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Whanganui District Council
Plan Change 58 Outer Castlecliff

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CONFIDENTIAL

Preliminary Geotechnical Appraisal

wsp

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Disclaimers and Limitations

This report ('**Report**') has been prepared by WSP exclusively for Whanganui District Council ('**Client**') in relation to a preliminary geotechnical appraisal for a proposed District Plan zoning change ('**Purpose**') and in accordance with the Short Form Agreement dated 11 November 2019. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

1 Introduction

Whanganui District Council is currently investigating re-zoning of areas in Castlecliff which are currently zoned Reserves and Open Space, and Rural Lifestyle, to a Residential zoning. As part of this process technical reports have been requested to investigate aspects of these areas.

WSP has been commissioned to prepare a Preliminary Geotechnical Appraisal report covering the proposed re-zoning area.

This Preliminary Geotechnical Appraisal report is to investigate the geological and geotechnical conditions of the areas, and to identify the natural hazards that may be present, and where possible, quantify the hazard.

This report is a desktop assessment of the geological and geotechnical aspects of the area. A walk-over of the areas that are publicly accessible to confirm ground conditions was completed.

No physical investigations have been completed on the site. All the data used for the assessment is from previously published reports, maps, and databases, and from observations from the site visit and aerial photographs. This approach is considered appropriate for a plan change process.

2 Background

Plan Change 58 will investigate rezoning four areas of land at Castlecliff – currently zoned Reserves and Open Space, and Rural Lifestyle – to Residential. The areas are north of Waitai Street (part of the Castlecliff Golf Course), north of Waitote Street and east of Karaka Street, and part of Longbeach Drive to the top of the cul-de-sac. These areas are shown on Figure 1.

A geotechnical appraisal of the areas is required to inform the plan change process.

3 Site Description

The proposed areas are shown on Figure 1 below labelled Areas 1 to 4. The figure shows the current District Plan zoning of the area.

Area 1 – forms part of the Castlecliff Golf Club (CGC). Currently zoned Reserves and Open Spaces.

Area 2 – essentially an extension of the Golf Vue Place, a privately owned area with access from Waitote Street, Golf Vue Place and Longbeach Drive. It is zoned Rural Lifestyle.

Area 3 – a small section of privately owned land south of Area 2, located to the rear of existing residential zoned properties on Waitote and Karaka Streets.

Area 4 – properties on Longbeach Drive which are currently developed as large residential lots with urban reticulated water and stormwater services, and a few lots also have wastewater connecting to the Golf Vue Place reticulated service.

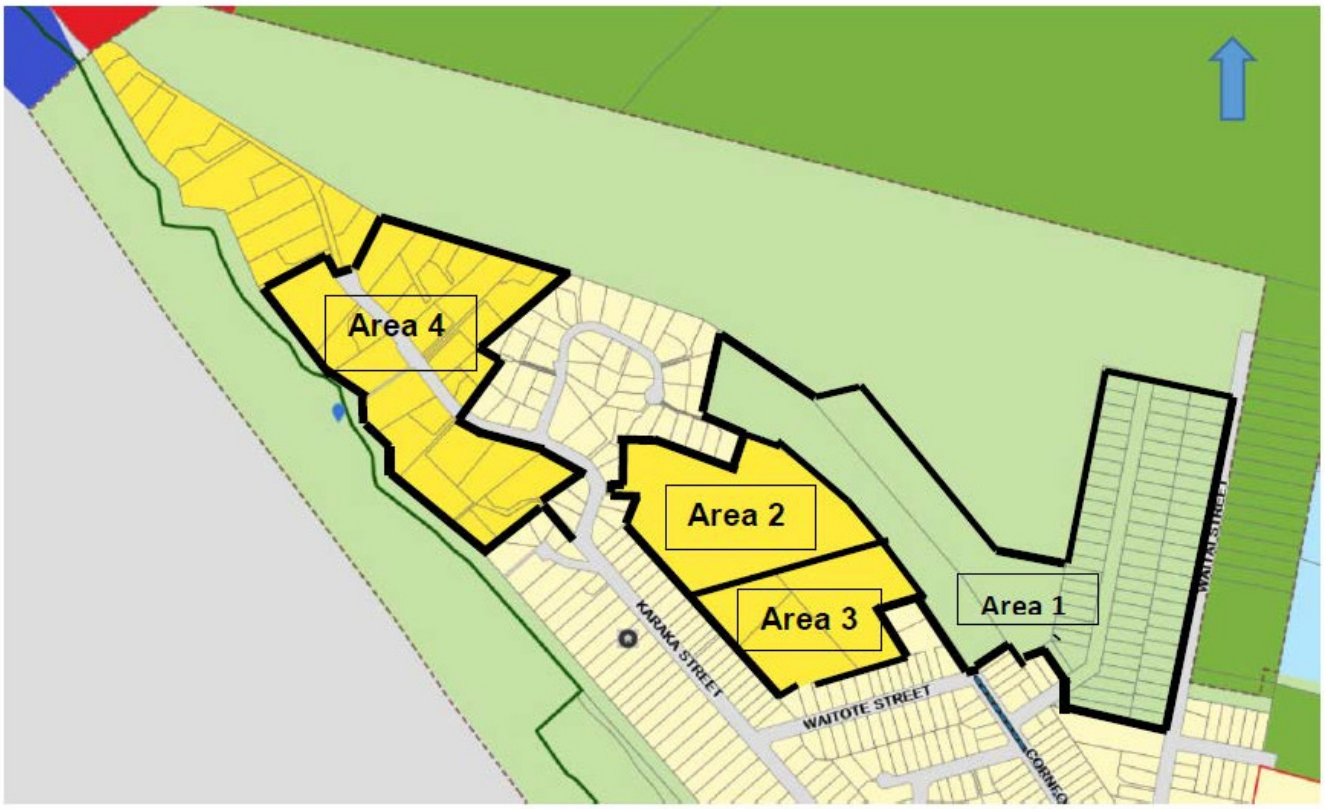

Figure 1: Outer Castlecliff area proposed to be rezoned Residential. (Map retrieved from the Whanganui District Council Plan Change 58).

Area 1 comprises modified land within the boundaries of the Castlecliff Golf Club. It is currently used for the entrance to the clubhouse, maintenance sheds, carparking, practice fairways and part of the golf course proper. The contour is generally gentle and previously modified.

Area 2 and 3 comprises land behind the strip-type development along Waitote and Karaka Streets and Golf Vue. It is generally in pasture and grazed (Area 3), or undeveloped and scrub covered (Area 2). These areas have a moderately steep to very steep contour.

Area 4 is land that has previously been developed and has large residential lots that could be subdivided following the plan change.

4 Geology

4.1 Regional Geology

The regional geology is described on Geology of the Taranaki area, GNS 1:250,000 geological map 11 (Townsend, Vonk, & Kamp, 2008). It indicates the site to be underlain by loose, poorly consolidated sand, mainly in fixed sand dunes (Q1d).

4.2 Active Faults

The GNS active fault database (http://data.gns.cri.nz/af/) shows no active faults in the vicinity.

4.3 Geomorphology

The South Taranaki-Whanganui area contains some of the best developed sets of marine terraces in New Zealand. These terraces are as the result of quaternary[1] sea level fluctuations and tectonic uplift (Pillans, 1990). The Castlecliff area is at the southern extent of the observable marine terraces.

In the study area, these marine terraces are obscured by Holocene-aged sand dunes, that have transgressed over the marine terraces from the coast, and then become fixed as they become stranded by on-going uplift and changing sea levels.

The marine terraces in the region typically consist of a basal wave cut platform overlain by marine sediments, which grades up into non-marine sediments (Pillans, 1990). In the wider South Taranaki-Whanganui region, the wave cut platforms, which have been cut into older Pliocene-Pleistocene-aged sediments, are covered by up to 15m of marine sand. The sediments grade upwards into peat and other littoral[2] and terrestrial deposits, which may include fluvial sediments tephra (ash), dune sand, and loess. In the study area, these marine and non-marine deposits have then been covered with recent (i.e. <10,000 years old) dunes.

The sand dunes, as they move in over the marine terrace surface, disrupt established drainage paths and channels. This can result in the formation of swamps or lakes in the interdunal areas. Westmere Lake and Virginia Lake are examples of this lake formation process. These areas accumulate organic matter, which can rot and decay.

Figure 2 : Existing Contours Areas 1, 2 and 3 (from https://data.whanganui.govt.nz/maps/mapstore2-whanganuidc/#/viewer/openlayers/437)

[1] The most recent period of geological time, covering the last 2 million years.
[2] Between the tide extents

5 Previous Investigations

The New Zealand Geotechnical Database was searched for any investigations in or near the study area. No records were found.

6 Site Observations

Area 1

Area 1 comprises parts of the Castlecliff Golf Course. The area has a modified contour and is grass-covered. To the southwest side of the entrance road to the clubhouse are a series of shed used by greenkeepers for the storage of machinery and chemicals. Modification of the ground surface has occurred in the past to contour the tees, fairways and greens. Some areas of fill are likely to be present across Area 1.

Photograph 1 : From Waitai St, looking north, fairway on left of photo

Area 2 and 3

Area 2 is undeveloped land between the CGC, Golf Vue, and properties along the north side of Karaka Street. There are remnants of pasture in small areas, but it is generally covered in low scrub. Modification has occurred in the north-west corner of the area, and soil material and debris has been deposited. The area may also have been used to borrow material. The area contains moderate to steep slopes up to 8m high, with a variation in height across the area of about 10m. The ground form is variable with a series of dune mounds and valleys. There is a tendency for the dunes to follow a WNW-ESE orientation, which matches the orientation of dunes on the north side of the Whanganui River. In the valleys between the dunes the ground conditions were dry and comprised sand material. No groundwater was observed in the valleys despite many not having any outflow channels. Water discharge from this area is via soakage through sand and into the local groundwater regime.

Photograph 2 : Area 2 from behind houses on Longbeach Drive, looking north. Houses shown accessed from end of Golf Vue. Note steep vegetated slopes below houses.

Area 3 is semi-developed and currently contains at least two residencies. The land is covered in rough pasture and areas of advancing scrub. The contour is more uniform and less random than Area 2, and at the south and south-east extent, has a moderate slope. This area also contains low hollows that have no natural surface drainage, but again no ponding was observed during the inspection. Some modification has been undertaken to form building platforms and accessways.

There was no evidence of the base of the sand dune deposits, where older deposits might be exposed. This might be evidenced by groundwater seepages or changes in vegetation, as the underlying older material might be more impermeable.

Area 4

Area 4 is an area currently zoned Rural Lifestyle and has been almost fully developed under the current District Plan rules. The ground surface has previously been modified for building platforms and site contouring, smoothing out the dune landform. There may be areas of non-structural on properties formed during the previous development of the lots.

Photograph 3 : General view of Area 4, north side of Longbeach Drive.

7 Preliminary Geotechnical Appraisal

7.1 General

The preliminary geotechnical appraisal is based on a desk study of relevant information including reports, maps, previous investigations, along with a walk-over to confirm ground surface conditions.

7.2 Slope Instability

There is no evidence of any large scale instability within the study area.

Area 1 has a flat to moderately steep contour and there is a low risk of slope instability.

Area 2 and 3 contains slopes that are steep to very steep. There were no significant slope failures observed during the walkover, and no slope failures observed on aerial photographs. The slopes are inferred to comprise dune sand, and failures would therefore be expected to be shallow and involve most of the slope length. Existing slopes in Areas 2 and 3 are as steep as 36˚, but more typically 30˚ - 33˚. This slope would represent the angle of repose of loose windblown sand.

Area 4 has a modified ground surface from previous development works and slopes are generally gentle to moderate. Slope instability is unlikely in this area, except for the southern side of Longbeach Drive, where properties back on to the eroded relict sea cliff. Parts of this old sea cliff exhibits some instability, and further investigation would be required to confirm the stability of this area.

7.3 Seismic Hazard

7.3.1 Ground Shaking

NZS1170.5 contains the elastic site spectra for New Zealand that has been derived from results of a probabilistic seismic hazard model developed by the Institute of Geological and Nuclear Sciences (GNS).

For calculating the seismic forces for a building at the proposed plan change site, the methodology of NZS1170.5 should be followed. The probabilistic seismic hazard model allows for known active faults and the ground shaking they may cause, and allows for a grid of distributed-seismicity sources with parameters estimated from the catalogue of historic earthquakes (Standards New Zealand, 2004).

The return period for various Modified Mercalli Shaking Intensity for Whanganui city was reported on in 2016 (Dellow, Abbott, Scott, Reis, & Lukovic, 2016)

Table 1 : Modified Mercalli Shaking Intensity Return Periods for Whanganui (in years) (from (Dellow, Abbott, Scott, Reis, & Lukovic, 2016))

Town	MM7	MM8	MM9	MM10
Whanganui	40	278	3,448	58,824

Table 2 : NZ Modified Mercalli Intensity Scale (from https://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/Monitoring-Earthquakes/Other-earthquake-questions/What-is-the-Modified-Mercalli-Intensity-Scale)

MM 7: Damaging	General alarm. People experience difficulty standing. Furniture and appliances are shifted. Substantial damage to fragile or unsecured objects. A few weak buildings are damaged.
MM 8: Heavily damaging	Alarm may approach panic. A few buildings are damaged and some weak buildings are destroyed.
MM 9: Destructive	Some buildings are damaged and many weak buildings are destroyed.
MM 10: Very destructive	Many buildings are damaged and most weak buildings are destroyed.

7.3.2 Fault Rupture

As no active faults are shown in the GNS Active Fault Database, the risk of fault rupture affecting the area is very low.

7.3.3 NZS1170.5 Site Sub Soil Class

GNS Science reported to the Manawatu-Whanganui Lifelines Advisory Group with a report updating its 2005 Risks and Responsibilities report. This report (Dellow, Abbott, Scott, Reis, & Lukovic, 2016) presented the updated hazards information provided to the Horizons Regional Council (HRC) for use by the Lifelines Group. Part of this information was the inferred earthquake ground shaking site sub-soil class. The GNS Science maps produced for the above report are only suitable for regional-scale use. Site-specific information including the soil profile with depth is not included in this analysis.

Based on the GNS Science report, and our present knowledge of the local geology, this site is classified as Class D – Deep or soft soil sites as per the NZS1170.5:2004 classification.

7.3.4 Liquefaction

The most comprehensive study of liquefaction in the Whanganui city area was by Beetham et al (1998). This report was based on the study of geological maps, historical investigations and some investigations completed specifically for the report. This report indicates that the current study area generally has a low susceptibility to liquefaction. Isolated areas within the study area are shown to have a moderate susceptibility. It is inferred this is based on surface geology from maps, with possible wet swampy areas having a greater susceptibility. The map from 1998, covering the current study area is presented below as Figure 3.

The GNS Science report (Dellow, et al 2016), which updated hazard information for the Horizons area produced regional-scale liquefaction maps. This liquefaction hazard map indicated a low risk of liquefaction in the study area.

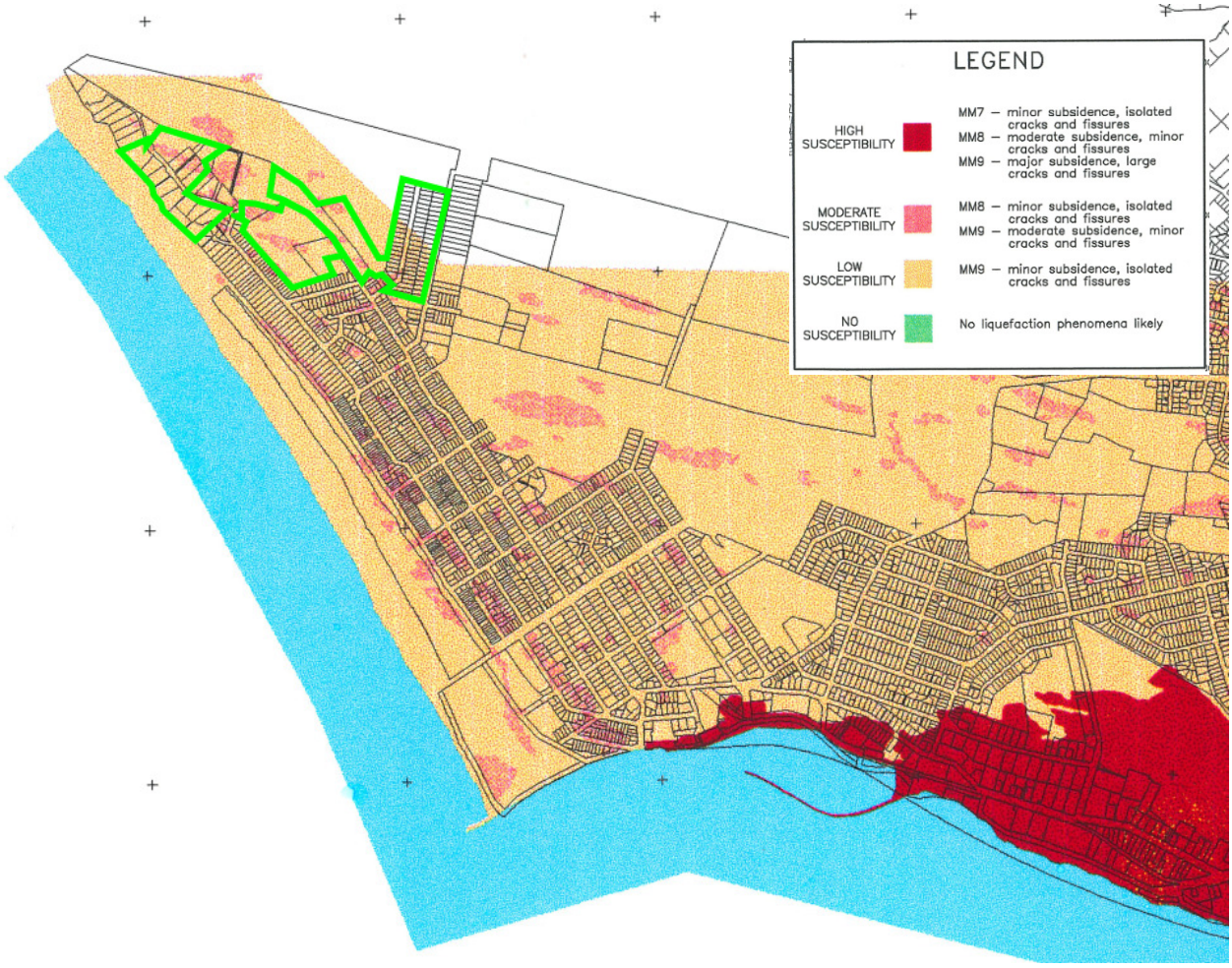

Figure 3 : Liquefaction Susceptibility - study areas highlighted in green (from Beetham et al. 1998)

The report describes the sand dune susceptibility as follows "At the coast the modern beach and dune belt is up to 500 m wide. The modern beach is unlikely to be susceptible to liquefaction owing to the high energy of its environment of deposition. However, the modern dune belt behind the beach may contain isolated swampy areas that may be susceptible to liquefaction and the dunes themselves may undergo differential settlements during strong earthquake shaking." (Beetham, Dellow, & Barker, 1998).

The report goes on to describe the sand dunes in Whanganui as "(a) loose, uniform sand that historical earthquakes show is not prone to ground damage at MM8 intensity, and tends to "protect" buildings from damage."

Further investigations during subdivision stage should be undertaken to investigate whether the susceptibility of the area is greater than low.

7.4 Coastal Erosion

There appears to be no active coastal erosional processes acting upon the old sea cliff below properties on the southern side of Longbeach Drive in Area 4. This area is protected by a lower fore-dune behind the beach, and the sea cliff is well-vegetated. Groundwater discharges the cliff on impermeable layers below the dune sand. Parts of the sea cliff are oversteep, and although not affected by coastal erosion, are likely to be affected by other erosional processes and should be regarded as potentially unstable. Any subdivision of areas near these cliffs should be subject to specific study of their stability, and where appropriate, building setbacks from the edge of the cliff specified.

7.5 Flooding

Overland flow paths and areas of ponding are shown on Whanganui District Council's GIS on-line mapping. We understand this ground surface model has been generated from LIDAR surface data and computer modelling. The modelling shows overland flow paths and areas of ponding. This is based on the ground contours and may or may not represent areas of actual ponding during a heavy rainfall event. The permeable nature of the dune sand may result in soakage into the ground, avoiding ponding to the extent shown.

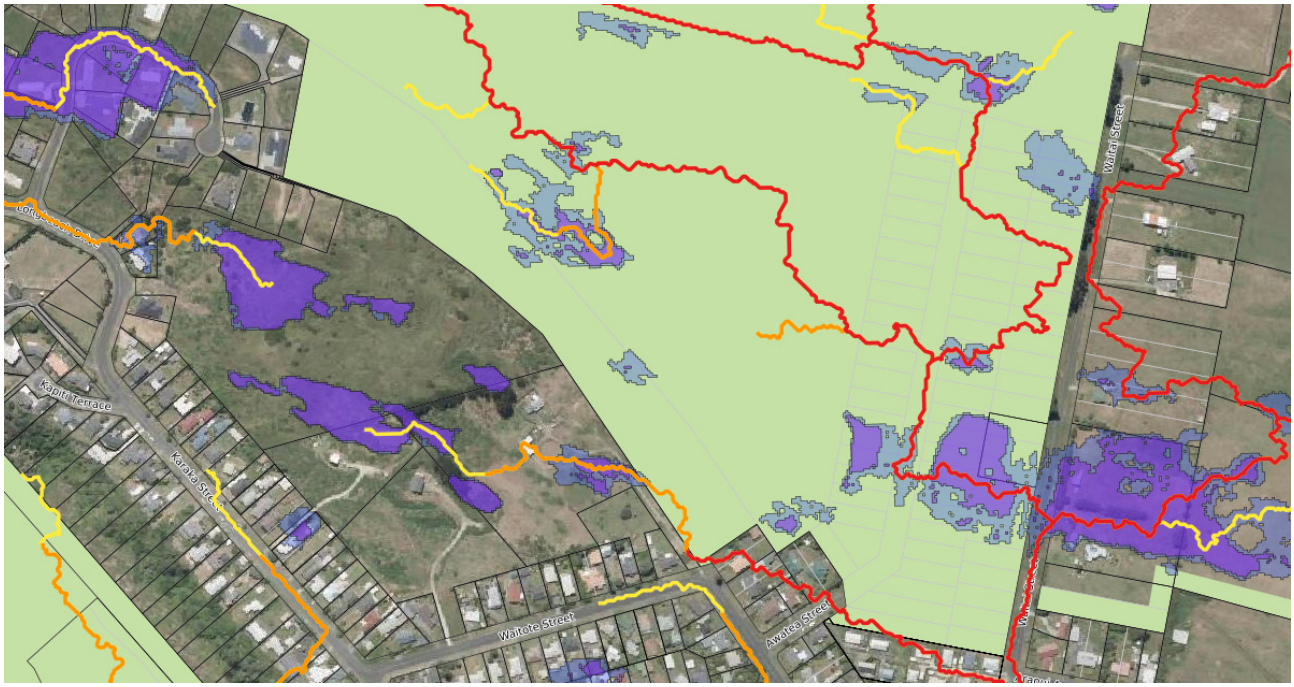

Figure 4 : Overland Flow Paths - Area 1, 2, & 3 (from https://data.whanganui.govt.nz/mapstore2-whanganuidc/#/viewer/openlayers/346)

Horizons Regional Council's flood plain mapping web portal (https://www.horizons.govt.nz/flood-emergency-management/flood-plain-mapping/flood-plain-mapping-portal) was reviewed for any modelling in the study area. No modelling was available within the study areas.

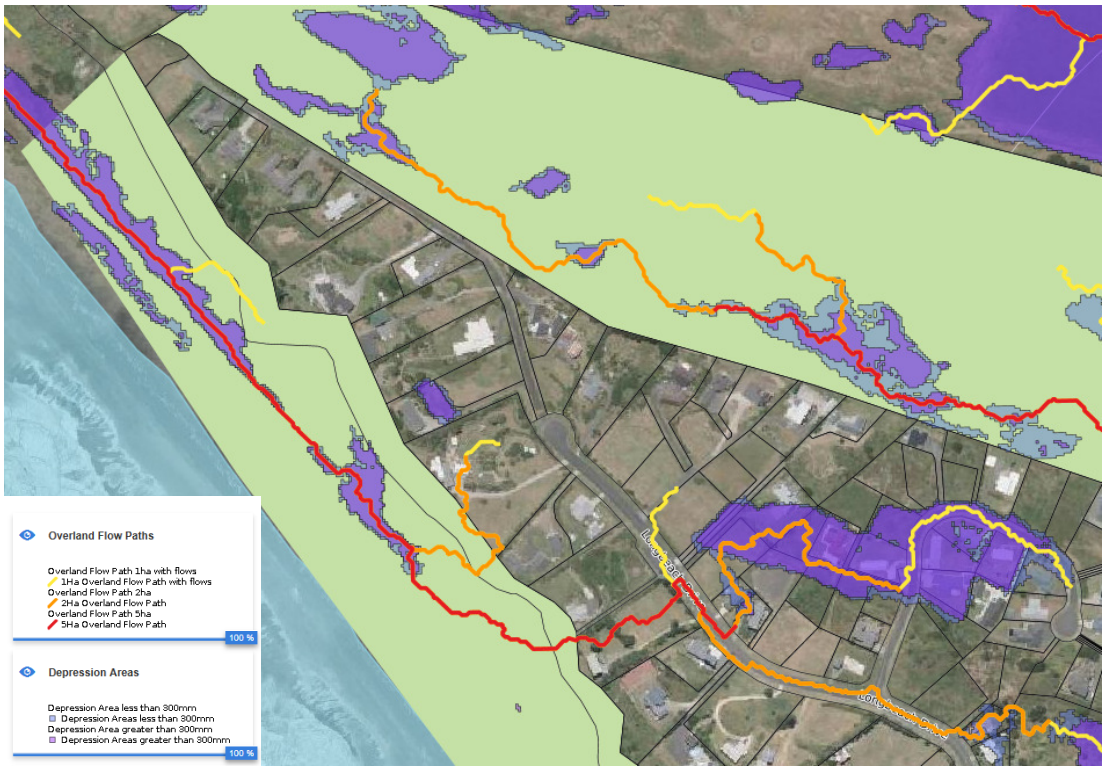

Figure 5 : Overland Flow Paths - Area 4 (from https://data.whanganui.govt.nz/mapstore2-whanganuidc/#/viewer/openlayers/346)

7.6 Earthworks

Earthworks will be required for the development of residential lots in Areas 2 and 3. In Area 2 in particular, large cuts and fills would be required for the provision of building platforms and access roads and lanes. Given the anticipated ground conditions, cut and fill quantities could be balanced within Area 2, and no imported material should be required. There were no obvious areas of unsuitable material observed, but future investigations should be completed in the lower lying areas to check for compressible organic material that would need to be removed and disposed to waste prior to filling.

Cut and fill batters will be required in dune sand material. Further analysis would be required at design stage, but both cut and fill batters should be stable at between 2H:1V and 3H:1V, particularly if they are dry. Current fill batters on the Golf Vue development appear to be significantly steeper than this, and no stability issues are currently observable.

Settlement of fill embankments constructed from sand should be immediate, and no ongoing consolidation type settlement should be expected from this cohesionless material. Settlement would only be expected if the sand was poorly compacted, such as compacted layer thicknesses being too great, insufficient compactive effort, or poor management of water content.

The areas are likely to have poorly developed topsoil layers, and management of this material during and following earthworks, and the establishment of vegetation will be required to avoid wind and water erosion. During earthworks, wind-blown will need to be controlled by water sprinklers or water trucks.

The uniform particle size of the sand and the minimal finer particles should make sediment control from earthworks areas straightforward, and flocculation systems should not be required.

7.7 Building Foundations

No expansive soils will be encountered on any of the areas.

Provided that adequate compaction of fills is completed, settlement of foundations should be small and take place during construction of foundations.

Standard NZS3604 – type foundations should be able to be used for new residential properties in the four areas, assuming any organic material encountered is fully removed from under footings.

7.8 Previous Use and Development

Area 1 forms part of the Castlecliff Golf Course. Fairways and greens may have been sprayed with agrichemicals leaving residuals in the soils. This should be investigated at subdivision stage to determine if any remedial measures are required.

Storage of chemicals has also occurred within Area 1 and this area should be further investigated.

Modification of the landform of some areas may have occurred, included formation of fills, with no intention of them being used in the future for residential buildings. During subdivision stage detailed analysis of historical aerial photographs should be undertaken to identify any areas of significant filling (greater than 0.6m), and an investigation programme planned around their location.

Photograph 4 : Aerial view from 2005 during construction of Golf Vue development. (from Google Earth)

There was evidence of construction debris and possible placing of fill within Area 2. Further investigations will be required at subdivision consent stage to determine the extent and quality of this material.

7.9 Contaminated Land

An assessment of contaminated soils within the study area is beyond the scope of this report. As previously discussed, the use of areas as a golf course for a long period of time would suggest that there is a history of chemical application and storage that should be investigated further should the area be subdivided.

Figure 6 : Storage sheds and Hazchem storage - Castlecliff Golf Club

7.10 Infrastructure Development

During any future development, additional infrastructure will be required to support the additional properties, particularly in Areas 1, 2 and 3. This infrastructure will include roads, 3 waters reticulation, telecommunication and power cabling and potentially gas reticulation. These will require trenching into the ground. There appears to be no issues with trenching, other than the *in situ* soil's ability to stand near vertical above the water table in the trench side walls. Soil excavated from the trench will be suitable for re-use in the trench backfill.

The sand should provide a good subgrade for road pavements, and it would be expected a design subgrade CBR value of greater than 8% could be conservatively assumed.

There was no indication of high groundwater across the study areas. This area is higher than the Rangiora Street end of Karaka Street, where high groundwater is experienced. The iron ochre bug, which causes a biological build-up of slime, blocking subsoil drainage systems, is prevalent in this lower Castlecliff area. The need for any subsoil drainage in the development of any of the areas would need to be assessed following investigations, and if required, appropriate design measures put in place to limit or reduce the development of the iron ochre.

8 Conclusions and Opinion

This report considers the geotechnical and geological aspects of the four area in relation to the proposed plan change to a Residential zoning. No physical investigations were completed as part of this study. This report has been a desk-top study using existing maps, plans and reports. This is appropriate for a proposed plan change process.

Further enquiries and investigations will be required at subdivision consent stage.

This report has not identified any geotechnical issues that should stop or alter the plan change process.

Any issues that might need to be addressed during later stages of work can readily be addressed with engineering design for a reasonable cost.

In conclusion, there are no geotechnical or geological issues identified that would have a significant impact on the plan change process.

9 References

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