15 November 2023

PROPOSED WHENUAPAI BUSINESS PARK PLAN CHANGE

TRIG ROAD AND BRIGHAM CREEK ROAD, WHENUAPAI

GEOTECHNICAL ASSESSMENT REPORT

Neil Construction Limited

AKL2023-0230AB Rev 0

AKL2023-0230AB		
Date	**Revision**	**Comments**
26 October 2023	A	Initial draft for Client review
13 November 2023	B	Final draft for internal review
15 November 2023	0	Final issue

	Name	Signature	Position
Prepared by	Andrew Linton		Principal Geotechnical Engineer CMEngNZ, CPEng
Reviewed and Authorised by	Richard Knowles		Principal Geotechnical Engineer CMEngNZ, CPEng

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Appendices

1 INTRODUCTION

CMW Geosciences (CMW) was engaged by Neil Construction Limited to carry out a geotechnical investigation of a site located at Trig Road and Brigham Creek Road, Whenuapai,. This report is to provide geotechnical input to support a Private Plan Change (PPC) Application to rezone a 47.5 hectare and parcel from Future Urban to Business – Light Industry zone.

The purpose of this report is to summarise the existing information, preliminary ground conditions expected, and to identify and quantify geotechnical risks to the proposed subdivision development.

1.1 Scope of Work

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced AKL2023-0203AA, Rev 0 dated 21 September 2023, and is defined as follows:

- Desktop analysis of the site, including review of available existing reports, historic aerial photographs, and published geology.
- Site walkover and geomorphological mapping.
- Site investigations comprising 16 hand auger boreholes and 7 Cone Penetration tests.
- Laboratory testing of 5 samples to assess Atterberg Limits and Plasticity Index
- Provision of plans showing anticipated geology, geomorphology, and geotechnical hazard / constraint zones.
- Preparation of a Geotechnical Assessment Report summarising the findings above, which will include any areas of historic filling identified and discuss potential constraints to future commercial development.

2 SITE LOCATION AND LANDFORM

The site comprises an area of approximately 47.5 hectares and comprises the 13 following land parcels, as shown on ***Figure 1***:

- 69, 71, 73, 94, 96 and 96a Trig Road,
- 141, 145, 151, 153, 155 to 157 and 159 Brigham Creek Road.

The current general landform is presented on ***Figure 2***.

Current land use varies, and comprises a mix of rural pasture, agricultural and infrastructure activities, with stand-alone rural-residential dwellings and farm sheds scattered across the properties. Bulk earthworks have been undertaken recently across 69, 71,73 and 94 Trig Road and 151 and 155 Brigham Creek Road. Various rows of shelter belt trees are (or were) located across the area. Due to the historical farming land use, rubbish fills, offal pits and uncontrolled fills may exist.

The area is characterised by an alluvial terrace that grades from Trig Road in the southwest gently towards the northwest and gently to moderately to the east/northeast. A minor stream runs from west to northeast through the centre of the main site, with a larger southwest to northeast trending stream located to the south-east of the overall block. The overall topography falls from a high point on Trig Road of RL45m, to a low on the south-eastern flank of RL14m and in the eastern corner of RL12m.

Figure 1: Site Location Plan (Reference Auckland Council Geomaps)

Figure 2: Site Contour Plan (Reference Auckland Council Geomaps)

3 DESKTOP STUDY

Related Documents
Geotechnical Investigation Report for Trig & Brigham Creek Road, referenced AKL2019-0040AB Rev.0, dated 29 March 2019
Geotechnical Investigation Report for Trig & Brigham Creek Road, referenced AKL2019-0040AD Rev.0, dated 15 January 2020
CMW Geosciences Natural Hazards Risk Assessment for Land Subdivision at Trig & Brigham Creek Road, referenced AKL2019-0040AE Rev.0, dated 15 January 2020
Geotechnical Investigation Report for 71 Trig Road, referenced AKL2020-0231AB Rev.1, dated 24 June 2021
Geotechnical Investigation Report for 94 Trig Road, referenced AKL2021-0133AB Rev.1, dated 3 November 2021
Bridge Abutment Pile Parameters for Trig & Brigham Creek Road, referenced AKL2019-0040AJ Rev.0, dated 22 December 2021
Geotechnical Investigation Report for Proposed Mixed-Use Subdivision Development, Corner Brigham Creek Road & Kauri Road, Whenuapai, referenced AKL2017-0167AC Rev.1, dated 7 December 2022
Geotechnical Investigation Report for 73 Trig Road, referenced AKL2019-0040AN Rev.0, dated 23 January 2023
Geotechnical Desk-Top Study for 96A Trig Road, referenced AKL2023-0108AB Rev.0, dated 28 April 2023

Historical Aerial Photographs		
Source	**Photograph Set**	**Notes/Observations**
Retrolens	23/04/1940, SN143, Run 92, Photo 21, Scale 1:16000	Earliest known photograph. Site is predominantly in pasture, with houses at #141 and #145 Brigham Creek Road.
	19/09/0950, SN583, Run 1915, Photo 20, Scale 1:15900	House and sheds on 96/96A Trig Road.
	24/04/1963, SN1392, Run 3232, Photo 40, Scale 1:16700	Apparent horse training track on 94 Trig Rd.
	14/04/1972, SN3552, Run 4599, Photo 4, Scale 1:23900	Horse training track gone from 94 Trig Rd.
	20/03/1988, SN8772, Run H, Photo 16, Scale 1:25000	Market gardens present across much of 69, 71 & 73 Trig Rd, and 141 & 155 Brigham Creek Rd. Filling of minor gully in eastern corner of 69 Trig Rd.
Auckland Council Geomaps	Aerial Photography Set – 2000 Waitakere	Market garden share has reduced. Orchards and shelterbelts across 69 Trig Rd and 151 Brigham Creek Rd. Houses present at 73 Trig Rd and 151 & 159 Brigham Creek Rd. Structures present on 145 Brigham Creek Rd.
	Aerial Photography Set - 2017	Minimal changes from 2000 photo.

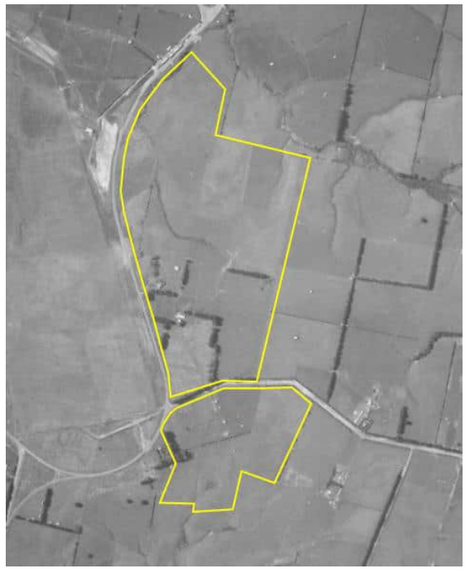


Figure 3: 1940 (Retrolens)

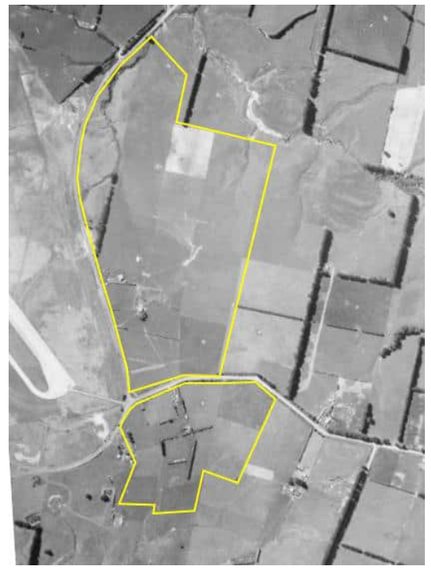


Figure 4: 1950 (Retrolens)

Figure 5: 1988 (Retrolens)

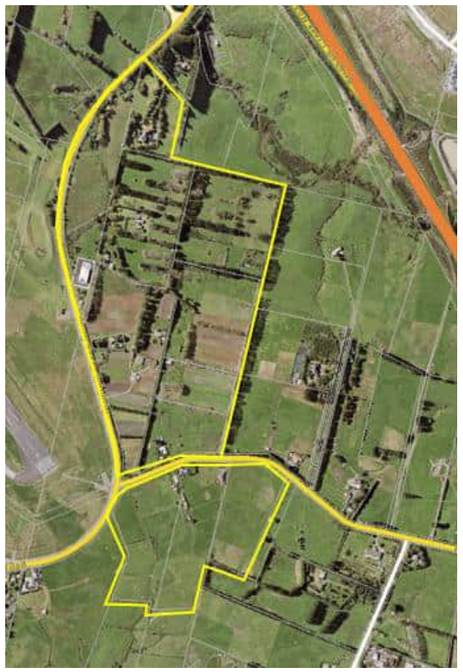


Figure 6: 2017 (AC Geomaps)

FACTUAL

3.1 Existing Investigations

Figure 7 below shows the extent of investigations contained within the New Zealand Geotechnical Database (NZGD) which have been undertaken on nearby sites.

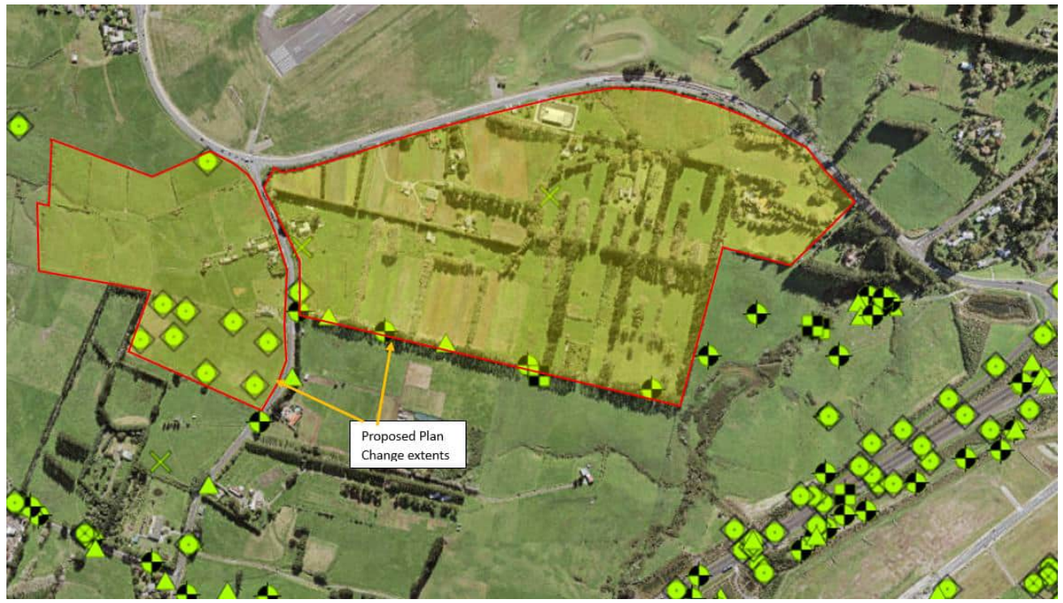


Figure 7: NZGD Investigation Plan

4 INVESTIGATION

4.1 Site Investigations

Site investigations have been previously undertaken by CMW across some of the properties comprised within the proposed Plan Change area. Investigations have also been recently completed across the properties at 96 Trig Road and 141 & 159 Brigham Creek Road, to supplement the previous investigations. The scope of recent fieldwork completed comprised a suite of hand auger boreholes (HA01-23 to HA16-23) and Cone Penetration Tests (CPT). The appended Site Investigation Plan, and ***Figure 8*** below show all CMW investigations that have been completed within the subject area.

Additional site investigation plans showing the extent of CMW investigations undertaken across the adjacent properties are also appended to this report.

Figure 8: CMW Site Investigation Plan

4.2 Laboratory Testing

Laboratory testing has been undertaken on select samples from the recent investigations to assess general soil parameters. All testing was scheduled by CMW and carried out by Roadtest, an IANZ registered Testing Authority. The extent of testing carried out is presented below.

Laboratory Testing				
Test ID/ Location	**Type of Test**	**Test Method**	**Depth (m bgl)**	**Results**
HA01-23	Atterberg + PI	NZS4402 Test 2.1, 2.3, 2.4, 2.5 & 2.6	0.5 – 0.9	CPL = 102, PL = 40, PI = 62, LS = 20, MC = 41.4%
HA05-23				CPL = 94, PL = 40, PI = 54, LS = 21, MC = 48.7%
HA09-23				CPL = 51, PL = 26, PI = 25, LS = 13, MC = 28.9%
HA13-23				CPL = 68, PL = 32, PI = 36, LS = 17, MC = 38.0%
HA16-23				CPL = 186*, PL =114, PI = 72, LS = 24, MC = 115.6%
Notes: CPL = Cone Penetration Limit; PL = Plastic Limit; PI = Plasticity Index; LS = linear shrinkage; MC = moisture content • Also checked and confirmed presence of Allophanic soils				

4.3 Groundwater

During the various investigations, groundwater was encountered at depths ranging from 0.2m to 3.8m below existing ground levels.

Prior to earthworks operations commencing in 73 and 94 Trig Road, groundwater monitoring piezometers were installed in a number of the boreholes, to various depths below existing ground level, using 32mm uPVC, gravel and a bentonite plug. Results of groundwater monitoring showed a groundwater table within the upper 1.5m of the soil profile. Earthworks undertaken within these sites to date have proved the measured groundwater table to be perched, with near surface groundwater flows travelling along a highly permeable silty sandy layer at around 1m depth.

Within the recent investigations, groundwater has been measured in all boreholes, ranging in depth from 0.2m to 3.8m below ground surface.

5 GROUND MODEL

5.1 Published Geology

Published geological maps[1] for the area depict the regional geology as comprising Late Pliocene to Mid Pleistocene alluvial deposits of the Puketoka Formation (Pup) as illustrated in ***Figure 9*** below.

These alluvial deposits include pumiceous mud, sand and gravel with muddy peat and lignite, rhyolitic pumice (including non-welded ignimbrite, tephra and alluvial pumice deposits) and massive micaceous sand beds. Below these upper soil layers, the deeper geological formation is reported to comprise, interbedded muddy sandstones and siltstones of the East Cast Bays Formation (Mwe) within the Waitemata Group.

The main geotechnical hazards within the Puketoka Formation strata are low bearing capacity and settlement from soft/organic soils.

We also expect that uncertified fill is present across parts of the development site, a portion of which has already been remediated within 69 Trig Road.

5.2 Geomorphology

The geomorphology of the site was mapped by examination of aerial photographs, and during various site walkovers, and is presented in the Geomorphology plan as ***Figure 10***.

As noted above, site gradients are typically relatively gentle, although they do steepen adjacent to the watercourses that flow through or adjacent to the site.

5.3 Investigation Findings

In general, the various investigations undertaken across the Plan Change area have confirmed the expected geology and ground conditions.

The area predominantly comprises firm to very stiff clayey silts and silty clays. There are dense sand deposits recorded at depth in several CPTs towards the north and north-east part of the subject area, and East Coast Bays Formation rock has been identified during investigations for a future bridge within 157 Brigham Creek Road. There are also soft peat and organic clays identified in a number of boreholes, and a CPT, within 141 Brigham Creek Road.

Alluvial clay deposits are generally inferred to extend to depths of between 8m and 15m below the existing ground surface, underlain by dense sand deposits and East Coast Bays Formation rock. The depth to dense sands reduces in the northeast corner of 159 Brigham Creek Road to approximately 5m.

5.4 Groundwater

Groundwater has been measured in all boreholes, ranging in depth from 0.2m to 3.8m below ground surface. It is likely that the higher recorded levels are perched, while the lower levels are expected to be related to the regional groundwater table.

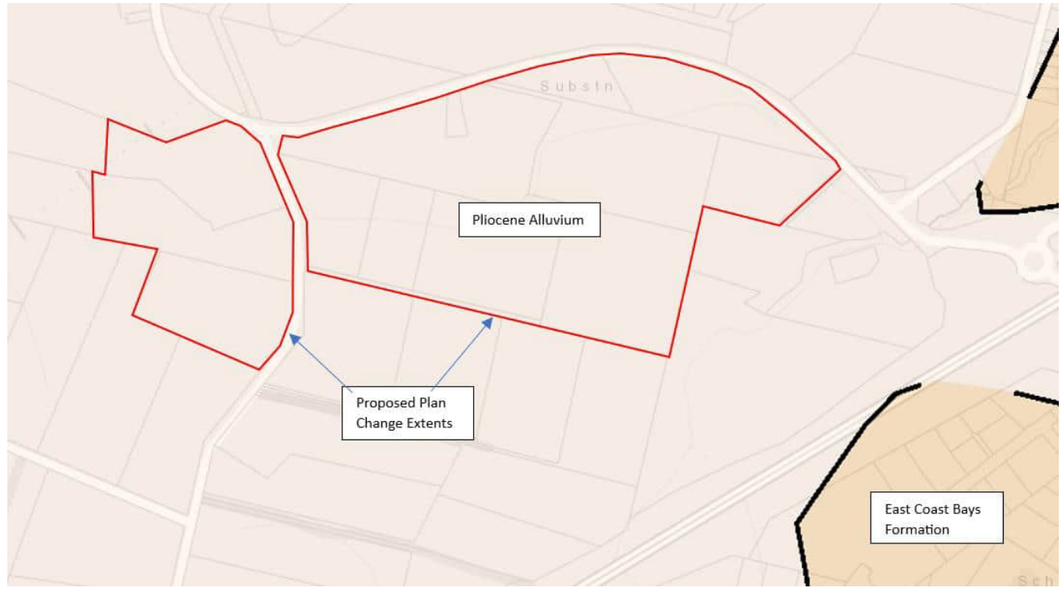


Figure 9: Regional Geology (GNS Science Web Geology Map)

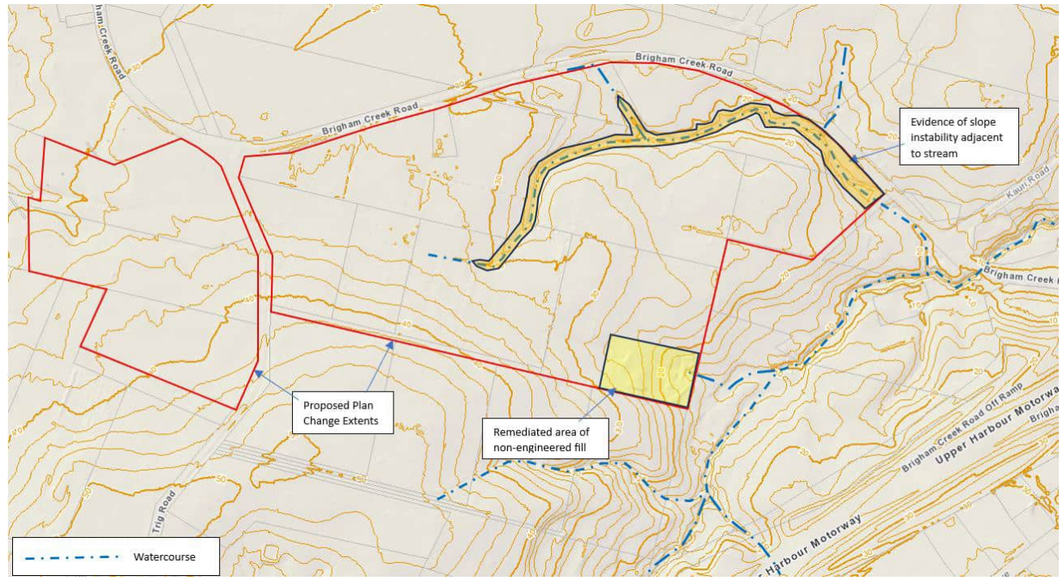


Figure 10: Geomorphology Plan

INTERPRETIVE

6 GEOHAZARDS ASSESSMENT & MITIGATION

Geotechnical Assessment and Mitigation			
Geotechnical Hazard	**Description**	**Area Affected**	**Comments and Geotechnical Control / Mitigation Measures**
Water/Groundwater	Surface Water	Alluvial terrace (Geohazard Zone 2)	A single low-flow watercourse runs through the north-eastern portion of the subject area. The source of this watercourse appears to be a spring located just inside the northern boundary of 71 Trig Road and flows to the north. South of this spring, an overland flowpath has been altered over time to form a farm drain For the purposes of this report, we have assumed that the overland flowpath extents can be filled. It can be assumed that any filling will have underfill drainage placed beneath it to allow the flow of any occasional water flows to continue and to prevent the build-up of groundwater pressures from developing beneath the fill.
	Shallow Groundwater	Entire Site	During the site investigations, and recent earthworks undertaken within 94 Trig Road and 155 Brigham Creek Road, high groundwater levels have been recorded in some locations. Based on our observations during the earthworks, it is likely that the higher levels encountered during the investigations are in fact sitting within a siltier/sandier layer perched on top of an impermeable clay lens. The lower groundwater depths measured elsewhere are more likely to be regional groundwater levels. Potentially mitigated by the installation of subsoil drainage, dependent on earthworks required for site development. Additional groundwater monitoring may be required to assess need for take and diversion consents, again dependent on proposed earthworks. Stormwater soakage to ground is typically not feasible.
Erosion	Cut Batters	Unknown (future cut areas)	Mitigated by designing for maximum 1V:3H gradient, or steeper with surface stabilisation / treatment included in design (such as undercuts, by over excavation and replacement, soil nails, retaining walls).
	Fill Batters	Unknown (future fill areas)	Mitigated by designing for maximum 1V:3H gradient, stormwater control and/ or steeper with surface stabilisation / treatment in design (such as reinforced earth slopes / walls).
Landslip	Global Slope Instability	Elevated areas and slopes.	Most of the site is relatively gently sloping and not considered subject to instability risk. Steeper gradients are present adjacent to the stream that runs through 155, 157 and 159 Brigham Creek Road. Slope stability remedial works in this geology may require undercuts and/or small shear keys along the riparian margin where the overall drop in contour into the stream is limited to several metres. Where a larger drop is present, installation of palisade piles, or set-backs from the steeper slopes, may be required. Would be subject to detailed investigation and stability analysis, dependant on the earthworks and/or future development proposed.
	Soil Creep	Elevated areas and slopes.	A function of slope gradient and the expansive nature of the materials, movement is typically limited to approximately 1m depth, where present. Creep is limited to the sloped areas partially along ridge flanks. To be mitigated by design of slope gradients, including use of retaining walls, subsoil drainage and by design of footings.
	Cut & Fill Batter Instability	Future cut, and fill areas	Mitigated by stormwater control and surface stabilisation, smart construction staging and temporary and permanent retaining.
Expansive Soils	Expansive Soils	Entire site	Expansive soils are classified in NZS 3604 as those soils having a liquid limit of more than 50% and linear shrinkage of more than 15%. Alluvial soils are typically moderately to highly expansive. Mitigation of the expansive soil hazard is by foundation design at Building Consent stage and will be addressed on a lot-by-lot basis in the Geotechnical Completion Report(s) at the conclusion of the development works.
Subsidence	Soft Soils/ Load Induced Settlement	Entire Site	In areas where fills and/ or significant building construction or storage loads are placed over soft deposits, allowance needs to be made for post-construction settlement of the fills and the underlying ground that could cause damage to structures. Consideration in the design needs to be given to the quantum of settlement that is likely to occur (i.e. ensuring it is insufficient to influence the cut/ fill volumes and balance during earthworks and/ or damage structures) and the time taken for the settlement to occur (i.e. ensuring it will be largely completed by the time a normal civil works programme would likely be commencing). The topography and existing information indicate that a paleo-channel alignment may run through 141 Brigham Creek Road, where peat soils have been identified adjacent to Brigham Creek Road. The most appropriate mitigation is to avoid the potential for highly loaded structures in these areas during Master Planning, or to allow for ground improvement / piled foundations.

Geotechnical Assessment and Mitigation			
Geotechnical Hazard	**Description**	**Area Affected**	**Comments and Geotechnical Control / Mitigation Measures**
			Remedial options for accelerating settlements in areas of deep alluvium / peat soils include preloading and installation of wick drains but based on our experience in alluvial soils in the Milldale development to the north, pre-loading without wick drains is able to provide good results. Locations and heights of surcharge must be subject to geotechnical review to avoid causing bearing capacity failure in the underlying alluvium.
Existing Fill	Uncertified Fill	Entire Site	Localised zones of existing uncertified fill area have been identified in isolated locations across the larger site. Re-engineering of existing fill may be required in some areas. Following environmental testing (by others) material reworking may be considered appropriate.
Seismicity	Liquefaction	Entire Site	Liquefaction is a process where typically saturated, granular soils develop excess pore water pressures during cyclic (earthquake) loading that exceed the effective stress of the soil. Liquefaction potential will be largely dependent on material characteristics of the underlying soils. A region-wide liquefaction assessment has been undertaken by Auckland Council in accordance with MBIE document "Planning and engineering guidance for potential liquefaction-prone land Resource Management Act and Building Act aspects" (2017). The liquefaction potential has been assessed to be unlikely. However additional investigations will be required to determine the potential for the recently identified peat soils to be subject to liquefaction.

7 CONCLUSION

Based on our hazard assessment, we consider that the land is generally suitable for creating stable building platforms and infrastructure, having acceptable levels of post-development residual risk from natural hazards. Consideration of the key geotechnical hazards for each zone should be incorporated into Master Planning. These include:

- Due to the presence of soft soils within 141 Brigham Creek Road this area is considered highly likely to be subject to load induced settlements. Therefore, will require ground improvement beneath building platforms and/or specific foundation design.

Development may require earthworks and drainage to provide adequate stability around the stream which runs through the site. This is achievable given appropriate design, and construction. Any proposed earthworks are to be undertaken in accordance with all relevant standards and documents. The engineering controls required to control existing, latent risks are commonplace works in this terrain that are consistent with those being adopted on adjacent land. Further site investigation and design will need to be undertaken to quantify the geotechnical controls prior to resource consent application and the commencement of any works.

8 CLOSURE

Additional important information regarding the use of your CMW report is provided in the '*Using your CMW Report*' document attached to this report.

This report has been prepared for use by Neil Construction Limited in relation to the Whenuapai Business Park Private Plan Change project in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than Neil Construction Limited seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

USING YOUR CMW GEOTECHNICAL REPORT

Geotechnical reporting relies on interpretation of facts and collected information using experience, professional judgement, and opinion. As such it generally has a level of uncertainty attached to it, which is often far less exact than other engineering design disciplines. The notes below provide general advice on what can be reasonably expected from your report and the inherent limitations of a geotechnical report.

Preparation of your report

Your geotechnical report has been written for your use on your project. The contents of your report may not meet the needs of others who may have different objectives or requirements. The report has been prepared using generally accepted Geotechnical Engineering and Engineering Geology practices and procedures. The opinions and conclusions reached in your report are made in accordance with these accepted principles. Specific items of geotechnical or geological importance are highlighted in the report.

In producing your report, we have relied on the information which is referenced or summarised in the report. If further information becomes available or the nature of your project changes, then the findings in this report may no longer be appropriate. In such cases the report must be reviewed, and any necessary changes must be made by us.

Your geotechnical report is based on your project's requirements

Your geotechnical report has been developed based on your specific project requirements and only applies to the site in this report. Project requirements could include the type of works being undertaken; project locality, size and configuration; the location of any structures on or around the site; the presence of underground utilities; proposed design methodology; the duration or design life of the works; and construction method and/or sequencing.

The information or advice in your geotechnical report should not be applied to any other project given the intrinsic differences between different projects and site locations. Similarly geotechnical information, data and conclusions from other sites and projects may not be relevant or appropriate for your project.

Interpretation of geotechnical data

Site investigations identify subsurface conditions at discrete locations. Additional geotechnical information (e.g. literature and external data source review, laboratory testing etc) are interpreted by Geologists or Engineers to provide an opinion about a site specific ground models, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist due to the variability of geological environments. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. Interpretation of factual data can be influenced by design and/or construction methods. Where these methods change review of the interpretation in the report may be required.

Subsurface conditions can change

Subsurface conditions are created by natural processes and then can be altered anthropically or over time. For example, groundwater levels can vary with time or activities adjacent to your site, fill may be placed on a site, or the consistency of near surface conditions might be susceptible to seasonal changes. The report is based on conditions which existed at the time of investigation. It is important to confirm whether conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation and use by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. To help avoid misinterpretations, it is important to retain the assistance of CMW to work with other project design professionals who are affected by the contents of your report. CMW staff can explain the report implications to design professionals and then review design plans and specifications to see that they have correctly incorporated the findings of this report.

Your report's recommendations require confirmation during construction

Your report is based on site conditions as revealed through selective point sampling. Engineering judgement is then applied to assess how indicative of actual conditions throughout an area the point sampling might be. Any assumptions made cannot be substantiated until construction is complete. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances from previous assumption, conduct additional tests if required and recommend solutions to problems encountered on site.

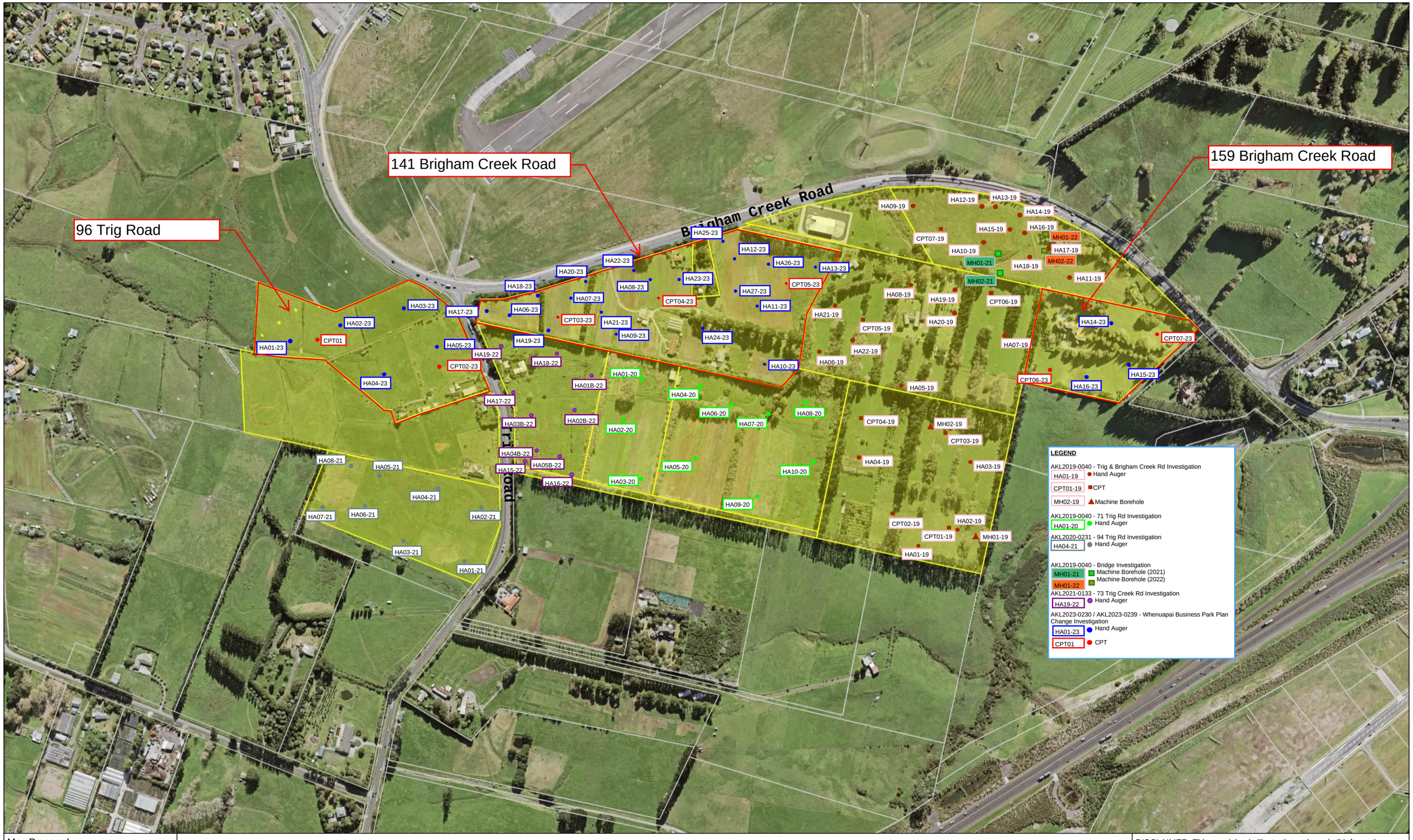
A Geotechnical Engineer, who is fully familiar with the site and the background information, can assess whether the report's recommendations remain valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Environmental Matters Are Not Covered

Unless specifically discussed in your report environmental matters are not covered by a CMW Geotechnical Report. Environmental matters might include the level of contaminants present of the site covered by this report, potential uses or treatment of contaminated materials or the disposal of contaminated materials. These matters can be complex and are often governed by specific legislation.

The personnel, equipment, and techniques used to perform an environmental study can differ significantly from those used in this report. For that reason, our report does not provide environmental recommendations. Unanticipated subsurface environmental problems can have large consequences for your site. If you have not obtained your own environmental information about the project site, ask your CMW contact about how to find environmental risk-management guidance.

Appendix A: Site Investigation Plan



Map Prepared

The Neil Group Limited

Proposed Whenuapai Business Park Plan Change
Trig Road and Brigham Creek Road, Whenuapai
Site Investigation Plan

1:5000 @ A3

AKL2023-0230, Drawing 01 - Rev 1, 13 November 2023

GRIP