26 July 2021 Ref No: J01779

Andrea and Michael Mynott
C/- Cato Bolam Consultants Limited

Attention: Mr M Goodwin

Dear Myles

RE: Geotechnical Investigation Report for Proposed New Lot and Nominated Building Platform at 14 Kaipara Road, Warkworth

1 PROJECT BRIEF

This report has been prepared for Andrea and Michael Mynott in support of an application to the Auckland Council for Resource Consent in accordance with the requirements of the Resource Management Act 1991.

Where appropriate, it is in accordance with the recommendations of NZS 4404, Land Development and Subdivision Engineering; Auckland Council Code of Practice for Land Development and Subdivision, Section 2 Earthworks and Geotechnical Requirements (version 1.6); and related documents.

2 SCOPE AND OBJECTIVES

The scope of this report encompasses the geotechnical suitability and stability of the land having regard for the nature of the development proposals.

Its principal objectives were to assess the nature, bearing qualities and relative uniformity of the subsoils to the depths likely to be affected by proposed land development works and future building loads

3 SITE DESCRIPTION AND DEVELOPMENT PROPOSALS

The site, legally described as Lot 2 DP 129355 with an area of approximately 10.72Ha. An existing dwelling with ancillary buildings is located in the northern corner of the site with a stand alone shed located mid-way down the western boundary. The majority of the site is in pasture.

The proposed new lot (Lot 2) is located in the southern portion of the site and a nominated building platform is located in the south-east corner. The building platform is sited on the north-western face of a ridge spur and slopes are approximately 1(v) in 4(h). There were no obvious visual sings of ground instability observed by us during the time of our site investigation.

4 GEOLOGY

A review of GNS digital QMaps indicates that the site is adjacent to a boundary between the Waihangaru Formation (Waitemata Group), the Pakiri Formation (Waitemata Group) and Holocene

alluvium (Tauranga Group). Based on our observations of the landform, we consider that the site is likely underlain by the Pakiri Formation.

The Pakiri Formation consists of thick, volcanic rich sandstone beds. These materials generally weather to red, orange and light grey clays, silts and sands residual soils and can include manganese and iron oxides.

5 FIEDLWORK AND FINDINGS

5.1 Fieldwork Programme

Our fieldwork was conducted on 5 July 2021 and involved drilling of 3 hand auger boreholes to target depths of between 3.0m and 5.0m in the positions indicated on the appended site plan (refer Figure 01). Undrained shear strengths were measured at 0.5m intervals throughout. Additionally, a cross section was measured using on site using a tape and electronic 'zip' level and drawn as appended (refer Figure 02) in order to facilitate slope stability analyses.

Results of all in-situ tests and detailed descriptions and depths of strata encountered during drilling of the boreholes are appended.

5.2 Findings

5.2.1 Topsoil

Topsoil was encountered within each of our hand auger borehole to depths of 0.2m.

5.2.2 Pre-Existing Fills

No filling was detected at our borehole locations although in farm environments the presence of old rubbish pits can never be discounted.

5.2.3 Residual Pakiri Formation Soils

Residual Pakiri Formation soils were noted in each hand auger borehole underlying the topsoil deposits. Hand augers found red, brown, orange silts and clays with occasional limonite. Undrained shear strength readings were between 86 (stiff) to greater than 201kPa (the upper limit of our shear vane dial, hard), being over 100kPa (very stiff) on average.

5.2.4 Groundwater

No groundwater was encountered within any of our hand auger boreholes over the depths drilled at the time of the field investigation.

6 SLOPE STABILTITY ANALYSIS

6.1 Methods

Cross section AA' was measured on site via tape and electronic zip level and drawn as appended (Figure 2).

This section was then analysed using computer modelling software Slide2 using the Morgenstern/Price method for circular slips. Planar slips are considered unlikely given the prevailing subsoil geometry and have therefore been dismissed as a potential failure mode.

The slope was analysed for each long term (existing groundwater), short term (elevated groundwater, set at 1m below ground level) and pseudo static (seismic) scenarios. Peak Ground acceleration (PGA) were calculated as discussed in Section 6.2 below.

For our analyses, effective stress soil parameters were selected based on our experience similar terrain and are not less conservative than soil strength parameters outlined in the ACCoP, Schedule 2E. A full table of effective stress parameters are included on the slope stability outputs (appended).

The degree of stability of a slope is expressed as the factor of safety (FoS), which is the ratio of the forces resisting failure to the driving forces causing instability. Theoretical failure of a slope is possible when the factor is 1.0, while increasing values above 1.0 indicate improving stability. Acceptable factors of safety (FoS) for static and seismic slope stability cases are prescribed in ACCoP Schedule 2C for residential developments:

- Normal Groundwater Condition (Long Term Scenario) 1.5
- Elevated Groundwater Condition (Short Term Scenario): 1.3
- Pseudo-Static (Seismic) Condition (1/150-year event): 1.2

6.2 Seismic Site Class

The seismic site class has been determined to be Class C, Shallow soil site - very stiff or hard materials less than 60m deep. (NZS1170.5:2004, Table 3.2).

Peak Ground Acceleration (PGA) has been calculated based on formula provided in the NZGS Earthquake Geotechnical Engineering Practice Module 1 and the NZTA Bridge Manual (SP/M/022) 3rd ed. 2016 based on a 50-year working life. The following PGA factors have been selected.

- Return Period Factor (R) as per NZS1170.5:2004 Table 3.5: 1 (1/500yr)
- Site Response Factor (f) as per Bridge Manual Section 6.2.2: 1.33 (site class C)
- PGA Coefficient (C0,1000) as per Bridge Manual Table 6A.1: 0.13 (Warkworth)
- Based on the above, a PGA of 0.133g is calculated

It is generally accepted that a seismic reduction factor of 65% may be applied because the very short duration of the acceleration. After applying the seismic reduction factor PGA is calculated as 0.086g (rounded to 0.09g for the analysis).

6.3 Results

Each scenario analysed found satisfactory factors of safety as summarised in our table below:

Table 1: Slope Stability Analysis Results Summary

Scenario	Required FoS	FoS Achieved
Long Term: Existing Conditions	1.5	2.3
Short Term: Elevated Groundwater Conditions	1.3	1.6
Seismic (PGA= 0.09g)	1.2	1.7

7 PROJECT EVALUATION AND RECOMMENDATIONS

7.1 General

The undertaking of earthworks and construction works in accordance with the following specific subdivision and building development recommendations, NZS 4404 and related documents and Auckland Council's Code of Practice, where appropriate, should ensure that the completed development is generally suitable for conventional light timber framed dwellings constructed in accordance with the requirements of NZS 3604, with expansive Site Class provisions. Specific comments and recommendations follow:

7.1.1 Bearing Capacity and Settlement Potential

A geotechnical ultimate bearing capacity of 300 kPa should generally be available for all shallow strip and pad foundations constructed on certified filling and on the natural ground.

Further geotechnical endorsement as necessary should be carried out for all buildings having loads greater than these, and/ or where cuts or fills in excess of 0.6m are proposed in the vicinity of the nominated building platform and/ or where development proposals extend outside of the nominated building platform.

Anticipated differential settlements beneath shallow strip and pad footings at foundation working loads are assessed to be within code limits.

7.1.2 Expansive Site Class

A phenomenon common to the plastic soils found throughout this region is their expansive nature and tendency to shrink and swell, particularly with seasonal fluctuations of near surface water contents. Expansive soils are outside the provisions of NZS 3604 (according to its definition of “good ground”) and therefore foundations on such soils require specific design to establish appropriate embedment depths and/ or concrete reinforcement configurations.

Based on visual-tactile assessments of the soils recovered from our boreholes and our knowledge of the soils encountered within this area of Auckland, the **preliminary** expansive site class for this site is as follows when assessed in accordance with MBIE (Acceptable Solution and Verification Methods Amendment 19) and AS2870:2011 guidelines is as follows:

MBIE Acceptable Solutions and Verification Methods Amendment 19

- Class H (high)
- Characteristic ground movement of up to 78mm

AS2870:2011

- Class H2 (High)
- Characteristic ground movement of 75mm

On this basis, foundation design may be carried out in accordance with NZ3604 with provision for expansive soils as outlined in MBIE B1/AS1 if the buildings meet the simple structure definition outlined in section 3.2.2 of that document **or** alternatively the buildings may be designed in accordance with AS2870:2011 provided they are designed to the recommendations above on expansive site class and characteristic ground movement.

For expansive soils, if on-grade floor slab construction takes place during a long dry summer, exposed building platform soils may dry out and become highly desiccated. Over time the rehydration

of the soils below the floor slab can cause swelling and floor slab uplift. Floor slab uplift can cause distress on tile floors and in garages where cracks are more apparent. It may also rack upper storeys and/ or rooflines if non-load bearing ground floor walls are lifted and act as struts. It is prudent to place hardfill immediately upon complete of subgrade trimming, followed by thorough soaking of the hardfill prior to concrete placement (e.g., for slab on-grade construction), all of which can help to limit the problem.

This preliminary expansive site classification should be re-addressed at Building Consent stage via site specific analyses, such as laboratory shrink-swell testing as recommended by MBIE.

7.1.3 Strength Reduction Factor

As required by Section B1/VM4 of the New Zealand Building Code Handbook, a strength reduction factor of 0.50 or 0.80 must be applied to all recommended geotechnical ultimate soil capacity in conjunction with their use in factored design load cases for static and earthquake overload conditions respectively.

7.2 Pavement Subgrade

Given the generally very stiff surficial subsoils present across the site, we consider that a design CBR value of 2% to 4% maybe adopted for the natural soils, if this is a design requirement for driveways. As CBR values are affected by moisture content and trafficking, we recommend that subgrades are only trimmed to final level immediately prior to placing basecourse and that a programme of Scala Penetrometer testing be carried out during construction to confirm the design value.

7.3 General Siteworks Recommendations

7.3.1 General

No earthworks plans have been provided, not anticipated that earthworks will be undertaken to facilitate the subdivision. However, it is envisaged that some cuts and fills will be required to form the end user building platform. The following general recommendations for earthworks apply:

- Topsoil and vegetation should be stripped clear of the building platform area and the building platform should be subject to inspection from the certifying geotechnical professional to confirm all unsuitable materials have been properly removed.
- In accordance with the normal requirements of NZS 4404 and related documents slopes should be benched prior to the placement and compaction of filling and should be the subject of engineering inspections.
- Any borrow materials from site proposed to be reused in engineer certified fills along with any imported fill materials should be subject to geotechnical engineering inspection to determine its suitability for inclusion in the earthworks.
- It is anticipated that any excess cut materials will be re-spread on site. Proposed respread areas should be assessed by the certifying engineers.
- All engineered fills should be placed and compacted in lifts of no greater than 200mm to 300mm and fill compaction testing should be undertaken to ensure that fills meet minimum compaction requirements. Fill compaction requirements should be set by the certifying geotechnical professional prior to fill placement and once proposed fill materials are known.

- It would be prudent that underground service trenches are carefully backfilled with compacted clay fill to prevent them from becoming cut-off drains, with associated scour and piping problems.

7.4 Stormwater Disposal

It is important that due care is paid to the design and construction of appropriate stormwater disposals systems.

Outfall structures should be designed by Engineer or in accordance with Council outfall design specifications. However, we consider it would appropriate to discharge stormwater towards the overland flow path to the north-west of the nominated building platform via a level spreader or similar low velocity outlet.

The exact positioning of the outlet is a building consent issue that will need to be assessed on-site commensurate with the end user building proposals.

7.5 Effluent Disposal

Based on our knowledge of soils of this geology and visual-tactile observation of the soils at this site, we have classified the soils on the proposed development as being category 6 (silty clay), as defined in Table 5.1 of TP58. Each on-site effluent disposal should be specifically designed at building consent stage using an aerial loading rate 3mm per day, given in TP58. We consider that there is suitable land on this site in relatively close proximity to the nominated platforms to locate primary and secondary fields in this regard. Due regard should be made to any overland flow paths in locating effluent fields and effluent fields are recommended to be placed upslope of any on-site discharge point for stormwater (see preceding section).

We have provided an indicative wastewater disposal field on our site plan (Figure 01). The indicative wastewater disposal field is beyond 3m from the building platforms, 1.5m from the site boundaries and 17.7m from any surface water (for 15-degree slopes, taken to be the overland flow paths shown on the Council GeoMaps database) for soil category 6 as per Table 5.2 of TP58 for secondary and advanced secondary treatment levels. Boreholes HA02 and HA03 (within the indicative wastewater disposal field areas) found no groundwater over their 3.0m depth, therefore meeting the minimum 900mm to 600mm separation distance for groundwater as per Table 5.2.

The final placement of on-site effluent disposal is a building consent issue that will need to be commensurate with the end use building proposal.

8 PLAN REVIEW AND FURTHER WORK

If significant changes are proposed to be made to the plans reviewed to date, we reserve the right to revisit our evaluations and recommendations when they come to hand.

9 LIMITATIONS

This report has been prepared solely for the use of our client, Andrea and Michael Mynott, their professional advisers and the relevant Territorial Authorities in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity. All future owners of this property should seek professional geotechnical advice to satisfy themselves as to its ongoing suitability for their intended use. The opinions, recommendations and comments given in this report result from the application of normal methods of site investigation. As factual evidence has been obtained solely from boreholes which by their nature only provide

information about a relatively small volume of subsoils, there may be special conditions pertaining to this site which have not been disclosed by the investigation and which have not been taken into account in the report.

If variations in the subsoils occur from those described or assumed to exist, then the matter should be referred back to us immediately.

For and on behalf of Lander Geotechnical Consultants Limited

Prepared By:	Reviewed By:	Authorised By:
		
pp. A. Huang	**J. Lam**	**S. Lander**
Engineering Geologist	Engineering Geologist	Principal Geotechnical Engineer CMEngNZ, CPEng, IntPENZ

Attachments

- Cato Bolam Scheme Plan
- Figure 01: Site investigation Plan
- Figure 02: Cross Section AA'
- Hand Auger Borehole Records
- Slope Stability Outputs
- MBIE Guideline

Auckland Council
Comprised in: RT NA77B/879
Total Area: 10.7233ha

Areas and measurements are subject to survey.

Area Ⓐ (1.3ha) is to be subject to a land covenant to protect wetland.

Proposed Building Area 1000m²

Watercourse

Cato Bolam
creating great places
PLANNERS | SURVEYORS | ENGINEERS
ARCHITECTS | ENVIRONMENTAL

M.T.& A.L. Mynott
14 Kaipara Hills Road
Warkworth

Lots 1 & 2 being
Proposed Subdivision of
Lot 2 DP 129355

FOR DISCUSSION

No.	REVISION (DESCRIPTIONS)	NAME	DATE
A	Issued for discussion	MG	27/05/2021
	SURVEYED		
	DESIGNED		
	DRAWN	LS	24/05/2021

DATE	ORIGINAL SCALE	ORIGINAL SIZE
27/05/2021	1:2500	A3

DRAWING NO. 42036-DR-PLN-1200
REVISION A

Legend and/or Notes:

- Cross section
- Hand auger borehole
- Nominated Building Platform
- Indicative Wastewater Disposal Field (1000m2)

Basemap retrieved from Auckland Council Geomap
Date retrieved 08 July 2021

revision	description	drawn	approved	date

0 20.0 40.0 60.0
Horizontal Scale (metres)
0 20.0 40.0 60.0
Vertical Scale (metres)

drawn	AH
approved	JL
date	08.07.21
scale	1:1000
original size	A3

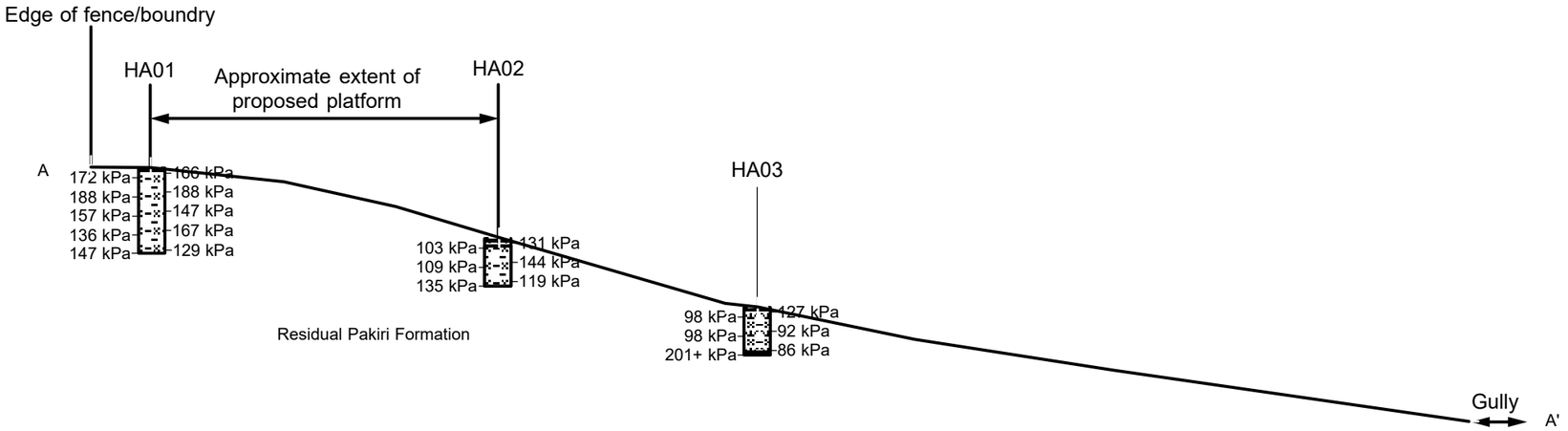
LANDER geotechnical

client: **ANDREA & MICHAEL MYNOTT**
project: **14 KAIPARA HILLS ROAD WARKWORTH**
title: **SITE INVESTIGATION PLAN**
project no: **J 01779** figure no: **01**

Template revision: 1:1000 (10/12/14)

Legend and/or Notes:

- Topsoil
- Clayey silt
- Silty clay
- AA' — Extend of cross section



revision	description	drawn	approved	date

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Horizontal Scale (metres)
0 10.0 20.0 30.0
Vertical Scale (metres)

drawn	AH
approved	JL
date	09.07.21
scale	1:500
original size	A3

LANDER geotechnical

client: **Andrea and Michael Mynott**

project: **14 Kaipara Hills Road, Warkworth**

title: **CROSS SECTION A-A'**

project no: **J 01779** figure no: **02**

Template revision: 1:500 (10/12/14)

Client : ANDREA & MICHAEL MYNOTT

Project Location : 14 KAIPARA HILLS ROAD WARKWORTH

Job Number: J01779

Auger Borehole No. HA01

Sheet 1 of 3

Vane Head:	Logged By:	Processor :	Date:
2153	JM	AH	08.07.21

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION

Depth (m)	Soil Description	Vane Shear(kPa) peak / residual	Soil Sensitivity
	TOPSOIL		
	silty CLAY, orange streaked light yellow/grey. Very stiff, moist, high plasticity, moderately sensitive, [RESIDUAL PAKIRI FORMATION]		
0.5		166/85	2.0
1.0	becoming insensitive becoming red and orange mottled light grey	172/101	1.7
	becoming orange, red and pink mottled light grey, medium to high plasticity, with trace fine sand		
1.5		188/99	1.9
2.0	becoming orange, red, pink and light grey mottled, medium plasticty, with minor fine sand	188/111	1.7
2.5		147/79	1.9
3.0	becoming moderately sensitive	157/67	2.3
	with trace fine gravel sized hard dark orange limonite silt clast inclusions		
3.5		167/77	2.2
	without limonite silt inclusions		
4.0	becoming insensitive	136/71	1.9
4.5		129/79	1.6
5.0	EOB at 5.0m. Target depth	147/82	1.8
5.5			
6.0			

Standing Water Level

Sample and Laboratory / Other Test Details

LANDER geotechnical

Comments:
Groundwater not encountered.

UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: RZ

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : ANDREA & MICHAEL MYNOTT

Project Location : 14 KAIPARA HILLS ROAD WARKWORTH

Job Number: J01779

Auger Borehole No. HA2

Sheet 2 of 3

Vane Head:	Logged By:	Processor :	Date:
2007	AH	AH	06.07.21

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Vane Shear(kPa) peak / residual	Soil Sensitivity
TOPSOIL			
clayey SILT, streaked orange and brown. Very stiff, dry to moist, no to low plasticity, moderately sensitive [RESIDUAL PAKIRI FORMATION]	0.5	131/51	2.6
silty CLAY, streaked yellow and brown. Very stiff, moist, medium to high plasticity, moderately sensitive, with trace limonite	1.0	103/48	2.1
becoming high plasticity			
becoming grey mottled pink/orange			
becoming insensitive	1.5	144/87	1.7
becoming moist to wet, moderately insensitive	2.0	109/38	2.7
with minor limonite			
	2.5	119/61	2.0
at 3.0m, becoming insensitive			
EOB at 3.0m. Target Depth	3.0	135/96	1.4
	3.5		
	4.0		
	4.5		
	5.0		
	5.5		
	6.0		

LANDER geotechnical

Comments:
Groundwater not encountered.

UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: RZ

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Client : ANDREA & MICHAEL MYNOTT

Project Location : 14 KAIPARA HILLS ROAD WARKWORTH

Job Number: J01779

Auger Borehole No. HA3

Sheet 3 of 3

Vane Head:	Logged By:	Processor :	Date:
307	RZ	AH	05.07.21

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

SOIL DESCRIPTION	Depth (m)	Vane Shear(kPa) peak / residual	Soil Sensitivity
TOPSOIL			
silty CLAY, brown streaked orange/brown. Very stiff, moist, high plasticity, insensitive [RESIDUAL PAKIRI FORMATION]			
becoming grey streaked orange	0.5	127/72	1.8
becoming stiff, insensitive	1.0	98/58	1.7
	1.5	92/63	1.5
	2.0	98/60	1.6
becoming moderately sensitive	2.5	86/26	3.1
silty CLAY, orange and red light grey mottled. Hard, moist, high plasticity			
EOB at 3.0m. Target Depth	3.0	201+	
	3.5		
	4.0		
	4.5		
	5.0		
	5.5		
	6.0		

LANDER geotechnical

Comments:
Groundwater not encountered.

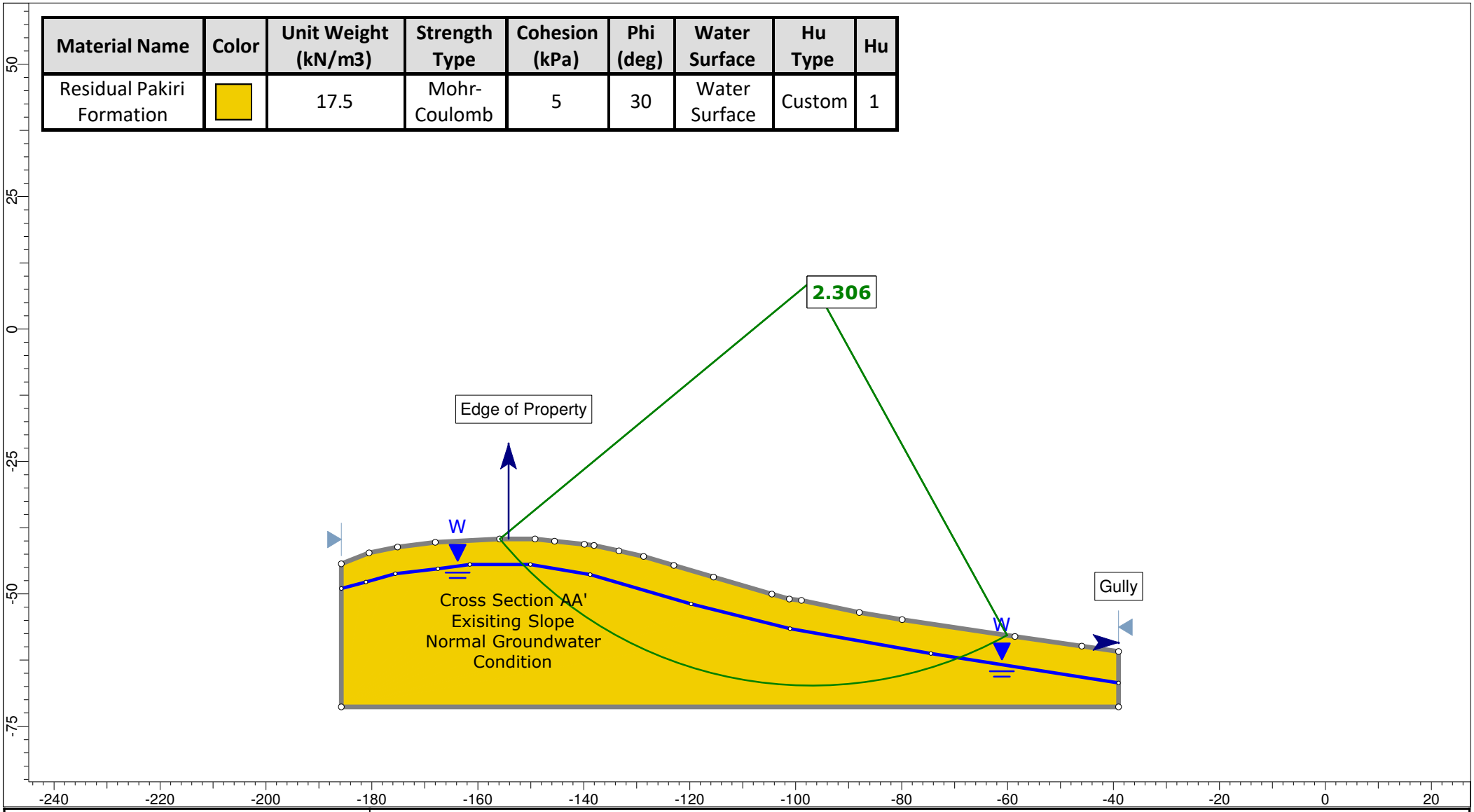
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: RZ

Topsoil	Sand	Sandstone	Plutonic		
Fill	Gravel	Siltstone	No Core		
Clay	Organic	Limestone			
Silt	Pumice	Volcanic			

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Residual Pakiri Formation		17.5	Mohr-Coulomb	5	30	Water Surface	Custom	1

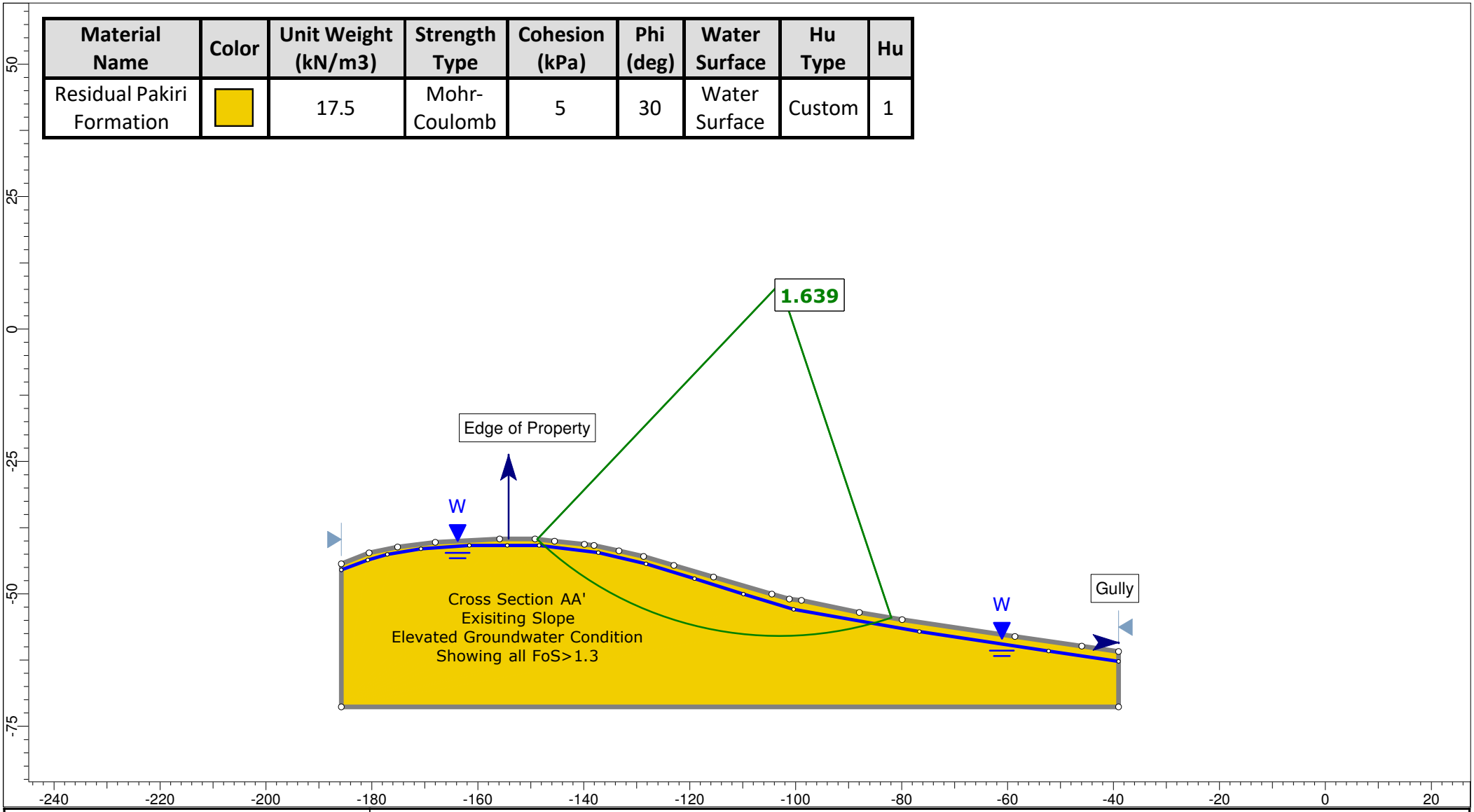


LANDER geotechnical

SLIDEINTERPRET 9.018

Analysis Description	Existing Slope - Existing Groundwater				
Cross Section	A-A'	*Case No.*	1		J01779 14 Kaipara Hills Road, Warkworth
Drawn By	AH	*F.O.S Filter*	1.5	*Company*	Lander Geotechnical Consultants Ltd
Date	15/07/2021	*Scale*	1:1000	*File Name*	J01779_210708_slope stability.slmd

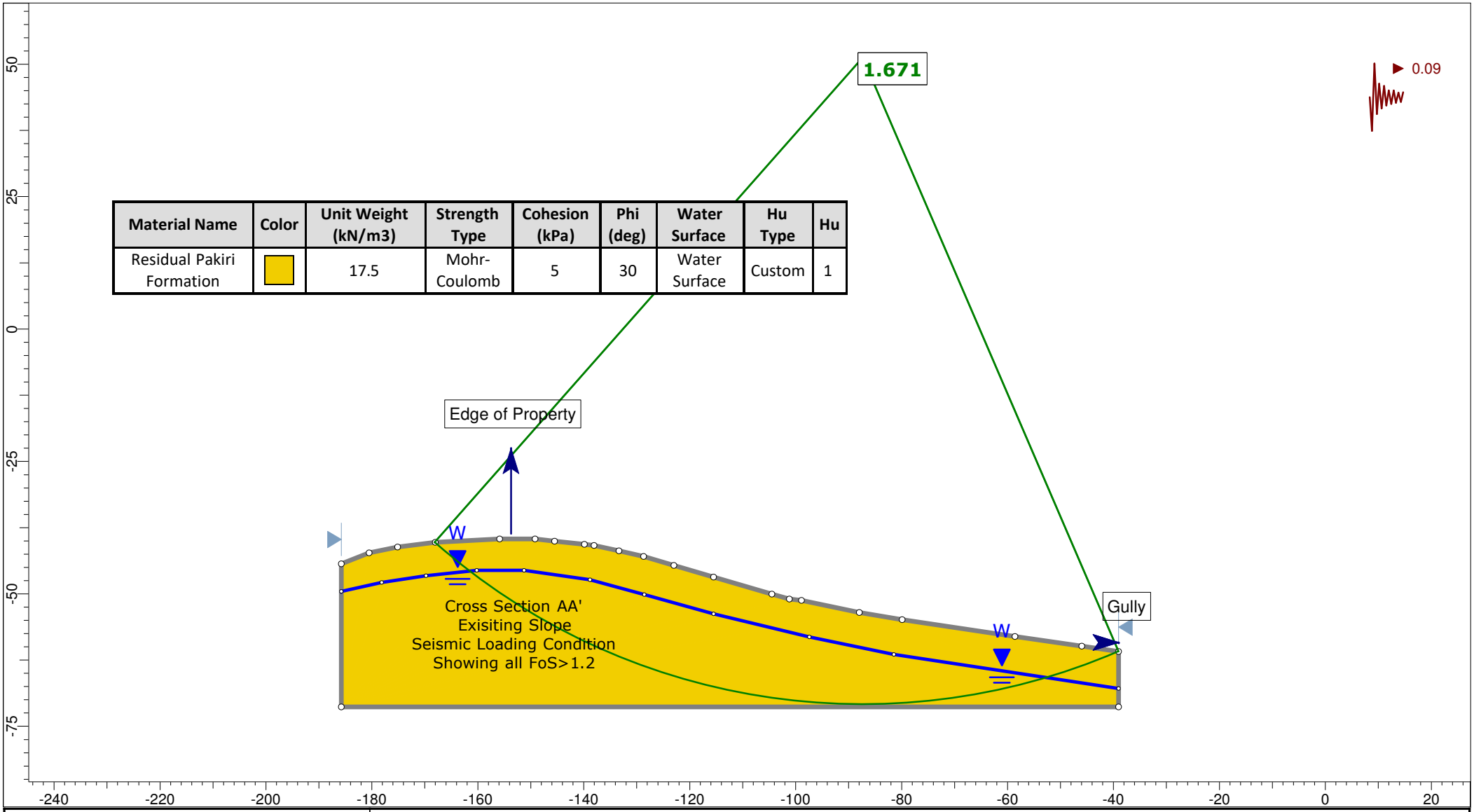
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Residual Pakiri Formation		17.5	Mohr-Coulomb	5	30	Water Surface	Custom	1



LANDER geotechnical

SLIDEINTERPRET 9.018

Analysis Description	Existing Slope - Elevated Groundwater				
Cross Section	A-A'	*Case No.*	2		J01779 14 Kaipara Hills Road, Warkworth
Drawn By	AH	*F.O.S Filter*	1.3	*Company*	Lander Geotechnical Consultants Ltd
Date	15/07/2021	*Scale*	1:1000	*File Name*	J01779_210708_slope stability.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Residual Pakiri Formation		17.5	Mohr-Coulomb	5	30	Water Surface	Custom	1

LANDER geotechnical

SLIDEINTERPRET 9.018

Analysis Description	Existing Slope - Seismic Loading				
Cross Section	A-A'	*Case No.*	3		J01779 14 Kaipara Hills Road, Warkworth
Drawn By	AH	*F.O.S Filter*	1.2	*Company*	Lander Geotechnical Consultants Ltd
Date	15/07/2021	*Scale*	1:1000	*File Name*	J01779_210708_slope stability.slmd

3.2 Slab-on-ground in expansive soils

3.2.1 NZS 3604 Clause 1.1.2 Buildings covered by this Standard

Amend 1.1.2(a) to read:

"Buildings founded on good ground or on expansive soils where the requirements of 1.1.5 are met"

3.2.2 NZS 3604 New Clause

Add new: "**Clause 1.1.5 Buildings on expansive soils**

Buildings on expansive soils shall be supported on slab-on-ground foundations complying with 7.5.13 and in addition to 1.1.2 shall be limited as follows:

(a) single storey, stand-alone household unit, and

(b) maximum length or width of floor of 24.0 m including any attached garage, and

(c) simple plan shapes such as rectangular, L, T or boomerang, and

(d) concrete slab-on-ground with a minimum thickness of 100 mm and a minimum concrete compressive strength of 20 MPa, and

(e) simple roof forms, incorporating hips, valleys, gables or mono pitches, and

(f) maximum overall height of 7.0 m to roof apex from lowest cleared ground level, and

(g) maximum roof height of 3.0 m, and

(h) roof slope between 10° and 35° from the horizontal, and

(i) maximum span of roof truss 12.0 m, and

(j) external walls maximum of 2.4 m height studs, other than gable end walls and walls to mono-pitched roofs, which shall not exceed 4.0 m.

COMMENT:

Floor plans

Where floor plans incorporate re-entrant corners then continuity of the exterior ground beam shall be maintained by continuing it as an internal beam, with the exterior beam details continued for a length of at least 1.0 m into the internal beam. This is only applicable where internal beams are specified in Tables 7.4A and 7.4B. This is aimed to bring the solution in NZS 3604 in line with Clause 5.3.8 of AS 2870:2011.

Amend 19 Nov 2019

Ground movement

Provision for the additional ground movement effects from trees near to foundations in expansive soils should be considered. Trees remove moisture from the soil for a radius equal to the height of the tree. This causes expansive soils to shrink to varying degrees, and when near houses leads to differential settlement occurring under foundations. Movement of the foundations may lead to cracks in the building and door jamming.

Where existing trees (including trees that have been recently removed) are located closer to the foundations than 1.5 times the mature height of a tree, then additional geotechnical advice should be obtained. Planting of new trees should be avoided near foundations of new buildings or neighbouring buildings on sites with expansive soils.

3.2.3 NZS 3604 Clause 7.5.1

Add the following paragraph at the end of Clause 7.5.1:

"Slabs on expansive soils for buildings meeting the requirements of 1.1.5 shall, in addition to meeting the requirements of 7.5.1 to 7.5.12, meet the requirements of 7.5.13. Where there is conflict the requirements of 7.5.13 shall apply."

3.2.4 NZS 3604 New clause, tables and figures

Add new: **Clause 7.5.13 Slab-on-ground in expansive soils**

7.5.13.1 Identification of expansive soils

7.5.13.1.1 Should reasonable enquiry as outlined in 3.1.3 show any signs of expansive soils, the expansive soil class, as defined in AS 2870, shall be established by one or all of:

(a) enquiry to the local territorial authority, and/or

(b) reference to the certificate of suitability issued in terms of NZS 4431, and/or

(c) a soil test undertaken by a suitably qualified soils engineer.

7.5.13.1.2 Expansive soil class shall be defined as:

(a) Slightly 'S', having an I_{SS} range of 0–1.9%, and a 500 year design characteristic surface movement return (y_S) of 22 mm, or

(b) Moderately 'M', having an I_{SS} range of 2.0–3.7% and a 500 year design characteristic surface movement return (y_S) of 44 mm, or

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(c) Highly 'H', having an I_{SS} range of 3.8–6.5%and a 500 year design characteristic surface movement return (y_S) of 78 mm, or

(d) Extremely 'E', having an I_{SS} range of 6.6–7.5% and a 500 year design characteristic surface movement return (y_S) of 90 mm.

7.5.13.2 Maximum aspect ratio of concrete slabs

The aspect ratio of the concrete slabs or bays of concrete slabs, such as in the case of L, T or boomerang concrete slab shapes, shall not exceed 5 to 1 (length to width).

7.5.13.3 Foundation details

7.5.13.3.1 For the identified expansive soil class the foundation details, external and internal thickenings shall be as follows.

(a) For light wall claddings refer to Table 7.4A and Figure 7.22.

(b) For medium wall or heavy wall claddings refer to Table 7.4B and Figure 7.23.

7.5.13.3.2 Situations where no internal thickenings shall be required are limited to a rectangular slab with long side not exceeding 17.0 m. Where this limit is exceeded, add additional internal thickenings across the slab with the same cross section dimensions and reinforcing as the external footing, so that the centre to centre spacing of thickenings is always less than 17.0 m.

COMMENT:

Design constraints:

a) The characteristic surface movements and the corresponding expansivity classifications have been calculated based on design for ultimate limit state (ULS) conditions for a 1 in 1000 year "extreme" drought event, and the serviceability limit state (SLS) conditions for a 1 in 500 year drought event.

b) Maximum soil movements are calculated to be based on a 500 year return period for SLS, and a 1000 year return period for ULS*;

(*NB: *This differed from the recommendations contained within BRANZ Study Report 120A (BSR120A) which used a 300 year return period for the design level drought conditions)*

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c) Climate parameters adopted from BSR120A of Δu = 1.2 pF, Hs = 1.5 m, and a crack depth of 0.5 Hs

d) The I_{SS} (soil stability index) ranges attributed to the expansivity classifications as defined in 3.2.4 above have been calculated using the parameters presented in BSR120A and Equation 2.3.1 of AS 2870:2011.

e) Sites subject to parameters that differ from those mentioned above, in particular sites where the crack depth is less than 0.75 m, such as cut natural ground or clay backfill, require specific engineering assessment to confirm their appropriate site classification.

f) The effects of nearby trees (whether existing, recently removed, or future planting) are not considered in these solutions. It is recommended that specific geotechnical engineering advice is obtained where a tree is within a lateral distance of 1.5 times its mature height of the foundations.

Maintenance of foundations in expansive soils

Normal maintenance is that work generally recognised as necessary to achieve the expected performance over time of the foundation located on expansive soils. Unless otherwise specified by the designer and noted on the drawings, basic normal maintenance tasks should ensure that:

a) the drainage and wetting of the site is controlled so that extremes of wetting and drying of the soils are prevented, and

b) the position and operation of gardens adjacent to the dwelling are controlled, and the planting of trees near to foundations is suitably restricted, and

c) any leaks which develop in plumbing, storm water or sanitary sewage systems are repaired promptly.

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Table 7.4A **Reinforced concrete foundations in expansive soils for light wall claddings**
Clause 7.5.13 and Figure 7.22

Expansive soil class	Slightly 'S'	Moderately 'M'	Highly 'H'	Extremely 'E'
Soil embedment (De)	375 mm	525 mm	575 mm	625 mm
Top steel (A_S top)	2/D 16	2/ D16	2/ D16	2/ D16
Bottom steel (A_S bottom)	1/ D16	1/ D25	1/ D20	1/ D25
Stirrups	R6/ 125 crs.	R6/ 125 crs.	R6/ 300 crs.	R6/ 300 crs.
Maximum spacing of internal thickenings	no internal thickening	no internal thickening	2.5 m crs.	2.5 m crs.
Depth of thickening (D1)	–	–	400 mm	450 mm
Base width (B1)	–	–	300 mm	350 mm
Top steel (A_S top)	–	–	2/ D20	2/ D20
Bottom steel (A_S bottom)	–	–	2/ D16	2/ D20
Stirrups	–	–	R6/ 150 crs.	R6/ 150 crs.

Table 7.4B **Reinforced concrete foundations in expansive soils for medium wall and heavy wall claddings**
Clause 7.5.13 and Figure 7.23

Expansive soil class	Slightly 'S'	Moderately 'M'	Highly 'H'	Extremely 'E'
Soil embedment (De)	500 mm	550 mm	775 mm	800 mm
Top steel (A_S top)	2/ D16	2/ D20	2/ D20	3/ D20
Bottom steel (A_S bottom)	2/ D16	2/ D16	2/ D20	2/ D20
Stirrups	R6/ 125 crs.	R6/ 250 crs.	R6/ 300 crs.	R6/ 300 crs.
Maximum spacing of internal thickenings	–	2.5 m crs.	2.5 m crs.	2.5 m crs.
Depth of thickening (D1)	–	350 mm	450 mm	500 mm
Base width (B1)	–	300 mm	300 mm	350 mm
Top steel (A_S top)	–	2/ D16	3/ D20	3/ D20
Bottom steel (A_S bottom)	–	2/ D16	2/ D16	2/ D20
Stirrups	–	R6/ 125 crs.	R6/ 150 crs.	R6/ 150 crs.

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