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

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OCEANA GOLD (NEW ZEALAND) LIMITED
WAIHI NORTH PROJECT
TAILINGS STORAGE AND ROCK DISPOSAL
VOLUME 4
NORTHERN ROCK STACK RL173
PROPOSED ROCK DISPOSAL FACILITY
TECHNICAL REPORT

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P O Box 190
WAIHI 3641

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

Engineering Geology Limited (EGL) has been appointed by Oceana Gold (New Zealand) Limited (OGNZL) to undertake a technical report for the new Northern Rock Stack (NRS) for resource consent for the Waihi North Project (WNP). The NRS is located at the Development Site. This is the name given to the area occupied by the existing Tailings Storage Facilities (Storage 2 and Storage 1A), the new TSF (Storage 3), and the NRS. They are identified in Figure 2. The proposed rock storage facility has a maximum working crest level of RL173 (see Drawings 0715, 0716, 0717 in Appendix A) and will be an operational stockpile which will be closed as an engineered landform with a maximum crest of RL148 (Drawings 0780, 0781, 0782). It will permanently store surplus overburden earth and rock from underground and open pit mining that is not used for Tailings Storage Facility (TSF) construction or underground and open pit backfill.

This technical report has been prepared for consents under the Fast-track Approvals Act and details a design for the assessment of environmental effects as required . This report is Volume 4 of a 4-part series of reports prepared on the tailings storage and rock disposal for the 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) Tailing Storage Facility (TSF) (Ref. 2) and Volume 3 is a technical report on the new TSF, Storage 3 (Ref. 3).

Some of the rock at Waihi is potentially acid forming (PAF) if left exposed to air and water and therefore the NRS will have design and operational features to prevent and to contain any acid drainage. They include earth liners (base and cap), subsurface drainage beneath the liner (subsoil drains), subsurface drains on top of the liner (leachate drains) and the addition of limestone to provide both a geotechnically and geochemically stable landform of earth and rock during operation and closure.

The NRS includes an extension of the Northern Uphill Diversion Drain (Drawings 0715, 0730 to 0733). This drain diverts clean run-on water around the site so the water does not need to be treated. This extension includes diversion of a tributary stream (labelled TB1) of the Ohinemuri River.

To make room for the NRS, the existing Development Site Workshop will need to be relocated onsite. The proposed new location is adjacent to the bottom of the existing haul road Workshop Ramp (Drawing 0715).

Above the Northern Uphill Diversion Drain, a cut and fill platform will be created for a magazine (explosives storage) (Drawing 0715). This will require the relocation of the existing staff facilities adjacent to the loadout as they are in the blast zone. The new staff facilities will be located adjacent to the newly relocated Development Site Workshop.

A new collection pond called NRS Collection Pond is required (Drawings 0715, 0761). A new perimeter drain (NRS Perimeter Drain) at the toe of the stockpile will collect and direct surface runoff to the NRS Collection Pond.

Stockpiles for rehabilitation material are also required beyond the footprint of the NRS (Drawing 0715). The northern rehabilitation stockpiles are positioned adjacent to Golden Valley Road. This location of stockpiles also provides some benefit as a noise screen.

2.0 BACKGROUND AND CURRENT SITE FACILITIES

2.1. Location and existing stockpiles

The existing Waihi gold mining operation operated by OGNZL is centred in and around the Waihi Township (Figure 1) and includes Martha Open Pit, and a series of underground mines including Trio Underground Mine, Favona Underground Mine, Correnso Underground Mine, and Martha Underground Mine (MUG). Martha Open Pit is located within the Waihi Township and the underground mines are located to the east and southeast of the pit at depth.

Three main stockpiles: Northern, Central, and East Stockpiles are located on the Development Site which is located adjacent and east of the Ohinemuri River and north of the Ruahorehore Stream (Figure 2 and Figure 3). The Development Site is connected to the Martha Open Pit by a belt conveyor (Figure 2). A crusher located at Martha Open Pit crushes the rock before loading the material on to the conveyor belt.

The operation includes the Processing Plant and a Water Treatment Plant. They are located to the southeast of the Waihi Township, adjacent and west of the Ohinemuri River (Figure 2). Any ore from Martha Open Pit is loaded off the existing conveyor at the ore Processing Plant. Adjacent to the Water Treatment Plant is the Polishing Pond Stockpile, which is used for the temporary stockpiling of ore or run of mine material. Overburden material from Martha Open Pit is conveyed past the Processing Plant to the Development Site. Lime is added to PAF material on the conveyor belt, ready to be placed in the TSF embankment or stockpiles.

2.2. Construction and operation

In the late 1980s open pit mining of Martha Hill commenced. Open pit mining created a source of earth and rock fill (overburden) material to construct downstream embankment dams to store the tailings behind. The overburden material from open pit mining is a valuable resource for building TSF embankments and backfilling of underground operations. However, working stockpiles are required for temporary stockpiling and long-term storage of overburden materials.

Construction of the initial TSF, Storage 2, in 1987 required a Northern Stockpile and a Southern Stockpile to manage materials delivered to the Development Site from Martha Open Pit. Both stockpiles were located against the Storage 2 embankments, to the north and south, as their titles suggest. The construction of Storage 1A followed in 1998. The Southern Stockpile was covered by the construction of Storage 1A and the existing Central Stockpile (Figure 3). As part of the expansion works associated with Storage 1A the Northern Stockpile was expanded to its current Northern Stockpile footprint.

From 2000, hard ignimbrite rockfill was separately stockpiled in the Eastern Haul Road Stockpile behind Storage 2. This stockpile is often called the Ignimbrite Stockpile (Figure 3). The purpose of the stockpile is to separate out the non-acid forming (NAF) ignimbrite rockfill from the finer NAF fill placed in the Northern Stockpile. Ignimbrite rockfill is used for the wearing and base course layers in the haul roads and as a NAF fill for closure capping of the tailings.

Topsoil stockpiles (Figure 3) remain around the toe of the Northern Stockpile, Storage 2, and Storage 1A. The Polishing Pond Stockpile located at the Processing Plant and Water Treatment site (Figure 3) is also engineered to store PAF material. The Polishing Pond Stockpile has subsoil drainage installed below a low permeability earthfill pad (0.6m thick of Zone A). Leachate drains are installed on top of the liner at the toe of the stockpile. It was originally constructed in 2006 and used to store ore. Since 2020 the Polishing Pond Stockpile area has been used to temporarily stockpile material to be used as backfill for the underground mines. The topsoil stockpiles and the Polishing Pond Stockpile are temporary stockpiles and will not remain in closure.

2.3. Current stockpiles

The focus of this report is the three main large stockpiles at the Development Site. NAF and PAF materials are separately stockpiled for use in different embankment zones. The Northern Stockpile is used only for NAF. Central and East Stockpiles are set up to receive PAF. However, if required they can be used to stockpile NAF.

The **Northern Stockpile** (Figure 3) does not have a Zone A base pad and is only used for NAF material. The stockpile does have some subsurface leachate drains to collect seepage from PAF material placed at the toe of the Storage 2 embankment. Ignimbrite rock was placed as a toe bund around the perimeter of the Northern Stockpile to manage wet materials placed in the stockpile. The ignimbrite toe bund has been partly removed for use elsewhere onsite. The Northern Stockpile is to be replaced by the NRS.

The **Central Stockpile** has subsurface drains, a Zone A base pad and leachate drains. The surface runoff reports to Collection Pond S3 via an open channel drain down the rehabilitated embankment face.

The **East Stockpile** is lined with a Zone A pad. This pad was placed over the Surplus Soil Stockpile to allow stockpiling of PAF material. An ignimbrite rockfill toe bund was constructed to ensure the stability of the East Stockpile. Leachate and subsoil drains collect seepage from the stockpile. The surface water runoff reports to Collection Pond S5 with overflow draining to Collection Pond S4 via the Perimeter Drain.

2.4. Management of current stockpiles with zonation, liming and drainage

The overburden rock and ore at Waihi is of volcanic origin and some of the material is potentially acid forming if left exposed to air and water. Acid generation can result in the mobilisation of naturally-occurring metals from the overburden rock into the water.

The existing Central and East Stockpiles embankments include specific fill zones to prevent and manage the long-term acid generation of PAF materials. Limitations on where PAF rock can be used are set and PAF materials are encapsulated in an outer layer of low permeability NAF fill as each facility is progressively built toward its final profile. This final surface is established in pasture or other vegetation. The low permeability NAF fill restricts both oxygen and water entry in the long-term. Figure 4 shows cross-sections of the East Stockpile which is designed to dispose of PAF overburden. Zone A fill is a low permeability zone that restricts seepage from overlying rock materials within the stockpiles into underlying ground. Further description of the zoned stockpile fills are described in Section 9.2 which are intended to be used for the design of the proposed NRS.

Until the final surface is reached, and rehabilitation layers constructed, exposed PAF surfaces in the stockpiles are managed through liming and testing. Liming provides acid neutralisation capacity to the exposed surface of the stockpile and testing confirms which materials are potentially acid generating.

Subsurface drains are incorporated beneath the stockpile Zone A base pads and beneath the TSFs (subsoil drains). They function to intercept groundwater seepage. Leachate drains are installed on top of the Zone A base pad to collect leachate from the overburden material. The collected groundwater seepage and leachate are collected in sumps and pumped back to the Water Treatment Plant for treatment prior to discharge to the Ohinemuri River. The subsoil drains are located in low points in the original ground profile below the stockpile and include a downstream toe drain cut into rock at the downstream toe.

For final rehabilitation a surface drainage system comprising berms/benches, sumps and pipes, perimeter collection drains, and ponds is operated. Currently, runoff collected in Collection Ponds S3, S4 and S5 is of a suitable quality that allows runoff to be directly discharged to the Ruahorehore Stream. If water does not meet the required water quality criteria for direct discharge, it is pumped back to the Water Treatment Plant where it is treated to meet the required receiving water standards and then discharged to the Ohinemuri River.

The Northern and Southern Uphill Diversion Drain start above Storage 1A and divert clean surface runoff from upslope to tributaries of the Ohinemuri River and the Ruahorehore Stream.

2.5. Annual monitoring and surveillance

A comprehensive monitoring and surveillance program is in place to enable the performance and condition of TSFs at Waihi. Management and performance of the TSFs encompasses the monitoring and surveillance of adjacent design elements such as the stockpiles. This includes:

- Record of construction and rehabilitation works
- Record of material movements in and out of stockpiles
- Visual inspection of the stockpiles
- Monitoring of acid generation and lime addition on the top of the stockpiles
- Monitoring of all aspects of water quality in and around the facilities: groundwater wells, subsurface and leachate drainage, collection and silt ponds

Resource consents for the Tailings Storage Facilities Storage 1A and Storage 2 and associated stockpiles require the preparation, review and update of a Tailings Storage Facility Monitoring Plan (TSFMP) (Ref. 4). Updates of the Plan are provided to the relevant consenting authorities. The TSFMP includes annual review of risks, structural integrity, geochemistry, underdrainage, and groundwater. These reports are further peer reviewed by an independent peer review panel (PRP).

2.6. Performance to date

The zoned design of the stockpiles, liming, collection of seepage with leachate and subsoil drainage, and progressive rehabilitation of surfaces has contributed to the good performance of the stockpiles and TSF embankments as designed and within the existing resource consent conditions. The monitoring results from the annual reviews indicate leachate from the stockpiles and TSF embankments is primarily collected and captured on top of the Zone A pad. Residual seepage through the Zone A liner is intercepted in the subsoil drains beneath the Zone A liner, which are positioned to intercept the ground water seepage beneath the stockpiles. A series of detection and compliance groundwater wells around the perimeter of the existing Development Site indicate that these subsoil drains are effective in capturing any seepage through the Zone A liner from the stockpiles.

Similar design intent along with the annual monitoring and surveillance program is to be applied to the proposed NRS to effectively manage its performance and adherence to resource consent conditions.

3.0 DESCRIPTION OF WAIHI NORTH PROJECT AND NORTHERN ROCK STACK

3.1. Waihi North Project

The WNP adds the Wharekirauponga Underground (WUG) Mine, 10km north of Waihi township, and Gladstone Open Pit (GOP) Mine, adjacent to the Processing Plant, to the existing mining operation at Waihi. This requires new tailings storage facilities to accommodate the increased tailings production. The new tailings storage is to be provided by a new TSF (Storage 3) and utilising the void created by mining the GOP. Storage 3 TSF is a zoned downstream embankment dam. The initial stages of construction will use material sourced from local borrow areas within the area of TSF3 (Borrow Areas 1 and 2) and beneath the NRS (Borrow Area 3). Later raises of the downstream embankment and lined impoundment will be constructed using the overburden material from the GOP. The GOP TSF is a lined TSF constructed in the void remaining after mining. The liner proposed includes partial backfill of the pit with PAF material to create the surface on which to place the pit liner. Overburden materials for construction of the TSFs will be managed in the NRS.

3.1.1. Material characteristics

The overburden material from GOP and material from MOP4 is the primary material that will need to be managed in a stockpile. The chemistry of MOP4 material is the same as the existing materials that have been managed onsite to date. The GOP includes some material that has higher acid forming potential and higher mercury content. The current overburden management controls for PAF material will inherently manage the mercury. AECOM has recommended that high mercury (>3.5 mg/kg) NAF is not used in NAF zones which perform a liner function (Zones A, G, H) or where exposed to the surface (i.e. surface of Zone I).

3.1.2. Stockpiling requirements

Currently at the Development Site there is potential to store up to 1.0 Mm^3 (million cubic metres) of NAF material in the existing Northern Stockpile and potential to store up to 1.5 Mm^3 of PAF material in the Central Stockpile (0.9 Mm^3) and in the East Stockpile (0.6 Mm^3). However, most of the storage in East Stockpile no longer exist with the construction of Storage 3.

Approximately 6.8 Mt or 3.6 Mm^3 of material is to be locally borrowed from Storage 3 and NRS sites for Storage 3 starter embankment construction. The total volume of overburden material scheduled from the GOP is 18.7 Mt or approximately 9.3 Mm^3. MOP4 produces 4.1 Mt or approximately 2.2 Mm^3 of overburden. Total overburden scheduled from MUG is 2.2 Mt or approximately 1.2 Mm^3. Total overburden schedule from WUG is 3.3 Mt or approximately 1.7 Mm^3. MUG and WUG material will be required for backfill of the underground. Some material will be able to go direct to backfill. However, stockpile capacity is required to manage backfill materials. Most of the material from WUG will be managed at the Willows Rock Stack however some material associated with the development of the Wharekirauponga Access Tunnel development may require stockpiling at the Polishing Pond Stockpile or Development Site.

For GOP there is 2.5 Mm^3 of NAF material with low mercury that will be used for Zone A lining of Storage 3 or be stockpiled for rehabilitation capping for closure. There is 6.8 Mm^3 of high mercury NAF or PAF material that will be placed directly to Storage 3 or managed and conditioned in stockpile for later placement to Storage 3 or reserved for GOP TSF backfill. GOP TSF requires approximately 2.5 Mm^3 of backfill. This material will either come from MOP4 or GOP material stockpiled in the NRS.

The maximum stockpiling capacity provided for in the proposed NRS layout is 7.5 Mm^3. This will be sufficient to manage the movement of materials at the Development Site for the WNP. It is estimated that the stockpile will operate at between 3 to 5 Mm^3 during operation and at closure it will be depleted to approximately 0.5 to 1.5 Mm^3. Up to 4 Mm^3 has been allowed for in the closure profile.

3.1.3. Local Borrow

The project includes three local borrow areas. Borrow Area 1 (Central) and Borrow Area 2 (Eastern) are located within and adjacent to the footprint of the proposed TSF3. Borrow Area 3 (Western) is located within the footprint of the NRS, downslope of the Northern Uphill Diversion Drain Alignment.

Borrow Area 3 within the NRS footprint is shown in Drawing 0715. This has 495,000 m^3 of material which is required for the construction of Storage 3 starter embankment.

3.2. Proposed Northern Rock Stack

The NRS is proposed as the new stockpile and permanent rock storage facility at the Development Site. The stockpile will be required to store both NAF and PAF materials. It will abut the Storage 2 embankment at its south extent and extend to the north over the existing Northern Stockpile and existing farmland owned by OGNZL. Along its west boundary is the Ohinemuri River and to the east is a series of hills covered in vegetation and farmland. The proposed location is shown in Figure 5 and on Drawing 0715 in Appendix A.

4.0 GEOTECHNICAL INVESTIGATIONS AND SITE GEOLOGY

Geotechnical investigations have been undertaken in the footprint of the proposed NRS in 1994, 1995, 1996, 1997, 2001, 2007, 2009, 2010, 2017, and 2018. The investigations are documented in the Geotechnical Factual Report (GFR) for the NRS site (Ref. 5). Figure 6 to Figure 9 show the locations of machine drillholes, hand auger boreholes, test pits and Cone Penetrometer Tests (CPTs) undertaken at the NRS site.

4.1. Overview

The NRS is located within a broad gully (Figure 5) overlying rhyolite, dacite and ignimbrite. A thin blanket of volcanic ash blankets the alluvium except in low lying areas where it has been eroded. Over most of the low-lying areas, the alluvium is of variable thickness. A geological map showing the deposits beneath the alluvium and ash is in Figure 13.

Beneath the dacite are varying thicknesses of volcaniclastics, hydrothermal vent breccia, and then andesite rock. Regional andesite rock underlies the site at depth. Andesite outcrops at the hills (Black, Winner, Gladstone, Union, and Favona) to the south-west and west of the NRS. The surface of the andesite and dacite dips down towards the east beneath the rhyolite.

The interpretation of these geological units is described in the following sections from the youngest and shallowest to oldest and deepest. Five geological cross sections through the NRS site are shown in Figure 14 to Figure 18. The plan locations of the sections are shown in Figure 13. The geological sections show the geology interpreted from the investigations and include the machine drillholes and CPTs used in the interpretation. They do not show the andesite at depth as this is too deep to affect the design of the NRS.

4.2. Topsoil

Across the site is a layer of topsoil which typically varies in thickness from 0.1 m to 0.4 m. The variation in thickness is shown in Figure 10. There are some locations where the thickness of topsoil is locally thicker, up to 0.6 m, likely due to their position near gully features. In some areas fill may be encountered at the surface above the topsoil layer due to placement of material as part of the current mine operation.

4.3. Volcanic ash

The NRS site is partially covered in a sequence of volcanic ash. The ash covering on the rhyolite hills to the east is highly variable. However, some inference can be made that the gullies appear to be absent of ash. This translates to the lower topography where natural overland flow paths appear to have eroded the ash cover. The coverage of ash based on the spot locations is shown in Figure 11. Indicative lines in Figure 11 have been drawn to illustrate areas where ash layers appear to be mostly continuous and where they are not.

Of the locations where ash was identified, the thickness ranged from 0.2 to 6.5 m with an average thickness of approximately 1.1m. At boreholes WRS1a and MW2C the ash layers appear to total 4 to 6.5m thickness, which is thicker than the rest of the site. It is possible some of these layers are alluvium.

Three major ash units have been identified: Waihi, Hauparu and Rotoehu. The most widespread is the Waihi Ash Series. Further description about the different ash units is detailed in the GFR (Ref. 5). The volcanic ashes are normally well drained. However, the less cohesive units are prone to erosion.

4.4. Colluvium

Layers of colluvium are typically encountered on the hills on the eastern side of the Northern Rock Stack. The colluvium may be encountered beneath a layer of ash. The colluvium is generally a slightly gravelly clayey silt. Strengths are generally firm to stiff. Of the locations where colluvium was identified, the thickness is 0.4 to 2.3 m. The typical area where colluvium is encountered is illustrated in Figure 12.

4.5. Surficial alluvium

Alluvium covers the site below the ash soils. It is variable in nature (organic silt, clays and sands, gravels) and generally soft to stiff. The depth of the surficial alluvium layers is summarised in Figure 12. Deeper alluvial layers associated with older erosional surfaces and channels are considered separately in Sections 4.7.

The lower terraces consist of stiffer (50-150 kPa) alluvium overlain by volcanic ash soil. The lowest lying areas consist of alluvium that can be soft with strengths as low as 12 kPa ranging up to stiff 100 kPa.

Peat deposits are found in some of the gullies, e.g. BHN58 and TPN57. These deposits are characterised by a very high organic content and a wet swampy surface, with strengths from soft to firm (25-50 kPa).

4.6. Ignimbrite

Ignimbrite deposits have been located in a paleo channel that runs between the dacite outcrops and the eastern rhyolite hills, in a north-south direction, to the east of the Ohinemuri River. This unit includes variably weathered lithic ignimbrite, some of which is completely weathered to a soil. The extent of the ignimbrite is shown in Figure 13. Beneath the existing Northern Stockpile, ignimbrite is present over the dacite.

The ignimbrite is poorly welded, characterised by a high proportion of gravel sized lithics, which include fragments of variably weathered rhyolitic pumice, rhyolite and dacite. The ignimbrite varies from slightly to completely weathered.

The completely weathered ignimbrite in WG5 has firm to stiff soil strength with Standard Penetrometer Test (SPT) N values from 3 to 11. The slightly weathered to highly weathered ignimbrite rock encountered below 10 m depth has strength ranging from extremely weak to very weak. A core sample from borehole WG5 at a depth of 18 m, had an unconfined uniaxial compressive strength of 1.6 MPa, (refer to the GFR - Ref. 5).

Borehole WG5 is the deepest profile of ignimbrite encountered, reaching 30 m without passing through the ignimbrite.

4.7. Boulder & cobble alluvium

A boulder and cobble alluvial unit occurs at the base of the ignimbrite flows in some locations as indicated by boreholes WR8 and DH5. Its extent is difficult to determine and in some boreholes the unit logged as alluvium may be a breccia deposit. The alluvium is mainly boulder and cobble clast supported, with a weakly cemented matrix of sand and silt. The boulders and cobbles are mainly rhyolitic and dacitic, ranging from fresh to moderately weathered and are generally moderately strong to strong.

4.8. Rhyolite tuff (Homunga Rhyolite)

Rhyolite tuff associated with the Homunga Rhyolite from the Ruahorehore Dome may be found in pockets across the site as shown in Figure 13. It is typically white or light purple, and where unwelded is sometimes sensitive with quick behaviour, and typically has a high water content. It is possible that the rhyolite tuff shown on Figure 13 is the weathered surface of the dacite.

4.9. Rhyolite flow (Homunga Rhyolite)

Across the hills of the Ruahorehore Dome there are many variations of rhyolite. This includes rhyolite as lava flows and tuff, with a variety of different textures. Rhyolite found on the eastern side of the NRS site appears to be the western edge of the local

Ruahorehore Dome. The extent of rhyolite is shown in Figure 13. Rhyolite rock is found in Borehole WRS3a (at 19.6 m depth) and WRS8 (at 9 m depth). DH8 drilled to 25.9 m extends through 8 m of rhyolite lava rock and into a dacitic breccia above the dacite flow.

The rock exposed in some test pits is also thought to be rhyolite. TPW4 reaches rhyolite near to the surface and is brecciated in the photos. The brecciated pattern is similar to a pyroclastic mixture of rhyolitic ash and boulder sized rhyolite found on the northern slopes of the Storage 3 site.

The strength of rhyolite is highly dependent on the degree of weathering and decomposition of rock, varying from very weak to strong (Unconfined Compression Strength, UCS = 1 to 100 MPa) on the eastern edge of the NRS site. In borehole DH8 the rhyolite is very weak (1 to 5 MPa) at the surface increasing to moderately strong (20 to 50 MPa) after a couple of meters. The rhyolite in TPW4 and TPN55 was too hard to excavate with a 14-tonne excavator.

4.10. Dacite flow (Uretata Formation)

Dacite lava (flows) are found across the NRS site near to the surface or overlain by ignimbrite, old alluvium or rhyolite. The extent of dacite near the surface is shown in Figure 13.

The dacite, to the north of NRS site varies in weathering from residual soil to slightly weathered. The completely weathered dacite has soil strengths. The slightly weathered dacite rock can be moderately strong through to strong. In boreholes WRS7, DH7, DH8 and DH9, materials consisting of angular clasts of dacite within the lava flow or tuff matrix have been interpreted as dacite breccia.

Borehole logs for groundwater monitoring holes indicate that dacite is near to the surface along the Ohinemuri River immediately west of the existing Northern Stockpile. Dacite is also near the surface just beyond the northern toe of the existing Northern Stockpile. A weathered profile of dacite was encountered at depths from 4m to 8m (in DH6, DH7, WRS1a and WRS2a). Further to the north, borehole WRS5a also indicated dacite rock near to the surface.

Borehole WR8 indicates the dacite is approximately 85 m thick. Beneath the dacite, clay altered volcanic materials are logged, possibly associated with a non-active fault zone. Investigations on the west side of the Ohinemuri River indicate varying thicknesses of volcaniclastics, hydrothermal vent breccia and andesite rock.

5.0 HYDROGEOLOGY

5.1. Overview

GHD has developed a conceptual ground water model for the NRS site and the following is taken from their report (Ref. 6). The geology at the NRS is notably different to that at the GOP and Storage 3 TSF, with no clear separation of shallow and deeper groundwater systems. This is due to the presence of multiple alluvial paleochannels within and overlying variable volcanics (ignimbrite, dacite and rhyolite). The deep andesite, which outcrops to the west of the Ohinemuri River, is present below 200 m depth at the NRS due to the dip of the unit and faulting (Golden Valley Fault). All wells at NRS are installed in the shallow system, with some paired between the water table and deeper within the shallow system (up to 25 m bgl; referred to as “deeper” wells or groundwater in this section), to provide an understanding of vertical hydraulic gradients beneath the site.

Overall, whilst slight differences in groundwater are apparent between the shallow and deeper groundwater, it is interpreted that this groundwater collectively discharges to the Ohinemuri River west of the NRS. The conceptual groundwater model developed by GHD is focused on the shallow system to 25 m depth.

5.2. Groundwater system

Monitoring wells installed at the proposed NRS site are located between 100 m to 770 m east of the Ohinemuri River. The majority of monitoring wells at NRS have recorded groundwater levels at less than 5 m below ground level (bgl), with some locations within 10 m bgl (1,095 – 1,106 m RL). The groundwater levels in the well pair located at the foot of the rhyolite dome (WRS03 and WRS03a) 770 m east of the river, record groundwater levels much higher than the rest of the NRS wells (approximately 1,130 m RL) due to their elevated location.

Groundwater recharge is expected to occur from rainfall infiltration over the elevated rhyolite dome, as well as across the alluvial river plain. Recharge to the elevated rhyolite drives the upward vertical groundwater gradients at the base of the hill, east of the proposed NRS footprint. Groundwater and surface water levels recorded in a number of locations across the site are summarised below:

- The water table nearest to the Ohinemuri River and tributary show the greatest response to rainfall. The rapid response of groundwater is likely to be due to the higher permeability of the shallow geological units (completely weathered to residual volcanics in wells WRS04, WRS05, WRS08).

- Conversely, near tributary location TB1a the deeper groundwater levels demonstrate the greatest response to rainfall when compared to the water table (DH05/DH05a/WRS06). This is considered to be a function of the higher transmissivity of the ignimbrite paleochannel and underlying boulder and cobble alluvium at depth, providing a preferential groundwater flow pathway at depth (WRS06 and DH05a) and allowing transmission of recharge from higher in the catchment. The water table and deeper groundwater contours demonstrate the influence that this preferential pathway has on groundwater flow directions.

- Downward vertical gradients are observed near the Ohinemuri River and along the tributary, with deeper groundwater inferred to be recharged in these areas. The strongest downward vertical gradients during summer baseflow conditions are observed south of the site near the existing northern stockpile. Milder downward gradients are observed closer towards the Ohinemuri River, where groundwater levels and vertical gradients suggests that both shallow and deeper groundwater is expected to be discharging to the river (WRS04 and WRS05).

- A delayed and more muted response to rainfall occurs at the foot of the rhyolite dome in the east of the site (WRS07/DH09 and WRS03/WRS03a). Mild to moderate upward vertical hydraulic gradients occur at these locations, which indicates that the upper reaches of the tributary are spring fed. Groundwater levels and gradients typically follow the topography, with a steeper gradient at the hill to the east (0.1), becoming gentler in the alluvial flats below the NRS site (0.03). The shallow groundwater flow direction is approximately west to northwest, following the site topography, towards the perennial tributary (TB1f to TB1a) and the Ohinemuri River. The Ohinemuri River flows roughly north to south past the western side of the NRS site. At this location, the deep aquifer andesite is inferred to flow to the west and is sufficiently deep to be hydraulically separate from the proposed NRS facility.

Former gullies and permeable material across the site, including the boulder and cobble alluvium and weathered ignimbrite in the NRS paleochannel, have the potential to act as preferential pathways for groundwater flow, providing a conduit for groundwater discharge to the Ohinemuri River. Elsewhere, depending on the hydraulic gradients and NRS base elevation, seepage may infiltrate deeper in the shallow groundwater system and ultimately discharge to the Ohinemuri River via existing groundwater flow paths.

6.0 SEISMIC HAZARD

Estimates of seismic hazard for the site have been provided by GNS Science in 2007 and 2017 (Ref. 7). The 2017 update incorporated the latest knowledge of the Kerepehi Fault System (Ref. 8) and the Hikurangi subduction zone and updated estimates of background seismicity. The tectonic environment and seismic hazard estimates are discussed in Volume 1 (Ref. 1).

The design uniform hazard spectra from the probabilistic and deterministic estimates of seismic hazard are shown in Figure 20. The spectra are 5% damped, larger horizontal component acceleration spectra, for Site Class B rock conditions.

Peak ground acceleration (PGA) values and corresponding average magnitudes at the base of the embankment are as follows:

150-year return period	PGA = 0.10g,	M_w = 6.3
84th percentile level for Kerepehi Fault Rupture	PGA = 0.23g	M_w =7.3
2500-year return period:	PGA = 0.27g	M_w = 6.6
10,000-year return period:	PGA = 0.39g,	M_w = 6.9

7.0 FLOOD HAZARD

The flood hazard from the Ohinemuri River was assessed by GHD. A 1 in 100 year flow was modelled. This is described in the Tailings Storage and Rock Disposal Natural Hazards and Options Report (Ref. 1). The flood hazard is localised to the incised channel of the Ohinemuri River. No stopbanks are along the Ohinemuri River in the vicinity of site. Flood flows in the tributary TB1, which flows from the southeast near the existing Northern

Stockpile, to northwest across the proposed NRS site, are to be considered in the design of the new stream diversion.

8.0 DESIGN BASIS

8.1. Geotechnical stability

The proposed design criteria for the NRS are summarised in Table 1.

TABLE 1: SUMMARY OF PROPOSED GEOTECHNICAL DESIGN CRITERIA

Design Parameter	Design Criteria
Earthquake loading • Operational Basis Earthquake (OBE) • Safety Evaluation Earthquake (SEE)	 Probabilistic 150 year return period Probabilistic 2,500 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 NRS 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 NRS is subjected to the seismic load imposed by the SEE. Damage to the structure (liner, drains, capping) may have occurred, however, it is readily recoverable.

8.2. Uphill diversion drain sizing

At closure the upper reaches of the existing Northern Uphill Diversion Drain will be redirected to Storage 2, which will provide detention and control of flows in the drain.

For the sections of the drain which are only required during operation, 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).

For sections of the uphill diversion drain that are to be permanent, the drain should be designed to pass a 1 in 100-year flow. This will be able to rely on the detention provided by Storage 2 closure pond.

8.3. Permanent surface water collection systems

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

8.4. Northern Rock Stack Collection Pond sizing

The NRS Collection Pond is likely to have a capacity greater than 20,000 m^3 and have a downstream embankment height greater than 4 m high. This will mean that the collection pond will be classified as a large dam under the Building Act and will require a Building Consent. Design, construction, and operation will need to be in accordance with the New Zealand Dam Safety Guidelines (NZDSG) (Ref. 9). A dam breach assessment will need to be undertaken to determine its Potential Impact Classification (PIC). The PIC sets the design criteria under the NZDSG. It is likely the dam will be assessed as a Low PIC dam.

The collection ponds will be sized to manage runoff from a 10 year ARI (72 hour storm) as recommended by GHD (Ref. 10).

9.0 DEVELOPMENT OF THE NORTHERN ROCK STACK

9.1. Design concepts

The proposed NRS provides additional area for working stockpiles and long-term disposal of rock as an engineered landform, for the WNP. The proposed facility presented in Drawing 0715 is the maximum potential profile for the proposed footprint. It has a crest elevation of RL173, extending from the lowest existing ground level of RL97 in the TB1 stream (tributary of the Ohinemuri River) which currently runs through the proposed site. The embankment takes the form of a 76 m high engineered landform. The NRS is formed by progressive placement of fill within the footprint as it is mined from GOP and MOP4.

The proposed outer profile as shown in Drawing 0715 is the maximum benched profile that could be rehabilitated. Not all this volume may be required during operation or at closure. The benched slopes target 3h to 1v slopes with benches at 10 m vertical intervals for surface water control. The 3h to 1v slopes are selected for effective rehabilitation in pasture or other vegetation. The overall average slope is therefore 3.4h to 1v which is an achievable, geotechnically stable profile, which allows for the management of some materials with weaker strengths. The proposed maximum profile is shown in Drawings 0716 and 0717.

The proposed layout of the NRS as shown in Drawing 0715 provides for storage of 7.5 Mm^3 of material, including the volume created by the proposed local borrow activities. This includes the volume of the existing material in the Northern Stockpile.

This total volume can accommodate approximately 14.25 Mt of rock, assuming a minimum average dry density of 1.9 t/m^3.

The NRS facility will provide for storage of PAF and NAF rock. The PAF rock requires a management strategy which mitigates the potential for acid generation. The proposed strategy includes a low permeability NAF earthfill liner, leachate collection drains on top of the liner, a system of subsurface drains beneath the liner to manage natural ground water seepage and that act as a contingency to intercept any seepage through the liner, addition of crushed limestone to the rock to increase its acid neutralising capacity, and rehabilitation capping to restrict long term infiltration of oxygen and water. This is the same strategy used and shown to be effective in the construction of the existing TSFs. Seepage collected by the leachate drains above the liner is pumped to the Water Treatment Plant. Groundwater seepage from the subsurface drains beneath the liner is directed to sumps and pumped to the Water Treatment Plant. A series of detection and compliance groundwater monitoring wells check the performance of the facility so long-term closure conditions can be estimated. Surface water runoff from the operational stockpile is captured in lined perimeter drains and is directed to the proposed NRS Collection Pond, which will be sized to manage runoff from a 1 in 10 year, 72 hour storm event without discharging. The collected water is pumped back to the Water Treatment Plant or Processing Plant before being discharged to the Ohinemuri River or reused for the Processing Plant operation.

Stockpiles for rehabilitation material (topsoil and stripped surficial soils) are required. 184,500 m^3 capacity for stockpiling of rehabilitation material is shown in Drawing 0715. The volumes assume 3H:1V slopes and any undercut required will be managed in stockpile. The northern rehabilitation stockpiles are positioned along Golden Valley Road, which leaves room for future expansion of the NRS for future projects as required. These stockpiles will require erosion and sediment control in the form of sediment fences, bund and silt retention ponds (SRPs). Conceptual positions of the SRPs required outside of the NRS footprint are shown in Drawing 0715. Access to the stockpiles adjacent to Golden Valley Road will be via a single lane access track which will be formed by widening the farm tracks and upgrading the culverts across the stream as required.

The Northern Rock Stack requires:

- Uphill diversion drain to collect run-on clean water and divert it around the site to the Ohinemuri River. This diversion drain will also divert the stream (TB1). This drain also collects the existing Northern Uphill Diversion drain flow from behind Storage 2.
- Subsurface subsoil drains installed in the foundation up the existing gully features to intercept groundwater for construction of the lining and long-term control of seepage.
- Subsurface toe drain installed at the base of the slope. This will be combined with a 30 to 50 m wide shear key to rock around the toe of the embankment. The toe drain and shear key will assist long term stability and favourable performance in earthquakes and assist interception of any seepage of groundwater from beneath the facility. It will also intercept any seepage of leachate through the liner.
- A Zone A base earth liner, 0.75 m thick, over the full extent of the foundation.
- Leachate drainage installed on top of the Zone A liner at the toe of the slopes and in the low points of the liner.

- NAF perimeter embankment with a lined perimeter surface drain, and access road. The perimeter drain will be lined with a HDPE liner as is done for Storage 1A.
- Lined NRS Collection Pond to collect run off water from PAF rock areas, with pumps to return the run off to the Water Treatment Plant and Processing Plant.
- Perimeter "ring" system of sumps and pipes to collect groundwater seepage and leachate from the associated subsurface drains, which are pumped back to the Water Treatment and Processing Plant.
- Placement of PAF material with lime addition to improve acid neutralising capacity of the placed material.
- Compaction and lining of PAF material from GOP with short lag times.
- Outer capping layer consisting of topsoil, 0.5 m thick Zone H NAF vegetation growth layer, 1.5 m thick Zone G NAF/low mercury low permeability liner layer, 1.5m thick Zone F PAF drainage layer against the stockpile bulk fill zone (refer s9.2).

9.2. Northern Rock Stack zonation

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

Zone A	-	Low permeability zone that restricts seepage from waste rock into underlying ground.
Zone B	-	Low permeability zone that restricts seepage from waste rock into underlying ground. Used above Zone A to provide additional protection against seepage in locations where settlement causing strain on the liner may be possible.
Stockpile bulk fill zone	-	Bulk fill zone for general fill. Material placement will depend on strength and zones will be defined during operation (conceptual Zones D2, D3 and E shown on drawings and stability analyses).
Zone F	-	Structural fill zone on outside shoulder that also provides a transition between the coarser material in bulk fill zone 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 waste rock and rock with high mercury contents is not permitted for use in Zones A, G, H and I. It is only permitted in the stockpile bulk fill zone and Zone F.

Design of the NRS is undertaken with the purpose of providing a long term geotechnically and geochemically stable landform of earth and rock. Geotechnically, the stability is assessed against industry standard geotechnical Factors of Safety (FOS) for static stability and post-earthquake stability, and performance criteria for earthquake induced deformation. Geochemically, the design follows the well-established and effective practices at Waihi for the disposal of PAF rock within the TSF embankments which is described in this report.

In operation, weaker material may need to be confined to particular areas or toe bunds may need to be constructed to ensure geotechnical stability. The weakest overburden material can flow when tipped in wet conditions, but it eventually consolidates and can become useable. This practice has been effective in the Northern and East Stockpiles in the past.

9.3. Subsurface drainage

The subsurface drainage shown on Drawing 772 includes subsoil drains installed up the centre of the gullies and around the embankment slope toe. The subsurface drains intercept the groundwater flow immediately beneath the Zone A base earth liner to control groundwater seepage during construction and to collect any leachate that may have seeped through the liner.

The drains are formed using drainage metal wrapped in geotextile to provide a filter for finer material. A sand filter (Type A Drainage Metal) is proposed along the 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 drain metal. ABS pipes are proposed as they are very strong and have performed well in the existing embankments forming Storage 1A and 2. In the long term if the pipes deteriorate and crush the gravel surrounding them will still provide drainage.

9.4. Stockpile base liner system

The stockpile embankment is to be underlain by a 0.75 m thick Zone A earthfill liner. Previously the Zone A base liner was 1.5 m thick beneath the East Stockpile and Storage 1A 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 other critical locations, like capping of the embankments.

9.5. Leachate collector drainage

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 slope toe and up the gullies on top of the Zone A base earth liner as shown in Drawing 770.

9.6. Northern Uphill Diversion Drain and stream diversion

The extension of the Northern Uphill Diversion Drain and stream diversion is to be constructed before the foundations are stripped in the area of the TB1 stream. The clean water diversion minimises the amount of water needing to be treated for sediment and, once PAF material is being placed, treatment for potential contaminants. The uphill and perimeter drains are shown in plan on Drawing 0715 and in cross section in Drawings 0730, 0731, 0732, to 733.

9.7. Surface water

Runoff from the ground above the NRS is intercepted and diverted by the uphill diversion drain that is to be constructed. This includes diversion of the stream TB1 which is a tributary of the Ohinemuri River.

Runoff from the NRS site will initially be managed through a series of diversion channels, earth bunds and sediment retention ponds. Initially materials onsite will only be NAF. An erosion and sediment control plan will be prepared that will cover these works.

As PAF material is placed, the ability to collect PAF runoff and pump it to the treatment plant is required. There is an existing Northern Stockpile silt pond that collects runoff from the Northern Stockpile. This silt pond currently discharges to the TB1 stream. It could be used during development of the NRS to collect runoff for pumping back to the Water Treatment Plant. Ultimately the Northern Collection Pond will store runoff from the NRS and the haul road Workshop Ramp.

Runoff from the downstream shoulder of the NRS embankment is to be collected via grassed benches at approximately 10m vertical intervals. Water will 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 Northern Collection Pond, which is then pumped to the Processing Plant or to the Water Treatment Plant. Once water quality improves in the Collection Pond it can be directly discharged into the Ohinemuri River.

9.8. Northern Rock Stack Collection Pond

The NRS Collection Pond will be fully lined with HDPE. It will have its own subsoil drainage and collection sump. The pond will be sized to manage (with pumping) runoff from a 1 in 10 year, 72-hour rain event without discharge. The pond will have a spillway channel which will discharge to the Ohinemuri River. A typical section for the collection pond is shown in Drawing 0761.

We recommend that a detailed design report, drawings, and specification is prepared for the NRS Collection Pond because it is likely to meet the definition of a large dam in the Building Act and will need to be designed, constructed and operated in accordance with the NZDSG (Ref. 9). If the dam is a Medium PIC it will need to have a formal dam safety management system and require annual Intermediate Dam Safety Reviews to be undertaken. The Collection Pond requires both resource consent and building consent.

9.9. Northern Rock Stack stockpiles

Three stockpiles are shown on Drawing 0715. These are for stockpiling of topsoil and surplus soils from the stripping of the NRS foundations. These materials can be used for construction and rehabilitation of the NRS. Only NAF material is allowed in the stockpiles. Topsoil and rhyolite, dacite and ignimbrite soils that will be stripped from the site are expected to be NAF. Allowance for a total stockpile volume of approximately 184,000 m^3 has been made. This is less than the estimated total undercut of the foundations. The rest of the undercut volume will need to be managed within the footprint of the NRS or elsewhere in the Development Site. The stockpiles will require an access road and perimeter drains leading to SRPs.

9.10. NRS local borrow

The NRS local borrow provides Storage 3 starter embankment construction material. Its location is shown in Drawing 0715 and 0731.

This borrow is within the proposed Northern Rock Stack footprint and will be in rhyolite rock below downslope of the Northern Uphill Diversion Drain. Some of the rock will require drilling and blasting. The cut will be lined with Zone A where PAF rock is placed. The proposed slopes for this additional borrow cut are 1 vertical to 3 horizontal to allow for Zone A lining.

9.11. Construction aspects

The construction of the NRS will likely be undertaken in stages as the requirement for rock storage volume develops.

Initially the working areas of the NRS will consist of converting the existing NAF Northern Stockpile into a PAF stockpile. This will require constructing a Zone A liner and leachate drains and utilising the existing Northern Collection Pond and Northern Stockpile Silt Pond. It will also need to avoid permanently covering any existing NAF material.

The northern part of the site beyond the Northern Stockpile will then be developed along with the NRS Collection Pond. The perimeter infrastructure (road, surface water drain and seepage collection system) and uphill diversion drain will also be constructed.

The estimated volumes of material to be excavated from the foundations of the NRS are summarised in Table 2. An initial estimate of fill volumes by NAF, PAF, and topsoil, and by NRS zonation has been made and is summarised in Table 3 and Table 4. Approximately 1,180,000 m^3 of NAF is required. 504,000 m^3 of NAF material is estimated to be cut from the existing site (Table 2). Not all this material will be suitable for construction. Assuming only half the alluvium is suitable it is estimated that 470,000 m^3 can be obtained from the NRS foundation works and that 710,000 m^3 of NAF mine overburden material will be required from GOP and MOP4. Management of NAF stockpile volumes and site preparation is required to ensure suitable quantities of ash, alluvium, and rhyolite is won from the Development Site prior to NRS construction.

To initially establish the NRS site it is estimated that only 465,000 m^3 of NAF material (i.e. Zone A and I volumes in Table 3) is required. This required volume is equal to the undercut NAF volume mentioned previously, however it is expected that material will still be required from GOP or MOP4, as materials stripped from the site that are better suited to rehabilitation layers Zones G and H may preferentially be stockpiled for use at a later date.

Materials required to be sourced offsite from external suppliers, such as drainage metal, sand filter material, rockfill lining, pipes, sumps, concrete, and decants, are summarised in Table 5.

Section 13.0 outlines the Erosion and Sediment Control Plan aspects.

TABLE 2: NORTHERN ROCK STACK UNDERCUT VOLUMES

Material	Cut Volume (m^3)*
NAF - Ash	85,950
NAF - Alluvium, Residual soil	73,000
NAF - Rhy	185,250
NAF - Zone I (material requiring undercut in stockpile)	160,000
Topsoil	112,500
Subtotal	**616,700**
NRS Local Borrow Area 3 (Western)**	495,000
Total	**1,111,700**

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

** Volume of cut within the NRS footprint that is scheduled to be excavated, loaded and hauled and placed as fill for the construction of Storage 3 embankment.

TABLE 3: NORTHERN ROCK STACK FILL VOLUMES BY MATERIAL ZONATION

	Fill Volumes (m^3)*					
Construction Stage	**Zone A**	**Zone I**	**Zone F**	**Zone G/H**	**Topsoil**	**Totals**
Site establishment (base liner, perimeter infrastructure, collection pond and uphill diversion drain)	198,241	266,348	-	-	1,300	**465,889**
Stockpile operation	-	-	765,700	161,200	8,060	**934,960**
Closure Capping	-	-	417,300	556,400	27,820	**1,001,520**
Totals	**198,241**	**266,348**	**1,183,000**	**717,600**	**37,180**	**2,402,369**

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

TABLE 4: NORTHERN ROCK STACK FILL VOLUMES BY NAF/PAF/TOPSOIL

	Fill Volumes (m^3)*			
Construction Stage	**NAF**	**PAF**	**Topsoil**	**Totals**
Site establishment (base liner, perimeter infrastructure, collection pond and uphill diversion drain)	464,589	-	1,300	**465,889**
Stockpile operation (Required materials only)	161,200	765,700	8,060	**934,960**
Closure Capping	556,400	417,300	27,820	**1,001,520**
Totals	**1,182,189**	**1,183,000**	**37,180**	**2,402,369**

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

TABLE 5: NORTHERN ROCK STACK CONSTRUCTION EXTERNALLY SOURCED MATERIALS

Item	Quantity	Units
Drainage metal and filter sand	13,500 to 16,700	m^3
Roading metal	1,700 to 2,000	m^3
Rockfill lining	2,100 to 2,500	m^3
Geotextile	30,000 to 35,000	m^2
ABS Subsoil Pipes (80 to 150mm dia.)	4,900 to 5,900	m
PE Subsoil Pipes (110mm dia.)	1000 to 1300	m
Geomembrane (HDPE)	35,000 to 42,500	m^2
Sumps (i.e. 2.3m dia. manholes)	80 to 100	m
Concrete	100 to 120	m^3
Collection sys. PVC pipes (225mm dia.)	440 to 530	m
Embankment surface water PVC pipes	530 to 630	m
PE Delivery and Return Pipes	1250 to 1500	m

*Preliminary estimates only, actual volumes will vary

9.12. Closure Plan

The closure plan concepts for the NRS are shown in Drawings 0780, 0781 and 0782. The current plan comprises a capping layer of Zone G and H NAF material and establishment of pasture or other vegetation. The final maximum closure height of RL148 is lower than the maximum operational height of RL173. The closure profile is less than the operational profile as stockpile material is eventually used in TSF construction or underground backfill. The closure profile indicated is a maximum and may be less for the WNP. The NRS Collection Pond will be converted to wetlands and will be rehabilitated. The Northern Uphill Diversion Drain is to be retained permanently as it will provide the outlet channel for Storage 2 in closure. Closure details will be advanced, and possibly revised, in the site's Annual Rehabilitation and Closure Plan.

10.0 DESIGN ASSESSMENT

10.1. Stability

Slope stability analyses for the proposed NRS have been carried out using limit equilibrium methods outlined in Appendix B. The stability design criteria are outlined in Section 8.1. 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 0715 and in cross section in Drawings 0716 and 0717. Section 1 runs from the southeast corner to the northwest. It includes the west slope of the NRS. The foundations include rhyolite over dacite and ignimbrite materials. Section 2 runs from the south to the north and includes the north slope of the NRS. The foundations include fill placed for the Workshop Ramp (haul road) at the south end, with rhyolite overlying weathered dacite materials. On Section 2 there are some minor ignimbrite materials at the surface, which are stronger than the weathered dacite surface and therefore a weathered dacite profile has been preferentially applied in the analyses. Geotechnical stability is dependent on the management of materials of different strengths within stockpile. Weaker material strengths were applied in the analyses in the centre of the stockpile with stronger material applied at the outer extents. The analyses indicate that with the key cut to rock at the toe of the outer slope and preferential placement of the stronger stockpile material at the toe, there is the ability to manage any weaker materials in stockpile while meeting design criteria proposed.

The assessed factor of safety (FOS) values for each loading condition are summarised in Table 6 below. Refer to Appendix B for the calculations and analysis outputs.

TABLE 6: SUMMARY OF NRS SLOPE STABILITY ANALYSIS

Design case	**FOS required**	**Section 1 FOS**	**Section 2 FOS**
Stockpile global static stability	≥1.5	1.50	2.27
Post-earthquake global static stability	≥ 1.2	1.21	1.24
Earthquake case	**EQ performance criteria**	**Section 1 estimated slope displacement**	**Section 2 estimated slope displacement**
1 in 150 year earthquake slope displacement estimate	Damage is minor and easily repairable	-Max Operation 0.8 to 4 cm -Max Closure <0.5 cm -Negligible disp. Criteria can be met.	-Max Operation <0.5 to 3 cm -Max Closure <0.5 cm -Negligible. Criteria can be met.
1 in 2,500 year earthquake slope displacement estimate	No major instability. Damage is recoverable.	-Max Operation 11 to 47 cm -Max Closure 0.6 to 5 cm -Minor disp. Criteria can be met	-Max Operation 10 to 40 cm -Max Closure <0.5 to 4 cm -Minor disp. Criteria can be met

10.2. Seepage

GHD (Ref. 6) assesses that there will be very little change to groundwater flow and levels due to placement of the NRS, as most construction works are anticipated to be undertaken above the groundwater table. Existing rainfall recharge will be intercepted by the waste rock and the perimeter drains, however, this will be partially offset by seepage of leachate through the NRS soil liner (Zone A) and discharge to ground. For the purposes of seepage and water quality assessment GHD assumed that the Zone A liner will be under-drained, and that groundwater levels beneath the NRS will be at an elevation lower than that of the subsoil drains.

10.3. Northern Uphill Diversion Drain and stream diversion

Previous consents have required the uphill diversion drains to be sized for a 1 in 10 year ARI storm event. The uphill diversion drain presented for this preliminary design has been sized for a 1 in 50 year event. At closure the upper reaches of the existing Northern Uphill Diversion Drain will be redirected to Storage 2, which will provide detention and control of flows in the drain.

For the sections of the drain which are only required during operation we recommend that the conditions continue to require a 1 in 10 year flow.

For sections of the uphill diversion drain that are to be permanent the drain should be designed to pass a 1 in 100 year flow. This will be able to rely on the detention provided by Storage 2 closure.

10.4. Surface water collection system

As per Section 8.3 surface water drainage systems on the NRS are to be designed to manage a 100 year ARI flow. The surface runoff pipes or surface drains are likely to be at approximately 200 m centres and pipes are likely to be 225 to 300 mm in diameter. The design concepts will be 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 NRS slopes.

A similar piped surface water system on Storage 1A and 2 has operated without incident throughout the operation of the embankments. Maintenance of the castle sumps is required. The same consistent performance is expected for the NRS.

10.5. Northern Rock Stack Collection Pond

As outlined in Section 8.4 the NRS Collection Pond will likely be considered a large dam and be designed to the NZDSG. As per Section 9.8 the pond will be lined and incorporate its own subsurface drainage system. 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. This will be confirmed at later detailed design stages with a separate design report and drawings.

11.0 DRAWINGS

The following drawings listed in Table 7 have been prepared for resource consent for NRS to RL173.

TABLE 7: NRS RESOURCE CONSENT DRAWING LIST

Drawing No.	Drawing Title
WAI-983-080-DWG-CI-0700	Locality Plan and Index - Northern Rock Stack - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0715	Layout Plan - Northern Rock Stack - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0716	Sections - Northern Rock Stack - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0717	Sections - Northern Rock Stack - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0730	Perimeter and Diversion Drains Sections Sheet 1 of 4 - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0731	Perimeter and Diversion Drains Sections Sheet 2 of 4 - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0732	Perimeter and Diversion Drains Sections Sheet 3 of 4 - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0733	Perimeter and Diversion Drains Sections Sheet 4 of 4 - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0761	Sections – Collection Pond - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0770	Layout Plan - Leachate Drain - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0772	Layout Plan - Subsoil Drains - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0780	Layout Plan - Closure Rehabilitation - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0781	Sections - Closure Rehabilitation - Tails / Waste Rock 080
WAI-983-080-DWG-CI-0782	Sections - Closure Rehabilitation - Tails / Waste Rock 080

12.0 CONSTRUCTION MANAGEMENT

Construction of the NRS will be undertaken by an independent Contractor supervised by OGNZL.

The Contractor will prepare a Construction Management Plan. This plan will set out specifically, among the other things that are required, the construction methodology and quality plan to meet the specification. It shall also set out the operation of the NRS as a stockpile, including management of NAF and PAF material, surface water management, implementation of the erosion and sediment control plan, and the stages of rehabilitation of the NRS

OGNZL will operate a Principal's Quality Assurance Plan to confirm the Contractor has met the Specification.

As-built records of construction will be maintained by OGNZL. Records will be kept including:

1. As-built survey records of all stripped surfaces prior to placement of fill and all final surfaces
2. Earthworks quantities
3. Photographs
4. Quality control test results including results from tests undertaken by an Independent Testing Authority
5. Construction plant
6. Notes on any issues that arise during construction

A schedule of construction inspections and monitoring required to be undertaken will be prepared during detailed design. Construction related inspections and monitoring will be incorporated into the Principal's Quality Assurance Plan and the Contractors Management Plan. Operational monitoring items will be incorporated into the Operational Management Plan for the NRS.

It is expected that OGNZL will have principal hazard management plans for the NRS stockpile operation, uphill diversion drain cuts requiring explosives, and magazine storage area as required under the Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016 (Ref. 11). OGNZL is experienced in developing and enacting principal hazard management plans. These plans will add to the safe construction of the NRS which does not require a building consent.

13.0 EROSION AND SEDIMENT CONTROL

The NRS will have a site-specific erosion and sediment control plan (SSESCP). This plan will establish the specific erosion and sediment controls required during construction, operation, and closure. The plan will cover key stages of the works:

- Site establishment
- Uphill diversion drain construction and TB1 stream diversion
- Foundation works
- Establishment of perimeter infrastructure and collection pond
- Operation
- Final rehabilitation establishment

During site establishment and, uphill diversion drain construction, TB1 stream diversion, foundation works and establishment of infrastructure and collection pond, only NAF material will be cut or placed and therefore erosion and sediment controls can follow typical erosion and sediment control practices as outlined by Waikato Regional Council Guidelines for Soil Disturbing Activities (Ref. 12).

Use of flocculant may be required to meet these guidelines. Flocculant use is currently prohibited by the existing resource consent conditions that authorise other structures but may be necessary during the initial construction phase of NRS and needs to be provided for. Once the site is controlled with a perimeter drain and collection pond and with pumped connection back to the Water Treatment Plant, use of flocculant will not be required.

PAF material can be placed once the perimeter controls, subsurface drainage, Zone A pad, and return pumping system are in place.

14.0 OPERATION MAINTENANCE AND SURVEILLANCE

OGNZL will have an Operation Management Plan (OMP) that will outline operational, maintenance and surveillance items for the NRS, similar to the Operational Maintenance and Surveillance (OMS) manual required for the TSFs. This OMP will include quality assurance during construction, the classification of the PAF/NAF material, maintenance of surface water and subsurface drains, surveillance of ground water and surface water quality, monitoring of surfaces for acid generally and application of limestone to surfaces, and regular review of stability assessments and controls.

Surveillance and monitoring are to be undertaken to monitor the performance of NRS. The purpose is to allow the performance of the NRS to be assessed and reported, and to provide for the detection and mitigation of potential deficiencies or adverse trends. This is important for geotechnical stability and ground water quality protection. Instrumentation that is likely required for monitoring the performance are summarised below:

i. Piezometers are to be located in the stockpile and foundations and read monthly.
ii. Deformation monitoring stations are to be installed at the toe of the NRS embankment and on rehabilitated benches, and surveyed yearly.
iii. Seepage flows and groundwater sampling in the subsurface and leachate drains to be measured monthly.
iv. Visual inspection of the stockpile to be undertaken monthly.
v. Slurry testing of the surface material for pH and lime dosing to occur monthly.
vi. Visual inspection of the NRS Collection Pond to occur weekly or during rainfall.
vii. Visual inspection of the uphill and perimeter drain to occur weekly or during rainfall.

15.0 CONSENTING REQUIREMENTS

Consent requirements relate to the obligations under the Fast-track Approvals Act, Resource Management Act (1991) and the Building Act (2004). The Fast-track Approvals Act and Resource Management Act relates to the use of resources (air, water, land) and discharges to the environment and requires an assessment of effects. The Building Act relates to the structures and their performance requirements, which are set out in the Building Code under the Building Regulations (1992). The likely consenting requirements are set out for the relevant parts of the NRS in the following sections.

15.1. Northern Rock Stack – stockpile and infrastructure

The NRS will be an operational stockpile and will be closed as an engineered landform with rehabilitation to re-establish the land to either pasture or other vegetation.

Assessment of civil engineering related aspects in regard to design layout, material quantities and sources, geotechnical stability and construction have been made by EGL in this report. The following effects have been considered by others:

- Geochemical assessment of the overburden sources has been made by AECOM (Ref. 13).
- Assessment of the groundwater quality effects have been made by GHD (Ref. 6).
- Assessment of surface water effects have been made by GHD (Ref. 10).
- Assessment of dust effects will be prepared by Beca.
- Assessment of noise effects will be prepared by Marshall Day.

Past resource consent conditions have set requirements specific to the sizing of key elements. The following recommendations are made regarding the key elements:

- Uphill drain sizing

  For the sections of the drain which are only required during operation, the uphill diversion drain is 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).

  For sections of the uphill diversion drain that are to be permanent, the drain is designed to pass a 1 in 100-year flow. The design has been discussed in Sections 9.6 and 10.3.

- Collection pond sizing

  The collection pond for the NRS is sized to hold the runoff from a 1 in 10 year return period, 72-hour storm. This has already been discussed in Sections 8.4, 9.8 and 10.5.

- Zone A base pad earth liner thickness

  Modelling undertaken by GHD (Ref. 6) has shown that a Zone A base pad earth liner thickness of 0.75 m provides adequate protection to groundwater. This is half the thickness of the Zone A base pad thickness used under the existing TSF embankments. There was surplus NAF material available in previous stages that allowed a conservative thickness for Zone A. We support the adoption of 0.75m for Zone A because there are now limited quantities of NAF material, and there are other important zones where it is required.

- Zone G capping liner thickness

The existing Zone G thickness is 1.5 m on Storage 1A and 2. The thickness of Zone G for NRS is proposed to be 1.5 m.

- Surface water drainage on the NRS rehabilitated surface

  The permanent surface water drainage criterion is recommended to convey a 1 in 100 year flow without erosion of the NRS. This allows for a range of options including overland sheet flow, open channel flow, and piped drainage systems to be considered or combined.

- Local borrow drilling and blasting

  The proposed local borrow of up to 495,000 m^3 of soil and rock from the foundation of NRS as shown in Drawing 0715. Some of the rock will require drill and blasting.

Detailed design is required for the NRS as drains and stability considerations require assessment, and drawings and specifications are required for construction. So, while building consent is not required under the Building Act, a peer review of the detailed design is recommended, to be provided by an appropriately qualified independent party. The requirement for detailed design peer review of the stockpile could be a resource consent condition.

15.2. Northern Rock Stack Collection Pond

The NRS Collection Pond is likely to be classified as a large dam as mentioned in previous Sections 8.4, 9.8 and 10.5. Based on past assessment of the existing collection ponds on site EGL expects the NRS Collection Pond to have a Low Potential Impact Classification. This will be assessed as part of detailed design. It is recommended that a detailed design report, drawings, and specification is prepared for the NRS Collection Pond. The Collection Pond requires both resource consent and building consent.

15.3. Workshop relocation

The relocated Development Site Workshop will require a resource consent and building consent.

15.4. Magazine platform

The magazine platform forms part of this scope of works for resource consent. Any other consenting requirements for hazardous/explosive substances should be considered by OGNZL.

16.0 SUMMARY OF POTENTIAL RISKS AND MITIGATION MEASURES

1. Potential risks associated with the proposed NRS will be minimised by designing, constructing and operating in accordance with practices that have already been employed successfully at the Development Site.

2. The risks associated with inadequate design will be mitigated by using a Designer with appropriate experience. Engineering Geology Limited will be the lead Designer and has over 35 years of experience in the design and construction of dams and stockpiles on mining sites generally and specifically at Waihi.

3. The risks associated with the NRS 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 full time supervision by OGNZL which employs people with expertise in the construction of such facilities and the Design Engineer undertaking regular inspection of the sites. The Design Engineer 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 by using a Contractor with experience in the construction and operation of similar facilities.

5. The main design risks are the stability of the stockpile and the management of PAF materials in the stockpile. These risks can be mitigated by design, construction, and operation in accordance with high standards. Specific design, construction and monitoring features include removal of weak foundation soils, the adoption of appropriate geometry and zoning, placement and compaction of fill in structural zones to specified standards, controls on layer thickness and locations of bulk fill, subsurface drains to intercept seepage beneath and within the NRS to control the level of saturation, appropriate detailing of liners and drains and monitoring of groundwater levels within, beneath and downstream of the NRS.

6. Potential geotechnical risks have been investigated by comprehensive geotechnical investigations. Extensive investigations have been undertaken and are documented in the NRS site GFR.

7. A cut to rock to form a shear key at the downstream toe will minimise risks associated with instability in the foundations.

8. The outer surface of the NRS has slopes of 3h to 1v slopes with capping and internal drainage within the stockpile. These features will ensure good performance of the stockpile when subject to earthquake ground motions.

9. Erosion and sediment control plans will be prepared for the works. The layout of the site allows for effective erosion and sediment control measures to be prepared. Specific plans depend on the staging of the works.

10. Water for construction is available at the existing operation Storage 2 pond.

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

12. Potential environmental risks will be controlled and managed during operation by appropriate operation, maintenance, and surveillance. This is to ensure the NRS is maintained in a geotechnically and geochemically stable condition to protect the environment downstream. The requirements will be incorporated in an Operation, Maintenance and Surveillance Manual.

17.0 CONCLUSIONS

The proposed NRS rock storage facility as part of WNP has a maximum working crest level of RL173 (76m high) and will be an operational stockpile, located north of Storage 2 at the Waihi Development Site. It will be closed as an engineered landform with a maximum crest of RL148 (51m high).

The NRS is required to effectively manage overburden materials from GOP and MOP4 during operation and for TSF construction. In closure it will permanently store surplus overburden earth and rock from open pit and underground mining that is not used for Tailings Storage Facility (TSF) construction.

NRS will be required to stockpile both NAF and PAF materials. This technical report presents the proposed NRS design, and construction, operation, maintenance and surveillance strategies, which have been successful for the management of the existing TSF embankments and stockpiles at Waihi.

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2. GHD NZ Ltd (2025). ‘Gladstone Pit TSF Design Report.

3. Engineering Geology Ltd (2025). ‘Oceana Gold (New Zealand) Ltd, Tailings Storage and Rock Disposal Volume 3. Proposed Tailings Storage Facility Storage 3 RL155 Technical Report’. EGL Ref: 8983. Doc ID: WAI-983-080-REP-CI-0012.

4. OceanaGold Waihi ‘Tailings Storage Facility Monitoring Plan’. Document ID: WAI-200-PLN-010.

5. Engineering Geology Ltd. ‘Waihi Mine Northern Rock Stack, Geotechnical Factual Report’. EGL Report Ref: 8332.

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12. Waikato Regional Council. ‘Erosion and Sediment Control Guidelines for Soil Disturbing Activities’, January 2009 (updated 2014). Environment Waikato Technical Report No. 2009/02. ISSN 1177-9284 (online).

13. AECOM (2025). ‘Waihi North Project Geochemical Assessment. Geochemistry of Tailings and Overburden, Treatment and Mitigation’. AECOM Ref: 60544823. Doc ID: WAI-985-000-REP-LC-0038.

FIGURES

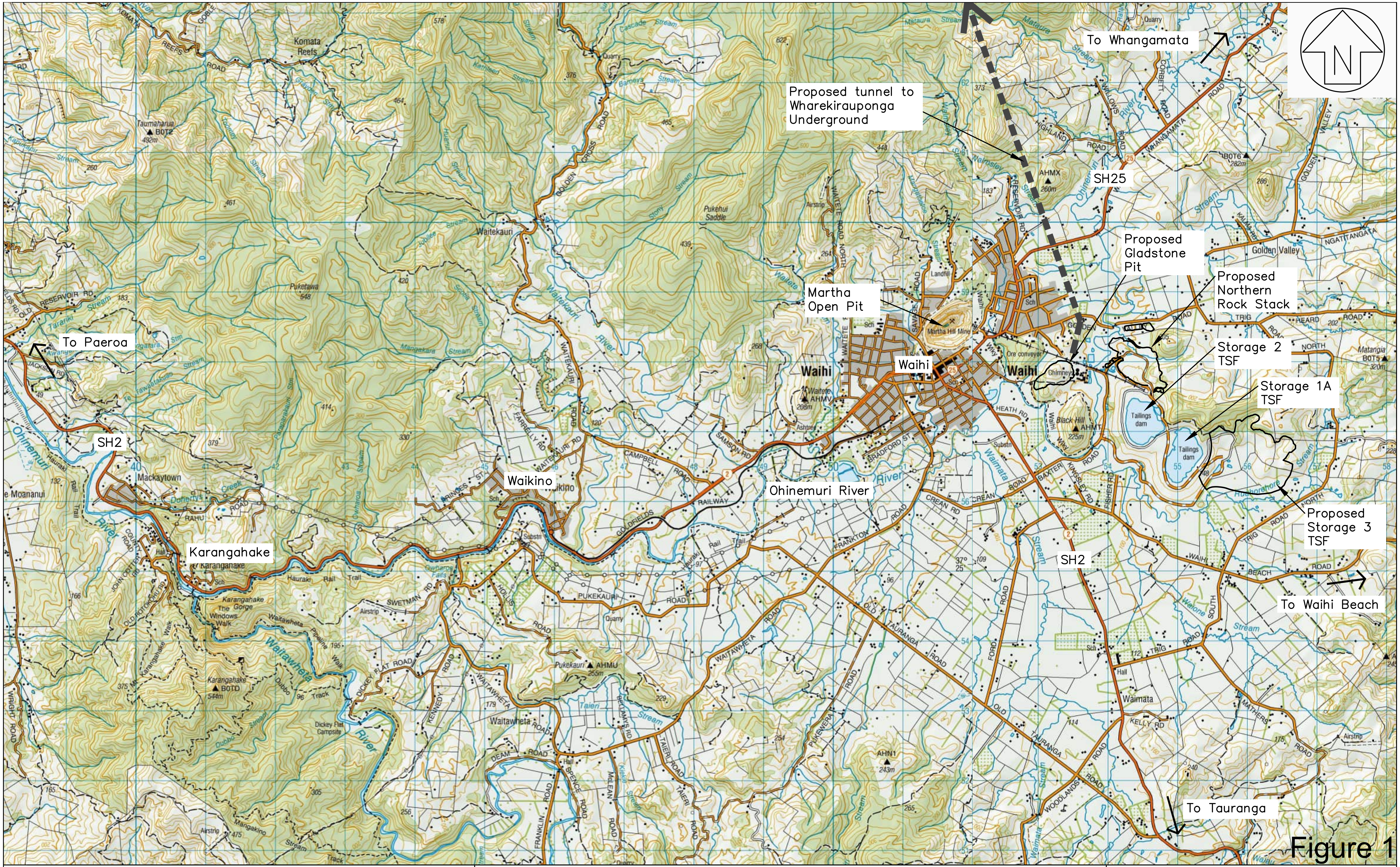

Figure 1

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

EGL Geotechnical, Earthquake and Dam Engineers

OCEANA GOLD (NEW ZEALAND) LIMITED - WAIHI
Northern Rock Stack
Locality Plan

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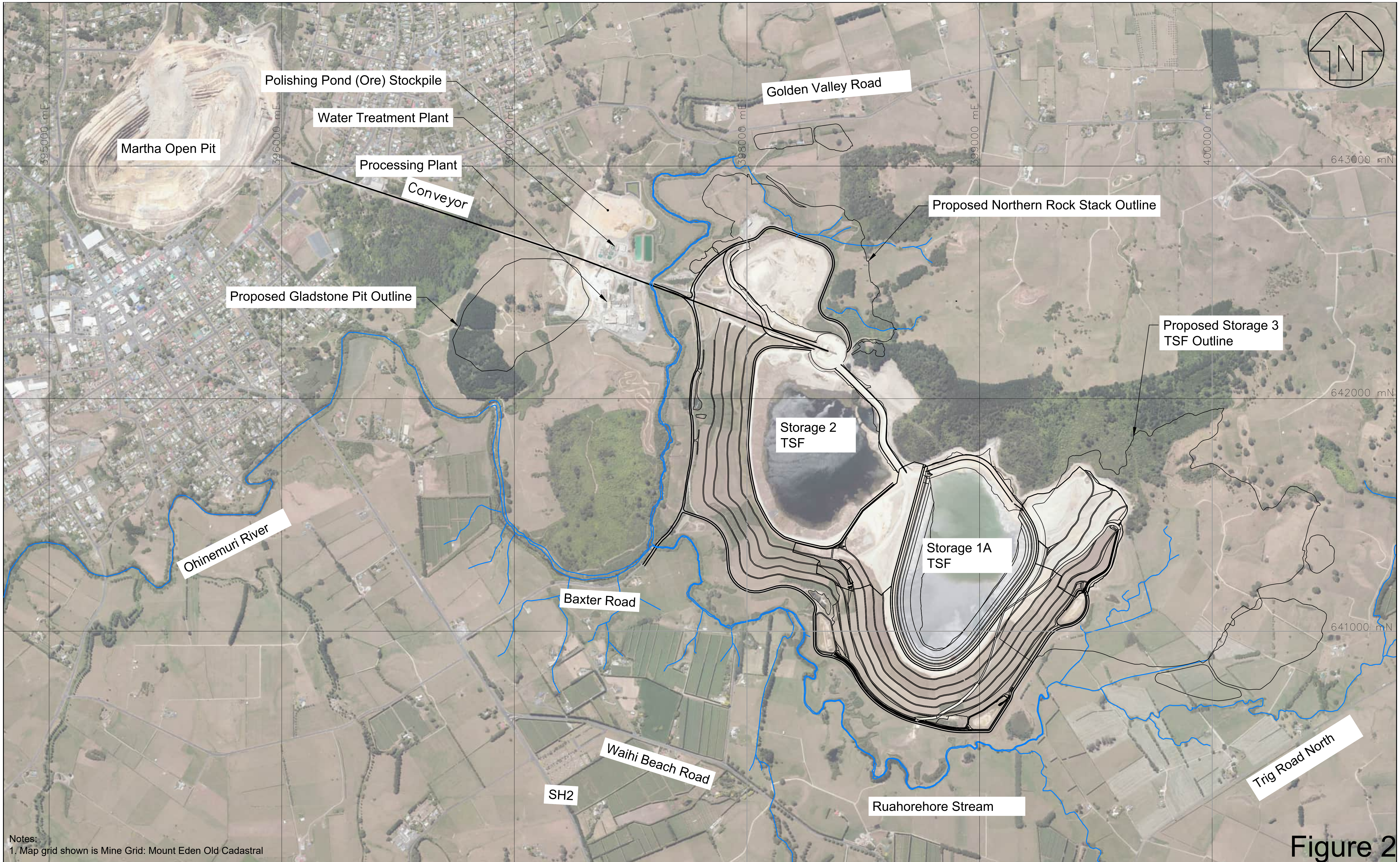

Notes:
1. Map grid shown is Mine Grid: Mount Eden Old Cadastral

Figure 2

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
Northern Rock Stack
Site Layout

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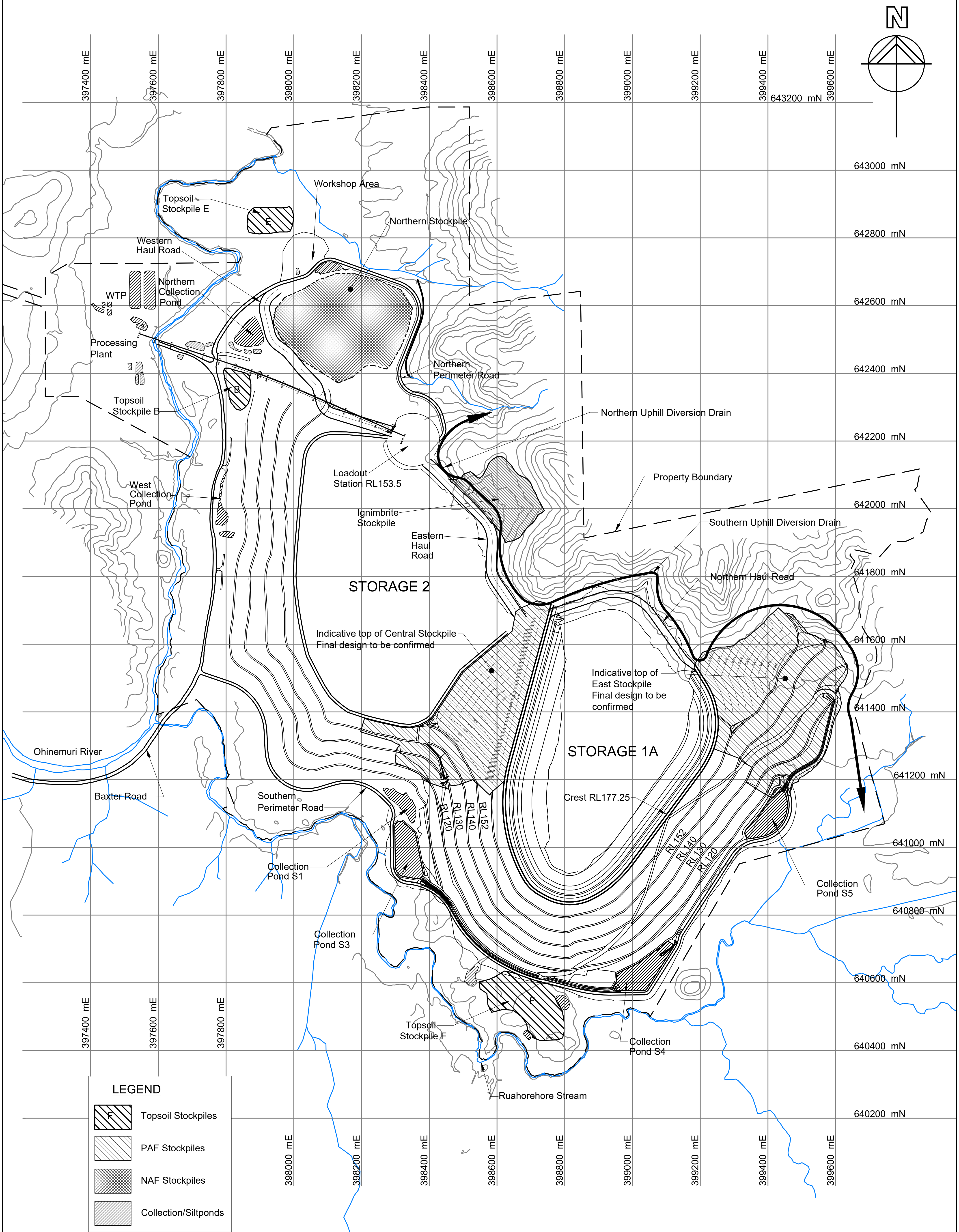

Figure 3

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) LTD - WAIHI
Northern Rock Stack
Development Site General Layout

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Drawn:	JL
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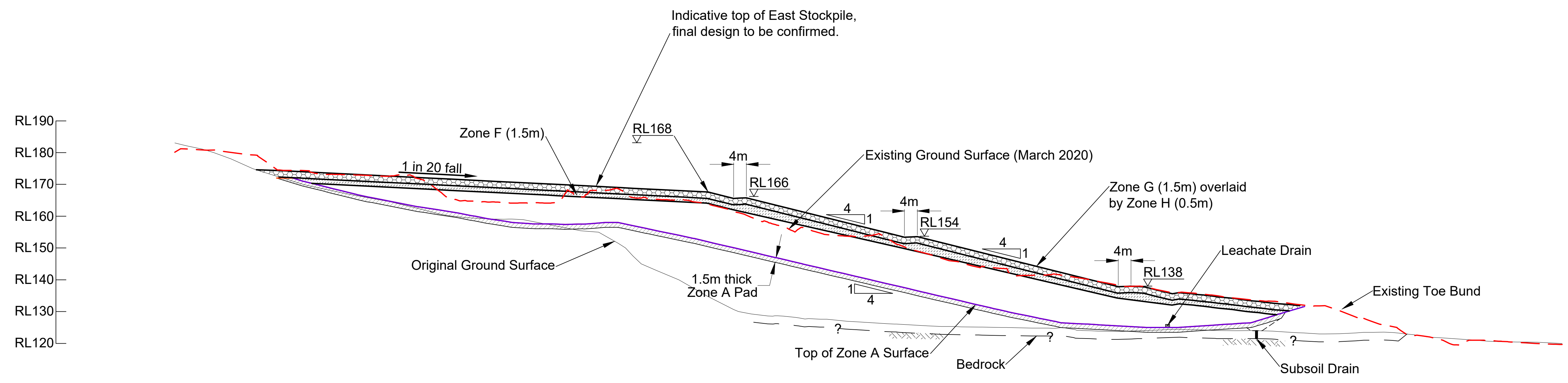
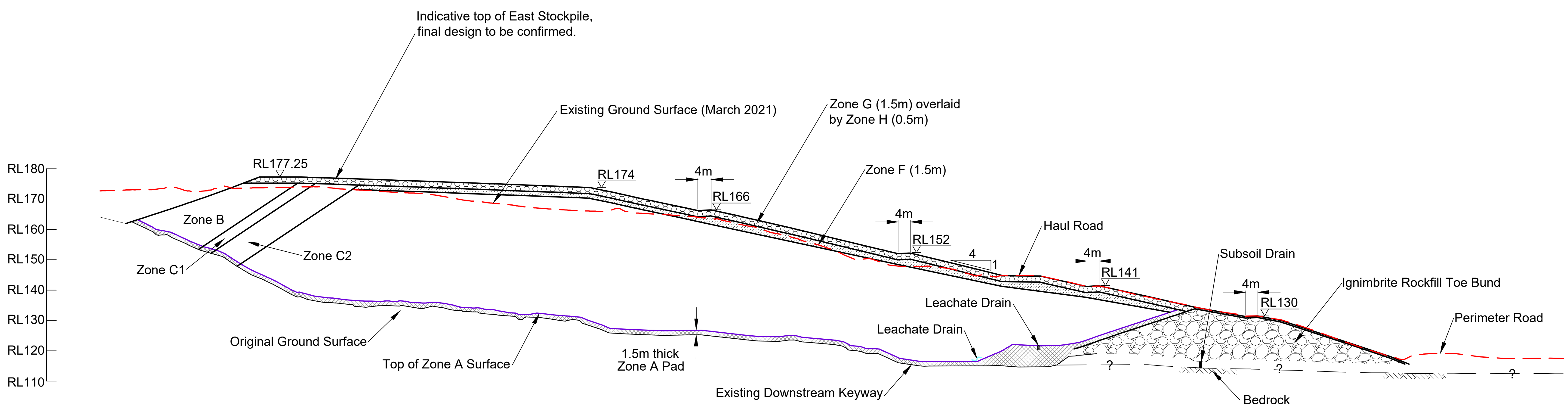


East Stockpile - Cross Section 10/50



East Stockpile - Cross Section 11/50

Figure 4

OCEANAGOLD
WAIHI OPERATION

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

Preliminary Issue	Signed:	Date:
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:26-04-2014

No.	BY	DATE	REVISION	CHECKED	APPROV.
3	JL	24-05-2021	Asbuilt March 2021 Contours	ET	TM
2	JL	04-12-2020	Project Title / OG DWG No.	ET	TM
1	JL	26-11-20	Construction 2020 Update	ET	TM
0	PHH	18-6-2014	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	6-12-2013
CHECKED	TM	6-12-2013
DRAWN	PHH	18-6-2014

OG DWG No. WAI-983-080-DWG-CI-9379

PROJECT: Storage 1A RL173.3

AREA: Development Site

CONSULTANT DRAWING No. 7604-52.dwg

JOB NUMBER:	ORIGINAL SCALE:	SIZE:
7604	1:1500	A3

TITLE
EAST STOCKPILE
Cross Sections

DRAWING No. 7604-52

REV. No. 3

Figure 5

OCEANAGOLD WAIHI OPERATION

EGL Engineering Geology Ltd
Geotechnical, Earthquake and Dam Engineers
+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

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

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

	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN		

PROJECT: Martha Mine NRS

AREA: DEVELOPMENT SITE

TITLE
Site Plan
Waste Disposal Area
Tails / Waste Rock 080

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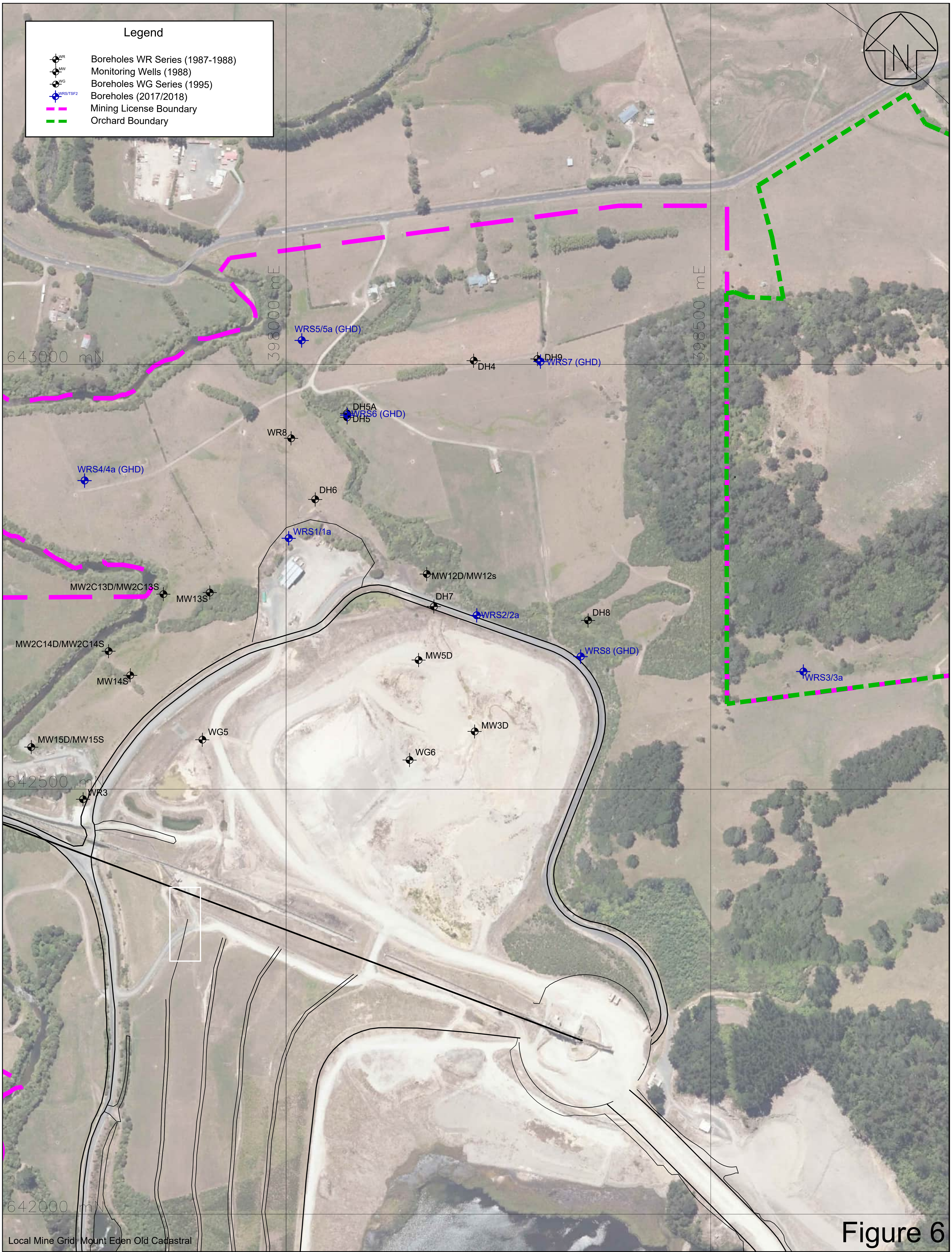

Figure 6

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OCEANA GOLD (NZ) LTD - WAIHI
WAIHI NORTH PROJECT
Northern Rock Stack-
Borehole Location Plan

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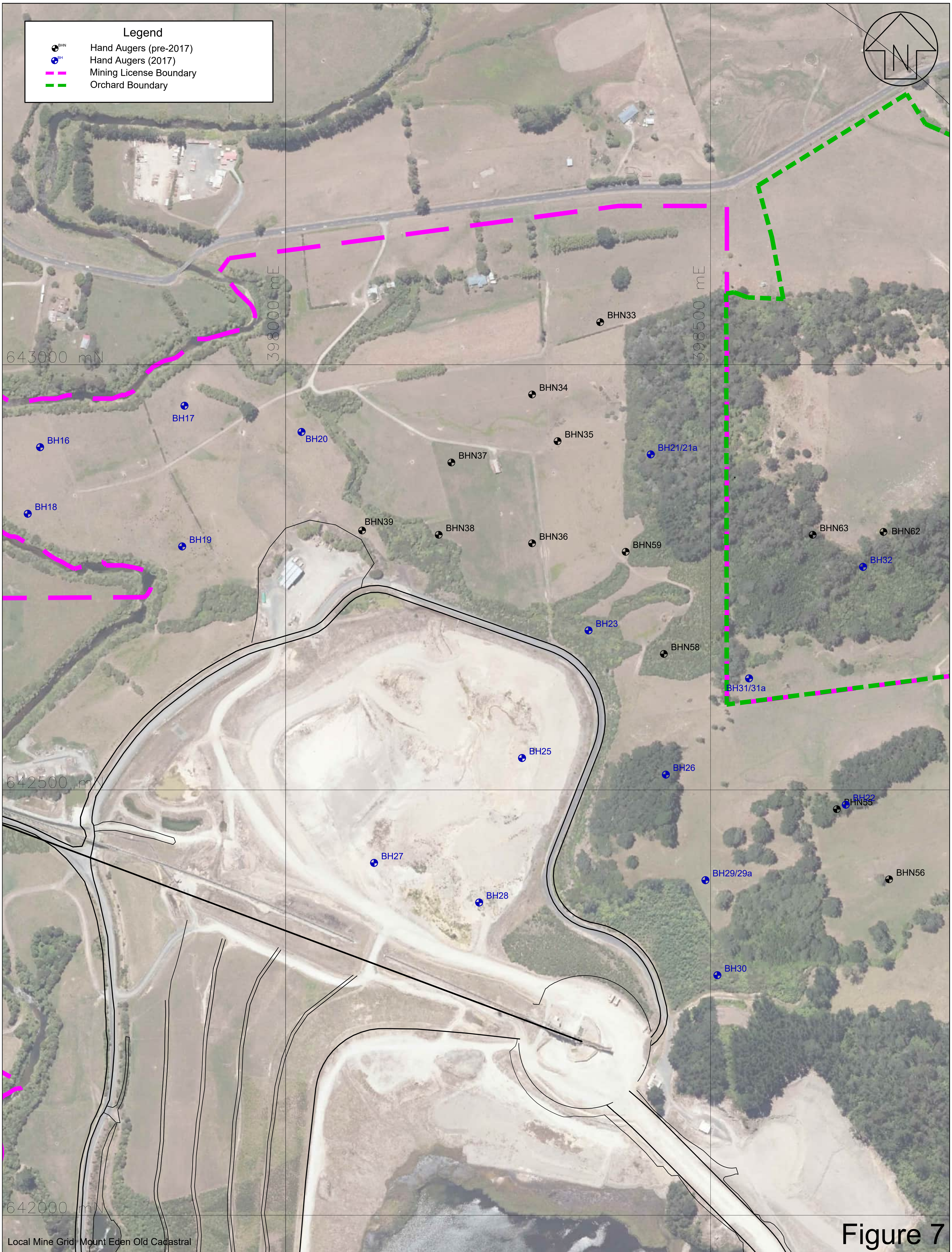

Figure 7

EGL
Geotechnical, Earthquake and Dam Engineers

OCEANA GOLD (NZ) LTD - WAIHI
WAIHI NORTH PROJECT
Northern Rock Stack-
Hand Auger Location Plan

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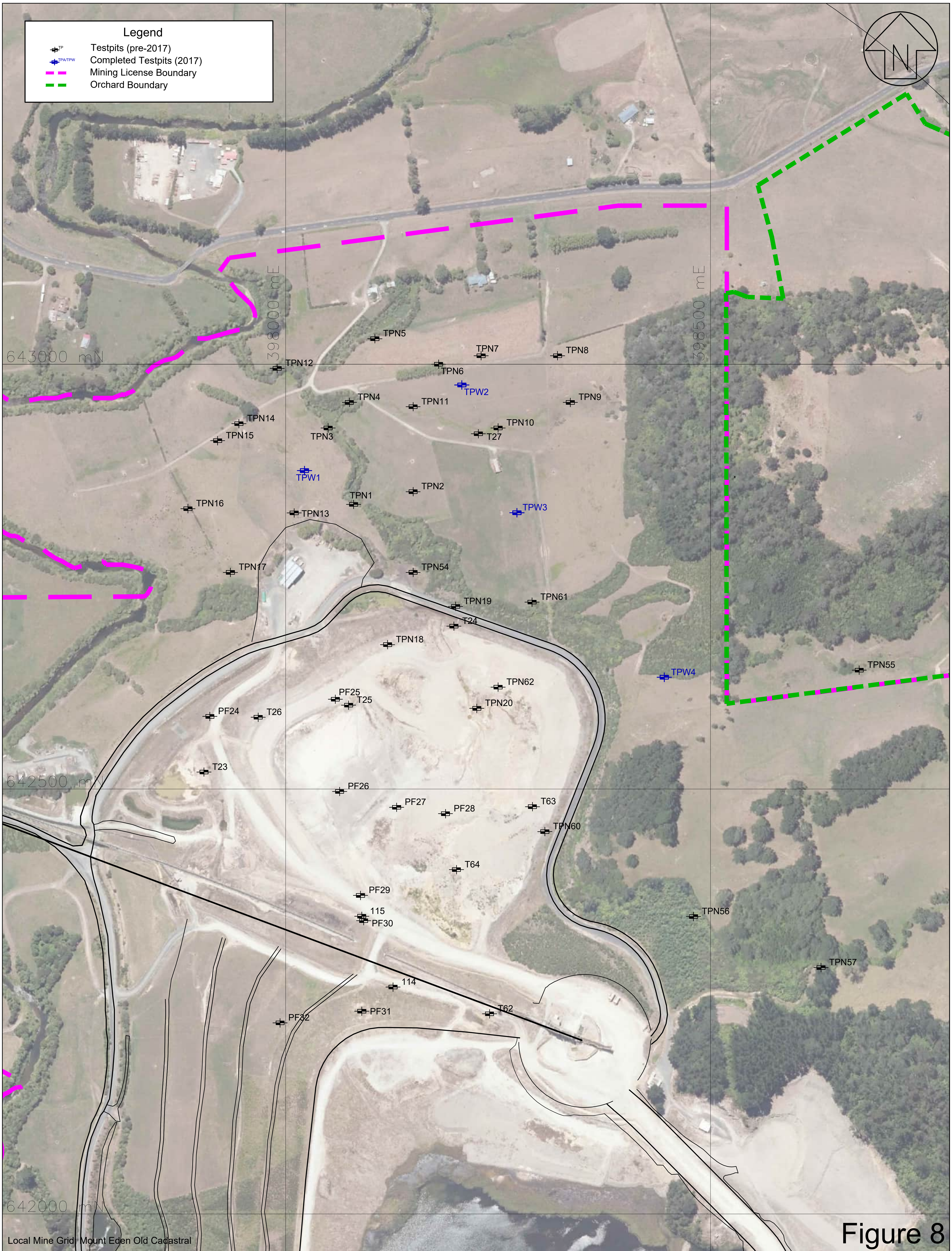

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Geotechnical, Earthquake and Dam Engineers

OCEANA GOLD (NZ) LTD - WAIHI
WAIHI NORTH PROJECT
Northern Rock Stack-
Test Pit Location Plan

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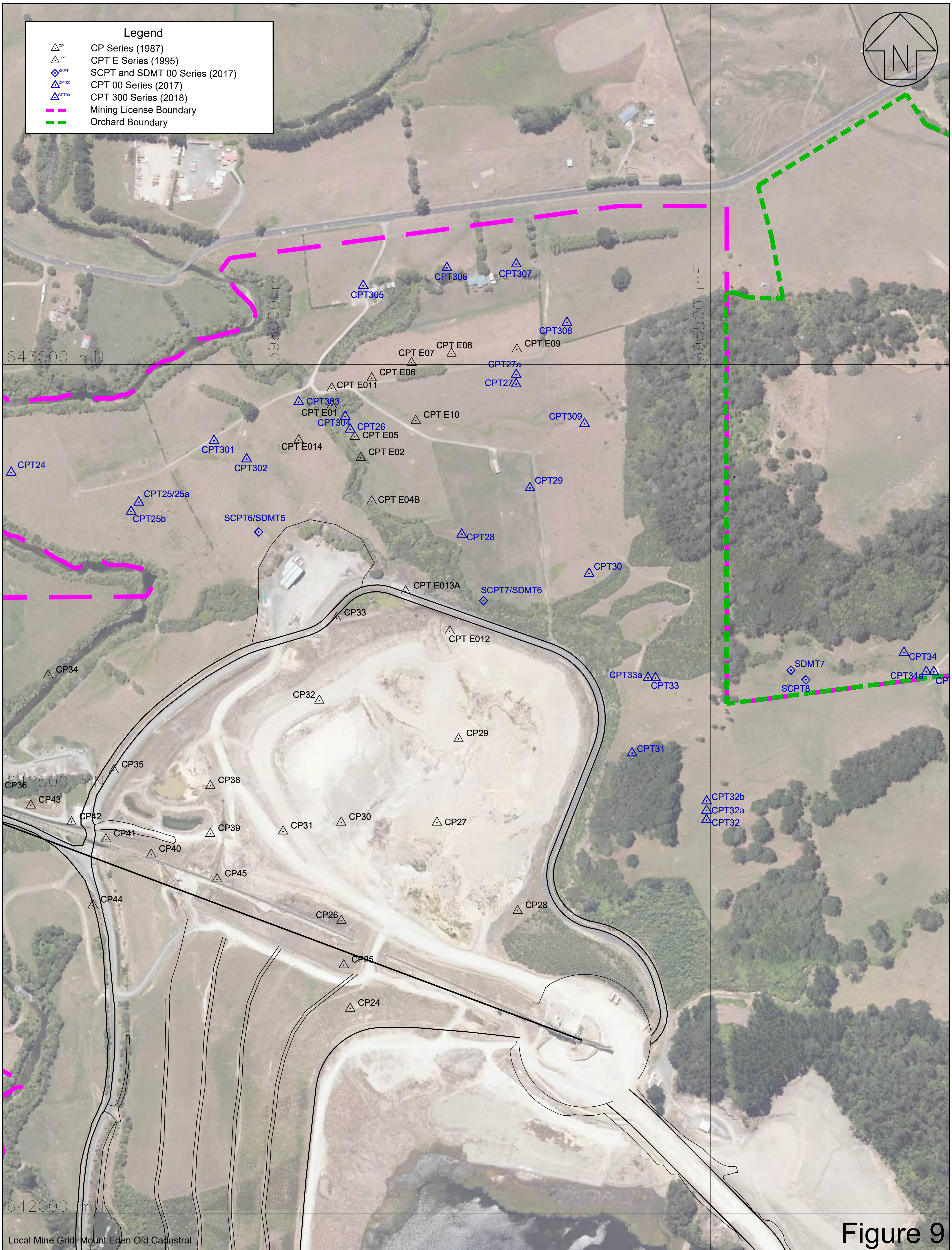

Figure 9

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OCEANA GOLD (NZ) LTD - WAIHI
WAIHI NORTH PROJECT
Northern Rock Stack-
CPT and Shearwave Velocity Location Plan

Drawing No.	8332–Fig8
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Drawn:	JL
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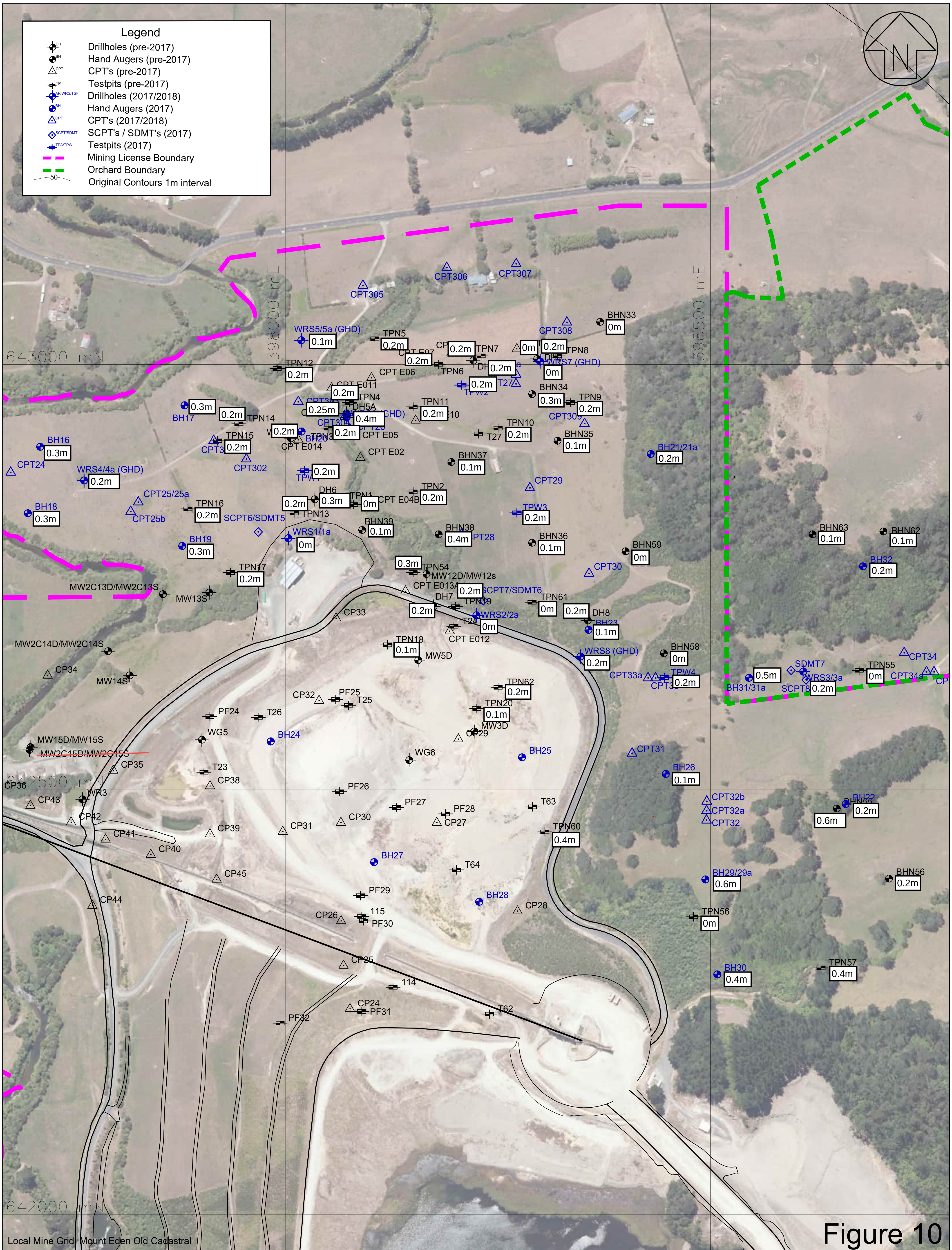

Figure 10

Geotechnical, Earthquake and Dam Engineers

OCEANA GOLD (NZ) LTD - WAIHI
WAIHI NORTH PROJECT
Northern Rock Stack-
Thickness of Topsoil

Drawing No.	8332–Fig9
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Drawn:	JL
Scale:	1: 4000 (@A3)
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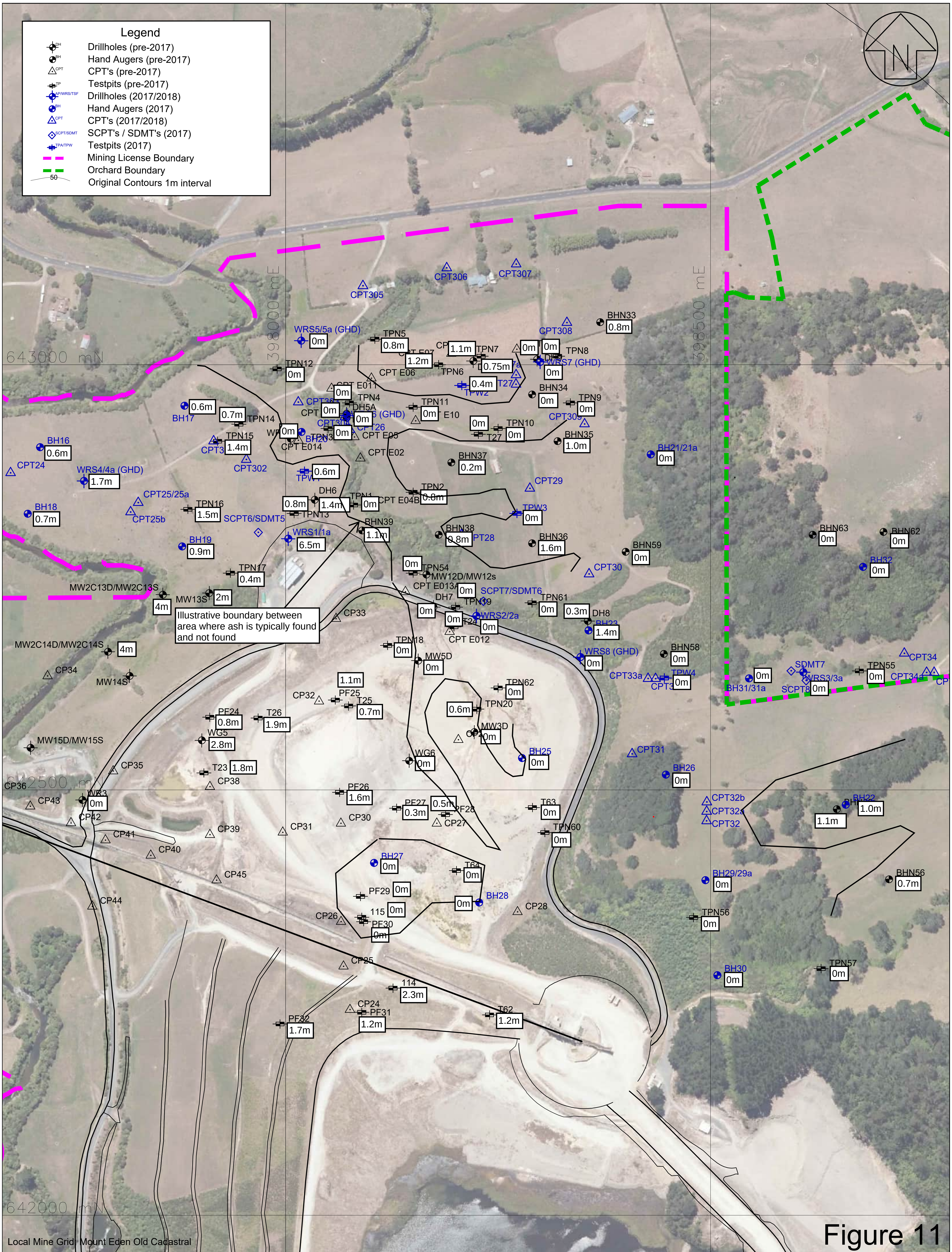

EGL Geotechnical, Earthquake and Dam Engineers

OCEANA GOLD (NZ) LTD - WAIHI
WAIHI NORTH PROJECT
Northern Rock Stack-
Thickness of Volcanic Ash Deposits

Drawing No.	8332–Fig10
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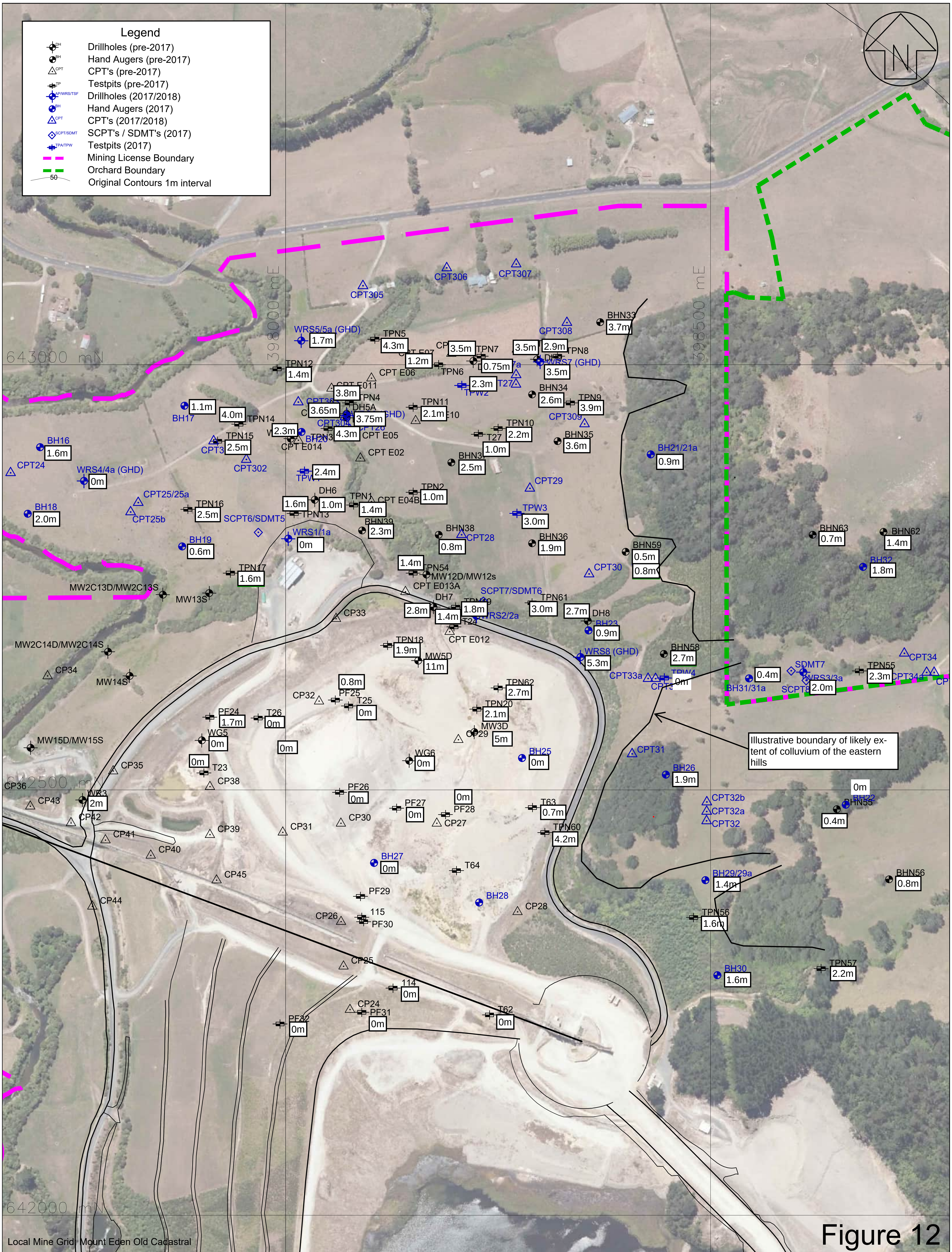

Geotechnical, Earthquake and Dam Engineers

OCEANA GOLD (NZ) LTD - WAIHI
WAIHI NORTH PROJECT
Northern Rock Stack-
Thickness of Surficial Alluvium and Colluvium

Drawing No.	8332–Fig11
Date:	Nov 2018
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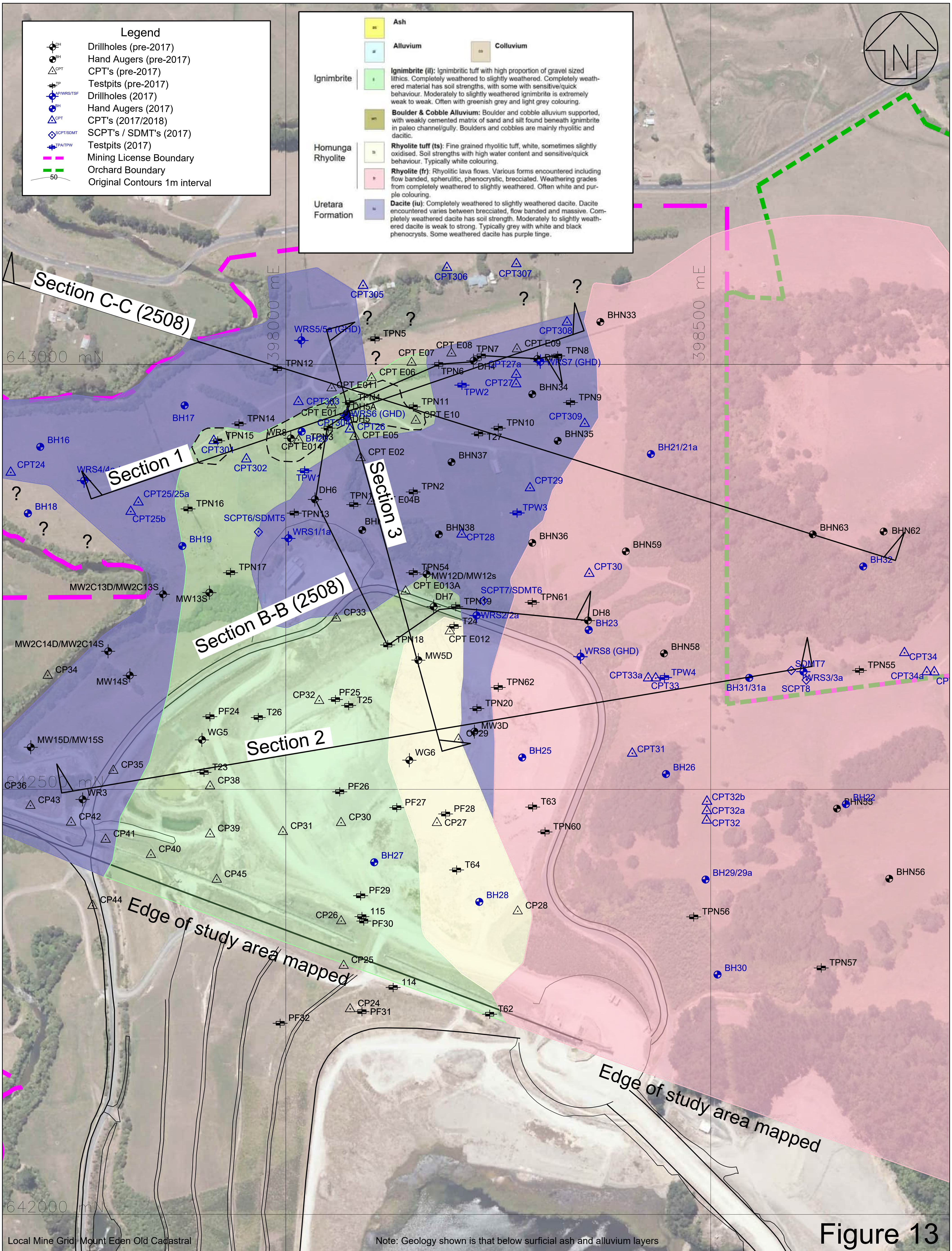


OCEANA GOLD (NZ) LTD - WAIHI

WAIHI NORTH PROJECT

Northern Rock Stack

Site Geology Plan

EGL Geotechnical, Earthquake and Dam Engineers

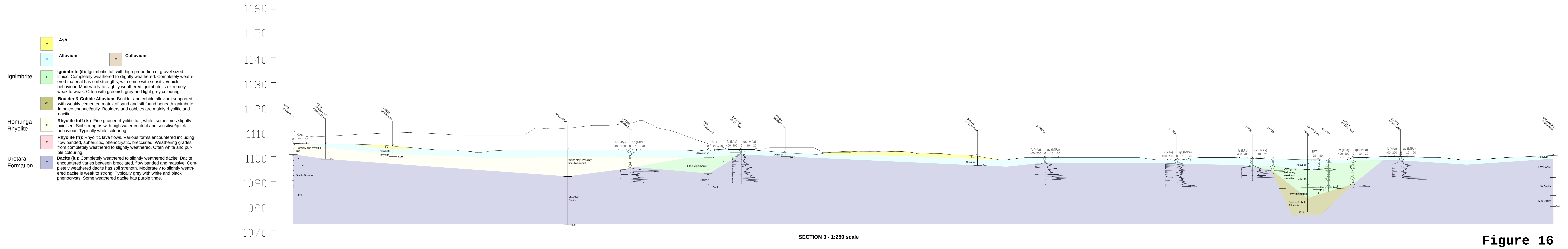
Drawing No.	8332–Fig12
Date:	May 2019
Drawn:	JL
Scale:	1: 4000 (@A3)
Filename:	8332–fig12.dwg

Ash
as
Alluvium
al
Colluvium
co
Ignimbrite
il
Ignimbrite (il): Ignimbritic tuff with high proportion of gravel sized lithics. Completely weathered to slightly weathered. Completely weathered material has soil strengths, with some with sensitive/quick behaviour. Moderately to slightly weathered ignimbrite is extremely weak to weak. Often with greenish grey and light grey colouring.
wn
Boulder & Cobble Alluvium: Boulder and cobble alluvium supported, with weakly cemented matrix of sand and silt found beneath ignimbrite in paleo channel/gully. Boulders and cobbles are mainly rhyolitic and dacitic.
Homunga Rhyolite
ts
Rhyolite tuff (ts): Fine grained rhyolitic tuff, white, sometimes slightly oxidised. Soil strengths with high water content and sensitive/quick behaviour. Typically white colouring.
fr
Rhyolite (fr): Rhyolitic lava flows. Various forms encountered including flow banded, spherulitic, phenocrystic, brecciated. Weathering grades from completely weathered to slightly weathered. Often white and purple colouring.
Uretara Formation
iu
Dacite (iu): Completely weathered to slightly weathered dacite. Dacite encountered varies between brecciated, flow banded and massive. Completely weathered dacite has soil strength. Moderately to slightly weathered dacite is weak to strong. Typically grey with white and black phenocrysts. Some weathered dacite has purple tinge.
1140
1130
1120
1110
1100
1090
1080
1070
1060
1050
SECTION 1 - 1:250 scale

Figure 14

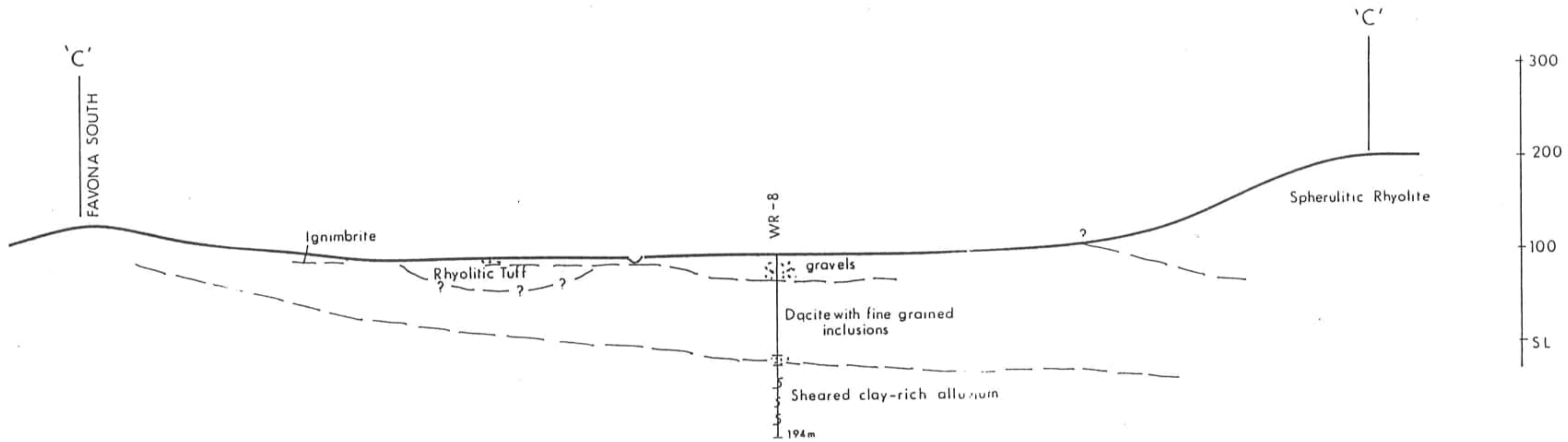
SECTION 2 - 1:250 scale

Figure 15



Ash
Alluvium
Colluvium
Ignimbrite
Ignimbrite (il): Ignimbritic tuff with high proportion of gravel sized lithics. Completely weathered to slightly weathered. Completely weathered material has soil strengths, with some with sensitive/quick behaviour. Moderately to slightly weathered ignimbrite is extremely weak to weak. Often with greenish grey and light grey colouring.
Boulder & Cobble Alluvium: Boulder and cobble alluvium supported, with weakly cemented matrix of sand and silt found beneath ignimbrite in paleo channel/gully. Boulders and cobbles are mainly rhyolitic and dacitic.
Homunga Rhyolite
Rhyolite tuff (ts): Fine grained rhyolitic tuff, white, sometimes slightly oxidised. Soil strengths with high water content and sensitive/quick behaviour. Typically white colouring.
Rhyolite (fr): Rhyolitic lava flows. Various forms encountered including flow banded, spherulitic, phenocrystic, brecciated. Weathering grades from completely weathered to slightly weathered. Often white and purple colouring.
Uretara Formation
Dacite (iu): Completely weathered to slightly weathered dacite. Dacite encountered varies between brecciated, flow banded and massive. Completely weathered dacite has soil strength. Moderately to slightly weathered dacite is weak to strong. Typically grey with white and black phenocrysts. Some weathered dacite has purple tinge.
1160
1150
1140
1130
1120
1110
1100
1090
1080
1070
SECTION 3 - 1:250 scale

Figure 16



Key:

Ignimbrites - Whitianga group
Rhyolitic tuffs - mainly pumice breccias - Whitianga group
Rhyolites - mainly sperulitic flows & domes - Minden rhyolite
Dacites - flows domes dikes & sills - Omahia andesites
Alluvium & Clays
Andesites - Beesons Island Volcanics

Figure 17

CROSS-SECTION C-C

DRAWING 2508C-17

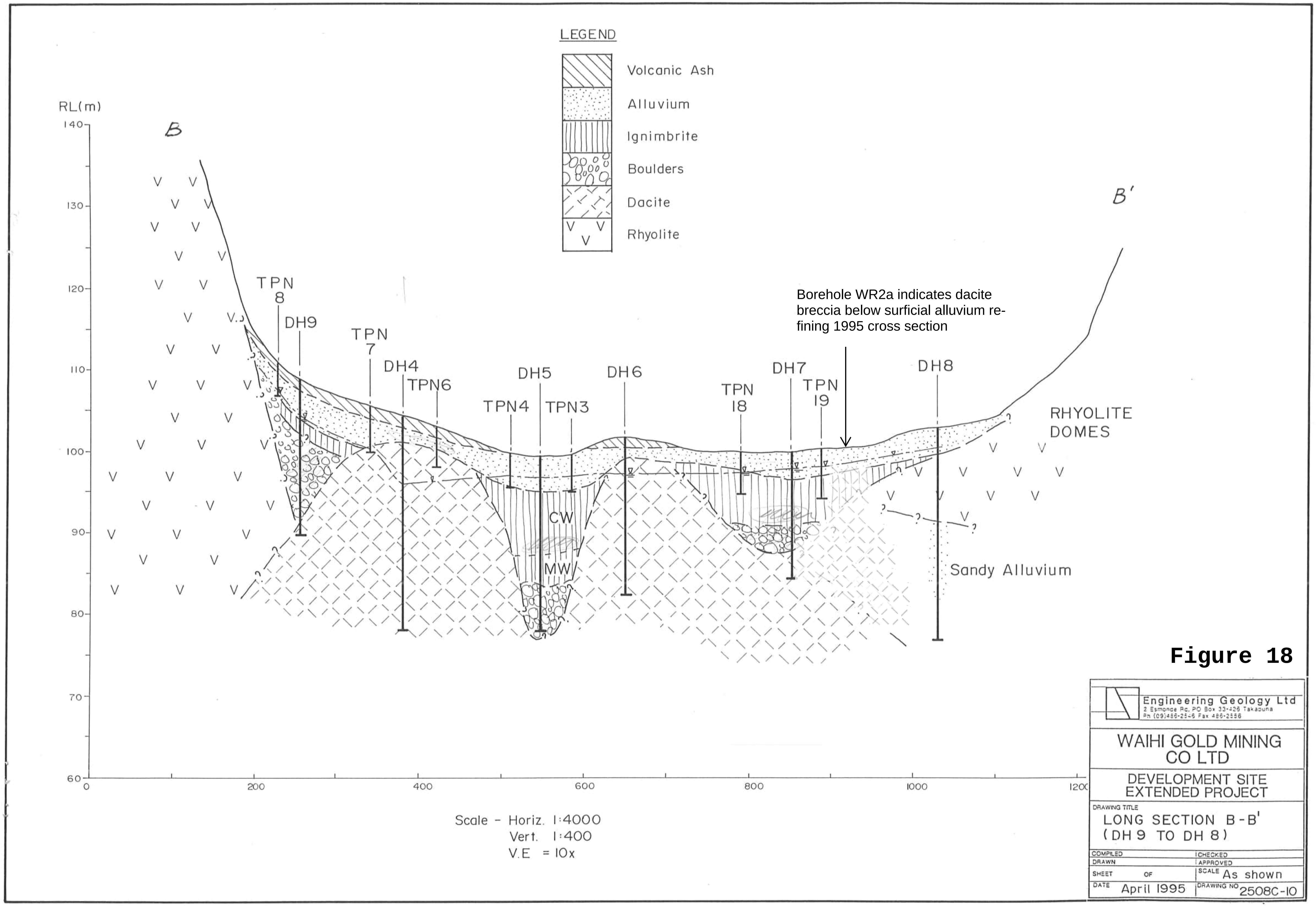
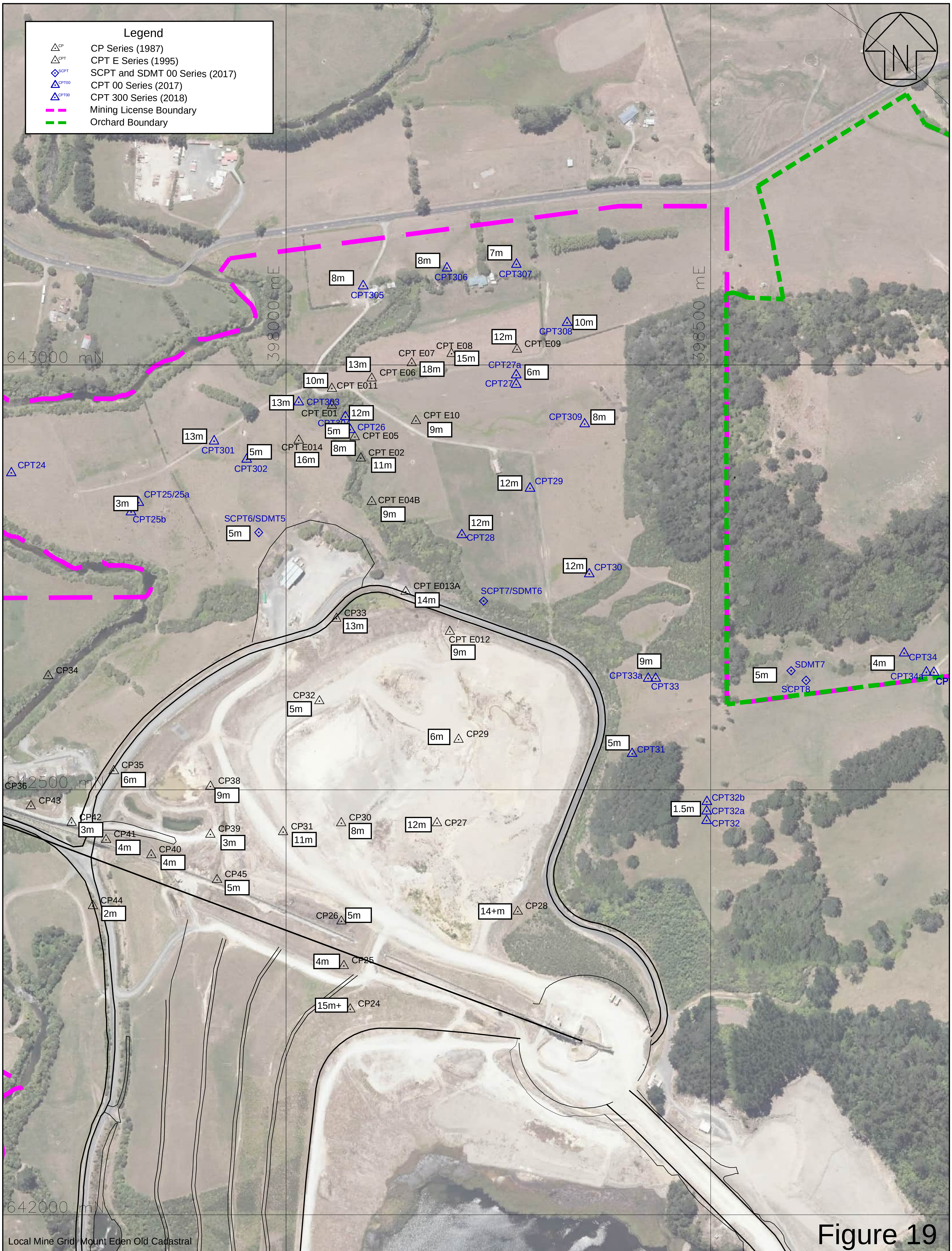

LEGEND
Volcanic Ash
Alluvium
Ignimbrite
Boulders
Dacite
Rhyolite
RL(m)
140
130
120
110
100
90
80
70
60
0
200
400
600
800
1000
1200
B
B'
TPN 8
DH9
TPN 7
DH4
TPN6
DH5
TPN4
TPN3
DH6
TPN 18
DH7
TPN 19
DH8
Borehole WR2a indicates dacite breccia below surficial alluvium re-fining 1995 cross section
RHYOLITE DOMES
CW
MW
Sandy Alluvium
Scale - Horiz. 1:4000
Vert. 1:400
V.E = 10x
Engineering Geology Ltd
WAIHI GOLD MINING CO LTD
DEVELOPMENT SITE EXTENDED PROJECT
DRAWING TITLE
LONG SECTION B-B' (DH 9 TO DH 8)
COMPILED
CHECKED
DRAWN
APPROVED
SHEET
OF
SCALE As shown
DATE April 1995
DRAWING NO 2508C-10

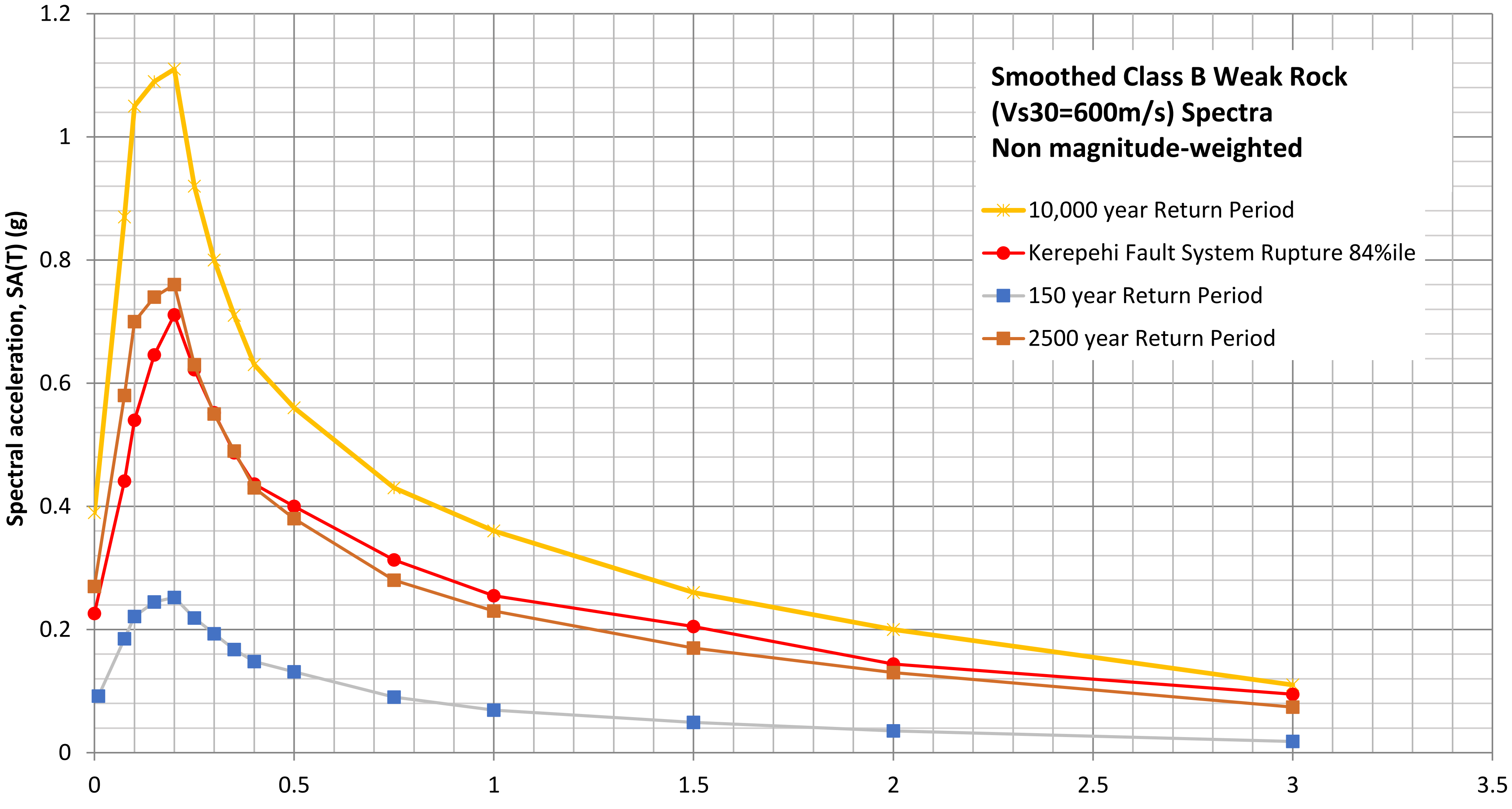
Figure 18



OCEANA GOLD (NZ) LTD - WAIHI
WAIHI NORTH PROJECT
Northern Rock Stack-
CPT Refusal Depth Plan

Geotechnical, Earthquake and Dam Engineers

Drawing No.	8332–Fig18
Date:	Nov 2018
Drawn:	JL
Scale:	1: 4000 (@A3)
Filename:	8332–fig17.dwg



SA(T) is larger component SA_{larger}

Figure 20

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 GNS SPECTRA *Response Spectra (5% Damping)*	Ref. No: 9018 Date: Aug 2021 Drawn: YW

APPENDIX A

DRAWINGS

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
EGL Geotechnical, Earthquake and Dam Engineers

DRAWING REGISTER AND TRANSMITTAL NOTICE

SHEET 1 OF 1

Client: OCEANA GOLD (NEW ZEALAND) LIMITED

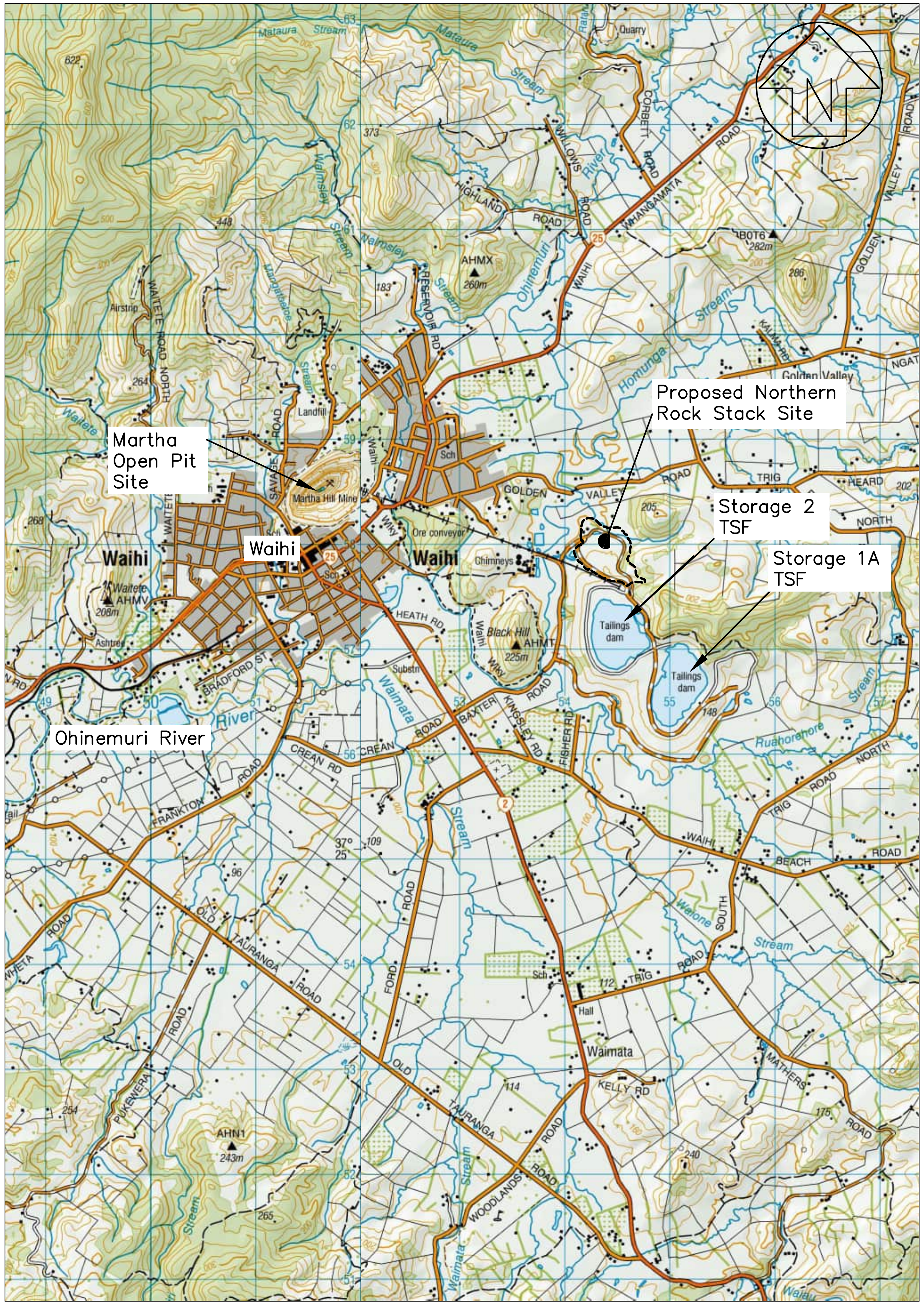
Job No. 9018

Site/Project: WAIHI NORTH PROJECT-NORTHERN ROCK STACK

	DAY	15	19	29	12	13
	MONTH	07	07	09	10	12
	YEAR	21	21	21	21	24
Drawing No.	**Drawing Title**	**Revision**				
WAI-983-080-DWG-CI-0700	Locality Plan and Index - Northern Rock Stack - Tails / Waste Rock 080	C	D	E		
WAI-983-080-DWG-CI-0715	Layout Plan - Northern Rock Stack - Tails / Waste Rock 080	B	C			D
WAI-983-080-DWG-CI-0716	Sections - Northern Rock Stack - Tails / Waste Rock 080	C	D		E	
WAI-983-080-DWG-CI-0717	Sections - Northern Rock Stack - Tails / Waste Rock 080	C	D		E	
WAI-983-080-DWG-CI-0730	Perimeter and Diversion Drains Sections Sheet 1 of 4 - Tails / Waste Rock 080	B				
WAI-983-080-DWG-CI-0731	Perimeter and Diversion Drains Sections Sheet 2 of 4 - Tails / Waste Rock 080	A				B
WAI-983-080-DWG-CI-0732	Perimeter and Diversion Drains Sections Sheet 3 of 4 - Tails / Waste Rock 080	A				
WAI-983-080-DWG-CI-0733	Perimeter and Diversion Drains Sections Sheet 4 of 4 - Tails / Waste Rock 080	A				
WAI-983-080-DWG-CI-0761	Typical Section - Collection Pond - Tails / Waste Rock 080			A		
WAI-983-080-DWG-CI-0770	Layout Plan - Leachate Drain - Tails / Waste Rock 080	C				D
WAI-983-080-DWG-CI-0772	Layout Plan - Subsoil Drains - Tails / Waste Rock 080	C		D		E
WAI-983-080-DWG-CI-0780	Layout Plan - Closure Rehabilitation - Tails / Waste Rock 080			A		B
WAI-983-080-DWG-CI-0781	Sections - Closure Rehabilitation - Tails / Waste Rock 080		A		B	
WAI-983-080-DWG-CI-0782	Sections - Closure Rehabilitation - Tails / Waste Rock 080		A		B	

Distribution	Reason Of Issue				
OCEANA GOLD (NEW ZEALAND) LIMITED	P	P	P	P	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–0700	Locality Plan and Index – Northern Rock Stack – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0715	Layout Plan – Northern Rock Stack – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0716	Sections – Northern Rock Stack – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0717	Sections – Northern Rock Stack – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0730	Perimeter and Diversion Drains Sections Sheet 1 of 4 – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0731	Perimeter and Diversion Drains Sections Sheet 2 of 4 – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0732	Perimeter and Diversion Drains Sections Sheet 3 of 4 – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0733	Perimeter and Diversion Drains Sections Sheet 4 of 4 – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0761	Typical Section – Collection Pond – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0770	Layout Plan – Leachate Drain – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0772	Layout Plan – Subsoil Drains – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0780	Layout Plan – NRS Closure – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0781	Sections – NRS Closure – Tails / Waste Rock 080
WAI–983–080–DWG–CI–0782	Sections – NRS Closure – Tails / Waste Rock 080

OCEANAGOLD WAIHI OPERATION

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

Preliminary Issue	Signed:	Date: 15–07–21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

No.	BY	DATE	REVISION	CHECKED	APPROV.
E	ET	29–09–21	Added Closure Plan	ET	TM
D	JL	19–07–21	Added Closure Section DWGs	ET	TM
C	MC	15–07–21	WNP Preliminary Issue	ET	TM
B	JL	13–11–20	Preliminary Issue	ET	TM
A	JL	09–09–20	Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	15–07–21
DESIGNED	ET	15–07–21
CHECKED	ET	15–07–21
DRAWN	MC	15–07–21

PROJECT: Northern Rock Stack

AREA: DEVELOPMENT SITE

JOB NUMBER: 9018 | ORIGINAL SCALE: as shown | SIZE: A3

TITLE: Locality Plan and Index Northern Rock Stack Tails / Waste Rock 080

DRAWING No. WAI–983–080–DWG–CI–0700 | REV. No. E

Local Mine Grid: Mount Eden Old Cadastral
2019 OGNZL Aerial

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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

Preliminary Issue	Signed:	Date: 15-07-21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

No.	BY	DATE	REVISION	CHECKED	APPROV.
D	SK	12-12-24	Addition of Borrow Area	AH	ET
C	JL	19-07-21	Closure Sections Reference	ET	TM
B	MC	15-07-21	Section updates	ET	TM
A	MC	08-07-21	WNP Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	15-07-21
DESIGNED	ET	15-07-21
CHECKED	ET	15-07-21
DRAWN	MC	15-07-21

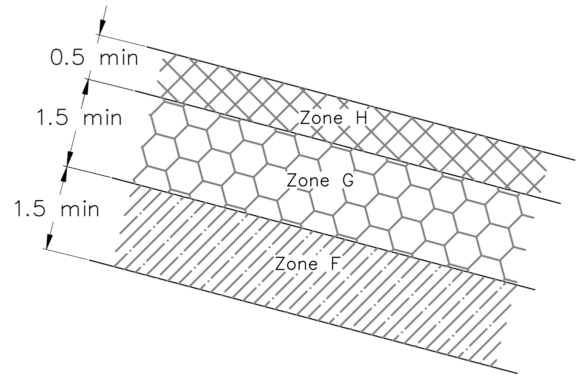
PROJECT: Waihi North Project

AREA: DEVELOPMENT SITE

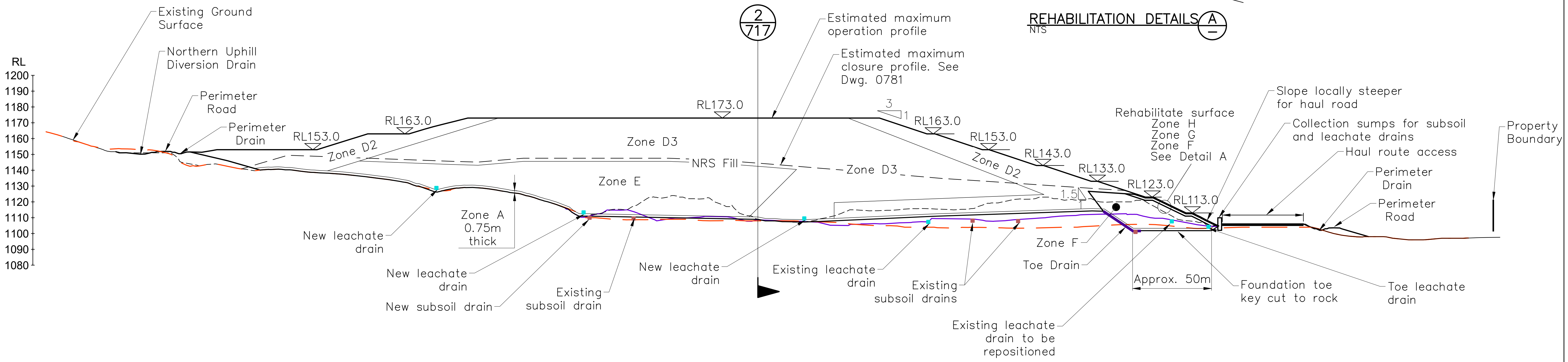
TITLE: Layout Plan Northern Rock Stack Tails / Waste Rock 080

JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.	REV. No.
9018	1:4000	A3	WAI-983-080-DWG-CI-0715	D

Proposed design
Estimated maximum closure profile
Ground profile
Existing ground profile
Original ground profile
Survey before fill placed in existing Northern Stockpile
Leachate drains
Subsoil drains



REHABILITATION DETAILS A
NTS



NORTHERN ROCK STACK SECTION 1 (1/715) (1/717) (1/770) (1/772)
scale 1:2500

Notes
1. Positions and levels of subsoil and leachate drains are indicative only.

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WAIHI OPERATION

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

Preliminary Issue	Signed:	Date: 15-07-21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

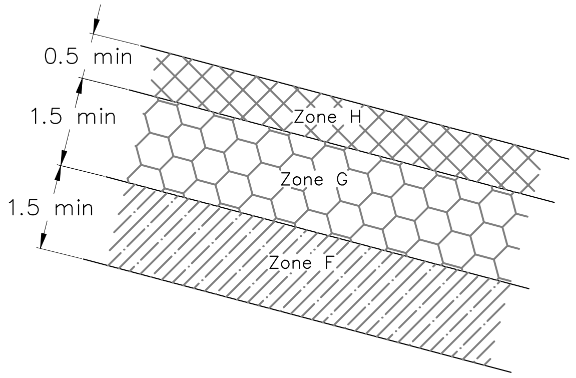
No.	BY	DATE	REVISION	CHECKED	APPROV.
E	ET	12-10-21	Added Zone D2, D3, E	TM	TM
D	JL	19-07-21	Changed Zone G,H and F	ET	TM
C	MC	15-07-21	WNP NRS Design Change	ET	TM
B	JL	15-02-21	Zone A Thickness and Label Change	ET	TM
A	JL	09-09-20	Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	15-07-21
DESIGNED	ET	15-07-21
CHECKED	ET	15-07-21
DRAWN	MC	15-07-21

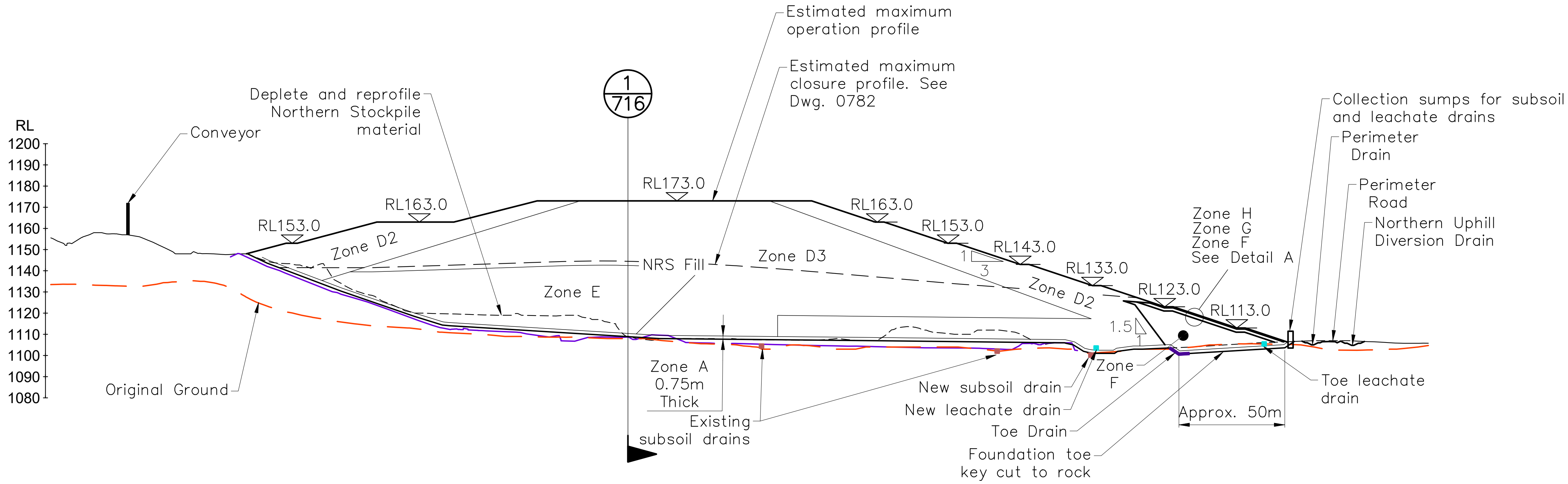
PROJECT: Northern Rock Stack
AREA: DEVELOPMENT SITE
JOB NUMBER: 9018
ORIGINAL SCALE: as shown
SIZE: A3

TITLE
Sections
Northern Rock Stack
Tails / Waste Rock 080
DRAWING No. WAI-983-080-DWG-CI-0716
REV. No. E

Proposed design
Estimated maximum closure profile
Ground profile
Existing ground profile
Original ground profile
Survey before fill placed in existing Northern Stockpile
Leachate drains
Subsoil drains



REHABILITATION DETAILS A
NTS



NORTHERN ROCK STACK SECTION 2 (2/715) (2/716) (2/770) (2/772)
scale 1:2500

Notes
1. Positions and levels of subsoil and leachate drains are indicative only.

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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

Preliminary Issue	Signed:	Date: 15-07-21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

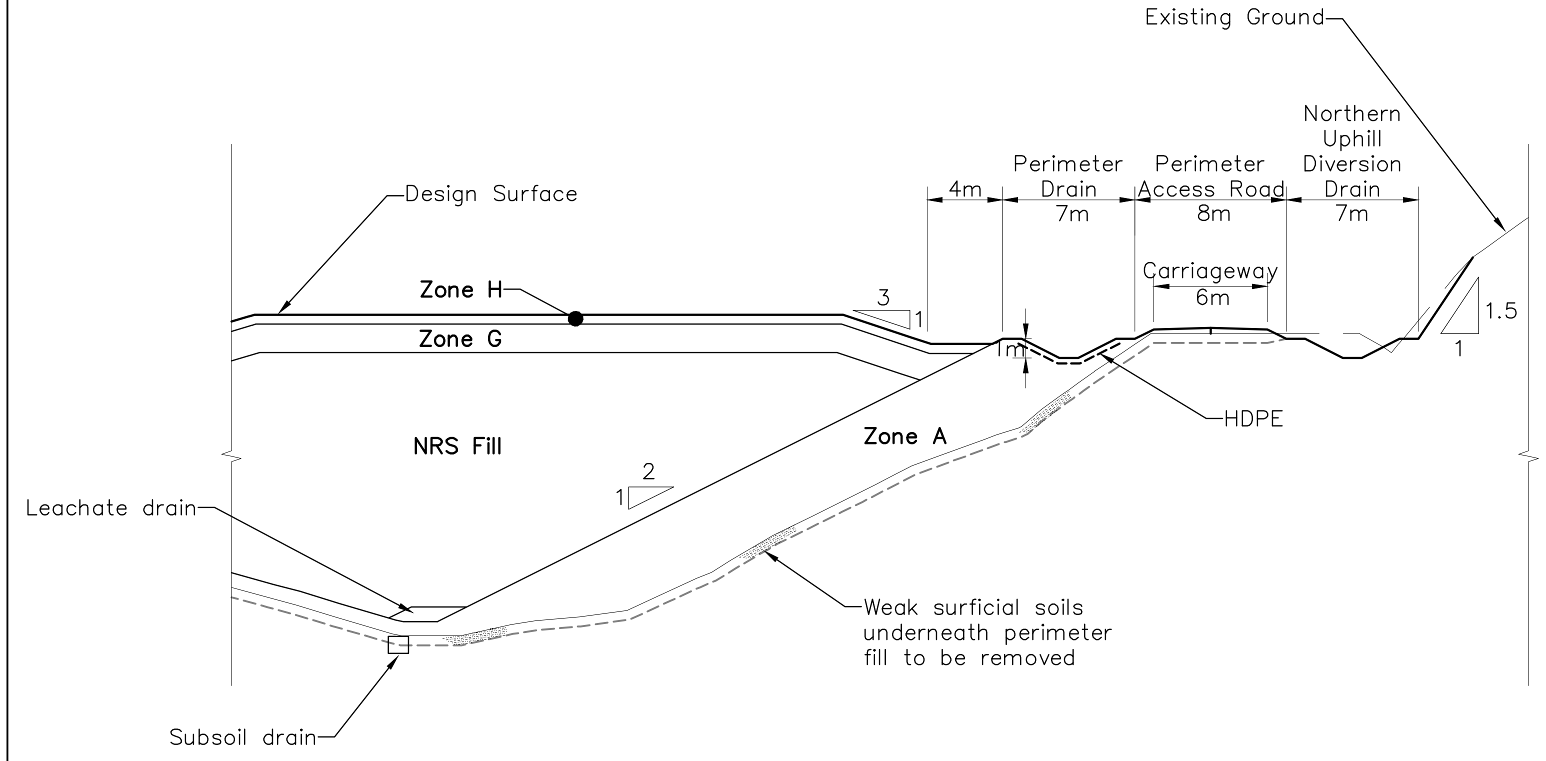
No.	BY	DATE	REVISION	CHECKED	APPROV.
E	ET	12-10-21	Added Zone D2, D3, E	TM	TM
D	JL	19-07-21	Changed Zone G,H and F	ET	TM
C	MC	15-07-21	WNP NRS Design Change	ET	TM
B	JL	15-02-21	Zone A Thickness and Label Change	ET	TM
A	JL	09-09-20	Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	15-07-21
DESIGNED	ET	15-07-21
CHECKED	ET	15-07-21
DRAWN	MC	15-07-21

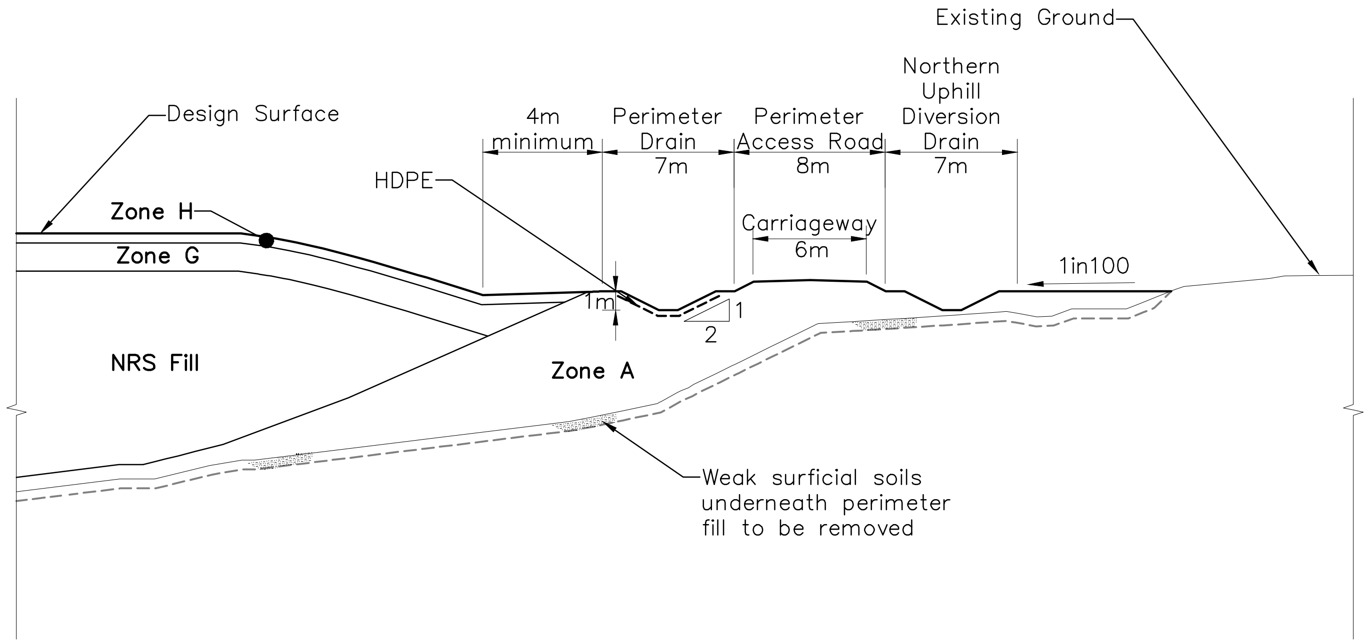
PROJECT: Northern Rock Stack
AREA: DEVELOPMENT SITE
JOB NUMBER: 9018
ORIGINAL SCALE: as shown
SIZE: A3

TITLE
Sections
Northern Rock Stack
Tails / Waste Rock 080

DRAWING No. WAI-983-080-DWG-CI-0717
REV. No. E



PERIMETER AND UPHILL DIVERSION DRAIN SECTION 7/715



PERIMETER AND UPHILL DIVERSION DRAIN SECTION 8/715

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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

Preliminary Issue	Signed:	Date: 15-07-21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	MC	15-07-21	WNP Drain Alignment Change	ET	TM
A	JL	09-09-20	Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	15-07-21
DESIGNED	ET	15-07-21
CHECKED	ET	15-07-21
DRAWN	MC	15-07-21

PROJECT: Northern Rock Stack

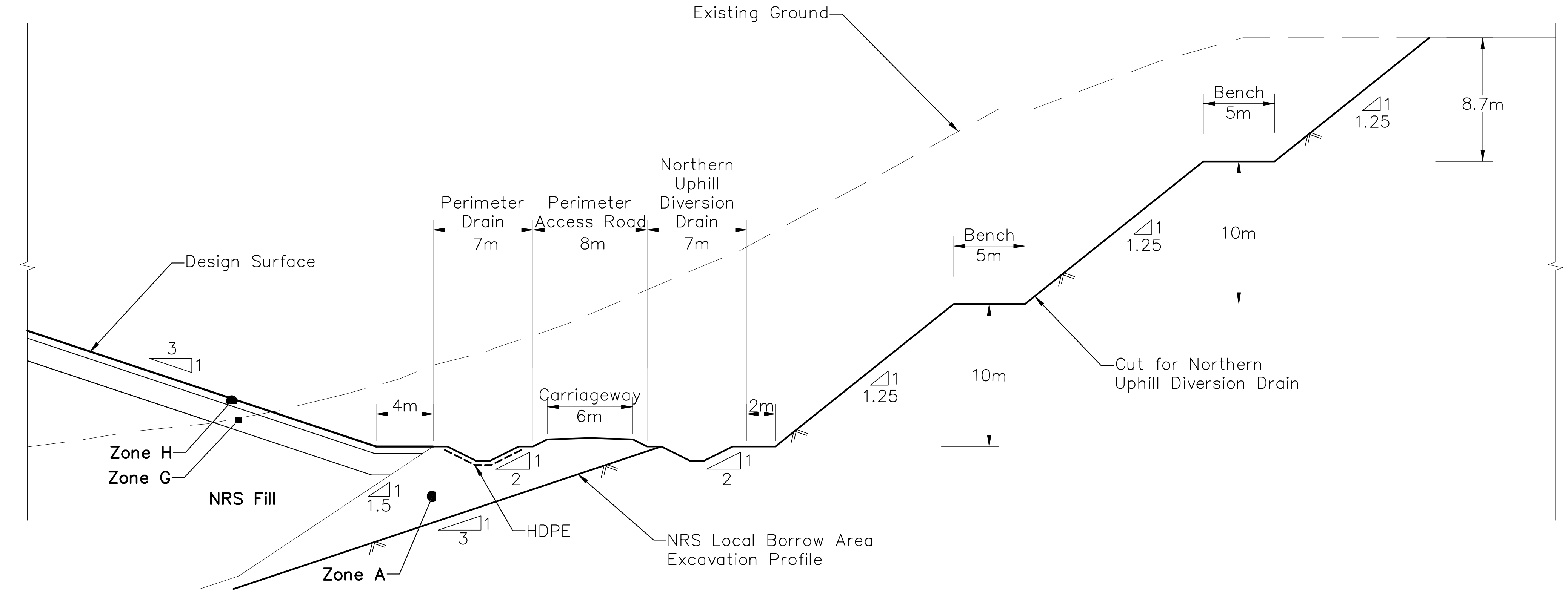
AREA: DEVELOPMENT SITE

JOB NUMBER:	ORIGINAL SCALE:	SIZE:
9018	1:400	A3

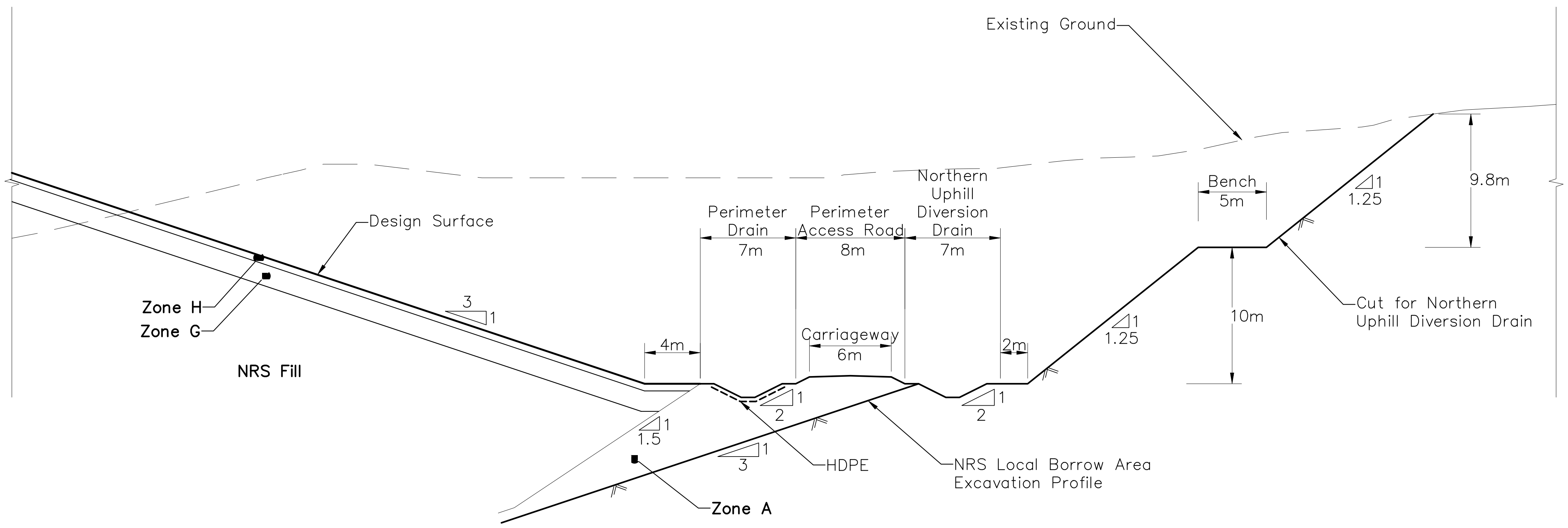
TITLE: Perimeter and Diversion Drains Sections Sheet 1 of 4 Tails / Waste Rock 080

DRAWING No. WAI-983-080-DWG-CI-0730

REV. No. B



PERIMETER AND UPHILL DIVERSION DRAIN SECTION 9/715



PERIMETER AND UPHILL DIVERSION DRAIN SECTION 10/715

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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

Preliminary Issue	Signed:	Date: 15–07–21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	SK	12–12–24	Addition of Borrow Area	AH	ET
A	MC	15–07–21	WNP Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	15–07–21
DESIGNED	ET	15–07–21
CHECKED	ET	15–07–21
DRAWN	MC	15–07–21

PROJECT: Northern Rock Stack

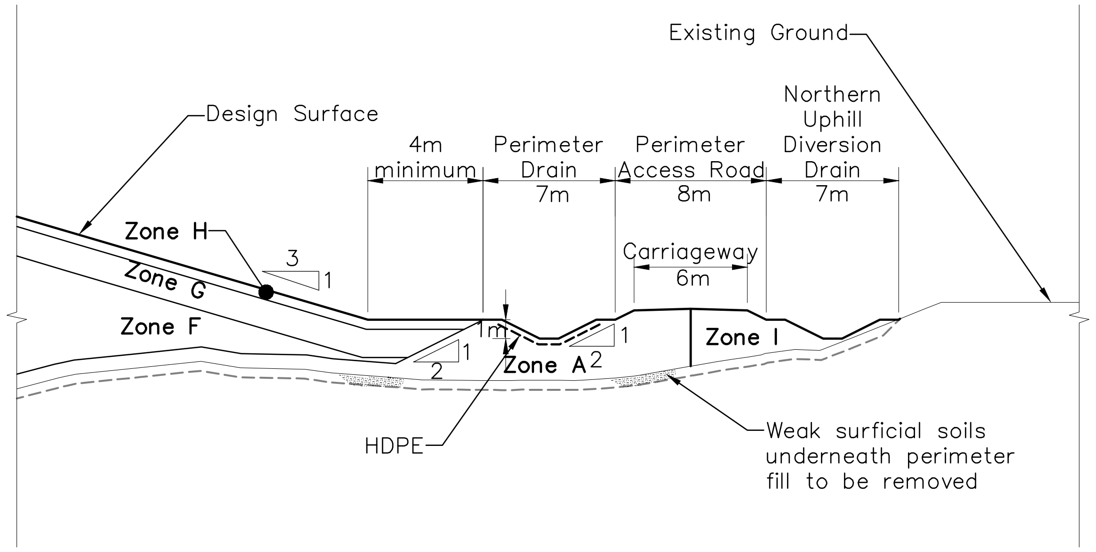
AREA: DEVELOPMENT SITE

JOB NUMBER:	ORIGINAL SCALE:	SIZE:
9018	1:400	A3

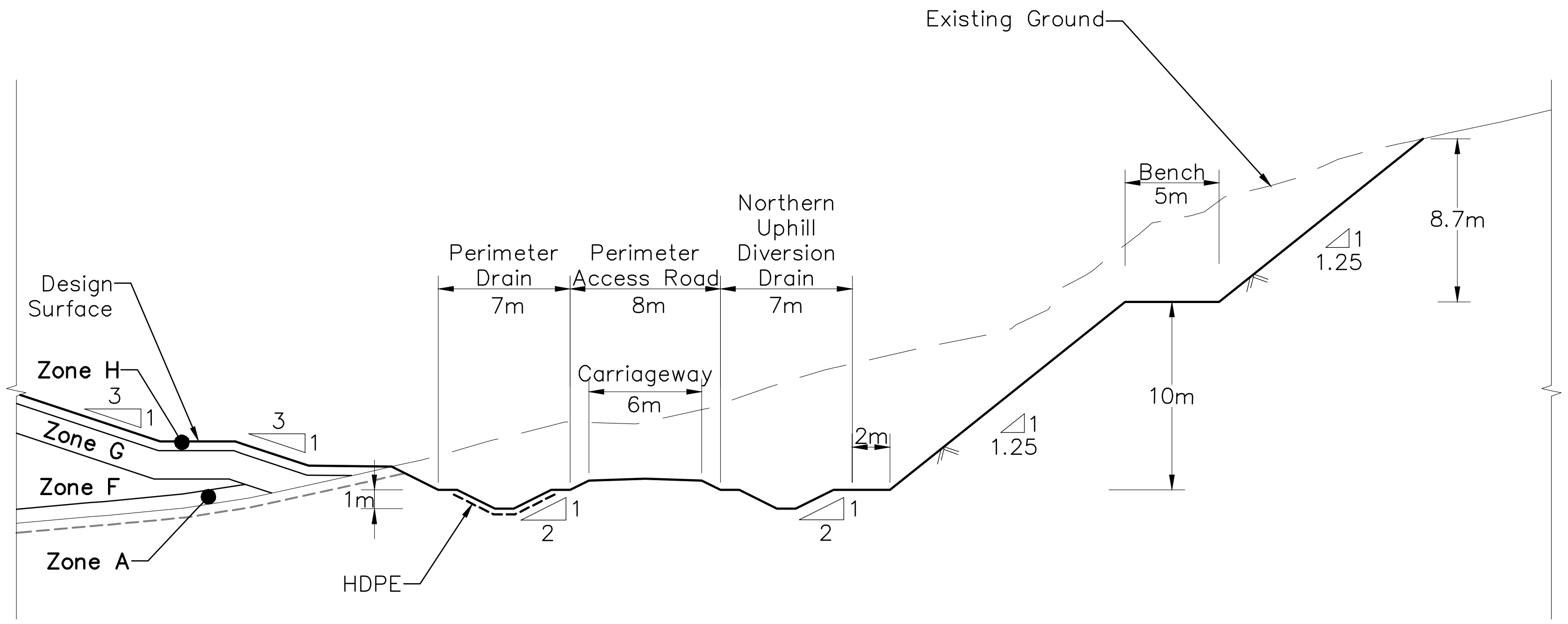
TITLE
Perimeter and Diversion Drains Sections Sheet 2 of 4
Tails / Waste Rock 080

DRAWING No.: WAI–983–080–DWG–CI–0731

REV. No.: B



PERIMETER AND UPHILL DIVERSION DRAIN SECTION 11/715



PERIMETER AND UPHILL DIVERSION DRAIN SECTION 12/715

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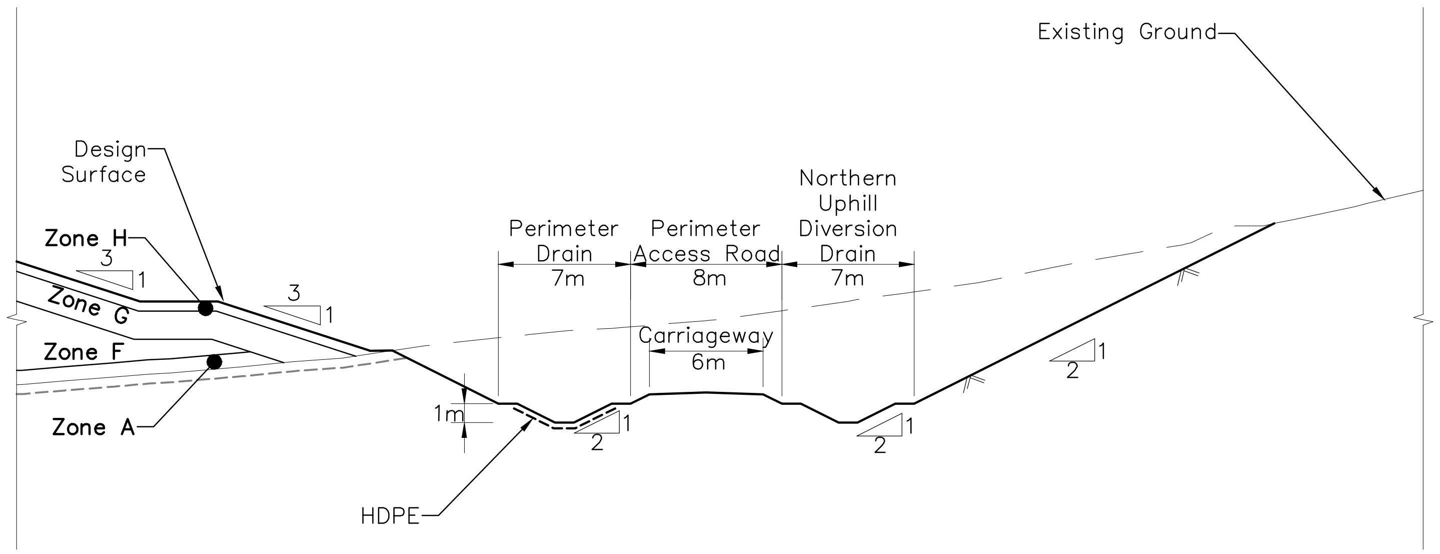
EGL Geotechnical, Earthquake and Dam Engineers
Engineering Geology Ltd
+64 9 486 2546
info@egl.co.nz
Unit 7C, 331 Rosedale Road, Albany, Auckland
PO Box 301054, Albany, Auckland 0752
www.egl.co.nz

Preliminary Issue	Signed:	Date: 15-07-21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

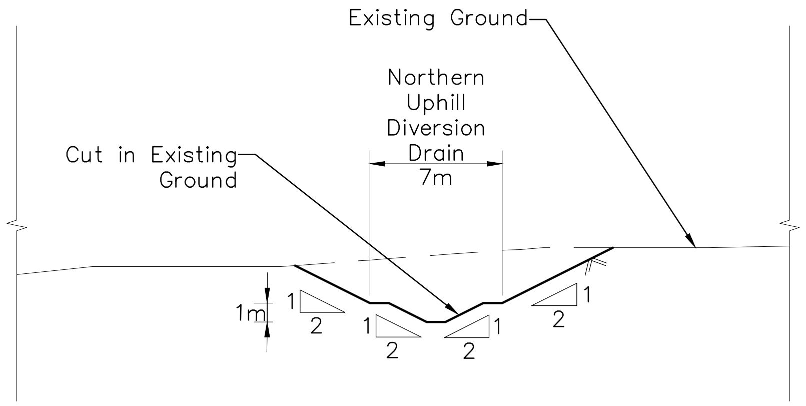
No.	BY	DATE	REVISION	CHECKED	APPROV.
A	MC	15-07-21	WNP Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	15-07-21
DESIGNED	ET	15-07-21
CHECKED	ET	15-07-21
DRAWN	MC	15-07-21

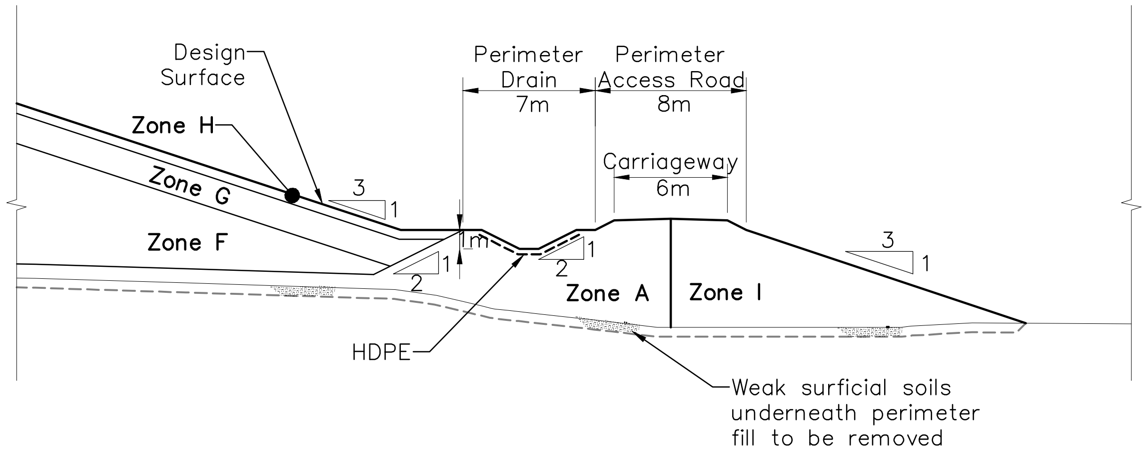
PROJECT: Northern Rock Stack
AREA: DEVELOPMENT SITE
JOB NUMBER: 9018
ORIGINAL SCALE: 1:400
SIZE: A3
TITLE: Perimeter and Diversion Drains Sections Sheet 3 of 4 Tails / Waste Rock 080
DRAWING No. WAI-983-080-DWG-CI-0732
REV. No. A



PERIMETER AND UPHILL DIVERSION DRAIN SECTION 13/715



UPHILL DIVERSION DRAIN SECTION 14/715



PERIMETER DIVERSION DRAIN SECTION 15/715

OCEANAGOLD WAIHI OPERATION

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

Preliminary Issue	Signed:	Date: 15-07-21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

No.	BY	DATE	REVISION	CHECKED	APPROV.
A	MC	15-07-21	WNP Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	15-07-21
DESIGNED	ET	15-07-21
CHECKED	ET	15-07-21
DRAWN	MC	15-07-21

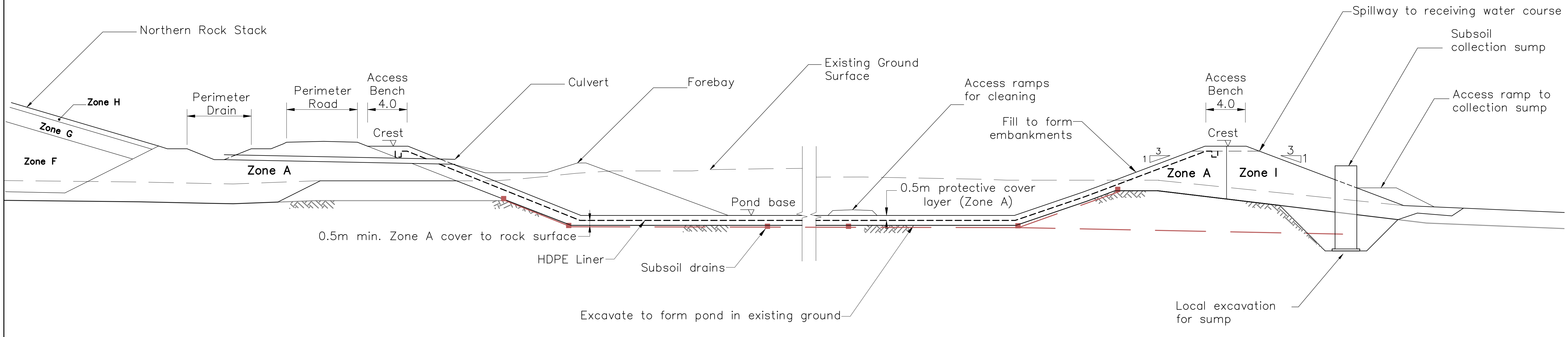
PROJECT: Northern Rock Stack

AREA: DEVELOPMENT SITE

JOB NUMBER: 9018 | ORIGINAL SCALE: 1:400 | SIZE: A3

TITLE: Perimeter and Diversion Drains Sections Sheet 4 of 4 Tails / Waste Rock 080

DRAWING No. WAI-983-080-DWG-CI-0733 | REV. No. A



Note: Zone A Fill within 0.5m of the HDPE liner shall not contain rock, stones or sharp objects greater than 20mm size

COLLECTION POND– TYPICAL SECTION 16 / –

Scale 1:400 (A3)

OCEANAGOLD WAIHI OPERATION

EGL Engineering Geology Ltd
Geotechnical, Earthquake and Dam Engineers
+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

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

No.	BY	DATE	REVISION	CHECKED	APPROV.
A	ET	29-09-21	Preliminary Issue		

	BY	DATE
PROJECT APPR.		
DESIGN APPR.		
DESIGNED		
CHECKED		
DRAWN	ET	29-09-21

PROJECT: Northern Rock Stack

AREA: DEVELOPMENT SITE

TITLE: Sections Collection Pond Tails / Waste Rock 080

JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.	REV. No.
9018	as shown	A3	WAI-983-080-DWG-CI-0761	A

Local Mine Grid: Mount Eden Old Cadastral

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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

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Preliminary Issue	Signed:	Date: 15-07-21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

No.	BY	DATE	REVISION	CHECKED	APPROV.
D	SK	12-12-24	Addition of Borrow Area	AH	ET
C	MC	15-07-21	WNP NRS Design Change	ET	TM
B	JL	13-11-20	Drains Layout Changes	ET	TM
A		09-09-20	Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	15-07-21
DESIGNED	ET	15-07-21
CHECKED	ET	15-07-21
DRAWN	MC	15-07-21

PROJECT: Northern Rock Stack

AREA: DEVELOPMENT SITE

TITLE: Layout Plan Leachate Drain Tails / Waste Rock 080

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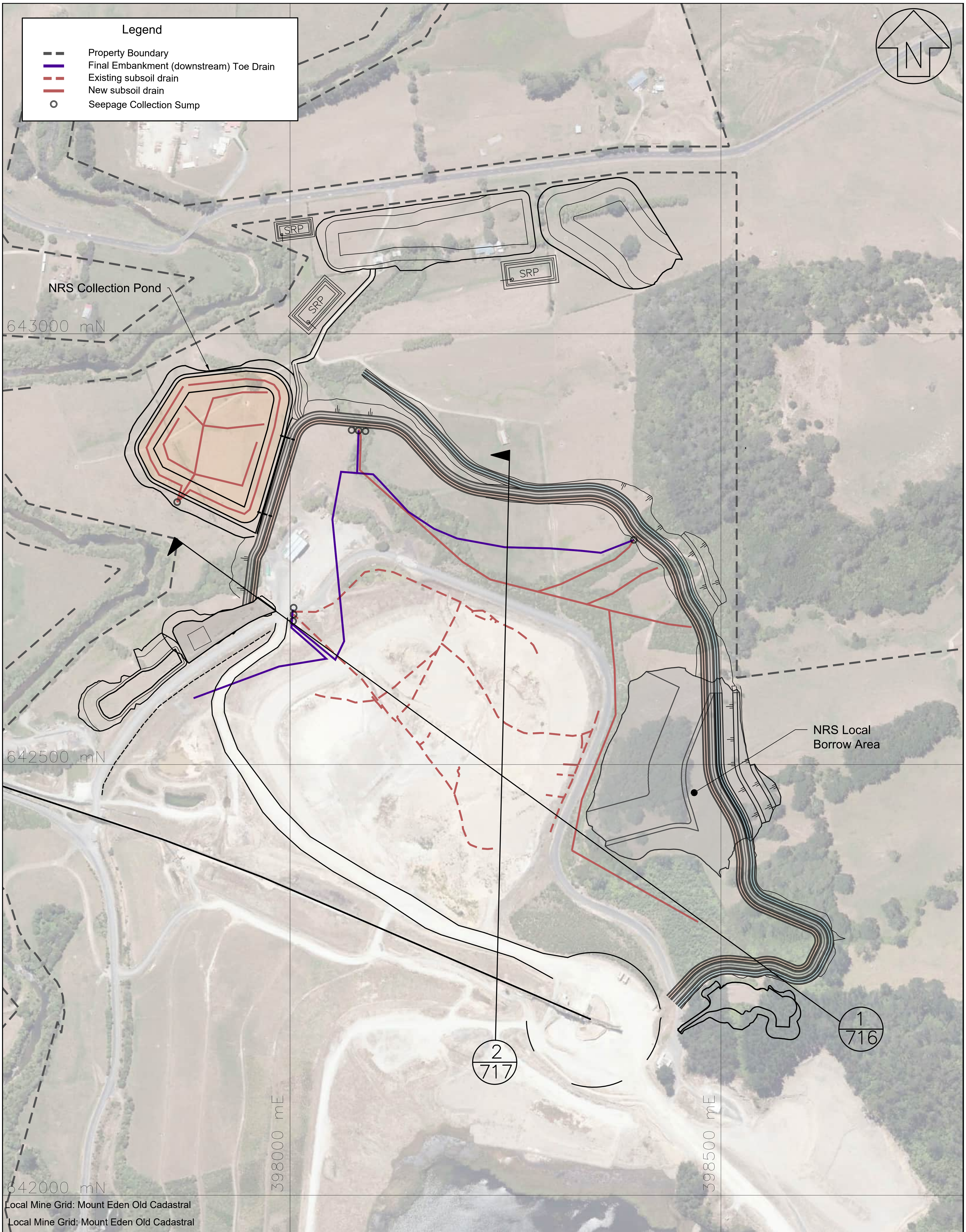

Local Mine Grid: Mount Eden Old Cadastral

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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

Preliminary Issue	Signed:	Date: 15-07-21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

No.	BY	DATE	REVISION	CHECKED	APPROV.
E	SK	12-12-24	Addition of Borrow Area	AH	ET
D	ET	29-09-21	Toe Drain Beneath WS Ramp	ET	TM
C	MC	15-07-21	WNP NRS Design Change	ET	TM
B	JL	13-11-20	Drains Layout Changes	ET	TM
A	JL	09-09-20	Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	15-07-21
DESIGNED	ET	15-07-21
CHECKED	ET	15-07-21
DRAWN	MC	15-07-21

PROJECT: Northern Rock Stack

AREA: DEVELOPMENT SITE

TITLE
Layout Plan
Subsoil Drains
Tails / Waste Rock 080

JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.	REV. No.
9018	1:4000	A3	WAI-983-080-DWG-CI-0772	E

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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

Preliminary Issue	Signed:	Date: 09-08-21
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	SK	12-12-24	Addition of Borrow Area	AH	ET
A	MC	09-08-21	WNP Preliminary Issue	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	09-08-21
DESIGNED	ET	09-08-21
CHECKED	ET	09-08-21
DRAWN	MC	09-08-21

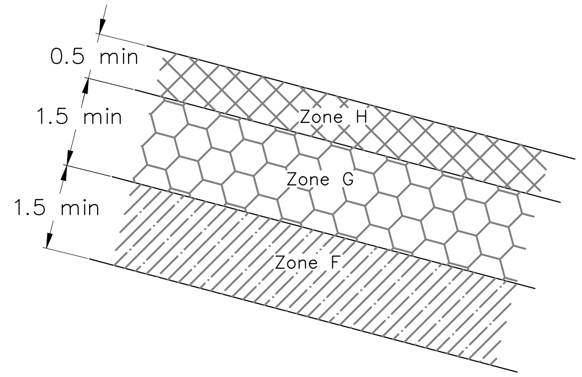
PROJECT: Waihi North Project

AREA: DEVELOPMENT SITE

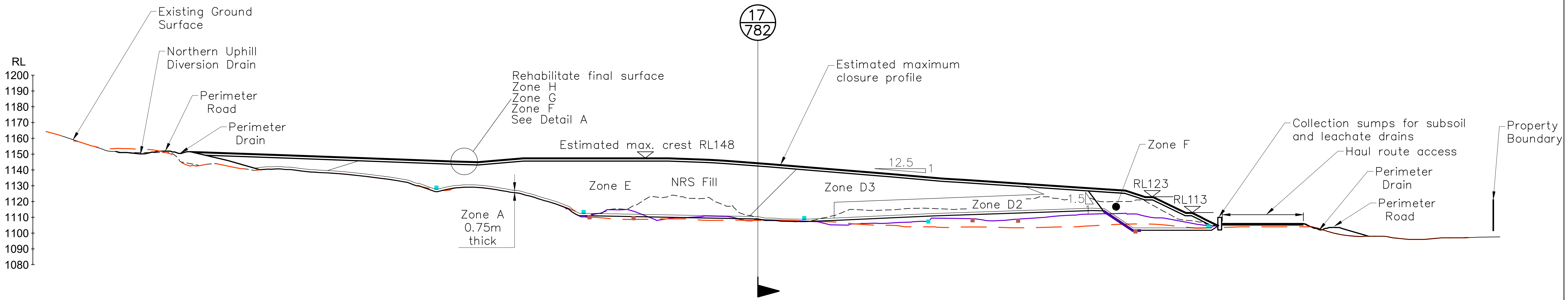
TITLE: Layout Plan NRS Closure Tails / Waste Rock 080

JOB NUMBER:	ORIGINAL SCALE:	SIZE:	DRAWING No.	REV. No.
9018	1:4000	A3	WAI-983-080-DWG-CI-0780	B

Estimated maximum closure profile
Ground profile
Existing ground profile
Original ground profile
Survey before fill placed in existing Northern Stockpile
Leachate drains
Subsoil drains



REHABILITATION DETAILS A
NTS



NORTHERN ROCK STACK CLOSURE TYPICAL SECTION 1 16/715 16/782
scale 1:2500

Notes
1. Positions and levels of subsoil and leachate drains are indicative only.

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EGL Engineering Geology Ltd
Geotechnical, Earthquake and Dam Engineers
+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

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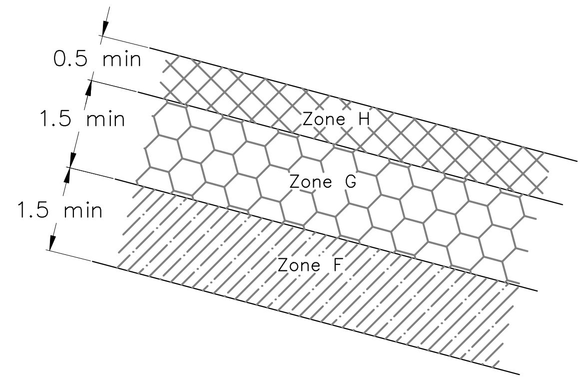
Tender Issue	Signed:	Date:
Construction Issue	Signed:	Date:

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	ET	12-10-21	Added Zone D3, D2, E	TM	TM
A	JL	19-07-21	Preliminary Issue WNP	ET	TM

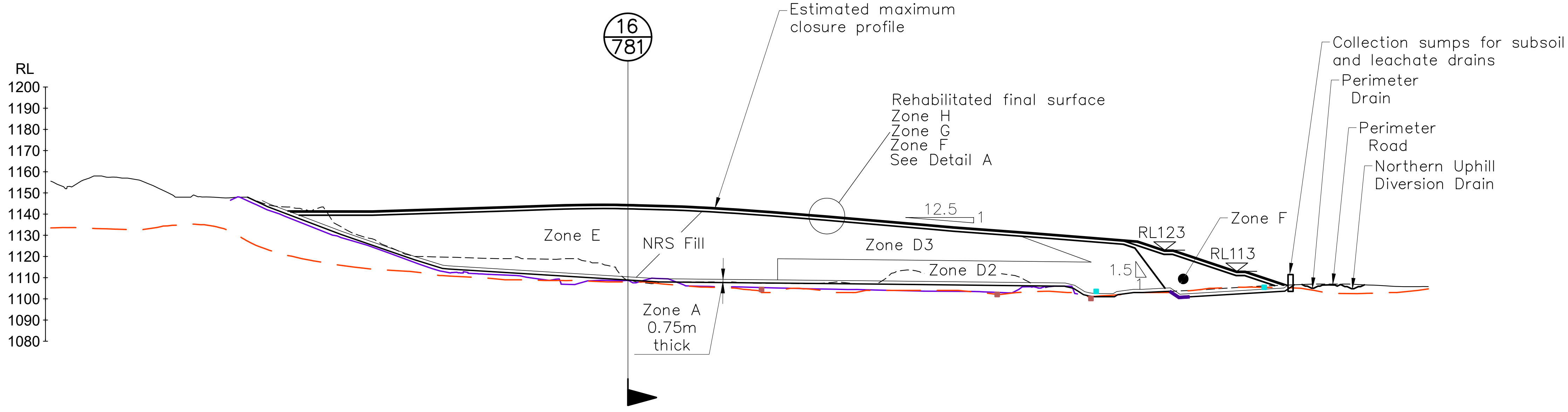
	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	19-07-21
DESIGNED	ET	19-07-21
CHECKED	ET	19-07-21
DRAWN	MC	19-07-21

PROJECT: Northern Rock Stack
AREA: DEVELOPMENT SITE
JOB NUMBER: 9018
ORIGINAL SCALE: as shown
SIZE: A3
TITLE: Sections NRS Closure Tails / Waste Rock 080
DRAWING No. WAI-983-080-DWG-CI-0781
REV. No. B

Estimated maximum closure profile
Ground profile
Existing ground profile
Original ground profile
Survey before fill placed in existing Northern Stockpile
Leachate drains
Subsoil drains



REHABILITATION DETAILS A
NTS



NORTHERN ROCK STACK CLOSURE TYPICAL SECTION 2 17/715 17/781
Scale 1:2500

Notes
1. Positions and levels of subsoil and leachate drains are indicative only.

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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

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

No.	BY	DATE	REVISION	CHECKED	APPROV.
B	ET	12-10-21	Added Zone D3, D2, E	TM	TM
A	JL	19-07-21	Preliminary Issue WNP	ET	TM

	BY	DATE
PROJECT APPR.		
DESIGN APPR.	TM	19-07-21
DESIGNED	ET	19-07-21
CHECKED	ET	19-07-21
DRAWN	MC	19-07-21

PROJECT: Northern Rock Stack
AREA: DEVELOPMENT SITE
JOB NUMBER: 9018
ORIGINAL SCALE: as shown
SIZE: A3

TITLE
Sections
NRS Closure
Tails / Waste Rock 080

DRAWING No. WAI-983-080-DWG-CI-0782
REV. No. B

APPENDIX B

STABILITY ANALYSES

APPENDIX B

STOCKPILE 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 maximum operational case for static and post-earthquake stability. Allow for lower strength material (Zone E and D3 strengths) in the centre of the stockpile with higher strengths (Zone D2) assigned at outer extents to meet stability criteria.
3. Assess earthquake displacements for maximum operational and closure profiles.
4. Assess stability for Sections 1 and 2 shown in plan on Drawing 0715 and cross section in Drawing 0716 and 0717 in the report and here in Appendix B on Figure B1.
5. Apply Morgenstern and Price stability calculation method with half sine interslice pressure distribution.
6. Review stability against industry standard geotechnical stability criteria.

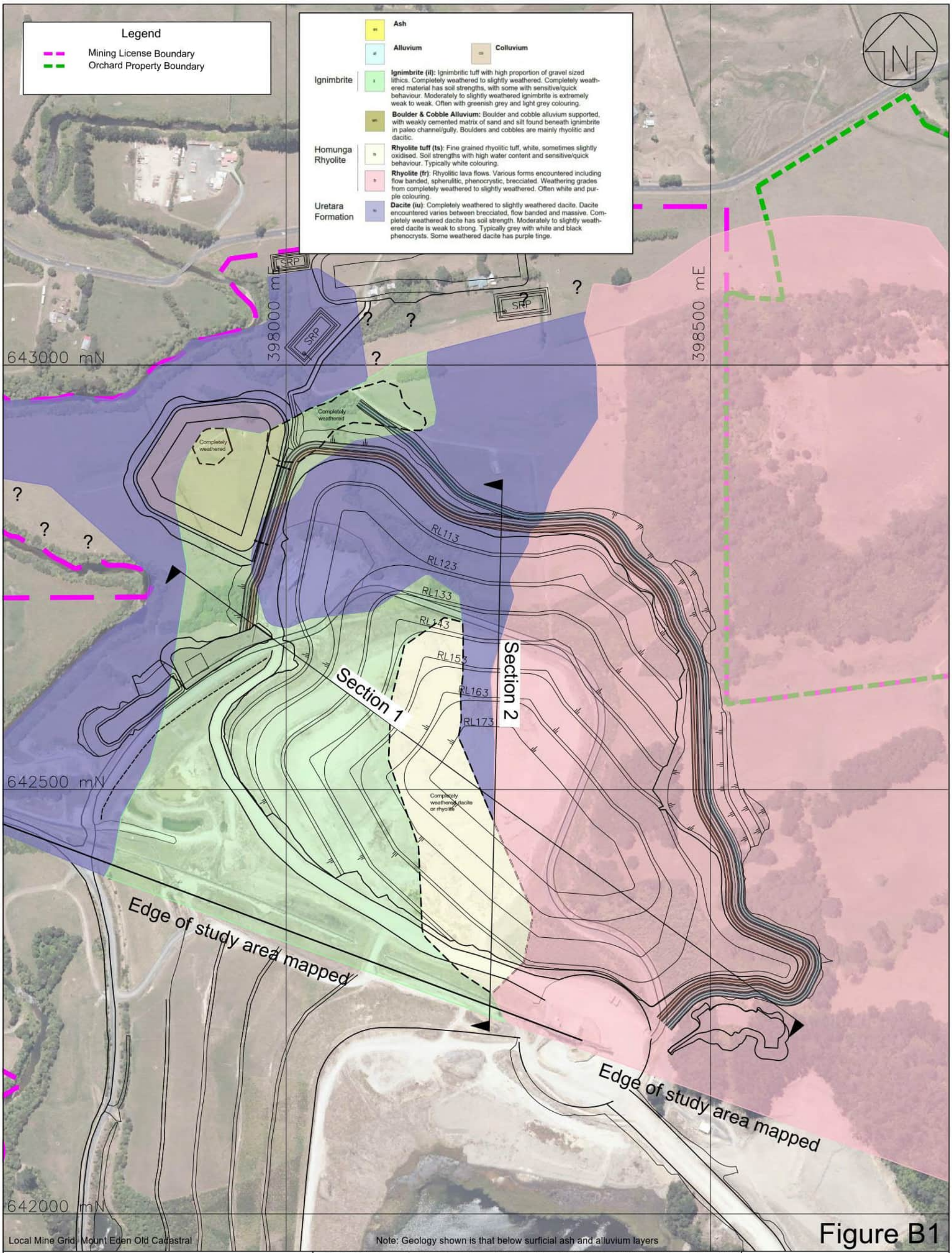


Figure B1

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
WAIHI NORTH PROJECT
Northern Rock Stack
Stability Analysis Section Location Plan

Drawing No.	9018–Fig13
Date:	Oct 2021
Drawn:	ET
Scale:	1: 4000 (@A3)
Filename:	Figure 13 Oct 2021.dwg

B3. STABILITY ASSESSMENT

The following strength parameter sets have been selected for NRS 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
EW/VW Rhy. & EW Dacite/ Ign.	EW/VW	crushed	V.poor	1	16	.04	0	.6
Rhyolite	W	blocky/ seamy	Fair	5	16	.12	.001	.5
VW Ignimbrite	VW	v.blocky	Fair	1.5	15	.16	.003	.5
VW Dacite	VW	crushed	Poor	2	17	.06	0	.55
W Rhy. Dac.	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: CURRENT CONDITION – DRAINED STRENGTH PARAMETER SET

Material	γ (kN/m^3)	Strength Parameters		Porewater Pressure	
				Operational	Closure
Zone A/I Fill – Sourced from mine overburden or 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 F Fill	20.5	Duncan Gravel/Cobbles with Cu>4 16%ile		$r_u = 0.05$	Phreatic^
Zone G Fill	20.5	c’=3kPa	ϕ’=31 deg	$r_u = 0.1$	Phreatic^
Stockpile (to Zone D2 Rockfill)	19.5	Duncan Gravel/Cobbles with Cu>4 16%ile		$r_u = 0.05$	Phreatic^
Stockpile (to Zone D3)	19.0	c’= 5kPa	ϕ’ = 31 deg	$r_u = 0.4$	Phreatic^
Stockpile (to Zone E)	19.0	c’ = 0 kPa	ϕ’ = 26 deg	$r_u = 0.6$	Phreatic^
Ignimbrite Rockfill	20.5	Duncan Gravel/Cobbles with Cu>4 16%ile		$r_u = 0.05$	Phreatic^
Ash/Surface CW Rhyolite/Dacite/Ign. UCS <0.5MPa SPTN <8	17.0	c’ = 0 kPa	ϕ’ = 26 deg	$r_u = 0.1$	Phreatic^
EW to VW Rhyolite & EW Ign. And Dacite Rock	17.5	Hoek – EW/VW Rhyolite & EW Dacite/ Ign.		Phreatic^ plus $r_u = 0.1$	Phreatic^
W Rhyolite Rock	21	Hoek – W Rhy. Dac.		Phreatic^	Phreatic^
VW Ignimbrite Rock	19	Hoek – VW Ign.		Phreatic^	Phreatic^
VW Dacite Rock	18	Hoek – VW Dacite.		Phreatic^	Phreatic^
W Dacite	25	Hoek – W Rhy. Dac.		Phreatic^	Phreatic^
Epiclastic Mat.	17.0	c’=5kPa	ϕ’=35 deg	Phreatic^	Phreatic^
Paleo Boulder Alluvium	18	c’=5kPa	ϕ’=35 deg	Phreatic^	Phreatic^

*Phreatic surface assumed at pond water level

TABLE B4: CURRENT CONDITION – UNDRAINED STRENGTH PARAMETER SET

Material	γ (kN/m^3)	Strength Parameters		Porewater Pressure	
				Operational	Closure
Zone A/I Fill – Sourced from mine overburden or foundation rock undercut	20.5	Su_{min}=150kPa Su/sigmav'=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 F Fill	20.5	Duncan Gravel/Cobbles with Cu>4 16%ile		r_u = 0.05	Phreatic^
Zone G Fill	20.5	Su=100kPa		-	-
Stockpile (to Zone D2 Rockfill)	19.5	Duncan Gravel/Cobbles with Cu>4 16%ile		r_u = 0.05	Phreatic^
Stockpile (to Zone D3)	19.0	c = 10 kPa	ϕ = 18 deg	r_u = 0.4	Phreatic^
Stockpile (to Zone E)	19.0	Su/σ_v' = 0.21		r_u = 0.6	Phreatic^
Ignimbrite Rockfill	20.5	Duncan Gravel/Cobbles with Cu>4 16%ile		r_u = 0.05	Phreatic^
Ash/Surface CW Rhyolite/Dacite/Ign. SPTN <8	17.0	Vert. eff. Stress (kPa)	Su (kPa)	r_u = 0.3	Phreatic^
		0	0		
		100	46		
		300	103		
		600	189		
		1000	288		
		2000	460		
EW to VW Rhyolite & EW Ign. And Dacite Rock	17.5	Hoek – EW/VW Rhyolite & EW Dacite/ Ign.		Phreatic^ plus r_u = 0.1	Phreatic^
W Rhyolite Rock	18.5	Hoek – W Rhy. Dac.		Phreatic^	Phreatic^
VW Ignimbrite Rock	19	Hoek – VW Ign.		Phreatic^	Phreatic^
VW Dacite Rock	18	Hoek – VW Dacite.		Phreatic^	Phreatic^
W Dacite	25	Hoek – W Rhy. Dac.		Phreatic^	Phreatic^
Epiclastic Mat.	17.0	c'=5kPa	ϕ'=35 deg	Phreatic^	Phreatic^
Paleo Boulder Alluvium	17.0	c'=5kPa	ϕ'=35 deg	Phreatic^	Phreatic^

TABLE B5: POST-EARTHQUAKE STRENGTH SET

Material	γ (kN/m^3)	Strength Parameters		Porewater Pressure	
				Operational	Closure
Zone A/I Fill – Sourced from mine overburden or foundation rock undercut	20.5	Su_{min} = 120kPa Su/sigmav' = 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 F Fill	20.5	Duncan Gravel/Cobbles with Cu>4 16%ile		r_u = 0.05	Phreatic^
Zone G Fill	20.5	Su=100kPa		-	-
Stockpile (to Zone D2 Rockfill)	19.5	Duncan Gravel/Cobbles with Cu>4 16%ile		r_u = 0.05	Phreatic^
Stockpile (to Zone D3)	19.0	c = 8 kPa	ϕ = 15 deg	r_u = 0.4	Phreatic^
Stockpile (to Zone E)	19.0	Su/σ_v' = 0.06		r_u = 0.6	Phreatic^
Ignimbrite Rockfill	20.5	Duncan Gravel/Cobbles with Cu>4 16%ile		r_u = 0.05	Phreatic^
Ash/Surface CW Rhyolite/Dacite/Ign. SPTN <8	17.0	Su/σ_v' = 0.23		r_u = 0.3	Phreatic^
EW to VW Rhyolite & EW Ign. And Dacite Rock	17.5	Hoek – EW/VW Rhyolite & EW Dacite/ Ign.		Phreatic^ plus r_u = 0.1	Phreatic^
W Rhyolite Rock	18.5	Hoek – W Rhy. Dac.		Phreatic^	Phreatic^
VW Ignimbrite Rock	19	Hoek – VW Ign.		Phreatic^	Phreatic^
VW Dacite Rock	18	Hoek – VW Dacite.		Phreatic^	Phreatic^
W Dacite	25	Hoek – W Rhy. Dac.		Phreatic^	Phreatic^
Epiclastic Mat.	17.0	c'=5kPa	ϕ'=35 deg	Phreatic^	Phreatic^
Paleo Boulder Alluvium	17.0	c'=5kPa	ϕ'=35 deg	Phreatic^	Phreatic^

Stability analyses are summarised in the tables below. Section 1 runs from the southeast corner to the northwest. It includes the west slope of the NRS. The foundations include rhyolite over dacite and ignimbrite materials. Section 2 runs from the south to the north and includes the north slope of the NRS. The foundations include fill placed for the Workshop Ramp (haul road) at the south end, with rhyolite overlying weathered dacite materials. On Section 2 there is some minor ignimbrite materials at the surface, which are stronger than the weathered dacite surface and therefore a weathered dacite profile has been preferentially applied in the analyses. Geotechnical stability is dependent on the management of materials of different strengths within the NRS. Weaker material strengths were applied in the analyses in the centre of the stockpile with stronger material applied at the outer extents.

TABLE B6: GEOTECHNICAL STABILITY SUMMARY SECTION 1 – WEST SLOPE

Stability Analyses	Strength Parameters	Figure	Slide Surface	Result	Comment
Static max operation – peak drained strength conditions	Stockpile and foundation Drained strength parameters applied using effective stresses based on excess porewater pressures due to fill placement.	B11a	Foundation – Circular	FOS = 1.92	Above FOS = 1.5. Criteria met.
		B11b	Foundation – Base Slide	FOS = 2.25	
Static max operation – peak undrained strength conditions	Stockpile and foundation Combination of drained and undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement.	B12a	Foundation – Circular	FOS = 1.63	Above FOS = 1.5. Criteria met.
		B12b	Foundation – Base Slide	FOS = 1.53	
Post-earthquake max operation – Undrained conditions	Stockpile and foundation Combination of drained and post-earthquake softened undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement.	B13a	Stockpile – Circular	FOS = 1.65	Above FOS = 1.2. Criteria met.
		B13b	Foundation – Base Slide	FOS = 1.28	
		B13c	Stockpile – Base Slide	FOS = 1.21	
EQ max operation 1 in 150 year embankment response	Stockpile and foundation Combination of drained and post-earthquake softened undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement. Post-earthquake strength applied from for assessment of yield acceleration	B14	Full stockpile embankment k_y = 0.04g	0.8 to 4 cm	See Table B11 for seismic parameters used for determining co-seismic deformations. Displacements estimates indicate acceptable performance with minor displacement in the 150 year return period case. For the 2500 return period case the displacements of 11 to 47cm for the maximum operation profile would result in minor damage to liners and drains however the risk is limited as the displacement reduce to minor for the depleted closure profile.
EQ max operation 1 in 2500 year embankment response		B14	Full stockpile embankment k_y = 0.04g	11 to 47 cm	
EQ max closure 1 in 150 year embankment response		B15	Full stockpile embankment k_y = 0.18g	< 0.5 cm	
EQ max closure 1 in 2500 year embankment response		B15	Full stockpile embankment k_y = 0.18g	0.6 to 5 cm	

TABLE B7: GEOTECHNICAL STABILITY SUMMARY SECTION 1 – UP SLOPE

Stability Analyses	Strength Parameters	Figure	Slide Surface	Result	Comment
Static max operation – peak drained strength conditions	Stockpile and foundation Drained strength parameters applied using effective stresses based on excess porewater pressures due to fill placement.	B16	Stockpile	FOS=3.44	Above FOS = 1.5. Criteria met.
Static max operation – peak undrained strength conditions	Stockpile and foundation Combination of drained and undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement.	B17	Stockpile	FOS=2.17	Above FOS = 1.5. Criteria met.
Post-earthquake max operation – Undrained conditions	Stockpile and foundation Combination of drained and post-earthquake softened undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement.	B18	Stockpile	FOS=1.56	Above FOS = 1.2. Criteria met.
EQ max operation 1 in 150 year embankment response	Stockpile and foundation Combination of drained and post-earthquake softened undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement. Post-earthquake strength applied from for assessment of yield acceleration	B19	Full embankment $k_y = 0.1g$	< 0.5 to 1cm	See Table B11 for seismic parameters used for determining co-seismic deformations. Displacements are minor. Upslope profile will be depleted in closure, removing the potential for upslope displacement under earthquake shaking.
EQ max operation 1 in 2500 year embankment response		B19	Full embankment $k_y = 0.1g$	6 to 25 cm	

TABLE B8: GEOTECHNICAL STABILITY SUMMARY SECTION 2 – NORTH SLOPE

Stability Analyses	Strength Parameters	Figure	Slide Surface	Result	Comment
Static max operation – peak drained strength conditions	Stockpile and foundation Drained strength parameters applied using effective stresses based on excess porewater pressures due to fill placement.	B21a	Foundation – Circular	FOS=1.88	Above FOS = 1.5. Criteria met.
		B21b	Foundation – Base Slide	FOS=2.16	
Static max operation – peak undrained strength conditions	Stockpile and foundation Combination of drained and undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement.	B22a	Foundation – Circular	FOS=1.61	Above FOS = 1.5. Criteria met.
		B22b	Foundation – Base Slide	FOS=1.50	
Post-earthquake max operation – Undrained conditions	Stockpile and foundation Combination of drained and post-earthquake softened undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement.	B23a	Stockpile and Foundation – Circular	FOS=1.54	Above FOS = 1.2. Criteria met.
		B23b	Foundation – Base Slide	FOS=1.25	
		B23c	Stockpile – Base Slide	FOS=1.24	
EQ max operation 1 in 150 year embankment response	Stockpile and foundation Combination of drained and post-earthquake softened undrained parameters applied using effective stresses based on excess porewater pressures due to fill placement. Post-earthquake strength applied from for assessment of yield acceleration	B24	Full embankment k_y = 0.05g	< 0.5 to 3 cm	See Table B11 for seismic parameters used for determining co-seismic deformations. Displacements estimates indicate acceptable performance with minor displacement in the 150 year return period case. For the 2500 return period case the displacements of 10 to 40cm for the maximum operation profile would result in minor damage to liners and drains however the risk is limited as the displacement reduce to minor for the depleted closure profile.
EQ max operation 1 in 2500 year embankment response		B25	Full embankment k_y = 0.05g	10 to 40 cm	
EQ max closure 1 in 150 year embankment response		B24	Full embankment k_y = 0.19g	< 0.5 cm	
EQ max closure 1 in 2500 year embankment response		B25	Full embankment k_y = 0.19g	< 0.5 to 4 cm	

NRS EMBANKMENT CO-SEISMIC DEFORMATION CALCULATIONS

B4. PURPOSE

Estimate the potential co-seismic deviatoric (shear) embankment deformations under earthquake loading for the NRS stockpile embankment.

B5. OBJECTIVES

1. Select design response spectra and mean moment magnitudes (Mw) for the stockpile site (Vs30 = 600m/s) for an:
   a. 150 year return period event
   b. 2,500 year return period event
2. 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 shear wave 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
- 2,500 year return period earthquake event

6.1. 150 year return period earthquake event

The 150 year return period uniform hazard spectrum is shown in Figure B2 and the associated deaggregation plots are shown in Figure B3, Figure B4 and Figure B5 for PGA, SA(0.5s) and SA(1.0s), respectively. The mean magnitude of the deaggregated earthquake 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 B9 by EGL for use in estimating co-seismic displacement.

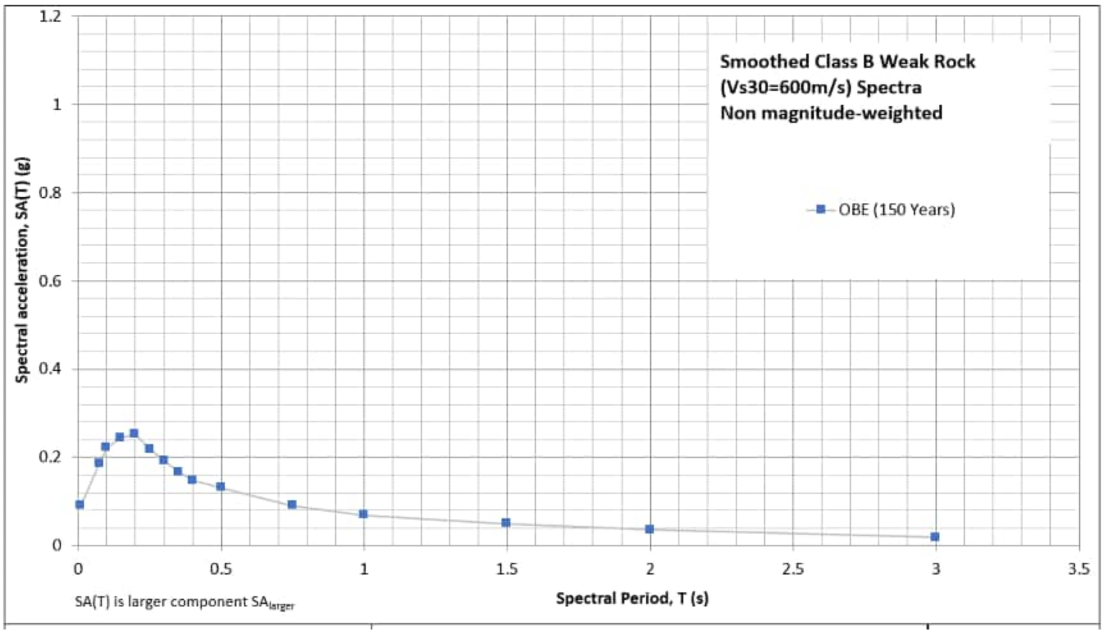


FIGURE B2: 150 YEAR RETURN RESPONSE SPECTRUM

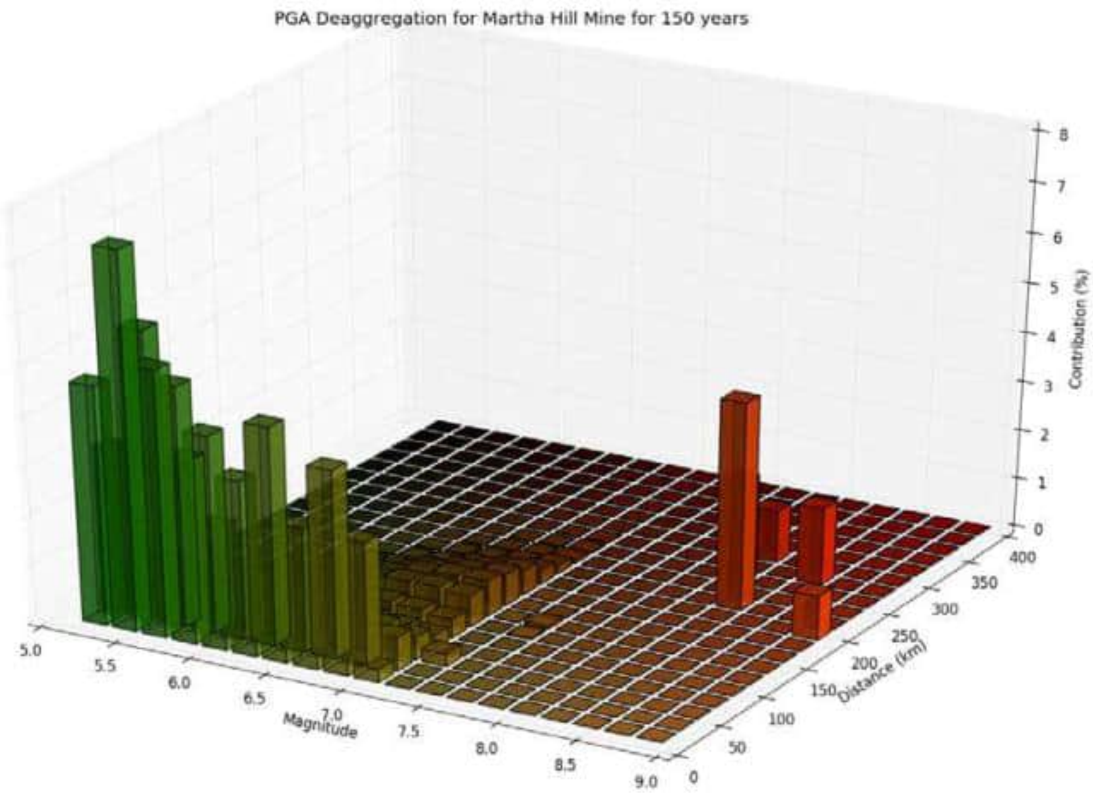


FIGURE B3: NON MAGNITUDE-WEIGHTED 150 YEAR PGA DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

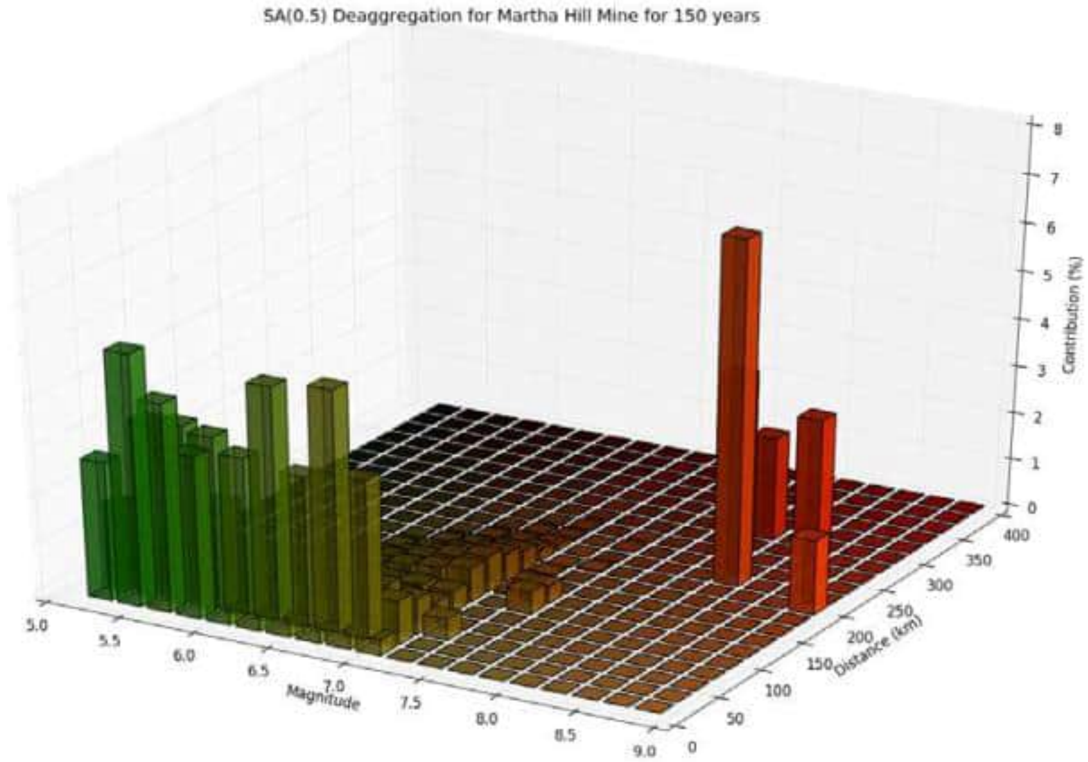


FIGURE B4: NON MAGNITUDE-WEIGHTED 150-YEAR SA (0.5S) DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

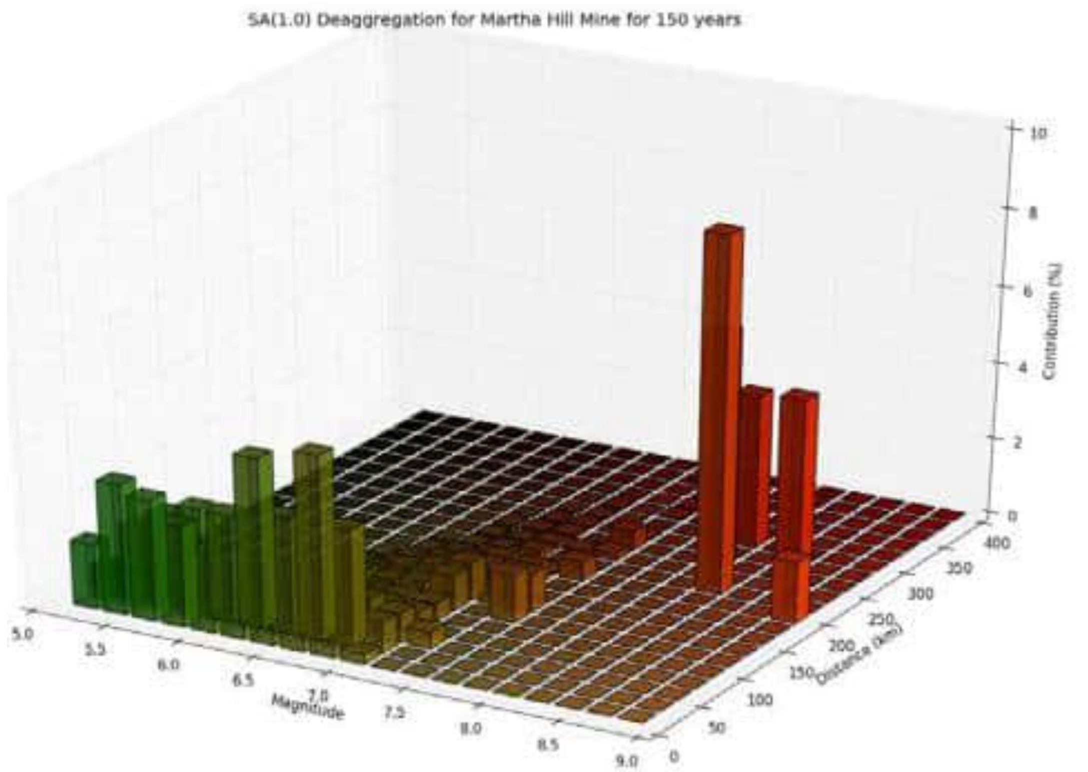


FIGURE B5: NON MAGNITUDE-WEIGHTED 150-YEAR SA (1.0 S) DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

TABLE B9: 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 plots (Figures B3 and B4)

6.2. 2500 year return period earthquake event

The 2,500 year return period uniform hazard spectrum is shown in Figure B6 and the Figure B7, Figure B8 and Figure B9 for PGA, SA(0.5s) and SA(1.0s), respectively. The mean magnitude of the deaggregated earthquake 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 B10 by EGL for use in estimating co-seismic displacement.

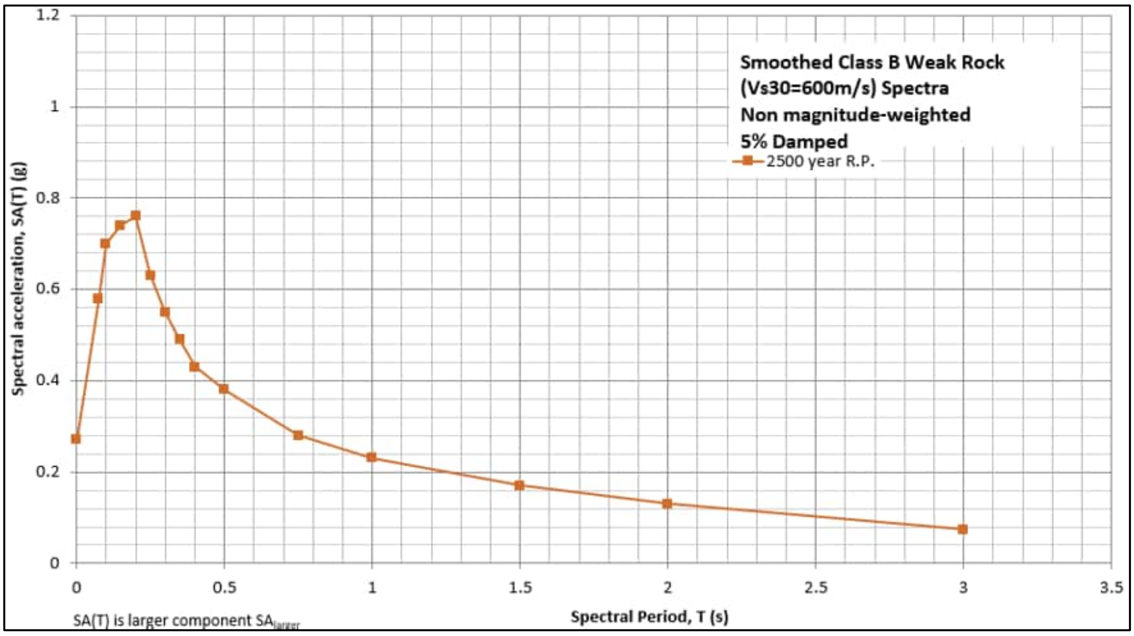


FIGURE B6: 2500 YEAR RETURN PERIOD RESPONSE SPECTRUM

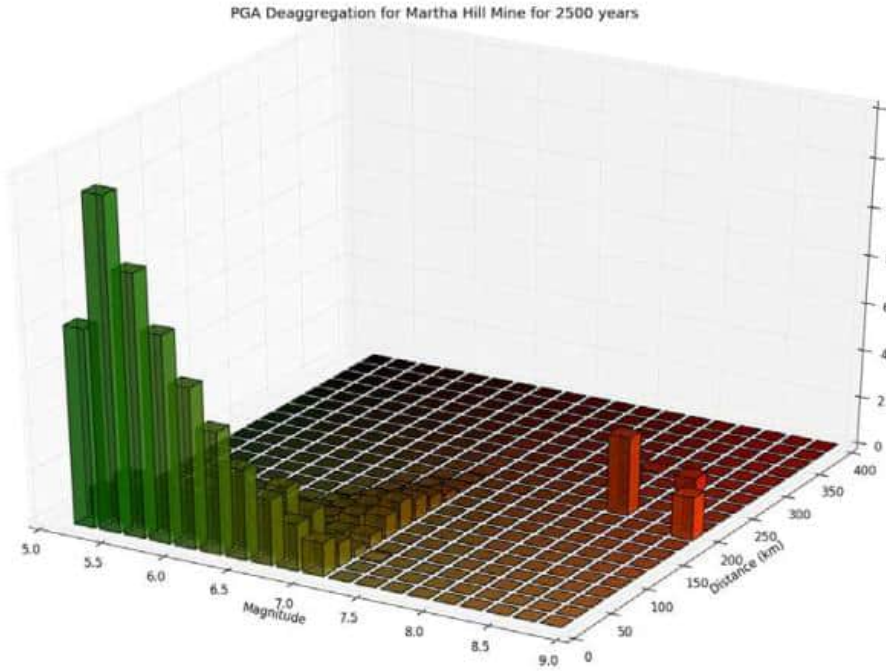


FIGURE B7: NON MAGNITUDE-WEIGHTED 2500 YEAR PGA DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

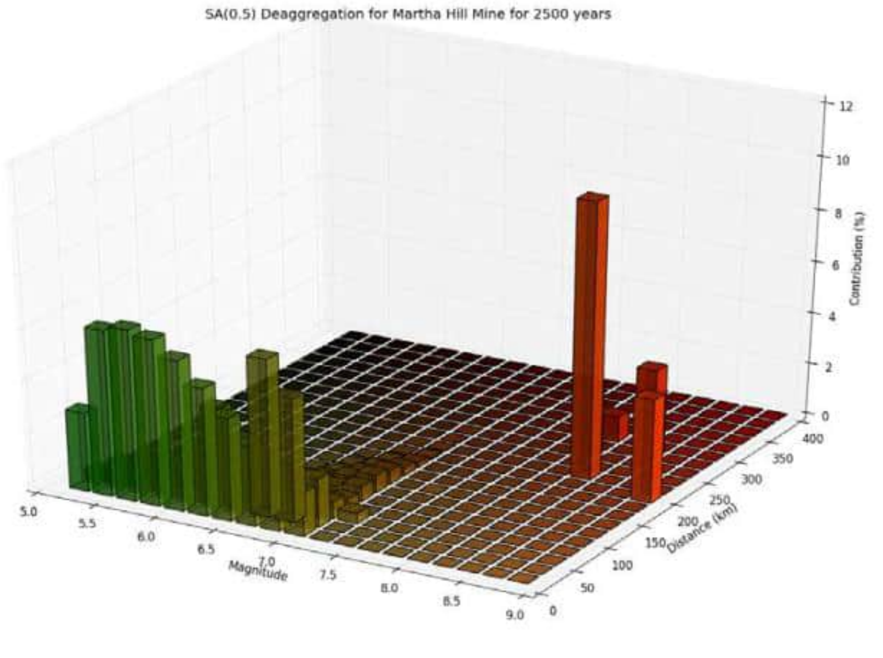


FIGURE B8: NON MAGNITUDE-WEIGHTED 2500-YEAR SA (0.5S) DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

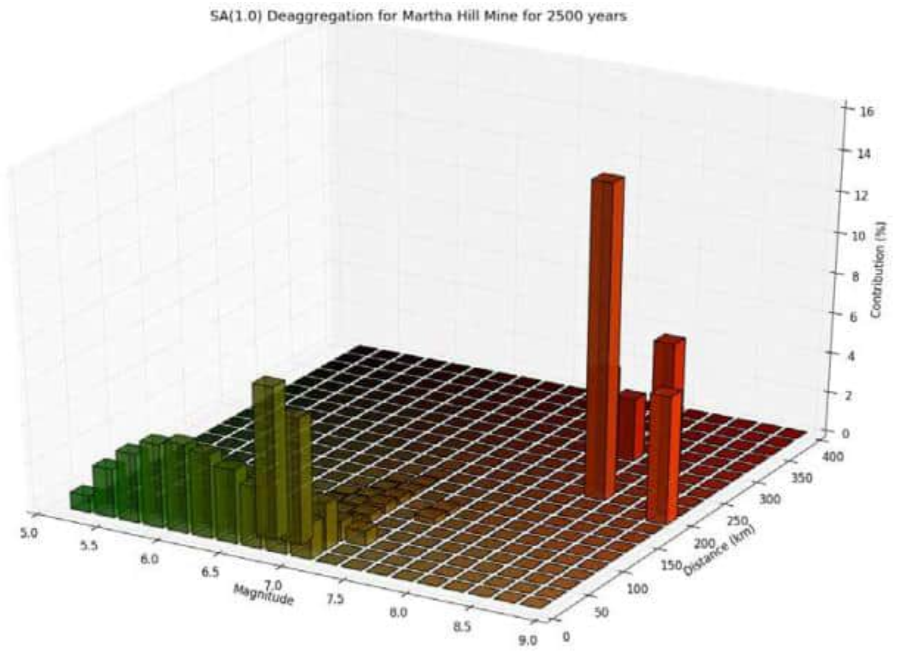


FIGURE B9: NON MAGNITUDE-WEIGHTED 2500-YEAR SA (1.0 S) DEAGGREGATION FOR MARTHA HILL MINE FOR CLASS B ROCK, VS30 = 600 M/S

TABLE B10: ESTIMATED MEAN MAGNITUDES FOR 2500 YEAR RETURN PERIOD SPECTRAL ACCELERATIONS

Intensity Parameter	Mean Magnitude (Mw)
PGA	6.9
SA(0.5s)	7.0*
SA(1.0s)	7.3*

*Visually estimated from GNS 2017 deaggregation plots (Figures B7 and B8)

B7. 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. Inputs and estimated potential displacements are summarised in Table B11.

Estimation of the period (Ts) of the slide mass depends on the geometry of the mass. 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.

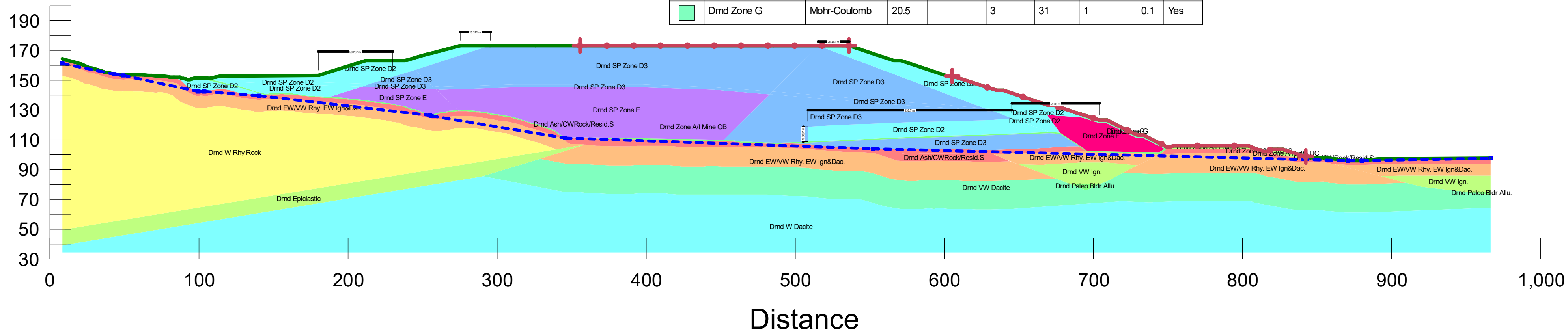
TABLE B11: ESTIMATED CO-SEISMIC SLOPE DEFORMATION CALCULATION INPUTS SECTION 1 AND 2

									150 year Return Period			2500 year Return Period		
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)**	**Mw applied**	**Permanent Def. (cm)**	**Sa ($1.3T_s$)**	**Mw applied**	**Permanent Def.(cm)**
1	West Slope	Oper.	Full emb	70	350	0.52	0.68	0.04	0.10	6.4	0.8 to 4 cm	0.30	7.0	11 to 47 cm
1	West Slope	Closure	Full emb.	30	300	0.26	0.34	0.18	0.16	6.4	< 0.5 cm	0.49	7.0	0.6 to 5 cm
1	Upslope	Oper.	Full emb	20	300	0.17	0.22	0.10	0.24	6.3	< 0.5 to 1 cm	0.72	6.9	6 to 25 cm
2	North Slope	Oper.	Full emb	80	350	0.59	0.77	0.05	0.09	6.7	< 0.5 to 3 cm	0.27	7.3	10 to 40 cm
2	North Slope	Closure	Full emb.	40	300	0.35	0.46	0.19	0.14	6.4	< 0.5 cm	0.40	7.0	< 0.5 to 4 cm

Section 1 - Stability Model Figures Showing
Geometry and Material Only

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.:

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Ash/CWRock/Resid.S	Mohr-Coulomb	17		0	26	1	0.1	Yes
	Drnd Epiclastic	Mohr-Coulomb	18		5	35	1		No
	Drnd EW/VW Rhy. EW Ign&Dac.	Shear/Normal Fn.	17.5	EW/VW Rhy. EW Ign. Dac.			1	0.1	Yes
	Drnd Paleo Bldr Allu.	Mohr-Coulomb	18		5	35	1		No
	Drnd SP Zone D2	Shear/Normal Fn.	19.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd SP Zone D3	Mohr-Coulomb	19		5	31	1	0.4	Yes
	Drnd SP Zone E	Mohr-Coulomb	19		0	26	1	0.6	Yes
	Drnd VW Dacite	Shear/Normal Fn.	18	VW Dacite			1		No
	Drnd VW Ign.	Shear/Normal Fn.	19	VW Ign.			1		No
	Drnd W Dacite	Shear/Normal Fn.	25	Weak Rhy. Dac.			1		No
	Drnd W Rhy Rock	Shear/Normal Fn.	18.5	Weak Rhy. Dac.			1		No
	Drnd Zone A/I Fdtn UC	Mohr-Coulomb	17.5		3	31	1	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5		5	35	1	0.1	Yes
	Drnd Zone F	Shear/Normal Fn.	20.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5		3	31	1	0.1	Yes



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
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Figure B11a West Slope Drnd

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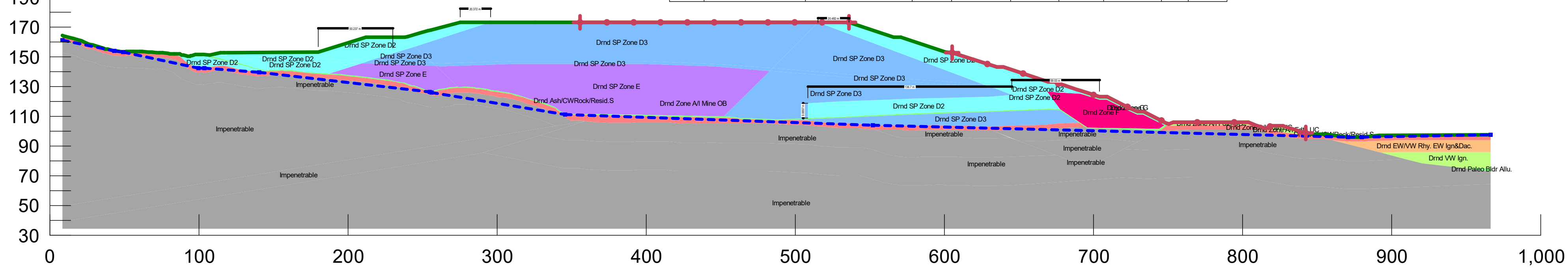
Section 1d.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Ash/CWRock/Resid.S	Mohr-Coulomb	17		0	26	1	0.1	Yes
	Drnd EW/VW Rhy. EW Ign&Dac.	Shear/Normal Fn.	17.5	EW/VW Rhy. EW Ign. Dac.			1	0.1	Yes
	Drnd Paleo Bldr Allu.	Mohr-Coulomb	18		5	35	1		No
	Drnd SP Zone D2	Shear/Normal Fn.	19.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd SP Zone D3	Mohr-Coulomb	19		5	31	1	0.4	Yes
	Drnd SP Zone E	Mohr-Coulomb	19		0	26	1	0.6	Yes
	Drnd VW Ign.	Shear/Normal Fn.	19	VW Ign.			1		No
	Drnd Zone A/I Fdtn UC	Mohr-Coulomb	17.5		3	31	1	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5		5	35	1	0.1	Yes
	Drnd Zone F	Shear/Normal Fn.	20.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5		3	31	1	0.1	Yes
	Impenetrable	Bedrock (Impenetrable)					1		No



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+64 9 486 2546
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PO Box 301054, Albany, Auckland 0752
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Figure B11b West Slope Drnd

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Section 1d.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Udrnd Ash/CWRock/Resid.S	Shear/Normal Fn.	17						Ash/CWRock	1	0.1	Yes
	Udrnd Epiclastic	Mohr-Coulomb	18				5	35		1		No
	Udrnd EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5						EW/VW Rhy. EW Ign. Dac.	1	0.1	Yes
	Udrnd Paleo Bldr Allu.	Mohr-Coulomb	18				5	35		1		No
	Udrnd SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd SP Zone D3	Mohr-Coulomb	19				10	18		1	0.4	Yes
	Udrnd SP Zone E	SHANSEP	19		0	0.21				1	0.6	Yes
	Udrnd VW Dacite	Shear/Normal Fn.	18						VW Dacite	1		No
	Udrnd VW Ign.	Shear/Normal Fn.	19						VW Ign.	1		No
	Udrnd W Dacite	Shear/Normal Fn.	25						Weak Rhy. Dac.	1		No
	Udrnd W Rhy Rock	Shear/Normal Fn.	18.5						Weak Rhy. Dac.	1		No
	Udrnd Zone A/I Fdtn UC	SHANSEP	17.5		80	0.35				1	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5		150	0.4				1	0.1	Yes
	Udrnd Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100						1		No

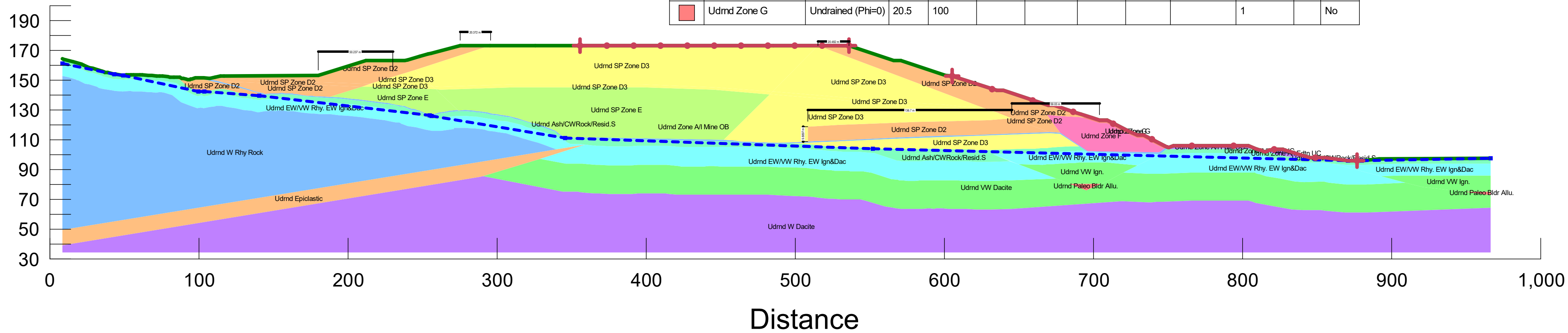

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Figure B12a West Slope Udrnd

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Section 1d.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	Udrnd Ash/CWRock/Resid.S	Shear/Normal Fn.	17						Ash/CWRock	1	0.1	Yes
	Udrnd SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd SP Zone D3	Mohr-Coulomb	19				10	18		1	0.4	Yes
	Udrnd SP Zone E	SHANSEP	19		0	0.21				1	0.6	Yes
	Udrnd Zone A/I Fdtn UC	SHANSEP	17.5		80	0.35				1	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5		150	0.4				1	0.1	Yes
	Udrnd Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100						1		No

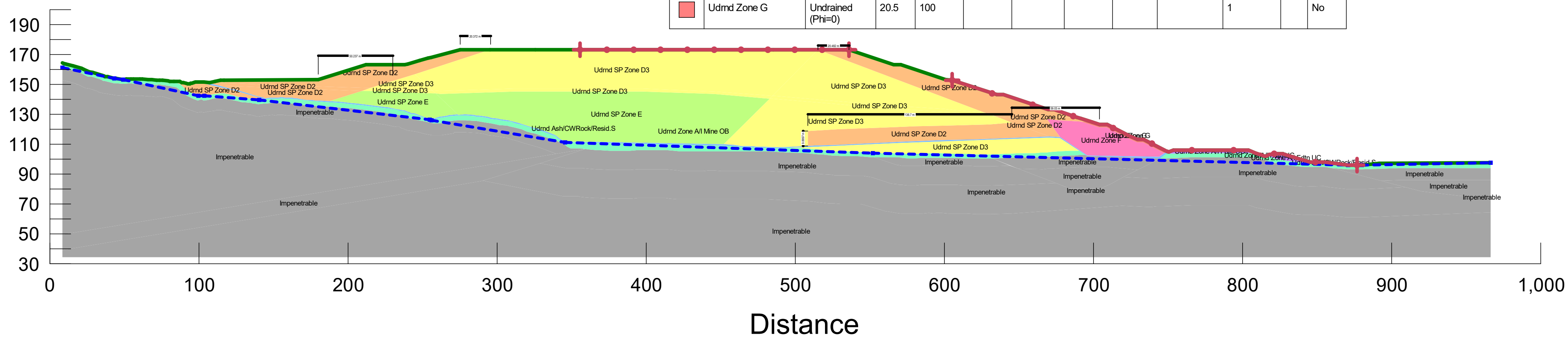

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Figure B12b West Slope Udrnd

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Section 1d.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ Epiclastic	Mohr-Coulomb	18			5	35			1		No
	PSTEQ EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5		EW/VW Rhy. EW Ign. Dac.					1		No
	PSTEQ Paleo Bldr Allu.	Mohr-Coulomb	18			5	35			1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19			8	15			1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ VW Dacite	Shear/Normal Fn.	18		VW Dacite					1		No
	PSTEQ VW Ign.	Shear/Normal Fn.	19		VW Ign.					1		No
	PSTEQ W Dacite	Shear/Normal Fn.	25		Weak Rhy. Dac.					1		No
	PSTEQ W Rhy Rock	Shear/Normal Fn.	18.5		Weak Rhy. Dac.					1		No
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

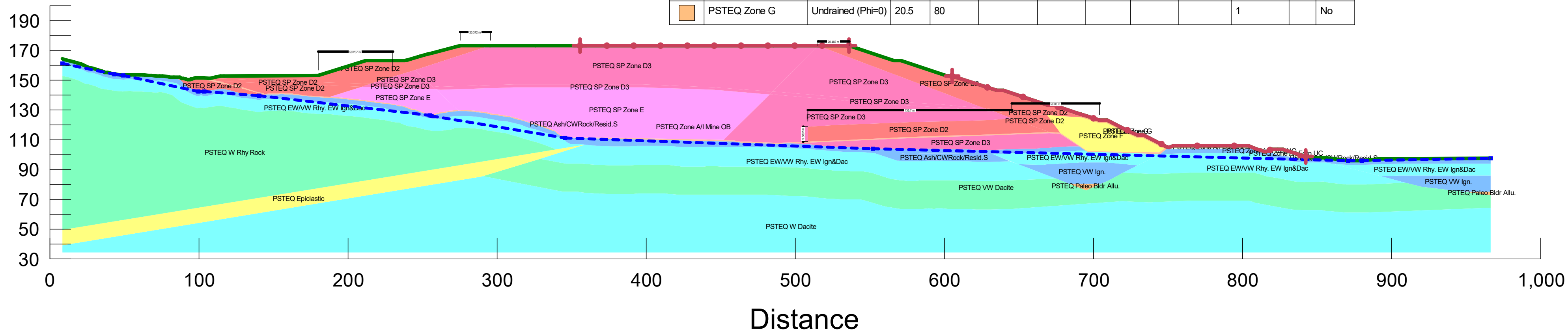

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Figure B13a West Slope PSTEQ

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Section 1d.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

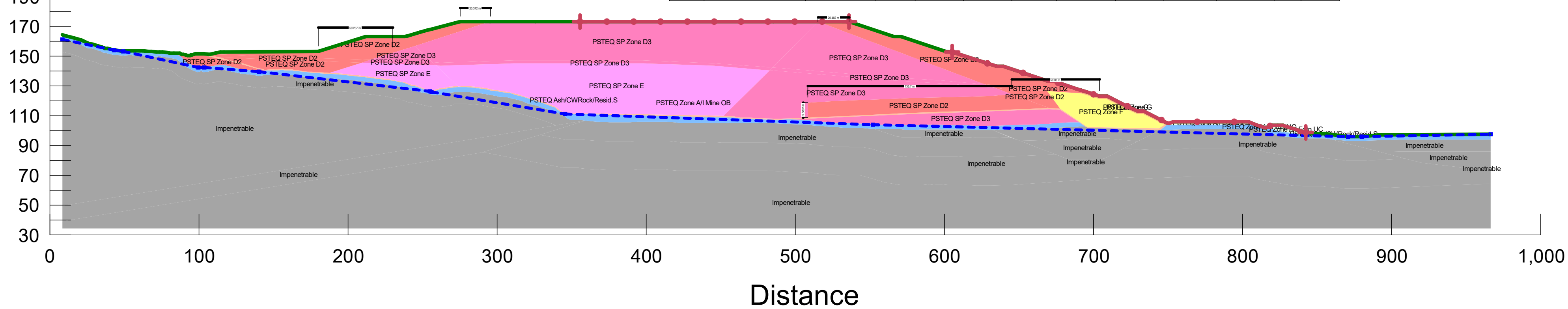

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Figure B13b West Slope PSTEQ

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Section 1d.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

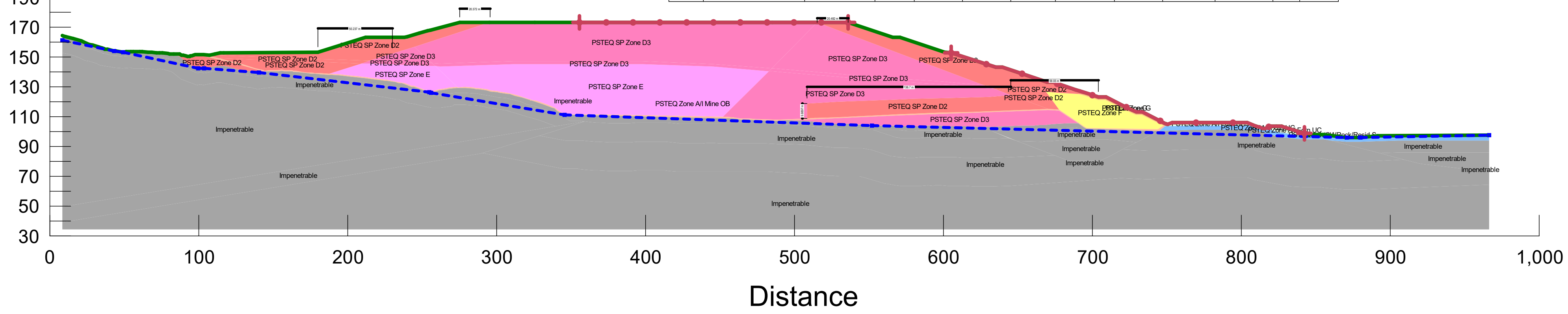

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Figure B13c West Slope PSTEQ

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Section 1d.gsz

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.: 0.04

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19				8	15		1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19		0	0.06				1	0.6	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5		120	0.32				1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

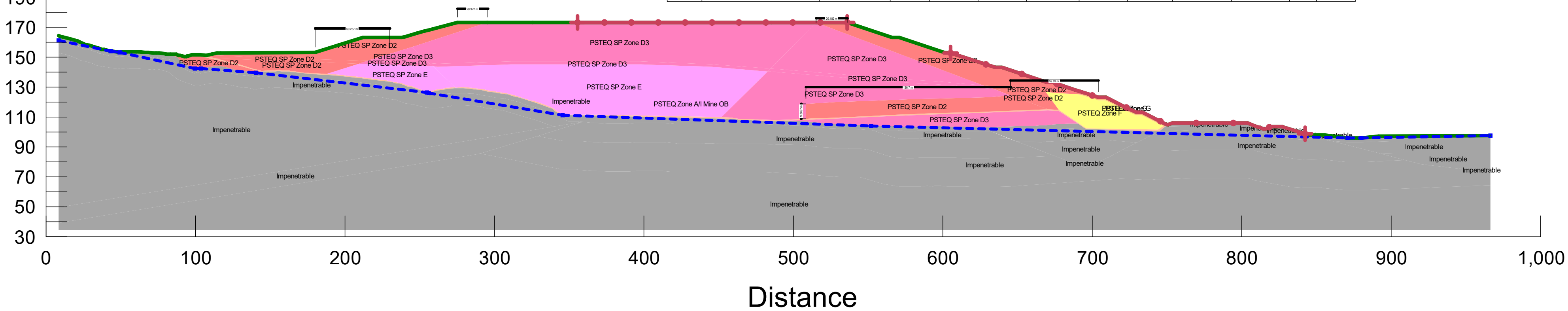

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Figure B14 West Slope Oper. EQ ky

13/10/2021 By: ET 1:4,000

Section 1d.gsz

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.: 0.18

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19				8	15		1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19		0	0.06				1	0.6	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5		120	0.32				1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

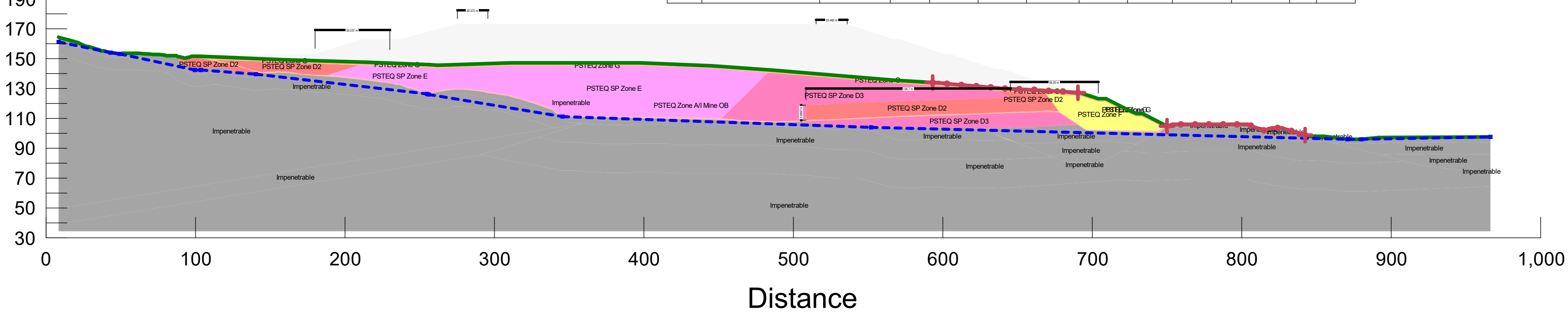

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Figure B15 West Slope Close EQ ky

13/10/2021 By: ET 1:4,000

Section 1d.gsz

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

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Ash/CWRock/Resid.S	Mohr-Coulomb	17		0	26	1	0.1	Yes
	Drnd Epiclastic	Mohr-Coulomb	18		5	35	1		No
	Drnd EW/VW Rhy. EW Ign&Dac.	Shear/Normal Fn.	17.5	EW/VW Rhy. EW Ign. Dac.			1	0.1	Yes
	Drnd Paleo Bldr Allu.	Mohr-Coulomb	18		5	35	1		No
	Drnd SP Zone D2	Shear/Normal Fn.	19.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd SP Zone D3	Mohr-Coulomb	19		5	31	1	0.4	Yes
	Drnd SP Zone E	Mohr-Coulomb	19		0	26	1	0.6	Yes
	Drnd VW Dacite	Shear/Normal Fn.	18	VW Dacite			1		No
	Drnd VW Ign.	Shear/Normal Fn.	19	VW Ign.			1		No
	Drnd W Dacite	Shear/Normal Fn.	25	Weak Rhy. Dac.			1		No
	Drnd W Rhy Rock	Shear/Normal Fn.	18.5	Weak Rhy. Dac.			1		No
	Drnd Zone A/I Fdtn UC	Mohr-Coulomb	17.5		3	31	1	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5		5	35	1	0.1	Yes
	Drnd Zone F	Shear/Normal Fn.	20.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5		3	31	1	0.1	Yes

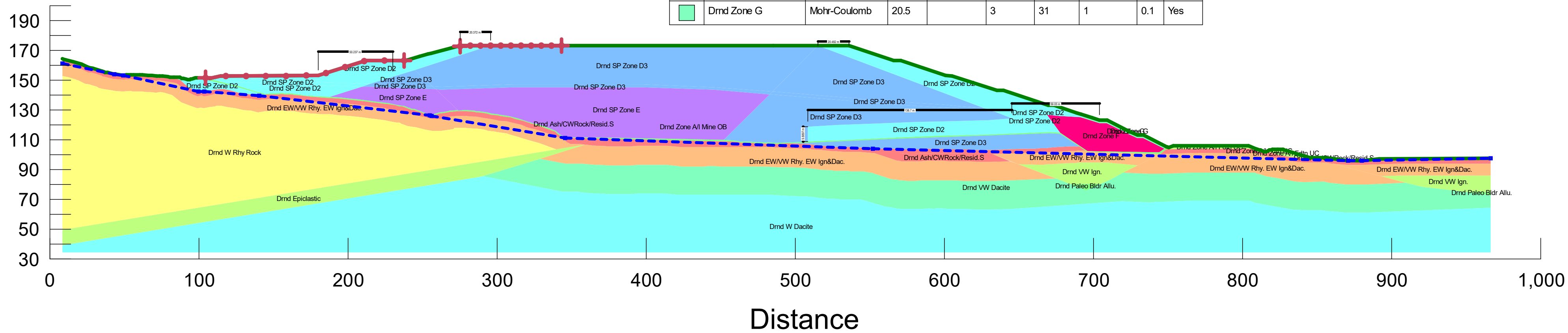

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Figure B16 Up Slope Drnd

13/10/2021 By: ET 1:4,000

Section 1d.gsz

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

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Udrnd Ash/CWRock/Resid.S	Shear/Normal Fn.	17						Ash/CWRock	1	0.1	Yes
	Udrnd Epiclastic	Mohr-Coulomb	18				5	35		1		No
	Udrnd EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5						EW/VW Rhy. EW Ign. Dac.	1	0.1	Yes
	Udrnd Paleo Bldr Allu.	Mohr-Coulomb	18				5	35		1		No
	Udrnd SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd SP Zone D3	Mohr-Coulomb	19				10	18		1	0.4	Yes
	Udrnd SP Zone E	SHANSEP	19		0	0.21				1	0.6	Yes
	Udrnd VW Dacite	Shear/Normal Fn.	18						VW Dacite	1		No
	Udrnd VW Ign.	Shear/Normal Fn.	19						VW Ign.	1		No
	Udrnd W Dacite	Shear/Normal Fn.	25						Weak Rhy. Dac.	1		No
	Udrnd W Rhy Rock	Shear/Normal Fn.	18.5						Weak Rhy. Dac.	1		No
	Udrnd Zone A/I Fdtn UC	SHANSEP	17.5		80	0.35				1	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5		150	0.4				1	0.1	Yes
	Udrnd Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100						1		No

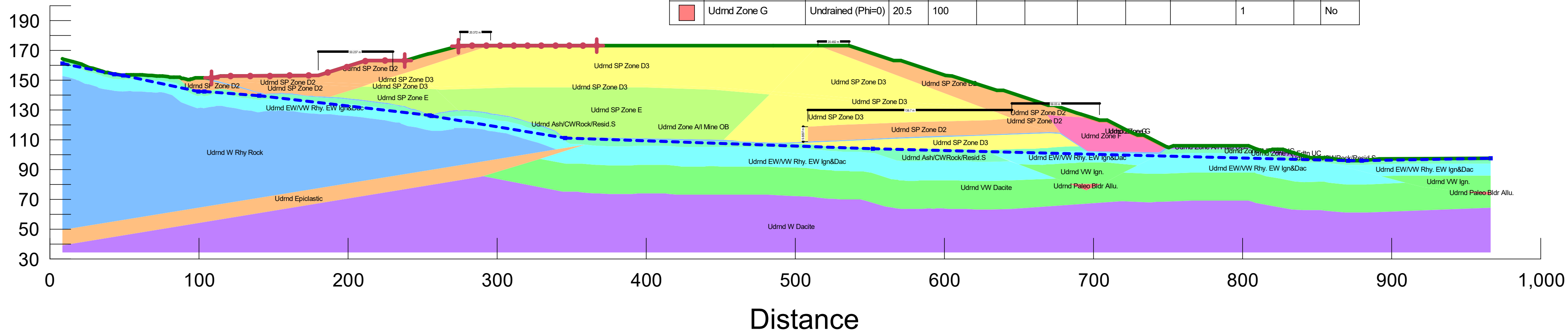

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Figure B17 Up Slope Udrnd

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Section 1d.gsz

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

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ Epiclastic	Mohr-Coulomb	18			5	35			1		No
	PSTEQ EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5		EW/VW Rhy. EW Ign. Dac.					1		No
	PSTEQ Paleo Bldr Allu.	Mohr-Coulomb	18			5	35			1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19			8	15			1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ VW Dacite	Shear/Normal Fn.	18		VW Dacite					1		No
	PSTEQ VW Ign.	Shear/Normal Fn.	19		VW Ign.					1		No
	PSTEQ W Dacite	Shear/Normal Fn.	25		Weak Rhy. Dac.					1		No
	PSTEQ W Rhy Rock	Shear/Normal Fn.	18.5		Weak Rhy. Dac.					1		No
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

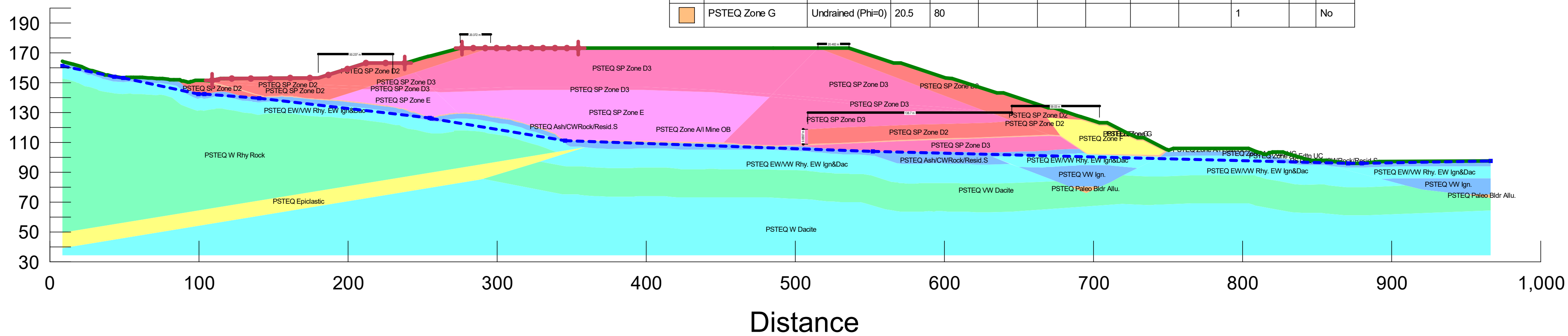

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Figure B18 Up Slope PSTEQ

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Section 1d.gsz

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0.1

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ Epiclastic	Mohr-Coulomb	18			5	35			1		No
	PSTEQ EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5		EW/VW Rhy. EW Ign. Dac.					1		No
	PSTEQ Paleo Bldr Allu.	Mohr-Coulomb	18			5	35			1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19			8	15			1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ VW Dacite	Shear/Normal Fn.	18		VW Dacite					1		No
	PSTEQ VW Ign.	Shear/Normal Fn.	19		VW Ign.					1		No
	PSTEQ W Dacite	Shear/Normal Fn.	25		Weak Rhy. Dac.					1		No
	PSTEQ W Rhy Rock	Shear/Normal Fn.	18.5		Weak Rhy. Dac.					1		No
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

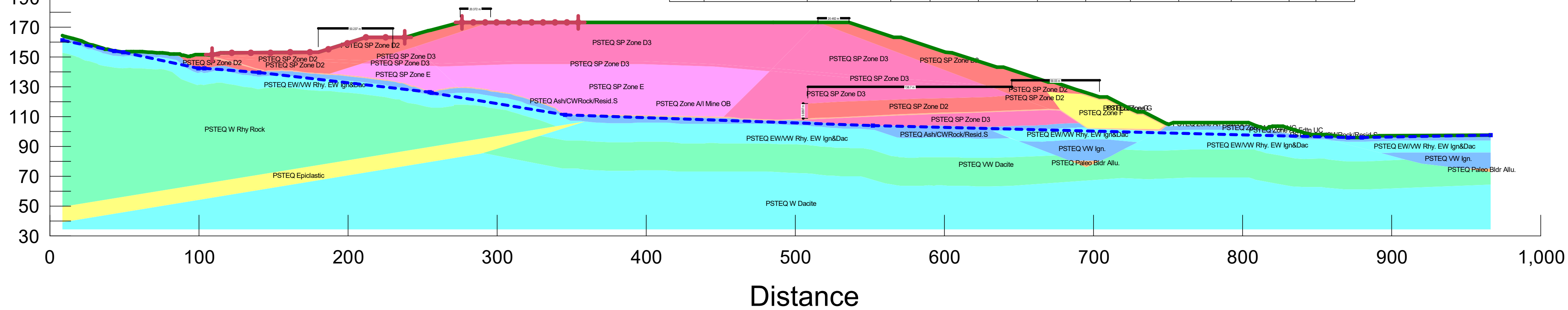

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Figure B19 Up Slope PSTEQ

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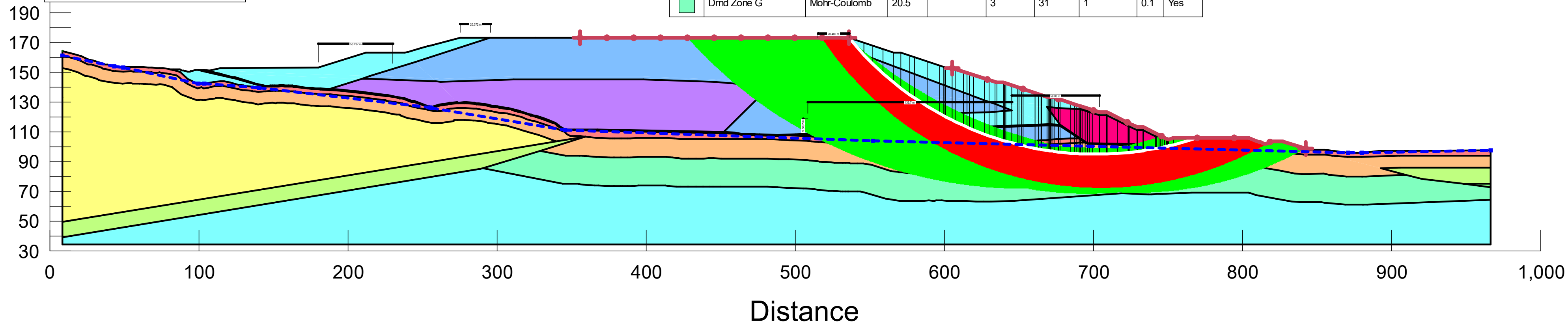
Section 1 - Stability Model Figures Showing Results

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.:

Factor of Safety: 1.92

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Ash/CWRock/Resid.S	Mohr-Coulomb	17		0	26	1	0.1	Yes
	Drnd Epiclastic	Mohr-Coulomb	18		5	35	1		No
	Drnd EW/VW Rhy. EW Ign&Dac.	Shear/Normal Fn.	17.5	EW/VW Rhy. EW Ign. Dac.			1	0.1	Yes
	Drnd Paleo Bldr Allu.	Mohr-Coulomb	18		5	35	1		No
	Drnd SP Zone D2	Shear/Normal Fn.	19.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd SP Zone D3	Mohr-Coulomb	19		5	31	1	0.4	Yes
	Drnd SP Zone E	Mohr-Coulomb	19		0	26	1	0.6	Yes
	Drnd VW Dacite	Shear/Normal Fn.	18	VW Dacite			1		No
	Drnd VW Ign.	Shear/Normal Fn.	19	VW Ign.			1		No
	Drnd W Dacite	Shear/Normal Fn.	25	Weak Rhy. Dac.			1		No
	Drnd W Rhy Rock	Shear/Normal Fn.	18.5	Weak Rhy. Dac.			1		No
	Drnd Zone A/I Fdtn UC	Mohr-Coulomb	17.5		3	31	1	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5		5	35	1	0.1	Yes
	Drnd Zone F	Shear/Normal Fn.	20.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5		3	31	1	0.1	Yes

Factor of Safety
- 1.92 - 2.02
- 2.02 - 2.12
- ≥ 2.12



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Engineering Geology Ltd
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info@egl.co.nz
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Figure B11a West Slope Drnd

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Section 1d.gsz

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.:

Factor of Safety: 2.25

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Ash/CWRock/Resid.S	Mohr-Coulomb	17		0	26	1	0.1	Yes
	Drnd EW/VW Rhy. EW Ign&Dac.	Shear/Normal Fn.	17.5	EW/VW Rhy. EW Ign. Dac.			1	0.1	Yes
	Drnd Paleo Bldr Allu.	Mohr-Coulomb	18		5	35	1		No
	Drnd SP Zone D2	Shear/Normal Fn.	19.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd SP Zone D3	Mohr-Coulomb	19		5	31	1	0.4	Yes
	Drnd SP Zone E	Mohr-Coulomb	19		0	26	1	0.6	Yes
	Drnd VW Ign.	Shear/Normal Fn.	19	VW Ign.			1		No
	Drnd Zone A/I Fdtn UC	Mohr-Coulomb	17.5		3	31	1	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5		5	35	1	0.1	Yes
	Drnd Zone F	Shear/Normal Fn.	20.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5		3	31	1	0.1	Yes
	Impenetrable	Bedrock (Impenetrable)					1		No

Factor of Safety

- 2.25 - 2.35
- 2.35 - 2.45
- ≥ 2.45

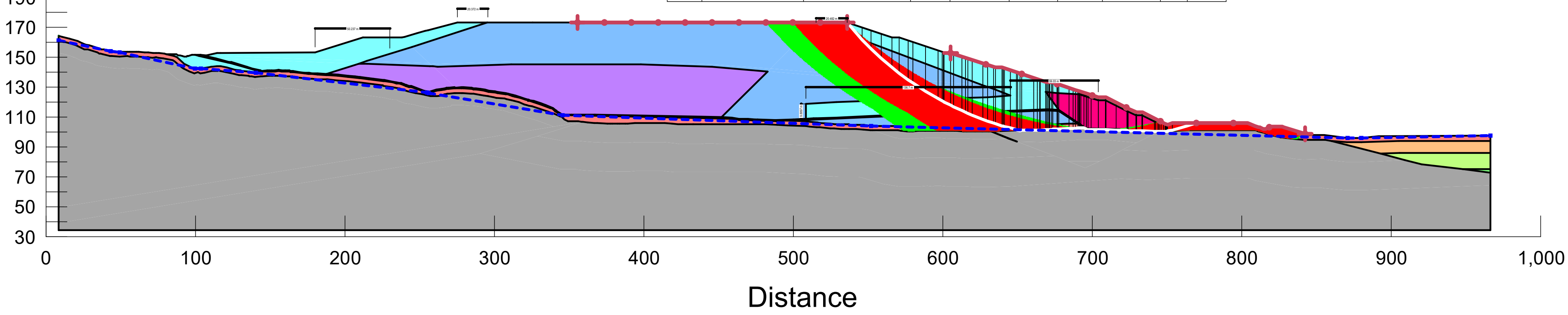

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Figure B11b West Slope Drnd

13/10/2021 By: ET 1:4,000

Section 1d.gsz

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.:

Factor of Safety: 1.63

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Udrnd Ash/CWRock/Resid.S	Shear/Normal Fn.	17						Ash/CWRock	1	0.1	Yes
	Udrnd Epiclastic	Mohr-Coulomb	18				5	35		1		No
	Udrnd EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5						EW/VW Rhy. EW Ign. Dac.	1	0.1	Yes
	Udrnd Paleo Bldr Allu.	Mohr-Coulomb	18				5	35		1		No
	Udrnd SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd SP Zone D3	Mohr-Coulomb	19				10	18		1	0.4	Yes
	Udrnd SP Zone E	SHANSEP	19		0	0.21				1	0.6	Yes
	Udrnd VW Dacite	Shear/Normal Fn.	18						VW Dacite	1		No
	Udrnd VW Ign.	Shear/Normal Fn.	19						VW Ign.	1		No
	Udrnd W Dacite	Shear/Normal Fn.	25						Weak Rhy. Dac.	1		No
	Udrnd W Rhy Rock	Shear/Normal Fn.	18.5						Weak Rhy. Dac.	1		No
	Udrnd Zone A/I Fdtn UC	SHANSEP	17.5		80	0.35				1	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5		150	0.4				1	0.1	Yes
	Udrnd Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100						1		No

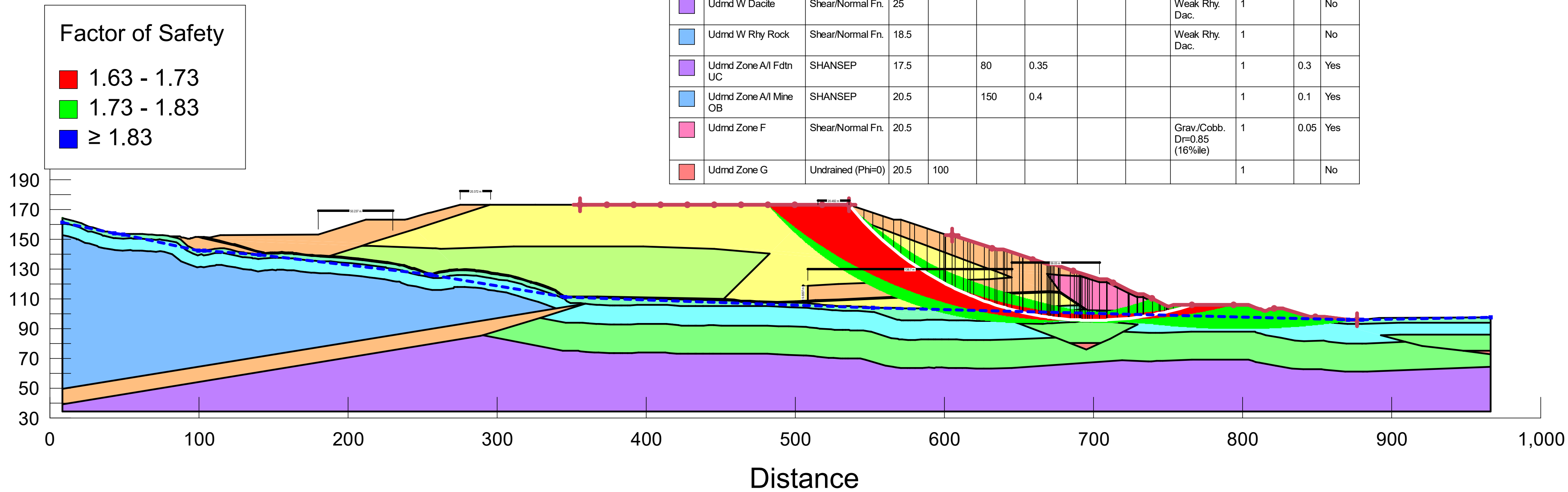

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Figure B12a West Slope Udrnd

13/10/2021 By: ET 1:4,000

Section 1d.gsz

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.:

Factor of Safety: 1.53

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	Udmd Ash/CWRock/Resid.S	Shear/Normal Fn.	17						Ash/CWRock	1	0.1	Yes
	Udmd SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udmd SP Zone D3	Mohr-Coulomb	19				10	18		1	0.4	Yes
	Udmd SP Zone E	SHANSEP	19		0	0.21				1	0.6	Yes
	Udmd Zone A/I Fdtn UC	SHANSEP	17.5		80	0.35				1	0.3	Yes
	Udmd Zone A/I Mine OB	SHANSEP	20.5		150	0.4				1	0.1	Yes
	Udmd Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udmd Zone G	Undrained (Phi=0)	20.5	100						1		No

Factor of Safety
1.53 - 1.63
1.63 - 1.73
≥ 1.73

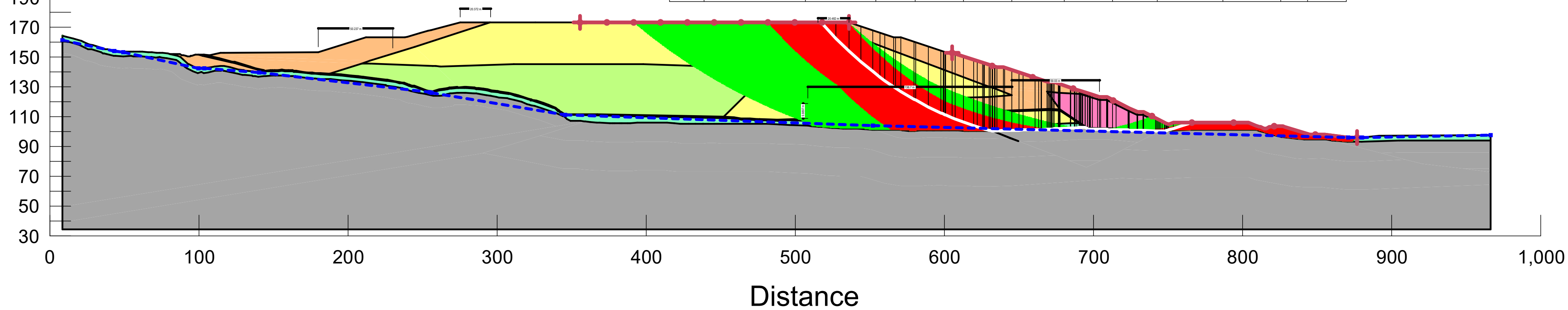

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Figure B12b West Slope Udrnd

13/10/2021 By: ET 1:4,000

Section 1d.gsz

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.:

Factor of Safety: 1.65

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ Epiclastic	Mohr-Coulomb	18			5	35			1		No
	PSTEQ EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5		EW/VW Rhy. EW Ign. Dac.					1		No
	PSTEQ Paleo Bldr Allu.	Mohr-Coulomb	18			5	35			1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19			8	15			1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ VW Dacite	Shear/Normal Fn.	18		VW Dacite					1		No
	PSTEQ VW Ign.	Shear/Normal Fn.	19		VW Ign.					1		No
	PSTEQ W Dacite	Shear/Normal Fn.	25		Weak Rhy. Dac.					1		No
	PSTEQ W Rhy Rock	Shear/Normal Fn.	18.5		Weak Rhy. Dac.					1		No
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

Factor of Safety
- 1.65 - 1.75
- 1.75 - 1.85
- ≥ 1.85

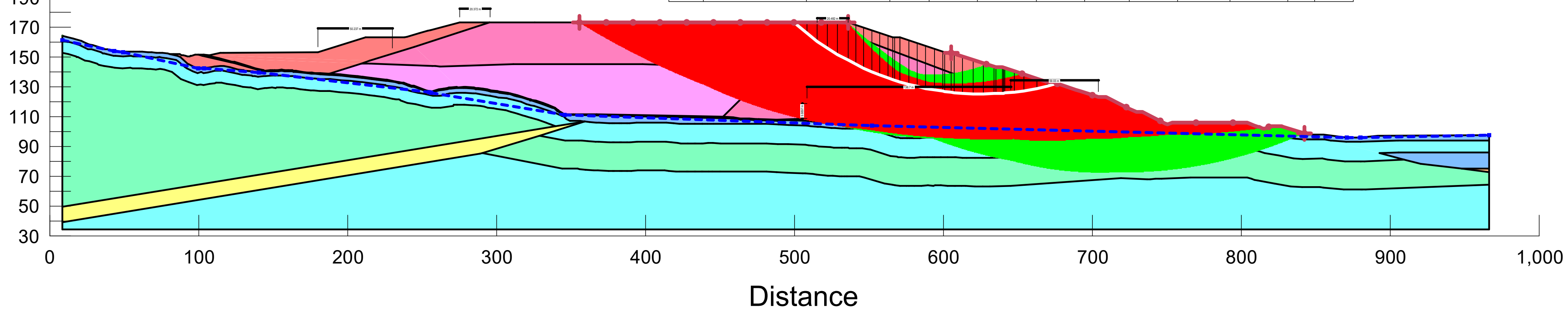

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Figure B13a West Slope PSTEQ

13/10/2021 By: ET 1:4,000

Section 1d.gsz

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.:

Factor of Safety: 1.28

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

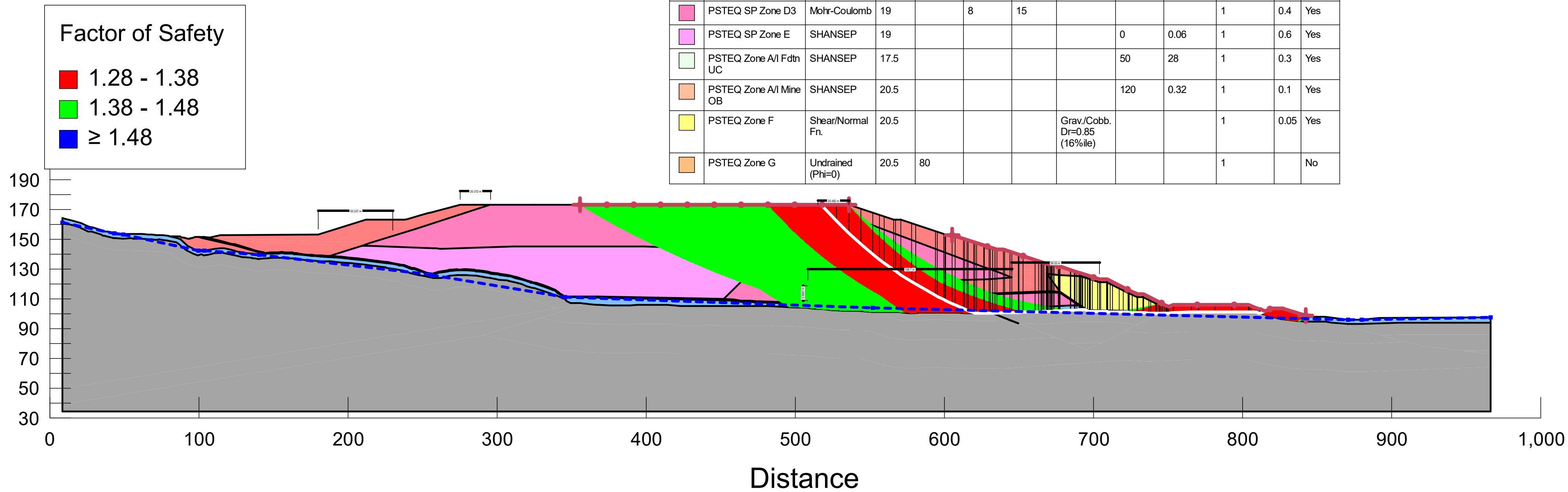

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Figure B13b West Slope PSTEQ

13/10/2021 By: ET 1:4,000

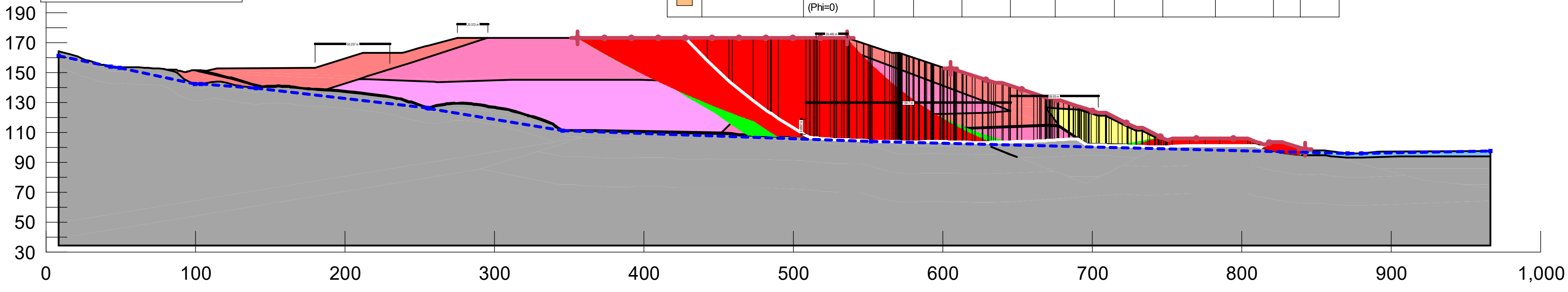
Section 1d.gsz

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.:

Factor of Safety: 1.21

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

Factor of Safety
- 1.21 - 1.31
- 1.31 - 1.41
- ≥ 1.41



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Engineering Geology Ltd
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Figure B13c West Slope PSTEQ

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Section 1d.gsz

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.: 0.04

Factor of Safety: 0.99

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19				8	15		1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19		0	0.06				1	0.6	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5		120	0.32				1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

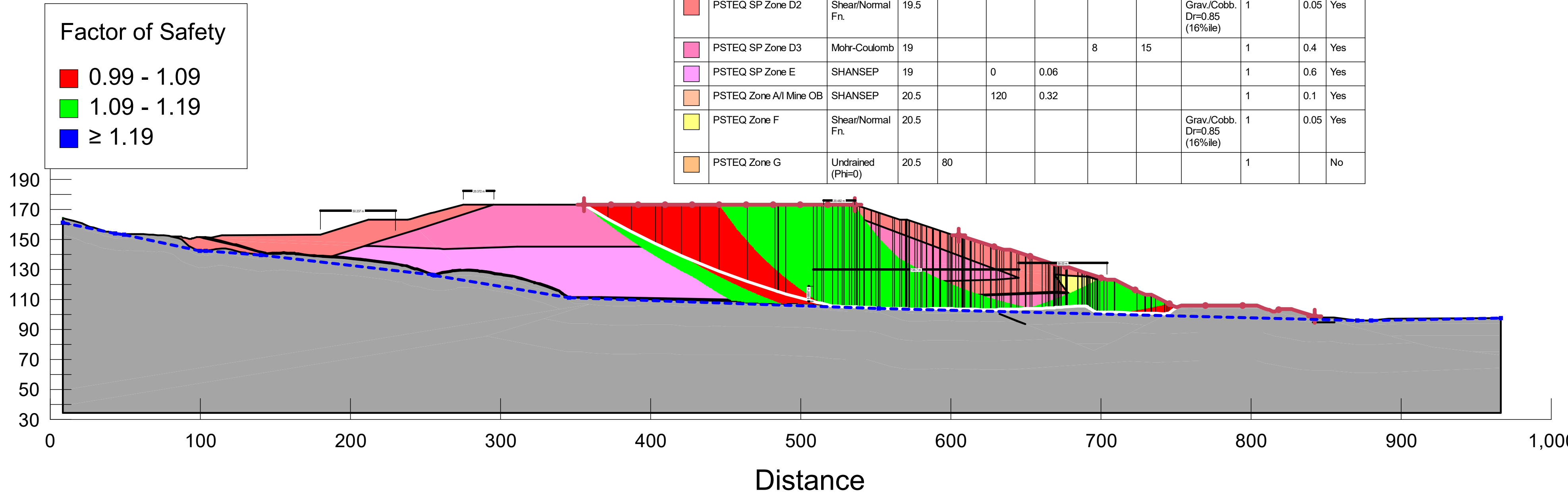

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Figure B14 West Slope Oper. EQ ky

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Section 1d.gsz

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.: 0.18

Factor of Safety: 1.03

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19				8	15		1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19		0	0.06				1	0.6	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5		120	0.32				1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

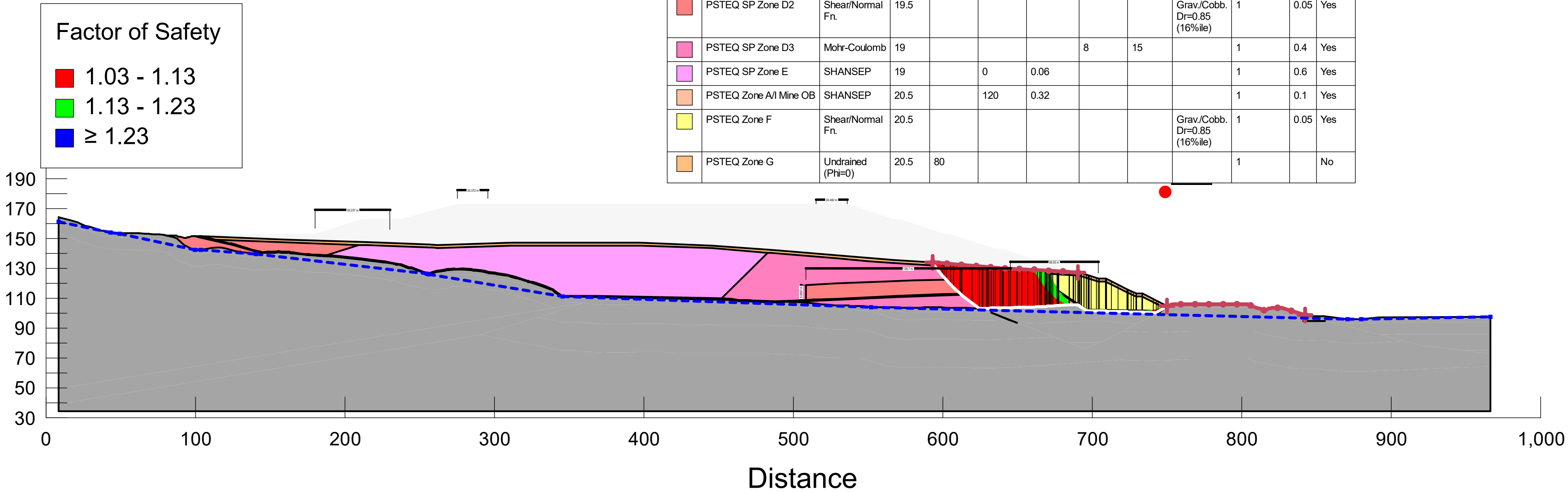

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Figure B15 West Slope Close EQ ky

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Section 1d.gsz

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

Factor of Safety: 3.44

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Ash/CWRock/Resid.S	Mohr-Coulomb	17		0	26	1	0.1	Yes
	Drnd Epiclastic	Mohr-Coulomb	18		5	35	1		No
	Drnd EW/VW Rhy. EW Ign&Dac.	Shear/Normal Fn.	17.5	EW/VW Rhy. EW Ign. Dac.			1	0.1	Yes
	Drnd Paleo Bldr Allu.	Mohr-Coulomb	18		5	35	1		No
	Drnd SP Zone D2	Shear/Normal Fn.	19.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd SP Zone D3	Mohr-Coulomb	19		5	31	1	0.4	Yes
	Drnd SP Zone E	Mohr-Coulomb	19		0	26	1	0.6	Yes
	Drnd VW Dacite	Shear/Normal Fn.	18	VW Dacite			1		No
	Drnd VW Ign.	Shear/Normal Fn.	19	VW Ign.			1		No
	Drnd W Dacite	Shear/Normal Fn.	25	Weak Rhy. Dac.			1		No
	Drnd W Rhy Rock	Shear/Normal Fn.	18.5	Weak Rhy. Dac.			1		No
	Drnd Zone A/I Fdtn UC	Mohr-Coulomb	17.5		3	31	1	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5		5	35	1	0.1	Yes
	Drnd Zone F	Shear/Normal Fn.	20.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5		3	31	1	0.1	Yes

Factor of Safety
- 3.44 - 3.54
- 3.54 - 3.64
- ≥ 3.64

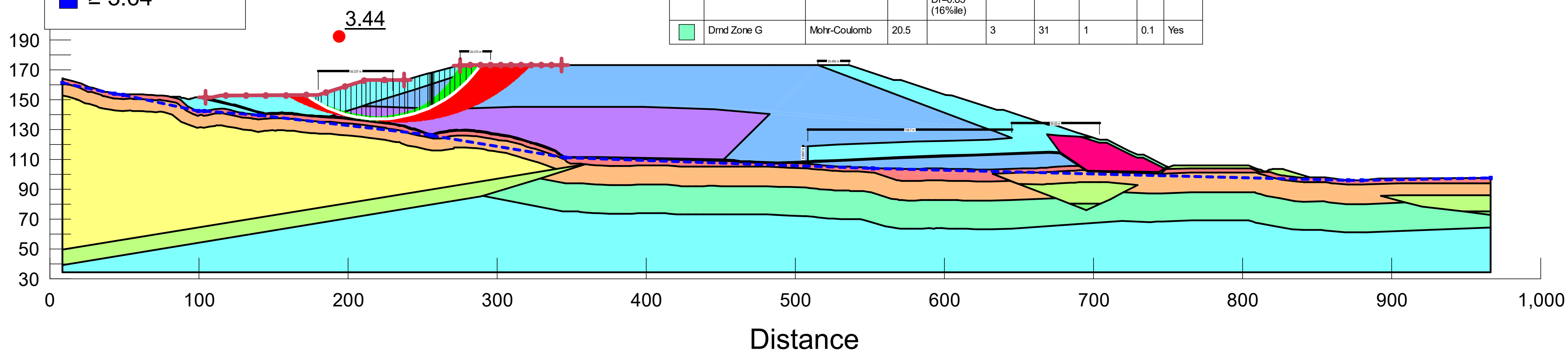

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Figure B16 Up Slope Drnd

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Section 1d.gsz

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

Factor of Safety: 2.17

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Udrnd Ash/CWRock/Resid.S	Shear/Normal Fn.	17						Ash/CWRock	1	0.1	Yes
	Udrnd Epiclastic	Mohr-Coulomb	18				5	35		1		No
	Udrnd EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5						EW/VW Rhy. EW Ign. Dac.	1	0.1	Yes
	Udrnd Paleo Bldr Allu.	Mohr-Coulomb	18				5	35		1		No
	Udrnd SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd SP Zone D3	Mohr-Coulomb	19				10	18		1	0.4	Yes
	Udrnd SP Zone E	SHANSEP	19		0	0.21				1	0.6	Yes
	Udrnd VW Dacite	Shear/Normal Fn.	18						VW Dacite	1		No
	Udrnd VW Ign.	Shear/Normal Fn.	19						VW Ign.	1		No
	Udrnd W Dacite	Shear/Normal Fn.	25						Weak Rhy. Dac.	1		No
	Udrnd W Rhy Rock	Shear/Normal Fn.	18.5						Weak Rhy. Dac.	1		No
	Udrnd Zone A/I Fdtn UC	SHANSEP	17.5		80	0.35				1	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5		150	0.4				1	0.1	Yes
	Udrnd Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100						1		No

Factor of Safety
- 2.17 - 2.27
- 2.27 - 2.37
- ≥ 2.37

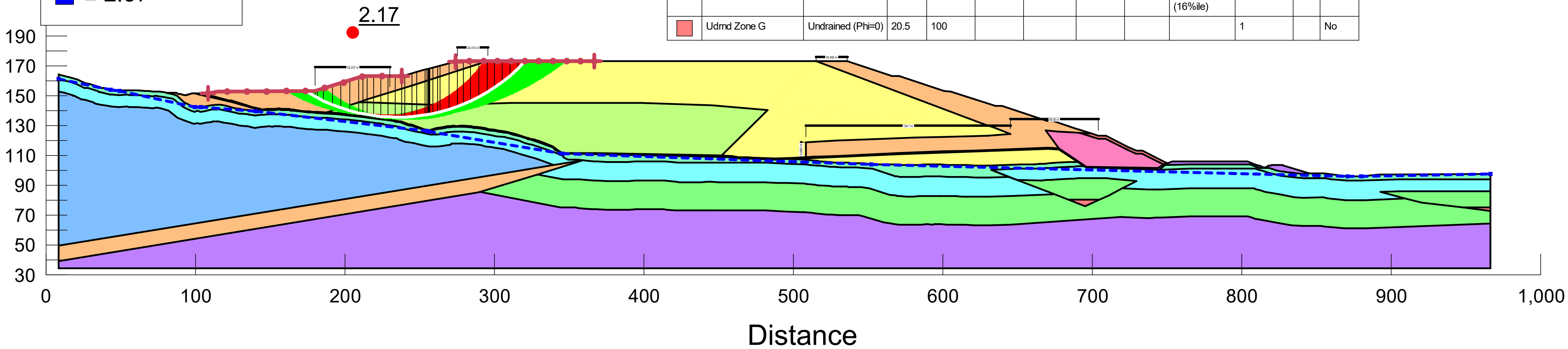

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Figure B17 Up Slope Udrnd

13/10/2021 By: ET 1:4,000

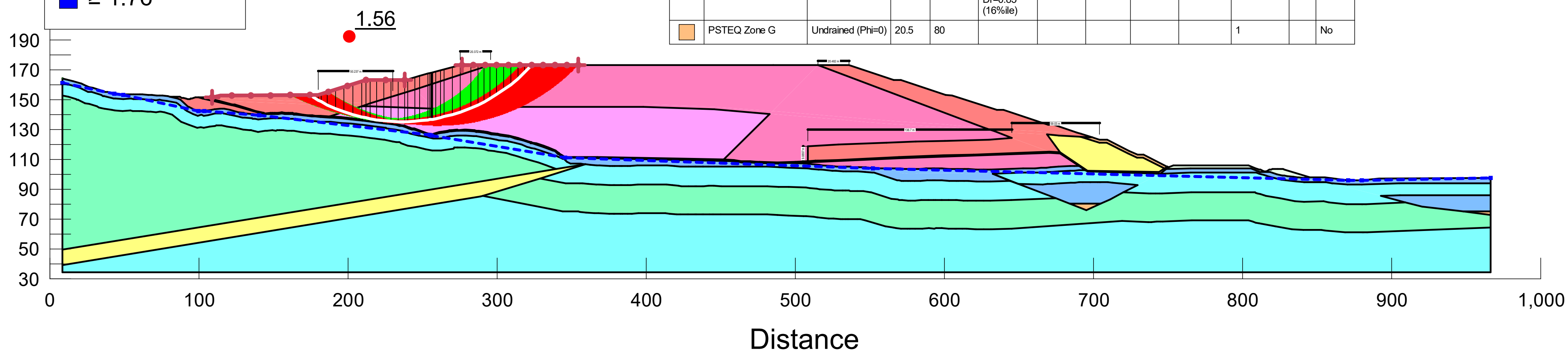
Section 1d.gsz

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

Factor of Safety: 1.56

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ Epiclastic	Mohr-Coulomb	18			5	35			1		No
	PSTEQ EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5		EW/VW Rhy. EW Ign. Dac.					1		No
	PSTEQ Paleo Bldr Allu.	Mohr-Coulomb	18			5	35			1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19			8	15			1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ VW Dacite	Shear/Normal Fn.	18		VW Dacite					1		No
	PSTEQ VW Ign.	Shear/Normal Fn.	19		VW Ign.					1		No
	PSTEQ W Dacite	Shear/Normal Fn.	25		Weak Rhy. Dac.					1		No
	PSTEQ W Rhy Rock	Shear/Normal Fn.	18.5		Weak Rhy. Dac.					1		No
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

Factor of Safety
1.56 - 1.66
1.66 - 1.76
≥ 1.76



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Engineering Geology Ltd
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Figure B18 Up Slope PSTEQ

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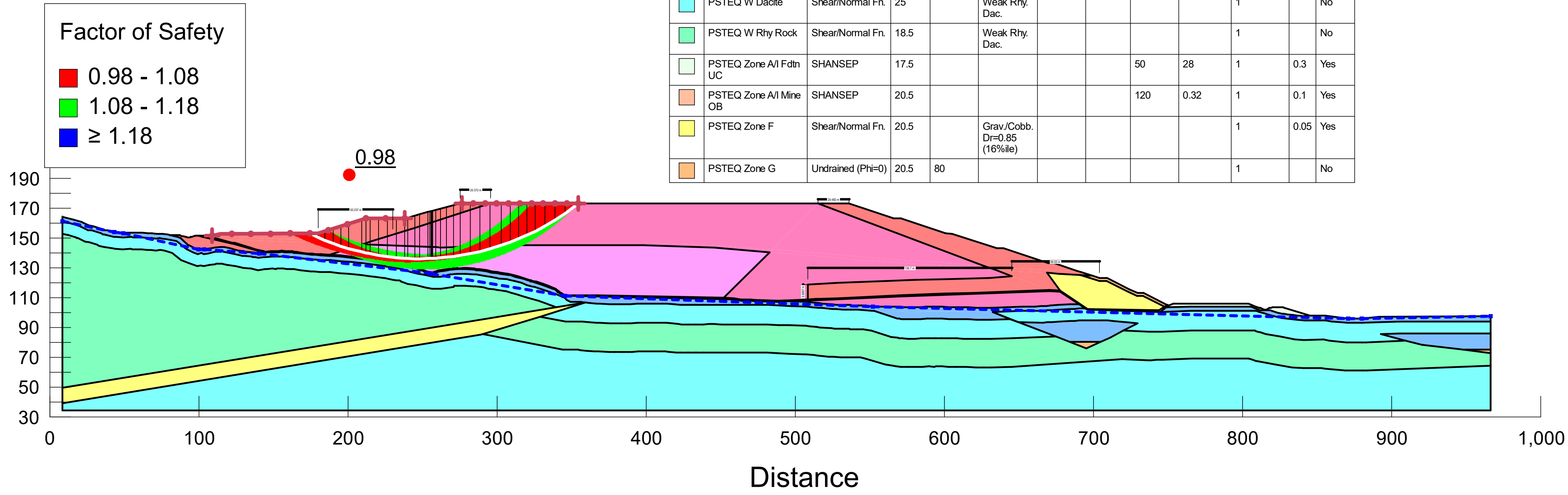
Section 1d.gsz

Analysis Settings
Method: Morgenstern-Price
Direction of movement: Right to Left
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.: 0.1

Factor of Safety: 0.98

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ Epiclastic	Mohr-Coulomb	18			5	35			1		No
	PSTEQ EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5		EW/VW Rhy. EW Ign. Dac.					1		No
	PSTEQ Paleo Bldr Allu.	Mohr-Coulomb	18			5	35			1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19			8	15			1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ VW Dacite	Shear/Normal Fn.	18		VW Dacite					1		No
	PSTEQ VW Ign.	Shear/Normal Fn.	19		VW Ign.					1		No
	PSTEQ W Dacite	Shear/Normal Fn.	25		Weak Rhy. Dac.					1		No
	PSTEQ W Rhy Rock	Shear/Normal Fn.	18.5		Weak Rhy. Dac.					1		No
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5		Grav./Cobb. Dr=0.85 (16%ile)					1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No



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Engineering Geology Ltd
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info@egl.co.nz
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Figure B19 Up Slope PSTEQ

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Section 1d.gsz

Section 2 - Stability Model Figures Showing Geometry and Material Only

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.:

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Ash/CWRock/Resid.S	Mohr-Coulomb	17		0	26	1	0.1	Yes
	Drnd EW/VW Rhy. EW Ign&Dac.	Shear/Normal Fn.	17.5	EW/VW Rhy. EW Ign. Dac.			1	0.1	Yes
	Drnd SP Zone D2	Shear/Normal Fn.	19.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd SP Zone D3	Mohr-Coulomb	19		5	31	1	0.4	Yes
	Drnd SP Zone E	Mohr-Coulomb	19		0	26	1	0.6	Yes
	Drnd VW Dacite	Shear/Normal Fn.	18	VW Dacite			1		No
	Drnd W Dacite	Shear/Normal Fn.	25	Weak Rhy. Dac.			1		No
	Drnd W Rhy Rock	Shear/Normal Fn.	18.5	Weak Rhy. Dac.			1		No
	Drnd Zone A/I Fdtn UC	Mohr-Coulomb	17.5		3	31	1	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5		5	35	1	0.1	Yes
	Drnd Zone F	Shear/Normal Fn.	20.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5		3	31	1	0.1	Yes

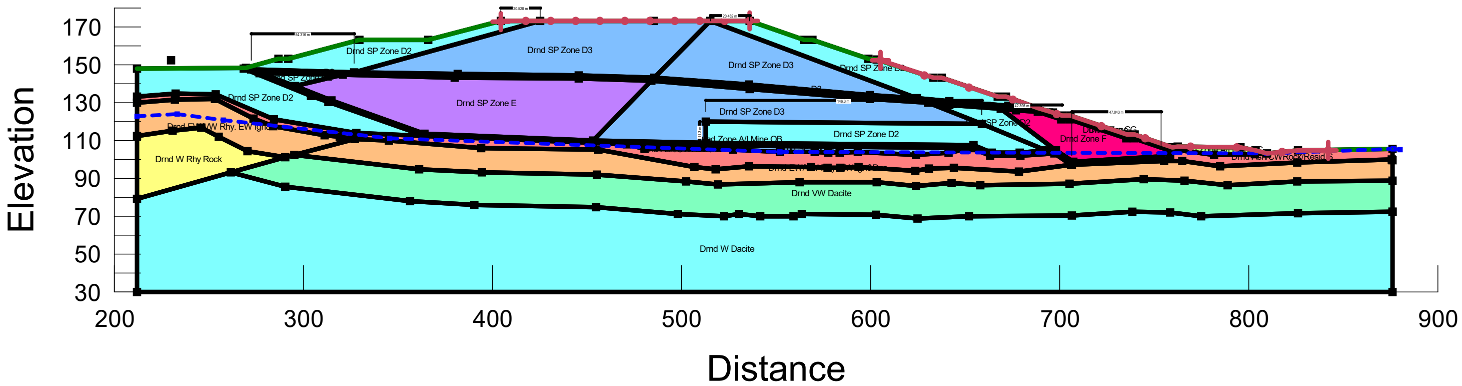

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Figure B21a North Slope Drnd

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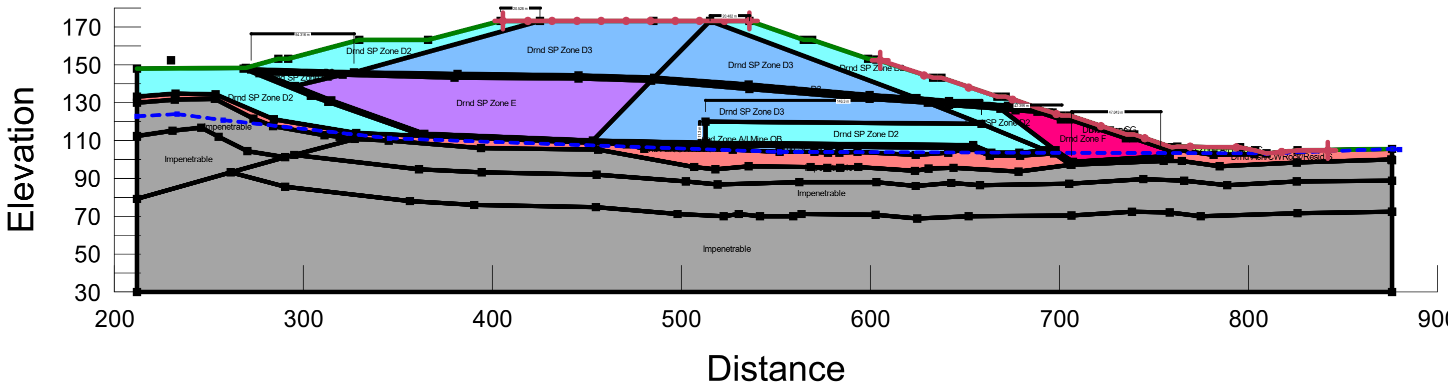
Section 2a.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Ash/CWRock/Resid.S	Mohr-Coulomb	17		0	26	1	0.1	Yes
	Drnd SP Zone D2	Shear/Normal Fn.	19.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd SP Zone D3	Mohr-Coulomb	19		5	31	1	0.4	Yes
	Drnd SP Zone E	Mohr-Coulomb	19		0	26	1	0.6	Yes
	Drnd Zone A/I Fdtn UC	Mohr-Coulomb	17.5		3	31	1	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5		5	35	1	0.1	Yes
	Drnd Zone F	Shear/Normal Fn.	20.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5		3	31	1	0.1	Yes
	Impenetrable	Bedrock (Impenetrable)					1		No



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info@egl.co.nz
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PO Box 301054, Albany, Auckland 0752
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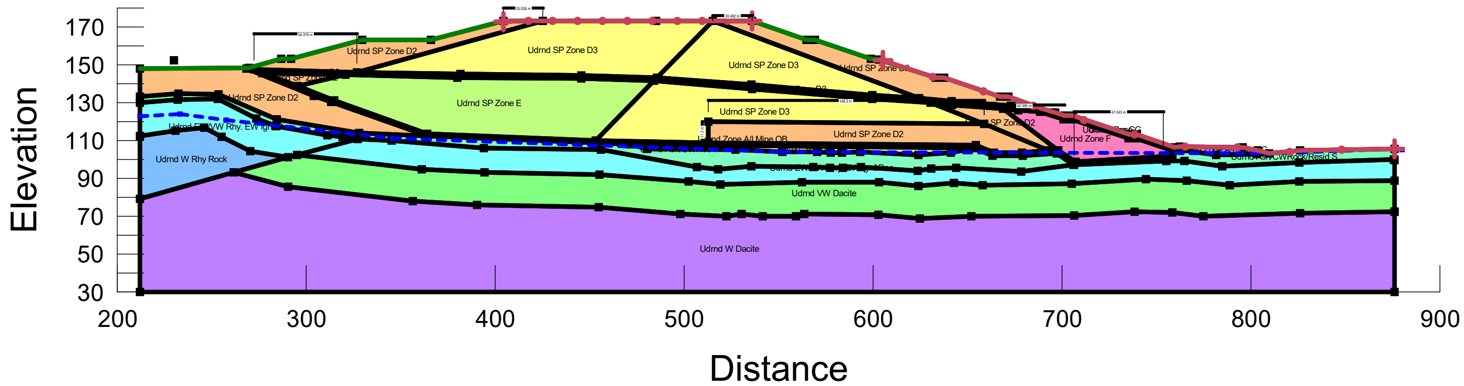
Figure B21b North Slope Drnd

13/10/2021 By: ET 1:4,000

Section 2a.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Udrnd Ash/CWRock/Resid.S	Shear/Normal Fn.	17						Ash/CWRock	1	0.1	Yes
	Udrnd EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5						EW/VW Rhy. EW Ign. Dac.	1	0.1	Yes
	Udrnd SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd SP Zone D3	Mohr-Coulomb	19				10	18		1	0.4	Yes
	Udrnd SP Zone E	SHANSEP	19		0	0.21				1	0.6	Yes
	Udrnd VW Dacite	Shear/Normal Fn.	18						VW Dacite	1		No
	Udrnd W Dacite	Shear/Normal Fn.	25						Weak Rhy. Dac.	1		No
	Udrnd W Rhy Rock	Shear/Normal Fn.	18.5						Weak Rhy. Dac.	1		No
	Udrnd Zone A/I Fdtn UC	SHANSEP	17.5		80	0.35				1	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5		150	0.4				1	0.1	Yes
	Udrnd Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100						1		No



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Geotechnical, Earthquake and Dam Engineers
Engineering Geology Ltd
+64 9 486 2546
info@egl.co.nz
Unit 7C, 331 Rosedale Road, Albany, Auckland
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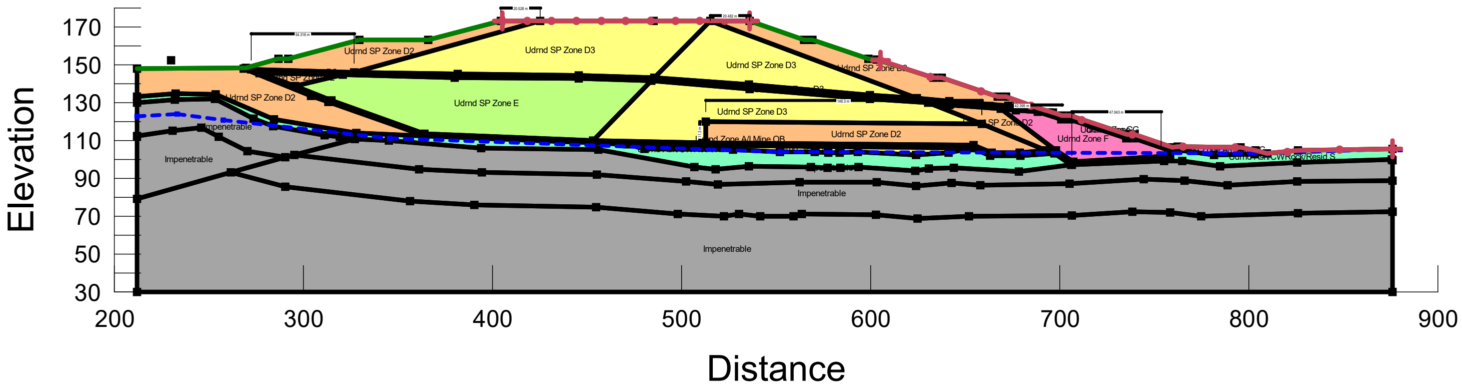
Figure B22a North Slope Udrnd

13/10/2021 By: ET 1:4,000

Section 2a.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	Udrnd Ash/CWRock/Resid.S	Shear/Normal Fn.	17						Ash/CWRock	1	0.1	Yes
	Udrnd SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd SP Zone D3	Mohr-Coulomb	19				10	18		1	0.4	Yes
	Udrnd SP Zone E	SHANSEP	19		0	0.21				1	0.6	Yes
	Udrnd Zone A/I Fdtn UC	SHANSEP	17.5		80	0.35				1	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5		150	0.4				1	0.1	Yes
	Udrnd Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100						1		No



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Geotechnical, Earthquake and Dam Engineers
Engineering Geology Ltd
+64 9 486 2546
info@egl.co.nz
Unit 7C, 331 Rosedale Road, Albany, Auckland
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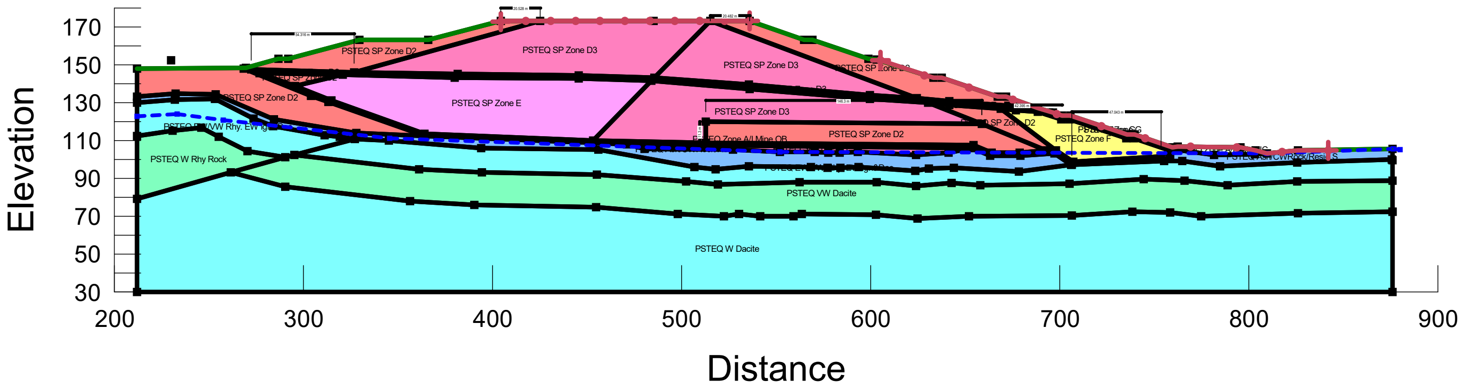
Figure B22b North Slope Udrnd

13/10/2021 By: ET 1:4,000

Section 2a.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5				EW/VW Rhy. EW Ign. Dac.			1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ VW Dacite	Shear/Normal Fn.	18				VW Dacite			1		No
	PSTEQ W Dacite	Shear/Normal Fn.	25				Weak Rhy. Dac.			1		No
	PSTEQ W Rhy Rock	Shear/Normal Fn.	18.5				Weak Rhy. Dac.			1		No
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No



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Geotechnical, Earthquake and Dam Engineers
Engineering Geology Ltd
+64 9 486 2546
info@egl.co.nz
Unit 7C, 331 Rosedale Road, Albany, Auckland
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Figure B23a North Slope PSTEQ

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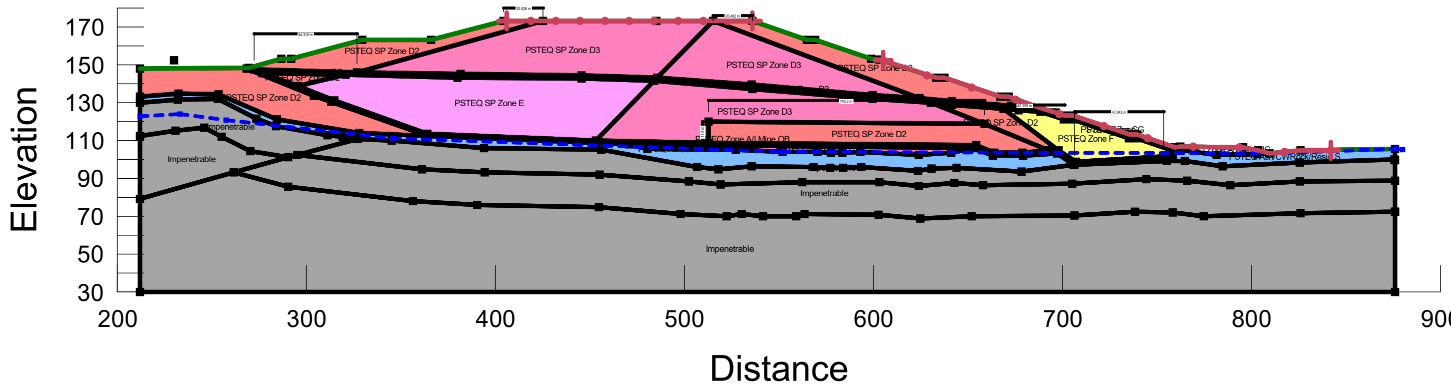
Section 2a.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No



Engineering Geology Ltd
EGL Geotechnical, Earthquake and Dam Engineers
+64 9 486 2546
info@egl.co.nz
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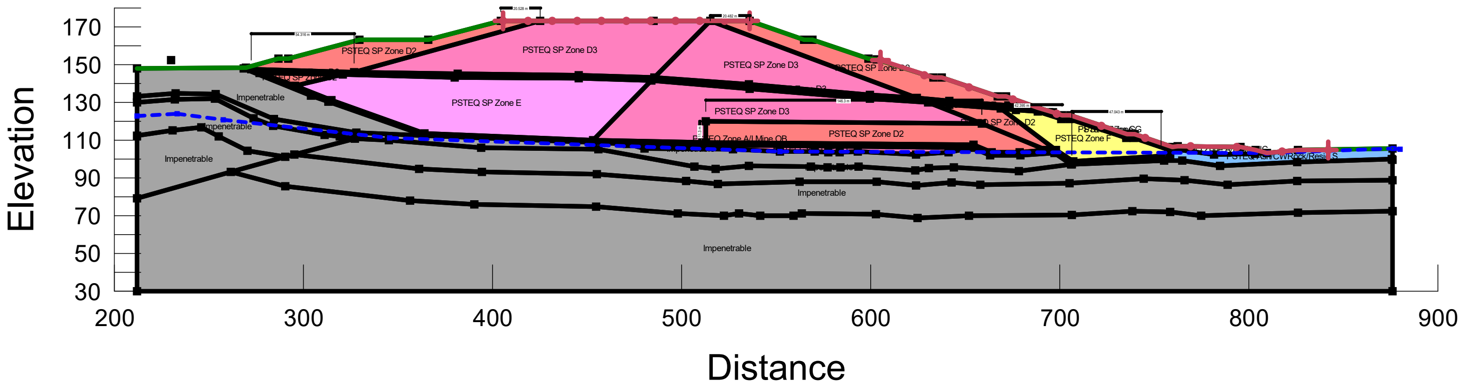
Figure B23b North Slope PSTEQ

13/10/2021 By: ET 1:4,000

Section 2a.gsz

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.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No



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Geotechnical, Earthquake and Dam Engineers
Engineering Geology Ltd
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Figure B23c North Slope PSTEQ

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Section 2a.gsz

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.: 0.05

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

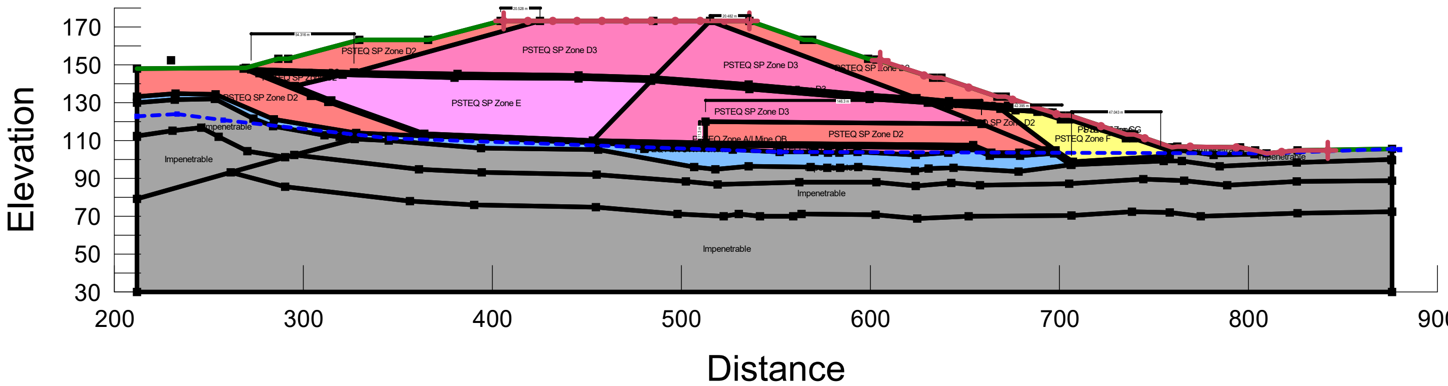

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Figure B24 North Slope Oper. EQ ky

13/10/2021 By: ET 1:4,000

Section 2a.gsz

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.: 0.19

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

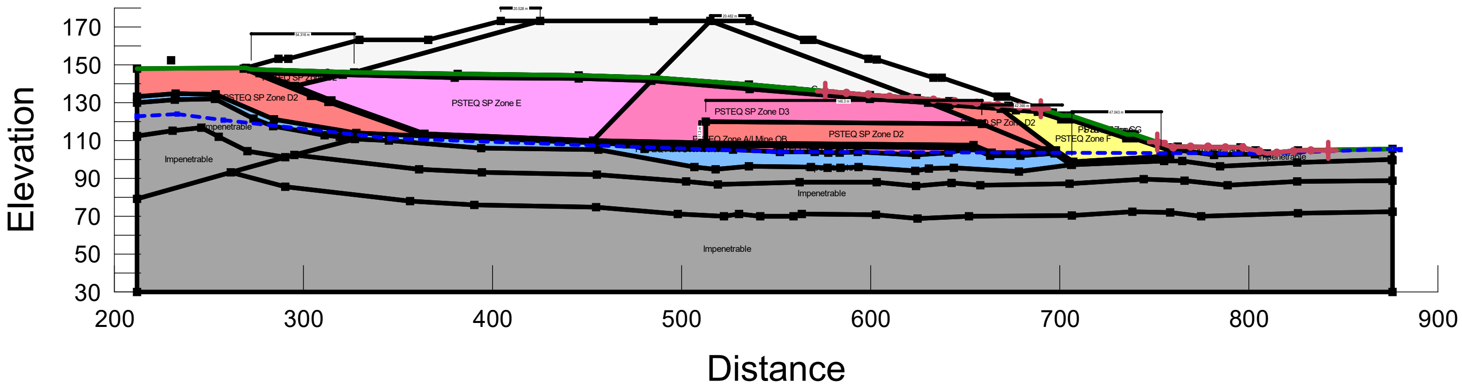

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Figure B25 North Slope Close EQ ky

13/10/2021 By: ET 1:4,000

Section 2a.gsz

Section 2 - Stability Model Figures Showing Results

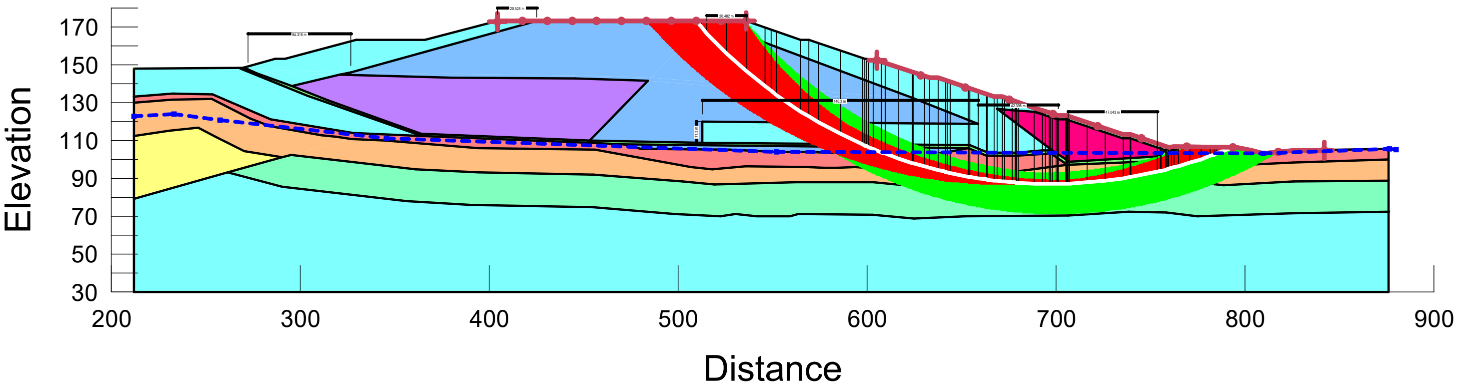
Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.:

Factor of Safety: 1.88

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Ash/CWRock/Resid.S	Mohr-Coulomb	17		0	26	1	0.1	Yes
	Drnd EW/VW Rhy. EW Ign&Dac.	Shear/Normal Fn.	17.5	EW/VW Rhy. EW Ign. Dac.			1	0.1	Yes
	Drnd SP Zone D2	Shear/Normal Fn.	19.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd SP Zone D3	Mohr-Coulomb	19		5	31	1	0.4	Yes
	Drnd SP Zone E	Mohr-Coulomb	19		0	26	1	0.6	Yes
	Drnd VW Dacite	Shear/Normal Fn.	18	VW Dacite			1		No
	Drnd W Dacite	Shear/Normal Fn.	25	Weak Rhy. Dac.			1		No
	Drnd W Rhy Rock	Shear/Normal Fn.	18.5	Weak Rhy. Dac.			1		No
	Drnd Zone A/I Fdtn UC	Mohr-Coulomb	17.5		3	31	1	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5		5	35	1	0.1	Yes
	Drnd Zone F	Shear/Normal Fn.	20.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5		3	31	1	0.1	Yes

Factor of Safety

- 1.88 - 1.98
- 1.98 - 2.08
- ≥ 2.08



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Engineering Geology Ltd
+64 9 486 2546
info@egl.co.nz
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Figure B21a North Slope Drnd

13/10/2021 By: ET 1:4,000

Section 2a.gsz

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.:

Factor of Safety: 2.16

Color	Name	Model	Unit Weight (kN/m³)	Strength Function	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line	Ru	Include Ru in PWP
	Drnd Ash/CWRock/Resid.S	Mohr-Coulomb	17		0	26	1	0.1	Yes
	Drnd SP Zone D2	Shear/Normal Fn.	19.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd SP Zone D3	Mohr-Coulomb	19		5	31	1	0.4	Yes
	Drnd SP Zone E	Mohr-Coulomb	19		0	26	1	0.6	Yes
	Drnd Zone A/I Fdtn UC	Mohr-Coulomb	17.5		3	31	1	0.3	Yes
	Drnd Zone A/I Mine OB	Mohr-Coulomb	20.5		5	35	1	0.1	Yes
	Drnd Zone F	Shear/Normal Fn.	20.5	Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	Drnd Zone G	Mohr-Coulomb	20.5		3	31	1	0.1	Yes
	Impenetrable	Bedrock (Impenetrable)					1		No

Factor of Safety
- 2.16 - 2.26
- 2.26 - 2.36
- ≥ 2.36

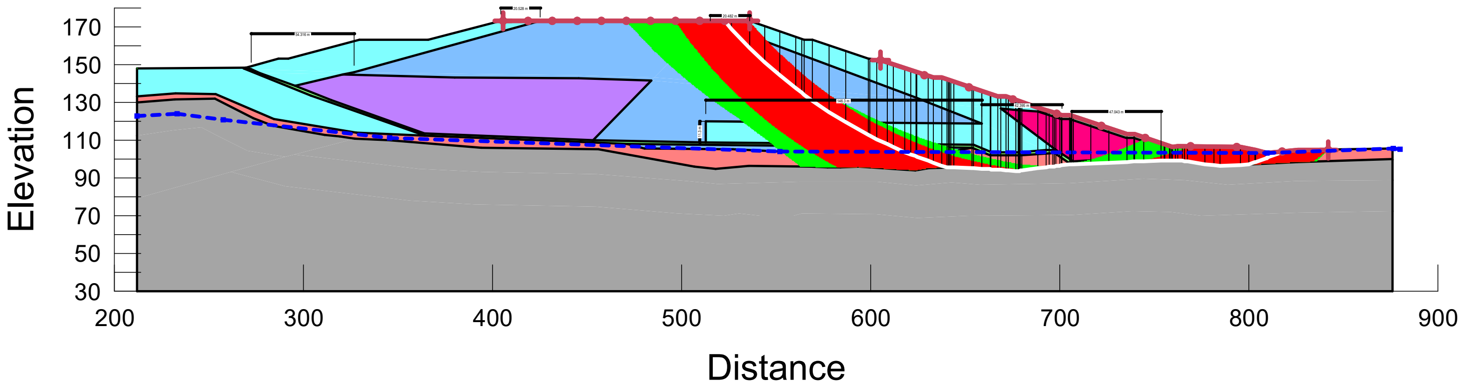

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Figure B21b North Slope Drnd

13/10/2021 By: ET 1:4,000

Section 2a.gsz

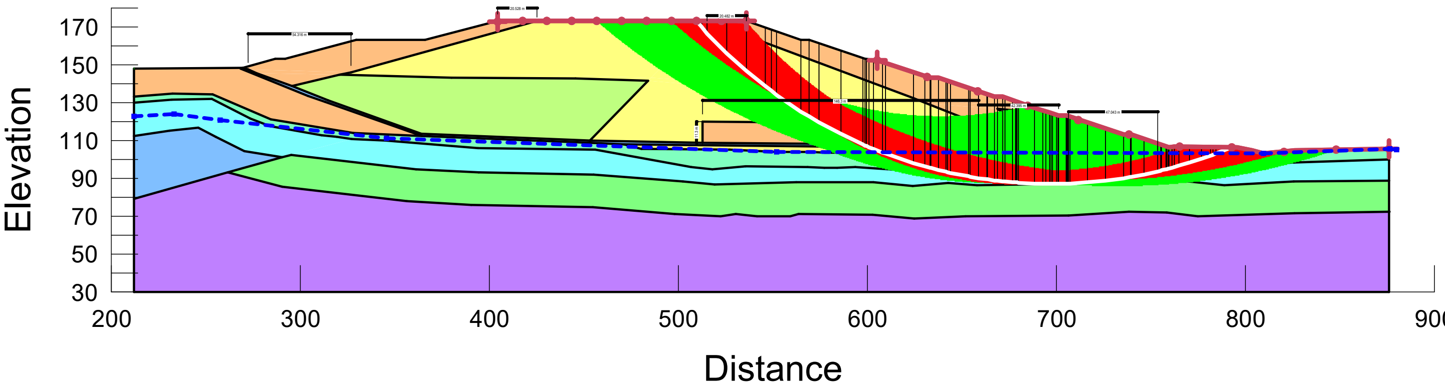
Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.:

Factor of Safety: 1.61

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Udrnd Ash/CWRock/Resid.S	Shear/Normal Fn.	17						Ash/CWRock	1	0.1	Yes
	Udrnd EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5						EW/VW Rhy. EW Ign. Dac.	1	0.1	Yes
	Udrnd SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd SP Zone D3	Mohr-Coulomb	19				10	18		1	0.4	Yes
	Udrnd SP Zone E	SHANSEP	19		0	0.21				1	0.6	Yes
	Udrnd VW Dacite	Shear/Normal Fn.	18						VW Dacite	1		No
	Udrnd W Dacite	Shear/Normal Fn.	25						Weak Rhy. Dac.	1		No
	Udrnd W Rhy Rock	Shear/Normal Fn.	18.5						Weak Rhy. Dac.	1		No
	Udrnd Zone A/I Fdtn UC	SHANSEP	17.5		80	0.35				1	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5		150	0.4				1	0.1	Yes
	Udrnd Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100						1		No

Factor of Safety

- 1.61 - 1.71
- 1.71 - 1.81
- ≥ 1.81



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+64 9 486 2546
info@egl.co.nz
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Figure B22a North Slope Udrnd

13/10/2021 By: ET 1:4,000

Section 2a.gsz

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.:

Factor of Safety: 1.50

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Minimum Strength (kPa)	Tau/Sigma Ratio	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	Udrnd Ash/CWRock/Resid.S	Shear/Normal Fn.	17						Ash/CWRock	1	0.1	Yes
	Udrnd SP Zone D2	Shear/Normal Fn.	19.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd SP Zone D3	Mohr-Coulomb	19				10	18		1	0.4	Yes
	Udrnd SP Zone E	SHANSEP	19		0	0.21				1	0.6	Yes
	Udrnd Zone A/I Fdtn UC	SHANSEP	17.5		80	0.35				1	0.3	Yes
	Udrnd Zone A/I Mine OB	SHANSEP	20.5		150	0.4				1	0.1	Yes
	Udrnd Zone F	Shear/Normal Fn.	20.5						Grav./Cobb. Dr=0.85 (16%ile)	1	0.05	Yes
	Udrnd Zone G	Undrained (Phi=0)	20.5	100						1		No

Factor of Safety

- 1.50 - 1.60
- 1.60 - 1.70
- ≥ 1.70

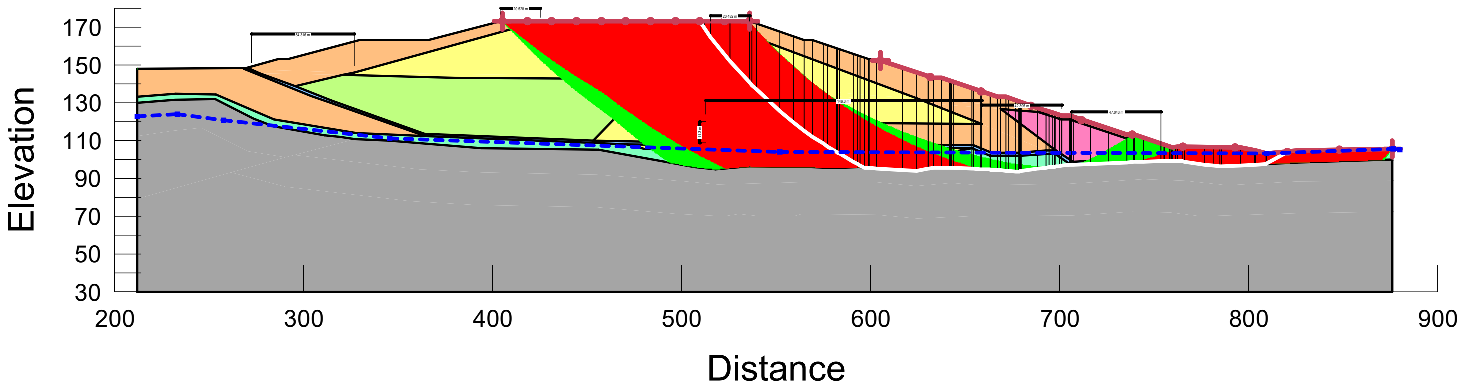

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Figure B22b North Slope Udrnd

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Section 2a.gsz

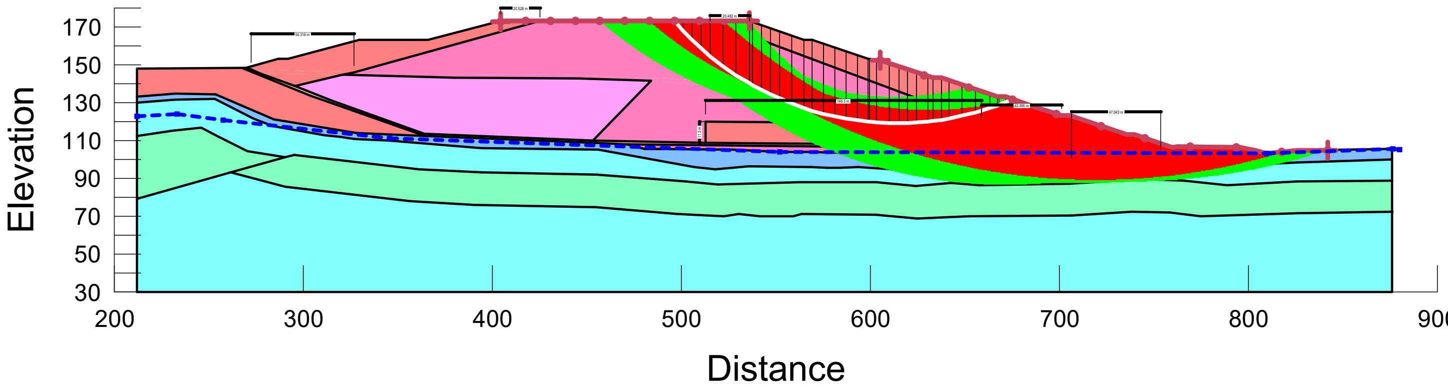
Analysis Settings
Method: Morgenstern-Price
Direction of movement: Left to Right
Slip Surface Option: Entry and Exit
Unit Weight of Water: 9.807 kN/m³
Horz Seismic Coef.:

Factor of Safety: 1.54

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ EW/VW Rhy. EW Ign&Dac	Shear/Normal Fn.	17.5				EW/VW Rhy. EW Ign. Dac.			1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ VW Dacite	Shear/Normal Fn.	18				VW Dacite			1		No
	PSTEQ W Dacite	Shear/Normal Fn.	25				Weak Rhy. Dac.			1		No
	PSTEQ W Rhy Rock	Shear/Normal Fn.	18.5				Weak Rhy. Dac.			1		No
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

Factor of Safety

- 1.54 - 1.64
- 1.64 - 1.74
- ≥ 1.74



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

Figure B23a North Slope PSTEQ

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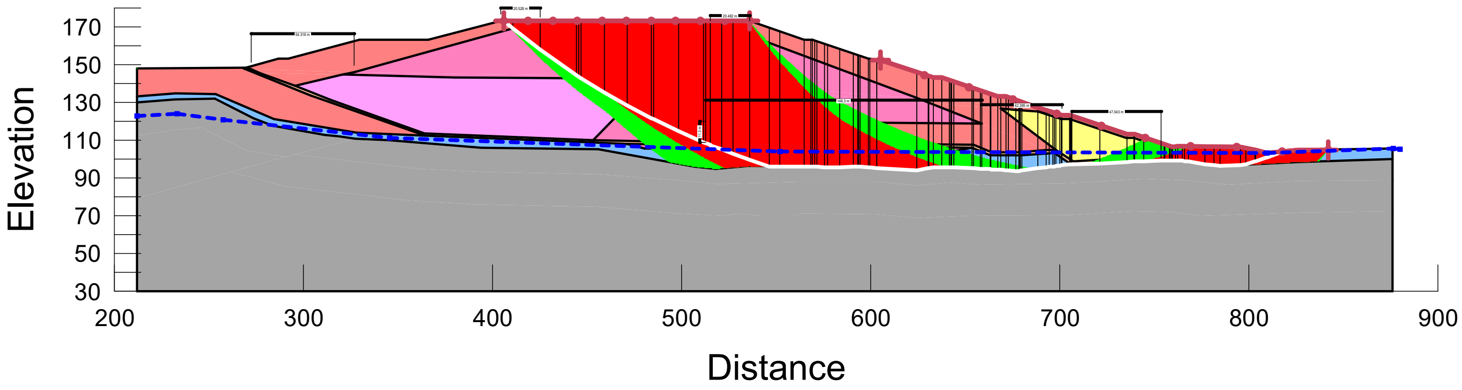
Section 2a.gsz

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.:

Factor of Safety: 1.25

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

Factor of Safety
- 1.25 - 1.35
- 1.35 - 1.45
- ≥ 1.45



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Geotechnical, Earthquake and Dam Engineers
Engineering Geology Ltd
+64 9 486 2546
info@egl.co.nz
Unit 7C, 331 Rosedale Road, Albany, Auckland
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Figure B23b North Slope PSTEQ

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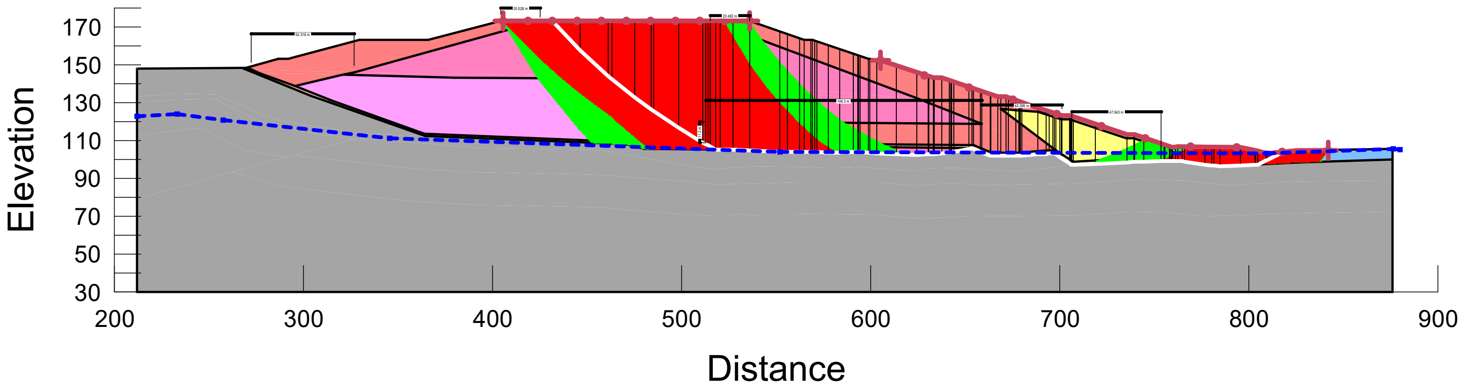
Section 2a.gsz

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.:

Factor of Safety: 1.24

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Fdtn UC	SHANSEP	17.5					50	28	1	0.3	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

Factor of Safety
1.24 - 1.34
1.34 - 1.44
≥ 1.44



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Geotechnical, Earthquake and Dam Engineers
Engineering Geology Ltd
+64 9 486 2546
info@egl.co.nz
Unit 7C, 331 Rosedale Road, Albany, Auckland
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Figure B23c North Slope PSTEQ

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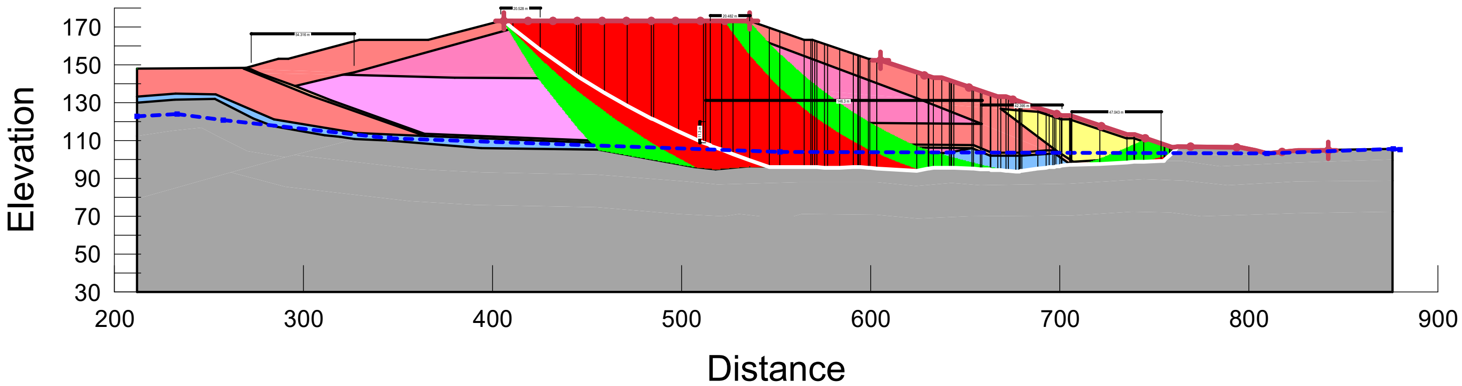
Section 2a.gsz

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.: 0.05

Factor of Safety: 1.00

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

Factor of Safety
1.00 - 1.10
1.10 - 1.20
≥ 1.20



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
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Figure B24 North Slope Oper. EQ ky

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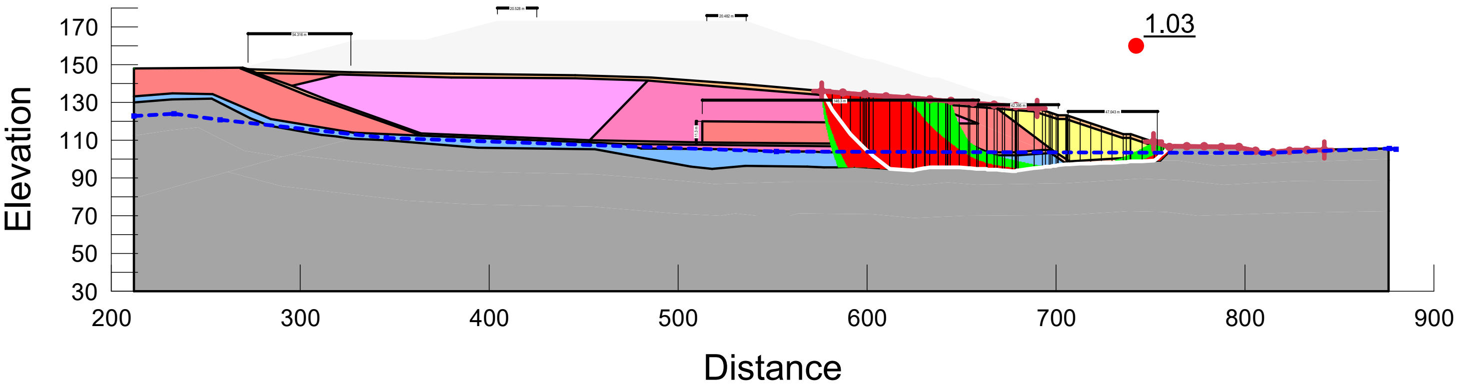
Section 2a.gsz

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.: 0.19

Factor of Safety: 1.03

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Strength Function	Minimum Strength (kPa)	Tau/Sigma Ratio	Piezometric Line	Ru	Include Ru in PWP
	Impenetrable	Bedrock (Impenetrable)								1		No
	PSTEQ Ash/CWRock/Resid.S	SHANSEP	17					0	0.23	1		No
	PSTEQ SP Zone D2	Shear/Normal Fn.	19.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ SP Zone D3	Mohr-Coulomb	19		8	15				1	0.4	Yes
	PSTEQ SP Zone E	SHANSEP	19					0	0.06	1	0.6	Yes
	PSTEQ Zone A/I Mine OB	SHANSEP	20.5					120	0.32	1	0.1	Yes
	PSTEQ Zone F	Shear/Normal Fn.	20.5				Grav./Cobb. Dr=0.85 (16%ile)			1	0.05	Yes
	PSTEQ Zone G	Undrained (Phi=0)	20.5	80						1		No

Factor of Safety
- 1.03 - 1.13
- 1.13 - 1.23
- ≥ 1.23



EGL
Geotechnical, Earthquake and Dam Engineers
Engineering Geology Ltd
+64 9 486 2546
info@egl.co.nz
Unit 7C, 331 Rosedale Road, Albany, Auckland
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Figure B25 North Slope Close EQ ky

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Section 2a.gsz