GOLDING MEADOWS DEVELOPMENT LTD & AUCKLAND TROTTING CLUB INC

GOLDING ROAD, PUKEKOHE

GEOTECHNICAL FEASIBILITY ASSESSMENT FOR A PROPOSED PLAN CHANGE

REF: R6518-1A
DATE: 27 NOVEMBER 2020

GCL
Ground Consulting Ltd

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

A geotechnical feasibility assessment has been undertaken by GCL for a proposed plan change comprising the properties held by Golding Meadows Development Ltd and Auckland Trotting Club which includes:

- 240 & 242 Station Road.
- 27 & 49 Yates Road.
- 17, 25, 27 & 27A Royal Daulton Drive.
- 152, 154, 156, 158, 160 & 162 Golding Road.

This geotechnical feasibility assessment has been prepared for the purpose of providing sufficient geotechnical information in order to develop and progress a proposed plan change to allow subdivision for residential and light industry purposes.

1.2 PROPOSED SITE DEVELOPMENT

Birch Surveyors Ltd have provided a Concept Plan for the proposed plan change as shown on Drawing 001. The Concept Plan in summary shows the following:

- A "light industry zone" is located along Station Road. The zone is accessed off Station Road and includes a small section of Yates Road on the southern boundary.
- A "mixed housing urban zone" is located within the central portion of the site. The zone is accessed via new public roads off Station Road, Yates Road and Golding Road.
- A "mixed housing suburban zone" is located within the eastern portion of the site. The zone is accessed via new public roads off Station Road, Yates Road and Golding Road.
- Other areas include an indicative park ("recreation area"), "indicative open space" and "neighbourhood centre zone".

Our expectations on building types associated with the various zones are as follows:

- Light industry zone: Building materials consisting of a combination of timber/steel framing, steel cladding & concrete panels founded on a reinforced concrete floor slab with shallow foundations. Live loads may be high depending on the building end use.
- Mixed urban and suburban zones: Light weight NZS 3604 type houses/units founded on a reinforced concrete floor slab with shallow foundations.
- Neighbourhood centre zone: Building materials consisting of a combination of timber/steel framing, steel/weatherboard/brick cladding & concrete panels founded on a reinforced concrete floor slab with shallow foundations. Live loads may be high depending on the building end use.

The development of the proposed plan change area will require earthworks (consisting of cut to fills) in order to provide suitable gradients for some development areas. No earthworks plans have been provided to date and as such we have assumed likely earthworks profiles.

A map of the anticipated site development area and proposed land-use concept plan is presented below as Figure 1:

FIGURE 1: PROPOSED CONCEPT PLAN

REPORT PART 1: SITE CONDITIONS

2 DESKTOP STUDY

2.1 PREVIOUS INVESTIGATIONS

GCL has undertaken a number of geotechnical investigations within the area surrounding the proposed site development and are therefore familiar with the local geology.

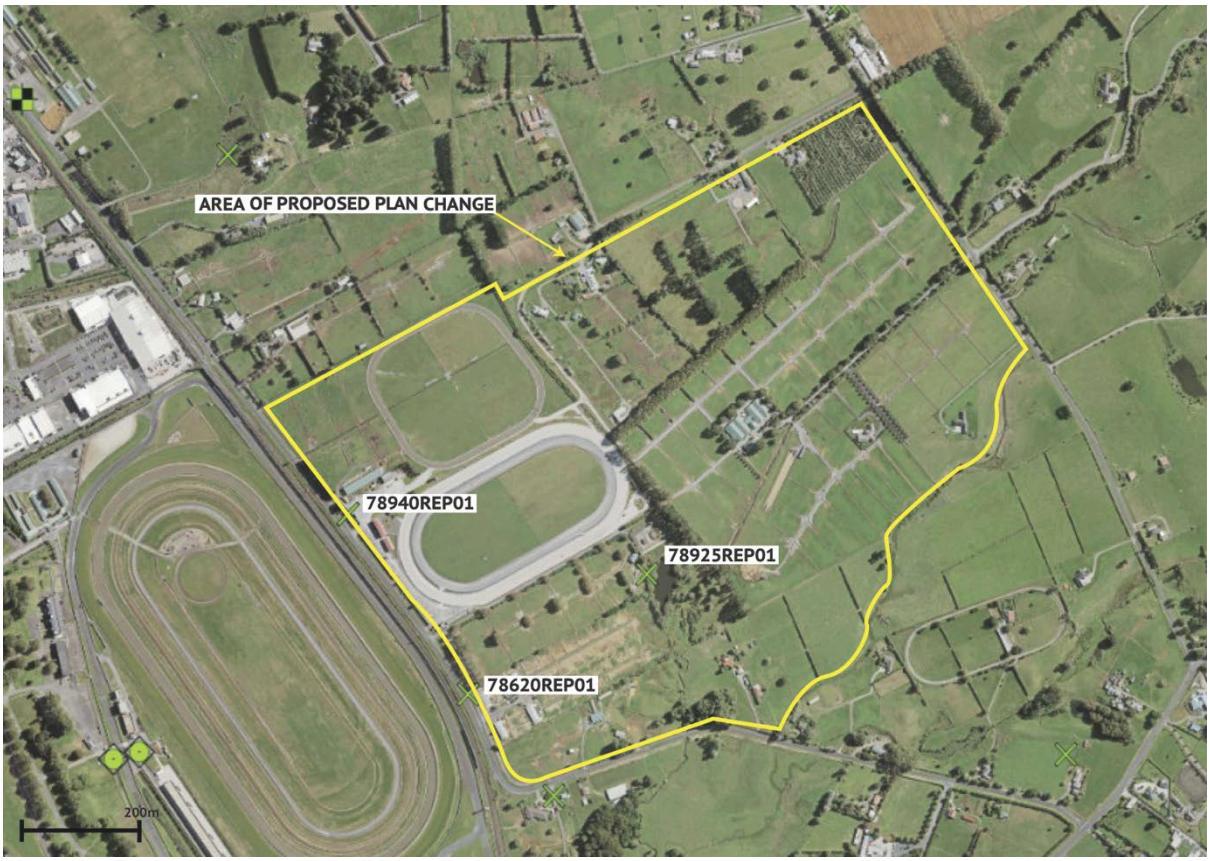
Additionally, GCL have undertaken an investigation within the proposed development area (report reference, R1899-1A dated 11th April 2015). The report was undertaken within the current property of 158 Golding Road (formerly 156 Golding Road at the time of assessment). The investigations were undertaken upon an area of semi-level and relatively raised topography and recorded "good ground" comprising weathered ash soils associated with the South Auckland Volcanic Field.

2.2 NEW ZEALAND GEOTECHNICAL DATABASE

The New Zealand Geotechnical Database (NZGD) has been viewed and has been found to contain at least 3 machine bore hole investigations, undertaken by the New Zealand Geological Survey.

A map from NZGD of the site location is presented below as Figure 2, with all relevant bore hole references annotated:

FIGURE 2: NZGD INVESTIGATION MAP



The three machine-bore hole investigations as shown above (ref; 78025Rep01, 78940Rep01 & 78620Rep01) generally record a thick upper mantle of Holocene alluvium clay, further underlain by variable conditions, including periods of peat (in the case of 78940Rep01) and basalt rock (within 78025Rep01 & 78620Rep01).

2.3 HISTORIC AERIAL PHOTOGRAPHS

Aerial photographs available from the Auckland Council GIS Viewer and Google Earth dating from 1942 to 2017 were studied to observe the site over time and assess the geomorphological setting. The review of historic aerial photography indicates that from at least 2001 there has been no significant modification to the proposed development area.

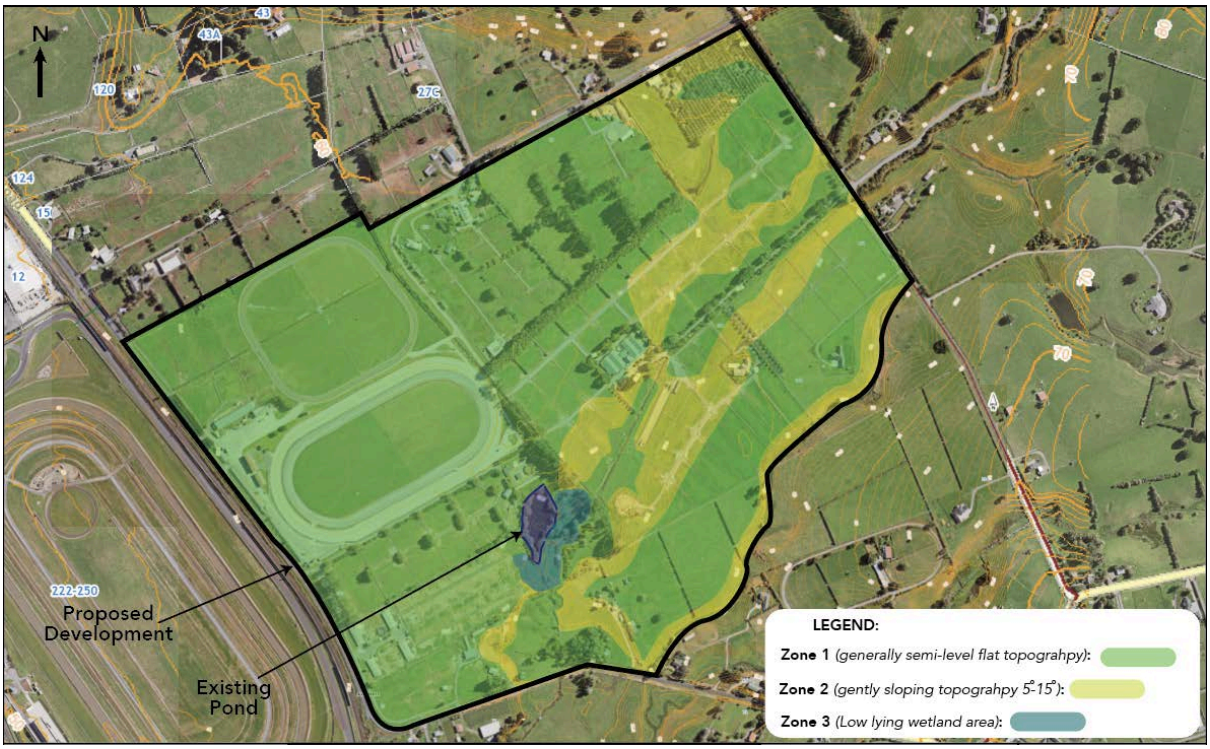
3 SITE CONDITIONS

3.1 SITE TOPOGRAHPY & GEOMORPHOLOGY

The proposed plan change area predominantly consists of flat to semi-level topography with some extents of gentle slopes and a confined area of low-lying wet land. These topographies have been split into three defined "zones", of which will be referred to through-out the report.

An overview of the site topography is presented on Figure 3 below.

FIGURE 3: SITE TOPOGRAPHY OVERVIEW



3.1.1 Flat to Semi-level Topography (ZONE 1)

Flat to semi-level topography comprises the majority of the proposed development area, as shown on Figure 2 and DRW002 attached below.

This topography consists of slopes with gradients less than 5° to the horizontal, and are typically utilised as pastureland, drained via. a series of ditch drains running parallel to the existing paddock forms.

3.1.2 Gently Sloping Topography (ZONE 2)

The proposed development area contains typically narrow sections of more gently inclined slopes, with measured slope angles of between 5° to 15° to the horizontal.

3.1.3 Moderately Steep Topography

Rare sections of moderately steep slopes have been observed during recent site mapping. The areas of such topography however are thin and extremely narrow and as such have not been illustrated on any site mapping contained within this report.

The moderately steep slopes have been observed immediately up-slope and down-slope of the existing pond feature shown on DRW002 and Figure 2. Additional moderately steep slopes have been observed within the ditch-drain and watercourse banks, as discussed below.

We expect that as part of standard site development protocols, these areas would typically be either earth-worked (re-profiled to form stable slopes) or alternatively avoided for future development, or retained as reserves.

3.1.4 Low lying Wet-Land Topography (ZONE 3)

An area of low-lying wet-land has been identified within the southern portion of the site. The wet-land area comprises semi-level topography and contains a boggy surface mantle.

Whilst the area shares similar elevations with other adjacent regions of the site, it is the only area mapped as containing a saturated surface mantle. We consider this may be related to the topographically raised pond situated up-slope and adjacent to the north-west. This is discussed further within Section 3.2.

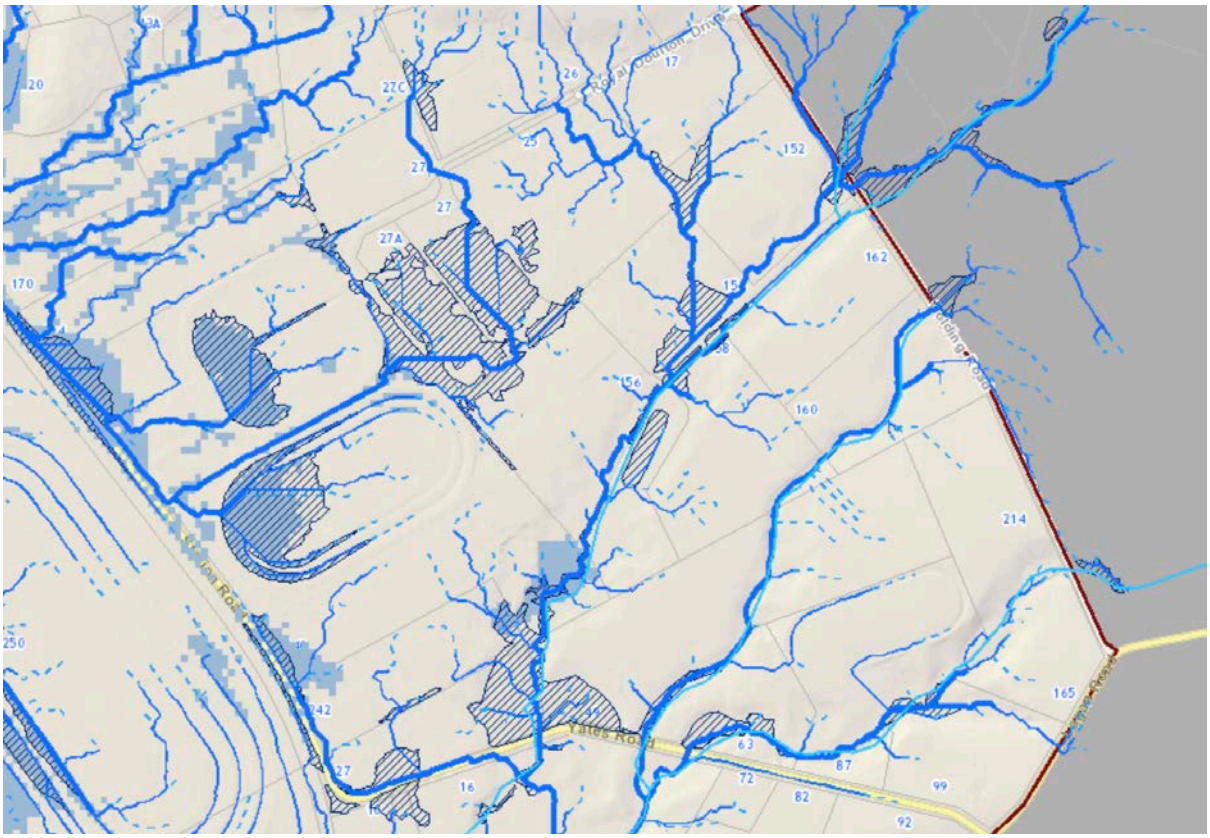
We note this area is largely proposed to be undeveloped, anticipated to be retained as a wetland reserve.

3.2 SITE SURFACE WATER FEATURES

The site contains a number of ditch drains and natural watercourse features. The water features are typically narrow in size and incise no greater than 2.0m below the adjacent topography in which they dissect.

Auckland Council GIS viewer shows a series of overland flow paths extending in a general north-east to south-west orientation through the site. The main overland flow paths contain a number of minor feeders. A number of the overland flows are associated with "flood prone areas" as shown on Figure 4.

FIGURE 4: SITE SURFACE WATER FEATURES FROM AUCKLAND COUNCIL GIS VIEWER



3.2.1 Ditch Drains

The flat and semi-level topographies typically contain a series of peripheral ditch drains which drain down to more arterial ditch drains located through-out the site.

The ditch drains contained minor flows on inspection and may dry up in more elevated portions of the site over the summer months.

3.2.2 Natural Watercourse

A series of natural watercourses also dissect the site, to which the majority of existing ditch drains flow and connect to.

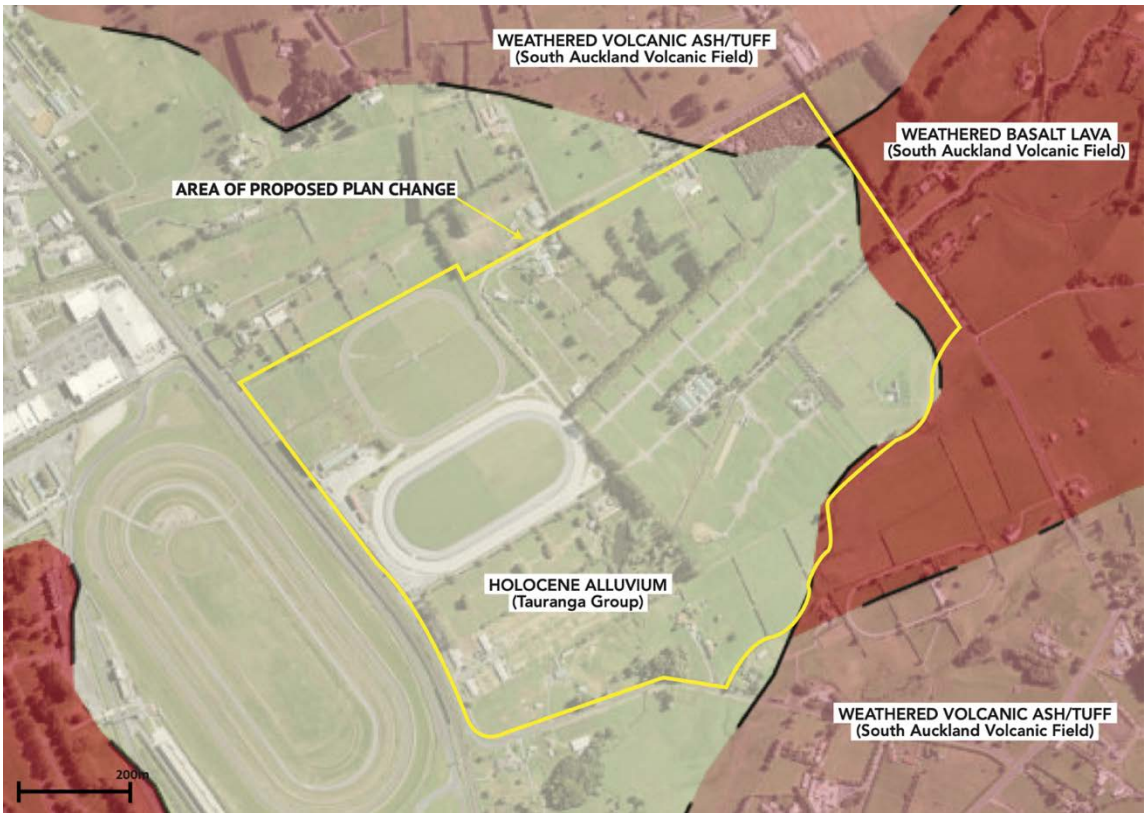
4 GROUND CONDITIONS

4.1 PUBLISHED GEOLOGY

The Geological Map of New Zealand, Sheet 3, at a scale of 1:250,000 maps the proposed development area as being predominantly underlain by Holocene alluvial deposits of the Tauranga Group. The Tauranga Group consists of soft, dark brown to black, mud, muddy sand, muddy peat and peat. Locally extensive peat bogs.

Figure 4(a) below provides an excerpt from the Geological Map of New Zealand, Sheet 3, at a scale of 1:250,000 which covers the proposed development area.

FIGURE 5: GEOLOGICAL MAP OF NEW ZEALAND, SHEET 3, 1:250,000



As observed from Figure 5(a), The Geological Map of New Zealand also maps the proposed development area as being surrounded by deposits of the South Auckland Volcanic Field, which consist of weathered volcanic ash/tuff, lapilli and basalt lava.

Based on recent geomorphological mapping, general site observations and previous ground investigations undertaken within the proposed development area, soils associated with the South Auckland Volcanic field also underlie the proposed development area as a weathered volcanic ash layer.

Based on the information to date, we consider the topographically elevated and sloping portions of the site are likely underlain by soils associated with the South Auckland Volcanic Field. The Low lying and topographically flat areas of the site are likely underlain by soils associated with Holocene alluvium deposits of the Tauranga Group.

4.1.1 Holocene Alluvium

Holocene alluvium of the Tauranga Group is a relatively geologically young unit, typically comprising comprises compressible clay, silt, and organic material. This is typically found in isolated low-lying areas adjacent to streams and gullies. However, it is also found in restricted flat areas where volcanic deposits have dammed a former stream and alluvial soils have been deposited in the lake formed behind or within former explosion craters.

4.1.2 Volcanic Ash/Tuff

Volcanic ash and tuff deposits of the South Auckland Volcanic Field underlies the broad majority of the Pukekohe region.

The ash typically comprises orange brown silty clay of moderate to high plasticity and can be up to 10m thick. The deposits are typically concentrated in rings around volcanic centres as proximal airfall deposits, often comprising a mixture of volcanic and country rock materials, typically comprising a sandy silt near surface, transitioning to weakly welded beds of sand and silt size, but occasionally fine gravel.

4.1.3 Basalt Lava

The basalt lava deposits of the South Auckland Volcanic Field typically have a weathered surface of between 2m and 10m thick, although this does vary and can be up to 20m with the inclusion of mantling ash/tuff where present, beneath which is fine grained basalt rock.

4.2 SUB-SURFACE CONDITIONS INFERRED FROM SITE MAPPING

Sub-surface investigations have not been undertaken as part of this feasibility assessment, however, from recent site mapping and previously undertaken ground investigations we note the following with respect to ground conditions:

- The semi-level and gentle slopes located within the eastern portion of the site are likely underlain by weathered Volcanic Ash associated with the South Auckland Volcanic Field (based on previous ground investigations inferences). These deposits are likely underlain by the Puketoka Formation at depth.
- The low lying, near level and wet-land topographies are likely underlain by Holocene alluvium which typically consist of clayey SILT and CLAY based soils with periods of PEAT. Alluvial soil can be weak, especially when combined with shallow groundwater levels as is likely the case across the majority of the flats within the central and western portion of the site.

As such, the site mapping undertaken does not differ significantly from the Published Geology.

5 GROUNDWATER CONDITIONS

Sub-surface investigations have not been undertaken as part of this feasibility assessment, however, from site mapping undertaken we note the following with respect to groundwater conditions:

- The low lying slopes and flats likely contain shallow groundwater levels. The groundwater table appears to be partially controlled by a series of ditch drains which extend through the flats. The groundwater table may reach the ground surface within the flats for periods during the winter months.
- The more elevated semi-level and gently sloping topographies likely contain depressed groundwater levels given their more elevated nature.

Shallow groundwater levels are expected along the base of the intermediary gullies.

REPORT PART 2: GEOTECHNICAL CONSIDERATIONS

6 SLOPE STABILITY

The proposed development area predominantly comprises semi-level topography, with some locations comprising more gently sloping topography with measured slope angles of up to 15° to the horizontal. The exceptions to this are the ditch-drains and stream/creek features. These areas would typically be either earth-worked (re-profiled to form stable slopes) or alternatively avoided for future development or retained as reserves.

Landforms have been categorised into three slope instability hazard vulnerability classes (low, medium and high) based on the expected geology (per the geological map) and the ground surface topography (LiDAR data). The slope profile limits have been derived based on our previous experience and knowledge of similar soils and topography within the greater Auckland region.

TABLE 1: Slope Instability Potential

GEOLOGICAL UNIT	SLOPE INSTABILITY POTENTIAL – SLOPE PROFILE LIMITS		
	Low	Moderate	High
HOLOCENE ALLUVIUM	0-10°	10-20°	>20°
SOUTH AUCKLAND VOLCANIC FIELD ASH/TUFF	0-18°	18-28°	>28°

As outlined in Section 3 of this report, the wide majority of the site comprises semi-level to gently sloping topographies with measured slope gradients equal or less than 15° to the horizontal. Furthermore, where slopes exceed 10°, the encompassing geology is considered to comprise weathered volcanic ash to at least the base of sloping ground <10°.

Rare sections of moderately steep slopes have been observed during recent site mapping; however, we expect that as part of standard site development protocols, these areas would typically be either earth-worked (re-profiled to form stable slopes) or alternatively avoided for future development, or retained as reserves.

As such, we consider the proposed site development area to comprise an overall low risk of slope instability potential.

7 CONSOLIDATION SETTLEMENT

7.1 GENERAL

The proposed development area is underlain by two geologies, that being the Holocene alluvium and weathered Volcanic Ash/Tuff.

The two geologies have distinct differences in potential compressibility due to their relative geological age, depositional history and shear strengths.

7.2 HOLOCENE ALLUVIUM

Holocene alluvium is mapped within the proposed development area according to the Geological Map of New Zealand; however, based on recent site observations and GCL's experience with the local geology, is considered to persist only within the more relatively low-lying flat portions of the site located within the central and western portions of the site.

The Holocene alluvium is a relatively young geology and as described within section 4.1.1 comprises relatively weak soils consisting of clays, silts and organic deposits. Beca Limited (Beca) has assessed settlements within Holocene Alluvium present in the southern parts of the Drury Structure Plan area may be in the range of 50mm to 250mm for fill depths in the order of 2m and could be in the range of 200mm to 1,000mm for fill depths up to 8m; which is considered analogous to the alluvium within the proposed development area. The above results are generally in keeping with GCL's experience with relative ground loads upon Holocene Alluvium of the South Auckland region.

As such, the Holocene Alluvium is considered to provide a relatively high settlement potential, necessitating restrictive limits on proposed development fill and building loads. Alternatively, specific site remedial measures may be adopted including site pre-loading and deep foundations embedded into competent ground at depth.

7.3 WEATHERED VOLCANIC ASH/TUFF

The volcanic soils present over the majority of the eastern portion of the site are typically competent, with relatively high shear strengths and low compressibility characteristics.

The weathered Volcanic ash/tuff deposits are considered to provide relatively low settlement potential.

8 LIQUEFACTION POTENTIAL

8.1 GENERAL

Liquefaction occurs due to an increase in pore water pressure as a result of an earthquake event resulting in significant loss of soil strength and ejection of soil at the ground surface leading to ground settlement. Loose silts and sands below the water table are the most susceptible to liquefaction.

The occurrence of liquefaction depends on many factors, including the soil particle size and distribution, groundwater level, soil density, and in-situ stresses. Following liquefaction, significant ground deformation may occur as the soil particles are re-arranged into a denser state. Such deformations can be damaging to structures located on such soils. There may also be additional building foundation settlement as a result of loss of bearing capacity.

8.2 LIQUEFACTION SUSCEPTIBILITY

As detailed within Section 4.2, the proposed development site is largely underlain by Holocene alluvium with a smaller area of weathered volcanic ash/tuff of the South Auckland Volcanic Field. The two geologies contain varying particle sizes, depositional environments and soil densities which influence a soil's susceptibility to experiencing liquefaction under potential seismic accelerations.

8.2.1 Holocene Alluvium

Holocene alluvium within the Pukekohe area typically comprise weak layered and geologically recent soil deposits consisting of compressible CLAY, loose SILT and periods of fine sand in some instances.

Holocene alluvium is typically deposited within locally low-lying environments confined by the erosional and/or damming horizons of more competent geological bodies (such as weathered Volcanic Ash/tuff and basalt lava of the South Auckland Volcanic Field); and therefore, typically contain elevated groundwater tables.

Furthermore, the Holocene alluvium deposits typically provide a seismic subsoil class D & E as according to NZS 1170: 2004 in relation to potential ground shaking severity. The above classification is generalised only and is based on our desktop study to date and our local experience in relation to depth to bedrock and relative soil strengths.

As such, the Holocene Alluvium typically comprises a range of soil properties susceptible to liquefaction under SLS and ULS seismic return periods for the Pukekohe area.

8.2.2 Weathered Volcanic Ash/Tuff

Weathered volcanic ash typically consists of CLAY and silty CLAY soil with depressed groundwater levels. Furthermore, the ash deposits typically provide a seismic subsoil class C & D as according to NZS 1170: 2004 in relation to potential ground shaking severity. The above classification is generalised only and is based on our desktop study to date and our local experience in relation to depth to bedrock and relative soil strengths.

As such, weathered volcanic ash is generally not considered to be suspectable to liquefaction under SLS and ULS seismic return periods for the Pukekohe area.

8.2.3 Summary

The underlying geologies have been categorised into three liquefaction vulnerability classes (low, medium and high) based on the expected nominal ULS land settlement during a magnitude 5.8 earthquake in conjunction with the anticipated seismic subsoil class discussed above for each geology. The expected nominal ULS land settlement has been derived based on our previous experience with the local geology and knowledge of the soil performance under similar seismic loading conditions.

TABLE 2: Liquefaction Potential

GEOLOGICAL UNIT	LIQUEFACTION POTENTIAL – EXPECTED NOMINAL ULS LAND SETTLEMENT		
	Low (0-25mm)	Moderate (25-100mm)	High (>100mm)
HOLOCENE ALLUVIUM		X	X
SOUTH AUCKLAND VOLCANIC FIELD ASH/TUFF	X		

We therefore consider the liquefaction potential within Holocene alluvium within the proposed development area to be "Moderate to High", with nominal ULS land settlements expected to be between 25mm to 200mm in relation to a seismic subsoil class D and a magnitude 5.8 earthquake with a 1/25 SLS and 1/500 ULS return period.

The liquefaction potential within the South Auckland Volcanic Field Ash/Tuff deposits are considered to be "Low" with nominal ULS land settlements expected to be less than 25mm in

relation to a seismic subsoil class C and a magnitude 5.8 earthquake with a 1/25 SLS and 1/500 ULS return period.

It should be noted that potential liquefaction can be effectively mitigated through the adoption of specific foundation designs in accordance with MBIE guidelines. Such foundation designs include standard concrete raft or a raised timber floor on pile foundation types for settlements of up to 100mm (TC1 & TC2 foundation guidelines) and ground improvement methods or deep pile foundations for settlements >100mm (TC3 foundation guidelines).

Additionally, it should be noted that similar remedial measures have been simply utilised in adjacent regions of the Pukekohe Area for both commercial and residential type buildings on similar ground conditions and liquefaction susceptibilities. We therefore believe the above liquefaction potentials to not prohibit the feasibility of proposed plan change developments.

Furthermore, the extent by which liquefaction can effect urban development can be coarsely assessed with knowledge of the "crust thickness" overlying a liquefiable soil, i.e. the thickness of the surface soils (non-liquefiable cohesive soils and/or above groundwater level) which 'raft' over the liquefied soils. Based on experience gained from the Christchurch sequence of earthquakes and published empirically based information (Ishihara, 1985) it is anticipated that where the "crust thickness" exceeds a minimum of 3m, the effects of liquefaction can generally be mitigated without significant damage to structures at ground surface. This assumes that the "crust" is of sufficient capacity/strength to 'raft' over the liquefiable layers, though this does not preclude global settlement and deep-seated lateral spreading.

9 SUBDIVISION DEVELOPMENT FEASBILITY

9.1 GENERAL

The subdivision has been divided into subdivision development zones as shown on Drawing 003. The subdivision development zones are based on the landform site mapping undertaken and the various geotechnical considerations provided in Sections 6 to 8 of this report. The subdivision development zones provide general recommendations on allowable subdivision development and constraints.

The mapped extent of the subdivision development zones should be considered as general only and the extent may differ from that shown based on further investigations undertaken.

The subdivision development zones are summarized as follows:

9.2 DEVELOPMENT ZONE A

9.2.1 General

Zone A is land is considered to be suitable for residential and light industrial development and is likely not subject to significant site development constraints. Zone A land is typically associated with:

- Gently sloping topography with slope angles of no steeper than 1(v) on 4(h) / 15° to the horizontal.
- Topography which is not associated with high groundwater levels.
- Topography which is not associated with surface water flows and/or ponding.

- Topography which is underlain by weathered volcanic deposits.

The extent of Zone A land is shown on Drawing 003 and comprises largely the eastern portion of the site.

9.2.2 Foundation Conditions

Zone A land is likely underlain by competent ground conditions which are expected to provide "good ground" according to NZS 3604:2011 in terms of bearing capacity. Weathered volcanic ash soil can provide expansive soil conditions, however, this can be accommodated with specific engineered foundation design.

9.2.3 Site Earthworks Constraints

Zone A is not expected to provide significant constraints on subdivision development earthworks.

9.2.4 On-site Stormwater Disposal

Zone A is expected to provide suitable conditions for the disposal of stormwater generated from impervious surfaces. This can be accommodated by soakage structures and/or detention and slow release structures.

9.2.5 Ground Consolidation

Zone A is underlain by competent ground conditions which are not expected to provide conditions susceptible to the development of significant ground settlement.

Some ground loading constraints may be required within some areas depending on the outcome of specific site investigations. Should any development exceed any set constraints, ground solutions such as site pre-loading or deep foundations are considered to be suitable improvement options.

9.2.6 Liquefaction Potential

Zone A is largely considered to provide a "low" Liquefaction potential.

9.3 DEVELOPMENT ZONE B

9.3.1 General

Zone B is land is considered to be suitable for residential and light industrial development but is likely subject to significant site development constraints and remedial measures. Zone B land is typically associated with:

- Topography which is associated with surface water flows and/or ponding.
- Topography which is associated with likely weak/compressible soils.

The extent of Zone B land is shown on Drawing 003 and comprises largely the central and western portion of the site.

We note that a limited portion of Zone B land may not reasonably be utilized for residential development given the likely prohibitive development costs associated with earthworks and

ground stabilisation measures. However, we note that the majority of these areas are referenced as reserve areas in the Concept Plan.

9.3.2 Remedial Measures

Zone B land can provide suitable subdivision development conditions with appropriate remedial measures. Such measures can include:

- Installation of subsoil drainage in order to maintain a depressed groundwater level and inhibit complications associated with saturated sub-grades.
- Pre-loading of medium to high load areas. This would mostly apply to the light industrial area where live loads may be high. Lightly loaded NZS3604 type structures are likely not affected by such provisions.
- Deep foundations embedded into competent ground conditions at depth.
- Gravel foundation rafts and engineered building platforms.

As previously discussed, similar remedial measures have been successfully utilised in other regions of the Pukekohe area of similar ground conditions.

10 LIMITATIONS

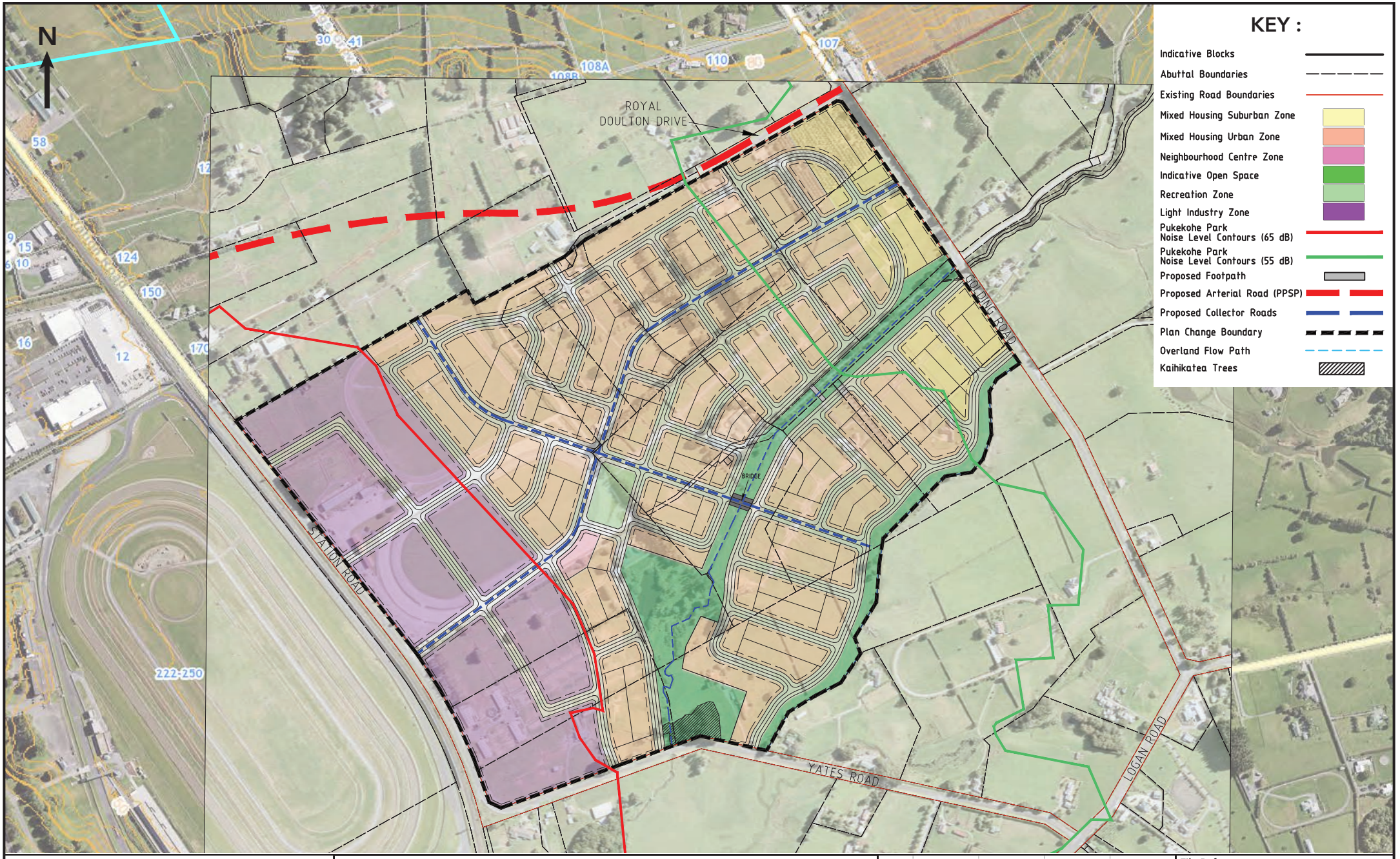
10.1 GENERAL

Ground Consulting Ltd has undertaken this assessment in accordance with the brief as provided, based on the site location as shown on Drawing 002. This report has been provided for the benefit of our client, and for the authoritative council to rely on for the purpose of processing the plan change request for the specific project described herein. No liability is accepted by this firm or any of its directors, servants or agents, in respect of its use by any other person, and any other person who relies upon information contained herein does so entirely at their own risk.

10.2 FURTHER INVESTIGATIONS REQUIRED

This assessment has been undertaken for the proposed site development to date for the purposes of obtaining a plan change. Any structural changes, alterations and additions made to the proposed development should be checked by a suitably qualified person and may require further investigations and analysis.

DRAWINGS



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PROPOSED PLAN CHANGE / CONCEPT PLAN

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A	17/09/2020	Issued	AL	FW

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Scale (A4) 1:8000

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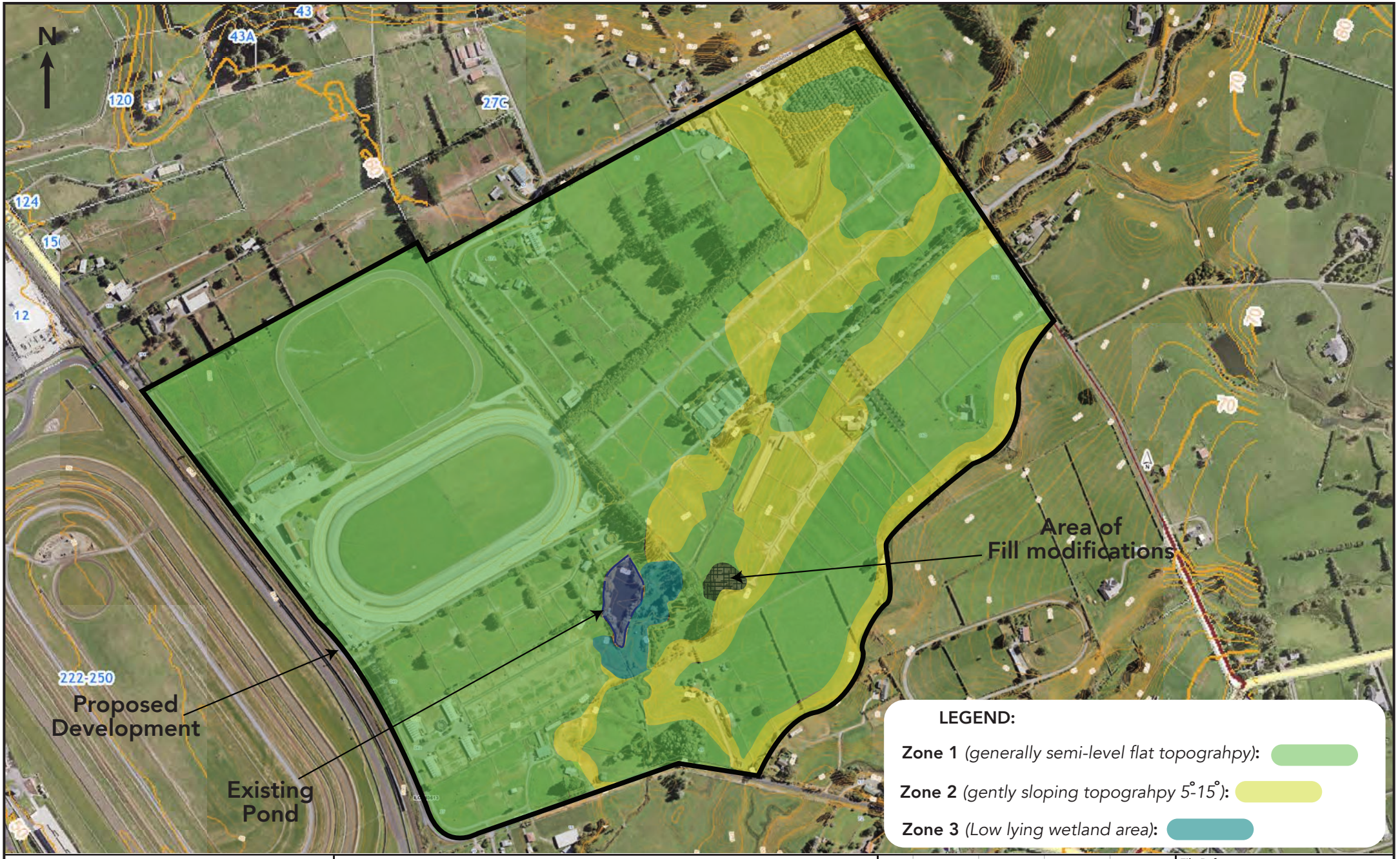
Project No. 6518

Report Ref. R6518-1A

Drawing No. 001



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SITE TOPOGRAHPY / GEOMORPHOLOGY OVERVIEW

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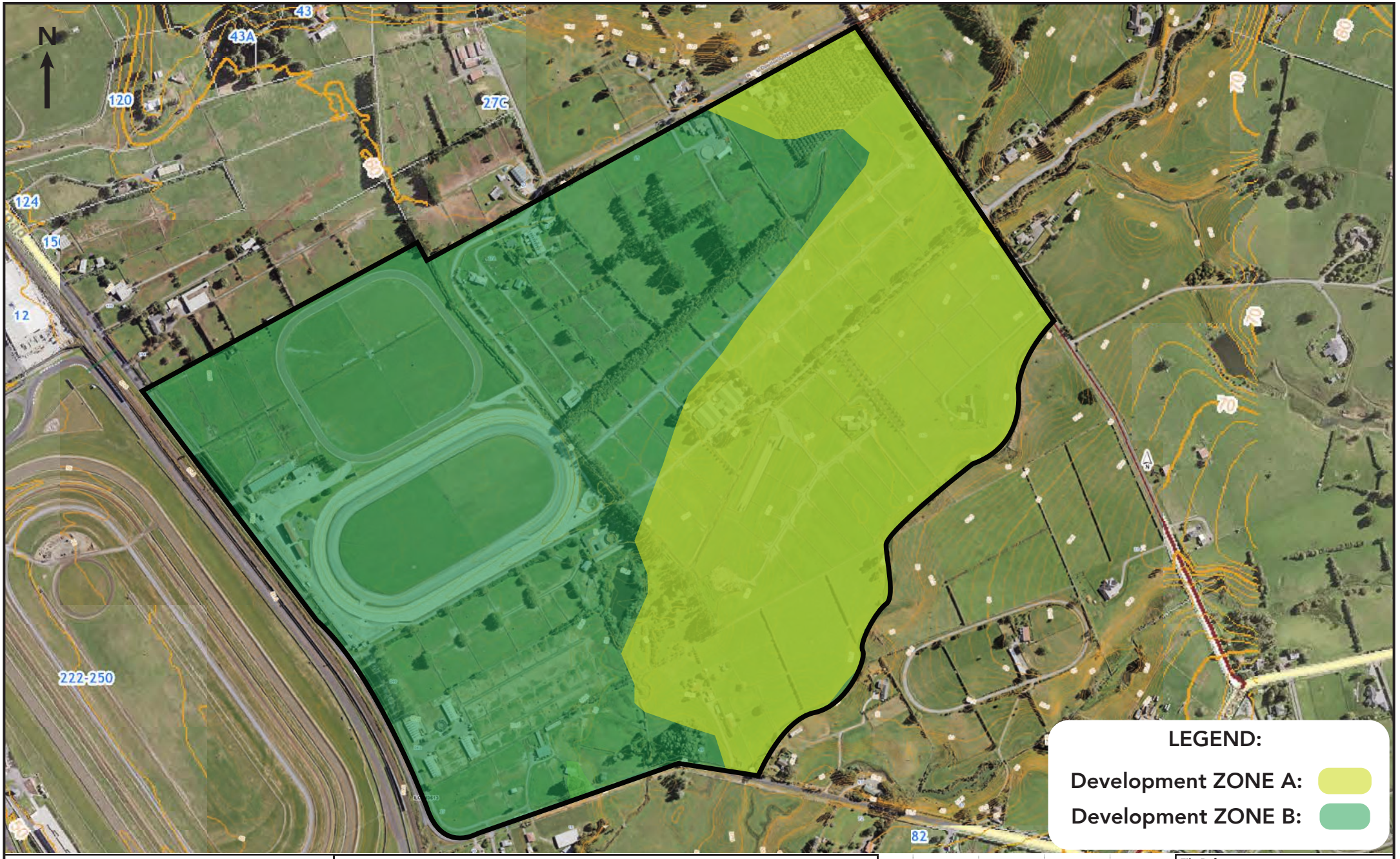
Project No. 6518

Report Ref. R6518-1A

Drawing No. 002



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SUBDIVISION DEVELOPMENT ZONING

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Scale (A4) 1:7,000

0 28 140 280m

Project No. 6518

Report Ref. R6518-1A

Drawing No. 003

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