B

APPENDIX B

WRS Geotechnical Assessments

EGL Geotechnical, Earthquake and Dam Engineers

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Ref: 8528

Oceana Gold (New Zealand) Limited
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DUNEDIN 9058

9 March 2020

Attention: Marty Hughes

Dear Marty,

Deepdell East Waste Rock Stack Design Report
Section 92 Response

Engineering Geology Limited (EGL) prepared the Deepdell East Waste Rock Stack (WRS) Design Report, dated 8 November 2019 (EGL ref: 8528) for Oceana Gold (New Zealand) Limited (OGNZL). Under the Section 92 of the Resource Management Act, four requests for further information were received relating to the Deepdell East WRS Design Report. This letter provides further information in reply to these requests.

The requests for information were:

Macraes Gold Project, Deepdell East Waste Rock Stack Design Report, by Engineering Geology Ltd	
a	From the volumes discussed in Section 1.0, it appears that the volume of waste rock will exceed that of the proposed waste rock stack (WRS). Please clarify that other appropriate locations have been or will be identified for disposal of the balance of waste rock, and that appropriate consents are in place or will be applied for.
b	Please confirm that the large tension cracks observed in the Deepdell South Pit eastern wall have been appropriately considered in the slope stability analyses. It may be appropriate to undertake a sensitivity analysis considering a significantly reduced cohesion value for the schist.
c	Please clarify when and how the design requirement for shear keys will be reviewed. Will additional test pits be carried out in the vicinity of the potential shear key prior to construction of the WRS?
d	We note that mapped dips are not always in the downslope direction, however, there is variability in both dip and downslope directions across the WRS footprint. Please provide justification for the use of a downslope dip of 15 degrees at Section B-B' (20 degree dip mapped nearby), 10 degrees at Section C-C' (25 degrees mapped nearby) and 0 degrees at Section D-D' (25 degrees mapped nearby). Alternatively, sensitivity analyses could be undertaken to assess the effect of more unfavourable dip/slope combinations which may exist.

The following responses are provided:

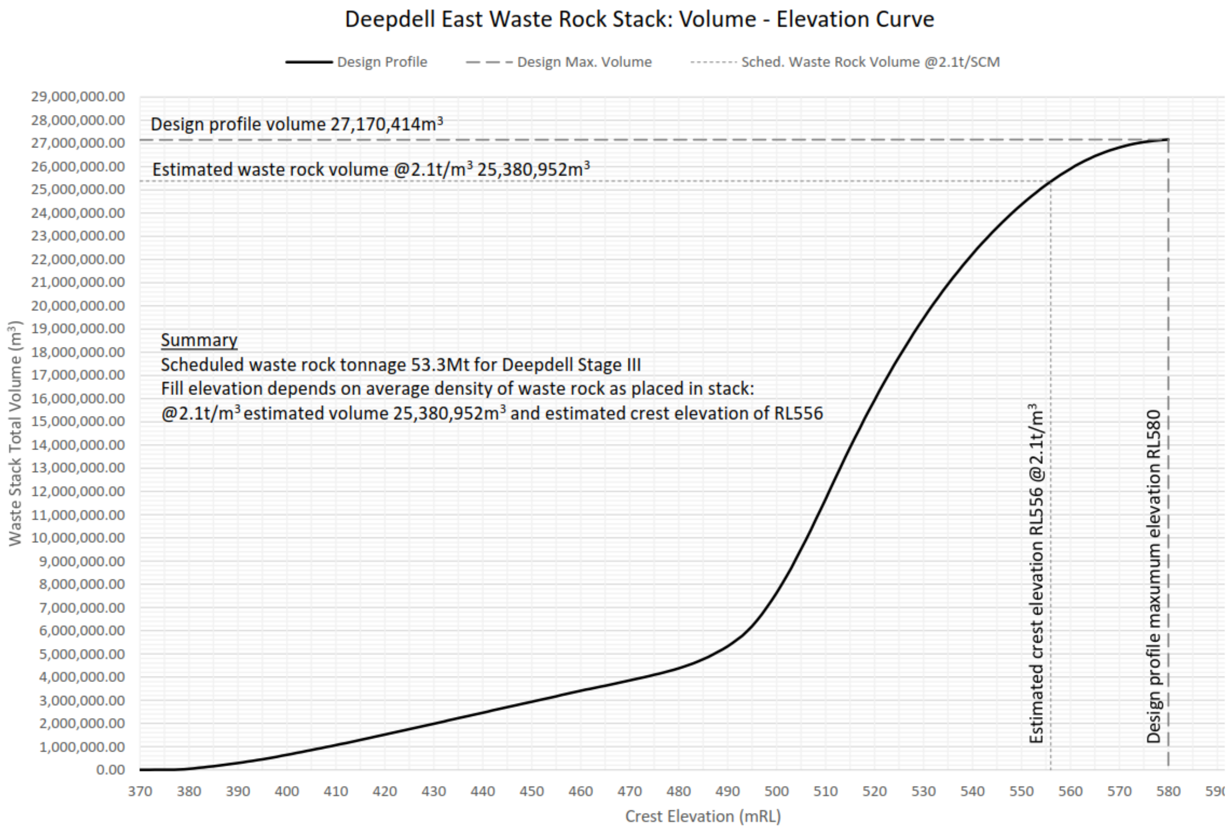
Item a response

The design profile shown and considered in the design report for Deepdell East WRS, is the maximum profile to RL580. The total volume capacity to RL580 is 27.2Mm^3. The scheduled waste rock tonnage is 53.3Mt. Using an average density of 2.1t/m^3 the scheduled rock volume is equal to 25.4Mm^3 and the consequent crest elevation is RL556. 2.1t/m^3 is the typical density used on site to scope the size of the waste rock stacks. There is, therefore, sufficient volume within the Deepdell WRS design profile to stockpile the scheduled waste rock.

The previously reported crest of RL540 was related to the scheduled waste, however, the reported crest is too low to accommodate the scheduled waste at average density likely achievable. The design report text in Section 1.0 has been updated.

To assist with understanding we have provided a volume-elevation curve for the WRS in Figure 1 below.

Figure 1. Deepdell East Waste Rock Stack: Volume-Elevation Curve



Item b response

The tension cracks around the top of the Deepdell Pit the pit are sub vertical (70deg) and relate to some movement of a mass of rock in the wall towards the pit. We include a photo in Figure 2, looking across to the rock mass where the vertical cracks are visible at the top.

This mass of rock will be buttressed by the waste rock placed in the pit and will have similar properties to the waste rock material. As the waste rock strengths have been applied in the stability analysis immediately adjacent to this displaced rock mass with the cracks, the cracks have effectively been considered and overall do not affect the ultimate WRS stability.

Figure 2. Photo looking across Deepdell South Pit to the rock mass with the vertical cracks.

Item c response

The shear keys are a 30m wide area around the toe of the stack slope where the overlying topsoil and loess is to be stripped off to rock. Sufficient test pitting has been undertaken to indicate the expected soil profile to rock. In many areas the schist rock also is visible at the surface and most of the areas test pitted indicate the depth of overlying soils is less than 1m. Only at the north eastern extent, around Testpit 4, is there indicated to be a thicker layer of loess around 4m thick. Rock is easily identifiable on this site and stripping back to rock is to be inspected and documented by OGNZL staff.

Item d response

The angle of the foliations in the design report are selected to approximately represent the in-plane angle of the foliation for the section being analysed for slope stability. They, therefore, vary from the measured dip which was often off angle to the stability analysis plane. The strength parameters for the foliations in the slope model are applied to all surfaces within +/-5deg of the foliation angle reported. We have, therefore, already allowed for some variability in the potential angles. Only the foliation dip angle was reported and not the range of angles applied. We have updated the report to include mention of the range of angles applied.

To demonstrate the stability isn't sensitive to the angles analysed, we have undertaken further analysis where we have broadened the range of angles to +/-15 degrees and re-run the static stability cases. The calculated factor of safety values, using limit equilibrium calculation methods, are presented in Table 1 below. This sensitivity analysis demonstrates that even over a larger range of dip angles, applied concurrently on any part of the failure plane, the calculated factor of safety under static conditions is still above 1.5.

Similar to the static FOS, co-seismic slope displacements of the rock stack are not expected to be sensitive to the foliation angles considered here.

Table 1. Foliation dip sensitivity check on static stability

Figure	Cross Section	Overlying loess soil	Unfavourable foliation dip considered*	Critical Failure Surface	Calculated Factor of Safety
A01a	A-A’	Yes	+15 to -15deg	Block slide along schist foliation	2.1
A02b	B-B’	No	0 to -15deg	Circular Slide	1.6
A03c	C-C’	No	+5 to -30deg	Circular Slide	1.7
A04a	D-D’	No	+15 to -15deg	Block slide along schist foliation	1.8

*Strength reduced along all failure planes within the defined range concurrently

Yours Sincerely

ENGINEERING GEOLOGY LIMITED

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EGL Ref: 8528
Revision 1

MACRAES GOLD PROJECT
DEEPDELL EAST WASTE ROCK STACK
DESIGN REPORT

Prepared for:

10 March 2020

Oceana Gold (New Zealand) Ltd
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MACRAES GOLD PROJECT
DEEPDELL EAST WASTE ROCK STACK
DESIGN REPORT

1.0 INTRODUCTION

Oceana Gold (New Zealand) Ltd (OceanaGold) operates the gold mine, known as the Macraes Gold Project (MGP), at Macraes Flat in East Otago. The mine is located between Middlemarch and Palmerston as shown in Figure 1. Gold extraction from the current mining operation involves mining of open pits and underground (Frasers Underground). Associated with the MGP are waste rock stacks for disposal of pit overburden material and tailings storage facilities for disposal of tailings.

The Deepdell North Stage III project is located on the northern side of Deepdell Creek as shown in Figure 2. The project involves the following:

- Re-mining of an extension of the Deepdell North Pit located immediately south of Horse Flat Road, to be known as Deepdell North Stage III Pit.
- Construction of a new waste rock stack, to be known as Deepdell East Waste Rock Stack (WRS), immediately south of Horse Flat Road. This will include backfill of the Deepdell South Pit.
- Partial realignment of Horse Flat Road past the WRS.

There is an existing haul road between the Coronation North Project to the north and the MGP Process Plant located on the southern side of Deepdell Creek. The haul road is on the western side of Deepdell North Stage III project (refer Figure 3) and will provide access to the new pit and WRS. No significant length of new haul road will therefore be required for the project other than a short length to access the WRS.

Details of the proposed Deepdell North Project III comprises:

- Deepdell North Stage III Pit will produce 3.5Mt of ore and 53.3Mt of waste rock. The new pit comprises an extension to the existing Deepdell North Pit (Stage 2). The footprint will be 38ha of which 18.7ha was previously disturbed by mining.
- Deepdell East WRS comprises backfilling of the existing Deepdell South Pit and will approximately re-establish the original ground contours, before raising the ground profile to the north. At the WRS northern extent the WRS crosses Horse Flat Road and the road is to be realigned. Overall the WRS has a footprint of 70.8ha and a storage capacity of 27.2Mm^3, up to the design crest elevation of RL580. The RL580 design crest has been used in this report for stability assessment. For the scheduled waste rock mass at an average density of 2.1t/m^3 the volume is 25.4Mm^3 and is estimated to reach a crest elevation of approximately RL556.

This design report by Engineering Geology Limited (EGL) is for the Deepdell East WRS. Pells Sullivan Meynink is carrying out the design for Deepdell North Stage III Pit and their design considers the impact of the open pit on the stability of the WRS and Pit Backfill (Ref. 2). The analyses covered by this report therefore only consider the shallow stability of the WRS and excludes analyses of potential shear failure into the new pit.

All plans grids, references and geological orientations referred to in this report are to mine north, which is approximately 45 degrees anti-clockwise from true north.

2.0 RESOURCE CONSENTS

Consents held for the existing Coronation North Project are listed in Table 2.1 below and in the Macraes Water Quality Management Plan. It is anticipated that similar consent conditions will apply to the proposed Deepdell East WRS and the design has been carried out on this basis.

Table 2.1: Consent Conditions for Existing Coronation North WRS

Consent	Description
Land Use Consent – 201.2016.779, 201.2013.360.1, LUC-2016-234 and LUC-2013-225A	Land Use Consent for Coronation and Coronation North gold mining operations
Land Use Consent - RM16.138.01	To disturb, deposit and reclaim the bed of unnamed tributaries of Maori Hen Creek, Trimbells Gully, Mare Burn and Coal Creek for the purpose of constructing the Coronation North Waste Rock Stack
Discharge Permit - RM16.138.03	To discharge silt and sediment to water for the purpose of constructing the Coronation North Waste Rock Stack
Discharge Permit - RM16.138.04	To discharge contaminants and water from silt ponds to unnamed tributaries of Maori Hen Creek, Trimbells Gully, Mare Burn and Coal Creek for the purpose of operating silt ponds for Coronation North Pit and the Coronation North Waste Rock Stack.
Discharge Permit - RM16.138.05	To discharge water from the base and toe of the Coronation North Waste Rock Stack for the purpose of operating Coronation North Waste Rock Stack.
Discharge Permit - RM16.138.06	To discharge water containing contaminants from Coronation North Pit Lake to unnamed tributaries of Maori Hen Creek, Trimbells Gully, Mare Burn and Coal Creek for the purpose of pit lake overflow
Discharge Permit - RM16.138.09	To discharge waste rock and contaminants from waste rock to land, or into land in circumstances which may result in contaminants entering water for the purpose of constructing the Coronation North Waste Rock Stack.

Discharge Permit - RM16.138.10	To discharge waste rock to land within the Coronation North Pit for the purpose of disposing of waste rock
Water Permit - RM16.138.11	To take surface water for the purpose of dewatering Coronation North Pit and use for the purpose of dust suppression
Water Permit - RM16.138.12	To take surface water for the purpose of creating the Coronation North Pit Lake
Water Permit - RM16.138.13	To take groundwater for the purpose of dewatering Coronation North Pit and use for the purpose of dust suppression
Water Permit - RM16.138.14	To take groundwater for the purpose of creating the Coronation North Pit Lake
Water Permit - RM16.138 .15	To divert water around the open pit known as Coronation North Pit Pit and into unnamed tributaries of Maori Hen Creek, Trimbells Gully, Mare Burn and Coal Creek for the purpose of preventing surface water ingress and managing the surface water runoff
Water Permit – RM16.138.17	To dam water in Coronation North Pit for the purpose of creating the Coronation North Pit Lake
Discharge Permit – RM16.138.19	To discharge contaminants from mining operations and post mining rehabilitation to air for the purpose of undertaking mining operations
Water Permit – RM16.138.20	To permanently divert water around the Coronation North Waste Rock Stack and into Maori Hen Creek, Trimbells Gully, Mare Burn and Coal Creek the for the purpose of preventing surface water ingress and managing stormwater runoff

Condition 11.2 of land use consent 201.2016.779, 201.2013.360.1, LUC-2016-234 and LUC-2013-225A requires the consent holder to engage a suitably qualified geotechnical engineer to design the waste rock stack and submit a Design Report prior to the construction of the new rock stack.

Condition 11.2.
The consent holder shall engage a suitably qualified geotechnical engineer to design the waste rock stack. A construction report shall be prepared for the waste rock stack and this report provided to the Councils prior to the commencement of construction of the waste rock stack. The report shall include details of site formation, design construction, appearance, and testing for stability of the waste rock stack, and shall include evaluation of the long-term stability and performance of the waste rock stack.

Condition 3 of Resource Consent RM16.138.01 relates to the requirement to construct underdrains in the watercourses that underlie the waste rock stack unless the "Best Practicable Options Report" identifies otherwise.

- *Condition 3.*
  Underdrains shall be constructed in the natural channels that form the unnamed tributaries of Maori Hen Creek, Trimbells Gully, Mare Burn and Coal Creek beneath the footprint of the Coronation North Waste Rock Stack by placement of large rocks covered by appropriately graded material to provide sufficient filtering to prevent blockage of the drains by finer material unless it is identified in the "Best Practicable Options Report" required by Condition 5 of Consent RM16.136.02 that underdrains should be constructed differently or not be constructed at all.

Condition 11.1 of Land Use Consent 201.2016.779, 201.2013.360.1, LUC-2016-234 and LUC-2013-225A relates to the seismic requirements for the waste rock stack and is addressed within this report.

- *Condition 11.1*
  The Coronation North waste rock stack shall be designed for operating basis earthquake (OBE) with a recurrence interval of 150 years and maximum design earthquake (MDE) with a recurrence interval of 2,500 years and otherwise shall otherwise be designed in accordance with sound engineering practice.

3.0 SITE AND PROJECT DESCRIPTION

Deepdell North Stage III is located on a relatively flat plain running east west, which is approximately 1km wide. Deepdell Creek meanders down the southern side of the plain and is incised about 130m lower. The northern side of the plain comprises a mountain range rising up about 200m.

The existing Deepdell South Pit is located on the southern edge of the plain as shown in Figure 3 and extends partway down the steep slope to Deepdell Creek. The sloping ground varies between about 1v:4h to 1v:1.3h. The existing south pit is to be backfilled and merges with the waste rock to be placed north of the pit, on Horse Flat, to form the proposed Deepdell East WRS. On Horse Flat, a local high point lies beneath the centre of the WRS with ground sloping to the east, west and south. To the west of the WRS, the ground slopes relatively gently at approximately 1v:30h to 1v:15h. To the east the ground also slopes relatively gently at 1v:30h to 1v:10h which steepens into the gully side slopes of approximately 1v:3h, down to Deepdell Creek. The northern toe of the WRS approaches the toe of the hills to the north of Horse Flat.

The new Deepdell North Stage III Pit is north west of the existing Deepdell South Pit and located over the central southern area of the plain, immediately south of Horse Flat Road, east of the existing haul road and west of the Deepdell East WRS as shown in Figure 3. This area has been previously mined in part for Deepdell North Pit Stage II. The new pit is to be excavated deeper and extended further than the previous pit.

All stormwater runoff from Deepdell North Stage III project will drain via a series of gullies and creeks to Deepdell Creek, that forms part of the Shag Catchment.

The batter slopes of the WRS have been designed to blend as naturally as possible with the natural landscape. The maximum height of the WRS is approximately 200m and the outer shoulders have an overall slope of about 1(v):3(h). The WRS and Deepdell South Pit are shown in Figure 4 with the underlying topography and the location of the cross sections. The design profile of Deepdell East WRS is shown on cross sections (X1-X1' and X2-X2') in Figure 5 and the long sections (L1-L1' and L2-L2') in Figure 6.

4.0 GEOLOGY AND GEOTECHNICAL INVESTIGATION

4.1. Regional Geology

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

From previous geotechnical investigations for the MGP, it is apparent that the prominent geological structure includes a well-developed schistosity with two dominant fault sets. West of the Footwall Fault, that defines the footwall of the Hyde – Macraes Shear Zone (HMSZ). The schistosity is folded and has a varying trend over the project area revealing a series of anticlines and synclines. Foliation dips either to the northwest, north, west or south west. East of the Footwall Fault (Hanging wall) the schistosity has more of an easterly trend. At Coronation the Footwall Fault position is inferred as a subtle feature on the landscape. The WRS is located to the south of the proposed Coronation North Pit and east of the both the Footwall Fault and the Hanging Wall Shear.

The major set of faults has an eastern trend. They exhibit Miocene (recent tectonic) deformations and are related to the formation of the Alpine Fault. This deformation has faulted and folded the surface within Central and East Otago to produce the present-day basin and range topography.

The second set of faults has a northern trend, and the most significant of these is the Hyde-Macraes Shear Zone.

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

4.2. Geotechnical Investigation

Specific geotechnical investigation for Deepdell East WRS comprised field mapping and test pits. Test pits were excavated on Horse Flat where the schist is mantled by a layer of loess.

4.2.1. Fieldwork

The fieldwork was carried out on the 27^{th} and 28^{th} of June 2019. The fieldwork comprised a walkover survey, mapping and the excavation and logging of test pits by a senior engineering geologist. The results of the field mapping are shown in Figure 7. The test pit logs are in Appendix A.

4.2.2. Soils

The prevalent rock outcrops and head scarps of shallow slips observed on the sides of gullies and farm tracks, show that there is generally only a thin layer of soil overlying the bedrock on Horse Flat. Soil depths over the extent of the WRS was typically 0.3 to 0.5m with one location (TP4) with 4m of soil and another location (TP3) with 1.3m of soil. The soil comprises loess or residual soil (of the underlying schist) and comprises layers of silt with varying amounts of clay, sand and gravel.

Particle size distributions and Atterberg limit tests were undertaken on three loess soil samples (results are in Appendix B). The results of the three loess samples comprised silt with some clay with a Plasticity Index (PI) of 3 and 12.

4.2.3. Schist

The schist observed on site comprises well foliated, highly to moderately jointed semi-psammitic schist.

The foliation is well developed. A recent walk over survey and testpits show that the foliation generally dipping between 10° and 30° mine south east on Horse Flat. On the northern end of the Deepdell South Pit Backfill, the dip of the foliation varies between 10° and 20° towards the mine north. On the southern side of the existing Deepdell South Pit Backfill, the foliation dips about 25° to the south.

The schist is moderately to highly jointed with joints generally steeply dipping between 60° and 80° in multiple directions around the Deepdell East WRS. The joints dip between 60° and 80° to the northwest to northeast on the southern end of the Deepdell South Pit and to the south on the northern end of the Deepdell South Pit (Figure 7). Large tension cracks were observed on the eastern pit wall of the existing pit which were dipping steeply to the north west. Toppling failure was observed across the pit wall in this area.

No strength testing has been undertaken on schist in the Deepdell North Stage III area. However, elsewhere on the Macraes Gold Project, the typical unconfined compressive strength of unweathered schist is between about 20MPa and 40MPa, normal to the foliation. Schist typically has a lower unconfined compressive strength along the direction of foliation. This is reflective of the layered nature of the rock and the presence of weak, mica-rich laminations. It is anticipated that the strength of the schist underlying the proposed WRS will be consistent with that found elsewhere in the Macraes Gold Project area.

4.2.4. Inferred Areas of Instability

No areas of significant historical or incipient instability were observed on site.

Where the creeks dissect the underlying schist bedrock the steepness of the slopes generally vary depending on the local dip of the foliation and discontinuities. Typically, the side slopes to the creeks are steeper where the foliation is dipping into the slope (i.e. governed by block failures) and gentler sloping where the foliation is dipping out of the slope (i.e. governed by block sliding on the foliations and the slopes are typically parallel to the dip).

Localised shallow slumping/instability is evident on the hills to the north of Horse Flat, more than the slopes to the south down to Deepdell Creek. This shallow instability is considered to be associated with erosion and undercutting at the toe of the slopes during heavy rainfall and flow within the creeks.

Soil creep was also inferred on some of the steeper slopes on the hills however this does not effect the WRS. Where localised soil creep was evident, the soil mantle is reasonably thin and can be cleared as part of the foundation stripping.

5.0 DESIGN

5.1. Design Life

The estimated duration of the operation and rehabilitation of the Deepdell East WRS is about 5 years (2020 – 2025) and will remain in place in perpetuity.

5.2. Stability

5.2.1. General

Engineering Geology Ltd (EGL) has carried out both static and seismic stability analyses for the WRS. The analyses do not include the stability of potential shear failures into the new Deepdell North Stage III Pit. This has been covered by Pells Sullivan Meynink in their design for the pit (Ref.2). They conclude in their report that the eastern offset to the WRS is sufficient that no additional loads will be placed on the adjacent pit wall; as such this will not have an effect on stability.

The stability of the WRS has been analysed using the same design approach and parameters as that used for the existing consented Coronation Project WRS (Ref.3 and Ref.12).

Analyses of long-term static stability of the shoulders of the waste rock stack and stability when subjected to design earthquake loads have been undertaken. Limit equilibrium analyses of the slope have been undertaken using the SLOPE/W program, Geostudio 2012 (Ref.4). The Spencer solution method (Ref 5.) has been used for the analyses of circular potential failure surfaces. The Janbu simplified method (Ref.6) has been used for the analyses of potential block/non- circular failure surfaces.

Limit equilibrium analyses have been undertaken to calculate the Factor of Safety (FoS) for static and seismic loading conditions. Where seismic loading results in a FoS less than one it has also been used to determine the yield coefficient (k_y) to calculate co-seismic displacement.

The possibility of failure through the foundation soils has been considered. The seismic stability of the Deepdell East WRS complies with Condition 11.1 of DCC and WDC Consents (No. 201.2016.779, 201.2013.360.1, LUC-2016-234 and LUC-2013-225A (Ref.3). This condition requires that "*the waste rock stacks shall be designed for operating basis earthquake (OBE) with a recurrence interval of 150 years and maximum design earthquake (MDE) with a recurrence interval of 2,500 years and otherwise shall be designed in accordance with sound engineering practice"*. The WRS profile maybe subjected to settlement and horizontal displacement in an earthquake, however, the profile is stable post-earthquake.

Stability analyses have been undertaken for four cross sections through the WRS. These are representative of the critical cross sections in terms of loading, topography and rock foliation/discontinuities. The location of the cross-sections is shown in Figure 4 and the cross sections are shown in the stability analyses included in Appendix C.

5.2.2. Waste Rock Characteristics

The waste rock is anticipated to consist of a mixture of psammitic and pelitic schist. It is to be excavated from the new Deepdell North Stage III Pit. The schist rock varies from completely to slightly weathered, depending on the relative depth of excavation.

Physical characteristics of the excavated rockfill were assessed during the design phase for the tailings embankments and were based on tests conducted on samples of rockfill, schist and other various rock types used for similar projects.

The waste rock to be placed in the WRS and Pit Backfill will be end-tipped, so it is assumed to be non-structural fill. The waste rock segregates when end-tipped, such that each lift (approximately 10-20m high) varies from coarse rock at the bottom to silty sandy rockfill at the top. Consequently, the WRS consists of layers of rockfill of varying permeability. Generally, the rockfill could be expected to be free draining, except at the top of each lift where a thin low permeability layer is created by the trafficking of the dump trucks.

The following shear strength function has been adopted for waste rock which is consistent with that previously used for WRS at MGP and Coronation WRS (Ref.3 and Ref 12):

Shear strength (τ) = 1.29 $\sigma'^{\,0.91}$ (kPa), where σ' is the effective overburden pressure.

The design unit weight used is 21.5kN/m^3.

5.2.3. Foundation Material Characteristics

The *in-situ* rock beneath the proposed Deepdell East WRS is similar to that beneath the existing Coronation WRS (Ref.3 and Ref.12), so the same foundation shear strength parameters have been adopted for design. They are summarised below:

Intact rock

Effective cohesion	=	50 kPa
Effective friction	=	40 degrees

The above shear strength parameters are based on shearing through relatively intact rock at about right angles to the foliation dip. As discussed in Section 4.2.3, the measured foliation dips between about 10° and 30° to mine south east around Horse Flat. On the northern end of the existing Deepdell South Pit, the dip of the foliation varies between 10° and 20° towards mine north. On the southern side of the Deepdell South Pit the foliation dips about 25° to mine south (Figure 7).

A second set of shear strength parameters has therefore been adopted for the rock where failure could potentially occur along the rock foliation and any minor faults/shear zones dipping to the north east. The shear strength parameters are the same as those adopted in similar circumstances for the stability analysis of the existing Coronation WRS (Ref.3 and Ref.12) and given below.

Shear along foliations and minor faults/shear zones

Effective cohesion	=	47 kPa

Effective friction = 23 degrees

5.2.4. Ground Water Conditions

The stability analyses for the WRS assume that the natural ground is saturated and the waste rock is fully drained. The WRS will be comprised of rockfill and the gullies beneath the WRS are to be infilled with coarse rockfill to ensure good drainage. Some localised perched groundwater may occur on the thin low permeability trafficked layers within the WRS (refer Section 5.2.2), but due to the 10 to 20m vertical spacing between these layers is unlikely to significantly affect the overall stability of the WRS.

Similarly, in the existing Deepdell South Pit, the rockfill material in the pit is assumed to be drained and the natural ground is assumed to be saturated.

5.2.5. Static Stability

The results of the static stability analyses are presented in Appendix C and are summarised in Table 5.1 below. Static stability analyses considered potential failure conditions using circular and block type failure surfaces which passed through the rockfill material and/or original ground foundation. Only the critical failure slip surfaces are presented in this report.

Two key variables in the setup of the stability analysis were the inclusion of the overlying loess soil between the rockfill and the foundation rock around Cross Section A-A’ and the potential for unfavourable foliations in the schist rock (i.e. in the direction of slope movement). Table 5.1 summarises which cross sections these conditions are applied to.

Cross Sections A-A’ and B-B’ (refer to Figure 4 for plan and Appendix C for cross sections) check the stability of the Deepdell East WRS on Horse Flat.

Cross Section A-A’ (refer to Figure A05 in Appendix C) is through the greatest thickness of rock fill where the deepest overlying soil is found. For stability analysis, the overlying soils in the area of Section A-A’ are assumed to be continuous and 4m thick and a foliation dip of zero degrees. In reality, test pitting has demonstrated the thickness of overlying soils is much less than 4m on average and this assumption is just for the stability analyses.

Cross Section B-B’ cuts through the steepest topography with a foliation dip direction that is more unfavourable than Cross Section A-A’. A downslope dip of 15 degrees has been applied.

Cross Sections C-C’ and D-D’ (refer to Figure 4 for plan and Appendix C for cross sections) have been used to check the stability of the Deepdell South Pit area with the addition of the East WRS.

For Cross Section D-D’ the dip direction of the foliations is assumed to be at zero degrees. For Cross Section C-C’ it is assumed the dip direction of the foliations is at 10 degrees, as the dip of 25 degrees noted in this area is not directly downslope.

In the model, we have applied the reduced strength along the foliations to plus and minus 5 degrees from that indicated in Table 5.1.

Table 5.1. Summary of Static Slope Stability Analyses

Figure	Cross Section	Over lying loess soil	Unfavourable foliation dip considered*	Critical Failure Surface	FoS
A01a	A-A'	Yes	+5 to -5deg	Block slide along schist foliation	2.0
A02a	B-B'	No	+20 to +10deg	Block slide along schist foliation	2.1
A03b	C-C'	No	+15 to +5deg	Block slide along schist foliation	1.7
A04a	D-D'	No	+5 to -5deg	Block slide along schist foliation	1.8

*Strength reduced along all failure planes within the defined range concurrently and positive values are dipping downslope

Based on the above analyses, the performance of the WRS under static loading is satisfactory, as all the calculated FoS are above 1.5, a typical minimum value applied for long-term static stability and considered suitable for the WRS.

5.2.6. Seismic Stability

Seismic stability analyses of the WRS have been undertaken for the following two levels of earthquake shaking;

- Operating Basis Earthquake (OBE) - 150 year return period
- Safety Evaluation Earthquake (SEE) – 2,500 year return period.

Note that the SEE was previously referred to as the Maximum Design Earthquake (MDE) but has been changed to SEE to follow the terminology used in the latest NZSOLD New Zealand Dam Safety Guidelines (2015). The WRS is not a dam, however, and therefore the NZSOLD definitions are used only as reference. For the WRS the OBE earthquake is a design limit state which aims to have minor damage and the SEE earthquake would look to prevent collapse so not to cause a hazard.

The cross-section geometry used for static stability has been used to assess seismic stability.

Peak horizontal ground accelerations for the OBE and SEE were obtained from acceleration response spectra determined in a site specific seismic hazard study by the Institute of Geological and Nuclear Science (GNS) for the MGP (Ref.7). The spectra were generated from a model which combines earthquakes associated with the three closest faults to the MGP (Billy's Ridge, Taieri Ridge, and Hyde faults).

The levels of peak ground acceleration used for analysis of the seismic stability are:

- OBE (150 yr) = 0.13 g
- SEE (2,500 yr) = 0.65 g

The ground motion amplification (ratio of crest acceleration to PGA) relationship given by Harder et al. (Ref.8) has been used to determine the peak motion at the crest of the WRS. This method is based on actual measurements of ground motions recorded at the crests of embankments relative to those recorded near the base. Crest accelerations using this method are 3.3 and 1.4 times the base ground acceleration for the OBE and SEE. Accelerations will vary throughout the WRS and this needs to be accounted for in the stability analyses. The estimated average horizontal accelerations for both OBE and SEE levels of earthquake shaking applied to each potential failure surface (kmax) are given in Table 5.2.

Stability has been assessed for potential failure surfaces located at 1/3H, 2/3H and 1H below the top of the WRS, where H is the full height of the WRS. Where yielding is predicted, permanent co-seismic (during an earthquake) slope deformations are estimated using the Bray and Travasarou (2007) displacement calculation (Ref.9). Spectral accelerations used for this calculation are reported in Table 5.2. The development of the calculation approach considered the dynamic response of the potential failure sliding mass.

The overlying loess soils around Cross Section A-A’ are potentially susceptible to liquefaction if saturated. The test pit logs and the laboratory testing indicate that the loess layers are low-plastic silt with PI less than 12 and therefore are susceptible to liquefaction under the PI criteria of Bray and Sancio (2006) (Ref.13). We have not been able to use the water content over liquid limit criteria as the ground water conditions are currently dry in these layers.

As a perched ground water table beneath the WRS could potentially occur and saturate the loess soils, triggering of liquefaction from shaking equivalent to OBE and SEE, using Idriss and Boulanger (2008) (Ref.14), has been considered. A 35% or greater fines content has been assumed for the loess material. The cyclic stress ratio for the OBE earthquake beneath the WRS indicates that liquefaction is unlikely for the OBE earthquake, however, if the material is susceptible to liquefaction, triggering would have occurred with shaking less than the SEE. The stability analyses have, therefore, used non-liquefied strengths for the loess under the OBE and an undrained liquefied strength, based Olson and Stark (2002) (Ref.15), of 0.06 multiplied by the vertical effective stress for the SEE.

The limit equilibrium stability analyses are presented in Appendix C and summarised in Table 5.2 on the following page.

For the OBE cases, the seismic Factor of Safety is generally 1.0 or greater except for Figure A07 and A19 where small co-seismic displacements occur are estimated. For OBE cases with FoS greater than 1, limited horizontal displacements are expected, however, some vertical consolidation of the WRS, due to shake down, may occur.

With liquefaction of a continuous loess layer beneath the WRS, stability would not be maintained in the post-earthquake (SEE) case as shown in the analysis in Figure A05 in Appendix C with a FoS equal to 0.8. This is predominantly a consideration at the northern toe which the thickest covering of loess. The width of loess that would need to be removed, or waste rock contact directly on the bedrock that would need to be proven, has been determined to be 30m. A 30m wide shear key starting at the WRS toe achieves a post-earthquake FoS of 1.1. This width has been shown as a shear key area in Figure 8. This extends over the Horse Flat area however in many locations to the South East rock is outcropping anyway.

Cross Section A-A’ has the greatest co-seismic displacements in the analyses with 12 to 46cm (16%ile to 84%ile) of displacement estimated. Of the other cross-sections, B-B’ had the greatest estimated displacements of 11 to 41cm. For these to section the greatest displacement is associated with a shallow slip mechanism along the embankment slope face. With the higher shaking of the SEE, greater vertical shake down (consolidation) settlement of the WRS can be expected. Settlement associated with shake down may be in the order of a tens of centimetres to possibly a meter. In the SEE, these displacements are acceptable as there are no critical elements which would be affected, and the post-earthquake stability has been shown to achieve a FoS of 1.1.

To achieve a stable profile post-earthquake, the extent of loess is to be determined and material removed to match the design assumptions. This will require monitoring at the construction stage.

Table 5.2. Summary of Seismic Slope Stability Analyses and Co-seismic Displacement Estimates

Figure No.	Cross section	Loading condition	Failure surface location	Topographical Amp. Factor	Seismic FoS[1]					Co-seismic displacement estimates[3]	
					H (m)	T (s)	Sa(1.5T)	Sa(1.5T) x Amp. Factor[2]	FoS	ky (g) -	Estimated co-seismic displacements using Bray and Travasarou (2007) (cm)
A05	**A-A' (No shear keys)**	Post EQ – Su_{liq}=0.06	H						0.8	-	-
A06		Post EQ – Su_{liq}=0.06	H						1.1	-	-
A07			1/3H	3.3	30	0.26	0.28	0.92	<1.0	0.46	0 - 5.1
A08			2/3H	2.2	50	0.43	0.17	0.36	1.1	-	-
A09	**A-A' (30m shear keys)**	OBE	H	1.0	80	1.07	0.07	0.07	1.7	-	-
A10			1/3H	1.4	20	0.17	1.59	2.23	<1.0	0.44	**12.4 - 46.2**
A11			2/3H	1.2	50	0.43	0.74	0.88	<1.0	0.42	0 - 7.6
A12		SEE	H	1.0	70	0.93	0.35	0.35	<1.0	0.12	7.3 - 27.8
A13			1/3H	3.3	20	0.17	0.36	1.19	<1.0	0.48	1.8 - 8.8
A14			2/3H	2.2	40	0.35	0.21	0.46	<1.0	0.44	<1.0
A15		OBE	H	1.0	70	0.93	0.08	0.08	1.2	-	-
A16	**B-B'**		1/3H	1.4	20	0.17	1.59	2.23	<1.0	0.48	**11.0 – 41.0**
A17			2/3H	1.2	40	0.35	0.92	1.10	<1.0	0.44	2.5 - 11.5
A18		SEE	H	1.0	125	1.67	0.19	0.19	<1.0	0.14	0 - 9.9
A19			1/3H	3.3	60	0.80	0.09	0.31	<1.0	0.31	<1.0
A20			2/3H	2.2	70	0.93	0.08	0.17	1.2	-	-
A21		OBE	H	1.0	100	1.33	0.05	0.05	1.4	-	-
A22	**C-C'**		1/3H	1.4	60	0.80	0.42	0.58	<1.0	0.32	0 - 7.8
A23			2/3H	1.2	70	0.93	0.35	0.42	<1.0	0.26	0 - 6.0
A24		SEE	H	1.0	100	1.33	0.24	0.24	<1.0	0.17	0 - 6.4
A25			1/3H	3.3	60	0.80	0.09	0.31	1.1	-	-
A26		OBE	2/3H	2.2	100	1.33	0.05	0.12	1.6	-	-
A27			H	1.0	125	1.67	0.04	0.04	1.5	-	-
A28	**D-D'**		1/3H	1.4	80	1.07	0.30	0.43	<1.0	0.33	0 - 3
A29		SEE	2/3H	1.2	100	1.33	0.24	0.29	<1.0	0.29	0 - 2.7
A30			H	1.0	125	1.67	0.19	0.19	<1.0	0.15	0 - 3.9

1. H is the total height of the slip mass. Slide mass fundamental period (T) is estimated using 4H/Vs for deep block failure slips and 2.6H/Vs for shallow circular failure slips.
2. The amplified spectral accelerations at the degraded slide period are applied as pseudostatic horizontal acceleration in seismic stability analysis.
3. Co-seismic displacement calculation is only undertaken when seismic FoS, using full pseudostatic horizontal coefficient equal to SA(1.5T)xAmp, is less than 1. Co-seismic displacements are calculated for a mean magnitude of 7.2.

5.3. Surface Drainage

A perimeter drain or bund will be constructed around the toe of the WRS to collect stormwater runoff and divert it into silt ponds. Runoff flows are expected to be quite small because a high proportion of rainfall is expected to infiltrate the rock fill. This is consistent with what has been observed on site for the existing WRS.

Where necessary, perimeter drains are to be constructed largely by excavating into the natural ground. Some short sections may be located in fill. Drains will be sized to have sufficient capacity to carry the peak runoff from the 10-minute, 5 percent AEP (20 year storm) whilst retaining 0.25m freeboard.

Temporary clean water diversion drains and diversion culvert will be constructed at the early stages of the WRS to reduce the catchments contributing to the silt ponds.

5.4. Subsurface Drainage

Existing ephemeral gullies beneath the WRS footprint are to be filled with coarse free draining waste rock material either through high tip-head segregation or direct placement. This will enable subsurface drainage of gullies which are filled downstream by waste rock.

5.5. Silt Control

Runoff from the WRS during construction will be directed to silt ponds located in the gullies immediately downstream, as discussed in the erosion and sediment control report (Ref.10). Temporary silt ponds may also be constructed upstream of the main silt ponds in the early stages of development of the WRS as required. The WRS will be constructed with the working surface sloping down away from the outside shoulder. The runoff will then infiltrate the rockfill and percolate through the coarse fill subsurface drainage system before discharging as seepage downstream of the WRS. Experience to date indicates that not much silt is generated during waste rock stack construction due to a combination of the material used and the progressive nature of stripping and rehabilitation as the waste rock stack is constructed. Most of the runoff infiltrates the rockfill and the silt is removed before the seepage emerges from the toe of the rock stack.

5.6. Rehabilitation

The final contoured surface of the WRS is to be rehabilitated by spreading 1.65m of weathered rock plus 0.2m of topsoil, excavated from the foundations, and then grassed. Once the grass is established, any runoff from the WRS is generally of good quality.

6.0 CONSTRUCTION AND QUALITY CONTROL

Construction of the WRS will be undertaken by OceanaGold, or in part by contractors under the direct supervision of OceanaGold employees. OceanaGold is responsible for setting out the works, ensuring that the rock stack is constructed to the design profile, that foundation stripping and preparation is properly carried out, subsurface drainage material is suitably placed, surface drainage is properly constructed and maintained, and that rehabilitation (i.e. topsoil and grassing) is to high standards. The proposed construction methods and rehabilitation strategies are similar to those employed on the existing tailing storage facilities and waste rock stacks, and these have been successful during the 25 years of operation at the MGP.

The design requirement for shear keys beneath WRS can be reviewed with additional ground investigation information. Shear keys would be constructed of waste rock and would need to extend through the soils and contact the schist rock over the areas shown in Figure 8.

It is anticipated that similar consent conditions to those for the existing Coronation North WRS will apply to the Deepdell East WRS, such as the specific requirements affecting construction as summarised below:

Conditions 8 and 9 of RM16.138.01, Condition 8 of RM16.138.15 and Condition 12 of RM16.138.20 refer to the requirement for cleaning of construction plant to avoid spreading didymo and the need to minimise work in waterways.

Condition 14a of RM16.138.01, condition 15a of RM16.138.15, condition 16a of RM16.138.20 and condition 14.6a of 201.2016.779, 201.2013.360.1, LUC-2016-234 and LUC-2013-225A requires if there is discovery of koiwi tangata (human skeletal remains) or Maori artefact material that the Consent Holder shall without delay:

i. Notify the Consent Authority, Tangata whenua and New Zealand Historical Society, in the case of skeletal remains, the New Zealand Police and
ii. Stop work within the immediate vicinity
iii. Any koiwi tangata discovered shall be handled and removed by tribal elders responsible for the tikanga (custom) appropriate to its removal or preservation

Condition 14b of RM16.138.01, Condition 15b of RM16.138.15, Condition 16b of RM16.138.20 and Condition 14.6b of 201.2016.779, 201.2013.360.1, LUC-2016-234 and LUC-2013-225A requires if there is discovery of any features or archaeological features that pre-dates 1900, or heritage material, or disturbs a previously unidentified archaeological or history site that the Permit Holder shall without delay:

i. Stop work within the immediate vicinity
ii. Advise the New Zealand Historical Places Trust, and in the case of Maori features or materials, the Tangata whenua, and if required, shall make an application for an Archaeological Authority pursuant to the Historic Places Act 1993
iii. Arrange for a suitably qualified archaeologist to undertake a survey of the site.

7.0 CONCLUSIONS

The Deepdell East WRS is designed in accordance with accepted engineering practices. Existing WRS have been designed to similar standards and their performance to date has been satisfactory. Construction procedures, including supervision and quality control practices for the Deepdell WRS will meet accepted engineering standards.

All final slopes of the WRS have been designed for a long term static factor of safety against instability exceeding 1.5 for the expected water levels.

The WRS has been designed for an operating basis earthquake (OBE) with a recurrence interval of 150 years and maximum design earthquake (SEE) with a recurrence interval of 2,500 years. Minor deformation is expected from the OBE and satisfactory performance is shown for the post-earthquake case and the SEE and settlement and slope deformation will not affect any critical elements of the WRS.

Based on the results of the static and seismic stability analyses conducted it is concluded that the WRS is sufficiently stable for the intended long-term use of pastoral farming post-rehabilitation and mine closure.

OceanaGold will ensure short and long term stability of the WRS, associated works, and surrounds at all time during the operational life of the structure. This will be achieved through construction, rehabilitation and ongoing monitoring in accordance with the controlling documents:

Deepdell East WRS Design Report (i.e. this report);
Deepdell North Stage III Erosion and Sediment Control Report (Ref 10);
Macraes Water Quality Management Plan (Ref.11)

ENGINEERING GEOLOGY LTD

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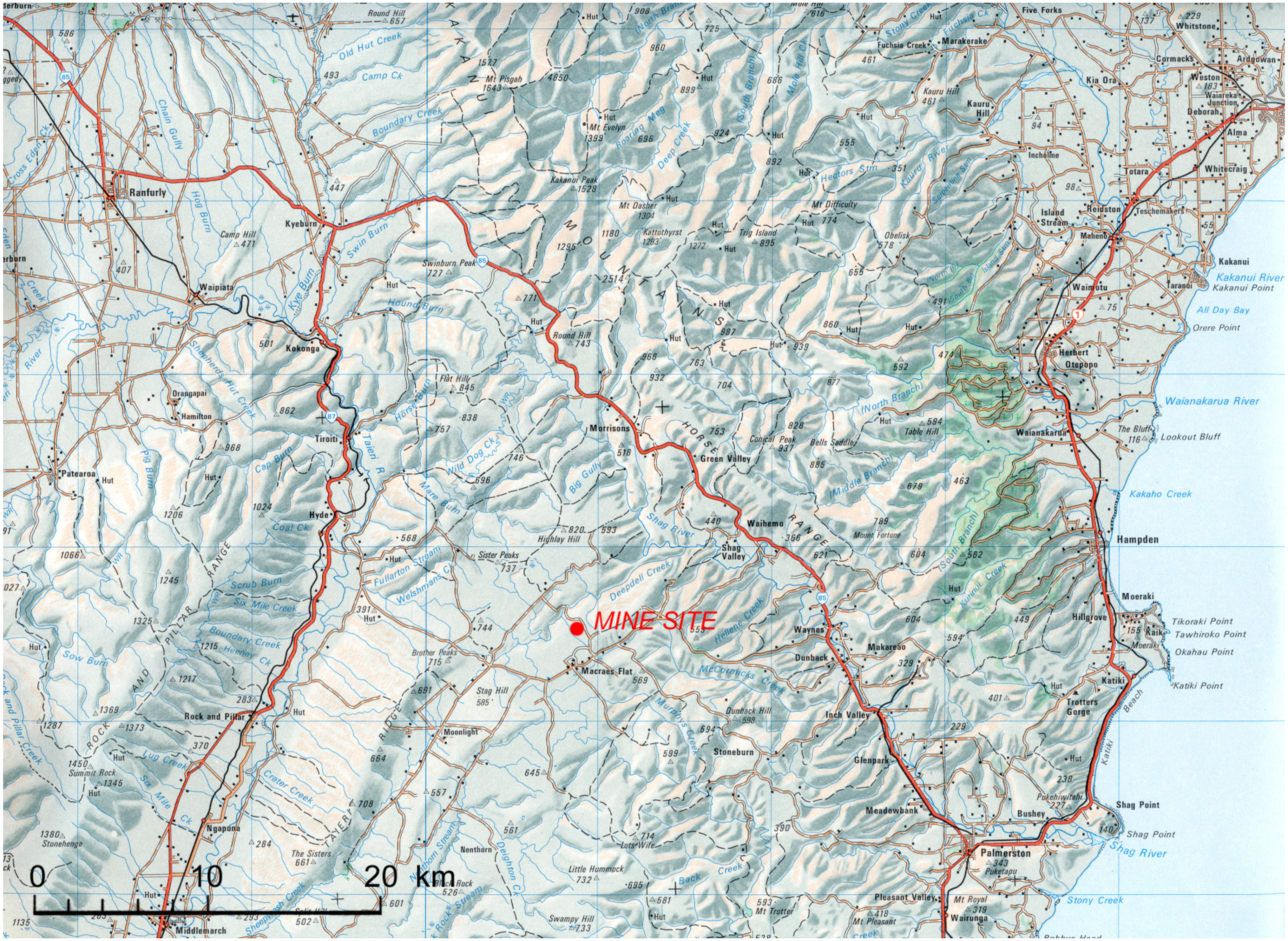
FIGURES
1 TO 8



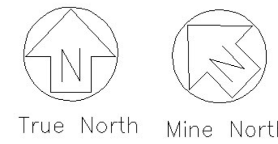


Figure 1

Source: NZMS Sheet 15 Waitaki.

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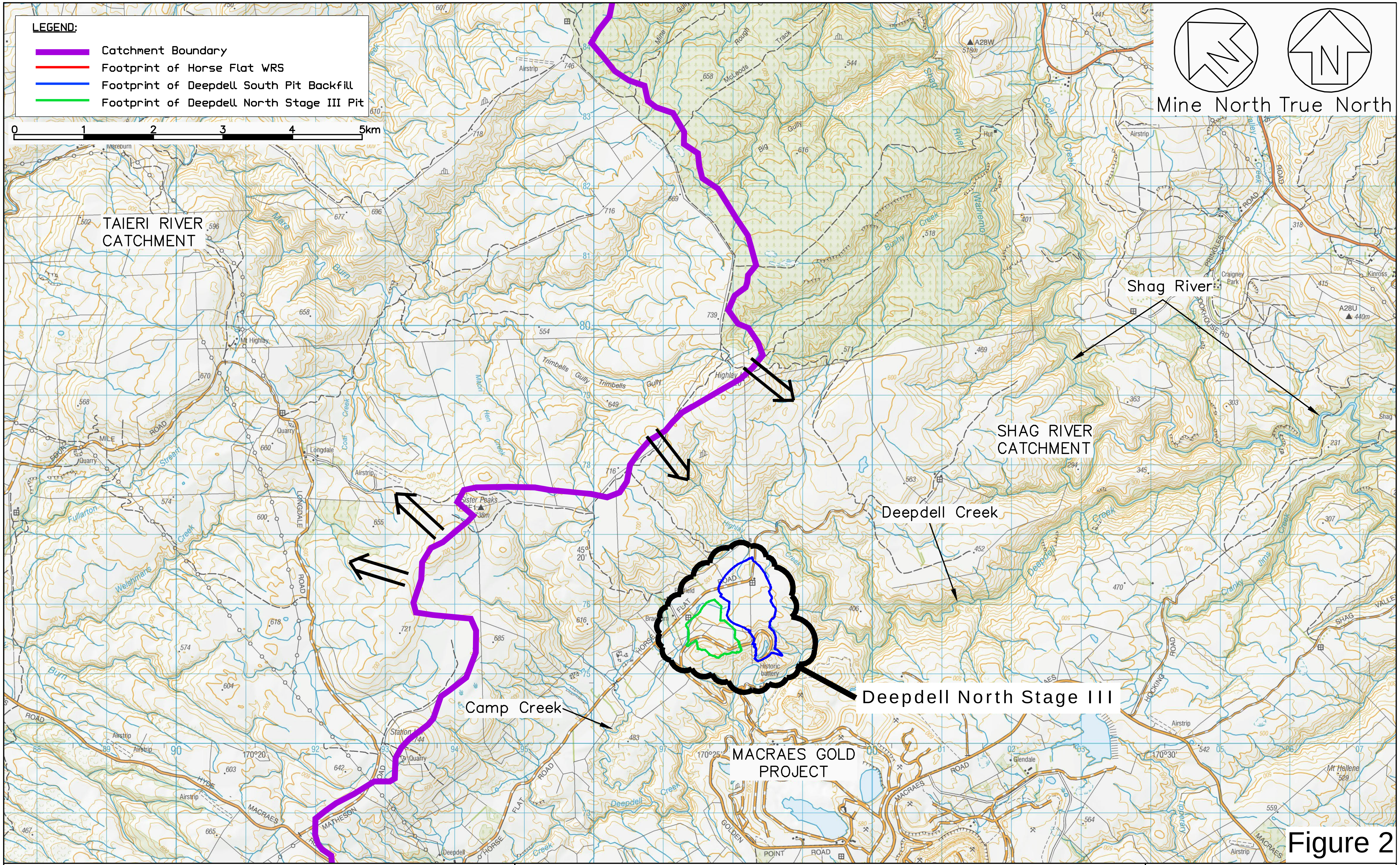
OCEANA GOLD (NEW ZEALAND) LTD
Macraes Gold Project
Locality Plan

Ref. No.: 1410
Date: 26 June 2002
Drawn: SP
File: local.grf



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OCEANA GOLD NZ LTD
MACRAES GOLD PROJECT- Deepdell North Stage III
Site Plan

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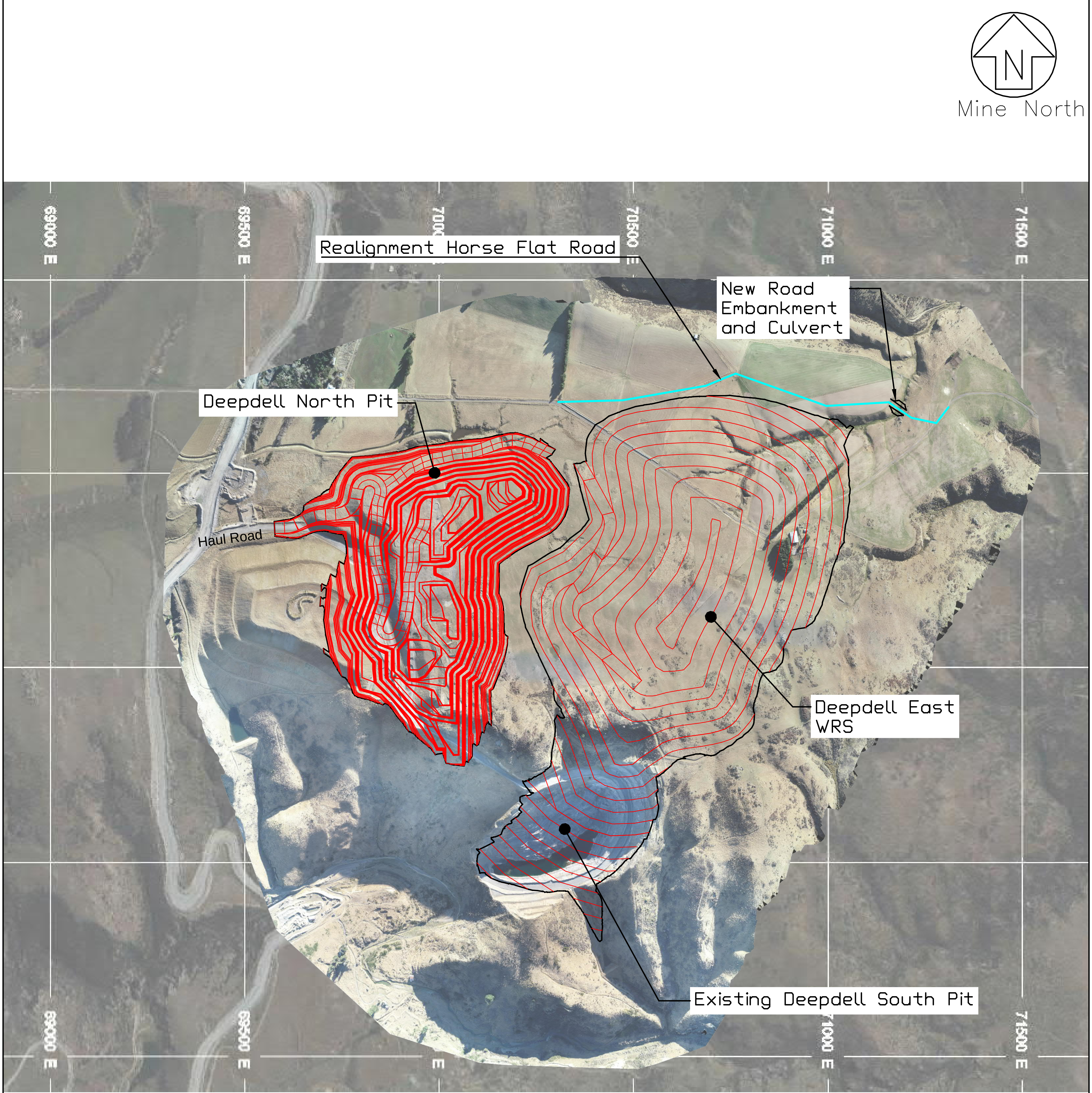

LEGEND:

- Deepdell East WRS - Contours 10m Intervals
- Deepdell North Stage III Pit - Contours 2.5m Intervals

Figure 3

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MACRAES GOLD PROJECT-
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Waste Rock Stack Plan

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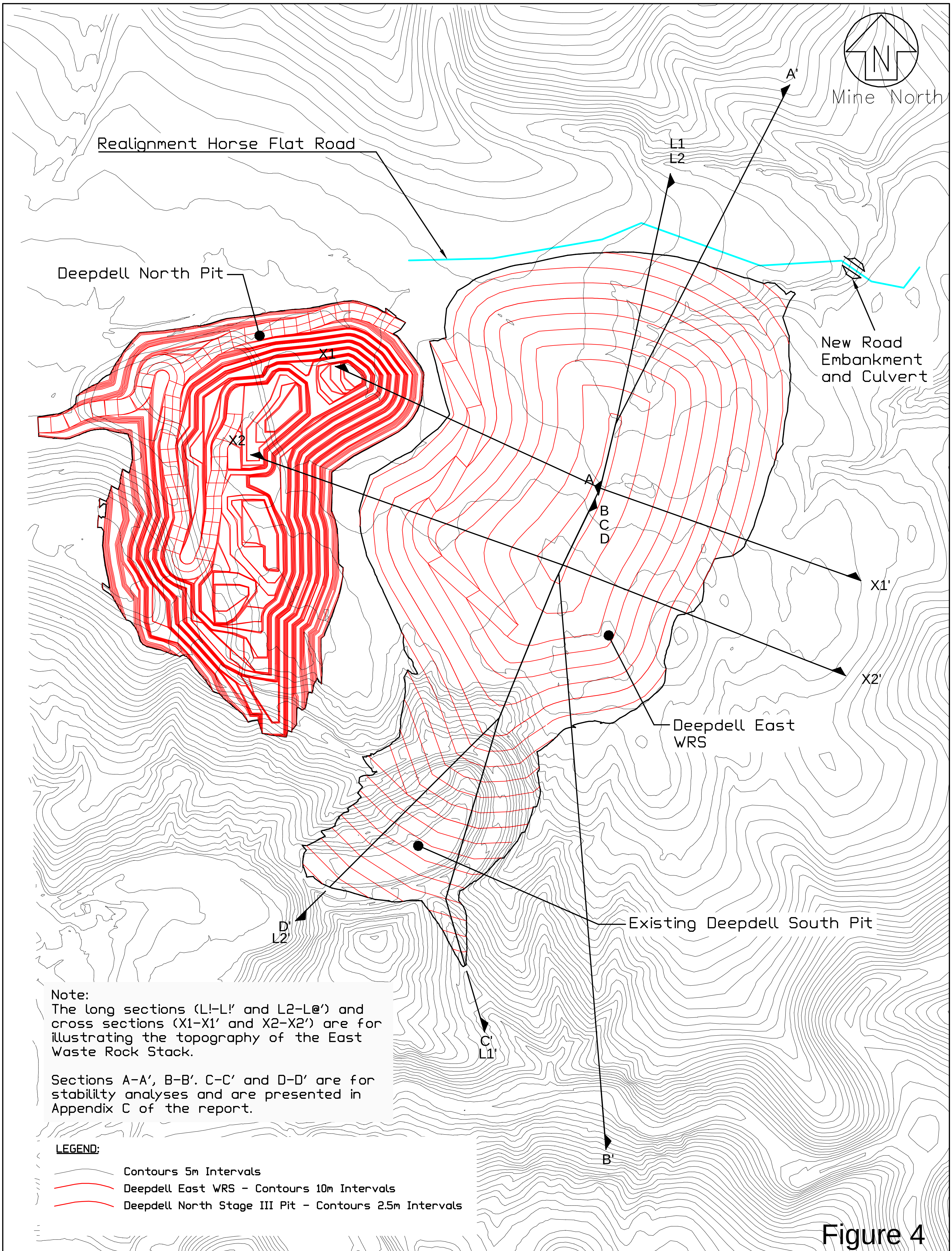

Figure 4

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MACRAES GOLD PROJECT-
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Waste Rock Stack Plan

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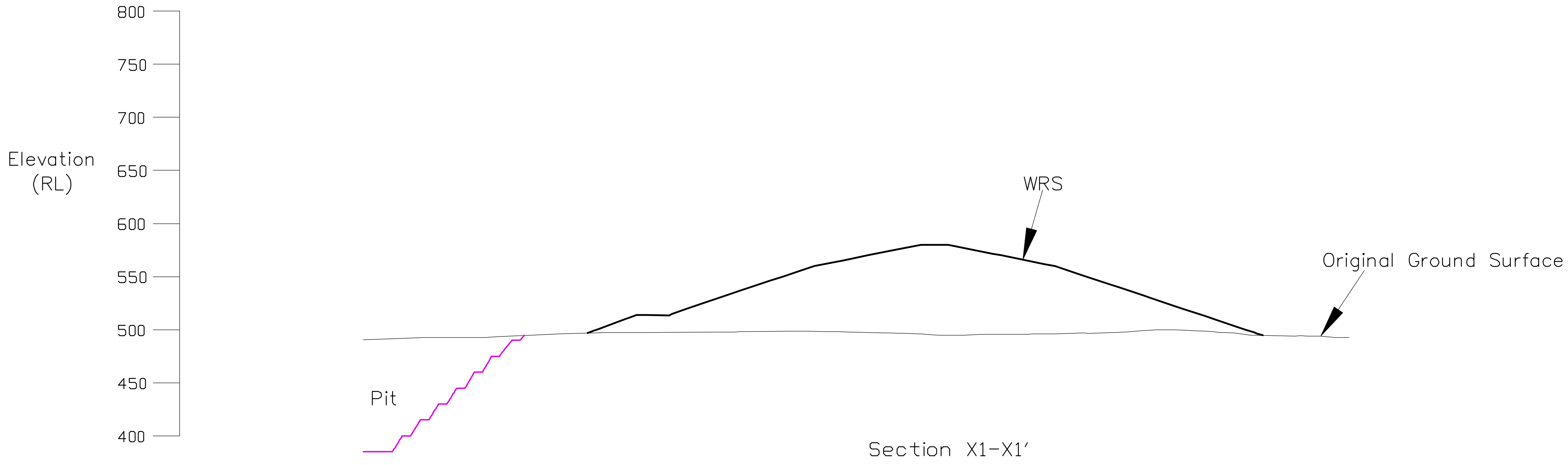

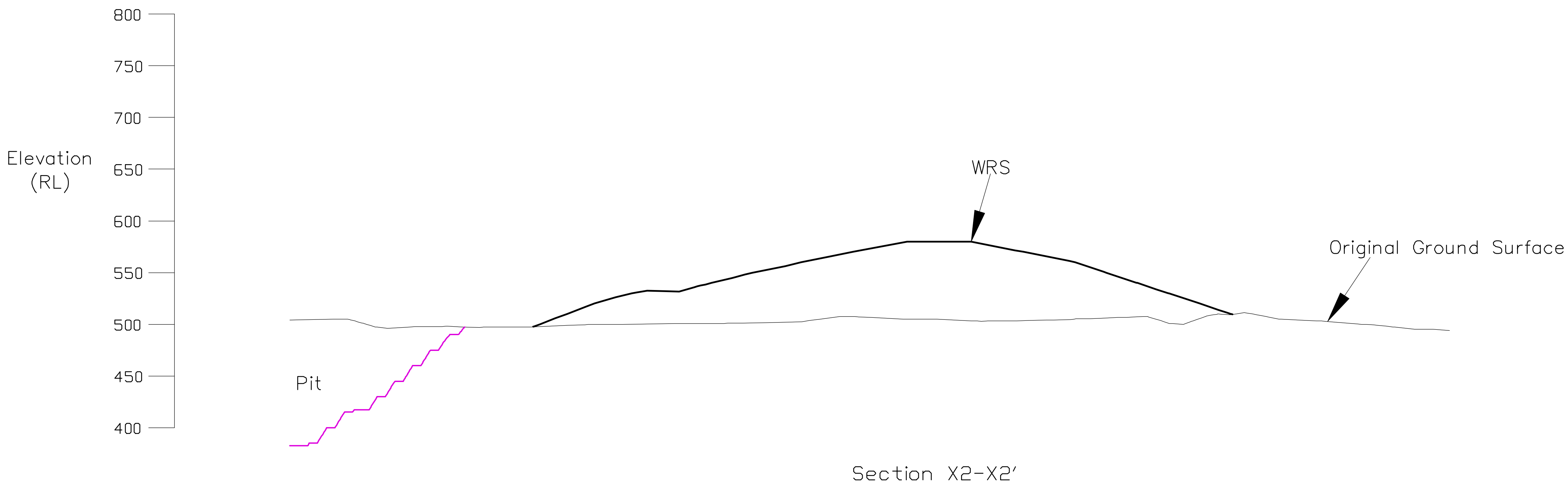

Figure 5

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MACRAES GOLD PROJECT- Deepdell North Stage III
Deepdell East Waste Rock Stack
Cross Sections

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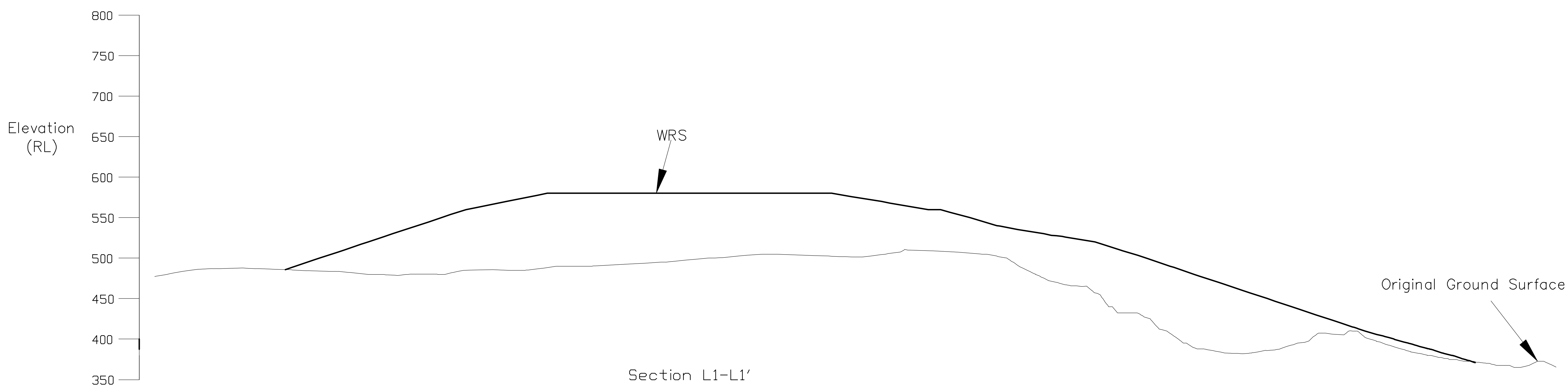
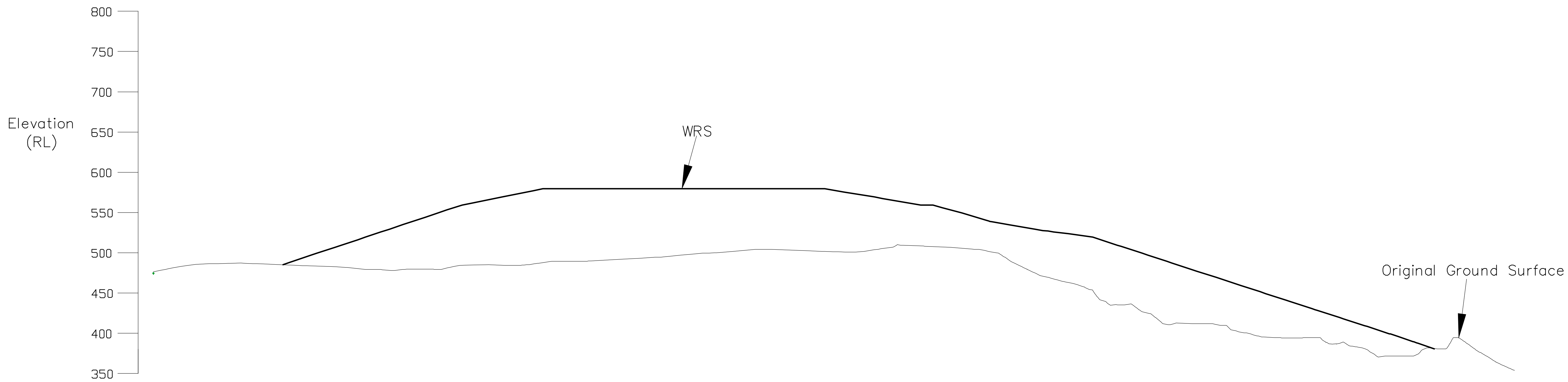


Section L1-L1'



Section L2-L2'

Figure 6

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MACRAES GOLD PROJECT- Deepdell North Stage III
Deepdell East Waste Rock Stack
Long Sections

Drawing No.	8528-Fig 6
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Drawn:	JL
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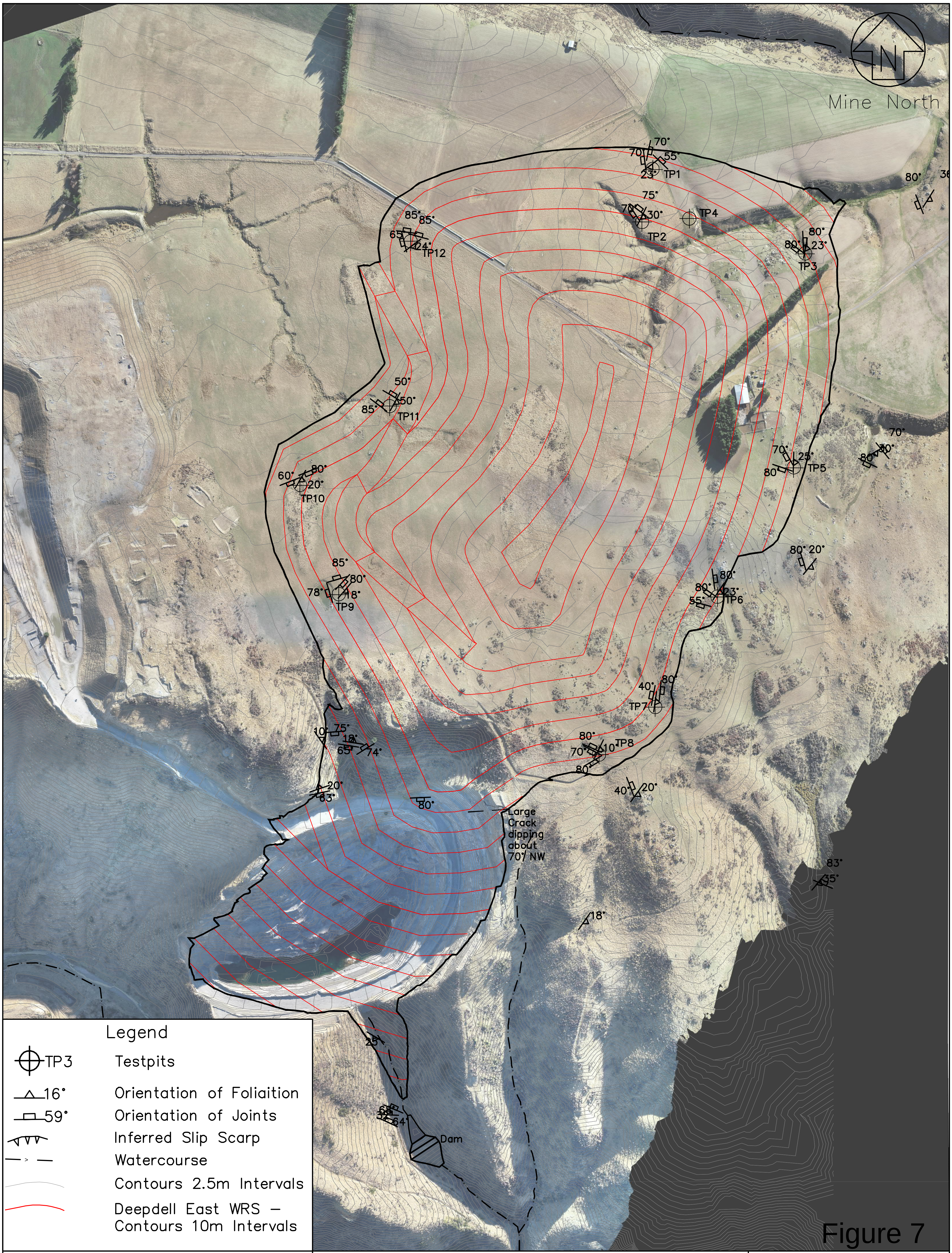

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OCEANA GOLD NZ LIMITED
MACRAES GOLD PROJECT-Deepdell North Stage III
Deepdell East Waste Rock Stack
Fieldwork Location Plan

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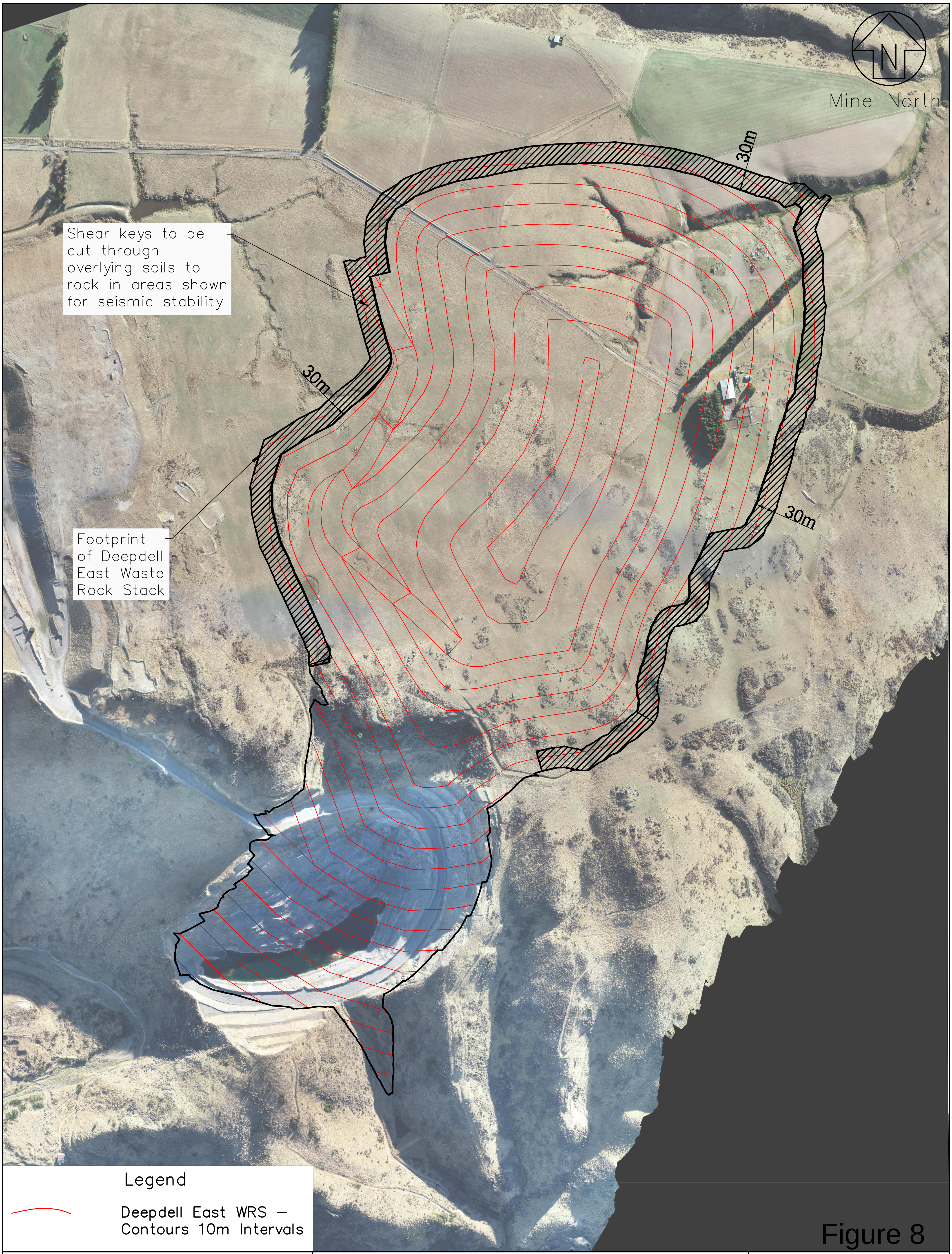

Figure 8

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OCEANA GOLD NZ LIMITED
MACRAES GOLD PROJECT-Deepdell North Stage III
Deepdell East Waste Rock Stack
Shear Key Option

Drawing No.	8528-Fig8
Date:	Jul 2019
Drawn:	NT
Scale:	1:5000 (@A3)
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APPENDIX A

GROUND INVESTIGATIONS

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP1

SHEET 1 OF 1

Job No.: 8528

PROJECT: Deepdell East WRS

LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago

COORDINATES: East 70781.4 North 17671.8 | **RL GROUND:** 484.4m | **DATE:** 27/06/2019

GRID: MMG | **DATUM:** Mine | **TESTPIT DEPTH:** 0.9m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Field Vane (BS 1377) ○ Remoulded Field Vane (50, 100, 150)	FIELD TESTS
TS	Organic SILT, trace clay; grey brown. Very stiff, moist, low plasticity	484.4 / 0.2	TS		M	VSt			Groundwater Not Encountered		
Loess	SILT, tr. clay; grey orange brown. V. Stiff, moist, low plasticity	484.2 / 0.3								● (~114)	SV: 0.3m, 114 / - kPa (N/A)
	Bag sample 1, 0.35-0.4m	484.1 / 0.4					◣				
Rakaia Terrane TZIII Schist	Highly weathered, light grey, orange, SCHIST; extremely weak to very weak	484.0 / 0.7			D-M	EW-VW					SV: 0.4m, UTP
	mod.-sl. weathered, weak, Foliation 187°/23° E Joints 87°/55° NNW, 145°/70° NE, 306°/70° SW, tight, smooth, discontinuous	483.7 / 0.9				W					

EOH: 0.90 m

NOTES:
E.O.P. @ 0.9m (Too hard to excavate), Test pit was dry on 27 June 2019.

LOGGED: DLM

CHECKED: ET

EXCAVATOR: 20 Tonne Excavator

EGL - Hand Auger - Test Pit v7 - 4/07/2019 1:06:32 PM - Produced with Core-GS by Geroc

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 1

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP2

SHEET 1 OF 1

Job No.: 8528

PROJECT: Deepdell East WRS
LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago
COORDINATES: East 70766.0 North 17593.9 **RL GROUND:** 480.0m **DATE:** 27/06/2019
GRID: MMG **DATUM:** Mine **TESTPIT DEPTH:** 0.8m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
TS	Organic SILT, trace clay, some gravel; grey brown. Very stiff, moist, low plasticity; Bag sample 1, 0.25m	480.0 / 0.3	TS		M	VSt			Groundwater Not Encountered		SV: 0.3m, UTP
Rakaia Terrane TZIII Schist	Completely weathered, orange brown, light grey, SCHIST; extremely weak to very weak; weathered to a clayey gravel	479.8 / 0.4			D-M	EW-VW					
	Moderately weathered, grey, orange brown, SCHIST; very weak	479.6 / 0.6				VW					
	mod.-sl. weathered, weak, Foliation 160°/30° ENE Joints 80°/75° N, 280°/76° S, tight, smooth, discontinuous	479.4 / 0.8				W					

EOH: 0.80 m

NOTES:
E.O.P. @ 0.8m (Too hard to excavate), Test pit was dry on 27 June 2019.

LOGGED: DLM
CHECKED: ET **EXCAVATOR:** 20 Tonne Excavator

EGL - Hand Auger - Test Pit v7 - 4/07/2019 1:06:32 PM - Produced with Core-GS by Geroc

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 1

Test Pit 2

ENGINEERING GEOLOGY LTD	TEST PIT LOG	**TESTPIT No.:** TP3 SHEET 1 OF 1 **Job No.:** 8528

PROJECT: Deepdell East WRS
LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago
COORDINATES: East 71003.1 North 17547.6 **RL GROUND:** 473.2m **DATE:** 27/06/2019
GRID: MMG **DATUM:** Mine **TESTPIT DEPTH:** 2.0m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
TS	Organic SILT, minor clay; grey brown. Very stiff, moist, low plasticity	473.2 0.2	TS		M	VSt					
Colluvium/Slopewash	SILT, some clay, gravelly (f-c); orange brown, light grey. Hard, mist, low plasticity	473.0 0.4			M	VSt					
	clasts of schist up to 50mm, Bag sample 1, 0.45m	472.8 0.7			M	H	■				SV: 0.5m, 200+ kPa
	Bag sample 2, 0.7m	472.5 1.3		1	M	H	■				SV: 0.7m, 200+ kPa
Rakaia Terrane TZIII Schist	Completely weathered, orange brown, SCHIST, extremely weak; weathered to a gravelly SILT, hard; Bag sample 3, 1.4m	471.9 1.5			M	H	■				SV: 1.4m, 200+ kPa
	Moderately weathered, grey, orange brown, SCHIST; very weak	471.7 1.8			M	VW			2.00m, 27/06/2019		
	sl. weathered, weak, Foliation 144°/23° NE Joints 260°/80° S, 131°/80° NE, tight, smooth, discontinuous, saturated, seepage at 2.0m	471.4 2.0		2	S	W			▽		

EOH: 2.00 m

NOTES:
E.O.P. @ 2.0m (Too hard to excavate).

LOGGED: DLM
CHECKED: ET **EXCAVATOR:** 20 Tonne Excavator

EGL - Hand Auger - Test Pit v7 - 4/07/2019 1:06:32 PM - Produced with Core-GS by Geroc

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 2

Test Pit 3

Test Pit 3

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP4

SHEET 1 OF 1

Job No.: 8528

PROJECT: Deepdell East WRS

LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago

COORDINATES: East 70835.6 North 17598.8 | **RL GROUND:** 477.1m | **DATE:** 27/06/2019

GRID: MMG | **DATUM:** Mine | **TESTPIT DEPTH:** 4.5m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER LEVEL	FIELD TESTS
TS	Organic SILT, trace clay; grey brown. Very stiff, moist, low plasticity	477.1 / 0.2		M	VSt		Groundwater Not Encountered	
Loess	SILT, trace clay; orange, grey yellow brown, light grey. Hard, moist, low plasticity. Bag sample 1, 0.4m	476.9		M	H	Bag (0.4m)		SV: 0.4m, 200+ kPa
Loess	very stiff, Bag sample 2, 1.0m	0.9 / 476.2 / 1.0	1	M	VSt	Bag (1.0m)		
Loess	trace gravel (f)	476.1		M	VSt			SV: 1.0m, 187 / - kPa (N/A); SV: 1.2m, 106 / - kPa (N/A)
Loess	some clay, Bag sample 3, 2.1m	2.0 / 475.1	2	M	VSt	Bag (2.1m)		
Loess	Bag sample 4, 3.0m	3.0 / 474.1	3	M	VSt	Bag (3.0m)		
Rakaia Terrane TZIII Schist	Completely weathered, grey orange brown, SCHIST; extremely weak; weathered to a SILT with some clay and gravel; Bag sample 5, 4.0m	4.0 / 473.1	4	M	H	Bag (4.0m)		
Rakaia Terrane TZIII Schist	Highly weathered, grey, orange brown, SCHIST; very weak	4.4 / 472.7 / 4.5		M	VW			

CORRECTED VANE SHEAR STRENGTH (kPa): ● Field Vane (BS 1377); ○ Remoulded Field Vane (scale 50, 100, 150)

EOH: 4.50 m

NOTES:
E.O.P. @ 4.5m (maximum reach of excavator), Test pit was dry on 27 June 2019.

LOGGED: DLM

CHECKED: ET

EXCAVATOR: 20 Tonne Excavator

EGL - Hand Auger - Test Pit v7 - 4/07/2019 1:06:32 PM - Produced with Core-GS by Geroc

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 4

Test Pit 4

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP5

SHEET 1 OF 1

Job No.: 8528

PROJECT: Deepdell East WRS

LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago

COORDINATES: East 70989.3 North 17232.4 **RL GROUND:** 492.9m **DATE:** 28/06/2019

GRID: MMG **DATUM:** Mine **TESTPIT DEPTH:** 1.2m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
TS	Organic SILT, tr. clay; grey brown. V. stiff, moist, low plasticity	492.9 / 0.1	TS		M	VSt			Groundwater Not Encountered		
Loess	SILT, minor clay; light grey orange brown, light grey, orange. Very stiff, moist, low plasticity	492.8 / 0.3								● 145	SV: 0.2m, 145 / - kPa (N/A)
	trace gravel (f), light grey, orange brown, hard, Bag sample 1, 0.3m	492.6 / 0.5				H	◣				SV: 0.3m, 200+ kPa; SV: 0.5m, UTP
Rakaia Terrane TZIII Schist	Completely to highly weathered, light grey, orange brown, SCHIST; extremely to very weak	492.4 / 0.7			D-M	EW-VW					
	highly weathered, very weak	492.2 / 0.9				VW					
	moderately to slightly weathered, weak Foliation 135°/25° NE Joints 285°/70° S, 242°/80° SSE, tight, smooth, discontinuous	492.0 / 1.2		1		W					

EOH: 1.20 m

NOTES:
E.O.P. @ 1.2m (Too hard to excavate), Test pit was dry on 28 June 2019.

LOGGED: DLM

CHECKED: ET **EXCAVATOR:** 20 Tonne Excavator

EGL - Hand Auger - Test Pit v7 - 4/07/2019 1:06:32 PM - Produced with Core-GS by Geroc

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 5

Test Pit 5

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP6
SHEET 1 OF 1
Job No.: 8528

PROJECT: Deepdell East WRS
LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago
COORDINATES: East 70876.9 North 17042.2 **RL GROUND:** 506.4m **DATE:** 28/06/2019
GRID: MMG **DATUM:** Mine **TESTPIT DEPTH:** 2.0m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
TS	Organic SILT, tr. clay; grey brown. V. stiff, moist, low plasticity	506.4 / 0.1	TS		M	VSt			Groundwater Not Encountered		
Loess	SILT, minor clay; light grey orange brown. Very stiff, moist, low plasticity	506.3 / 0.4			M	VSt				●	SV: 0.3m, 187 / - kPa (N/A)
Loess	some clay, tr. gravel, orange brown, Bag sample 1, 0.4m	506.0 / 0.5			M	VSt	◣			●	SV: 0.4m, 176 / - kPa (N/A)
Rakaia Terrane TZIII Schist	Completely weathered, orange brown, light grey, SCHIST; extremely weak; weathered to a silty GRAVEL; Bag sample 2, 0.5m	505.9 / 0.8			M	H	◣				SV: 0.5m, UTP
Rakaia Terrane TZIII Schist	Highly weathered, orange brown, grey, SCHIST; very weak	505.6 / 1.8		1	D-M	VW					
Rakaia Terrane TZIII Schist	moderately to slightly weathered, weak, Foliation 166°/23° E Joints 259°/80° S, 239°/85° SSE, 126°/80° NE, tight, smooth, discontinuous	504.6 / 2.0		2	D-M	W					

EOH: 2.00 m

NOTES:
E.O.P. @ 2.0m (Too hard to excavate), Test pit was dry on 28 June 2019.

LOGGED: DLM
CHECKED: ET **EXCAVATOR:** 20 Tonne Excavator

EGL - Hand Auger - Test Pit v7 - 4/07/2019 1:06:32 PM - Produced with Core-GS by Geroc

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 6

Test Pit 6

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP7

SHEET 1 OF 1

Job No.: 8528

PROJECT: Deepdell East WRS

LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago

COORDINATES: East 70785.5 North 16879.7 | **RL GROUND:** 510.0m | **DATE:** 28/06/2019

GRID: MMG | **DATUM:** Mine | **TESTPIT DEPTH:** 1.9m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Field Vane (BS 1377) ○ Remoulded Field Vane (50, 100, 150)	FIELD TESTS
TS	Organic SILT, tr. clay; grey brown. Very stiff, moist, low plasticity	510.0 / 0.2	TS		M	VSt			Groundwater Not Encountered		
Loess	SILT, tr. clay; grey orange brown. Hard, moist, low plasticity	509.9 / 0.3			M	H					SV: 0.3m, UTP
Loess	trace schist gravel and cobbles	509.8 / 0.4			M	H					
Loess	Bag sample 1, 0.35m	509.7 / 0.5			M	H	Bag sample				
Rakaia Terrane TZIII Schist	Completely weathered, light grey, orange, SCHIST; extremely weak; weathered to a gravelly SILT; Bag sample 2, 0.5m	509.5 / 0.7			M	H	Bag sample				SV: 0.5m, UTP
Rakaia Terrane TZIII Schist	Highly weathered, orange brown, grey, SCHIST; very weak	509.3 / 1.7		1	D-M	VW					
Rakaia Terrane TZIII Schist	moderately to slightly weathered, weak, Foliation 142°/20° NE Joints 324°/40° SW, 139°/80° NE, tight, smooth, discontinuous	508.3 / 1.9			D-M	W					

EOH: 1.90 m

NOTES:
E.O.P. @ 1.9m (Too hard to excavate), Test pit was dry on 28 June 2019.

LOGGED: DLM

CHECKED: ET

EXCAVATOR: 20 Tonne Excavator

EGL - Hand Auger - Test Pit v7 - 4/07/2019 1:06:32 PM - Produced with Core-GS by Geroc

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 7

Test Pit 7

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP8

SHEET 1 OF 1

Job No.: 8528

PROJECT: Deepdell East WRS

LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago

COORDINATES: East 70702.6 North 16809.7

RL GROUND: 505.2m

DATE: 28/06/2019

GRID: MMG

DATUM: Mine

TESTPIT DEPTH: 0.9m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
TS	Organic SILT; grey brown. Very stiff, moist, low plasticity	505.2 / 0.2	TS		M	VSt			Groundwater Not Encountered		
Loess	SILT, tr. clay, some gravel; orange brown. Hard, moist, low plasticity	505.1 / 0.3			M	H					SV: 0.2m, UTP
Rakaia Terrane TZIII Schist	Completely weathered, orange brown, grey, SCHIST; extremely weak; weathered to a silty gravel	504.9 / 0.5			D-M	H					
	Moderately weathered, grey, orange brown, SCHIST; very weak	504.7 / 0.7			D-M	VW					
	weak, Foliation 159°/10° ENE Joints 192°/80° E, 68°/80° NNW, 251°/70° SSE, tight, smooth, discontinuous	504.5 / 0.9			D-M	W					

EOH: 0.90 m

NOTES:
E.O.P. @ 0.9m (Too hard to excavate), Test pit was dry on 28 June 2019.

LOGGED: DLM

CHECKED: ET

EXCAVATOR: 20 Tonne Excavator

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 8

Test Pit 8

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP9

SHEET 1 OF 1

Job No.: 8528

PROJECT: Deepdell East WRS

LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago

COORDINATES: East 17045.9 North 17045.9 | **RL GROUND:** 502.5m | **DATE:** 27/06/2019

GRID: MMG | **DATUM:** Mine | **TESTPIT DEPTH:** 1.2m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
TS	Organic SILT; grey brown. Very stiff, moist, low plasticity	502.5 / 0.2			M	VSt			Groundwater Not Encountered		
Loess	SILT, tr. clay; grey orange brown. Hard, moist, low plasticity	502.3 / 0.4			M	H					SV: 0.4m, UTP
Rakaia Terrane TZIII Schist	Highly weathered, grey, orange brown, SCHIST; very weak	502.1 / 0.7			D-M	VW					
	moderately weathered, weak	501.8 / 1.0			D-M	W					
	slightly weathered, Foliation 174°/18° ENE Joints 296°/78°SSW, 177°/80° E, 27°/85° WNW, tight, smooth, discontinuous	501.5 / 1.2		1	D-M	W					

EOH: 1.20 m

NOTES:
E.O.P. @ 1.2m (Too hard to excavate), Test pit was dry on 27 June 2019.

LOGGED: DLM

CHECKED: ET

EXCAVATOR: 20 Tonne Excavator

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Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 9

Test Pit 9

ENGINEERING GEOLOGY LTD	**TEST PIT LOG**	**TESTPIT No.:** **TP10** SHEET 1 OF 1 **Job No.:** 8528

PROJECT: Deepdell East WRS
LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago
COORDINATES: East 70262.6 North 17206.6 **RL GROUND:** 499.8m **DATE:** 27/06/2019
GRID: MMG **DATUM:** Mine **TESTPIT DEPTH:** 1.1m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
TS	Organic SILT, trace clay; grey brown. Very stiff, moist, low plasticity.	499.8 / 0.2			M	VSt			Groundwater Not Encountered		
Loess	SILT, some gravel (f), trace clay; orange brown. Hard, moist, low plasticity.	499.6 / 0.5			M	H					SV: 0.3m, UTP
Rakaia Terrane TZIII Schist	Extremely weathered, orange brown, grey, SCHIST; very weak; weathered to a silty gravel	499.3 / 0.7			D-M	H					
	Moderately weathered, grey, orange brown, SCHIST; very weak	499.1 / 0.9			D-M	VW					
	moderate to slightly weathered, weak, Foliation 164°/20° E Joints 202°/60° ESE, 202°/80° ESE, tight, smooth, discontinuous	498.9 / 1.1		1	D-M	W					

EOH: 1.10 m

NOTES:
E.O.P. @ 1.1m (Too hard to excavate), Test pit was dry on 27 June 2019.

LOGGED: DLM
CHECKED: ET **EXCAVATOR:** 20 Tonne Excavator

EGL - Hand Auger - Test Pit v7 - 4/07/2019 1:06:32 PM - Produced with Core-GS by Geroc

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 10

Test Pit 10

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP11

SHEET 1 OF 1

Job No.: 8528

PROJECT: Deepdell East WRS

LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago

COORDINATES: East 70394.4 North 17322.7 **RL GROUND:** 497.5m **DATE:** 27/06/2019

GRID: MMG **DATUM:** Mine **TESTPIT DEPTH:** 0.7m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
TS	Organic SILT; grey brown. Very stiff, moist, low plasticity.	497.5 / 0.3	TS		M	VSt			Groundwater Not Encountered		SV: 0.3m, UTP
Terrane TZIII	Extremely weathered, grey, orange brown, SCHIST; very weak	497.2 / 0.5			D-M	VW					
	moderately weathered, weak, Foliation 162°/15° ENE Joints 80°/85° N, 74°/50° N, tight, smooth, discontinuous	497.0 / 0.7				W					

EOH: 0.70 m

NOTES:
E.O.P. @ 0.7m (Too hard to excavate), Test pit was dry on 27 June 2019.

LOGGED: DLM

CHECKED: ET

EXCAVATOR: 20 Tonne Excavator

EGL - Hand Auger - Test Pit v7 - 4/07/2019 1:06:32 PM - Produced with Core-GS by Geroc

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 11

Test Pit 11

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP12

SHEET 1 OF 1

Job No.: 8528

PROJECT: Deepdell East WRS

LOCATION: Deepdell East WRS, Oceana Gold Macraes Mine, Macraes Flat, Otago

COORDINATES: East 70435.4 North 17565.2 **RL GROUND:** 495.0m **DATE:** 27/06/2019

GRID: MMG **DATUM:** Mine **TESTPIT DEPTH:** 1.1m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
TS	Organic SILT, trace clay; grey brown. Very stiff, moist, low plasticity.	495.0 / 0.2	TS		M	VSt			Groundwater Not Encountered		
Loess	SILT, some gravel, minor clay; orange brown, grey brown; Very stiff, moist, low plasticity.	494.8 / 0.5									SV: 0.3m, UTP
Rakaia Terrane TZIII Schist	Extremely to highly weathered, orange brown, grey, SCHIST; very weak; weathered to a silty gravel	494.5 / 0.7			D-M	VW					
	Highly to moderately weathered, grey, orange brown, SCHIST; very weak to weak	494.3 / 0.9				VW-W					
	Foliation 186°/24° E Joints 59°/85° NNW, 299°/65° SSW, 51°/85° NW, tight, smooth, discontinuous	494.1 / 1.1		1							

EOH: 1.10 m

NOTES:
E.O.P. @ 1.1m (Too hard to excavate), Test pit was dry on 27 June 2019.

LOGGED: DLM

CHECKED: ET **EXCAVATOR:** 20 Tonne Excavator

EGL - Hand Auger - Test Pit v7 - 4/07/2019 1:06:32 PM - Produced with Core-GS by Geroc

Client Name.	Oceana Gold New Zealand Limited	Job No.	8528		
Engineering Geology Ltd CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS		Address	Deepdell East WRS		
		Photographer	DLM	Date:	27-28 June 2019
Title:	**TEST PIT PHOTOGRAPHS**				

Test Pit 12

Test Pit 12

APPENDIX B

LABORATORY TESTING

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 19/2051

Date: 15 July 2019

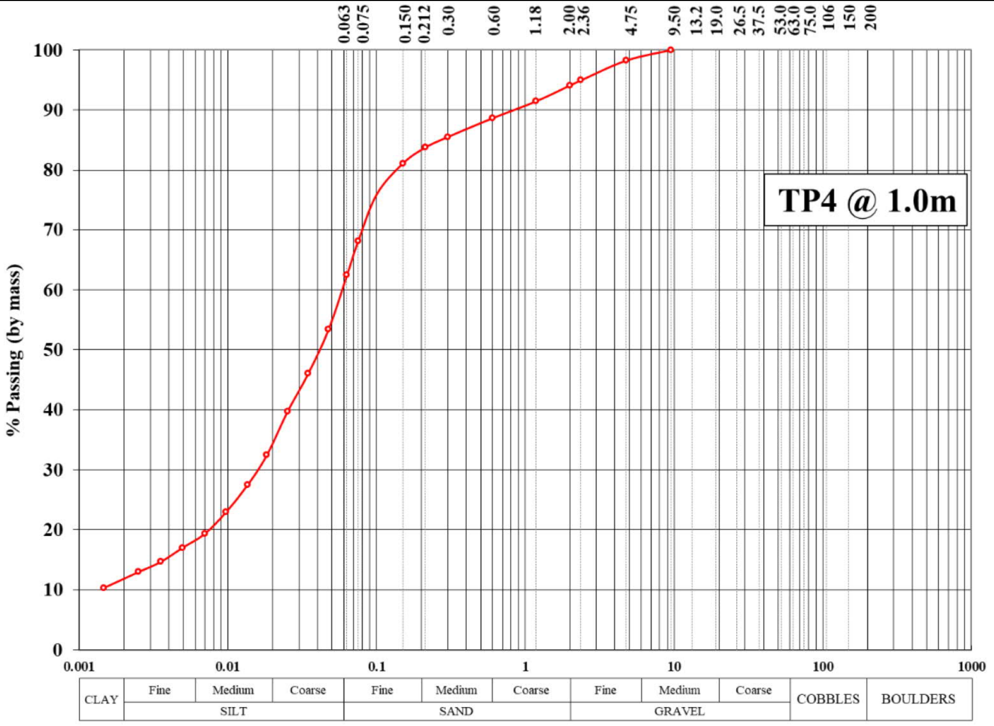
TEST REPORT – OCEANA GOLD INVESTIGATIONS

Client Details:	Oceana Gold, Golden Point Road, RD3 Macraes Flat, East Otago	**Attention:**	M. Hughes
Job Description:	Oceana Gold – DDN3; Deep Dell WRS Samples		
Sample Description:	Sandy SILT with minor / some clay and minor gravel	**Client Reference No:**	8528
Sample Source:	Test Pit 4, Sample 2 @ 1.0m	**Sample Label No:**	N/A
Date & Time Sampled:	27-Jun-19	**Sampled By:**	Oceana Gold
Sample Method:	Test Pit *	**Date Received:**	8-Jul-19

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	100
4.75	98
2.36	95
2.00	94
1.18	91
0.60	89
0.30	86
0.212	84
0.150	81
0.075	68
0.063	62

Fraction Size	Interpolated % Passing
60 µm	61
20 µm	34
6 µm	18
2 µm	12



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 9.0. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	60.0mm to 20.0mm	-	Fine Sand	200 µm to 60 µm	22
Medium Gravel	20.0mm to 6.0mm	1	Coarse Silt	60 µm to 20 µm	27
Fine Gravel	6.0mm to 2.00 mm	5	Medium Silt	20 µm to 6 µm	16
Coarse Sand	2.00mm to 600 µm	5	Fine Silt	6 µm to 2 µm	6
Medium Sand	600 µm to 200 µm	6	Clay	< 2 µm	12

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4

Water Content: ("All In" As Received)	13.4 %
Liquid Limit: (LL)	25
Plastic Limit: (PL)	22
Plasticity Index: (PI)	3

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Note:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the sample method * and sampling.*
- *This report may not be reproduced except in full.*

Tested By: L.T. Smith **Date:** 10 to 12-Jul-19

Checked By: [signature]

Tests indicated as Not Accredited are outside the scope of the laboratory's accreditation

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Reference No: 19/2051

Date: 15 July 2019

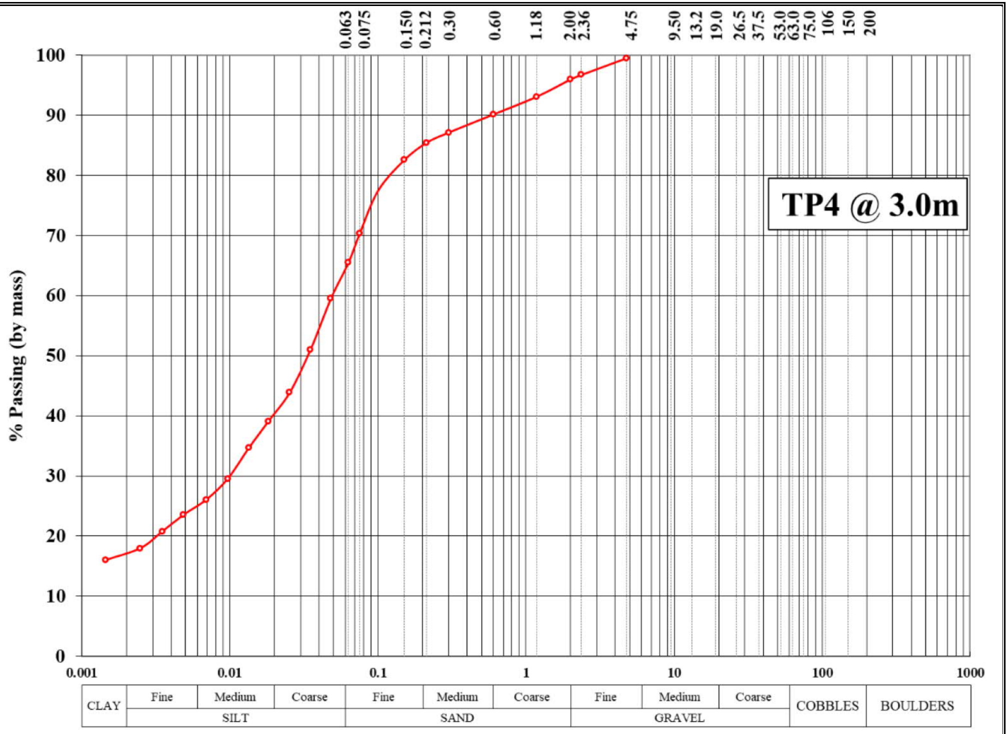
TEST REPORT – OCEANA GOLD INVESTIGATIONS

Client Details:	**Oceana Gold, Golden Point Road, RD3 Macraes Flat, East Otago**	**Attention:**	**M. Hughes**
Job Description:	**Oceana Gold – DDN3; Deep Dell WRS Samples**		
Sample Description:	**Sandy SILT with some clay and trace of gravel**	**Client Reference No:**	**8528**
Sample Source:	**Test Pit 4, Sample 4 @ 3.0m**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**27-Jun-19**	**Sampled By:**	**Oceana Gold**
Sample Method:	**Test Pit ***	**Date Received:**	**8-Jul-19**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	
4.75	100
2.36	97
2.00	96
1.18	93
0.60	90
0.30	87
0.212	85
0.150	83
0.075	70
0.063	65

Fraction Size	Interpolated % Passing
60 µm	64
20 µm	40
6 µm	25
2 µm	17



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 9.0. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	60.0mm to 20.0mm	-	Fine Sand	200 µm to 60 µm	21
Medium Gravel	20.0mm to 6.0mm	-	Coarse Silt	60 µm to 20 µm	24
Fine Gravel	6.0mm to 2.00 mm	4	Medium Silt	20 µm to 6 µm	15
Coarse Sand	2.00mm to 600 µm	6	Fine Silt	6 µm to 2 µm	8
Medium Sand	600 µm to 200 µm	5	Clay	< 2 µm	17

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4

Water Content: ("All In" As Received)	16.6 %
Liquid Limit: (LL)	24
Plastic Limit: (PL)	20
Plasticity Index: (PI)	4

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Note:

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- ***This report may not be reproduced except in full.***

Tested By: **L.T. Smith** **Date:** **10 to 12-Jul-19**

Checked By: [signature]

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Reference No: 19/2051

Date: 15 July 2019

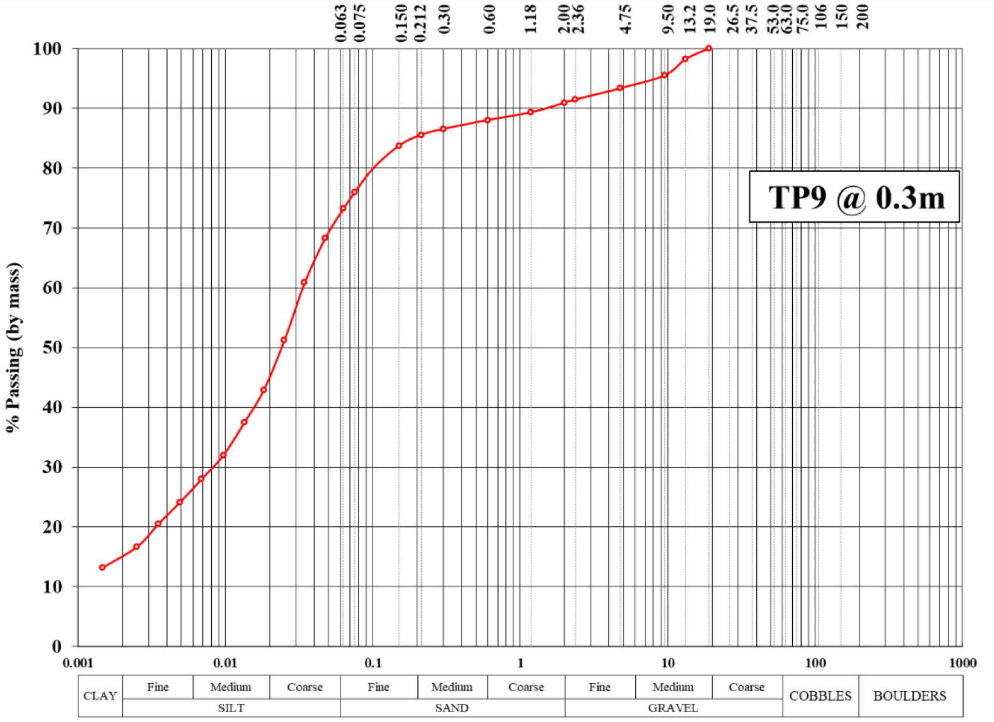
TEST REPORT –OCEANA GOLD INVESTIGATIONS

Client Details:	**Oceana Gold, Golden Point Road, RD3 Macraes Flat, East Otago**	**Attention:**	**M. Hughes**
Job Description:	**Oceana Gold – DDN3; Deep Dell WRS Samples**		
Sample Description:	**SILT with some sand, some clay and minor gravel**	**Client Reference No:**	**8528**
Sample Source:	**Test Pit 9, Sample 1 @ 0.3m**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**27-Jun-19**	**Sampled By:**	**Oceana Gold**
Sample Method:	**Test Pi ***	**Date Received:**	**8-Jul-19**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	100
13.2	98
9.50	96
4.75	93
2.36	91
2.00	91
1.18	89
0.60	88
0.30	87
0.212	86
0.150	84
0.075	76
0.063	73

Fraction Size	Interpolated % Passing
60 µm	72
20 µm	45
6 µm	26
2 µm	15



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.5. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	60.0mm to 20.0mm	-	Fine Sand	200 µm to 60 µm	13
Medium Gravel	20.0mm to 6.0mm	6	Coarse Silt	60 µm to 20 µm	27
Fine Gravel	6.0mm to 2.00 mm	3	Medium Silt	20 µm to 6 µm	19
Coarse Sand	2.00mm to 600 µm	3	Fine Silt	6 µm to 2 µm	11
Medium Sand	600 µm to 200 µm	3	Clay	< 2 µm	15

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4

Water Content: ("All In" As Received)	20.1 %
Liquid Limit: (LL)	45
Plastic Limit: (PL)	33
Plasticity Index: (PI)	12

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Note:

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- *This report may not be reproduced except in full.*

Tested By: L.T. Smith **Date:** 10 to 12-Jul-19

Checked By: [signature]

Approved Signatory

[signature]

A.P. Julius
Laboratory Manager

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APPENDIX C

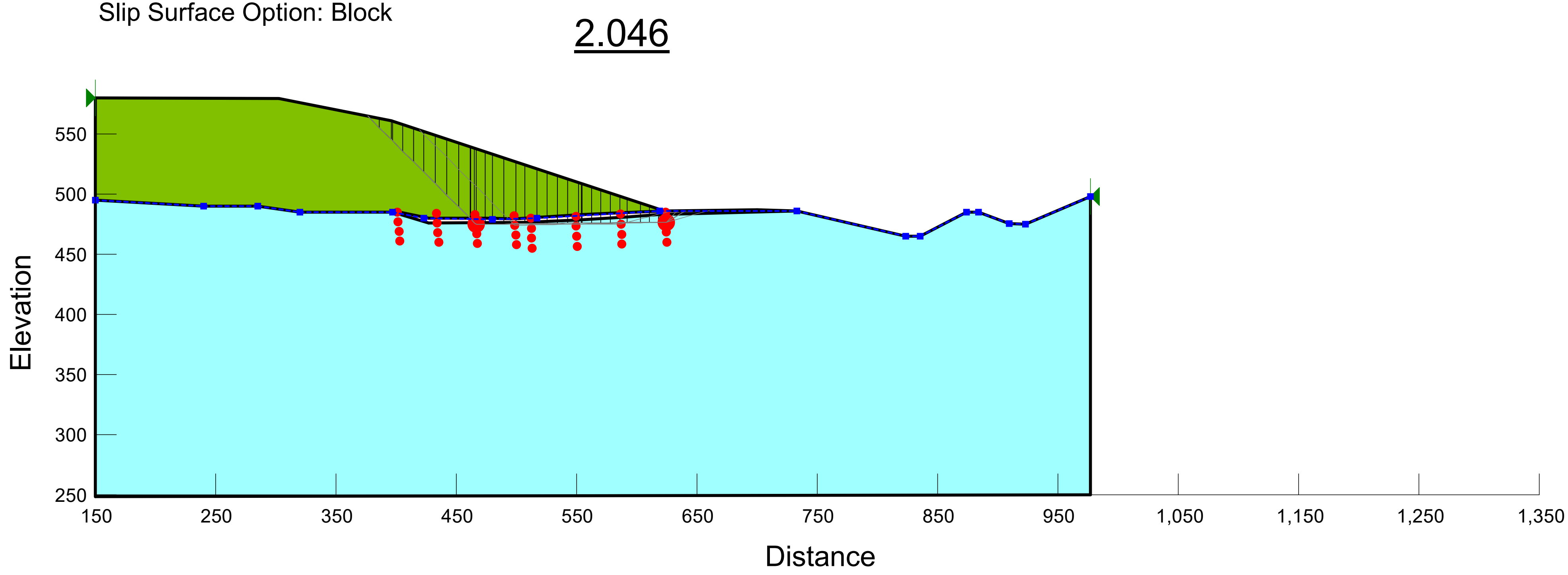
STABILITY ANALYSES

Static Stability Analyses

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Piezometric Line: 1

Name: Loess
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion': 0 kPa
Phi': 30 °
Phi-B: 0 °
Piezometric Line: 1

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS
Section A-A'
Name: Figure A01a SLOPE/W Analysis - Static Block Slide

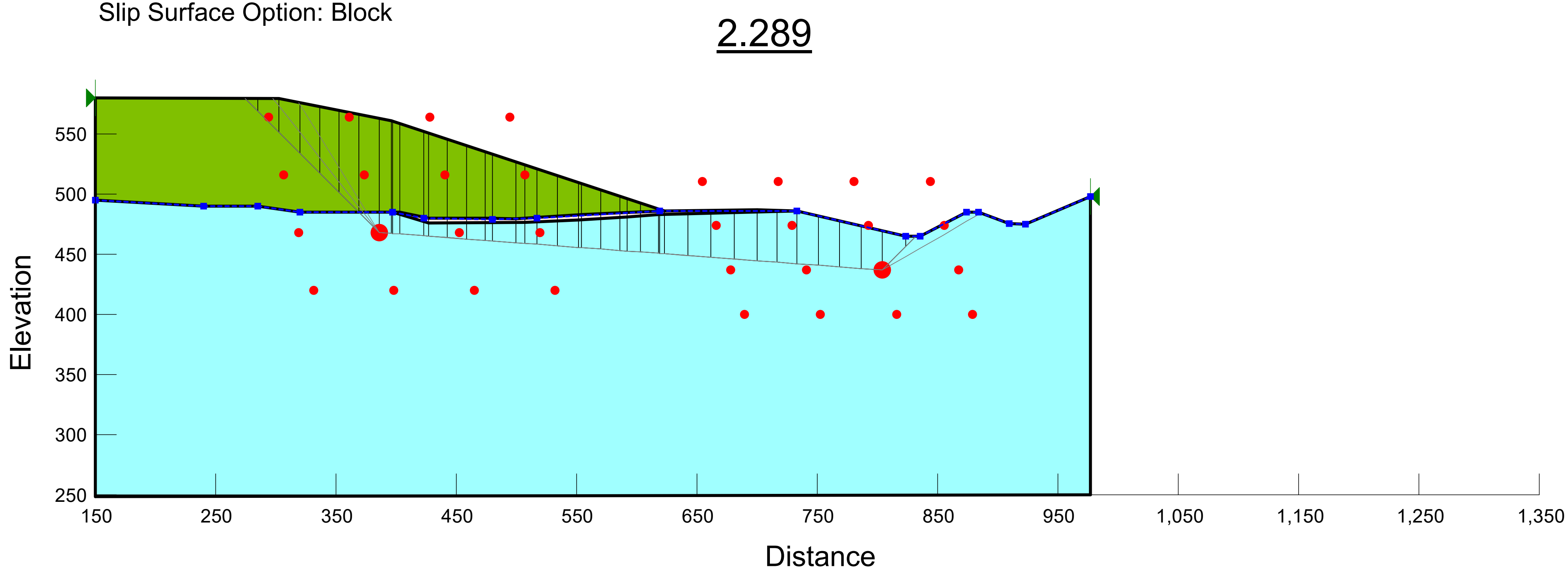
Engineering Geology Limited

Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Piezometric Line: 1

Name: Loess
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion': 0 kPa
Phi': 30 °
Phi-B: 0 °
Piezometric Line: 1

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS

Section A-A'

Name: Figure A01b SLOPE/W Analysis - Static Block Slide

Engineering Geology Limited

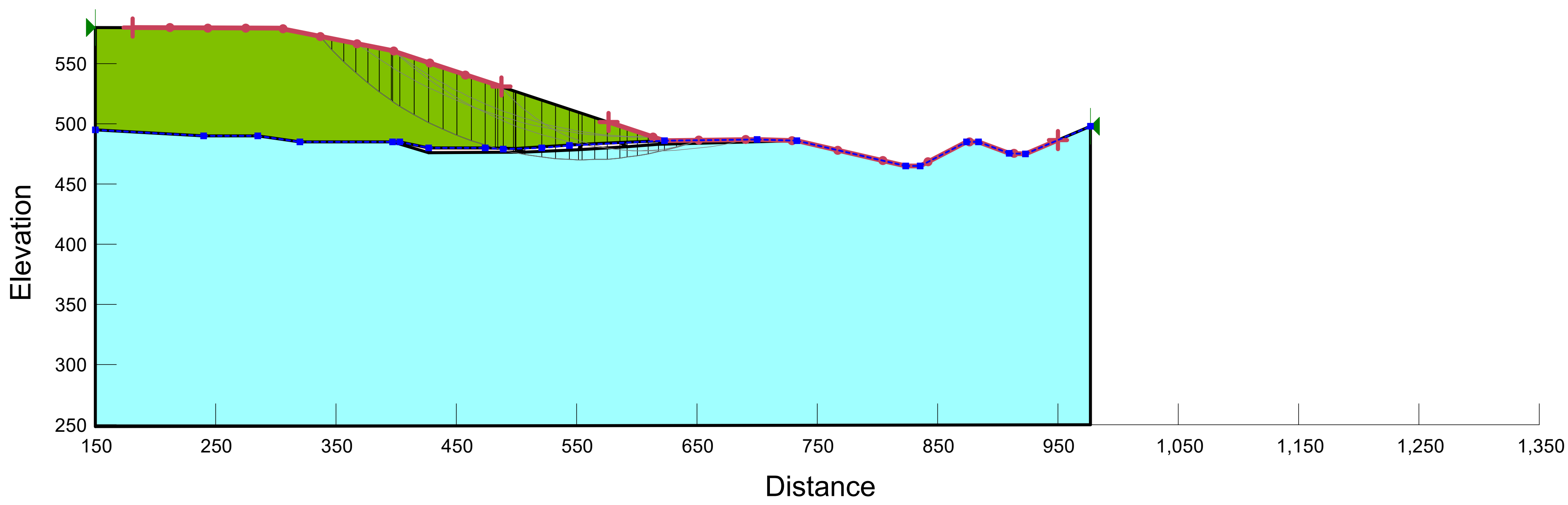
Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Piezometric Line: 1

Name: Loess
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion': 0 kPa
Phi': 30 °
Phi-B: 0 °
Piezometric Line: 1

Method: Spencer
Slip Surface Option: Entry and Exit

2.437



Deepdell East WRS
Section A-A'
Name: Figure A01c SLOPE/W Analysis - Static Circular Slide

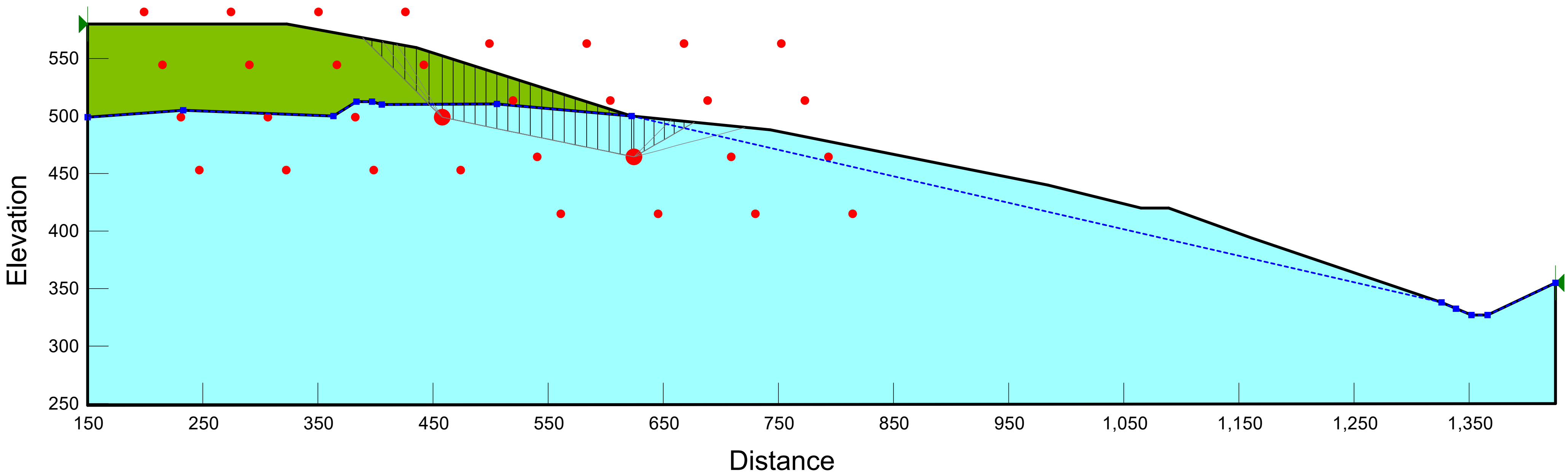
Engineering Geology Limited

Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

2.109

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS

Section B-B'

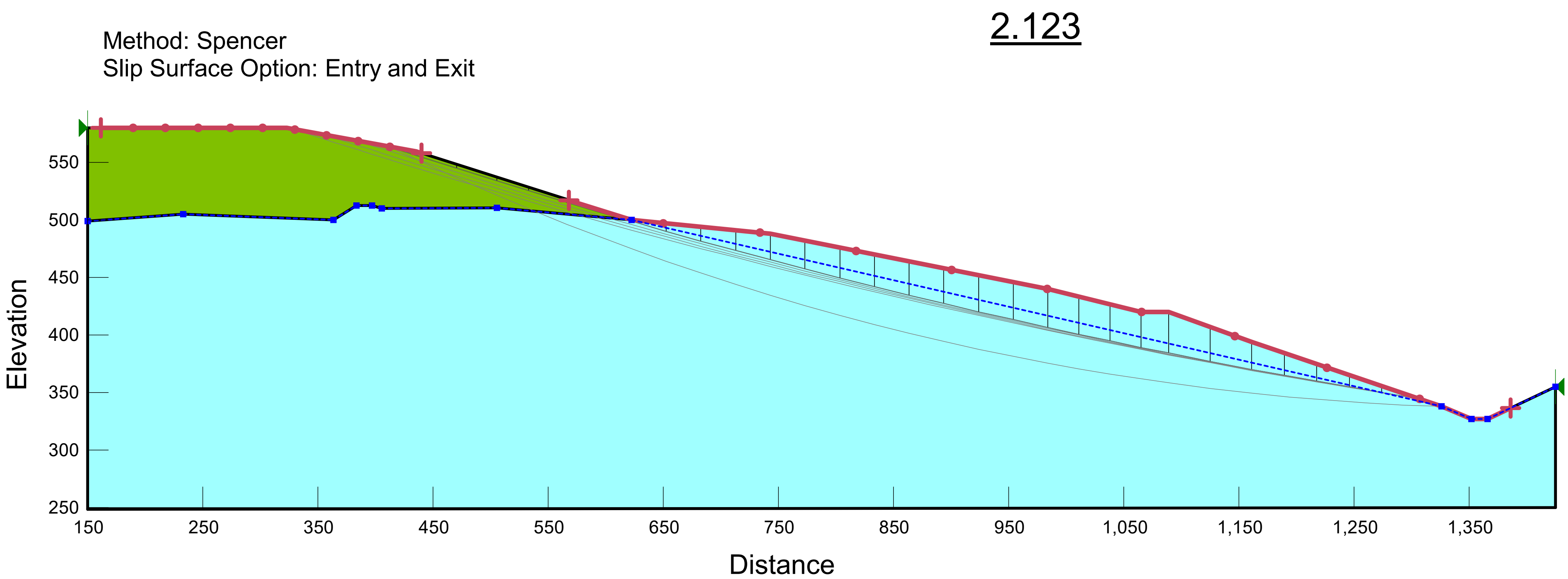
Name: Figure A02a SLOPE/W Analysis - Static Block Slide

Engineering Geology Limited

Name: Schist (Foliation 15 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Method: Spencer
Slip Surface Option: Entry and Exit



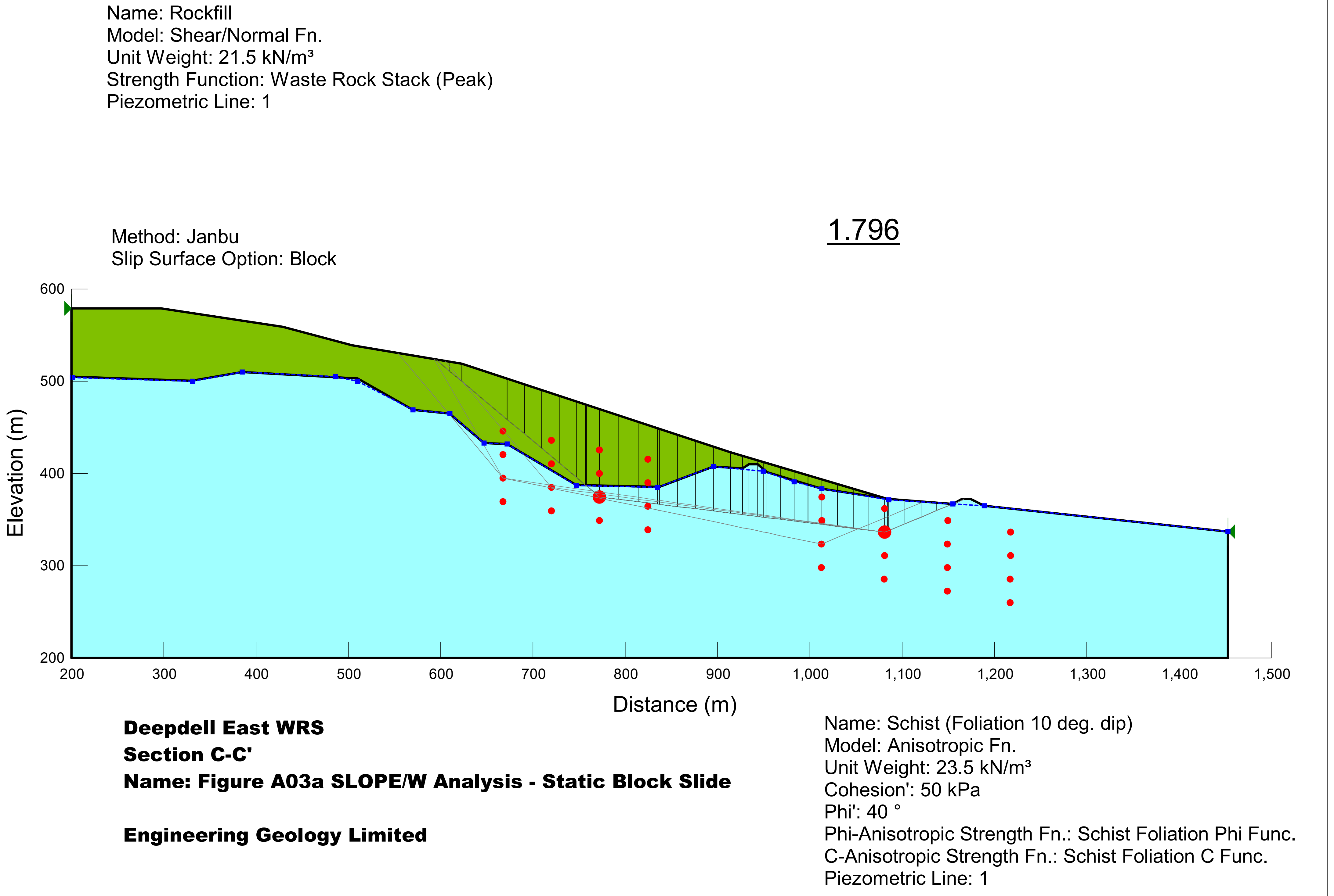
Deepdell East WRS

Section B-B'

Name: Figure A02b SLOPE/W Analysis - Static Circular Slide

Engineering Geology Limited

Name: Schist (Foliation 15 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1



Deepdell East WRS

Section C-C'

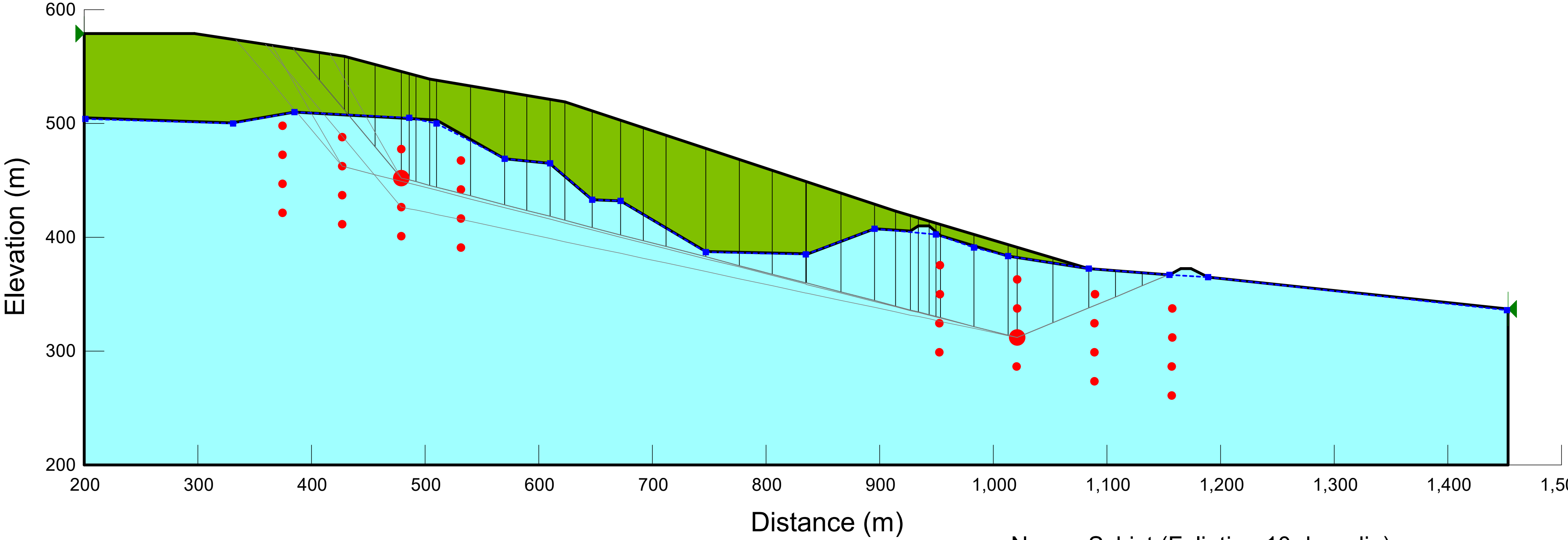
Name: Figure A03a SLOPE/W Analysis - Static Block Slide

Engineering Geology Limited

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste Rock Stack (Peak)
Piezometric Line: 1

Method: Janbu
Slip Surface Option: Block

1.696



Deepdell East WRS

Section C-C'

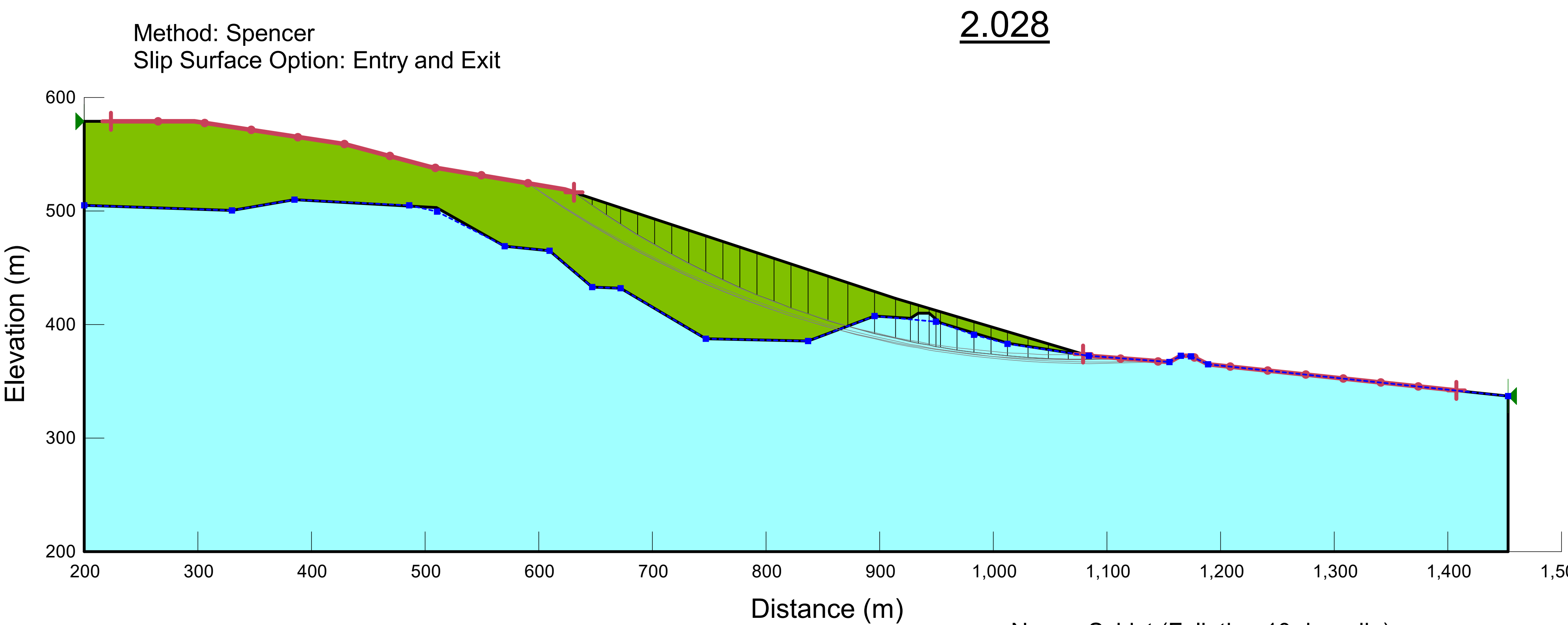
Name: Figure A03b SLOPE/W Analysis - Static Block Slide

Engineering Geology Limited

Name: Schist (Foliation 10 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste Rock Stack (Peak)
Piezometric Line: 1

Method: Spencer
Slip Surface Option: Entry and Exit



Deepdell East WRS

Section C-C'

Name: Figure A03c SLOPE/W Analysis - Static Circular Slide

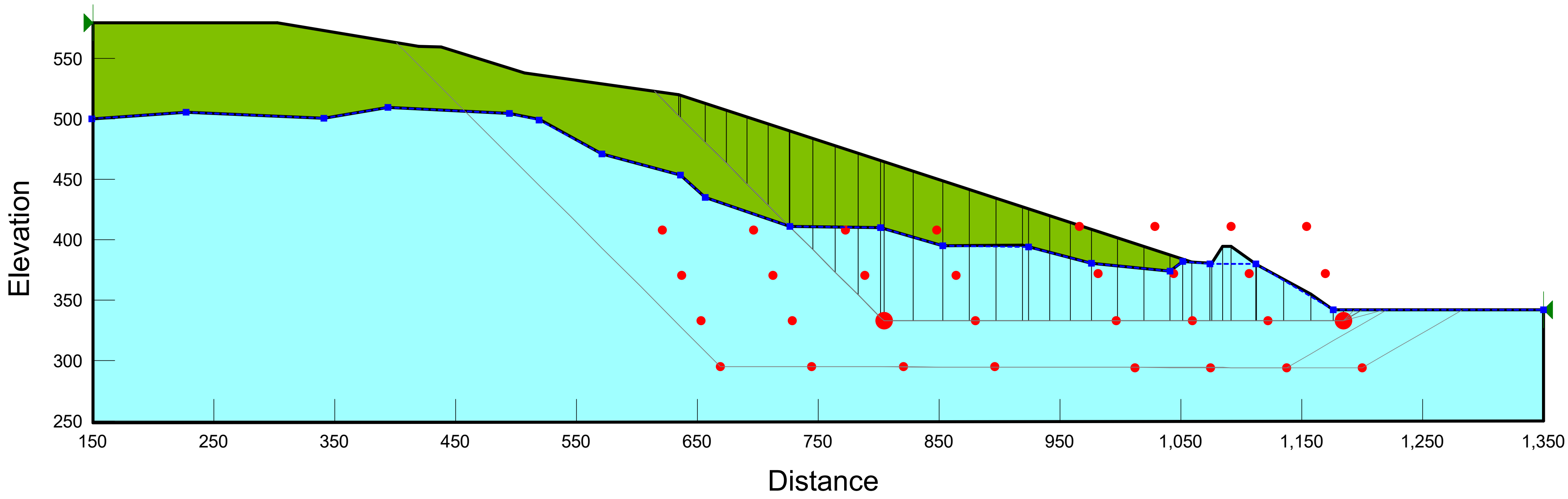
Engineering Geology Limited

Name: Schist (Foliation 10 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Method: Janbu
Slip Surface Option: Block

1.752



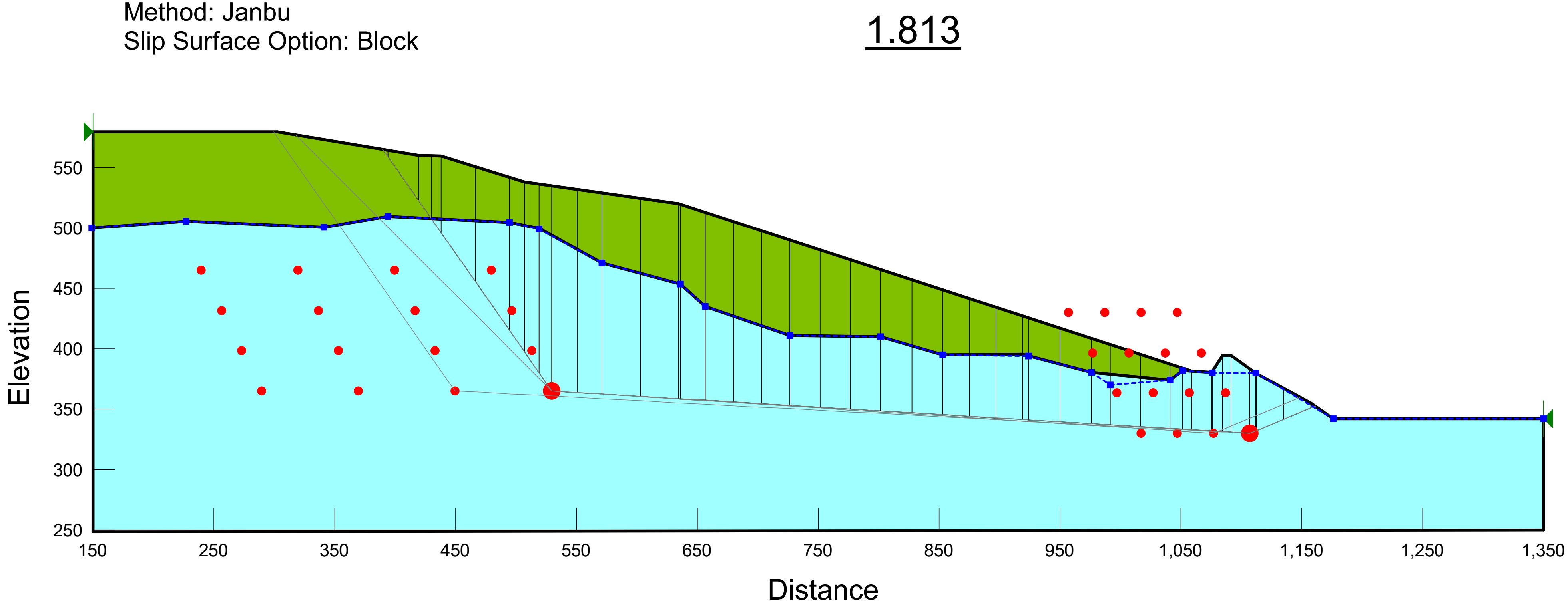
Deepdell East WRS
Section D-D'
Name: Figure A04a SLOPE/W Analysis - Static Block Slide

Engineering Geology Limited

Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS

Section D-D'

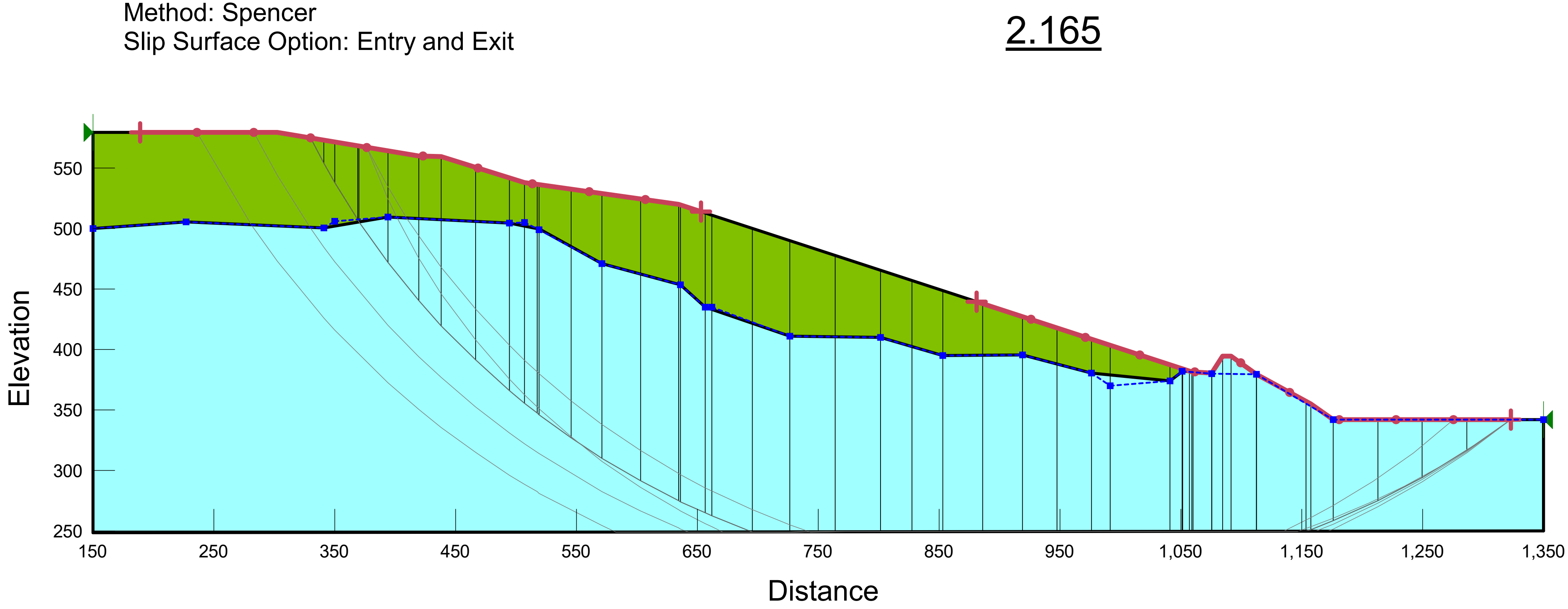
Name: Figure A04b SLOPE/W Analysis - Static Block Slide

Engineering Geology Limited

Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Method: Spencer
Slip Surface Option: Entry and Exit



Deepdell East WRS

Section D-D'

Name: Figure A04c SLOPE/W Analysis - Static Circular Slide

Engineering Geology Limited

Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

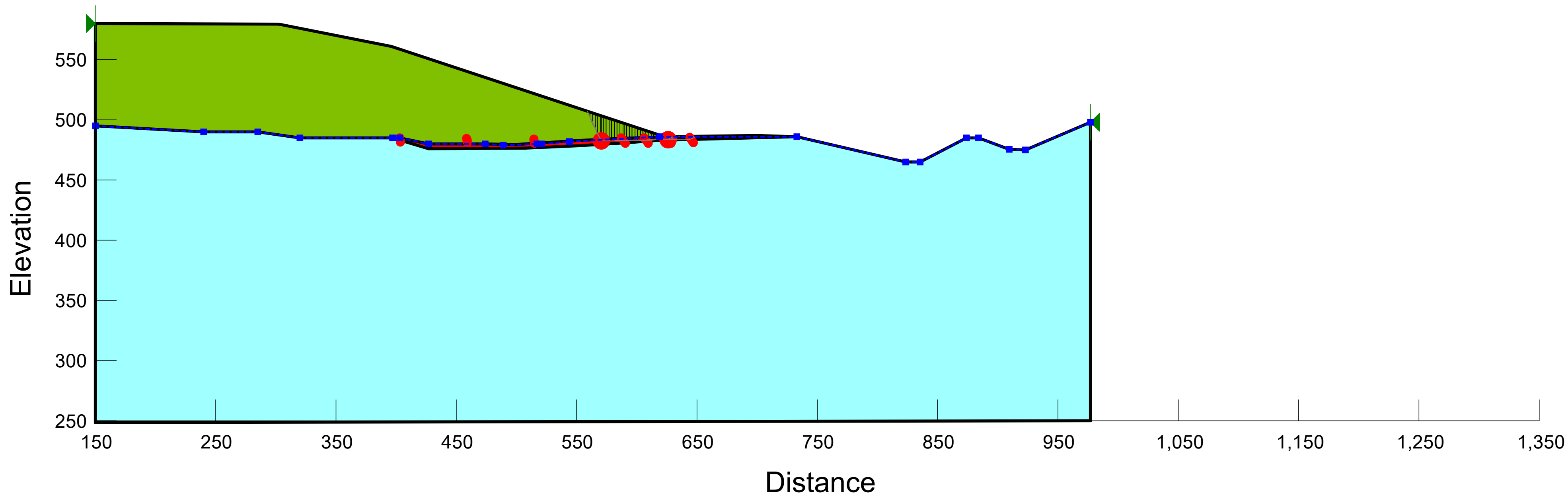
Seismic Stability Analyses

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Piezometric Line: 1

Name: Loess Liquefied
Model: S=f(overburden)
Unit Weight: 18 kN/m³
Tau/Sigma Ratio: 0.06
Minimum Strength: 0
Piezometric Line: 1

Method: Janbu
Slip Surface Option: Block

0.850



Deepdell East WRS

Section A-A'

Name: Figure A05 SLOPE/W Analysis - Seismic Post EQ Liq B. Slide

Engineering Geology Limited

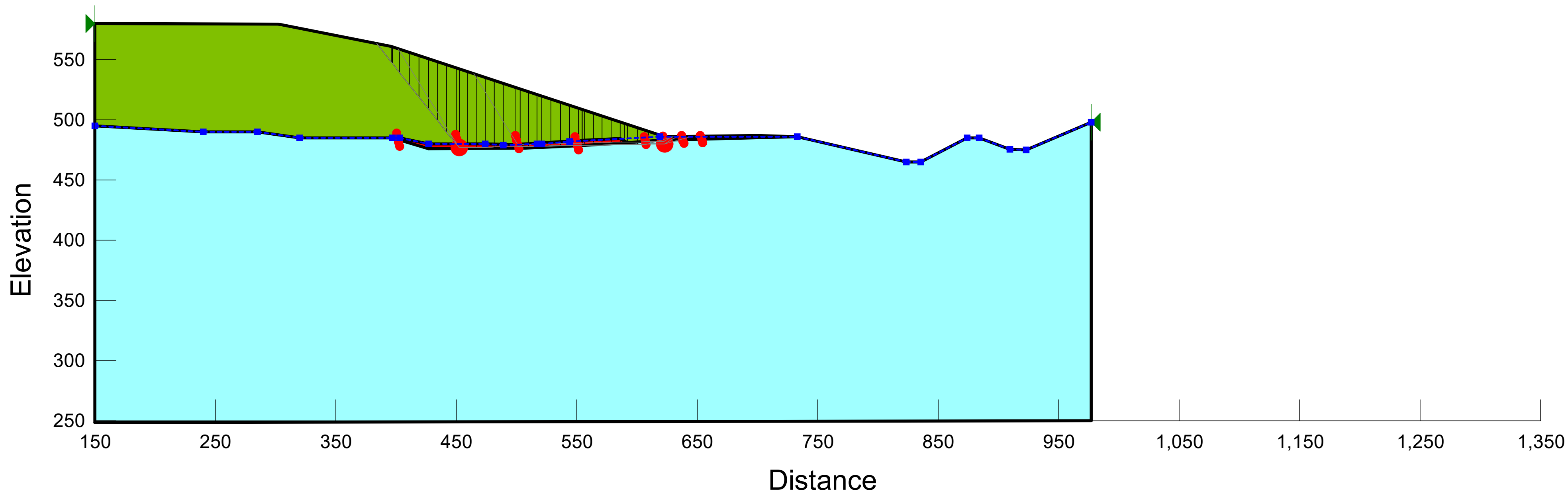
Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Piezometric Line: 1

Name: Loess Liquefied
Model: S=f(overburden)
Unit Weight: 18 kN/m³
Tau/Sigma Ratio: 0.06
Minimum Strength: 0
Piezometric Line: 1

Method: Janbu
Slip Surface Option: Block

1.161



Deepdell East WRS
Section A-A'
Name: Figure A06 SLOPE/W Analysis - Seismic Post EQ Liq Shear Key B. Slide

Engineering Geology Limited

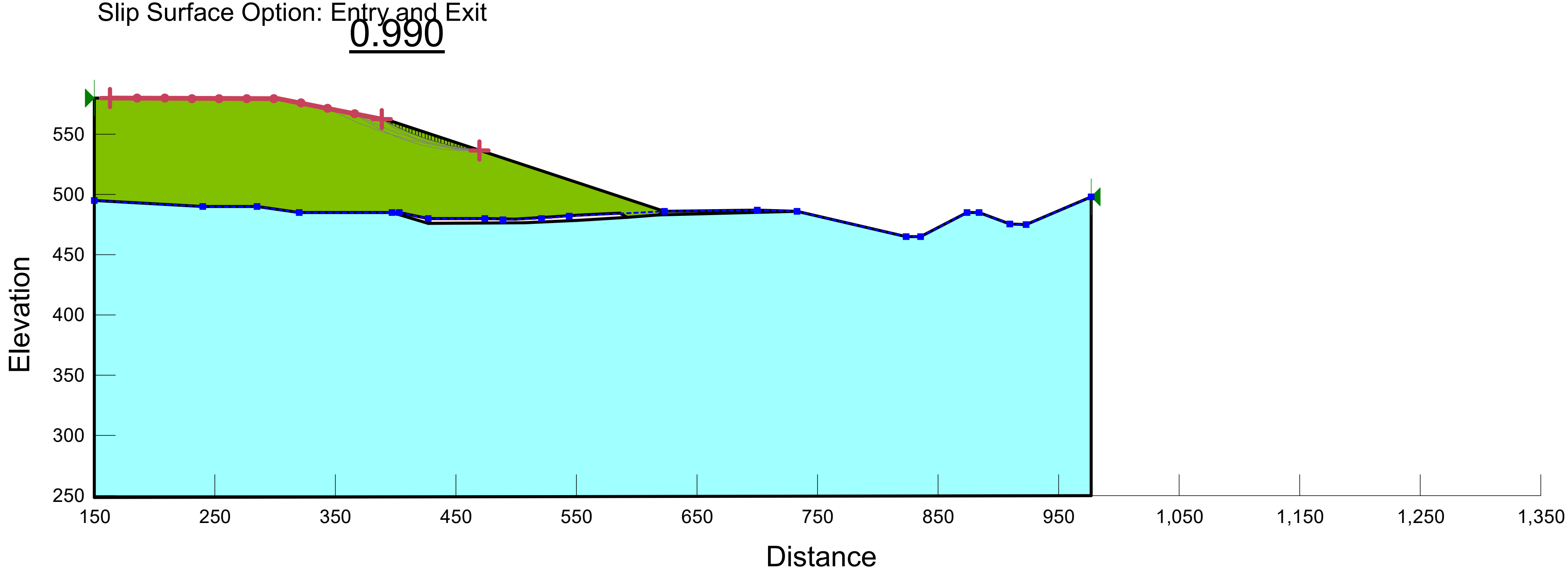
Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Piezometric Line: 1

Name: Loess
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion': 0 kPa
Phi': 30 °
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.46
Ignore seismic load in strength: No

Method: Spencer
Slip Surface Option: Entry and Exit



Deepdell East WRS
Section A-A'
Name: Figure A07 SLOPE/W Analysis - OBE 1/3H Circular Slide

Engineering Geology Limited

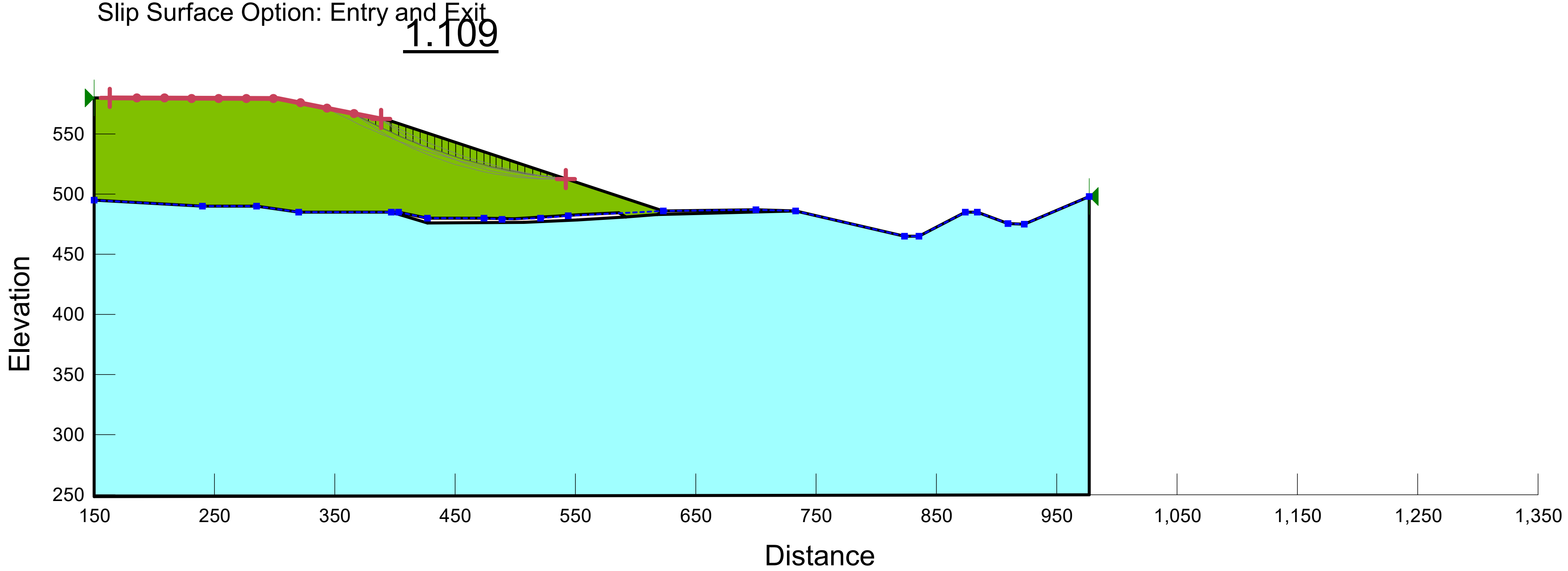
Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Piezometric Line: 1

Name: Loess
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion': 0 kPa
Phi': 30 °
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.355
Ignore seismic load in strength: No

Method: Spencer
Slip Surface Option: Entry and Exit



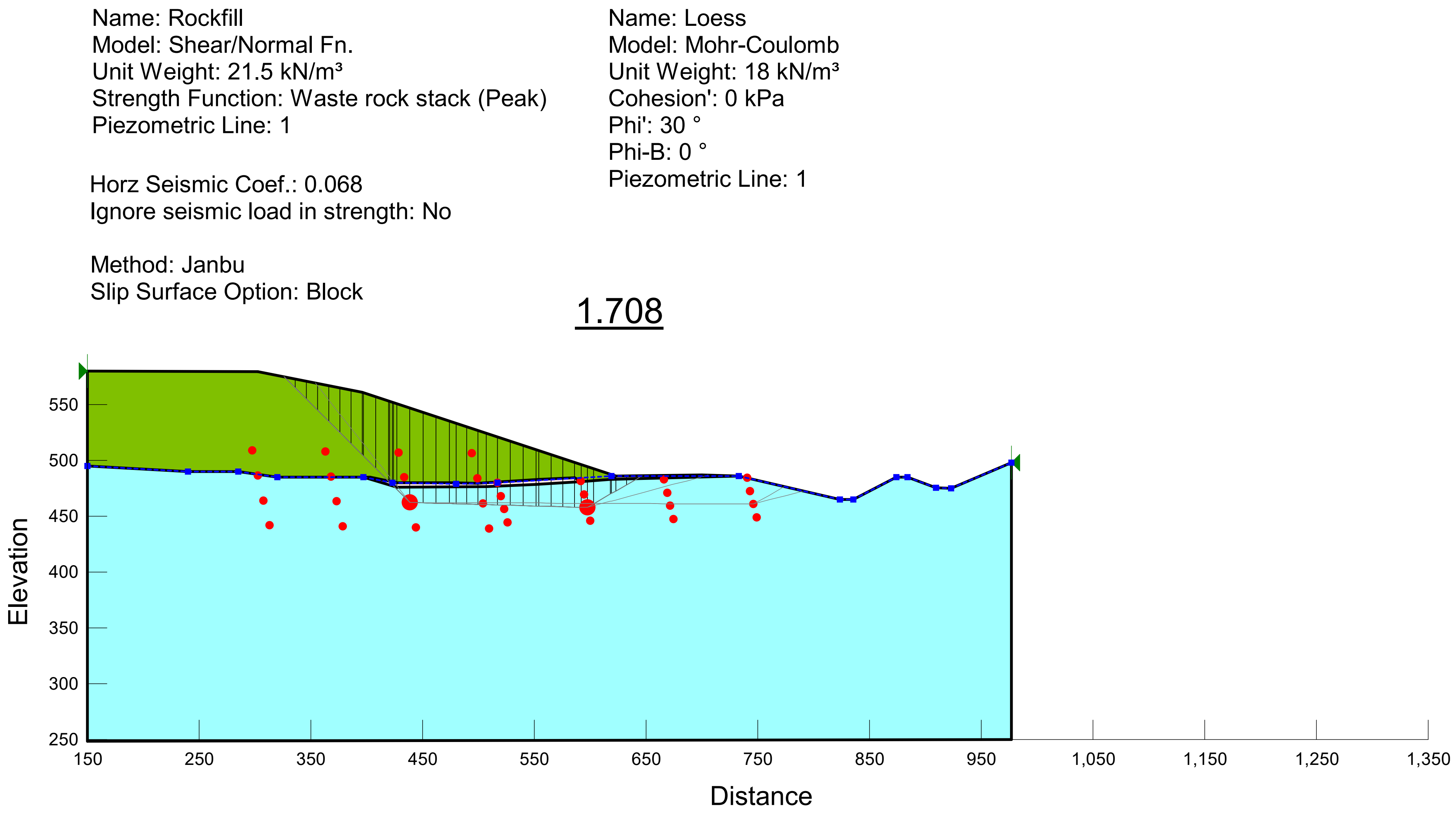
Deepdell East WRS

Section A-A'

Name: Figure A08 SLOPE/W Analysis - OBE 2/3H Circular Slide

Engineering Geology Limited

Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1



Deepdell East WRS

Section A-A'

Name: Figure A09 SLOPE/W Analysis - OBE 1H Block Slide

Engineering Geology Limited

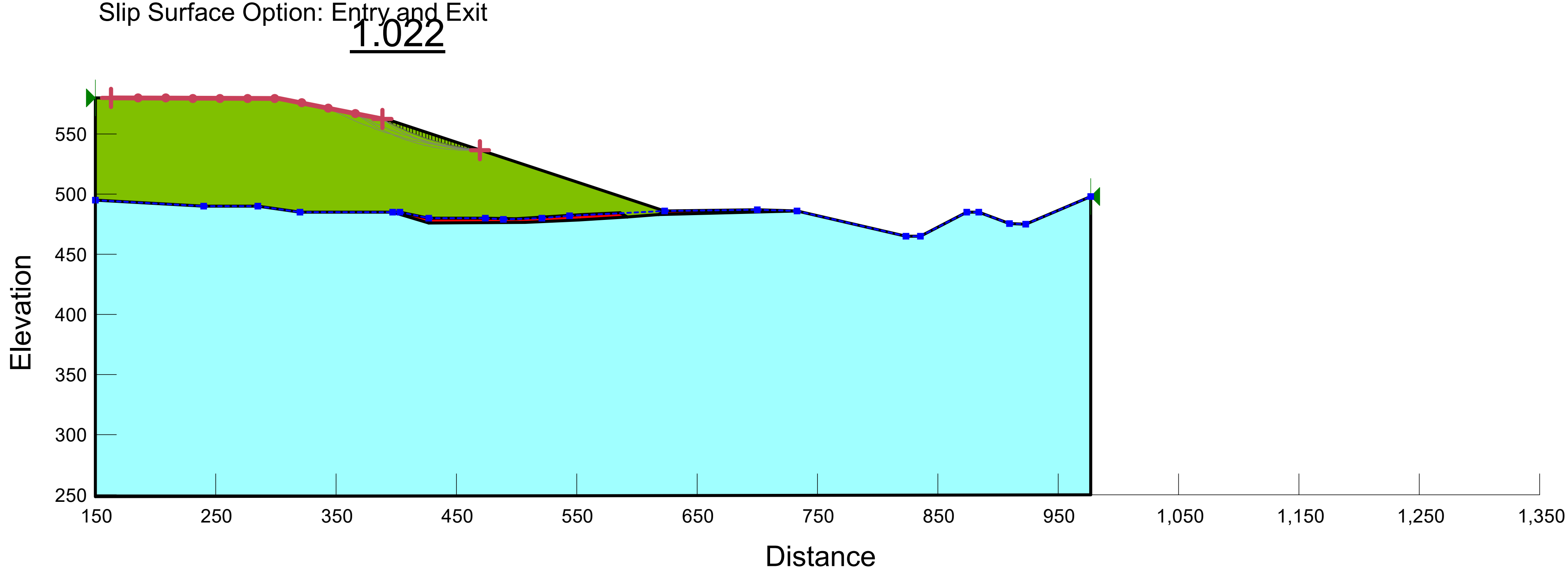
Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Piezometric Line: 1

Name: Loess Liquefied
Model: S=f(overburden)
Unit Weight: 18 kN/m³
Tau/Sigma Ratio: 0.06
Minimum Strength: 0
Piezometric Line: 1

Horz Seismic Coef.: 0.44
Ignore seismic load in strength: No

Method: Spencer
Slip Surface Option: Entry and Exit



Deepdell East WRS

Section A-A'

Name: Figure A10 SLOPE/W Analysis - SEE 1/3H Circular Slide

Engineering Geology Limited

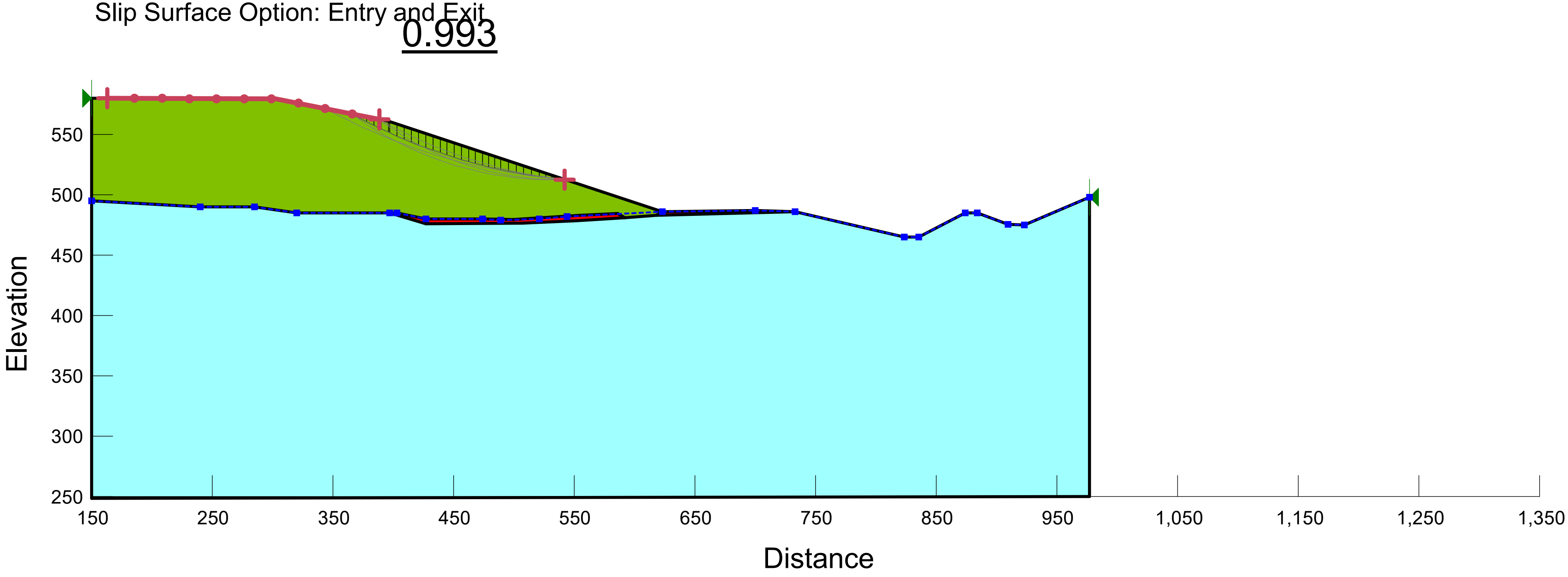
Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Piezometric Line: 1

Horz Seismic Coef.: 0.42
Ignore seismic load in strength: No

Method: Spencer
Slip Surface Option: Entry and Exit

Name: Loess Liquefied
Model: S=f(overburden)
Unit Weight: 18 kN/m³
Tau/Sigma Ratio: 0.06
Minimum Strength: 0
Piezometric Line: 1



Deepdell East WRS

Section A-A'

Name: Figure A11 SLOPE/W Analysis - SEE 2/3H Circular Slide

Engineering Geology Limited

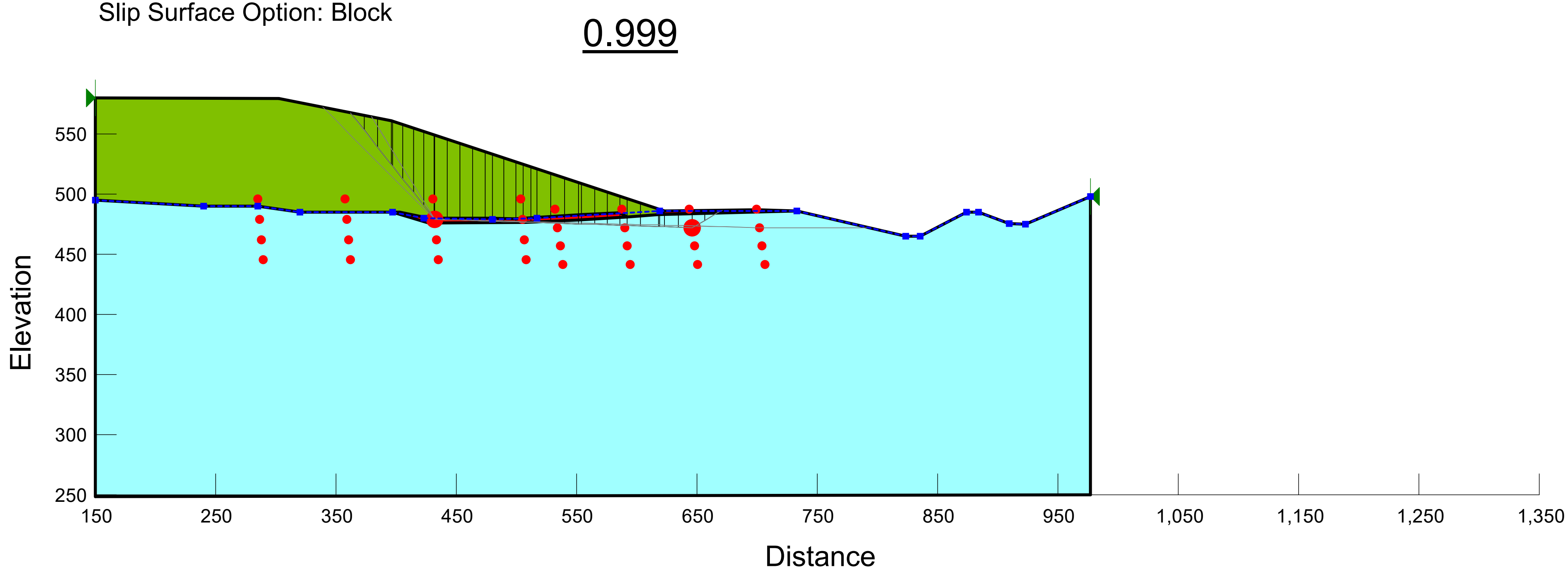
Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Piezometric Line: 1

Name: Loess Liquefied
Model: S=f(overburden)
Unit Weight: 18 kN/m³
Tau/Sigma Ratio: 0.06
Minimum Strength: 0
Piezometric Line: 1

Horz Seismic Coef.: 0.12
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS

Section A-A'

Name: Figure A12 SLOPE/W Analysis - SEE 1H Block Slide

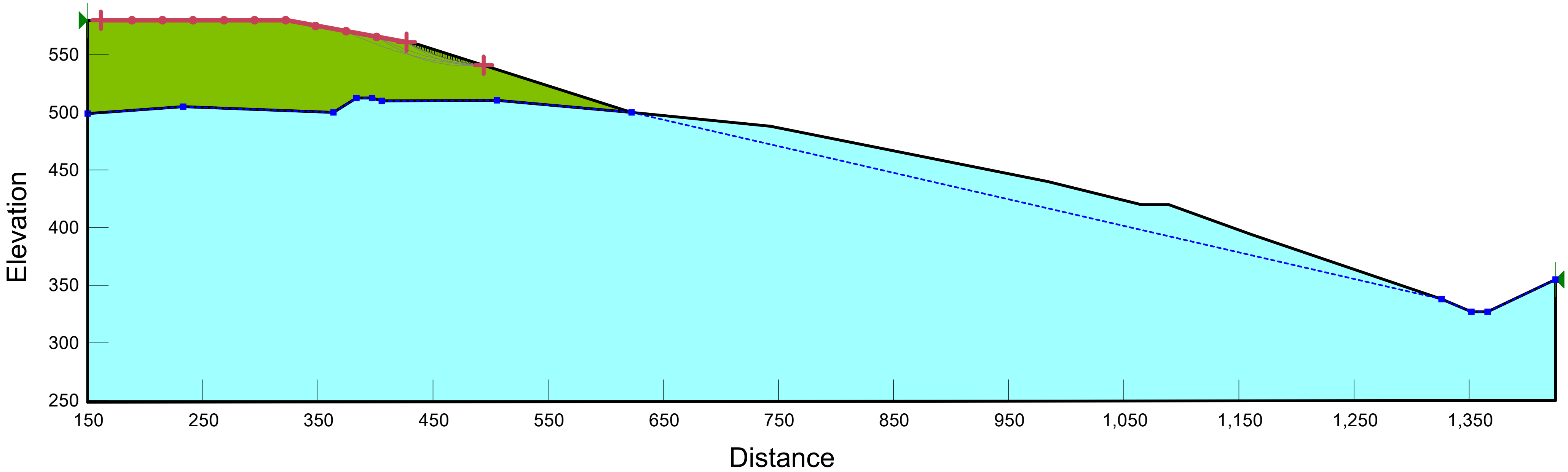
Engineering Geology Limited

Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.48
Ignore seismic load in strength: No

Method: Spencer 0.999
Slip Surface Option: Entry and Exit



Deepdell East WRS

Section B-B'

Name: Figure A13 SLOPE/W Analysis - OBE 1/3H Circular Slide

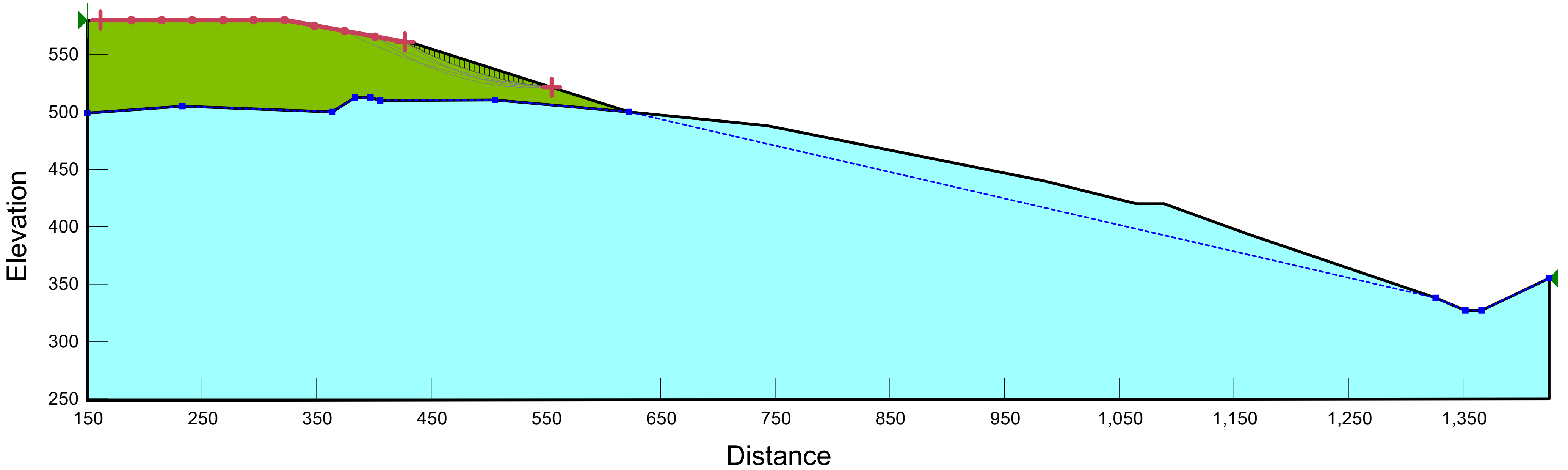
Engineering Geology Limited

Name: Schist (Foliation 15 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.44
Ignore seismic load in strength: No

Method: Spencer <u>1.000</u>
Slip Surface Option: Entry and Exit



Deepdell East WRS

Section B-B'

Name: Figure A14 SLOPE/W Analysis - OBE 2/3H Circular Slide

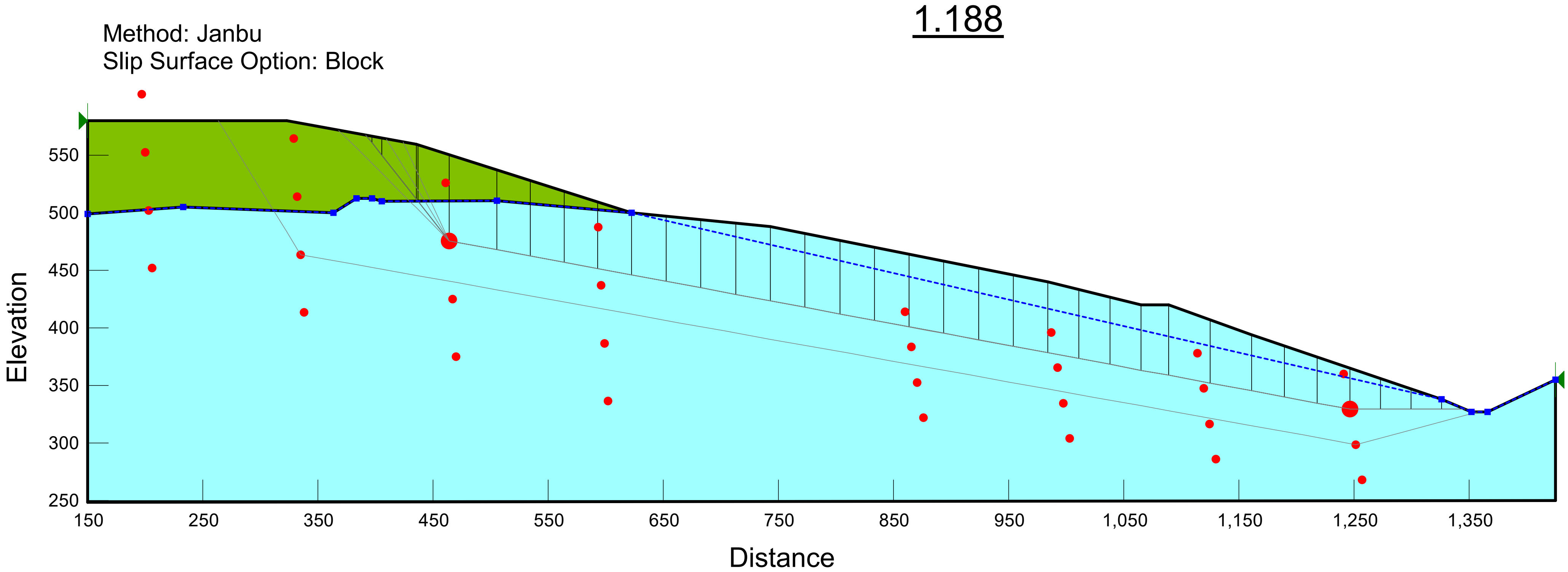
Engineering Geology Limited

Name: Schist (Foliation 15 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.08
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS

Section B-B'

Name: Figure A15 SLOPE/W Analysis - OBE 1H Block Slide

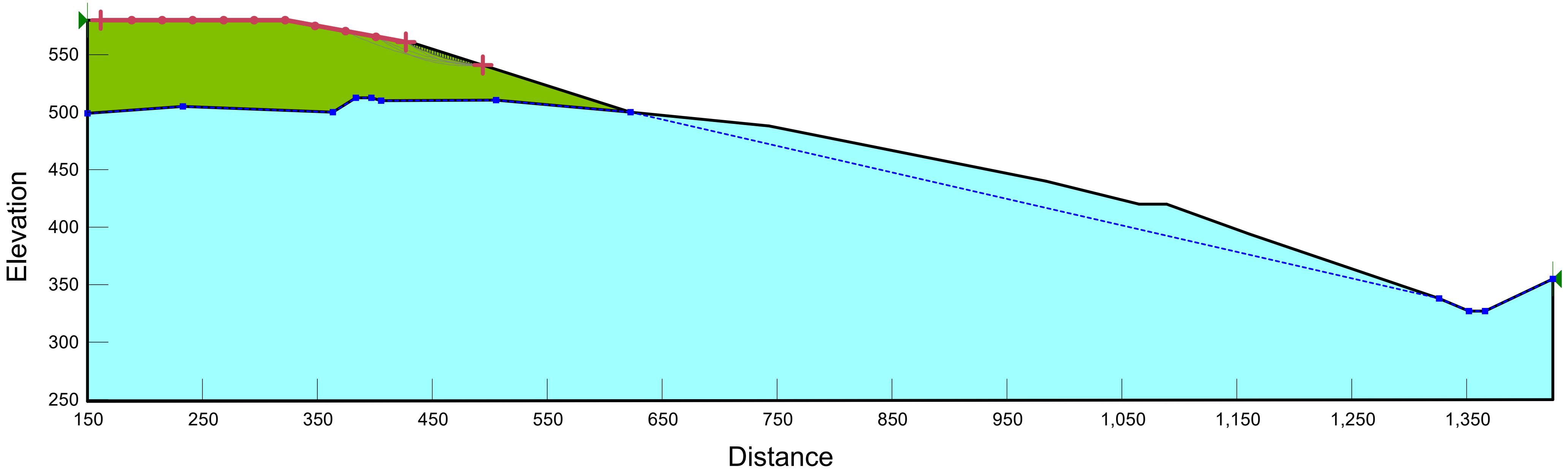
Engineering Geology Limited

Name: Schist (Foliation 15 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.48
Ignore seismic load in strength: No

Method: Spencer 0.999
Slip Surface Option: Entry and Exit



Deepdell East WRS

Section B-B'

Name: Figure A16 SLOPE/W Analysis - SEE 1/3H Circular Slide

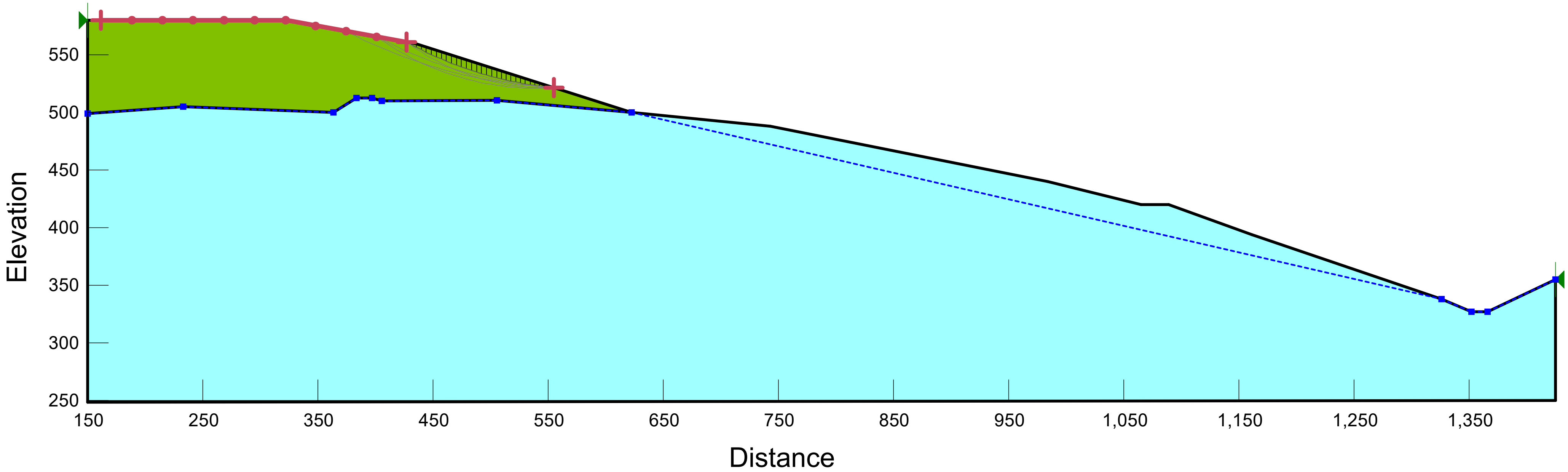
Engineering Geology Limited

Name: Schist (Foliation 15 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.44
Ignore seismic load in strength: No

Method: Spencer 1.000
Slip Surface Option: Entry and Exit



Deepdell East WRS

Section B-B'

Name: Figure A17 SLOPE/W Analysis - SEE 2/3H Circular Slide

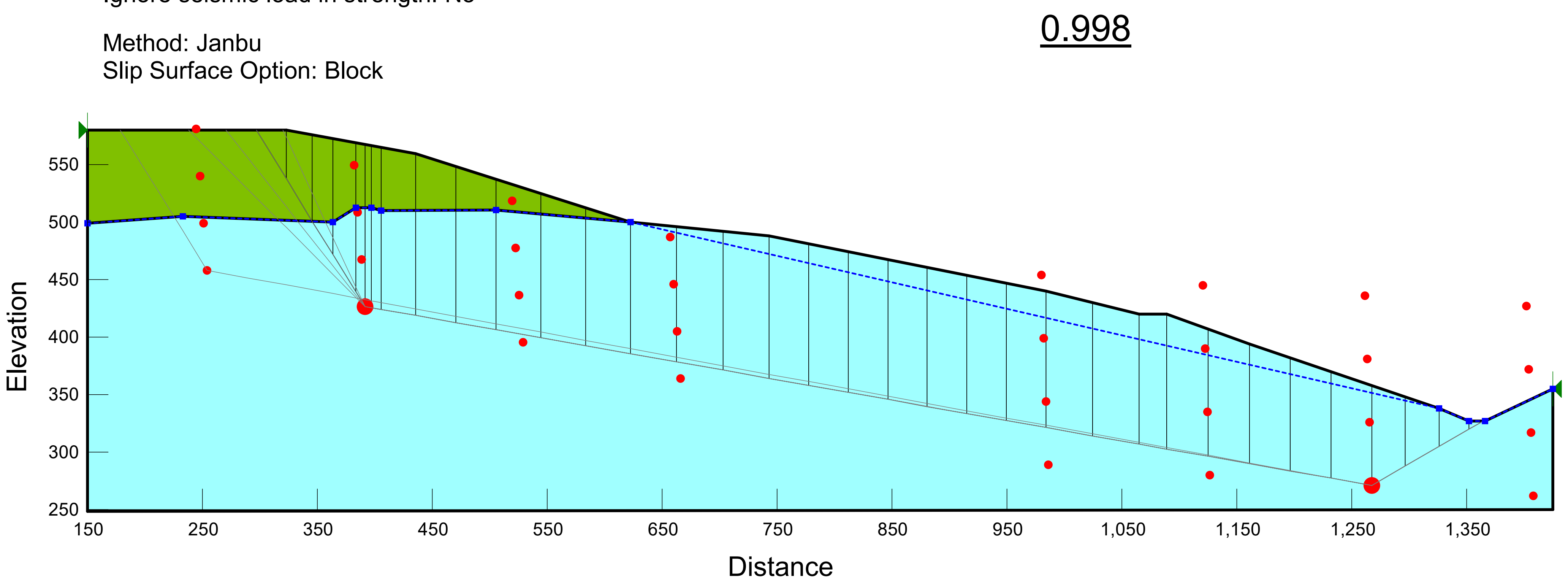
Engineering Geology Limited

Name: Schist (Foliation 15 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.14
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS

Section B-B'

Name: Figure A18 SLOPE/W Analysis - SEE 1H Block Slide

Engineering Geology Limited

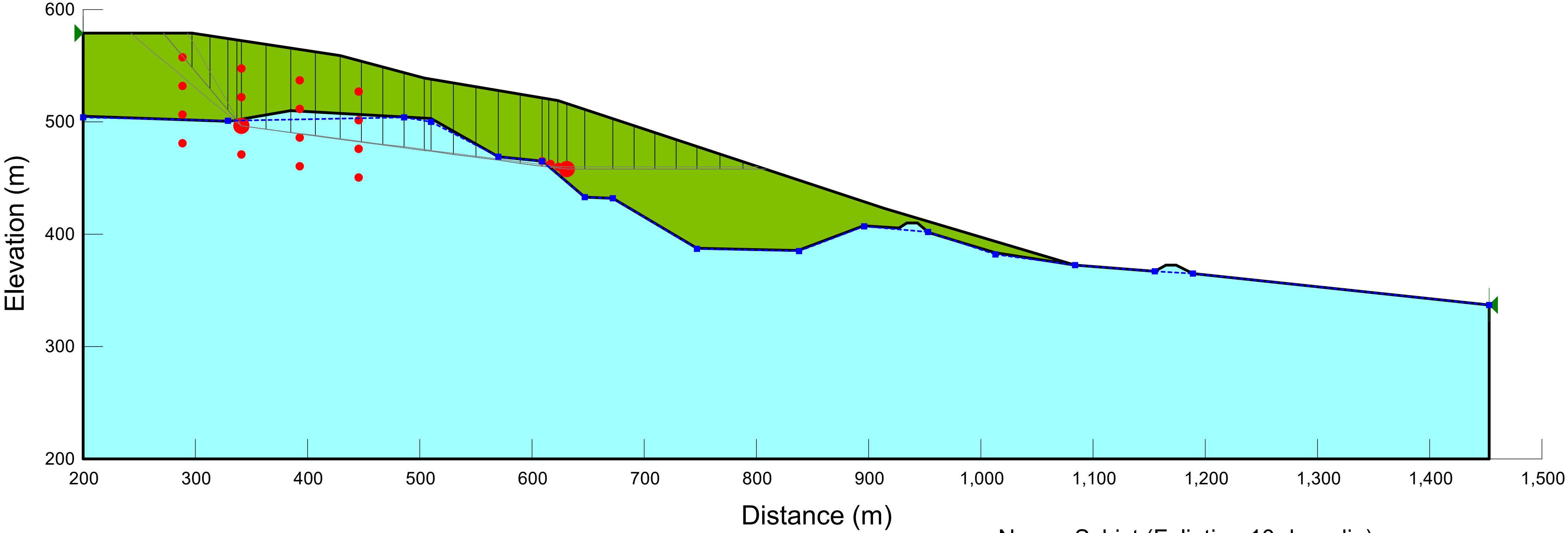
Name: Schist (Foliation 15 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste Rock Stack (Peak)
Piezometric Line: 1

Horz Seismic Coef.: 0.31
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block

0.998



Deepdell East WRS

Section C-C'

Name: Figure A19 SLOPE/W Analysis - OBE 1/3H Block Slide

Engineering Geology Limited

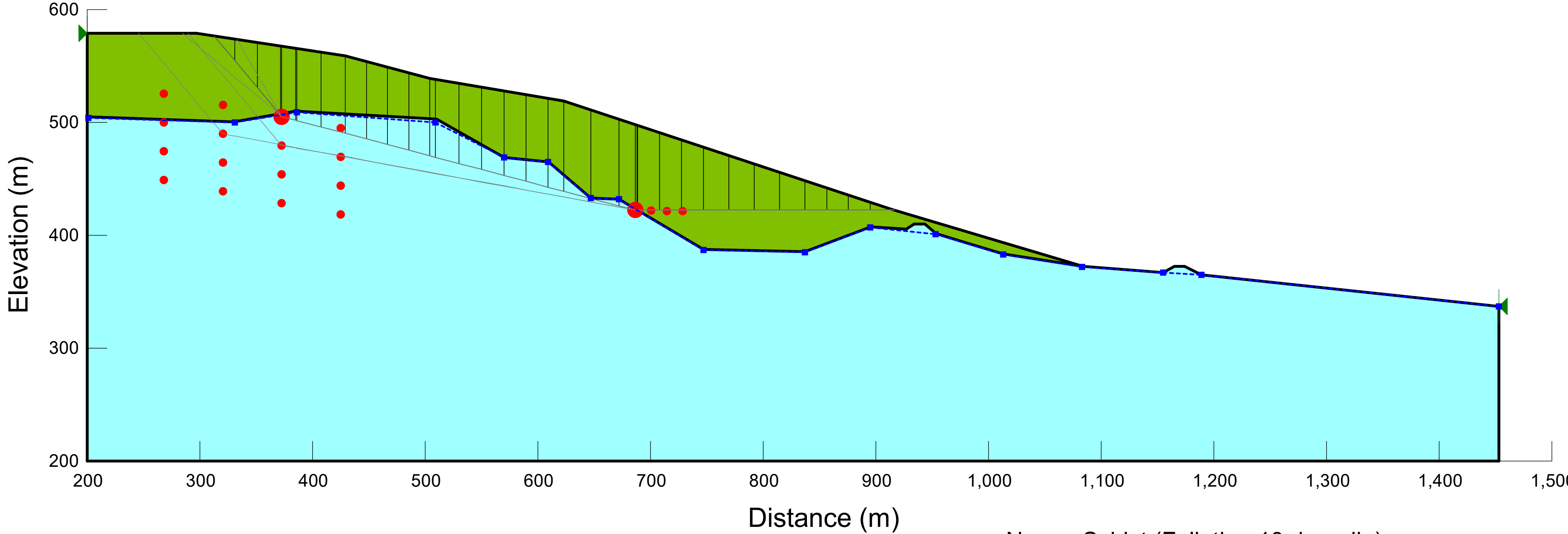
Name: Schist (Foliation 10 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste Rock Stack (Peak)
Piezometric Line: 1

Horz Seismic Coef.: 0.171
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block

1.231



Deepdell East WRS

Section C-C'

Name: Figure A20 SLOPE/W Analysis - OBE 2/3H Block Slide

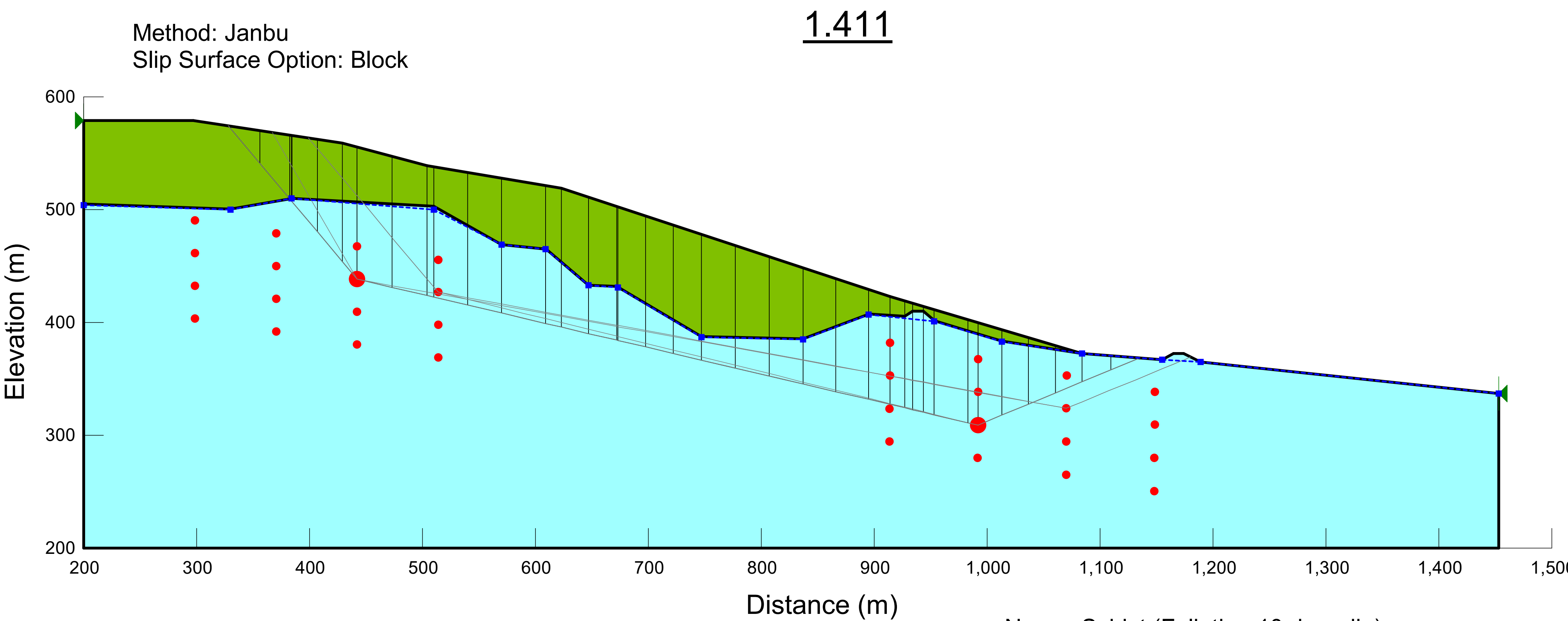
Engineering Geology Limited

Name: Schist (Foliation 10 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste Rock Stack (Peak)
Piezometric Line: 1

Horz Seismic Coef.: 0.054
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS

Section C-C'

Name: Figure A21 SLOPE/W Analysis - OBE 1H Block Slide

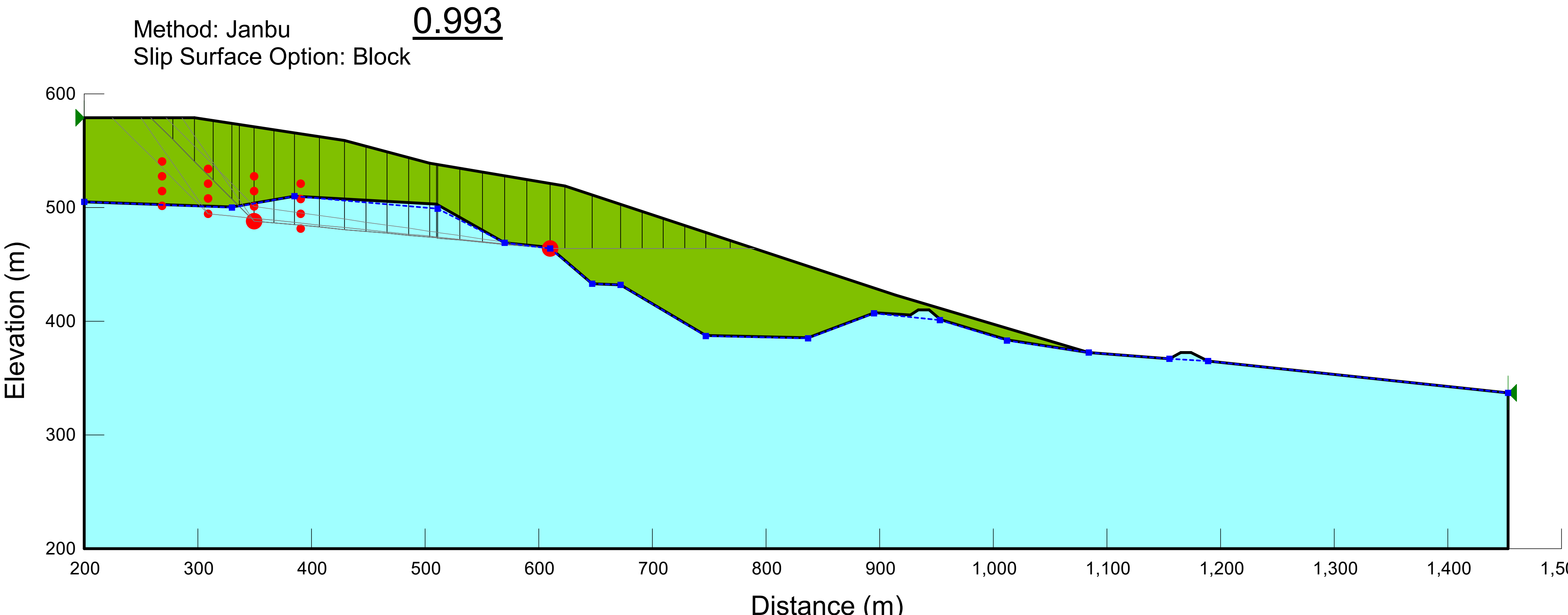
Engineering Geology Limited

Name: Schist (Foliation 10 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste Rock Stack (Peak)
Piezometric Line: 1

Horz Seismic Coef.: 0.32
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS

Section C-C'

Name: Figure A22 SLOPE/W Analysis - SEE 1/3H Block Slide

Engineering Geology Limited

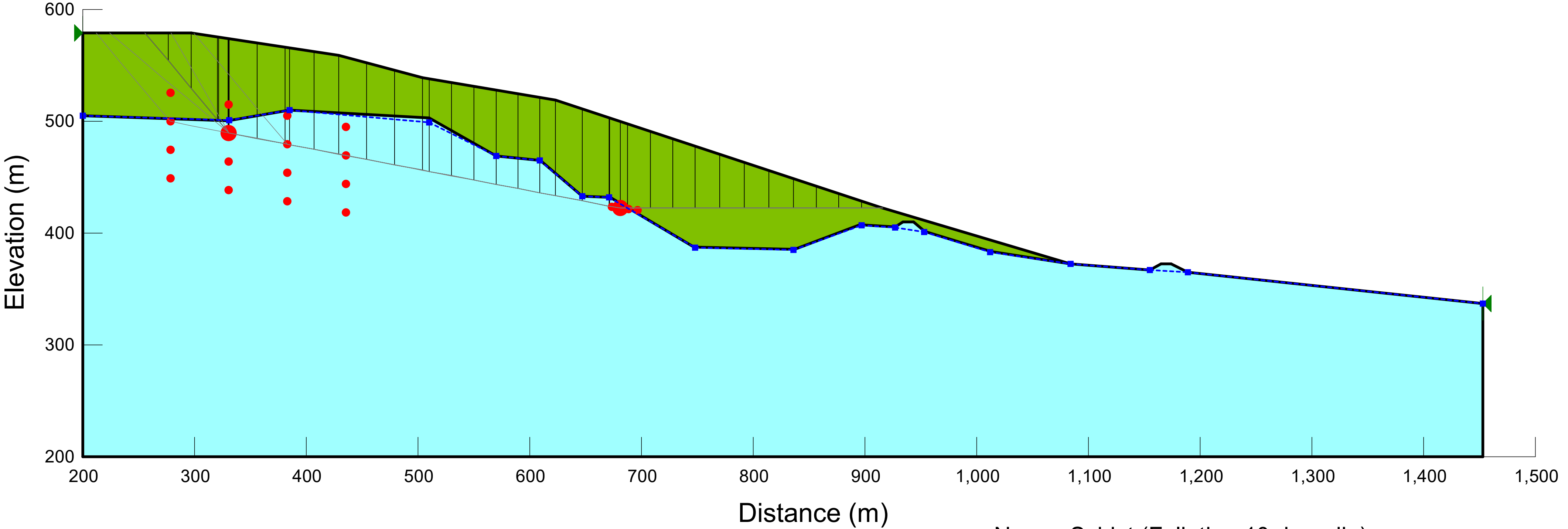
Name: Schist (Foliation 10 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste Rock Stack (Peak)
Piezometric Line: 1

Horz Seismic Coef.: 0.26
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block

1.000



Deepdell East WRS

Section C-C'

Name: Figure A23 SLOPE/W Analysis - SEE 2/3H Block Slide

Engineering Geology Limited

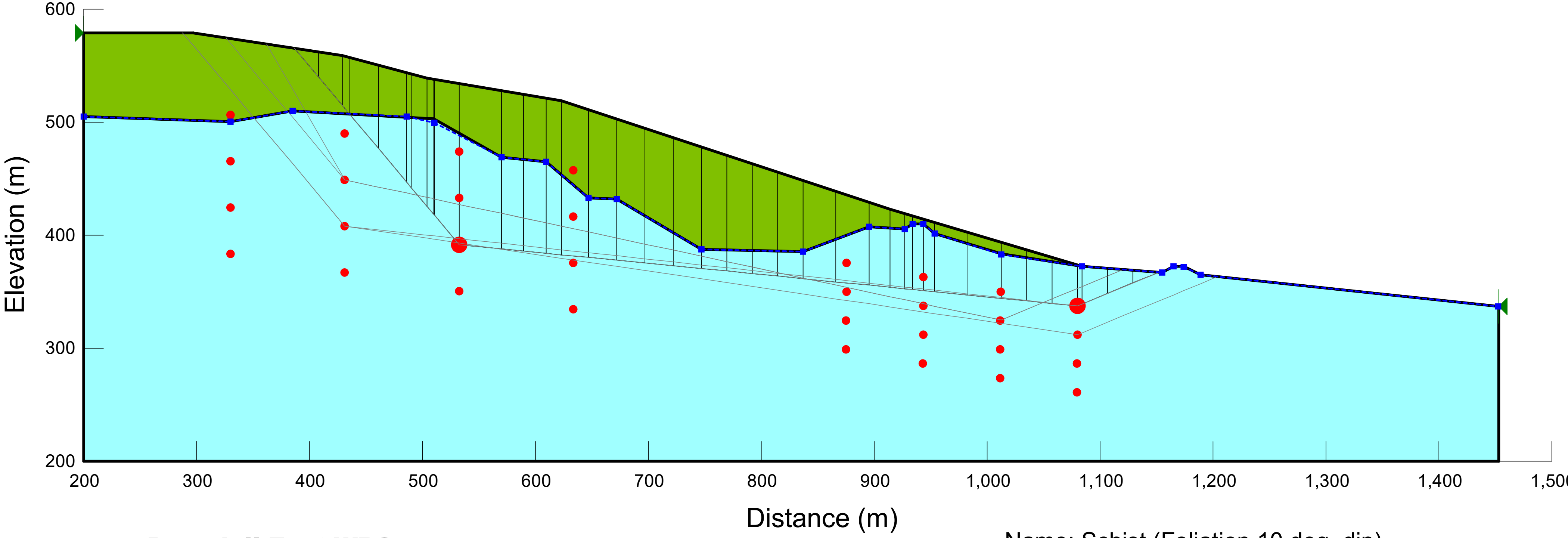
Name: Schist (Foliation 10 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste Rock Stack (Peak)
Piezometric Line: 1

Horz Seismic Coef.: 0.17
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block

0.997



Deepdell East WRS

Section C-C'

Name: Figure A24 SLOPE/W Analysis - SEE 1H Block Slide

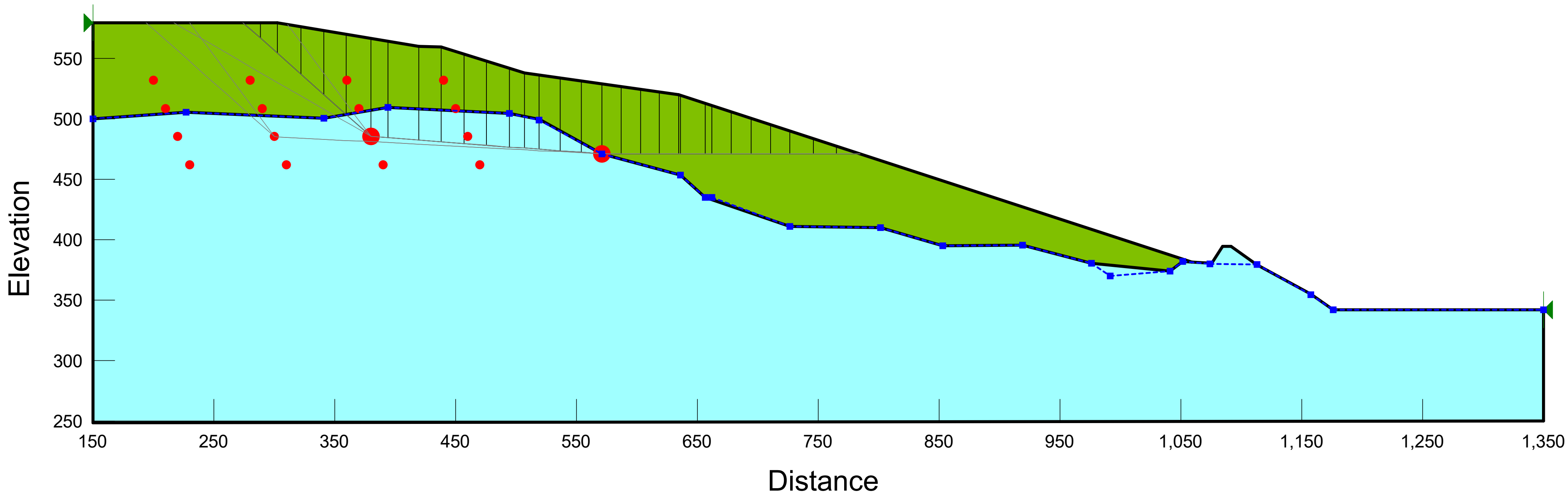
Engineering Geology Limited

Name: Schist (Foliation 10 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.314
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block 1.080



Deepdell East WRS

Section D-D'

Name: Figure A25 SLOPE/W Analysis - OBE 1/3H Block Slide

Engineering Geology Limited

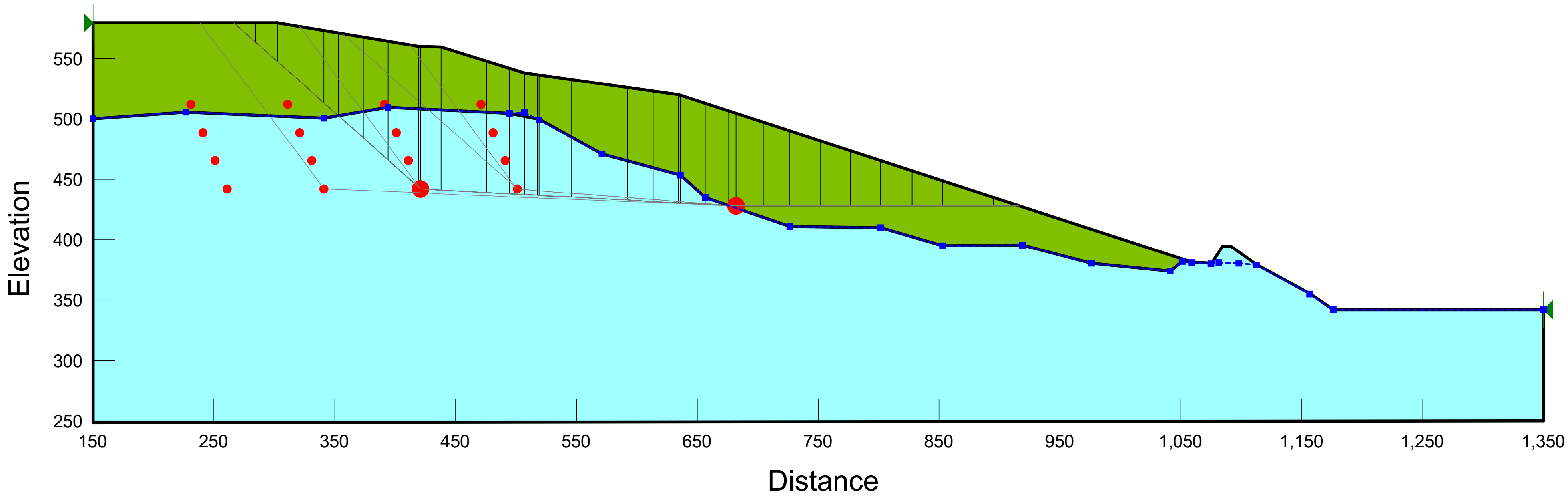
Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.116
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block

1.607



Deepdell East WRS
Section D-D'
Name: Figure A26 SLOPE/W Analysis - OBE 2/3H Block Slide

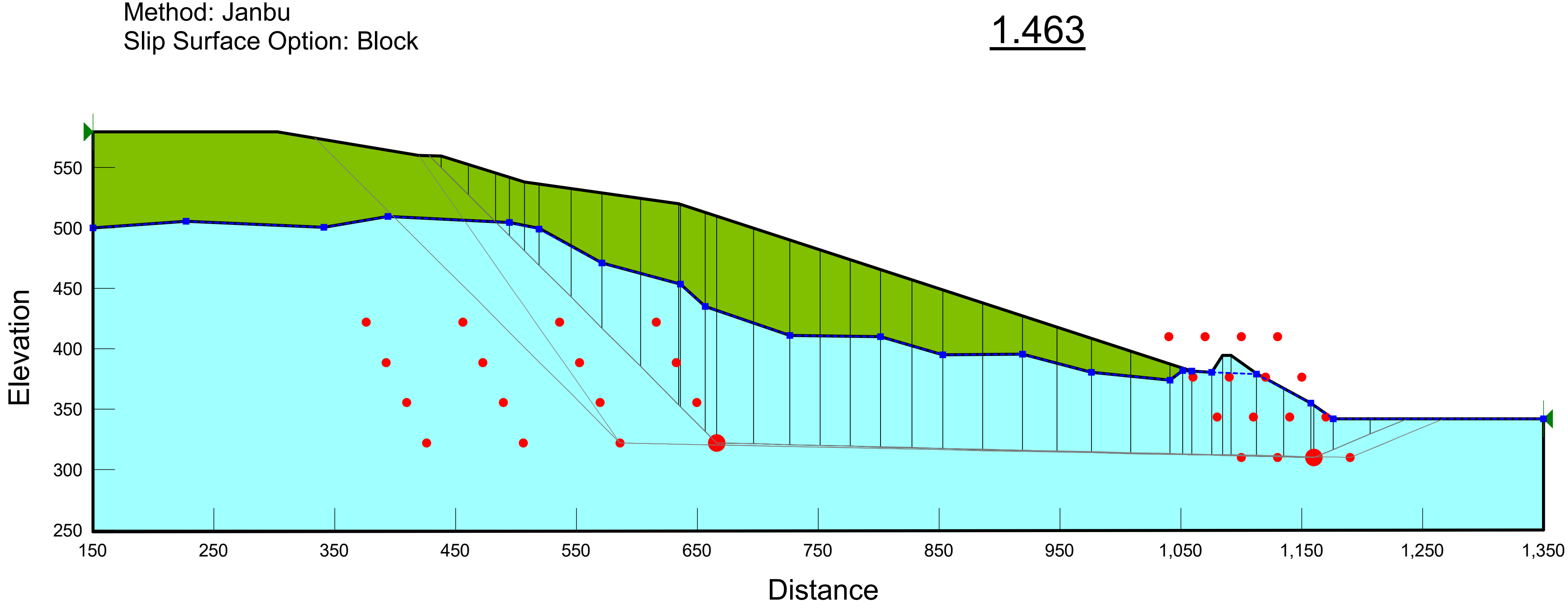
Engineering Geology Limited

Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.043
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS
Section D-D'
Name: Figure A27 SLOPE/W Analysis - OBE 1H Block Slide

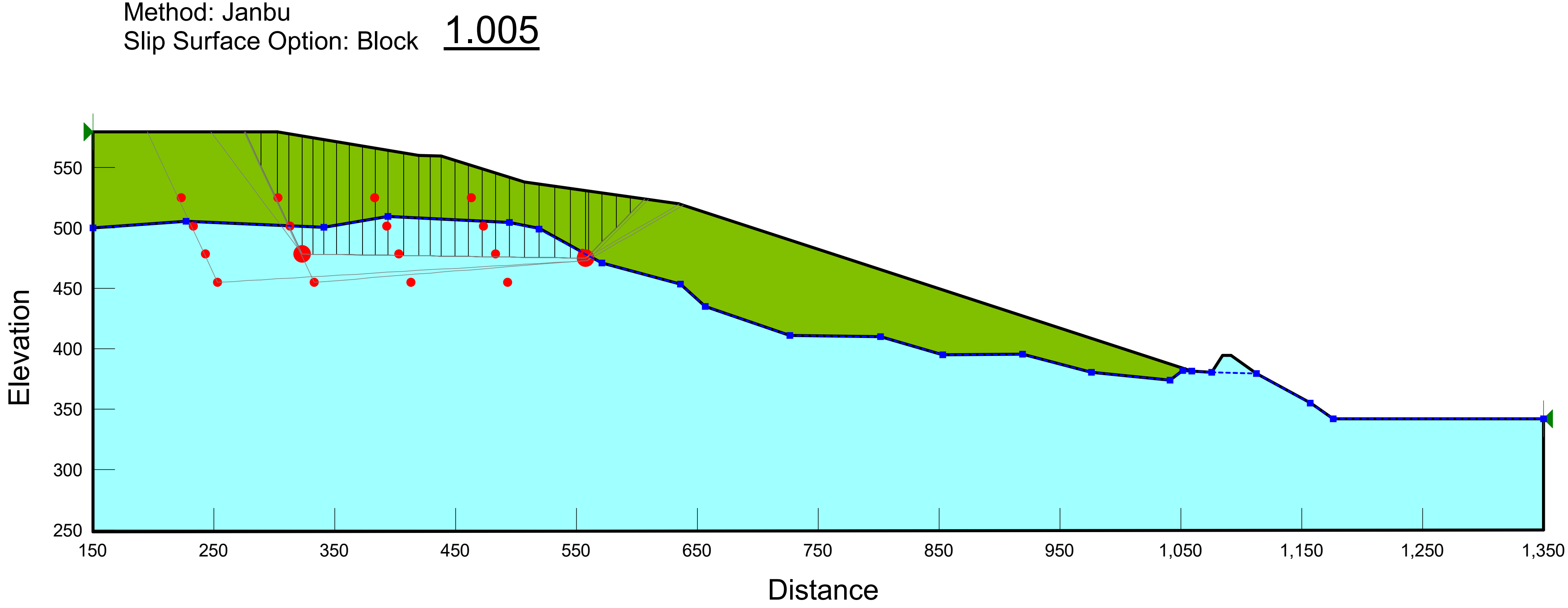
Engineering Geology Limited

Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.33
Ignore seismic load in strength: Yes

Method: Janbu
Slip Surface Option: Block



Deepdell East WRS

Section D-D'

Name: Figure A28 SLOPE/W Analysis - SEE 1/3H Block Slide

Engineering Geology Limited

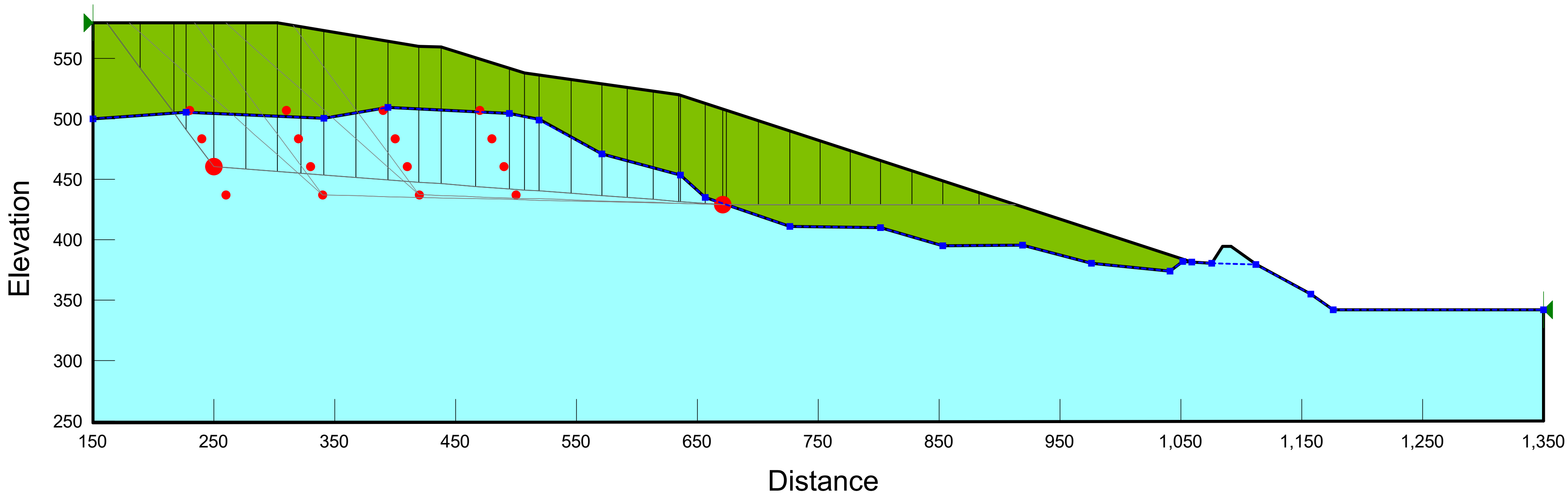
Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.288
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block

1.010



Deepdell East WRS

Section D-D'

Name: Figure A29 SLOPE/W Analysis - SEE 2/3H Block Slide

Engineering Geology Limited

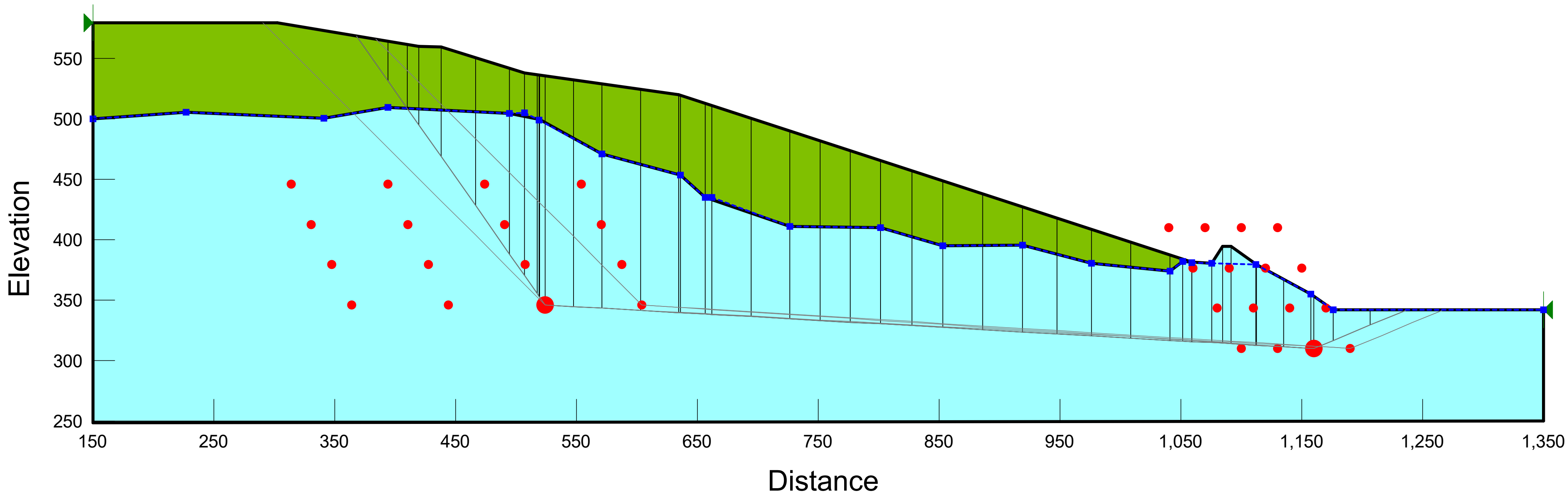
Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1

Name: Rockfill
Model: Shear/Normal Fn.
Unit Weight: 21.5 kN/m³
Strength Function: Waste rock stack (Peak)
Phi-B: 0 °
Piezometric Line: 1

Horz Seismic Coef.: 0.15
Ignore seismic load in strength: No

Method: Janbu
Slip Surface Option: Block

1.001



Deepdell East WRS

Section D-D'

Name: Figure A30 SLOPE/W Analysis - SEE 1H Block Slide

Engineering Geology Limited

Name: Schist (Foliation 0 deg. dip)
Model: Anisotropic Fn.
Unit Weight: 23.5 kN/m³
Cohesion': 50 kPa
Phi': 40 °
Phi-Anisotropic Strength Fn.: Schist Foliation Phi Func.
C-Anisotropic Strength Fn.: Schist Foliation C Func.
Phi-B: 0 °
Piezometric Line: 1