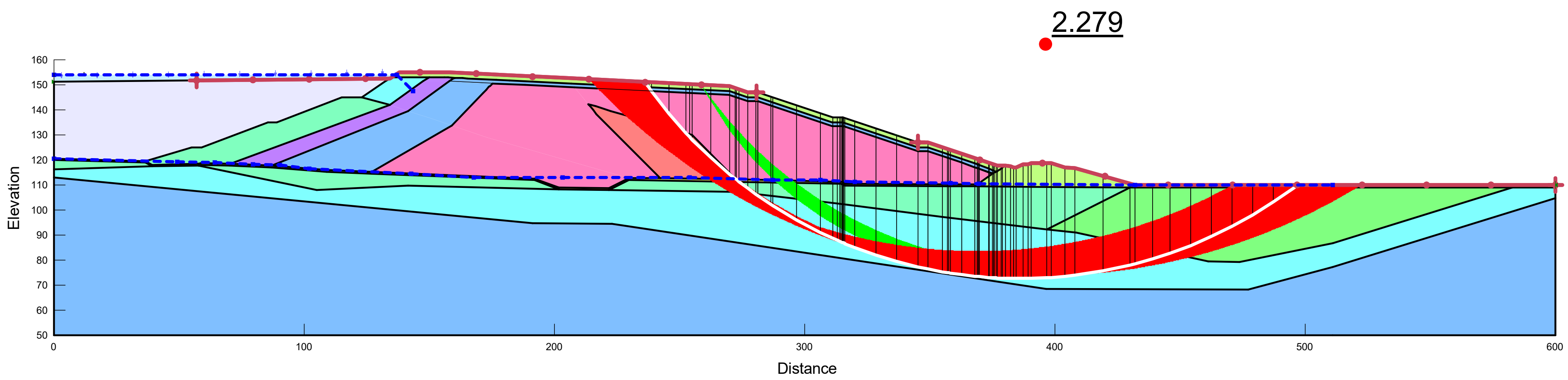

Figure B04-Static-Oper-Peak-Drnd-Fdn

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Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.397

Factor of Safety
- 2.397 - 2.497
- 2.497 - 2.597
- ≥ 2.597

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5				3	31	0	2	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5				5	35	0	2	0.3	Yes
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5				5	35	0	1		No
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5				3	31	0		0.5	Yes
	Drnd Zone C1	Mohr-Coulomb	20.5				21	21	0	2	0.3	Yes
	Drnd Zone C2/F	Shear/Normal Fn.	20.5			Gravels/Cobbles Dr=0.85 (16%ile)			0	2	0.05	Yes
	Drnd Zone D2	Mohr-Coulomb	19.5				5	35	0	2	0.1	Yes
	Drnd Zone D3	Mohr-Coulomb	19				10	18	0	2	0.4	Yes
	Drnd Zone G	Mohr-Coulomb	20.5				3	31	0	2		No
	Impenetrable	Bedrock (Impenetrable)								1		No
	Tails Fresh	SHANSEP	16	0	0.04					1		No

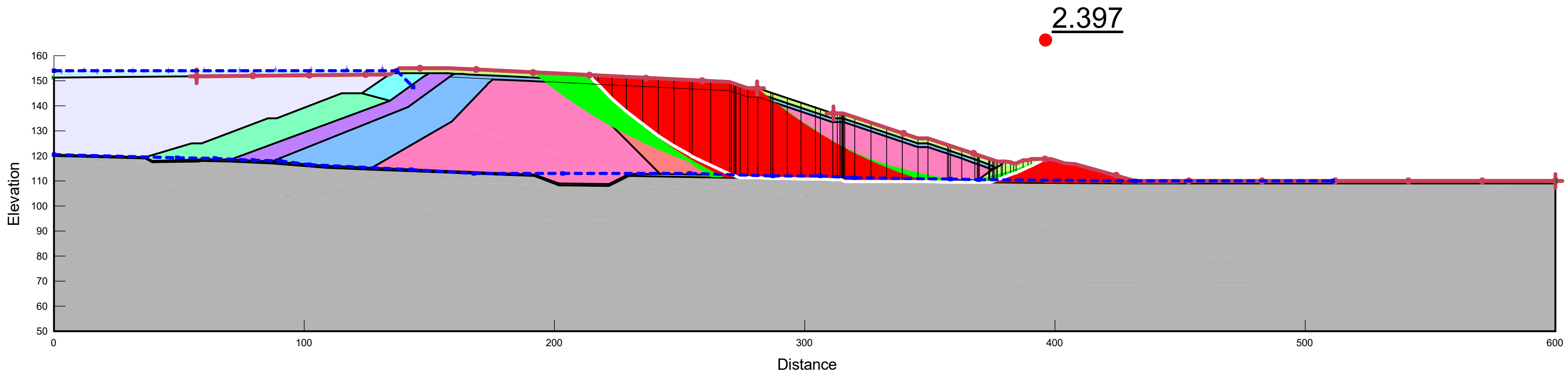

Figure B05-Static-Oper-Peak-Drnd-ZneA

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Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.686

Factor of Safety
- 2.686 - 2.786
- 2.786 - 2.886
- ≥ 2.886

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd PG Fill	Shear/Normal Fn.	20.5					Gravels/Cobbles Dr=0.85 (16%ile)	0	1		No
	Drnd Rhy. CW	Mohr-Coulomb	17			0	26		0	2	0.1	Yes
	Drnd Rhy. HW/MW	Mohr-Coulomb	17.5			5	35		0	2		No
	Drnd Rhy. Sens. Tuff	Mohr-Coulomb	16.5			0	37		0	2	0.1	Yes
	Drnd Rhy. Weak	Shear/Normal Fn.	18.5					Weak Rhyolite	0	2		No
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5			3	31		0	2	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5			5	35		0	2	0.3	Yes
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5			5	35		0	1		No
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5			3	31		0		0.5	Yes
	Drnd Zone C1	Mohr-Coulomb	20.5			21	21		0	2	0.1	Yes
	Drnd Zone C2/F	Shear/Normal Fn.	20.5					Gravels/Cobbles Dr=0.85 (16%ile)	0	2	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5			3	31		0	2		No
	Tails Fresh	SHANSEP	16	0	0.04					1		No
	Udrnd Zone D2	Mohr-Coulomb	19.5			5	35		0	2	0.1	Yes
	Udrnd Zone D3	Mohr-Coulomb	19			10	18		0	2	0.4	Yes

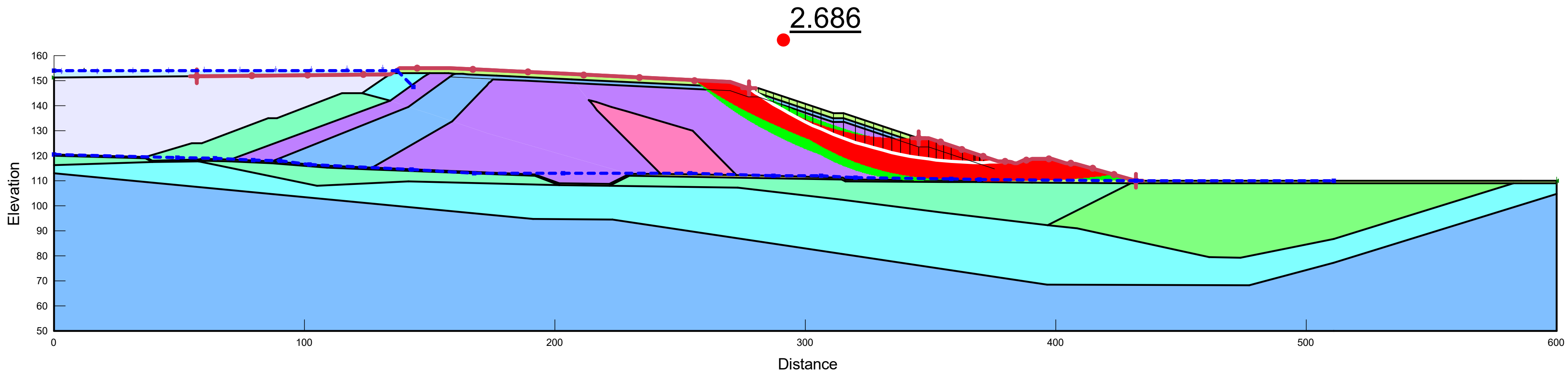

Figure B06-Static-Oper-Peak-Drnd-Emb

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Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.309

Factor of Safety
2.309 - 2.409
2.409 - 2.509
≥ 2.509

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line
	Tails Fresh	SHANSEP	16						0		0.04	1
	Udrnd PG Fill	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)	0				1
	Udrnd Rhy. CW	SHANSEP	17						0	Ash/CW Rhy Surface		2
	Udrnd Rhy. Hw/Mw	Mohr-Coulomb	17.5		5	35		0				2
	Udrnd Rhy. Sen. Tuff.	SHANSEP	16.5						0		0.21	2
	Udrnd Rhy. Weak	Shear/Normal Fn.	18.5				Weak Rhyolite	0				2
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5		21	21		0				1
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5		10	18		0				
	Udrnd Zone C1	Mohr-Coulomb	20.5		21	21		0				2
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)	0				2
	Udrnd Zone D2	Mohr-Coulomb	19.5		5	35		0				2
	Udrnd Zone D3	Mohr-Coulomb	19		10	18		0				2
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2

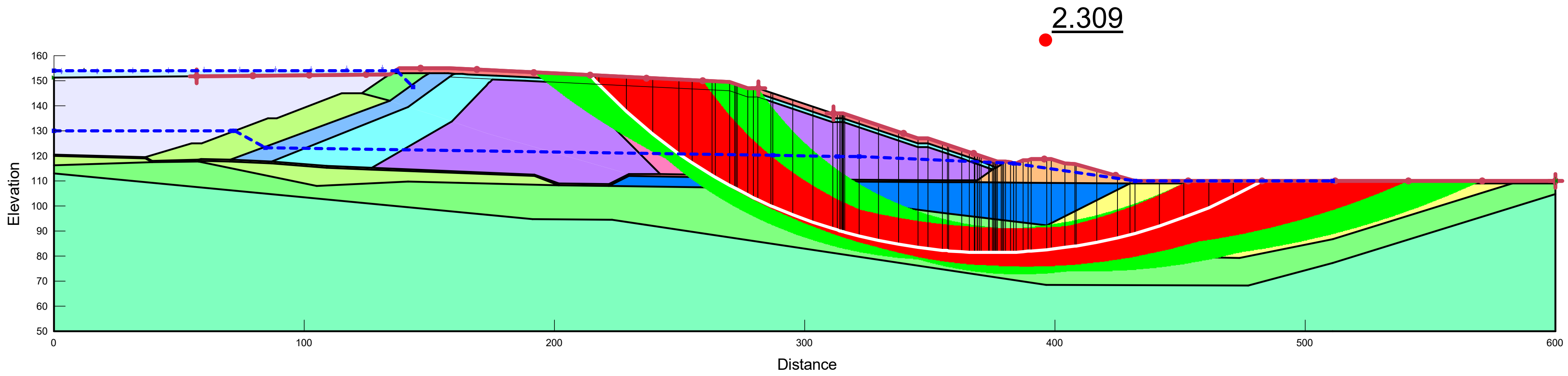

Figure B07-Static-Close-Peak-Udrnd-Fdn

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.121

Factor of Safety
- 2.121 - 2.221
- 2.221 - 2.321
- ≥ 2.321

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line
	Impenetrable	Bedrock (Impenetrable)										1
	Tails Fresh	SHANSEP	16						0		0.04	1
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5			21	21	0				1
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5			10	18	0				
	Udrnd Zone C1	Mohr-Coulomb	20.5			21	21	0				2
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0				2
	Udrnd Zone D2	Mohr-Coulomb	19.5			5	35	0				2
	Udrnd Zone D3	Mohr-Coulomb	19			10	18	0				2
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2

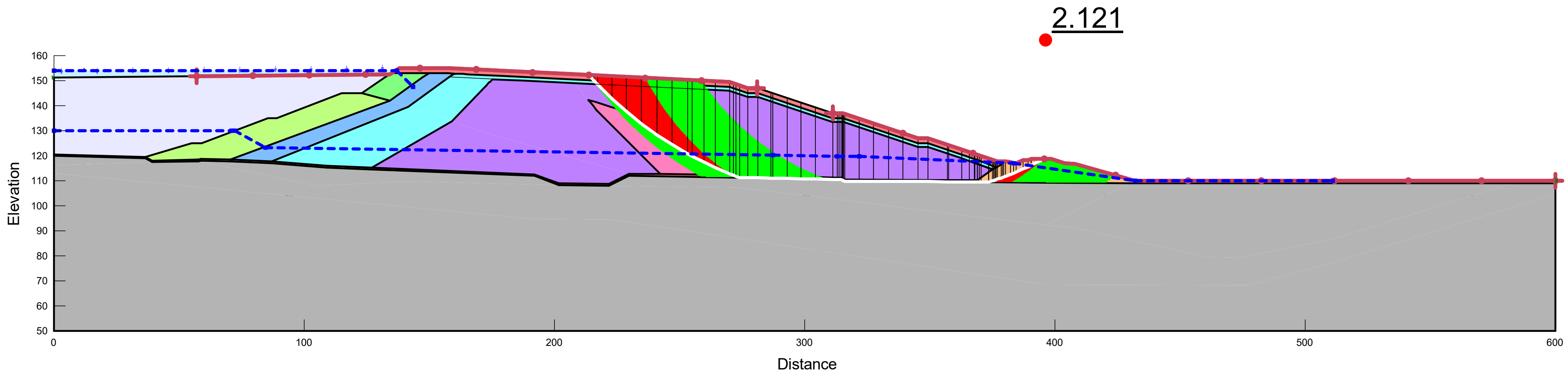

Figure B08-Static-Close-Peak-Udrnd-ZneA

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.516

Factor of Safety
- 2.516 - 2.616
- 2.616 - 2.716
- ≥ 2.716

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line
	Tails Fresh	SHANSEP	16						0		0.04	1
	Udrnd PG Fill	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)	0				1
	Udrnd Rhy. CW	SHANSEP	17						0	Ash/CW Rhy Surface		2
	Udrnd Rhy. Hw/Mw	Mohr-Coulomb	17.5		5	35		0				2
	Udrnd Rhy. Sen. Tuff.	SHANSEP	16.5						0		0.21	2
	Udrnd Rhy. Weak	Shear/Normal Fn.	18.5				Weak Rhyolite	0				2
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5		21	21		0				1
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5		10	18		0				
	Udrnd Zone C1	Mohr-Coulomb	20.5		21	21		0				2
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)	0				2
	Udrnd Zone D2	Mohr-Coulomb	19.5		5	35		0				2
	Udrnd Zone D3	Mohr-Coulomb	19		10	18		0				2
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2

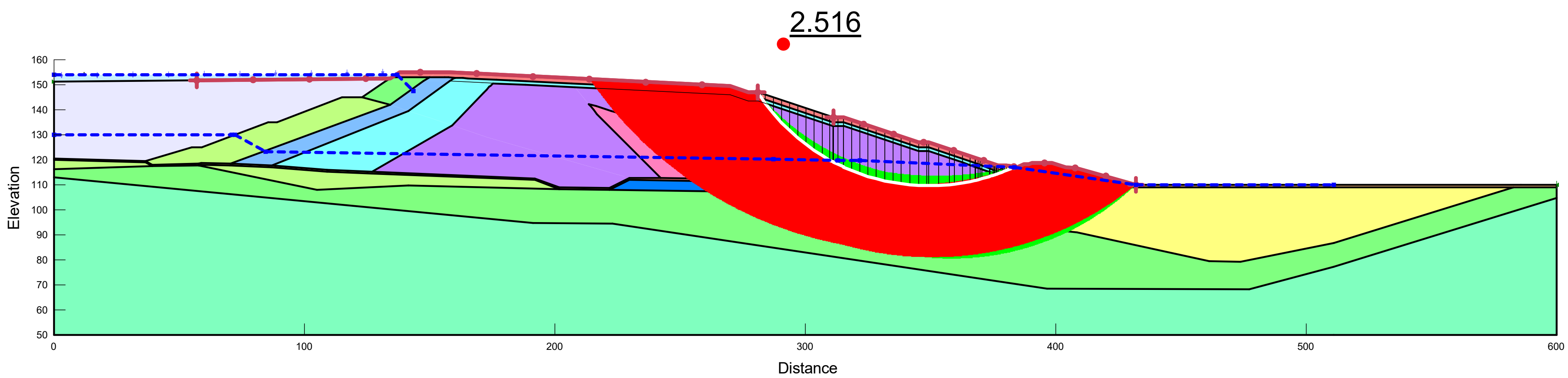

Figure B09-Static-Close-Peak-Udrnd-Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.449

Factor of Safety
2.449 - 2.549
2.549 - 2.649
≥ 2.649

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Phi-B (°)	Piezometric Line
	Drnd PG Fill	Shear/Normal Fn.	20.5					Gravels/Cobbles Dr=0.85 (16%ile)	0	1
	Drnd Rhy. CW	Mohr-Coulomb	17			0	26		0	2
	Drnd Rhy. HW/MW	Mohr-Coulomb	17.5			5	35		0	2
	Drnd Rhy. Sens. Tuff	Mohr-Coulomb	16.5			0	37		0	2
	Drnd Rhy. Weak	Shear/Normal Fn.	18.5					Weak Rhyolite	0	2
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5			3	31		0	2
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5			5	35		0	2
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5			5	35		0	1
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5			3	31		0	
	Drnd Zone C1	Mohr-Coulomb	20.5			21	21		0	2
	Drnd Zone C2/F	Shear/Normal Fn.	20.5					Gravels/Cobbles Dr=0.85 (16%ile)	0	2
	Drnd Zone D2	Mohr-Coulomb	19.5			5	35		0	2
	Drnd Zone D3	Mohr-Coulomb	19			10	18		0	2
	Drnd Zone G	Mohr-Coulomb	20.5			3	31		0	2
	Tails Fresh	SHANSEP	16	0	0.04					1

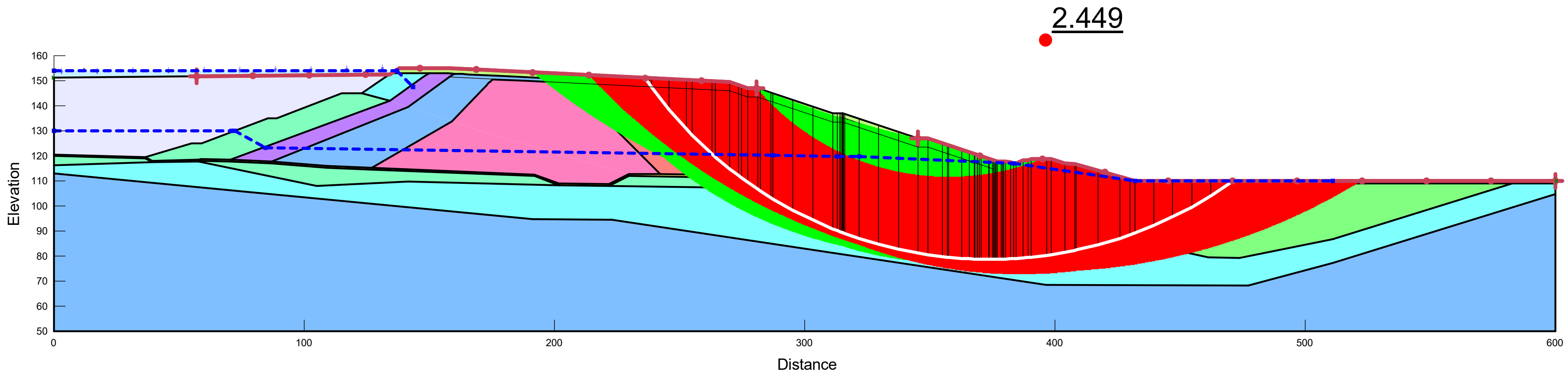

Figure B10-Static-Close-Peak-Drnd-Fdn

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.417

Factor of Safety
- 2.417 - 2.517
- 2.517 - 2.617
- ≥ 2.617

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5				3	31	0	2
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5				5	35	0	2
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5				5	35	0	1
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5				3	31	0	
	Drnd Zone C1	Mohr-Coulomb	20.5				21	21	0	2
	Drnd Zone C2/F	Shear/Normal Fn.	20.5			Gravels/Cobbles Dr=0.85 (16%ile)			0	2
	Drnd Zone D2	Mohr-Coulomb	19.5				5	35	0	2
	Drnd Zone D3	Mohr-Coulomb	19				10	18	0	2
	Drnd Zone G	Mohr-Coulomb	20.5				3	31	0	2
	Impenetrable	Bedrock (Impenetrable)								1
	Tails Fresh	SHANSEP	16	0	0.04					1

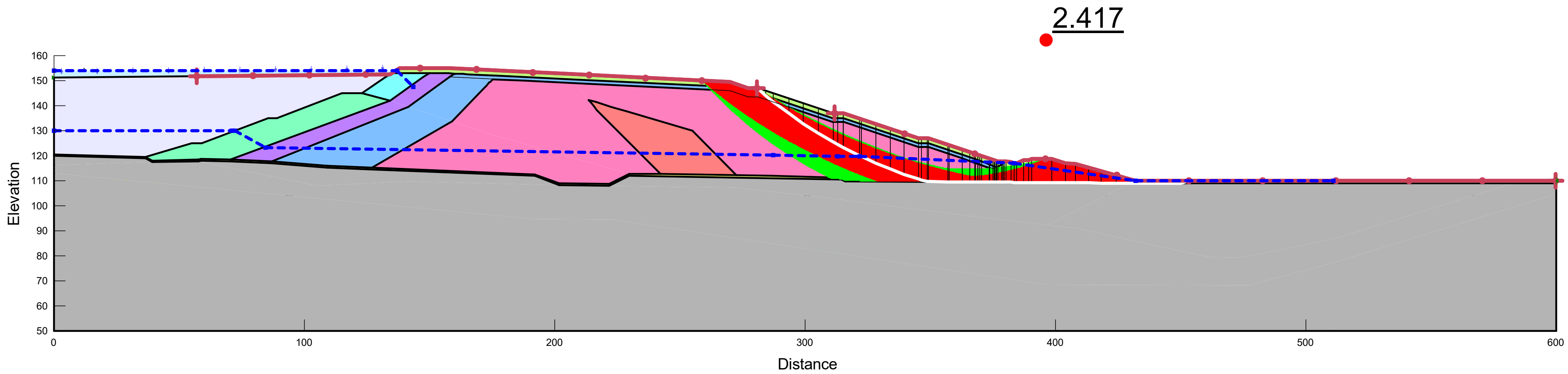

Figure B11-Static-Close-Peak-Drnd-ZneA

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.482

Factor of Safety
2.482 - 2.582
2.582 - 2.682
≥ 2.682

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Phi-B (°)	Piezometric Line
	Drnd PG Fill	Shear/Normal Fn.	20.5					Gravels/Cobbles Dr=0.85 (16%ile)	0	1
	Drnd Rhy. CW	Mohr-Coulomb	17			0	26		0	2
	Drnd Rhy. HW/MW	Mohr-Coulomb	17.5			5	35		0	2
	Drnd Rhy. Sens. Tuff	Mohr-Coulomb	16.5			0	37		0	2
	Drnd Rhy. Weak	Shear/Normal Fn.	18.5					Weak Rhyolite	0	2
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5			3	31		0	2
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5			5	35		0	2
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5			5	35		0	1
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5			3	31		0	
	Drnd Zone C1	Mohr-Coulomb	20.5			21	21		0	2
	Drnd Zone C2/F	Shear/Normal Fn.	20.5					Gravels/Cobbles Dr=0.85 (16%ile)	0	2
	Drnd Zone G	Mohr-Coulomb	20.5			3	31		0	2
	Tails Fresh	SHANSEP	16	0	0.04					1
	Udrnd Zone D2	Mohr-Coulomb	19.5			5	35		0	2
	Udrnd Zone D3	Mohr-Coulomb	19			10	18		0	2

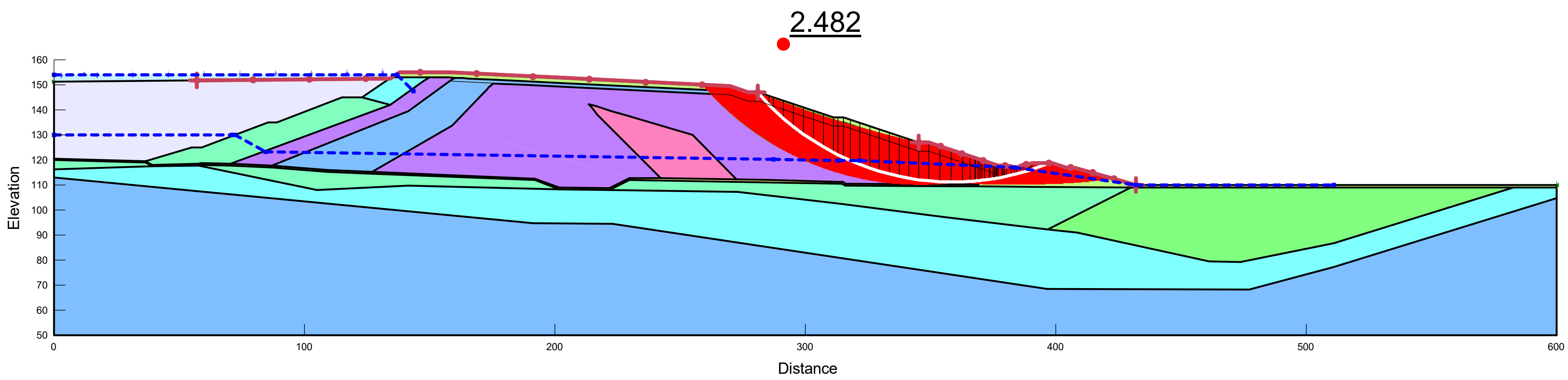

Figure B12-Static-Close-Peak-Drnd-Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.107

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ PG Fill	Shear/Normal Fn.	20.5						Gravels/Cobbles Dr=0.85 (16%ile)	0	1		No
	PSTEQ Rhy. CW	SHANSEP	17				0	0.23			2	0.1	Yes
	PSTEQ Rhy. Hw/Mw	Mohr-Coulomb	17.5		5	35				0	2	0.1	Yes
	PSTEQ Rhy. Sen. Tuff. 0.06	SHANSEP	16.5				0	0.06			2	0.1	Yes
	PSTEQ Rhy. Weak	Shear/Normal Fn.	18.5						Weak Rhyolite	0	2	0.1	Yes
	PSTEQ Zone A/I Found UC	SHANSEP	17.5				50	0.38			2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5				120	0.32			2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5		17	17				0	1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5		8	15				0		0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5		17	17				0	2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5						Gravels/Cobbles Dr=0.85 (16%ile)	0	2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5		5	35				0	2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19		8	15				0	2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16				0	0.04			1		No

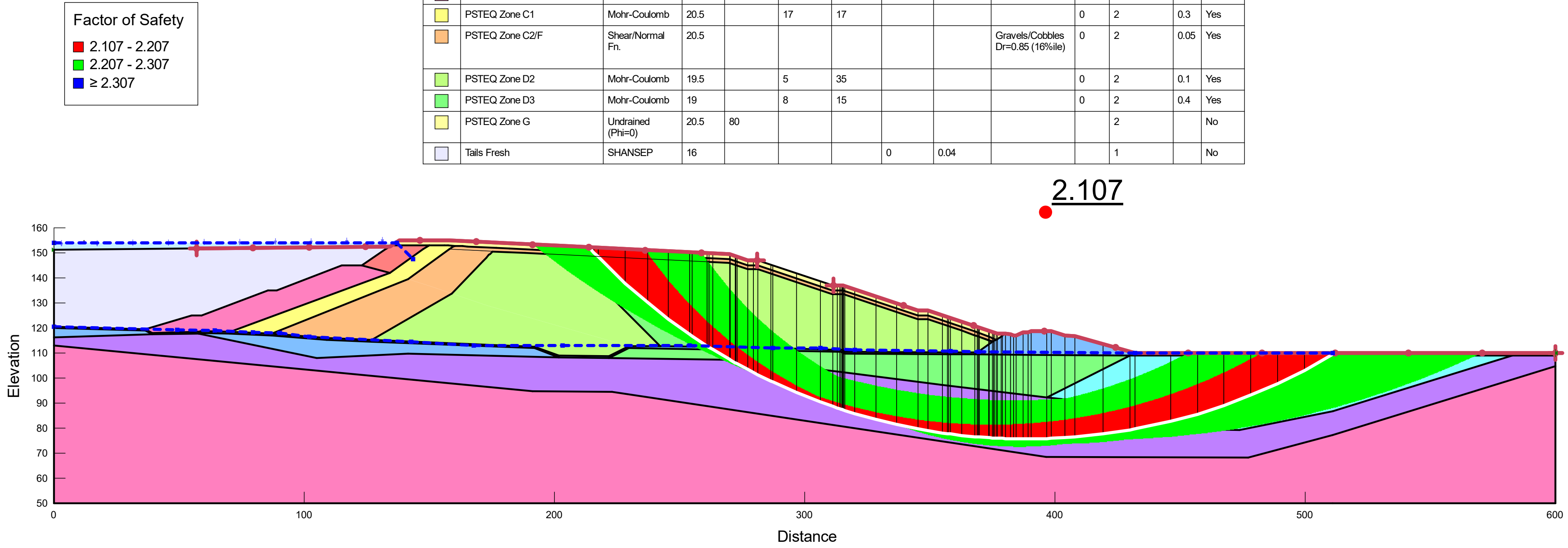

Figure B13-PstEq-Oper-PstEqUdrnd-Fdn

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 1.630

Factor of Safety
- 1.630 - 1.730
- 1.730 - 1.830
- ≥ 1.830

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)									1		No
	PSTEQ Zone A/I Found UC	SHANSEP	17.5						50	0.38	2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5						120	0.32	2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5			17	17	0			1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5			8	15	0				0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5			17	17	0			2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0			2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5			5	35	0			2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19			8	15	0			2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16						0	0.04	1		No

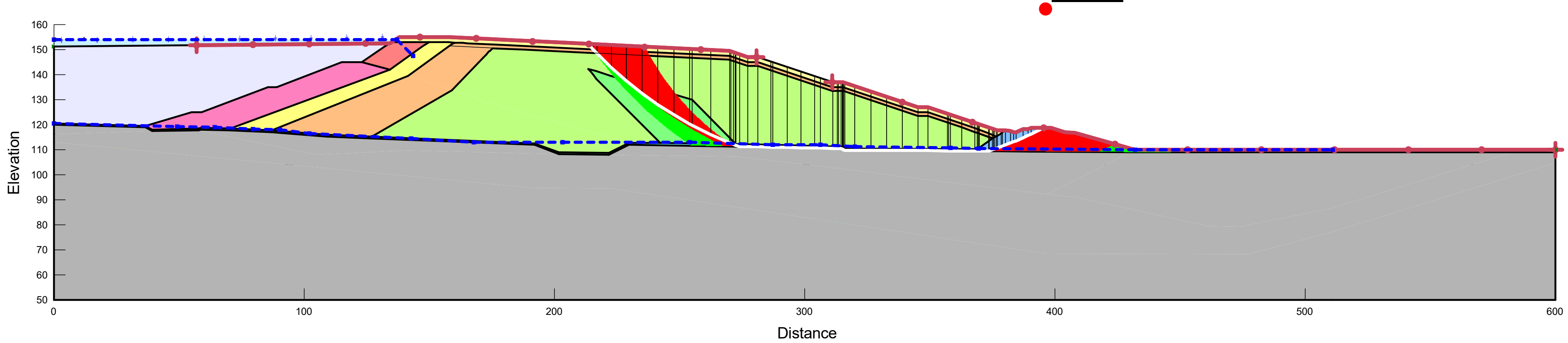

Figure B14-PstEq-Oper-PstEqUdrnd-ZneA

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.383

Factor of Safety
- 2.383 - 2.483
- 2.483 - 2.583
- ≥ 2.583

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ PG Fill	Shear/Normal Fn.	20.5						Gravels/Cobbles Dr=0.85 (16%ile)	0	1		No
	PSTEQ Rhy. CW	SHANSEP	17				0	0.23			2	0.1	Yes
	PSTEQ Rhy. Hw/Mw	Mohr-Coulomb	17.5		5	35				0	2	0.1	Yes
	PSTEQ Rhy. Sen. Tuff. 0.06	SHANSEP	16.5				0	0.06			2	0.1	Yes
	PSTEQ Rhy. Weak	Shear/Normal Fn.	18.5						Weak Rhyolite	0	2	0.1	Yes
	PSTEQ Zone A/I Found UC	SHANSEP	17.5				50	0.38			2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5				120	0.32			2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5		17	17				0	1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5		8	15				0		0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5		17	17				0	2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5						Gravels/Cobbles Dr=0.85 (16%ile)	0	2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5		5	35				0	2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19		8	15				0	2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16				0	0.04			1		No

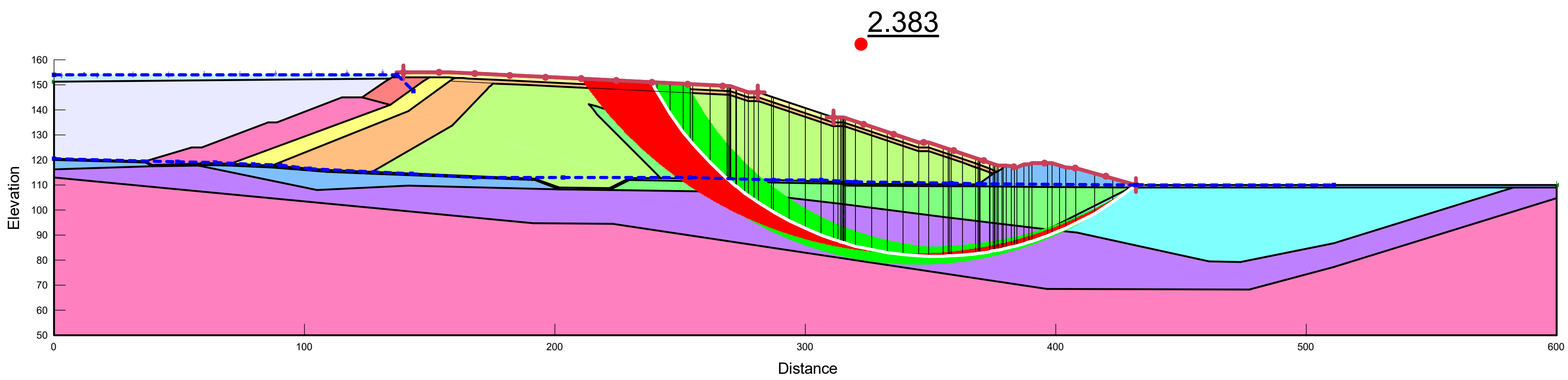

Figure B15-PstEq-Oper-PstEqUdrnd-Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0.55

Factor of Safety: 1.012

Factor of Safety
1.012 - 1.112
1.112 - 1.212
≥ 1.212

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Rhy. CW	Mohr-Coulomb	17					0	26	0	2	0.1	Yes
	PSTEQ PG Fill	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)			0	1		No
	PSTEQ Rhy. Hw/Mw	Mohr-Coulomb	17.5					5	35	0	2	0.1	Yes
	PSTEQ Rhy. Sen. Tuff. 0.15	SHANSEP	16.5		0	0.15					2	0.1	Yes
	PSTEQ Rhy. Weak	Shear/Normal Fn.	18.5				Weak Rhyolite			0	2	0.1	Yes
	PSTEQ Zone A/I Found UC	SHANSEP	17.5		50	0.38					2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5		120	0.32					2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5					17	17	0	1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5					8	15	0		0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5					17	17	0	2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)			0	2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5					5	35	0	2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19					8	15	0	2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16		0	0.04					1		No

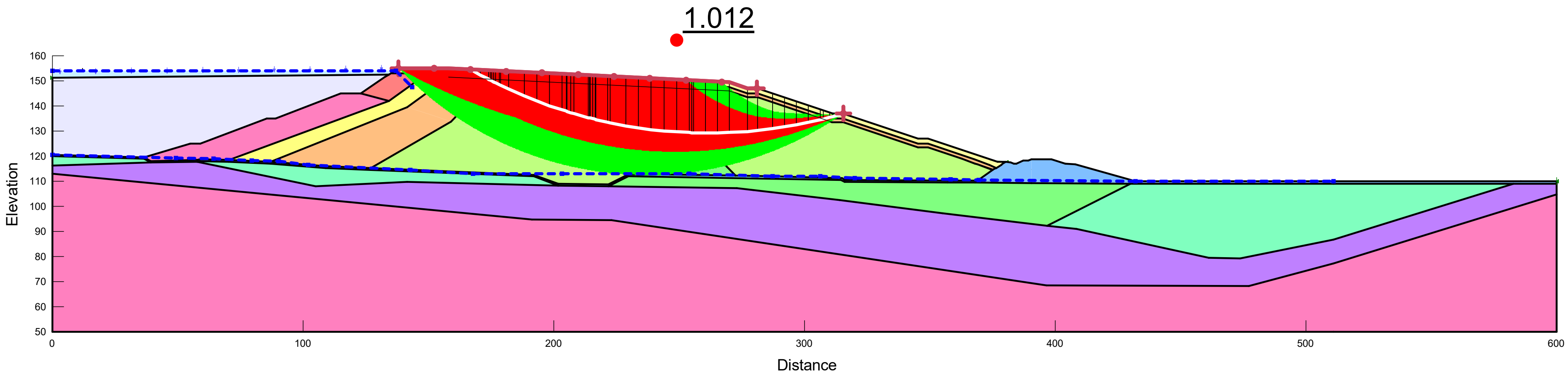

Figure B16-Eq-Oper-EqUdrnd-1/3Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0.45

Factor of Safety: 1.013

Factor of Safety
1.013 - 1.113
1.113 - 1.213
≥ 1.213

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Rhy. CW	Mohr-Coulomb	17					0	26	0	2	0.1	Yes
	PSTEQ PG Fill	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)			0	1		No
	PSTEQ Rhy. Hw/Mw	Mohr-Coulomb	17.5					5	35	0	2	0.1	Yes
	PSTEQ Rhy. Sen. Tuff. 0.15	SHANSEP	16.5		0	0.15					2	0.1	Yes
	PSTEQ Rhy. Weak	Shear/Normal Fn.	18.5				Weak Rhyolite			0	2	0.1	Yes
	PSTEQ Zone A/I Found UC	SHANSEP	17.5		50	0.38					2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5		120	0.32					2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5					17	17	0	1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5					8	15	0		0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5					17	17	0	2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5				Gravels/Cobbles Dr=0.85 (16%ile)			0	2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5					5	35	0	2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19					8	15	0	2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16		0	0.04					1		No

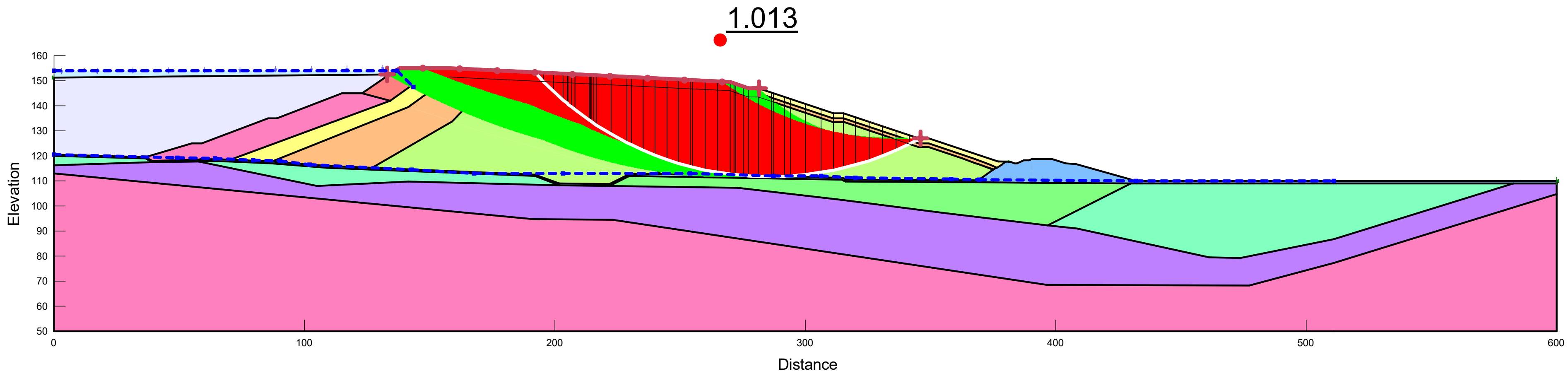

Figure B17-Eq-Oper-EqUdrnd-2/3Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0.12

Factor of Safety: 1.022

Factor of Safety
- 1.022 - 1.122
- 1.122 - 1.222
- ≥ 1.222

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)									1		No
	PSTEQ Zone A/I Found UC	SHANSEP	17.5						50	0.38	2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5						120	0.32	2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5			17	17	0			1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5			8	15	0				0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5			17	17	0			2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0			2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5			5	35	0			2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19			8	15	0			2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16						0	0.04	1		No

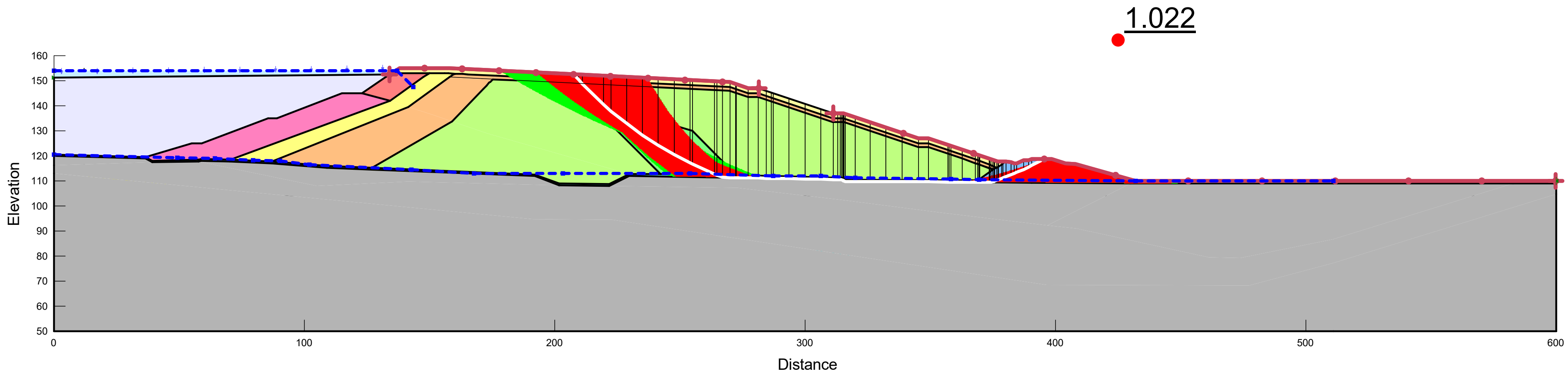

Figure B18-Eq-Oper-EqUdrnd-ZneA

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 1

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

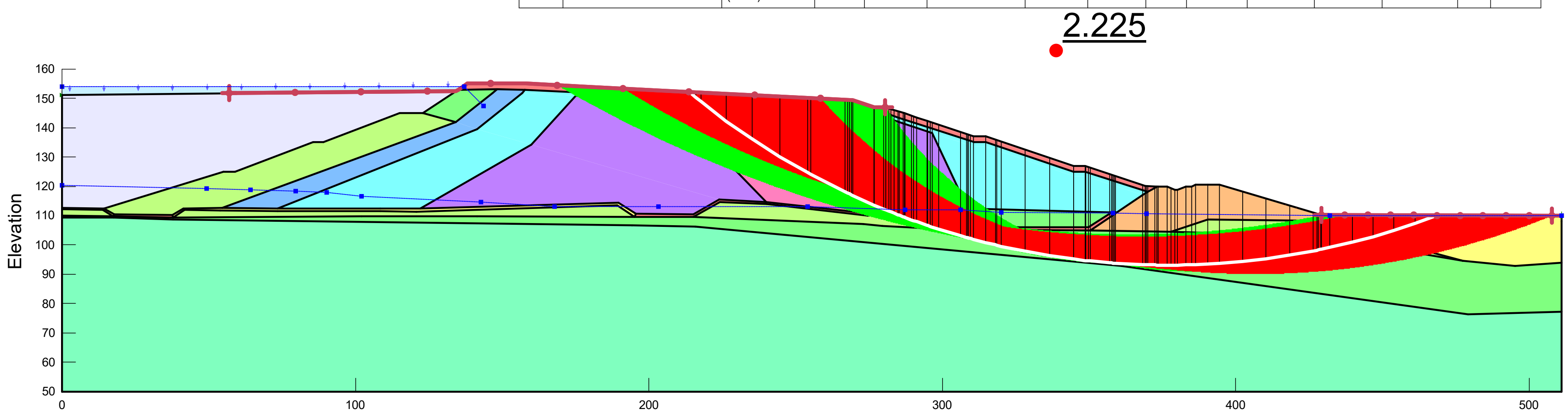
Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.225

Factor of Safety
- 2.225 - 2.325
- 2.325 - 2.425
- ≥ 2.425

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Tails Fresh	SHANSEP	16						0		0.04	1		No
	Udrnd Rhy. CW	SHANSEP	17						0	Ash/CW Rhy Surface		2	0.1	Yes
	Udrnd Rhy. Hw/Mw	Mohr-Coulomb	17.5			5	35	0				2	0.1	Yes
	Udrnd Rhy. Sen. Tuff.	SHANSEP	16.5						0		0.21	2	0.1	Yes
	Udrnd Rhy. Weak	Shear/Normal Fn.	18.5		Weak Rhyolite			0				2	0.1	Yes
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2	0.3	Yes
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2	0.1	Yes
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5			21	21	0				1		No
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5			10	18	0					0.5	Yes
	Udrnd Zone C1	Mohr-Coulomb	20.5			21	21	0				2	0.3	Yes
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0				2	0.05	Yes
	Udrnd Zone D2	Mohr-Coulomb	19.5			5	35	0				2	0.1	Yes
	Udrnd Zone D3	Mohr-Coulomb	19			10	18	0				2	0.4	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2		No



Distance

Figure B19-Static-Oper-Peak-Udrnd-Fdn

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 1.709

Factor of Safety
1.709 - 1.809
1.809 - 1.909
≥ 1.909

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)										1		No
	Tails Fresh	SHANSEP	16						0		0.04	1		No
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2	0.3	Yes
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2	0.3	Yes
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5			21	21	0				1		No
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5			10	18	0					0.5	Yes
	Udrnd Zone C1	Mohr-Coulomb	20.5			21	21	0				2	0.3	Yes
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0				2	0.05	Yes
	Udrnd Zone D2	Mohr-Coulomb	19.5			5	35	0				2	0.1	Yes
	Udrnd Zone D3	Mohr-Coulomb	19			10	18	0				2	0.4	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2		No

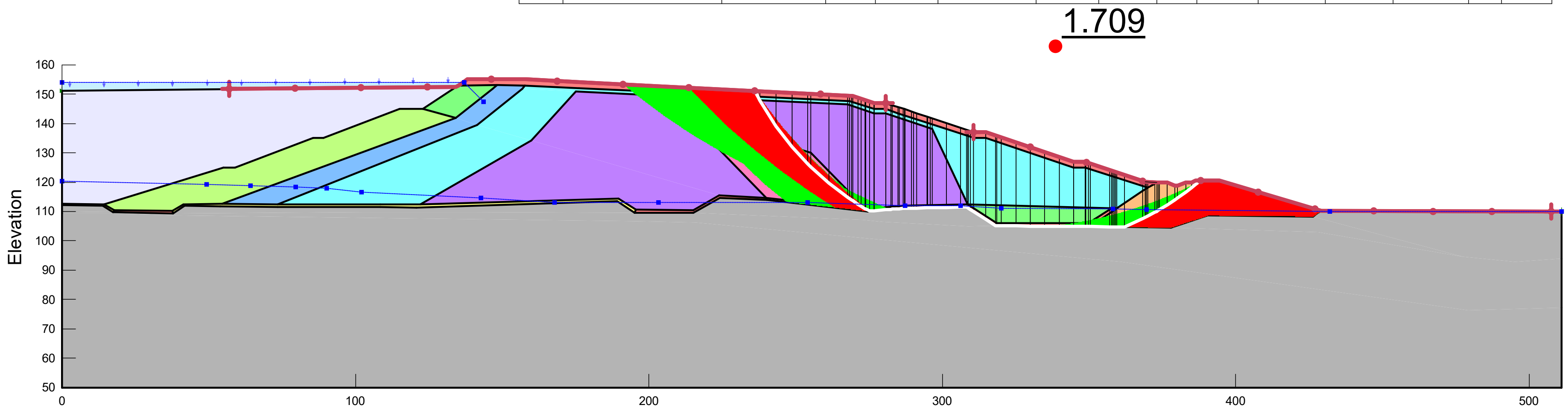

Figure B20-Static-Oper-Peak-Udrnd-ZneA

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.110

Factor of Safety
2.110 - 2.210
2.210 - 2.310
≥ 2.310

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Tails Fresh	SHANSEP	16						0		0.04	1		No
	Udrnd Rhy. CW	SHANSEP	17						0	Ash/CW Rhy Surface		2	0.1	Yes
	Udrnd Rhy. Hw/Mw	Mohr-Coulomb	17.5			5	35	0				2		No
	Udrnd Rhy. Sen. Tuff.	SHANSEP	16.5						0		0.21	2	0.1	Yes
	Udrnd Rhy. Weak	Shear/Normal Fn.	18.5		Weak Rhyolite			0				2		No
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2	0.3	Yes
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2	0.3	Yes
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5			21	21	0				1		No
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5			10	18	0					0.5	Yes
	Udrnd Zone C1	Mohr-Coulomb	20.5			21	21	0				2	0.1	Yes
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0				2	0.05	Yes
	Udrnd Zone D2	Mohr-Coulomb	19.5			5	35	0				2	0.1	Yes
	Udrnd Zone D3	Mohr-Coulomb	19			10	18	0				2	0.4	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2		No

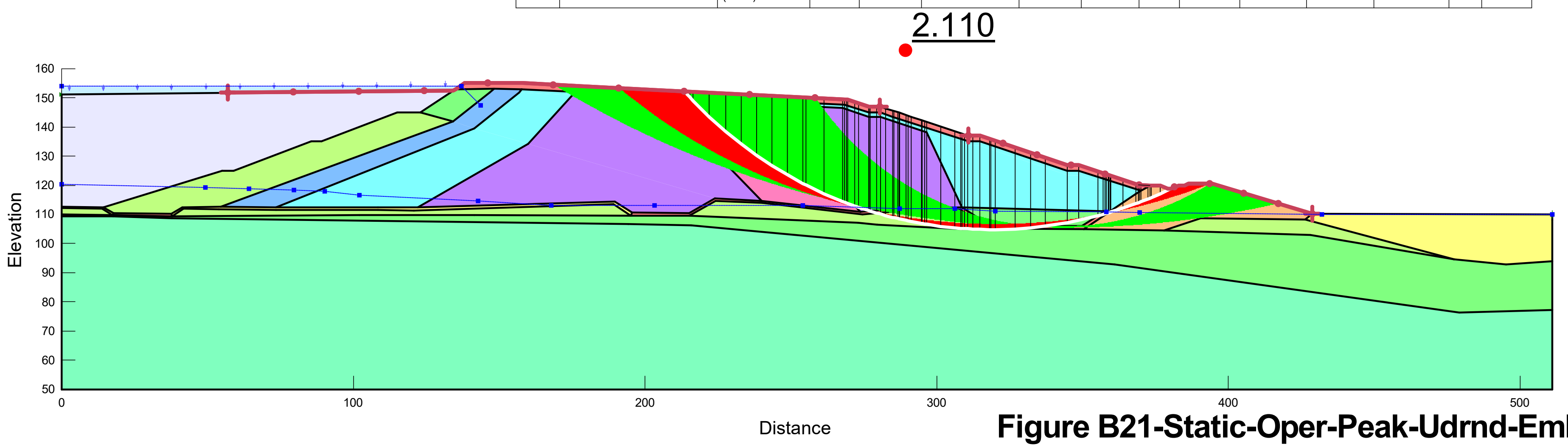

Figure B21-Static-Oper-Peak-Udrnd-Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.290

Factor of Safety
2.290 - 2.390
2.390 - 2.490
≥ 2.490

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Rhy. CW	Mohr-Coulomb	17				0	26	0	2	0.1	Yes
	Drnd Rhy. HW/MW	Mohr-Coulomb	17.5				5	35	0	2	0.1	Yes
	Drnd Rhy. Sens. Tuff	Mohr-Coulomb	16.5				0	37	0	2	0.1	Yes
	Drnd Rhy. Weak	Shear/Normal Fn.	18.5			Weak Rhyolite			0	2	0.1	Yes
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5				3	31	0	2	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5				5	35	0	2	0.1	Yes
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5				5	35	0	1		No
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5				3	31	0		0.5	Yes
	Drnd Zone C1	Mohr-Coulomb	20.5				21	21	0	2	0.3	Yes
	Drnd Zone C2/F	Shear/Normal Fn.	20.5			Gravels/Cobbles Dr=0.85 (16%ile)			0	2	0.05	Yes
	Drnd Zone D2	Mohr-Coulomb	19.5				5	35	0	2	0.1	Yes
	Drnd Zone D3	Mohr-Coulomb	19				10	18	0	2	0.4	Yes
	Drnd Zone G	Mohr-Coulomb	20.5				3	31	0	2		No
	Tails Fresh	SHANSEP	16	0	0.04					1		No

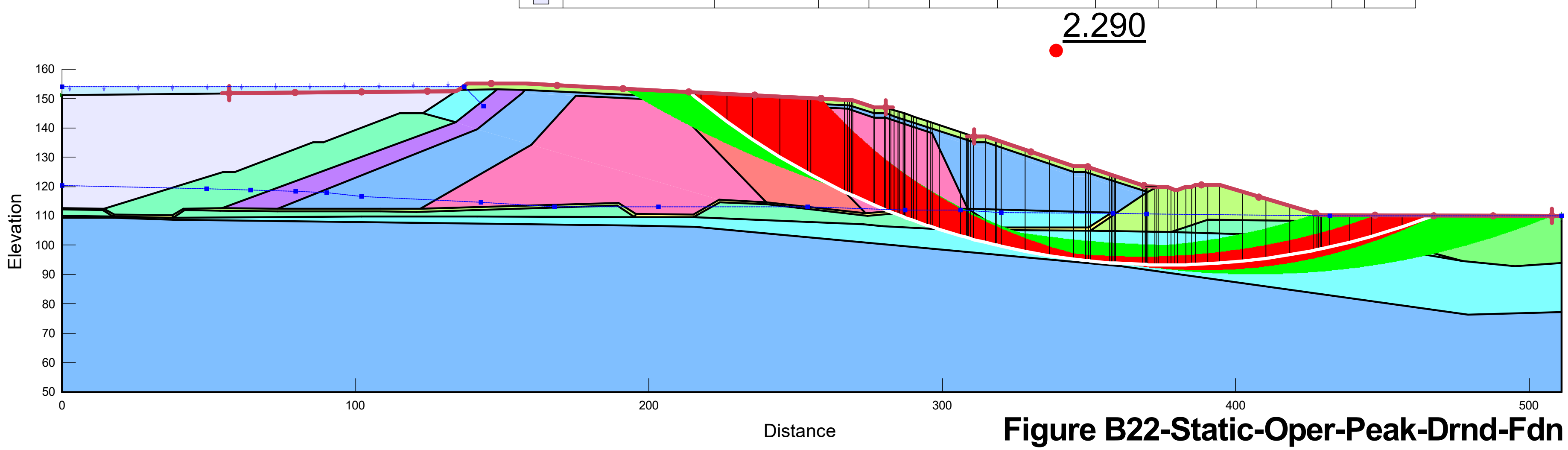

Figure B22-Static-Oper-Peak-Drnd-Fdn

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OCEANA GOLD NEW ZEALAND LTD
TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.256

Factor of Safety
2.256 - 2.356
2.356 - 2.456
≥ 2.456

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5				3	31	0	2	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5				5	35	0	2	0.3	Yes
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5				5	35	0	1		No
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5				3	31	0		0.5	Yes
	Drnd Zone C1	Mohr-Coulomb	20.5				21	21	0	2	0.3	Yes
	Drnd Zone C2/F	Shear/Normal Fn.	20.5			Gravels/Cobbles Dr=0.85 (16%ile)			0	2	0.05	Yes
	Drnd Zone D2	Mohr-Coulomb	19.5				5	35	0	2	0.1	Yes
	Drnd Zone D3	Mohr-Coulomb	19				10	18	0	2	0.4	Yes
	Drnd Zone G	Mohr-Coulomb	20.5				3	31	0	2		No
	Impenetrable	Bedrock (Impenetrable)								1		No
	Tails Fresh	SHANSEP	16	0	0.04					1		No

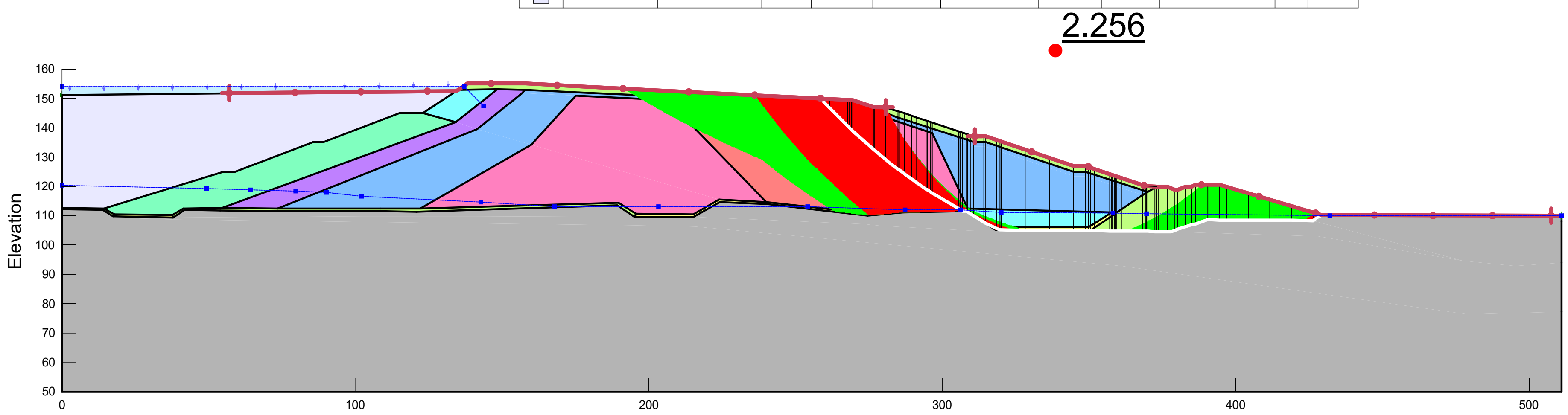

Figure B23-Static-Oper-Peak-Drnd-ZneA

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OCEANA GOLD NEW ZEALAND LTD
TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.577

Factor of Safety
- 2.577 - 2.677
- 2.677 - 2.777
- ≥ 2.777

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Rhy. CW	Mohr-Coulomb	17				0	26	0	2	0.1	Yes
	Drnd Rhy. HW/MW	Mohr-Coulomb	17.5				5	35	0	2		No
	Drnd Rhy. Sens. Tuff	Mohr-Coulomb	16.5				0	37	0	2	0.1	Yes
	Drnd Rhy. Weak	Shear/Normal Fn.	18.5			Weak Rhyolite			0	2		No
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5				3	31	0	2	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5				5	35	0	2	0.3	Yes
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5				5	35	0	1		No
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5				3	31	0		0.5	Yes
	Drnd Zone C1	Mohr-Coulomb	20.5				21	21	0	2	0.1	Yes
	Drnd Zone C2/F	Shear/Normal Fn.	20.5			Gravels/Cobbles Dr=0.85 (16%ile)			0	2	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5				3	31	0	2		No
	Tails Fresh	SHANSEP	16	0	0.04					1		No
	Udrnd Zone D2	Mohr-Coulomb	19.5				5	35	0	2	0.1	Yes
	Udrnd Zone D3	Mohr-Coulomb	19				10	18	0	2	0.4	Yes

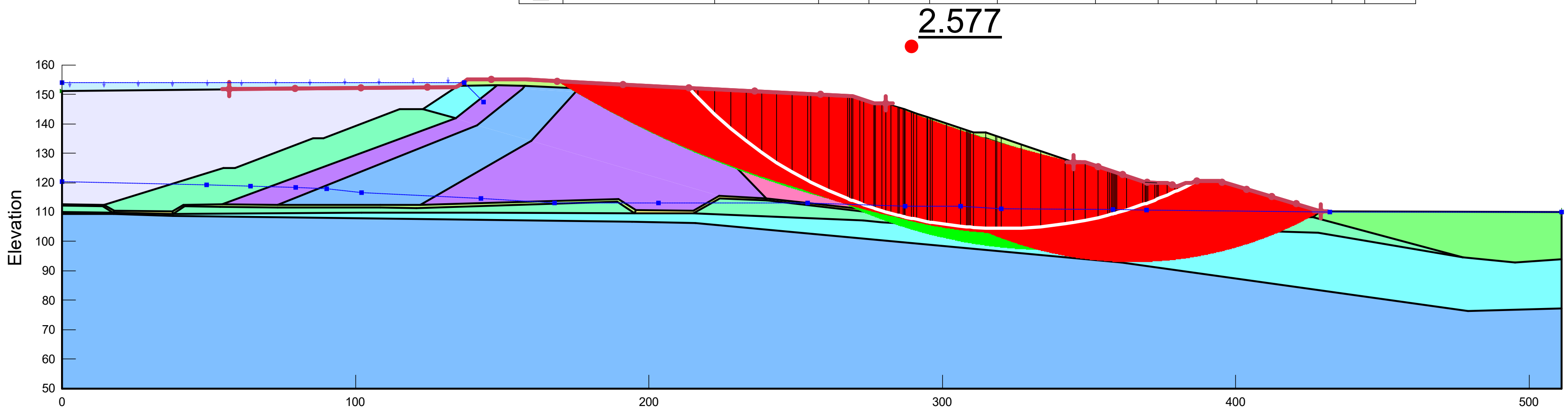

Figure B24-Static-Oper-Peak-Drnd-Emb

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OCEANA GOLD NEW ZEALAND LTD
TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.202

Factor of Safety
2.202 - 2.302
2.302 - 2.402
≥ 2.402

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line
	Tails Fresh	SHANSEP	16						0		0.04	1
	Udrnd Rhy. CW	SHANSEP	17						0	Ash/CW Rhy Surface		2
	Udrnd Rhy. Hw/Mw	Mohr-Coulomb	17.5			5	35	0				2
	Udrnd Rhy. Sen. Tuff.	SHANSEP	16.5						0		0.21	2
	Udrnd Rhy. Weak	Shear/Normal Fn.	18.5		Weak Rhyolite			0				2
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5			21	21	0				1
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5			10	18	0				
	Udrnd Zone C1	Mohr-Coulomb	20.5			21	21	0				2
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0				2
	Udrnd Zone D2	Mohr-Coulomb	19.5			5	35	0				2
	Udrnd Zone D3	Mohr-Coulomb	19			10	18	0				2
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2

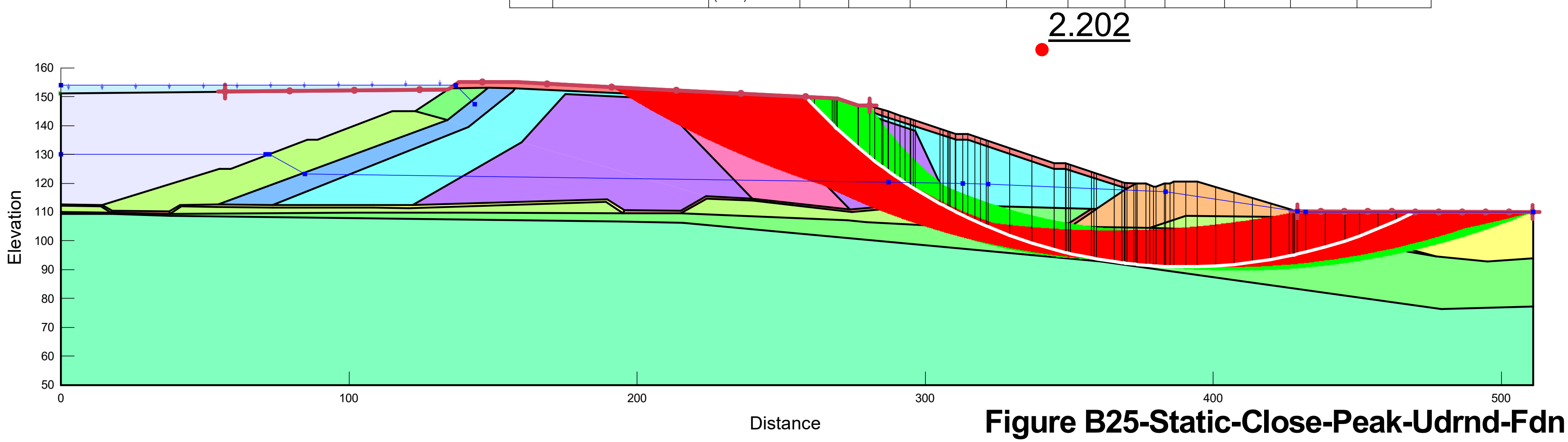

Figure B25-Static-Close-Peak-Udrnd-Fdn

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 1.999

Factor of Safety
- 1.999 - 2.099
- 2.099 - 2.199
- ≥ 2.199

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line
	Impenetrable	Bedrock (Impenetrable)										1
	Tails Fresh	SHANSEP	16						0		0.04	1
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5			21	21	0				1
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5			10	18	0				
	Udrnd Zone C1	Mohr-Coulomb	20.5			21	21	0				2
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0				2
	Udrnd Zone D2	Mohr-Coulomb	19.5			5	35	0				2
	Udrnd Zone D3	Mohr-Coulomb	19			10	18	0				2
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2

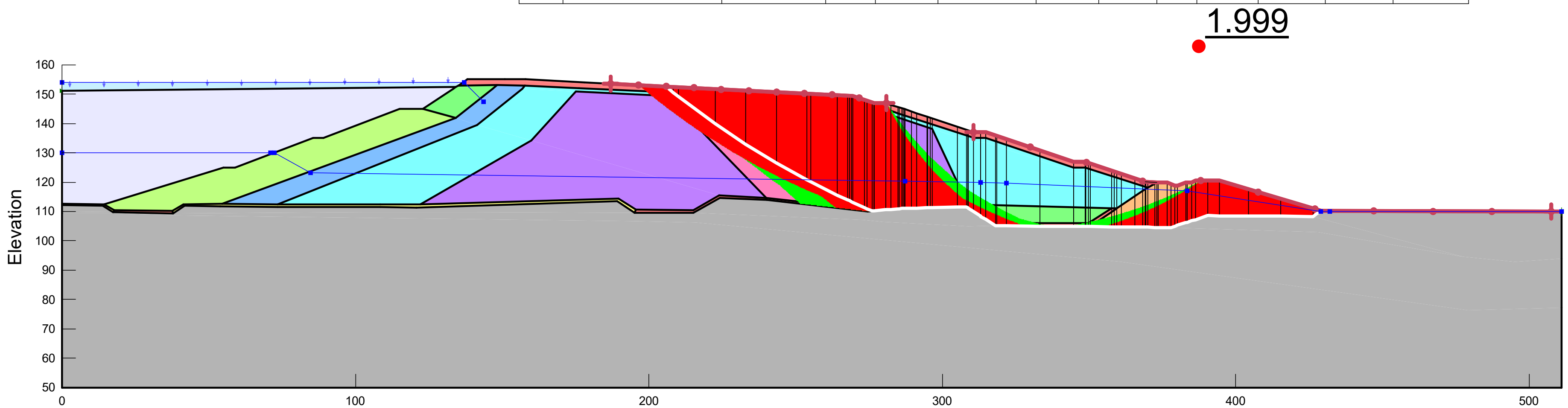

Figure B26-Static-Close-Peak-Udrnd-ZneA

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.151

Factor of Safety
- 2.151 - 2.251
- 2.251 - 2.351
- ≥ 2.351

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Undrained Shear Strength vs Vertical Effective Stress Function	Tau/Sigma Ratio	Piezometric Line
	Tails Fresh	SHANSEP	16						0		0.04	1
	Udrnd Rhy. CW	SHANSEP	17						0	Ash/CW Rhy Surface		2
	Udrnd Rhy. Hw/Mw	Mohr-Coulomb	17.5			5	35	0				2
	Udrnd Rhy. Sen. Tuff.	SHANSEP	16.5						0		0.21	2
	Udrnd Rhy. Weak	Shear/Normal Fn.	18.5		Weak Rhyolite			0				2
	Udrnd Zone A Insitu Ash	SHANSEP	17						0	Ash/CW Rhy Surface		2
	Udrnd Zone A/I Found UC	SHANSEP	17.5						80		0.35	2
	Udrnd Zone A/I Mine OB	SHANSEP	20.5						150		0.4	2
	Udrnd Zone B Above RL145	Mohr-Coulomb	20.5			21	21	0				1
	Udrnd Zone B Below RL145	Mohr-Coulomb	20.5			10	18	0				
	Udrnd Zone C1	Mohr-Coulomb	20.5			21	21	0				2
	Udrnd Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0				2
	Udrnd Zone D2	Mohr-Coulomb	19.5			5	35	0				2
	Udrnd Zone D3	Mohr-Coulomb	19			10	18	0				2
	Udrnd Zone G	Undrained (Phi=0)	20.5	100								2

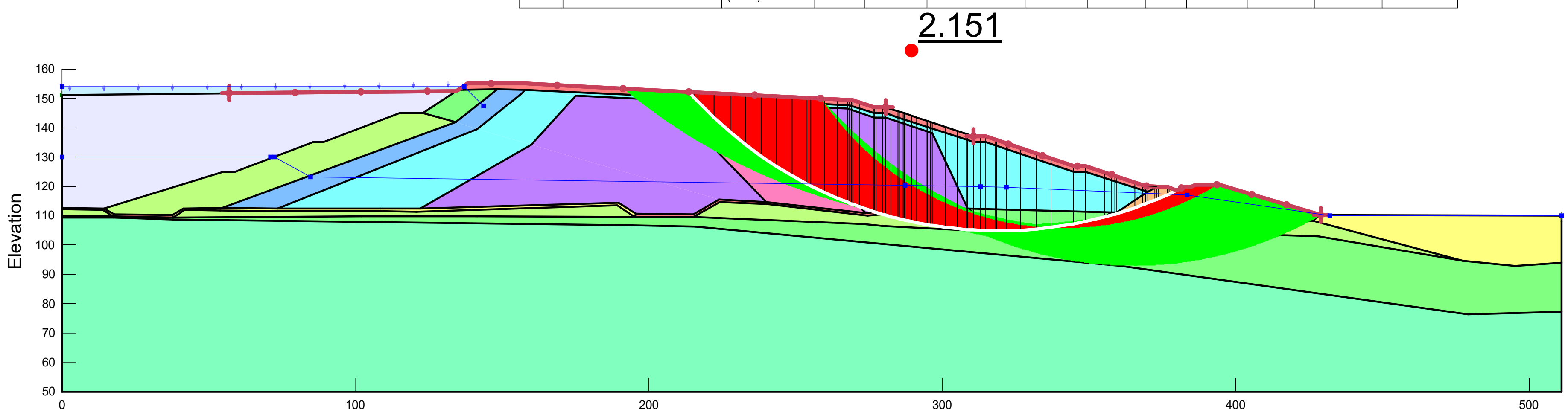

Figure B27-Static-Close-Peak-Udrnd-Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 13/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.287

Factor of Safety	
Red	2.287 - 2.387
Green	2.387 - 2.487
Blue	≥ 2.487

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	Drnd Rhy. CW	Mohr-Coulomb	17				0	26	0	2
	Drnd Rhy. HW/MW	Mohr-Coulomb	17.5				5	35	0	2
	Drnd Rhy. Sens. Tuff	Mohr-Coulomb	16.5				0	37	0	2
	Drnd Rhy. Weak	Shear/Normal Fn.	18.5			Weak Rhyolite			0	2
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5				3	31	0	2
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5				5	35	0	2
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5				5	35	0	1
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5				3	31	0	
	Drnd Zone C1	Mohr-Coulomb	20.5				21	21	0	2
	Drnd Zone C2/F	Shear/Normal Fn.	20.5			Gravels/Cobbles Dr=0.85 (16%ile)			0	2
	Drnd Zone D2	Mohr-Coulomb	19.5				5	35	0	2
	Drnd Zone D3	Mohr-Coulomb	19				10	18	0	2
	Drnd Zone G	Mohr-Coulomb	20.5				3	31	0	2
	Tails Fresh	SHANSEP	16	0	0.04					1

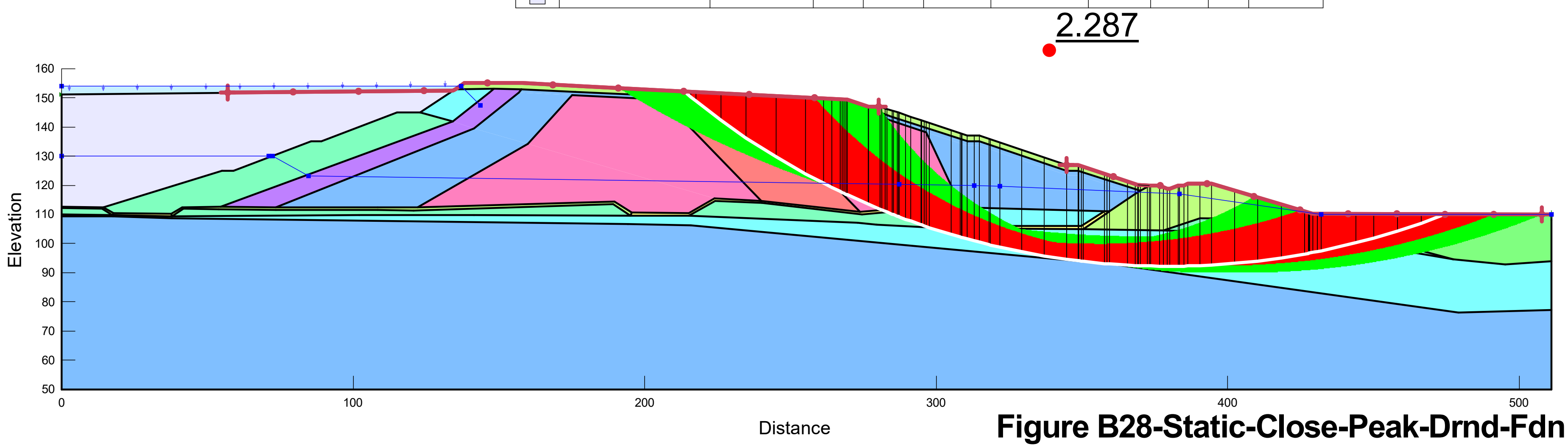

Figure B28-Static-Close-Peak-Drnd-Fdn

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.527

Factor of Safety
2.527 - 2.627
2.627 - 2.727
≥ 2.727

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5				3	31	0	2
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5				5	35	0	2
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5				5	35	0	1
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5				3	31	0	
	Drnd Zone C1	Mohr-Coulomb	20.5				21	21	0	2
	Drnd Zone C2/F	Shear/Normal Fn.	20.5			Gravels/Cobbles Dr=0.85 (16%ile)			0	2
	Drnd Zone D2	Mohr-Coulomb	19.5				5	35	0	2
	Drnd Zone D3	Mohr-Coulomb	19				10	18	0	2
	Drnd Zone G	Mohr-Coulomb	20.5				3	31	0	2
	Impenetrable	Bedrock (Impenetrable)								1
	Tails Fresh	SHANSEP	16	0	0.04					1

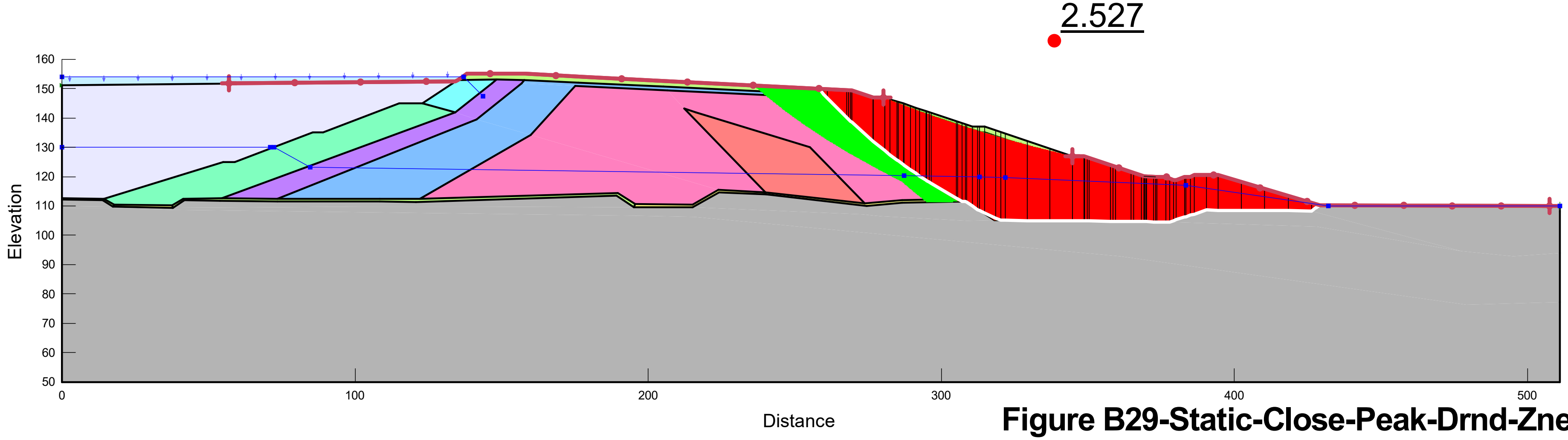

Figure B29-Static-Close-Peak-Drnd-ZneA

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OCEANA GOLD NEW ZEALAND LTD
TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

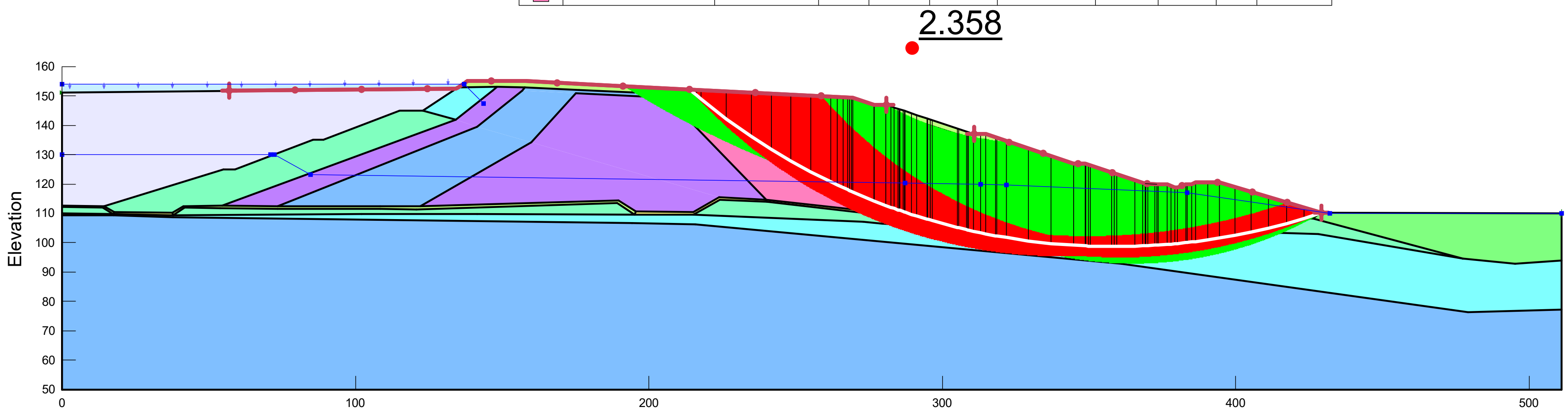
Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.358

Factor of Safety
- 2.358 - 2.458
- 2.458 - 2.558
- ≥ 2.558

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Minimum Strength (kPa)	Tau/Sigma Ratio	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line
	Drnd Rhy. CW	Mohr-Coulomb	17				0	26	0	2
	Drnd Rhy. HW/MW	Mohr-Coulomb	17.5				5	35	0	2
	Drnd Rhy. Sens. Tuff	Mohr-Coulomb	16.5				0	37	0	2
	Drnd Rhy. Weak	Shear/Normal Fn.	18.5			Weak Rhyolite			0	2
	Drnd Zone A/I Found UC	Mohr-Coulomb	17.5				3	31	0	2
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5				5	35	0	2
	Drnd Zone B Above RL145	Mohr-Coulomb	20.5				5	35	0	1
	Drnd Zone B Below RL145	Mohr-Coulomb	20.5				3	31	0	
	Drnd Zone C1	Mohr-Coulomb	20.5				21	21	0	2
	Drnd Zone C2/F	Shear/Normal Fn.	20.5			Gravels/Cobbles Dr=0.85 (16%ile)			0	2
	Drnd Zone G	Mohr-Coulomb	20.5				3	31	0	2
	Tails Fresh	SHANSEP	16	0	0.04					1
	Udrnd Zone D2	Mohr-Coulomb	19.5				5	35	0	2
	Udrnd Zone D3	Mohr-Coulomb	19				10	18	0	2



Distance

Figure B30-Static-Close-Peak-Drnd-Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 2.083

Factor of Safety
- 2.083 - 2.183
- 2.183 - 2.283
- ≥ 2.283

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ Rhy. CW	SHANSEP	17						0	0.23	2	0.1	Yes
	PSTEQ Rhy. Hw/Mw	Mohr-Coulomb	17.5			5	35	0			2	0.1	Yes
	PSTEQ Rhy. Sen. Tuff. 0.06	SHANSEP	16.5						0	0.06	2	0.1	Yes
	PSTEQ Rhy. Weak	Shear/Normal Fn.	18.5		Weak Rhydite			0			2	0.1	Yes
	PSTEQ Zone A/I Found UC	SHANSEP	17.5						50	0.38	2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5						120	0.32	2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5			17	17	0			1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5			8	15	0				0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5			17	17	0			2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0			2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5			5	35	0			2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19			8	15	0			2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16						0	0.04	1		No

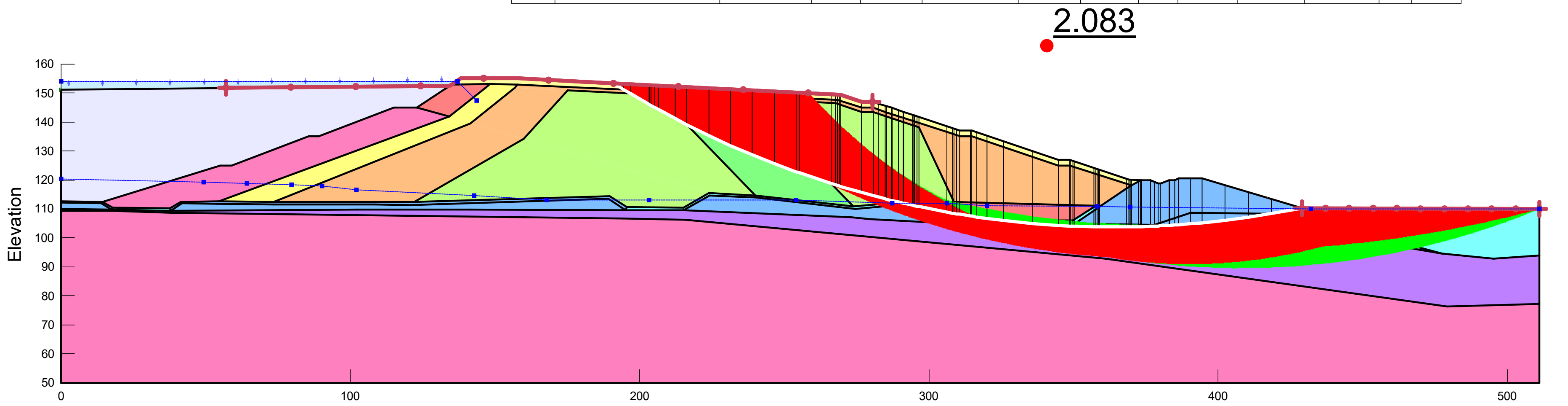

Figure B31-PstEq-Oper-PstEqUdrnd-Fdn

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 1.524

Factor of Safety
1.524 - 1.624
1.624 - 1.724
≥ 1.724

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)									1		No
	PSTEQ Zone A/I Found UC	SHANSEP	17.5						50	0.38	2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5						120	0.32	2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5			17	17	0			1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5			8	15	0				0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5			17	17	0			2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0			2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5			5	35	0			2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19			8	15	0			2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16						0	0.04	1		No

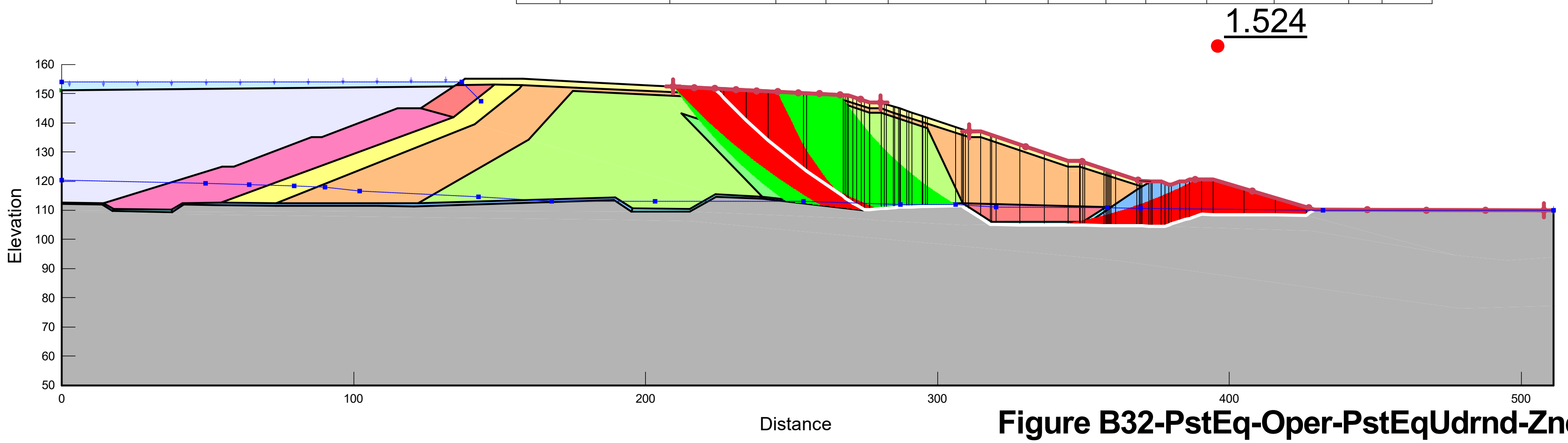

Figure B32-PstEq-Oper-PstEqUdrnd-ZneA

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0

Factor of Safety: 1.795

Factor of Safety
1.795 - 1.895
1.895 - 1.995
≥ 1.995

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ Rhy. CW	SHANSEP	17						0	0.23	2	0.1	Yes
	PSTEQ Rhy. Hw/Mw	Mohr-Coulomb	17.5			5	35	0			2	0.1	Yes
	PSTEQ Rhy. Sen. Tuff. 0.06	SHANSEP	16.5						0	0.06	2	0.1	Yes
	PSTEQ Rhy. Weak	Shear/Normal Fn.	18.5		Weak Rhydite			0			2	0.1	Yes
	PSTEQ Zone A/I Found UC	SHANSEP	17.5						50	0.38	2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5						120	0.32	2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5			17	17	0			1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5			8	15	0				0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5			17	17	0			2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0			2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5			5	35	0			2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19			8	15	0			2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16						0	0.04	1		No

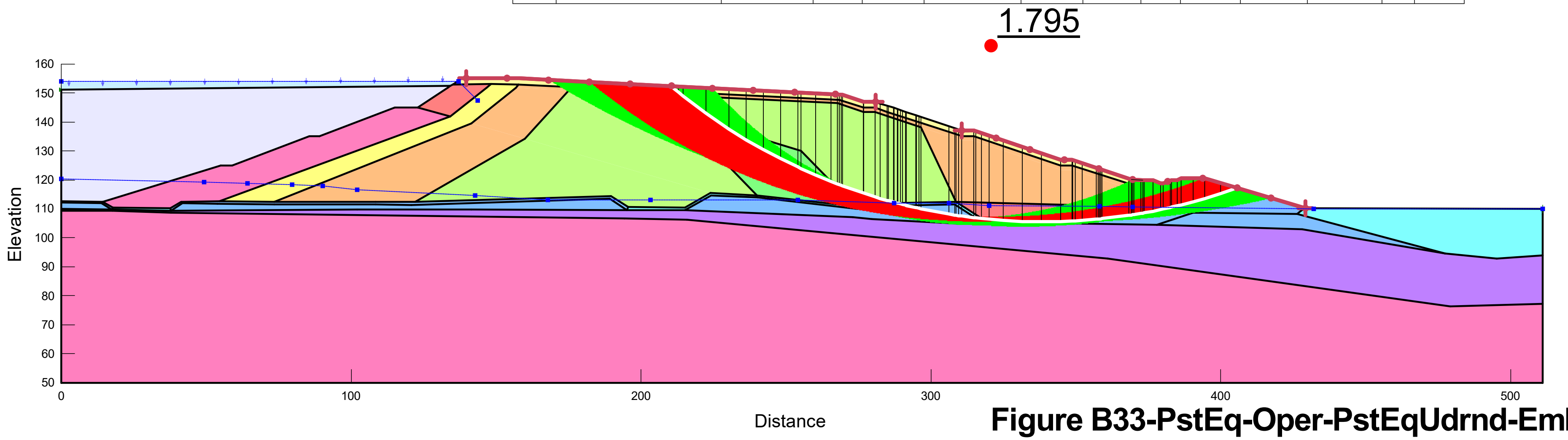

Figure B33-PstEq-Oper-PstEqUdrnd-Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0.54

Factor of Safety: 1.055

Factor of Safety
1.055 - 1.155
1.155 - 1.255
≥ 1.255

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	Dmd Rhy. CW	Mohr-Coulomb	17					0	26	0	2	0.1	Yes
	PSTEQ Rhy. CW	SHANSEP	17			0	0.23				2	0.1	Yes
	PSTEQ Rhy. Hw/Mw	Mohr-Coulomb	17.5					5	35	0	2	0.1	Yes
	PSTEQ Rhy. Sen. Tuff. 0.15	SHANSEP	16.5			0	0.15				2	0.1	Yes
	PSTEQ Rhy. Weak	Shear/Normal Fn.	18.5		Weak Rhydite					0	2	0.1	Yes
	PSTEQ Zone A/I Found UC	SHANSEP	17.5			50	0.38				2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5			120	0.32				2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5					17	17	0	1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5					8	15	0		0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5					17	17	0	2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)					0	2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5					5	35	0	2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19					8	15	0	2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16			0	0.04				1		No

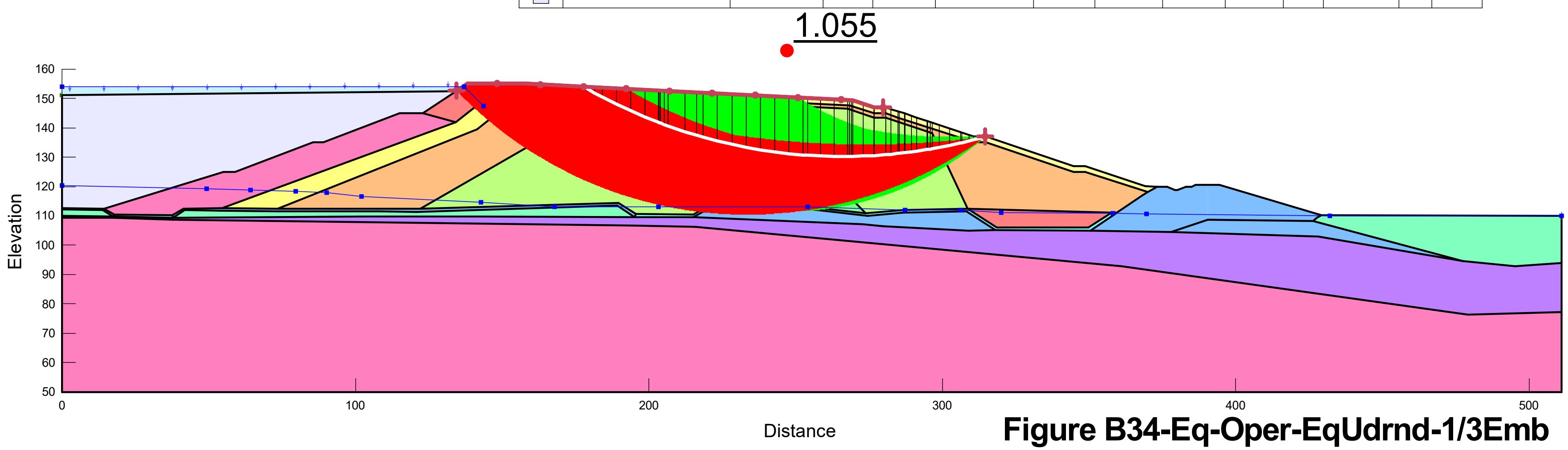

Figure B34-Eq-Oper-EqUdrnd-1/3Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0.46

Factor of Safety: 1.007

Factor of Safety
1.007 - 1.107
1.107 - 1.207
≥ 1.207

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Piezometric Line	Ru	Include Ru in PWP
	Dmd Rhy. CW	Mohr-Coulomb	17					0	26	0	2	0.1	Yes
	PSTEQ Rhy. CW	SHANSEP	17			0	0.23				2	0.1	Yes
	PSTEQ Rhy. Hw/Mw	Mohr-Coulomb	17.5					5	35	0	2	0.1	Yes
	PSTEQ Rhy. Sen. Tuff. 0.15	SHANSEP	16.5			0	0.15				2	0.1	Yes
	PSTEQ Rhy. Weak	Shear/Normal Fn.	18.5		Weak Rhyolite					0	2	0.1	Yes
	PSTEQ Zone A/I Found UC	SHANSEP	17.5			50	0.38				2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5			120	0.32				2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5					17	17	0	1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5					8	15	0		0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5					17	17	0	2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)					0	2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5					5	35	0	2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19					8	15	0	2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16			0	0.04				1		No

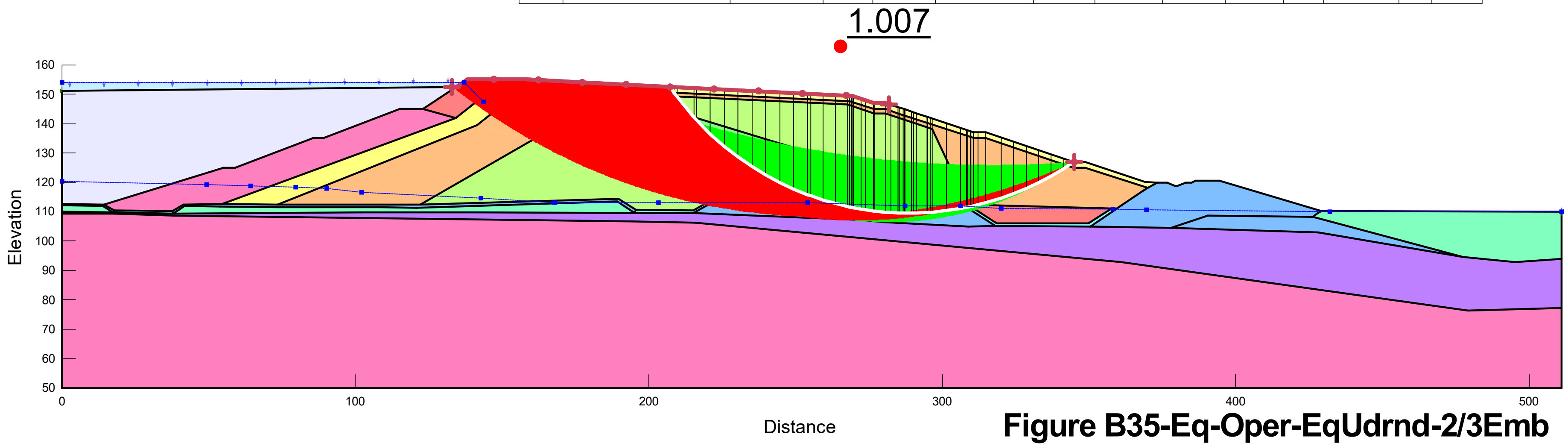

Figure B35-Eq-Oper-EqUdrnd-2/3Emb

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983

Analysis Parameters

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0.085

Factor of Safety: 1.066

Factor of Safety
1.066 - 1.166
1.166 - 1.266
≥ 1.266

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Total Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)									1		No
	PSTEQ Zone A/I Found UC	SHANSEP	17.5						50	0.38	2	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5						120	0.32	2	0.1	Yes
	PSTEQ Zone B Above RL145	Mohr-Coulomb	20.5			17	17	0			1		No
	PSTEQ Zone B Below RL145	Mohr-Coulomb	20.5			8	15	0				0.5	Yes
	PSTEQ Zone C1	Mohr-Coulomb	20.5			17	17	0			2	0.3	Yes
	PSTEQ Zone C2/F	Shear/Normal Fn.	20.5		Gravels/Cobbles Dr=0.85 (16%ile)			0			2	0.05	Yes
	PSTEQ Zone D2	Mohr-Coulomb	19.5			5	35	0			2	0.1	Yes
	PSTEQ Zone D3	Mohr-Coulomb	19			8	15	0			2	0.4	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80							2		No
	Tails Fresh	SHANSEP	16						0	0.04	1		No

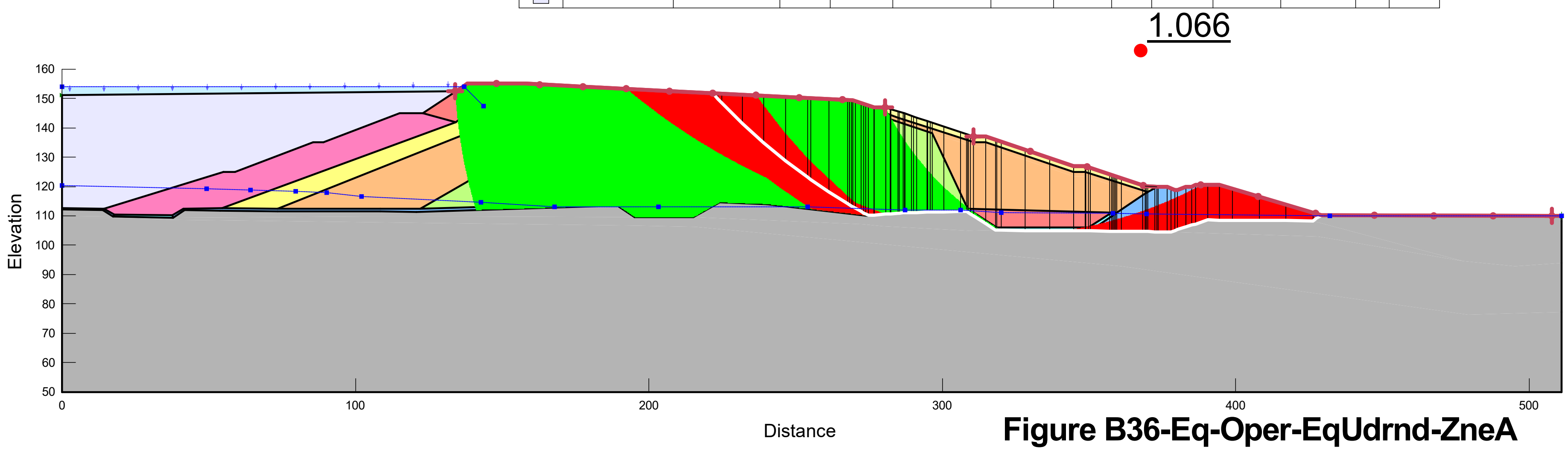

Figure B36-Eq-Oper-EqUdrnd-ZneA

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OCEANA GOLD NEW ZEALAND LTD

TSF3 RL 155 - Section 2

Date: 10/02/2025
Drawn: ET/TO
Ref: 8983