Appendix D - Groundwater Desktop Report

Whanganui District Council

Mill Road Manufacturing Zone Structure Plan

Groundwater Desktop Review

October 2017

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Appendices

1. Introduction

1.1 Background and Scope

Whanganui District Council (Whanganui DC) are developing a Structure Plan for the Mill Road Manufacturing Zone, to enable the Whanganui DC to identify the rate of investment for infrastructure within this site and to support uptake of the existing zoned land.

This report provides a high-level assessment of the shallow groundwater environment within the Mill Road area based on a desktop review of the readily available information. The following has been prepared for Whanganui DC in accordance with the proposal '*Mill Road Manufacturing Area Structure Plan – fee proposal*' provided by GHD dated 4 July 2017.

The scope outlines that an understanding of the hydrogeological conditions is important to inform the Structure Plan approach. In particular, review of the following was proposed to inform stormwater infrastructure and costings:

- Determine likely underlying ground conditions
- Identify areas where surface infiltration could be limited.
- Provide an understanding of environmental risk, such as potential for downstream flooding, and potential mitigation options.

1.2 General Site Setting

The Mill Road Structure Plan area (the 'Study Area') is situated within Whanganui. Whanganui is a small city with a population of approximately 44,000 (MBIE, 2017), and is located within the Manawatu-Wanganui region of New Zealand (Figure 1). The entire site is zoned 'Manufacturing Zone' in the Whanganui District Plan (Figure 2). Figures are provided in Appendix B

The Study Area is on the outskirts of Whanganui, and is approximately 107 ha in size. The area is predominantly pastoral greenfield with some existing industrial development covering approximately 10 ha of area in two separate 'pockets'. The Study Area is surrounded by rural and residential land, with the adjacent Springvale Structure Plan area (which has recently undergone a similar assessment for Whanganui DC) located to the west.

1.3 Limitations

This report has been prepared by GHD Limited (GHD) for Whanganui District Council (WDC) and may only be used and relied on by WDC for the purpose agreed between GHD and WDC as set out in Section 1 of this report. GHD otherwise disclaims responsibility to any person other than WDC arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this report on the basis of information provided by WDC and others who provided information to GHD (including Horizons Regional Council) which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the

report which were caused by errors or omissions in that information. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described here and in Section 2 this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Data Review

This Stage 1 work has comprised the following steps:

- **Data collection (Section 2):** A desktop review was undertaken, and is described below. Information obtained from a recent site walkover and drilling investigations at Springvale (GHD, 2017a) have also been included in the data review.
- **Conceptual hydrogeological understanding (Section 3):** A preliminary conceptualisation of the groundwater system is provided, based on the reviewed information.
- **Assessment of Data Gaps (Section 4):** As part of the groundwater conceptualisation, key data gaps were identified. These are noted here along with how these could affect the stormwater design.
- **Recommendations (Section 5):** A proposed approach to address the residual uncertainty associated with the data gaps.

2.1 Desktop Assessment

The Study Area is defined in this review as the area bound by Waitai Street to the west, Tayford Road to the north, and by Mosston Road to the east (refer to Figure 1).

Information reviewed as part of this assessment is summarised in **Section 6** (References), and has been used to inform a preliminary conceptual understanding of the shallow groundwater system within the Structure Plan area.

A list of boreholes and associated bore data within 2 km of the centre of the Site was obtained from Horizons Regional Council (Horizons, 2017). The bore search yielded 43 bore locations, and the ten boreholes recently drilled at Springvale have been added to the bore list (Appendix B).

GHD evaluated the metadata attached to each bore and assigned a rating to each based on the amount of available useful data (**Table 1**). The well locations were georeferenced in ArcGIS to enable the information on subsurface lithology to be spatially analysed (Figure 3)**.** The analysis enabled the development of the conceptual understanding of the groundwater system and subsequent identification of data gaps.

Table 1 Dataset Quality

Map Symbol	Rating	Classification	Definition	No. of Bores	% of Dataset
	3	Excellent	Shallow well, bore log and water level available	10	19%
	2	Average	Shallow well, and either borelog OR water level available	2	4%
	1	Poor	Deeper well bore log; OR shallow well with water quality	18	34%
	0	None	No useable data	23	43%
				53	100%

2.2 Site Observations

A site walkover was conducted on 12 September 2017 by a suitably qualified and experienced Environmental Scientist from GHD. The purpose of this visit was to broadly assess the area, the likely underlying ground conditions and provide information regarding the geographic features via visual assessment only.

Drilling investigations were completed by GHD (2017a) on 22 September 2017 at the neighbouring Springvale Structure plan area (the 'Springvale site'). The Springvale Site is a similar project commissioned by Whanganui DC, and is located east of the Study Area. Hydrogeological investigations are currently underway at Springvale to better understand the potential risks to proposed stormwater drainage. These sites are considered to be comparable; where the Springvale site is located within the same E-W black Holocene sand dune system as the Mill Road Study Area, and has similar characteristics, including hummocky dunes and standing water in areas of low topography.

3. Conceptual Hydrogeological Understanding

3.1 General Environmental Setting

The site is located approximately 2 km from the coast. The Study Area is characterised predominantly by sand dune morphology. Land-use is pastoral land typically associated with rural, rural-residential and residential activities. The area is bounded to the south by the residential section suburb of Castlecliff. There are three residential dwellings currently onsite.

To the west, leading back towards central Whanganui, the Study Area is bounded by rural land that connects to Mosston Road, an arterial road serving Whanganui East. Mosston Road separates the Springvale Structure Plan are from the Mill Road Structure Plan area.

3.2 Geology

The surface geology across the site comprises Quaternary sand dunes, comprising loose, poorly consolidated Holocene sands, mainly in fixed dunes (Q1d) (Figure 3).

The reviewed bore log data indicates that the shallow lithology is comprised of black sands, with small layers of organic materials encountered at various depths (peat/wood layers, typically less than 0.5 m thick). This lithology is present to approximately 30 m below ground level, where the materials begins to change. In the Springvale area, shells were encountered at depth; whereas approximately 1,800 m north of the Study Area, small bands of iron sand were reported up to a depth of approximately 30 m below ground level (m bgl; Bore ID 790025).

Numerous bore logs for the assessment area describe the deeper geology predominantly as fine grained “papa” sandstone/mudstone/limestone, encountered at variable depths across the Site (13 m bgl to 100 m bgl). These units are inferred to be part of the upper Rangitikei sequence of marine deposits, which comprises the local basement rock.

3.3 Topography and Hydrology

The topography is dominated by sand dune morphology, with relic dune features running E-W across the site. The dune features typically range between 1 m to 3 m in height. The general surface gradient of the site is from north to south, towards the Whanganui River, with some undulating areas associated with the sand deposits.

The Whanganui River enters the South Taranaki Bight approximately 1.4 km south of the site at its closest point. The coastal marine area is located approximately 1.7 km south-west of the site.

Low-lying areas within the Study Area between the sand dunes are prone to becoming boggy, or have standing water present, during winter and high rainfall events. This indicates poor drainage and potentially high groundwater levels at the site, as discussed in the preliminary geotechnical and groundwater reports produced for the nearby Springvale area (GHD, 2012; GHD, 2017b).

Information gathered on site was in general agreement with the geological and geomorphological evidence gained during the desktop phase of this investigation:

- Evidence of small-scale slope instability was noted within the sand dunes (**Plate 1**).
- Standing water was observed in low points between dunes in several locations (**Plate 2**).

The Plate locations are indicated on Figure 2.

Plate 1 (left): View to west along ridge of E-W dune

(Location 10 with a view to Location 11). Ponded water visible (far right) in the topographic low north of the dune.

Plate 2 (right): Ponded water in a topographic low south of Mill Road

(Location 1)

3.4 Hydrogeology

3.4.1 Groundwater Table Levels

Based on the available groundwater level data (Appendix B), the water table is generally shallow throughout the Study area. Water levels are reported as shallow as 0.1 m bgl in the Springvale area, to as deep as 3.6 m in elevated areas (Bore ID 790128)

Groundwater levels are expected to be similar to Springvale and will likely vary seasonally and following periods of sustained rainfall. The available information suggests that groundwater has the potential to be higher than reported above. Ongoing groundwater level monitoring is continuing to assess groundwater response to rainfall.

As noted in Section 3.3, the winter groundwater level is therefore likely to manifest as high standing water levels, near to, or above, the ground surface at various locations within the site, such as low-lying areas (e.g. between dune hummocks, within stormwater drains, Titoki wetland to the south).

Recent local investigations (GHD, 2017a) indicate that ponded surface water may be caused by a combination of high groundwater levels in some locations and/or top soil of low permeability causing low infiltration rates.

Plate 1 and Plate 2 above shows observations of ponded water in low-lying areas in the Study Area.

3.4.2 Deeper Aquifer Groundwater Levels

The upper Rangitikei sequence is considered to comprise a permeable basement rock, which overlies the less permeable Torlesse greywacke basement rock (GNS, 2005). A number of boreholes installed in deeper aquifers of the Rangitikei sequence within the assessment area

exhibit strongly confined and artesian conditions (bore depths between 90 to 107 m, with reported artesian water levels between 0.6 and 2 m above ground level (Bore IDs 790105, 790022, 790067).

This information indicates a strong upward vertical hydraulic gradient across the Site for the confined aquifer system.

3.4.3 Groundwater Flow

Recharge of the water table aquifer is likely to occur predominantly from rainfall. The groundwater flow direction is likely to be towards the south to southwest, discharging to the Whanganui River and the coast.

3.4.4 Hydraulic Parameters

Specific permeability data of the water table aquifer is unknown. However, it is acknowledged that the Late Quaternary deposits are extensive and form the most productive aquifers in the region (GNS, 2005). As such, the water table aquifer beneath the site is likely to a have high permeability. The hydraulic conductivity for clean sands can range from 1 to 520 m/day (Freeze and Cherry, 1979; Domenico and Schwartz, 1990). Preliminary hydraulic testing results from the Springvale site are in the order of 5 to 10 m/day (GHD, 2017a).

Peat, where present, is likely to have a significantly lower permeability.

3.5 Potential Effects of Dewatering

The desktop geotechnical report prepared the nearby Springvale development (GHD, 2012) suggests that historical drainage of the land for residential, market garden and agricultural purposes has resulted in subsidence and settlement (based on anecdotal evidence).

Settlement related to drainage/dewatering typically occurs in compressible materials (such as peat) when groundwater levels are lowered below the lowest natural seasonal groundwater level. This can occur from such installations as the proposed swale.

Organic units, including peat layers, are recorded at shallow depth at several locations within the assessment area (refer to Table B2, Appendix B). As such, the risk of settlement resulting from any proposed excavations to enable stormwater drainage should be investigated.

4. Conclusions and Gap Analysis

An understanding of the proposed stormwater management methods for the Study Area is required to understand the requirement for further works (e.g. infrastructure types, dimensions and sub-surface excavations, including lowering of the ground surface).

The key risks identified in this assessment relate to sub-surface excavations.

The **key risks** identified are:

- Whether the proposed methods for managing stormwater will have capacity to convey groundwater inflows (if the groundwater table is encountered).
- The potential settlement risk associated with drainage of compressible materials such as peat (if drainage below the water table is required).

The **key information required** to inform the Mill Road Structure Plan (where excavations are proposed):

- An understanding of sediments and seasonal groundwater levels beneath the Study Area. Specifically; the presence, depth and extent of compressible units such as peat.
- Infiltration rates of the top soil materials and permeability of the sand aquifer.

5. Recommendations

Where sub-surface excavations are proposed, further works are recommended to address the areas of uncertainty associated with groundwater at the site. In order to address the data gaps identified in Section 4, the following is recommended:

- An understanding of the maximum depth of any excavations proposed to manage/mitigate stormwater in the Study Area.
- Collection of site-specific hydrogeological data via field investigations. Given the close proximity and similar site setting, information obtained through the Springvale field investigation may allow for a more limited investigation scope at Mill Road.
- Further assessment would be advised on review of the site data.
- Geotechnical Assessment: Additional testing and assessment has been identified from the gap analysis (GHD, 2017b). To promote efficiencies, it is recommended that any groundwater investigations undertaken be carried out in conjunction with the geotechnical field programme.

If the results of the additional assessment deems that significant groundwater inflows and/or settlement to be a key risk to the Structure Plan, further works may be recommended to quantify the risk. This may include additional site investigations and analysis (including modelling).

6. References

Domenico, P.A. and F.W. Schwartz, 1990. Physical and Chemical Hydrogeology, John Wiley & Sons, New York, 824 p.

Freeze, R. A. and Cherry, J.A., (1979). Groundwater. Prentice-Hall. Inc., Englewood Cliffs, NJ. 604 pp

GHD Ltd. (2012). Report for Springvale Structure Plan – Initial Review of Geotechnical Information. Draft report prepared for Whanganui District Council, dated January 2012.

GHD, 2017a. Springvale Structure Plan – Preliminary Drilling Investigation Data (drilling programme completed 22 September 2017). Factual data compilation *in prep* at time of writing.

GHD, 2017b. Mill Road Structure Plan – Geotechnical Assessment. Draft report for Whanganui DC *in prep* at time of writing.

GNS (2005). Geological synopsis of the Manawatu-Horowhenua area for a review of the region's hydrogeology. Client report 2005/172. Confidential report prepared by Institute of Geological and Nuclear Sciences Limited for Horizons Manawatu Regional Council, dated December 2005.

Horizons (2017). Geological Borehole Information from Horizons Regional Council. Received by email March 2017.

MBIE, 2017. Regional Economic Activity, Ministry for Business, Employment and Innovation (MBIE). Available at: http://webrear.mbie.govt.nz. Accessed on 04/07/17.

Townsend, D., Vonk, A., and Kamp, P.J.J. (compilers) (2008). Geology of the Taranaki area: scale 1:250,000. Lower Hutt: GNS Science. Institute of Geological & Nuclear Sciences 1:250,000 geological map 7.

Appendices

Appendix A – Figures

List of Figures:

LEGEND

Study Area

Paper Size A4

0 100 200 400 600 800 1,000

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

N

WHANGANUI DISTRICT COUNCIL
MILL ROAD MANUFACTURING AREA
STRUCTURE PLAN

Job Number 51-37446
Revision A
Date 10 Oct 2017

Site Location

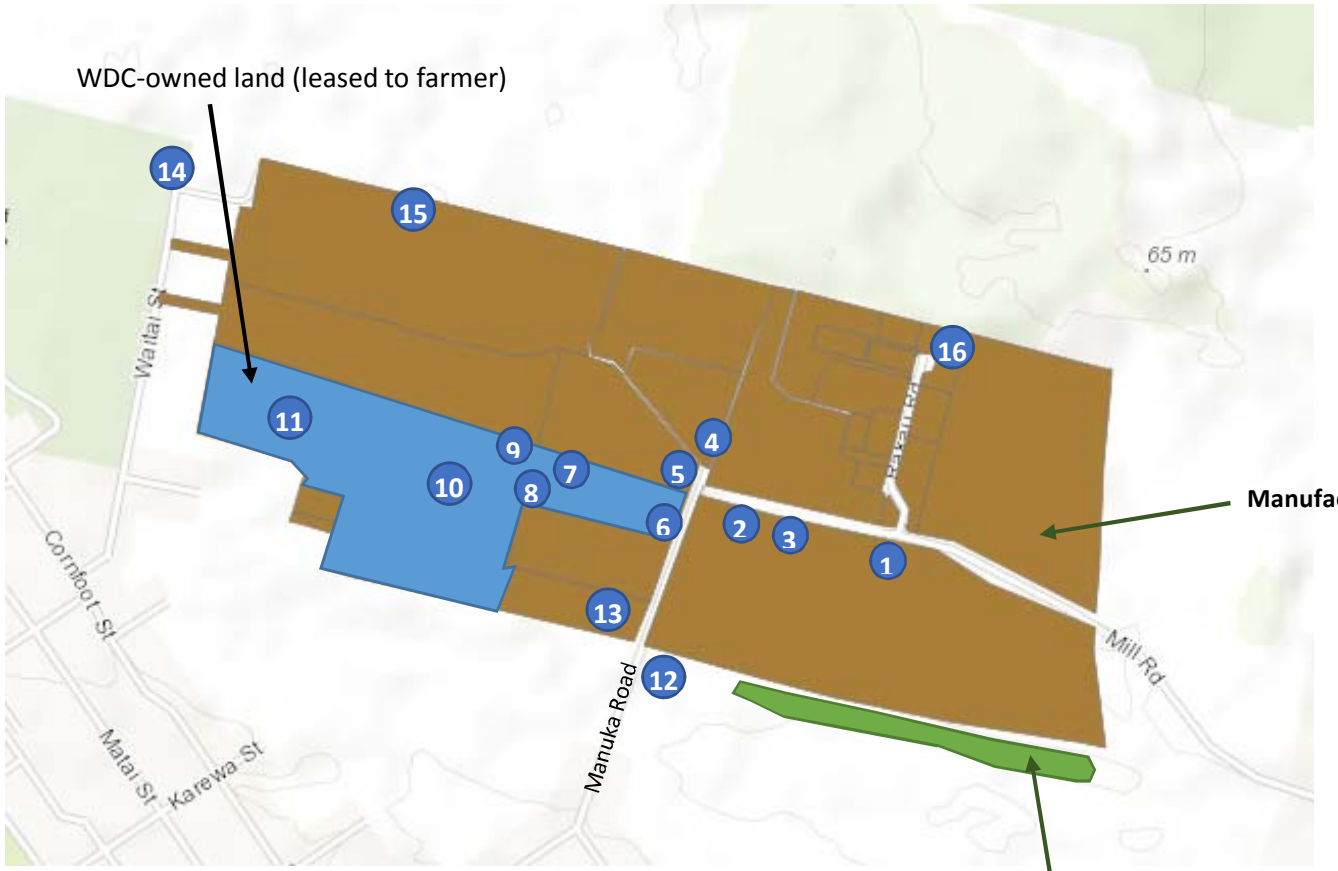
Figure 1

Level 3 138 Victoria Street Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.com **W** www.ghd.com

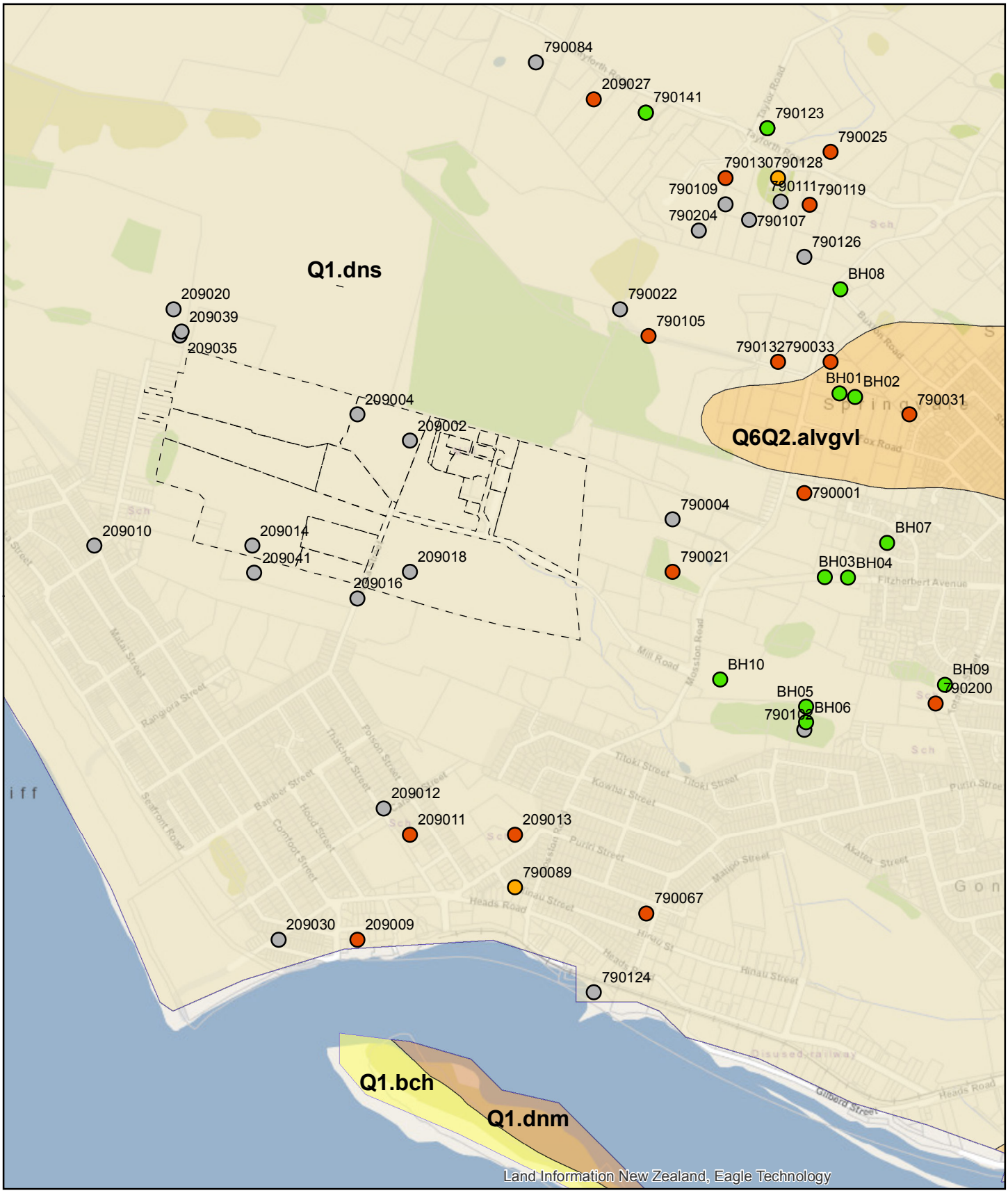
N:\NZ\Wellington\Projects\51\37446\GIS\Maps\Working\513744602_FIGURE1_Mill_Road_RS.mxd

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:rsharplin

Figure 2: Site Walkover Observations Locations (included for selected Plate references)



Dunes in an E-W alignment across the Plan area.
Slumping typically observed on southern side of dunes.



LEGEND

Geology

- Q1.bch: Holocene Ocean Beach Deposits
- Q1.dnm: Holocene Active Dune Deposits
- Q1.dns: Holocene Stable Dune Deposits
- Q6Q2.alvgvl: Mid-Late Pleistocene River Deposits

Bore locations and Metadata Ratings:

- 0
- 1
- 2
- 3

Study Area

Paper Size A4

0 125 250 500

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

N

GHD

WHANGANUI DISTRICT COUNCIL

MILL ROAD MANUFACTURING AREA STRUCTURE PLAN

Job Number 51-37446
Revision A
Date 10 Oct 2017

Geology and Bore Data

Figure 3

Level 3 138 Victoria Street Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.com **W** www.ghd.com

N:\NZ\Wellington\Projects\51\37446\GIS\Maps\Working\513744602_FIGURE2_Mill_Road_RS.mxd

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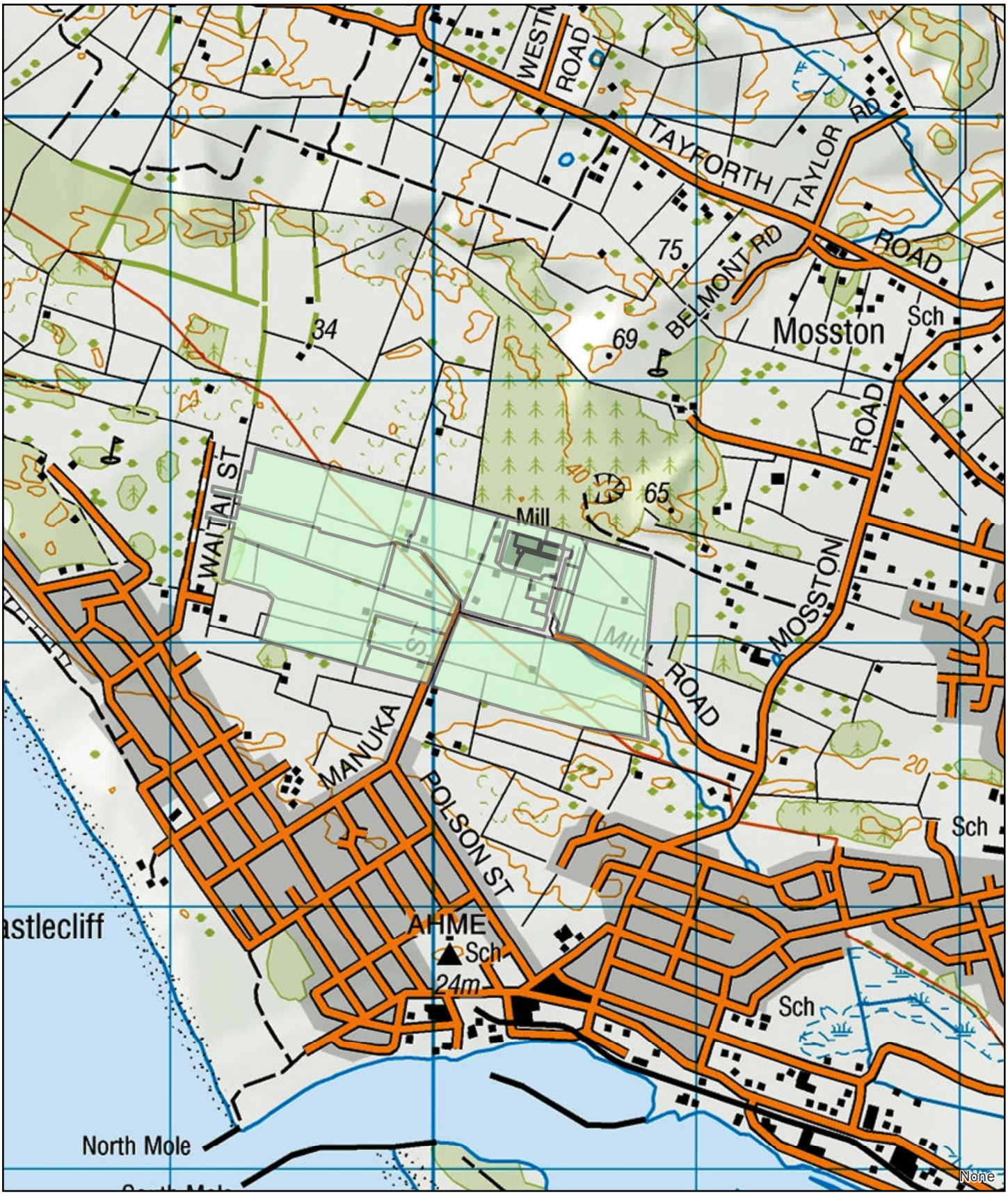

LEGEND

Study Area

Paper Size A4

0 70 140 280 420 560

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

N

GHD

WHANGANUI DISTRICT COUNCIL
MILL ROAD MANUFACTURING ZONE
STRUCTURE PLAN

Topography

Job Number 51-37446
Revision A
Date 29 Sep 2017

Figure 4

Level 3 138 Victoria Street Christchurch 8141 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.com **W** www.ghd.com

N:\NZ\Wellington\Projects\51\37446\GIS\Maps\Working\Mill_Road_Figure3.mxd

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:spollock

Appendix B – Bore Search

Table B1: Registered Bores within the Assessment Area

Bore ID	Elevation	Depth (m)	Owner (Purpose)	Water Level (m bgl)	Artesian?	Metadata Rating*
209002	24.841	177	Private owner	-5.3	Yes	0
209004	25.219	41	Private owner			0
209009	2.99	317	Wanganui Harbour	-8.1	Yes	1
209010	21.985	9	Aranui School			0
209011	14.795	86.93	Wanganui District Council (Public supply)	-13	Yes	1
209012	21	5	Castlecliff School			0
209013	11.365	59.78	Tekura Kaupapa School			1
209014	22.378	28	Private owner			0
209016	18.788	30	Private owner			0
209018	24.29	24	Private owner			0
209020	29.974	55	Private owner			0
209027	59	73.8	Private owner			1
209030	8.605		Wanganui Abattoirs	7.1		0
209035	29.646	180.5	Private owner (Irrigation)	-9.5	Yes	0
209039	29.487	43.3	Private owner (Irrigation)	19.5		0
209041	25	39.62	Private owner (Irrigation)	17.35		0
790001	24.408	59.5	Private owner	6		1
790004	22.683	117	Aitchison Indust			0
790021	28	117.4	Aitchison Industries			1
790022	30.166	94	Wanganui Golf Club	-2.4	Yes	0
790025	44	55.5	Wanganui Mushrooms (Industrial supply)			1
790031	31	51.2	Wanganui Mushrooms	6.1		1
790033	34	106.6	Private owner	-1	Yes	1
790067	5.48	90.22	Kokohuia School	0.6		1
790069	19.046	62.48	Rutherford Intermediate	6.1		1
790084	67.612	82	Private owner	20.5		0
790089	19	4	Caltex Wanganui	2		2
790102	23	5	Tawhero School			0
790104	22	5	Rutherford Int			0
790105	30	104.9	Belmont Golf Course (Irrigation)	-2.1	Yes	1
790107	36	8	Private owner			0
790109	40		Private owner	6		0
790111	40	60	Private owner			0

Bore ID	Elevation	Depth (m)	Owner (Purpose)	Water Level (m bgl)	Artesian?	Metadata Rating*
790119	40	56.5	Private owner (Domestic & farm supply)	13.6		1
790123	40	663	Wanganui District Council (Resource investigation/testing)	-0.3	Yes	1
790124	3.1	55	Private owner			0
790126	39	38	Private owner			0
790128	45	5	BWE Tasker	3.6		2
790130	46	6	Springvale Mushrooms			1
790132	36	6	Mowlern			1
790141	22.6	76	Private owner (Farm supply)	34.7		1
790200	23	6	Private owner			1
790204	41	8	Private owner			0

Ratings:

Symbol	Rating	Meaning	Definition
●	3	Excellent	Shallow well, bore log and water level available
●	2	Average	Shallow well, and either borelog OR water level available
●	1	Poor	Deeper well bore log; OR shallow well with water quality
●	0	None	No useable data

Table B2: Whanganui DC Springvale Site Monitoring Wells (preliminary data)

Bore ID	Depth (m)	Water Level (m bgl)	Peat Layer m encountered (thickness)	Metadata Rating*
BH1	5	1.3	-	3
BH2	7	0.2	-	3
BH3	5	0.95	3.85 – 4.15 (0.3 m)	3
BH4	5	1.2	4.1 – 4.4 (0.3 m)	3
BH5	5	1.8	-	3
BH6	30	0.8	-	3
BH7	5	2.4	3.85 – 4.25 (0.4 m)	3
BH8	30	2.8	7.2 – 7.45 (0.25 m) 10.1 – 10.2 m (0.1 m) 26.5 – 27 m (0.5 m)	3
BH9	5	0.8	3.9 – 4.1 (0.2 m)	3
BH10	5	0.7	-	3

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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