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Geotechnical Investigation for Proposed Residential Subdivision at 158 Vinegar Hill Road, Kauri – Resource Consent 2

Rev A

24 May 2021

Job No. NL20029/S2



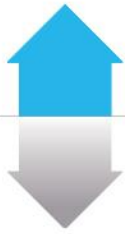
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**GEOTECHNICAL INVESTIGATION
FOR PROPOSED RESIDENTIAL SUBDIVISION AT
158 VINEGAR HILL ROAD, KAURI
RESOURCE CONSENT 2**

Job Number:	NL20029/S2
Name of Project:	158 Vinegar Hill Road, Kauri – Resource Consent 2
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Appendix B: Investigation Logs (Augerholes, Scala Penetrometer Results)

Appendix C: Slope Stability Results

Report Summary

The following summarises the findings of this report however is not to be taken in isolation. It is a requirement that any user of this report review the document in its entirety, including all appendices.

Feature	Commentary
RMA: Section106	No <i>geotechnical</i> natural hazards were identified (as listed in this Act) that are considered an undue impediment to subdivision/construction (respectively) or that cannot be reasonably addressed by typical engineering design and construction
Topsoil and Non-Engineered Fill	Topsoil and non-engineered fill were encountered to a maximum depth of 0.4m below present ground level (bpgl), excluding within the hand augerholes PZ01 and PZ02 at the location of the existing pond dam. These soils are unsuitable to support any permanent structures
Natural Soils	In general, soft to hard alluvial deposits underlain by stiff to hard Northland Allochthon soils
Unduly Weak, Sensitive, or Compressible Soils	Weak soil not encountered within the test holes carried out on the subject sites however there is a distinct horizon of very weak, saturated soils underlying Lot 2 to the north east of the proposed Lot 19. Mitigation work for the weak soil encountered in Lot 2 is discussed in a separate report. Moderately sensitive soils encountered on site.
Groundwater	Groundwater was encountered between 2.6m and 2.8m bpgl, excluding the measurements carried out within the hand augerholes PZ01 and PZ02 at the location of the existing ponds dam, where it was encountered to depths between 0.8m and 3.2m bpgl
Seismic Site Class	Site Class C
Expansive Soils	Inferred as Moderately Expansive in accordance with B1/AS1
Slope Stability	Slopes steeper than 1V:5H (11°) are present in places. We consider the site to be suitable for the proposed subdivision from a land stability point of view provided our development recommendations are adopted.
Preliminary Foundation	Shallow foundations are suitable for the support of typical residential dwellings where slope inclination is flatter than 1V:4H (14°). Outside of the above, foundations must be designed to resist lateral loads - pile foundations are likely to be required
Retaining	Any future retaining system over 600mm in height or within 1.5m of any permanent structure should be Engineer-designed.
Pavement	For preliminary design a CBR value of 3% or a modulus of subgrade reaction of 20kPa/mm are considered appropriate for flexible and rigid pavements respectively.
Construction Constraints	Topsoil and Non-engineered fill are present Sensitive soils are present across the site Northland Allochthon soil are prone to instability when disturbed and exposed to elements. Temporary (unsupported) cuts should not be in excess of 1.2m in height and construction will benefit from being carried out in summertime conditions
Earthwork Construction Observation	Recommended

1.0 Introduction

Soil & Rock Consultants (S&RC) were engaged by Evo Land Ltd to carry out a geotechnical investigation at 158 Vinegar Hill Road, Kauri – Resource Consent 2 regarding a proposed residential subdivision.

The subdivision will be carried out in three separate Resource Consent stages. This report is to support 'Resource Consent 2', being creation of twenty one new lots (Lots 3 to 22 inclusive and the balance Lot 800).

Our investigation has been informed by Section 106 of the Resource Management Act which lists 'Natural Hazards' that must be considered by Council when assessing a Resource Consent application. Our assessment has also extended to consideration of the following:

- Provision of a seismic site class in accordance with NZS1170.5:2004.
- Provision of geotechnical comments and/or recommendations related to site stability and site formation work requirements for residential subdivision.

The primary purpose of this reporting is to identify the issues discussed above and provide associated remedial, mitigation, and design recommendations in order that Subdivision Consent can be granted. Information and advice related to good construction practise are also provided. Preliminary foundation design advice is provided as is information.

1.1 Limitations

This report has been prepared by Soil & Rock Consultants for the sole benefit of Evo Land Ltd (the client) with respect to 158 Vinegar Hill Road, Kauri – Resource Consent 2 and the brief given to us. The data and/or opinions contained in this report may not be used in other contexts, for any other purpose or by any other party without our prior review and agreement. This report may only be read or transmitted in its entirety, including the appendices.

The recommendations given in this report are based on data obtained from discrete locations and soil conditions between locations are inferred only. Our geotechnical models are based on those actual and inferred conditions however variations between test locations may occur and Soil & Rock Consultants should be contacted in this event.

Soil & Rock Consultants should also be contacted should the scope or scale of the development proposal vary from that currently indicated.

Preliminary foundation design advice is provided in this report however that information will be confirmed or modified as appropriate at the Building Consent stage.

2.0 Site Description (General Area)

The subject site comprised of several land titles legally described as Lot 1 DP 189623, Lot 2 DP 189623, Lot 2 DP 120527, Lot 2 DP 337386, is irregular in shape and covers an area of approximately 34.6 hectares. The site is bounded by Vinegar Hill and Riversong Road to the west, Patanui Stream to the east and by farmland to the north and south.

The site is rural and is currently used as grazing land. Built development comprises an existing dwelling, sheds, farm paddocks, gravel farm tracks and boundary fences. A 'manmade' pond is present to the west of the property. The site vegetation is mainly grass with shrubs and trees in places particularly along the Patanui Stream and around the pond. The site may be accessed from Vinegar Hill Road and Riversong Road. The location and approximate boundary of the site is shown in Figure 1 below.

The ground surface is generally gentle to moderately sloping (inclinations less than 10°) throughout the site with a dominant slope direction from the west to the east and becomes near-level where approaching the Patanui Stream along the eastern boundary. Localised steep slopes (approximately 18°) exist in places.

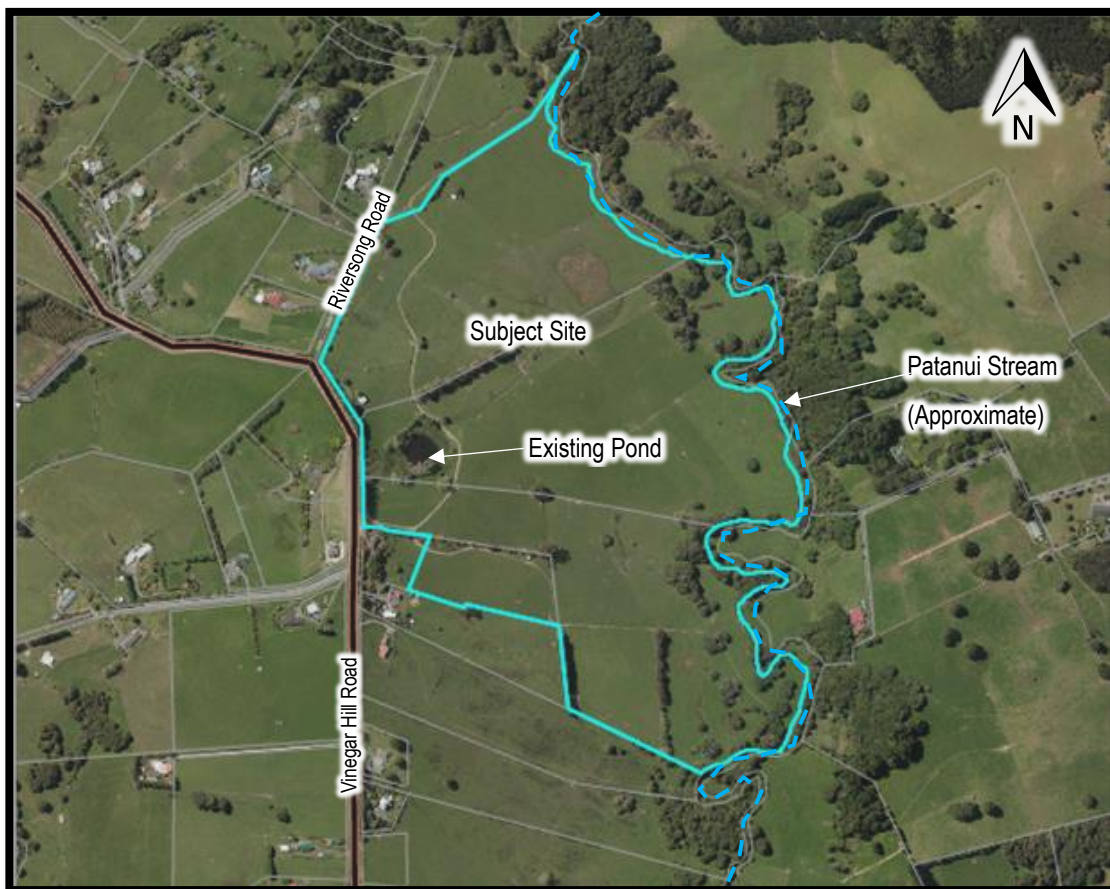


Figure 1: Aerial Image (Source: Whangarei District Council GIS Map)

2.1 Proposed Development

Drawings prepared by Cato Bolam show the proposal is to subdivide the overall property into a total of sixty-one rural-residential Lots. Under the 'Resource Consent 2' (RC2) application the site will be subdivided for residential development for Lot 3 to Lot 22 inclusive and the Balance Lot 800. The proposed RC2 residential development is generally situated to the west of the property as shown in Figure 2 below and will be referred to collectively as 'the site' in this report. No development is proposed on the balance Lot 800. Access to the individual lots will be via common driveways from Vinegar Hill Road.

The same set of plans shows a 1% Annual Exceedance Probability (AEP) flood plain is present to the east of the site. These areas will be included in a 'Resource Consent 3' report at a later date.



Figure 2: Proposed Subdivision (Source: Cato Bolam Consultants)

3.0 Geology

Reference to the GNS New Zealand Geological Web Map 1:250,000 Geology map, indicates the site is underlain by two geological units, Recent Alluvial deposits of the Tauranga Group and Melange of Northland Allochthon Group (See Figure 3). These deposits were encountered during our investigation and a description of the encountered soils is given below.

Recent (Holocene) Alluvial Deposits. These materials are variable in terms of consistency and strength and are found typically along stream channels and flood plains of creeks, or along localised gully features. They are typically present as beds of light grey to orange brown muds, sand and gravel, comprising some rock fragments in places. Holocene alluvial deposits may include some beds of black, humus rich clay and fibrous peat. These materials are unconsolidated and very soft and are unsuited to support of residential construction.

Tauranga Group Alluvial Deposits. These deposits are of Pliocene/Pleistocene age, and are therefore older and typically more consolidated than the materials described above. They are typically suited to residential construction however some caution is required as they can vary markedly in composition and engineering characteristics.

Geotechnical risks associated with these deposits are the presence of loose, saturated soils and peats of lesser vane shear strength underlying a stiff crust typically of 2.5m to 3.0m thickness. These soils can be prone to undue consolidation settlement and are subject to seasonal shrinking and swelling as a result of moisture content changes.

Melange of Northland Allochthon. These materials are closely fractured to sheared siliceous and locally calcareous mudstone with micaceous sandstone, siltstone, green and brown shale and some muddy limestone. The complex commonly occurs as a melange of mixed lithologies with a sheared mudstone matrix and many small serpentinite bodies within melange units. The rocks are light to dark coloured.

Due to the high densities of rock mass defects these rocks rapidly weather to weak clay rich materials that form areas of subdued rolling topography. The clays are soft to very soft smectite rich, low shear strength high plasticity clays that are prone to debris sliding and deep-seated creep even on slopes less than 10° (Shakes 1983) which is the underlying reason behind the gentle topography when compared to other soil types. Weathering can extend to 10m depth.

Geotechnical risks associated with these deposits are stability issues even at gentle inclinations. Earthworks (cut and fill) batters should be inclined at no greater than 1V:5H. Depending on cut depth, under-cutting and compacted-clay capping (at least 600mm thick) may be required within the earthwork area.

Other Lithologies. To the east of the stream (along the eastern boundary) are volcanic deposits of the Kerikeri Group. Volcanic ash (tuff) may be present on the site in isolated areas as the lithology boundaries shown on the geologic maps are approximate only.

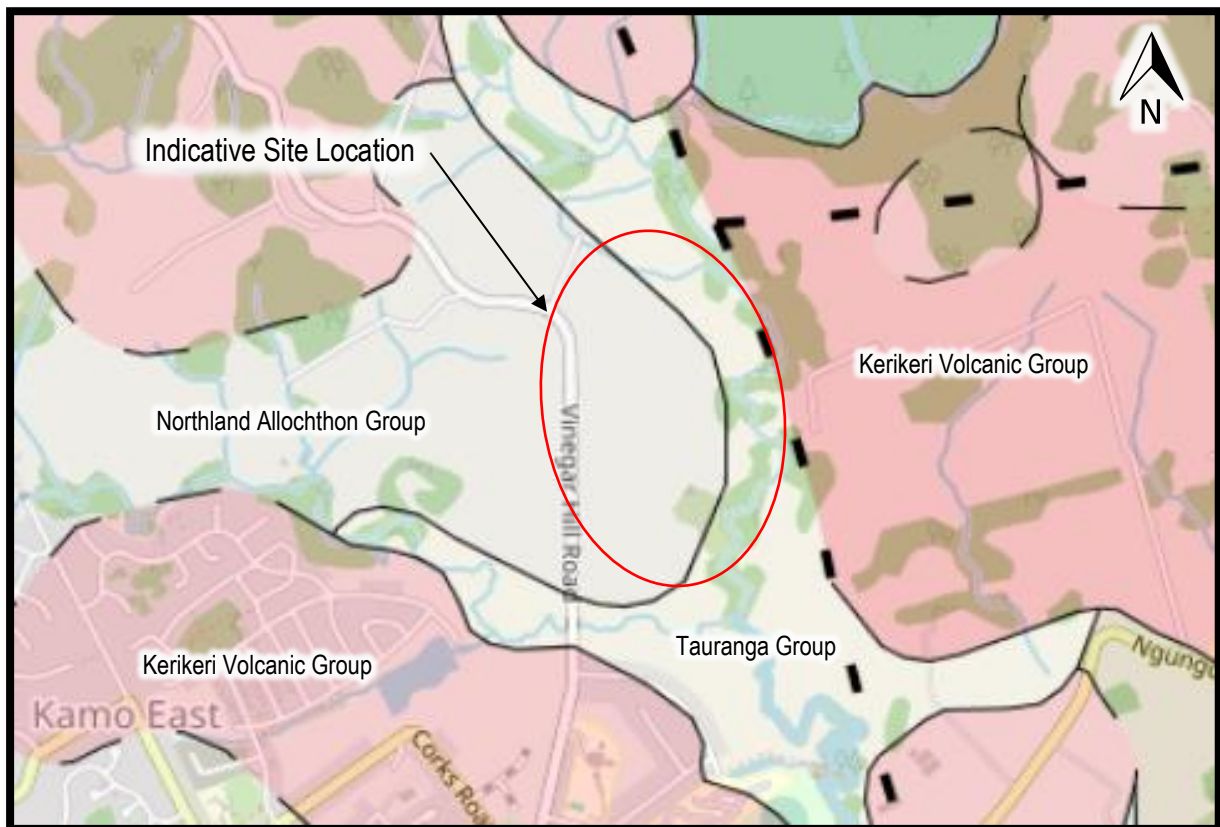


Figure 3: Geological Map (Source: GNS WebMaps Website)

4.0 Field Investigation

The field investigation carried out on 8 and 9 December 2020 comprised the following components:

- Visual appraisal of the site;
- Drilling of twelve hand augerholes (AH03a, AH03b, AH04, AH05, AH11 to AH15 inclusive, PZ01 and PZ02) to depths between 3.0m and 5.0m below present ground level (bpgl);
- Installation of two piezometers for groundwater monitoring within hand augerholes PZ01 and PZ02;
- Scala penetrometer testing from the base of selected augerholes;

-
- Drilling of four probe hand augerholes (WW01 to WW04 inclusive) to depths of 1.2m bpgl to assist in wastewater assessment;
 - Measurement of three cross sections (A-A', C-C' and D-D') using measuring tape and clinometer.

The test locations are shown on the attached Site Plan, Drawing NL20029/S2/01 in Appendix A. These locations were determined from hand-held GPS and are therefore approximate only.

Measurements of undrained shear strength were undertaken in the hand augerholes (AH03 to AH15 inclusive, PZ01 and PZ02) at intervals of depth using a handheld shear vane in accordance with the New Zealand Geotechnical Society Guidelines for Handheld Shear Vane Tests, dated August 2001. Peak and remoulded vane shear strengths shown on the attached augerhole logs represent dial readings off the shear vane adjusted using the BS 1377 calibration correction factor given on the log.

A visual-tactile field classification of the soils encountered during drilling was carried out in accordance with "Guidelines for the Field Classification and Description of Soil and Rock for Engineering Purposes", issued by the New Zealand Geotechnical Society Inc. (2005).

Dynamic Cone (Scala) Penetrometer testing was carried out from the base of selected augerholes until refusal was reached. Refusal is defined as five consecutive blow counts of 10 or greater per 50mm penetration or a blow count of 20 for 50mm penetration. The results are given on the attached sheet (Appendix B).

4.1 Subsurface Conditions

Subsurface conditions have been interpolated between the test locations and localised variations between and away from the test locations will exist.

In general, the soils encountered comprised topsoil and fill underlain by alluvial deposits and in turn underlain by Northland Allochthon soils. An outline of the soil conditions and investigation results is given below and summarised in Tables 1 and 2 below, and detailed descriptions of the soils are given on the attached logs (Appendix B).

- **Topsoil and Fill.** Topsoil and/or fill was encountered at each test location generally to a maximum depth of 0.4m below present ground level (bpgl). Deeper fill deposits were encountered in augerholes PZ01 and PZ02 to depths of 3.1m and 1.0m bpgl respectively, being the dam structure. PZ01 and PZ02 were drilled near the dam crest and near the toe.
-

Due to the measured shear strengths and variable composition of the fill material is considered unsuited to residential house construction - unsuitable for the support of permanent structures (i.e. building foundations, floor slabs, pavements etc.).

The depth, lateral extent, and composition of the fill material will vary across the site.

- **Alluvial Deposits.** Alluvial deposits were encountered at most test locations (with the exception of hand augerholes AH04, AH05, AH09 and PZ01) underlying the topsoil and/or fill to depths ranging between 1.2m (minimum drilled depth) and 5.0m (maximum drilled depth) bpgl. The alluvial soils comprised soft to hard silts with lesser amounts of clay and fine sand with occasional clay-dominant zones. Vane shear strengths recorded within the alluvial material generally ranged between 58kPa and greater than 200kPa.

Lower vane shear strength readings between 14kPa and 35kPa were recorded in hand augerhole AH03a at depth between 2.5m and 3.0m bpgl. Augerhole AH03a was drilled in Lot 2, beyond the subject site, to the northeast of proposed Lot 19. Mitigation work for the weak soil encountered in Lot 2 is discussed in a separate report (job ref NL20029/S1, date 26 February 2021).

- **Northland Allochthon Soils.** Northland Allochthon soils were encountered underlying the topsoil/fill and alluvial deposits (where encountered) to the termination depths of the hand augerholes (exception is hand augerholes AH03a, WW01 and WW03). The Allochthon soils comprised stiff to hard silts with varying amounts of clays and sands. Vane shear strengths ranged from 51kPa to greater than 200kPa where the soil strength was in excess of the shear vane dial capacity or was 'UTP' – Unable to Penetrate into the soil.

At shallow depth, (ground level to 2.0m) the soils are more sensitive to disturbance. Below 2.0m depth, the re-moulded vane strengths were generally within 50% of the undisturbed test values, indicating low sensitivity of the soil.

- **Scala Penetrometer Testing.** Scala Penetrometer testing was carried out from the base of selected augerholes. Refusal, inferred to be contact with the transition zone into an underlying dense stratum, was encountered at depths ranging between 3.7m and 7.2m bpgl.

'Sudden' refusal is inferred to indicate contact with a hard or dense surface (such as sandstone/mudstone) and was encountered within hand augerholes AH03a, AH03b, AH13 and AH15 at depths between 3.7m and 6.6mbpgl.

- **Groundwater.** Groundwater measurements were carried out within the hand augerholes on the day of drilling (8 & 9 December 2020) and are summarised in Table 1 and 2 below.
-

Groundwater measurements taken during drilling are not always an accurate portrayal of the actual long-term groundwater table as groundwater levels can take time to stabilise within the hand augerholes following drilling.

In all cases, shallow groundwater should be expected within low lying areas during the wet months of the year. The areas of shallow groundwater would typically be concurrent with flood plains however may be present at other locations.

Plants of the 'Rush' type usually indicate localised areas of shallow groundwater, including springs.

Groundwater level monitoring was carried out within the piezometers, PZ01 and PZ02, and will be presented/discussed in a separate document ('Dam Report').

Table 1 – Summary of Subsurface Conditions – AHs & PZs

Test ID	Termination Depth	Depth to the base of Topsoil/Fill	Vane Shear Strength Range within Natural Ground (kPa)	Scala Penetrometer Termination	Groundwater Depth
All depths measured in (m) below present ground level. (Rounded to 1 DP)					
AH03a	5.0	0.2	14 - 200+ UTP	6.6	2.6 (2.2)
AH03b	5.0	0.4	76 - 200+ UTP	5.0	NE (3.5)
AH04	5.0	0.4	62 - 200+ UTP	6.3	2.8 (2.1)
AH05	3.5	0.2	60 - 200+ UTP	NT	NE (1.7)
AH09	3.0	0.4	97 - 200+ UTP	NT	NE (2.5)
AH11	5.0	0.2	92 – 200+ UTP	7.2	NE (3.5)
AH12	5.0	0.2	88 – 200+ UTP	6.4	NE (0.6)
AH13	5.0	0.2	51 – 200+ UTP	5.2	2.7
AH14	4.2 ⁽¹⁾	0.2	95 – 200+ UTP	5.9	NE (0.6)
AH15	3.0 ⁽¹⁾	0.2	133 – 200+ UTP	3.7	NE (2.2)
PZ01	5.0	3.1	86 – 118	NT	3.7
PZ02	3.0	1.0	108 – 200+	NT	0.8

Key:

(1) = Too hard/dense to hand auger

NE = Not Encountered,

NT = Not Tested,

UTP = Unable to penetrate the soil.

Figures in Brackets: Depth to soil logged as 'wet' or 'moist to wet' – where within 0.6m from ground surface moistness or wetness is likely due to surface water

Table 2 – Summary of Subsurface Conditions – WW Augerholes

Test ID	Termination Depth	Depth to the base of Topsoil/Fill	Vane Shear Strength Range within Natural Ground (kPa)	Scala Penetrometer Termination	Groundwater Depth
All depths measured in (m) below present ground level. (Rounded to 1 DP)					
WW01	1.2	0.4	NT	NT	NE
WW02	1.2	0.1	NT	NT	NE
WW03	1.2	0.2	NT	NT	NE
WW04	1.2	0.2	NT	NT	NE

NE = Not Encountered

NT = Not Tested

5.0 Non-Engineered Fill

Non-engineered fill is a man-made soil deposit (not created by natural processes). The term 'non-engineered' implies that the fill was placed without engineering supervision or certification. The potential random composition of this deposit, the uncontrolled manner of placement and resulting unpredictable strength/deformation characteristics render non-engineered fill unsuitable for support of any permanent structures e.g. building foundations, retaining walls, pavements etc.

The composition of the in-situ fill and the tested vane shear strength indicate that the fill was placed without engineering controls therefore it is considered non-engineered.

6.0 Expansive Soils

Visual and tactile assessment indicates that the soils, encountered on site lie in '**Expansive Soil Class M – Moderately Expansive**' as given in B1/AS1. B1/AS1 states that Class M soils experience surface movements of up to 44mm.

In any case, expansivity testing is recommended for future dwelling development.

7.0 Sensitive Soils

Alluvial deposits and Allochthonous soils can be very sensitive to mechanical disturbance and/or exposure to the elements and our investigation logs indicate the soils in the upper 2.0m are slightly to moderately sensitive. The practical outcome of this characteristic is that soils that test well in-situ can perform poorly when construction is under way. Care is therefore required during construction to ensure the soils are protected to ensure favourable short and long-term subgrade performance.

Practical means of protecting the soils include avoidance of vibration-based compaction equipment, protecting the subgrade following initial site clearance, and minimising the passage of heavy or vibrating construction plant. Reference should be made to Section 12.0 of this report regarding subgrade protection measures.

8.0 Seismic Design Parameters

The site is considered a Class C – ‘Shallow Soil Site’ as defined by NZS 1170.5:2004.

The Peak Ground Acceleration (PGA) value for a structure of Importance Level 2, adopted for stability analysis of the site is 0.133g (ULS).

9.0 Slope Stability

Qualitative Assessment

Northland Allochthon soils are sensitive to water and disturbance, and are prone to instability even at relatively gentle inclinations (e.g. slopes steeper than 1V: 4H, (14°), sometimes as flat as 1V:5H). It is common for Allochthonous soils to have a natural capping of approximately 1.5m to 4.0m thick clayey silt or silty clay overlying the sensitive layer. The sensitive layer is commonly grey in colour and is very stiff to hard when undisturbed.

The augerholes shows the natural capping is approximately 1.5m thick however could be lesser away from the test locations. It is highly recommended that at least 0.5m of the natural capping remain in place.

The ground surface on site is mainly gentle to moderately sloping with inclinations generally being less than 10° with localised steep slopes (approximately 13°) in places.

At the time of our investigation no visual evidence of major, deep-seated instability was identified.

Our initial assessment is that the site is suitable for the proposed development provided any excavation remains within the natural capping otherwise specific engineering recommendations are required.

Quantitative Assessment

To quantitatively check the overall stability of the slope within the proposed building platforms, stability analyses have been undertaken for the existing topography through cross sections A-A', C-C', and D-D' as indicated on the Site Plan, Drawing NL20029/S2/01.

The computer program SLIDE Version 2018 for slope stability analysis, developed by RocScience Inc. was used for stability calculations. Stability of theoretical translational surfaces was assessed using the Morgenstern-Price method.

Stability analyses have been undertaken for the normal (measured) groundwater, extreme (worst credible) groundwater, and seismic conditions. The measured groundwater condition has been adopted for the seismic condition. Peak Ground Acceleration (PGA) values for the Whangarei Region have been determined as per Section 8.0 of this report.

Lower-bound effective stress shear strength parameters used for our analyses are summarised in Table 3. These have been developed from the soil description, in-situ strength testing, limited back analysis, reference to literature regarding the Allochthon and our experience with these soil types in both the immediate area and the wider region.

Table 3 – Effective Stress Strength Parameters

Soil Type	Estimated Unit Weight γ (kN/m ³)	Effective Cohesion on the Failure Plane c' (kPa)	Effective Angle of Internal Friction ϕ' (°)
In-situ Fill	18	0	24
Tauranga Group	18	2	26
Weak Transitional Zone	17	3	20
Weathered Northland Allochthon	17	5	24
Less Weathered Northland Allochthon	18	5	30

The ratio of resisting forces to disturbing forces is presented as a 'Factor of Safety' (FOS) against slope instability occurring. A FOS of 1 indicates a slope near or at equilibrium.

We have adopted the following for the purposes of our assessment:

- FoS of 1.5 or higher for long-term stability when modelling the existing site conditions (measured groundwater level).
- FoS of 1.3 or higher for medium-term stability to model the worst-credible-case scenario (elevated groundwater level) and
- FoS of 1.2 or higher used for short-term stability to model the effect of extreme conditions (seismic loading).

The values above were adopted from Auckland Council's Code of Practice Factors of Safety for Residential Development.

The results of our analyses are summarised in Table 4 below.

Table 4 – Stability Analysis Results

Section	Modelled Conditions	Global Factor of Safety		Compliant
		Required	Calculated	
A-A'	Normal Groundwater	1.5	2.2	Yes
	Extreme (Worst Credible) Groundwater	1.3	1.9	Yes
	Seismic Loading	1.2	1.2	Yes
C-C'	Normal Groundwater	1.5	2.5	Yes
	Extreme (Worst Credible) Groundwater	1.3	2.0	Yes
	Seismic Loading	1.2	1.5	Yes
D-D'	Normal Groundwater	1.5	2.2	Yes
	Extreme (Worst Credible) Groundwater	1.3	1.7	Yes
	Seismic Loading	1.2	1.3	Yes

Stability Conclusions

The minimum factors of safety within the 'practical building platforms' were greater or equal to the required FoS.

We therefore consider the site to be suitable for the proposed development from a global land stability point of view contingent upon the recommendations of this report being adopted in design and construction.

10.0 Geotechnical Discussion

It is our opinion that any geotechnical impediment to the development from 'Natural Hazards' (as listed in Section 106 of the Resource Management Act) can be mitigated through design. This opinion is confined to the geotechnical aspects of RMA Section 106 and assessment of the potential for 'Inundation' from floodwater is excluded from our assessment.

We consider the site to be geotechnically suitable for subdivision and typical residential development within Lots 3 to 20 inclusive provided the recommendations given in this report are observed.

11.0 Site Formation Works

We are not aware of the proposed engineered topography of the site at this stage. We expect earthworks to be carried out in association with the formation of building platforms and access roads to service the proposed subdivision.

The following procedures should be observed during earthworks:

- Prior to commencing earthworks, a sediment control system must be constructed to ensure the Territorial and Regional Authority requirements are met.
 - All earthworks should be carried out to the requirements of NZS 4404:2010 '*Land Development and Subdivision Infrastructure*' and NZS 4431:1989, '*Code of Practice for Earthfilling for Residential Development*'.
 - It is highly recommended that a minimum of 0.5m of the natural highly plastic clayey or silty soil must remain or be placed over any unweathered mudstone or claystone (sensitive layer). This could be achieved by undercutting and reworking the top 0.5m of soil within the earthworks area to an engineered standard. The use of highly plastic clayey soil is recommended in that top 0.5m to act as a capping material.
 - Maximum inclination of any natural soil slope (following cut activity) should be 1V:4H (14°) unless special engineered consideration is applied.
 - No unsupported cut may be greater than 1.5m in height
 - Batters formed by placement of engineered fill may be formed no steeper than 1V:4H (14°) unless special engineered consideration is applied.
 - No fill may be deeper than 1.5m unless the subject of specific stability assessment.
 - Unsuitable materials (topsoil, non-engineered fill) encountered during building platform preparation should be excavated, removed and replaced with good quality granular fill compacted in layers no greater than 150mm, loose.
 - Any springs or seepage of water observed at ground level or intercepted by stripping operations should be captured in a suitable sealed pipe and taken via the shortest route to a safe discharge point as per the Geotechnical Engineer's advice.
 - The surficial soils (present on site) can be sensitive to disturbance and must be protected at all the time from exposure to the elements, and from excessive construction plant vibration in order to prevent loss of strength.
 - Service trenches should be backfilled with engineered granular fill where this is deemed necessary e.g. under pavements and other permanent structures.
-

-
- A Geotechnical Engineer should inspect the prepared subgrade prior to placement of fill and test the fill during placement.

12.0 Pavements

All topsoil, non-engineered fill, vegetation, organic or otherwise unsuitable material should be removed from under pavement areas prior to construction.

For preliminary design a CBR value of 3% or a modulus of subgrade reaction of 20kPa/mm are considered appropriate for flexible and rigid pavements respectively. These values should be confirmed by specific testing by S&RC following preparation of the subgrade.

Maintaining the natural moisture content of a subgrade prior to construction is important. The subgrade can be protected from desiccation, rain damage, and plant-trafficking by placing a protective layer of granular fill immediately upon excavating or filling to grade following inspection by the Geotechnical Engineer. The granular fill can later be left in-situ as a construction sub-base or basecourse if managed well and protected from damage. In summertime conditions consideration should be given to watering the subgrade approximately 48 hours prior to concrete placement to return the subgrade to its inferred pre-excavation moisture content is recommended, the aim being to prevent swell pressure from post-construction re-hydration of the soils damaging the structure.

Any pavement should be underlain by a basecourse of clean, free-draining granular fill as specified by the designer and should be subjected to compaction by a device of appropriate weight and energy. Silty or sandy subgrades are generally sensitive to disturbance and 'static' rolling only (no vibration) is recommended.

13.0 Preliminary Foundation Design Recommendations

Shallow foundations and/or piled foundations are suitable for the support of typical residential dwellings provided they are supported by stiff natural ground or engineered-quality fill.

S&RC should inspect all foundation excavations to determine whether the exposed soil and foundation conditions are consistent with those described in this report.

Soil expansivity and bearing capacity values will be confirmed during the Building Consent stage.

Shallow Foundations

Shallow foundations are suitable where slope inclination is flatter than 1V:4H (14°) and the foundations are for the support of typical residential dwellings constructed in accordance with NZS3604:2011 and designed to accommodate movement of soil associated with a Soil Reactivity (**Class M – Moderately Reactive**).

A Dependable Bearing Capacity of 150kPa (Ultimate Bearing Capacity = 300kPa, $\phi_{bc} = 0.5$) is available for shallow foundations (excluding rib-rafts/waffle slabs) designed to NZS3604:2011 and designed to accommodate movement of soil associated with Soil Expansivity Class M – Moderately Reactive. Note: as described above, that expansivity class should be confirmed as part of Building Consent preparation as it is possible that Site Class H – Highly Expansive soils are present..

Pile Foundations

Piled foundations may be required as follows:

- Where the structural requirements are greater than that given for shallow foundations.
- Where bridging of services is required.
- To provide resistance to Soil Creep where a foundation is situated within 2.0m horizontally of natural ground with a surface inclination steeper than 1V:4H (14°).
- Where any retaining is within the influence zone of the building platform.

Static design of piles can be carried out using the following parameters:

1. A Design End Bearing Capacity of 250kPa (Ultimate End Bearing Capacity = 500kPa, $\phi_{pc} = 0.5$) is available for piled foundations embedded a minimum of 3.5m into stiff natural ground (Structural design may require deeper embedment).
 2. Design Skin Friction of 20kPa (Ultimate Skin Friction Capacity = 40kPa, $\phi_{pc} = 0.5$) where within natural cohesive soil or engineered fill.
 3. No skin friction should be calculated within the 1.0m of any pile to account for the shrink/swell activity of the soil and shallow soil creep.
 4. No skin friction should be calculated within any non-engineered fill layer.
 5. Soil creep of at least 1.0m (could be deeper depending on actual location) should be expected where a foundation is within 2.0m of ground sloping steeper than 1V:4H (14°). For design against soil creep the following may be adopted.
-

-
- The pile exposed to lateral soil pressure calculated over a width of $3d$, where d is the bored pile diameter, and to a 1.0m depth, and using the parameters below
 - Soil bulk density: 18kN/m^3 ,
 - Internal Friction Angle: 17° for natural soils* and engineered fill,
 - K_0 (At-Rest) for pile design.

**Due to the sensitivity of the surficial soils, we recommend a lowered value of friction angle to be used for pile design.*

14.0 Retaining Structures

We recommend that any future retaining system within the subdivision that will be over 600mm in height or within 1.5m of any permanent structure be Engineer-designed.

Factors of safety and surcharge loadings appropriate to the conditions should be in accordance with 'Limit State Design of Retaining Walls and Foundations for Geotechnical and Structural Engineers' SESOC Seminar Series 2005.

No cutting or filling may be carried out that is in excess of 600mm depth or serviced by batters steeper than 1V:4H (14°) without specific geotechnical assessment, which depending on the location and scale may range from drawing review to further in-ground investigation.

15.0 Stormwater

Concentrated stormwater flows must not be allowed to run onto or over slopes or saturate the ground as this could adversely affect slope stability or foundation conditions. Flows from all impermeable areas must be collected and carried in sealed pipes to a disposal point approved by Council.

Disposal to ground may only be carried out subject to consultation with S&RC or an engineer experienced with Northland Allochthon soils.

16.0 On-site Wastewater Treatment and Dispersal

No reticulated sanitary sewer services the subdivision therefore an on-site wastewater treatment and disposal system is required to service future dwellings.

The purpose of this section is to confirm to Council that on-site treatment and dispersal of domestic wastewater is feasible, and we have demonstrated this by considering a notional four-bedroom dwelling on each Lot as described below. Actual designs suited to individual lots and development proposals will be carried out as part of preparation for Building Consents.

On Site Wastewater Dispersal Feasibility Assessment

We have assessed the feasibility of onsite effluent disposal in accordance with AS/NZS1547:2012 and referred to the Regional Soil and Water Plan (RWSP) for Northland.

We consider that the subsoils encountered within our handauger holes should be categorised as Soil Category 5 – 6 ‘Slowly Draining’ in accordance with Table 5.1 of AS/NZS1547:2012.

Table M1 of AS/NZS1547:2012 recommends a drip irrigation Design Irrigation Rate (DIR) for Soil Category 5 - 6 of 3.0 mm/day as given in Table 5 below.

On slopes steeper than 1H:4V (14°) a lesser discharge rate (2.5mm/day or 2.0mm/day) may be required to avoid land instability. That can be determined by the design Engineer at the time. The minimum Reserve area specified by NZS1547:2012 is 30% of the Primary area however our view is that 50% would be more appropriate.

Table 5 adopts NZS1547:2012 values and illustrates the required wastewater dispersal field for a typical **four**-bedroom dwelling discharging treated effluent to a Pressure Compensated Dripper Irrigation (PCDI) system. Table 5 indicates that a Reserve field of 30% of the Primary field is available in order to demonstrate compliance with NZS1547:2012. In reality a larger area is available for Reserve treatment if required.

Our handauger ‘probes’ did not encounter groundwater within 1.2m of ground surface.

Table 5: Summary of Onsite Effluent Dispersal Field Sizing and Set-Backs

Number of Bedrooms	4			
Design Occupancy	6			
Water supply	Roof tank water supply			
Typical design flow	180/L/person/day			
Total design discharge rate	1080L/day			
Soil Category	5-6			
Design Irrigation Rate (maximum)	3mm/day			
Primary dispersal field	360m ²			
Reserve area (30% & 50%)	(30%)	108m ²	(50%)	180m ²
Total area		508m ²		540m ²
Setback from a Water Body	Per Northland Regional Plan 2020: Setbacks range 5m – 20m			

We conclude that:

- Each proposed Lot is capable of supporting an on-site wastewater treatment and dispersal system for a typical **four**-bedroom house;
- Designs for larger dwellings are likely to be feasible;
- All designs for on-site wastewater systems should be carried out by an Engineer experienced in on-site wastewater disposal.

17.0 Earthwork Construction Constraints

Geotechnical aspects of earthwork construction that are anticipated to require special attention by the Contractor and inspecting Geotechnical Engineer include (but are not necessarily limited to) the following:

- Moderately sensitive soils are present across the site which can exhibit a significant strength reduction when disturbed or exposed to the weather. Care is therefore required to protect the exposed soils during construction. Reference should be made to Section 12.0 of this report in this regard.
- Northland Allochthon soils are prone to instability when disturbed and exposed to elements hence care is required to protect exposed subgrade.
- Unsupported cuts in the Allochthon soils can lead to failure of slopes above the cut. Care and prudence are required of the Contractor.

18.0 Observation of Construction

S&RC should be engaged to inspect excavations conditions exposed during construction so that 'actual' ground conditions can be compared with those assumed in formulating this report.

The aspects of the development that require geotechnical observation, testing, and final certification will be determined by Council and given in the Special Conditions of the Consent. The Contractor should make themselves familiar with those conditions and ensure adequate observations are carried out. In any case, the contractor should notify S&RC should ground conditions encountered during construction vary from those described in this report.

Any ground covered by fill or concrete prior to geotechnical inspection will be specifically excluded from completion certification.

19.0 Earthworks Completion Report

Council will require an Earthworks Completion Report (ECR) be submitted by the Geotechnical Engineer at the close of the subdivision earthworks. That document will contain a 'Statement of Professional Opinion' (SOPO) that Council will rely upon to assist with RMA 'Section 224C' processing.

Preliminary recommendations regarding soil characteristics and stability recommendations provided in this report will be confirmed or modified as appropriate within the ECR and SOPO.

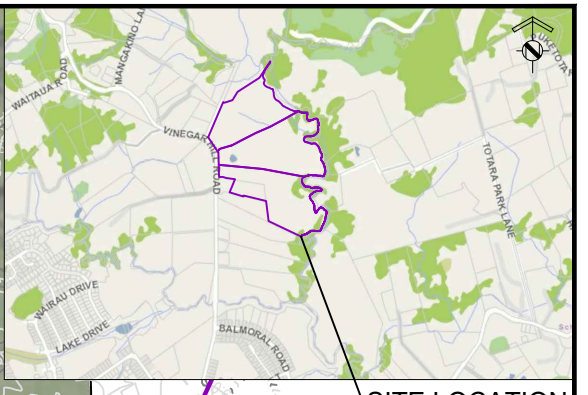
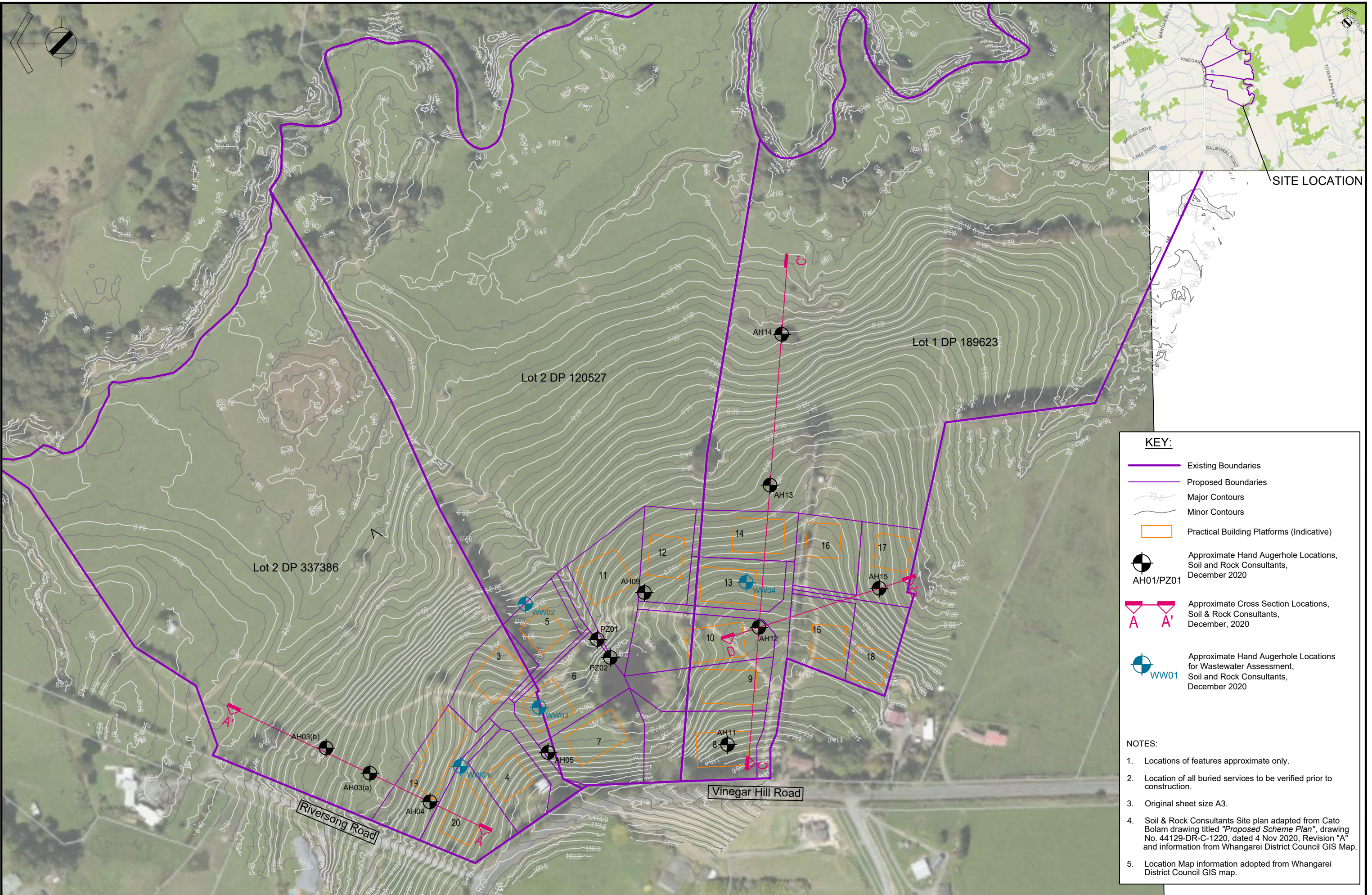
Most of these observations would normally be made during subdivisional earthworks monitoring and testing however at this site, we expect that work to be minimal. The developer may opt to have a number of 'bearing capacity' augerholes carried out in order to provide greater detail in the ECR and less reliance, or need for, subsequent site-specific geotechnical work to support Building Consent applications. Some aspects, such as testing for shrink-swell characteristics and bearing capacities of building platforms established in cut ground can only be carried out at the close of earthworks.

It follows that any preliminary designs (typically residential housing) prepared prior to the issue of the ECR and SOPO is at the risk of the designer.

End of Report Text – Appendices Follow

Appendix A

Drawings: Soil & Rock Consultants Site Plan, Cross
Sections and Wastewater Disposal Plan



SITE LOCATION

KEY:

- Existing Boundaries
- Proposed Boundaries
- Major Contours
- Minor Contours
- Practical Building Platforms (Indicative)
- Approximate Hand Augerhole Locations, Soil & Rock Consultants, December 2020
AH01/PZ01
- Approximate Cross Section Locations, Soil & Rock Consultants, December, 2020
A A'
- Approximate Hand Augerhole Locations for Wastewater Assessment, Soil and Rock Consultants, December 2020
WW01

- NOTES:**
1. Locations of features approximate only.
 2. Location of all buried services to be verified prior to construction.
 3. Original sheet size A3.
 4. Soil & Rock Consultants Site plan adapted from Cato Bolam drawing titled "Proposed Scheme Plan", drawing No. 44129-DR-C-1220, dated 4 Nov 2020, Revision "A" and information from Whangarei District Council GIS Map.
 5. Location Map information adopted from Whangarei District Council GIS map.

AMENDMENTS		
DATE	REV	DESCRIPTION
2021-02-04	A	Report Issue

Soil & Rock Consultants
Your responsive & cost-effective engineers

Level 1, 131 Lincoln Road, Waitakere
PO Box 21-424 Henderson, Waitakere 0650
Ph 09 835 1740 Fax 09 835 1847
www.soilandrock.co.nz

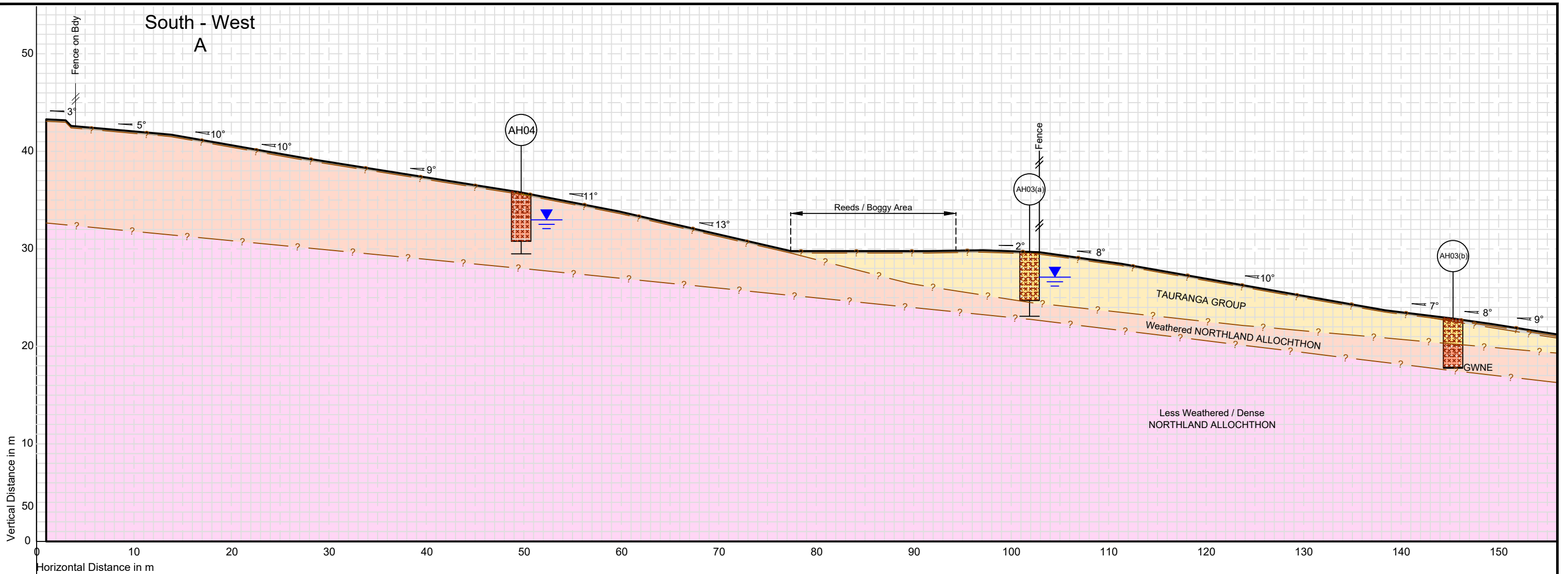
Check all dimensions and levels on site before commencing construction.
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158 VINEGAR HILL ROAD
KAURI

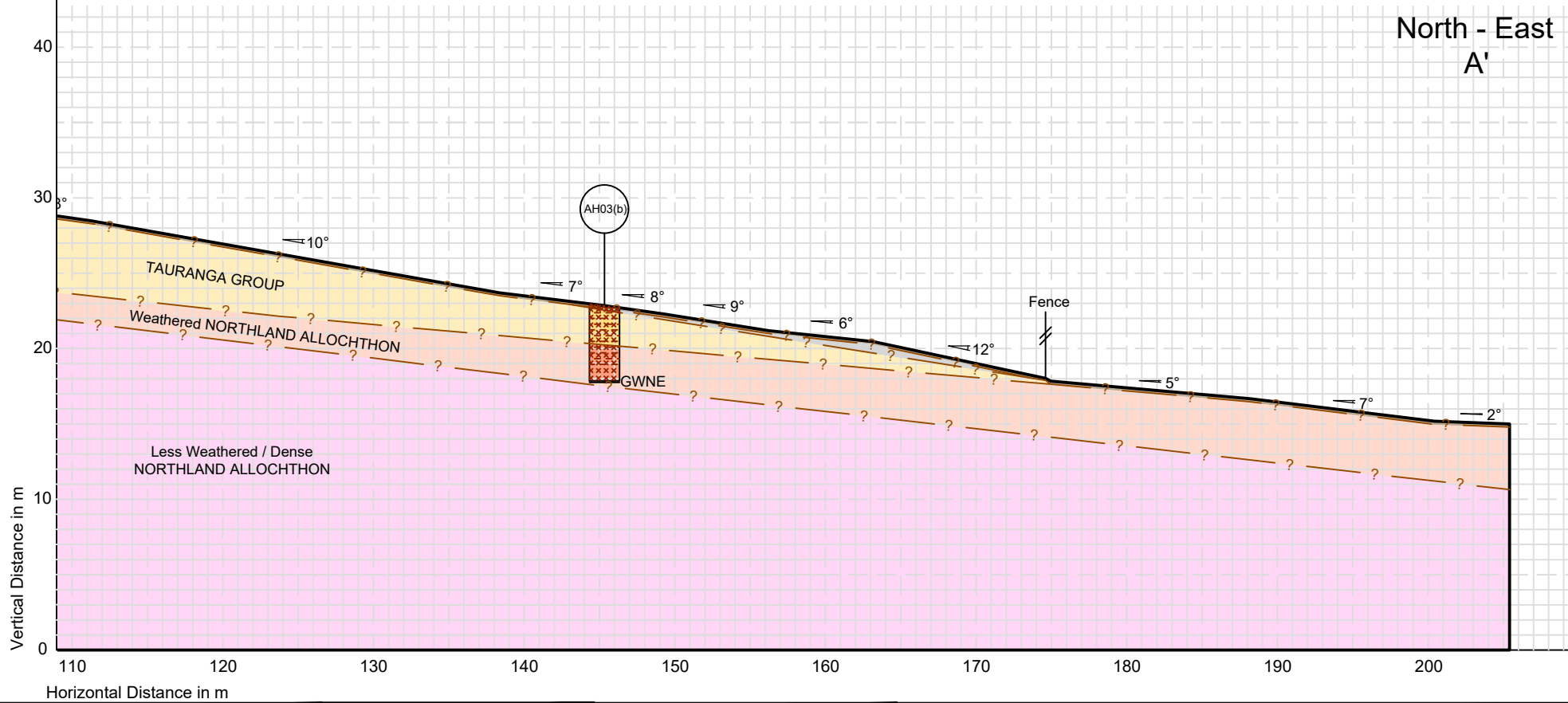
SITE PLAN

NL20029/S2/01	DRAWN: MB	DATE: January 13, 2021
SCALES: 1: 2500 AT A3	CHECKED: CSH	REV: A
DESIGNED:		
Filename: nl20029 - site plan - combined.dwg		

South - West
A



North - East
A'



KEY TO CROSS SECTION SYMBOLS

- Hand drilled Auger Hole
- Groundwater Level
- GWNE No Groundwater encountered
- Scala Penetrometer Test from base of Auger Hole

KEY TO LITHOLOGY HATCHES

- Fill
- Clay
- Silt
- Clayey Silt/Silty Clay
- Sand
- Sandy Silt/Silty Sand

KEY TO LITHOLOGY SHADES

- Topsoil
- Fill
- Tauranga Group
- Weathered Northland Allochthon
- Dense / Less Weathered Allochthon

Background Shade
Shade at Borehole/Augerhole

NOTES:

1. Soil and Rock Consultants Cross Sections measured by tape and clinometer.
2. Soil descriptions shown approximate only, refer to borelogs for details.
3. Extrapolation of soil conditions away from boreholes has been made but cannot be guaranteed due to the variability of Soil deposits.
4. Groundwater measurements were made December 2020.
5. Locations of features approximate only.

AMENDMENTS		
DATE	REV	DESCRIPTION
2021-01-14	A	Report Issue

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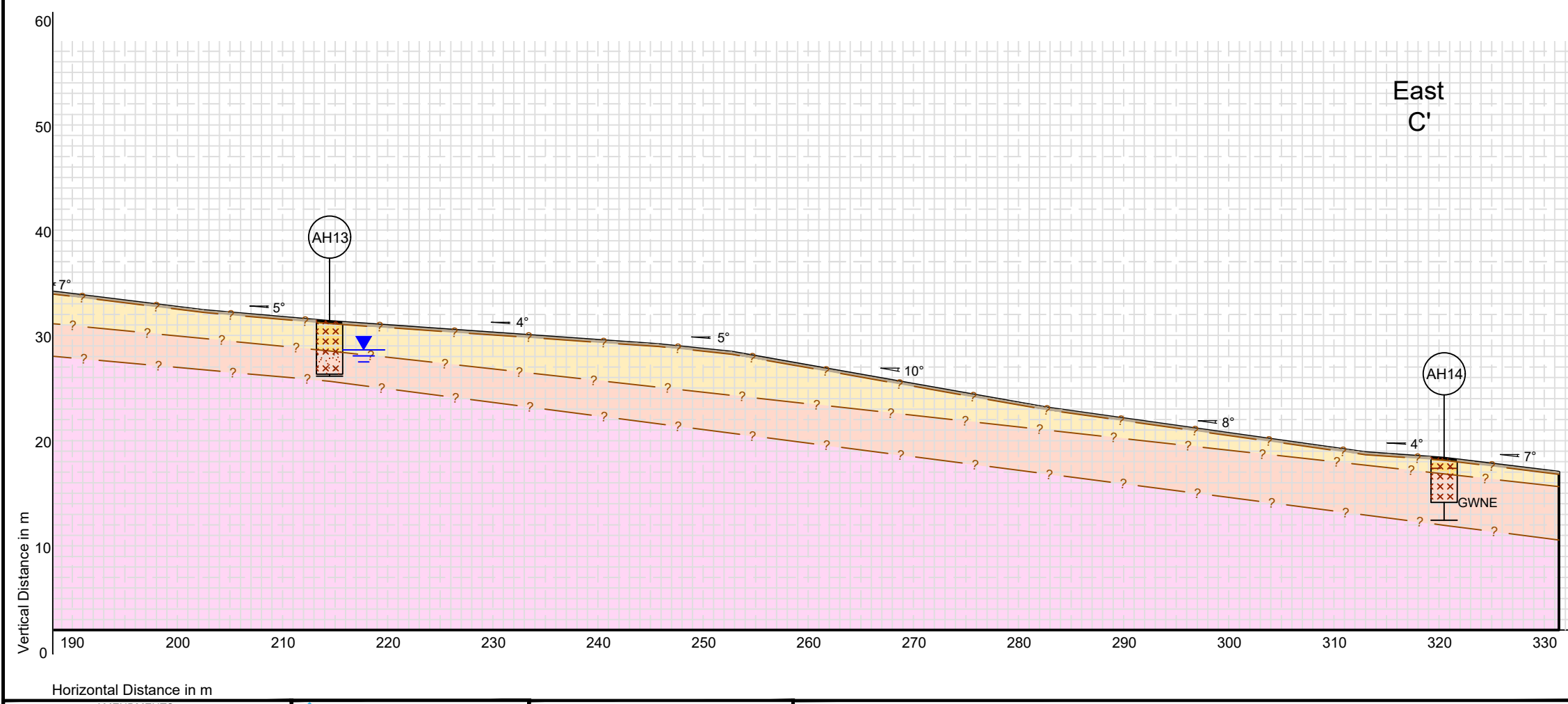
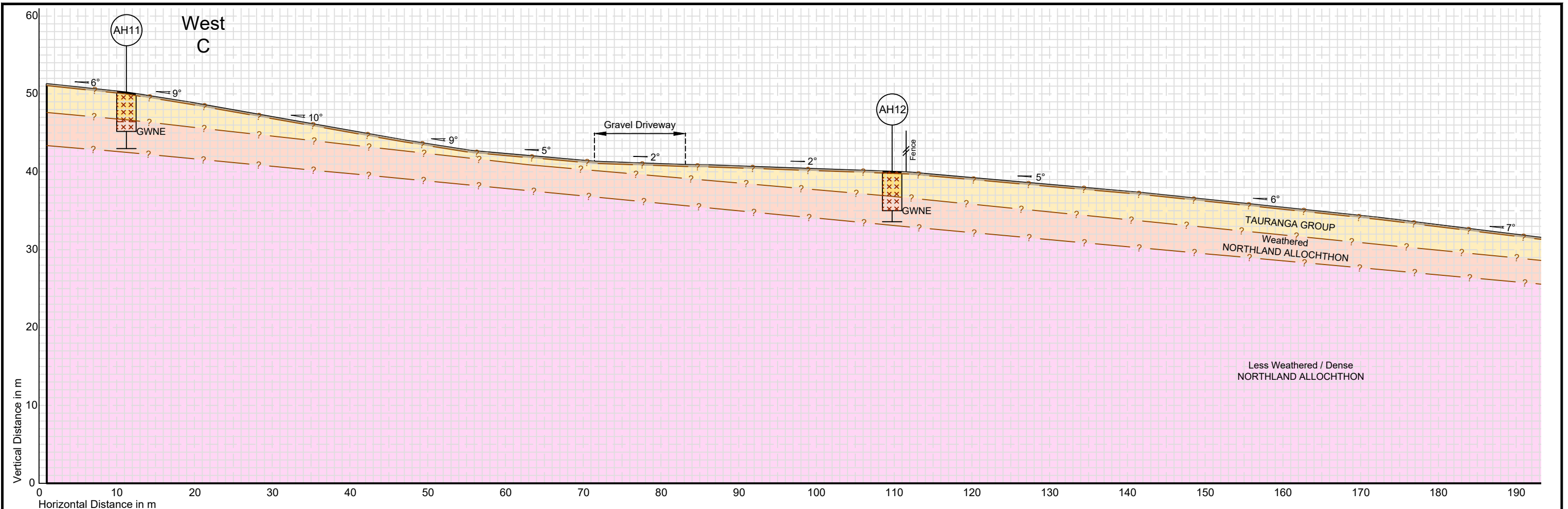
Level 1, 131 Lincoln Road, Waitakere
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KAURI

CROSS SECTION A-A'

NL20029/S2/02	DRAWN: MB	DATE: 14 Jan 2021
SCALES: 1: 400 AT A3	CHECKED: CsH	REV. A
	DESIGNED:	
Filename: NL20029 - Cross Sections		



KEY TO CROSS SECTION SYMBOLS

- Hand drilled Auger Hole
- Groundwater Level
- GWNE No Groundwater encountered
- Scala Penetrometer Test from base of Auger Hole

KEY TO LITHOLOGY HATCHES

- Fill
- Clay
- Silt
- Clayey Silt/Silty Clay
- Sand
- Sandy Silt/Silty Sand

KEY TO LITHOLOGY SHADES

- Topsoil
- Fill
- Tauranga Group
- Weathered Northland Allochthon
- Dense / Less Weathered Allochthon

- NOTES:**
1. Soil and Rock Consultants Cross Sections measured by tape and clinometer.
 2. Soil descriptions shown approximate only, refer to borelogs for details.
 3. Extrapolation of soil conditions away from boreholes has been made but cannot be guaranteed due to the variability of Soil deposits.
 4. Groundwater measurements were made December 2020.
 5. Locations of features approximate only.

AMENDMENTS		
DATE	REV	DESCRIPTION
2021-01-14	A	Report Issue

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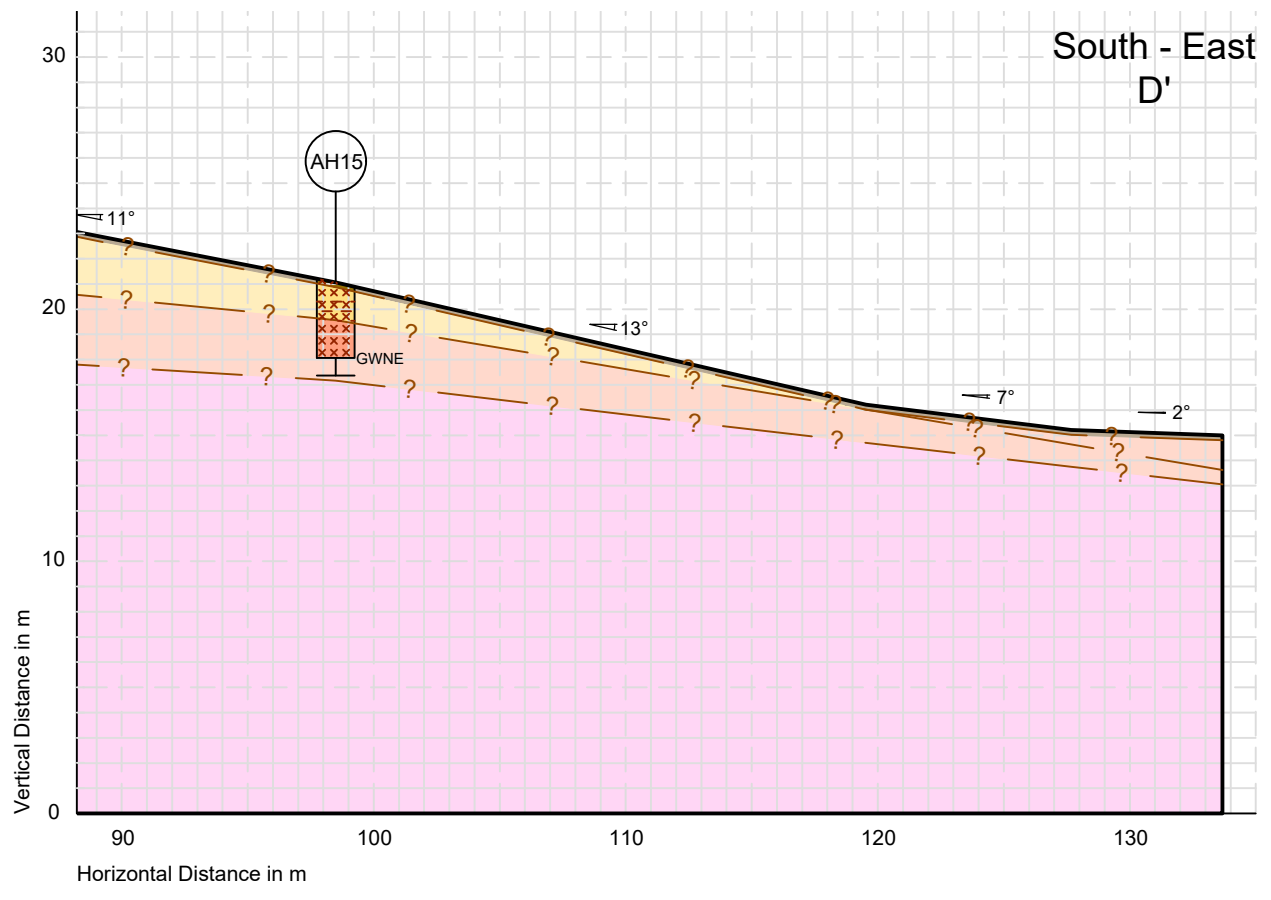
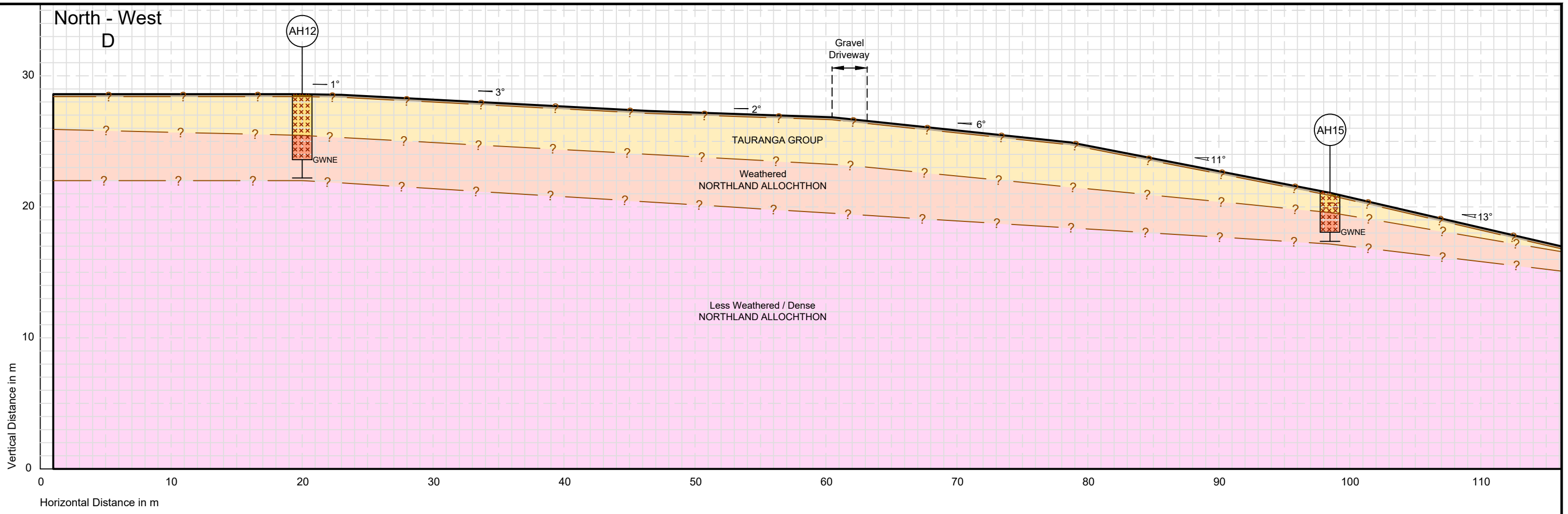
Level 1, 131 Lincoln Road, Waitakere
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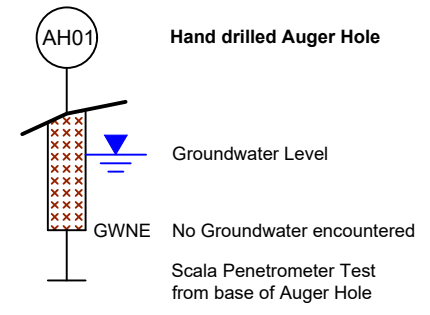
**158 VINEGAR HILL ROAD
KAURI**

CROSS SECTION C-C'

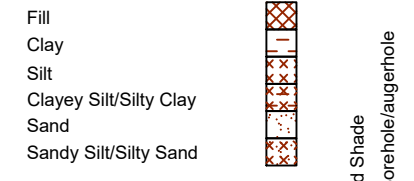
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	DESIGNED:	
Filename: NL20029 - Cross Sections		



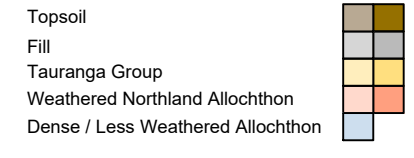
KEY TO CROSS SECTION SYMBOLS



KEY TO LITHOLOGY HATCHES



KEY TO LITHOLOGY SHADES



NOTES:

1. Soil and Rock Consultants Cross Sections measured by tape and clinometer.
2. Soil descriptions shown approximate only, refer to borelogs for details.
3. Extrapolation of soil conditions away from boreholes has been made but cannot be guaranteed due to the variability of Soil deposits.
4. Groundwater measurements were made December 2020.
5. Locations of features approximate only.

AMENDMENTS		
DATE	REV	DESCRIPTION
2021-01-14	A	Report Issue

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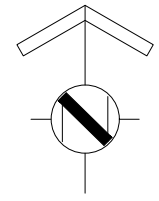
Level 1, 131 Lincoln Road, Waitakere
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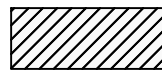
**158 VINEGAR HILL ROAD
 KAURI**

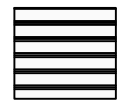
CROSS SECTION D-D'

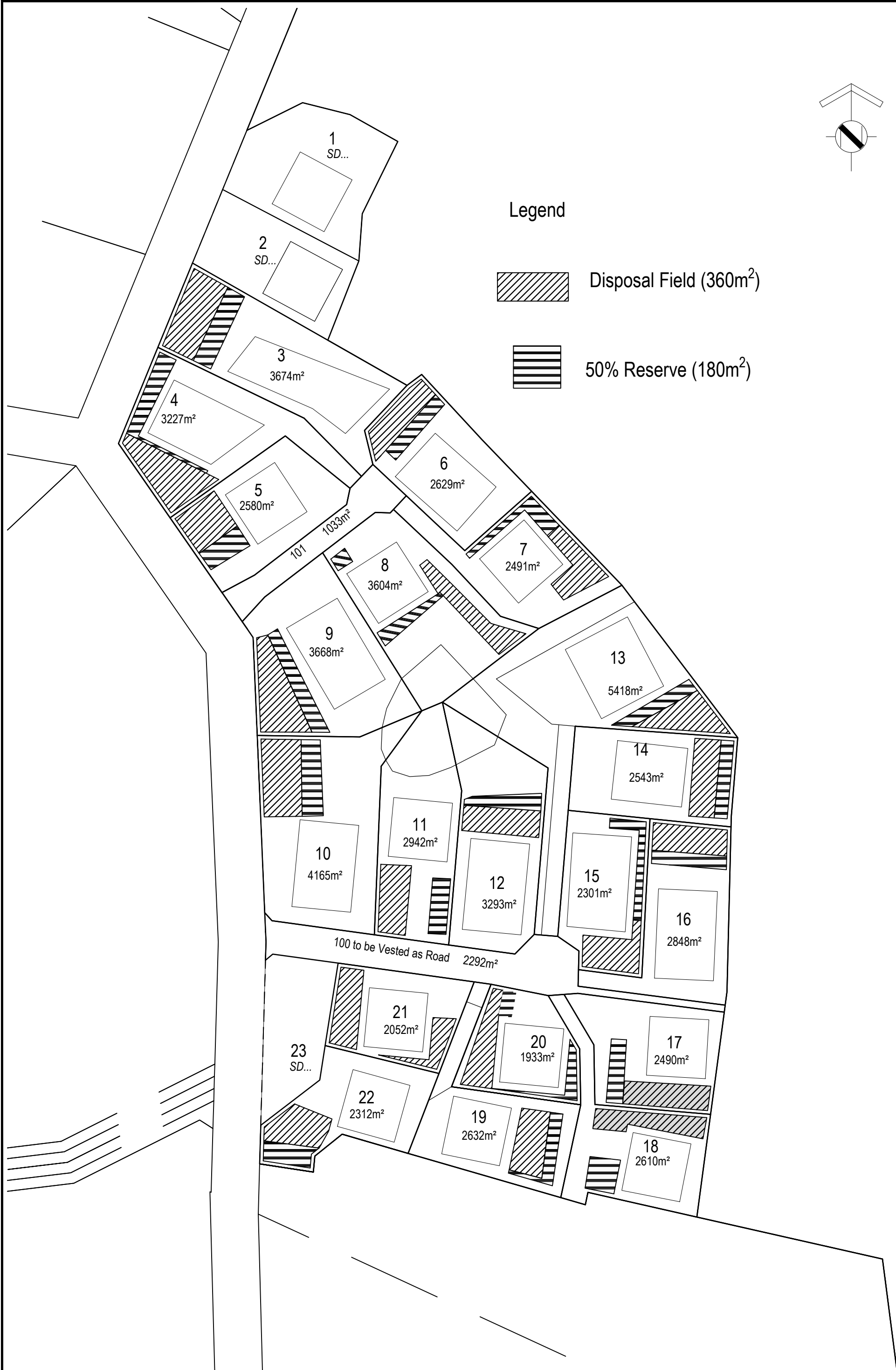
NL20029/S2/04	DRAWN: MB	DATE: 14 Jan 2021
SCALES: 1: 300 AT A3	CHECKED:	REV. A
	DESIGNED:	
Filename: NL20029 - Cross Sections		



Legend

 Disposal Field (360m²)

 50% Reserve (180m²)



AMENDMENTS		
DATE	REV	DESCRIPTION

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158 Vinegar Hill Road
Kauri

Wastewater Field for Stage 1

2021/05	DRAWN: NH	DATE: September 8, 2020
SCALES: 1: 2000 AT A3	CHECKED:	REV.
	DESIGNED:	
Filename: 44129 wastewater field.dwg		

Appendix B

Investigation Logs
(Hand Augerholes, Scala Penetrometer Results)



CLIENT: Evo Land Ltd c/- Cato Bolam Consultants

Auger Hole No: AH03(a)

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

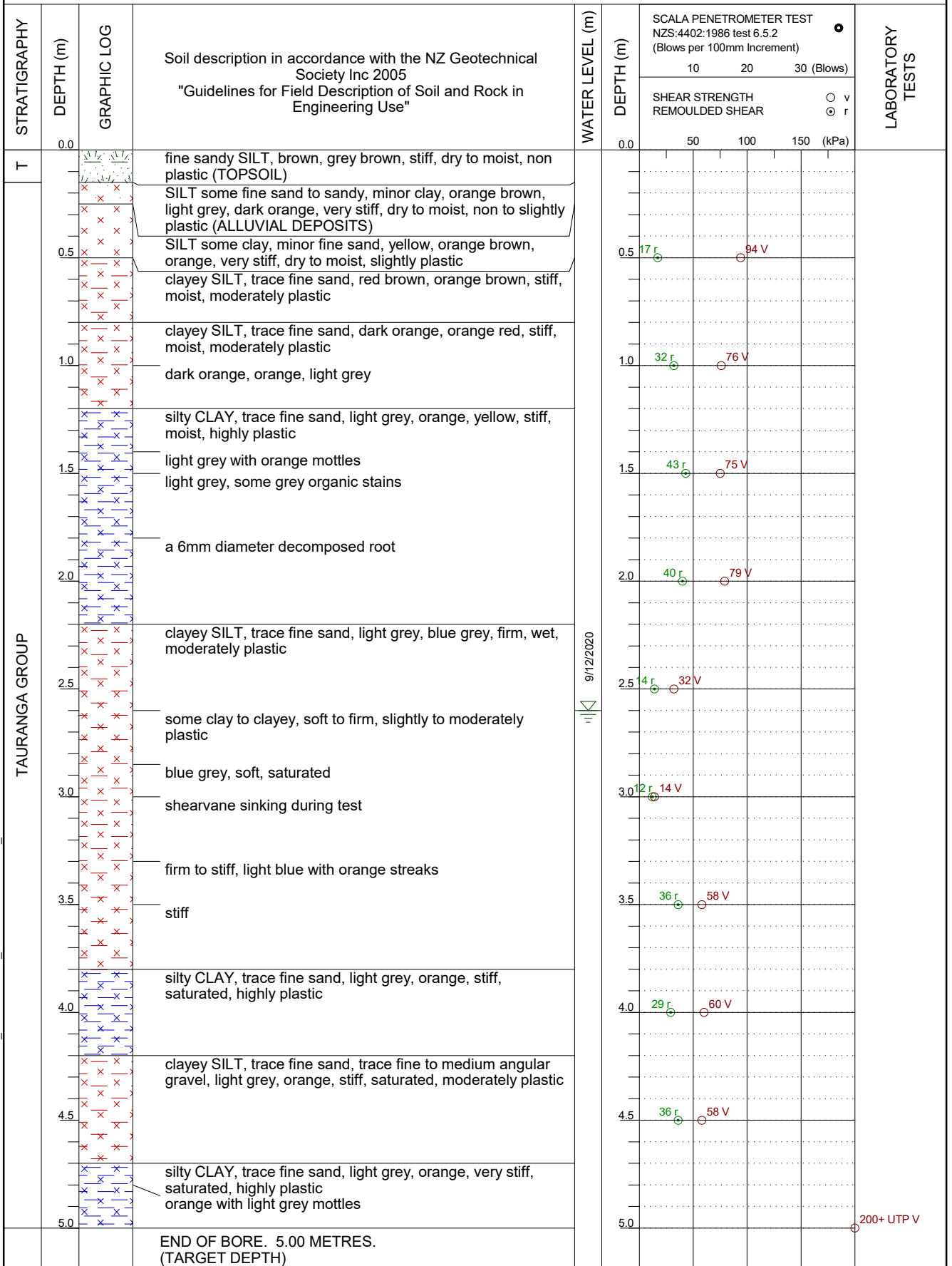
Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: DEG
 Date Started: 9/12/20
 Date Finished: 9/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: 2.6m 9/12/2020

Logged By: DEG
 Shear Vane No - Calibration Date: GEO2199 - 2/10/2020
 Surface Conditions: Near Level, Grass

HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R 2013.GDT 5/2/21





CLIENT: Evo Land Ltd c/- Cato Bolam Consultants

Auger Hole No: AH03(b)

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

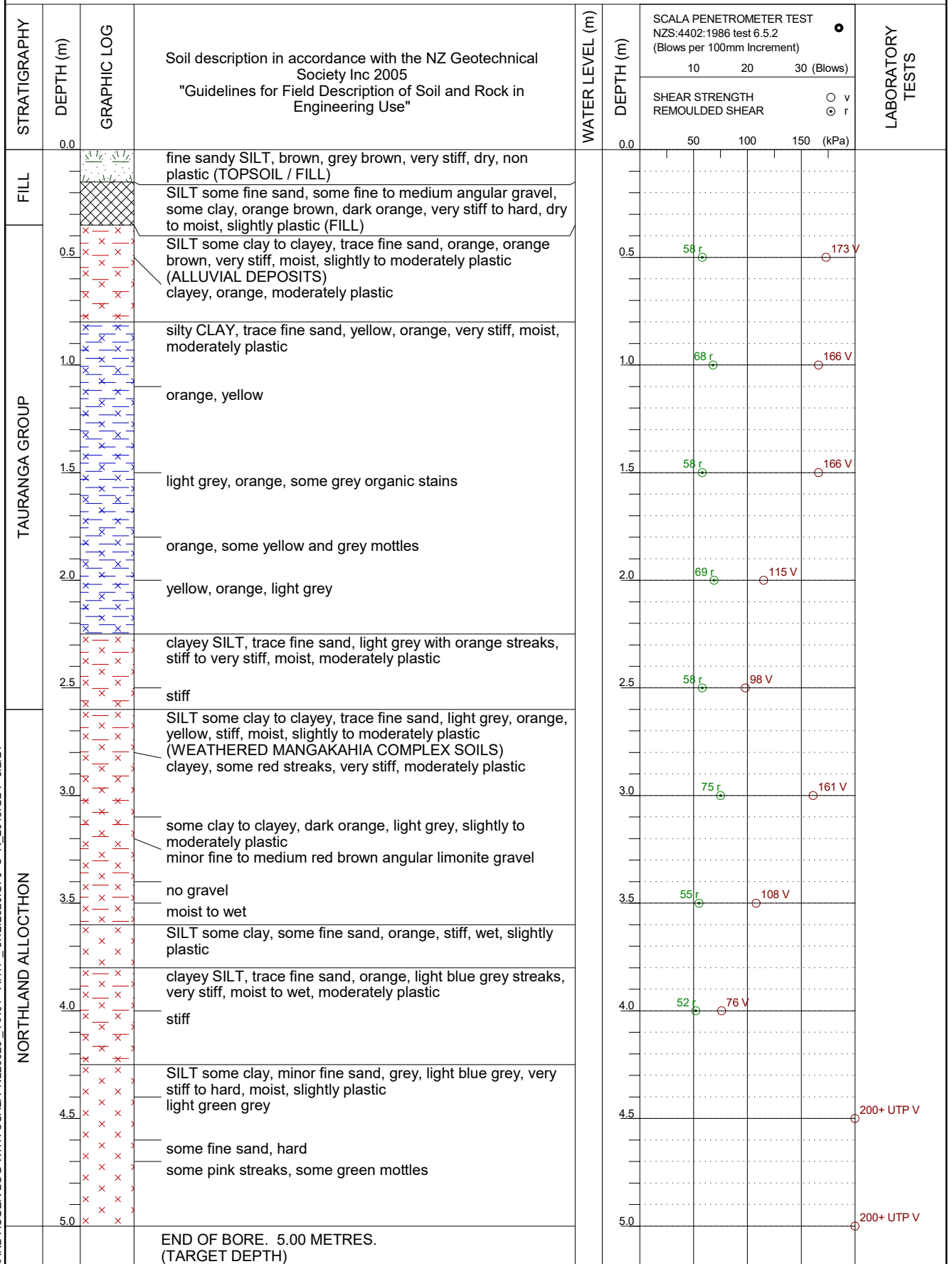
Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: DEG
 Date Started: 9/12/20
 Date Finished: 9/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: Not Encountered

Logged By: DEG
 Shear Vane No - Calibration Date: GEO2199 - 2/10/2020
 Surface Conditions: Slight Sloping, Grass

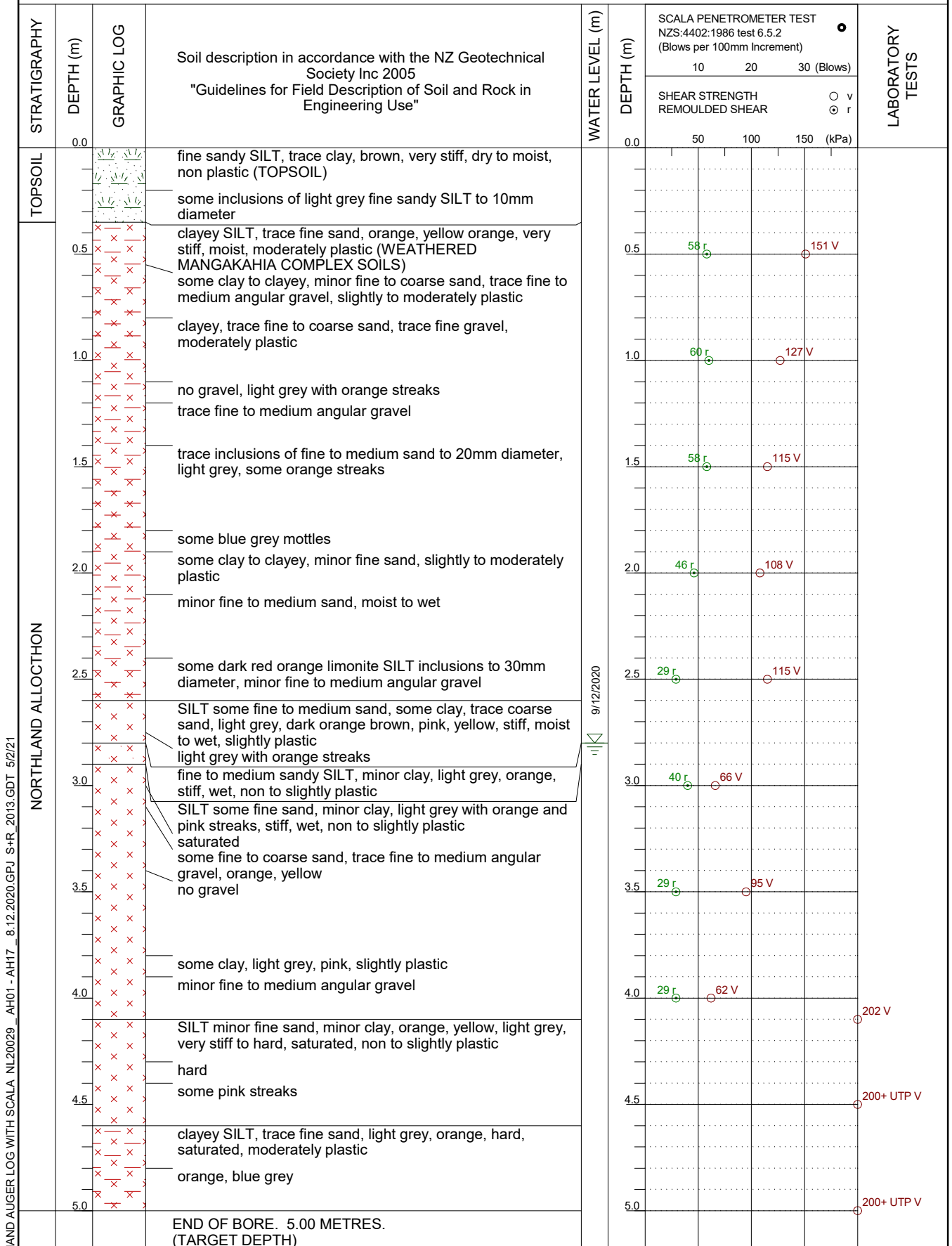
HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R_2013.GDT 5/2/21



Drill Type: 50mm Hand Auger
 Drilled By: DEG
 Date Started: 9/12/20
 Date Finished: 9/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: 2.8m 9/12/2020

Logged By: DEG
 Shear Vane No - Calibration Date: GEO2199 - 2/10/2020
 Surface Conditions: Slight to Moderate Slope, Grass



HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R 2013.GDT 5/2/21



CLIENT: Evo Land Ltd c/- Cato Bolam Consultants

Auger Hole No: AH05

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

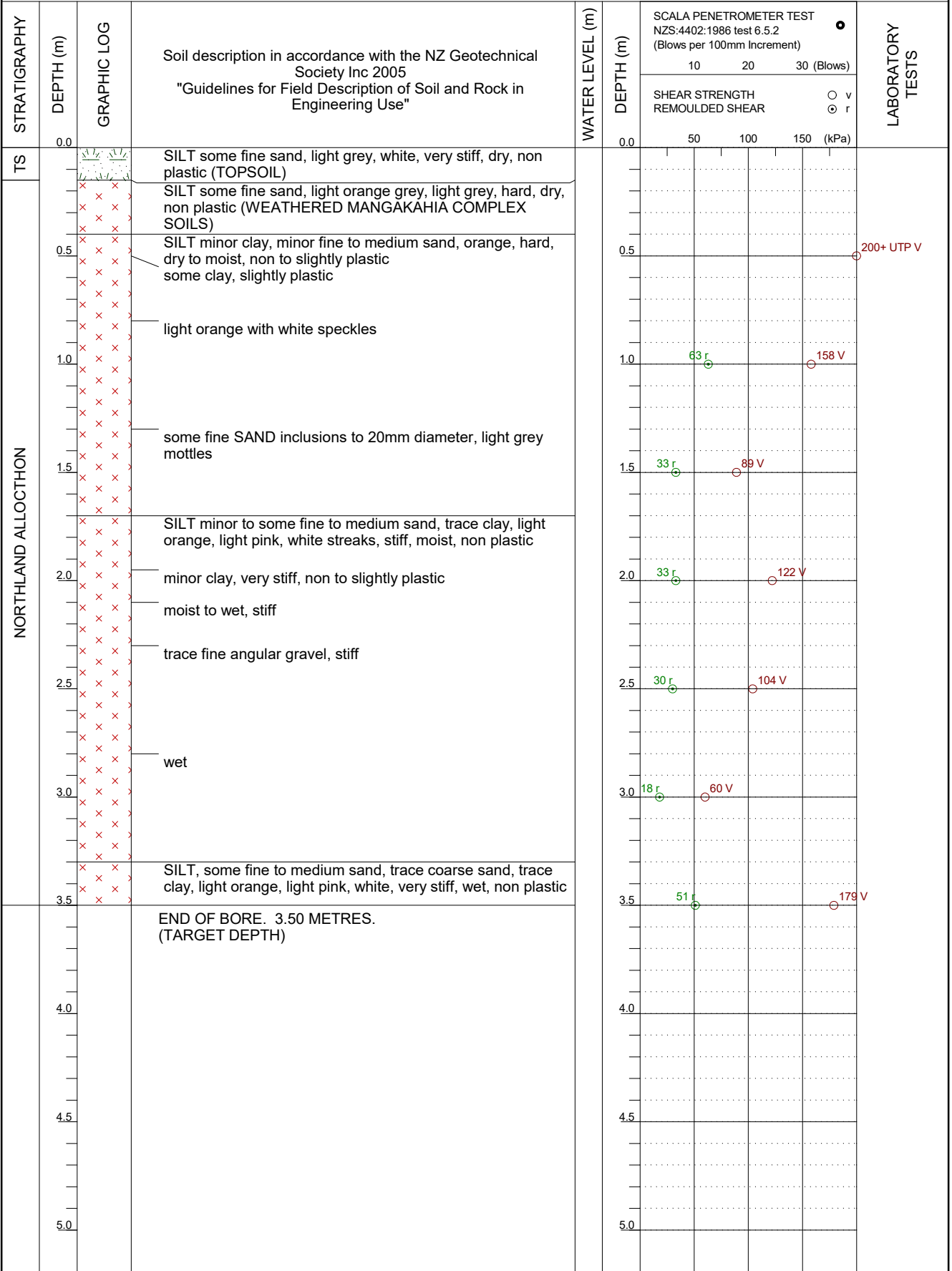
Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: JP
 Date Started: 9/12/20
 Date Finished: 9/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: Not Encountered

Logged By: JP
 Shear Vane No - Calibration Date: GEO2418 - 2/09/2020
 Surface Conditions: Steep Sloping, Grass

HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R 2013.GDT 5/2/21





CLIENT: Evo Land Ltd c/- Cato Bolam Consultants

Auger Hole No: AH09

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

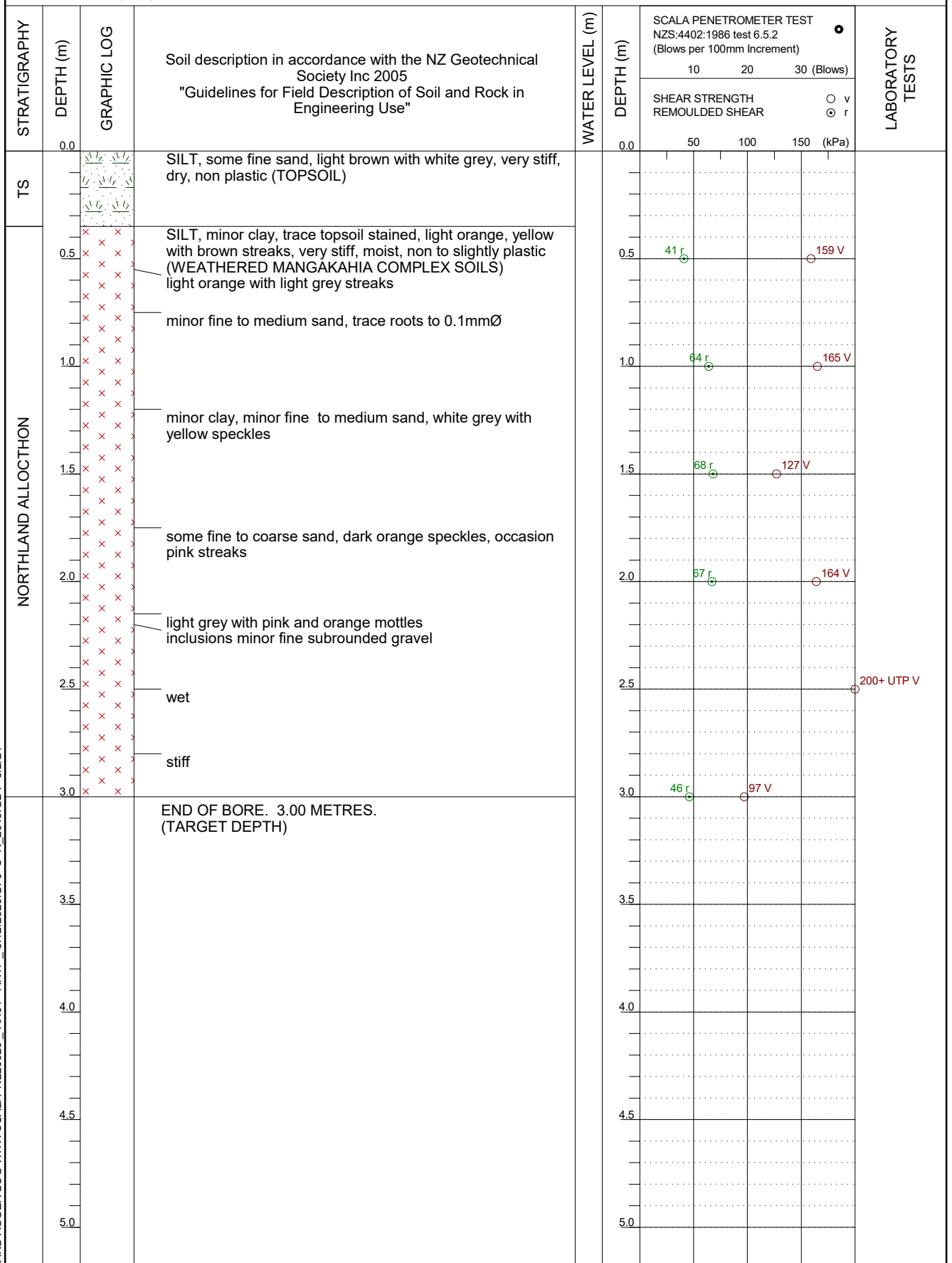
Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: NN
 Date Started: 9/12/20
 Date Finished: 9/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: Not Encountered

Logged By: NN
 Shear Vane No - Calibration Date: GEO604 - 24/11/2020
 Surface Conditions: Slightly Sloping, Grass

HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R 2013.GDT 5/2/21





CLIENT: Evo Land Ltd c/- Cato Bolam Consultants

Auger Hole No: AH11

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

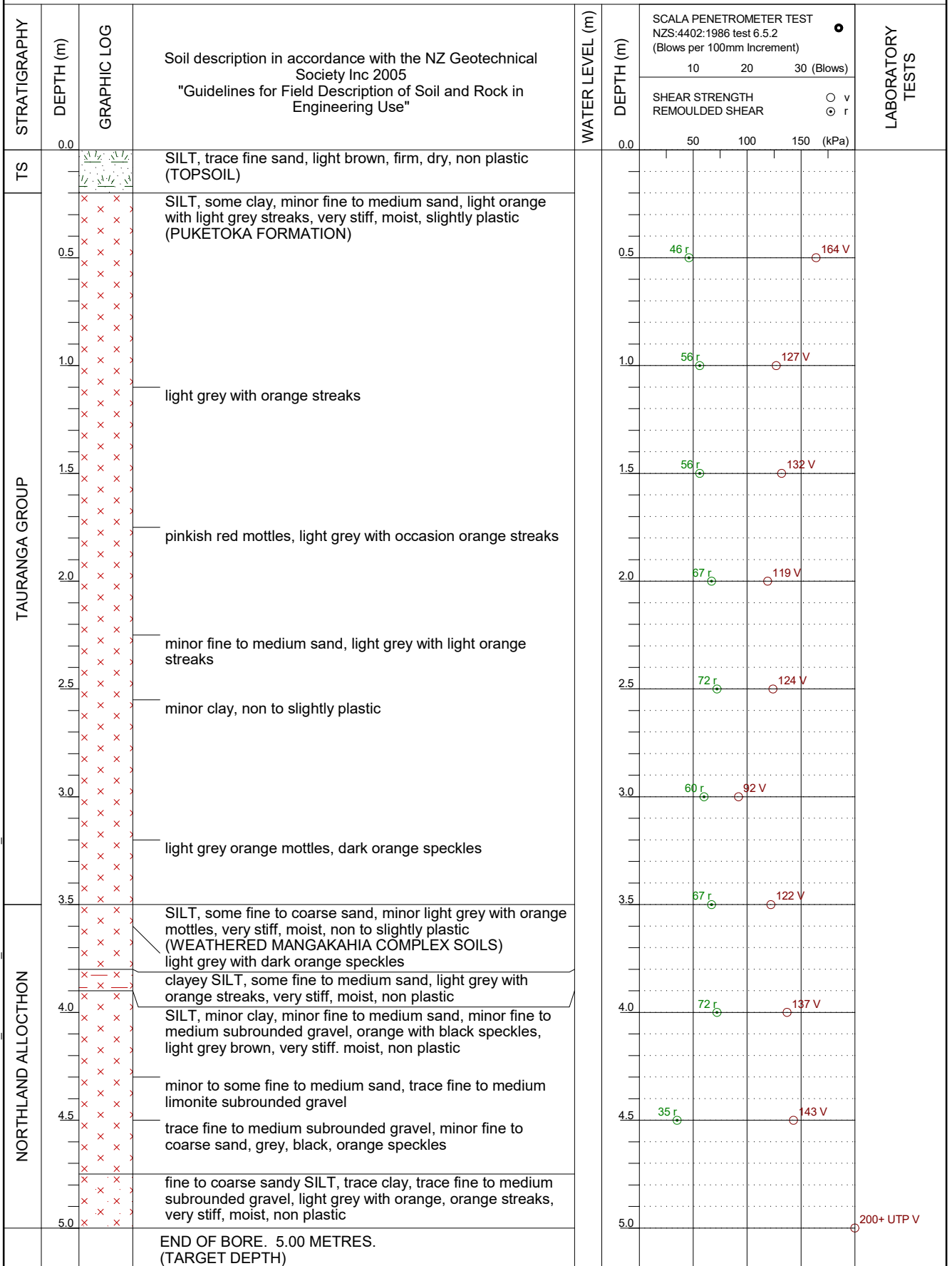
Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: NN
 Date Started: 8/12/20
 Date Finished: 8/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: Not Encountered

Logged By: NN
 Shear Vane No - Calibration Date: GEO604 - 24/11/2020
 Surface Conditions: Slightly Sloping, Grass

HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R 2013.GDT 5/2/21





CLIENT: Evo Land Ltd c/- Cato Bolam Consultants

Auger Hole No: AH12

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

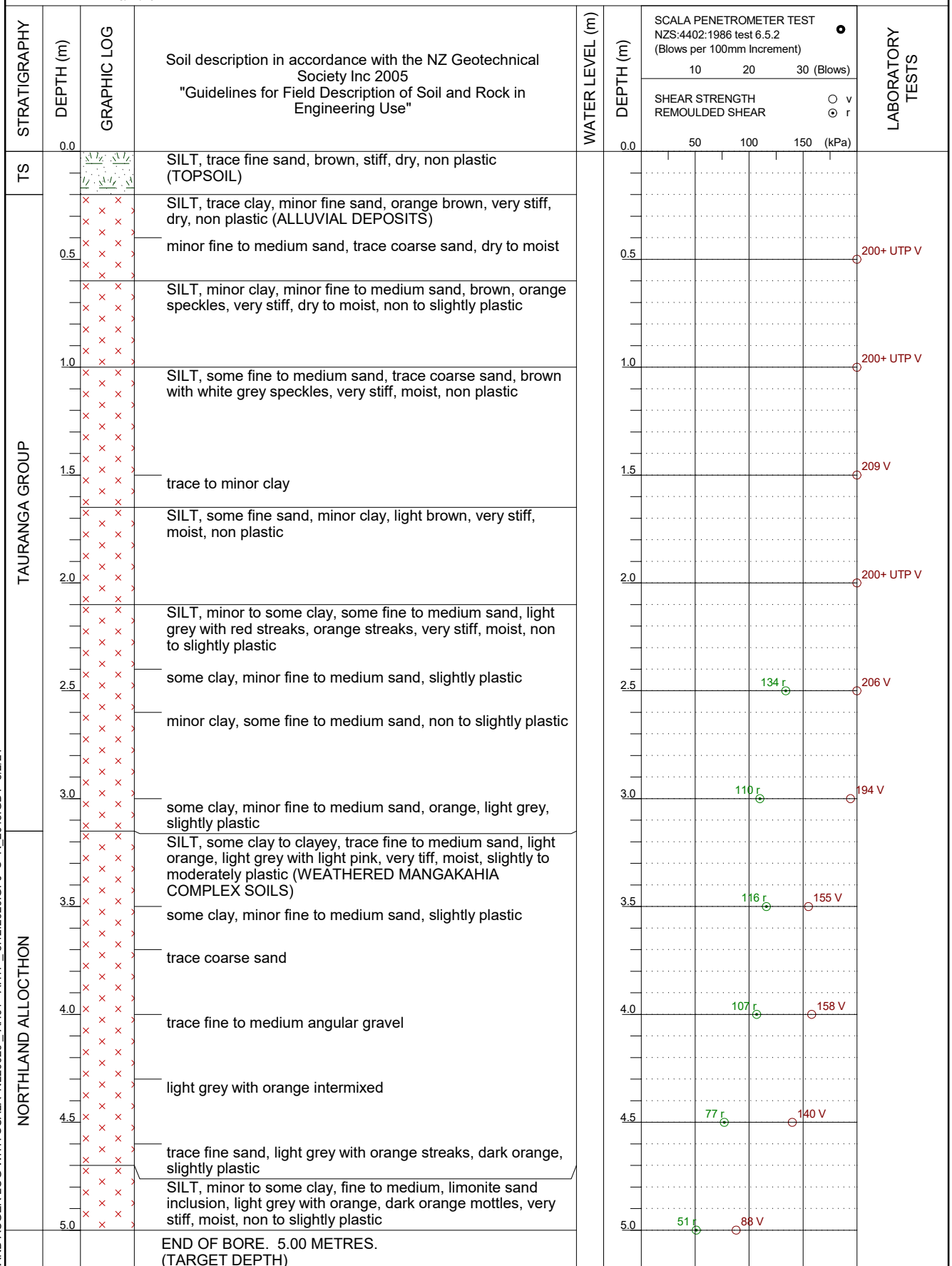
Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: JP
 Date Started: 8/12/20
 Date Finished: 8/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: Not Encountered

Logged By: JP
 Shear Vane No - Calibration Date: GEO2418 - 2/09/2020
 Surface Conditions: Near Level, Grass

HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R_2013.GDT_5/2/21





CLIENT: Evo Land Ltd c/- Cato Bolam Consultants

Auger Hole No: AH13

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

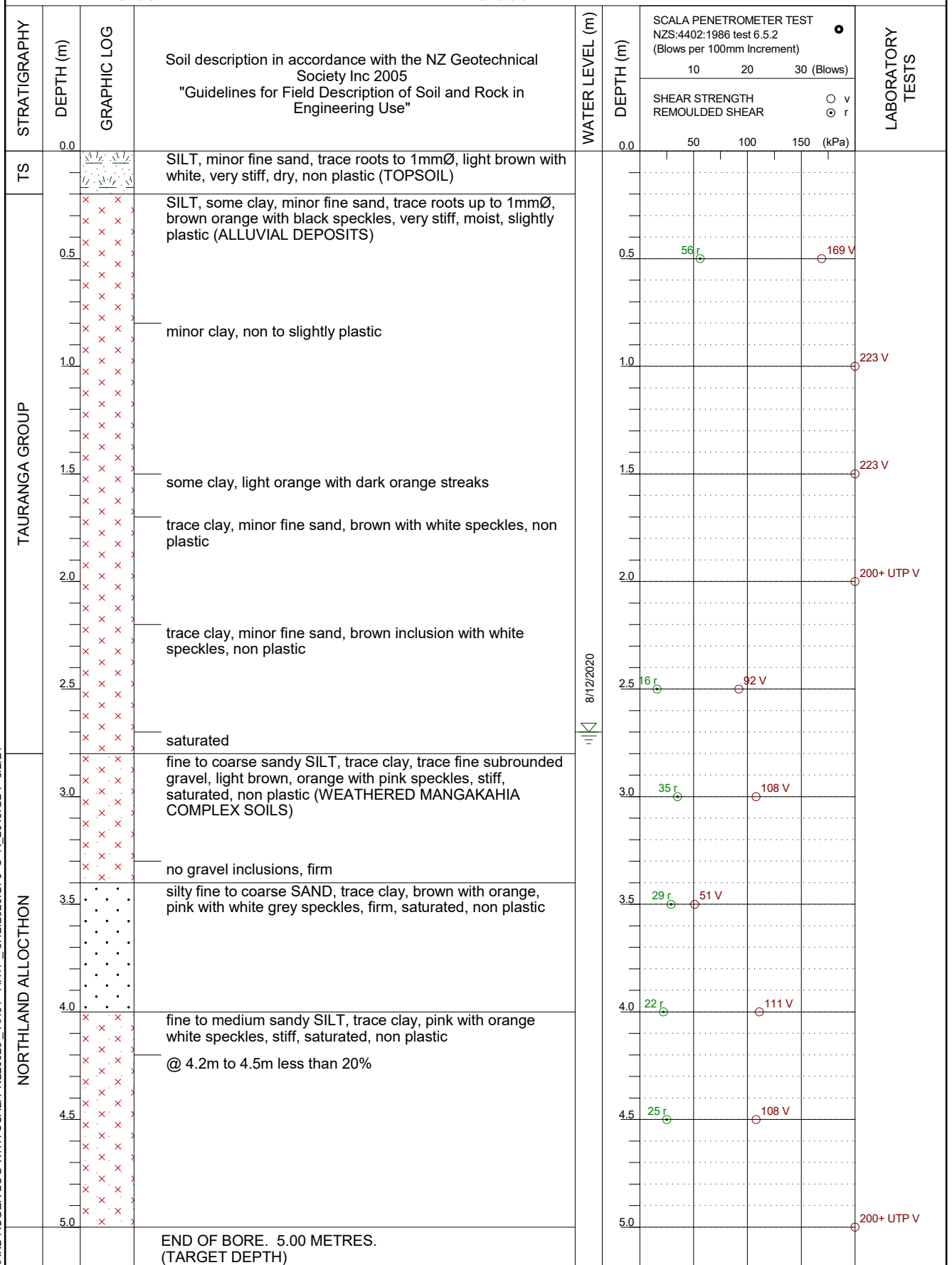
Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: NN
 Date Started: 8/12/20
 Date Finished: 8/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: 2.7m 8/12/2020

Logged By: NN
 Shear Vane No - Calibration Date: GEO604 - 24/11/2020
 Surface Conditions: Slightly Sloping, Grass

HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R 2013.GDT 5/2/21





CLIENT: Evo Land Ltd c/- Cato Bolam Consultants

Auger Hole No: AH14

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

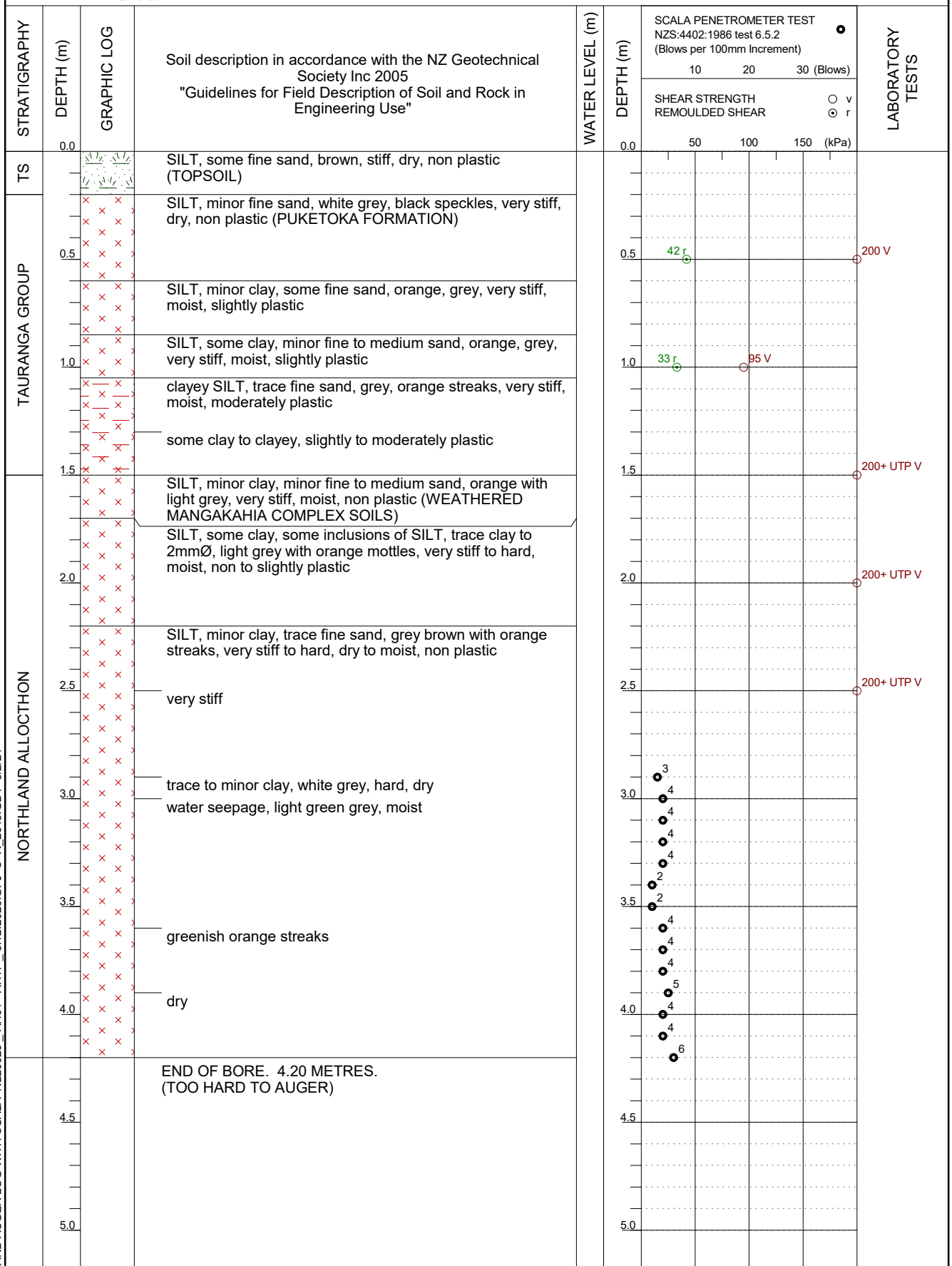
Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: JP
 Date Started: 8/12/20
 Date Finished: 8/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: Not Encountered

Logged By: JP
 Shear Vane No - Calibration Date: GEO2418 - 2/09/2020
 Surface Conditions: Nearly Level Grass

HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R_2013.GDT_5/2/21





CLIENT: Evo Land Ltd c/- Cato Bolam Consultants

Auger Hole No: AH15

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

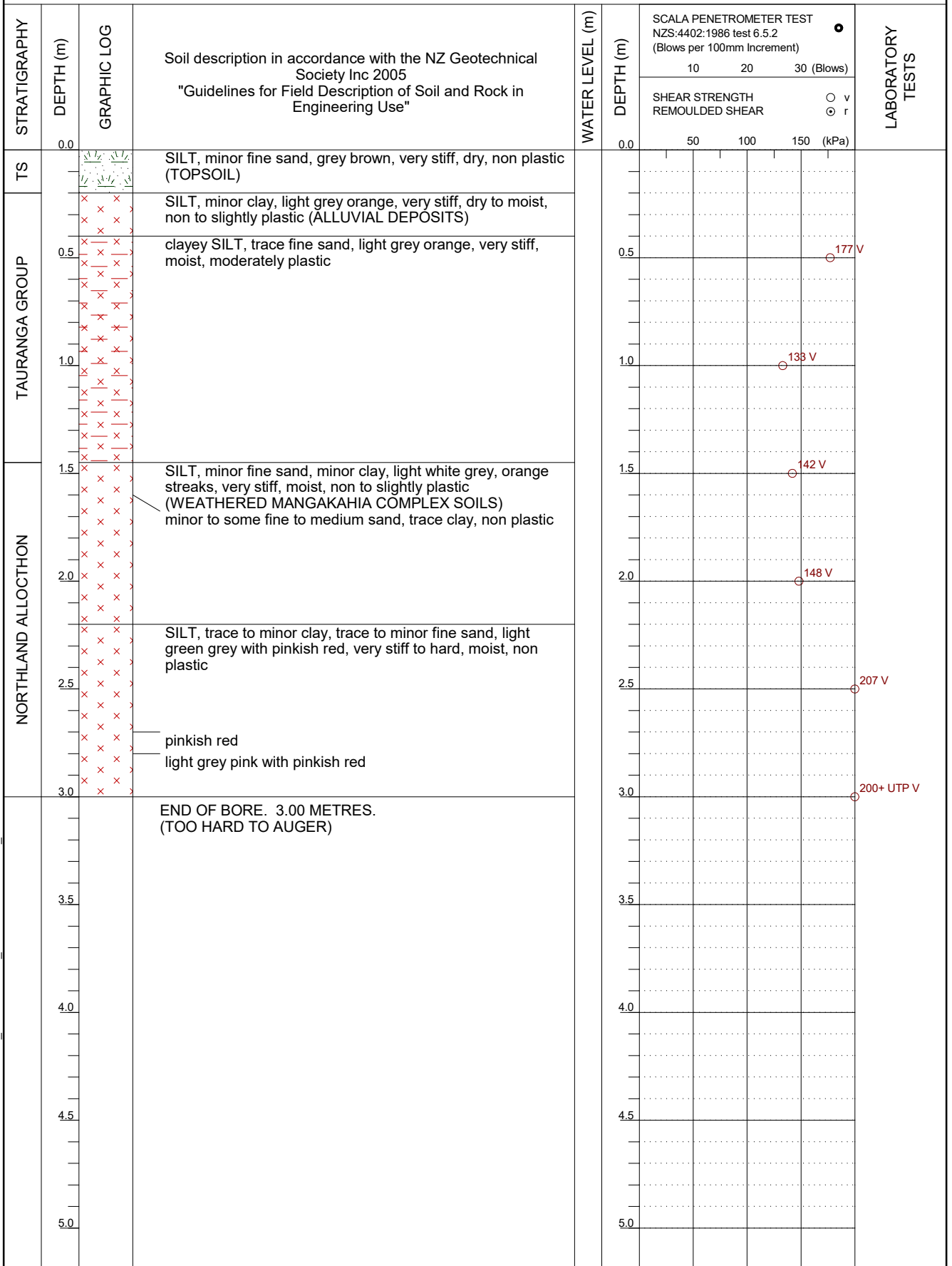
Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: STL
 Date Started: 9/12/20
 Date Finished: 9/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: Not Encountered

Logged By: STL
 Shear Vane No - Calibration Date: GEO1050 - 3/12/2020
 Surface Conditions: Moderately Slope Grass

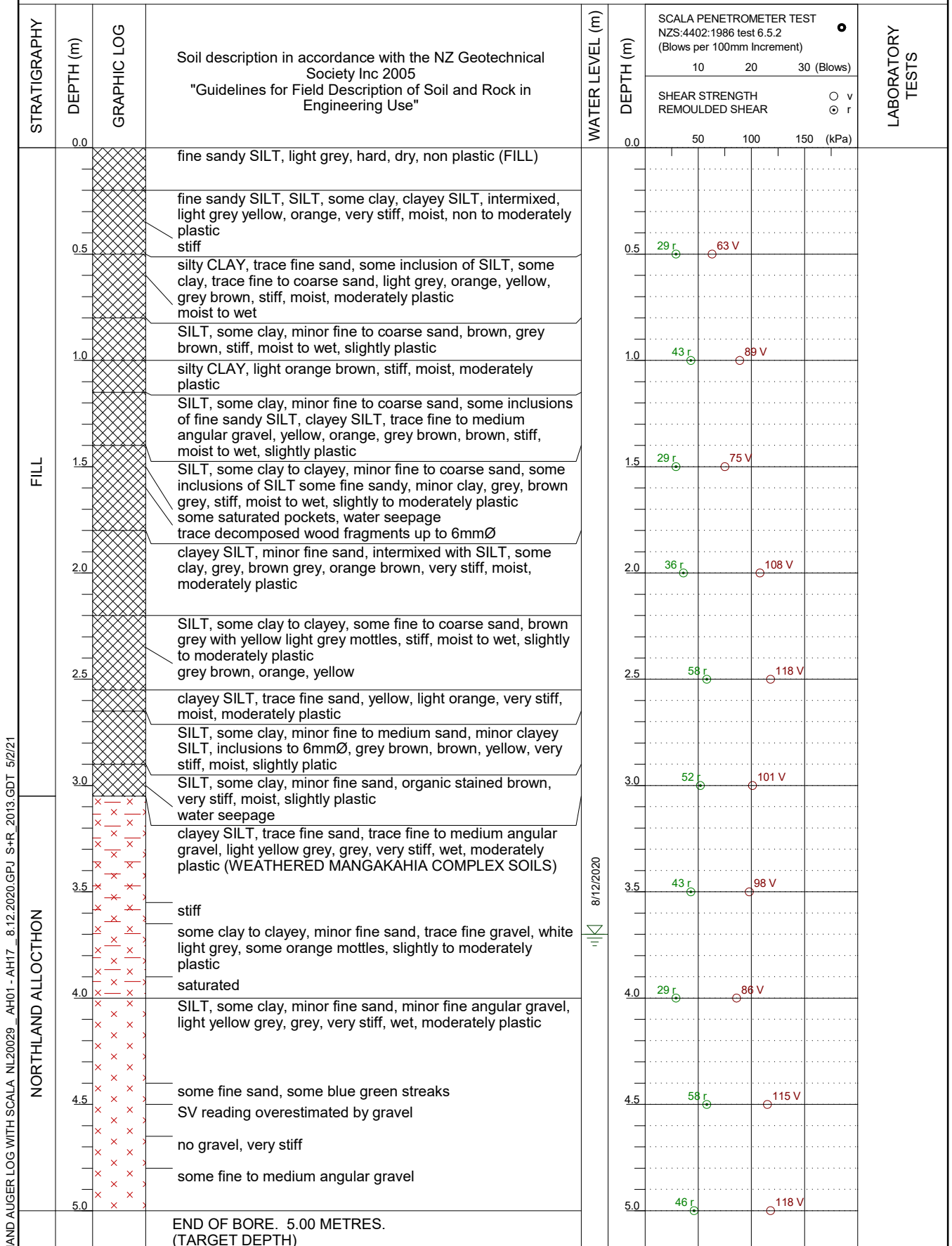
HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R 2013.GDT 5/2/21



Drill Type: 50mm Hand Auger
 Drilled By: DEG
 Date Started: 8/12/20
 Date Finished: 8/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: 3.7m 8/12/2020

Logged By: DEG
 Shear Vane No - Calibration Date: GEO2199 - 2/10/2020
 Surface Conditions: Top of Dam



HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R_2013.GDT 5/2/21



CLIENT: Evo Land Ltd c/- Cato Bolam Consultants

Auger Hole No: PZ02

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

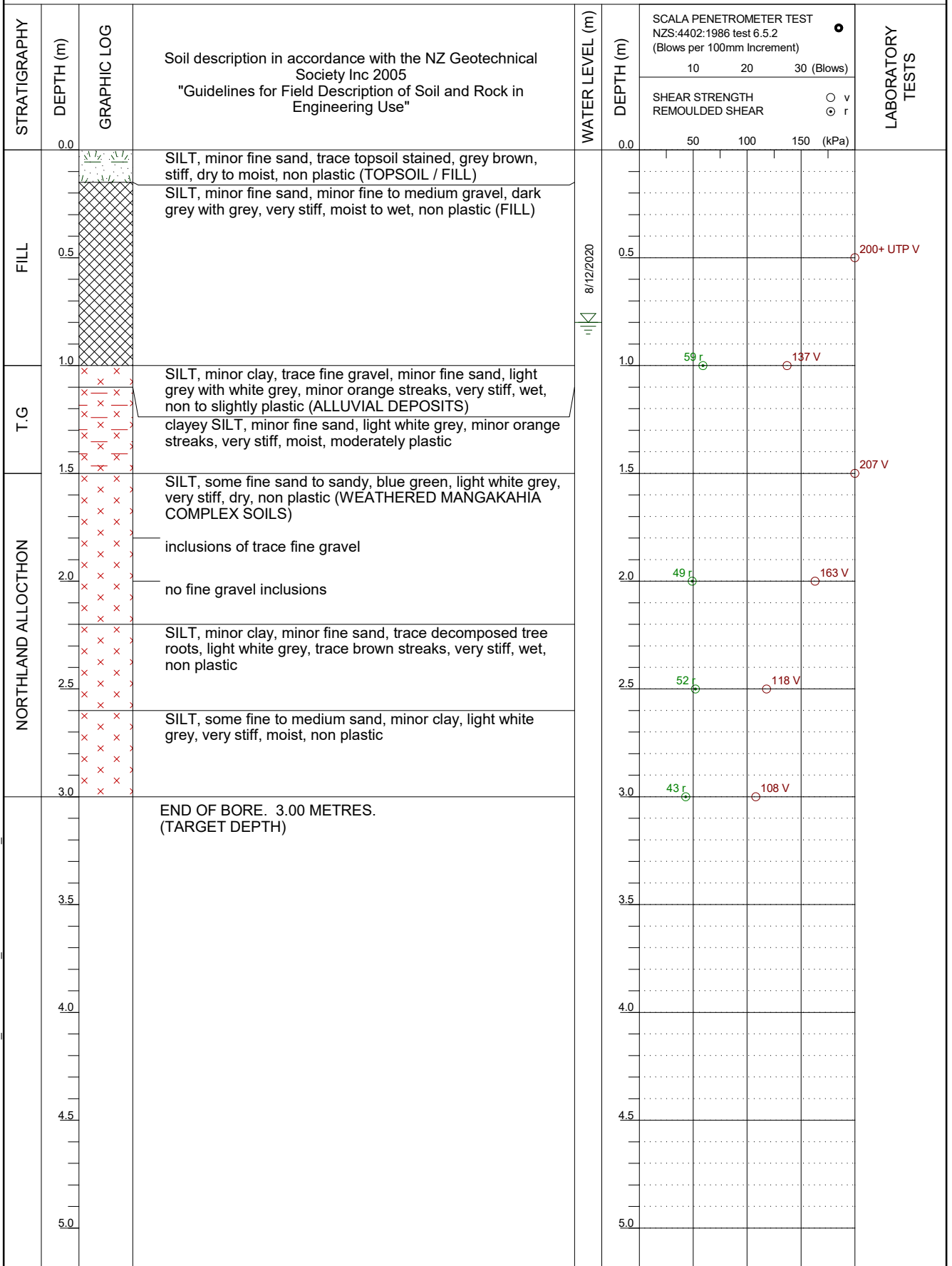
Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: STL
 Date Started: 8/12/20
 Date Finished: 8/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: 0.8m 8/12/2020

Logged By: STL
 Shear Vane No - Calibration Date: GEO1050 - 3/12/2020
 Surface Conditions: Bottom of Dam

HAND AUGER LOG WITH SCALA NL20029_AH01 - AH17_8.12.2020.GPJ S+R 2013.GDT 5/2/21





CLIENT: Evo Land Ltd C/- Cato Bolam Consultants

Auger Hole No: WW01

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: CSH
 Date Started: 9/12/20
 Date Finished: 9/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: Not Encountered

Logged By: CSH
 Shear Vane No - Calibration Date:
 Surface Conditions: Sloping, Grass

HAND AUGER LOG WITH SCALA NL20029_WASTE-WATER-LOGS_9.12.2020.GPJ S+R_2013.GDT 5/2/21

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	SCALA PENETROMETER TEST NZS:4402:1986 test 6.5.2 (Blows per 100mm Increment)			LABORATORY TESTS
					DEPTH (m)	10	20	
FILL	0.0		SILT, minor fine to medium sand, grey, trace roots up to 1mmØ, stiff, dry, non plastic (TOPSOIL / FILL)					
			SILT, minor fine to medium sand, light grey with orange speckles, firm, dry to moist, non plastic (FILL)					
TAURANGA GROUP	0.5		SILT, some clay, trace fine to medium sand, orange, slightly plastic (ALLUVIAL DEPOSITS)					
	1.0		some clay to clayey, light orange with light orange streaks, slightly to moderately plastic minor fine sand					
	1.5		END OF BORE. 1.20 METRES. TARGET DEPTH					
	2.0							



CLIENT: Evo Land Ltd C/- Cato Bolam Consultants

Auger Hole No: WW02

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

Sheet 1 of 1

Drill Type: 50mm Hand Auger	Project No: NL20029/S2	Logged By: JP
Drilled By: JP	Coordinates:	Shear Vane No - Calibration Date: GEO2418 - 2/09/2020
Date Started: 9/12/20	Ground Elevation:	Surface Conditions: Near Level, Grass
Date Finished: 9/12/20	Water Level: Not Encountered	

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	SCALA PENETROMETER TEST NZS:4402:1986 test 6.5.2 (Blows per 100mm Increment)			LABORATORY TESTS
					DEPTH (m)	10	20	
NORTHLAND ALLOTCHON	0.0		SILT, some fine sand, brown, very stiff, dry (TOPSOIL)					
			SILT, some fine sand, orange brown, very stiff, hard, dry, non plastic (WEATHERED MANGAKAHIA COMPLEX SOILS)					
	0.5		SILT, minor to some clay, minor fine to medium sand, trace fine angular gravel, very stiff, moist, non to slightly plastic					
	1.0		SILT, minor clay, minor fine to medium sand, orange, white speckles, very stiff, moist, non plastic					
	1.5		END OF BORE. 1.20 METRES. TARGET DEPTH					
	2.0							

HAND AUGER LOG WITH SCALA NL20029_WASTE-WATER-LOGS_9.12.2020.GPJ S+R_2013.GDT 5/2/21



CLIENT: Evo Land Ltd C/- Cato Bolam Consultants

Auger Hole No: WW03

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

Sheet 1 of 1

Drill Type: 50mm Hand Auger	Project No: NL20029/S2	Logged By: JP
Drilled By: JP	Coordinates:	Shear Vane No - Calibration Date: GEO2418 - 2/09/2020
Date Started: 9/12/20	Ground Elevation:	Surface Conditions: Slightly Sloping, Grass
Date Finished: 9/12/20	Water Level: Not Encountered	

HAND AUGER LOG WITH SCALA NL20029_WASTE-WATER-LOGS_9.12.2020.GPJ S+R_2013.GDT 5/2/21

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	SCALA PENETROMETER TEST NZS:4402:1986 test 6.5.2 (Blows per 100mm Increment)			LABORATORY TESTS	
					DEPTH (m)	10	20		30 (Blows)
TOP SOIL	0.0		SILT, some fine sand, grey brown, very stiff, dry, non plastic (TOPSOIL)		0.0				
TAURANGA GROUP			SILT, some fine sand, trace clay, orange with grey, very stiff, dry, non plastic (ALLUVIAL DEPOSITS)						
	0.5		SILT, minor to some clay, minor fine sand, orange, very stiff, dry to moist, non plastic minor clay, moist, non to slightly plastic		0.5				
			minor to some clay, minor fine to medium sand, slightly plastic						
			some clay						
	1.0		clayey SILT, trace fine sand, light grey orange, very stiff, moist, moderately plastic		1.0				
	1.5		END OF BORE. 1.20 METRES. TARGET DEPTH		1.5				
	2.0				2.0				



CLIENT: Evo Land Ltd C/- Cato Bolam Consultants

Auger Hole No: WW04

PROJECT: Geotechnical Investigation, 158 Vinegar Hill Road, Kauri

Sheet 1 of 1

Drill Type: 50mm Hand Auger
 Drilled By: JP
 Date Started: 9/12/20
 Date Finished: 9/12/20

Project No: NL20029/S2
 Coordinates:
 Ground Elevation:
 Water Level: Not Encountered

Logged By: JP
 Shear Vane No - Calibration Date: GEO2418 - 2/09/2020
 Surface Conditions: Slightly Sloping, Grass

HAND AUGER LOG WITH SCALA NL20029_WASTE-WATER-LOGS_9.12.2020.GPJ S+R_2013.GDT 5/2/21

STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"	WATER LEVEL (m)	SCALA PENETROMETER TEST NZS:4402:1986 test 6.5.2 (Blows per 100mm Increment)			LABORATORY TESTS
					DEPTH (m)	10	20	
TOP SOIL	0.0		SILT, some fine sand, brown, very stiff, dry, non plastic (TOPSOIL)					
NORTHLAND ALLOCTHON	0.0 - 0.5		SILT, minor clay, some fine to medium sand, trace fine gravel, orange with light grey, very stiff, dry, non to slightly plastic (WEATHERED MANGAKAHIA COMPLEX SOILS)					
	0.5 - 1.0		for 80mm; some clay, slightly plastic moist dark orange streaks dark orange streaks					
	1.0 - 2.0		END OF BORE. 1.20 METRES. TARGET DEPTH					



SCALA PENETROMETER SHEET - TABLE OF BLOWS PER INCREMENT

JOB NO: NL20029/S2

TESTED BY: CsH/STL/NN/JP/DEG

JOB NAME: 158 Vinegar Hill Road-Kauri

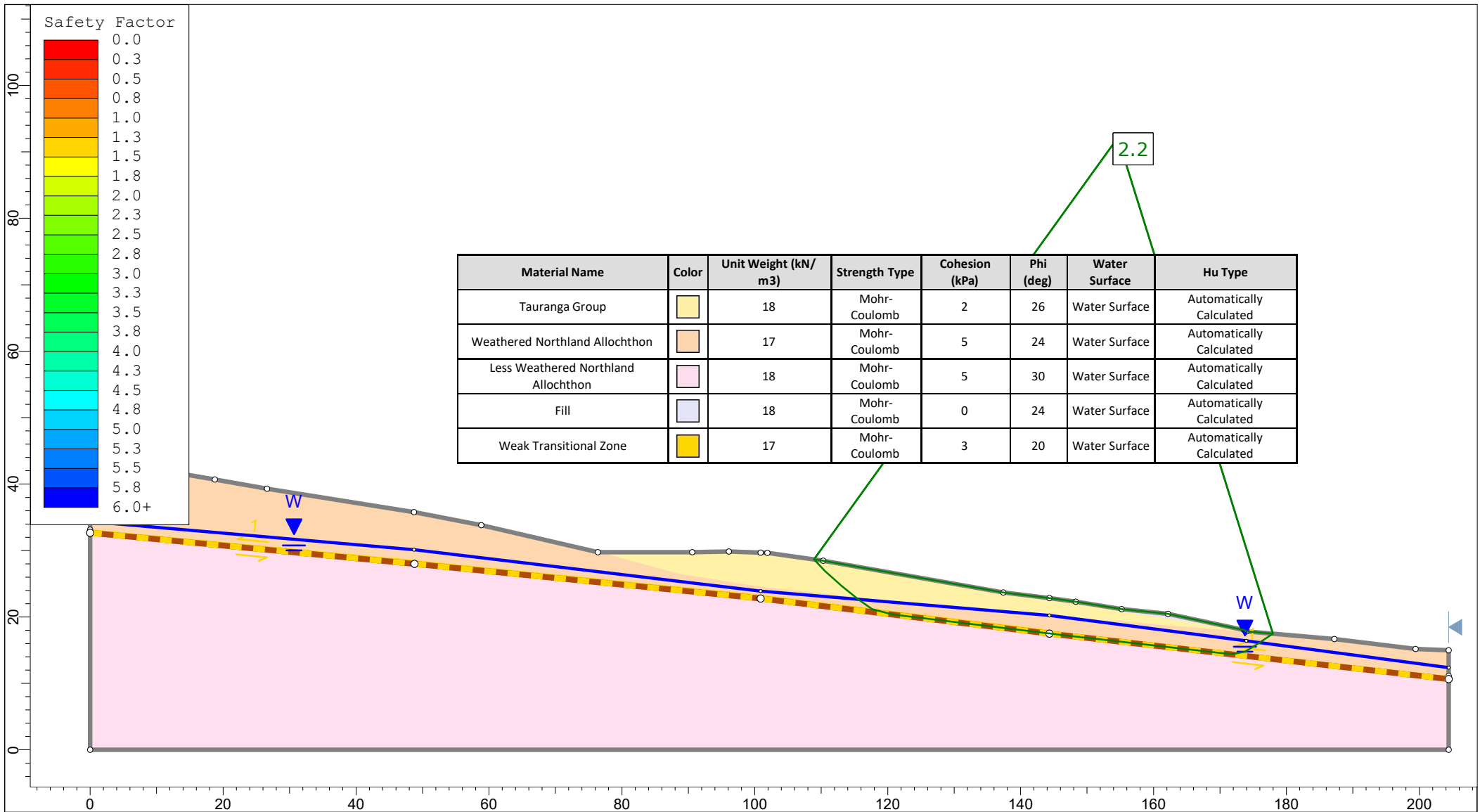
DATE: 8/12/2020


Depth of Penetration [mm]	AH03a	AH03b	AH04	AH11	Cont...	AH12	AH13	AH14	AH15			
DEPTH START [m] →	5.00	5.00	5.00	5.00	7.00	5.00	5.00	4.20	3.00			
50 mm	4	20+	2	11	10	0.5	4	3	2			
100	2		2	18	10	0.5	6	3	3			
150	4		2	7	10	1	20+	4	8			
200	3		3	4	10	1		4	8			
250	1		3	4		1		4	7			
300	2		4	4		2		4	13			
350	1		4	4		2		4	10			
400	3		5	4		2		4	8			
450	3		6	5		2		5	9			
500	4		5	6		2		5	8			
550	4		6	5		3		5	8			
600	4		6	5		2		5	9			
650	3		7	4		3		6	14			
700	3		7	6		4		6	20+			
750	3		6	6		4		8				
800	3		5	5		4		8				
850	3		5	5		4		8				
900	3		6	6		9		8				
950	3		8	5		7		8				
1000	5		9	5		8		8				
1050	5		10	5		9		7				
1100	5		10	8		9		8				
1150	5		11	7		10		8				
1200	6		11	7		10		8				
1250	6		11	7		10		9				
1300	7			7		11		8				
1350	9			7		12		8				
1400	9			9				9				
1450	9			5				8				
1500	10			7				10				
1550	12			7				11				
1600	20+			8				12				
1650				7				12				
1700				7				12				
1750				10								
1800				7								
1850				8								
1900				8								
1950				7								
2000				10								
DEPTH END [m] →	6.60	5.05	6.25	7.00	7.20	6.35	5.15	5.90	3.70			

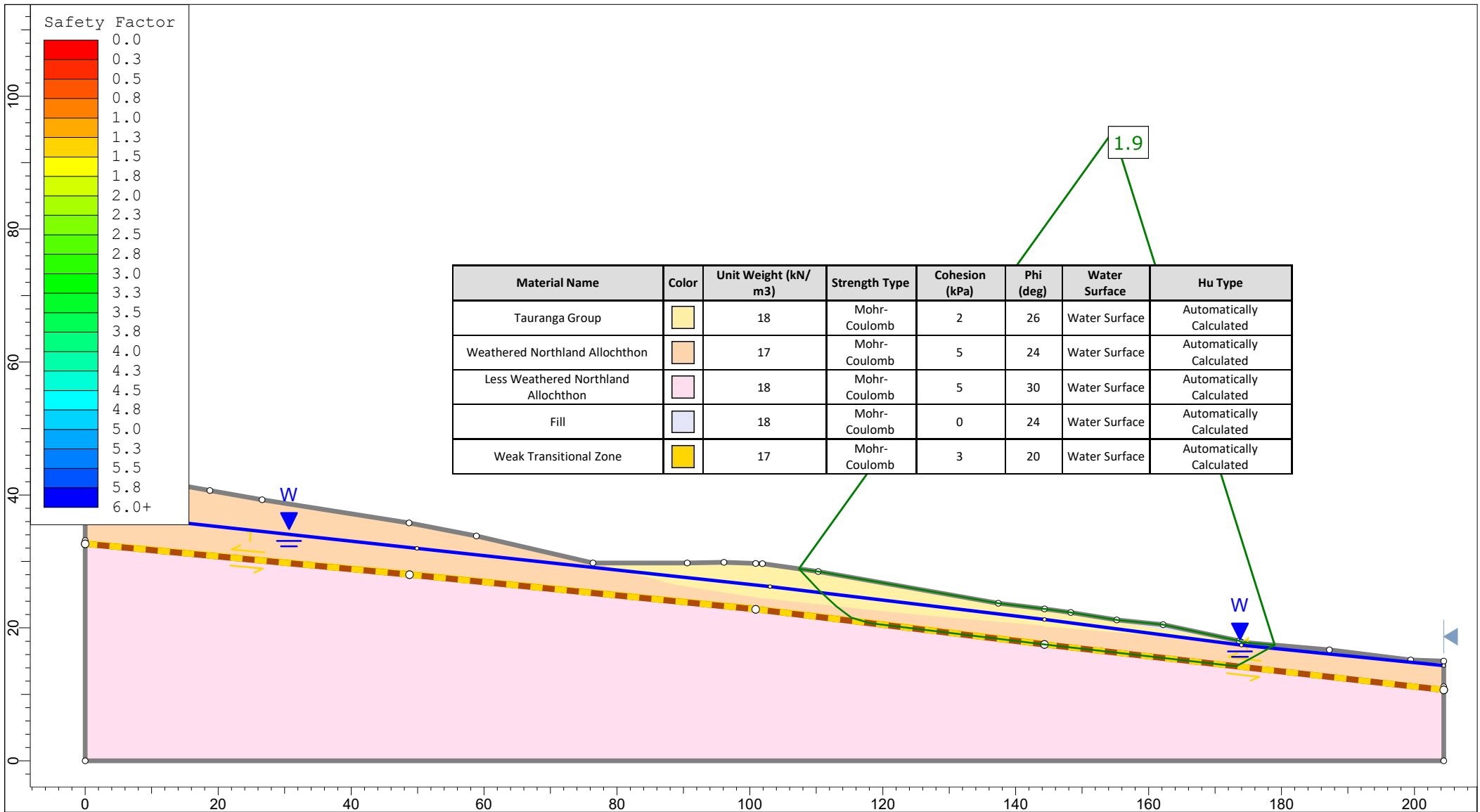
Testing Method: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer

Appendix C


Slope Stability Results

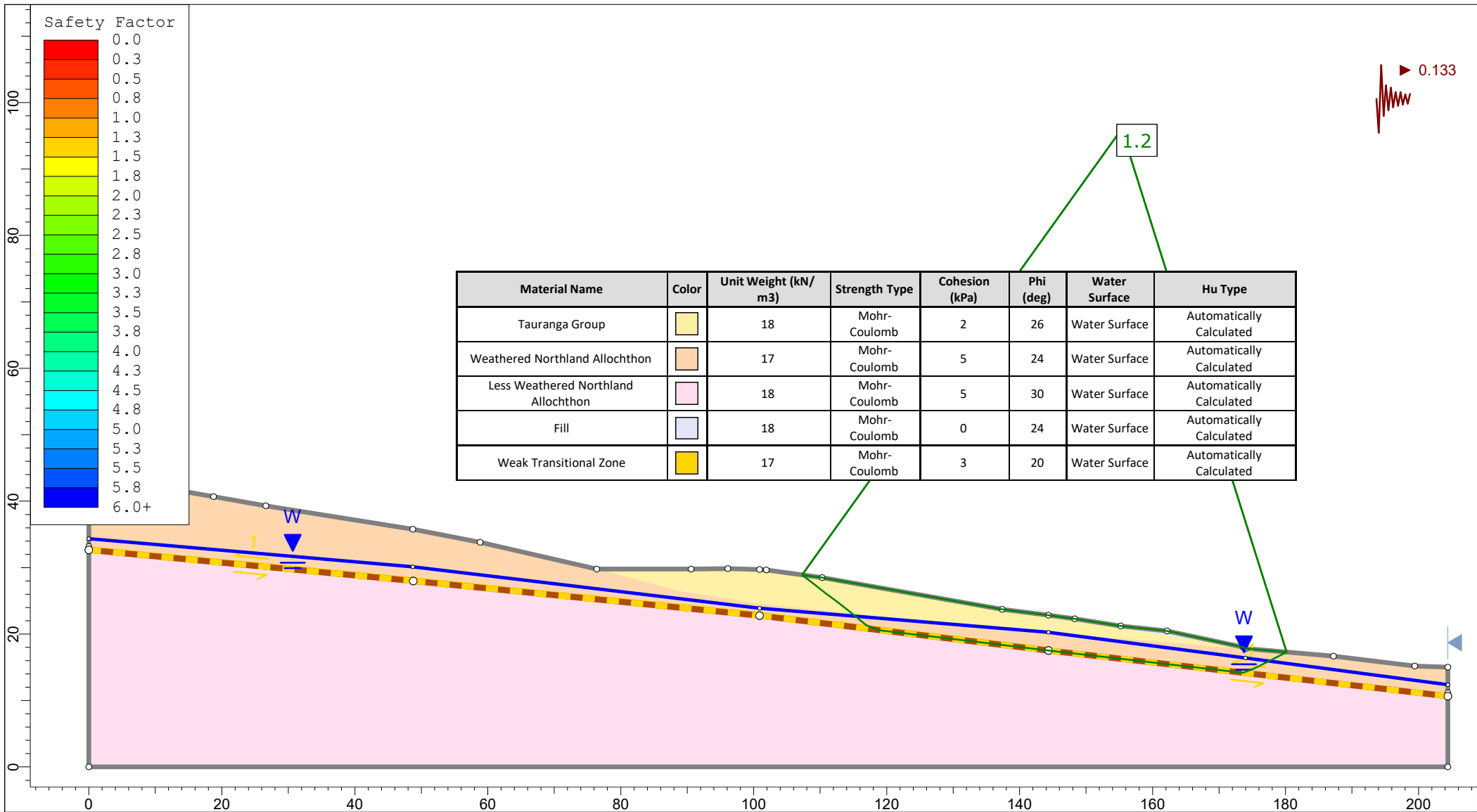


 Soil & Rock Consultants <i>Your responsive & cost-effective engineers</i>	Project		158 Vinegar Hill Road, Kauri		
	Group		Section A-A'	Scenario	Normal Groundwater Condition - Non Circular
	Drawn By		RL	Company	Soil & Rock Consultants
	Date		25 January 2021	File Name	A-A'.slmd
	SLIDEINTERPRET 9.008				

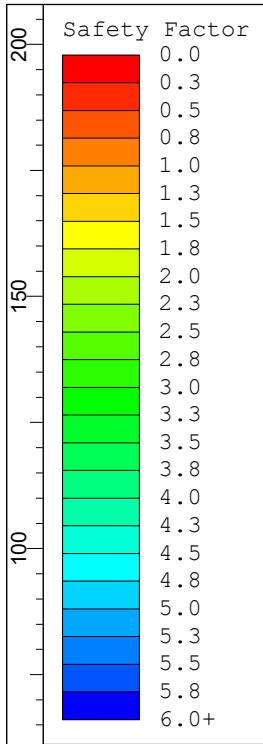


Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Tauranga Group	Yellow	18	Mohr-Coulomb	2	26	Water Surface	Automatically Calculated
Weathered Northland Allochthon	Orange	17	Mohr-Coulomb	5	24	Water Surface	Automatically Calculated
Less Weathered Northland Allochthon	Pink	18	Mohr-Coulomb	5	30	Water Surface	Automatically Calculated
Fill	Light Blue	18	Mohr-Coulomb	0	24	Water Surface	Automatically Calculated
Weak Transitional Zone	Yellow	17	Mohr-Coulomb	3	20	Water Surface	Automatically Calculated

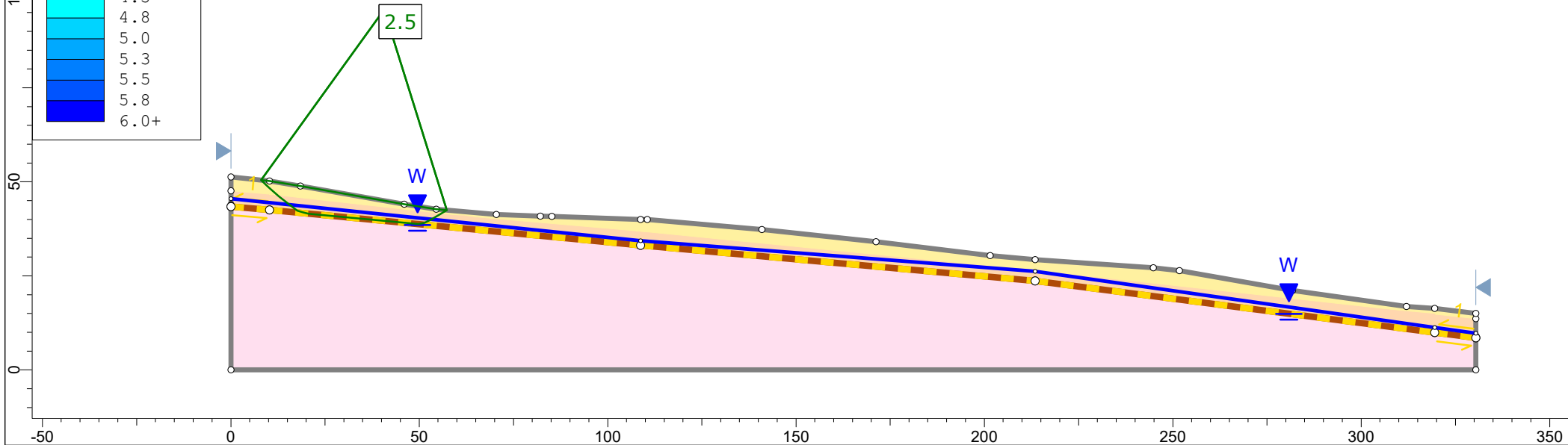
 Soil & Rock Consultants <i>Your responsive & cost-effective engineers</i>	Project	158 Vinegar Hill Road, Kauri		
	Group	Section A-A'	Scenario	Extreme Groundwater Condition - Non Circular
	Drawn By	RL	Company	Soil & Rock Consultants
	Date	25 January 2021	File Name	A-A'.slmd
	SLIDEINTERPRET 9.008			



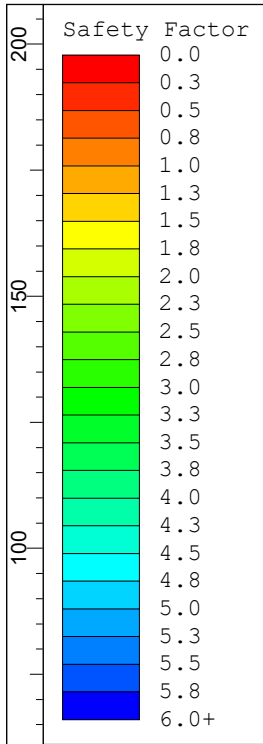
<p>Soil & Rock Consultants Your responsive & cost-effective engineers</p>	Project	158 Vinegar Hill Road, Kauri		
	Group	Section A-A'	Scenario	Seismic Condition - Non Circular
	Drawn By	RL	Company	Soil & Rock Consultants
	Date	25 January 2021	File Name	A-A'.slmd



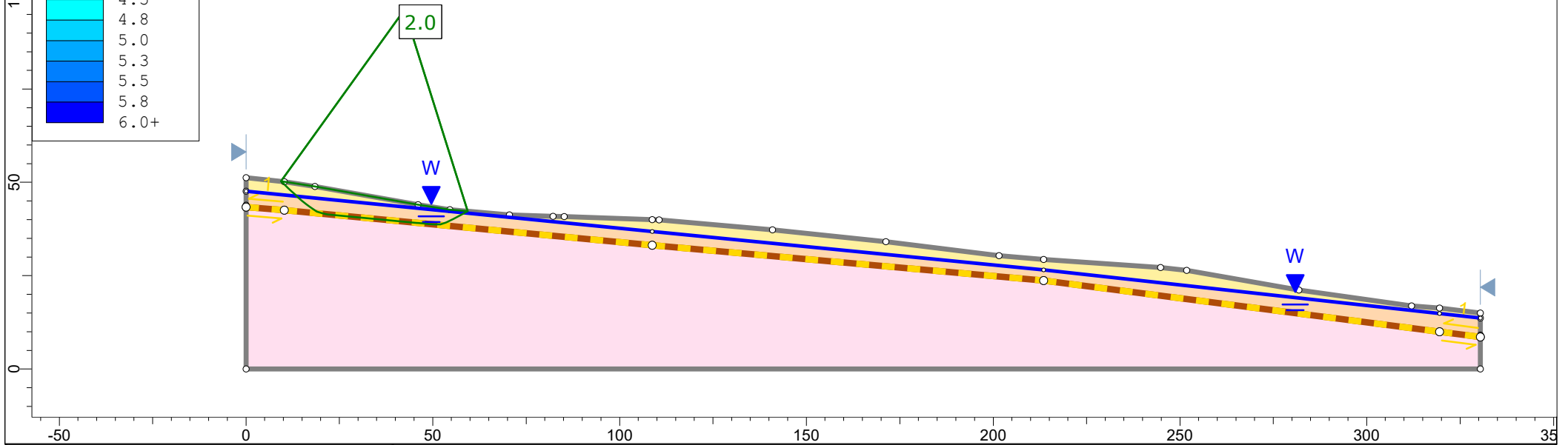
Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Tauranga Group		18	Mohr-Coulomb	2	26	Water Surface	Automatically Calculated
Weathered Northland Allochthon		17	Mohr-Coulomb	5	24	Water Surface	Automatically Calculated
Weak Transitional Zone		17	Mohr-Coulomb	3	20	Water Surface	Automatically Calculated
Less Weathered Allochthon		18	Mohr-Coulomb	5	30	Water Surface	Automatically Calculated



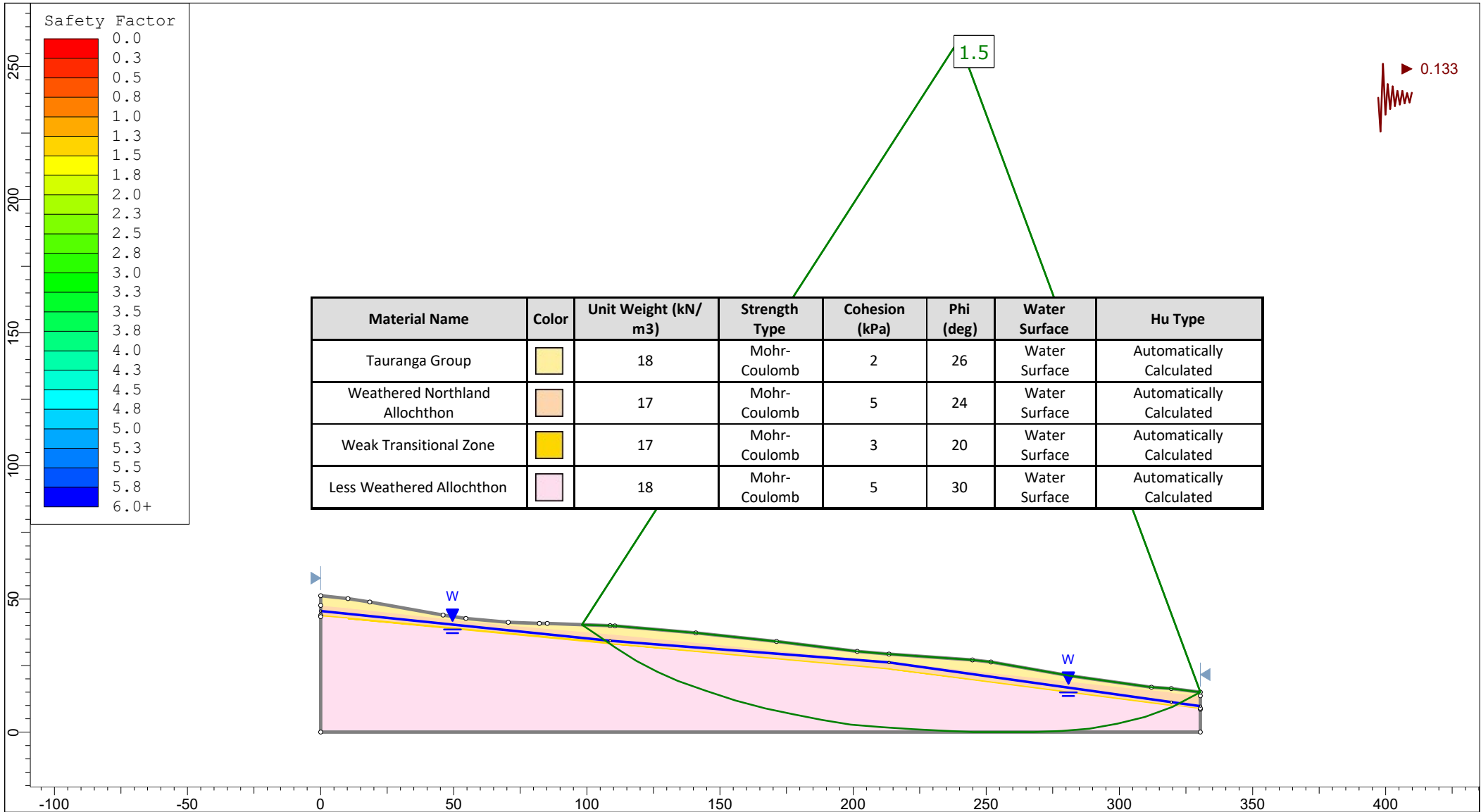
<p>Soil & Rock Consultants Your responsive & cost-effective engineers</p>	Project	158 Vinegar Hill Road, Kauri		
	Group	Section C-C'	Scenario	Normal Groundwater Condition - Non Circular
	Drawn By	RL	Company	Soil & Rock Consultants
	Date	14 January 2021	File Name	C-C'.slmd



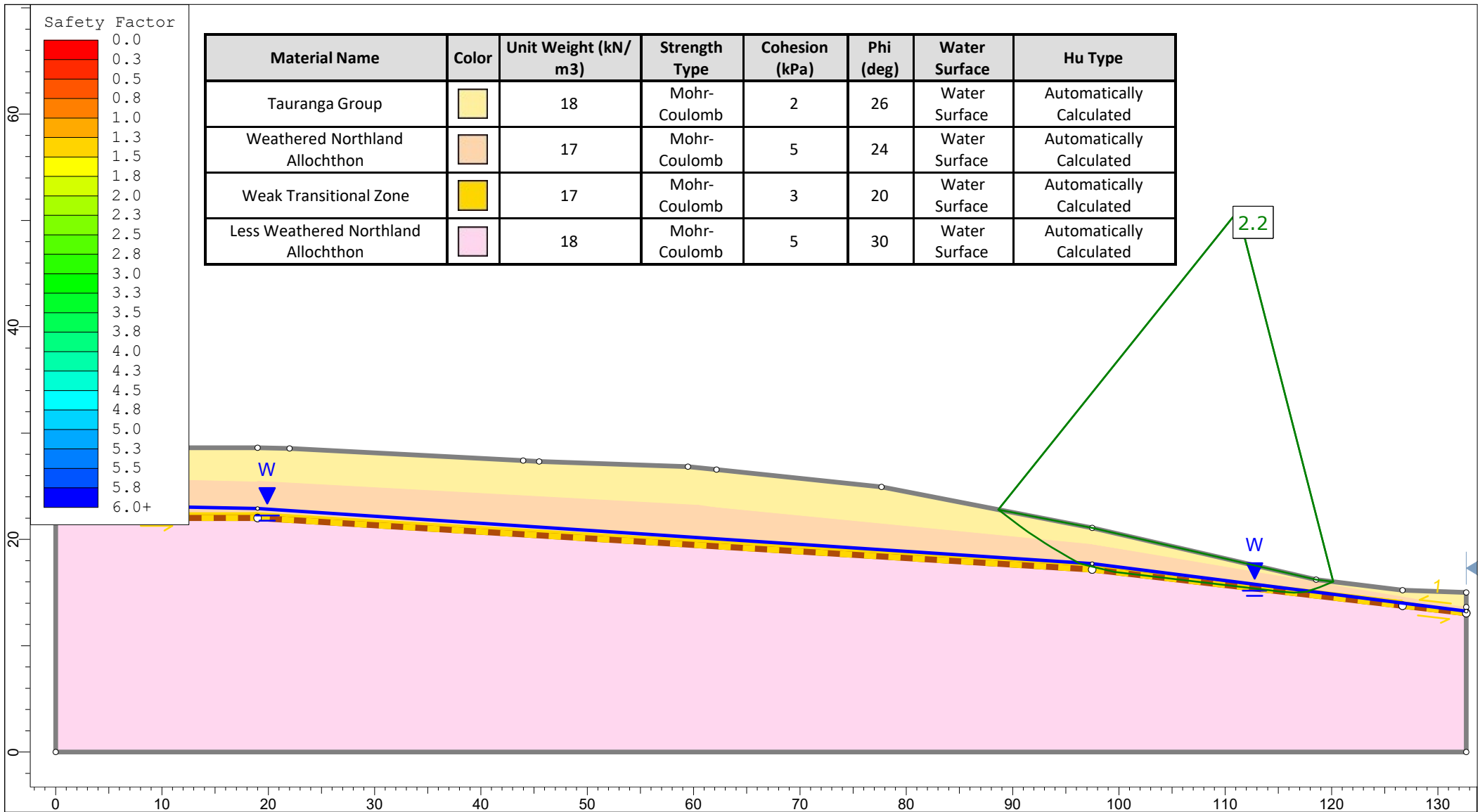
Material Name	Color	Unit Weight (kN/m ³)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Tauranga Group		18	Mohr-Coulomb	2	26	Water Surface	Automatically Calculated
Weathered Northland Allochthon		17	Mohr-Coulomb	5	24	Water Surface	Automatically Calculated
Weak Transitional Zone		17	Mohr-Coulomb	3	20	Water Surface	Automatically Calculated
Less Weathered Allochthon		18	Mohr-Coulomb	5	30	Water Surface	Automatically Calculated




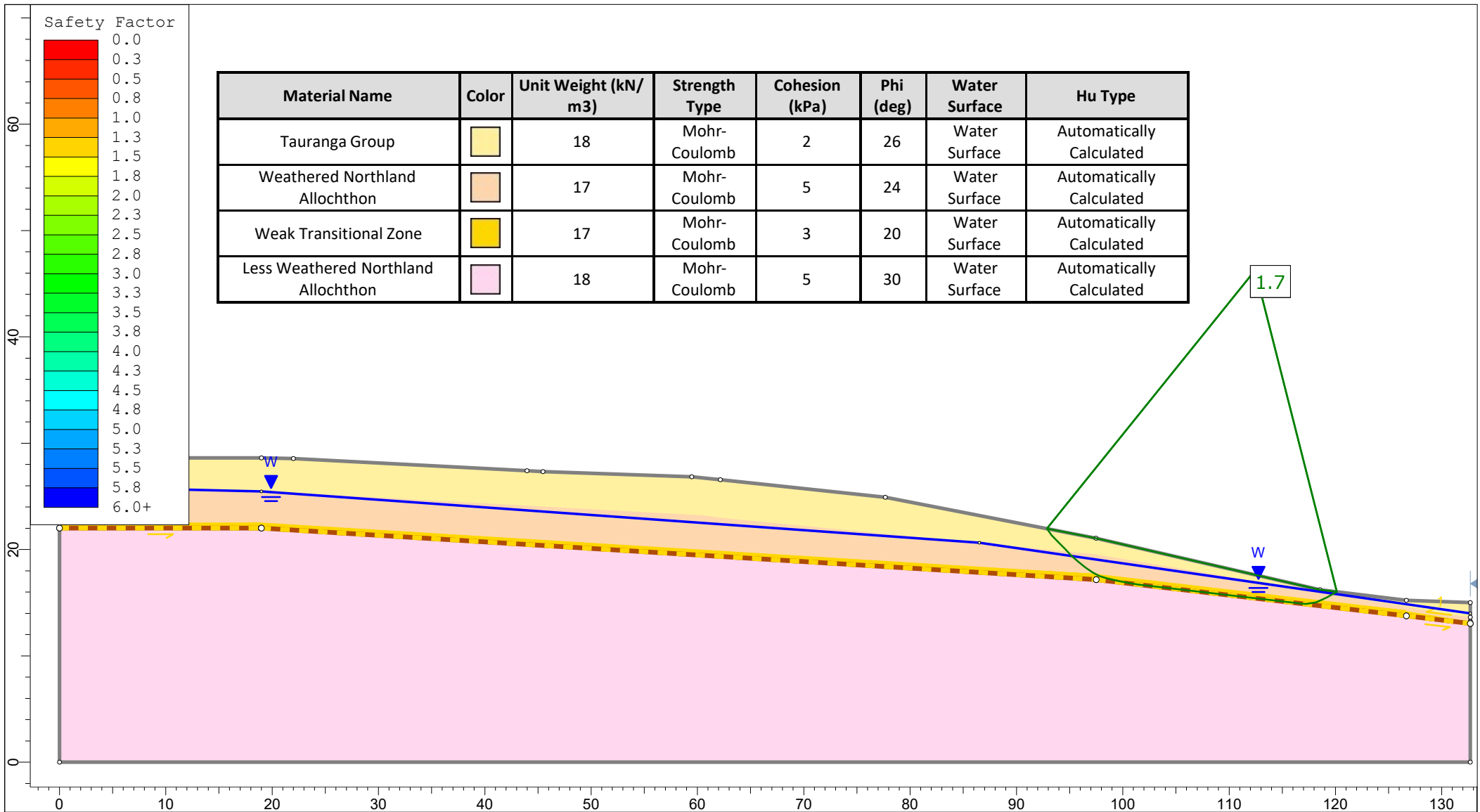
<p>Soil & Rock Consultants Your responsive & cost-effective engineers</p>	Project	158 Vinegar Hill Road, Kauri		
	Group	Section C-C'	Scenario	Extreme Groundwater Condition - Non Circular
	Drawn By	RL	Company	Soil & Rock Consultants
	Date	14 January 2021	File Name	C-C'.slmd




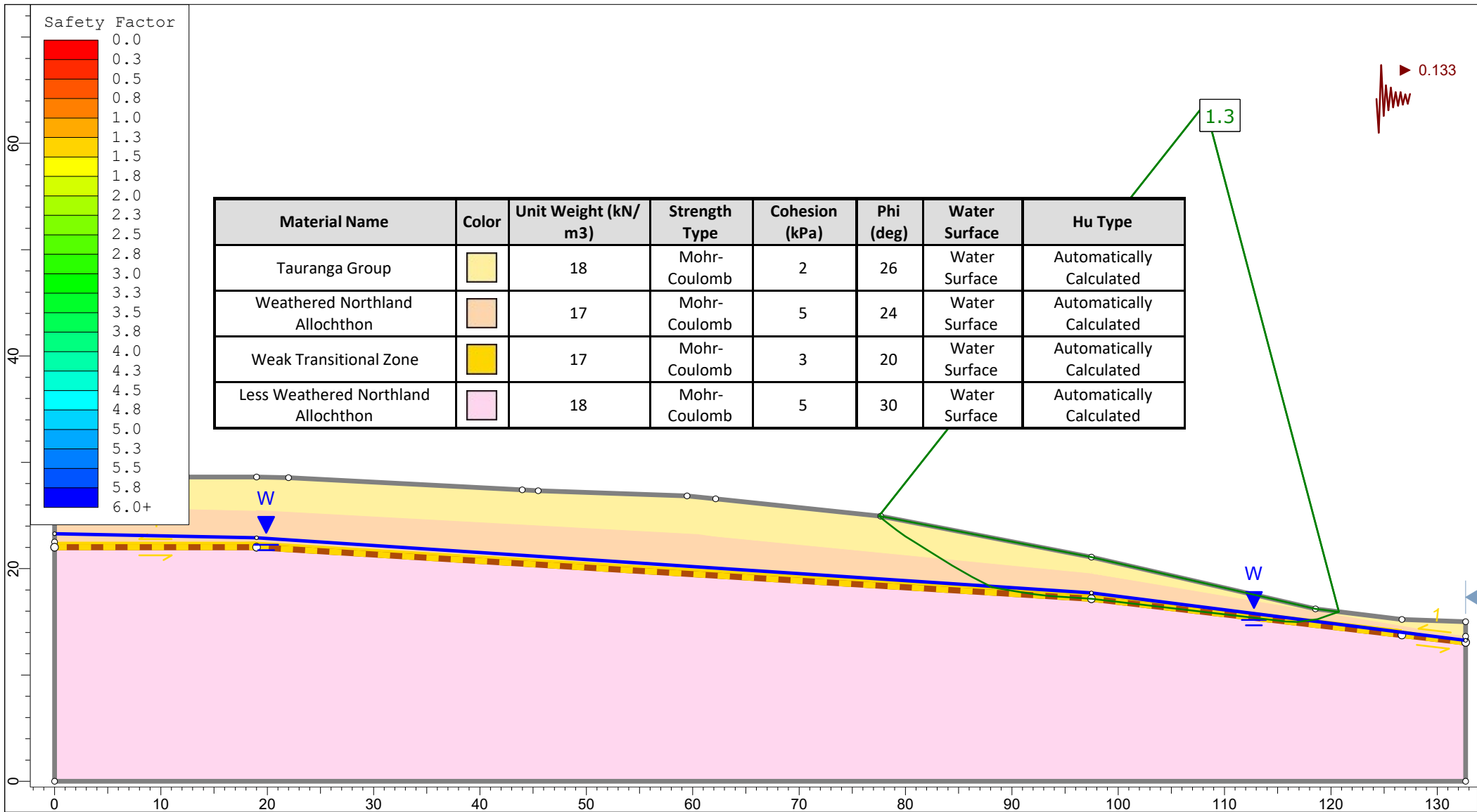
<p>Soil & Rock Consultants Your responsive & cost-effective engineers</p>	Project	158 Vinegar Hill Road, Kauri	
	Group	Section C-C'	Scenario Seismic Condition - Non Circular
	Drawn By	RL	Company Soil & Rock Consultants
	Date	14 January 2021	File Name C-C'.slmd




 Soil & Rock Consultants <i>Your responsive & cost-effective engineers</i>	Project		158 Vinegar Hill Road, Kauri		
	Group		Section D-D'	Scenario	Normal Groundwater Condition - Non Circular
	Drawn By		RL	Company	Soil & Rock Consultants
	Date		25 January 2021	File Name	D-D'.slmd



 Soil & Rock Consultants <i>Your responsive & cost-effective engineers</i>	Project		158 Vinegar Hill Road, Kauri		
	Group		Section D-D'	Scenario	Extreme Groundwater Condition - Non Circular
	Drawn By		RL	Company	Soil & Rock Consultants
	Date		25 January 2021	File Name	D-D'.slmd



 Soil & Rock Consultants <i>Your responsive & cost-effective engineers</i>	Project	158 Vinegar Hill Road, Kauri		
	Group	Section D-D'	Scenario	Seismic Condition - Non Circular
	Drawn By	RL	Company	Soil & Rock Consultants
	Date	25 January 2021	File Name	D-D'.slmd