Consulting Engineers

Structural & Geotechnical Engineering Solutions

Rotokawa Development

Tikanga Ora Charitable trust

671 Puaiti Road, Waikite Valley

Geotechnical, Services and Earthworks Assessment Report

Consulting Engineers

Contact Details

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Document Details

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Reviewed By

Philip McDonald — *Principal Structural Engineer*

Document History

Revision	Date	Author	Detail

EXECUTIVE SUMMARY- For Local Authorities

Tikanga Ora Charitable Trust proposes an initial geotechnical engineering assessment for the proposed new site for the Puwhakamua reintegration facility at 671 Puaiti Road, Waikite Valley Road. BSK Consulting Engineers Limited has been engaged to provide engineering services for Resource and Building consent.

Scope of works	
Ground Investigation	Previous geotechnical report Two hand augers and accompanying scala penetrometers
Assessment and design	Geotechnical Hazard Assessment Earthwork recommendations
Report	Geotechnical Assessment Report
Drawings	Site Location Plan

Geotechnical Risks	
Suitability of proposed Land	Ok with the proposed solutions
Weak Ground	Encountered
Settlement	Low risk
Groundwater	Not encountered
Retaining walls	Not required
Slope Stability	Low risk with designated area
Rockfall	Negligible risk
Fills	Encountered
Erosion	Negligible risk
Geothermal	Not encountered
Expansive/collapsible soils	Not encountered
Ground Rupture/Faults	Low risk
Seismic Effects	Low risk

Our Recommendations are	
Foundations	NZS3604:2011 piles and concrete slab following earthworks.
Ground Improvement	Area to be flatted with cuts and fills up to 3.5m
Stormwater	Tanked system and spreader bar outlet
Wastewater	Suitable area identified for OSET design

Inspections Required for Construction	
Earthworks	As per the BSK specification

Contents

1 GENERAL

1.1 Objective

This report assesses the proposed location and suitability for geotechnical engineering, stormwater and wastewater recommendations. BSK Consulting Engineers Limited (BSK) has assessed the ground conditions for the geotechnical risks and provide means to achieve resource consent.

1.2 Scope

The scope is in accordance with the short form agreement dated 3rd October 2024.

In general terms, the scope of work is as follows:

- Ground investigation,
- Desktop study of already available geotechnical information,
- Site Walkover,
- Provision of factual information from site investigations,
- Stormwater tank design,
- Wastewater area determination,
- Assessment of geotechnical risks and,
- Recommendations for foundation types and earthworks.

1.3 Proposed Development

The Tikanga Ora Charitable Trust has requested an initial geotechnical assessment for the proposed new site for the Puwhakamua reintegration facility at 671 Puaiti Road, Waikite Valley. The assessment aims to evaluate the suitability of ground conditions and assess the geotechnical hazards at the site. This assessment will be crucial in determining the viability of the proposed development and ensuring that any potential geotechnical risks are adequately addressed.

2 SITE LOCATION AND DESCRIPTION

The site location is provided in Figure 1, and in the site location plan in Appendix A.

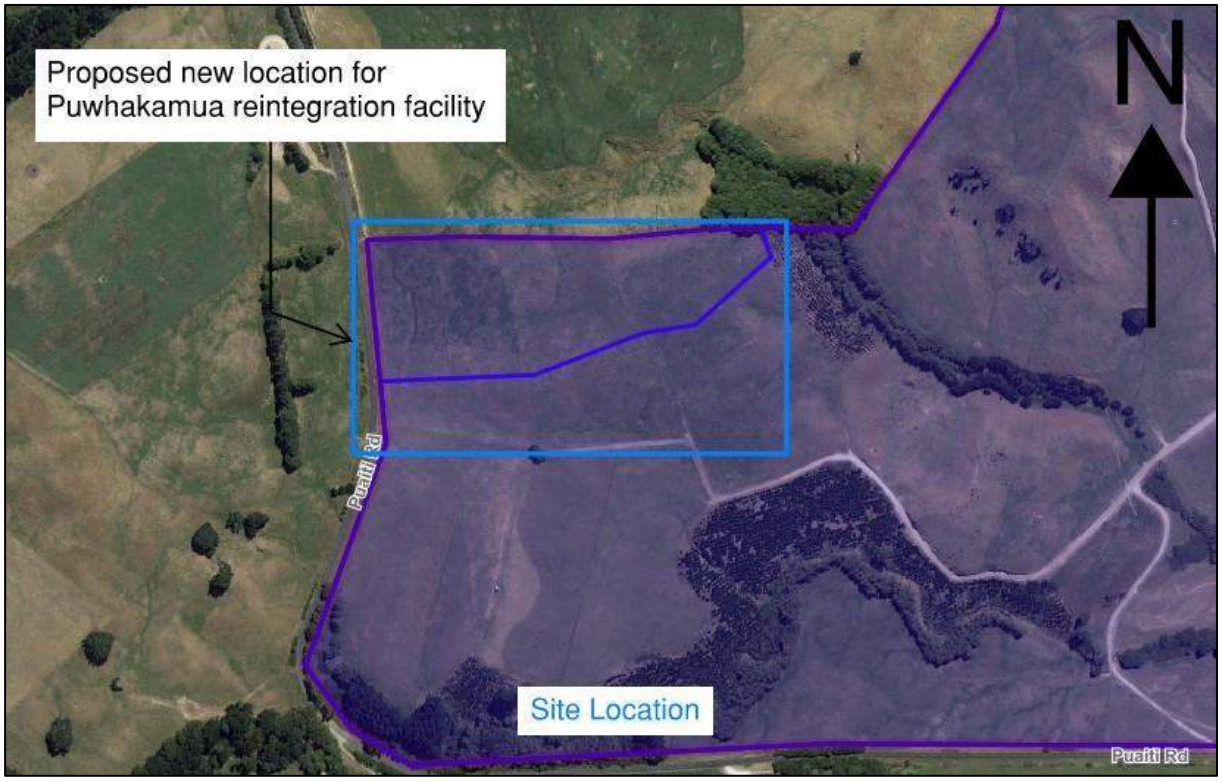

Figure 1. Site Location. Image courtesy of RLC Map, Geyserview.

2.1 Legal Description

The site has a legal title of Farmhouse as the council records have not yet been updated. This site has an area of approximately 22.355m^2.

2.2 Topography

The subject site is located in the western part of a large farmland near Puaiti Road. The land consists of numerous undulations with gentle to moderate slopes. The less steep slope is situated near Puaiti Road on the western side of the proposed location, while the moderate slopes are mainly located on the eastern side of the proposed location. Being formerly used as farmland, the land is grass covered.

2.3 Site History

The site has a history of being farmland with no construction identified on the property. The topography of the land has not changed over the years by earthworks or natural processes.

3 SOURCES OF INFORMATION

3.1 Previous Reporting

A single geotechnical report exists for the site, TGA2021-0342AB Rev0. This report was undertaken for subdivision and defines a safe building platform area. The main risks being slope stability and fault lines,

3.2 Local and Regional Authority

Rotorua Lakes Council GIS mapping system, Geyserview, has been used for this geotechnical assessment.

4 GEOLOGY AND GEOMORPHOLOGY

4.1 Geology

The geological maps for the area, (Leonard, Begg, & Wilson, 2010) and Briggs et al, 1996 indicate that the site is underlain by "Reporoa Group" sediments, from the "Rhyolite ignimbrite, crystal- and pumice-poor, pink, and yellow through to vapor-phase-altered at the top; minor fall deposits rock group: ignimbrite". Part of the geological map for the site's location has been reproduced in Figure 2.

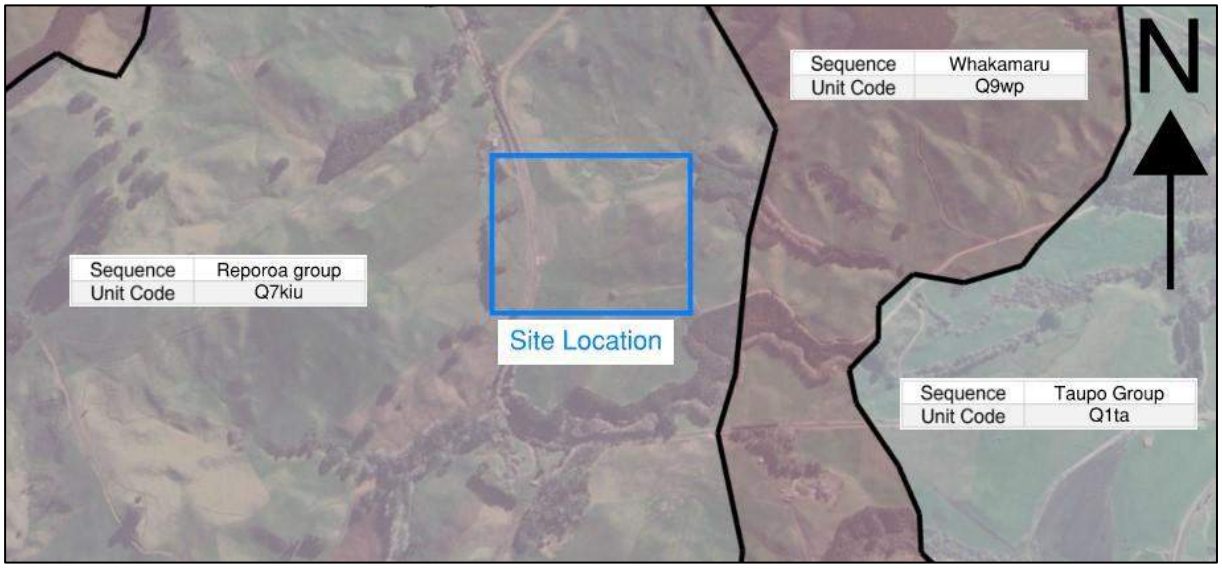

Figure 2. Geology of the site, image courtesy of Google Earth and Geyserview.

4.2 Geomorphology

The area around 671 Puaiti Road, Waikite Valley, Rotorua, is likely characterized by a dynamic interplay of volcanic activity, tectonics, hydrothermal processes, and erosion. The landscape is shaped by its geological history, with features such as volcanic deposits, fault lines, and eroded valleys creating a diverse and complex terrain.

The proposed subject site is characterized by volcanic rocks, primarily ignimbrites, and rhyolitic lava flows, which are typical of the Taupō Volcanic Zone. The area may also feature geothermal alteration because it is close to active geothermal fields. The local geology is influenced by past volcanic activity, faulting, and recent sedimentary processes, creating a complex and dynamic geological environment.

Figure 3. Aerial Image and Site Contours. Image courtesy of RLC contour map.

Site observations and the contour maps show that the slight undulations steepen to the east and drop approximately 25m down to a lower terrace. A stream is located another 5m lower than this platform to the northeast.

5 GROUND INVESTIGATIONS

Site investigations were undertaken on the 30th of July 2024 by BSK. These investigations consisted of two hand augers (HA) with associated Scala Penetrometer to depths of up to 2.0m below ground level (BGL). These were in areas away from the existing tests that were tightly grouped, with the main task of identifying soil types for use in earthworks.

Previous testing has been undertaken and consists of three hand augers.

The test locations are presented on the test location plan in Appendix A, with the test results presented in Appendix B.

Groundwater was not discovered at the site during our ground investigations.

6 GEOTECHNICAL ASSESSMENT

6.1 Ground Conditions

At the proposed site, the subsurface profile reveals varying soil layers with notable differences between two specific points: HA01, located at an elevated position, and HA02, situated at a lower elevation.

- Topsoil Layer:

Both HA01 and HA02 have a topsoil layer at the surface. However, HA02 has a thicker topsoil layer, extending up to 0.4 meters below ground level (BGL), whereas HA01 has a thinner topsoil layer.

- Subsoil Layers:

Loose to Medium Dense Fine to Medium Sand: Below the topsoil, both locations feature a layer of fine to medium sand. This sand layer varies in density from loose to medium dense, with the specific density depending on the depth and location.

Very Loose to Dense Gravelly Sand: Underneath the sand layer, the soil transitions to a gravelly sand layer. This layer varies significantly in density, ranging from very loose to dense.

The ground investigations aligned with the geological maps for the site and previous testing. Table 1 below details the ground conditions identified.

Unit	Depth From (m BGL)	Depth To (m BGL)	Description
1	0.0	0.3	Topsoil
2	0.3	0.6-1.0	Fine to medium sand
3	0.6-1.0	1.7-2.6	Sandy silt
4	1.7-2.6	5.0	Fine to medium sand

Table 1. Ground Condition Interpreted from Ground Investigation Data

6.2 Weak Ground

The ground investigations identified the presence of surficial, weak materials, which could impact the stability and bearing capacity of the foundation. To address this, the

proposed foundation system has been specifically designed to accommodate these weak materials, ensuring adequate support and minimizing potential settlement.

We also have significant earthworks to be undertaken to provide a flattened set of building platforms. Site testing will be undertake on the fill materials and investigations on the areas that have been cut down.

6.3 Settlement

Settlement is not considered to be a significant risk to the proposed development due to the following reasons:

- The presence of granular materials which undergo immediate settlement when additional load is applied,
- Limited cohesive materials that may undergo consolidation settlement,
- The foundation options and associated remedial options improve the site.

6.4 Groundwater

Groundwater was not encountered during the investigation of this site, which suggests that the water table is likely deeper beneath the surface. This assumption is supported by the elevated nature of the site and the stream that is approximately 30m below the site level.

6.5 Retaining walls

Retaining walls are not proposed for this site.

6.6 Slope Stability

The proposed dwelling location features low-angle slopes, which are assessed to be stable with negligible risk of instability. The geotechnical analysis confirms that the slope angles, combined with favourable soil and groundwater conditions, ensure a high factor of safety. Consequently, standard construction practices can be applied without additional slope stability measures as we have relied upon the CMW BRL provided as part of the subdivision works.

The earthworks will require slopes when approaching the western and northern boundaries. All slopes will be less than 3.5m in height and the aesthetic for the site requires very low angled slopes that do not appear to require detailed slope analysis. This is because they will provide factors of safety in excess of industry practice limits. If steeper slopes are required, these will be provided at building consent stage. The two options proposed for the silty sand soils

- Northern slopes have a short sections where and overall 35 degree benched profile will be used. Individual 1m high, 70 degree slopes will be used with 1m wide benches. These benches will then be vegetated with pittosporum and flax every 1.5m centres.

- A 1 in 2.5 (vertical to horizontal) slope that will also be vegetated in the same manner. This same slope will be used in the filling operations.

6.7 Fills

No uncertified fill material was encountered during the geotechnical investigations.

6.8 Geothermal

671 Puaiti Road is outside of any known geothermal fields. No geothermal activity was identified on or near the site during the site walkover and investigations.

6.9 Expansive/collapsible soils

No expansive or collapsible soils were encountered during the geotechnical investigations.

6.10 Ground Rupture/Faults

The proposed site is located near the Puketerata Fault, which is a known normal fault with a recurrence interval of ≤2,000 years. This relatively frequent seismic activity suggests that the fault could generate ground movements or earthquakes within that time frame. The presence of this fault has been considered in the design and the building locations have been moved outside of these areas.

Figure 4. Aerial Image and Site Contours. Image courtesy of GNS active fault map.

6.11 Liquefaction, strain softening and lateral spread

Seismic effects on soils can differ depending on soils type, water content, size and duration of the event. Strength loss can be experienced by these soils and affect the

foundations, structure, or slope stability. Liquefaction occurs with coarse soil (gravel, sand, and coarse silt) behaviour in soils beneath the groundwater level due to increases in pore water pressure. Strain softening can occur in fine grained soils due to increase in pore water pressure and disturbance of soil structure.

Liquefaction is not considered a risk for this site. The soil conditions, groundwater levels, and geological characteristics of the area indicate that the potential for liquefaction during seismic events is negligible.

7 DESIGN

7.1 Foundations

We propose that standard NZS3604:2011 foundations can be used at the site once the earthworks is completed using NZS 4431:2022 Engineered fill.

8 EARTHWORKS

We have provided our earthworks specification for the site in Appendix C. Appendix C has the initial drawings to provide a flat platform at RL463.0m. This has cuts of up to 3.5m and also fills of up to 3.5m.

The materials are predominantly sands of volcanic tephra origin. These are anticipated to bulk when excavated by approximately 20% but then compact with considerable volume loss due to depositional history. We anticipate as much as 30% on original in-situ volume.

Once the earthworks is complete, NZS3604:2011 foundations will be proposed for the piled and slab on grade foundations.

8.1 Pavement

The Regional Infrastructure Technical Specifications (RITS), May 2018, were used as the basis for the pavement design using Drawing 3-17 for an asphalt surface, however the asphalt thickness will be replaced with additional GAP40. A "residential strength vehicle crossing (multi dwellings 2-6)" was selected with a concrete surface. From the From Drawing 3-17, Figure 2 provides pavement construction detail. This provides vehicles per day for the proposed number of cars (10).

Once earthworks is undertaken, a CBR of 10 will be achieved in upper granular layers. The Scala Penetrometer will be used for the subgrade materials and the Clegg Hammer used for the GAP40. A summary of CBR values is provided in Table 1.

9 STORMWATER

9.1 Locality

The site is designated rural and water tanks are to be used to capture stormwater and attenuate it. Multiple connected tanks will be used to attenuate flows, with a 10m wide spreader bar on the southern boundary.

Sheet 2 of 2 in Appendix A shows the site and surrounding catchments. The proposal is to collect and divert water at the base of the same catchment which will then continue the same path to the stream to the west. This is only for overland flows that originate within the same property, no water will change catchments.

The main reason for this is that during the subdivision a new access road was constructed that now dams overland flows, potentially causing a geotechnical hazard. This is weak and water logged ground that could lead to erosion and sediment control issues for the stream and then the Mangatete Stream. To stop this risk and address the error in subdivision, the proposed swale will reduce this water and discharge in a controlled manner to where the water discharged prior to the construction of the road.

The upstream catchment of approximately 11,000m^2 is split three ways (blue paths on drawings 2 of 2 in Appendix A. The proposal is to reduce the volume to the longer path, so that water does not pool in the new access track. This volume will be slowed and attenuated in the rock filled swale next to the proposed driveway and then spread across the new flatter platform before continuing down the two existing flowpaths. The lower flowpath will still receive some volume, however significantly reduced and spread over a larger area, giving it greater chance to soak to ground. There is also a further reduction in the catchment volume due to the roof area volumes being captured to the stormwater tanks.

9.2 Stormwater Attenuation and Water Supply

9.2.1 Stormwater Design Philosophy

An attenuation tank/water tank is required for the site. This is because there will be a tanked water supply and using part of the tank system is proposed to attenuate stormwater volumes. We therefore recommend an attenuation tank with limited orifice and discharge trench to attenuate stormwater flows to predevelopment rates.

There will be a flush diverter and 100mm height of dead storage that collect the downpipes, remove sediment and deleterious materials from the water before it

flows into the house system or discharge trench. Any additional volumes will back up through the 100mm diameter overflow and flow over land in the designated overland flowpath area to the east of the building platform.

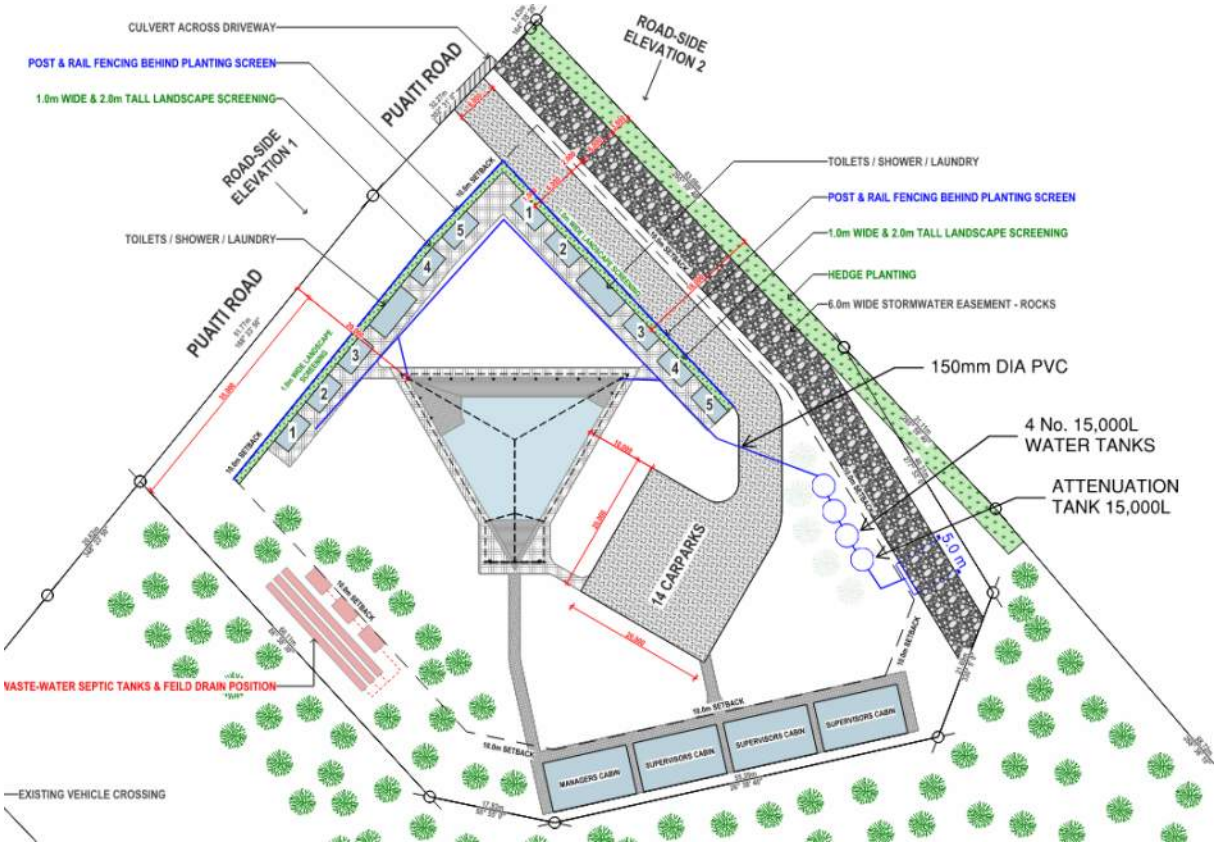

Figure 5. Plan view with outlines of roof and gravel path areas.

As this is a detention system, the system needs to be sealed, this is from the downpipes, all the way through the connections to the trench outlet.

1. Stormwater Run-Off

Calculation of the stormwater run-off for the post-development sites are attached as Appendix C of this report, and are based off the following parameters:

- Post-development areas as detailed in Table 2 below
- Run-off coefficients as per E1
    - 0.95 for roof areas
    - 0.90 for hardstand areas
    - 0.5 for unsealed/metalled area
    - 0.30 for grassed areas
- A storm return period of 10 years (10 ARI)
- RCP8.5 scenario for the period 2081 – 2100 to allow for climate change over the 10-year design period of the system from NIWA HIRDS.

The calculated run-off rates are shown in Table 3 below.

Table 3. Stormwater run-off parameters.

Site	Grass Areas (m^2)	Hardstand Areas (m^2)	Roof Areas (m^2)	Total Area (m^2)	Total Peak Run-off (l/s)
Pre-development	1,008	-	-	1,008	7.51
Post-development	-	865*	1,008	1,008	31.92

*This is all below the tank and will be graded into the overland flow path at the stormwater easement.

9.2.2 Detention & Controlled Release System Design

Detention calculations, as shown in Appendix C show that at a post development rate of 31.92L/s, the proposed system requires a storage capacity of 29,570L to cater for the critical volume design storm event.

As shown in Table 4 below this will be achieved using a 15,000L Devan or Promax above-groundwater tank. Stormwater flows from the proposed roof area will be stored within the tank and will exit via a restricted orifice measuring 40mm in diameter. The peak flow rate of the water exiting the detention system is 6.01l/s. This means that the total run-off from the post-development site is equal to that of the pre-development site.

Table 4: Detention tank installation parameters.

Parameter	Description
System Type	2 x 15,000L Water Tank in series 2 x additional tanks for water supply and firefighting
Total System Volume	30,000L
Maximum Calculated Design Detention Volume	29,570L
Tank Height	2.0m
Tank Diameter	3.5m
Total System Basal Area	9.621m^2
Restricted Orifice Outlet Diameter	40mm
Top of Tank to Orifice Height	1.6m

9.2.3 Secondary System

The calculated volume and restricted orifice calculations satisfy the requirements of the design rainfall events. If rainfall events exceeding the design intensities and durations occurs, a 150mm diameter or 2 x 100mm overflow pipe is linked directly to the outlet described in the following section of this report, to dispose of excess stormwater volume.

9.2.4 System Outlet

The attenuated flows exiting the detention tank will be released via a PVC or flexible solid Novacoil and into a dispersion trench at the edge of the stormwater easement.

10 WASTEWATER

An OSET designer is required for the wastewater system. We understand that this is to be a system with dripper lines in the southern part of the site.

Soils have been tested on site are described as fine to medium sand and sandy silt in accordance with the NZGS guide. This description is equivalent to a Soil Category of 3 in accordance with NZS 1547:2012 Table E1. None of the soils identified on site are classified on the limited soils list from the BAY OF PLENTY ON-SITE EFFLUENT TREATMENT REGIONAL PLAN, Plan change 2 (Maintenance Zones) incorporated on 12 August 2014.

11 REFERENCES

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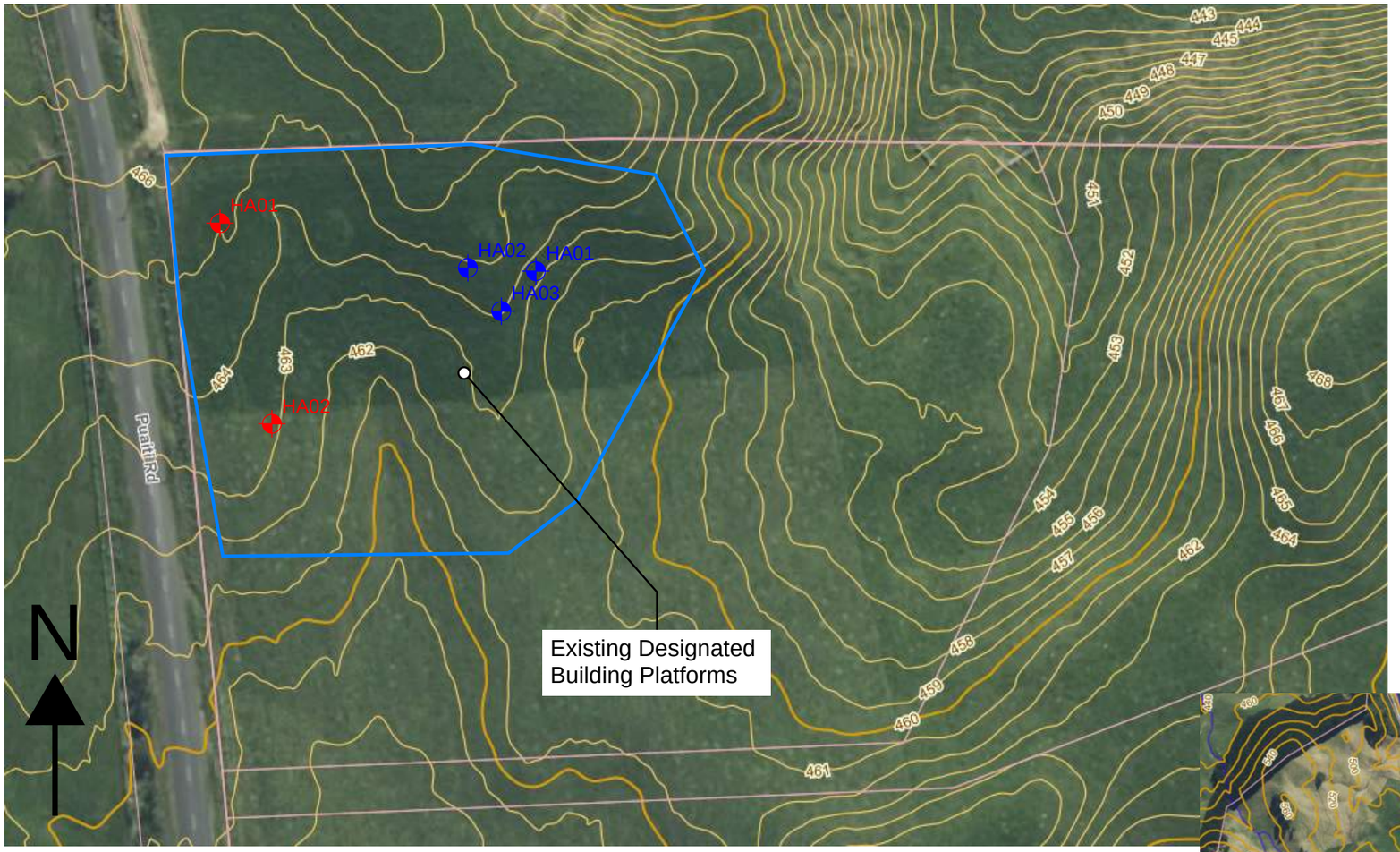
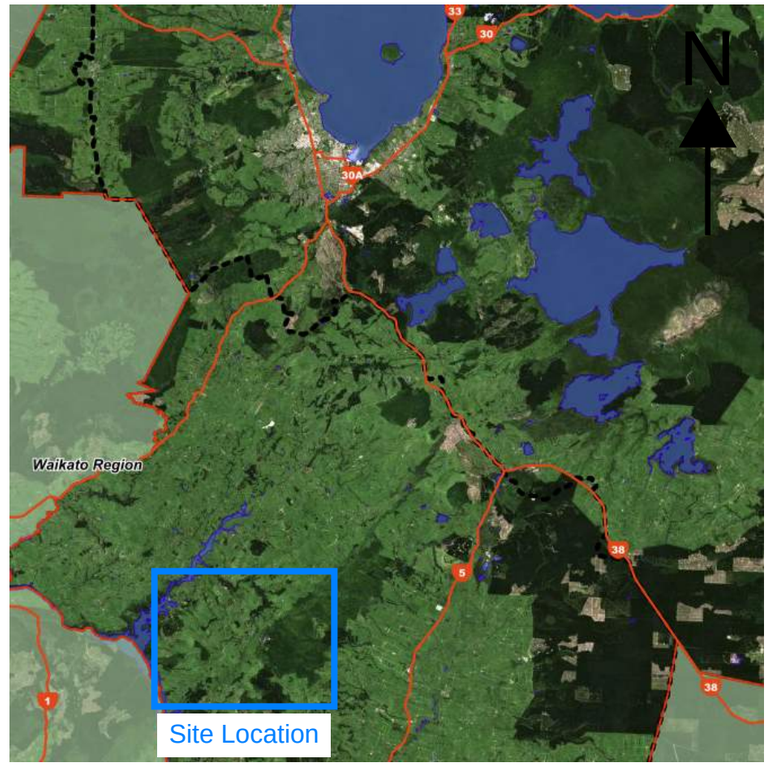
APPENDIX A - SITE PLANS





LEGEND

HA — Hand Auger (BSK)

HA — Hand Auger (CMW)

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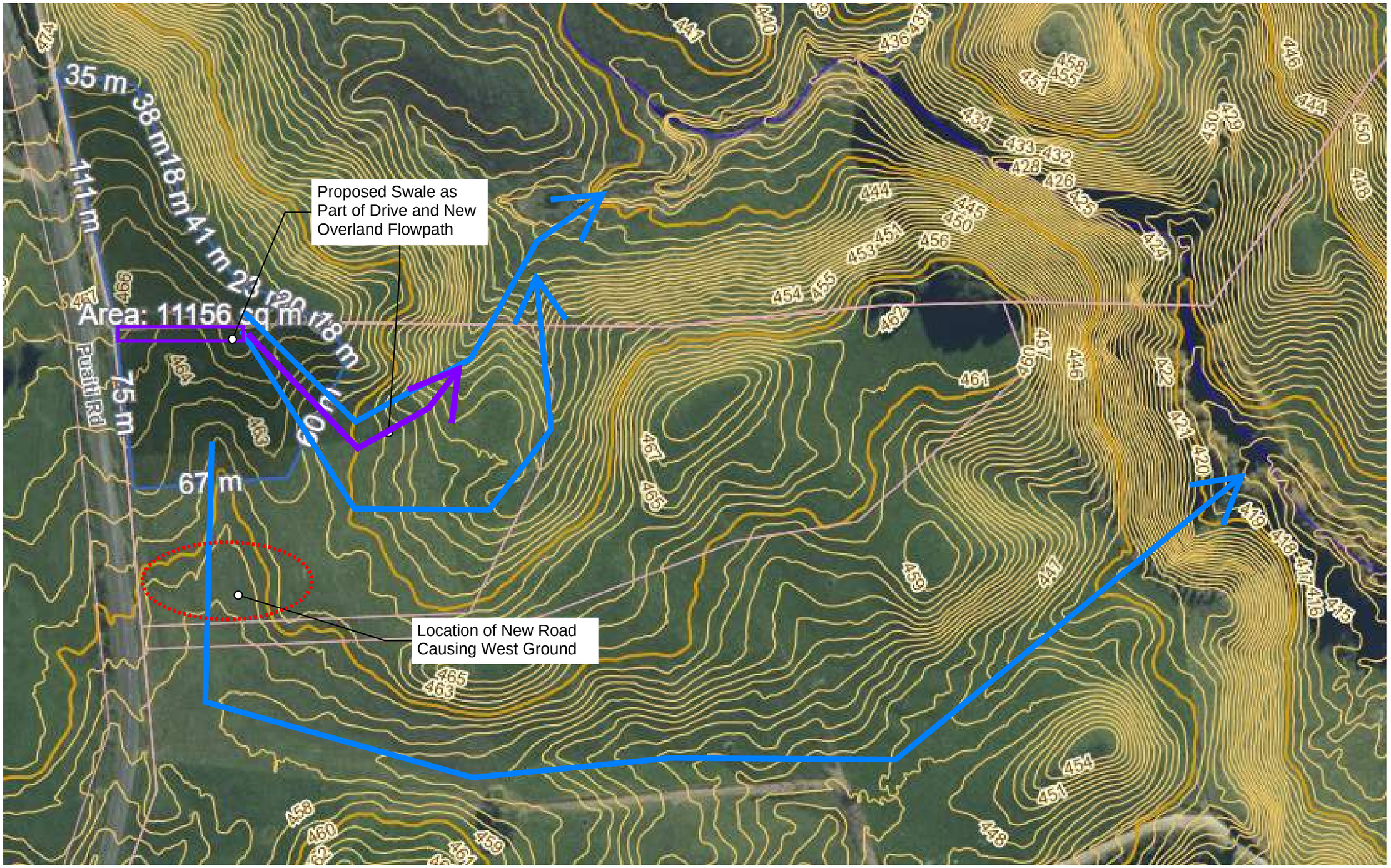
ISSUE:	DATE:	DESCRIPTION:
1	23/02/2024	DIAMETER

SCALES:	N/A
DESIGNED:	AB
DRAWN:	AB
APPROVED:	PM
SHEET No.:	1 OF 2

PROJECT No.: 25594

DRAWING NAME: SITE LOCATION PLAN

PROJECT: 1590A STATE HIGHWAY 30, LAKE ROTITI



Existing Flowpaths

Proposed Flowpath

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ISSUE:	DATE:	DESCRIPTION:	SHEET No.:	2 OF 2
1	23/02/2024	DIAMETER	APPROVED:	PM
			DRAWN:	AB
			DESIGNED:	AB
			SCALES:	N/A

PROJECT No.: 25594

DRAWING NAME: SITE CATCHMENT PLAN

PROJECT: 1590A STATE HIGHWAY 30, LAKE ROTITI

APPENDIX B - SITE INVESTIGATIONS

APPENDIX B - SITE INVESTIGATIONS
HAND AUGERS

Hand Auger Log

Test Location ID: HA01

Project Reference:	25594	Testing Date:	30/07/2024
Project Name:	Rotokawa Development	Shear Vane ID:	N/A
Client Name:	Tikanga Ora Trust	Shear Vane Correction:	N/A
Site Location:	671 Puaiti Road	Logged By:	A.G
Level (mRL):	551mRL	Checked By:	P.M/A.B

BSK Consulting Engineers

Soils have been described in general accordance with NZGS Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes, 2005.
Undrained shear strengths are reported in general accordance with NZGS Guideline for hand held shear vane test, 2001.

Auger Diameter	Depth BGL (meters)	Soil Description (NZGS 2005 Soil and Rock Description)	Geological Unit	In-Situ Test Data: Vane Shear Strength (kPa) Peak / Residual	In-Situ Test Data: Scala Penetrometer Blows per 100mm	Groundwater Depth BGL (meters)
	0.0	*Soil Description Starts Below…*			0 1 2 3 7 >17 (Very loose / Loose / Medium Dense / Dense)	
50mm diameter		**Topsoil**	T/S		1	Groundwater not encountered
		Fine **SAND**; light brown; loose to medium dense; moist.	Taupo Group		2 2 3 3 3 6 6 6 6 6 6 13 13 13 13 13 13 13 13 13 12 12 12 12 12 12 12 12 12 8 8 8 8 8 8 8 8 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1	
	0.5	Fine to medium **SAND** trace gravel; light brown; dense; moist. Pumiceous				
		Gravelly fine to coarse **SAND**; light greyish brown; loose to dense; moist. Pumiceous.				
	1.0					
		END OF AUGER- TARGET DEPTH ACHIEVED			1 2 4 3 2 2 2	
	1.5					
	2.0					
	2.5					
	3.0					
	3.5					
	4.0					
	4.5					
	5.0					
	5.5					
	6.0					

Additional Notes

* based on diagnostic properties undertaken in the field

Hand Auger Log

Test Location ID: HA02

Project Reference:	25594	Testing Date:	30/07/2024
Project Name:	Rotokawa Development	Shear Vane ID:	N/A
Client Name:	Tikanga Ora Trust	Shear Vane Correction:	N/A
Site Location:	671 Puaiti Road	Logged By:	A.G
Level (mRL):	551mRL	Checked By:	P.M/A.B

BSK Consulting Engineers

Soils have been described in general accordance with NZGS Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes, 2005.
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Auger Diameter	Depth BGL (meters)	Soil Description (NZGS 2005 Soil and Rock Description)	Geological Unit	In-Situ Test Data: Vane Shear Strength (kPa) Peak / Residual	In-Situ Test Data: Scala Penetrometer Blows per 100mm	Groundwater Depth BGL (meters)
50mm diameter	0.0	*Soil Description Starts Below…*			Very loose: 0 1 / Loose: 2 / Medium Dense: 3 / Dense: 7 / >17	Groundwater not encountered
		Topsoil	T/S		1	
	0.5	Fine to coarse **SAND**; brown; medium dense; moist. pumicoeus.			2 2	
		Gravelly fine to coarse **SAND**; light greyish brown; very loose to medium dense; moist.	Taupo Group		3 3 3	
	1.0				3 3 3	
					4 4 4 4	
					2 2	
					1	
	1.5				2 2	
					2 2	
					2 2	
					2 2	
	2.0				5 5 5 5 5	
					6 6 6 6 6 6	
					4 4 4 4	
	2.5				1	
					1	
					2 2	
	3.0				2 2	
					2 2	
					3 3 3	
	3.5					
	4.0					
	4.5					
	5.0					
	5.5					
	6.0	END OF AUGER- TARGET DEPTH ACHIEVED				

Additional Notes

* based on diagnostic properties undertaken in the field

APPENDIX B - SITE INVESTIGATIONS
CMW HAND AUGERS

HAND AUGER BOREHOLE LOG - HA01

Client: Ian Rew
Project: 671 Puaiti Road, Waikite Valley
Site Location: Waikite Valley
Project No.: TGA2021-0342
Date: 10/11/2021
Borehole Location: Refer to Drawing 01 Logged by: BM Checked by: LP Scale: 1:25 Sheet 1 of 1
Position: 375523.1mE; 728212.1mN Projection: NZTM
Elevation: 463.00m Datum: Moturiki Survey Source: Geyserview

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			463.0			OL: Organic SILT: dark brownish black. Low plasticity. (Topsoil)			
			462.8			ML: SILT: brown. Low plasticity. (Uncontrolled Fill)			
			462.7			SM: Silty fine SAND: light brown. Uniformly graded. (Volcanic Ash)			
			462.6			SW: Fine to coarse SAND: brown. Well graded, pumiceous. (Volcanic Ash)		L	2, 1
			462.4			ML: Sandy SILT: brown. Low plasticity, moderately sensitive to sensitive; Sand, fine to coarse, pumiceous. (Volcanic Ash)			
	0.7	Peak = 87kPa Residual = 30kPa					M	St	
	1.0	Peak = 70kPa Residual = 17kPa		1					
	1.3	Peak = 140kPa Residual = 33kPa							
	1.6	Peak = 147kPa Residual = 37kPa						VSt	
			461.3			SM: Silty fine SAND: grey. Uniformly graded. (Volcanic Ash)			22
						Borehole terminated at 1.8 m			
				2					
				3					
				4					
				5					

Termination Reason: Refusal
Shear Vane No: 2017 DCP No: 14
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA02

Client: Ian Rew
Project: 671 Puaiti Road, Waikite Valley
Site Location: Waikite Valley
Project No.: TGA2021-0342
Date: 10/11/2021
Borehole Location: Refer to Drawing 01 Logged by: BM Checked by: LP Scale: 1:25 Sheet 1 of 1
Position: 375506.3mE; 728207.5mN Projection: NZTM
Elevation: 463.00m Datum: Moturiki Survey Source: Geyserview

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			463.0			OL: Organic SILT: dark brownish black. Low plasticity. (Topsoil)			
			462.8			ML: SILT: brown. Low plasticity. (Uncontrolled Fill)			
			462.7			SM: Silty fine SAND: light brown. Uniformly graded. (Volcanic Ash)		L to MD	3, 2, 1
						... at 0.50m, contains fine to coarse sand			
			462.4			ML: Sandy SILT: brown. Low plasticity, moderately sensitive to sensitive; Sand, fine to coarse, pumiceous. (Volcanic Ash)		VSt	
	0.7	Peak = 107kPa Residual = 33kPa							
	1.0	Peak = 57kPa Residual = 30kPa		1		... at 1.00m, contains trace gravel, fine, pumiceous.			
	1.2	Peak = 53kPa Residual = 17kPa					M		
	1.6	Peak = 53kPa Residual = 17kPa						St	
	2.0	Peak = 90kPa Residual = 20kPa		2					
	2.4	Peak = 100kPa Residual = 43kPa							
			460.4			SP: Fine to medium SAND: yellowish grey. Poorly graded, pumiceous. (Volcanic Ash)		D to VD	5, 8, 20
				3		Borehole terminated at 2.9 m			
				4					
				5					

Termination Reason: Refusal
Shear Vane No: 2017 DCP No: 14
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA03

Client: Ian Rew
Project: 671 Puaiti Road, Waikite Valley
Site Location: Waikite Valley
Project No.: TGA2021-0342
Date: 10/11/2021
Borehole Location: Refer to Drawing 01 Logged by: BM Checked by: LP Scale: 1:25 Sheet 1 of 1
Position: 375511.4mE; 728196.5mN Projection: NZTM
Elevation: 461.50m Datum: Moturiki Survey Source: Geyserview

CMW Geosciences

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
			461.5			OL: Organic SILT: dark brownish black. Low plasticity, (Topsoil)			
			461.2			SM: Silty fine to medium SAND: light brown. Poorly graded. (Volcanic Ash) *... at 0.40m, contains fine to coarse sand and minor gravel, fine.*		MD	2, 2, 4, 2, 2, 3, 2
	1.1	Peak = 73kPa Residual = 40kPa	460.5	1		ML: SILT: with some sand; brown. Low plasticity, moderately sensitive to sensitive; Sand, fine to coarse, pumiceous. (Volcanic Ash)	M	St	
	1.5	Peak = 100kPa Residual = 30kPa							
	1.9	Peak = 103kPa Residual = 30kPa		2				VSt	
	2.3	Peak = 134kPa Residual = 40kPa							
			458.9			SM: Silty fine to medium SAND: light greyish brown. Poorly graded, pumiceous. (Volcanic Ash)		D	12, 13, 14, 11, 5, 6, 15, 10, 8, 8, 10, 12, 13, 8, 8, 8, 8, 8, 8, 11, 12, 14, 8
				3					
				4			M to W		
				5		Borehole terminated at 5.0 m			

Termination Reason: Target Depth Reached
Shear Vane No: 2017 DCP No: 14
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

APPENDIX C - DESIGN EARTHWORKS DRAWINGS AND SPECIFICATION

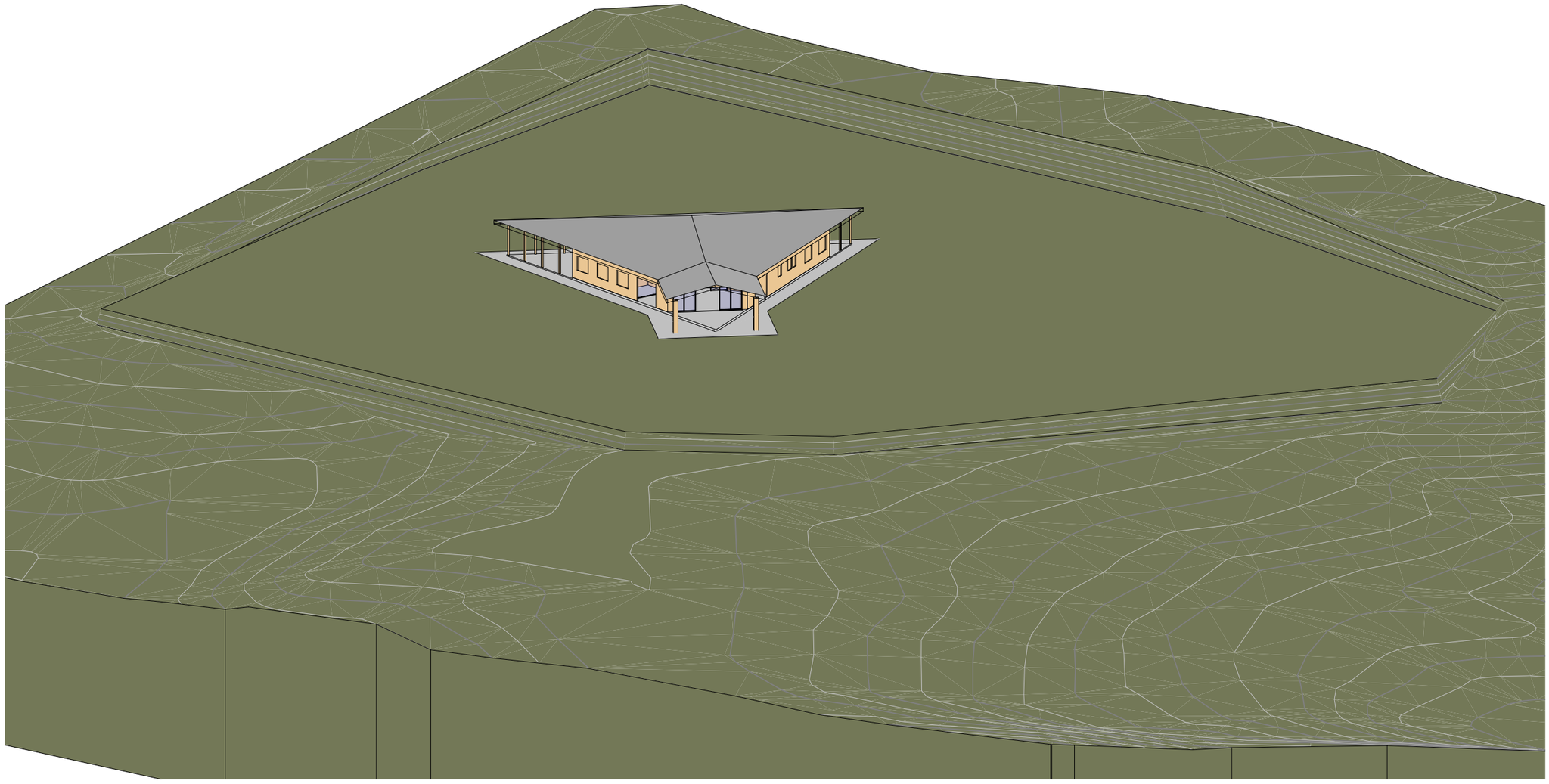
TIKANGA ARORO CHARITABLE TRUST
PUWHAKAMUA DEVELOPMENT NEW SITE
PUAITI ROAD, WAIKITE

P.O. BOX 23, 314 MALFROY RD,
ROTORUA, NEW ZEALAND
PHONE: (07) 348 5394
EMAIL: admin@bsk.co.nz
WEB: www.bsk.co.nz

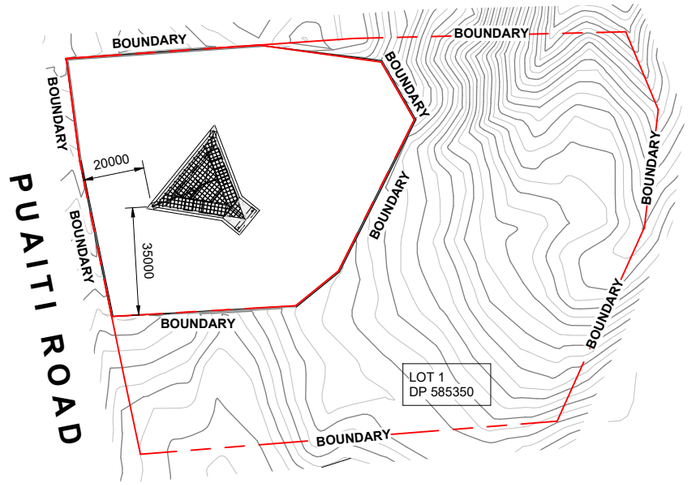
Consulting Engineers

ace new zealand

association of consulting and engineering



JOB REF No: 25594
ISSUE: ISSUE FOR RESOURCE
DATE: 26 SEPTEMBER 2024

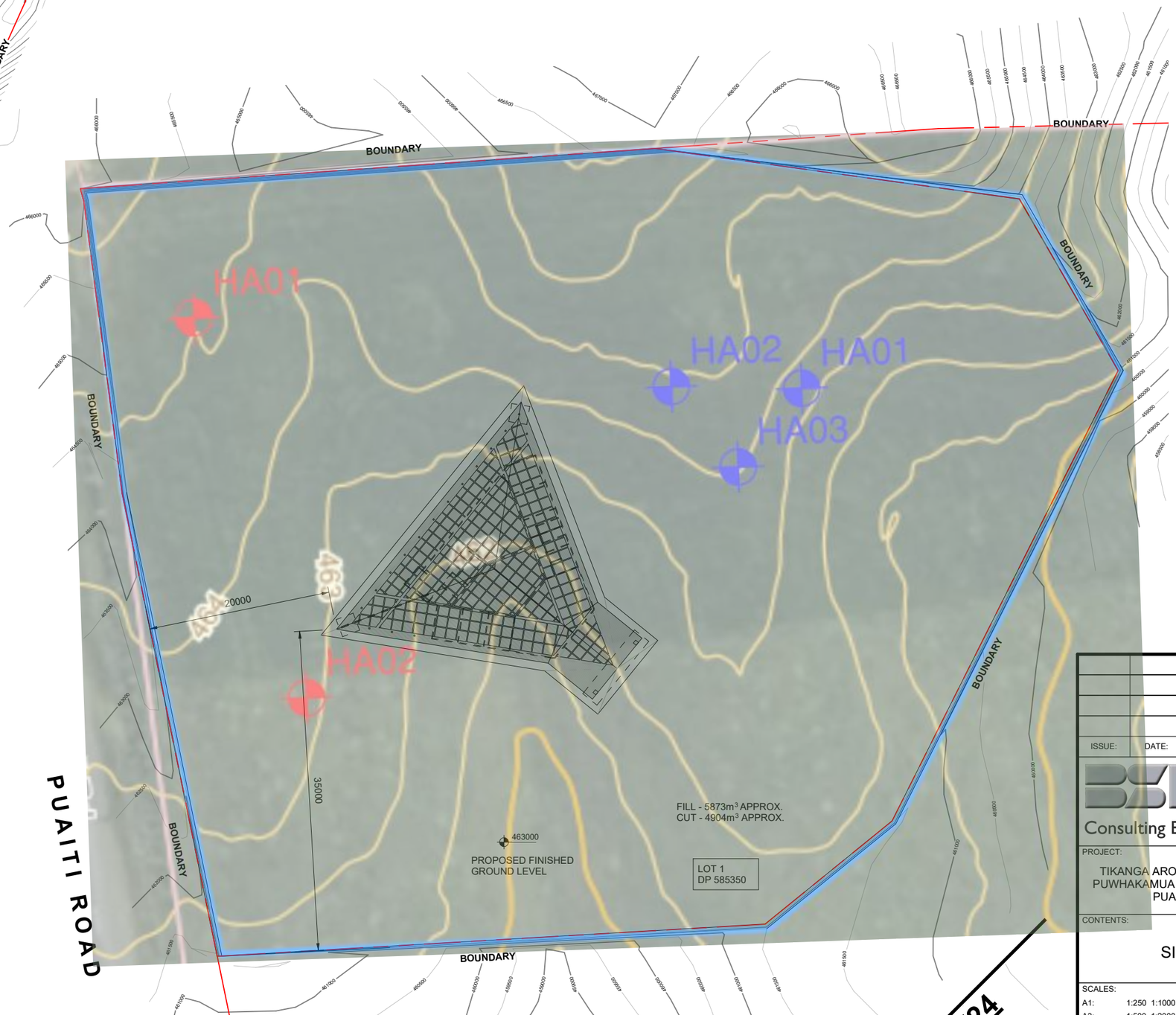


NORTH

OVERALL SITE PLAN

1 : 1000 @ A1

NORTH



ENLARGED SITE PLAN

1 : 250 @ A1

26/09/24

ISSUE:	DATE:	DESCRIPTION:

P.O. BOX 23, 314 MALFROY RD,
ROTORUA, NEW ZEALAND
PHONE: (07) 348 5394
EMAIL: admin@bsk.co.nz
WEB: www.bsk.co.nz

Consulting Engineers

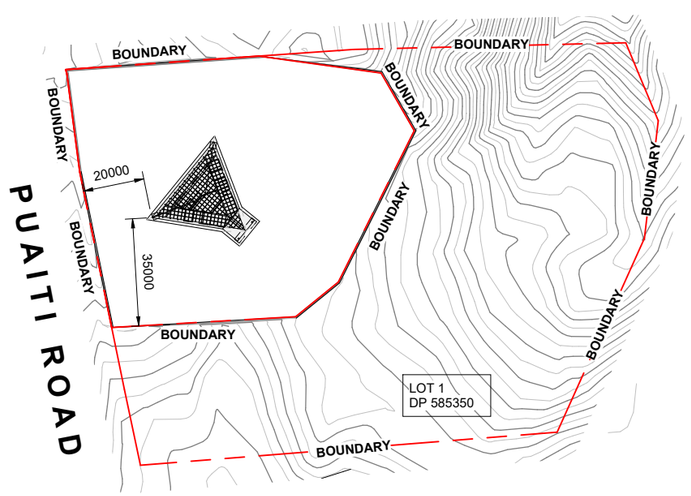
PROJECT:

TIKANGA ARORO CHARITABLE TRUST - PUWHAKAMUA DEVELOPMENT NEW SITE
PUAITI RD, WAIKITE

CONTENTS:

SITE PLANS- BEFORE

SCALES:			DATE: SEPTEMBER 2024
A1:	1:250	1:1000	
A3:	1:500	1:2000	JOB REF No: 25594
DESIGNED:			SHEET No: 1 OF:
DRAWN:	KM		
APPROVED:	AB		DRAWING SET ISSUE DATE:
CHECKED:			



OVERALL SITE PLAN

1 : 1000 @ A1

NORTH

NORTH

ENLARGED SITE PLAN

1 : 250 @ A1

26/09/24

ISSUE:	DATE:	DESCRIPTION:

P.O. BOX 23, 314 MALFROY RD,
ROTORUA, NEW ZEALAND
PHONE: (07) 348 5394
EMAIL: admin@bsk.co.nz
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Consulting Engineers

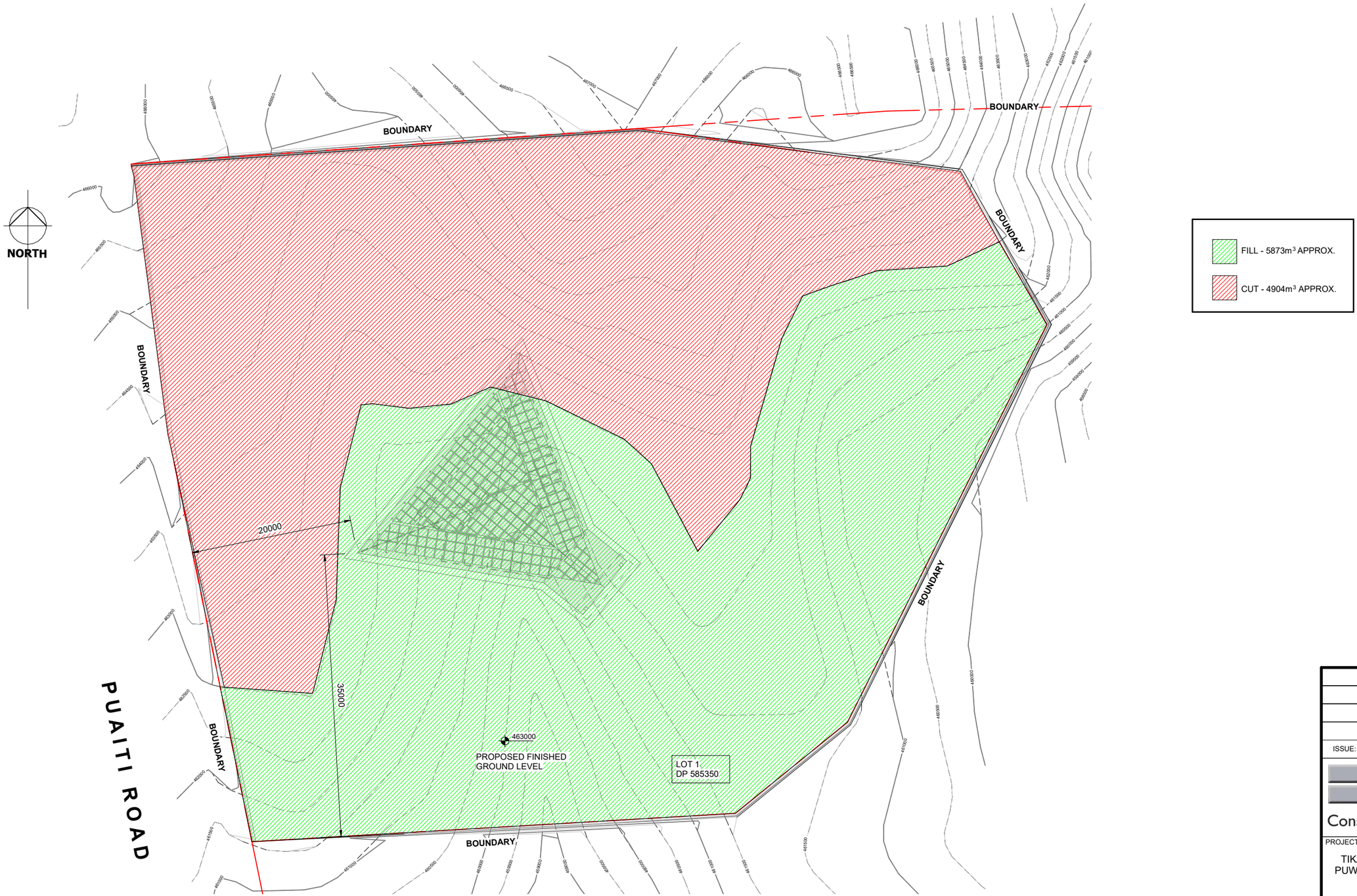
PROJECT:

TIKANGA ARORO CHARITABLE TRUST - PUWHAKAMUA DEVELOPMENT NEW SITE PUAITI RD, WAIKITE

CONTENTS:

SITE PLANS- AFTER

SCALES: A1: 1:250 1:1000 A3: 1:500 1:2000	DATE: SEPTEMBER 2024
DESIGNED:	JOB REF No: 25594
DRAWN: KM	SHEET No: 2 OF: 2
APPROVED: AB	DRAWING SET ISSUE DATE:
CHECKED:	



CUT & FILL PLAN

1 : 250 @ A1

ISSUE:	DATE:	DESCRIPTION:

BSK Consulting Engineers
P.O. BOX 23, 314 MALFROY RD,
ROTORUA, NEW ZEALAND
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WEB: www.bsk.co.nz

PROJECT:

TIKANGA ARORO CHARITABLE TRUST - PUWHAKAMUA DEVELOPMENT NEW SITE
PUAITI RD, WAIKITE

CONTENTS:

CUT AND FILL

SCALES: A1: A3:	DATE: SEPTEMBER 2024
DESIGNED:	JOB REF No: 25594
DRAWN: KM	SHEET No: 2 OF:
APPROVED:	DRAWING SET ISSUE DATE:
CHECKED:	

Consulting Engineers

Structural & Geotechnical Engineering Solutions

671 Puaiti Road, Waikite Valley, Rotorua

Earthworks Specification

Report Prepared by:
Ash Bowtell

Reviewed by:
Philip McDonald

BSK REF:23779
February 2021

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Document Details

Reference 23779
Status ISSUE
Date 03 February 2021

Document History

Revision	Date	Author	Detail
1	04/02/2021	Ash B	Refining On Site Testing
2	10/10/2024	Ash B	Site Specific

Table of Contents

1 PRELIMINARY AND GENERAL

1.1 The Contract Works

The Contract Works include all work necessary to prepare the Puaiti Road Subdivision, 671 Puaiti Road, Rotorua for residential development. The work includes preparation of the subgrade, structural filling and contouring to match surrounding contours.

1.2 Site Information

The Site is located just west of Waikite Valley to the east of Puaiti Road. The site is currently grassed and previously used for cattle grazing.

1.3 Roles and Responsibilities

TIKANGA ARORO CHARITABLE TRUST (Client) has engaged BSK Consulting Engineers Ltd (BSK) to undertake Quality Assurance & Quality Control for the construction of structural fill. BSK are therefore Engineer to the contract.

1.4 Documents

This specification is exclusively for the Puwhakamua development single site. No claims will be admitted in respect of work not specifically mentioned for this area without agreement prior to works being undertaken.

The drawings forming part of the contract documents are as listed in Appendix A.

1.5 Materials and Workmanship

All manufactured materials shall be new, unless otherwise specified, and in accordance with the requirements of this specification. Where a particular Standard is not called for in the Specifications, Materials shall comply with the relevant New Zealand Standards (NZS) or Engineer approved alternative. Reference to any Standard in this specification shall include any amendment to or substitution for the referenced Standard.

Where an item is mentioned by a trade name or other specific reference, the Contractor may offer for the Engineer's approval any materials considered by the Contractor to be of equivalent quality. Approval or otherwise of offered alternatives shall be at the Engineer's sole discretion.

Where sample approval is specified, samples of materials shall be provided and the Engineer's approval obtained prior to incorporating such Materials in the Contract Works. The Contractor shall retain samples of approved materials on site for comparison with those used in the contract works.

1.6 Site Safety Management

The Contractor shall establish and maintain a Site Safety Management System that ensures the safety of all persons on the Site in accordance with the Health and Safety at Work Act 2015 in all matters related to safety.

The safety management system shall ensure compliance with Worksafe NZ and shall include, but not be limited to:

- A hazard register identifying, assessing, eliminating, isolating and minimising hazards;
- Safety procedures;
- Contractors safety policy and recent safety records;
- Requirements for appropriate safety equipment;
- Evacuation and emergency procedures.

The Contractor shall provide first aid facilities and personnel with relevant first aid training as required by the relevant laws.

The Contractor shall conduct Site-wide safety audits as frequently as required to ensure the safety of all persons on the Site and, in any event, at least fortnightly.

The Contractor shall also maintain a register of hazards for the Site in which the Contractor shall record any identified hazard, the date it was identified and any steps taken to eliminate, mitigate, mark or isolate the hazard.

1.7 Hazardous Substances and Materials

The following hazards may be associated with the Contract Works or the Site:

- Vehicle movements within and around the Site areas.
- Open water in existing silt/stormwater ponds.
- Underground services.
- Construction noise and exhaust emissions from machinery.
- Wind-blown Dust.

2 QUALITY AND ENVIRONMENTAL MANAGEMENT

2.1 Quality Assurance Procedures

2.1.1 General

Cheal Consultants Limited have provided the design for the final landform which is to be adopted as the quality plan for the site.

2.1.2 Contractor's Quality Plan

The Contractor shall provide a quality plan outlining:

- Management Structure,
- Subcontractors,
- Materials,
- Quality Records,
- Management of Non-Conformance.

2.1.3 Contractor's Records

All records shall be maintained on-Site in a secure storage area with access granted to the Engineer.

2.1.4 Quality Assurance Certificate

The nominated representative responsible for the quality assurance procedures will be required to certify to the Client by way of a Producer Statement 3 (ENZ PS3) that all work has been carried out in full accordance with approved methods of all earthworks.

2.1.5 As-Built Drawings

BSK are to provide As-Built drawings of the excavations and filled areas using survey data provided by the Contractor.

The Contractor shall prepare and submit to the Engineer:

- Survey data of the extent of all excavations +2m outside of the extent,
- Photographs of each excavation area extent,
- A record of the number of lifts of fill placed in each excavation area with placed fill thickness.

3 EARTHWORKS

3.1 General

The Contractor must ensure earthworks is performed as per the Cheal design and to achieve the compaction targets. The Contractor's scope of work must include but not be limited to:

- Excavation mark-out,
- Location of services,
- Construct erosion and sedimentation measures,
- Install temporary fencing,
- Temporary works design,
- Site clearance,
- Removal of topsoil,
- Protection of the works,

- Bulk excavations with battered slopes and/or benched slopes,
- Removal of unsuitable fill,
- Subgrade Testing (BSK),
- Plateau Testing (under supervision of BSK),
- Placing and testing compaction of bulk fill (Self Scala Penetrometer and Clegg Hammer, Nuclear densometer by WSP and random verification testing by BSK),
- Topsoiling,
- Landscaping,
- Removal of temporary fencing and erosion and sediment controls.

The Contractor shall advise the Engineer in writing of the individual responsible for undertaking the quality assurance procedures.

3.2 Related Specifications, Acts and Regulations

Current versions of the following standards, codes, guidelines and references shall apply:

- NZS 4431:202- Code of practice for earth fill for residential development,
- NZS 4402:1986 Methods of Soil Testing for Civil Engineering Purposes (& 1998 supplement)
- NZTA F/1- Specification for Earthworks Construction,
- Local and Regional Council Erosion and Sedimentation Control Guidelines.

The Contractor shall comply with all Acts of Parliament, Government Regulations and Local Authority Bylaws.

3.3 Erosion and Sediment Control

Erosion and Sediment Controls are required for the contracted earthworks so that erosion that is detrimental to site stability and that sediment is not transported offsite.

The Contractor shall plan the works and install any necessary controls so that sediment is not transported off the site.

3.4 Temporary Fencing

Temporary fencing should not be required.

3.5 Design of Temporary Works

If required in addition to the Cheal design to achieve a safe work site, the Contractor shall submit to the Engineer, the design of such works for approval.

3.6 Clearing

Any cleared vegetation or other materials to enable the earthworks shall be removed from site to a dump area approved by Council for receiving the cleared material. Alternatively, an approved dump area must be approved by Council.

3.7 Removal of Topsoil

Topsoil shall be removed from the earthworks area, stored and then spread back over the completed earthworks.

3.8 Protection of the Works

The Contractor shall protect the surface of the earthworks at all times during construction. The Contractor shall provide temporary drainage systems to safeguard the integrity of the works.

The surface shall be constructed so that no area of the earthworks will pond water.

3.9 Inspections

The Contractor shall arrange for all necessary quality control testing and quality assurance inspections to ensure that all work is performed in accordance with the Cheal design and BSK compaction targets.

3.10 Tolerances

The finished surface level of all bulk earthworks in all areas shall be accurate to within a tolerance of –100 to +100mm of the design level prior to topsoiling.

4 EXCAVATION

4.1 General

Excavation shall be undertaken to achieve the form of the design indicated on the Drawings. Other than design, excavations shall be formed to shed surface water and provide a suitable working platform.

The excavation shall be carried out in such a manner to avoid mixing of the materials when the material being excavated include “site-won”/“cut to fill” and “cut to waste”,

4.2 Batter Slopes

excavation batters shall be trimmed with any loose and unstable material removed as the cut proceeds.

4.3 Benching

Any portion of the ground which has a slope steeper than 5 horizontal to 1 vertical shall be benched before filling is placed on it.

Each bench shall be constructed to a width adequate to permit suitable construction equipment to operate on it and have a maximum height of 1 metre.

The base of the benches and main excavation shall be sloped inwards at a slope of 20 horizontal to 1 vertical and be longitudinally graded to ensure adequate drainage and discharge of water to the erosion and sedimentation measures.

4.4 Undercutting of Subgrade

After final excavation depth, the Contractor may encounter material which is unsuitable for the placing of fills onto. The Contractor shall identify such areas and inform the Engineer. The Engineer shall determine whether or not the material is unsuitable and authorise the amount of undercutting to be undertaken.

The area to be undercut shall be measured and agreed by the Contractor, Client and the Engineer before undercutting is undertaken.

4.5 Disposal of Unsuitable Material

Any materials deemed by the Engineer to be unsuitable shall be removed from the work area and stockpiled for use as landscape fill where possible and approved by Council, or removed from site to a suitable facility.

5 BULK FILLING

5.1 General

Fill material shall be excavated from earthworks areas and borrow areas so that compaction test results shall be made available to the Engineer prior to construction. Additional testing shall be undertaken as required during construction if significant variations in available fill materials occur to affect the results.

Fill shall be constructed as per NZS 4431 with the main criteria being:

- Greater than or equal to 95% of the fill's maximum dry density ascertained from the NZ Standard compaction test (2.5kg),
- Fewer than 10% air voids and,
- +/- 2% of optimum moisture content.

Material from cut areas and material from undercuts which is considered suitable by the Engineer shall be used for fills. The Contractor shall use the better materials selectively in critical locations as directed by the Engineer. The Contractor shall also mix different materials from the cut areas to obtain uniform fills.

All fill is to be placed and compacted in accordance with these specifications and with NZS4431-Code of Practice for Earth Fill for Residential Development.

5.2 Fill Laboratory Testing

Before earthworks are to commence, the proposed fill material shall be laboratory tested to confirm material suitability and determine the compaction characteristics. Representative samples of the fill shall be taken and submitted to an IANZ accredited soil laboratory.

The number and type of tests varies depending on material type and volume. Soil testing requirements are provided in Table 1.

The Engineer may require the contractor to undertake additional laboratory testing during the duration of the earthworks. This may be required due to variation in the fill, anomalous results or anomalous site results.

Table 1- Preparatory Fill Material Testing Requirements

Material	Test	Reference	Minimum Frequency	Requirement
Site Won Granular or Silt/Clay	Organic Content	Visual Inspection OR NZS 4402: Test 3.1.2	1 test from each source.	Organic content less than 5%
	Standard or heavy Dry Density/Moisture Content relationship	NZS 4402: Test 4.1.1/2	Minimum of 2 tests for each material type.	Standard compaction for smaller plant, heavy for larger plant (>8 tonne). Include shear vane for silty/clay.
	Particle Size distribution	NZS 4407: Test 3.8.1	Minimum of 1 test for each material.	Confirm the material grading.
	Solid Density	NZS4407: Test 3.7	Minimum of 1 test for each material.	Consider effect of pumice vesicles.
Engineered Granular	Standard or heavy Dry Density/Moisture Content relationship	NZS 4402: Test 4.1.1/2	Minimum of 2 tests for each material type.	Standard compaction for smaller plant, heavy for larger plant (>8 tonne).
	The Particle Size Distribution – Preferred Method by Wet Sieving	NZS4407: Test 3.8.1	Minimum of 1 test for each material.	The hardfill aggregate is to have a grading which falls within the limits defined in Tauranga City Council Infrastructure Development Code
	Solid Density	NZS4407: Test 3.7	Minimum of 1 test for each material.	
	The Crushing Resistance of Coarse Aggregate under a Specific Load	NZS4407: Test 3.10	Minimum of 1 test for each material.	The minimum crushing resistance of 120kN for GAP/WHAP products.
	The Weathering Quality Index of Coarse Aggregate	NZS4407: Test 3.11	Minimum of 1 test for each material.	The samples should produce more than 10% fines.

5.3 FILL CONSTRUCTION

This fill specification is a method type specification where the following plateau test process shall be followed at each of the four earthworks locations:

1. An area of 5m by 10m shall be established with the Engineer present on site,
2. Once the subgrade has been approved, single layer of fill at 150mm thickness shall be placed,
3. The fill is to be rolled with the proposed sheepsfoot roller and rolled with 8-12 passes.
4. A second 150mm layer shall be placed and given two passes with the proposed roller.
5. A nuclear densometer test to 150mm depth shall be undertaken with 5 (no.) Clegg Hammer tests. The locations shall be selected by the Engineer.
6. Two more passes shall be performed before the same testing as per point 5 is completed.
7. Point 6 is repeated until the lift has been exposed to 14 passes.
8. The Engineer will then confirm the compaction targets and the compaction method (lift thickness and number of passes).

Filling shall be placed in horizontal layers that shall extend across the whole area uniformly compacted to meet the specified standard before the next layer is placed.

The maximum dimension of any soil particles within the layer to be compacted shall be 100mm. Any larger fragments shall be removed or broken up where possible.

If at any stage during the compaction the fill is not meeting the compaction criteria, the Engineer may order a halt to works until tests have been undertaken to determine whether the specified compaction has been achieved.

Actual layer thickness and number of passes of the compaction plant will depend on the material and size of the compaction machinery.

Weaving or pumping of the fill or subgrade during compaction can be due to over compaction and pore water pressure. Where this occurs, the material will likely require to be replaced of left for periods of 24 hours before being re-tested.

Due to the high moisture content that can occur in volcanic soils, the use of a vibrating roller may affect the ability to compact base layers.

Any subsequent fill layers or lifts placed on top of fills that have not been passed by the Engineer are done so at the Contractor's risk. If the underlying fills fail to meet the compaction criteria, they may need to be removed and recompacted.

5.3.1 Control of Moisture Content

All fills shall be compacted at a moisture content maintained to within 2% above and 2% below the optimum moisture content as determined by Test No. 4.1.1 of NZS 4402, unless otherwise approved by the Engineer.

It is anticipated that under most weather conditions excavated material will require drying and silt materials will be sensitive with high moisture contents. This risk is reduced as the materials have already been through a cycle of earthworks.

The Contractor shall be responsible for determining any wetting and drying of the fill materials necessary to achieve the specified moisture content range for compaction.

When drying of fill material is required, the full depth of the wet layers shall be exposed allowing the material to dry uniformly until such time as the moisture content is within the specified limits. This shall be achieved by either discing or other suitable means and shall only be carried out in favourable weather conditions. An alternative to this is to place the uncompacted lift and allow to dry before compacting.

If fill material has a moisture content below the specified lower bound, water shall be applied as necessary. Plant which ensures a uniform and controlled distribution of water shall be used. When the soil has regained a moisture content after the wetting or drying process, which is within the specified limits, it shall be re-compacted to the specified standard.

5.3.2 Standard of Compaction (Targets)

The compaction requirements to be achieved by the Contractor and testing frequencies to show compliance are set out below. These are to be confirmed from laboratory testing and Plateau testing at the start of each of the four areas.

Table 2. Compaction Criteria.

Material	95% Maximum Dry Density (Mg/m^3)	Air Voids	Moisture Content (%)
Silty gravelly SAND	Initial MDD is 1.25 giving a minimum of 1.19 from plateau test	Less than 10%	+/-2%

Upon receipt and review of the lab test data, the Engineer will confirm the compaction targets. If the materials do not provide a suitable performance or fail to achieve the specification, the Contractor shall nominate a new source and laboratory data.

5.3.3 Control Testing

Testing by nuclear densometer shall be undertaken by an IANZ accredited laboratory.

All other testing shall be undertaken by the Contractor and BSK as per the testing schedule in Table 3.

Should any test result fail to achieve the specified density and air voids, further testing and compaction will be required. If this material continues to fail the criteria, the defective material shall be removed or dried out and re-compacted to the specified standard at no additional cost to the Client.

If the soil types vary from the source or are mixed, the Engineer may instruct that laboratory tests are undertaken.

The IANZ laboratory shall record test locations on a plan with the lift number and test co-ordinates from a handheld GPS or GPS survey.

Table 3- Compaction Test Schedule

Material	Test	Reference	Minimum Frequency	Requirement
Site won sandy Silt (Ash or tephra) Area D	Nuclear Densometer	NZS4407 Test 4.2 Direct Transmission 300mm.	Testing every 600mm of fill placed in 200mm lifts with 3 tests per 200m^2 with a minimum of 3 tests per round of testing. (greater of the two numbers).	Minimum average of 95% of maximum dry density, with minimum single test of 92%.
	Water content	NZS4402 Test 2.1	With each Nuclear Densometer test	TBC
	Scala Penetrometer	NZS4402 Test 6.5.2	Testing every 600mm lift with 1 test per 50m^2 with a minimum of 5 tests over the area (greater of the two numbers).	Minimum average of 5 blows/100mm or 15 per 300mm. Minimum single value of 4 blows/100mm.
Site won Silt or Clay	Vane Shear Strength	Guideline for handheld shear vane test. NZ Geotechnical Society.	Testing every 400mm lift with 1 test per 50m^2 with a minimum of 3 tests at each location. Minimum of 3 test locations per visit (greater of the two numbers).	TBC
	Nuclear Densometer	NZS4407 Test 4.2 Direct Transmission 300mm.	Testing every 400mm lift with 1 test per 200m^2 with a minimum of 3 tests per round of testing. (greater of the two numbers).	Minimum average of 95% of maximum dry density, with minimum single test of 92%.
	Water content	NZS4402 Test 2.1	With each Nuclear Densometer test	TBC
Site Won Granular or Engineered Granular	Scala Penetrometer	NZS4402 Test 6.5.2	Testing every 600mm lift with 1 test per 50m^2 with a minimum of 5 tests over the area (greater of the two numbers).	Minimum average of 5 blows/100mm or 15 per 300mm. Minimum single value of 4 blows/100mm.
	Nuclear Densometer	NZS4407 Test 4.2 Direct Transmission at 300mm depth. OR NZS4407 Test 4.2 Backscatter for GAP/WHAP products	Testing every 400mm lift with 1 test per 200m2 with a minimum of 5 tests per round of testing. The greater number shall apply.	Minimum average of 95% of maximum dry density, with minimum single test of 92%.
	Water content	NZS4402 Test 2.1	With each Nuclear Densometer test	TBC

	Clegg Impact Value (CIV) Tests	ASTM D5874	Undertake tests on each lift with 1 test per 50m^2 with at least 5 tests per round of testing (greater of the two numbers).	Minimum average impact value of 20, with minimum single 15.

5.4 Test Reports

Results of Clegg Hammer, Scala Penetrometer and Nuclear Densometer shall be provided to the Engineer in electronic format and display the following information:

- A test plan for each test location (also marked by Contractors GPS and provided in DWG format,
- Confirmation of fill source location (site won at location or imported),
- Scala Penetrometer Testing shall be reported as blows per 100mm,
- Clegg Hammer tests shall show 4 blow counts and the Clegg CIV,
- Nuclear densometer tests shall provide the probe depth.

5.4.1 Random Verification Testing

The Engineer will periodically undertake random verification testing of Scala Penetrometers and Clegg Hammers.

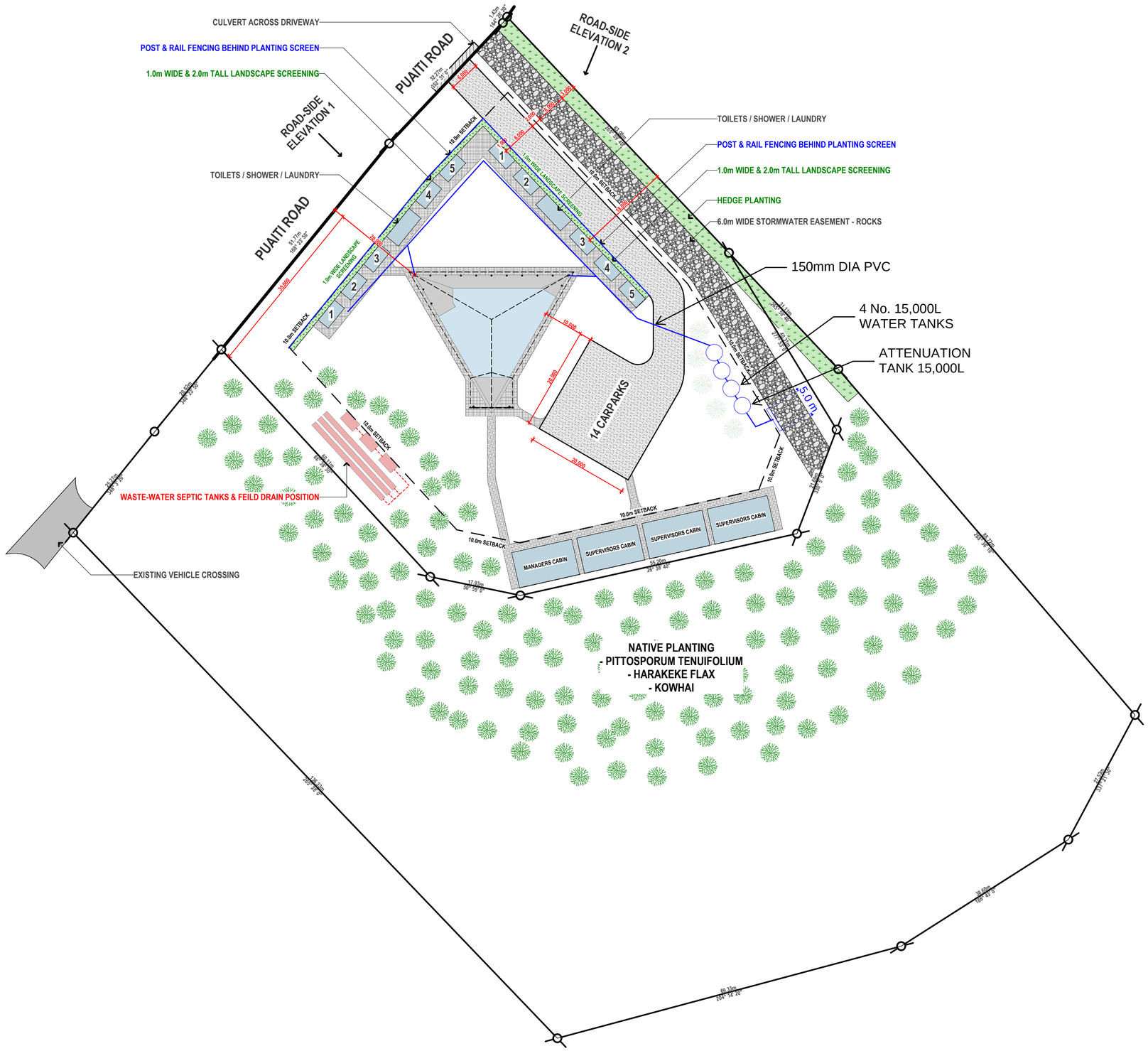
5.4.2 Acceptance

A pass for the lift compaction will be provided by the Engineer when:

- All test results have been received and reviewed with the results showing a pass that the compaction criteria have been achieved,
- A visual inspection of the compacted surface has been undertaken and/or photographed,
- Any failed areas have also been re-tested and deemed to meet the compaction criteria.

Acceptance will be provided verbally and in writing.

APPENDIX C - DESIGN STORMWATER



SITE INFORMATION:

PUAITI ROAD, WAIKITE
LOT 1 - DP 585350
Property Area: 22399m²

TOPOGRAPHY : T1
CLIMATE ZONE : 4
WIND REGION : A
WIND ZONE: VERY HIGH
EARTHQUAKE ZONE: ZONE 2
DURABILITY: ZONE B
SUB-SOIL CLASSIFICATION: CLASS D

SITE COVERAGES:

ALLOWABLE COVERAGE:
1000m² OR 4.46%

TOTAL GROUND FLOOR AREA:
(including all structures on site)
777.25m²

TOTAL COVERAGE OVER FRAME:
(including soffits over 600mm)
918.5m² OR 4.1%

IMPERVIOUS SURAFCE COVERAGE:
1950m² OR 8.7%

BUILDING SET-OUT:

- Site Plan to be read in conjunction with Ground Floor Plan & Foundation Plan to ensure correct set-out
-Soak pits to be located 3.0m min away from buildings & 1.5m min away from boundaries

SITE LEVELS:

FFL : -

FGL : -

SITE LEVELS ARE RELEVANT TO THE MOTURIKI DATUM

F5/AS1 SITE SAFETY NOTE:

A SITE FENCE IS TO REMAIN IN PLACE DURING THE BUILD PERIOD COMPLYING WITH F5/AS1 ACCEPTABLE SOLUTION 1.1 SITE FENCES & HOARDINGS

SITE FENCE NOTE AS PER F5/AS1
1.1 Site fences and hoardings
1.1.1 Fences and hoardings shall extend at least 2.0 m in height from ground level on the side accessible to the public.
1.1.2 An acceptable fence may be constructed with galvanised chainlink netting having a maximum sized grid of 50 mm x 50 mm. Post spacing shall be a maximum of 2.5 m, and the gap between the bottom of the fence and ground no greater than 100mm.

DGD
DARIN GRANT DESIGN
ARCHITECTURAL DESIGN SERVICES
1122 PUKAKI STREET, ROTORUA
DARINGRANTDESIGN@XTRA.CO.NZ
027 6684 664

LICENSED BUILDING PRACTITIONER www.dbh.govt.nz BUILDING CONFIDENCE

TIKANGA ARORO CHARITABLE TRUST:
PUAITI ROAD, WAIKITE
LAYOUT NAME:
SITE PLAN

NOTES:
PLANS ARE TO BE PRINTED ON A2
PLANS ARE TO BE PRINTED IN COLOUR
E & OE APPLIES

STATUS:	CONCEPT 01
DATE:	14/10/2024
SCALE:	1:600
PROJECT NO.:	#DG20
DRAWN:	LENNOX

SHEET NO.
02

Consulting Engineers

Structural & Geotechnical Engineering Solutions

Project Title:	*Puwhakamua*	***Project Reference:***	*25594*	***Designer:***	*AB*
Site Location:	*671 Puaiti Road*	***Date:***	*17/10/2024*	***Checked By:***	*PM*

Design Process

The Rational Method

Enter area data for design (roof and hard stands) for pre and post

Use Rainfall Intensity Data (https://hirds.niwa.co.nz/) Pre Data: "Historical Data" Post Data: "RCP 8.5 Scenario 2081-2100"

Adjust "Detention Tank Design Summary" parameters from tank supplier

Using the "Goal Seek" function, run each storm duration (Data- What-If Analysis- GOAL SEEK)

Determine duration that gives the maximum volume of detention. The orrifice diameter needs to be a minimum value

Change the other orrifice sizes to this minimum value- this gives the final tank volume

Pre Development Catchment Areas Summary

Catchment	Area	Unit
Roof	0	m^2
Hardstand	0	m^2
Grass	1008	m^2
Total	1008	m^2

Post Development Catchment Areas Summary

Catchment	Area	Unit
Roof	1008	m^2
Hardstand		m^2
Grass	0	m^2
Total	1008	m^2

Pre Development Stormwater Run-off

Catchment Area		Area Ratios						Run-off factor (c)			c*A
Ref.	Area (m^2)	% Roof	Area (m^2)	% Hardstand	Area (m^2)	% Grass	Area (m^2)	Roof	Hardstand	Grass	
Total	1008	0%	0	0%	0.0	100%	1008	0.95	0.9	0.3	302.4

ARI	10						
Duration	**10 min**	**20 min**	**30 min**	**60 min**	**2 hr**	**6 hr**	**12 hr**
Intensity (mm/hr)	89.4	63.7	51.7	35.6	23.9	12.2	7.8
Run-off Total (Q) l/s	7.51	5.35	4.34	2.99	2.01	1.02	0.65
Run-off 80% (Q) l/s	**6.01**	**4.28**	**3.47**	**2.39**	**1.61**	**0.82**	**0.52**

NIWA HIRDS Historic Rainfall Data

1008

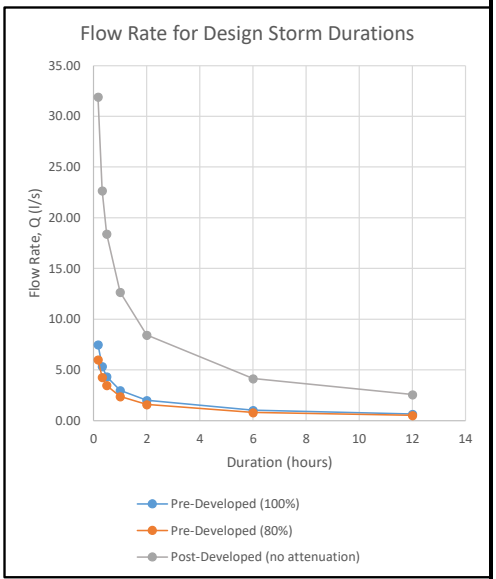
Post Development Stormwater Run-off

Catchment Area		Area Ratios						Run-off factor (c)			c*A
Ref.	Area (m^2)	% Roof	Area (m^2)	% Hardstand	Area (m^2)	% Grass	Area (m^2)	Roof	Hardstand	Grass	
Total	1008	100%	1008	0%	0	0%	0	0.95	0.5	0.3	957.6

ARI	10						
Duration	**10 min**	**20 min**	**30 min**	**60 min**	**2 hr**	**6 hr**	**12 hr**
Intensity I (mm/hr)	120.0	85.3	69.2	47.6	31.7	15.6	9.7
Run-off Roof Q (l/s)	**31.92**	**22.69**	**18.41**	**12.66**	**8.43**	**4.15**	**2.57**
Run-off Hardstand Q (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Run-off Grass Q (l/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Run-off Q (l/s)	31.92	22.69	18.41	12.66	8.43	4.15	2.57

NIWA HIRDS Projected Rainfall Data (RCP8.5)

Duration	**10 min**	**20 min**	**30 min**	**60 min**	**2 hr**	**6 hr**	**12 hr**
Detention outflow Q (l/s)	**6.01**	**6.01**	**6.01**	**6.01**	**6.01**	**6.01**	**6.01**



Detention Tank Calculation Summary

Duration	**10 min**	**20 min**	**30 min**	**60 min**	**2 hr**	**6 hr**	**12 hr**
Storage Volume Vs (L)	17237	22767	25905	29570	27496	9043	2893
Maximum Outflow (l/s)	4.74	5.45	5.81	6.21	6.12	4.13	3.11
Tank Basal Area A (m2)	9.621	9.621	9.621	9.621	9.621	9.621	9.621
Outlet Dia d (m)	0.040	0.040	0.040	0.040	0.040	0.040	0.040
Height h (m)	1.89	2.49	2.83	3.24	3.01	0.99	0.32

Detention Tank Design Summary

Minimum Required Detention Volume (L)	29570.1
Restricted Orifice Diameter (mm)	15.0
Tank Details	Devan 15,000
Tank Type	Round
Tank Diameter (m)	3.5
Tank Width (m)	
Tank Length (m)	