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Preliminary Geotechnical Investigation for Proposed Service Centre at

47 Millbrook Road, Waipu

Rev A **28 November 2022** **Rev. B** **Job No. NL220045**

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PRELIMINARY GEOTECHNICAL INVESTIGATION FOR PROPOSED SERVICE CENTRE AT 47 MILLBROOK ROAD, WAIPU

Job Number:	NL220045
Name of Project:	47 Millbrook Road, Waipu
Client:	Vaco Investments (Waipu) Limited
Author	Ben Young, Senior Engineering Geologist, MEngNZ
Reviewer: / Authoriser:	Bruce Green, Principal Geotechnical Engineer, CMEngNZ, CPEng
Document Version:	A
Printed:	28 November 2022
Author Signature:	
Reviewer: / Authoriser:	

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Appendices:

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 *geotechnical* natural hazards were identified (as listed in thisAct) that are considered an undue impediment to development or that cannot be reasonably addressed by typical engineering design and construction
Unduly Weak, Sensitive, or Compressible Soils	Alluvial soils of variable strength (soft to dense) were found beneath the site. These soils are highly variable in strength and composition over short vertical and lateral distances. Geotechnical risks associated with these soils include lower bearing capacity, liquefaction, settlement under loads and shallow groundwater.
Groundwater	Encountered up to a maximum depth of 0.2 m bpgl.
Natural Soils	Firm to very stiff Tauranga Group soils
Foundations	Suitable foundation types will be confirmed following confirmation of settlement and liquefaction risks.
Expansive Soils	Classified as Extremely Expansive in accordance with B1/AS1
Seismic Site Class	Preliminary site class recommendation of Class C – 'Shallow Soil Site' (as defined by NZS 1170.5:2004) for preliminary design. This site classification should be confirmed by deeper testing (CPT).
Further Work Required	The extent of proposed development was extended to the south following our ground investigation. Additional investigation will be needed in this area during the detailed design (i.e. Building Consent) stage. Further work is recommended to validate and quantify the risk of settlement and liquefaction. Cone penetration testing (CPT) and detailed assessment using proprietary software is recommended. The results of that further work may impact on the preliminary recommendations contained in this report. Results from that CPT testing can also be applied to proprietary software that assesses the settlement potential of the soils. Specific assessment and design for individual structures will be needed at the detailed design stage. The scope of the assessment and design needed will be confirmed once detailed plans of the development are available.
Construction Constraints	Construction constraints at the site are expected to include: • Soils sensitive to disturbance • Elevated groundwater levels • Low strength soils

1.0 Introduction

Soil & Rock Consultants (S&RC) were engaged by Vaco Investments (Waipu) Limited to carry out a geotechnical investigation at 47 Millbrook Road, Waipu. Our investigation and assessment relates to the proposed development of the site which includes construction of a service centre.

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:

- Assessment of the suitability of the site for supporting the proposed buildings and infrastructure.
- Qualitative assessment of the potential for liquefaction and settlement affecting the development.
- Laboratory testing to determine the potential for acid sulphate soils to have an effect on the development.
- Determining a groundwater model for the site.
- Preliminary recommendations for future building foundations and earthworks.
- Assessment of natural geotechnical hazards that could affect the site as outlined in Section 106 of the Resource Management Act.

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

1.1 Limitations

This report has been prepared by Soil & Rock Consultants for the sole benefit of Vaco Investments (Waipu) Limited (the client) with respect to 47 Millbrook Road, Waipu and the brief given to us. This report is also intended to be used by client-appointed consultants to support designs and by Council for the purpose of assessing a Resource Consent application for the building work described in this report. 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.

2.0 Site Description

The subject site is located at the corner of Millbrook Road and State Highway 1 and is legally described as Part Lot 1 DP 44163. The site is irregular in shape (see Figure 1). The site and its neighbouring properties comprise rural farmland and are near level.

Figure 1: Site Plan *(Source of background image: Northland Regional Council)*

2.1 Proposed Development

Preliminary drawings provided to us[1] show the proposed development will include construction of:

- three stormwater disposal swales;
- five wastewater disposal areas;
- a petrol station which includes deep (approx. 4.5 m bpgl) buried fuel tanks, forecourt, truck stop and mechanics workshop;
- several buildings such as supermarkets and retail spaces;
- water storage tanks;
- parking and roadways over much of the site.

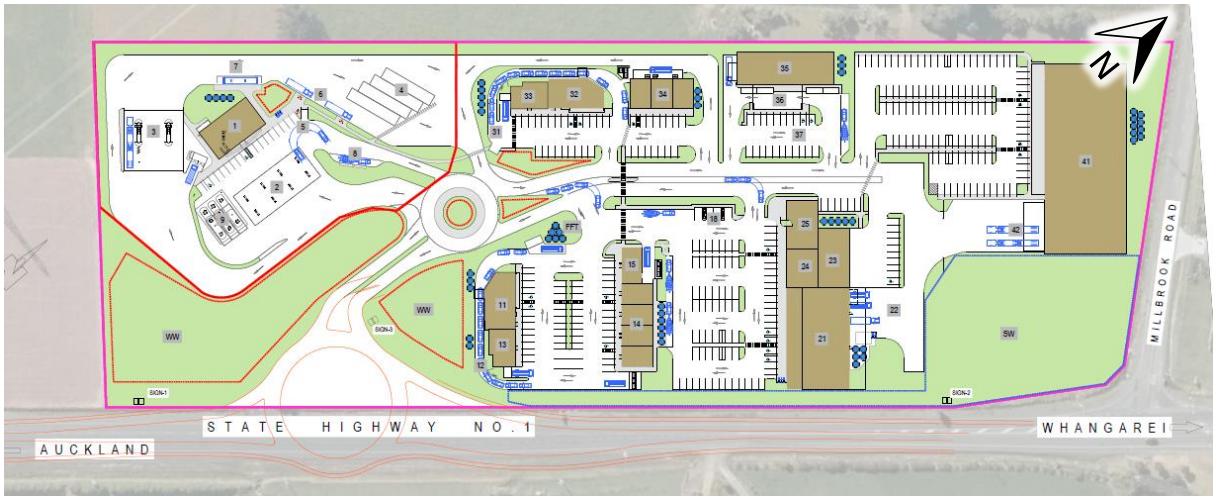

Figure 2: Proposed Development *(Source:* Site Plan by Technitrades Architecture)

The layout and details of the development are preliminary and subject to change.

3.0 Results of Ground Investigation

3.1 Geology

A geological map of the area[2] indicates that the site is underlain by Late Pleistocene River Deposits of the Tauranga group (refer to Figure 1). These materials generally comprise poorly consolidated mud, sand, gravel, and peat deposits of alluvial, swamp and estuarine origins.

[1] 'Proposed Service Centre' Drawing No. 3096-E01 revision P2 dated 20/10/2022 prepared by Technitrades Architecture.
[2] New Zealand Geology Web Map, http://data.gns.cri.nz/geology

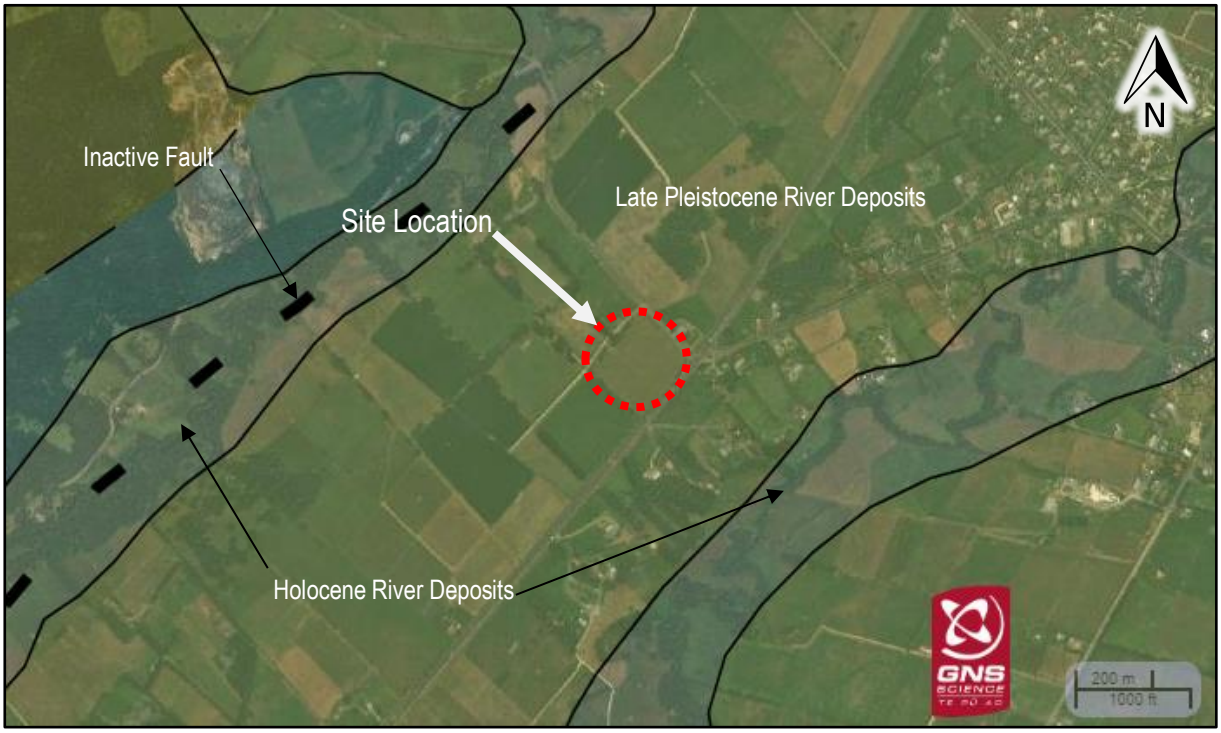

Figure 1 Geological Map *(Source: GNS WebMaps Website)*

Alluvial soils are inherently variable and can change in both strength and composition over short vertical and lateral distances.

Geotechnical risks associated with alluvial soils include:

- settlement
- liquefaction
- lower bearing capacities
- elevated groundwater levels

Preliminary assessment of geotechnical risks and methods to mitigate these are discussed further in this report.

3.2 Field Investigation

Our field investigation was carried out on 6th, 7th and 12th April 2022 and included the following:

- Visual appraisal of the site
- Drilling of ten (10) hand augerholes (AH01 – AH10 inclusive)
- Retrieval and laboratory testing of five (5) soil expansivity samples (SS01 – SS05)
- Installation of standpipe piezometers within 2 of the augerholes (PZ01 within AH09 and PZ02 with AH10).
- Carrying out ten shallow Scala penetrometer tests to 1.0 m to assess near surface conditions for pavement design (SC01 to SC10).
- Soil sampling for acid sulphate analysis (10 sample location with 4 samples per location)

The test locations are shown on the Site Plan, Drawing No NL220045/1 and NL220045/2 (Appendix A). Augerhole logs and the Scala test results are presented in Appendix B. Laboratory test results are presented in Appendix C. Our investigation has been limited to the northeastern half of the site. Following our investigation the extent of proposed development was extended to the south. This area will need additional investigation at the detailed design stage.

All testing was undertaken in accordance with relevant standards and guidelines.

3.3 Quality Assurance

Measurements of undrained shear strength were undertaken in the augerholes 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 each 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).

3.4 Subsurface Conditions

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

A thin layer of topsoil was found underlain by alluvial deposits of Tauranga Group soils. An outline of the soil conditions and investigation results is given below and summarised in Table 1. Detailed descriptions of the soils are given on the attached logs (Appendix B).

- **Topsoil.** Topsoil was encountered at each test location to depths between 0.1m and 0.3m below present ground level (bpgl). Topsoil is unsuitable for the support of permanent structures (i.e. building foundations, floor slabs, pavements etc.).

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

- **Tauranga Group.** Puketoka Formation alluvial deposits were encountered at each test location underlying the topsoil to the termination depths of the augerholes. The alluvial soils were highly variable and comprised soft to very stiff silt and clay with occasional organic rich layers.

  All augerholes were terminated before their target depth due to collapse of soil below the water table.

  Vane shear strengths recorded within the alluvial material ranged between 26kPa to greater than 200kPa.

- **Scala Penetrometer Testing.** Scala Penetrometer testing was carried out from the base of each augerhole. Refusal was encountered at depths ranging between 3.8m and 6.5m bpgl. Refusal was generally due to a gradual increase in resistance and is inferred to be due to increased friction on the Scala rods. No defined hard or dense surface is inferred at the termination depth of the testing however such a layer may be present within a few metres of that termination.

- **Groundwater.** Groundwater measurements were carried out within the hand augerholes on the day of drilling and on three subsequent dates.

  Groundwater measurements taken during drilling (summarised in Table 1) are not always an accurate portrayal of the actual long-term groundwater table as groundwater levels can rise within the augerhole following drilling. As a guide, we expect groundwater to develop at a stable level within augerholes at the depths where soils were logged as ‘wet’ or ‘saturated’.

Groundwater levels measured within piezometers across subsequent visits are more representative of actual conditions. The results of the groundwater monitoring are summarised in Table 2.

Table 1 – Summary of Subsurface Conditions

Test ID	Termination Depth	Depth to the base of Topsoil/Fill	Vane Shear Strength Range (kPa)	Scala Penetrometer Termination	Groundwater Depth
All depths measured in (m) below present ground level. (Rounded to 1 DP)					
AH01	3.4	0.2	33 – 200+	6.2	3.4
AH02	3.9	0.1	55 - 133	6.2	3.0
AH03	3.5	0.1	59 – 200+	5.9	1.3
AH04	3.2	0.3	29 - 173	6.3	0.6
AH05	3.2	0.1	37 - 99	6.5	2.2
AH06	4.0	0.3	54 – 200+	6.5	2.0
AH07	3.5	0.1	37 – 200+	5.7	2.2
AH08	2.3	0.1	39 - 68	3.8	0.7
AH09	3.7	0.3	26 – 200+	6.3	0.6
AH10	3.0	0.1	35 - 122	4.7	2.9

Table 2 – Summary of groundwater monitoring results

Test ID	Termination Depth	Groundwater Depth		
All depths measured in (m) below present ground level. (Rounded to 1 DP)				
		8/04/2022 (Day 1)	14/04/2022 (Day 7)	20/04/2022 (Day 13)
PZ01	3.7	0.6	0.5	0.2
PZ02	3.0	2.9	0.8	0.4

3.5 Expansive Soils

Five soil samples (SS01 – SS05) were retrieved from near-surface strata and tested in our laboratory to determine soil expansivity characteristics in accordance with AS 1289.7.1.1.

The laboratory test results indicate the soils ranged between expansive soil Class H to Class E being ‘highly expansive’ to ‘extremely expansive’ as given in B1/AS1.

We recommend that Class H soil expansivity is assumed for design purposes. B1/AS1 states that Class E soils experience surface movements of up to 90 mm and foundation design should take account of this classification. Laboratory test results are presented in Appendix C.

3.6 Sensitive Soils

The ratio of peak to remoulded vane shear strength values recorded during our investigation ranges approximately between 2 and 8, indicative of a 'normal to sensitive' subgrade. These soils are potentially susceptible to mechanical disturbance and/or exposure to the elements.

Soils that test well in-situ can perform poorly when construction is underway. Care is therefore required during construction to ensure the soils are protected to ensure favourable short and long-term subgrade and foundation performance.

4.0 Assessment of Natural Hazards

Section 106 of the Resource Management Act (RMA) requires consenting authorities to consider the possible risks various natural hazards pose to site where development is planned. The following points identify potential natural *geotechnical* hazards ss identified in the RMA. The likelihood of each of these hazards affecting the property is summarised in the following points.

- **Earthquake (seismic loading and liquefaction).** The PGA for the site is discussed in Section 4.1 below. Refer to section 0 for our assessment of the risk of liquefaction. Design of foundations and structures should include an allowance for the design PGA.
- **Tsunami.** The site is shown to be located with the 'Safe Area' for Tsunami Evacuation Zones as shown on Northland Regional Councils Hazard maps[3].
- **Erosion.** The site is not located nearby any sources of erosion such as watercourses or overland flow paths. The site is not at risk of being affected by erosion.
- **Volcanic and geothermal activity.** The site is not located near any known volcanic vents. The site is not subject to any unusual risk of volcanic or geothermal activity.
- **Landslip.** The site is nearly level. Landslip / slope failure is not a risk at the site.
- **Subsidence.** The risk of subsidence (or settlement) is discussed in section 4.3 below.
- **Sedimentation.** There is no risk of the site being affected by sedimentation.

[3] https://www.nrc.govt.nz/environment/river-flooding-and-coastal-hazards/natural-hazard-map-portal/

- **Flooding.** The site is shown to be outside of the coastal inundation and river flood zones shown on Northland Regional Councils Hazard maps.

Some natural hazards with a geotechnical basis have been identified as possibly affecting the site. Provided that allowance is made for these in the detailed design phase then the risk to structures built on the site, from natural hazards with a geotechnical basis, is low.

4.1 Seismic Design Parameters

Based on our preliminary investigation we recommend a preliminary site class of Class C – 'Shallow Soil Site' (as defined by NZS 1170.5:2004) is adopted for preliminary design. This site classification should be confirmed by deeper testing (CPT).

We have calculated the Peak Ground Acceleration (PGA) in accordance with Section 6.2 of the Bridge Manual based on the following assumptions:

- Class C soils
- A design life of 50 years
- An ARI of 1/500 (Table 3.3 of 1170.0: 2002)
- Ru of 1 (Table 3.5 of 1170.5: 2004)
- F = 1.33 (Section 6.2 of the Bridge Manual)
- C0,1000 = 0.13 (Figure 6.1(a) of the Bridge Manual)

A PGA value of 0.13g (ULS) with an effective earthquake magnitude of 5.6 (from Figure 6.2(d) of the Bridge Manual) should be adopted for design purposes for structures with a 50-year design life and an importance level of 2.

A different PGA will need to be calculated for structures with different importance levels / design life requirements or for liquefaction screening assessments.

4.2 Qualitative Liquefaction Assessment

Liquefaction is a process in which loose, saturated, cohesionless soils are subject to temporary, but essentially full, loss of strength due to incremental pore pressure build-up under reverse cyclic shear loading generated during an earthquake. As a consequence of this temporary strength loss, the liquefied soil can deform and settle. Case histories show that liquefaction is limited almost exclusively to saturated, fine to medium grained sands and low plasticity silts.

Liquefaction can only occur at and below the surface of the groundwater.

The site is underlain by weaker alluvial soils with shallow groundwater levels. Due to the presence of high groundwater and the presence of liquefiable material (sands/ silty sands) liquefaction is possible.

We recommend further testing and detailed assessment to validate and quantify the potential for liquefaction to affect structures at the site. This will also allow for preliminary recommendations for earthquake-resistant foundation designs to be developed.

4.3 Qualitative Assessment of Static Settlement Risk

Weaker alluvial soils underly the site. These soils are prone to settlement under imposed loads (e.g. new building loads or fill being placed above the existing ground level). Specific assessment of the risk of settlement affecting structures should be carried out to quantify the settlement risk and to discuss design options to mitigate that risk if it is identified.

Options to mitigate the risk of settlement typically include over-sizing of foundations to reduce loads applied to the underlying soils or application of load to the soil before construction and monitoring to confirm settlement has been fully realised ('preloading').

4.4 Acid Sulphate soils

Acid sulphate soils are present across much of Northland and have the potential to corrode buried metal structures and degrade concrete unless each has protective coatings or additives. We have carried out sampling and testing to assess the risk of acid sulphate soils affecting structures at the site. The results of our sampling and assessment are reported on separately.

5.0 Preliminary Recommendations

There are potentially significant constraints on development, being:

- Shallow groundwater
- Weak soils:
  - Soil strengths vary markedly across the site.
  - A reduced Bearing Capacity must be adopted in design
  - The soils are prone to settlement under building loads
- Potentially liquefiable soil column
- Site Class 'E' soil expansivity

The extent of those constraints has yet to be determined as further investigation and analysis related to the liquefiable and settlement characteristics are required.

Preliminary foundation recommendations for the proposed development are outlined in the following sections.

5.1.1 Shallow Foundation Discussion

The natural site soils are likely to be suitable for the use of shallow foundations to support lightweight structures. Shallow foundations are likely to take the form of a 'waffle' or 'rib-raft' slab (surface-supported, no embedment) however traditional strip/pad/Senton footings embedded appropriately designed/embedded to address the soil expansivity class may be suitable depending of the findings of further investigation and 'actual' building designs.

Design of shallow foundations will need to incorporate assessment of:

- Suitable bearing capacities. Recommendations for lower bearing capacities (in the range of 200 kPa Geotechnical ultimate bearing capacity) should be expected to allow for weaker soils within the zone of influence of shallow foundations.
- Total and differential settlements (discussed in section 4.3)
- Liquefaction risks (discussed in section 4.2)
- Class E soil expansivity

It is likely that ground improvement, taking the form of a geogrid-reinforced 'raft' will be required. This type of ground improvement addresses settlement and liquefaction issues and can also act to reduce soil expansivity by at least one class (e.g. from Class E down to Class H)

5.1.2 Pile Foundation Discussion

Pile foundations are likely to be required:

- For the bridging of underground services (not expected)
- Where bearing capacity requirements are greater than those given for shallow foundations
- Where ground improvement alone is insufficient to provide a reliable subgrade

Pile excavations will be susceptible to collapse and casing is likely to be required. Pumps capable of handling slurry-rich material will also be required during construction

Pile design requirements will need to be confirmed following specific investigation and assessment at the detailed design stage.

5.2 Floor Slab Discussion

High groundwater levels were encountered during our investigation. Engineering assessment and design will be needed to ensure that suitable separation between maximum groundwater levels and the underside of floorslabs is maintained. Options include one or several of the following:

- using physical separation barriers (e.g. suitably specified damp proof membrane)
- elevating finished floor levels such that a suitable separation is obtained between groundwater and the underside of floorslabs
- including subsoil drains below floorslabs. This will be effective only where the same are elevated. If building platforms are not elevated there may be insufficient separation between the sub-platform drains and the groundwater table to achieve effective drainage.

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

5.3 Pavements

All topsoil, non-engineered fill, vegetation, organic or otherwise unsuitable material should be removed from 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.

Shallow groundwater may be an issue when preparing the subgrade for the placement of sub-base materials and sumps and pumps may be required. We recommend placement of a mudstop grade of textile as a separation layer between the natural subgrade and any fill or sub-base.

Design for low CBR may require excavate-and-replace of natural subgrade with granular fill and placement of geogrid in the sub-base and base courses, in addition to the mudstop separation fabric referenced above.

5.4 Subgrade Protection

Protection of a prepared subgrade is recommended.

Practical means of protecting the soils include avoidance of vibration-based compaction equipment, protecting the subgrade following initial site clearance, minimising the passage of heavy or vibrating construction plant, and extra care during foundation excavations, particularly any pile excavations.

Maintaining the natural moisture content of a subgrade prior to construction is important. The subgrade should 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 dry conditions, we recommend watering the subgrade approximately 48 hours prior to concrete placement to return the subgrade to its inferred pre-excavation moisture content.

Any concrete floor-slab or 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.

5.5 Earthworks

The site is generally near level and major earthworks are not expected in relation to the development. Where earthworks are required the following procedures should be observed:

- Settlement risks associated with filling above settlement-prone soils should be considered in the earthworks design. Typical methods for mitigating settlement effects include preloading using temporary stockpiled fill.
- The contractors construction methodology should allow for excavation below the water table for any excavations.
- Prior to commencing earthworks, a sediment control system must be constructed to ensure the Territorial and Regional Authority requirements are met.
- Unsuitable materials (topsoil, unsuitable soils) encountered should be excavated, removed and replaced with good quality granular fill compacted in layers no greater than 150mm (loose, prior to compaction).

- 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.
- Service trenches should be backfilled with engineered granular fill where this is deemed necessary e.g. under pavements and other permanent structures.
- All fills, regardless of depth, must be placed in accordance with NZS 4431:1989 with respect to subgrade preparation and standard of compaction.
- A Geotechnical Engineer should inspect the prepared subgrade prior to placement of fill and test the fill compaction during placement.

5.6 Stormwater Disposal

Stormwater disposal systems should be designed to collect all runoff from sealed areas, building roofs and water tank overflows and dispose of it in a controlled manner. Design of the stormwater disposal system will be carried out by others.

5.7 Wastewater Disposal Areas

Design of the wastewater disposal system(s) must account for near-surface groundwater levels. Design of the wastewater disposal system will be carried out by others.

5.8 Underground Services

5.8.1 Proposed Services

High groundwater levels were measured during groundwater monitoring at the site. Groundwater should be assumed to be at the ground surface for design purposes.

Design of buried services (including service lines, pipes, storage tanks etc) must consider buoyancy effects as well as the potential for damage from Acid Sulphate soils. The risk of damage from Acid Sulphate soils is reported on separately.

5.8.2 Existing Services

Based on our service checks completed during preparation for our fieldwork public service lines are not present at the site. Regardless a thorough service search should be carried out prior to the commencement of excavations.

6.0 Purpose of Resource Consent

This report has been prepared to support a Resource Consent (RC) application. It does not represent a full design report that would accompany a Building Consent (BC) application.

The purpose of the RC is to identify potential issues and determine whether or not they are addressable by engineered design - it is not necessary to provide that fully developed design as that is part of the Building Consent process; and that process would accommodate any Conditions imposed by the RC.

7.0 Further work

Further work is recommended to better refine the risks of consolidation settlement and liquefaction.

Cone penetration testing (CPT) and detailed assessment using proprietary software is recommended as the most efficient and cost-effective means of achieving this aim. The results of that further work may impact on the preliminary recommendations contained in this report.

Deeper CPT testing should be undertaken to confirm the preliminary seismic site class assumed in this report and provide data that would show if pile designs are feasible.

Specific assessment and design for individual structures will be needed at the detailed design (i.e. Building Consent) stage. The scope of the assessment and design needed will be confirmed once detailed plans of the development are available.

8.0 Construction Constraints

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

- Sensitive soils are present across the site which exhibit a significant strength reduction when disturbed or exposed to the weather. Care is therefore required to protect the exposed soils during construction.
- A shallow groundwater level is present. Any excavations will need to take this into account.

9.0 Observation of Construction

The recommendations given in this report are based on limited site data from discrete locations and it is in the nature of geotechnical engineering that variations in ground conditions will exist across a site. S&RC should be engaged to inspect excavations and foundation 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 (PS4).

End of Report Text – Appendices Follow

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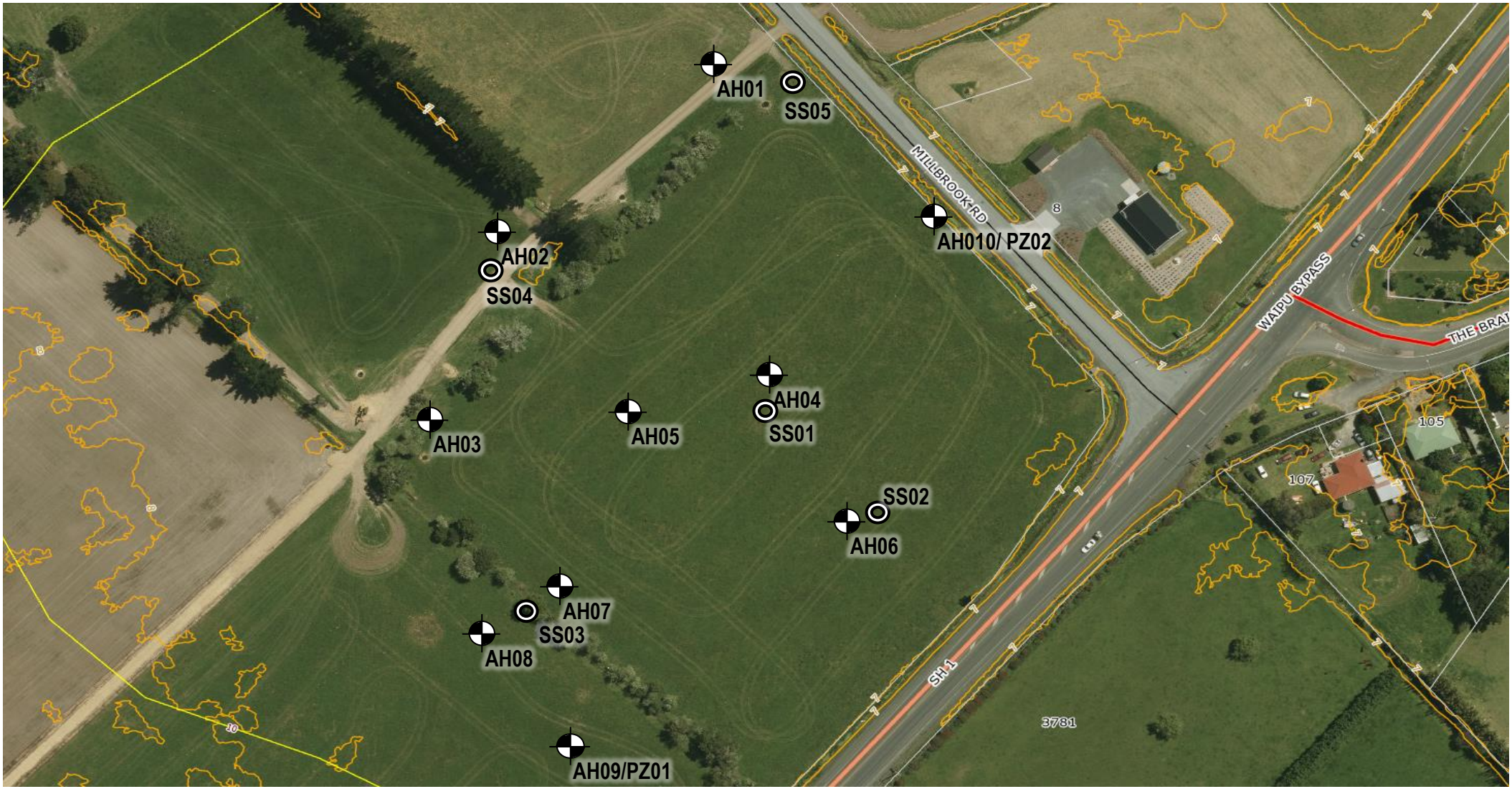
Appendix A

Investigation Plans



Aerial Photo from Auckland Council GeoMaps Webservice

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DRAWING NO:	**NL220045 /1**
DATE:	June 2022
DRAWN:	NB
SCALE:	NTS

SITE PLAN
47 MILLBROOK ROAD, WAIPU

Key:

- **AH** S&RC Hand Augerhole Locations 06 Apr 2022
- **SS** S&RC Expansivity Sample Locations 06 Apr 2022
- **PZ** S&RC Piezometer Locations 06 Apr 2022

Aerial Photo from Auckland Council GeoMaps Webservice

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DRAWING NO:	**NL220045 /2**
DATE:	June 2022
DRAWN:	B.Young
SCALE:	NTS

SITE PLAN
47 MILLBROOK ROAD, WAIPU

Key:

SC S&RC Scala Test Locations 06 Apr 2022

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Appendix B

Investigation Logs (Augerholes, Scala Penetrometer Results and Piezometers)

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CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

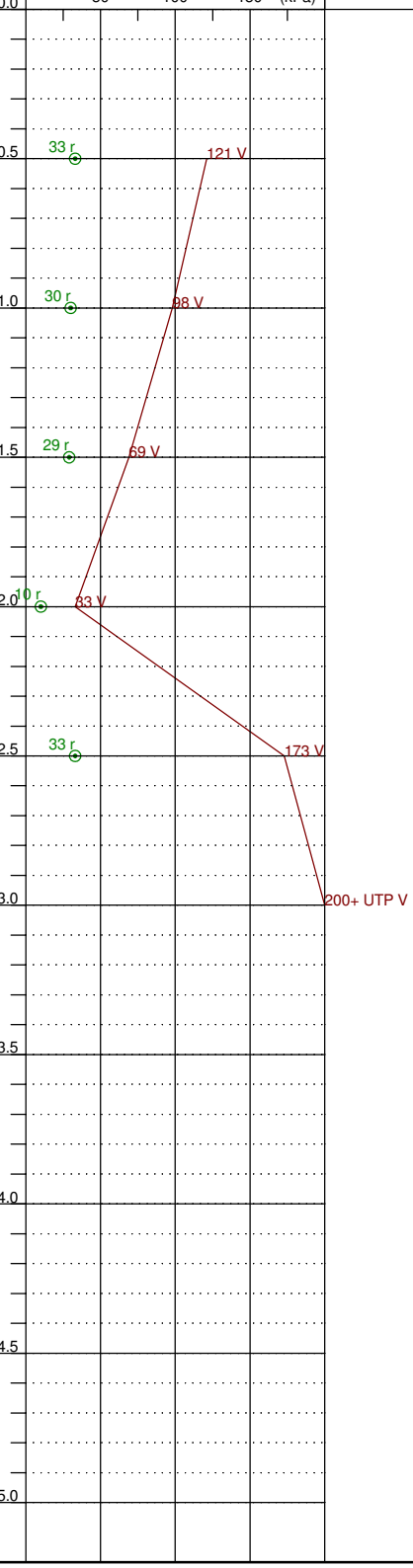
Auger Hole No: AH01

Sheet 1 of 1

Drill Type:	50mmØ Hand Auger	Project No:	NL220045	Logged By:	RH
Drilled By:	RH	Coordinates:		Shear Vane No - Calibration Date:	GEO119 - 10/03/2021
Date Started:	6/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	6/4/22	Water Level:	3.4m 6/04/2022		

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"
TS	0.0		TOPSOIL
TAURANGA GROUP			SILT, some clay, minor fine sand, grey brown, stiff, moist, slightly plastic (ALLUVIAL DEPOSITS)
	0.5		SILT, some clay to clayey, minor fine sand, light grey, orange streaks, black mottles, very stiff, moist, slightly to moderately plastic
			clayey, trace fine sand, white grey, orange streaks, no mottles, moderately plastic
			occasional orange streaks
	1.0		
	1.5		silty CLAY, trace fine sand, white grey, occasional orange streaks, stiff, moist, highly plastic moist to wet
			minor fine sand, firm
	2.0		
	2.5		SILT, some clay to clayey, some fine to medium sand, orange, white grey, orange streaks, very stiff, moist to wet, slightly to moderately plastic
			SILT, some fine to medium sand to sandy, some clay, light blue, very stiff, moist to wet, slightly plastic
			fine to medium sandy SILT, minor clay, non to slightly plastic
			trace clay, greenish light blue, hard, non plastic
	3.0		silty fine to medium sand, light blue, medium dense, wet
			saturated
			less than 5% recovery
	3.5		END OF BORE. 3.40 METRES. (HOLE COLLAPSE)
	4.0		
	4.5		
	5.0		

WATER LEVEL (m): 6/04/2022



LABORATORY TESTS

HAND AUGER LOG NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

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CLIENT: Vaco Investments Limited

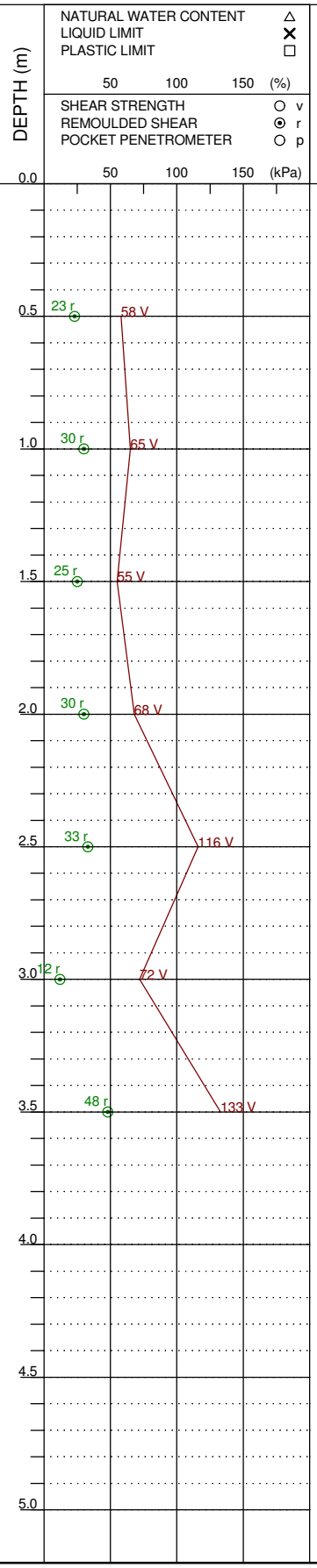
PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: AH02

Sheet 1 of 1

Drill Type:	50mmØ Hand Auger	Project No:	NL220045	Logged By:	JT
Drilled By:	JT	Coordinates:		Shear Vane No - Calibration Date:	GEO740 - 3/02/2022
Date Started:	6/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	6/4/22	Water Level:	3.0m 6/04/2022		

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)
TS	0.0		TOPSOIL	
TAURANGA GROUP			clayey SILT, trace fine sand, grey, orange mottles, stiff, moist, moderately plastic (ALLUVIAL DEPOSITS)	
	1.5		wet trace wood fragments to 4mmØ grey, orange streaks no wood fragments	
	2.5		minor fine sand very stiff some fine to medium sand, no orange streaks wet to saturated	
	3.0		fine to medium sandy SILT, some clay, green grey, stiff, wet to saturated, slightly plastic saturated dark grey minor decomposed wood fragments, trace clay, non plastic	6/04/2022
	3.5		10% recovery silty fine to medium SAND, trace clay, trace decomposed wood fragments to 2mmØ, loose, saturated no recovery	
	4.0		END OF BORE. 3.85 METRES. (HOLE COLLAPSE)	
	4.5			
	5.0			



LABORATORY TESTS

HAND AUGER LOG NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

Soil&Rock Consultants
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CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: AH03

Sheet 1 of 1

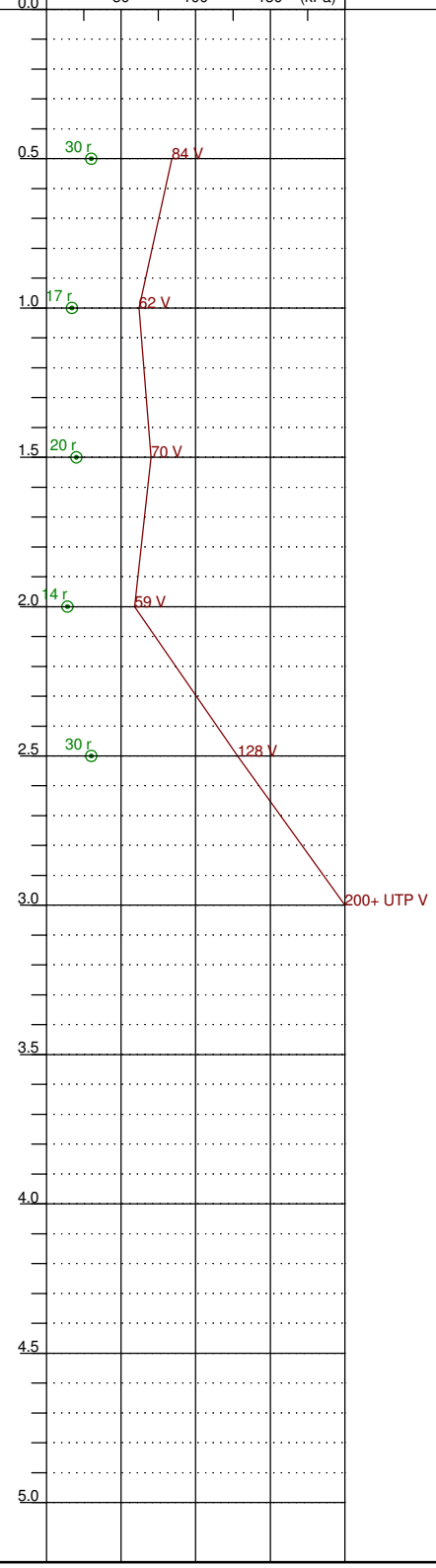
Drill Type:	50mmØ Hand Auger	Project No:	NL220045	Logged By:	JT
Drilled By:	JT	Coordinates:		Shear Vane No - Calibration Date:	GEO740 - 3/02/2022
Date Started:	6/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	6/4/22	Water Level:	1.3m 6/04/2022		

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"
TS	0.0		TOPSOIL
TAURANGA GROUP			clayey SILT, some fine to medium sand, grey, orange streaks, stiff, moist, moderately plastic (ALLUVIAL DEPOSITS)
	0.5		trace to minor fine sand, moist to wet
	1.0		wet
			saturated
	1.5		minor fine sand
	2.0		SILT, some clay, some fine sand, grey, orange streaks, very stiff, saturated, slightly plastic
	2.5		green grey
			fine to medium sandy SILT, some clay, green grey, very stiff, saturated, slightly plastic
	3.0		trace to minor clay, non plastic
			hard
			silty fine to medium SAND, green grey, medium dense, saturated
	3.5		10% recovery
			no recovery
			END OF BORE. 3.50 METRES. (HOLE COLLAPSE)
	4.0		
	4.5		
	5.0		

WATER LEVEL (m): 6/04/2022

NATURAL WATER CONTENT △
LIQUID LIMIT ×
PLASTIC LIMIT □
50 100 150 (%)

SHEAR STRENGTH ○ v
REMOULDED SHEAR ◉ r
POCKET PENETROMETER ○ p
50 100 150 (kPa)



LABORATORY TESTS

HAND AUGER LOG NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

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CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: AH04

Sheet 1 of 1

Drill Type:	50mmØ Hand Auger	Project No:	NL220045	Logged By:	RH
Drilled By:	RH	Coordinates:		Shear Vane No - Calibration Date:	GEO119 - 10/03/2021
Date Started:	6/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	6/4/22	Water Level:	0.6m 6/04/2022		

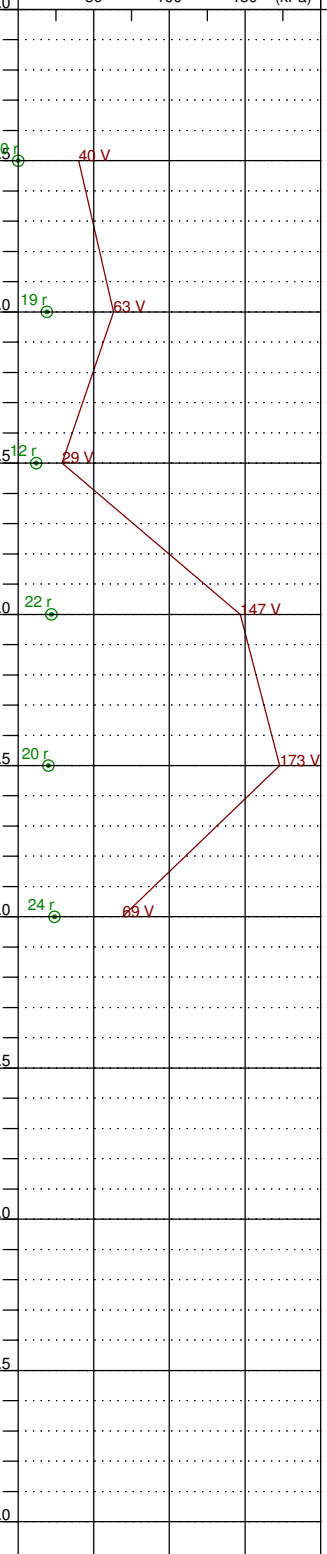
STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TS	0.0		TOPSOIL
TAURANGA GROUP	0.5		clayey SILT, minor fine sand, white grey, orange streaks, stiff, moist, moderately plastic (ALLUVIAL DEPOSITS)
			trace fine sand, firm
			minor decomposed plant fibres, no fine sand, organic stained brown and black, saturated
			firm
	1.0		silty CLAY, trace fine sand, white grey, yellow white, black speckles, stiff, saturated, highly plastic
			no fine sand
	1.5		firm
			minor fine sand
	2.0		fine to medium sandy SILT, minor clay, white grey, occasional orange streaks, very stiff, saturated, non to slightly plastic
			light blue, greenish blue
	2.5		
			for 50mm; SILT, some fine to medium sand to sandy, minor clay, organic stained dark brown and greyish brown, stiff, non to slightly plastic
	3.0		less then 5% recovery
			END OF BORE. 3.20 METRES. (HOLE COLLAPSE)
	3.5		
	4.0		
	4.5		
	5.0		

WATER LEVEL (m): 6/04/2022

DEPTH (m)

NATURAL WATER CONTENT △
LIQUID LIMIT ×
PLASTIC LIMIT □
50 100 150 (%)

SHEAR STRENGTH ○ v
REMOULDED SHEAR ◉ r
POCKET PENETROMETER ○ p
50 100 150 (kPa)



LABORATORY TESTS

HAND AUGER LOG NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

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CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

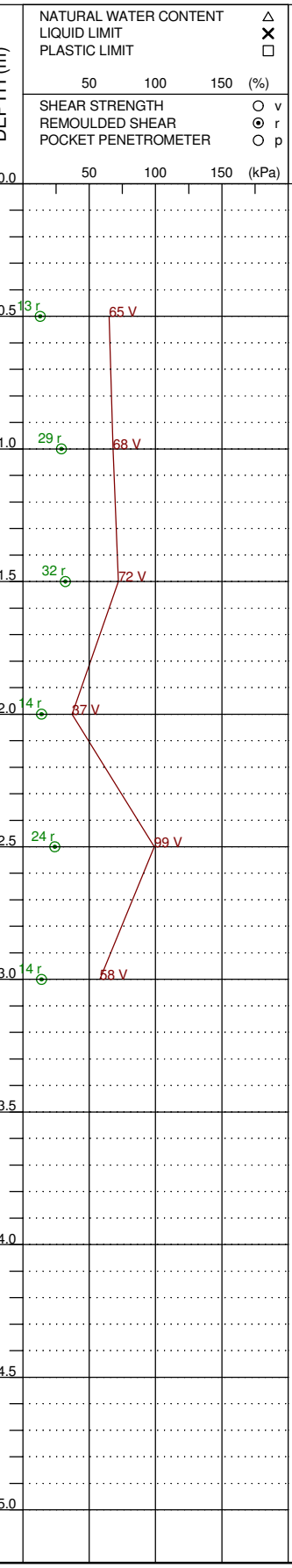
Auger Hole No: AH05

Sheet 1 of 1

Drill Type:	50mmØ Hand Auger	Project No:	NL220045	Logged By:	RH
Drilled By:	RH	Coordinates:		Shear Vane No - Calibration Date:	GEO119 - 10/03/2021
Date Started:	6/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	6/4/22	Water Level:	2.2m 6/04/2022		

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"
TS	0.0		TOPSOIL
TAURANGA GROUP	0.5		SILT, some fine sand, minor clay, yellowish white streaks, stiff, moist, non to slightly plastic (ALLUVIAL DEPOSITS)
			clayey SILT, yellowish white, orange streaks, stiff, moist, moderately plastic
	1.0		silty CLAY, trace fine sand, white, occasional orange streaks, stiff, moist, highly plastic
			wet
			moist
	1.5		wet to saturated
			minor fine sand, firm
	2.0		saturated
	2.5		SILT, some clay to clayey, some fine to medium sand, bluish white, very stiff, saturated, slightly to moderately plastic
	3.0		SILT, some fine to medium sand to sandy, some clay, light blue, greenish blue, stiff, saturated, slightly plastic fine to medium sandy SILT, minor clay, organic stained brown, non to slightly plastic less than 10% recovery
			END OF BORE. 3.20 METRES. (HOLE COLLAPSE)
	3.5		
	4.0		
	4.5		
	5.0		

WATER LEVEL (m): 6/04/2022



LABORATORY TESTS

HAND AUGER LOG NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

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CLIENT: Vaco Investments Limited

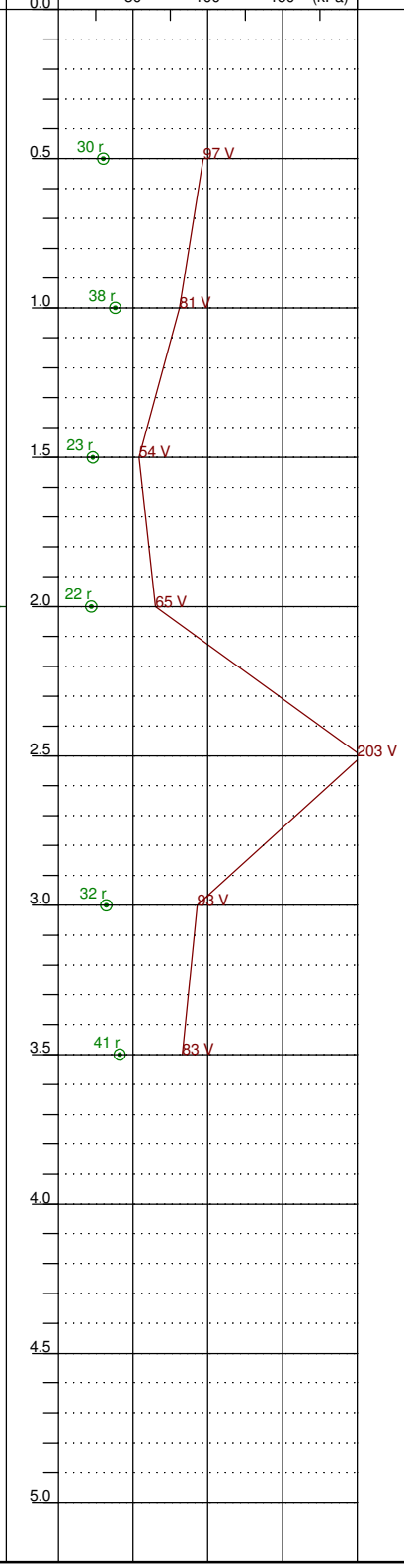
PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: AH06

Sheet 1 of 1

Drill Type:	50mmØ Hand Auger	Project No:	NL220045	Logged By:	JT
Drilled By:	JT	Coordinates:		Shear Vane No - Calibration Date:	GEO740 - 3/02/2022
Date Started:	6/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	6/4/22	Water Level:	2.0m 6/04/2022		

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)
TS	0.0		TOPSOIL	
TAURANGA GROUP	0.5		clayey SILT, trace fine sand, grey, orange streaks, stiff, moist, moderately plastic (ALLUVIAL DEPOSITS)	
			wet	
	1.0			
	1.5		grey	
	2.0		saturated	6/04/2022
	2.5		fine to medium sandy SILT, minor clay, green grey, very stiff, saturated, non to slightly plastic	
	3.0		dark grey trace to minor decomposed wood fibres, black streaks, stiff	
	3.5		no wood fragments, 10% recovery	
	4.0		silty fine to medium SAND, dark grey, loose, saturated no recovery	
	4.5		END OF BORE. 4.00 METRES. (HOLE COLLAPSE)	
	5.0			



LABORATORY TESTS

HAND AUGER LOG NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

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CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: AH07

Sheet 1 of 1

Drill Type:	50mmØ Hand Auger	Project No:	NL220045	Logged By:	RH
Drilled By:	RH	Coordinates:		Shear Vane No - Calibration Date:	GEO119 - 10/03/2021
Date Started:	7/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	7/4/22	Water Level:	2.2m 7/04/2022		

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"
TS	0.0		TOPSOIL
TAURANGA GROUP	0.5		fine sandy SILT, minor clay, yellowish white, stiff, moist, non to slightly plastic (ALLUVIAL DEPOSITS)
			some clay, slightly plastic
			clayey SILT, trace fine sand, white grey, orange streaks, stiff, moist, moderately plastic
	1.0		silty CLAY, white grey, occasional orange streaks, stiff, moist, highly plastic
			minor decomposed tree fibres to 5mmØ, dark reddish brown, black speckles,
	1.5		firm to stiff
			wet
	2.0		firm, saturated
	2.5		
	3.0		fine to medium sandy SILT, minor clay, bluish white, hard, saturated, non to slightly plastic
	3.5		silty fine to medium SAND, bluish light grey, organic stained purple grey, loose, saturated
			END OF BORE. 3.50 METRES. (HOLE COLLAPSE)
	4.0		
	4.5		
	5.0		

WATER LEVEL (m): 7/04/2022

NATURAL WATER CONTENT △
LIQUID LIMIT ×
PLASTIC LIMIT □
50 100 150 (%)
SHEAR STRENGTH ○ v
REMOULDED SHEAR ◉ r
POCKET PENETROMETER ○ p
50 100 150 (kPa)

DEPTH (m) 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0

22 r, 88 V
30 r, 63 V
16 r, 45 V
10 r, 37 V
29 r, 63 V
200+ UTP V
200+ UTP V

LABORATORY TESTS

HAND AUGER LOG NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

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CLIENT: Vaco Investments Limited

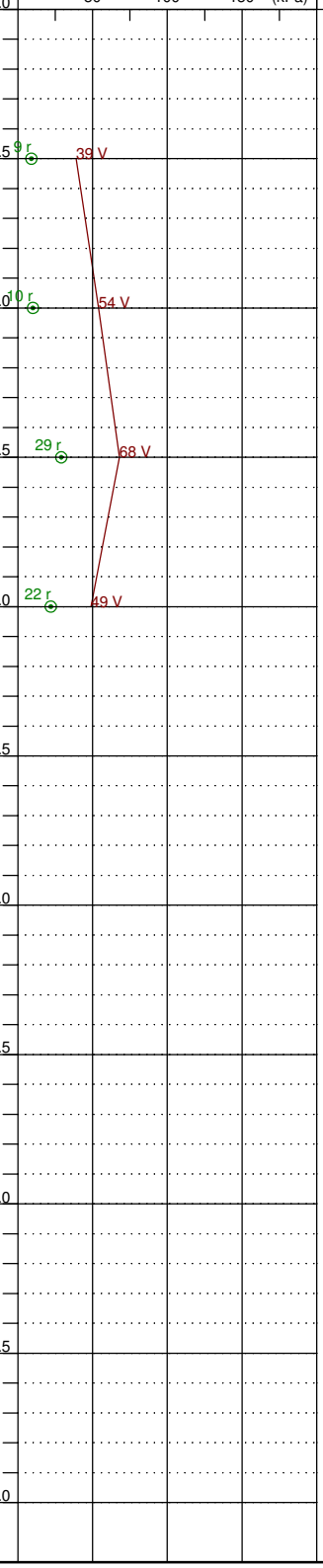
PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: AH08

Sheet 1 of 1

Drill Type:	50mmØ Hand Auger	Project No:	NL220045	Logged By:	JT
Drilled By:	JT	Coordinates:		Shear Vane No - Calibration Date:	GEO740 - 3/02/2022
Date Started:	7/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	7/4/22	Water Level:	0.7m 7/04/2022		

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)
TS	0.0		TOPSOIL	
TAURANGA GROUP	0.5		SILT, some clay, minor to some fine to medium sand, grey, orange speckles, firm, moist to wet, slightly plastic (ALLUVIAL DEPOSITS) wet	7/04/2022
	1.0		clayey SILT, minor fine sand, light orange grey, orange streaks, stiff, wet to saturated, moderately plastic saturated high suction, poor recovery	
	1.5		firm	
	2.0		some fine to medium sand, light grey	
	2.5		END OF BORE. 2.30 METRES. (HOLE COLLAPSE)	
	3.0			
	3.5			
	4.0			
	4.5			
	5.0			



LABORATORY TESTS

HAND AUGER LOG NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

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CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: AH09

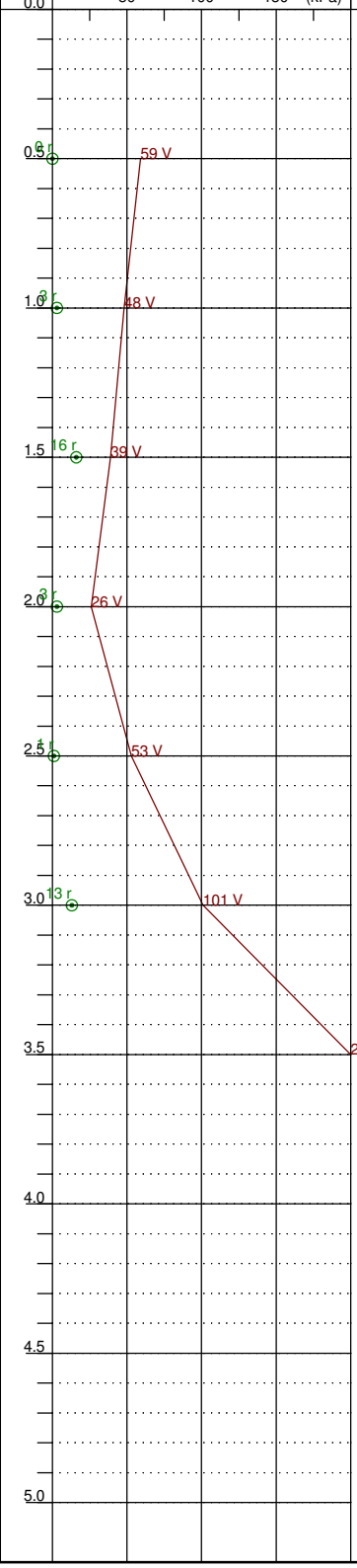
Sheet 1 of 1

Drill Type:	75mmØ Hand Auger	Project No:	NL220045	Logged By:	RH
Drilled By:	RH	Coordinates:		Shear Vane No - Calibration Date:	GEO119 - 10/03/2021
Date Started:	7/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	7/4/22	Water Level:	0.6m 7/04/2022		

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"
TS	0.0		TOPSOIL
TAURANGA GROUP	0.5		SILT, some fine sand to sandy, minor clay, yellowish light grey, stiff, moist, non to slightly plastic (ALLUVIAL DEPOSITS)
			clayey SILT, trace fine sand, white grey, orange streaks, stiff, moist, moderately plastic saturated
	1.0		silty CLAY, white grey, occasional orange streaks, stiff, saturated, highly plastic occasional black speckles
	1.5		firm
	2.0		soft to firm
	2.5		minor fine sand, bluish white, occasional reddish dark orange streaks, stiff
			SILT, some fine to medium sand to sandy, some clay, bluish light grey, stiff, saturated, slightly plastic
	3.0		fine to medium sandy SILT, bluish grey, greenish blue, very stiff minor clay, non to slightly plastic
	3.5		fine to medium SAND, some silt, dark grey, organic stained black, dark purple, medium dense, saturated
			END OF BORE. 3.70 METRES. (HOLE COLLAPSE)
	4.0		
	4.5		
	5.0		

WATER LEVEL (m): 7/04/2022

NATURAL WATER CONTENT △
LIQUID LIMIT ×
PLASTIC LIMIT □
50 100 150 (%)
SHEAR STRENGTH ○ v
REMOULDED SHEAR ◉ r
POCKET PENETROMETER ○ p
50 100 150 (kPa)



LABORATORY TESTS

HAND AUGER LOG NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

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CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: AH10

Sheet 1 of 1

Drill Type:	75mmØ Hand Auger	Project No:	NL220045	Logged By:	JT
Drilled By:	JT	Coordinates:		Shear Vane No - Calibration Date:	GEO740 - 3/02/2022
Date Started:	7/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	7/4/22	Water Level:	2.9m 7/04/2022		

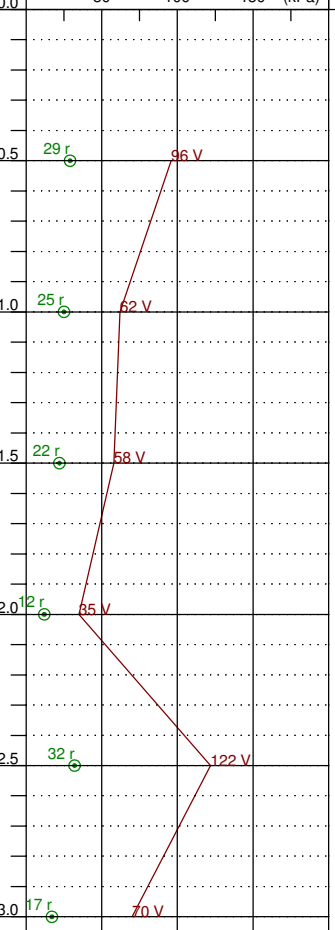
STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TS	0.0		TOPSOIL
TAURANGA GROUP	0.5		SILT, some clay, some fine to medium sand, grey, orange streaks, stiff, moist, slightly plastic (ALLUVIAL DEPOSITS)
	1.0		clayey SILT, trace fine sand, grey, orange mottles, stiff, moist, moderately plastic
	1.5		wet
			grey, firm
	2.0		
	2.5		fine to medium sandy SILT, some clay, green, grey, very stiff, wet, slightly plastic
			minor clay, non to slightly plastic
	3.0		saturated, no recovery
			END OF BORE. 3.00 METRES. (HOLE COLLAPSE)
	3.5		
	4.0		
	4.5		
	5.0		

WATER LEVEL (m): 7/04/2022

DEPTH (m)

NATURAL WATER CONTENT △
LIQUID LIMIT ×
PLASTIC LIMIT □
50 100 150 (%)

SHEAR STRENGTH ○ v
REMOULDED SHEAR ◉ r
POCKET PENETROMETER ○ p
50 100 150 (kPa)



LABORATORY TESTS

HAND AUGER LOG NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

Soil&Rock Consultants
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PO Box 21-424 Henderson, Waitakere 0650
09 835 1740
info@soilandrock.co.nz
www.soilandrock.co.nz

SCALA PENETROMETER SHEET - TABLE OF BLOWS PER INCREMENT

JOB NO: NL220045 **TESTED BY:** JT / RH

JOB NAME: 47 Millbrook Road, Waipu **DATE:** 06-07 /04/2022

Depth of Penetration [mm]	AH01	Con't		AH02	Con't		AH03	Con't		AH04	Con't	
DEPTH START[m]	3.40	5.40		3.85	5.85		3.50	5.50		3.15	5.15	
50 mm	SUNK	7		2	7		2	7		2	8	
100		7		4	11		3	8		3	7	
150		8		4	13		4	9		3	7	
200		6		3	13		4	10		4	7	
250	2	6		6	15		3	11		3	6	
300	2	7		6	15		2	10		4	5	
350	3	6		7			2	10		4	6	
400	3	6		3			1	10		4	6	
450	3	6		2			2			5	7	
500	3	7		1			2			4	7	
550	3	7		2			2			3	6	
600	4	10		1			1			3	6	
650	3	10		2			1			2	7	
700	2	10		1			1			2	7	
750	3	10		2			2			3	7	
800	4	10		2			2			3	10	
850	5			1			2			3	9	
900	5			2			3			3	10	
950	3			2			3			3	11	
1000	4			3			3			4	11	
1050	4			5			2			3	11	
1100	3			7			3			4	11	
1150	3			6			4			4		
1200	3			6			5			4		
1250	4			7			5			4		
1300	3			8			6			4		
1350	4			8			6			4		
1400	5			7			6			4		
1450	5			5			6			5		
1500	5			5			5			6		
1550	7			5			5			6		
1600	7			4			5			5		
1650	6			5			5			7		
1700	6			5			5			8		
1750	6			4			5			7		
1800	8			6			5			7		
1850	8			5			7			5		
1900	9			6			8			7		
1950	8			6			7			7		
2000	9			6			7			7		
DEPTH END [m]		6.20			6.15			5.90			6.25	

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

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SCALA PENETROMETER SHEET - TABLE OF BLOWS PER INCREMENT

JOB NO: NL220045 **TESTED BY:** JT / RH

JOB NAME: 47 Millbrook Road, Waipu **DATE:** 06-07 /04/2022

Depth of Penetration [mm]	AH05	Con't		AH06	Con't		AH07	Con't		AH08		
DEPTH START[m]	3.15	5.15		4.00	6.00		3.50	5.50		2.30		
50 mm	0.5	7		0.5	6		SUNK	10		1		
100	0.5	8		0.5	7			10		1		
150	1	8		1	7			10		1		
200	0.5	6		0.5	6					1		
250	0.5	6		0.5	7					1		
300	1	5		0.5	10					2		
350	1	5		0.5	10		2			2		
400	1	4		1	11		4			2		
450	1	4		1	10		4			4		
500	1	4		1	11		6			5		
550	1	4		1			4			5		
600	1	5		1			4			5		
650	1	6		1			5			3		
700	1	5		1			6			3		
750	1	6		1			4			4		
800	2	5		2			3			4		
850	2	6		2			4			8		
900	3	8		2			7			8		
950	4	8		2			7			8		
1000	5	8		3			8			8		
1050	5	8		3			7			9		
1100	6	10		3			6			8		
1150	6	10		3			3			9		
1200	5	10		3			3			9		
1250	4	10		4			3			8		
1300	3	10		3			3			10		
1350	3			4			3			10		
1400	2			4			5			14		
1450	3			4			4			11		
1500	3			4			5			10		
1550	4			4			6					
1600	3			4			6					
1650	3			5			5					
1700	4			4			6					
1750	3			4			6					
1800	5			4			6					
1850	5			5			8					
1900	6			5			9					
1950	6			4			11					
2000	6			6			10					
DEPTH END [m]		6.45			6.50			5.65		3.80		

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

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SCALA PENETROMETER SHEET - TABLE OF BLOWS PER INCREMENT

JOB NO: NL220045 **TESTED BY:** JT / RH

JOB NAME: 47 Millbrook Road, Waipu **DATE:** 06-07 /04/2022

Depth of Penetration [mm]	AH09	Con't		AH10								
DEPTH START[m]	3.70	5.70		3.00								
50 mm	5	6		SUNK								
100	2	6										
150	0.5	7										
200	0.5	7										
250	0.5	8		1								
300	0.5	7		2								
350	1	8		3								
400	1	10		3								
450	1	10		4								
500	1	10		6								
550	0.5	10		7								
600	0.5	10		6								
650	0.5			5								
700	0.5			6								
750	SUNK			2								
800				2								
850				3								
900				3								
950				2								
1000				3								
1050	1			5								
1100	2			6								
1150	2			6								
1200	2			7								
1250	2			6								
1300	2			3								
1350	3			5								
1400	4			6								
1450	5			6								
1500	4			10								
1550	4			10								
1600	5			12								
1650	4			11								
1700	5			12								
1750	4											
1800	4											
1850	4											
1900	5											
1950	5											
2000	5											
DEPTH END [m]		6.30		4.70								

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

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SCALA PENETROMETER SHEET - TABLE OF BLOWS PER INCREMENT

JOB NO: NL220045 **TESTED BY:** JT/RH

JOB NAME: Waipu Service Centre, Waipu **DATE:** 6/04/2022

Depth of Penetration [mm]	SC01	SC02	SC03	SC04	SC05	SC06	SC07	SC08	SC09	SC10		
DEPTH START[m]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
50 mm	1	2	1	1	1	1	1	2	1	0.5		
100	1	1	1	1	2	1	1	2	1	0.5		
150	2	2	1	1	2	1	1	2	0.5	1		
200	1	1	1	1	2	2	2	3	0.5	1		
250	2	2	1	0.5	1	1	2	2	1	1		
300	1	1	1	0.5	2	1	1	2	1	1		
350	2	1	1	1	2	1	1	2	1	1		
400	1	2	1	1	2	1	1	1	1	1		
450	1	1	1	1	2	0.5	2	1	1	0.5		
500	1	2	1	1	2	0.5	1	2	1	0.5		
550	1	2	1	1	2	0.5	1	1	1	1		
600	1	1	1	1	2	0.5	1	2	1	1		
650	2	1	1	0.5	2	1	1	1	0.5	1		
700	1	2	1	0.5	2	1	1	1	0.5	1		
750	1	1	0.5	0.5	2	0.5	1	2	1	0.5		
800	1	2	0.5	0.5	2	0.5	1	1	1	0.5		
850	1	2	1	1	2	0.5	1	1	1	0.5		
900	1	2	1	1	2	0.5	1	2	1	0.5		
950												
1000												
1050												
1100												
1150												
1200												
1250												
1300												
1350												
1400												
1450												
1500												
1550												
1600												
1650												
1700												
1750												
1800												
1850												
1900												
1950												
2000												
DEPTH END [m]	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90		

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

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CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: PZ01

Sheet 1 of 1

Drill Type:	75mmØ Hand Auger	Project No:	NL220045	Logged By:	RH
Drilled By:	RH	Coordinates:		Shear Vane No - Calibration Date:	GEO119 - 10/03/2021
Date Started:	7/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	7/4/22	Water Level:	0.6m 7/04/2022		

STRATIGRAPHY	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)	DEPTH (m)	SAMPLE TYPE	SPT / c_u (kPa)	DRILLING METHOD	RECOVERY (%)	STANDPIPE PIEZOMETER Ø32mm
TS		TOPSOIL		0.0					TOP CAP
TAURANGA GROUP		SILT, some fine sand to sandy, minor clay, yellowish light grey, stiff, moist, non to slightly plastic (ALLUVIAL DEPOSITS)	7/04/2022	0.5		V,59 VR,0			BENTONITE SEAL
		clayey SILT, trace fine sand, white grey, orange streaks, stiff, moist, moderately plastic saturated							
		silty CLAY, white grey, occasional orange streaks, stiff, saturated, highly plastic occasional black speckles		1.0		V,48 VR,3			
		firm		1.5		V,39 VR,16			FILTER PACK
		soft to firm		2.0		V,26 VR,3			
		minor fine sand, bluish white, occasional reddish dark orange streaks, stiff		2.5		V,53 VR,1			SLOTTED PIPE WITH FILTER SOCK
		SILT, some fine to medium sand to sandy, some clay, bluish light grey, stiff, saturated, slightly plastic fine to medium sandy SILT, bluish grey, greenish blue, very stiff minor clay, non to slightly plastic		3.0		V,101 VR,13			
		fine to medium SAND, some silt, dark grey, organic stained black, dark purple, medium dense, saturated		3.5		V,200+ UTP			
		END OF BORE. 3.70 METRES. (HOLE COLLAPSE)		4.0					
				4.5					
				5.0					

CONTAM AH WELL NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

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CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: PZ02

Sheet 1 of 1

Drill Type:	75mmØ Hand Auger	Project No:	NL220045	Logged By:	JT
Drilled By:	JT	Coordinates:		Shear Vane No - Calibration Date:	GEO740 - 3/02/2022
Date Started:	7/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	7/4/22	Water Level:	2.9m 7/04/2022		

STRATIGRAPHY	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)	DEPTH (m)	SAMPLE TYPE	SPT / c_u (kPa) (blows/300mm)	DRILLING METHOD	RECOVERY (%)	STANDPIPE PIEZOMETER Ø32mm
TS		TOPSOIL		0.0					TOP CAP
TAURANGA GROUP		SILT, some clay, some fine to medium sand, grey, orange streaks, stiff, moist, slightly plastic (ALLUVIAL DEPOSITS)							BENTONITE SEAL
		clayey SILT, trace fine sand, grey, orange mottles, stiff, moist, moderately plastic		0.5		V,96 VR,29			
				1.0		V,62 VR,25			FILTER PACK
		wet		1.5		V,58 VR,22			
		grey, firm		2.0		V,35 VR,12			
		fine to medium sandy SILT, some clay, green, grey, very stiff, wet, slightly plastic							SLOTTED PIPE WITH FILTER SOCK
		minor clay, non to slightly plastic		2.5		V,122 VR,32			
		saturated, no recovery	7/04/2022	3.0		V,70 VR,17			
		END OF BORE. 3.00 METRES. (HOLE COLLAPSE)		3.5					
				4.0					
				4.5					
				5.0					

CONTAM AH WELL NL220045- AH01-AH10- WAIPU SERVICE CENTRE - CORNER SH1 AND MILLBROOK ROAD, WAIPU- 2022-04-11.GPJ S+R_2013.GDT 13/4/22

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Appendix C

Laboratory Test Results

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SS01

Shrink-Swell Test Results

Job Name:	47 Millbrook Road, Waipu	Job No:	NL220045
Date:	12-Apr-22	Tested By:	TDS
Sample Location:	SS01	Date Sampled:	07-Apr-22
Sampling method:	Push Tube	Sampled By:	RH
Sampling depth (m):	0.5-0.9	Inert inclusions (%):	<1
Sample condition:	Good	Extent of cracking (%):	<1
		Extent of crumbling (%):	<1

Sample description: silty CLAY, light grey brown, orange streaks, very stiff, moist, highly plastic (NATURAL)

Wet Density	γ (t/m^3) =	1.64
Dry Density	γ_d (t/m^3) =	1.05

Shrinkage Test

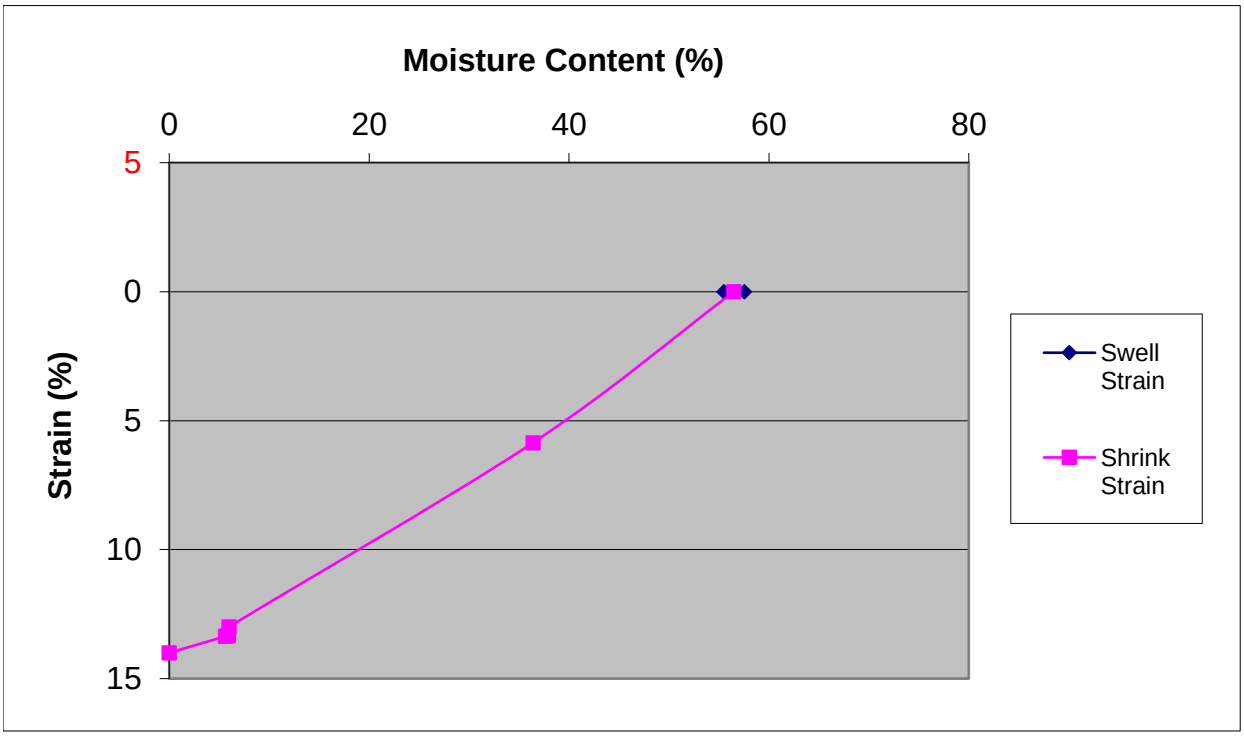
Initial moisture content (%) =	56.5
ε_{sh} = Magnitude of total shrinkage strain (%) =	14.0

Swell Test

ε_{sw} = Magnitude of the swelling strain (%) =	-0.2

(Note: The ε_{sw} value is negative if the sample has undergone consolidation)

Initial moisture content (%) =	55.5
Final moisture content (%) =	57.6



Shrink-Swell index **Iss =** **7.8** **Strain per ΔpF (%)**

Testing Method: AS1289.7.1.1 - 2003 Soil reactivity tests

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SS02

Shrink-Swell Test Results

Job Name:	47 Millbrook Road, Waipu	Job No:	NL220045
Date:	12-Apr-22	Tested By:	TDS
Sample Location:	SS02	Date Sampled:	07-Apr-22
Sampling method:	Push Tube	Sampled By:	RH
Sampling depth (m):	0.55-0.9	Inert inclusions (%):	1
Sample condition:	Good	Extent of cracking (%):	0
		Extent of crumbling (%):	0

Sample description: silty CLAY, light brown, grey, orange streaks, very stiff, moist, highly plastic (NATURAL)

Wet Density	γ (t/m^3) =	1.69
Dry Density	γ_d (t/m^3) =	1.12

Shrinkage Test

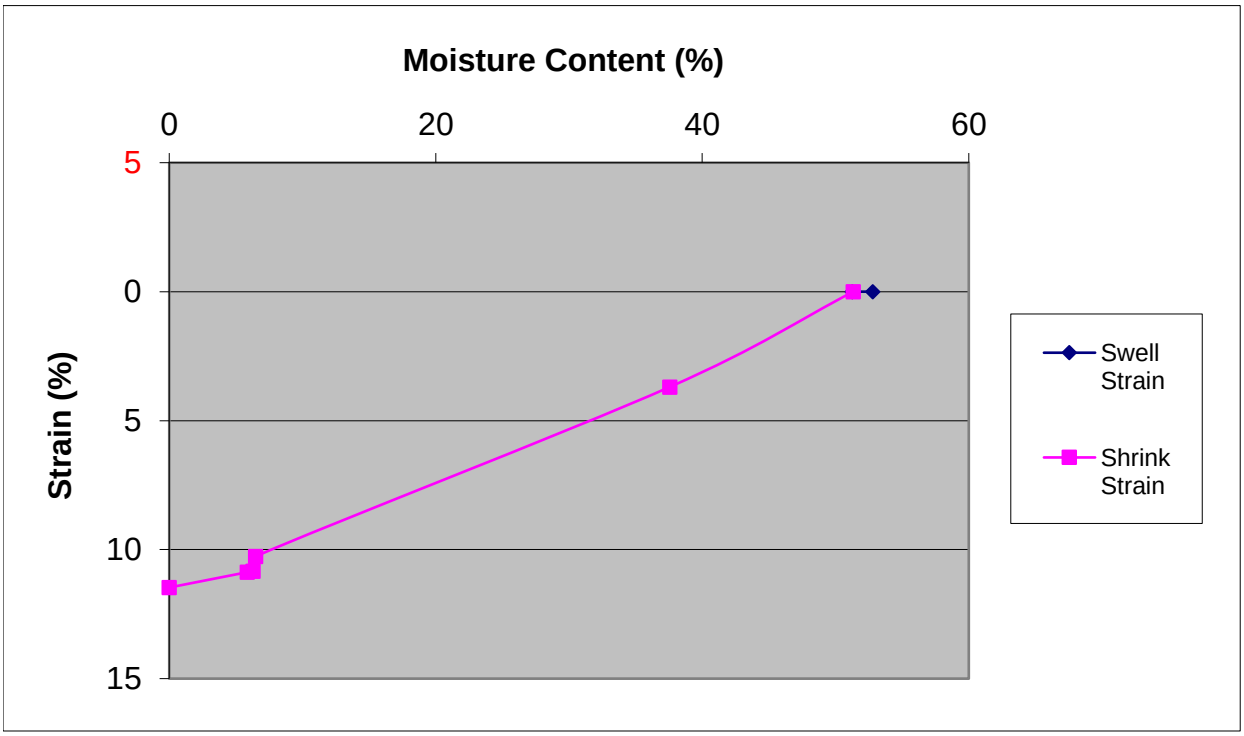
Initial moisture content (%) =	51.3
ε_{sh} = Magnitude of total shrinkage strain (%) =	11.5

Swell Test

ε_{sw} = Magnitude of the swelling strain (%) =	-0.5

(Note: The ε_{sw} value is negative if the sample has undergone consolidation)

Initial moisture content (%) =	51.3
Final moisture content (%) =	52.8



Shrink-Swell index **Iss =** **6.4** **Strain per ΔpF (%)**

Testing Method: AS1289.7.1.1 - 2003 Soil reactivity tests

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SS03

Shrink-Swell Test Results

Job Name:	47 Millbrook Road, Waipu	Job No:	NL220045
Date:	12-Apr-22	Tested By:	TDS
Sample Location:	SS03	Date Sampled:	07-Apr-22
Sampling method:	Push Tube	Sampled By:	JT
Sampling depth (m):	0.6-0.95	Inert inclusions (%):	1
Sample condition:	Good	Extent of cracking (%):	1
		Extent of crumbling (%):	<5

Sample description: silty CLAY, orange, light grey mottles,stiff, saturated, highly plastic (NATURAL)

Wet Density	γ (t/m^3) =	1.59
Dry Density	γ_d (t/m^3) =	0.94

Shrinkage Test

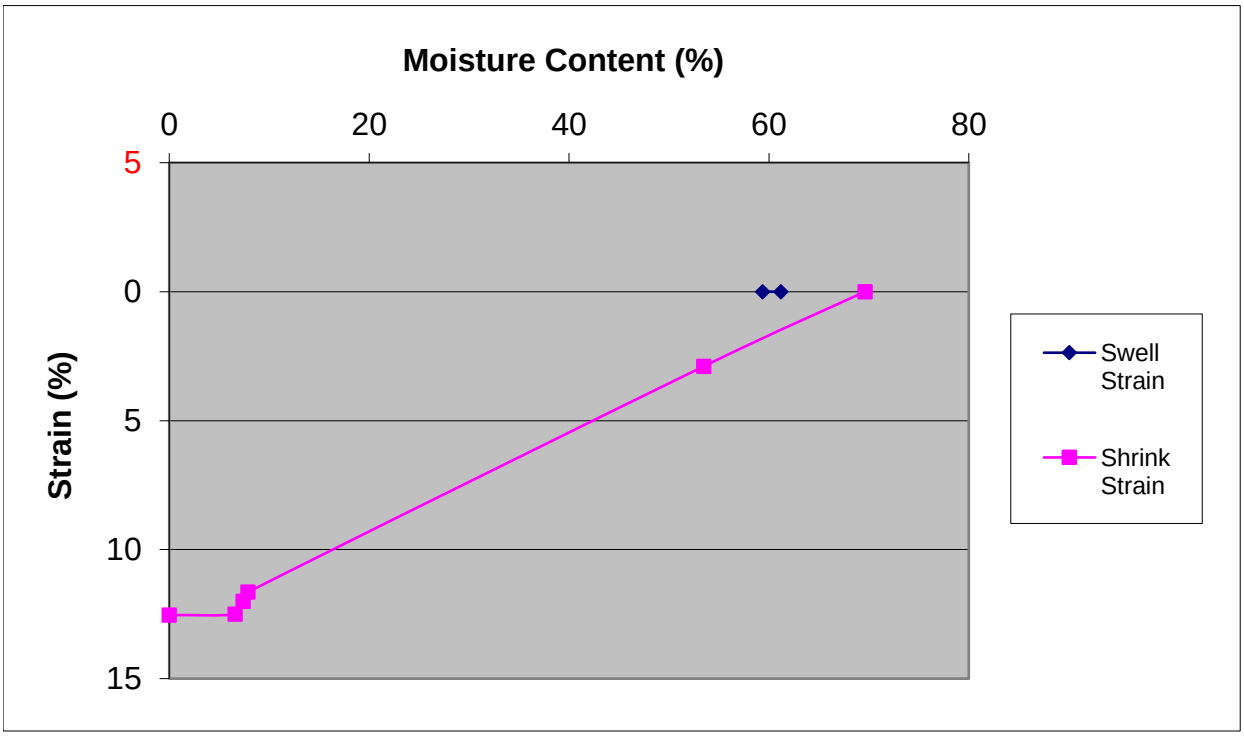
Initial moisture content (%) =	69.6
ε_{sh} = Magnitude of total shrinkage strain (%) =	12.5

Swell Test

ε_{sw} = Magnitude of the swelling strain (%) =	-0.7

(Note: The ε_{sw} value is negative if the sample has undergone consolidation)

Initial moisture content (%) =	61.2
Final moisture content (%) =	59.4



Shrink-Swell index **Iss =** **7.0** **Strain per ΔpF (%)**

Testing Method: AS1289.7.1.1 - 2003 Soil reactivity tests

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SS04

Shrink-Swell Test Results

Job Name:	47 Millbrook Road, Waipu	Job No:	NL220045
Date:	12-Apr-22	Tested By:	TDS
Sample Location:	SS04	Date Sampled:	07-Apr-22
Sampling method:	Push Tube	Sampled By:	JT
Sampling depth (m):	0.5-0.85	Inert inclusions (%):	<1
Sample condition:	Good	Extent of cracking (%):	<1
		Extent of crumbling (%):	<1

Sample description: silty CLAY, brownish grey, orange streaks, very stiff, moist, highly plastic (NATURAL)

Wet Density	γ (t/m^3) =	1.72
Dry Density	γ_d (t/m^3) =	1.13

Shrinkage Test

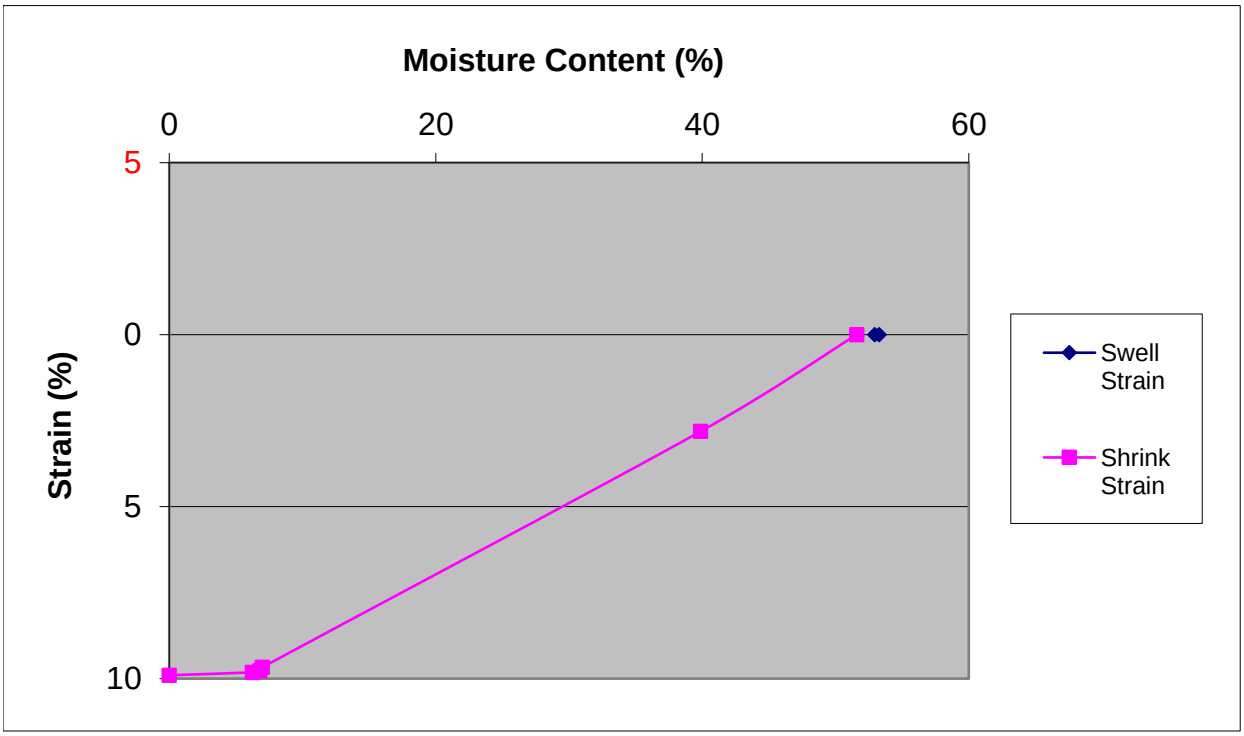
Initial moisture content (%) =	51.6
ε_{sh} = Magnitude of total shrinkage strain (%) =	9.9

Swell Test

ε_{sw} = Magnitude of the swelling strain (%) =	-0.1

(Note: The ε_{sw} value is negative if the sample has undergone consolidation)

Initial moisture content (%) =	53.3
Final moisture content (%) =	52.9



Shrink-Swell index **Iss =** **5.5** **Strain per ΔpF (%)**

Testing Method: AS1289.7.1.1 - 2003 Soil reactivity tests

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SS05

Shrink-Swell Test Results

Job Name:	47 Millbrook Road, Waipu	Job No:	NL220045
Date:	12-Apr-22	Tested By:	TDS
Sample Location:	SS05	Date Sampled:	07-Apr-22
Sampling method:	Push Tube	Sampled By:	RH
Sampling depth (m):	0.4-0.8	Inert inclusions (%):	<1
Sample condition:	Good	Extent of cracking (%):	1
		Extent of crumbling (%):	1

Sample description: silty CLAY, brownish grey, orange mottles, dark brown speckles, very stiff, moist, highly plastic (NATURAL)

Wet Density	γ (t/m^3) =	1.66
Dry Density	γ_d (t/m^3) =	1.13

Shrinkage Test

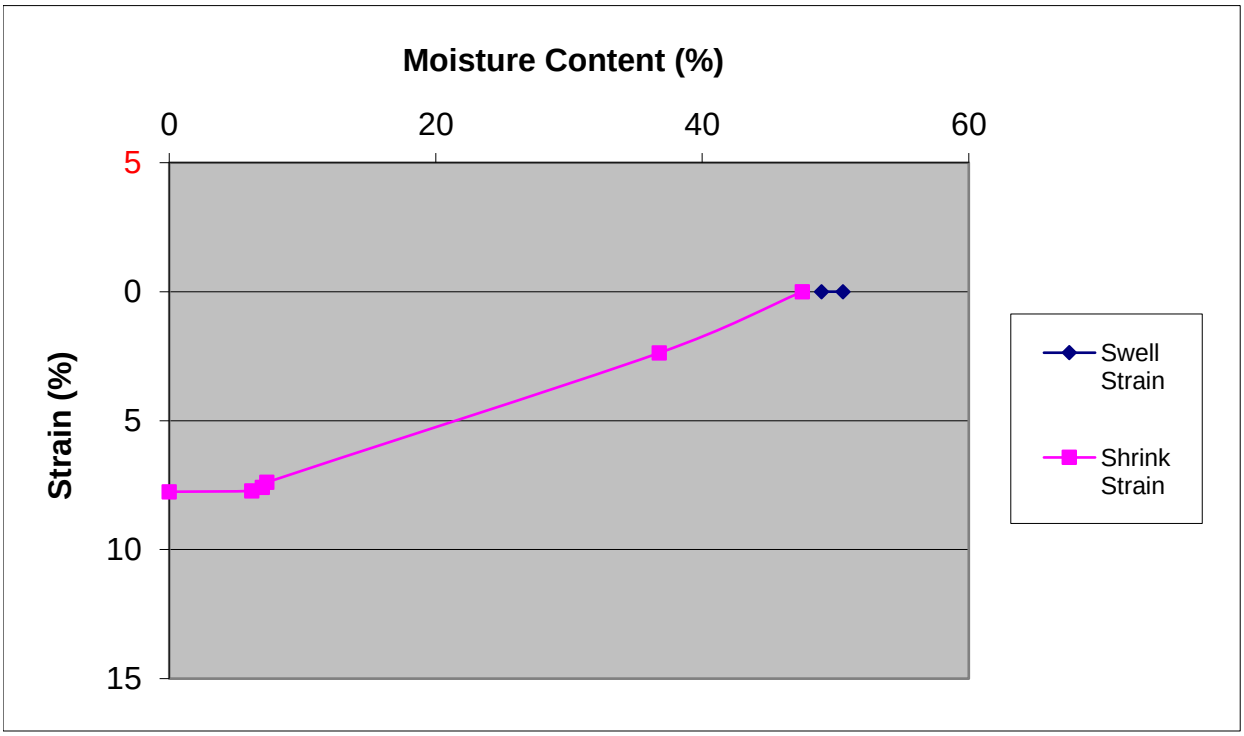
Initial moisture content (%) =	47.5
ε_{sh} = Magnitude of total shrinkage strain (%) =	7.8

Swell Test

ε_{sw} = Magnitude of the swelling strain (%) =	0.0

(Note: The ε_{sw} value is negative if the sample has undergone consolidation)

Initial moisture content (%) =	49.0
Final moisture content (%) =	50.6



Shrink-Swell index **Iss =** **4.3** **Strain per ΔpF (%)**

Testing Method: AS1289.7.1.1 - 2003 Soil reactivity tests