



Geotechnical Investigation Report

Amberfield Development

Peacockes Road

Hamilton

Submitted to:

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c/- Harrison Grierson Limited

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1 Executive Summary

This report provides the results of our geotechnical investigation of the Amberfields Development at Peacocks Road, Hamilton East.

The site encompasses a number of broad river terraces with steep transition slopes between terraces and large, steep free face slopes proximal to the Waikato River and the gully cutting through the centre of the site.

Based on our investigations, site soils are consistent with published geological maps and can be broadly classified into the following soil units:

- SAND – Fine to coarse sand, found to be very loose to very dense. This is predominantly high pumice content sand though some layers of non-pumiceous sands were also encountered.
- SILT and CLAY – Cohesive soils generally silt and clay rich with variable sand content, found to be soft to hard.
- Very Dense Soils – Inferred from Cone Penetrometer results, anticipated to be very dense gravel.

Our investigations show that these soil types are commonly interbedded with one another on site, with the sandy soils commonly found in greater thicknesses and frequency in the eastern portion of the site, and cohesive (silt and clay) soils more prominent in the western portions of the site.

During our investigation, groundwater levels observed in boreholes and inferred from pore water pressure recorded in CPTs ranged from the ground surface to over 7.2 m depth, with no apparent pattern between elevation and water level. Due to the interbedded nature of the site soils, we consider it likely that the cohesive layers could form aquitards, trapping water at various elevations within the soil profile.

Given this variance, careful observations should be made during earthworks to determine soil moisture content and safe construction batter angles. We recommend cut slopes of no steeper than 1V:3H when above the water table and no steeper than 1V: 4H when at or below the water table. Where wet soils are encountered during earthworks (as is likely on this site), spreading and drying or mixing of soils may be required in order to reach optimum moisture content prior to placement and compaction as engineered fill.

Liquefaction and lateral spread assessments indicate that the majority of the site can expect limited to minor expression of liquefaction and marginal to moderate lateral spreading in a 1 in 150-year design earthquake.

Steep site slopes show widespread evidence of soil creep and shallow soil failure, particularly proximal to the Waikato River and the Central Valley. Preliminary slope stability assessments indicated that the seismic loading condition is typically the critical case for slope stability, and that land behind a 1V: 3.2H setback line from the base of the Central Valley and Waikato River can be considered protected against slope instability. Development in areas not considered protected against slope instability will require remedial earthworks or construction of specifically designed retaining structures and / or ground improvement. We anticipate remedial earthworks (cut to fill activities) to be sufficient to protect land near terrace transition slopes from soil creep and shallow soil failure.

Based on our investigations and assessment, we consider the site at Peacockes Road to be geotechnically suitable for the proposed residential subdivision subject to the recommendations of this report.

2 Project Brief

This report has been prepared for Weston Lea Limited in support of an application to the Hamilton City Council for Resource Consent to undertake a residential subdivision in accordance with the requirements of the Resource Management Act 1991. This report is also intended to support the subcatchment integrated catchment management plan (ICMP) process associated with the Amberfield Subdivision Resource Consent process.

This report includes consideration of the slope stability of both existing and proposed contours.

Where appropriate, it is in accordance with the recommendations of NZS 4404 Land Development and Subdivision Engineering, the Hamilton City Development Manual, the Hamilton City Infrastructure Technical Specifications and related documents.

3 Scope and Objectives

The scope of this report encompasses the geotechnical suitability and stability of the land having regard for the nature of the development proposals.

Its principal objectives were to assess:

- Existing geomorphological features and their effects on existing site stability;
- The nature, bearing qualities and relative uniformity of the subsoils to the depths likely to be affected by proposed land development works and future building loads;
- Soil strength, classification, consolidation and effective stress parameters as considered relevant to the design issues of this development
- Engineering works required to remediate areas having identified slope instability, poor bearing capacity, high settlement potential or groundwater problems;
- The engineering properties of the materials to be used as filling; and
- The nature and likely extent of any unsuitable materials that may be present across the site.

4 Site Description

The overall site at Peacockes Road is located south of Hamilton City, on the western side of the Waikato River. The study site comprises approximately 130 Ha of farmland and is bordered by rural residential lifestyle blocks and farmland to the west and south and by the Waikato River to the north and east as illustrated in the Site Plan - see Appendix 1. It should be noted that the overall site area is larger than the proposed Amberfield Development area, which comprises approximately 105 Ha.

The site is currently largely undeveloped and is in pasture with seven building structures serving both residential and farming purposes. The steeper area directly adjacent to the Waikato River is densely vegetated with bush and shrubs.

5 Related Reports

As part of the preparation of this report we have reviewed the results and conclusions of the ENGEO Limited Preliminary Geotechnical Investigation report on this site dated 22.09.2017, reference 14280.000.000_08.

Results of field and laboratory testing undertaken as part of that report have been incorporated into the findings of this report.

6 Development Proposals

Our understanding of the proposed development is derived from the following documents:

- Email: Adare Stage 2A Master Plan, sent by Simon Murphy of Harrison Grierson Limited on 4 July 2017;
- Request for Proposal Letter – Peacocks Development Preliminary Site Investigation, Harrison Grierson, reference: 9820-141842-01, dated 13 July 2017; and
- Harrison Grierson Stage 2a Scheme Layout Co-Ordination Plan, reference 9820-141842 drawing 141842 – SK023 rev A dated 28.09.2017.

Based on the above documentation and our correspondence with Harrison Grierson, we understand that the site is to be subdivided into approximately 1,000 residential lots with a number of access ways and residential roads. We have been advised (subsequent to completing our analyses), that Road 2 has now been moved back into the site by approximately 5 metres.

Finished site contours and the extent and depth of cut and fill earthworks proposed onsite were provided to us via the following plans:

- Harrison Grierson Stage 2a Bank Survey Section Location Plan. Sheets 1 and 2, reference 141842- SK091 and SK092 rev 2 dated 23.03.2018.
- Harrison Grierson Stage 2a Bank Survey Sections. Sheets 1 to 4, reference 141842- SK095 to SK098 rev 2 dated 23.03.2018.
- Harrison Grierson Finished Contour Plan. Sheets 1 to 6, reference 141842-1201 to 1206, rev 1 dated 25.01.2018.

These plans and sections were utilised as the ground surface lines for the slope stability analysis undertaken as part of this report.

It is apparent from the contours of the site that the earthworks (except for the fills proposed adjacent to the Waikato River at the northern end of the site), will generally ease the steeper contours and fill or partly fill the gully features with the exception of the north south trending gully which will remain as a natural feature. The large relict slump feature and other minor areas of instability will be undercut, drained, reworked and buttressed as necessary.

Residential building development is the main purpose of the subdivision, with construction to take place mainly in accordance with NZS 3604 Light Weight Timber Framed Buildings.

7 Historical Aerial Photography

7.1 Historical Aerial Photography

We have reviewed the historical aerial photographs from Retrolens and Google Earth for the years from 1938 through to 2017. In addition, we have sourced stereoscopic photographs for 1961 and 1990.

These photographs were viewed specifically under the context of identifying areas of potential instability and changes to landforms. The historic aerial photographs are included as an appendix in our environmental report for the site (Preliminary Site Investigation, reference: 14280.000.001_09, dated 20/09/2017).

Table 1: Historical Aerial Photography Summary

Source (year) [reference]	Summary
Retrolens (1938) [SN107]	The site is largely grassed with more mature vegetation (bushes, shrubs and trees) adjacent to the Waikato River. It should be noted that the vegetation cover on this slope may conceal signs of ongoing instability. There are a number of incised valleys and gullies which feed into the Waikato River (highlighted in blue below).  The entire site appears to be used for farming purposes with a number of residential buildings and sheds located across the site. The surrounding area is predominantly rural residential and grazing land.

Source (year) [reference]	Summary
Retrolens (1943) [SN266]	The 1943 photograph clearly shows the river terraces along the eastern portion of the site, along the length of the Waikato River. The slope angles of the incised valleys and gullies appear to be more prominent in this photograph, however this may be attributable to the camera angle.
Stereoscopic Imagery (1961) [SN1361]	There appears to be three prominent river terraces along the eastern boundary of the site against the Waikato River. The uppermost of these runs roughly north, sub-parallel to the valley and dips to the east. There are a series of scalloped depressions along the edge of this upper bench that appear to have formed from water seeping out of the slope. A series of river benches runs parallel to the river course along the central and northern sections of the site. The detail provided in this series of photographs provides more information on the benches, which was not available in the previous images. It is likely that the scalloped depressions were formed prior, however they are not visible in the earlier photographs.
Retrolens (1967) [SN2053]	The 1967 photograph shows evidence of soil ridging on the slopes of the Central Valley. This may be due to the improved resolution of the image. No visible change to the landform from the 1943 aerial photograph.
Retrolens (1972) [SN3569]	No visible change to the landform from the 1967 aerial photograph.
Retrolens (1973) [SN2624]	No visible change to the landform from the 1972 aerial photograph.
Retrolens (1979) [SN5479]	In the northern portion of the site, there are pale / light patches suggesting areas of bare earth and devoid of vegetation. No other visible changes to the landform from the 1973 aerial photograph.
Stereoscopic Imagery (1990) [SN9124]	The north-trending tributary to the east of the site is less pronounced than in previous images. There are two tributary streams running to the east from the elevated area in the southern portion of the site.
Google Earth (2008)	The 2008 photograph shows evidence of soil ridging on the slopes of the river terraces, gullies and valley. This may be due to the improved resolution and colour image. There is also an increase in vegetation by the mouth of the Central Valley as it connects to the Waikato River.
Google Earth (2017)	No other visible changes to the landform from the 2008 aerial photograph.

8 Geology / Geomorphology

8.1 Regional Geology

The Institute of Geological and Nuclear Sciences (GNS) map the site as being underlain by Holocene aged floodplain, valley and coastal alluvial and colluvium deposits and the Walton Subgroup and the Piako Subgroup of the Tauranga Group (Figure 1).

Figure 1: Regional Geology

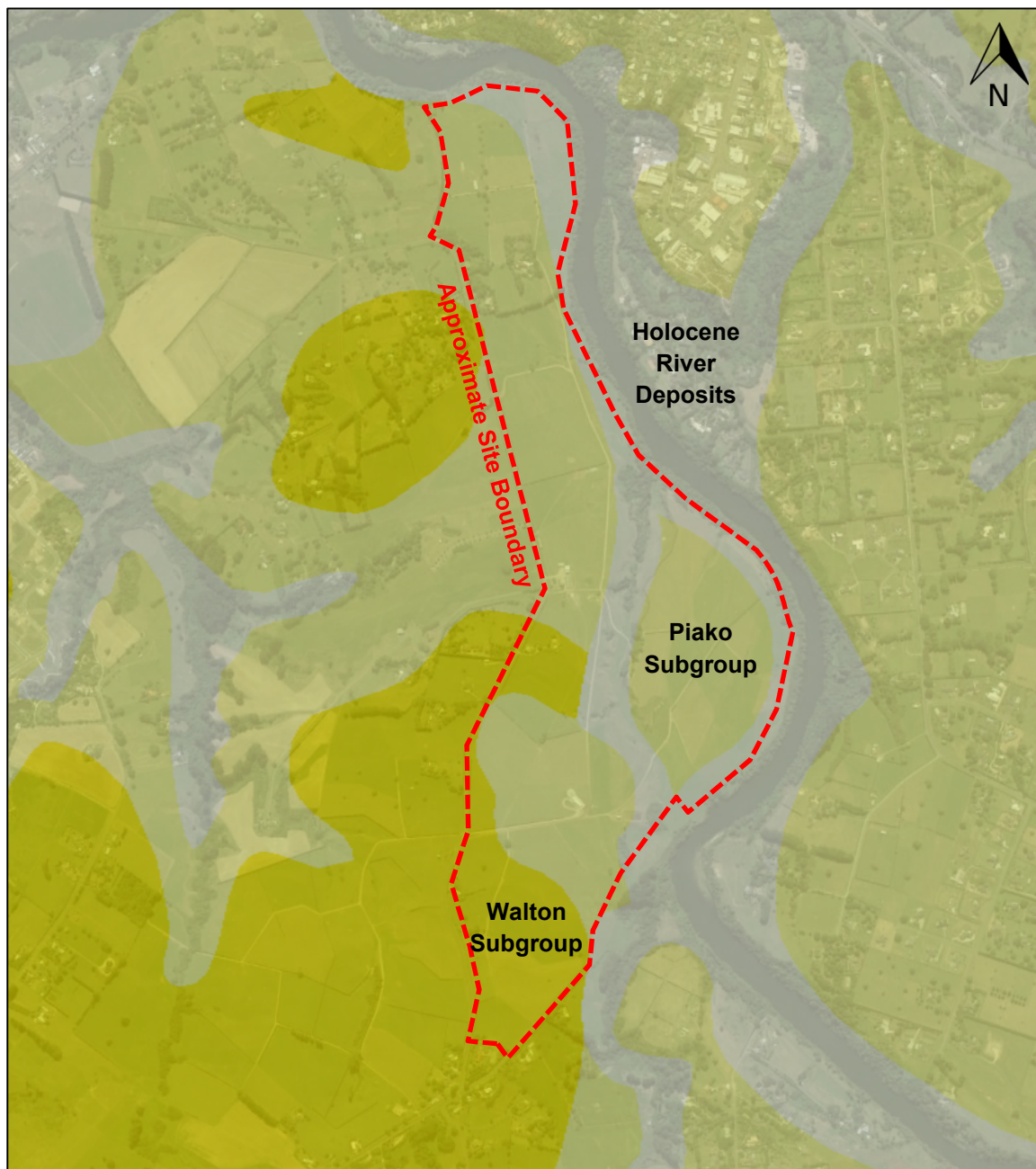


Image sourced from GNS and Google Earth (not to scale).

Holocene aged deposits are associated with the Waikato River and its tributaries. These deposits generally comprise variously coloured, unconsolidated silt, sand, clay and gravels with intercalated peat layers. The Piako Subgroup was deposited during the Late Pleistocene and Holocene and comprises of fluvial, lacustrine alluvium and colluvial sediments. The Piako Subgroup comprises of unconsolidated to poorly consolidated mud, sand, gravel and peat and is expected to be underlain by the Walton Subgroup or older rocks. Walton subgroup strata comprises a sequence of laterally interfingering lenses of pumiceous fine grained and gravelly sand and silt with interbedded peat, diatomaceous mud and non-welded ignimbrite and tephra.

8.2 Seismicity

We have reviewed the New Zealand Active Fault Database, which indicates there are no known active faults on-site, with the nearest active fault being the Kerepehi Fault located 37 km northeast of the site. Nearby inactive faults include the Wilton Fault, Karaka Fault, Manakotuku Fault and Mangapika Fault located 30 km to 35 km west of the site.

8.3 Volcanic Activity

Hamilton is located approximately equidistant from the South Auckland Volcanic Field (SAVF) and the Taupo Volcanic Zone (TVZ).

The SAVF is located approximately 60 km north of Hamilton City and 40 km south of Auckland City. The SAVF is centred around the Manukau Lowlands, extending over 300 km² to the Hunua Ranges in the east, Waikato River valley in the south and the Waiuku in the west. The eruption history of the SAVF is known to date from 0.5 and 1.6 million years ago with peak volcanic activity between 0.6 and 1.3 million years before present. This volcanic field is considered extinct and SAVF derived volcanism is unlikely to be of significant risk.

The TVZ is located 60 km east of Hamilton City and extends from White Island in the north to Ruapehu in the south. The TVZ is considered the most active volcanism in New Zealand for the past 1.6 million years and includes three active cone volcanoes (Ruapehu, Tongariro and White Island).

Hazards proximal to an eruption include pyroclastic surge, block fall and lava flows. Ash fall at a greater distance can cause large disturbance with remobilisation of ash deposits possible, particularly during rainfall events. With over 60 km separating the existing volcanic centres, ash fall presents the greatest risk in Hamilton.

8.4 Flooding

Flooding hazard assessment of this site is covered in the AWA Environmental Limited Adare Flood Hazard Report reference J000031 dated 10 November 2017.

The site is adjacent to the Waikato River and the lower parts of the site are floodable in extreme events. Awa Consulting have carried out a detailed assessment of potential flooding on the site and have concluded that the recommended design water level, including an allowance for free board and climate change effects, in a 1% AEP flood event are 20.1 m at the southern end of the site and 19.5m at the northern end of the site.

We note that these recommended water levels will result in the flood waters extending up to the existing lower paddocks on parts of the site. We anticipate that the final earthworks design will incorporate these design flood water levels and our final slope stability analysis will include our assessment of the impacts of the earthworks and design water levels.

8.5 Surface Conditions and Geomorphic Observations

The site has a number of geomorphological features that are largely a product of natural processes and the geological environment. In general terms, the site is characterised by broad, near level fluvial (river) terraces, separated by steep, linear transition slopes. These transition slopes commonly exhibit signs of soil creep, primarily in the form of soil ridging, and a number also show signs of shallow instability / land sliding.

We note that terrace transition slopes generally become steeper proximal to the Waikato River with an associated increase in magnitude and extent of soil creep and potential land instability. Accordingly, we consider these terrace slopes to be younger and more dynamic than terrace slopes located further from the river.

In addition to this, the site encompasses a number of surface waterways and drains, most of which flow toward the Waikato River or the Central Valley along a combination of incised flow paths and formed drains.

The largest of the internal waterways, the Central Valley, is a very distinct feature originating east to northeast of the milking shed and extending north toward the Waikato River. The gully flanks are over-steepened and show widespread evidence of soil instability. Due to the scale of this feature, its formation may be tied to historical activities of the Waikato River when sea levels were higher than today.

Marshy or swampy ground was also commonly observed proximal to the river in the north of the site, with many of these areas potentially fed by springs rather than overland flow. Marshy ground was also identified within the upper portion of the site, where it was commonly associated with the internal waterways.

We have constructed a series of geomorphic maps based on our site observations which are attached at the rear of this report as Appendix 4.

Figure 2: Site Photographs



Photo 1: Example of terrace with over steepened back slope.



Photo 2: Internal waterway west of Central Valley.



Photo 3: Near level land in the northern portion of the site.



Photo 4: View across northern and Central Valley.



Photo 5: View south along slope terraces, landslide debris and swampy ground adjacent to the Waikato River in the central to northern portion of the site.

9 Fieldwork

Preliminary fieldwork comprising twenty hand auger boreholes (HAs) and twenty cone penetration tests (CPTs) was undertaken in August 2017.

This initial investigation was supplemented by a further nineteen HAs, thirteen machine boreholes (MBHs), nine geotechnical test pits (TPs) and six seismic CPT tests. This additional testing was undertaken during November and December 2017.

A further twenty-two TPs were also excavated and logged by ENGEO on behalf of AWA Limited to determine the drainage characteristics of the site subsoils. The location of these tests is shown on the Site Investigation Location Plan in Appendix 1.

Prior to the commencement of these works power, telephone, water, electricity, gas and Council drainage as-built services plans were checked to ensure that there would be no conflict between these services and our selected test locations.

Machine boreholes were advanced with a Sonic rig supplied by Pro Drill Limited and test pits were advanced using a 12T hydraulic excavator.

All fieldwork was carried out under the full time supervision of one of our geologists and all samples recovered were carefully logged to assist with the preparation of detailed borehole records.

9.1.1 Hand Auger Boreholes

ENGEO completed 39 hand auger boreholes across the site with associated *in situ* testing - Scala penetrometer and shear vanes tests, to a maximum depth of 5.0 m. Full logs are presented in Appendix 2. These logs were prepared in general accordance with the New Zealand Geotechnical Society field classification guidelines (NZGS, 2005).

9.1.2 Cone Penetrometer Testing

Twenty-nine CPTs were undertaken within the site. These tests extended to depths of between 6.3 m and 24.0 m.

The CPT probe gathers raw data including cone tip resistance, friction sleeve resistance and pore water pressure at 2 cm intervals during the test. This information is used to infer the soil type, soil density and water pressure conditions in the ground, and can be used to determine the liquefaction susceptibility of the ground. CPT test locations are presented in Appendix 1 and the CPT logs are presented in Appendix 2.

In addition to the 29 CPT tests, a further six seismic CPT tests were undertaken within areas previously identified as having a high risk of liquefaction. Results of this testing are included in Appendix 2.

9.1.3 Machine Boreholes

Thirteen machine boreholes were drilled within the site, in the locations marked on the site investigation location plans included in Appendix 1. Standard Penetration Testing was undertaken typically at 1.5 m intervals within these boreholes and piezometers were installed within boreholes MBH01, MBH02, MBH04, MBH06, MBH07, MBH11 and MBH13 for ground water monitoring.

9.1.4 Test Pits

Test Pit data is included in Appendix 2. The geotechnical test pits were typically located within existing slopes to identify any failure planes present within these slopes.

9.1.5 Summary of Subsurface Conditions

The material encountered in our subsurface investigations is broadly consistent with published mapping. Table 2 provides a generalised summary of the subsurface conditions compiled from our investigations. Please refer to the hand auger borehole, test pit, machine borehole and CPT logs for

specific subsurface conditions at each location. A description of the materials encountered in our explorations is provided below.

Topsoil

Topsoil was generally encountered in the upper 0.4 m depth in all hand auger boreholes, with the exception of HA05 where no topsoil was present. Topsoil frequently contains amorphous organic matter and organic inclusions, such as rootlets.

Fill

No filling was encountered at our test locations. However, in farm environments the presence of buried offal and / or rubbish pits cannot be discounted.

Colluvium

Colluvium refers to a soil that has been mobilised and placed (or come to rest) adjacent to the toe of a slope, or has been disturbed by ongoing soil creep. As colluvium represents a mobilised soil, the material composition is similar to the source material, but is often highly disturbed and often exhibits lower soil strengths than the *in situ* source material.

Colluvium was exclusively encountered underlying topsoil in HA13 to depths up to 1.1 m. The colluvial soils at HA13 are underlain by native Holocene Deposits.

Holocene Deposits

Holocene Deposits were found underlying topsoil and colluvium in HA08, HA12, HA13, HA16 and HA18. These soils predominantly comprise silt and sand with variable clay content. These soils were found to generally increase in consistency and density with depth.

Piako Subgroup

Piako Subgroup soils were encountered underlying topsoil and Holocene Deposits. The Piako Subgroup typically comprises clayey silt and sand with variable gravel content. These soils do not show an increase in consistency and density with depth.

Walton Subgroup

The Walton Subgroup soils are encountered within the southern and southwest portion of the site. These soils typically comprise silt and clay with variable sand content. These soils, found to range from firm to hard consistency, did not show an increase in shear strength with depth.

Table 2: Generalised Summary of Subsurface Conditions

Top Depth Range (m)	Bottom Depth Range (m)	Description	Shear Strength Range (kPa)	Scala Penetrometer Range (blows/100 mm)	Consistency and / or Density
0.0	0.1 – 0.4	TOPSOIL	97 - 123	1 - 3	Stiff to Very Stiff
0.1	1.1	COLLUVIUM	NA ¹	0 - 1	Soft to Firm Very Loose
0.0 – 1.1	1.2 - >5.0	HOLOCENE DEPOSITS	24 – 200+	0 - >15	Soft to Hard Very Loose to Dense
0.0 – 1.3	>4.2	PIAKO SUBGROUP	32 - UTP	0 - >15	Soft to Hard Very Loose to Dense
0.3 – 0.4	1.6 – 2.2	WALTON SUBGROUP	49 – 200+	NA	Firm to Hard

¹NA = Not Assessed

9.1.6 Groundwater Conditions

In order to provide an indication of the winter groundwater conditions on-site, ENGEO measured standing water levels post-drilling in the hand auger boreholes. Further to this, we installed data loggers in the machine boreholes with piezometers and measured groundwater levels over the following two weeks. Groundwater levels at test locations are presented in Table 3. Variations in standing water levels are likely due to the sloping nature of the site, variable permeability of soil deposits or antecedent rainfall events.

Table 3: Standing Water Levels In Hand Auger Boreholes Drilled 28 to 30 August 2017

Hand Auger Investigation	Depth to Standing Water (m bgl)	Hand Auger Investigation	Depth to Standing Water (m bgl)
HA01	NE ¹	HA11	NE
HA02	3.6	HA12	NE
HA03	1.2	HA13	2.3
HA04	4.5	HA14	NE
HA05	1.6	HA15	2.5
HA06	0.9	HA16	0.4
HA07	1.2	HA17	3.3
HA08	0.6	HA18	1.0
HA09	NE	HA19	NE
HA10	0.5	HA20	NE

¹NE = Not Encountered

Table 4: Standing Water Levels In Hand Auger Boreholes Drilled 20 to 21 November 2017

Hand Auger Investigation	Depth to Standing Water (m bgl)	Hand Auger Investigation	Depth to Standing Water (m bgl)
HA21	NE ¹	HA31	NE
HA22	NE	HA32	0.2
HA23	NE	HA33	1.8
HA24	2.2	HA34	3.4
HA25	1.7	HA35	4.4
HA26	NE	HA36	2.8
HA27	NE	HA37	0.5
HA28	NE	HA38	NE
HA29	3.0	HA39	NE
HA30	NE		

Table 5: Standing Water Levels In Machine Boreholes Drilled 15 to 30 November 2017

Machine Borehole Investigation	Depth to Standing Water (m bgl)	Machine Borehole Investigation	Depth to Standing Water (m bgl)
1 ¹	7.87	7	9.48
2	12.18	11	6.88
4	8.37	13	19.25
6	19.88		

¹¹ Piezometers and groundwater level loggers were not installed in all boreholes.

Groundwater levels measured in the machine boreholes indicate that standing groundwater levels across the site are typically significantly below developed ground levels at depths ranging from 6.88 to 19.88 m below ground level.

However, water levels recorded in the hand auger boreholes suggest that perched and transitory water levels do occur across the site. It is our expectation that these perched groundwater levels can be managed during the construction phase through earthworks and drainage.

Although a well-drained soil profile would normally be expected in the typically granular soils identified onsite, perched groundwater tables were encountered in many areas. This is evident from the shallow depth at which groundwater was measured during the site investigations. The soil profile that facilitates these perched water tables typically comprises a relatively free draining alluvial sand interbedded with occasional horizons of cohesive soils and is most commonly found within eastern portions of the site.

10 Laboratory Testing

As part of this study, ENGEO arranged to have the following laboratory testing conducted:

- Four Atterberg limit tests and linear shrinkage;
- Six particle size distribution tests;
- Four Allophane presence tests; and
- Four Triaxial consolidated undrained CU tests

These tests were in accordance with NZS 4402, "Methods of Testing Soils for Civil Engineering Purposes" test section 2.

All results are IANZ (International Accreditation New Zealand) endorsed and full details are appended.

10.1 Atterberg and Linear Shrinkage Results

A summary of the laboratory results are presented in Table 6 with full laboratory test results presented in Appendix 5.

Table 6: Atterberg Limits and Linear Shrinkage Results

Investigation	Material Type	Sample Depth (m bgl)	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Linear Shrinkage (%)
HA01	High plasticity silt / Organic Soil	0.7 – 0.9	55	91	49	42	21
HA04	High plasticity silt / Organic Soil	0.6 – 0.8	46	77	44	33	17
HA15	Sandy SILT	0.9 – 1.1	NA ¹				
HA17	Silty SAND	0.8 – 1.0	NA				

¹NA = Not Assessed as material exhibited non-plastic behavior.

10.2 Particle Size Distribution Results

A summary of the laboratory results are presented in Table 7 with full laboratory test results presented in Appendix 5.

Table 7: Particle Size Distribution Results

Investigation	Sample Depth (m bgl)	Clay / Silt (%)	Sand (%)	Gravel (%)
HA05	1.5 – 1.8	0.6	78.8	20.6
HA06	0.8 – 1.8	1.1	84.4	14.5
HA10	0.2 – 0.7	5.4	83	11.6
HA12	2.4 – 2.7	0.3	98.8	0.9
HA13	0.1 – 0.7	0.9	98.4	0.7
HA17	1.3 – 1.7	0.6	62.2	37.2

10.2.1 Allophane

The allophane content, which was determined by chemical reaction, is an indication only of the amount of allophanic clay minerals in the soil. Allophanic soils show marked irreversible changes in their physical properties when dried below the natural water content. This is attributed to the collapse of the allophanic gel-like structure and aggregation into much coarser grain sizes.

Four Allophane tests were carried out on selected samples in accordance with NZS 4402, test number 3.4 to determine the presence or otherwise of allophanic minerals.

An allophane content of less than 5% is not considered to be significant in terms of the ease of handling and usability of the soils. A content of 5 to 7%, indicates the possibility of compaction difficulties. Results of the laboratory allophane testing undertaken for this site are presented in Table 8.

Table 8: Allophane Test Results

Borehole Number	Sample Depth m bgl	Sample Description	Allophane Content
MBH02	3.95	High Plasticity Clay	< 5%
HA21	3.5	Low Plasticity Sandy Silt	>7%
HA23	1.3 to 1.6	Sand	< 5%
HA27	1.2	High Plasticity Silty Clay	< 5%

On the basis of this testing we conclude that the majority of the site soils are not highly allophanic and should not cause concern for standard earthworks compaction. However, allophanic soils are expected to be encountered in some areas and methods to deal with this material where it is encountered are noted later in this report.

10.2.2 Effective Stress Triaxial Tests

The four sets of three consolidated-undrained triaxial tests carried out on samples recovered from the depths and locations noted in Table 9 produced the following effective stress parameters:

Table 9: Effective Stress CU Triaxial Test Results

Borehole Number	Depth (m)	Sample Description	C' (kPa)	Ø' (degrees)
MBH02	3.0 to 3.5	Moderately plastic clayey SILT	1	32
MBH03	10.6 to 11.1	Amorphous Peat and organic SILT	0	38
MBH06	4.5 to 5.0	Pumiceous sandy SILT	7	30
MBH06	9.1 to 9.6	Silty CLAY	8	30

11 Discussion On Ground Conditions

11.1 Pumiceous Soils

Pumiceous silts and sands of the type that have been identified on this site are often difficult materials to build on or use in earthworks operations.

Pumiceous silts can be difficult to earthwork due to high moisture contents which can bog down earthworks machinery. Where confined, they usually exhibit considerable strength e.g. SPT 'N' counts of 24 to greater than 50, CPT cone resistance values of up to 40 MPa and shear vanes / hand augers unable to penetrate. However, where exposed they are prone to rapid weathering, erosion, slumping and collapse. They are also quite porous and can contain artesian groundwater when confined between materials of low permeability. They are also very difficult to earthwork, being prone to collapse under elevator/compactor loads, often forming a slurry of silt and water.

Earthworks should therefore be undertaken across broad areas utilising thin lifts to allow the exposed soil to dry back prior to the next skim. Site planning should allow for broad cut and fill areas with significant drying pads in order to maintain progress in areas of deeper cuts.

11.2 Expansive Soils

Expansive soils are not considered to be an issue for the soils identified on-site.

12 Seismic Hazards and Assessment

Potential seismic hazards resulting from nearby moderate to major earthquakes can generally be classified as primary and secondary. The primary effect is ground rupture, also called surface faulting. The common secondary seismic hazards include ground shaking, ground lurching, regional subsidence or uplift, soil liquefaction, lateral spreading, landslides, tsunamis, flooding, or seiches. Based on topographic and lithologic data, risk from earthquake-induced regional subsidence / uplift, ground lurching, landslides, and tsunamis and seiches is considered negligible at the site. The following sections present a discussion of the other seismic hazards as they apply to the site.

12.1 Ground Rupture

As previously discussed, there are no known active faults located within the site. Based on regional mapping, and the results of our field exploration, it is our opinion that fault-related ground rupture is unlikely at the subject site.

12.2 Soil Classification

For the purpose of seismic design, we anticipate the soil classification in line with NZS1170.5:2004 to be 'Class D – Deep or Soft Soil'.

This classification has been verified with an attempt to identify deeper soil horizons in MBH13 which was drilled in a lower lying portion of the site to a depth of 30.95 m bgl.

12.3 Ground Shaking

We consider that the proposed development will eventually encompass a large number of residential dwellings - Importance Level 2 buildings. According to NZS 1170.5:2004, Importance Level 2 buildings are required to be designed to resist earthquake shaking with an annual probability of

exceedance of 1/500 (i.e. a 500 year return period). This is the ultimate limit state (ULS) design seismic loading. Structures are expected to retain their structural integrity during the ULS earthquake, and not collapse or endanger life. Furthermore, Importance Level 2 buildings should sustain little or no structural damage under a serviceability limit state (SLS) design load case, which is based on earthquake shaking with a 25 year return period.

Peak horizontal ground accelerations (a_{max}) have been calculated in accordance with MBIE/NZGS Module 1 (2016) using the following formula:

$$a_{max} = C_{0,1000} R f g / 1.3$$

$$C_{0,1000} = 0.28 \text{ for Hamilton (NZTA Bridge Manual (2016) Table 6A.1)}$$

$$R = \begin{aligned} &= 1.0 \text{ for a 500 year return period event (NZS1170.5) (ULS)} \\ &0.25 \text{ for a 25 year return period event (NZS1170.5) (SLS)} \end{aligned}$$

$$f = 1.0 \text{ for Class D}$$

$$\text{Thus } a_{max} = 0.28 \times 1.0 \times 1.0 g / 1.3 = 0.22 g \text{ for ULS (1 in 500 year event)}$$

$$= 0.28 \times 0.25 \times 1.0 g / 1.3 = 0.05 g \text{ for SLS (1 in 25 year event)}$$

However, for the purposes of this preliminary assessment, we have considered an intermediate SLS case and have therefore scaled 'R' to a 1 in 150 year seismic event (as per Table 3.5 NZS1170.5). This intermediary earthquake will be able to give an indication of land performance for an event between the ULS and SLS cases.

$$\text{Thus } a_{max} = 0.28 \times 0.7 \times 1.0 g / 1.3 = 0.15 g \text{ for a 1 in 150-year seismic event.}$$

The effective earthquake magnitude is taken as 5.9.

12.4 Liquefaction and Lateral Spreading

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded, fine-grained, cohesionless materials. Empirical evidence indicates that loose to medium dense gravels, silty sands, low-plasticity silts, and some low-plasticity clays are also potentially liquefiable. These soils have been identified in our boreholes and test pits and confirmed with laboratory testing.

When seismic ground shaking occurs, the soil is subjected to cyclic shear stresses that can cause excess hydrostatic pressures to develop. If excess hydrostatic pressures exceed the effective confining stress of the soil, the soil is considered to have liquefied. If the soil consolidates or vents to the surface during and following liquefaction, ground settlement and surface deformation may occur.

Lateral spread is the lateral movement of ground as a result of liquefaction during an earthquake. Lateral spread occurs when a soil mass slides laterally on a liquefied layer and gravitational and seismic forces cause the layer, and overlying non-liquefied material, to move in a downslope direction or towards a free face. The magnitude of lateral spreading depends on a variety of factors including earthquake magnitude and peak ground acceleration, thickness of the liquefied layer, and ground slope or ratio of free-face height to distance between the free face.

Due to the presence of potentially liquefiable soils at the site we have assessed the potential for liquefaction and associated vertical settlements. In addition, we have undertaken a lateral spread assessment due to the proximity of the site to the Waikato River free face, and the presence of the incised valley running through the site.

12.4.1 Assessment of Liquefaction and Lateral Spread Potential

It should be noted that the greater percentage of the sands encountered underlying this site contain a significant proportion of pumiceous material. This material is known to be difficult to evaluate using standard CPT test based analysis for liquefaction potential as the CPT rig crushes the weaker pumice sands during testing. In this instance we have used traditional CPT based analysis to highlight areas of concern and to gain a general appreciation of the site liquefaction risk, then undertaken seismic CPT testing to better define the risk in the areas of concern.

We have assessed the risk of soil liquefaction occurring at the site using the subsurface data from the collated CPT investigations and the methodology developed by Idriss and Boulanger (2014). Liquefaction induced vertical settlements were calculated using the method put forward by Zhang et al (2002).

To estimate liquefaction-induced lateral displacement (lateral spread) we used the methodology described by Zhang, Robertson and Brachman (2004) and the on-site CPT data. This methodology is based on a database of observed lateral spread events correlated to factor of safety and relative density from CPTs within the material where lateral spreading occurred. As such, without validation from observed behaviour, this methodology should be used as an indication of likely displacements rather than to develop definitive estimates of displacement.

Displacements calculated below twice the free face height were not included in our estimated lateral deformation due to the negligible static shear stress below this depth, as discussed in Chu and Stuart (2009).

In addition to the above analyses we have calculated the Liquefaction Severity Number (LSN) for each assessed CPT. The LSN is an index representing vulnerability to liquefaction damage, i.e. consequential liquefaction. LSN has been checked by analysis of more than 11,000 CPT tests, comparing to land and foundation performance observations from seven earthquakes which triggered liquefaction in Canterbury.

Liquefaction and lateral spread analyses have been undertaken using a 1 in 150 year seismic event with a 0.15 g PGA and an earthquake magnitude of 5.9. We have modelled the groundwater at depths outlined in Table 3 based on the pore water pressures encountered onsite.

We have considered the location and elevation of the CPT investigation relative to free faces to assist in determining the risk of lateral spread (Table 10). We understand the southern portion of the site is to be excavated as a fill source thus, CPT01, CPT02 and CPT03 were not considered for lateral spread analyses. In the case of CPT05, we have evaluated the soil log and noted anomalous cone resistance and friction ratio values which as a result, has indicated highly sensitive soil behaviour types and voids. Our nearby soakage test (SKT7) and hand auger borehole (HA04) does not correlate with the soils indicated by CPT05. Accordingly, we do not consider the results of CPT05 to be representative of *in situ* conditions and have dismissed this test from our liquefaction and lateral spread assessment.

Table 10: Summary of Lateral Spread Parameters

CPT Investigation	Elevation ¹ (m)	Free Face ¹ (m)	Distance to Free Face (m)	Free Face (Waikato River / Valley)
CPT04	46.0	10.0	60	Valley
CPT06	48.0	17.0	340	Valley
CPT07	50.5	20.5	200	Valley
CPT08	35.5	20.5	135	Waikato River
CPT09	38.5	8.5	120	Valley
CPT09	38.5	23.5	140	Waikato River
CPT10	31.0	16.0	100	Waikato River
CPT11	38.5	23.5	130	Waikato River
CPT12	37.5	13.5	50	Valley
CPT13	45.0	30.0	330	Waikato River
CPT14	25.5	10.5	60	Waikato River
CPT15	45.5	30.5	260	Waikato River
CPT16	37.0	22.0	210	Waikato River
CPT17	21.5	6.5	65	Waikato River
CPT18	37.5	22.5	370	Waikato River
CPT19	22.0	7.0	50	Waikato River
CPT20	39.0	24.0	54	Waikato River
CPT21	28.0	13	36	Waikato River

¹RL based on New Zealand 2016 Datum

12.4.2 Results

The liquefaction analyses indicate liquefiable layers located between the water table and 18 m depth under the design 1 in 150 year seismic loading. The calculated vertical settlements over the full CPT depths range from 0 mm to 350 mm and in the upper 10 m range from 0 mm to 200 mm. The largest vertical settlements were calculated in CPT03, CPT04, CPT07 and CPT14, which have settlement

values in excess of 100 mm. However, calculated settlements in the upper 10 m of the soil profile are less than 100 mm in all CPTs with the exception of CPT14.

We have calculated Liquefaction Severity Numbers (LSNs) for each CPT trace. The majority of CPT traces have LSNs that indicate little to no expression of liquefaction is expected following the 1 in 150-year earthquake. Three investigations (CPT04, CPT16 and CPT19) have LSNs that indicate minor expression of liquefaction with some sand boils is expected, and only one investigation (CPT14) shows moderate to severe expression of liquefaction where settlement may cause structural damage.

Lateral spread analyses generally show marginal lateral displacement (< 15 mm) for nine of the 17 investigations analysed under the 1 in 150 year design seismic loading. Minor lateral displacement (< 100 mm) was recorded at the locations of CPT08, CPT12, CPT16, CPT18 and CPT21 and minor to moderate lateral displacement (< 200 mm) was recorded at the location of CPT04. Major lateral displacement (200 mm to 500 mm) was recorded at the location of CPT09 and lateral displacement in excess 500 mm was recorded at CPT14.

The results of these analyses are attached (Appendix 6) and summarised in Table 11.

Table 11: Summary of Liquefaction and Lateral Spread Results (1 in 150 year seismic loading)

CPT Investigation (Depth of test)	Total Vertical Settlement (mm)	Settlement within upper 10 m (mm)	Lateral Displacement (mm)	Liquefaction Severity Number	Expected Liquefaction Expression
CPT01 (20.0 m)	25	15	NA ¹	3	Little to None
CPT02 (6.34 m)	35	35	NA	8.6	Little to None
CPT03 (18.54 m)	350	80	NA	9.6	Little to None
CPT04 (14.04 m)	110	90	120	18.5	Minor
CPT06 (14.74 m)	25	18	0	2.9	Little to None
CPT07 (17.64 m)	100	50	1	9.9	Little to None
CPT08 (16.28 m)	45	35	17	9.4	Little to None
CPT09 – Valley (16.88 m)	60	55	250	15.7	Little to None
CPT09 – Waikato River (16.88 m)	60	55	250	15.7	Little to None
CPT10 (13.46 m)	45	45	8	8.6	Little to None
CPT11 (19.02 m)	15	5	0	0.7	Little to None

CPT Investigation (Depth of test)	Total Vertical Settlement (mm)	Settlement within upper 10 m (mm)	Lateral Displacement (mm)	Liquefaction Severity Number	Expected Liquefaction Expression
CPT12 (20.0 m)	30	15	35	1.8	Little to None
CPT13 (7.24 m)	0	0	0	0	Little to None
CPT14 (14.44 m)	250	200	1500	35.3	Moderate to Severe
CPT15 (11.86 m)	2	2	0	0.3	Little to None
CPT16 (20.0 m)	70	60	90	15.1	Minor
CPT17 (9.92 m)	15	15	1	5.6	Little to None
CPT18 (14.66 m)	90	40	30	4.7	Little to None
CPT19 (13.90 m)	20	5	0	1	Minor
CPT20 (20.0 m)	0	0	0	0	Little to None
CPT21 (17.44 m)	60	40	40	5.7	Little to None

¹NA = Not Assessed

12.4.3 Discussion of Liquefaction and Lateral Spread Results

As described above, we encountered layers of potentially liquefiable material across the site. There is no apparent spatial pattern to the results of the liquefaction and the lateral spread assessment. Depth and thickness of these layers vary across the site and with the exception of CPT14, the vertical settlements calculated in the upper 10 m of the soil profile are less than 100 mm. Calculated LSNs generally indicate little to minor expression of liquefaction can be expected in a 1 in 150-year design earthquake.

Preliminary lateral spread analyses indicate there is marginal to moderate potential for lateral spreading across the majority of investigations which is generally consistent with the calculated LSNs.

Areas of concern arising from this CPT based analysis were then assessed using seismic CPT testing as attached in Appendix 6. This analysis was undertaken using the Kayen et. al (2013) method with the liquefaction analysis software program CLiq V2.2.0.32. This analysis was undertaken using the ULS pga of 0.22g and indicates that liquefaction is unlikely in most areas even under ULS accelerations.

A summary of liquefaction potential based on seismic CPT testing within the portions of site considered most likely to liquefy (as identified by our CPT screening process), is given in Table 12.

Table 12: Summary of Seismic CPT Liquefaction Analysis – ULS pga

CPT number	Result
SCPT01	Minor Liquefaction in a very thin layer of susceptible soils at 5.0m depth. FoS > 2 for the rest of the soil profile
SCPT02	FoS > 2 for full profile
SCPT03	FoS > 2 for full profile
SCPT04a	Minor Liquefaction in thin layers of susceptible soils at 6.0m and 9.0m depth. FoS > 1 for the rest of the soil profile
SCPT05	FoS > 1 for full profile
SCPT06	Minor Liquefaction in a very thin layer of susceptible soils at 10.0m depth. FoS > 2 for the rest of the soil profile

As can be seen from Table 12; soil liquefaction is considered unlikely (except within some thin soil horizons at isolated locations), even under ULS pga of 0.22g. It should be noted that the seismic CPT testing was targeted to evaluate the areas of site considered most likely to liquefy based on conventional CPT based analysis methods.

Minor soil liquefaction is considered most likely to occur in the vicinity of SCPT04a with only isolated expression of liquefaction in the remainder of the areas tested. This area has been highlighted in the Geoconstraints maps included in Appendix 3 and is discussed later in this report. With reference to the current development plans, we understand that the development will be suitably set back from this area. Further discussion of this area is presented in Sections 13 and 14.

13 Slope Stability

As described in Section 8, widespread evidence of soil creep and shallow soil failure was observed within the site, primarily along terrace back-slopes, free faces above the Waikato River and the flanks of the Central Valley.

We consider that soil creep and slope terrace soil failures are likely to continue to occur in the foreseeable future as natural gully regression and erosion processes continue within the site. We consider that larger scale soil failures are likely to be driven by external triggering mechanisms such as seismic loading.

ENGEO has undertaken assessment of land potentially at risk of soil failure or soil creep which incorporates both geomorphological site observations and the results of slope stability models.

13.1 Slope Stability Modelling

In order to assess the stability and geotechnical suitability of the site, 11 representative cross sections were selected for analyses to inform indicative setback lines from over-steepened slopes.

These cross sections were modelled in the software package SLIDE 7.0, produced by Rocscience Limited, utilising the GLE / Morgenstern Price Method for both circular and composite failure surfaces.

After reviewing investigation findings, basic soil models were generated using the material properties outlined below, and assume that the hard layer encountered at the base of the CPT investigations is continuous with depth.

Table 13: Soil Parameters

Material	Unit Weight (kN/m ³)	Effective cohesion, c' (kPa)	Effective angle of friction, ϕ (degrees) ²	Undrained Shear Strength (kPa) ¹
Very Loose to Loose SAND	17.0	0	29	-
Soft to Firm SILT	17.0	2	26	35
Medium Dense SAND	17.5	0	34	-
Stiff to Very Stiff SILT	17.5	5	30	150
Peat and Organic Soils	16	1	24	
Colluvium - SAND	16.0	0	28	
Colluvium - SILT	16.0	1	26	
Engineered Fill	17.0	4	30	

¹ Undrained Shear Strength parameters may not have been used in all Seismic Condition models. Where undrained parameters yield consistent results, these results have been presented. This is considered to be a more conservative approach.

The following scenarios were modelled:

- **Normal Groundwater Condition** – Groundwater is modelled at approximately 6.0 m bgl along the upper portion of the site, approximately 1.0 to 3.0 m bgl along the lower slopes, depending on specific groundwater observations. A Factor of Safety (FoS) equal to or greater than 1.5 is considered acceptable for residential development.
- **Transient Groundwater Conditions** – Groundwater is modelled at approximately 2.0-3.0 m bgl along the upper portion of the site and nearing ground surface along the lower slopes. A FoS equal to or greater than 1.3 is considered acceptable for residential development.
- **Seismic Condition** – A seismic coefficient of 0.15 is used to model the behaviour of the slope during a 1 in 500-year seismic event and a seismic coefficient of 0.11 has been used to model the behaviour of the slope in a 1 in 150-year seismic event. These coefficients have been applied in the horizontal direction toward failure only, and have been factored by 0.67 to remove the vertical component of ground acceleration. In a 1 in 500-year event, a FoS equal to or greater than 1.0 is considered acceptable for residential development and in a 1 in 150-year event a FoS equal to or greater than 1.2 is considered acceptable for residential development.

13.2 Existing Site Contours

Analyses of the 11 Geological Sections supplied to us (as supplied by HG Limited) have resulted in the preparation of the Geotechnical Constraints Map contained within Appendix 3A. Full results of the analyses can be found in Appendix 7.

Where applicable (primarily for Cross-Section 8) stability results have been computed for both slope flanks captured in the section.

In summary, although unacceptably low slope factors of safety were observed along every section, these global minimum factors of safety are located on or adjacent to the observed steep slopes. Factors of Safety increase with increased distance from the slope crests. The offset from slope crest to an acceptable FoS is shown on each slope model and this informs the Geotechnical Zoning Plan presented in Appendix 3 and discussed in Section 14.

Please note that Cross-Section 11 has been shortened for the purposes of this analysis in order to focus on the stability of the upper portion of the site, adjacent to the proposed development.

13.3 Discussion on Proposed Development

HG has supplied ENGEO with a site model showing proposed finished surface levels (March, 2018), including design ground profiles marked over our 11 Geological Sections – please see Appendix 8A and 8B for a cut to fill plan, and geological sections showing current versus final ground contours. ENGEO has run additional slope stability model iterations to estimate the effects that these changes will have on slopes factor of safety. Where there are minor or no changes to the slope profile, we have provided comment on existing slope constraints.

Where bulk filling is proposed proximal to steep slopes and Factors of Safety have worsened, ENGEO has first run a model iteration including the addition of counterfort drains spaced at 20 m centres horizontally, extending 5 m below the original ground surface in order to restrict groundwater elevation to no higher than 4 m below the pre-existing ground surface.

Should drainage not achieve adequate long term FoS for the proposed development, specific design and implementation of ground improvements will be required to stabilise the proposed landform, future residential lots and future roads. Where appropriate, ENGEO has completed a preliminary check to determine the size and composite strength of the improved soils block in the identified critical design case.

We note the following relevant information:

- The 1 in 150 year seismic condition has been identified as the critical slope case for Section 1, with an offset of 38 m from the crest of the riverbank to the 'safe' zone. Simulating the placement of the design 3 m of fill has increased this setback to 56 m, with the subdivision access road and the first row of residential lots not considered protected against long term factors of safety. The implementation of counterfort drainage in this area only minimally improves this situation.

Accordingly, specific design and implementation of ground improvements will be required on the downslope side of the road. Alternatively, ENGEO can provide further guidance regarding forming a more favourable final landform, which should include cuts rather than fills adjacent to riverbank or gully slopes. For the full analysis sheets for Section 1, please see pages 1 through 7 of Appendix 7.

- Similarly to Section 1, the critical design case under existing site conditions for Section 2 is the 1 in 150 year seismic event, with an identified setback of 14 m. The proposed earthworks along Section 2 include the placement of up to 6 m of fill with a near vertical face, located at the northeast extent of the proposed roadway and proximal to the riverbank. Discussions with HG indicate that this face is likely to be supported by a Mechanically Stabilised Earth (MSE) or Reinforced Earth (RE) retaining wall. This wall will require specific design.

The addition of the fill has a significant impact on global stability, particularly in the 1 in 150 year seismic event, where the required minimum setback from the riverbank has increased from 14 m to 46 m, approximately 36 m back from the proposed MSE wall and encompassing the road and the first row of residential lots. We acknowledge the difficulty in achieving adequate fall on any subsurface drainage in this area, thus the groundwater suppression below original ground level will be set at ~2 to 3 m. Counterfort drainage reduces the required minimum setback to 37 m from the riverbank and 28 m from the leading edge of the fill. In order to provide adequate FoS to the road and first row of residential lots, specifically designed ground improvements will be necessary below the proposed MSE wall. Ground improvement properties and lateral extent must be confirmed through detailed design and may or may not require counterfort drainage to function adequately. For the full analysis on Section 2, please see pages 8 through 17 in Appendix 7.

- Along the Section 3 alignment the previous proposed development is set back approximately 20 m from the riverbank, which aligns with the edge of the zone considered suitable for residential development. As proposed cuts and fills are minimal along this slope profile we have not reassessed the stability of the final landform. We note that north of Section 3 (between Sections 3 and 2) specific assessment of the fill slopes will be required, potentially necessitating ground improvements.
- Section 4 extends along the large terrace slope failure with roading proposed approximately 20 m back from the scarp and residential lots adjacent to the road. Due to naturally high groundwater levels, the pre-existing topography model shows a setback of 64 m in the 1 in 150 year seismic event. The current proposed development includes up to 4 m of cut along adjacent to the historical landslide scarp, which will aid global stability. In order to achieve the required long term factor of safety, extensive drainage of the slope, particularly the lower slope (slide debris) will be required. Construction of this drainage may be challenging as there is potential to uncover saturated (flowing) sands and drainage outlets should not be placed below the 2% AEP flood elevation. Specific design in this area should involve additional ground investigations to reduce uncertainty in groundwater elevation and soil strength.
- There are no proposed landscape changes within 55 m of the gully slope crest in Section 5. Slope stability models incorporating the existing site contours indicated a setback of 57 m from the crest of the slope in both the 1 in 150 and 1 in 500 year seismic events, which generally seems to be met by the current proposed development.
- Proximal to Section 6 the proposed development is set back ~50 m from the riverbank slope which broadly aligns with the identified 'safe' setback of 40 m (transient groundwater case). To the east of Section 6 the proposed developments are within 20-30 m of the slope crest, which will require specific assessment of these slopes at a later stage. We note that bulk cut is proposed in these areas, however the increase in factor of safety from these cutting activities has not been quantified.

- Along the Section 7 alignment, a proposed roadway is located approximately 20 m from the crest of the gully slope, which aligns with the 20 m setback identified in the 1 in 150-year seismic model. Minor filling (1 m or less) is proposed adjacent to the roadway, with lots to the west being primarily in terraced cut.
- Minor cut to fill (up to ~ 2 m) is proposed in the west of Section 8, with no filling within approximately 28 m of the gully's western slope crest. We note that the roadway is currently shown as approximately 37 m away from the crest of the slope, which is within the 50 m setback identified on the base model. Earthworks cut is recommended along the crest of this slope, with cuts of 4 m coupled with additional investigation considered likely to provide adequate long term factors of safety to the proposed road and residential lots. Alternatively, ground improvement options or a combination of cut and ground improvements may be considered.
- Bulk earthworks cut of up to 5 m is proposed in the east of Section 8, which results in the previously identified 28 m setback no longer being required (a global minimum FoS of 1.2 was achieved in the critical case). It is our opinion that a practicable building platform can be sited in these lots, however this is dependent on subsequent developments within the scheme plan maintaining effective cut in this area. Once the earthworks design has been advanced further slope stability checks elsewhere along the eastern gully slope may be required.
- The west of Section 9 has no proposed cut to fill and the land proximal to the gully slope is not tagged for development. Slope stability analyses indicated a setback of 29 m would be required in the transient groundwater condition, which we understand is well clear of development. With the current proposed scheme, no additional analysis is required on Section 9 at this stage.
- Up to 6 m of cut is proposed in the east of Section 9, lowering the total remaining slope height to ~7 to 8 m. As with the east of Section 8, it is our opinion that a practicable / 'safe' building platform can be sited within the lots proximal to the slope cut. The road can also be considered protected against land instability as it is setback approximately 16 m from the cut slope crest.
- Proposed earthworks along Section 10 include bulk cutting in the northwest and limited cutting proximal to the riverbank. Slope stability assessments based on the existing site conditions recommended a setback of 39 m in the 1 in 150 year seismic event. A proposed roadway is located adjacent to the riverbank, with residential lots immediately northwest of the road, well within the identified specific design zone. Applying the proposed earthworks surface improves the 'safe' setback distance to 36 m. This may be improved by advancing earthworks cut near to the riverbank and may be refined by improving our understanding of the ground conditions. Alternatively, ground improvements may be implemented – see sheet 55 in Appendix 7. The exact properties and extent of this ground improvement would need to be determined through detailed design.
- Minimal formation works are proposed along Section 11, with bulk cut being less than 1 m. Analysis of the existing landform around Section 11 suggests that lots located proximal to the slope should allow for a practicable building platform to be sited, which we recommend be located 10 m clear of the slope crest. This appears to affect only a single lot.

14 Project Evaluation and Recommendations

14.1 General

The undertaking of earthworks construction and drainage works in accordance with the following specific subdivision and building development recommendations, NZS 4404, "Code of Practice for Urban Land Subdivision" and related documents should provide that the completed development is generally suitable for conventional / light timber framed dwellings constructed in accordance with the requirements of NZS 3604.

Specific lot requirements relating to allowable bearing capacities, limits of allowable cuts and fills and limits on development where initial site gradients exceed 1V in 4H, are discussed generally below but will be dealt with in detail at the time of preparation of our Geotechnical Completion Report.

Building zone boundaries will need to be fixed at the time of preparation of our Geotechnical Completion Report. These zones will include standard NZS 3604 building zones, specific site investigation and design zones (usually on land having gradients greater than 1 in 4 or being adjacent to such land) and no-build zones.

Limitations relating to the quantities of cuts and fills that should take place within the respective zones will also be presented in our Geotechnical Completion Report.

We understand that earthworks plans will provide in most places for a significantly easing of the steeper contours throughout the site and will generally involve the cutting down of the high ground and the filling of the minor gullies to create a gently contoured landscape. Specific design will be required to determine slope stabilising measures in areas where development is proposed within the Specific Design Zone.

Specific comments and recommendations follow:

14.2 Key Geotechnical Constraints

Earthworks required to reach final site contours will generally involve trimming the head of steep slopes above the main gully feature, flattening off the existing terrace slopes and the head of the steep river banks above the Waikato River. The following geotechnical constraints will need to be addressed during site development:

- Soil creep and soil instability, particularly near the Central Valley, the Waikato River, historical landslide scarps and along terrace transition slopes;
- Large scale soil instability under earthquake loading;
- Liquefaction induced settlement and lateral spread towards free faces (the Waikato River and gullies) under earthquake loading;
- Marshy / swampy ground and terrace transition 'springs'; and
- Waterways and areas of stream incision.

These constraints and the results of our slope stability assessments have been considered in the preparation of two Geotechnical Constraints Plans included in Appendix 3A and 3B. On these plan, we have separated land within the proposed development area into the following categories:

- Non-specific design zone (Green) - Areas sufficiently setback from unstable slopes to be considered stable and suitable for standard residential development; and
- Specific Design Zones (Yellow) - Areas identified to be at risk of slope instability, particularly where geomorphological observations indicate that there is potential for large scale land instability. Further specific investigation and design will be required for some areas where slope regrading using earthworks solutions is considered undesirable or infeasible. These areas will be the subject of specific design reports and the extent of these areas will be determined following completion of the subdivision layout and earthworks plans.

Appendix 3A focuses on the geotechnical constraints inherent to the existing landform, while Appendix 3B presents geotechnical constraints for the proposed landform created during subdivisional earthworks.

14.3 Addressing Geotechnical Constraints

The majority of these constraints can be effectively managed by:

- Slope offsets from the Waikato River, Central Valley etc. and / or construction of in-ground retaining walls or bulk ground improvements to protect against soil creep and shallow instability;
- Specifically designed remedial earthworks, primarily cutting and regrading of the over-steepened terrace slopes and the hills in the south of the site to reduce the risk of soil creep and shallow soil failure. This also has the benefit of generating a larger number of lots with shallower slope gradients. Site drainage may be implemented at this time, particularly if development is proposed within areas of marshy ground or if fills are being placed proximal to sloping ground; and
- Specific design of slope stabilising measures such as deep soil mixing adjacent to steep slopes, particularly where fills are proposed adjacent to riverbank slopes or where bulk filling is required for flood protection purposes.

14.4 River and Gully Hazard Areas

We have been informed by Harrison Grierson Limited that one of the proposed residential lots, Lot 299, falls within an area marked on the Hamilton City Operative District Plan as within the River and Gully Hazard Area.

Lot 299 is located within the northern end of the proposed development. Based on our site specific mapping we consider that this area has been incorrectly zoned on the Hazard Area map. This is likely due to the difficulties inherent with interpretation of aerial photographs. As such, no specific requirements have been apportioned to this lot and we consider that this portion of the site should be removed from the Hazard Area map as part of the next update of that map.

Residential lots proposed as part of this development are outside of the published mapped "River and Gully Hazard Area" in all areas except for this lot.

14.5 Slope Stability

It is apparent from the results of our computer analyses that the bulk earthworks should generally be able to improve the long term factors of safety under both saturated and drained ground conditions. Further, in some locations, where marginal factors of safety have been obtained using conservatively low effective stress soil parameters under worst case scenario, highly saturated ground conditions, it

has been demonstrated that reducing load on the head of the slopes as part of the bulk earthworks reshaping of the land, will result in long term factors of safety in excess of 1.5. This scenario will be further enhanced by general land coverage by the filling of gullies, residential buildings, roads, pavements, planting of trees etc.

In summary, provided that the construction works and subsoil drainage works recommended in the following sections are carried out as intended, we have no undue concerns about the overall long term stability of the land and in all instances we consider that the proposed development works should serve to enhance equilibrium conditions and should generally provide for greater factors of safety against long term slope instability than exist at the present time.

14.6 Foundations for Buildings

A geotechnical ultimate bearing capacity of 300 kPa should generally be available for light-weight, two-storey, timber framed dwellings with shallow strip or raft foundations constructed on certified filling or on undisturbed or re-compacted native ground.

However, due to variations in measured shear strengths within the natural ground, a value of less than 300 kPa may be specified for shallow foundation design in some areas.

Further site specific investigations and design modifications, as necessary, should be carried out for all buildings greater than two storeys or of heavy weight construction. Anticipated differential settlements beneath shallow strip and pad footings at foundation working loads are assessed to be within code limits.

Variations in bearing capacity or settlement criteria will be re-addressed in our Geotechnical Completion Report.

14.6.1 System Design

The proposed stormwater management solution has been designed to serve both a water quality and quantity purpose. For water quality the swale component of the devices has been sized to accept discharge from one third of the two-year event including climate change allowing road run-off and pollutants to be captured and treated. For water quantity the under-drained component of the devices has been sized to accept discharge from the ten-year event including climate change. Discharge will enter the under-drain via inlets in the swale.

In events that exceed the capacity of the primary system the bio-infiltration devices, in conjunction with the roads, will provide a secondary system to convey run-off to dedicated overflow locations. Discharge locations will require specific design to mitigate scour in the open channels associated with these outlet devices.

Soakage rates are expected to be moderate to high across the site with the majority of the site comprising surficial deposits of highly permeable sand. Areas of more plastic clay (identified within the western portion of the site) are likely to have more moderate soakage rates as indicated by the preliminary soakage testing undertaken to date.

Where these plastic clays are utilised as fill it is likely that they will be mixed with other materials to form a composite fill. This mixing and compacting process will likely release water from allophanic clays and result in a breakdown of their initial structure. The blended compacted fill is therefore likely to have better soakage rates than the initial clay materials.

Given the high sand content of the *in situ* soils we consider piping erosion to be unlikely however some deposits of pumiceous sandy silt may be susceptible to this phenomenon. Inspection of stormwater disposal sites will therefore be required once finished site contours have been decided upon and stormwater systems finalised.

14.7 Stormwater and Wastewater Management

As part of the preparation of this report we have been provided with concept sketches and an overview of the proposed stormwater management system for this site. We have also been provided with a set of draft Stormwater Flow Plans (Harrison Grierson Limited reference 141842-SK027 sheets 1 to 6) for the subdivision which detail how overflows from the subdivisional stormwater soakage and detention system will be channelled via the roads to overland flow path outlet locations. Sketches were provided by AWA Limited and depict vegetated swale drains located on both sides of the subdivision roading network.

We are advised that it is proposed to use retention of rainwater and stormwater soakage as the primary stormwater disposal solution as preferred in the Hamilton City Council stormwater management disposal hierarchy.

Run-off from each roof will be directed to a rain-tank connected via an overflow into a lot soakage device. Run-off from the impervious lot area will also be directed into the lot soakage device. Run-off from the lot pervious area and driveway will be directed into the primary stormwater management system located within the road reserve. The primary stormwater management system will collect road run-off, and lot run-off as described above, and dispose of it into linear under-drained bio-infiltration devices. This solution will manage stormwater as close to the point of origin as possible, reducing the need for collection and conveyance infrastructure.

14.8 Roding and Services

It is apparent from the bulk earthworks plan that the majority of the subdivisional roading will be in either cut or filled ground, rather than at existing subgrade levels.

At best, road subgrade CBR's in the native soils may be around 3% or slightly higher. However, over most of the carriageway values of between 2% and 4% should be expected.

These conditions are suited to the use of geotextiles or geogrids to minimise depths of undercuts.

We recommend that a programme of penetration resistance testing is carried out when the roads are being formed to their final levels to confirm actual CBR values.

Cement stabilisation of subgrades may be an economical alternative to undercutting in areas where low CBR's are recorded. Appropriate response and strength testing should be carried out before earthworks commence if this option is to be adopted.

Construction of the stormwater and sanitary sewage reticulation during the winter months could involve raised groundwater levels and the presence of pumiceous soils and could cause problems with the stability of trench sides, leading to a need for additional subsoil drainage and/or dewatering, especially in areas where deep lines are required.

14.8.1 Pumiceous Soils in Subgrades and Trenches

Where highly pumiceous soils are exposed at or near road subgrades or in service trenches, then design changes involving the altering of subgrade and invert levels and / or invert gradients should be

considered if possible as these materials are highly sensitive and prone to piping and internal erosion whenever there is high groundwater or a hydraulic head available. This often leads to silt migration into poorly compacted trench backfill.

A geotextile filter used as a fines barrier may be required to control the problem. Decisions regarding the use of such measures are best made on site when the materials are exposed.

14.9 Earthworks Operations

14.9.1 Gully Filling

As a general rule, no fill should be placed on pre-existing colluvium or alluvium without specific investigation and design due to the risk of activating an underlying shear zone, consolidation, or adding driving force toward slope failure. Prior to placing any fill within gully features, all soft, loose, organic rich or disturbed soils should be removed in order to expose the underlying very stiff, native site soils.

We consider an indicative muck out depth of up to 0.5 m should be allowed for. This is based on limited preliminary information and will need to be confirmed on-site. Sub-drainage will also likely be required when filling gully areas.

14.9.2 Material Suitability

Earthworks operations involving borrow materials, usually from the elevated portions of the site, should be relatively straightforward. Generally, both cuts and fills will involve inorganic, alluvial sands and silts that should be suitable, with conditioning, for handling and compaction by conventional earthmoving plant. However, we have yet to carry out the appropriate compaction specification testing.

Due to the typically variable nature of the site materials, allowance should always be made for the presence of layers of soft sensitive clays and silts, together with groundwater, especially in the deeper cuts. These can cause problems for earthmoving plant but usually the materials become suitable for inclusion in the earthworks after drying and / or mixing.

Any stability problems that occur during earthworks will probably be associated with localised high groundwater levels (e.g. resulting from storm events or perching) and possibly the close proximity of relatively impervious strata to the ground surface in areas where cutting down is taking place. These conditions can lead to temporary localised slope instability due to the effect of toe unloading which causes increases in pore pressures and reductions in effective strengths below critical values. Solutions to this problem are generally centred on the installation of appropriate subsoil drainage and possibly the redesign of final landforms.

However, based on our experience with adjacent subdivisional works, it is anticipated that optimum water contents will most likely be lower than the range of natural water contents and accordingly it will probably be necessary for some drying to take place before compaction, by taking thin cuts over broad areas, or by discing *in situ* before transportation, or by carrying out the earthworks at a relatively slow and controlled rate with minimal plant.

14.9.3 Pumiceous Silts in Earthworks

As discussed earlier, the pumiceous silts encountered on this site typically exhibited high strengths. It has been our experience that these materials generally have satisfactory bearing characteristics

when left untouched and confined beneath building foundations. However, when highly pumiceous, they are very troublesome when exposed to the elements as their weakly cemented structure rapidly collapses when wet. Therefore, benching and cut operations which involve these materials should be completed as rapidly as possible and any exposures should be covered with a compacted clay layer to prevent erosion, scour and possible piping upon completion of the site development works.

When layers of pumiceous silts are exposed during cut to fill operations they should be well mixed with the more clayey materials and compacted in the normal manner.

14.9.4 Benching of Slopes

All benching of slopes prior to the placement and compaction of filling should be in accordance with the normal requirements of NZS 4404 and related documents and should be the subject of Engineering inspections prior to the placement of any drainage works or filling.

14.9.5 Cut and Fill Batter Slopes

Native soil types vary across the site and hence the recommended batter slope for cuts and fills is expected to be refined during detailed design, taking into account the nature of the site materials at specific cut and fill areas.

However, as a general guide, we recommend cut batters be designed for a slope of 3H : 1V, unless the presence of groundwater seepage or specific poor soils require a flatter batter.

Fill batters (for engineered fill), should be designed for a slope of 3H : 1V where the normal on-site sand/silt soils are used in conjunction with underfill drainage. All topsoil, soft, organic or compressible soils must be undercut from below fill embankments prior to fill placement. Steeper fill slopes may be used in areas where there is restricted width for the fill batter, but these situations will require specific assessment at detailed design stage and a higher degree of on-site control of fill material selection, mixing, compaction and site observation during construction.

14.9.6 Unsuitables

All identifiable deposits of unsuitable materials including existing uncertified filling that are considered unfit for reworking should be undercut and disposed of off the site or on topsoil stockpiles if appropriate.

Generally, the gully boreholes have identified relatively small quantities of soft, organic or otherwise unsuitable materials (up to approximately 0.5 metres depth over apparently narrow widths), although it is difficult to estimate overall volumes from limited borehole information.

14.10 Land Drainage

14.10.1 Subsoil Drainage

Subsoil drainage will also be required in areas remote from the gullies where the water table is encountered near to the ground surface. The positions of such drains are best determined during earthworks construction.

14.10.2 Counterfort / and Bored / Drainage

Counterfort and / or bored drains will be required in all areas of sloping ground where the water table is near to the ground surface and where it is necessary to provide control over groundwater levels to maintain a minimum factor of safety of 1.5 against instability.

The counterfort drains should be at least 600 mm wide and installed to approximately 5.0 metres depth at approximately 20 metre centres.

The approximate locations of all counterfort drains will need to be shown on the development plans and their exact positions determined by the geotechnical engineer on-site during construction.

14.11 Compaction Control

Laboratory testing should be undertaken in the near future to establish specific compaction control criteria, but at this stage it is envisaged that earthworks control will be in terms of 95% of the maximum dry density within the appropriate water content range for the general subdivisional work and 100% of maximum dry density when within 600 mm or road subgrade level.

Upon instruction we will undertake compaction control testing prior to commencement of the earthworks.

14.12 Sediment Detention Ponds

Our investigations have highlighted the presence of sandy / silty soils across the site and accordingly, it may be necessary to provide a liner for sediment detention ponds, unless appropriate permeability rates can be demonstrated by laboratory testing of site soils.

However, initial indications are that suitable clayey soils for use as a liner are available within the western portion of the site. Indicatively, we would anticipate that a clayey liner would need to be of the order of 600 mm thick and a compaction specification should be developed following confirmation of the material suitability by laboratory testing.

Careful inspections must be undertaken during construction and appropriate producer statements should be prepared confirming each aspect of the work. This is especially important if the works are not all inspected by the same Consultancy.

14.13 Plan Review and Further Work

It should be noted that it was not possible to cover all proposed building lots during the site investigation work carried out for this report. Accordingly, it may be necessary at the time of preparation of our Geotechnical Completion report to undertake specific site investigation work on any previously uninvestigated lots that have either been cut or not affected by the earthworks.

Further work will be required to prepare a specific design report prior to starting earthworks on-site. This report will need to encompass specific design of all areas of the site where residential lots are proposed within the specific design zone. Specific design will also be required for MSE walls proposed on-site.

15 Limitations

- i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, Weston Lea Limited, their professional advisers and the relevant Territorial 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. The recommendations in this report are based on the ground conditions indicated from published sources, site assessments and subsurface investigations described in this report based on accepted normal methods of site investigations. Only a limited amount of information has been collected to meet the specific financial and technical requirements of the client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it should be appreciated that actual conditions could vary from the assumed model.
- iii. Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.
- iv. This Limitation should be read in conjunction with the Engineers NZ/ACENZ Standard Terms of Engagement.
- v. This report is not to be reproduced either wholly or in part without our prior written permission.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on (09) 972 2205 if you require any further information.

Report prepared by



Paul Fletcher, CMEngNZ (CPEng)

Associate Geotechnical Engineer

Report reviewed by



Don Bruggers, CMEngNZ (CPEng)

Principal Engineer

Report prepared by



Max Mclean

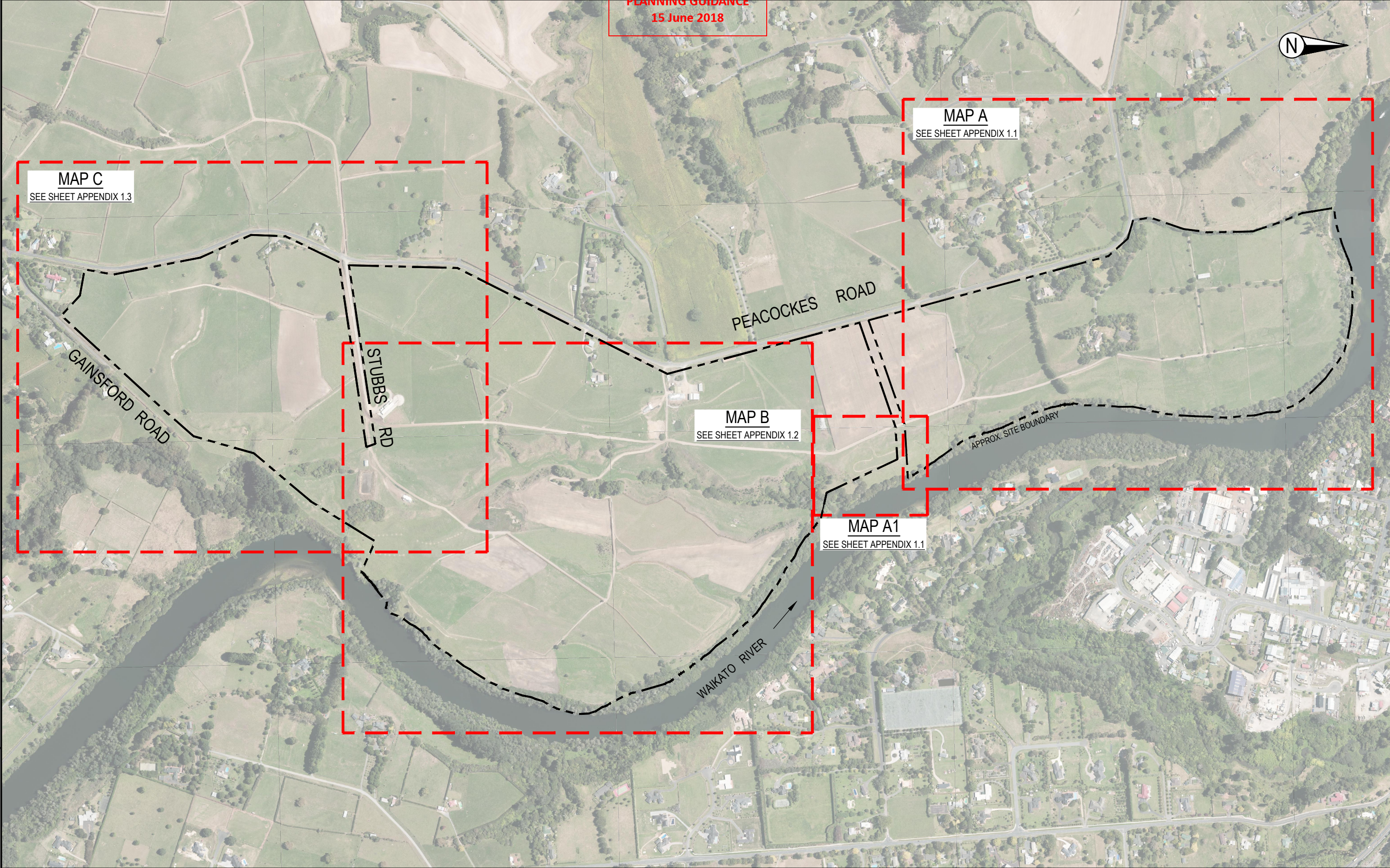
Engineering Geologist

APPENDIX 1:

Site Investigation Location Plans

DATE PLOTTED: 16 May 2018 1:27 p.m. BY: DOUG FINLAY

Received
PLANNING GUIDANCE
15 June 2018



3	16.5.18	Updated client & project details.	DF	PF	
2	29.3.18	Cross section location updates.	DF	MM	
1	30.01.18	MBH location updates.	DF	PF	
Rev	Date	Description	Drwn	Chkd	



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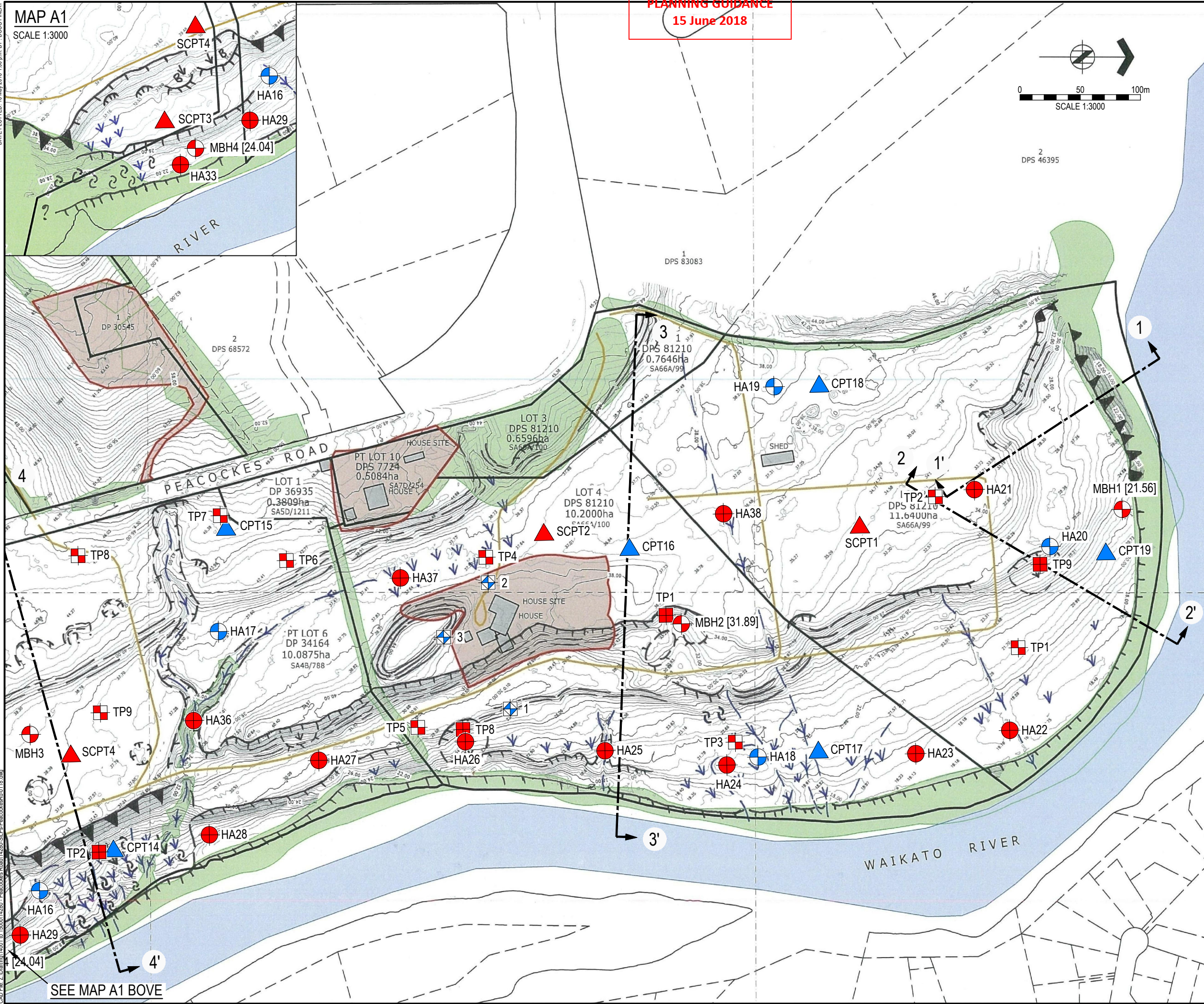
Title:

SITE INVESTIGATION LOCATION PLAN - MAP INDEX

Client: WESTON LEA LIMITED		Appendix No: 1	
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	Drawn: DF		
	Checked: -		
Proj No: 14280.000.000	Date: 16.01.18	Size: A3	
	Scale: 1:7500	Rev: 3	

XREFs: hamilton\01m-urban-aerial-photos-2015
CAD file: Z:\Drawing\14280 to 15000\14280 - Peacockes Road\14280-SI-PeacockesRd-0118.dwg

Received
PLANNING GUIDANCE
15 June 2018



Testing Legend

- 1 Soakage Test (Aug 2017)
- HA01 Hand Auger Test (Aug 2017)
- CPT01 Cone Penetrometer Test (Aug 2017)
- MBH1 [21.56] Machine Borehole Test [with level] (Dec 2017)
- SCPT1 Seismic Cone Penetrometer Test (Dec 2017)
- TP1 AWA Test Pits (Dec 2017)
- TP1 ENGEO Test Pits (Dec 2017)
- HA21 ENGEO Hand Auger Test (Dec 2017)

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Rev	Date	Description	Drwn	Chkd
3	16.5.18	Updated client & project details.	DF	PF
2	29.3.18	Cross section location updates.	DF	MM
1	30.01.18	MBH location updates.	DF	PF

**SITE INVESTIGATION
LOCATION PLAN - MAP A**

Base drawing source: H&G drawing 141842-SS02A.

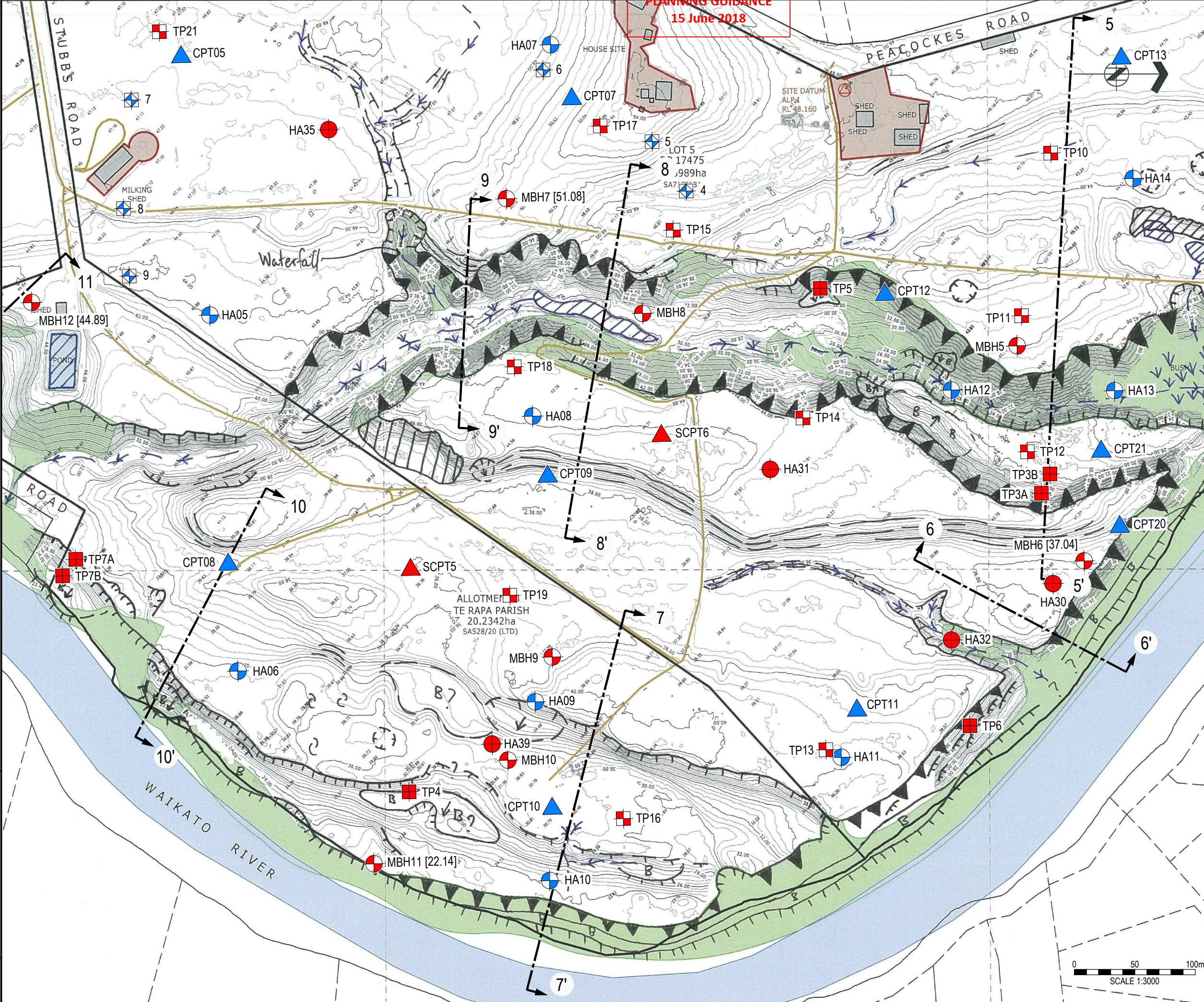
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Project: AMBERFIELD SUBDIVISION HAMILTON	Designed: PF	1.1
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	Checked: -	
	Date: 16.01.18	Size: A3
Project No: 14280.000.000	Scale: 1:3000	Rev: 3

DATE PLOTTED: 16 May 2018 1:32 p.m. BY: DOUG FINLAY

XREFs: hamilton01m-urban-aerial-photo-2015
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Testing Legend	
	1 Soakage Test (Aug 2017)
	HA01 Hand Auger Test (Aug 2017)
	CPT01 Cone Penetrometer Test (Aug 2017)
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	TP1 AWA Test Pits (Dec 2017)
	TP1 ENGEO Test Pits (Dec 2017)
	HA21 ENGEO Hand Auger Test (Dec 2017)



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Rev	Date	Description	Drwn	Chkd
3	16.5.18	Updated client & project details.	DF	PF
2	29.3.18	Cross section location updates.	DF	MM
1	30.01.18	MBH location updates.	DF	PF

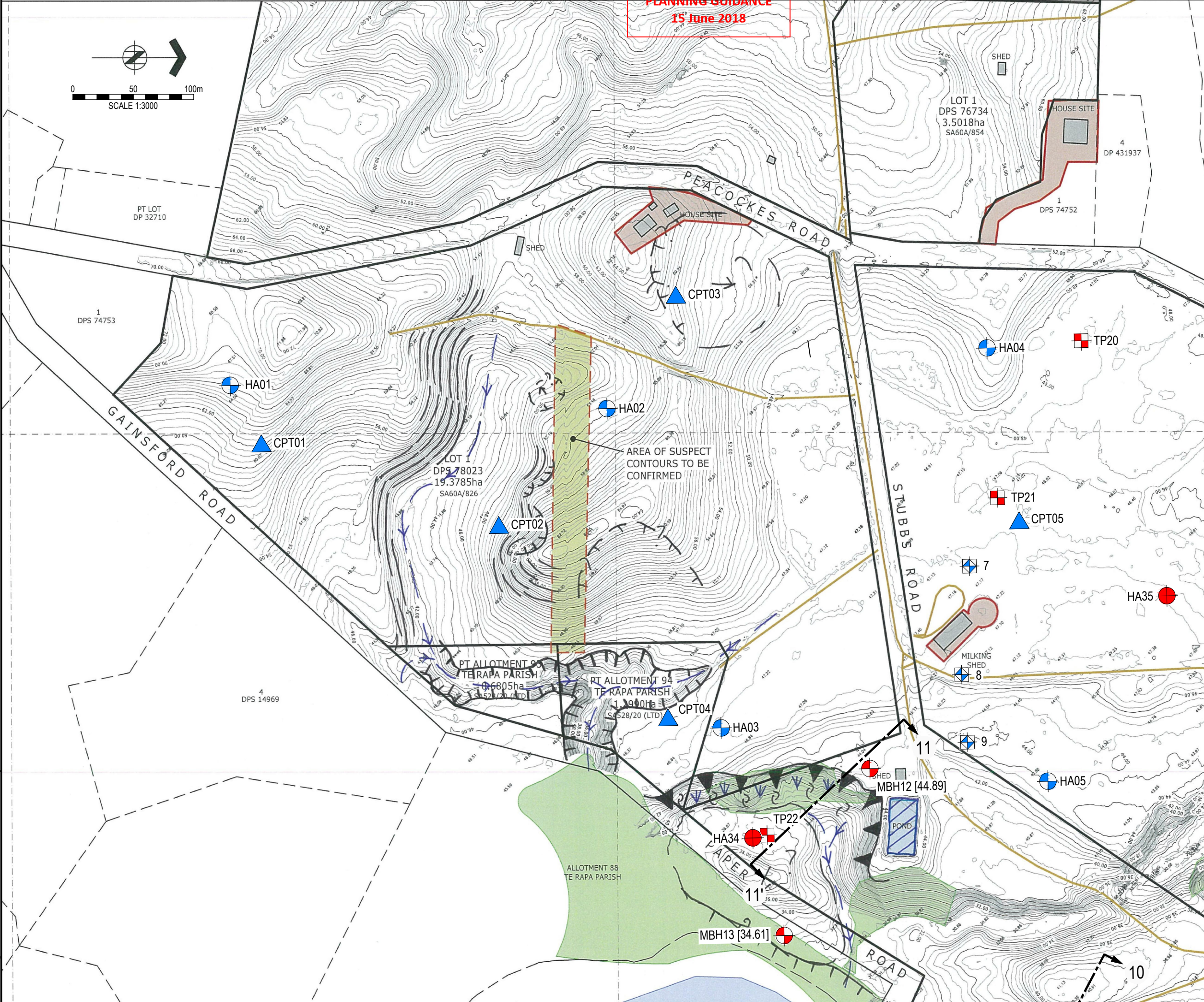
Title:
**SITE INVESTIGATION
LOCATION PLAN - MAP B**
Base drawing source: H&G drawing 141842-SS04A.

Client: WESTON LEA LIMITED		Appendix No:	
Project: AMBERFIELD SUBDIVISION HAMILTON	Designed: PF	1.2	Size: A3
	Drawn: DF		
	Checked: -		
Project No: 14280.000.000	Date: 16.01.18	Scale: 1:3000	Rev: 3
	Scale:		

DATE PLOTTED: 16 May 2018 1:33 p.m. BY: DOUG FINLAY
XREFs: hamilton\01m\urban\erial\chops\2015
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 - TP1 ENGEO Test Pits (Dec 2017)
 - HA21 ENGEO Hand Auger Test (Dec 2017)



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Rev	Date	Description	Drwn	Chkd
3	16.5.18	Updated client & project details.	DF	PF
2	29.3.18	Cross section location updates.	DF	MM
1	30.01.18	MBH location updates.	DF	PF

Title: **SITE INVESTIGATION LOCATION PLAN - MAP C**

Base drawing source: H&G drawing 141842-SS05A.

Client: WESTON LEA LIMITED		Appendix No:	
Project: AMBERFIELD SUBDIVISION HAMILTON	Designed: PF	1.3	Size: A3
	Drawn: DF		
	Checked: -		
Project No: 14280.000.000	Date: 16.01.18	Scale: 1:3000	Rev: 3

APPENDIX 2:
Site Investigation Data



LOG OF BORING BH01

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 28/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.19105
Longitude : -37.483078

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
												25 50 75	
0.0	TS			TOPSOIL.			W	N/A					
0.5		SP		Fine to medium SAND with minor silt; light orange brown. Poorly graded.			M	VL					
1.0													
1.5		GW		Fine to medium GRAVEL with some sand; light grey, orange, white and black. Well graded. Sand, medium to coarse, subrounded to subangular.					1/1/1/0/1/1 N=3				
2.0							W	VL					
2.5													
3.0		SP		Fine to medium pumiceous SAND; light brownish grey. Poorly graded.			M	L	1/2/1/1/2/2 N=6				
3.5		SW		Fine to coarse pumiceous SAND with minor gravel; light brownish grey. Well graded. Gravel, fine, subrounded.									
4.0													
4.5									2/1/2/1/2/2 N=7				
5.0							W	L					
5.5													
6.0													
6.5									2/2/2/2/2/2 N=8				
7.0													

GEOSCIENCE MACHINE BORING BH01-BH13. TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 7.87 m depth.



LOG OF BORING BH01

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 28/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
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Longitude : -37.483078

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			SW	Fine to coarse pumiceous SAND with minor gravel; light brownish grey. Well graded. Gravel, fine, subrounded. Occasional charcoal fragments encountered from 7.0 m depth. Gravel becomes fine to medium from 7.2 m depth.					2/1/1/1/2/2 N=6				
8.0				Some gravel encountered from 8.0 m depth.									
8.5								L					
9.0									1/1/1/1/1/1 N=6				
9.5													
10.0													
10.5							W		1/0/0/1/1/1 N=3				
11.0													
11.5													
12.0								VL - L					
12.5									10/1/1/1/1 N=4				
13.0													
13.5									0/1/0/0/1/0 N=1				
14.0													

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED
TS = TOPSOIL
Dip test showed standing water at 7.87 m depth.



LOG OF BORING BH01

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 28/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
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Longitude : -37.483078

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
14.5		×	SW	Fine to coarse pumiceous SAND with minor gravel; light brownish grey. Well graded. Gravel, fine, subrounded.				VL - L				25 50 75	
15.0		×											
15.5		×							1/0/1/1/2/2 N=6				
16.0		×											
16.5		×		Becomes light grey and grey from 16.1 m depth.									
17.0		×						L	1/2/1/1/1/1 N=4				
17.5		×		Gravel becomes fine to coarse from 17.55 m depth.									
18.0		×											
18.5		×		Wood fragments encountered from 18.2 m depth.					1/2/2/0/1/2 N=5				
19.0		×	SW	Fine to coarse pumiceous SAND with some fine gravel; light grey. Well graded. Gravel, fine, subrounded to subangular.									
19.5		×						L					
20.0		×		Decayed wood encountered from 19.7 m to 19.9 m depth.					1/1/2/1/2/2 N=7				

End of Hole Depth: 20.25 m
Termination: Target depth

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 7.87 m depth.



LOG OF BORING BH02

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 28/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.191613
Longitude : -37.484292

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
												25 50 75	
0.0	TS			TOPSOIL									
0.5		SP		Fine to medium pumiceous SAND with minor silt; light brownish grey. Poorly graded.			M	N/A					
0.5		ML		Clayey SILT with some fine sand; light brownish grey with orange streaks. Low plasticity.				N/A					
1.0													
1.5				Becomes brown from 1.3 m depth.				St					
2.0							W		1/1/1/1/1/1 N=4				
2.5		CH		Silty CLAY; light greyish brown. High plasticity.				St					
3.0													
3.5		CH		CLAY; light grey with light brown streaks. High plasticity.									
4.0							S	F - St					
4.5									0/0/0/0/0/1 N=1				
5.0		CH		Silty CLAY; light grey with orange mottles. High plasticity.									
5.5				Fine to medium SAND; light greenish brown with light grey and brown, poorly graded, encountered from 5.2 m to 5.25 m depth.									
6.0				Becomes orange brown with brown streaks at 5.27 m depth.									
6.5				Becomes light grey with orange streaks at 5.65 m depth.			M	St - VSt	1/1/1/1/1/1 N=4				
7.0				Black speckles encountered from 6.3 m to 6.55 m depth.									

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 12.18 m depth.



LOG OF BORING BH02

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 28/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.191613
Longitude : -37.484292

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			CH	Silty CLAY; light grey with orange mottles. High plasticity.								25 50 75	
8.0				Becomes light greyish brown from 7.6 m to 7.8 m depth.				St - Vst	0/1/2/2/2/1 N=7				
8.5				Becomes light greyish brown from 8.05 m depth.			M						
8.5			ML	SILT; light yellowish white. Low plasticity.				St					
9.0			SW	Fine to coarse SAND; dark brown. Well graded.				L	2/2/2/1/2/2 N=7				
9.0			SW	Becomes light yellowish grey with orange mottles from 8.52 m depth.									
9.5				Medium to coarse pumiceous SAND with some gravel; light brown. Well graded. Gravel, fine to medium, subrounded.									
9.5				Limonite staining encountered at 9.5 m depth.									
10.0			ML	Pumiceous SILT; light yellowish white with occasional orange bands. Low plasticity.				St					
10.5			SW	Interbedded very thin to thick bands of silty fine to coarse pumiceous SAND with minor gravel; light brown, well graded. gravel, fine, subrounded to subangular and very thin to moderately thin bands of pumiceous SILT; light yellowish white, low plasticity.					3/5/5/5/3/3 N=16				
11.0													
11.5													
12.0							W						
12.5				Charcoal fragments encountered at 12.1 m depth.				MD	1/0/2/3/3/2 N=10				
13.0				Trace coarse gravel encountered at 12.7 m depth.									
13.5									1/2/2/3/2/3 N=10				
14.0													

GEOSCIENCE MACHINE BORING BH01-BH13. TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 12.18 m depth.



LOG OF BORING BH02

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 28/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.191613
Longitude : -37.484292

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
14.5			SW	Interbedded very thin to thick bands of silty fine to coarse pumiceous SAND with minor gravel; light brown, well graded. gravel, fine, subrounded to subangular and very thin to moderately thin bands of pumiceous SILT; light yellowish white, low plasticity.				MD				25 50 75	
15.0													
15.5			SM	Silty fine to medium SAND; light grey with orange streaks. Well graded.					2/3/2/3/3/4 N=12				
16.0								MD					
16.5													
17.0			SW	Medium to coarse pumiceous SAND with minor gravel; light brown and light grey. Well graded. Gravel, fine to coarse, subrounded to subangular.					3/4/5/7/5/8 N=25				
17.5							W	MD					
18.0													
18.5			SM	Silty fine to medium pumiceous SAND; light grey with orange streaks. Well graded.				D	5/6/7/9/10/11 N=37				
19.0													
19.5			SW	Medium to coarse pumiceous SAND with minor gravel; light brown and light grey. Well graded. Gravel, fine to coarse, subrounded to subangular.				D					
20.0													
			SM	Silty fine to medium SAND; brown. Poorly graded.									
				30 mm band of medium to coarse SAND; light grey, black and white, poorly graded, encountered from 19.8 m to 19.83 m depth.				VD	9/12/12/12/18/8 N=50 for 30 mm				

End of Hole Depth: 20.25 m
Termination: Target depth

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 12.18 m depth.



LOG OF BORING BH03

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 22/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.191797
Longitude : -37.49032

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
												25 50 75	
0.0	TS			TOPSOIL.			W	N/A					
0.5			ML	SILT with minor sand; orange brown. Low plasticity. Sand, fine.			M	N/A					
1.0			SW	Gravelly fine to coarse SAND; brown, black and white. Well graded. Gravel, fine to coarse, subrounded.									
1.5							W	L	1/1/2/1/1/1 N=5				
2.0													
2.5			ML	Pumiceous SILT with some clay and trace sand; light grey with orange bands. Low plasticity.			S	F - St					
3.0			SM	Becomes interbedded with black organic streaks and speckles from 2.55 m to 2.7 m depth. Pumiceous silty fine SAND; light grey with orange bands. Poorly graded. Becomes light greyish brown from 3.0 m depth.			W		1/1/1/1/1/1 N=4				
3.5							S	L					
4.0				Becomes wet from 3.95 m depth. Black staining encountered from 4.05 m depth.			W						
4.5			SW	Fine to coarse SAND with minor gravel; light brownish grey, black and white. Well graded. Gravel, fine, subrounded.					1/2/2/2/2/2 N=8				
5.0													
5.5							M	L - MD					
6.0									2/2/2/3/4/4 N=13				
6.5													
7.0													

N/A = NOT ASSESSED

TS = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH03

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 22/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.191797
Longitude : -37.49032

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			SW	Fine to coarse SAND with minor gravel; light brownish grey, black and white. Well graded. Gravel, fine, subrounded.			M	L - MD				25 50 75	
8.0			SW	Fine to coarse SAND; dark reddish brown. Well graded.				MD	1/4/4/4/4/4 N=16				
8.5			SW	Fine to coarse SAND with minor gravel; light greyish brown, black and white. Well graded. Gravel, fine, subrounded.									
9.0				Becomes dark grey with dark brown streaks from 8.3 m depth. Becomes light grey, black and white from 8.4 m depth.				MD	2/2/4/4/5/5 N=18				
9.5													
10.0			ML	SILT with some clay and trace sand; light brownish grey. Low plasticity.			W						
10.5								VSt					
11.0													
11.5			CH	Silty CLAY with minor carbonaceous inclusions; brown with black streaks. High plasticity.					0/1/1/1/2/3 N=7				
12.0								F-St					
12.5				Becomes grey from 12.2 m depth.					0/0/0/0/1/0 N=1				
13.0			CH	Sandy CLAY with minor gravel; light grey. High plasticity. Sand, fine to medium. Gravel, fine, subrounded.			S	F-St					
13.5									0/0/1/0/0/1 N=2				
14.0				Wood encountered at 13.8 m depth.									

GEOSCIENCE MACHINE BORING BH01-BH13, TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

TS = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH03

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 22/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.191797
Longitude : -37.49032

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
			SW	Fine to coarse SAND with minor silt; light greyish brown. Well graded.				L				25 50 75	
14.5			CH	Silty CLAY with minor sand; light greyish green. High plasticity. Sand, fine. Becomes light grey with orange bands from 14.5 m depth.									
15.0													
15.5				Becomes thinly interbedded with thin bands of fine to medium SAND with minor silt; light grey with orange streaks, poorly graded, from 15.4 m depth.					0/2/2/2/4/3 N=11				
16.0													
16.5								VSt					
17.0									1/2/5/6/6/6 N=23				
17.5													
18.0				Black bands and mottles encountered from 17.9 m to 18.1 m depth.									
18.5									5/1/4/5/5/6 N=20				
19.0			SM	Silty fine to coarse pumiceous SAND with some gravel; light brownish grey and brown. Well graded. Gravel, fine to medium, subrounded to subangular.				D					
19.5													
20.0									4/8/9/11/10/16 N=46				
End of Hole Depth: 20.25 m Termination: Target depth													
N/A = NOT ASSESSED TS = TOPSOIL Ground water not assessed in borehole.													

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18



LOG OF BORING BH04

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 21/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192547
Longitude : -37.49001

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
												25 50 75	
	TS			TOPSOIL.				N/A					
0.5		SP		Fine to medium SAND with minor silt; orange brown. Poorly graded.				N/A					
		SP		Becomes light brownish grey with orange and brown streaks from 0.5 m depth.									
1.0				Silty fine to medium SAND with some clay; light grey with orange streaks. Poorly graded.			W						
1.5								L					
2.0		ML		Limonite staining encountered from 1.7 m to 1.73 m depth. Becomes brown from 1.73 m to 1.74 m depth.					3/2/2/1/1/2 N=6				
2.5				Clayey SILT with trace sand; intermixed brown, light greyish brown and orange. Low plasticity.				VSt					
3.0				Fissure filled with dark orange limonite gravel at 2.6 m depth.									
3.5		SM		Silty fine to coarse pumiceous SAND with minor gravel and trace clay; light brownish grey. Well graded. Gravel, fine to medium, subrounded.					2/2/2/2/3/4 N=11				
4.0													
4.5				Layer of clayey SILT; light brown with orange bands, low plasticity encountered from 3.95 m to 4.15 m depth.			M						
5.0				Medium to coarse pumice gravel, subangular, encountered from 4.2 m depth.					5/7/7/7/7/7 N=28				
5.5								MD - D					
6.0													
6.5									6/8/8/7/8/10 N=33				
7.0													

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 8.37 m depth.



LOG OF BORING BH04

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 21/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192547
Longitude : -37.49001

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			SM	Silty fine to coarse pumiceous SAND with minor gravel and trace clay; light brownish grey. Well graded. Gravel, fine to medium, subrounded. Becomes light orange brown from 7.0 m depth.									
8.0									5/6/6/6/6/7 N=25				
8.5				Becomes intermixed brown, dark brown and orange from 8.15 m to 8.6 m depth.		▼	M						
9.0													
9.5									5/4/4/5/5/4 N=18				
10.0				Becomes wet and light greyish brown with orange streaks from 10.0 m depth.									
10.5							MD						
11.0									3/4/4/5/5/5 N=19				
11.5													
12.0							W						
12.5									4/4/4/5/6/6 N=21				
13.0													
13.5													
14.0				Becomes light orange brown from 13.7 m depth.					4/4/5/5/6/6 N=21				

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 8.37 m depth.



LOG OF BORING BH04

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 21/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192547
Longitude : -37.49001

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
14.5		×	SM	Silty fine to coarse pumiceous SAND with minor gravel and trace clay; light brownish grey. Well graded. Gravel, fine to medium, subrounded.				MD					
15.0													
15.5		×		Layer of coarse SAND; black, grey and brown, poorly graded encountered from 15.25 m to 15.32 m depth.					4/4/5/7/10/10 N=32				
16.0				Becomes light greyish brown with orange streaks from 15.6 m depth.									
16.5													
17.0		×							5/5/5/8/8/9 N=30				
17.5							W	MD - D					
18.0													
18.5		×		Layer of coarse SAND; black, grey and brown, poorly graded encountered from 18.3 m to 18.5 m depth.					4/3/4/5/6/7 N=22				
19.0													
19.5													
20.0		×							3/3/3/4/5/4 N=16				

End of Hole Depth: 20.25 m
Termination: Target depth

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 8.37 m depth.



LOG OF BORING BH05

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 30/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192646
Longitude : -37.49924

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
	T			TOPSOIL.			M	N/A				25 50 75	
0.5			SW	Gravelly fine to coarse SAND with minor silt; light orange brown and grey. Well graded. Sand, fine to coarse. Gravel, fine to medium, subrounded.			D	L					
1.0													
1.5			SW	Gravelly coarse SAND; light orange and black. Well graded. Gravel, fine to coarse, subrounded to subangular.				L	2/1/2/2/2/2 N=8				
2.0													
2.5													
3.0			SW	Medium to coarse SAND with some gravel; light greyish brown, black and white. Well graded. Gravel, fine to medium, subrounded to subangular.			M		1/1/0/1/1/1 N=3				
3.5								VL - L					
4.0													
4.5									2/1/2/2/1/1 N=6				
5.0			ML	Clayey SILT; reddish brown. Low plasticity.				VSt					
5.5			CH	Sandy silty CLAY; light orange brown with light grey and black streaks. High plasticity. Sand, fine.				VSt					
6.0							W						
6.5				50 mm layer of CLAY; light greyish white with orange streaks, high plasticity encountered from 6.2 m to 6.25 m depth.					0/0/0/1/2/1 N=4				
6.5			CH	Silty CLAY with minor sand; light greyish white with orange streaks and black carbonaceous inclusions. High plasticity.				F - St					
7.0													

TAURANGA GROUP

N/A = NOT ASSESSED
T = TOPSOIL
Ground water not assessed in borehole.



LOG OF BORING BH05

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 30/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192646
Longitude : -37.49924

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			CH	Silty CLAY with minor sand; light greyish white with orange streaks and black carbonaceous inclusions. High plasticity.								25 50 75	
8.0				Becomes light orange grey with orange streaks from 7.8 m depth.					1/0/0/0/0/0 N=0				
8.5													
9.0							W	F - St					
9.5				Some sand and trace gravel encountered from 9.55 m depth.					0/0/0/0/0/0 N=0				
10.0													
10.5													
11.0									0/1/0/2/2/3 N=7				
11.5			SP	Becomes orange from 10.95 m depth. Fine to medium SAND; dark orange and orange. Poorly graded.			M	L					
12.0			CH	Silty CLAY with some sand; light purplish brown with significant orange limonite staining. High plasticity. Sand, fine. Limonite mottles become less frequent from 11.55 m depth. Light grey streaks encountered from 11.65 m depth.				St					
12.5			CH	Silty CLAY with some sand; light orange grey with orange streaks and black organics. High plasticity.				St	1/1/1/1/1/1 N=4				
13.0			SM	Silty fine to coarse SAND with trace clay; orange with dark orange streaks. Well graded.			W						
13.5				Significant limonite staining encountered from 13.1 m to 13.2 m depth. Becomes light greyish orange with orange bands from 13.3 m depth.				L					
14.0									1/1/1/1/2/2 N=6				

GEOSCIENCE MACHINE BORING BH01-BH13. TOBEREVIEWED GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

T = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH05

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 30/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192646
Longitude : -37.49924

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
14.5			SM	Silty fine to coarse SAND with trace clay; orange with dark orange streaks. Well graded.				L					
15.0													
15.5			ML	Clayey SILT; light orange grey with brown streaks. Low plasticity.					0/0/0/0/0/0 N=0				
16.0				Significant black organic streaks encountered from 16.0 m to 16.55 m depth. Becomes brownish grey at 16.05 m depth. Becomes light grey at 16.2 m depth.				F - St					
16.5													
17.0			SP	Fine to medium SAND with minor silt; light grey. Poorly graded. Becomes brownish grey from 16.7 m to 17.15 m depth.				L	1/1/2/2/2/2 N=8				
17.5							W						
18.0			ML	Clayey SILT; light brownish grey with orange streaks. Low plasticity.				St					
18.5			SM	Fine to coarse pumiceous SAND with minor silt; light grey. Well graded.					4/4/5/5/8/8 N=26				
19.0								MD					
19.5				Becomes thinly to moderately thinly interbedded with moderately thin bands of clayey SILT; light grey, low plasticity from 19.2 m depth.									
20.0									7/6/4/6/5/7 N=22				

End of Hole Depth: 20.25 m
Termination: Target depth

N/A = NOT ASSESSED

T = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH06

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 20/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.193448
Longitude : -37.491085

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
0.0	T			TOPSOIL.				N/A				25 50 75	
0.5			SW	Fine to coarse SAND with some gravel; light brown and brown. Well graded. Gravel, fine to medium, subrounded.				VL					
1.0				20 mm band of fine to medium GRAVEL; light brown and brown, subangular encountered at 1.0 m depth.									
1.5			SM	Silty fine to coarse SAND; light brownish grey with black mottles. Well graded.					0/0/0/0/0/0 N=0				
2.0								VL					
2.5													
3.0			ML	Sandy SILT; light brownish grey with black mottles. Low plasticity. Sand, fine.					0/0/0/0/0/0 N=0				
3.5							W						
4.0													
4.5								F					
5.0									0/0/0/0/0/0 N=0				
5.5													
6.0													
6.5				Minor fine to medium pumiceous GRAVEL, angular encountered from 6.2 m depth. Becomes light brownish grey with black mottles from 6.55 m depth.				F-VSt	1/0/0/1/1 N=3				
7.0													

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

T = TOPSOIL

Dip test showed standing water at 19.88 m depth



LOG OF BORING BH06

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 20/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.193448
Longitude : -37.491085

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			ML	Sandy SILT; light brownish grey with black mottles. Low plasticity. Sand, fine.								25 50 75	
8.0							W	F-Vst	3/4/4/5/5/6 N=20				
8.5				Orange mottles encountered from 8.35 m depth.									
9.0			CH	Orange limonite banding encountered from 8.65 m to 8.9 m depth and becomes moist from 8.65 m depth. Silty CLAY; light brownish grey. High plasticity.			M						
9.5							W	St					
10.0			ML	Sandy SILT trace clay; light brownish grey with black mottles. Low plasticity. Sand, fine.					0/0/0/1/1/1 N=3				
10.5				Becomes saturated at 10.0 m depth.									
11.0							S	F-St	1/1/2/2/1/2 N=7				
11.5													
12.0			ML	SILT with trace clay; light grey with orange mottles. Low plasticity.									
12.5				Becomes brown and orange from 12.15 m to 12.17 m depth.				F	0/0/1/0/1/0 N=2				
13.0							W						
13.5				40 mm band of fine to medium SAND; black and brown, poorly graded encountered at 13.2 m depth. Becomes interbedded with very thin bands of fine to coarse SAND with minor silt; light grey, well graded from 13.3 m depth. Orange bands encountered from 13.8 m to 13.9				St-Vst	0/0/4/5/4/2 N=15				
14.0													

N/A = NOT ASSESSED

T = TOPSOIL

Dip test showed standing water at 19.88 m depth



LOG OF BORING BH06

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 20/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.193448
Longitude : -37.491085

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
14.5		×	ML	m depth. SILT with trace clay; light grey with orange mottles. Low plasticity.				St-VSt				25 50 75	
15.0							W						
15.5		×	ML	Becomes orange brown from 15.1 m depth. Becomes light grey from 15.15 m depth. Sandy SILT; light grey. Low plasticity, Sand, fine.				VSt	4/4/4/5/5/6 N=20				
16.0			SW	Medium to coarse SAND with minor gravel; brown, brownish grey and dark reddish brown. Well graded, Gravel, fine, subrounded.									
16.5													
17.0		×							5/5/7/8/8/9 N=32				
17.5													
18.0							M	MD - D					
18.5		×							7/6/6/6/6/7 N=25				
19.0													
19.5													
20.0		×							3/5/6/6/5/6 N=23				

End of Hole Depth: 20.25 m
Termination: Target depth

N/A = NOT ASSESSED

T = TOPSOIL

Dip test showed standing water at 19.88 m depth



LOG OF BORING BH07

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 30/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192223
Longitude : -37.492491

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
0.0	TS	ML		TOPSOIL.			M	N/A				25 50 75	
0.5				Clayey SILT; orange brown. Low plasticity.									
1.0													
1.5									2/1/1/2/2/2 N=7				
2.0													
2.5													
3.0									0/0/1/0/0/1 N=2				
3.5							W	F-St					
4.0													
4.5				Black organic inclusions encountered at 4.1 m depth. Becomes interbedded with very thin to thin bands of sandy SILT; light brown, grey and black, low plasticity, sand, pumiceous, fine from 4.15 m to 4.95 m depth.					0/0/0/1/0/0 N=1				
5.0				Black organic mottles encountered from 4.95 m depth.									
5.5													
6.0									0/0/1/0/0/0 N=1				
6.5				Minor fine sand encountered from 6.5 m depth.									
7.0													

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 9.48 m depth.



LOG OF BORING BH07

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 30/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192223
Longitude : -37.492491

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			ML	Clayey SILT; orange brown. Low plasticity.				F-St					
8.0			ML	Clayey SILT with some sand; light brownish grey with orange streaks and black mottles. Low plasticity. Sand, pumiceous, fine to medium. Minor gravel encountered at 8.0 m depth. Gravel, pumiceous, fine to coarse, subrounded.					0/0/0/0/0/0 N=0				
9.0													
9.5									0/0/0/0/0/0 N=0				
10.0								S-St					
10.5							W						
11.0									0/0/0/0/0/0 N=0				
11.5													
12.0													
12.5									2/2/2/3/3/4 N=12				
13.0			SM	Silty fine to coarse pumiceous SAND with minor clay and gravel; light brownish grey with orange streaks and black mottles. Well graded. Gravel, pumiceous, fine to coarse, subrounded to subangular.				MD - D					
13.5													
14.0									3/4/4/4/5/5 N=18				

GEOSCIENCE MACHINE BORING BH01-BH13, TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 9.48 m depth.



LOG OF BORING BH07

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 30/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192223
Longitude : -37.492491

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
14.5			SM	Silty fine to coarse pumiceous SAND with minor clay and gravel; light brownish grey with orange streaks and black mottles. Well graded. Gravel, pumiceous, fine to coarse, subrounded to subangular.									
15.0				30 mm band of fine to coarse pumiceous SAND with some gravel encountered at 14.3 m depth. Gravel, light grey, pumiceous, fine to coarse.									
15.5				30 mm band of fine to coarse pumiceous SAND with some gravel encountered at 15.0 m depth. Gravel, light grey, pumiceous, fine to coarse.				MD - D	4/6/7/7/9/8 N=31				
16.0							W						
16.5													
17.0			SM	Silty fine SAND; orange. Poorly graded.				D	6/8/9/9/9/8 N=35				
17.5			ML	Significant limonite staining encountered from 17.2 m to 17.3 m depth. Pumiceous fine sandy SILT; light grey with brown streaks. Poorly graded.				St					
18.0													
18.5									4/3/2/1/2/2 N=7				
19.0			ML	Clayey SILT with some sand; light brownish grey with orange streaks and black mottles. Low plasticity. Sand, pumiceous, fine to medium.			M						
19.5								St - VSt					
20.0									1/1/2/2/2/3 N=9				

End of Hole Depth: 20.25 m
Termination: Target depth

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 9.48 m depth.



LOG OF BORING BH08

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 21/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192685
Longitude : -37.491752

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
												25 50 75	
0.0	TS			TOPSOIL.			W	N/A					
0.5			SM	Silty fine SAND; orange brown. Poorly graded.									
1.0							M	N/A					
1.5			SW	Fine to coarse pumiceous SAND with minor silt and gravel; light brown, orange and grey. Well graded. Gravel, fine to medium, subrounded.					1/2/2/2/3/1 N=8				
2.0													
2.5													
3.0													
3.5									1/1/0/1/1/1 N=3				
4.0							W	VL-L					
4.5													
5.0									1/0/0/1/1/1 N=3				
5.5													
6.0													
6.5									3/2/2/2/2/2 N=8				
6.5			SP	Fine SAND with minor silt; light greyish brown with occasional black carbonaceous streaks.			S	L					
7.0			ML	Poorly graded.			W	St					

GEOSCIENCE MACHINE BORING BH01-BH13. TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

TS = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH08

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 21/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192685
Longitude : -37.491752

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			ML	Clayey SILT; light brownish grey. Low plasticity. Clayey SILT; light brownish grey. Low plasticity. Becomes light grey from 7.05 m depth. Becomes light greyish green from 7.2 m depth.			W	St				25 50 75	
8.0			SW	Fine to coarse SAND with some gravel; light greyish brown, grey and white. Well graded. Gravel, fine to medium, subrounded. Becomes light grey, black and dark grey at 7.8 m depth.					3/3/3/3/4/5 N=15				
8.5													
9.0									1/2/2/2/3/3 N=10				
9.5													
10.0													
10.5							S	MD	3/3/3/3/3/4 N=13				
11.0													
11.5													
12.0													
12.5									2/3/3/4/4/4 N=15				
13.0													
13.5				30 mm band of medium to coarse SAND; dark brown, poorly graded, encountered from 13.2 m to 13.23 m depth.									
14.0			SP	Fine to medium SAND with some silt; light grey. Poorly graded.			W	D	5/6/8/9/8/7 N=33				

N/A = NOT ASSESSED

TS = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH08

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 21/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.192685
Longitude : -37.491752

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
			SP									25 50 75	
14.5				Fine to medium SAND with some silt; light grey. Poorly graded. 50 mm band of silty CLAY; light grey with orange streaks. High plasticity. Limonite staining encountered at 14.25 m depth. Becomes saturated from 14.3 m to 14.7 m depth and becomes interbedded with very thin bands of sandy fine to medium pumiceous GRAVEL; light grey, well graded, subrounded, sand, fine to coarse from 14.3 m to 14.5 m depth.			W						
15.0							S						
15.5								D	6/6/8/8/8/8 N=32				
16.0				30 mm band of sandy fine pumiceous GRAVEL; light grey, well graded, subangular, sand, fine to coarse encountered from 15.8 m to 15.83 m depth. Becomes light greenish grey from 16.05 m to 16.15 m depth.									
16.5				30 mm band of sandy fine pumiceous GRAVEL; light grey, well graded, subangular, sand, fine to coarse encountered from 16.25 m to 16.28 m depth.				MD	4/5/6/8/8/6 N=28				
17.0													
17.5							W						
18.0				30 mm band of sandy fine pumiceous GRAVEL; light grey, well graded, subangular, sand, fine to coarse encountered from 18.1 m to 18.13 m depth.					6/10/13/17/14/6 N=50 for 55 mm				
18.5													
19.0				40 mm band of sandy fine pumiceous GRAVEL; light grey, well graded, subangular, sand, fine to coarse encountered from 18.85 m to 18.89 m depth.				D - VD					
19.5				20 mm band of sandy fine pumiceous GRAVEL; light grey, well graded, subangular, sand, fine to coarse encountered from 18.9 m to 18.92 m depth.					10/11/12/10/10/11 N=43				
20.0													

End of Hole Depth: 20.25 m
Termination: Target depth

N/A = NOT ASSESSED

TS = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH09

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 17/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.193029
Longitude : -37.492461

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
				TOPSOIL				N/A				25 50 75	
0.5			SM	Silty fine to coarse SAND; brown. Well graded [FILL].									
1.0							W	VL					
1.5													
2.0			SP	Fine to medium SAND with minor gravel; brown. Poorly graded. Gravel, fine to medium, subrounded to subangular [FILL].				VL	1/0/0/1/0/1 N=2				
2.5			ML	SILT with trace fine sand; brownish grey. Low plasticity [FILL].				VL					
3.0				Tree roots encountered from 2.4 m to 2.5 m depth.									
3.5			SW	Fine to coarse SAND with minor gravel; dark brown, black and white. Well graded. Gravel, fine to medium, subrounded to subangular.				L	1/1/1/1/2/4 N=8				
4.0			ML	Clayey SILT; brownish grey. Low plasticity.				St					
4.5			SP	Silty fine to medium pumiceous SAND with minor gravel; light grey. Poorly graded. Gravel, pumiceous, fine to medium, subrounded to subangular.			S		1/1/1/1/1/1 N=4				
5.0													
5.5								L					
6.0			SW	200 mm layer of fine to coarse SAND with trace gravel; black, white and grey, well graded at 5.8 m depth.					1/1/1/1/1/1 N=4				
6.5													
7.0			ML	SILT with some fine sand and trace clay; brown. Low plasticity. 30 mm band of fine to coarse SAND; brown, well graded encountered from 6.75 m to 7.05 m depth.				St					

GEOSCIENCE MACHINE BORING BH01-BH13. TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

T = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH09

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 17/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.193029
Longitude : -37.492461

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			ML	SILT with some fine sand and trace clay; brown. Low plasticity.				St					
8.0			SM	Silty fine to medium pumiceous SAND with trace gravel; grey. Poorly graded.				VL	0/0/0/0/0/1 N=1				
8.5			ML	Clayey SILT with minor sand; light grey. Low plasticity. Sand, pumiceous, fine to medium.									
9.0													
9.5									0/0/0/0/0/0 N=0				
10.0				Becomes saturated from 9.8 m depth.									
10.5													
11.0				Becomes wet at 10.6 m depth.					0/0/0/0/0/0 N=0				
11.5				Becomes brownish grey at 11.05 m depth.			W	S-F					
12.0				Black organics inclusions encountered from 11.95 m to 12.0 m depth.									
12.5									0/0/0/0/0/0 N=0				
13.0				Becomes light grey from 12.65 m depth.									
13.5													
14.0				Becomes light greenish grey from 13.7 m to 13.9 m depth.					0/0/1/0/0/0 N=1				

GEOSCIENCE MACHINE BORING BH01-BH13. TOBEREVIEWED GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

T = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH09

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 17/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.193029
Longitude : -37.492461

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
14.5		ML		Clayey SILT with minor sand; light grey. Low plasticity. Sand, pumiceous, fine to medium.				S-F				25 50 75	
15.0													
15.5		SW		Fine to coarse SAND with minor silt; black white and light grey. Well graded.				VL	1/0/0/1/0/0/0 N=1				
16.0													
16.5													
17.0									2/2/2/3/4/4 N=13				
17.5													
18.0				Bands of light and dark greenish grey encountered from 18.0 m depth.				MD					
18.5				Becomes grey with dark grey bands from 18.75 m depth.					1/2/1/3/4/4 N=12				
19.0													
19.5													
20.0				Limonite staining encountered from 19.9 m depth.					3/2/2/2/3/5 N=12				
		SP		Fine to medium pumiceous SAND with minor gravel; light grey. Poorly graded. Gravel, pumiceous, fine to medium, subrounded to subangular. End of Hole Depth: 20.25 m Termination: Target depth				MD					

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

T = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH10

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 17/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 1751936.85
Longitude : -37.492542

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
												25 50 75	
0.0	TS	×		TOPSOIL.			S	N/A					
0.5			ML	Sandy SILT; light brown with orange streaks. Low plasticity. Sand, fine to medium.									
1.0													
1.5								F					
2.0				Fine to coarse SAND; light grey, brown and white, well graded encountered from 1.6 m to 1.9 m depth.					1/1/0/1/1/0 N=2				
2.5			SW	Fine to coarse SAND with trace fine gravel; light grey, brown and white. Well graded.									
3.0													
3.5									2/2/1/2/2/1 N=6				
4.0							W						
4.5								L-MD					
5.0									2/2/2/3/3/2 N=10				
5.5				Becomes interbedded with very thin bands of fine GRAVEL; light grey, brown, subrounded from 5.2 m top 5.5 m depth.									
6.0			ML	SILT; dark reddish brown. Low plasticity.				St					
6.5			CH	Sandy CLAY; brownish grey with light grey and black streaks. High plasticity, Sand, fine to medium.				S-St	0/0/0/0/0/0 N=0				
7.0													

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

TS = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH10

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 17/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 1751936.85
Longitude : -37.492542

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			CH	Sandy CLAY; brownish grey with light grey and black streaks. High plasticity, Sand, fine to medium.								25 50 75	
8.0				Band of SILT; dark reddish brown, low plasticity encountered from 7.8 m to 7.9 m depth.				S-St	0/0/0/0/0/0 N=0				
8.5				Black carbonaceous inclusions encountered from 8.45 m to 8.5 m depth. Becomes light grey and sand becomes fine to coarse from 8.6 m to 8.75 m depth.									
9.0			ML	Sandy SILT; light greenish grey and dark greenish grey. Low plasticity. Sand, pumiceous, fine to coarse.				F-St	0/0/1/1/2/1 N=5				
9.5													
10.0				Minor gravel encountered from 10.0 m to 12.65 m depth. Gravel, pumiceous, fine to medium, subrounded to subangular.									
10.5													
11.0									4/5/6/7/8/7 N=28				
11.5													
12.0								VSt - H					
12.5									3/7/7/7/7/7 N=28				
13.0													
13.5				Becomes very dense at 13.4 m depth.									
14.0			SP	Fine to medium pumiceous SAND with minor silt; grey with orange bands. Poorly graded.				MD - VD	6/6/10/8/8/7 N=33				

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

TS = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH10

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 17/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 1751936.85
Longitude : -37.492542

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
14.5			SP	Fine to medium pumiceous SAND with minor silt; grey with orange bands. Poorly graded. Becomes light brown at 14.1 m depth.								25 50 75	
15.0													
15.5									7/7/7/8/6/7 N=28				
16.0				Becomes light grey with orange streaks from 15.65 m depth.				MD - VD					
16.5													
17.0				Limonite staining encountered at 16.8 m depth. Limonite staining encountered at 16.85 m depth.					5/7/14/19/17 N=50 for 25 mm				
17.5				Occasional grey streaks from 17.5 m to 17.6 m depth.									
18.0			ML	Sandy SILT with some gravel; light grey with brown and orange streaks. Low plasticity. Sand, pumiceous, fine to coarse. Gravel, pumiceous, fine, subrounded.				H					
18.5			SM	Silty fine to medium pumiceous SAND; grey with orange bands. Well graded.					6/11/13/13/13/11 N=50 for 45 mm				
19.0				Dark grey staining encountered at 18.9 m depth. Dark grey staining encountered at 19.0 m depth.									
19.5				Becomes interbedded with very thin to thin bands of fine GRAVEL; light grey, subrounded from 19.3 m to 19.9 m depth.				D - VD					>>
20.0									7/10/10/9/8/9 N=36				
End of Hole Depth: 20.25 m Termination: Target depth													
N/A = NOT ASSESSED TS = TOPSOIL Ground water not assessed in borehole.													

GEOSCIENCE MACHINE BORING BH01-BH13. TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18



LOG OF BORING BH11

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 20/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.194512
Longitude : -37492649

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
												25 50 75	
0.0	TS			TOPSOIL.			W	N/A					
0.5			SW	Gravelly, fine to coarse SAND with trace silt; light brown, light grey and white. Well graded. Gravel, fine to medium, subrounded to subangular.									
1.0													
1.5				Minor gravel encountered from 1.5 m depth.					2/2/3/3/3/3 N=12				
2.0													
2.5							M	L - MD					
3.0				Fine to coarse gravel encountered from 3.0 m depth.					2/1/2/2/3/2 N=9				
3.5													
4.0			ML	200 mm layer of SILT with some fine to medium sand, light grey, low plasticity encountered at 3.85 m depth.									
4.5			SM	Silty fine to medium pumiceous SAND with some gravel; light grey and grey. Poorly graded. Gravel, pumiceous, angular.					1/1/1/0/1/1 N=3				
5.0													
5.5							S	VL					
6.0				Black carbonaceous inclusions encountered from 6.15 m to 6.2 m depth.					0/1/1/0/1/1 N=3				
6.5				Gravel becomes subrounded from 6.6 m to 7.4 m depth.									
7.0													

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 6.88 m depth.



LOG OF BORING BH11

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 20/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.194512
Longitude : -37492649

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5			SM	Silty fine to medium pumiceous SAND with some gravel; light grey and grey. Poorly graded. Gravel, pumiceous, angular. Black carbonaceous inclusions encountered from 7.0 m to 7.1 m depth.								25 50 75	
8.0								VL	1/1/0/1/0/1 N=2				
8.5													
9.0													
9.5			SP	Fine to medium pumiceous SAND with some gravel, minor silt and trace black carbonaceous fragments; light grey. Poorly graded. Gravel, pumiceous, fine to medium, subrounded to subangular.					1/0/0/1/1/0 N=2				
10.0													
10.5				Becomes gravelly from 10.5 m to 11.65 m depth.			S		1/1/0/1/0/0 N=1				
11.0													
11.5								VL					
12.0									1/1/0/1/0/2 N=3				
12.5													
13.0													
13.5									1/0/0/1/1/2 N=4				
14.0													

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 6.88 m depth.



LOG OF BORING BH11

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 20/11/2017
Hole Depth : 20.25 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.194512
Longitude : -37492649

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
												25 50 75	
14.5			SP				S	VL					
15.0			SM	Silty fine to medium pumiceous SAND with trace gravel; grey with orange and brown streaks. Well graded.									
15.5									4/6/5/5/5/5 N=20				
16.0							M	MD					
16.5													
17.0									2/2/3/3/4/5 N=15				
17.5			SP	Fine to medium pumiceous SAND with some gravel; light brownish grey and grey. Poorly graded. Gravel, pumiceous, fine to coarse, subrounded.									
18.0							W	MD					
18.5									3/2/2/3/4/4 N=13				
19.0			SM	Silty fine to medium pumiceous SAND with some gravel; light grey and grey. Poorly graded. Gravel, pumiceous, angular.			M	MD					
19.5			SW	Gravelly fine to coarse pumiceous SAND with minor silt; light brownish grey. Well graded. Gravel, pumiceous, fine to medium, subrounded to subangular.			W	MD					
20.0				Orange streaks encountered at 20.0 m depth.					5/4/5/5/5/6 N=21				

End of Hole Depth: 20.25 m
Termination: Target depth

N/A = NOT ASSESSED

TS = TOPSOIL

Dip test showed standing water at 6.88 m depth.



LOG OF BORING BH12

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 15/11/2017
Hole Depth : 27.7 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.19252
Longitude : -37.493845

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
	T	X	SM	TOPSOIL.				N/A				25 50 75	
0.5				Silty fine to coarse SAND; dark brown with brown streaks. Well graded.				L					
1.0				Becomes orange brown at 0.55 m depth.									
1.5			SP	Medium to coarse SAND; brownish grey. Poorly graded.				MD	1/2/1/2/3/3/3 N=11				
2.0			SW	Medium to coarse SAND with some fine to medium gravel; dark reddish brown and black. Well graded. Gravel, subrounded.			W	L					
2.5													
3.0			SP	Fine to medium silty SAND; light grey with orange bands. Poorly graded. Becomes light grey at 3.0 m depth.				L	2/2/1/1/2/2/2 N=7				
3.5													
4.0			SW	Medium to coarse SAND with some gravel; brownish grey. Well graded. Gravel, fine, subrounded to subangular. Limonite staining encountered at 3.9 m depth. 150 mm layer of silty fine SAND; light brownish grey. Poorly graded.				L					
4.5			OH	Interbedded very thin to thin layers of CLAY; light grey, high plasticity, and amorphous, PEAT; black and dark brown.					1/0/0/0/0/0/0 N=0				
5.0													
5.5								S-St					
6.0							S						
6.5									2/3/1/4/4/4/4 N=16				
7.0				Medium to coarse SAND brownish grey. Poorly graded.				MD					

N/A = NOT ASSESSED

T = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH12

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 15/11/2017
Hole Depth : 27.7 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.19252
Longitude : -37.493845

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
7.5				Medium to coarse SAND brownish grey. Poorly graded.				MD	1/2//4/5/5/5 N=19				
8.0			SW	Silty fine to coarse pumiceous SAND with some fine to medium gravel; dark reddish brown, black and white. Well graded. Gravel, subrounded. 50 mm band of limonite encountered at 8.3 m depth.									
8.5													
9.0													
9.5									2/1//3/4/4/4 N=15				
10.0				Becomes light grey at 9.8 m depth.									
10.5								L-MD					
11.0							S		4/3//3/4/4/5 N=16				
11.5													
12.0													
12.5									3/2//2/1/2/2 N=7				
13.0			ML	Clayey SILT with minor sand; grey with occasional dark grey and greenish grey bands. Low plasticity. Sand, fine.				St					
13.5													
14.0			PT	Firm, fibrous PEAT; black.				F	1/1//1/1/2/1				

GEOSCIENCE MACHINE BORING BH01-BH13. TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

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Ground water not assessed in borehole.



LOG OF BORING BH12

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 15/11/2017
Hole Depth : 27.7 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.19252
Longitude : -37.493845

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
14.5			PT	Firm, fibrous PEAT; black.			S	F	1/1/1/1/2/1				
15.0			SM	Silty coarse SAND with some clay; light grey. Poorly graded.				VL	0/0/0/0/0/1 N=1				
15.5				Becomes brownish grey from 14.9 m to 15.0 m depth.									
16.0			CH	Sandy CLAY; light grey with black mottles. High plasticity. Sand, medium to coarse.									
16.5				Black organic clay inclusions encountered from 16.0 m depth.				S-F					
17.0				50 mm band of silty CLAY; light grey, high plasticity encountered at 16.7 m depth.					0/0/0/0/1/1 N=2				
17.5			PT	Firm, amorphous PEAT; dark brown. 100 mm layer of silty fine to coarse SAND; light brownish grey, well graded at 17.25 m depth.			W	F					
18.0													
18.5			ML	Fine to medium sandy SILT; light grey. Low plasticity.					8/11/12/12/12/11 N=50 for 70 mm				
19.0				Becomes interbedded with thin to very thin bands of fine to coarse SAND; grey. Well graded.									
19.5				Becomes green from 19.3 m to 19.35 m depth.				VSt - H					
20.0				Becomes green from 19.55 m to 19.6 m depth.									
20.5				Firm, amorphous peat encountered from 19.88 m to 19.89 m depth.					1/0/2/3/3/3 N=11				
21.0			SW	Firm, amorphous peat encountered from 20.25 m to 20.1 m depth.									
21.5				Medium to coarse SAND with some fine gravel and minor silt; grey, black and white. Well graded. Gravel, fine, subrounded to subangular.				MD					

GEOSCIENCE MACHINE BORING BH01-BH13. TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

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Ground water not assessed in borehole.



LOG OF BORING BH12

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 15/11/2017
Hole Depth : 27.7 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude : 175.19252
Longitude : -37.493845

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
21.5			SW	Medium to coarse SAND with some fine gravel and minor silt; grey, black and white. Well graded. Gravel, fine, subrounded to subangular. Limonite staining encountered at 21.25 m depth.					2/4//4/5/5/4 N=18				
22.0				Becomes brownish grey at 21.75 m depth.									
22.5													
23.0				Band of gravelly fine to coarse SAND; black, white and grey, well graded, gravel, fine, subangular encountered from 23.1 to 23.25 m depth.				MD	4/5//5/5/6/6 N=22				
23.5													
24.0				Fine to medium gravel encountered from 24.0 m depth.									
24.5				Band of gravelly fine to coarse SAND; black, white and grey, well graded, gravel, fine, subangular encountered from 24.4 to 24.5 m depth. Becomes brown and dark brown from 24.5 m depth.			W		3/6//5/5/6/5 N=21				
25.0													
25.5			GP	Fine to medium GRAVEL; dark reddish brown. Poorly graded, subrounded to subangular.				MD					
26.0			SW	Fine to coarse SAND; light brownish grey. Well graded.					4/6//7/7/7/9 N=30				
26.5													
27.0								D					
27.5									6/10//8/9/9/9 N=35				

End of Hole Depth: 27.7 m
Termination: Target depth

N/A = NOT ASSESSED

T = TOPSOIL

Ground water not assessed in borehole.



LOG OF BORING BH13

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 16/11/2017
Hole Depth : 30.95 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude :
Longitude :

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
	T	X	ML	TOPSOIL				N/A				25 50 75	
0.5			SM	Silty fine to coarse SAND; dark brown and brown. Well graded.				N/A					
1.0			ML	Fine to medium sandy SILT with minor clay; light orange brown. Low plasticity. Becomes light brownish grey with orange bands from 0.65 m depth. 30 mm layer of gravel encountered at 0.8 m depth. Gravel, fine to medium, subrounded to subangular.									
1.5				Some black organic inclusions and limonite staining encountered from 1.5 to 1.9 m depth.			W	F-St	1/1//1/2/2/2 N=7				
2.0				Becomes light orange brown with light grey streaks and orange limonite staining from 2.0 m depth.									
2.5													
3.0			CH	Silty CLAY; light grey with orange streaks. High plasticity.				F					
3.5			ML	Fine to coarse sandy SILT with some clay; light grey. Low plasticity.					1/0//0/1/1/1 N=3				
4.0								S-F					
4.5													
5.0			CH	CLAY with minor fine to medium sand; light grey. High plasticity. 100 mm layer of fine to coarse sand with some silt, light grey, well graded from 5.3 m depth.			S		0/0//0/0/0/0 N=0				
5.5								S-F					
6.0													
6.5			SW	Fine to coarse pumiceous SAND with some silt; light grey. Well graded.				L	1/1//1/1/1/1 N=4				
6.5			ML	Fine to medium sandy SILT with trace clay; light grey. Low plasticity.			W	VSt-H					
7.0													

LANDSLIDE DEBRIS

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED
T = TOPSOIL
Dip test showed standing water at 19.25 m depth.



LOG OF BORING BH13

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 16/11/2017
Hole Depth : 30.95 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude :
Longitude :

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
												25 50 75	
7.5			ML	Fine to medium sandy SILT with trace clay; light grey. Low plasticity.				VSt-H					
8.0			SM	Silty fine to coarse SAND; light grey, black and white. Well graded.			W		4/5//8/9/11/11 N=39				
8.5				Becomes fine to medium sand from 8.4 m depth.				MD					
9.0				Becomes saturated at 8.8 m depth.			S						
9.5			OL	Clayey organic SILT; dark brown. Low plasticity.				S-F	1/0//1/1/1/0 N=3				
10.0			ML	Fine to medium sandy SILT; light brownish grey with orange mottles. Low plasticity.				St					
10.5				Becomes intermixed with silty fine SAND; dark brown, poorly graded at 10.5 m depth [POTENTIAL SHEAR ZONE].									
11.0			SW	Fine to coarse SAND with minor silt and trace gravel; brown with yellowish brown streaks and orange staining. Well graded.			W		1/2//2/2/4/4 N=12				
11.5				Limonite staining encountered at 11.35 m depth. Limonite staining encountered at 11.45 m depth.									
12.0								MD					
12.5									2/1//3/2/4/4 N=13				
13.0													
13.5													
14.0									4/6//7/5/6/7 N=25				

N/A = NOT ASSESSED

T = TOPSOIL

Dip test showed standing water at 19.25 m depth.



LOG OF BORING BH13

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 16/11/2017
Hole Depth : 30.95 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude :
Longitude :

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
14.5		×	SW	Fine to coarse SAND with minor silt and trace gravel; brown with yellowish brown streaks and orange staining. Well graded. Limonite staining encountered at 14.35 m depth.								25 50 75	
15.0		×											
15.5		×							3/2//4/4/5/5 N=18				
16.0		×		Limonite staining encountered at 15.85 m depth. Limonite staining encountered at 16.1 m depth.				MD					
16.5		×											
17.0		×							4/4//4/4/4/4 N=16				
17.5		×					W						
18.0		×											
18.5		×	SW	Fine to coarse SAND with minor silt; light brownish grey with orange streaks. Well graded.					4/3//6/9/9/10 N=34				
19.0		×						D					
19.5		×	SW	Fine to coarse SAND with minor silt and trace gravel; brown with yellowish brown streaks and orange staining. Well graded.									
20.0		×						L	1/1//1/1/2/3 N=7				
20.5		×	SW	Silty fine to coarse SAND; light brownish grey with orange streaks. Well graded.				MD					
21.0		×											

GEOSCIENCE MACHINE BORING BH01-BH13_TOBEREVIEWED.GPJ NZ DATA TEMPLATE 2.GDT 16/5/18

N/A = NOT ASSESSED

T = TOPSOIL

Dip test showed standing water at 19.25 m depth.



LOG OF BORING BH13

Geotechnical Investigation
Amberfield Development
Peacocks Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 16/11/2017
Hole Depth : 30.95 m
Drilling Method : Rotasonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude :
Longitude :

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
21.5			SW	Silty fine to coarse SAND; light brownish grey with orange streaks. Well graded.					7/9//8/5/5/5 N=23				
22.0													
22.5													
23.0									1/0//2/4/5/4 N=15				
23.5													
24.0													
24.5							W	MD	1/3//4/7/9/10 N=30				
25.0													
25.5													
26.0									3/3//5/3/3/4 N=15				
26.5													
27.0													
27.5									1/1//1/1/2/2 N=6				
28.0													

TAURANGA GROUP

N/A = NOT ASSESSED
T = TOPSOIL
Dip test showed standing water at 19.25 m depth.



LOG OF BORING BH13

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Date : 16/11/2017
Hole Depth : 30.95 m
Drilling Method : Rotosonic
Drilling Contractor : Prodrill Ltd

Core Diameter : 83 mm
Hammer Efficiency : %
Logged By/Reviewed By : KJL / AK
Latitude :
Longitude :

Depth (m)	Material	Sample Type	USCS Symbol	DESCRIPTION	Log Symbol	Water Level	Moisture	Consistency/ Density Index	SPT N-Value	Pocket Pen. UCS (kPa)	Torvane Shear (kPa)	Total Core Recovery (%)	Notes
28.5			SW	Silty fine to coarse SAND; light brownish grey with orange streaks. Well graded.				MD					
29.0			SW	Fine to coarse SAND with minor silt and gravel; orange brown. Well graded. Gravel, fine to coarse, subrounded. Becomes reddish brown at 28.55 m depth. Becomes light grey at 28.7 m depth. Becomes reddish brown at 29.2 m depth.					2/3/1/3/3/6/5 N=17				
29.5							W	MD					
30.0			SW	Fine to coarse SAND with some gravel and minor silt; orange brown. Well graded. Gravel, fine to medium, subangular to subrounded.				MD	2/2/1/2/3/4/4 N=13				
30.5													

End of Hole Depth: 30.95 m
Termination: Target depth

N/A = NOT ASSESSED

T = TOPSOIL

Dip test showed standing water at 19.25 m depth.



LOG OF AUGER HA01

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 28/08/17
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 1858
Logged By : AK
Reviewed By : KJL
Latitude : -37.832
Longitude : 175.3203

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
									2	4	6	8	10	12
	TS	ML	TOPSOIL				VSt	147/59						
0.5		ML	Clayey SILT with trace gravel; brown with dark brown mottles. Low plasticity.				VSt	132/57						
1.0		CH	CLAY; orange brown. High plasticity. Becomes brown with orange streaks at 1.1 m depth.				H	200+						
1.5							VSt	174/75						
		CH	Sandy CLAY; brown with brownish grey streaks. High plasticity. Sand, fine to coarse.				H	151/65						
2.0		CH	Silty CLAY; light brownish grey. High plasticity.				H	200+						
2.5								UTP						
		ML	Clayey SILT; orange brown with brown streaks and dark brown mottles. Low plasticity. Becomes brown with occasional dark grey mottles from 2.8 m depth.			W	VSt	163/47						
3.0								156/48						
3.5								123/31						
4.0								109/38						
4.5								139/34						
5.0							St	98/30						
								88/35						
								88/40						
								71/45						
End of Hole Depth: 5 m Termination Condition: Target depth														

Hand auger met target depth at 5 m.
Standing groundwater was not encountered
TS = TOPSOIL
UTP = UNABLE TO PENETRATE



LOG OF AUGER HA02

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 28/08/17
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : BF
Reviewed By : KJL
Latitude : -37.8294
Longitude : 175.3203

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
									2	4	6	8	10	12
	TS	ML	TOPSOIL				NA							
0.5			Clayey SILT with minor fine to medium sand; light orange brown. Low plasticity.			M	VSt	145/48						
1.0		ML	Becomes wet at 0.8 m depth.				St	97/16						
1.5			Clayey SILT with some fine to medium sand and minor organics; orange brown with black streaks. Low plasticity.			W	VSt	116/13						
2.0			Becomes orange brown at 2.0 m depth.					103/19						
2.5								113/19						
3.0			Becomes saturated at 2.6 m depth.					97/26						
3.5		ML	Poor recovery from 3.1 m depth.					90/19						
4.0			Becomes orange brown with occasional black streaks from 3.3 m depth.					93/23						
4.5								90/16						
5.0			Becomes orange brown from 3.7 m depth.			S	St	87/16						
			End of Hole Depth: 5 m Termination Condition: Target depth					87/16						
								90/13						
								90/16						
								90/16						

Hand auger met target depth at 5 m.
Dip test showed standing water at 3.6 m depth.
TS = TOPSOIL
NA = NOT ASSESSED



LOG OF AUGER HA03

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 28/08/17
Hole Depth : 1.7 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : BF
Reviewed By : KJL
Latitude : -37.8283
Longitude : 175.3236

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
	TS	ML	TOPSOIL				NA	145/32	2	4	6	8	10	12
		ML	Sandy SILT with minor gravel; orange brown. Low plasticity. Sand, fine to coarse. Gravel, fine to medium, sub angular to sub rounded.				VSt							
0.5			Fine to coarse SAND with gravel; orange brown. Well graded. Gravel, fine to medium, rounded.			W								
1.0		SW	Becomes saturated at 1.2 m depth.				L - D							
1.5						S								
2.0			End of Hole Depth: 1.7 m Termination Condition: Practical refusal											
2.5														
3.0														
3.5														
4.0														
4.5														
5.0														

Hand auger met practical refusal at 1.7 m depth due to poor recovery.
Scala Penetrometer met target depth at 2.6 m depth
Dip test showed standing water at 1.2 m depth.
TS = TOPSOIL

NA = NOT ASSESSED



LOG OF AUGER HA04

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 28/08/17
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 1858
Logged By : AK
Reviewed By : KJL
Latitude : -37.8267
Longitude : 175.3198

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
									2	4	6	8	10	12
	TS	ML	TOPSOIL			M	NA							
0.5			Clayey SILT; brown. Low plasticity.				St	98/45						
1.0			Becomes orange brown with brownish grey streaks at 0.8 m depth.				VSt	133/42						
1.5		ML	Becomes brown with occasional dark grey streaks at 1.5 m depth.				H	144/54						
2.0							VSt	UTP						
2.5			Silty CLAY; light brown. High plasticity.					174/28						
3.0		CH				W	VSt	175/42						
3.5								168/68						
4.0		CH	Silty CLAY with minor fine to coarse sand; light brownish grey. High plasticity. Sand becomes trace at 3.5 m depth.				H	160/44						
4.5							VSt	170/75						
5.0		ML	Clayey SILT with trace sand; light brown with orange and dark grey streaks. Low plasticity.				St	161/59						
			Becomes saturated at 4.7 m depth.					200+						
						S		112/33						
								88/35						
								79/37						
								72/30						
			End of Hole Depth: 5 m Termination Condition: Target depth											

Hand auger met target depth at 5 m.
Standing groundwater was not encountered
TS = TOPSOIL
NA = NOT ASSESSED



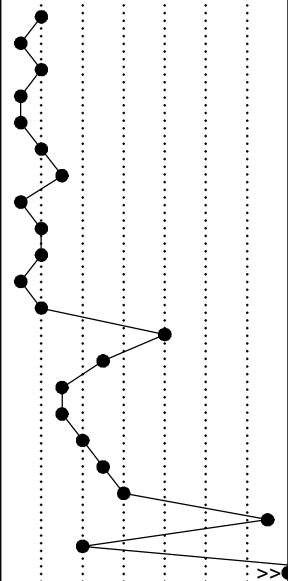
LOG OF AUGER HA05

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 28/08/17
Hole Depth : 2.2 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : BF
Reviewed By : KJL
Latitude : -37.8263
Longitude : 175.3238

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
									2	4	6	8	10	12
	ML		Sandy SILT with trace gravel; black. Low plasticity. Sand, fine to medium.				S - F							
0.5	SM		Silty fine to coarse SAND with minor fine to medium gravel; brown. Well graded. Gravel, rounded.			W	L							
1.0	SW		Fine to coarse SAND with minor fine to medium gravel; light orange brown. Well graded. Gravel, rounded.				L - D							
1.5						S								
2.0	SW		Fine to coarse SAND with some fine to medium gravel; dark brown with black streaks. Well graded. Gravel, rounded.				MD - D							
			End of Hole Depth: 2.2 m Termination Condition: Practical refusal											
2.5														
3.0														
3.5														
4.0														
4.5														
5.0														



Hand auger met practical refusal at 2.2 m depth on hard material.
Scala Penetrometer met practical refusal at 2.3 m depth.
Dip test showed standing water at 1.6 m depth.



LOG OF AUGER HA06

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 28/08/17
Hole Depth : 1.6 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : BF
Reviewed By : KJL
Latitude : -37.8259
Longitude : 175.3272

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
									2	4	6	8	10	12
	T	ML	TOPSOIL				NA							
0.5		SW	Fine to coarse SAND with trace gravel; orange brown. Well graded.			M	MD - D							
1.0		SM	Silty fine to coarse SAND; dark orange brown. Well graded.				MD							
1.5		SW	Fine to coarse SAND with minor fine to coarse gravel; light orange brown. Well graded. Gravel, rounded.			S	MD - D							
End of Hole Depth: 1.6 m Termination Condition: Practical refusal														
2.0														
2.5														
3.0														
3.5														
4.0														
4.5														
5.0														

Hand auger met practical refusal at 1.6 m depth due to poor recovery.
Scala Penetrometer met practical refusal at 1.6 m depth.
Dip test showed standing water at 0.9 m depth.
T = TOPSOIL

NA = NOT ASSESSED



LOG OF AUGER HA07

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 28/08/17
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 1858
Logged By : AK
Reviewed By : KJL
Latitude : -37.8232
Longitude : 175.3212

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
									2	4	6	8	10	12
	TS	ML	TOPSOIL			W	NA							
0.5			Clayey SILT; brown. Low plasticity.				VSt	116/45						
1.0								127/52						
1.5		ML	Becomes orange brown at 1.1 m depth.		▼	M		106/37						
2.0							H	200+						
2.5			Becomes light brown with dark grey mottles at 1.1 m depth.					UTP						
3.0								200+						
3.5			Silty CLAY; light brown with occasional dark grey mottles. High plasticity.				St	95/27						
4.0		CH				W		93/25						
4.5							VSt	120/58						
5.0							St	82/31						
								86/27						
							F	57/31						
								54/25						
								49/24						
			End of Hole Depth: 5 m Termination Condition: Target depth											

Hand auger met target depth at 5 m.
Dip test showed standing water at 1.2 m depth.
TS = TOPSOIL
NA = NOT ASSESSED

UTP = UNABLE TO PENETRATE



LOG OF AUGER HA08

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 28/08/17
Hole Depth : 5 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : BF
Reviewed By : KJL
Latitude : -37.8233
Longitude : 175.3247

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
									2	4	6	8	10	12
	TS	ML	TOPSOIL				NA	92/27						
0.5		ML	Clayey SILT; orange brown. Low plasticity.			W	St	UTP						
		ML	Sandy SILT with minor fine to medium gravel; orange brown. Low plasticity. Sand, fine to coarse. Gravel, sub rounded to rounded.				VSt							
1.0		SW	Fine to coarse SAND with minor fine to medium gravel; brown. Well graded. Gravel, sub rounded.				VL							
		CH	Silty CLAY; light grey. High plasticity.				St - VSt							
1.5			Clayey SILT with minor sand fine to coarse and fine to medium gravel; orange with light grey and brown. Low plasticity. Gravel, rounded.			S		24/2						
2.0		ML	Becomes light grey at 2.1 m depth.				S - F	35/19						
2.5			Clayey SILT; light bluish grey. Low plasticity.					200+						
								UTP						
3.0								UTP						
3.5							H	200+						
		ML	Becomes dark orange with bluish grey mottles at 3.5 m depth.			M		200+						
4.0								200+						
4.5							St	98/27						
5.0							VSt	114/61						
End of Hole Depth: 5 m Termination Condition: Target depth														

Hand auger met target depth at 5 m.
Dip test showed standing water at 0.6 m depth.
TS = TOPSOIL
NA = NOT ASSESSED



LOG OF AUGER HA09

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 28/08/17
Hole Depth : 2.5 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : BF/AK
Reviewed By : KJL
Latitude : -37.8233
Longitude : 175.3274

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
									2	4	6	8	10	12
	TS	ML	TOPSOIL				NA							
0.5		ML	Sandy SILT; brown. Low plasticity. Sand, fine to coarse.				F - St							
1.0		SW	Silty fine to coarse SAND; brown. Well graded.				VL							
1.5		SW	Fine to coarse SAND with trace gravel; light brown. Well graded.			W	VL							
2.0			Minor fine to medium gravel encountered at 1.5 m depth. Gravel, rounded to sub rounded.											
2.5			Minor fine to medium gravel encountered at 2.1 m depth. Gravel, rounded to sub rounded.											
2.5			End of Hole Depth: 2.5 m Termination Condition: Practical refusal											
3.0														
3.5														
4.0														
4.5														
5.0														

Hand auger met practical refusal at 2.5 m depth on inferred gravel and hole collapsed. NOT ASSESSED
Scala Penetrometer met target depth at 3.0 m depth
Standing groundwater was not encountered
TS = TOPSOIL



LOG OF AUGER HA10

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 28/08/17
Hole Depth : 1.8 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : BF
Reviewed By : KJL
Latitude : -37.8231
Longitude : 175.3292

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
									2	4	6	8	10	12
	T	ML	TOPSOIL				NA							
0.5		SW	Fine to coarse SAND with minor fine to medium gravel; dark orange brown. Well graded. Gravel, rounded.				L							
1.0		SW	Fine to coarse SAND with some fine to medium gravel; light brown and white. Well graded. Gravel, rounded.											
1.5		SW	Becomes saturated at 1.2 m depth.				L - D							
2.0			End of Hole Depth: 1.8 m Termination Condition: Practical refusal											
2.5														
3.0														
3.5														
4.0														
4.5														
5.0														

Hand auger met practical refusal at 1.8 m depth due to poor recovery.
Scala Penetrometer met target depth at 2.5 m depth
Dip test showed standing water at 0.8 m depth.
T = TOPSOIL

NA = NOT ASSESSED



LOG OF AUGER HA11

Geotechnical Investigation
Amberfield Development
Peacockes Road, Hamilton East
14280.000.000

Client : Weston Lea Ltd
Client Ref. : 14280
Date : 29/08/17
Hole Depth : 4.2 m
Hole Diameter : 50 mm

Shear Vane No : 2093
Logged By : BF/AK
Reviewed By : KJL
Latitude : -37.8213
Longitude : 175.3282

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Symbol	Water Level	Moisture Cond.	Consistency/ Density Index	Shear Vane Undrained Shear Strength (kPa) Peak/Remolded	Scala Penetrometer					
									Blows per 100mm					
									2	4	6	8	10	12
	TS	ML	TOPSOIL.				NA							
0.5		ML	Sandy SILT; brown. Low plasticity. Sand, fine.				VSt	116/31						
			Clayey SILT with trace sand and gravel; grey with orange brown streaks. Low plasticity.				St	93/16						
1.0			Becomes light grey with orange brown and dark grey streaks at 1.0 m depth.					139/3						
1.5			Minor fine to coarse sand encountered at 1.4 m depth.					145/16						
			Becomes light grey with occasional dark grey mottles at 1.4 m depth.				VSt	151/16						
2.0		ML				W		161/13						
2.5								148/16						
							St	64/6						
3.0								68/13						
								90/26						
3.5		ML	Clayey SILT with minor fine to medium sand; light brown. Low plasticity.				VSt	197/29						
			Clayey SILT with trace sand and gravel; grey with orange brown streaks. Low plasticity.				H	UTP						
4.0		ML					St	84/26						
							VSt	110/45						
4.5			End of Hole Depth: 4.2 m Termination Condition: Practical refusal											
5.0														

Hand auger met practical refusal at 4.2 m depth due to poor recovery.
Standing groundwater was not encountered
TS = TOPSOIL
NA = NOT ASSESSED

UTP = UNABLE TO PENETRATE