1 May 2024

Jackson Worsfold
jacksonw@dream-inc.co.nz

RE: Geotechnical Investigation for Proposed Plan Change at 18A Black Swamp Road, Mangawhai (Lot 2 DP 29903 & Section 25 Block IV Mangawhai SD).

Wiley Geotechnical Limited (WGL) was requested by Jackson Worsfold to provide a geotechnical investigation to support an application to Kaipara District Council for a proposed plan change.

We have received and reviewed a preferred zoning plan and a draft conceptual master plan for the site provided by the client, showing proposed building locations within the residential and commercial areas. We have previously completed geotechnical investigations and reporting at the subject site (Ref 22112_Rev1, dated November 2023) to support a subdivision application for the low-density residential zone outlined in the preferred zoning and conceptual master plan documents.

WGL visited the site between 25th March 2024 and 4th April 2024 and made the following observations:

- The site contains moderately sloping ground generally falling towards the north and northeast, with relatively flat areas towards the northern and northeastern bounds of the site.
- The site is currently a cattle farm and contains a number of ponds and overland flow paths.
- The inner reaches of the Mangawhai Estuary line the northern boundary of the site while the southern boundary reaches a maximum elevation of RL 55m.
- Two existing structures and a small pond are located towards the eastern boundary of the site.
- Two existing structures, a shed, and two ponds are located adjacent to the existing accessway.
- An existing farm track runs through the site west to east and north to south.
- Terracing likely created by livestock movements and soil creep is noted in the slopes between the west to east farm track and lower flat terrace above the estuary.
- An ~3.0m high rock faced 1V:1H batter is noted along the road edge from the western entrance to 18A Black Swamp Road, and back west towards to the Insley Street intersection.
- 23 hand augers were undertaken across the proposed development to a maximum depth of 3 m below ground level.

Geology

The GNS map for the site indicates that the lower elevations of the site are underlain by alluvium of the Tauranga Group comprising “Partly consolidated mud, sand, gravel and peat or lignite of alluvial, colluvial, lacustrine, swamp and estuarine origins”.

The GNS map also shows a geological boundary through the site and indicates that this area is underlain by sedimentary rocks of the Pakiri Formation (Waitemata Group) (PF) comprising “alternating thick-bedded, volcanic rich, graded sandstone and siltstone with volcaniclastic grit beds.”

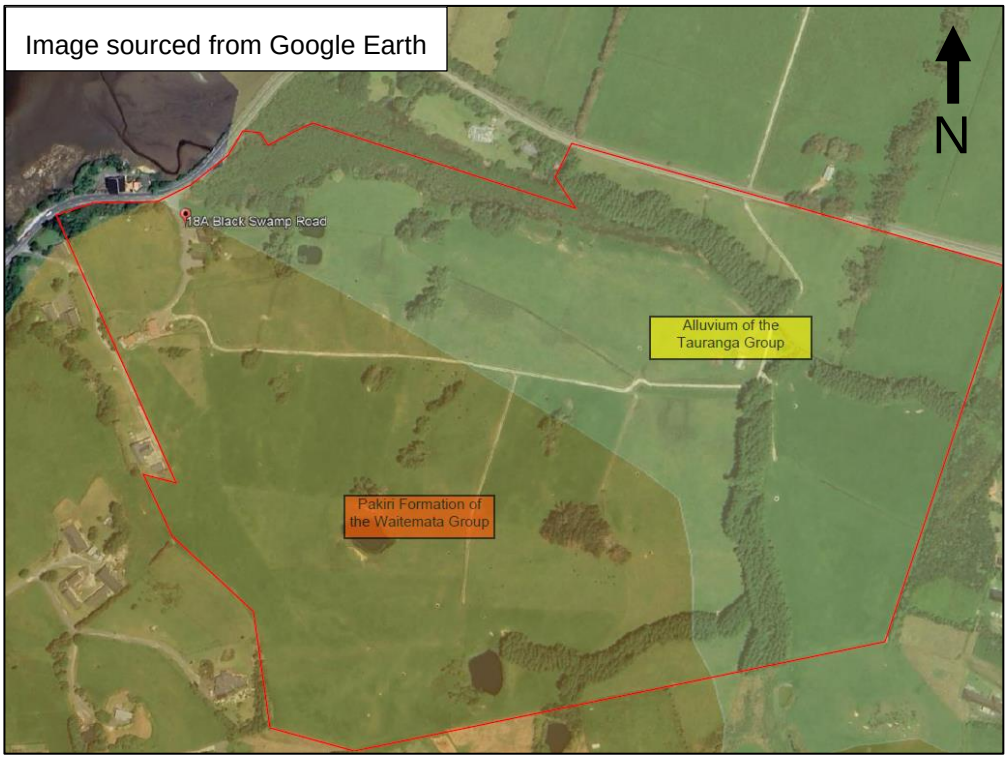


Figure 1: Geologic Boundary (GNS)

Historical Aerial Photos

As part of our reporting, available online historical aerial photos on Retros Lens (www.retrolens.co.nz) were reviewed. The available aerial photos date back to 1961 and show that the site has been used for farming prior to this. The current buildings were built before 1961. The various ponds across the site were constructed between 1961 and 1995.

No obvious signs of large-scale instability were noted in the historical aerial photos impacting the proposed building locations, however, due to the quality and scale of the image, a detailed assessment is difficult.

Landform

The site is north-northeast facing with a high point of RL 55 at the southernmost location, down to RL 0 at the estuary on the northern boundary.

Lower lying areas located towards the northern and eastern boundaries are relatively flat, the land then rises towards the south and west of the property.

There is a north-trending ridge along the western boundary and a north-eastern trending ridge in the centre of the site, both ridges start at the RL 55 high point.

Gradients across the site are generally 1V:5H and lower. Steeper slopes ~1V:2.5H are located towards the south-west extent of the property. A 1V:1H rock batter along the road edge is located in the north west corner of the site.

As shown in Figure 2 below there are a number of overland flow paths across the site flowing in the general direction of the landform. Man-made farm ponds are also located at a number of locations across the site feeding the overland flow paths.

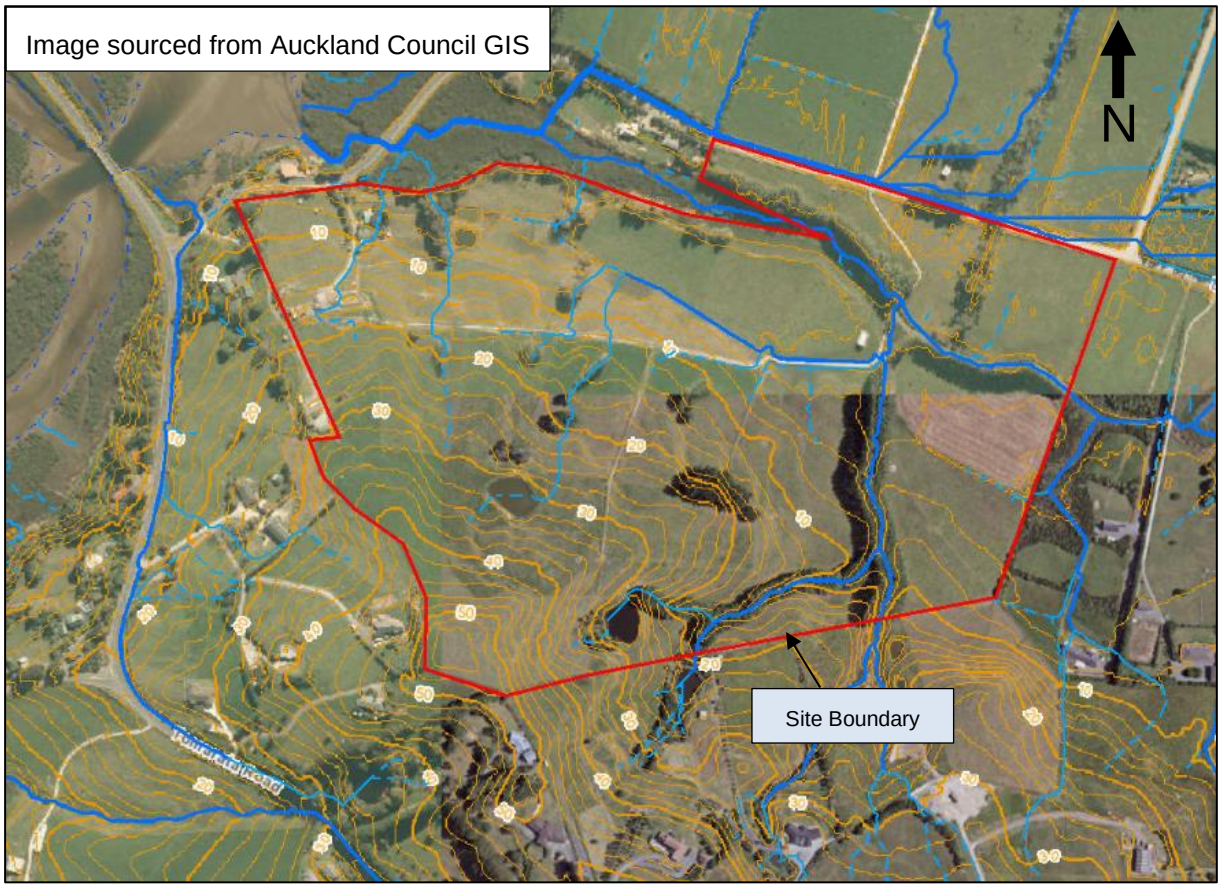


Figure 2: Contour (1m) and Overland Flowpath map (Auckland Council GIS GeoMaps)

NRC GIS Hazards Map

According to the Northland Regional Council Hazard Maps, some areas in the lower reaches of the subject site are included in an area of flooding risk. As seen in Figure 3, the site is located in Coastal Flood Hazard Zone 0 (Current), Zone 1 (50 years), Zone 2 (100 years) and Zone 3 (100 years and Rapid Sea Level Rise Scenario). The site is also shown to be within the Regionwide River Flood Zones 10 year, 50 year and 100 year CC extent.

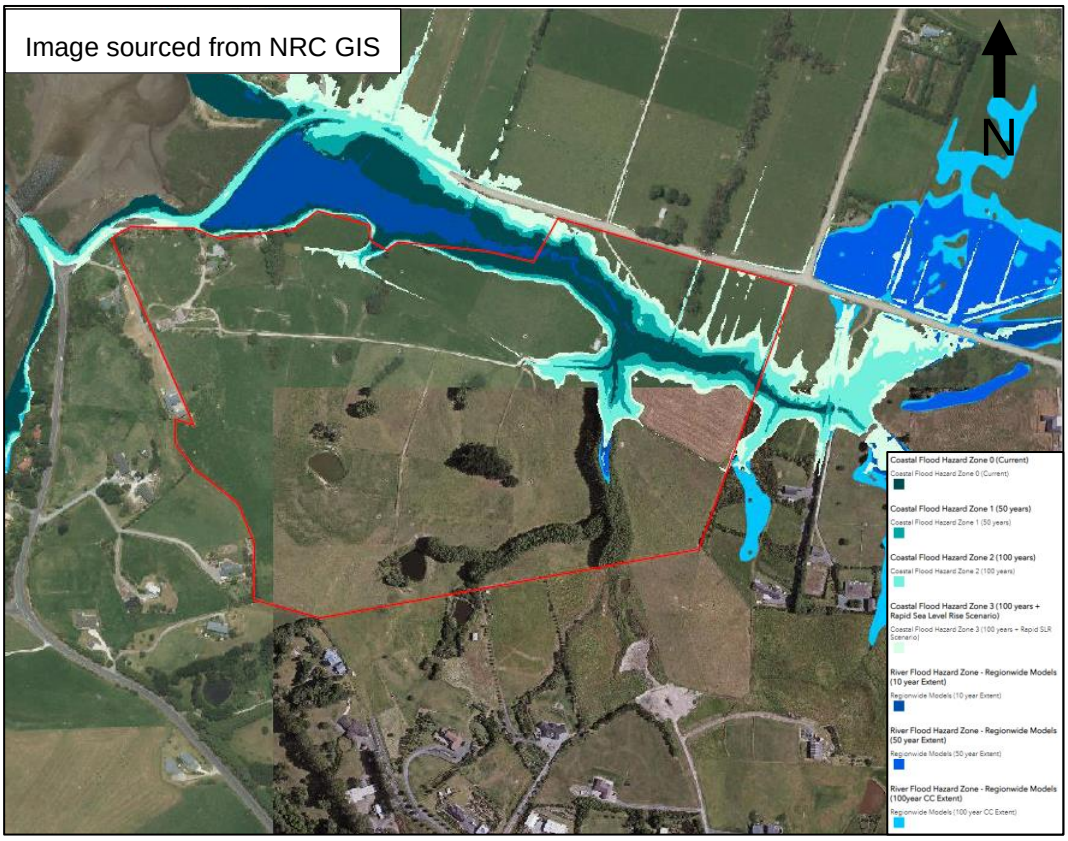


Figure 3: NRC Hazards Mapping (with approximate boundaries outlined in red).

Field Exploration and Subsurface Conditions

WGL carried out a shallow subsurface investigation consisting of 23 hand augers with shear vane and scala penetrometer testing within the approximate areas shown in Figure 4 below.

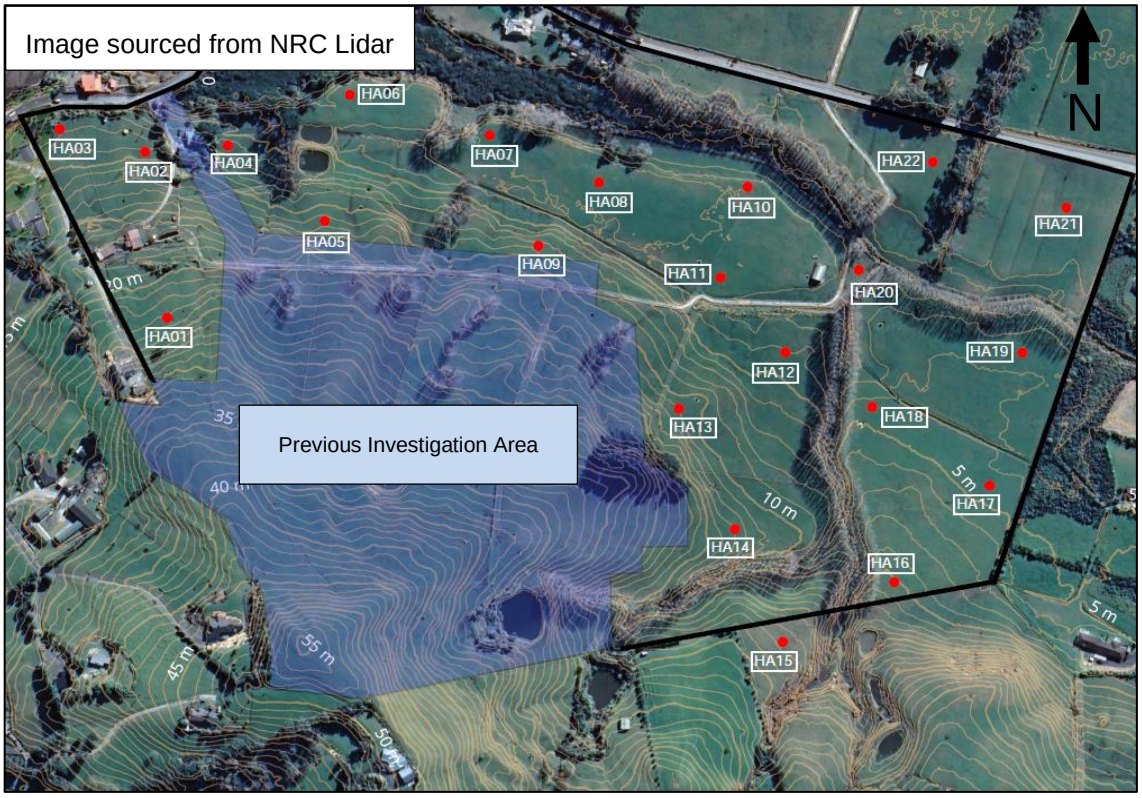


Figure 4: Approximate Subsurface Exploration Locations

The hand augers were carried out to depths ranging between 0.4 m and 3.0 m. The subsurface material encountered in our hand auger investigation can be generally described within two categories, those located roughly above the 4 m RL contour and those roughly below the 4 m RL contour line. Above the 4 m RL contour the subsurface material generally consisted of topsoil underlain by friable tephra material before grading into clayey SILT with varying amounts of sand. Below the 4 m RL contour line the subsurface material generally consisted of sandy topsoil underlain by silty sand or sandy silt before grading into clean light brown sand at depth. Sandstone hardpan was encountered in HA21 and HA23 and inferred along the length of the hand probe line at depths ranging between 0.3 m and 0.6 m where refusal was encountered. Measured undrained shear strengths ranged from 50 kPa to and inferred >200 kPa, however the majority of the undrained shear strength values exceeded 80 kPa.

Although not encountered in our site investigation, but based on observations during our site walkover and due to the use of the land for farming over the past 60+ years, areas of non-engineered fill are also to be expected across the site notably around existing buildings, ponds, drains, water troughs, and farm tracks.

Groundwater was encountered between 0.8 m and 2.8 m during our testing. The groundwater level may vary from the depth measured at the time of exploration, as a result of seasonal change, and recent rain events.

Based on our desktop study, site investigation, and walkover, the below generalised ground model of the site has been created. The ground model took into account the borehole data to create 3

approximate areas within the property which assigned a soil category in general accordance with the New Zealand Geotechnical Society field classification guidelines (NZGS, 2005).

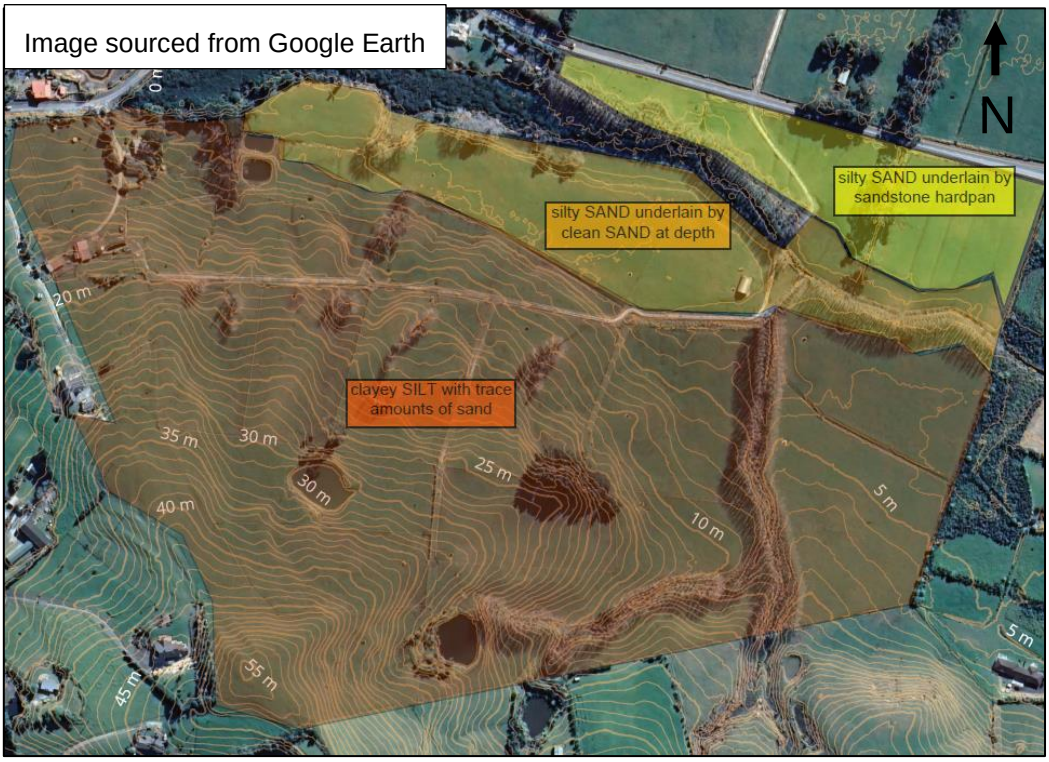


Figure 5: Generalised ground model based on current site investigation and desktop study

Based on this, it is our opinion that the material encountered in our subsurface investigation is broadly consistent with published geologic mapping with some minor adjustments to geological boundaries. The bore logs are presented as an appendix to this report and are written in general accordance with the New Zealand Geotechnical Society field classification guidelines (NZGS, 2005).

Expansive Soils

Expansive clay and silt soils are common in the wider Northland region and have the tendency to shrink and swell, particularly with seasonal fluctuations of soil water content. This behavior has implications for foundation design and surface structures and should be incorporated during foundation design.

Based on our visual and field assessment of the soils encountered onsite, and our experience in the area, we consider that the Expansive Site Class for the site to range from “A - no movement” to “M - moderate” in accordance with AS 2870 depending on the location on site.

Mitigation of the expansive soil hazard is undertaken by a combination of appropriate foundation design selection at Building Consent stage and appropriate moisture control within subgrade soils during construction.

Conclusions and Recommendations

Based on the findings of our preliminary geotechnical investigation and site assessment, it is our opinion that the site is generally suitable for the proposed subdivision development, subject to further

geotechnical investigations to develop more detailed geological models and provide engineering design recommendations to support subdivision of the site.

Foundations

This report is not to be used for the purposes of any building consent applications regarding the foundations of future structures.

Within areas identified as clayey SILT and silty SAND underlain by clean dense sand (Figure 5)

We anticipate that foundations designed in accordance with NZS3604 (2011) shall likely provide a suitable foundation for future dwellings. Further geotechnical investigations shall be required upon each Lot at subdivision or building consent stage to confirm if NZS 3604 foundation are suitable or what degree of engineered design is required to be implemented.

Based on the preliminary borehole investigations we would generally expect that a geotechnical ultimate bearing capacity of 300 kPa would be available; however, further geotechnical investigations and design shall have to be carried out.

Within area identified as silty SAND underlain by hardpan (Figure 5)

We anticipate that wooden piles designed in accordance with NZS3604 (2011) shall likely provide a suitable foundation for future dwellings with all piles to be embedded in the hardpan at a depth.

A concrete foundation may also be feasible. However, we would expect the sites to be undercut to expose the hardpan or dense sand before being built back up with certified engineered fill.

Based on the preliminary borehole investigations we would generally expect that a geotechnical ultimate bearing capacity of 300 kPa would be available; however, further geotechnical investigations and design shall have to be carried out.

Earthworks

For the development scheme provided we anticipate the earthworks will include site clearing and construction for the proposed Lots, roadway, and driveway access. We recommend that any site concept plans be discussed with WGL or suitably qualified Geotechnical Engineer familiar with the site and the contents of this report.

In addition, we suggest the following:

- All cut surfaces should be inspected by WGL (or suitably qualified Geotechnical Engineer) prior to placing any fill to ensure founding conditions are as anticipated;
- All excavated soil to be removed from site or placed in an engineered stockpile that is strategically placed such that it would not trigger slope instability. If there is any soil to be placed permanently on site, we suggest contacting WGL for further guidance:
- In areas of tree removal where planned structures or roadways are located, the full root ball should be removed;
- Any proposed earthworks and drainage plans should be approved by a suitably qualified Geotechnical Engineer familiar with both the site and the recommendations within this report for review and comment;

- Fill placement, should be placed in accordance NZS 4431 – Code of practice for Earth Fills for Residential development. Fill should be placed on a suitably stripped and prepared subgrade including the removal of any non-engineered fill;
- Additional design-level earthwork recommendations are required if cut and fills are greater than 600mm; and
- All proposed batter slopes should be restricted to gradients no steeper than 1v:3h.

Existing Ponds

Based on the supplied plans it is envisioned that the existing ponds located within proposed development area will be decommissioned. This will help to eliminate the risk of embankment slope failure and inundation of residential Lots. We recommend that decommissioning the pond involves safely draining all stored water and carrying out bulk earthworks to stabilise and regrade the land to a suitable long-term position. Aspects such as undercutting soft material, non-engineered fill, and back filling with engineered fill shall likely be required. Depending on ground water levels sub soil drains may also be required before back filling to ensure sufficient drainage.

The geotechnical engineer should review proposed earthwork plans prior to commencing on site. Monitoring and certifying decommissioning and associated earthworks should also be carried out by the geotechnical engineer.

Slope Stability

Some evidence of shallow instability in the form of hummocky ground, and soil creep was observed on steeper slopes across the site in particular above and below the main east-west trending farm track. However, due to the mostly moderate sloping ground across most of the site, slope instability is not considered a major risk; and WGL will review and assess this as earthwork and construction plans develop with site specific slope stability analysis to be undertaken in the future if required.

Liquefaction

Granular soils, such as sand, are susceptible to liquefaction in the event of future earthquakes. This may result in settlement or lateral deformation. This is considered low risk in the clayey SILT with trace sand (Figure 5) encountered on site due to the plastic nature of the soils, and their geological age.

Based on the regional earthquake risk the potential Liquefaction risk of the site is generally considered Low. However, granular sand soils paired with a shallow ground water table were encountered on site (silty SAND, Figure 5), and will require future site investigation and analysis to quantify the liquefaction risk if any. At worst specific engineering design or ground improvement would be required if liquefaction was found to be a significant risk.

Load Induced Settlement

Fill embankments and / or future building loads could induce settlements within soft underlying subsoils. In general, this hazard is considered to be low to moderate risk across the site with more potential risk in the area identified as Alluvium of the Tauranga Group in Figure 1.

Further site investigation will be required to quantify this potential, which at worst, would be problematic to deep fills and / or high spread floor loads such as in industrial development. The risk can be controlled by limiting fill depths in the worst affected areas, planning land use for low load requirements such as

residential development and if necessary, by use of pre-loads, specific design foundations or ground improvement.

Wastewater Disposal

Recommendations for the onsite wastewater disposal for the proposed large lot residential areas are included in our previous subdivision report (Ref 22112_Rev1, dated November 2023).

Due to the proposed reduced lot sizes, and discussions with the client we understand that connection to the Mangawhai Community Wastewater System and public sewer infrastructure is proposed in this next stage of the proposed development.

Stormwater

We understand that public stormwater infrastructure will be constructed as part of the proposed development. It is envisioned that the stormwater runoff from the Lots will be directed into this proposed stormwater infrastructure.

WGL will need to review and assess the stormwater infrastructure as earthwork and construction plans develop to ensure its appropriate geotechnically for the site and does not impact slope stability.

Sub Soil Drainage

Due to potential high ground water which was encountered during our site investigation, subsoil drains may be required to intercept groundwater from impacting the proposed development and help improve the overall stability. If required, sub soil locations shall be recommended by the geotechnical engineer as part of future subdivision geotechnical reporting.

Flooding

WGL has reviewed the Coastal Flood Hazard Assessment for Northland report produced by Tonkin & Taylor (Ref 10123601000.v4, dated March 2021). The coastal flood heights for the subject site are outlined below. Expected future sea level rise due to climate change was accounted for in the calculation process. WGL also sourced the priority flood level heights from NRC which are outlined below.

WGL sourced the region wide flood level heights from NRC which are outlined below along with the coastal flood hazard heights. These levels were taken at points to the north and north east of the site.

Region Wide River Flood Levels

Location	10Year (NZVD)	50Year (NZVD)	100Year+CC (NZVD)
Proposed Dwelling	1.66	1.87	2.9

Coastal Flood Levels

Location	CFHZ0 (NZVD)	CFHZ1(NZVD)	CFHZ2(NZVD)	CFHZ3(NZVD)
Proposed Dwelling	2.0	2.5	3.2	3.5

Based on the above flood map (Figure 3) and contours, flooding is likely to impact the lower areas of the development along the northern boundary and its north eastern portion.

Further Work

This report entailed a preliminary investigation for the proposed zoning plan change of the site. The recommendations and considerations outlined are indicative of what is to be expected based on the initial investigations.

At this stage WGL have only been provided with preliminary draft plans and further geotechnical investigations, engineering input, and reporting will be required through the subdivision process as scheme plans including earthworks, services, roading and drainage are developed. Further geotechnical investigations will include deep investigation using CPT (Cone Penetration Testing), and potentially test pitting with an excavator.

WGL should be provided with any revised plans to undertake a geotechnical review.

Geotechnical monitoring and certification of subdivision earthworks will be required.

LIMITATIONS

(i) This report has been prepared for the use of our client, Jackson Worsfold and their professional advisers and the relevant Regional Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

(ii) Assessments made in this report are based on the ground conditions indicated from published sources, site inspections and subsurface investigations described in this report based on accepted normal methods of site investigations. Variations in ground conditions may exist between test locations and therefore have not been taken into account in the report. If variations are found during excavation or at foundation preparation stage WGL should be notified immediately so we can amend our recommendations.

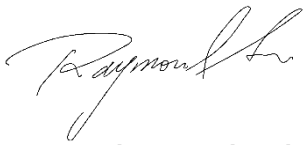
(iii) This Limitation should be read in conjunction with the ENZ/ACENZ Standard Terms of Engagement.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned at richard@wileygeotechnical.co.nz or matt@wileygeotechnical.co.nz if you require any further information.

Richard Tichborne - BSc, PgDip, MEngNZ
Senior Geotechnical Engineer

Matt Wiley, MSc(Hons), MEngNZ
Principal Engineer

Reviewed By:



Raymond Su - BE(Hon), MEngSc(Geotechnical), CMEngNZ, CPEng

Principal Engineer

Attachments:

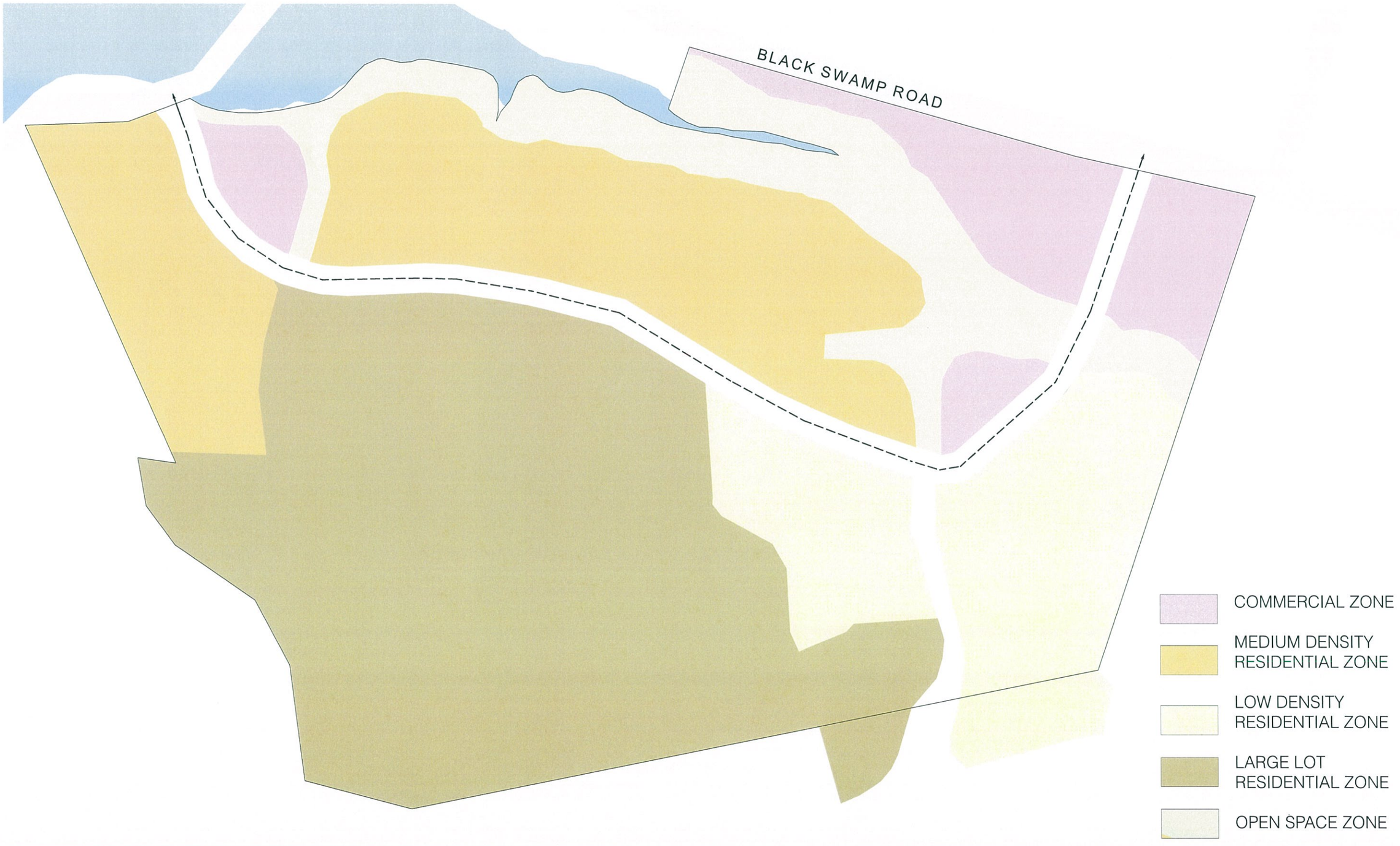
- Preferred Zoning Plan

- Draft Conceptual Master Plan

- Bore Logs

7. PREFERRED ZONING

7.1 The zoning strategy suggested (below) for the subject site aligns with the Master Planned Vision and importantly the zoning framework set out as part of the Exposure Plan.The specific mechanism to deliver the strategy and potential zoning such as the use of a Special Purpose Zone in this situation, is something that would be discussed with Councils Policy Team.



WILEY GEOTECHNICAL LTD

BOREHOLE No. 1

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, friable, to 200 mm							
Pakiri Formation of the Waitemata Group	SILT light brown intermixed with white grey, friable (tephra)						● 200	
	light brown with orange brown streaks, slightly clayey, slightly plastic, slightly sandy						● 200	
	occasional white clasts		1				● 200	
	increased clay and plasticity						○ 84 ● 200	
	light brown with orange brown streaks, moderately clayey, moderately plastic						○ 67 ● 131	
	moist		2				○ 64 ● 104	
	sandy layer						○ 50 ● 108	
							○ 50 ● 101	
			3				○ 50 ● 87	
							○ 74 ● 104	
			4					
			5					

NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 25-Mar-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 2

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, friable, to 200 mm							
Pakiri Formation of the Waitemata Group	SILT light brown with intermixed white grey, friable (tephra)							
	light brown with orange brown streaks, slightly clayey, slightly plastic, trace sand		1				● 200 ● 200 ● 200 ○ 67 ● 175 ○ 71 ● 151	
	increased clay and plasticity, slightly sandy		2				○ 60 ● 118 ○ 50 ● 108 ○ 50 ● 124	
	moist		3				○ 64 ● 124 ○ 50 ● 114	
	E.O.B: 3.0 m		4					
			5					

NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 25-Mar-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

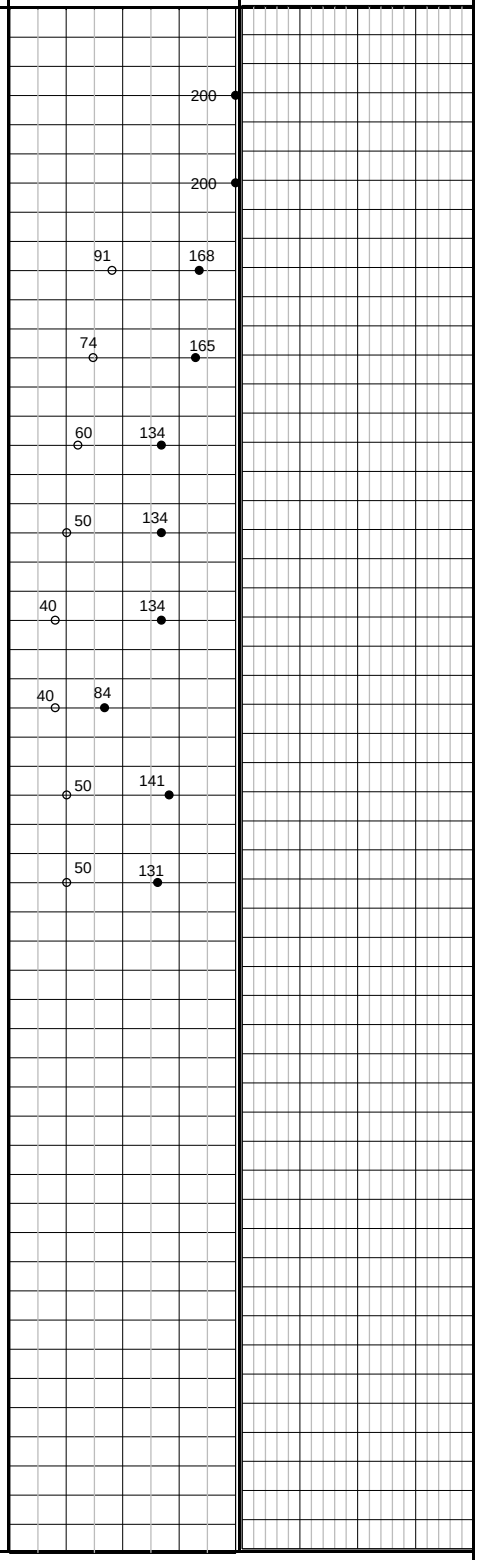
BOREHOLE No. 3

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, friable, to 200 mm							
Pakiri Formation of the Waitemata Group	SILT white grey, fine grained, friable (tephra)							
	light brown with orange brown streaks, slightly clayey, slightly plastic, trace sand							
	increased clay and plasticity		1					
	light brown with occasional orange brown staining, slightly clayey, slightly plastic, slightly sandy		2					
	increased orange brown, increased clay and plasticity		3					
	E.O.B: 3.0 m		4					
			5					



NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 25-Mar-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

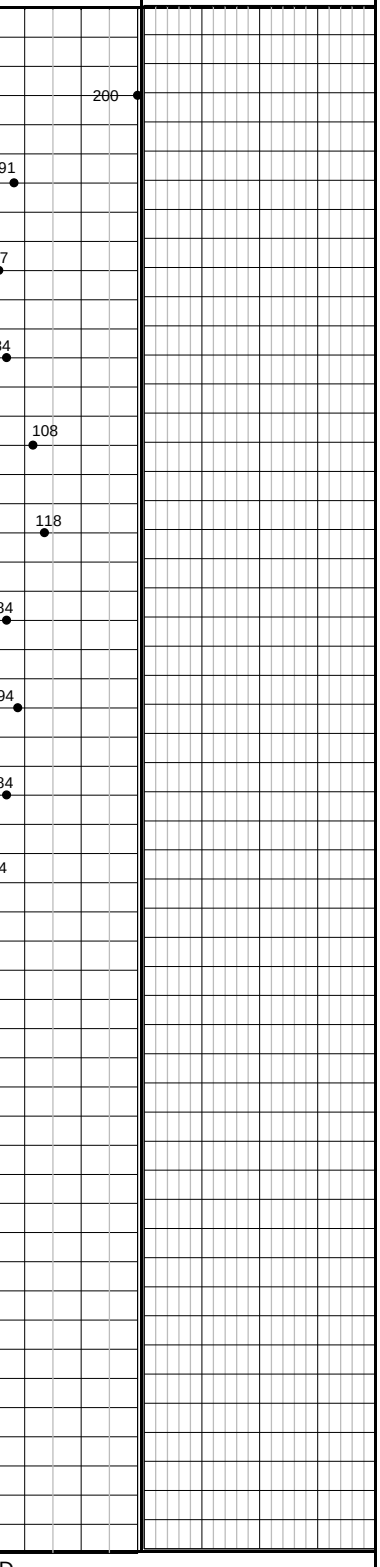
BOREHOLE No. 4

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, sandy, friable to 100 mm							
Pakiri Formation of the Waitemata Group	SILT dark brown, friable, fine grained, trace sand							
	grey, slightly plastic, moderately sandy							
	moist							
	light brown with orange brown streaks, moderately clayey, moderately plastic, trace sand, moist		1					
	blue grey, slightly to moderately clayey, slightly to moderately plastic, some sand, moist		2					
	occasional white clasts							
	wet to saturated							
	E.O.B: 3.0 m		3					
			4					
			5					



NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 4-Apr-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 5

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, friable, to 100 mm							
Pakiri Formation of the Waitemata Group	SILT dark brown with intermixed white grey (tephra), fine grained		1				200	
	light brown with orange brown streaks, slightly clayey, slightly plastic, some sand						200	
							200	
							200	
	light brown, decreased clay and plasticity, increased sand, slightly friable						200	
			2				200	
							47 ○ 158 ●	
	moist						200	
	occasional gritty inclusions, occasional rock fragments						200	
							200	
	E.O.B: 3.0 m		3				200	
			4					
			5					

NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 4-Apr-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 6

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL
T	TOPSOIL dark brown, sandy, friable, to 100 mm					
Alluvium of the Tauranga Group	SAND dark brown, silty, fine grained					
	light brown, fine grained, silty					
	SILT light brown, slightly plastic, sandy, fine to medium grained		1			
	SAND yellow brown with orange brown mottling, fine to medium grained, densely packed, hard to auger					
	poor retrieval due to dense sand		2			
	E.O.B: 2.0 m		3			
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Peak Field Vane

○ Remoulded Field vane

50 100 150

44 ○ 141 ●

37 ○ 151 ●

200 ●

SCALA PENETROMETER BLOWS / 100 mm

5 10 15

2 3 3 8 8 7 6 5 4 3 3 5 4 4 6 8 7 7 7 12 8 5 10 12 15 12 12 12 12

NOTES Groundwater was not encountered.

Hand auger encountered poor retrieval due to very dense sand.

Scala Penetrometer test performed from surface adjacent to borehole.

LOGGED BY: MD

DATE DRILLED: 4-Apr-24

DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 7

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, sandy, friable, to 100 mm							
Alluvium of the Tauranga Group	SAND light brown, fine grained, some silt							
	orange brown mottling, fine to medium grained, occasional rock fragments		1					
	light brown, clean, fine to medium grained, densely packed, hard to auger							
	moist to wet		2					
	poor retrieval due to densely packed sand							
	E.O.B: 2.2 m		3					
			4					
			5					

Peak Field Vane: 200 kPa; 200 kPa; 200 kPa

Scala Penetrometer BLOWS / 100 mm: 2, 3, 6, 3, 3, 3, 6, 6, 4, 5, 8, 9, 10, 9, 12, 15

NOTES Groundwater was not encountered.
Hand auger encountered poor retrieval due to densely packed sand.
Scala Penetrometer test performed from the surface adjacent to the borehole.

LOGGED BY: MD
DATE DRILLED: 4-Apr-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 8

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL
T	TOPSOIL dark brown to 100 mm					
Alluvium of the Tauranga Group	SILT dark brown, sandy, friable					
	light brown with orange brown mottling, sandy, friable					
	SAND light brown, slightly silty, slightly plastic, fine to medium grained					
	water at 2.0 m					V
	light brown, clean, fine to medium grained					
	wet to saturated					
	poor retrieval due to saturated soil					
	E.O.B: 2.5 m					

CORRECTED VANE SHEAR STRENGTH (kPa)

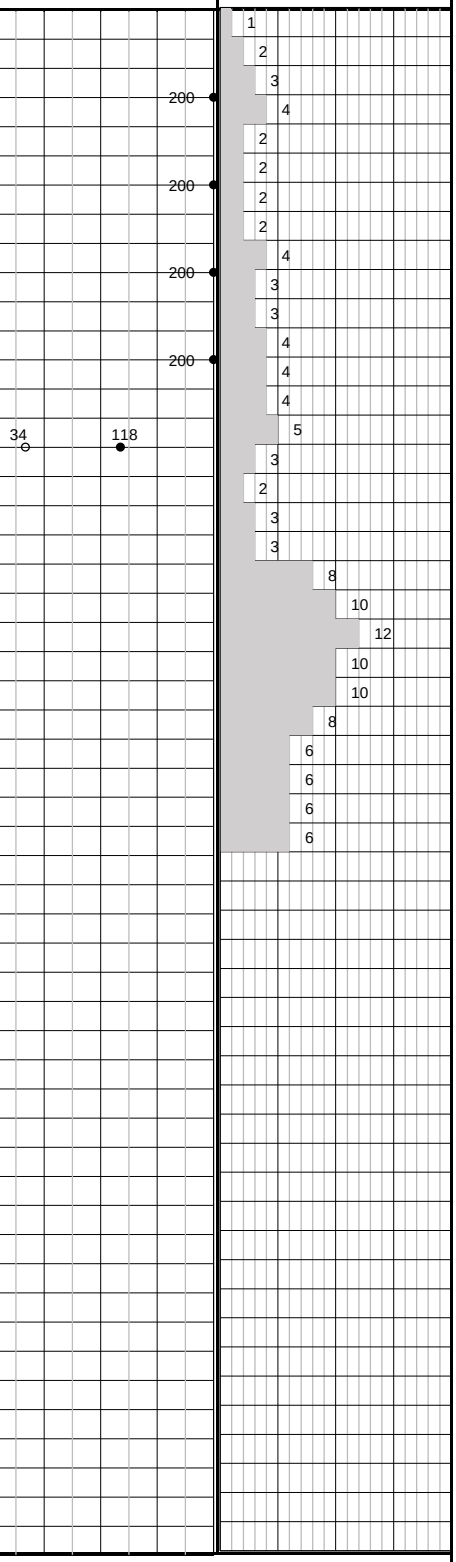
● Peak Field Vane

○ Remoulded Field vane

50 100 150

SCALA PENETROMETER BLOWS / 100 mm

5 10 15



NOTES Groundwater was encountered at 2.0 m

Hand auger encountered poor retrieval due to saturated soil at 2.5 m.

Scala Penetrometer test performed from surface adjacent to borehole.

LOGGED BY: MD

DATE DRILLED: 4-Apr-24

DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 9

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, sandy, friable, to 100 mm							
Pakiri Formation of the Waitemata Group	SILT dark brown, fine grained, intermixed white grey (tephra)							
	light brown with orange brown streaks, slightly to moderately clayey, slightly to moderately plastic, some sand							
	moderately clayey, moderately plastic, trace sand		1					
	light brown, slightly clayey, slightly plastic, some sand							
	moderately clayey layer, decreased sand		2					
	water at 2.8 m, root fragments					V		
	sandy layer		3					
	E.O.B: 3.0 m							
			4					
			5					

200 200 71 148 60 124 60 131 50 124 67 124 84 131 40 144 50 104

NOTES Groundwater was encountered at 2.8 m.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 4-Apr-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 10

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL
T	TOPSOIL dark brown, sandy, friable, to 150 mm					
Alluvium of the Tauranga Group	SAND light brown, fine grained, some silt					
	light brown with orange brown mottling, slightly silty, fine grained, medium dense		1			
	yellow brown, clean, fine to medium grained, medium density, moist					
	water at 2.5 m		2			V
	light grey, slightly silty, saturated					
	E.O.B: 3.0 m		3			
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Peak Field Vane

○ Remoulded Field vane

50 100 150

200

SCALA PENETROMETER BLOWS / 100 mm

5 10 15

1 3 4 1 7 6 5 6 8 8 7 8 12 12 9 12 8 12 15

NOTES Groundwater was encountered at 2.5 m.
Hand auger reached target depth at 3.0 m.
Scala Penetrometer test performed from the surface adjacent to the borehole.

LOGGED BY: MD

DATE DRILLED: 3-Apr-24

DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 11

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL
T	TOPSOIL dark brown, sandy, friable to 200 mm					
Alluvium of the Tauranga Group	SILT light brown with orange brown streaks, slightly to moderately clayey, slightly to moderately plastic, moderately sandy moist		1			
	SAND light brown, slightly silty, fine to medium grained, moist to wet water at 1.6 m grey, clean, fine to medium grained saturated		2			V
	E.O.B: 2.2. m		3			
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Peak Field Vane

○ Remoulded Field vane

50 100 150

Depth (m)	Peak	Remoulded
0.5	188	40
1.0	141	54
1.5	87	34
2.0	94	34
2.5	108	54
3.0	108	50
3.5	108	50

SCALA PENETROMETER BLOWS / 100 mm

5 10 15

Depth (m)	Blows / 100 mm
0.0	2
0.1	3
0.2	3
0.3	3
0.4	2
0.5	2
0.6	2
0.7	2
0.8	1
0.9	1
1.0	2
1.1	2
1.2	2
1.3	4
1.4	4
1.5	5
1.6	5
1.7	5
1.8	5
1.9	5
2.0	5
2.1	5
2.2	5
2.3	5
2.4	6
2.5	6
2.6	6
2.7	7
2.8	7

NOTES Groundwater was encountered at 1.6 m.

Hand auger encountered poor retrieval at 2.2 m due to saturated soil.

Scala Penetrometer test performed from surface adjacent to borehole.

LOGGED BY: MD

DATE DRILLED: 3-Apr-24

DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 12

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, sandy, to 150 mm							
Alluvium of the Tauranga Group	SILT light brown with intermixed white grey (tephra), friable							
	light brown with orange brown streaks, slightly to moderately clayey, slightly to moderately plastic, sandy							
	moist		1				200; 40 ○ 134 ●; 44 ○ 91 ●; 47 ○ 81 ●	
	grey, slightly clayey, fine grained, very stiff, hard to auger		2				50 ○ 91 ●; 200; 200; 200	
	poor retrieval due to very stiff soil							
	E.O.B: 2.5 m		3					
			4					
			5					

NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED:
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 13

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, sandy, to 100 mm							
Pakiri Formation of the Waitemata Group	SILT dark brown, sandy, friable							
	light brown with orange brown streaks, slightly to moderately clayey, slightly to moderately plastic, some sand		1				200 ● 64 ○ 138 ● 50 ○ 101 ● 50 ○ 87 ● 54 ○ 91 ●	
	light grey with orange brown streaks, increased clay and plastcity, decreased sand						54 ○ 134 ● 50 ○ 118 ● 47 ○ 108 ●	
	decreased clay and plasticity, increased sand		2				60 ○ 121 ● 40 ○ 121 ●	
	grey with occasional orange brown mottling, some sand, slightly clayey, slightly plastic							
	E.O.B: 3.0 m		3					
			4					
			5					

NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 3-Apr-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 14

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, friable, to 100 mm							
Pakiri Formation of the Waitemata Group	SILT brown with intermixed white grey (tephra), fine grained, friable							
	light brown with orange brown streaks, slightly clayey, slightly plastic, slightly sandy		1				● 200 ● 200 ● 200 ○ 121 ● 192 ○ 104 ● 171	
	light grey with orange brown streaks, moderately clayey, moderately plastic		2				○ 77 ● 111 ○ 74 ● 101 ○ 60 ● 101	
	moist to wet		3				○ 74 ● 108 ○ 50 ● 84	
	E.O.B: 3.0 m		4					
			5					

NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 3-Apr-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

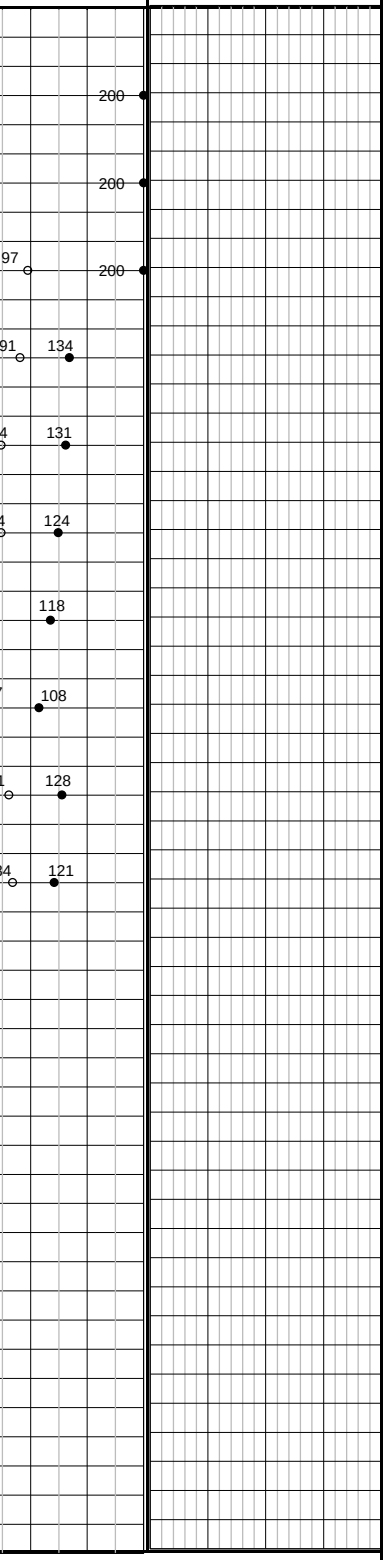
BOREHOLE No. 15

SITE: 18A Black Swamp Road, Mangawhai

REF: 24027

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, sandy, to 100 mm							
Pakiri Formation of the Waitemata Group	SILT brown, possible tephra mix, sandy, friable							
	orange brown, sandy, friable							
	orange brown with light brown streaks, slightly clayey, slightly plastic, slightly sandy		1					
	light grey with orange brown streaks, slightly to moderately clayey, slightly to moderately plastic		2					
	E.O.B: 3.0 m		3					
			4					
			5					



NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 3-Apr-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 16

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, friable, to 50 mm							
Alluvium of the Tauranga Group	SILT white grey, fine grained, friable (tephra)							
	orange brown, friable, burnt ash layer, hard to auger, broke with scala then continued with borehole		1				200	15, 12, 8, 6, 2
	light brown with occasional orange brown staining, slightly to moderately clayey, slightly to moderately plastic, slightly sandy						200, 71 ○ 124, 67 ○ 118, 50 ○ 118	
	increased sand		2				40 ○ 108	
	moist						47 ○ 84, 50 ○ 74	
	E.O.B: 3.0 m		3				84 ○ 151	
			4					
			5					

NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.
Scala Penetrometer used from 0.6 m to 1.1 m to break through burnt ash layer.

LOGGED BY: MD
DATE DRILLED: 27-Mar-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 17

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown to 50 mm							
Alluvium of the Tauranga Group	SILT white grey with intermixed brown inclusions, fine grained (tephra)							
	light brown with orange staining, slightly clayey, slightly plastic, slightly sandy		1				60 ○ 151 ●	
							64 ○ 128 ●	
	increased clay and plasticity, reduced sand						47 ○ 101 ●	
							47 ○ 118 ●	
	dense sandy layer		2				200 ●	
	dark grey, slightly clayey, slightly plastic, stiff						84 ○ 200 ●	
							200 ●	
			3				200 ●	
	E.O.B: 3.0 m						200 ●	
			4					
			5					

NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 27-Mar-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

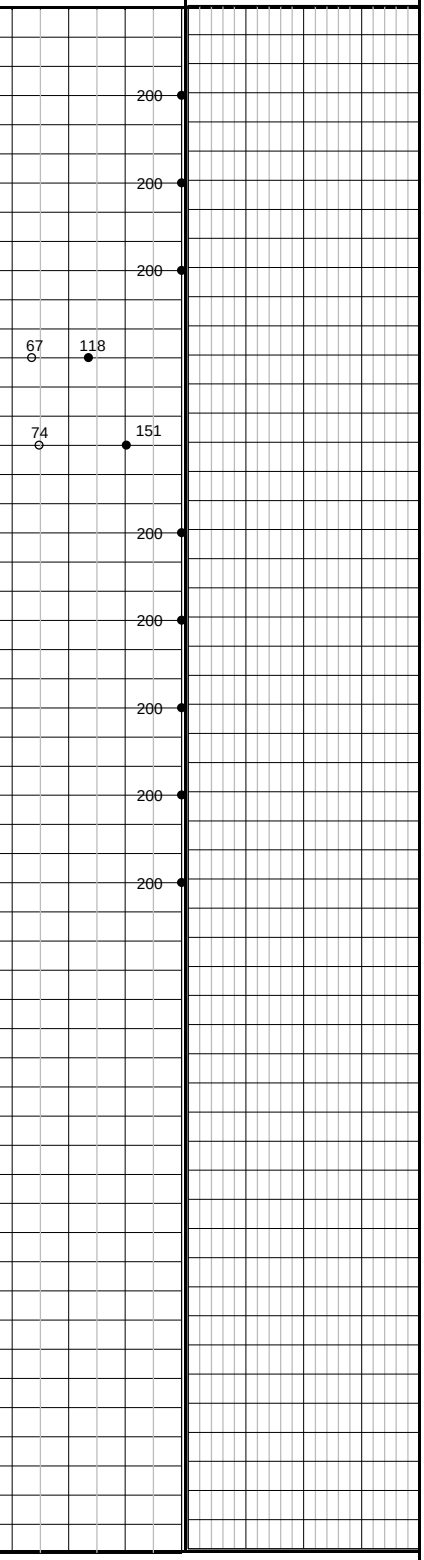
BOREHOLE No. 18

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, friable, to 100 mm							
Alluvium of the Tauranga Group	SILT white grey, fine grained (tephra)							
	light brown with orange brown mottling, slightly clayey, slightly plastic, trace sand, stiff							
	light grey with orange brown staining, slightly to moderately clayey, slightly to moderately plastic		1					
	occasional sandy horizons							
	dark grey, slightly clayey, slightly plastic, very stiff		2					
	decreased clay and plasticity, becoming friable							
	friable, fine grained		3					
	E.O.B: 3.0 m							
			4					
			5					



NOTES Groundwater was not encountered.
Hand auger reached target depth at 3.0 m.

LOGGED BY: MD
DATE DRILLED: 27-Mar-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 19

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Peak Field Vane ○ Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, sandy, to 200 mm							
Alluvium of the Tauranga Group	SAND light brown, clean, fine to medium grained, loose to medium dense						○40 ●124	2, 2, 3, 2, 2, 1, 1, 1, 1, 4, 6, 7, 8, 7, 8, 8, 8, 8, 9, 10, 10, 10, 8, 6, 6, 6, 6, 9, 9
	light grey, fine to medium dense		1					
	water at 1.8 m		2					
	E.O.B: 2.2. m		3					
			4					
			5					

NOTES Groundwater was encountered at 1.8 m.
Hand auger encountered poor retrieval at 2.2 m due to saturated soil.
Scala Penetrometer test performed from the surface adjacent to the borehole.

LOGGED BY: MD
DATE DRILLED: 27-Mar-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 20

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL
T	TOPSOIL dark brown, moist, slightly sandy, to 400 mm					
Tauranga Group	SILT dark grey, slightly clayey, slightly plastic, sandy, moist					
	water at 0.8 m					V
	dark brown, highly organic, rootlets					
	SAND grey, saturated		1			
	E.O.B: 1.1 m					
			2			
			3			
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Peak Field Vane

○ Remoulded Field vane

50 100 150

34 108

24 67

17 50

SCALA PENETROMETER BLOWS / 100 mm

5 10 15

3 0 1 2 4 5 5 7 10 15 15 15

NOTES Groundwater was encountered at 0.8 m.

Hand auger encountered practical refusal at 1.1 m on possible tree root.

Scala Penetrometer test performed from base of borehole.

LOGGED BY: MD

DATE DRILLED: 27-Mar-24

DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 21

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Peak Field Vane ○Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
Tauranga Group	SILT brown, sandy, fine grained, occasional grey sand							1, 2, 3, 3, 15
	E.O.B: 0.4 m		1, 2, 3, 4, 5					

NOTES Groundwater was not encountered.
Hand auger encountered practical refusal at 0.4 m upon inferred sandstone hardpan.
Scala Penetrometer Test performed from surface adjacent to borehole.

LOGGED BY: MD
DATE DRILLED: 27-Mar-24
DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 22

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL
T	TOPSOIL dark brown, sandy, to 300 mm					
Alluvium of the Tauranga Group	SILT dark brown, sandy, organic stained					
	SAND chocolate brown, slightly silty, medium to coarse grained, densely packed		1			
	water at 1.6 m					V
	E.O.B: 1.8 m		2			
			3			
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Peak Field Vane

○ Remoulded Field vane

50 100 150

50 146

24 67

200

200

200

SCALA PENETROMETER BLOWS / 100 mm

5 10 15

1 2 2 3 15 15

10 15

NOTES Groundwater was encountered at 1.6 m.

Hand auger encountered poor retrieval at 1.8 m due to saturated soil.

Scala Penetrometer test performed from surface and from base of borehole.

LOGGED BY: MD

DATE DRILLED: 27-Mar-24

DRILL METHOD 50 mm Hand Auger

WILEY GEOTECHNICAL LTD

BOREHOLE No. 23

SITE: 18A Black Swamp Road, Mangawhai

REF: 22112

Sheet 1 of 1

REDUCED LEVEL (RL) / INFERRED GEOLOGY	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Peak Field Vane ○Remoulded Field vane 50 100 150	SCALA PENETROMETER BLOWS / 100 mm 5 10 15
T	TOPSOIL dark brown, sandy to 200 mm							0
Tauranga Group	SILT dark brown, organic, sandy							2 2 2
	SAND chocolate brown, silty, medium to coarse grained							1 2 2 1
	E.O.B: 0.9 m		1 2 3 4 5					15

NOTES Groundwater was not encountered.
Hand auger encountered practical refusal at 0.9 m upon inferred sandstone hardpan.
Scala Penetrometer test performed from the surface adjacent to the borehole.

LOGGED BY: MD
DATE DRILLED: 27-Mar-24
DRILL METHOD 50 mm Hand Auger