09 August 2019

Drury Plan Change

GEOTECHNICAL ASSESSMENT REPORT

Fulton Hogan Land Development Limited

AKL2018-0233AB Rev 3

AKL2018-0233AB		
Date	**Revision**	**Comments**
10 May 2019	A	Initial draft for internal review
10 June 2019	0	Final issue to client
24 June 2019	1	Revised Final issue to client
15 July 2019	2	Revised Zoning, Final Issue to Client
09 August 2019	3	Updated Plan Change area

	Name	**Signature**	**Position**
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1 INTRODUCTION

1.1 Project Brief

CMW Geosciences (CMW) was engaged by Fulton Hogan Land Development Limited (FHLD) to carry out a geotechnical assessment of the Plan Change area which is located within Drury East and bound by Waihoehoe Road, Fitzgerald Road and Drury Hills Road. The Plan Change proposes to rezone this piece of land from Future Urban Zone to a mixture of residential zones.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter AKL2019-0233AA, Rev 0 dated 18 December 2014.

1.2 Scope of Work

The purpose of this report is to describe the assessment undertaken, identify any particular geotechnical risks or limitations to development, and provide geotechnical recommendations for future development of the Plan Change area.

1.3 Background

This report has been prepared to inform the Drury East Residential Plan Change on behalf of FHLD. The boundary of the Plan Change area is shown in Figure 1 in Section 2 below and on Drawing 01 in Appendix A.

The area subject to this Plan Change is located within Drury East and has a land area of approximately 200.2088 hectares. Drury East is contained by the Papakura urban area to the north, the Hunua foothills to the east, the Drury South Business zone to the south, and State Highway 1 to the west. FHLD has large landholdings within the Plan Change extent, which is bound by Fitzgerald Road, Drury Hills Road and Waihoehoe Road. A small area of land north of Waihoehoe Road would also be included in the Plan Change extents due to overall catchments. Currently, the Plan Change area are predominantly used for farming, with some rural lifestyle blocks.

Drury East has an extensive stream and flood plain network which connects headwaters to the Manukau Harbour. The Plan Change area is within the Hingaia Creek catchment and is traversed by several watercourses. The overall topography of the area is relatively undulating, with several low ridgelines.

The Plan Change area is currently zoned Future Urban under the Auckland Unitary Plan. FHLD are seeking to rezone the land for residential development Mixed Housing Urban and Mixed Housing Suburban. The Plan Change provides for a small mixed-use centre within the Plan Change area, as well as a range of public open spaces. New roading and servicing infrastructure is proposed to service the development. Once developed, it is anticipated that the Plan Change area could accommodate approximately 2800 dwellings.

2 SITE DESCRIPTION

2.1 Site Location

The Plan Change area comprises multiple properties to the east of the Drury township, with an area of approximately 200.2088 hectares, and is bound by Waihoehoe Road to the north, Fitzgerald Road to the west and south and Drury Hills Road to the east, as shown on Figure 1 below and Drawing 01 in Appendix A. A small area to the north of Waihoehoe Road will also be included due to catchment gradients.

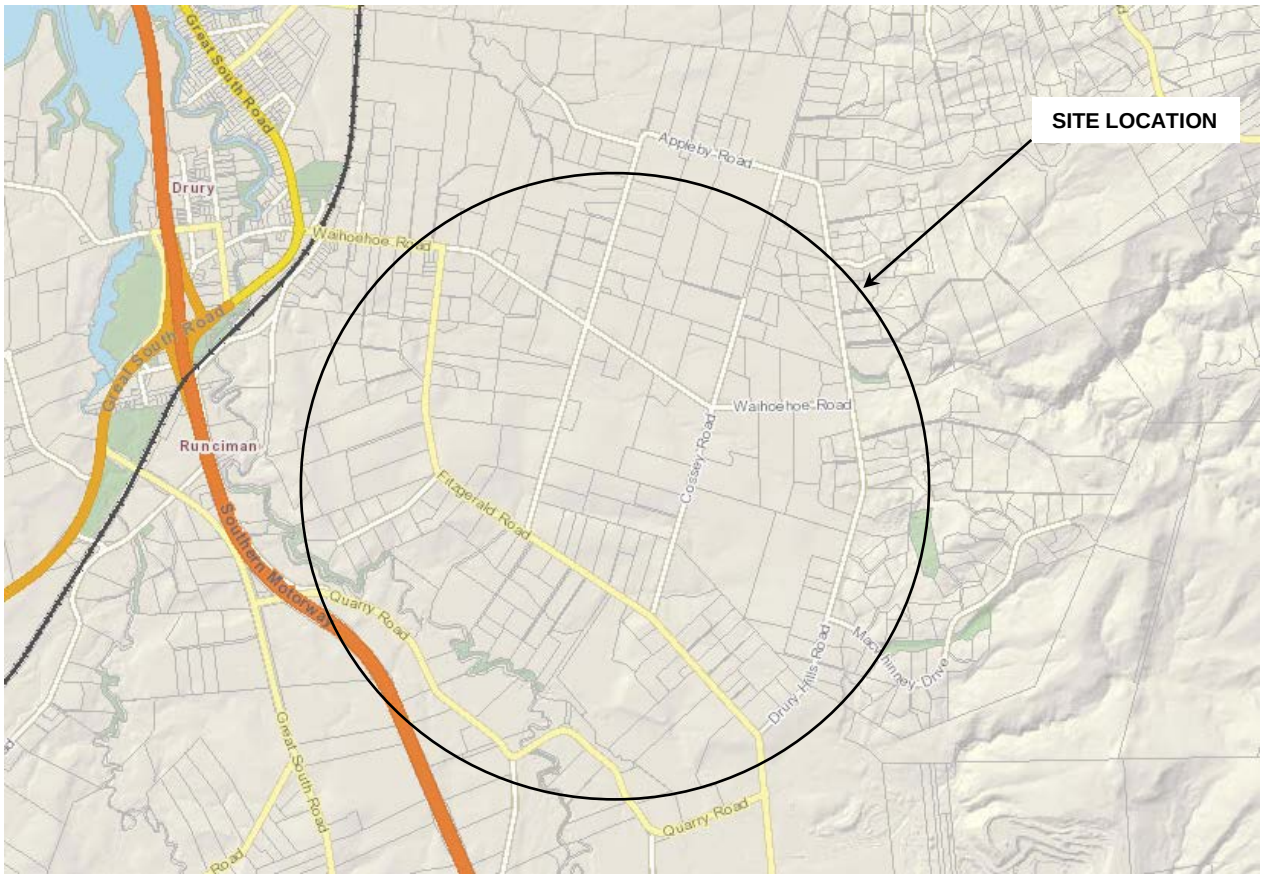

Figure 1: Site Location Plan (Reference: AC GIS)

2.2 Landform

The current general landform, together with associated features located within and adjacent to the Plan Change area is presented on the attached Existing Contours Plan (Drawing 01*)* in Appendix A*.*

The Plan Change area comprises a number of gently graded terraces falling towards the west with broad, shallow gullies bisecting the terraces. A local highpoint is located in the north-eastern corner of the Plan Change area, demarcated by a relatively sharp change in contour compared to the overall topography of the area. Drury Hills Road forms the eastern boundary of the site and essentially runs along the base of the Hunua foothills.

Ground levels grade from a highpoint of RL48m in the north-eastern corner to RL13m on the western boundary, over a distance of approximately 1.8km.

Several small watercourses run through the site, generally falling to the west and eventually discharge into the Hingaia Stream.

Development around the Plan Change area typically comprises either rural residential properties and farm and/or market garden type operations, with numerous residential and farm related dwellings and structures. There are several locations around the overall Plan Change area comprising commercial green-house operations.

3 DESKTOP STUDY

A desktop study of relevant available information has been undertaken as part of our site assessment, and included the following:

1. Aerial photograph review of the Retrolens and Auckland Council GIS database:
    a. 1942, Photoset SN192, Run Number 274;
    b. 1960, Photoset SN583, Run Number 1929B;
    c. 1961, Photoset SN1397, Run Number 3244;
    d. 1969, Photoset SN1875, Run Number 5048;
    e. 1975, Photoset SN3800, Run Number P;
    f. 1981, Photoset SN5783B, Run V,
    g. 1988, Photoset SN8772, Run V.
    h. AC GIS 1996,
    i. AC GIS 2003/2004,
    j. AC GIS 2006
    k. AC GIS 2008
    l. AC GIS 2010 / 2011
    m. AC HIS 2015/2016
    n. AC GIS 2017
2. IGNS, Geology of the Auckland Area, 1:250,000 Geological Map 3
3. Beca Carter Hollings & Ferner Ltd, Drury Fault Investigation, Ref 2012030, Dated August 2005
4. Beca Infrastructure Limited, Drury Project – Geotechnical Factual Report, Ref 3910474 // NZ1-1762748-10, Dated 1 July 2009
5. Beca Infrastructure Limited, Drury South Business Project Geotechnical Appraisal, Ref 3910474 // NZ1-2300665-23, Dated 10 February 2010
6. Beca Infrastructure Limited, Drury South Project – Geotechnical Addendum Report, Ref 3910474//NZ1-7132642-5, Dated 30 April 2013
7. Geoscience, Due Diligence Geotechnical Review, Project KEA, Drury, Auckland, Job Ref. 11294.0, Dated 08-09-2014
8. Gaia Engineers, Ararimu Development, Geotechnical Factual Report, Ref. 2053/04, Dated 20 April 2015
9. Ministry for the Environment Guidelines, “Planning for Development of Land on or Close to Active Faults.”, July 2003

4 HISTORICAL DEVELOPMENT

The aerial photograph review indicates historic development across the Plan Change area has been as follows:

- In 1942 the majority of the Plan Change area had been cleared and was being used as pasture. There were isolated small areas of bush and a larger bush area was located at the western end of the Plan Change area. Residential dwellings and farm buildings were located across the site. Fielding Road and Cossey Road had yet to be formed
- By 1960 the larger bush area had been felled and the remaining areas of bush had also decreased in number and scale. Pasture remained the predominant land-use. Cossey Road had been formed.
- The 1961 photos show Fielding Road had been formed.
- By 1981 development in the area had increased. There were more dwellings and structures across the overall Plan Change area. Green-houses and market gardens / orchards had started to appear in the north-west and south-east portions of the Plan Change area. There was evidence of the Vector Transmission line to the west of Fielding Road. Shelter belts were growing along numerous fence lines across the Plan Change area, particularly around the orchard/garden areas.
- By 1988 more green-houses and market gardens / orchards were present across the Plan Change area. Additional houses had also been built.
- Development across the site in 1996 is broadly similar to 1988, although it appeared that some orchard/garden areas had reverted to pasture. A pond of some description had been developed in Lot 56 DP 119.
- By 2003/2004 pasture in the centre of the Plan Change area appeared to be being converted to garden areas. A second pond had been formed in Lot 56 DP 119. More houses across the Plan Change area.
- In 2006 there was little change. A greenhouse at 319 Waihoehoe Road had been demolished.
- In 2010/2011, minimal change.
- In 2015/2016, market gardens were being developed in the south-west corner of the Plan Change area. Green-houses at 86 Fitzgerald Road and 37 Cossey Road had been removed. An additional green-house at 112 Cossey Road had been built. Significant areas across Lots 53, 56 and 57, DP 119 Lot 5 DP 185120 and Lot 2 DP487007 had been developed into market gardens.
- By 2017, the ponds in Lot 5 DP119 had been filled. Minimal other changes.

5 PUBLISHED GEOLOGY

Published geological maps[1] for the area (see Figure 2) depict the regional geology as comprising:

- Predominantly volcanic deposits from the South Auckland Volcanic Field (Qvs), consisting of basalt and scoria with areas of ash, lapilli and lithic tuff;
- Some of the western margin is mapped as being underlain by the Pleistocene aged Puketoka Formation (Pup), comprising alluvial deposits of pumiceous mud, sand and gravel with muddy black peat and lignite; rhyolite pumice, including non-welded ignimbrite, tephra and alluvial pumice deposits.
- Isolated areas of more recent Holocene aged Tauranga Group materials (Q1a), comprising alluvial/colluvial deposits.

[1] Edbrooke, S.W. (compiler) 2001. Geology of the Auckland area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 3. 1 sheet + 74p. Lower Hutt, New Zealand: Institute of Geological and Nuclear Sciences Limited.

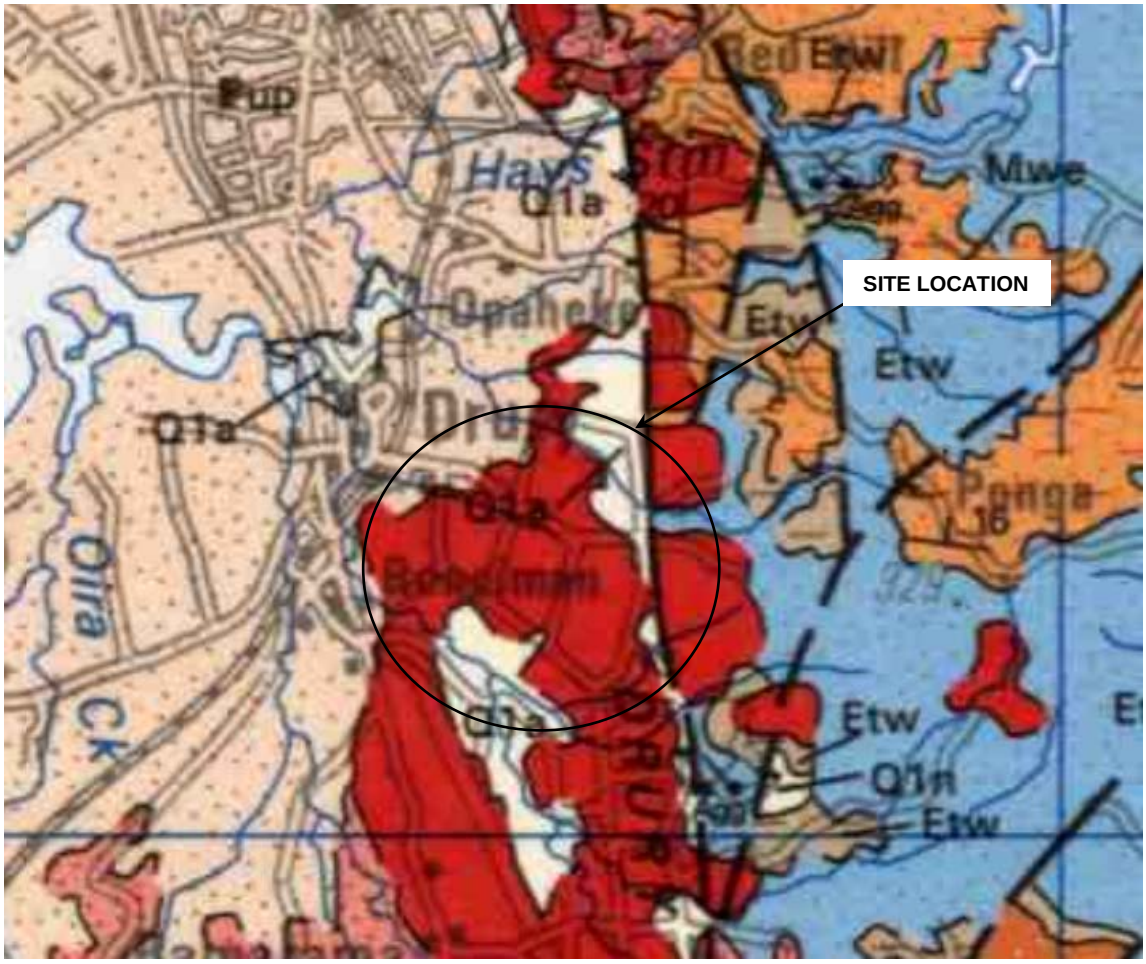

Figure 2: Regional Geology (GNS)

Based on the known history of the Plan Change area and surrounding land uses, some superficial depths of fill would also be anticipated as a result of landscaping and/or minor earthworks during prior development and infilling of ponds.

6 GEOHAZARDS ASSESSMENT

6.1 Context

Section 106 of the Resource Management Act (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. Although subdivision is not currently proposed, it will be an expected result of the Plan Change process. Accordingly, we have undertaken a natural hazard assessment of the overall Plan Change area in accordance with the Act. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land or structures (consequence).

The following sections of this report provide an assessment of the geohazards relevant to this Plan Change area.

6.2 Faulting and Seismicity

6.2.1 Drury Fault

The Plan Change area is located in close proximity to the mapped alignment of the Drury Fault, which trends in a NNW direction along the base of the Hunua foothills. The alignment of the fault is included on the Geological Map prepared by Edbrooke (2001) as shown in Figure 2 and at its nearest is indicated to run along the eastern edge of Drury Hills Road in the north-east corner of the site.

The fault is not included in the Geologic and Nuclear Sciences (GNS) database of Active New Zealand Faults. Beca undertook specific investigation of the Drury Fault in 2005 to assess whether this fault could be considered active (known movement within the past 125,000 years).

The Beca report determined that the most recent fault movement (or rupture) likely occurred some 45,000 years ago, with slip rates estimated in the range of 0.01mm to 0.03mm per year. On this basis, the Drury Fault could be considered active.

The site investigation information and topographic data obtained by Beca (2005) indicates that the mapped alignment of the fault as presented by Edbrooke (2001) is relatively accurate to within +/- 5m.

6.2.2 Wairoa North Fault

A second fault, the Wairoa North Fault is located some 12km to the east of the Plan Change area and is included in the GNS Active Fault database. Although the recurrence interval for movement along this fault has yet to be determined, a low vertical slip rate of between 0.1mm and 0.3mm per year has been reported by Edbrooke (2201) and Wise (1999) respectively.

6.2.3 Fault Rupture Risk

The MfE Guidelines define a “Fault Avoidance Zone” as “an area created by establishing a buffer zone either side of the known fault trace (or the identified likely fault rupture zone that appears on the land surface)”. They recommend a minimum buffer zone of 20m either side of the know fault trace or likely fault rupture zone.

As noted above, the nearest location of the Drury Fault alignment is indicated to run along the eastern edge of Drury Hills Road. Given the width of this road is 20m, it is unlikely that the fault rupture zone would have an impact on future development of the site. However, this should be considered in more detail as part of any future development proposals.

The Wairoa North Fault is not considered capable of causing a ground rupture risk due to the distance to this fault.

6.3 Liquefaction

6.3.1 General

Soil liquefaction is a process where typically saturated, granular soils develop excess pore water pressures during cyclic (earthquake) loading that exceed the effective stress of the soil. In loose soils, some dilation can occur during this process, which can lead to individual soil grains moving into suspension. Following the onset of liquefaction, the shear strength and stiffness of the liquefied soil is effectively lost causing excessive differential settlement of the ground surface, bearing capacity failure and collapse of structures and low-angle lateral spreading of slopes in liquefiable soils.

In accordance with NZGS guidance[2] the liquefaction susceptibility of the soils within the Plan Change area has been considered with respect to geological age, soil fabric and soil consistency / density.

6.3.2 Geological Age

The vast majority of case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills (Seed and Idriss, 1971). Youd and Perkins, 1978 also state that young Holocene age (15,000 years) sediments and man-made fills are susceptible to liquefaction. Table 1 of Idriss and Boulanger (extracted from Youd and Perkins (1978)), presents the susceptibility of soil deposits to liquefaction based on geological age, which states that Pleistocene aged alluvium (>12,000 years), as indicated to be present along the western margins of the site, has a very low to low risk of liquefaction.

The recent alluvium, units Q1a, if present within the Plan Change area, are of Holocene geological age and therefore, in terms of geological age, are considered potentially susceptible to liquefaction. Specific site investigations would be required to confirm the presence, or otherwise, of these materials and the potential liquefaction risk associated with them on future development.

Across the elevated terraces, volcanic deposits are indicated to be present and are considered to be at low risk of liquefaction.

6.3.3 Soil Fabric

Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. Based on more recent case histories, there is general agreement that sands, non-plastic silts, gravels and their mixtures form soils that are susceptible to liquefaction. Clays, although they may significantly soften under cyclic loading, do not exhibit liquefaction features, and therefore are not considered liquefiable. NZGS guidance sets out the plasticity index (PI) criteria for liquefaction susceptibility as follows:

PI < 7: Susceptible to Liquefaction

7 ≤ PI ≥ 12: Potentially Susceptible to Liquefaction

PI ≥ 12: Not Susceptible to Liquefaction

The fines content of any sands beneath the Plan Change area also has a significant impact on their liquefaction susceptibility.

Specific soil grading / plasticity index laboratory test results are not available for the site soils. However based on our experience in the area and with similar soils, and laboratory data associated with the adjacent Drury South development, the site soils are expected to generally have a PI greater than 12 and are therefore not considered liquefiable.

[2] Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards", (May 2016)

6.4 Lateral Spread

Following the onset of liquefaction, the liquefied soils behave as a very weak undrained material, which can give rise to lateral spreading where a free face is present within the vicinity of the site or where proposed cut and fill batters are proposed over or within liquefied soils.

Although likely to be a low risk, the potential for localised lateral spread may be higher adjacent to the existing watercourses and should be assessed as part of future development proposals.

6.5 Slope Stability

Overall the Plan Change area is gently graded and we expect development proposals are unlikely to require significant batter slopes. Existing cut batters within the site, generally associated with road formation, appear to be generally stable at relatively steep gradients. Nonetheless, slope stability will need to be assessed as part of any future development proposals.

6.6 Settlement

Fill embankments and / or future building loads could induce settlements within soft underlying subsoils. In general, this hazard is considered to be relatively low, but will require site specific investigation and assessment to confirm, once development proposals are available.

6.7 Expansive Soils

NZS 3604:2011 excludes from the definition of 'good ground', soils with a liquid limit of more than 50% and a linear shrinkage of more than 15% due to their potential to shrink and swell as a result of seasonal fluctuations in water content.

This shrinking and swelling results in vertical surface ground movement which can cause significant cracking of floor slabs and walls. There have been instances of concrete floors and/ or foundations that have been poured on dry, desiccated subgrades in summer months on expansive soils and have undergone heaving and cracking requiring extensive repairs or re-building once the soil moisture contents have returned to higher levels.

Based on our experience in the area and in similar soils, we consider that expansive soil deposits are likely to occur across the site.

Mitigation of the expansive soil hazard is undertaken by a combination of appropriate foundation design selection at Building Consent stage and appropriate moisture control within subgrade soils during construction. Foundation contractors must be made aware of this issue and the need to maintain appropriate moisture contents in the footings and building platform subgrade between the time of excavation and pouring concrete.

Remedial actions that may be appropriate include platform protection with a hard fill layer, pouring of a blinding layer of concrete in footing bases and soaking of the building platform with sprinklers for an extended period.

Home owners must also be made aware that the planting of high water demand plants where their roots may extend close to footings can also cause settlement damage.

6.8 Earthworks

Site soils are considered to be generally suitable for bulk earthworks operations. Conditioning of some areas may be required to ensure appropriate moisture contents are achieved prior to compaction.

All earthwork activities must be carried out in general accordance with the requirements of NZS 4431 and the requirements of the Auckland Council Infrastructure Development Code under the guidance of a Chartered Professional Geotechnical Engineer.

Specific requirements will need to be evaluated during site specific investigations and design as part of future development proposals.

6.9 Foundation Bearing Capacity

Once bulk earthworks are completed, a preliminary geotechnical ultimate bearing pressure of 300kPa should be available for shallow strip and pad foundations constructed within both the natural cut ground and engineered fill areas, subject to site specific investigations and recommendations developed as part of future development assessment.

There may be areas where localised variations in shear strength within the natural cut ground occur, particularly where the depth of cut varies across the building platforms. Further confirmation of available bearing pressures will be addressed at the time of post earthworks soil testing and preparation of the Geotechnical Completion Report (GCR) for the development.

6.10 Erosion

Overall erosion is considered to be a relatively low risk across the Plan Change area. However, some volcanic and alluvial deposits, including pumiceous silt beds, can be more susceptible to erosion action. Accordingly, any proposed cut and/or fill batters should be specifically assessed in relation to this hazard as part of site specific investigations and design.

6.11 Stormwater

Site specific testing has not been undertaken to assess suitability of Plan Change area soils for stormwater soakage design.

However, based on our experience in similar soils, we consider that the site soils are likely to provide moderate soakage capability. This should be confirmed with specific testing as part of detailed stormwater design.

7 CONCLUSION

Based on the desk-top study undertaken, in conjunction with our general understanding of ground conditions across the Plan Change area, we expect the Plan Change area can be satisfactorily developed from a geotechnical perspective using normal engineering techniques.

Appendix A: Drawings

AKL2018-0233 Drawing 01 - Existing Contours Plan
AKL2018-0233 Drawing 02 - Geological Plan

LEGEND:

SITE BOUNDARY

NOTES:

1. BASE PLAN ADAPTED FROM: AUCKLAND COUNCIL GIS MAP

1:10 000 0 100 200 300 400 500 m

CMW Geosciences

CLIENT: FULTON HOGAN LAND DEVELOPMENT		DRAWN: FMS	PROJECT No: AKL2018-0233
PROJECT: DRURY DEVELOPMENT PLAN CHANGE		CHECKED: AL	DRAWING: 01
		REVISION: 0	SCALE: 1:10000
TITLE: EXISTING CONTOUR PLAN		DATE: 30/05/2019	SHEET: A3

X:\01 PROJECTS\AKL\AKL2018\AKL2018-0201-0250\AKL2018-0233 - DRURY PLAN CHANGE\07 DRAWINGS\CAD\AKL2018-0233-FIG 01 SITE PLAN REV 0.DWG

LEGEND:

- SITE BOUNDARY
- INFERRED ALLUVIAL DEPOSITS
- INFERRED BASALT

NOTES:

1. BASE PLAN ADAPTED FROM: AUCKLAND COUNCIL GIS MAP

1:10 000 — 0 100 200 300 400 500 m

CMW Geosciences

CLIENT: FULTON HOGAN LAND DEVELOPMENT		DRAWN: FMS	PROJECT No: AKL2018-0233
PROJECT: DRURY DEVELOPMENT PLAN CHANGE		CHECKED: AL	DRAWING: 02
		REVISION: 0	SCALE: 1:10000
TITLE: INFERRED GEOLOGY PLAN		DATE: 30/05/2019	SHEET: A3

X:\01 PROJECTS\AKL\AKL2018\AKL2018-0201-0250\AKL2018-0233 - DRURY PLAN CHANGE\07 DRAWINGS\CAD\AKL2018-0233-FIG 01 SITE PLAN REV 0.DWG