Planning | Surveying | Engineering | Environmental

EARTHWORKS AND CIVIL WORKS INFRASTRUCTURE REPORT

Client: Vaco Investments Ltd.

Project Site: 47 Millbrook Road, Waipu

APPLICATION PRÉCIS

CLIENT	Vaco Investments Ltd
SITE LOCATION	47 Millbrook Road, Waipu
LEGAL DESCRIPTION	PT Lot 1, DP 44163
TERRITORIAL AUTHORITY	Whangarei District Council

DOCUMENT CONTROL

CKL REFERENCE	A21235
DOCUMENT STATUS	Approved
REVISION NO.	2
DATE	8/09/23
FILE NAME	A21235-ED-ENGDATA_EARTHWORKS MEMO.docx
AUTHOR	Frances Deamer-Phillips Engineer 
AUTHORISED BY	Sam Jackman  Engineer Manager
OFFICE OF ORIGIN	Auckland

TABLE OF CONTENTS

Appendix A – Drawings

Appendix B – Geotech Report

1.0 Introduction

The purpose of this memo is to demonstrate high level assessment for the provision of earthworks for a proposed development at 47 Millbrook Road, Waipu to support Iwi consultation.

The assessment is completed with information from the following sources:

- Whangarei District Council GIS Maps (accessed 23/11/2021)
- Whangarei District Council Environmental Engineering Standards, Issue 0.4, June 2022.
- Technitrades Architecture's Drawing (Scheme H)
- Preliminary Grotechnical Investigation by Soil and Rock (June 2022)

The scope of this memo details the following:

- Earthworks

Erosion and sediment control details will be provided in due course for consent applications.

Refer to appendix A for plans.

2.0 Background

2.1 Existing Site

The site was formerly used for general grazing, prior landuse is unknown and comprises an area of approximately 5.9 hectares located at 47 Millbrook Road, Waipu (refer Figure 1 – Site Location Plan). In general, the site is flat.

Figure 1 – SITE LOCATION PLAN

As seen in the geotechnical report as part of appendix B, it is reported that the geological maps of the area indicates that the site is underlain by Late Pleistocene River Deposits of the Tauranga group. These materials generally comprise poorly consolidated mud, sand, gravel, and peat deposits of alluvial, swamp and estuarine origins with high water table.

2.2 Proposed Development

Future subdivision and development of the site will comprise of light industrial buildings and commercial buildings which will provide a range of activities that are compatible with the travelling public and wider Waipu community, based on concept plans made available to CKL at the time of writing.

This memo outlines works to be covered under the bulk earthworks consent, which include the following:

- Bulk earthworks to re-grade the site for future development
- Erosion and sediment controls
- Site stabilisation upon completion of bulk earthworks

Refer to appendix A for plans

3.0 Earthworks

3.1 Earthworks

The proposed bulk earthworks comprise a cut to fill operation over an area of approximately 5.9 hectares. The total estimated earthworks volumes associated with the works are presented in Table 1 below.

Earthworks	Volume (m^3)
Cut volume – bulk earthworks	3,700
Fill volume – bulk earthworks	21,100
Balance	17,100

Table 1 : ESTIMATED EARTHWORKS VOLUMES

All estimated earthworks volumes are solid measure quantities and do not allow for compaction or bulking factors nor topsoil / subgrade depths.

As mentioned above, clay fill import and disposal of organic/unsuitable material offsite may be required to achieve design levels. Any fill material imported to site will first be confirmed as suitable for use by the Geotechnical Engineer and clean fill/contamination-free status verified. Imported fill may be specific to allow effluent field designs to be confirmed at future detailed design stage.

Refer to appendix A for plans

As seen the geotechnical report in appendix B, 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.

4.0 Roading

4.1 Existing roads

The existing roads adjacent to the proposed development are State Highway 1 (01N-0303) to the southeast and Millbrook Road to the northeast.

The site is located west of Waipu and is zoned rural production zone under the Whangarei district plan.

The general locality of the site is shown in Figure 2 below. This shows the site location in relation to SH1 and the town of Waipu.

According to the Waka Kotahi One Network Road Classification the estimated traffic (AADT) for SH1 adjacent to the development site is 7815/day with 115 (1.5%) estimated as heavy vehicles.

Conversely, Millbrook Road is estimated to have a traffic volume of 180/day and 7.8% heavy vehicles

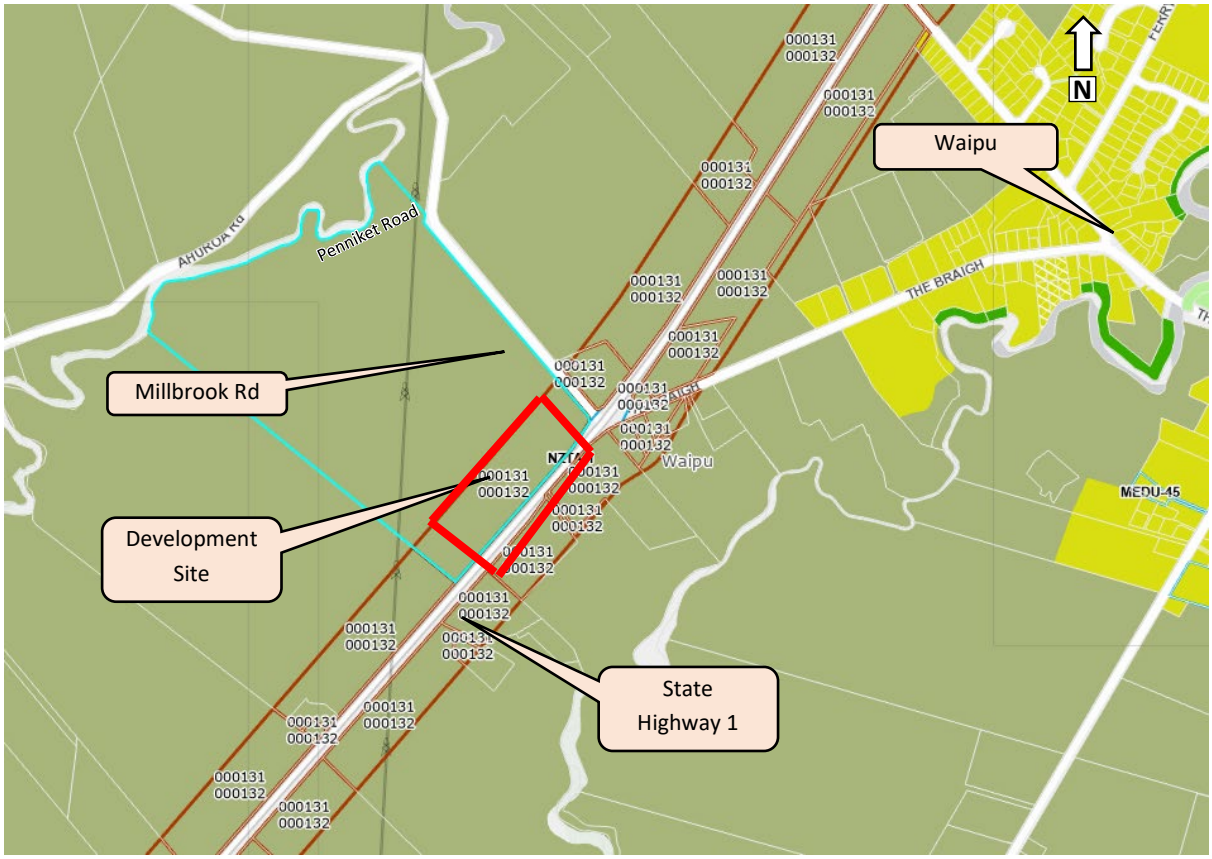


Figure 2: WDC Land use Zone

4.2 Proposed SH1 upgrade

Consultation with NZTA and TDC has been undertaken for preliminary concept designs of the proposed roundabout and highway upgrade. however, the road layout is preliminary and further refinements following additional consultation with NZTA and TDC will be implemented. Final layout including details on road cross section, tracking, longitudinal grades etc will be provided in due course following further consultation.

The road will likely be designed to an industrial road standard. The pavement design methodology will be agreed and provided in due course at detailed design stages.

The concept design for the public road has been based on a 3.5m wide sealed lanes with one lane southbound and one land northbound that transitions to a dual carriageway 7m wide.

A roundabout is conceptually proposed as the access to the development site and land is proposed to be vested to NZTA to accommodate public road to the tangent points of the northern leg entering the development site. The roundabout is proposed to operate as a single lane roundabout.

The transportation related effects of the proposed development will be assessed in due course, including but not limited to:

- The transport environment surrounding the subject site;
- An investigation into the proposed road from SH1 to Millbrook Rd and sight distance requirements;
- An estimation of the expected trip generation of the proposed development and addressing any potential impacts that these trips could cause on the adjoining road network; and
- Identifying the necessary mitigation measures to satisfactorily address these effects, if required.

It is standard practice that a Construction Traffic Management Plan (CTMP) is developed to outline how deliveries to and from the site will be managed and mitigated. The CTMP should include the following:

- Construction dates and hours of operation including any specific non-working hours for traffic congestion, noise, etc;
- Diagrams identifying which routes trucks will use to travel to and from the site;
- Temporary traffic management signage / details to appropriately manage vehicles and pedestrians in the vicinity of the site; and
- Details of site access / egress over the entire construction period noting that all access points to be located so that appropriate visibility is achieved onto the adjacent road network.

Based on experience with the construction planning and traffic management associated with earthworks projects of a similar magnitude, it is considered that construction activities can be managed to ensure an appropriately low level of construction traffic effects. Of note, the construction activities are temporary and with appropriate measures in place as identified above, will be able to be managed.

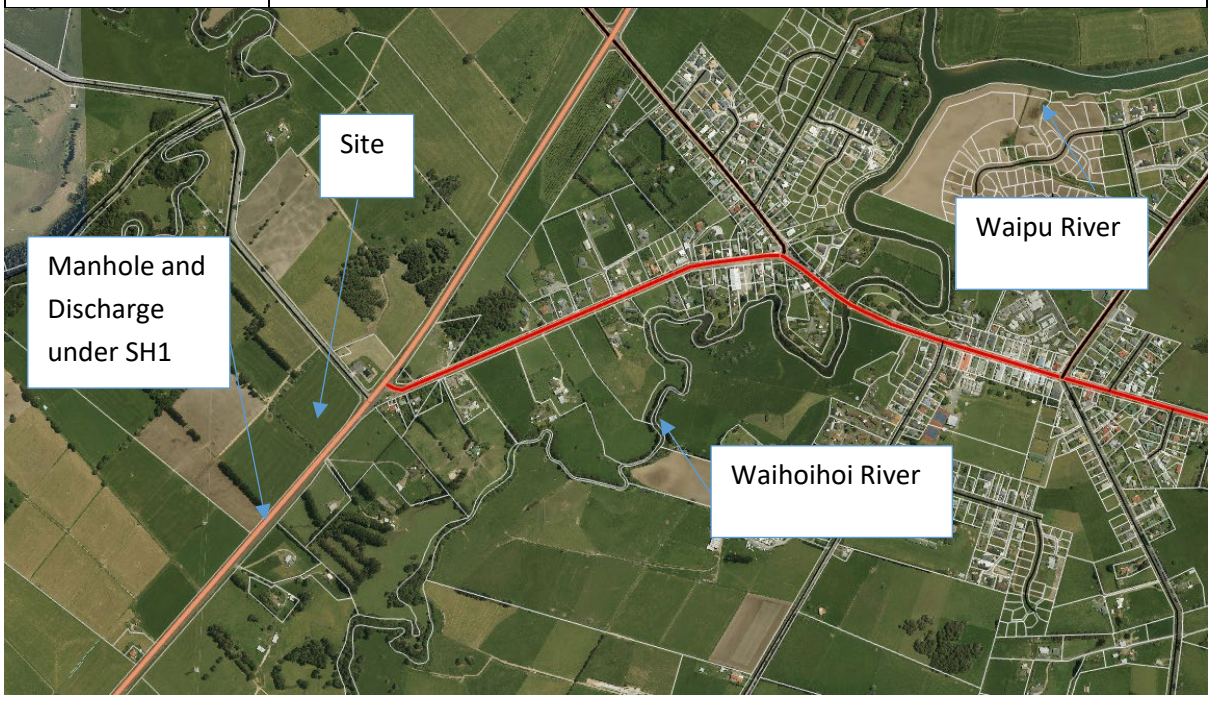
Construction effects are therefore considered to be less than minor and can be managed through the CTMP.

5.0 Stormwater

5.1 Existing site

Details of the existing site conditions are provided below.

Site address	47 Millbrook Road, Waipu, Whangarei District
Legal Description	PT Lot 1, DP 44163, NA 26A / 257 Area 317884 m2
Current & Historical land use	The land is currently used for general grazing and it is not known what the prior landuse was.
Topography	Generally flat with an mRL of 10m across the site.
Geotechnical	Tauranga Group (alluvial deposit with silt and clay), low infiltration, high groundwater
Existing drainage features	The site is bound by SH1 to the south-east and Millbrook Rd to the north-east, and farmland on the remaining boundaries. There is a culvert is located under Millbrook Road and under SH1 near southeast corner of site.
Receiving environment	The direct receiving environment is the roadside drain adjacent to SH1 which drains south and roadside drain to the north that drains to the north along SH1. The Waihoihoi River is located circa 370m (as the crow flies) from the site, which then flows into the Waipu River prior to discharging into the sea.



5.2 Proposed Development

The proposed development converts grassed land into largely impervious area of buildings and associated carparks.

5.3 Stormwater Objectives

The stormwater objectives are summarised below, based on the Whangarei District Council Environmental Engineering Standards (June 2022), in the absence of any catchment management plan specific to the area:

With respect to conveyance, a minimum 150mm connection is required for each commercial/industrial lot and be designed for a minimum 1 in 2-year ARI and 1 in 50year ARI with no surcharge.

With respect to flooding related issues, freeboard of 0.3m above the 1 in 100 ARI storm is required for commercial and industrial buildings, unless specific assessment demonstrates that a different freeboard is appropriate.
Overland flow paths and flood protection must be designed for 1 in 100 ARI storm event with a climate change allowance of an additional 20% to rainfall data[1]. National climate change factors have been recently and adopted by local government. Confirmation of the appropriate climate change allowance needs to be sought from WDC.

With respect to stormwater quality control, the development must comply with the NRC Regional Water and Soil Plan, in particular rules for stormwater discharges and diversion from roads and from land disturbance activities. Therefore, the activity will be permitted provided that:

a) The stormwater is diverted or discharged in the catchment from which it originates.
b) Water and sediment control measures (e.g. rock rip-rap, cut-off drains, sediment traps) are installed and maintained, to avoid or minimise erosion and to avoid or minimise sediment discharges to any adjacent water bodies or to any coastal waters.
c) The diversion and discharge has a no more than minor adverse effect (as determined by the relevant water quality guidelines in Section 7) on aquatic ecosystems and/or on neighbouring or downstream landowners/occupiers (e.g. deposition of sediment, exacerbation of flooding).

With respect to attenuation, the peak flow discharge shall be limited to 80% of the predevelopment levels for both primary and secondary flows.

With respect to disposal, an options assessment below considers the available options.

[1] This is subject to change due to national requirements. Confirmation is required from WDC, as to the adoption of national requirements.

5.4 Stormwater Optioneering

The stormwater option assessment was considered in CKL's 3 Water options assessment memo. Below Table 2 summarizes the options and the best practicable option.

Table 2: Stormwater Options Assessment

Option	Pros	Limitation	Recommendation
Soakage	Soakage stormwater runoff to ground water is considered the preferable option for mitigation effects on the environment, however, requires a high infiltration rate of native soil	The geotechnical report by Soil and Rock indicates the site's underlying soil is stiff silt and clay with low infiltration rates and high ground water level. This makes soakage infeasible.	Not feasible
Discharge to public network	Often requires less storage onsite if network is sized appropriately and no flooding downstream	There is no network nearby, so this is not considered feasible	Not feasible
Discharge to land	Existing situation sheet flows to roadside channels on SH1 and Millbrook Rd. This option will mimic existing situation and no require new public infrastructure	To not increase flooding in SH1, Millbrook Rd or neighbouring properties, large attenuation ponds are required here	Considered best practical option
Re-use	Stormwater re-use is encouraged as a means of attenuating the increased flow associated with a new development. The water demand for the proposed development is limited, but could provide some flow balancing.	Given the high-water use required for the site, large tanks across the site would be required for water supply. It has been recommended to extend a water main to site, therefore this is less practical	Can be used in conjunction with discharging to land

5.5 Best Practicable Option for Stormwater Management/Recommendations

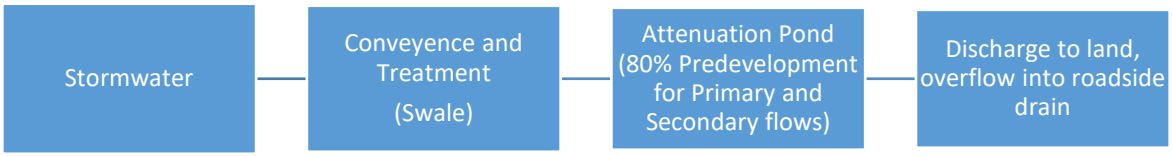
Based on the optioneering above, the best practicable option for stormwater disposal is considered to be discharge to land.

The table below includes high level for the development of a stormwater strategy.

Stormwater parameter	**Objective**	**Optioneering**	**Staging implications**
Discharge	Stormwater disposal to land	See Section **Error! Reference source not found.**	-
Conveyance	Minimum 1 in 2-year ARI with no surcharge and 1 in 5 year allowing discharge within 0.3m of the lid level	Shallow swale – benefit of combining treatment with conveyance	Swale relies on the ground levels
Flood related issues	Freeboard of 0.3m above 100-year ARI + climate change	Raise buildings platforms above floodplain (if exists). Fill site to remove any flooding inundation from lots	-
Stormwater quality control	See list above in Section 5.3.	Treatment swale – preferred option due to shallow grade. Proprietary treatment device (Upflo system) for limited head available.	A treatment train approach can be effective way to have desired water quality results. Therefore, on-lot treatment can minimise the size of the centralised treatment device (swale/proprietary unit). On lot treatment can be developed per stage.
Attenuation	Peak flow discharge shall be limited to 80% of the predevelopment levels for both primary (5yr) and secondary (100yr) flows.	Primary and Secondary event can be attenuated within proposed attenuation basins.	Two large attenuation ponds are proposed on the northern and southern side of site. Therefore stage 1 can utilize the southern basin and the northern one

			can be brought online in stage 2 of development.

The best practicable option for stormwater management is depicted in a chart below.



Indicative Attenuation Sizing

Sizing for the attenuation requirements is provided in the section below.

The total development area is 5.92ha with 62% imperviousness, based on site plan (Technitrades Architecture's Drawing (Scheme H).

Coverage	Pre-development (ha)		Post-development (ha)	
Roof/varandas/canopies	0.000	0%	0.760	13%
Impervious	0.000	0%	2.905	49%
Grass/pervious	5.913	100%	2.248	38%
TOTAL AREA	5.913	100%	5.92	100%

Rainfall depths were derived from HIRDS and increased by 20% for climate change, in accordance with WDC's Environmental Engineering Guidelines is shown below.

	ARI	HIRDS Rainfall Depth (mm)	Climate change Factor	Rainfall Depth +CC (mm)
Primary	5YR	125.0	20.00%	150.0
Secondary	100yr	228.0	20.00%	273.6

The existing site drains to two existing culverts on site, therefore the proposed earthworks design creates two separate catchments to mimic existing catchment. To achieve attenuation of the primary and secondary rainfall event, the volume required is 700m^3 and 1250m^3 for the two proposed attenuation basins. The southern one (Pond 2) will accommodate the BP, entrance to site and building 11 and 13 and parking associated with these buildings which is considered to be stage 1 of development.

The ponds have been sized to be 0.6m deep pond with 0.2m of freeboard. Scurffy dome outlets with orifice are sized to attenuate flow. The pond surface area of 1310m^2 for Pond 2 southern portion of site and 1415m^2 for Pond 1 and northern portion of site.

See CKL drawing #4000 for locations and sizing for attenuation ponds.

Primary and Secondary Conveyance

Given the site is so flat and high groundwater is found, a stormwater reticulation system underground would drive the level of the ponds too low and enter groundwater influence area, making them impractical to build. Therefore, swales are provided for treatment and primary conveyance. Onsite stormwater swale and OLFPs are sized in Appendix B.

The upstream overland flow paths will be directed around the site in conveyance swales prior to discharging to existing culvert, as in exiting scenario. Calculations for upstream OLFP diversion are provided in Appendix B.

6.0 Wastewater

6.1 Wastewater Demand

Wastewater flow and strength will be dependent on types of industry/commercial users on site, which has not been determined yet for each proposed building. Therefore, the initial sizing for wastewater demand was based on Watercare's The Auckland Water and Wastewater Code of Practice for Land Development and Subdivision. The estimated commercial design flows in the Code of practice were used along with the proposed building footprint. Assumptions were made on weather a building would be dry retail or wet retail based on assumed occupants of each building. Stage 1 will include the BP, Burger King and another food stop so are all considered 'wet retail' as they will provide toilets to customers. Stage 2 occupants is unknown, however, buildings area designed for either food (wet retail) or retail shops (dry retail) in mind. This methos was used to get an estimate of wastewater flow allowances. The determined total wastewater allowance for site was 25.887kl/day. See Appendix B for wastewater demand calculations.

It is not envisaged that any medical or pharmaceutical enterprises are proposed for this development.

6.2 Treatment

It is proposed to have a centralized, modular treatment plant which can be adapted for flow and strength of wastewater, pending the type of commercial activity on site and can be trimmed based on occupancy in order to achieve the desired effluent quality. The modular system can also be added to in stages as different part of the site are developed. Innoflow have provided preliminary design for the treatment plant and the following are proposed to be included for treatment for wastewater (Innoflow Treatment Plan included in Appendix B).

Demand

- Stage 1- 10,700 L/day
- Stage 2- 12,000 L/day

Influent to treatment plant

- cBOD5: <600 mg/L
- TSS: <800 mg/L
- TKN: <120 mg/L

Treatment Process

The proposed treatment process comprises mostly below-ground tanks housing septic tanks, media and pumps. The process comprises;

- Pre-treatment – grease traps
- Primary treatment – septic tanks
- Secondary treatment – anoxic packed bed reactors and recirculation.

Effluent from treatment plant

- The process can be adapted to accommodate nutrient removal requirements but typically achieves following effluent values:
- cBOD5: 20 mg/L
- TSS: 30 mg/L

The required effluent quality for Northland Regional Council standards (as confirm by Katie Mcguire on 7/6/23) is below. The above treatment design threats to a higher level than required.

Required NRC Effluent

- cBOD5: 30 mg/L
- TSS: 45 mg/L

6.3 Onsite Disposal

The preferred option for disposal of treated effluent from the centralized plant is by pressure compensating drip irrigation to adjacent land within the site. The geotechnical assessment has indicated that the soil permeability is relatively low and that the ground water levels fluctuate across the site, therefore disposal to land must be designed carefully to reduce risk to the receiving environment.

TP58 was used to size the disposal field assuming the native soil is based on Category 5 soils. TP58 indicated that a design loading rate of 5mm/day can be used where the depth of topsoil is 250mm or greater. Given the high ground water found onsite, the wastewater fields will be in imported fill to create at least 600mm separation from existing ground (assumed high ground water level is at surface of existing ground). The imported fill can be a mix of sand and topsoil to promote plant uptake of nitrogen and phosphorus and provided

increase treatment rates of the effluent from drip irrigation. Additionally, the effluent quality from the treatment plant is treated to higher standard than required. Therefore, the design loading rate of 5mm/day was used.

Testing of site-specific loading rates will be carried out at detailed design in location of proposed wastewater fields to confirm the loading rate.

The estimated area of the disposal is given above assumption is approximately 5,177**m^2**.

As confirmed by NRC, there is a contingency factor 30% reserve disposal area is required. This bring the total area of design and reserve wastewater field required to **6,731 m^2.**

It is recommended that approximately 600mm separation between ground water and drip irrigation is applied to ensure groundwater is not contaminated. Pending confirmation of permeability and groundwater, this will constitute a large volume of suitably permeable fill material to ensure proposer separation to groundwater.

The proposed drip irrigation lines are as follows:

Stage 1:

- Approx. 5 x variable sized sectors of pressure compensating drip irrigation lines (controlled by solenoid valves)
- Total approx. 3,220 lineal meters of dripline, spaced at 1m centres

Stage 2:

- Approx. 5 x variable sized sectors of pressure compensating drip irrigation lines (controlled by solenoid valves)
- Total approx. 3,220 lineal meters of dripline, spaced at 1m centres

It is proposed to include a lining and berms on the edges of the drip irrigation fields to ensure flow cannot laterally discharge through the fill and into nearby stormwater ponds or drains. There is a minimum of 5m offset from irrigation fields and wall surface water.

6.4 Staging

As mentioned above, the proposed Innoflow treatment plant is modular and can be added to in stages, therefore Stage 2 treatment requirements can be added to the treatment plant when developed along with staging the drip irrigation fields.

In discussions with WDC, there is a possibility that the public wastewater treatment plant and network will be upgraded in Waipu and can therefore service this site in the future. Therefore, Stage 2 of the development has two potential options for wastewater treatment; onsite wastewater as designed above (option 1) and connection to public network (option 2). Option 2 would reduce the required effluent dispersal field size on site and therefore potentially allow for additional building footprint in Stage 2 of the development.

7.0 Water Supply

7.1 Water Demand

If a reticulated pipe connection is provided, the water demand is estimated to be 120% of the peak wastewater demand i.e. 0.75 L/s.

Note: the onsite water demand assessment may result in different peak calculations.

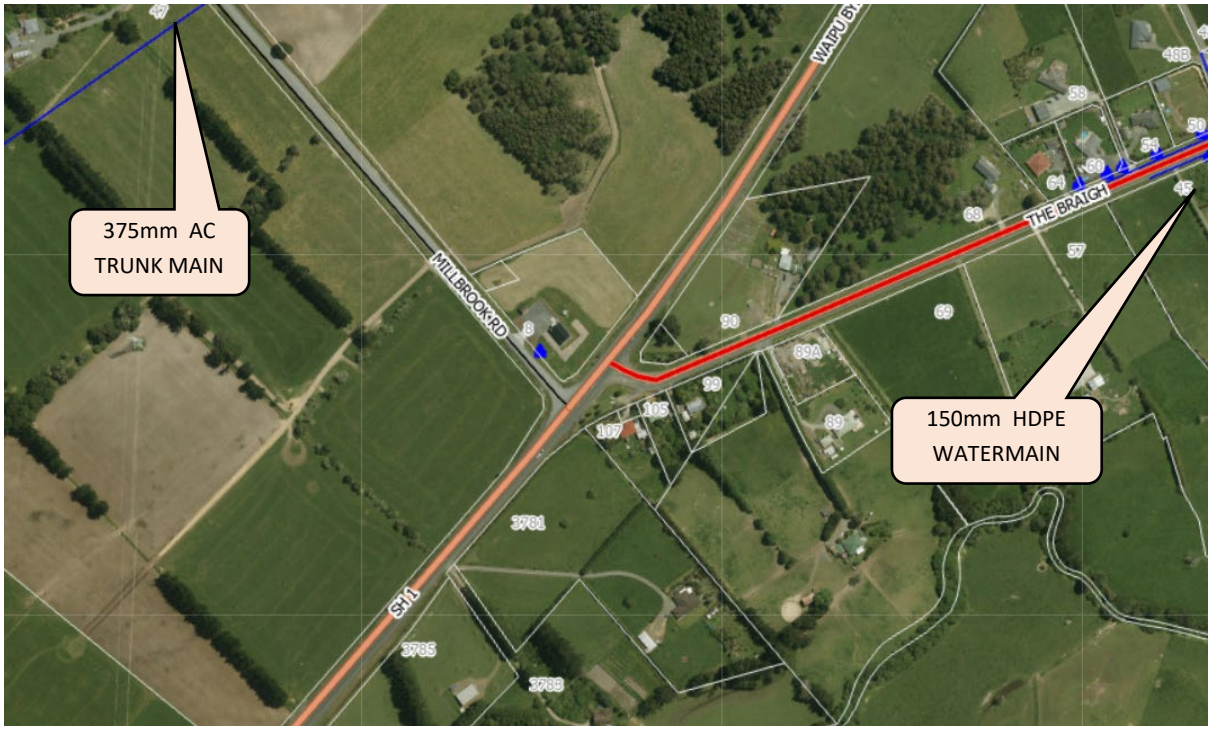
7.2 Options Assessment

Public Connection

Similarly for wastewater, a connection to the public water supply network is located circa. one kilometre from the subject site at The Braigh. A 150mm watermain and 50mm diameter ridermain are present within the road reserve.

In addition, it is noted that a 375mm diameter trunk watermain is present approximately 1km to the northwest of the site along Millbrook Road, which appears to be the main water supply feed to the Ruakaka township. This is the preferred connection point being that it does not need to cross SH1. Please see utilities plan for information.

Any connection to the existing public water supply network will require further discussion with Council to understand peak demands and current capacity to be able to supply the development site.



7.3 Onsite Rainwater Harvesting

Rainwater harvesting from roof runoff is a potential option to provide water supply to the development site. This would be subject to detailed calculations to determine that sufficient storage could be accommodate from roof water capture. It is likely that a rainwater tank farm or series of tanks may be necessary to provide both potable and fire supply. Depending on outcomes of discussions with the Council, rainwater harvesting could be used in conjunction with town supply from the public network as part of flow balancing for water supply to the development.

7.4 Fire Supply

Whilst subject to detailed assessment and whether a public connection can be made or onsite rainwater harvesting is utilised, the requirements for fire supply will need detailed consideration depending on the land use and activity type. An assessment in accordance with SNZ PAS 4509:2008 New Zealand Fire Fighting Water Supplies Code of Practice as well as NZBC C1-C6 will be necessary to determine the fire supply for firefighting requirements.

7.5 Recommendation

It is recommended to engage with Council to determine whether a water supply connection can be made to the available public water supply network in the vicinity of the site (either the local network or trunk main). Following these discussions, further assessment can be undertaken including onsite rainwater harvesting in the event a public connection is not possible.

8.0 Summary

Vaco Investments Ltd is proposing to undertake bulk earthworks to enable future development at 47 Millbrook Road, Waipu.

Bulk earthworks at the site will generally comprise a filling operation to achieve the design levels by importing circa 21000m³ of suitable fill material. Refer to table 1 above.

To prevent and mitigate any adverse environmental effects during the earthworks operation, erosion and sediment controls will be implemented in accordance with GD05 to control erosion and sediment discharges from the works area.

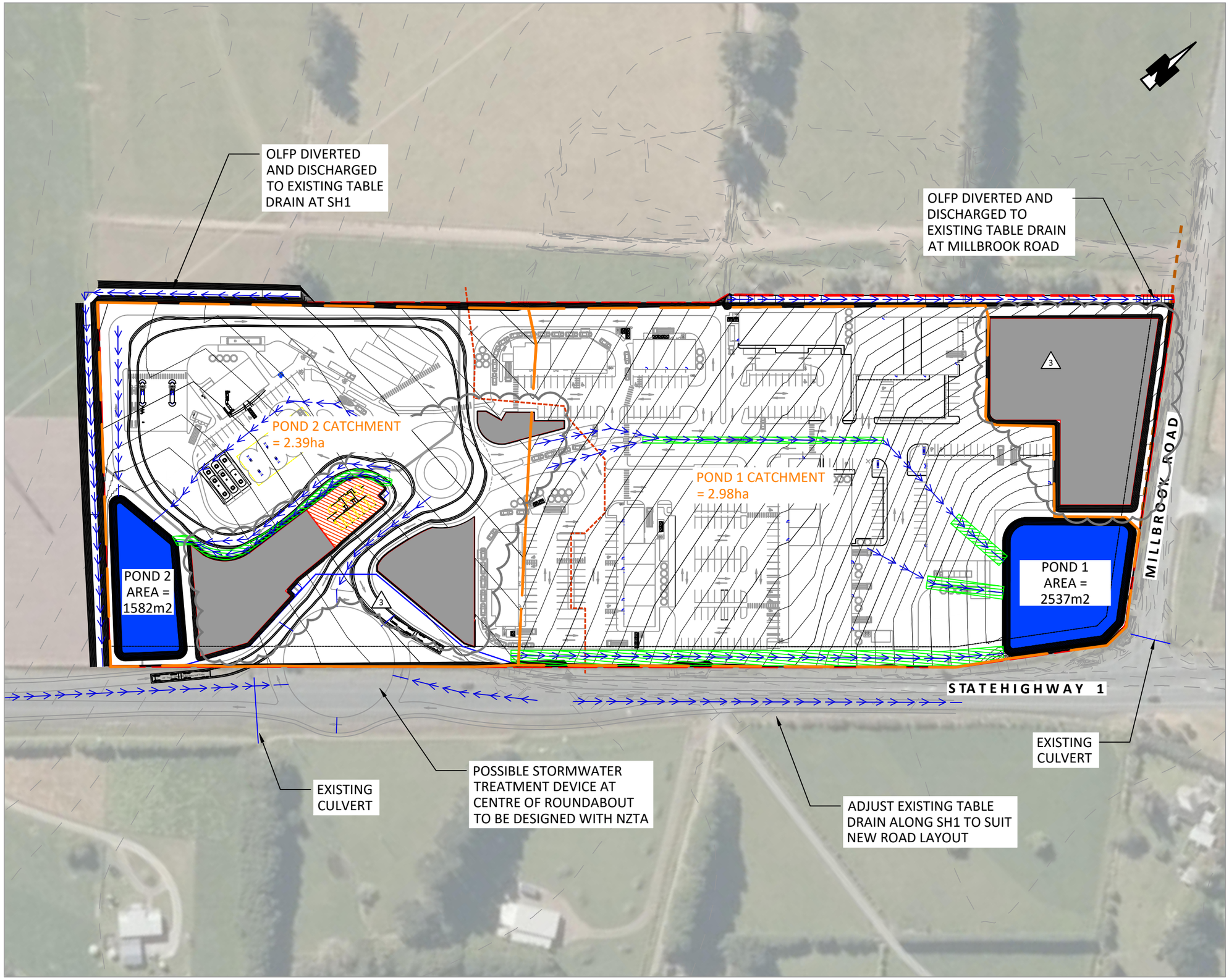
The site is subject to existing overland flow path (OLFP). OLFP running from north-west will be diverted along the boundary of the development (Refer to Appendix A plans).

9.0 Limitations

This report has been prepared solely for the benefit of our client with respect of the particular brief and it may not be relied upon in other contexts for any other purpose without the express approval by CKL. Neither CKL nor any employee or sub-consultant accepts any responsibility with respect to its use, either in full or in part, by any other person or entity. This disclaimer shall apply notwithstanding that the report may be made available to other persons including Council for an application for permission, approval or to fulfil a legal requirement

APPENDIX A

Drawings



STORMWATER NOTES:

1. ALL WORKS AND MATERIALS TO COMPLY WITH AUCKLAND COUNCIL CODE OF PRACTICE FOR LAND DEVELOPMENT AND SUBDIVISION AND ANY AMENDMENTS.
2. ALL PRIVATE DRAINAGE WORKS TO COMPLY WITH THE NEW ZEALAND BUILDING CODE.
3. ALL DRAINAGE WORKS SHALL BE CARRIED OUT UNDER THE SUPERVISION OF A REGISTERED DRAIN LAYER AND IN ACCORDANCE WITH CURRENT HEALTH AND SAFETY PRACTICES. WHERE REQUIRED, DRAINAGE WORKS ARE TO BE UNDERTAKEN BY AN APPROVED LICENSED CONTRACTOR (A.L.C.).
4. ALL MANHOLES ARE TO BE MIN. DN 1050 WITH D.I. LID AND COVERS UNLESS SHOWN OTHERWISE.
5. MANHOLE COVER HINGES WILL BE ORIENTED UPSTREAM FOR ALL MANHOLES LOCATED WITHIN OVERLAND FLOW PATHS
6. ALL MANHOLE LIDS IN TRAFFICABLE AREAS TO HAVE HEAVY DUTY CLASS E LIDS AND FRAMES.
7. WHERE SW CASCADES ARE PRESENT, MANHOLES TO BE FINSIHED IN 30MPa CONCRETE.
8. ALL ROAD CATCHPITS TO COMPRISE STANDARD SEMI-RESSESSED IN ACCORDANCE WITH TDM STANDARD DRAWING RD0020. WHERE LOCATED IN CYCLE LANES, CATCHPITS ARE TO INCLUDE CYCLE-FRIENDLY GRATES.
9. ALL CP LEADS ARE TO BE MIN. DN225 CLASS 4 PIPE UNLESS SHOWN OTHERWISE.
10. ALL ORDINARY TRENCH BACKFILL SHALL COMPRISE SUITABLE EARTHFILL FREE OF TOPSOIL/ORGANICS AND SHALL BE WELL COMPACTED IN LAYERS NOT EXCEEDING 200mm TO ACHIEVE MINIMUM SHEAR STRENGTHS OF 100 kPa/MAX. 10% AIR VOIDS OR AS PER THE EARTHWORKS SPECIFICATION.
11. ALL PIPE CROSSINGS UNDER CARRIAGEWAYS/TRAFFIC AREAS TO BE HARDFILL BACKFILLED WITH APPROVED GAP65 TO 1.0m BEYOND EXTENT OF CARRIAGEWAY. TRENCH HARDFILL BACKFILL TO BE WELL COMPACTED TO ACHIEVE MIN. CLEGG HAMMER CIV = 25.
12. WHERE CLEARANCE BETWEEN PIPELINE CROSSOVERS IS LESS THAN 100mm THE GAP IS TO BE POLYSTYRENE PACKED IN ADDITION TO HARDFILLING OF CROSSOVERS.
13. ALL EXISTING BERMS, CARRIAGEWAYS AND CROSSINGS TO BE RE-INSTATED AS PER COUNCIL/CONTROLLING AUTHORITY REQUIREMENTS.

STORMWATER LEGEND:

- OVERLAND FLOW (OLFP)
- TREATMENT + CONVEYANCE SWALE
- POND CATCHMENTS

FOR CONSENT

CKL
Planning | Surveying | Engineering | Environmental

OFFICE
AUCKLAND
A: 25 Broadway, Newmarket
P: 09 524 7029
E: Auckland@ckl.co.nz

WAIPU GATEWAY SERVICE CENTRE
VACO INVESTMENTS LTD
47 MILLBROOK ROAD, WAIPU

STORMWATER
LAYOUT
OVERVIEW PLAN

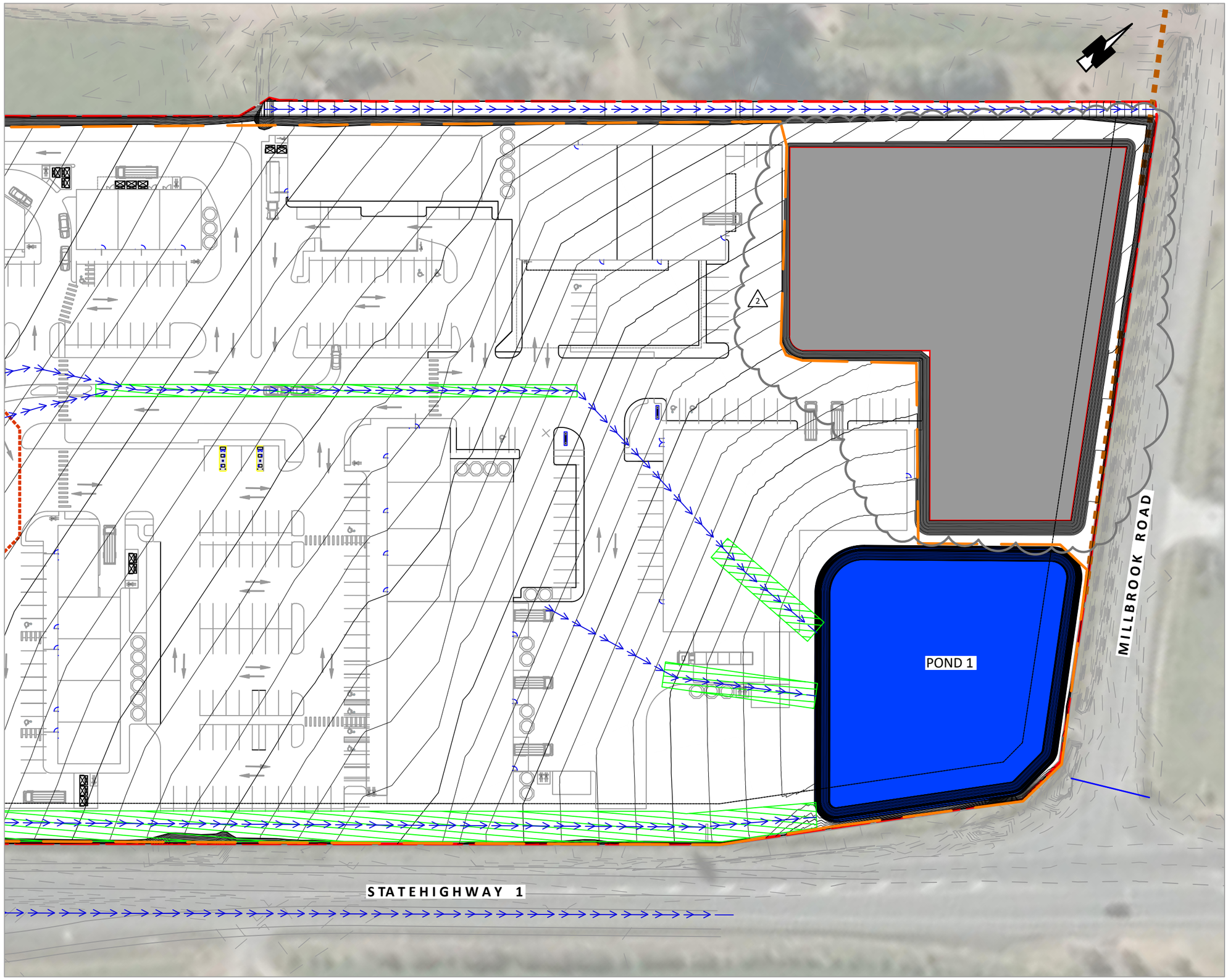
Issue	Description	Checked	Date
1	RESOURCE CONSENT	LC	2022.12.09
2	RESOURCE CONSENT	LC	2023.02.16
3	RESOURCE CONSENT	LC	08/09/23

		Date
Designed:	RS	01.12.2022
Drawn:	LD	01.12.2022
Checked:	LC	08/09/23

Scale: 1:1500 (A3 Original)

Job No: A21235 Dwg No: 4000-1 Rev: 3

C:\ProgramData\12DSynergy\data\CKL-AZU-SYN-1\C11 - Engineering_19993\01 Engineering Design\Drawings\BRISCAD\RC\A21235-4000-SW.dwg



STORMWATER NOTES:

1. ALL WORKS AND MATERIALS TO COMPLY WITH AUCKLAND COUNCIL CODE OF PRACTICE FOR LAND DEVELOPMENT AND SUBDIVISION AND ANY AMENDMENTS.
2. ALL PRIVATE DRAINAGE WORKS TO COMPLY WITH THE NEW ZEALAND BUILDING CODE.
3. ALL DRAINAGE WORKS SHALL BE CARRIED OUT UNDER THE SUPERVISION OF A REGISTERED DRAIN LAYER AND IN ACCORDANCE WITH CURRENT HEALTH AND SAFETY PRACTICES. WHERE REQUIRED, DRAINAGE WORKS ARE TO BE UNDERTAKEN BY AN APPROVED LICENSED CONTRACTOR (A.L.C.).
4. ALL MANHOLES ARE TO BE MIN. DN 1050 WITH D.I. LID AND COVERS UNLESS SHOWN OTHERWISE.
5. MANHOLE COVER HINGES WILL BE ORIENTED UPSTREAM FOR ALL MANHOLES LOCATED WITHIN OVERLAND FLOW PATHS
6. ALL MANHOLE LIDS IN TRAFFICABLE AREAS TO HAVE HEAVY DUTY CLASS E LIDS AND FRAMES.
7. WHERE SW CASCADES ARE PRESENT, MANHOLES TO BE FINSIHED IN 30MPa CONCRETE.
8. ALL ROAD CATCHPITS TO COMPRISE STANDARD SEMI-RESSESSED IN ACCORDANCE WITH TDM STANDARD DRAWING RD0020. WHERE LOCATED IN CYCLE LANES, CATCHPITS ARE TO INCLUDE CYCLE-FRIENDLY GRATES.
9. ALL CP LEADS ARE TO BE MIN. DN225 CLASS 4 PIPE UNLESS SHOWN OTHERWISE.
10. ALL ORDINARY TRENCH BACKFILL SHALL COMPRISE SUITABLE EARTHFILL FREE OF TOPSOIL/ORGANICS AND SHALL BE WELL COMPACTED IN LAYERS NOT EXCEEDING 200mm TO ACHIEVE MINIMUM SHEAR STRENGTHS OF 100 kPa/MAX. 10% AIR VOIDS OR AS PER THE EARTHWORKS SPECIFICATION.
11. ALL PIPE CROSSINGS UNDER CARRIAGEWAYS/TRAFFIC AREAS TO BE HARDFILL BACKFILLED WITH APPROVED GAP65 TO 1.0m BEYOND EXTENT OF CARRIAGEWAY. TRENCH HARDFILL BACKFILL TO BE WELL COMPACTED TO ACHIEVE MIN. CLEGG HAMMER CIV = 25.
12. WHERE CLEARANCE BETWEEN PIPELINE CROSSOVERS IS LESS THAN 100mm THE GAP IS TO BE POLYSTYRENE PACKED IN ADDITION TO HARDFILLING OF CROSSOVERS.
13. ALL EXISTING BERMS, CARRIAGEWAYS AND CROSSINGS TO BE RE-INSTATED AS PER COUNCIL/CONTROLLING AUTHORITY REQUIREMENTS.

STORMWATER LEGEND:

- EXISTING SW (PUBLIC)
- EXISTING WW (PUBLIC)
- PROPOSED SW (PUBLIC)
- PROPOSED SW (PRIVATE)
- PROPOSED TANK (PRIVATE)
- PROPOSED WW (PRIVATE)
- SITE EXTENT

FOR CONSENT

CKL
Planning | Surveying | Engineering | Environmental

OFFICE
AUCKLAND
A: 25 Broadway, Newmarket
P: 09 524 7029
E: Auckland@ckl.co.nz

WAIPU GATEWAY SERVICE CENTRE
VACO INVESTMENTS LTD
47 MILLBROOK ROAD, WAIPU

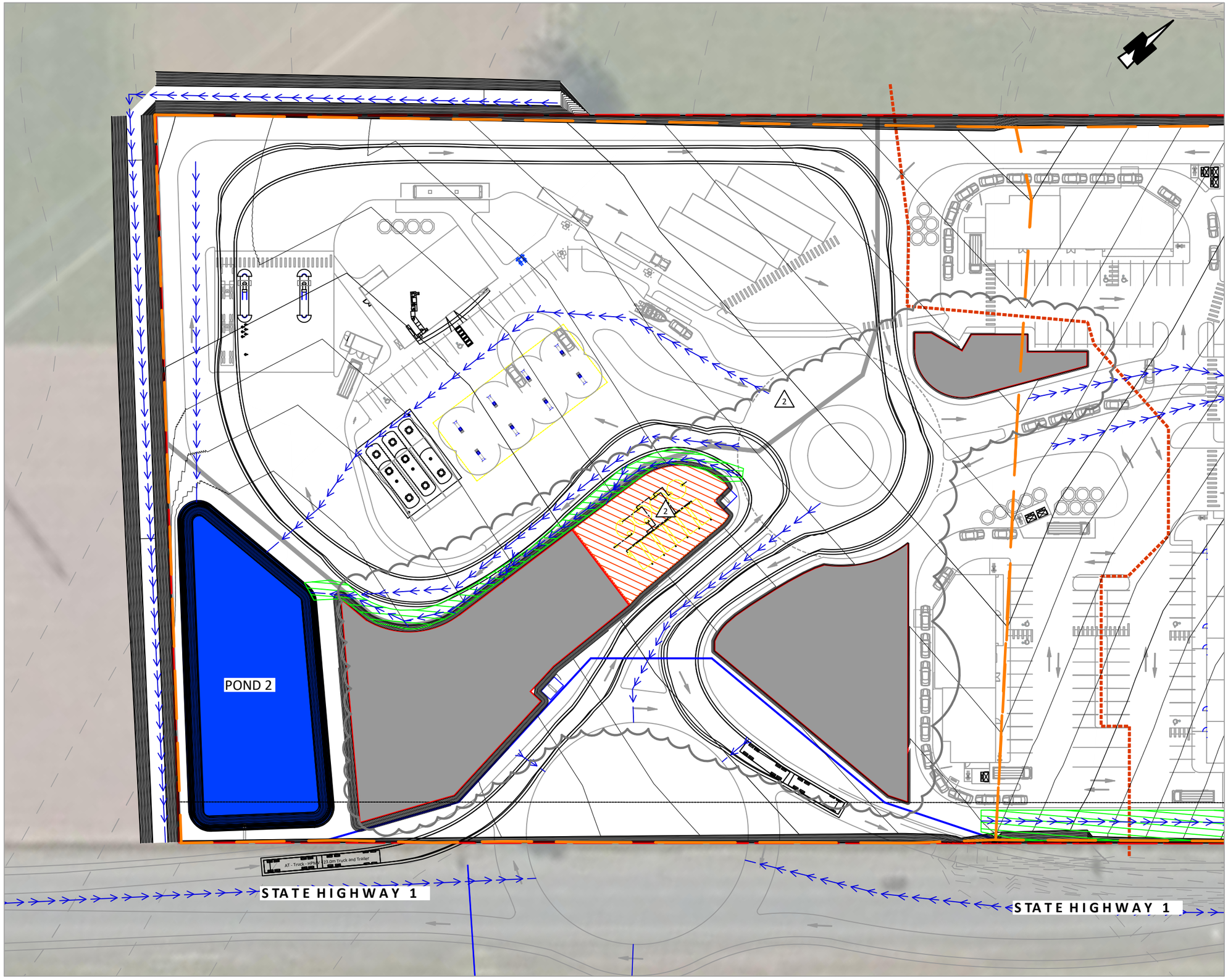
STORMWATER
LAYOUT PLAN
SHEET 1

Issue	Description	Checked	Date
1	RESOURCE CONSENT	LC	2022.12.09
2	RESOURCE CONSENT	LC	08/09/23

		Date
Designed:	RS	01.12.2022
Drawn:	LD	01.12.2022
Checked:	LC	08/09/23

Scale: 1:750 (A3 Original)

Job No: A21235 Dwg No: 4001-1 Rev: 2



STORMWATER NOTES:

1. ALL WORKS AND MATERIALS TO COMPLY WITH AUCKLAND COUNCIL CODE OF PRACTICE FOR LAND DEVELOPMENT AND SUBDIVISION AND ANY AMENDMENTS.
2. ALL PRIVATE DRAINAGE WORKS TO COMPLY WITH THE NEW ZEALAND BUILDING CODE.
3. ALL DRAINAGE WORKS SHALL BE CARRIED OUT UNDER THE SUPERVISION OF A REGISTERED DRAIN LAYER AND IN ACCORDANCE WITH CURRENT HEALTH AND SAFETY PRACTICES. WHERE REQUIRED, DRAINAGE WORKS ARE TO BE UNDERTAKEN BY AN APPROVED LICENSED CONTRACTOR (A.L.C.).
4. ALL MANHOLES ARE TO BE MIN. DN 1050 WITH D.I. LID AND COVERS UNLESS SHOWN OTHERWISE.
5. MANHOLE COVER HINGES WILL BE ORIENTED UPSTREAM FOR ALL MANHOLES LOCATED WITHIN OVERLAND FLOW PATHS
6. ALL MANHOLE LIDS IN TRAFFICABLE AREAS TO HAVE HEAVY DUTY CLASS E LIDS AND FRAMES.
7. WHERE SW CASCADES ARE PRESENT, MANHOLES TO BE FINSIHED IN 30MPa CONCRETE.
8. ALL ROAD CATCHPITS TO COMPRISE STANDARD SEMI-RESSESSED IN ACCORDANCE WITH TDM STANDARD DRAWING RD0020. WHERE LOCATED IN CYCLE LANES, CATCHPITS ARE TO INCLUDE CYCLE-FRIENDLY GRATES.
9. ALL CP LEADS ARE TO BE MIN. DN225 CLASS 4 PIPE UNLESS SHOWN OTHERWISE.
10. ALL ORDINARY TRENCH BACKFILL SHALL COMPRISE SUITABLE EARTHFILL FREE OF TOPSOIL/ORGANICS AND SHALL BE WELL COMPACTED IN LAYERS NOT EXCEEDING 200mm TO ACHIEVE MINIMUM SHEAR STRENGTHS OF 100 kPa/MAX. 10% AIR VOIDS OR AS PER THE EARTHWORKS SPECIFICATION.
11. ALL PIPE CROSSINGS UNDER CARRIAGEWAYS/TRAFFIC AREAS TO BE HARDFILL BACKFILLED WITH APPROVED GAP65 TO 1.0m BEYOND EXTENT OF CARRIAGEWAY. TRENCH HARDFILL BACKFILL TO BE WELL COMPACTED TO ACHIEVE MIN. CLEGG HAMMER CIV = 25.
12. WHERE CLEARANCE BETWEEN PIPELINE CROSSOVERS IS LESS THAN 100mm THE GAP IS TO BE POLYSTYRENE PACKED IN ADDITION TO HARDFILLING OF CROSSOVERS.
13. ALL EXISTING BERMS, CARRIAGEWAYS AND CROSSINGS TO BE RE-INSTATED AS PER COUNCIL/CONTROLLING AUTHORITY REQUIREMENTS.

STORMWATER LEGEND:

- EXISTING SW (PUBLIC)
- EXISTING WW (PUBLIC)
- PROPOSED SW (PUBLIC)
- PROPOSED SW (PRIVATE)
- PROPOSED TANK (PRIVATE)
- PROPOSED WW (PRIVATE)
- SITE EXTENT

FOR CONSENT

CKL
Planning | Surveying | Engineering | Environmental

OFFICE
AUCKLAND
A: 25 Broadway, Newmarket
P: 09 524 7029
E: Auckland@ckl.co.nz

WAIPU GATEWAY SERVICE CENTRE
VACO INVESTMENTS LTD
47 MILLBROOK ROAD, WAIPU

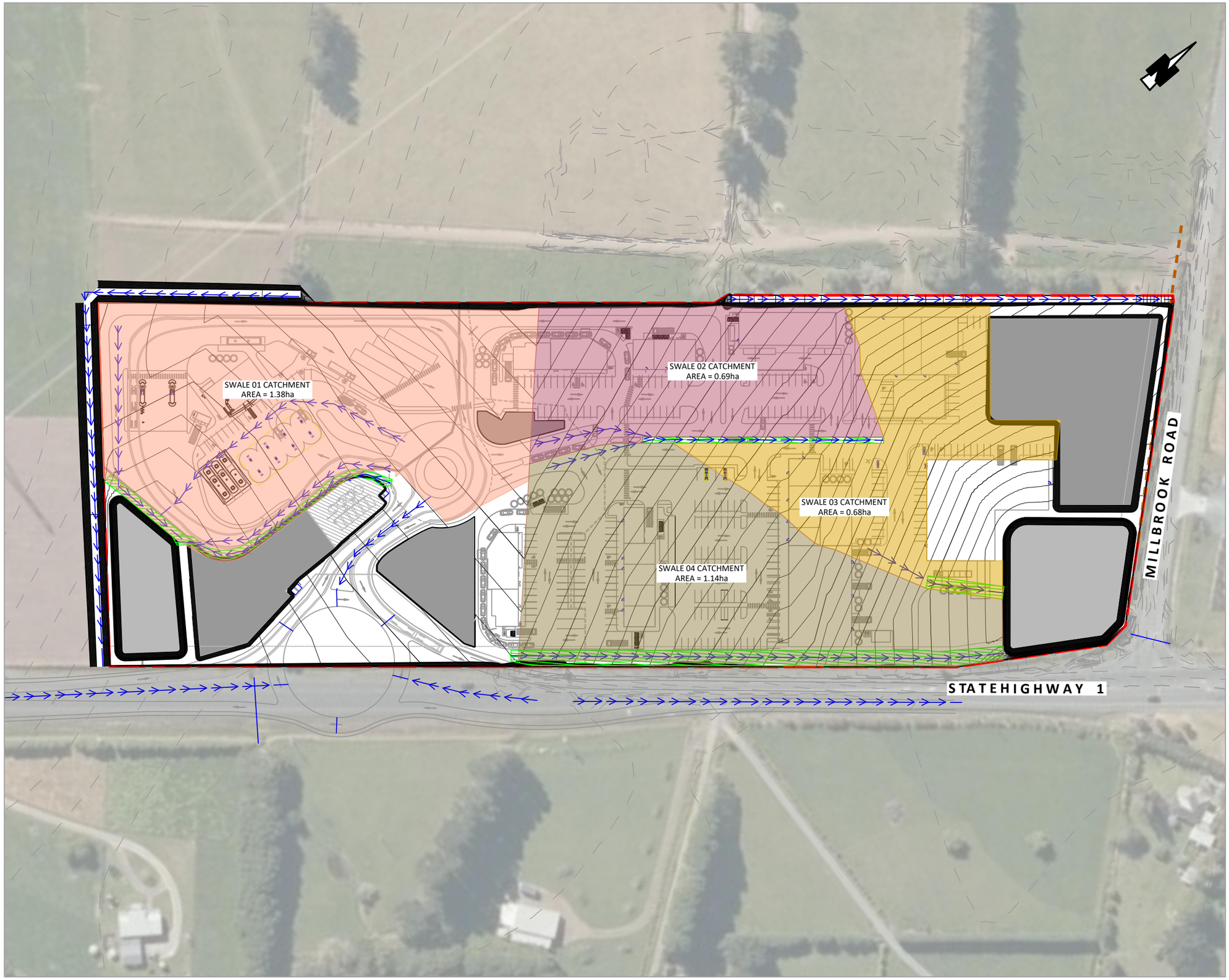
STORMWATER
LAYOUT PLAN
SHEET 2

Issue	Description	Checked	Date
1	RESOURCE CONSENT	LC	2022.12.09
2	RESOURCE CONSENT	LC	08/09/23

		Date
Designed:	RS	01.12.2022
Drawn:	LD	01.12.2022
Checked:	LC	08/09/23

Scale: 1:750 (A3 Original)

Job No: A21235 Dwg No: 4002-1 Rev: 2



STORMWATER NOTES:

1. ALL WORKS AND MATERIALS TO COMPLY WITH AUCKLAND COUNCIL CODE OF PRACTICE FOR LAND DEVELOPMENT AND SUBDIVISION AND ANY AMENDMENTS.
2. ALL PRIVATE DRAINAGE WORKS TO COMPLY WITH THE NEW ZEALAND BUILDING CODE.
3. ALL DRAINAGE WORKS SHALL BE CARRIED OUT UNDER THE SUPERVISION OF A REGISTERED DRAIN LAYER AND IN ACCORDANCE WITH CURRENT HEALTH AND SAFETY PRACTICES. WHERE REQUIRED, DRAINAGE WORKS ARE TO BE UNDERTAKEN BY AN APPROVED LICENSED CONTRACTOR (A.L.C.).
4. ALL MANHOLES ARE TO BE MIN. DN 1050 WITH D.I. LID AND COVERS UNLESS SHOWN OTHERWISE.
5. MANHOLE COVER HINGES WILL BE ORIENTED UPSTREAM FOR ALL MANHOLES LOCATED WITHIN OVERLAND FLOW PATHS
6. ALL MANHOLE LIDS IN TRAFFICABLE AREAS TO HAVE HEAVY DUTY CLASS E LIDS AND FRAMES.
7. WHERE SW CASCADES ARE PRESENT, MANHOLES TO BE FINSIHED IN 30MPa CONCRETE.
8. ALL ROAD CATCHPITS TO COMPRISE STANDARD SEMI-RESSESSED IN ACCORDANCE WITH TDM STANDARD DRAWING RD0020. WHERE LOCATED IN CYCLE LANES, CATCHPITS ARE TO INCLUDE CYCLE-FRIENDLY GRATES.
9. ALL CP LEADS ARE TO BE MIN. DN225 CLASS 4 PIPE UNLESS SHOWN OTHERWISE.
10. ALL ORDINARY TRENCH BACKFILL SHALL COMPRISE SUITABLE EARTHFILL FREE OF TOPSOIL/ORGANICS AND SHALL BE WELL COMPACTED IN LAYERS NOT EXCEEDING 200mm TO ACHIEVE MINIMUM SHEAR STRENGTHS OF 100 kPa/MAX. 10% AIR VOIDS OR AS PER THE EARTHWORKS SPECIFICATION.
11. ALL PIPE CROSSINGS UNDER CARRIAGEWAYS/TRAFFIC AREAS TO BE HARDFILL BACKFILLED WITH APPROVED GAP65 TO 1.0m BEYOND EXTENT OF CARRIAGEWAY. TRENCH HARDFILL BACKFILL TO BE WELL COMPACTED TO ACHIEVE MIN. CLEGG HAMMER CIV = 25.
12. WHERE CLEARANCE BETWEEN PIPELINE CROSSOVERS IS LESS THAN 100mm THE GAP IS TO BE POLYSTYRENE PACKED IN ADDITION TO HARDFILLING OF CROSSOVERS.
13. ALL EXISTING BERMS, CARRIAGEWAYS AND CROSSINGS TO BE RE-INSTATED AS PER COUNCIL/CONTROLLING AUTHORITY REQUIREMENTS.

STORMWATER LEGEND:

OVERLAND FLOW (OLFP)

TREATMENT + CONVEYANCE SWALE

FOR CONSENT

CKL
Planning | Surveying | Engineering | Environmental

OFFICE
AUCKLAND
A: 25 Broadway, Newmarket
P: 09 524 7029
E: Auckland@ckl.co.nz

WAIPU GATEWAY SERVICE CENTRE
VACO INVESTMENTS LTD
47 MILLBROOK ROAD, WAIPU

STORMWATER SWALE CATCHMENT PLAN

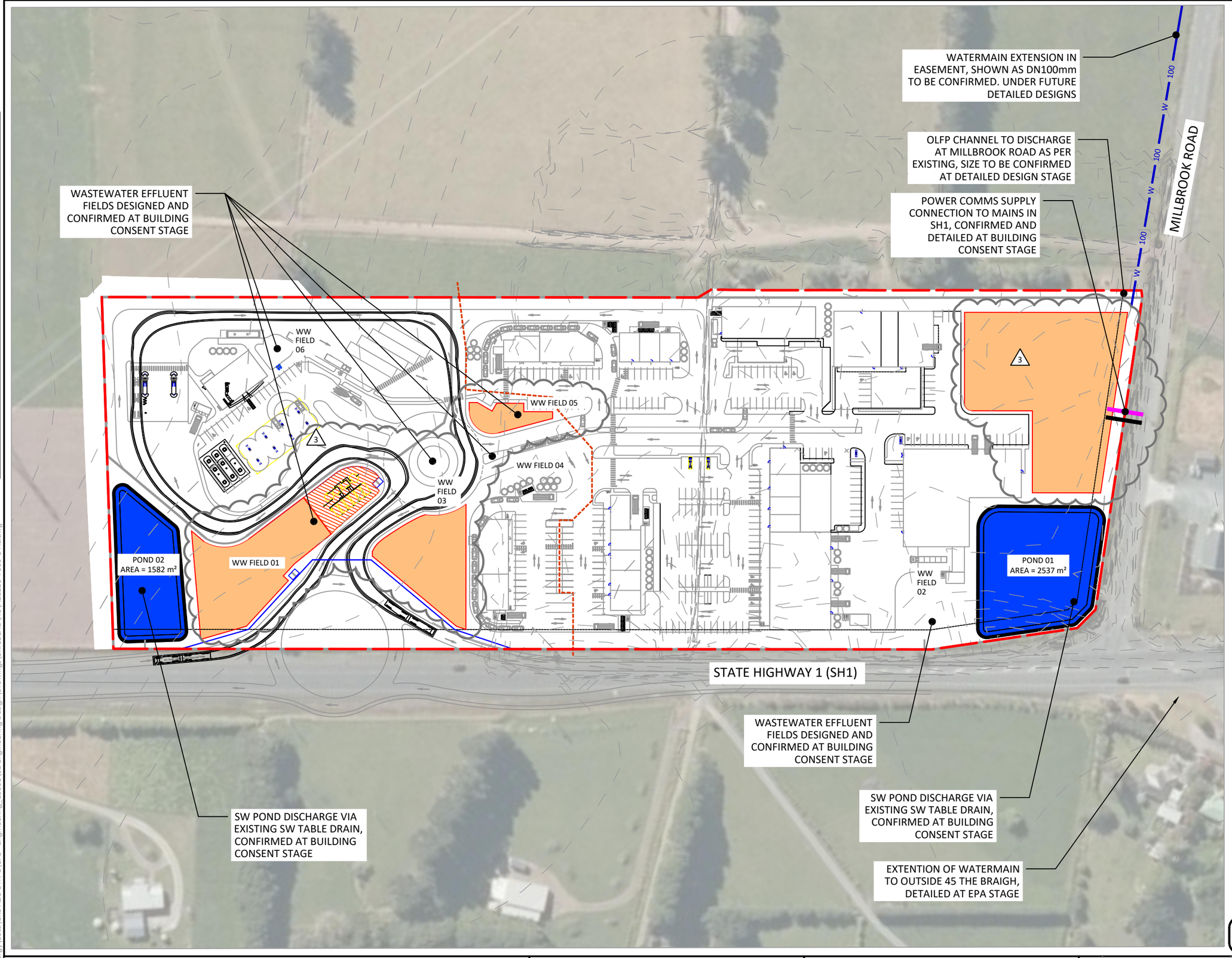
Issue	Description	Checked	Date
1	RESOURCE CONSENT	LC	08.09.2023

		Date
Designed:	FDP	08.09.2023
Drawn:	RB	08.09.2023
Checked:	LC	08.09.2023

Scale: 1:1500 (A3 Original)

Job No: A21235 Dwg No: 4200-1 Rev: 1

C:\ProgramData\12DSynergy\data\CKL-AZU-SYN-1\C1 Engineering_19993\01 Engineering Design\Drawings\BRICSCAD\RC\A21235-4200-SW CATCHMENT.dwg



NOTES:

1. ALL WORKS TO COMPLY WITH THE RELEVANT LOCAL AUTHORITY STANDARDS.
2. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO LOCATE ALL SERVICES PRIOR TO ANY EXCAVATION.
3. IT IS THE CONTRACTORS RESPONSIBILITY FOR HEALTH & SAFETY & SECURITY ON SITE, APPROPRIATE FENCING AND SIGNAGE SHALL BE ERECTED AND MAINTAINED AT ALL TIMES TO KEEP THE GENERAL PUBLIC OFF SITE.
4. IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE MAINTAIN AND PROTECT ALL LIVE SERVICES PRIOR TO WORKS COMMENCING.
5. CONTRACTOR TO PILOT ANY SERVICES LOCATED IN THE BERM AND ADVISE LOCATION AND DEPTHS TO THE ENGINEER FOR A SOLUTION TO BE DETERMINED WITH RESPECTIVE UTILITY PROVIDERS PRIOR TO EARTHWORKS.
6. ANY WORK OUTSIDE OF PROPERTY EXTENTS SHALL BE ON INSTRUCTION BY THE ENGINEER PRIOR TO COMMENCING WORKS.
7. SUITABLE TRAFFIC MANAGEMENT SHALL BE ADOPTED FOR WORKS IN THE BERM TO BE ARRANGED BY THE CONTRACTOR.
8. IN THE EVENT ITEMS OF ARCHAEOLOGICAL INTEREST ARE FOUND DURING WORKS, THE ENGINEER IS TO BE NOTIFIED IMMEDIATELY AND NO DAMAGE IS TO OCCUR TO ANY SUCH ITEMS IN THE MEANTIME.
9. IN THE EVENT ASBESTOS IS ENCOUNTERED THE ENGINEER IS TO BE ALERTED IMMEDIATELY AND NO WORKS ARE TO TAKE PLACE AROUND THE CONTAMINATED ZONE UNTIL CLEARED IN A COMPLIANT MANNER.
10. ANY EXCAVATIONS OVER 500mm IN HEIGHT SHALL BE BATTERED TO A 1:3 SAFE SLOPE.

FOR CONSENT

CKL
Planning | Surveying | Engineering | Environmental

OFFICE
AUCKLAND
A: 25 Broadway, Newmarket
P: 09 524 7029
E: Auckland@ckl.co.nz

WAIPU GATEWAY SERVICE CENTRE
VACO INVESTMENTS LTD
47 MILLBROOK ROAD, WAIPU

UTILITY SERVICES
LAYOUT OVERVIEW

Issue	Description	Checked	Date
1	RESOURCE CONSENT	SJ	09.12.2022
2	RESOURCE CONSENT	LC	2023.02.16
3	RESOPURCE CONSENT	LC	08/09/23

		Date
Designed:	RS	16.11.2022
Drawn:	LD	16.11.2022
Checked:	LC	08/09/23

Scale: 1:1500 (A3 Original)

Job No: A21235 Dwg No: 7000-1 Rev: 3

EX 375 AC TRUNK MAIN

WATER CONNECTION POINT

MILLBROOK ROAD

WATERMAIN EXTENSION IN EASEMENT, SHOWN AS DN100mm TO BE CONFIRMED. UNDER FUTURE DETAILED DESIGNS

WATERMAIN EXTENSION IN EASEMENT, UNDER FUTURE DETAILED DESIGNS

NOTES:

1. ALL WORKS TO COMPLY WITH THE RELEVANT LOCAL AUTHORITY STANDARDS.
2. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO LOCATE ALL SERVICES PRIOR TO ANY EXCAVATION.
3. IT IS THE CONTRACTORS RESPONSIBILITY FOR HEALTH & SAFETY & SECURITY ON SITE, APPROPRIATE FENCING AND SIGNAGE SHALL BE ERECTED AND MAINTAINED AT ALL TIMES TO KEEP THE GENERAL PUBLIC OFF SITE.
4. IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE MAINTAIN AND PROTECT ALL LIVE SERVICES PRIOR TO WORKS COMMENCING.
5. CONTRACTOR TO PILOT ANY SERVICES LOCATED IN THE BERM AND ADVISE LOCATION AND DEPTHS TO THE ENGINEER FOR A SOLUTION TO BE DETERMINED WITH RESPECTIVE UTILITY PROVIDERS PRIOR TO EARTHWORKS.
6. ANY WORK OUTSIDE OF PROPERTY EXTENTS SHALL BE ON INSTRUCTION BY THE ENGINEER PRIOR TO COMMENCING WORKS.
7. SUITABLE TRAFFIC MANAGEMENT SHALL BE ADOPTED FOR WORKS IN THE BERM TO BE ARRANGED BY THE CONTRACTOR.
8. IN THE EVENT ITEMS OF ARCHAEOLOGICAL INTEREST ARE FOUND DURING WORKS, THE ENGINEER IS TO BE NOTIFIED IMMEDIATELY AND NO DAMAGE IS TO OCCUR TO ANY SUCH ITEMS IN THE MEANTIME.
9. IN THE EVENT ASBESTOS IS ENCOUNTERED THE ENGINEER IS TO BE ALERTED IMMEDIATELY AND NO WORKS ARE TO TAKE PLACE AROUND THE CONTAMINATED ZONE UNTIL CLEARED IN A COMPLIANT MANNER.
10. ANY EXCAVATIONS OVER 500mm IN HEIGHT SHALL BE BATTERED TO A 1:3 SAFE SLOPE.

FOR CONSENT

C:\ProgramData\12DSynergy\data\CKL-AZU-SYN-1\CI 1 - Engineering_19993\01 Engineering Design\Drawings\BRICSCAD\RC\A21235-7000-UTIL.dwg

CKL
Planning | Surveying | Engineering | Environmental

OFFICE
AUCKLAND
A: 25 Broadway, Newmarket
P: 09 524 7029
E: Auckland@ckl.co.nz

WAIPU GATEWAY SERVICE CENTRE
VACO INVESTMENTS LTD
47 MILLBROOK ROAD, WAIPU

UTILITY SERVICES
LAYOUT SHEET 2

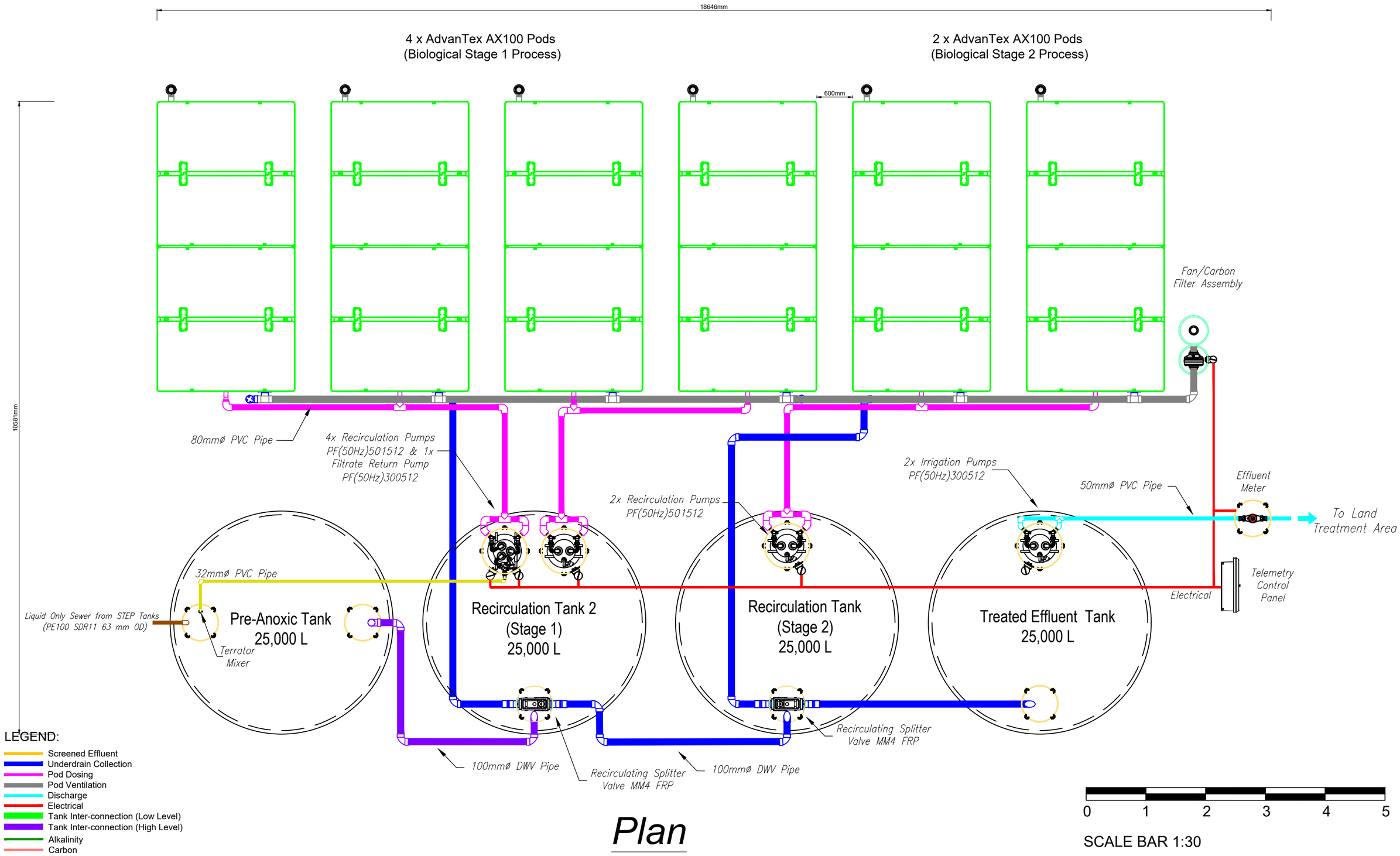
Issue	Description	Checked	Date
1	RESOURCE CONSENT	SJ	2022.12.09
2	RESOURCE CONSENT	LC	2023.02.16

		Date
Designed:	RB	09.12.2022
Drawn:	LD	09.12.2022
Checked:	LC	09.12.2022

Scale: 1:1500 (A3 Original)

Job No: A21235 Dwg No: 7001-1 Rev: 2

NOT FOR CONSTRUCTION



Plan

REV.	DESCRIPTION	DATE
–	–	–

DATE: 18th Aug 2023

SCALE: 1 : 30 (A1)

APPROVED		
CHECKED		
DESIGNED		

STATUS: Design

innoflow wastewater specialists
www.innoflowtechnologies.com

New Zealand
P.O. Box 300 572
North Shore City 0752
New Zealand
Freephone 0800 innoflow
Ph: + 64 9 426 1027
Fax: + 64 9 426 1047
info@innoflow.co.nz

Australia
P.O. Box 263
Ormeau
Queensland 4208
Australia
Freephone 0800 innoflow
Ph: + 61 7 5549 2416
Fax: + 61 7 5549 2416

CLIENT: VACO Investments Ltd

PROJECT: WAIPU GATEWAY

TITLE: AdvanTex Wastewater Treatment Plant Plan

DRAWING No.: 30005501301-10

REVISION: -

APPENDIX B

Calculations

Client :	Antony Arnerich
Site address :	47 Millbrook Rd
Job name :	Waipu Gateway
Job number :	A21235

Job Name	Waipu Gateway	File:	A21235-EV- -WW Calcs 22.xlsx
Date	9/11/2022	Sheet:	WW (rev JS)
Design	FDP	Review	JR

Wastewater

Design Criteria - Refer Watercare CoP Table 5.1.3

Residential:

ADWF =	2	Peaking factor - self cleansing
PWWF	5	Peaking factor - peak design flow dry retail
PWWF	6.7	Peaking factor - peak design flow wet retail

Post-Development Flows

	Subcatchment Details	Daily Average			Peak factors for pipe sizine				
		Floor Area (m2)	Design WW flow (l/day/m2) or (l/day/15m2)	Design WW flow ADWF (l/day)	PDWF Peaking Factor	PWWF Peaking Factor	Design PDWF (L/s)	Design PWWF (L/s)	
BP (Building 1)	Wet retail	305	15	4575.0	2.0	6.7	0.106	0.355	
Burger King (Building 11)	Wet retail	260	15	3900.0	2.0	6.7	0.090	0.302	
Food (building 12)	Wet retail	148	15	2220.0	2.0	6.7	0.051	0.172	
Stage 1 total		**713**		**10695.0**			**0.20**	**0.83**	10.695
Building 13	Dry retail	408	65	530.4	2.0	5.0	0.012	0.031	
Building 14	Wet retail	113	15	1695.0	2.0	6.7	0.039	0.131	
Building 16	Dry retail	1170	65	1521.0	2.0	5.0	0.035	0.088	
Building 18	Dry retail	296	65	384.8	2.0	5.0	0.009	0.022	
Building 19	Dry retail	90	65	117.0	2.0	5.0	0.003	0.007	
Building 19A	Dry retail	90	65	117.0	2.0	5.0	0.003	0.007	
Building 20	Dry retail	114	65	148.2	2.0	5.0	0.003	0.009	
Building 20A	Dry retail	135	65	175.5	2.0	5.0	0.004	0.010	
Building 22	Wet retail	260	15	3900.0	2.0	6.7	0.090	0.302	
Building 23	Wet retail	148	15	2220.0	2.0	6.7	0.051	0.172	
Building 24	Dry retail	294	65	382.2	2.0	5.0	0.009	0.022	
Building 25	Dry retail	500	65	650.0	2.0	5.0	0.015	0.038	
Building 28	Dry retail	1648	65	2142.4	2.0	5.0	0.050	0.124	
Building 29	Dry retail	930	65	1209.0	2.0	5.0	0.028	0.070	
TOTAL		**6909**	**805**	**25887.5**			**0.60**	**1.86**	25.8875

Rev 5 Sept JS
Based on Lance M rev

Commercial activity type	*Design wastewater flow allowance*	*Design wastewater peaking factors*	
		Peaking factor: Self-Cleansing Design Flow (Normal PDWF)	*Peaking factor: Peak Design Flow(PWWF or Exceptional PDWF)*
Dry retail (Note 1) (where kitchen/toilets are not normally made available to customers)	*1 person per 50m² net floor area at 65 litres per person per day.*	*2.0*	*5.0*
Office buildings and dry retail where toilet facilities, etc. are provided to customers.	*1 person per 15m² net floor area at 65 litres per person per day.*	*2.0*	*5.0*
Wet retail (Note 2): Food and or beverage retail/preparation e.g. coffee shop, restaurant, bar, butcher, fresh fruit and vegetable retail.	*15 litres per day per net m² of floor area (including kitchen and dining areas).*	*2.0*	*6.7*

Commercial activity type	*Design wastewater flow allowance*	*Design wastewater peaking factors*	
		Peaking factor: Self-Cleansing Design Flow (Normal PDWF)	*Peaking factor: Peak Design Flow(PWWF or Exceptional PDWF)*
Unknown and site area >10ha, <100ha	*1 L/s/ha (complete land area)*	*2.0*	*6.7*
Site area >100ha	*Refer to transmission design standards*	-	-

Table notes:

1. *Dry retail is where water is normally only used by staff for their own personal food preparation / toileting needs. Examples include: clothes shop, hardware retail.*
2. *Wet retail is where water is used to prepare food product for customers. Examples include: café, lunch bar, restaurant, butchery, fresh fruit and vegetable, food court-bar and supermarkets.*

Important:

Net floor area is the total floor area of the building (exclude any open land areas), less non-productive areas, such as:
lobbies; lifts; machine rooms; electrical services; stairwells; fire escapes; corridors and other passages used in common with other occupiers; car parking areas; etc. If net area is unknown, and the type of buildings are unknown, it can be assumed that the Net floor area is = 80% of the gross floor area of the building.

As a guide to how activities will be assessed, commercial washing activities such as car / boat washing activities, etc. would be regarded as a "wet-industry" and not as a commercial - wet retail, as the water is being used as a part of a process (washing). Large-scale food-processing (i.e. for supply to commercial customers, as opposed to on-site retail customers) would be regarded as an industrial type activity. Preparation / manufacture of non-food based products, is also regarded as an industrial activity. Industry design flows are detailed in the section below.

CKL Limited
PO Box 99 463, Auckland 1149
L2, 25 Broadway, Newmarket
Ph: 09 524 7029
Fax: 09 524 7032

Job Name	47 Millbrook Rd, Waipu	Sheet Name	ENTIRE WW ST 5 DLR 5
Job No.	A21235	By	FDP
Date	28/07/2023	Checked	CF

Aim: Permitted PCDI Effluent Disposal Area Sizing for existing dwelling

Design Flowrate		**Comments**	
Total Design Flow (L/d)	25887.00	From other spreadsheet	Rev by JS - 5 Sept Bsed on Lance M revs
Site Requirements			
Soil Type	5		
Design Loading Rate (mm/d)	5		
Area Required (m^2)	5177		
Reserve Area 30% (m^2)	1553		
Total Area Required 30% (m^2)	6731		

CKL Limited
PO Box 99 463, Auckland 1149
L2, 25 Broadway, Newmarket
Ph: 09 524 7029
Fax: 09 524 7032

Job Name	47 Millbrook Road, Waipu	File Name	A21235-EV- -SMP2.xlsx
Job No.	A21235	Sheet Name	Area summary
Date	8/09/2023	File Path	C:\ProgramData\12DSynergy\data\CKL-AZU-SYN-1\CI 1 - Engineering_19
By	FDP	Checked	

Total Area summary

Coverage	Pre-development (ha)		Post-development (ha)	
Roof	0.000	0%	0.765	13%
Impervious	0.000	0%	3.098	52%
Grass/pervious	5.913	100%	2.051	35%
TOTAL AREA	5.913	100%	5.913	100%

Pre- Sub Catchments summary

Coverage	Stage 1 (ha)	Stage 2 (ha)
Impervious	0.000	0.000
Pervious	2.255	3.486
TOTAL AREA	2.255	3.486

*excludes roundabout not falling to a pond

Post- SubCatchment summary

Coverage	Stage 1 (ha)	Stage 2 (ha)
Roof	0.177	0.588
Other Impervious	1.109	1.816
Pervious draining to pond	0.836	0.836
Pervious direct discharge	0.133	0.246
TOTAL AREA	2.255	3.4860

Pre- Sub Catchments summary (HEC)

Coverage	Stage 1 (km2)	Stage 2 (km2)
Impervious	0.00000	0.00000
Pervious	0.02255	0.03486
TOTAL AREA	0.02255	0.03486

Post- SubCatchment summary (HEC)

Coverage	Stage 1 (km2)	Stage 2 (km2)
Roof	0.0018	0.0059
Impervious	0.0111	0.0182
Total Imp	0.0129	0.0240
Pervious draining to pond	0.0084	0.0084
Pervious direct discharge	0.0013	0.0025
TOTAL AREA	0.0225	0.0349

CKL
Planning | Surveying | Engineering | Environmental

CKL Limited
PO Box 99 463, Auckland 1149
L2, 25 Broadway, Newmarket
Ph: 09 524 7029
Fax: 09 524 7032

Job Name	47 Millbrook Road, Waipu	File Name	A21235-EV- -SMP2.xlsx
Job No.	A21235	Sheet Name	Pond Stage Storage
Date	8/09/2023	File Path	C:\ProgramData\12DSynergy\data\CKL-AZU-SYN-1\CI 1 - Engineering_19993\0
By	FDP	Checked	

Pond Storage-Elevation

Stage 1 Pond (Pond 2)

Elevation	Storage (m3)	Storage (1000m3)
7.4	0	0.0000
7.5	115.63	0.1156
7.6	235.85	0.2359
7.7	360.72	0.3607
7.8	490.28	0.4903
7.9	624.60	0.6246
8	763.73	0.7637

Stage 2 Pond (Pond 1)

Elevation	Storage (m3)	Storage (1000m3)
6.4	0	0.0000
6.5	204.98	0.2050
6.6	415.25	0.4152
6.7	630.87	0.6309
6.8	851.90	0.8519
6.9	1078.39	1.0784
7	1310.39	1.3104

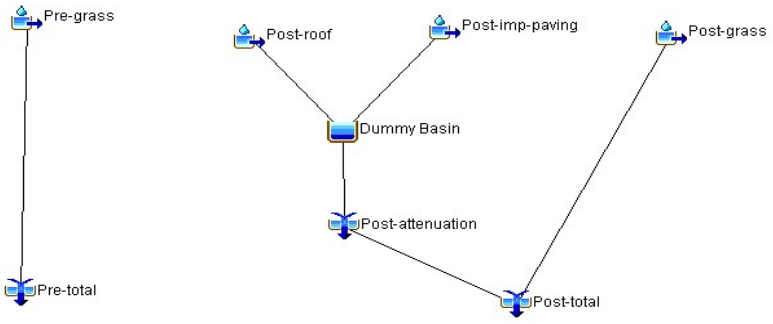
CKL Limited
PO Box 99 463, Auckland 1149
L2, 25 Broadway, Newmarket
Ph: 09 524 7029
Fax: 09 524 7032

Job Name	47 Millbrook Road, Waipu	File Name	A21235-EV- -SMP2.xlsx
Job No.	A21235	Sheet Name	HEC HMS model
Date	30/11/2021	File Path	C:\ProgramData\12DSynergy\data\CKL-AZU-SYN-1\Cl 1
By	FDP	Checked	

Assumptions

Land use		Pervious	Impervious
SCS Curve Number		74.0	98.0
Initial Abstraction, Ia	mm	5.0	0.0
Time of Concentration (tc)	min	10.0	
Time of Concentraion for SCS	min	6.7	

Basin model



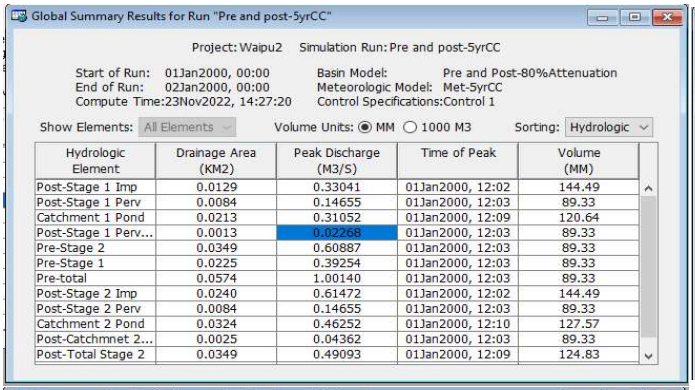
Model result - Pre Development

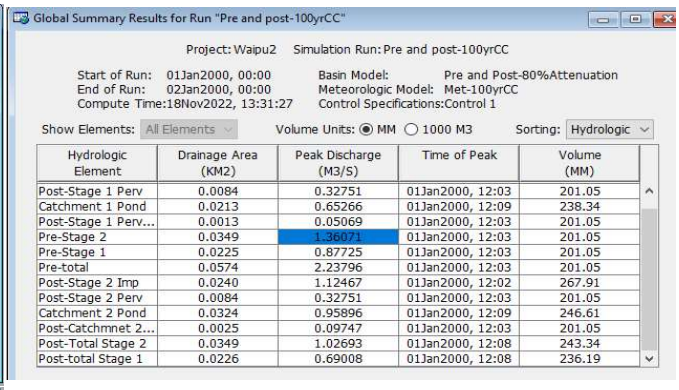
Storm ARI	Stage 1 (m3/s)	Stage 2 (m3/s)	**Total (m3/s)**
5YR	0.393	0.609	**1.002**
100YR	0.877	1.361	**2.238**
80% 100YR	0.702	1.089	**1.790**

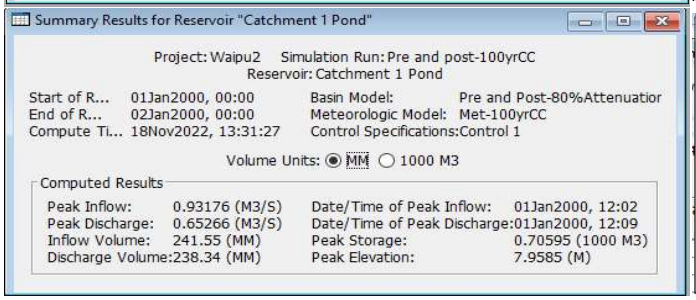
Model result - Pre Development

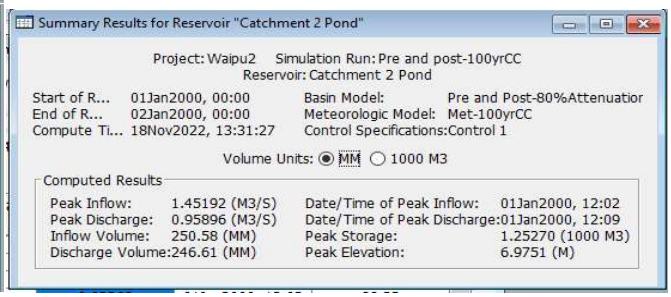
Storm ARI	Stage 1 (m3/s)	Stage 2 (m3/s)	**Total (m3/s)**
5YR	0.326	0.491	**0.817**
100YR	0.690	1.026	**1.716**

Pond Details	Stage 1 Pond	Stage 2 Pond
100yr Peak Volume (m3)	706	1253
Peak eleveation (mRL)	7.96	6.98
Bottom of pond (mRl)	7.40	6.40
Peak depth (m)	0.56	0.58


Global Summary Results for Run "Pre and post-5yrCC"
Project: Waipu2 Simulation Run: Pre and post-5yrCC
Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 23Nov2022, 14:27:20
Basin Model: Pre and Post-80%Attenuation
Meteorologic Model: Met-5yrCC
Control Specifications: Control 1
Show Elements: All Elements
Volume Units: MM 1000 M3
Sorting: Hydrologic
Hydrologic Element | Drainage Area (KM2) | Peak Discharge (M3/S) | Time of Peak | Volume (MM)
Post-Stage 1 Imp | 0.0129 | 0.33041 | 01Jan2000, 12:02 | 144.49
Post-Stage 1 Perv | 0.0084 | 0.14655 | 01Jan2000, 12:03 | 89.33
Catchment 1 Pond | 0.0213 | 0.31052 | 01Jan2000, 12:09 | 120.64
Post-Stage 1 Perv... | 0.0013 | 0.02268 | 01Jan2000, 12:03 | 89.33
Pre-Stage 2 | 0.0349 | 0.60887 | 01Jan2000, 12:03 | 89.33
Pre-Stage 1 | 0.0225 | 0.39254 | 01Jan2000, 12:03 | 89.33
Pre-total | 0.0574 | 1.00140 | 01Jan2000, 12:03 | 89.33
Post-Stage 2 Imp | 0.0240 | 0.61472 | 01Jan2000, 12:02 | 144.49
Post-Stage 2 Perv | 0.0084 | 0.14655 | 01Jan2000, 12:03 | 89.33
Catchment 2 Pond | 0.0324 | 0.46252 | 01Jan2000, 12:10 | 127.57
Post-Catchmnet 2... | 0.0025 | 0.04362 | 01Jan2000, 12:03 | 89.33
Post-Total Stage 2 | 0.0349 | 0.49093 | 01Jan2000, 12:09 | 124.83


Global Summary Results for Run "Pre and post-100yrCC"
Project: Waipu2 Simulation Run: Pre and post-100yrCC
Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 18Nov2022, 13:31:27
Basin Model: Pre and Post-80%Attenuation
Meteorologic Model: Met-100yrCC
Control Specifications: Control 1
Show Elements: All Elements
Volume Units: MM 1000 M3
Sorting: Hydrologic
Hydrologic Element | Drainage Area (KM2) | Peak Discharge (M3/S) | Time of Peak | Volume (MM)
Post-Stage 1 Perv | 0.0084 | 0.32751 | 01Jan2000, 12:03 | 201.05
Catchment 1 Pond | 0.0213 | 0.65266 | 01Jan2000, 12:09 | 238.34
Post-Stage 1 Perv... | 0.0013 | 0.05069 | 01Jan2000, 12:03 | 201.05
Pre-Stage 2 | 0.0349 | 1.36071 | 01Jan2000, 12:03 | 201.05
Pre-Stage 1 | 0.0225 | 0.87725 | 01Jan2000, 12:03 | 201.05
Pre-total | 0.0574 | 2.23796 | 01Jan2000, 12:03 | 201.05
Post-Stage 2 Imp | 0.0240 | 1.12467 | 01Jan2000, 12:02 | 267.91
Post-Stage 2 Perv | 0.0084 | 0.32751 | 01Jan2000, 12:03 | 201.05
Catchment 2 Pond | 0.0324 | 0.95896 | 01Jan2000, 12:09 | 246.61
Post-Catchmnet 2... | 0.0025 | 0.09747 | 01Jan2000, 12:03 | 201.05
Post-Total Stage 2 | 0.0349 | 1.02693 | 01Jan2000, 12:08 | 243.34
Post-total Stage 1 | 0.0226 | 0.69008 | 01Jan2000, 12:08 | 236.19


Summary Results for Reservoir "Catchment 1 Pond"
Project: Waipu2 Simulation Run: Pre and post-100yrCC
Reservoir: Catchment 1 Pond
Start of R... 01Jan2000, 00:00
End of R... 02Jan2000, 00:00
Compute Ti... 18Nov2022, 13:31:27
Basin Model: Pre and Post-80%Attenuatior
Meteorologic Model: Met-100yrCC
Control Specifications: Control 1
Volume Units: MM 1000 M3
Computed Results
Peak Inflow: 0.93176 (M3/S)
Peak Discharge: 0.65266 (M3/S)
Inflow Volume: 241.55 (MM)
Discharge Volume: 238.34 (MM)
Date/Time of Peak Inflow: 01Jan2000, 12:02
Date/Time of Peak Discharge: 01Jan2000, 12:09
Peak Storage: 0.70595 (1000 M3)
Peak Elevation: 7.9585 (M)


Summary Results for Reservoir "Catchment 2 Pond"
Project: Waipu2 Simulation Run: Pre and post-100yrCC
Reservoir: Catchment 2 Pond
Start of R... 01Jan2000, 00:00
End of R... 02Jan2000, 00:00
Compute Ti... 18Nov2022, 13:31:27
Basin Model: Pre and Post-80%Attenuatior
Meteorologic Model: Met-100yrCC
Control Specifications: Control 1
Volume Units: MM 1000 M3
Computed Results
Peak Inflow: 1.45192 (M3/S)
Peak Discharge: 0.95896 (M3/S)
Inflow Volume: 250.58 (MM)
Discharge Volume: 246.61 (MM)
Date/Time of Peak Inflow: 01Jan2000, 12:02
Date/Time of Peak Discharge: 01Jan2000, 12:09
Peak Storage: 1.25270 (1000 M3)
Peak Elevation: 6.9751 (M)

CKL Limited
PO Box 99 463, Auckland 1149
L2, 25 Broadway, Newmarket
Ph: 09 524 7029
Fax: 09 524 7032

Job Name	Iona Road, Havelock North	File Name	A21235-EV- -SMP2.xlsx
Job No.	A18259	Sheet Name	HIRDS
Date	30/11/2021	File Path	C:\ProgramData\12DSynergy\data\CKL-AZU-SYN-1\CI 1 - Engineering_1999
By	CL	Checked	

24 hr Rainfall Depth

Reference: HBRC Waterways Design Guidelines Stormwater Management

ARI	Hirds Rainfall Depth (mm) *	Climage change Factor	Rainfall Depth +CC (mm)
5YR	125.0	20.00%	150.0
10yr	148.0	20.00%	177.6
100yr	228.0	20.00%	273.6

HIRDS V4 Depth-Duration-Frequency Results
Site Name: 47 millbrook road, waipu
Coordinate System: WGS84
Longitude: 174.4243
Latitude: -35.9827

Rainfall depths (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h
1.58	0.633	8.79	13.3	16.8	24.2	33.8	53.9	69.3	86.5
2	0.5	9.67	14.7	18.5	26.6	37.2	59.3	76.3	95.2
5	0.2	12.7	19.3	24.3	35.1	49	78.1	101	125
10	0.1	15	22.8	28.7	41.4	57.8	92.1	119	148
20	0.05	17.4	26.4	33.2	47.9	66.9	107	137	171
30	0.033	18.8	28.5	35.9	51.8	72.4	115	148	185
40	0.025	19.8	30.1	37.8	54.6	76.3	122	156	195
50	0.02	20.6	31.3	39.4	56.8	79.4	126	163	203
60	0.017	21.3	32.3	40.6	58.6	81.9	130	168	209
80	0.012	22.3	33.9	42.6	61.4	85.9	137	176	220
100	0.01	23.1	35.1	44.1	63.7	89	142	182	228
250	0.004	26.4	40.1	50.4	72.7	102	162	208	260

Rainfall intensities (mm/hr) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h
1.58	0.633	52.7	40	33.5	24.2	16.9	8.98	5.78	3.6
2	0.5	58	44	36.9	26.6	18.6	9.88	6.36	3.97
5	0.2	76.4	58	48.6	35.1	24.5	13	8.38	5.22
10	0.1	90.2	68.4	57.4	41.4	28.9	15.4	9.88	6.16
20	0.05	104	79.2	66.4	47.9	33.5	17.8	11.4	7.13
30	0.033	113	85.6	71.8	51.8	36.2	19.2	12.4	7.71
40	0.025	119	90.3	75.7	54.6	38.2	20.3	13	8.13
50	0.02	124	93.9	78.7	56.8	39.7	21.1	13.6	8.46
60	0.017	128	96.9	81.2	58.6	40.9	21.7	14	8.73
80	0.012	134	102	85.2	61.4	42.9	22.8	14.7	9.15
100	0.01	139	105	88.2	63.7	44.5	23.6	15.2	9.48
250	0.004	158	120	101	72.7	50.8	27	17.4	10.8

CKL Limited
PO Box 99 463, Auckland 1149
25 Broadway, Newmarket
Ph: 09 524 7029
Fax: 09 524 7032

Job number	A21235	File Name	A21235-EV- -Swale Design- draft.xlsx
Job name	Waipu Gateway	Sheet Name	Swale 1
Date	8/09/2023	Path	
Prepared by	MB	Checked	JR

Design of swale 1

Assumptions:

Runoff Coefficient (c):
c=0.95 for roof
c=0.9 for driveway
c=0.3 for permeable surafces

Roughness factor (k):
k = 1.5 (conservative value for existing concrete & plastic pipes)
See NZS4404 Table 4.2 for more details

Design rainfall:	**100yr 10min +CC**	**187.0 mm/hr**

Catchment Details

Total Catchment area (ha)	1.38
Total Catchment area (m2)	13800

	Impervious	**Pervious**
Surface area (m^2)	8556	5244
WQ intensity (mm/hr)	10	
100% AEP Rainfall (mm/hr)	187.0	
C	0.95	0.3
WQ Q_p (L/s) (Roads Runoff)	22.6	
100% AEP qP(L/s)	422.55	81.78
Total Flow	504.34	

100yrCC Swale

	100yrCC	WQV
Catchment area (m^2)	13,800	13,800
Q (m^3/s)	0.504	0.023
Depth, d (m)	0.2	0.1
Longitudinal Slope	1.60%	1.60%
Side Slopes, z	3	3
Base Width, b (m)	2.00	2.00
Top width	3.20	2.60
Area (m^2)	0.52	0.23
Wetted Perimeter (m)	3.26	2.63
Hydraulic Radius (m)	0.16	0.09
n	0.03	0.25
Q swale (m^3/s)	0.640	0.023
Velocity (m/s)	1.23	0.10
Residence time (mins)	0.00	9.00
Length (m)		53
Total Length (m)		107
Freeboard for 100yr (m)	0.15	

Swale size

Base width (m)	2.00
Total Height (m)	0.350
Top width (m)	4.10
Longitudinal slope (%)	1.60%
Side slope (H:V)	3

CKL Limited
PO Box 99 463, Auckland 1149
25 Broadway, Newmarket
Ph: 09 524 7029
Fax: 09 524 7032

Job number	A21235	File Name	A21235-EV- -Swale Design-
Job name	Waipu Gateway	Sheet Name	Swale 2
Date	8/09/2023	Path	
Prepared by	MB	Checked	JR

Design of swale 2

Assumptions:

Runoff Coefficient (c): c=0.95 for roof
c=0.9 for driveway
c=0.3 for permeable surafces

Roughness factor (k): k = 1.5 (conservative value for existing concrete & plastic pipes)
See NZS4404 Table 4.2 for more details

Design rainfall:	**100yr 10min +CC**	**187.0 mm/hr**

Catchment Details

Total Catchment area (ha)	0.69
Total Catchment area (m2)	6900

	Impervious	**Pervious**
Surface area (m^2)	4278	2622
WQ intensity (mm/hr)	10	
100% AEP Rainfall (mm/hr)	187.0	
C	0.95	0.3
WQ Q_p (L/s) (Roads Runoff)	11.3	
100% AEP qP(L/s)	211.28	40.89
Total Flow	252.17	

100yrCC Swale

	100yrCC	WQV
Catchment area (m^2)	6,900	6,900
Q (m^3/s)	0.252	0.011
Depth, d (m)	0.15	0.1
Longitudinal Slope	1.50%	1.50%
Side Slopes, z	3	3
Base Width, b (m)	1.50	1.50
Top width	2.40	2.10
Area (m^2)	0.29	0.18
Wetted Perimeter (m)	2.45	2.13
Hydraulic Radius (m)	0.12	0.08
n	0.03	0.25
Q swale (m^3/s)	0.288	0.017
Velocity (m/s)	0.98	0.09
Residence time (mins)	0.00	9.00
Length (m)		50
Total Length (m)		101
Freeboard for 100yr (m)	0.15	

Swale size

Base width (m)	1.50
Total Height (m)	0.300
Top width (m)	3.30
Longitudinal slope (%)	1.50%
Side slope (H:V)	3

CKL Limited
PO Box 99 463, Auckland 1149
25 Broadway, Newmarket
Ph: 09 524 7029
Fax: 09 524 7032

Job number	A21235	File Name	A21235-EV- -Swale Design-
Job name	Waipu Gateway	Sheet Name	Swale 3
Date	8/09/2023	Path	
Prepared by	MB	Checked	JR

Design of swale 3

Assumptions:

Runoff Coefficient (c): c=0.95 for roof
c=0.9 for driveway
c=0.3 for permeable surafces

Roughness factor (k): k = 1.5 (conservative value for existing concrete & plastic pipes)
See NZS4404 Table 4.2 for more details

Design rainfall:	**100yr 10min +CC**	**187.0 mm/hr**

Catchment Details

Total Catchment area (ha)	1.37
Total Catchment area (m2)	13700

	Impervious	**Pervious**
Surface area (m^2)	8494	5206
WQ intensity (mm/hr)	10	
100% AEP Rainfall (mm/hr)	187.0	
C	0.95	0.3
WQ Q_p (L/s) (Roads Runoff)	22.4	
100% AEP qP(L/s)	419.49	81.19
Total Flow	500.68	

100yrCC Swale

	100yrCC	WQV
Catchment area (m^2)	13,700	13,700
Q (m^3/s)	0.501	0.022
Depth, d (m)	0.19	0.1
Longitudinal Slope	1.60%	1.60%
Side Slopes, z	3	3
Base Width, b (m)	2.00	2.00
Top width	3.14	2.60
Area (m^2)	0.49	0.23
Wetted Perimeter (m)	3.20	2.63
Hydraulic Radius (m)	0.15	0.09
n	0.03	0.25
Q swale (m^3/s)	0.584	0.023
Velocity (m/s)	1.20	0.10
Residence time (mins)	0.00	9.00
Length (m)		53
Total Length (m)		107
Freeboard for 100yr (m)	0.15	

Swale size

Base width (m)	2.00
Total Height (m)	0.340
Top width (m)	4.04
Longitudinal slope (%)	1.60%
Side slope (H:V)	3

CKL Limited
PO Box 99 463, Auckland 1149
25 Broadway, Newmarket
Ph: 09 524 7029
Fax: 09 524 7032

Job number	A21235	File Name	A21235-EV- -Swale Design-
Job name	Waipu Gateway	Sheet Name	Swale 4
Date	8/09/2023	Path	
Prepared by	MB	Checked	JR

Design of swale 4

Assumptions:

Runoff Coefficient (c): c=0.95 for roof
c=0.9 for driveway
c=0.3 for permeable surafces

Roughness factor (k): k = 1.5 (conservative value for existing concrete & plastic pipes)
See NZS4404 Table 4.2 for more details

Design rainfall:	**100yr 10min +CC**	**187.0 mm/hr**

Catchment Details

Total Catchment area (ha)	1.14
Total Catchment area (m2)	11400

	Impervious	**Pervious**
Surface area (m^2)	7068	4332
WQ intensity (mm/hr)	10	
100% AEP Rainfall (mm/hr)	187.0	
C	0.95	0.3
WQ Q_p (L/s) (Roads Runoff)	18.7	
100% AEP qP(L/s)	349.07	67.56
Total Flow	416.63	

100yrCC Swale

	100yrCC	WQV
Catchment area (m^2)	11,400	11,400
Q (m^3/s)	0.417	0.019
Depth, d (m)	0.2	0.1
Longitudinal Slope	1.00%	1.00%
Side Slopes, z	3	3
Base Width, b (m)	2.00	2.00
Top width	3.20	2.60
Area (m^2)	0.52	0.23
Wetted Perimeter (m)	3.26	2.63
Hydraulic Radius (m)	0.16	0.09
n	0.03	0.25
Q swale (m^3/s)	0.506	0.018
Velocity (m/s)	0.97	0.08
Residence time (mins)	0.00	9.00
Length (m)		42
Total Length (m)		84
Freeboard for 100yr (m)	0.15	

Swale size

Base width (m)	2.00
Total Height (m)	0.350
Top width (m)	4.10
Longitudinal slope (%)	1.0%
Side slope (H:V)	3

CKL Limited
PO Box 99 463, Auckland 1149
L2, 25 Broadway, Newmarket
Ph: 09 524 7029
Fax: 09 524 7032

Job Name	47 Millbrook Road, Waipu	File Name	A21235-EV- -SMP2.xlsx
Job No.	A21235	Sheet Name	Upstream OLFP
Date	30/11/2021	File Path	C:\ProgramData\12DSynergy\data\CKL-AZU-SYN-1\CI 1 - Engineering_19993\01 Engineering Design\Calculations\Stormwater & WW
By	CL	Checked	

Catchment Breakdowns and Peak Flow Calculation for Existing Pipe Network

Assumptions:

Runoff Coefficient (c): c=0.95 for roof
c=0.9 for driveway
c=0.3 for permeable surafces

Roughness factor (k): k = 0.6 (conservative value for existing concrete & plastic pipes)
See NZS4404 Table 4.2 for more details

Design rainfall: 100yr 10min +CC 167 mm/hr

Colebrook-White Equation for Pipe Velocity

$$V = -2\sqrt{2g \cdot D \cdot S_f} \cdot log\left(\frac{k_s}{3.70\,D} + \frac{2.51\,\upsilon}{D\sqrt{2g\,D\,S_f}}\right)$$

with $S_f = \frac{h_f}{L}$

V =	mean velocity	[m/s]
D =	Hydraulic Diameter	[m]
k_s =	surface roughness	[m]
υ =	Kinematic viscosity water, 20°C= 1.00 · 10^{-6}	[kg/ms]
S_f =	slope of hydraulic gradient	[-]
h_f =	frictional head loss	[m]
L =	Length between the Head Loss	[m]
g =	earths gravity	[m/s^2]

Catchment Details

Catchment	Description	Area	% Impervious	Impervious Area	Pervious Area	Roof Area	Other Impervious Area	Pervious Area	Weighted c	Peak Flow from Catchment (L/s)
A	Southern OLFP	136000	0.0%	0	136000.00	0.0%	0%	100%	0.30	1891.9
B	Eastern OLFP	104000	0.0%	0	104000.00	0.0%	0%	100%	0.30	1446.8

Table 4.2 – Guide to roughness coefficients for gravity stormwater pipes concentrically jointed and clean

Description	Colebrook-White coefficient k (mm)	Manning roughness coefficient (n)
Circular pipes		
PVC	0.003 – 0.015	0.008 – 0.009
PE	0.003 – 0.015	0.008 – 0.009
Vitreous clay	0.15 – 0.6	0.010 – 0.013
Concrete – machine made to AS/NZS 4058	0.03 – 0.15	0.009 – 0.012
Corrugated metal	–	0.012 – 0.024
GRP (glass reinforced plastic)	0.003 – 0.015	0.008 – 0.009
Culverts		
Concrete pre-cast (pipes and boxes)	0.6	0.016
Open channel		
Straight uniform channel in earth and gravel in good condition	–	0.0225
Unlined channel in earth and gravel with some bends and in fair condition	–	0.025
Channel with rough stony bed or with weeds on earth bank and natural streams with clean straight banks	–	0.030
Winding natural streams with generally clean bed but with some pools and shoals	–	0.035
Winding natural streams with irregular cross section and some obstruction with vegetation and debris	–	0.045
Irregular natural stream with obstruction from vegetation and debris	–	0.060
Very weedy irregular winding stream obstructed with significant overgrown vegetation and debris	–	0.100

NOTE –
Refer to AS 2200 table 2 and notes, and *Metrication: Hydraulic data and formulae* (Lamont).

Planning | Surveying | Engineering | Environmental

Client : [Company Name]
Site address : [Site Address]
Job name : [Job Name]
Job number : [Job Number]

MANNINGS OPEN CHANNEL FLOW CALCULATION SHEET			
		File Name	Southern OLFP
		Sheet Name	A21235-EV- -SMP2.xlsx
Date			
By		Checked	

Channel ID:	**XS 1**
Channel Type:	Trapezoidal

Input Data:

Channel Longitudinal Slope S =	0.07%	
Base width b =	3.000	m
Channel side slope Z =	3	H:1V
Design flow depth d =	0.700	m
Manning Material	Pasture, no brush high grass	
Manning number n =	0.03	

Calculated Parameters:

X-sectional Flow Area A =	3.570	m^2
Wetted Perimeter P =	7.4272	m
Hydraulic radius R =	0.481	m

Check Flow Rates:

Design Flow Rate Q_d =	1.892	m^3/s	
Calculated Channel Capacity Q_c =	1.890	m^3/s	**Channel capacity less than design flow**

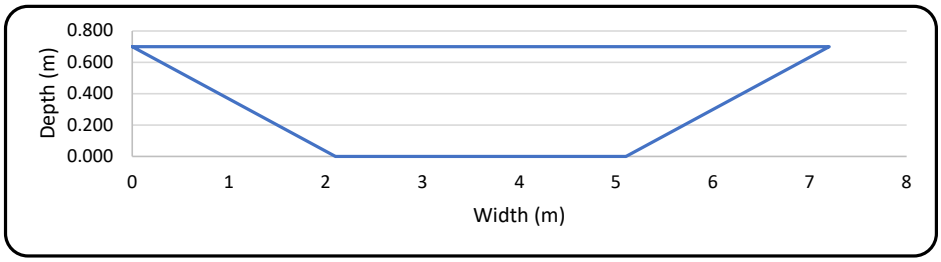
Freeboard:

Proposed freeboard=	0.000	m

Final Channel Geometry:

Total depth =	0.700	m
Base width =	3.000	m
Top width =	7.200	m

Channel Cross Section:



Planning | Surveying | Engineering | Environmental

Client : [Company Name]
Site address : [Site Address]
Job name : [Job Name]
Job number : [Job Number]

MANNINGS OPEN CHANNEL FLOW CALCULATION SHEET			
		File Name	Western OLFP
		Sheet Name	A21235-EV- -SMP2.xlsx
Date			
By		Checked	

Channel ID:	**XS 1**
Channel Type:	Trapezoidal

Input Data:

Channel Longitudinal Slope S =	0.48%	
Base width b =	3.000	m
Channel side slope Z =	3	H:1V
Design flow depth d =	0.360	m
Manning Material	Pasture, no brush high grass	
Manning number n =	0.03	

Calculated Parameters:

X-sectional Flow Area A =	1.469	m^2
Wetted Perimeter P =	5.2768	m
Hydraulic radius R =	0.278	m

Check Flow Rates:

Design Flow Rate Q_d =	1.447	m^3/s	
Calculated Channel Capacity Q_c =	1.452	m^3/s	**Channel size sufficient**

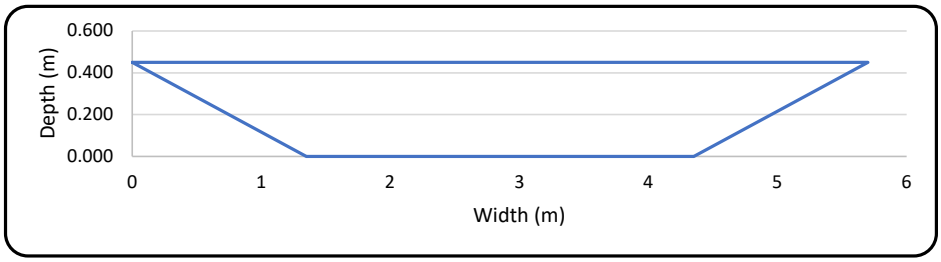
Freeboard:

Proposed freeboard=	0.090	m

Final Channel Geometry:

Total depth =	0.450	m
Base width =	3.000	m
Top width =	5.700	m

Channel Cross Section:



APPENDIX C

Geotech report

Soil&Rock Consultants

Your responsive & cost-effective engineers

30+ YEARS OF SOIL&ROCK since 1987

Preliminary Geotechnical Investigation for Proposed Service Centre at

47 Millbrook Road, Waipu

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

Auckland (09) 835 1740

Northland (09) 982 8053

Wellington (04) 896 0675

Christchurch (03) 352 4519

www.soilandrock.co.nz

Soil&Rock Consultants

Your responsive & cost-effective engineers

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:	

Table of Contents

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.

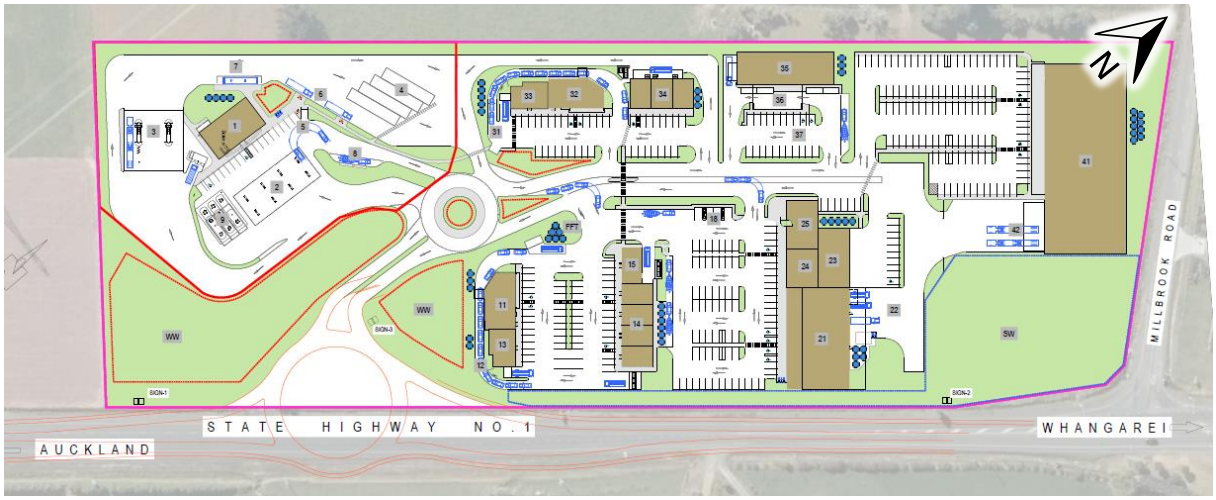


Figure 2: Proposed Development *(Source:* Site Plan by Technitrades Architecture)

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

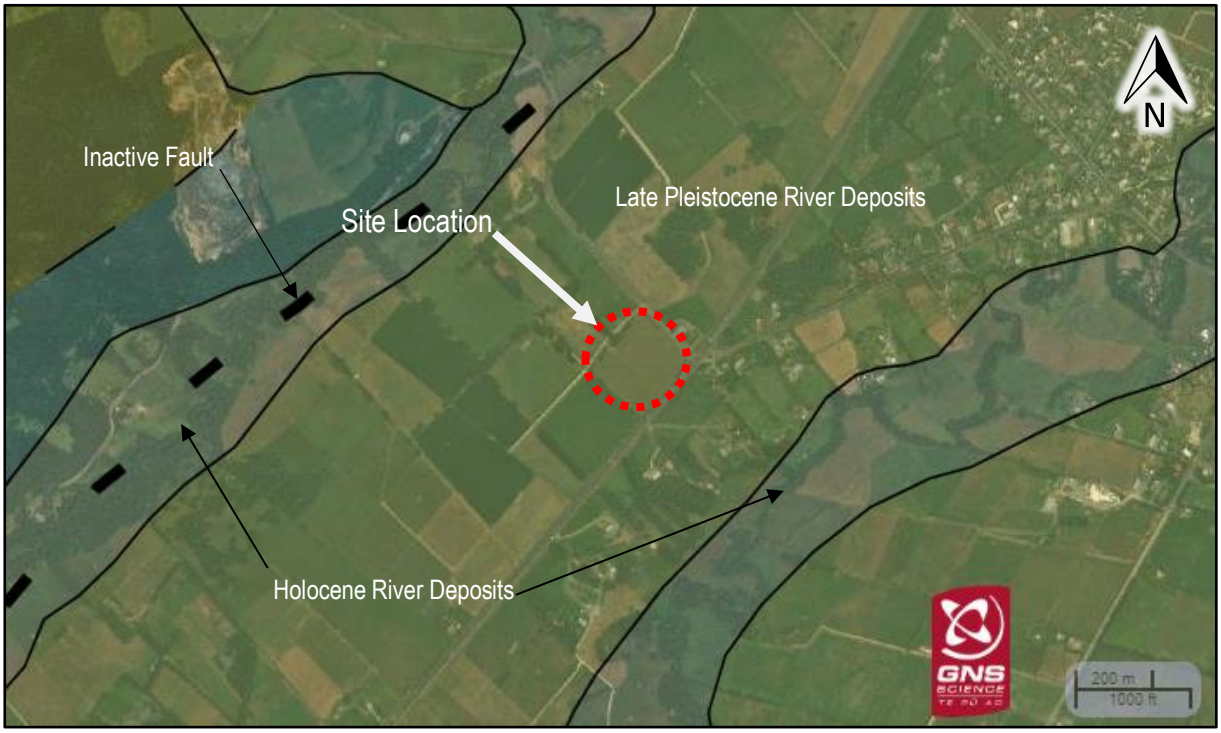


Figure 1 Geological Map *(Source: GNS WebMaps Website)*

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).

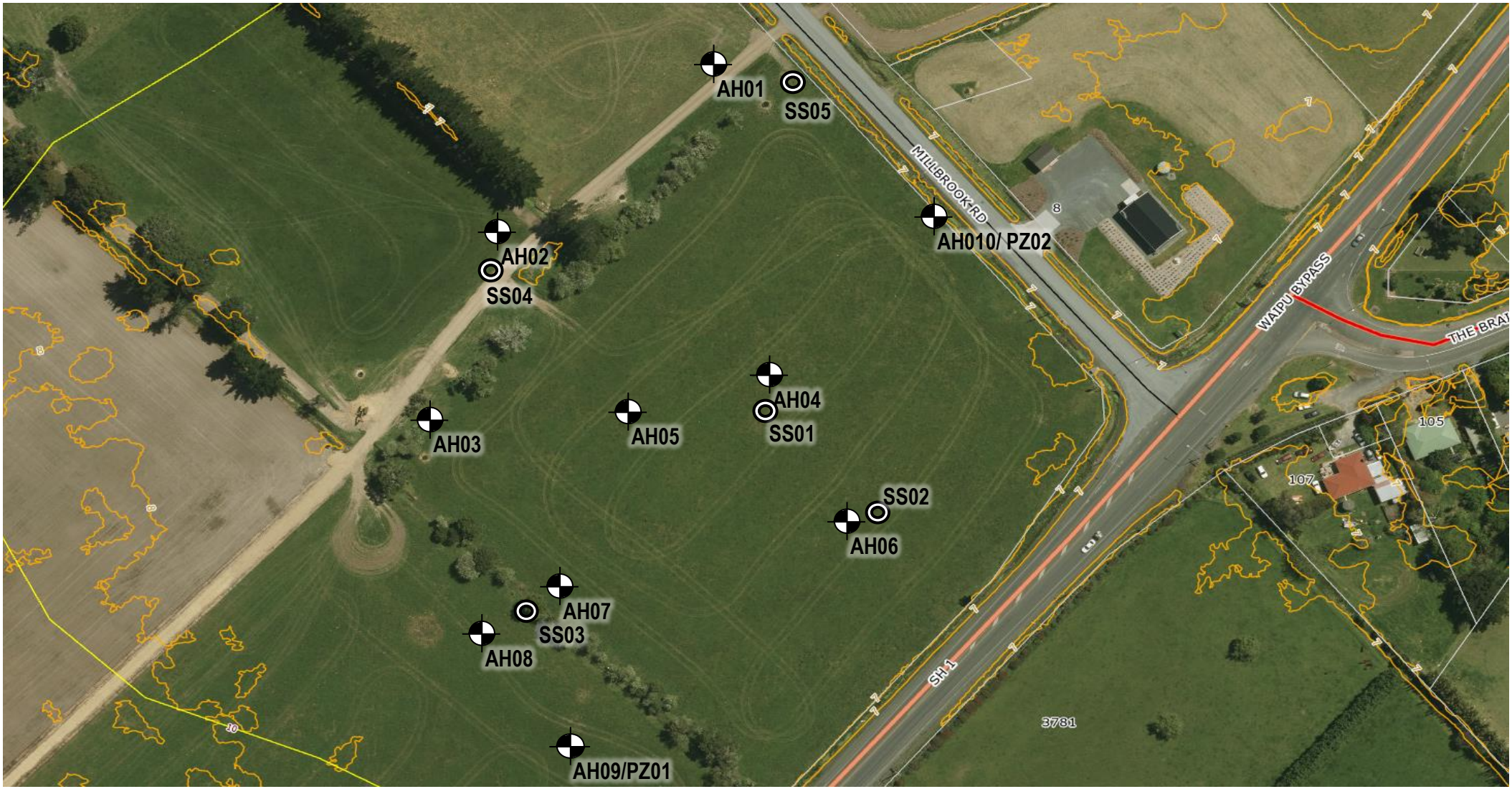
End of Report Text – Appendices Follow

Soil&Rock Consultants

Your responsive & cost-effective engineers

Appendix A

Investigation Plans



Aerial Photo from Auckland Council GeoMaps Webservice

Soil&Rock Consultants

Your responsive & cost-effective engineers

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

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

Soil&Rock Consultants

Your responsive & cost-effective engineers

Appendix B

Investigation Logs (Augerholes, Scala Penetrometer Results and Piezometers)

Soil&Rock Consultants
Your responsive & cost-effective engineers

CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

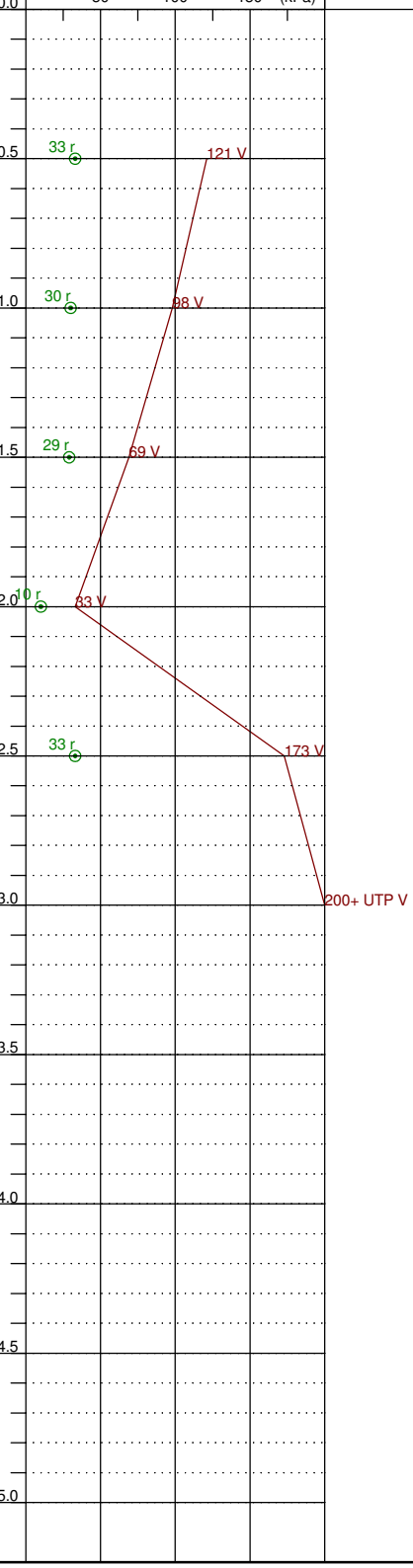
Auger Hole No: AH01

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

CLIENT: Vaco Investments Limited

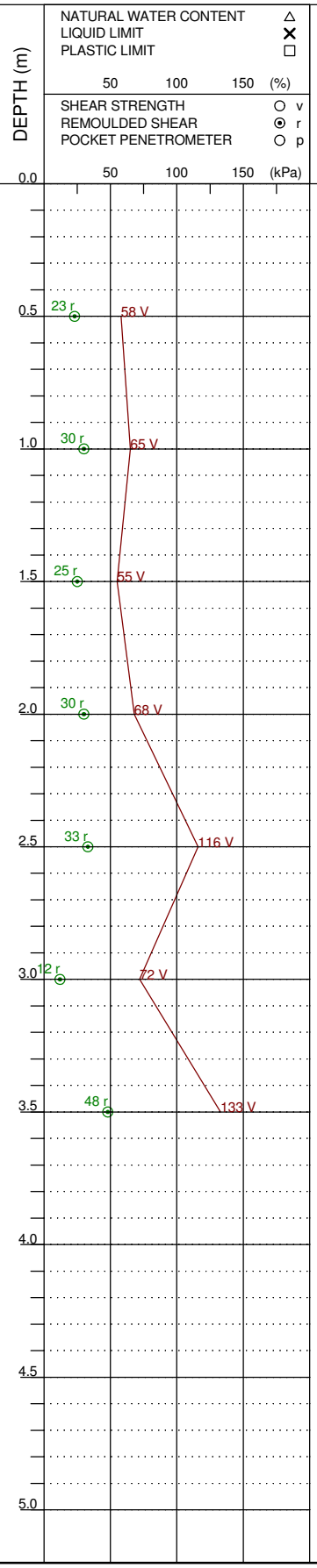
PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

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
Your responsive & cost-effective engineers

CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: AH03

Sheet 1 of 1

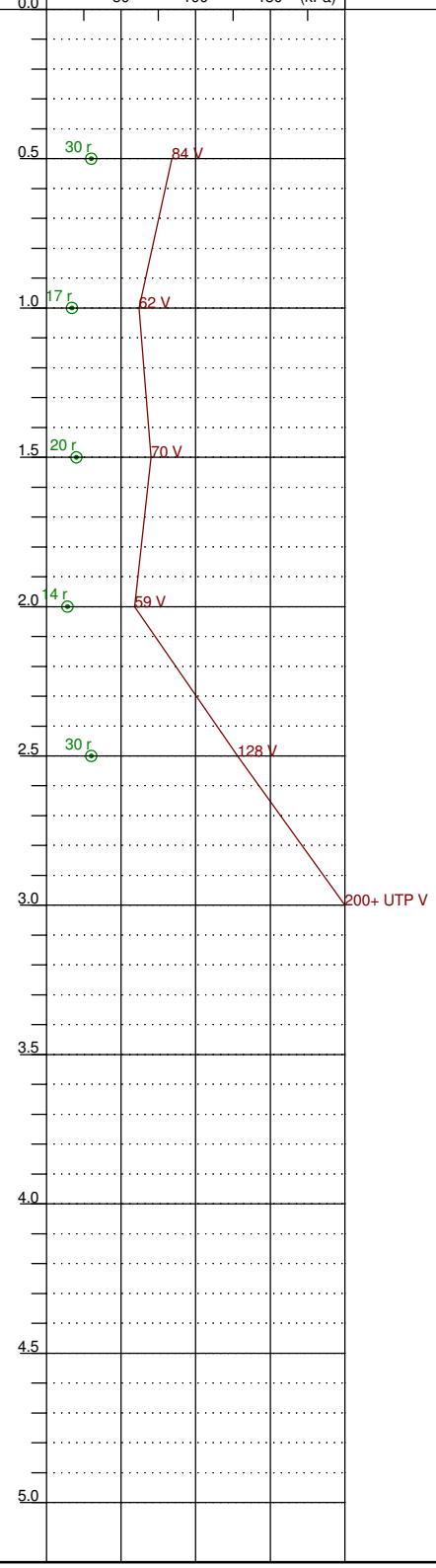
Drill Type:	50mmØ Hand Auger	Project No:	NL220045	Logged By:	JT
Drilled By:	JT	Coordinates:		Shear Vane No - Calibration Date:	GEO740 - 3/02/2022
Date Started:	6/4/22	Ground Elevation:		Surface Conditions:	Near Level, Grass
Date Finished:	6/4/22	Water Level:	1.3m 6/04/2022		

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

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		

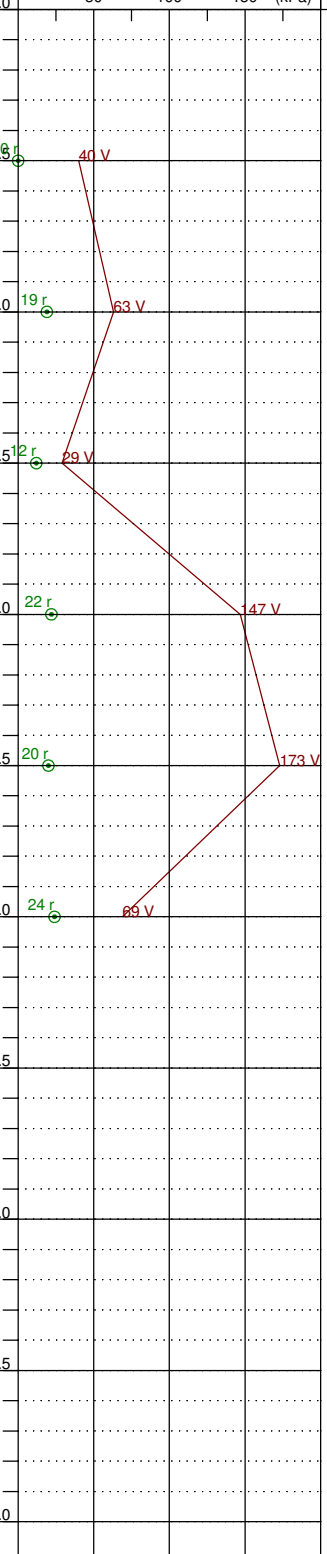
STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TS	0.0		TOPSOIL
TAURANGA GROUP	0.5		clayey SILT, minor fine sand, white grey, orange streaks, stiff, moist, moderately plastic (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

Soil&Rock Consultants
Your responsive & cost-effective engineers

CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

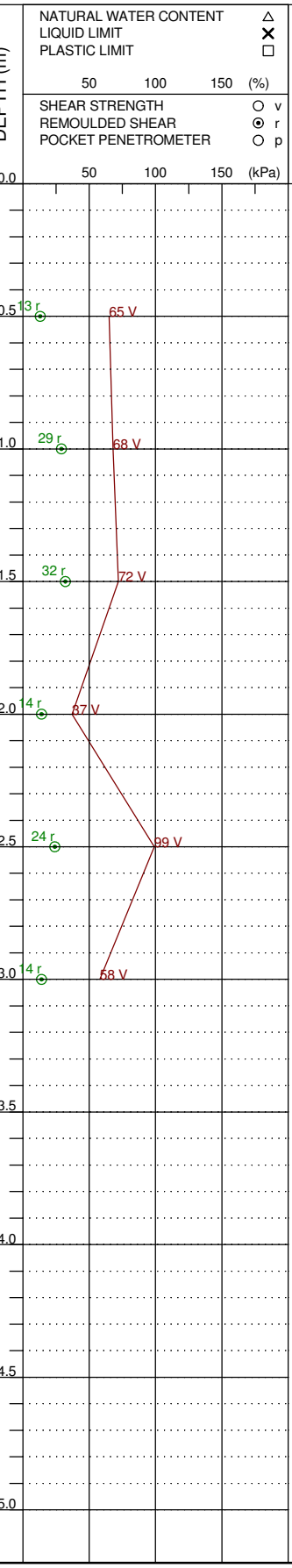
Auger Hole No: AH05

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

CLIENT: Vaco Investments Limited

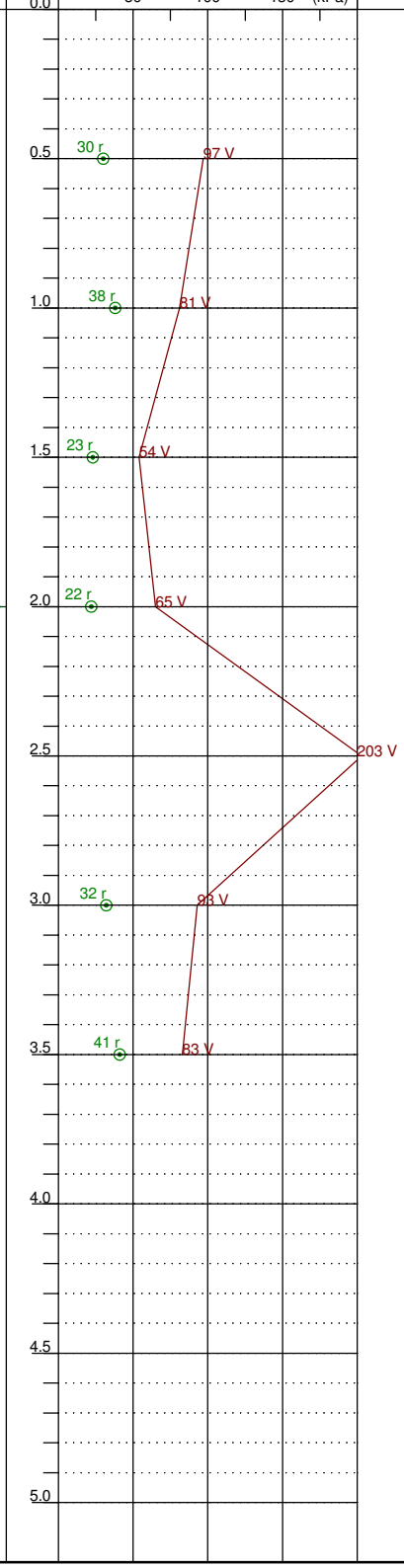
PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

CLIENT: Vaco Investments Limited

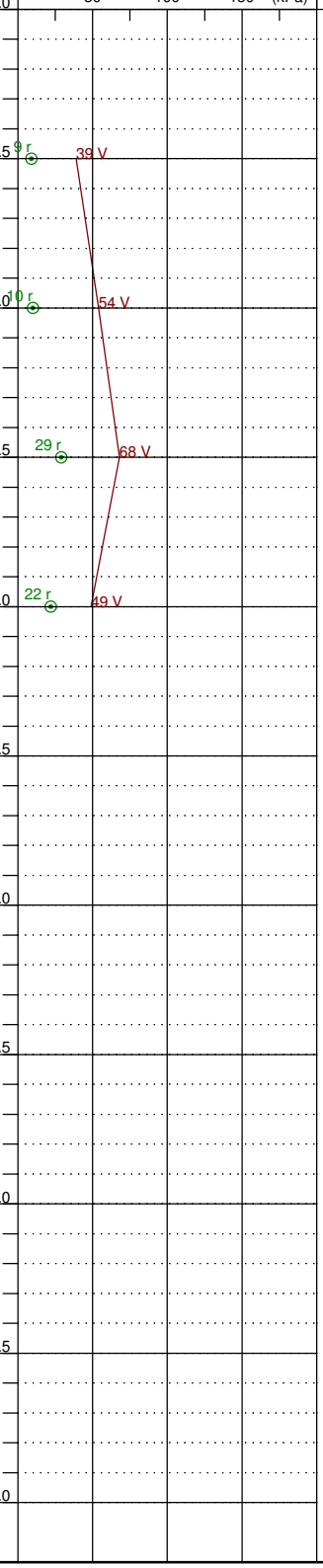
PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

CLIENT: Vaco Investments Limited

PROJECT: Geotechnical Investigation, 47 Millbrook Road, Waipu

Auger Hole No: AH09

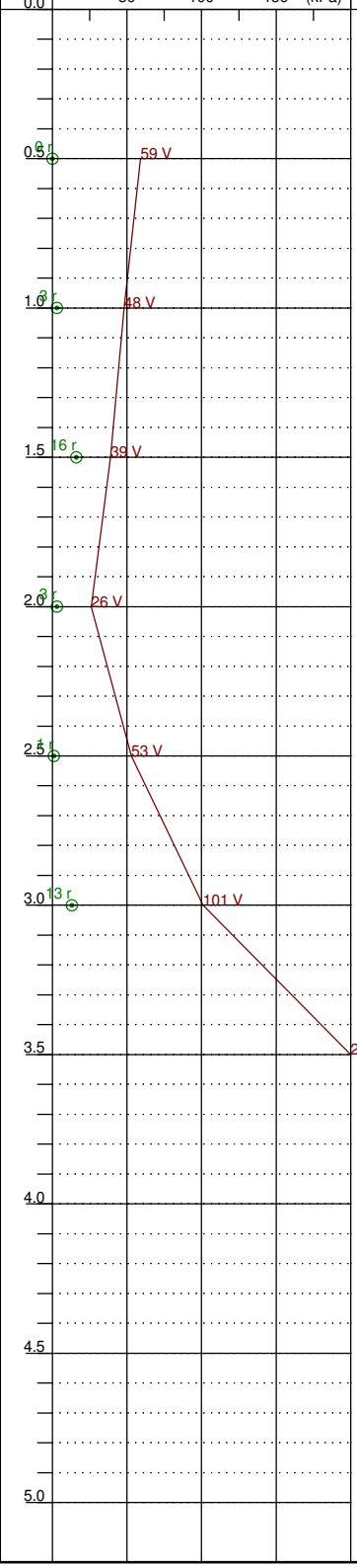
Sheet 1 of 1

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

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		

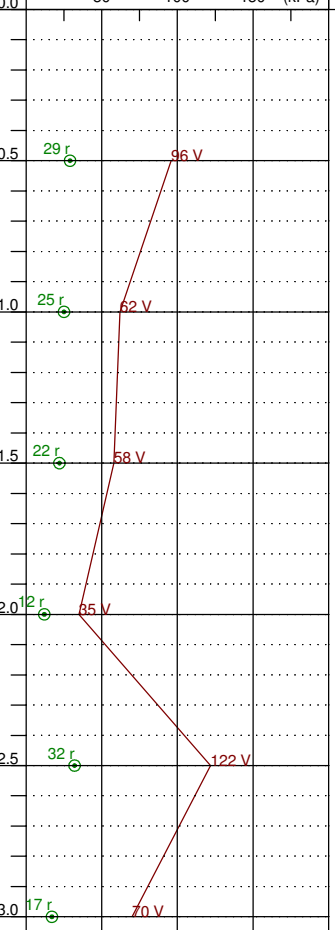
STRATIGRAPHY	DEPTH (m)	GRAPHIC LOG	Soil description in accordance with the NZ Geotechnical Society Inc 2005 "Guidelines for Field Description of Soil and Rock in Engineering Use"
TS	0.0		TOPSOIL
TAURANGA GROUP	0.5		SILT, some clay, some fine to medium sand, grey, orange streaks, stiff, moist, slightly 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
Your responsive & cost-effective engineers

Level 1, 131 Lincoln Road, Waitakere 0612
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

Soil&Rock Consultants
Your responsive & cost-effective engineers

Level 1, 131 Lincoln Road, Waitakere 0612
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]	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

Soil&Rock Consultants
Your responsive & cost-effective engineers

Level 1, 131 Lincoln Road, Waitakere 0612
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]	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

Soil&Rock Consultants
Your responsive & cost-effective engineers

289 Lincoln Road, Waitakere 0612
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: 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

Soil&Rock Consultants
Your responsive & cost-effective engineers

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

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

Soil&Rock Consultants

Your responsive & cost-effective engineers

Appendix C

Laboratory Test Results

Soil&Rock Consultants
Your responsive & cost-effective engineers

Level 1, 131 Lincoln Road, Waitakere 0612
PO Box 21-424 Henderson, Waitakere 0650
09 835 1740 Fax 09 835 1847
www.soilandrock.co.nz

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

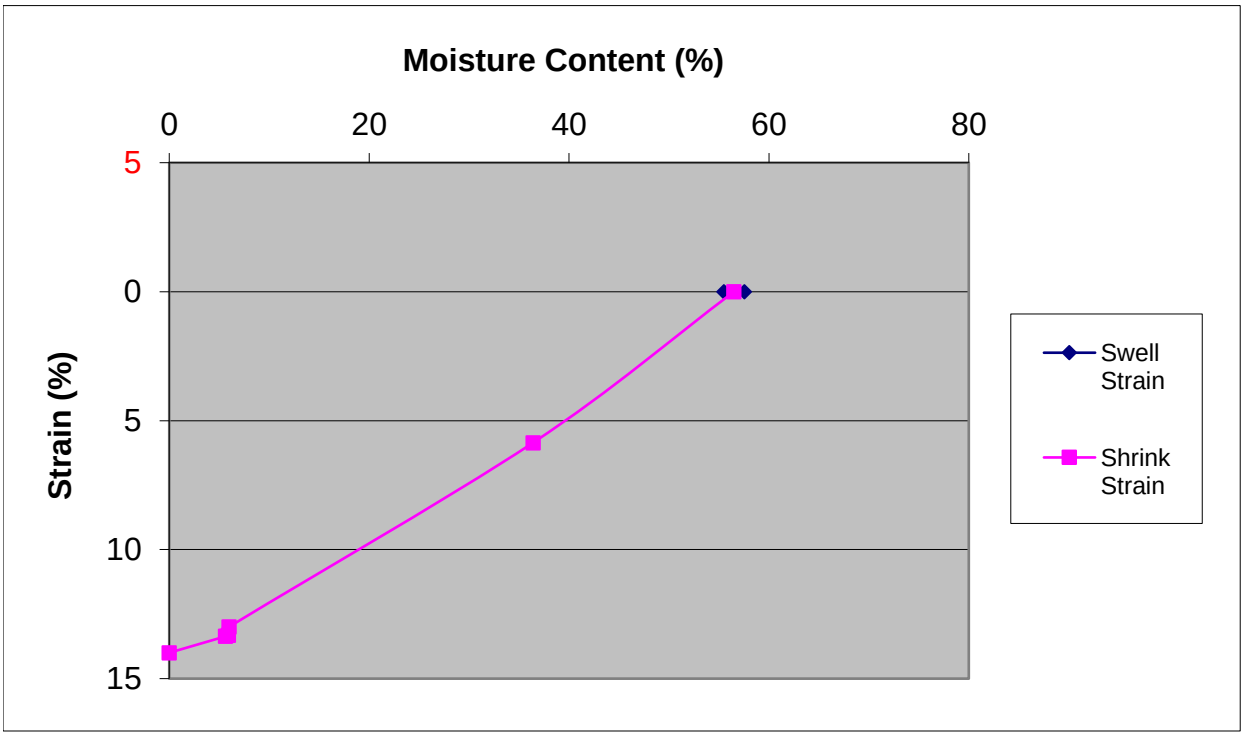
Initial moisture content (%) =	56.5
ε_{sh} = Magnitude of total shrinkage strain (%) =	14.0

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

Level 1, 131 Lincoln Road, Waitakere 0612
PO Box 21-424 Henderson, Waitakere 0650
09 835 1740 Fax 09 835 1847
www.soilandrock.co.nz

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

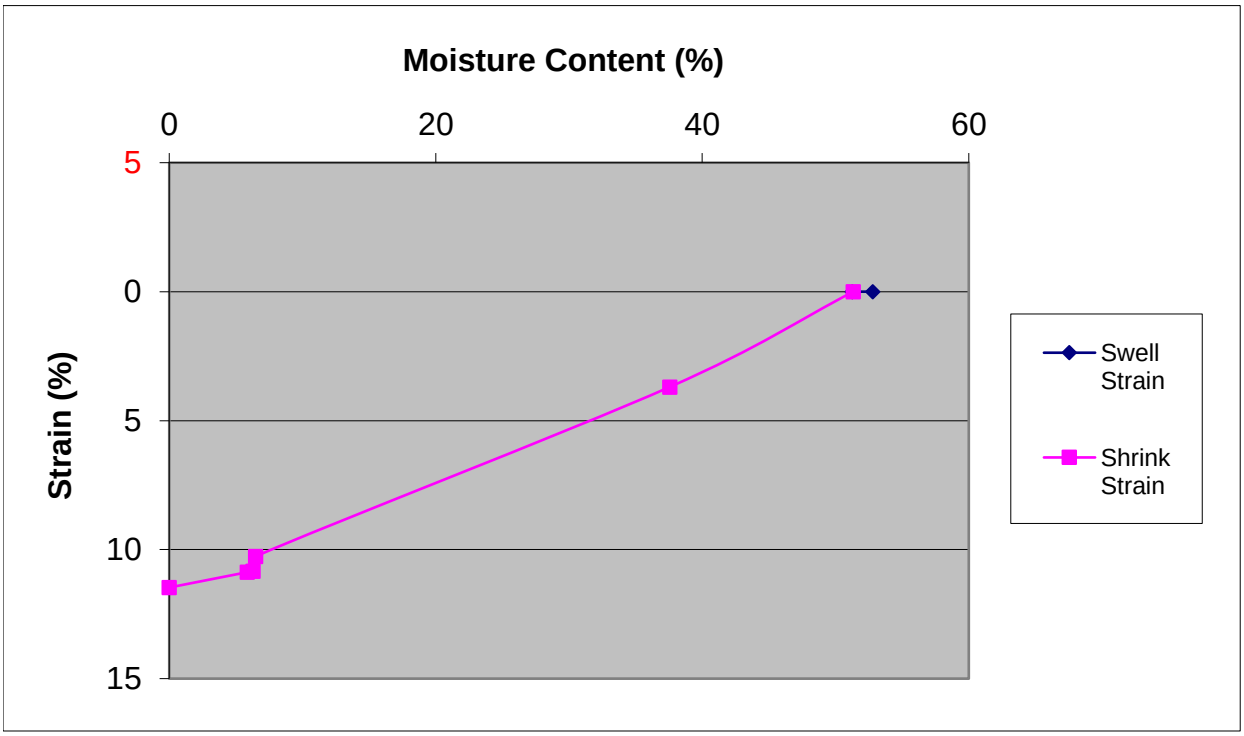
Initial moisture content (%) =	51.3
ε_{sh} = Magnitude of total shrinkage strain (%) =	11.5

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

Level 1, 131 Lincoln Road, Waitakere 0612
PO Box 21-424 Henderson, Waitakere 0650
09 835 1740 Fax 09 835 1847
www.soilandrock.co.nz

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

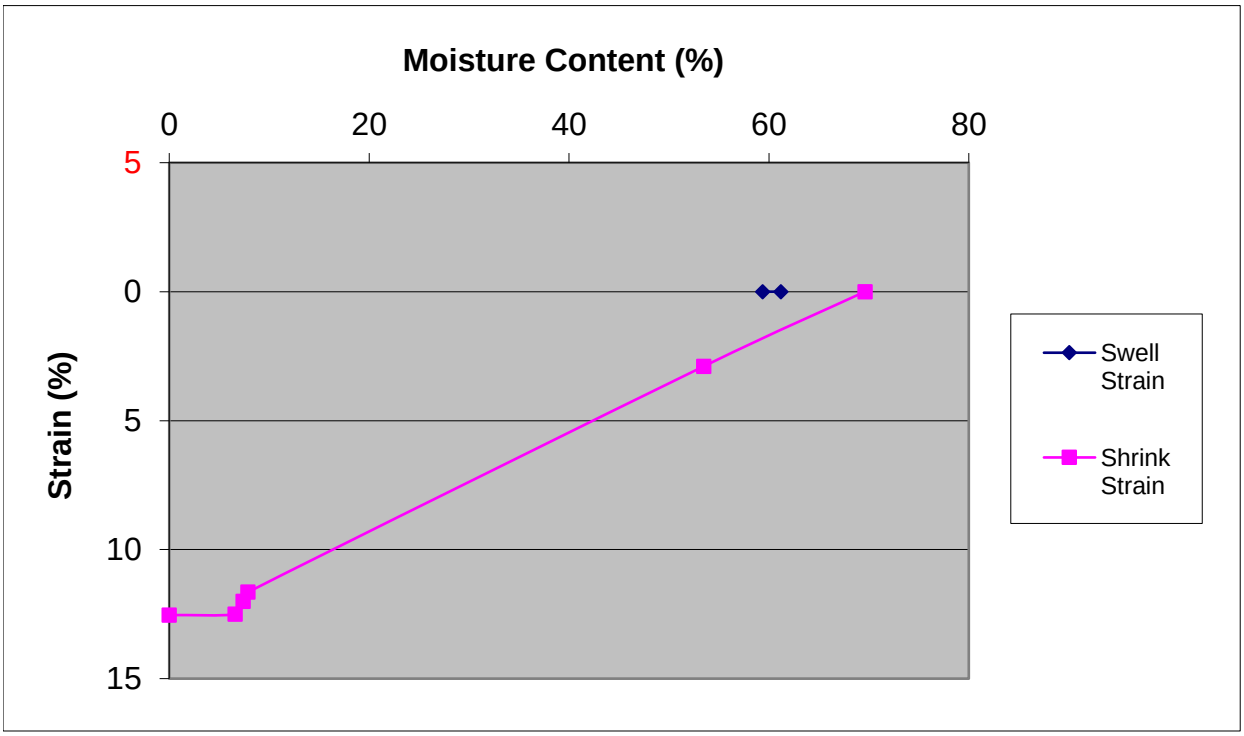
Initial moisture content (%) =	69.6
ε_{sh} = Magnitude of total shrinkage strain (%) =	12.5

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

Level 1, 131 Lincoln Road, Waitakere 0612
PO Box 21-424 Henderson, Waitakere 0650
09 835 1740 Fax 09 835 1847
www.soilandrock.co.nz

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

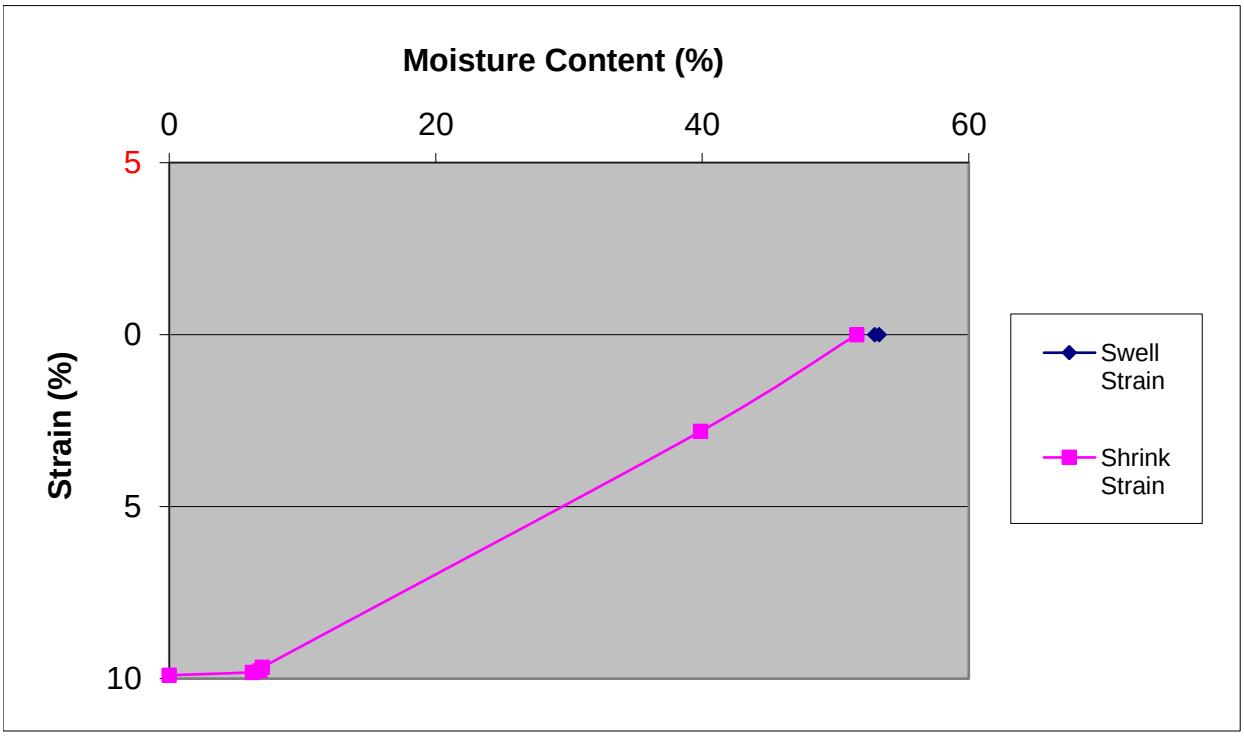
Initial moisture content (%) =	51.6
ε_{sh} = Magnitude of total shrinkage strain (%) =	9.9

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

Soil&Rock Consultants
Your responsive & cost-effective engineers

Level 1, 131 Lincoln Road, Waitakere 0612
PO Box 21-424 Henderson, Waitakere 0650
09 835 1740 Fax 09 835 1847
www.soilandrock.co.nz

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

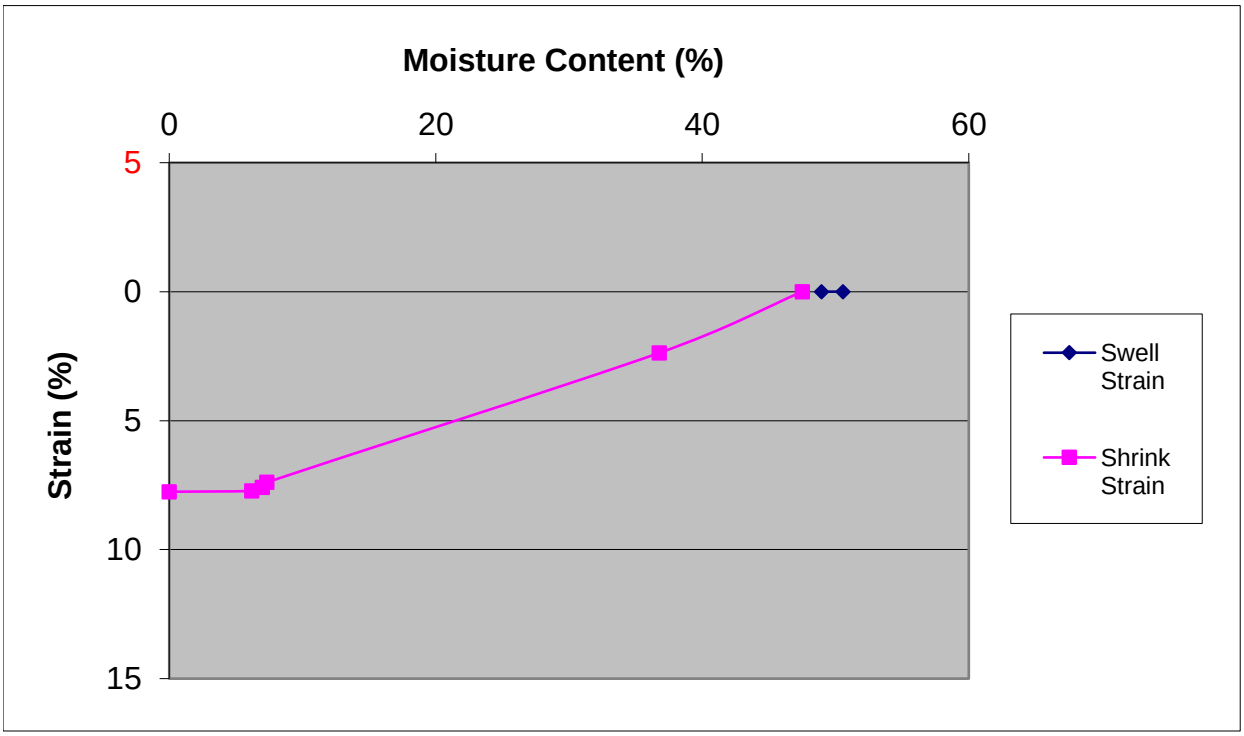
Initial moisture content (%) =	47.5
ε_{sh} = Magnitude of total shrinkage strain (%) =	7.8

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