Assessment of Groundwater Effects - 104 Ryans Road

Prepared for

Carter Group Limited

August 2025

PATTLE DELAMORE PARTNERS LTD
Level 2, 134 Oxford Terrace
Christchurch Central, Christchurch 8011
PO Box 389, Christchurch 8140, New Zealand

Tel +64 3 **345 7100**
Web www.pdp.co.nz

solutions for your environment

Quality Control Sheet

TITLE	Assessment of Groundwater Effects - 104 Ryans Road
CLIENT	Carter Group Limited
ISSUE DATE	5 August 2025
JOB REFERENCE	C052850001

Revision History

REV	Date	Status/Purpose	Prepared By	Reviewed by	Approved
A	23/01/2025	Draft memo	Alesha Watkins Nic Love	Carl Steffens	Eoghan O'Neill
B	24/02/2025	Draft memo	Alesha Watkins Nic Love	Carl Steffens	Eoghan O'Neill
C	4/03/2025	Final report	Alesha Watkins Nic Love	Carl Steffens	Eoghan O'Neill
D	05/08/2025	Final report	Alesha Watkins Nic Love	Carl Steffens	Eoghan O'Neill

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Alesha Watkins

Nic Love

Reviewed by

SIGNATURE

Carl Steffens

Approved by

Eoghan O'Neill

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Carter Group Ltd and others (not directly contracted by PDP for the work), including Tetra Tech Coffey. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Carter Group Ltd for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Executive Summary

Pattle Delamore Partners Limited (PDP) has been engaged by Carter Group Ltd to provide a technical assessment on the potential effects on groundwater to support the Fast-track application for operational stormwater discharge at the proposed industrial subdivision at 104 Ryans Road, Yaldhurst.

The 104 Ryans Road site encompasses an area of 55.5 ha and is located adjacent to Christchurch International Airport along its northwestern boundary. A discharge consent is required for the operational-phase stormwater discharge as a non-complying activity under the Land and Water Regional Plan (LWRP) in relation to rules 5.96 and 5.97. Construction phase stormwater consents will also be required with respect to rule 5.94B.

The proposed stormwater system has been developed to isolate and filter clean contaminated run-off to efficiently manage, treat and dispose of run-off to ground. Stormwater within the proposed site will be managed as follows:

- All run-off from roofed areas on each lot will be collected and be disposed to ground with no treatment by onsite soak pit(s),
- Remaining stormwater runoff generated on the individual lots from hardstand and pervious areas will be directed to an onsite proprietary treatment device for treatment of the "first flush" flow prior to disposal to ground via a soak pit(s), and
- Run-off generated from road, footpath and berm areas will be collected in sumps and conveyed via a reticulated network for treatment in a first flush infiltration basin/soak pit system. There are two proposed stormwater management areas (SMA), one to the north of the development, and one to the east.

There are five Community Drinking Water Protection Zones (CDWPZ) located within 2 km of the proposed subdivision site. The downgradient community drinking water supply bores are situated at distances greater than 1.4 km from the nearest site boundary. There are 154 domestic supply bores and domestic and stockwater bores shown to be located within the 2 km buffer. Most of the domestic water supply bores and stockwater bores are likely to be upgradient or cross-gradient of any potential stormwater discharge effects. There is one active bore (M35/3176) with irrigation recorded as its primary use within the site, and 73 within the 2 km area surrounding the site. There are five active and one proposed commercial/industrial bores within the 2 km buffer zone.

Microbial transport from the site has been modelled using the Microbial Risk Assessment tool developed by ESR. The modelling indicates that infiltration through the vadose zone and transport and infiltration through the aquifer is likely to achieve a total log reduction distribution ranging between 4.1 and 7.2. The tool shows that the probability of the *E. coli* concentration exceeding the

Maximum Acceptable Value (MAV) (<1 MPN/100 mL) at the nearest downgradient bore (37 m) is 0.04 %. The probability of *E. coli* concentrations exceeding the MAV is expected to decrease further with distance from the site as transport through the aquifer, and therefore log reduction, increases. As such, bores located at distances greater than 37 m downgradient are unlikely to be adversely affected as a result of the stormwater discharge.

The expected total metal concentrations in the untreated stormwater runoff for chromium, copper, lead and zinc are all well below the relevant MAV and/or Aesthetic Value (AV) prior to treatment. The expected concentrations of total petroleum hydrocarbons and total polycyclic aromatic hydrocarbons in the untreated stormwater runoff are typically below the detection limits of laboratory analysis. The concentrations of contaminants can be expected to reduce further post treatment based on the basins and treatment devices achieving the removal rates. As such, no effects on groundwater users from metals or hydrocarbons are expected as a result of the discharge.

An assessment of groundwater mounding due to stormwater disposal from the proposed stormwater design was undertaken. The assessments included both short-term and long-term mounding effects due to infiltration of stormwater from individual lots as well as from roadways across the site via infiltration basins across a range of potential transmissivities. Transmissivity of the gravelly strata is more likely to be in the range of 1,200 to 3,500 m^2/day. The results for these scenarios indicate that mounding is not expected to be a concern, with mounding during a 24-hour 2% AEP storm event between 1.47 and 2.38 m at SMA East and between 1.26 and 1.89 m at SMA North. Overall, the results indicate that mounding at the site is not expected to be of concern.

Overall, concentrations of faecal bacteria, metals and hydrocarbons are not expected to exceed the MAVs in the nearest downgradient receptors (domestic supply bores) of the stormwater discharge locations. The mounding assessments undertaken indicate that the disposal of stormwater to ground at the site is not expected to be inhibited by groundwater mounding effects.

Table of Contents

Table of Figures

Table of Tables

Appendices

1.0 Introduction

Pattle Delamore Partners Limited (PDP) has undertaken a groundwater assessment to assess the potential effects on groundwater arising from operational-phase stormwater discharge at Carter Group Ltd's proposed industrial subdivision at 104 Ryans Road, Yaldhurst.

The groundwater assessment is detailed within this report and will be used to support an application under the Fast-track Approvals Act for resource consent for the stormwater discharge. A discharge consent is required for the operational-phase stormwater discharge as a non-complying activity under the Land and Water Regional Plan (LWRP) in relation to rules 5.96 and 5.97. The activity is deemed not permitted as it does not meet the requirements of Rule 5.96 as the proposed discharge is from an industrial land use. The activity is deemed non-complying as it does not meet the relevant permitted activity rules, and it is located within the bounds of Christchurch City Council. Construction phase stormwater consents will also be required with respect to rule 5.94B.

2.0 Site Location and Hydrological Setting

2.1 Site Location and Surface Waterways

The site is located at 104 Ryans Road, Yaldhurst and is adjacent to Christchurch International Airport along its northwestern boundary. The site encompasses an area of 55.5 ha. The topography is generally flat, sloping from northwest to southeast at an average gradient of 1:200. The nearest major surface watercourse is the Waimakariri River, situated approximately 6 km north of the proposed site. Surface water bodies within proximity of the site include an open channel of the Paparua water race scheme, which runs along Ryans Road on the southern boundary of the site. The Paparua water race confluences with Paparua Stream within the Yaldhurst Park subdivision which is approximately 1.7 km south of the site at the nearest point. The mapped headwaters of Ilam Stream are located 2 km southeast of the site.

2.2 Geology and Soils

The GNS Science 1:250k scale geological map describes the near surface geology underlying the site as Holocene modern river floodplain deposits, comprising variably sorted gravel, sand, silt and clay.

A geotechnical investigation of the site has been carried out by Tetra Tech Coffey (dated 9 December 2024), which generally described the subsurface profile as:

- 0 – 300 mm Topsoil,
- 300 – 4000 mm Sand, and
- 4000 mm – unknown depth Sandy Gravel.

It is noted that depth to gravel was generally between 3 to 5 m below ground level (bgl) across the site, however gravel was nearer the surface at depths of between 1 to 2 m bgl along the southern boundary of the site (i.e. test pits 20 to 22). Silty lenses were observed within the sand layer and it is expected that silt content is variable across the site.

S-Map Online indicates that there are two different soil types across the site. The soils are classed as moderately deep well drained silt with 'moderate over rapid permeability', and deep well drained loam over sand with 'moderate permeability'. Based on the results of soakage and infiltration testing undertaken by Tera Tech Coffey (2024), they consider an infiltration rate of 600 mm/hr achievable across the site with sufficient embedment into the gravel layer.

A review of bores with bore log records within 250 m of the site was undertaken using the Environment Canterbury (ECan) GIS database (Canterbury Maps). Bore logs were not available for bores within the site boundary, however, two representative logs are described in detail here, M35/1666 and M35/9913, and are appended to this report (Appendix A). These bore logs were chosen because of their proximity to the site, and they are situated near the northern and southern boundaries of the site to give a geographical spread across the wider site surrounds. Bore M35/1666 is located to the north of the site where the moderately deep well drained silt soils are mapped and M35/9913 is situated to the south where deep well drained loam over sand soils are mapped.

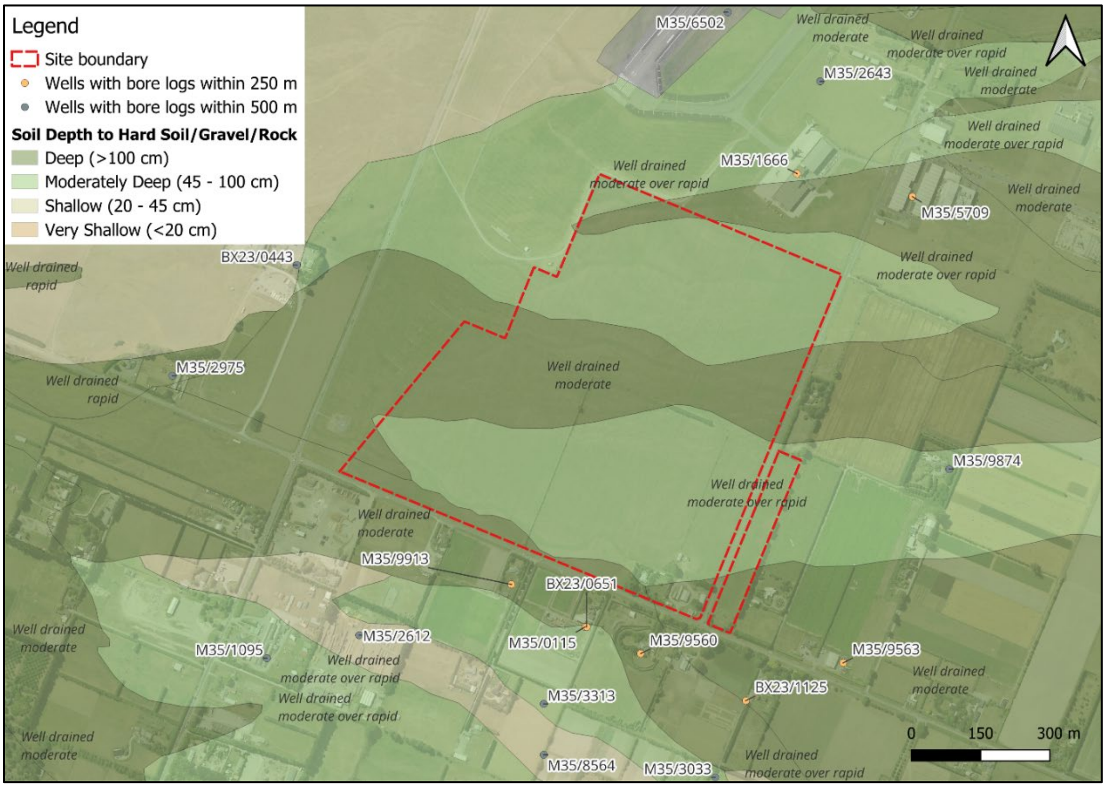

Figure 1: Soil types and bores with bore logs within 500 m of the site.

The bore log for M35/1666 indicates a layer of topsoil (0 – 0.3 m bgl), silt (0.3 – 2.59 m bgl), grey gravels (2.59 – 13 m bgl), gravel and fine sand (13 – 19.5 m bgl) and gravels with coarse sand (19.5 – 24 m bgl) to the base of the borehole. The gravelly strata from 13 m bgl are inferred by ECan to be the Riccarton Gravel Formation which is the first confined aquifer underlying Christchurch City. However, in the west of the city (including at this site) the thick confining strata that overlie the Riccarton Gravel aquifer further east are not present and the aquifer is unconfined. The bore log for M35/9913 has limited detail but the driller's description indicates a layer of topsoil (0 – 0.2 m bgl) underlain by sandy gravel (0.2 –30 m bgl) to the base of the borehole. The M35/9113 log notes that the strata was dry to 16.6 m bgl, where the driller notes 'little water' at this depth. From a depth of 27.1 m 'more water' is noted by the driller.

Bore logs from the six other bores located within the 250 m radius recorded similar alluvial strata descriptions to the two described above with slight variations. Additionally, the next closest bore log to the site extending below the Riccarton Gravels (M35/2975, around 330 m west of the site) indicates that the base of the Riccarton Gravels terminates around 47.5 m bgl (as inferred by ECan). The log descriptions from boreholes in the area are generally consistent with the test pitting descriptions and bore log review made by Tetra Tech Coffey.

Bore logs for M35/9913, M35/1666 and M35/2975 have been appended to this report (Appendix A).

2.3 Groundwater

Regional piezometric contours provided on the ECan GIS database indicate that the overall groundwater flow direction is southeast towards the coast (Figure 2), although minor local scale variations are likely.

Figure 2: Regional piezometric contours and groundwater flow direction

2.3.1 Depth to Groundwater

Depth to groundwater information is available on ECan's GIS database, which has multiple depth to water surveys available. The Christchurch Aquifer 1 average level survey indicates that the depth to groundwater varies from approximately 13 to 15 m bgl across the site with depth to groundwater decreasing from south-west to north-east. This appears to be similar to initial water levels recorded at bores shallower than 50 m within 500 m of the site. These bores have recorded initial static water levels that range from 11.5 to 18 m bgl. It should be noted that there is some uncertainty with static water levels, as groundwater levels may be impacted by the drilling of the bore. An ECan groundwater level monitoring bore (M35/1111) which is 21.4 m deep is located approximately 400 m south of the site and has 462 groundwater level records from 1974 to

2024 (Figure 3). The frequency of measurements varies across the monitoring record with one or two measurements per year taken between 1974 and 1987, increasing to mostly monthly frequency from 1989 onward. The measurements show that depth to groundwater varies between approximately 12.3 to 18.6 m bgl, with a seasonal pattern of generally higher water levels in winter and early spring and lower water levels in summer and early autumn. Typically, seasonally low groundwater levels have remained within the average range of around 16 to 18 m bgl with shallower groundwater level spikes to around 12 to 15 m bgl typically observed in the winter months.

Based on the available information, the depth to groundwater at the site is estimated to range between around 11.5 to 19 m bgl. There is some uncertainty in this estimated range as there is no site-specific data, however it is considered reasonable to assume the surrounding data is generally representative for the site.

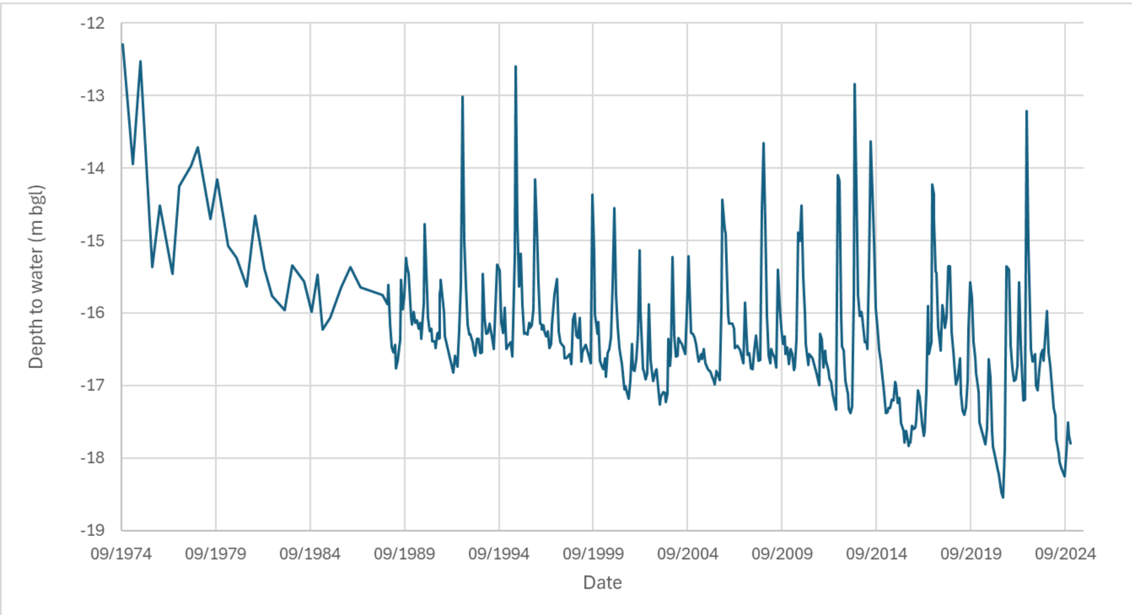

Figure 3: Depth to water (m bgl) in nearby ECan Monitoring Bore M35/1111

2.3.2 Aquifer Parameters

Available pumping test reports for bores in the surrounding area can potentially be used to estimate aquifer parameters. A search of the ECan well database identified three shallow bores with publicly available aquifer test data (from step-drawdown testing) within about 1.2 km of the site. The bore depths, yields, and transmissivity values are presented in Table 1 below.

Table 1: Yield and Aquifer Parameters Derived from Pumping Tests in Nearby Bores

Pumped bore	Distance from site (m)	Depth (m bgl)	Yield (L/s)	Transmissivity (T) (m^2/day)
M35/3176	Within site	26.1	27.9	3500[1]
M35/0115	110	31.5	7.2	1200
M35/5648	1,100	30.0	17.4	3500

Notes:

1. *ECan review of the test set up and reporting assessed as 'Unreliable', and test analysis and parameters assessed as 'Marginal'.*

The available information indicates that the shallow gravel strata is reasonably transmissive, although there is no aquifer test data available from the strata at the water table. However, given bore logs in the area do not show signs of significant stratification, it is considered that the derived transmissivity estimates can be used as an approximation for the shallow aquifer properties at the site (for strata between the water table and up to 32 m in depth).

2.3.3 Groundwater Quality

The ECan GIS database shows that there are 31 bores which have groundwater quality results available within 2,000 m of the site. Bore M35/1382 is located approximately 1.8 km northeast of the site, is 30.5 m deep and is screened between 24.4 to 30.5 m bgl. This bore has the most comprehensive water quality monitoring data set (136 samples) with records dating from 1966 to 2024. A summary of key groundwater quality parameters recorded at this bore is shown in Table 2 with comparison to the Water Services Regulations (2022) health based Maximum Acceptable Values (MAV) limits and Taumata Arowai (2022) Aesthetic Value (AV) concentrations.

Monitoring of groundwater quality at M35/1382 shows that water quality parameters are generally below the relevant the MAV and AV limits. *E. coli* has not been detected in any of the samples taken over the monitoring record. Total coliforms have been detected on two occasions with measurements of 3 MPN/100 mL and 2,400 MPN/100 mL. The elevated detection of 2,400 MPN/100 mL occurred in September 2000 and no further detections have occurred in subsequent samples. pH has been below the AV lower limit of 7 on several occasions, however, Canterbury ground waters are often below the drinking water aesthetic values due to natural recharge processes and pH values of rainfall being slightly below 7. Iron (total and dissolved) was above the AV value on one occasion, however, concentrations are typically below the detection limit. A maximum temperature of 17 °C was recorded in November 1989 which is in exceedance of the AV limit of 15 °C. Temperature of groundwater may be influenced by sampling techniques. The temperature of groundwater at this site is typically below the AV limit, with a median of 13.1 °C.

Table 2: M35/1382 Water Quality Summary with Comparison to Drinking Water MAVs and GVs.

Parameter (mg/L unless stated otherwise)	No. samples	MAV	AV	Minimum	Average	Maximum
Alkalinity, Total (g/m^3 as $CACO_3$)	29			41.0	49.7	54
Aluminium, Dissolved	1	1	≤ 0.1	0.0015	-	0.0015
Ammoniacal Nitrogen	113		≤ 1.5	<0.005	0.0084	0.05
Arsenic, Total	4	0.01		<0.0005	-	0.0005
Boron, Dissolved	4	2.4		0.020	0.0215	0.023
Calcium, Dissolved	93			9.00	14.605	21
Calcium, Total	15			11.00	12.6	14
Chloride	147		≤ 250	1.90	3.531	10
Chromium, Total	3	0.05		<0.0005	-	<0.04
Conductivity (mS/m)	97			6.00	10.890	15.6
Copper, Dissolved	1	2	≤ 1	0.0006	-	0.0006
Copper, Total	2	2	≤ 1	<0.01	-	0.003
Dissolved Oxygen	107			0.16	8.68	13.2
E. coli (MPN/100 mL)	42	<1		<1	-	<1
Fluoride	75	1.5		<0.05	0.037	0.08

Table 2: M35/1382 Water Quality Summary with Comparison to Drinking Water MAVs and GVs.

Parameter (mg/L unless stated otherwise)	No. samples	MAV	AV	Minimum	Average	Maximum
Hardness, Total (g/m^3 as $CACO_3$)	62		≤ 200	28.0	44.2	62.0
Iron, Dissolved	74		≤ 0.3	<0.02	0.068	**2.8**
Iron, Total	43		≤ 0.3	<0.01	0.118	**3.1**
Manganese, Dissolved	70	0.4	≤ 0.04 (staining) ≤ 0.10 (taste)	<0.005	0.003	0.027
Nitrate Nitrogen	141	11.3		0.02	0.511	1.67
Nitrite Nitrogen	12			<0.002	0.004	0.016
pH (unitless)	147		7.0 – 8.5	**5.8**	7.0	8.1
Sodium, Dissolved	89		≤ 200	4.0	4.6	9.1
Sulphate	139		≤ 250	2.70	5.17	9.5
Total coliforms (MPN/100 mL)	56			<1	-	2400
Water Temperature (field °C)	113		<15	11.4	13.2	**17.0**
Zinc, Dissolved	1		≤ 1.5	0.003	-	0.003

Notes:

1. *Red text indicates an exceedance of the AV. No MAV exceedances were observed in the dataset.*

2.3.4 Community Drinking Water Protection Zones

The Community Drinking Water Protection Zones (CDWPZ) located in Yaldhurst (Figure 4) do not currently overlap with the proposed site location. A 2 km buffer has been applied for the purposes of identifying potential groundwater receptors (community drinking water supply bores).

The 2 km buffer around the site overlaps with five CDWPZs. The CDWPZs for community supply bores M35/3731, BX23/0430 and BX23/0428 are mostly fully within the 2 km radius, and the CDWPZs for BX23/0228 and M35/6040 overlap by approximately 40 m on the upgradient side. The CDWPZ for bore M35/18384 is just within the 2 km radius with a 4 m overlap. The potential effects of the stormwater discharge on these bores are assessed in Sections 4.4 and 6.2.

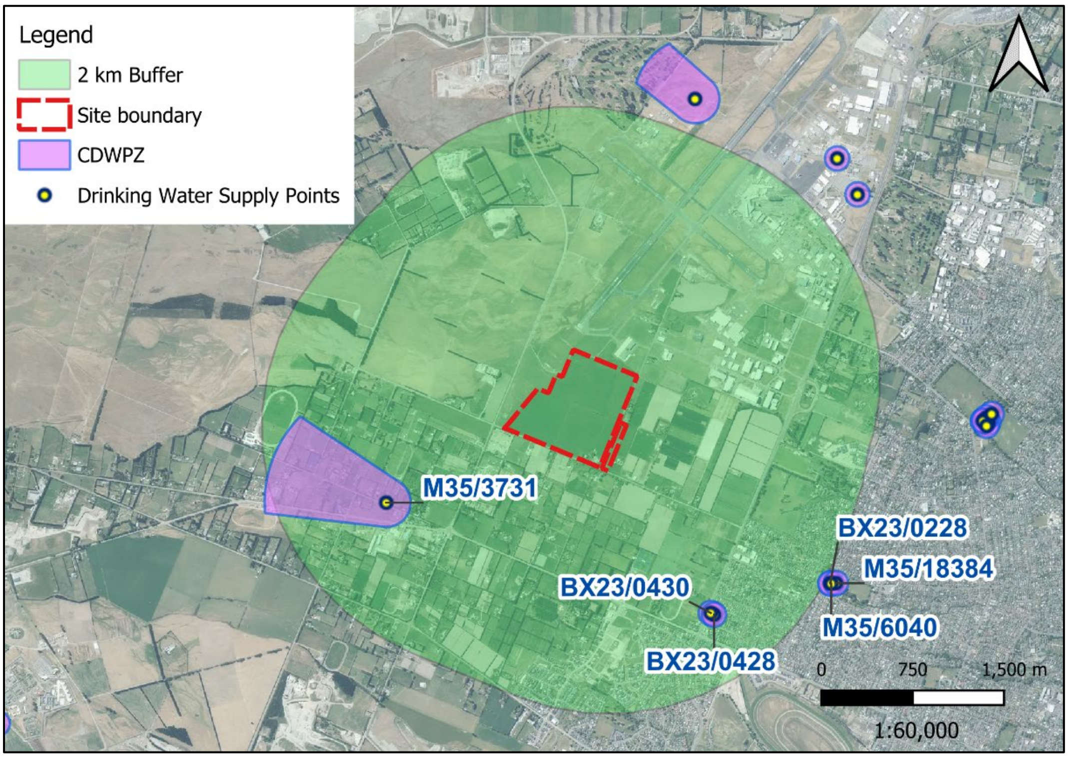

Figure 4: Community Drinking Water Protection Zones

3.0 Reasons for Consent

Table 3 below outlines the applicable rule requirements of the LWRP which are not met, the reasons for consent being required and the activity status for the necessary consent application.

Table 3: Regional Planning Rule Summary

Activity	Rule[1]	Reason for Consent	Activity Status
Discharge of Construction-Phase Stormwater	LWRP Rule 5.94B	Area disturbed is more than 2 ha. The discharge is from potentially contaminated land	Restricted Discretionary
Discharge of Operational Stormwater from roads and other public hardstand areas	LWRP Rule 5.93	A reticulated stormwater system will be constructed for this development to collect stormwater from accessways, roads and other public hardstand areas. Treated stormwater from this reticulated system will be discharged into land through soak pits.	Restricted Discretionary
Discharge of Operational Stormwater from rooves and hardstand areas of individual lots.	LWRP Rule 5.97	Discharge is from industrial land use. Site is located in Christchurch City Council within boundary	Non-Complying

Notes:
1. LWRP: Canterbury Land and Water Regional Plan.

4.0 Potential Receptors for Water Quality Impacts

4.1 Domestic Water Supply Bores

Figure 5 shows the active shallow domestic supply bores and domestic and stockwater bores located within 2 km of the site. Bores deeper than 50 m have been excluded from this assessment given they are assumed to be screened within the deeper Linwood Gravel Aquifer or deeper, which will be less sensitive to surface derived stormwater discharges. The bores down gradient of the site are potential receptors to microbial pathogens and other contaminants that may be transported in groundwater as a result of the stormwater discharges to ground within the site. It is likely that the owners of these bores currently utilise the bores from their drinking water supply as reticulated supply is not available in this area. It is unknown whether the owners of the bores provide an appropriate level of treatment to the abstracted groundwater. It is acknowledged that these bores, particularly shallow bores, will be vulnerable to microbial pathogens from a number of existing sources, such as wastewater discharges, agricultural land use, other stormwater discharges and surface water recharge and should ideally be receiving appropriate treatment for these risks if they are in use.

There is one domestic supply bore within the site, M35/3347 (unknown depth). It is understood that this bore will be decommissioned and removed when construction works commence so is not considered to be potentially affected.

There are 153 additional domestic supply bores and domestic and stockwater bores shown to be located within the 2 km buffer. Most of these bores are likely to be upgradient or cross-gradient of any potential stormwater discharge effects, but there are also a number of bores situated downgradient of the site (as shown in Figure 5).

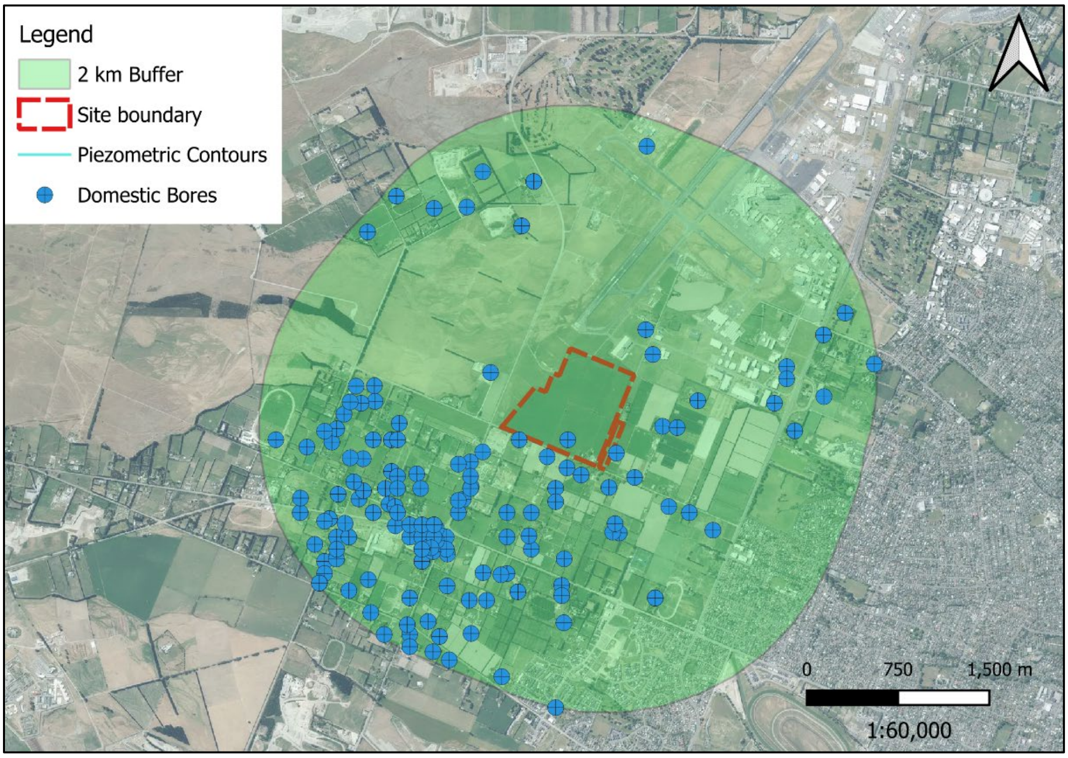

Figure 5: Domestic Supply Bores within 2 km of the Site

4.2 Commercial/Industrial Water Supply Bores

According to the ECan database, there are five active and one proposed (BX23/0640) commercial/industrial bores located within 2 km of the site (Figure 6). Bores M35/2814 and M35/3637 are upgradient of any potential stormwater discharge effects and therefore are not considered to be affected by the site's stormwater discharge to ground. Bores M35/5578, BX23/1456 and BX23/1448 are between 27 m and 31.4 m deep. Bore BX23/1456 is nearest to the site at approximately 1 km.

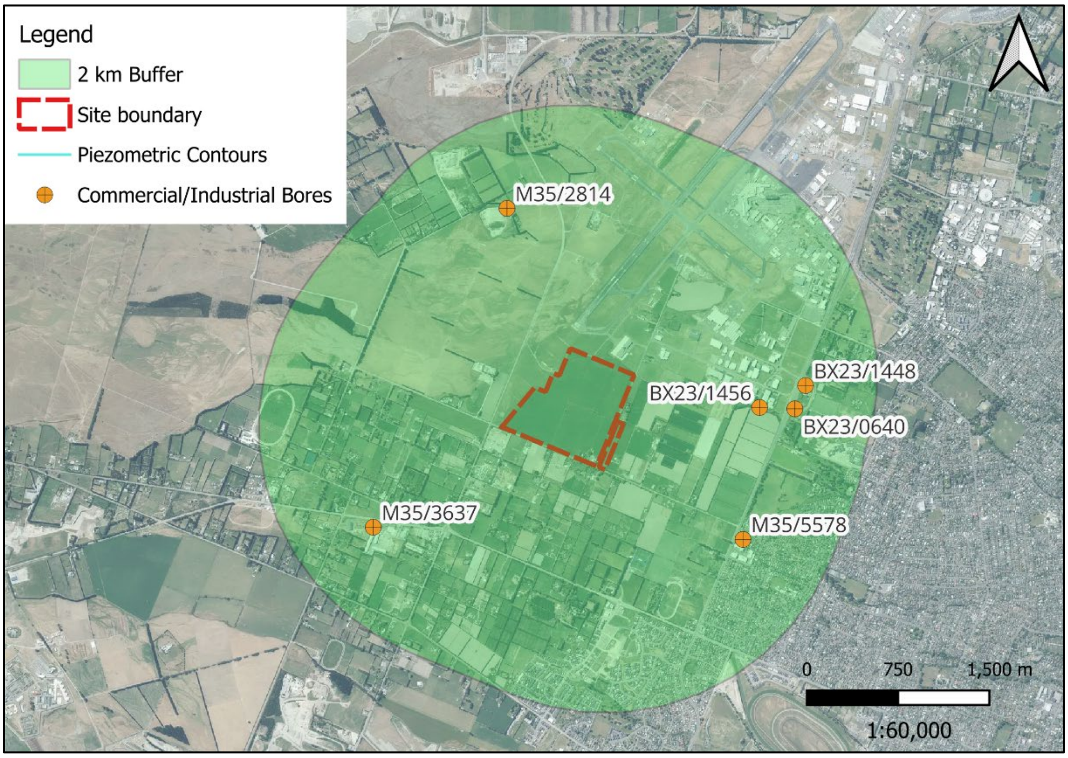

Figure 6: Commercial/Industrial Bores within 2 km of the Site

4.3 Irrigation Water Supply Bores

There is one active bore (M35/3176) with irrigation recorded as its primary use within the site, and 73 within the 2 km radius surrounding the site (Figure 7). It is understood that bore M35/3176 (26 m deep) will be decommissioned and capped during subdivision construction works. Water used for irrigation purposes is not required to meet drinking water standards. No adverse effects on the ability of these bores to be used for irrigation purposes is anticipated as a result of the proposed stormwater discharge at the site.

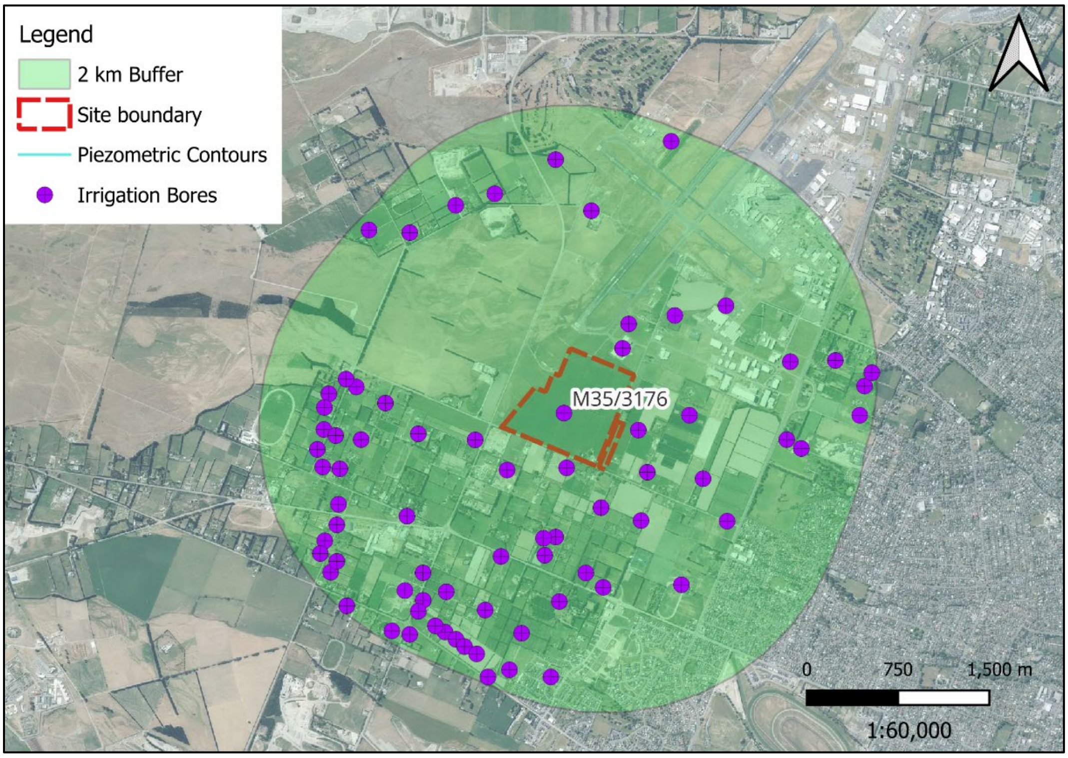

Figure 7: Irrigation Supply Bores within 2 km of the Site

4.4 Public Drinking Water Supply Sources

There are three public drinking water supply or small community water supply bores within a 2 km proximity of the site (Figure 4). As stated in Section 2.3.4, the 2 km buffer around the site overlaps with five CDWPZs.

Bore M35/3731 is a small community supply bore (24 m deep) located approximately 1.1 km southwest of the site. The bore and associated CDWPZ are considered upgradient of the site. Bores BX23/0430 andBX23/0428 (located within the 2 km buffer), in addition to BX23/0228 and M35/6040 (their CDWPZ's are intercepted by the 2 km buffer) are Christchurch City Council public drinking water supply bores. These bores are all located more than 1.3 km from the nearest site boundary. In addition, these bores are all deep ranging in depth between 132 m to 250 m and are screened within confined aquifers. Borelogs for these bores all show there are thick accumulations of fine-grained strata between the ground surface and the screen intervals in these bores which will impede the downward flow of surface derived contaminants to the gravel permeable gravel strata targeted by the well screens. Therefore, these bores are considered to be less sensitive to surface derived stormwater discharges.

4.5 Properties with Potential Supply Bore

A reticulated water supply is not available in the Yaldhurst area. Therefore, it is assumed that all dwellings near the site have or share one of the domestic supply bores shown on the ECan database (Figure 5).

5.0 Proposed Stormwater System Design

As outlined in the stormwater management technical assessment prepared by PDP (2025), the operational stormwater management plan proposes to provide treatment, attenuation and disposal to ground of all site run-off. The proposed stormwater system has been developed to isolate and filter clean contaminated run-off to efficiently manage, treat and dispose of run-off to ground.

The system will operate as follows:

- All run-off from roofed areas on each lot will be collected and be disposed to ground with no treatment by onsite soak pit(s) sized to accommodate the critical design event (identified to be the 3hr 2% annual exceedance probability (AEP) event).
- All other stormwater generated on each lot from hardstand areas will be directed to an onsite proprietary treatment device for treatment of the "first flush" flow prior to disposal to ground via a soak pit(s) sized to accommodate the critical design event. The first flush flow is the flow generated by up to a 5 mm/hr rainfall intensity on the catchment area.
- Run-off generated from road, footpath and berm areas will be collected in sumps and conveyed via a reticulated network for treatment in a first flush infiltration basin/soak pit system sized to accommodate 2% AEP flows. There are two proposed stormwater management areas (SMA), one to the north of the development, and one to the east.

The locations of the relevant stormwater catchments and SMAs are shown on the figure below.

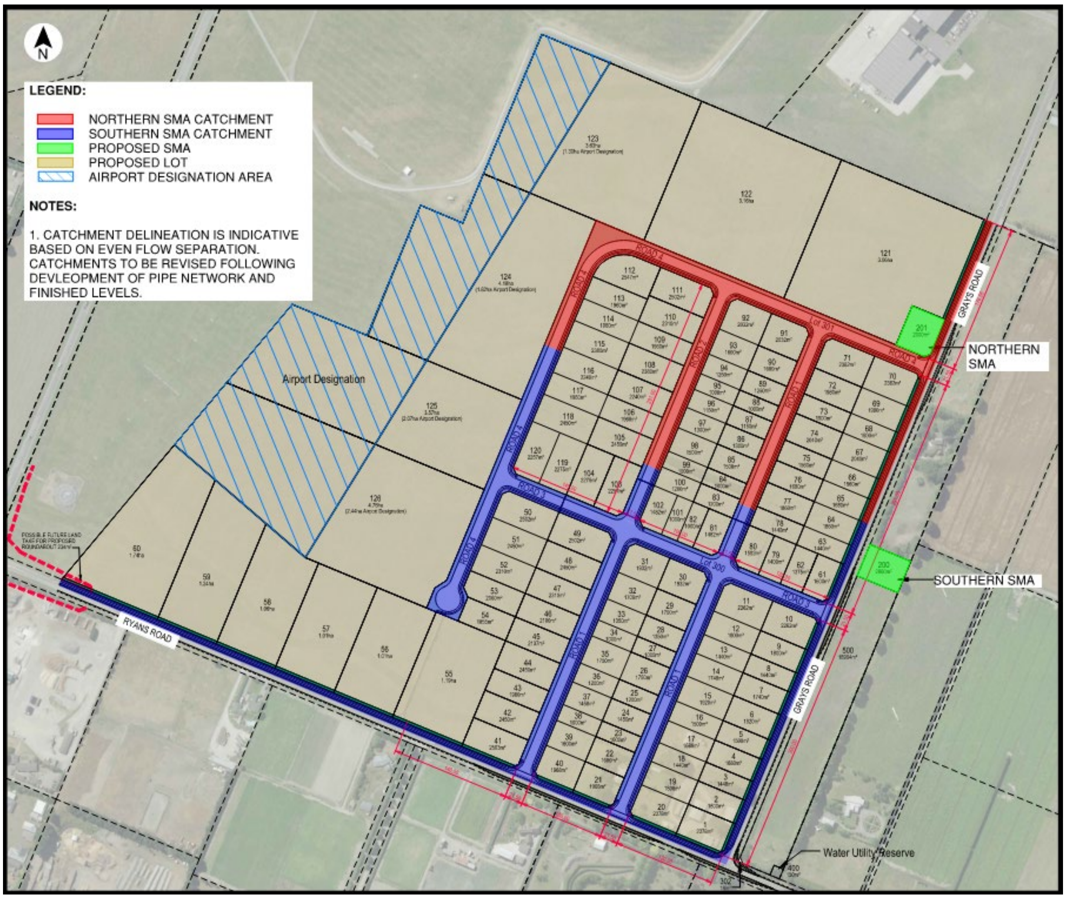

Figure 8: Lot designation for purpose of operational stormwater assessment (background layout plan courtesy of 'Capture Land Development Consultants')

6.0 Contaminant Transport Modelling

6.1 Microbial Transport Modelling Methodology

Microbial transport from the site has been modelled using the Microbial Risk Assessment tool developed by ESR (MRA Tool · Streamlit). The tool was developed for regional councils and organisations within New Zealand to make decisions regarding the management of activities near drinking water supply wells where the activities have the potential to pose a risk to drinking water quality.

The tool provides a distribution of initial concentrations for the microbial source of interest, which in this assessment the microbial source is *E. coli* which is an indicator of faecal contamination in all land-use scenarios. The tool provides the distribution of the log reduction in concentration based on soil type and depth, vadose zone material and depth (unsaturated), and transport and filtration through the aquifer (saturated zone). The output shows the resulting distribution of the total concentration at the bore compared to the MAV

(<1 MPN/100 mL) and probability of an exceedance of the MAV as a result of the proposed development.

Inputs into the tool have assumed low recharge rates (Climate Group G1) characteristic of Canterbury with an annual average recharge of 1.09 mm/day. Land use was set to 'Stormwater' which is described as combined sources of septage, sewage overflow, urban/agricultural runoff and animal faeces (including avian sources). The tool simulates a first flush discharge of stormwater to ground via soak pit. The pumping scenario is a single dwelling (nearest to the bore site). Alluvial gravels were selected for the aquifer and vadose materials, with a conservative vadose depth of 2 m selected on account of the soak pits being constructed to depths of up to around 5 to 6 m, a conservative mounding effect of around 3.7 m (as discussed in Section 7) and a maximum groundwater level of around 11.5 m bgl. In reality, the maximum mounding effect during a 24-hour 2% AEP storm event is more likely to be around 2.4 m or less based on aquifer test data near the site.

For this assessment, stormwater disposal to ground has been assessed as a point source, with distance to the nearest receptor taken from the nearest boundary.

6.2 Modelling Results

The modelling indicates that infiltration through the vadose zone is likely to achieve a log reduction of 1.4 to 2.2, and transport through the aquifer is likely to achieve a log reduction of 2.5 to 4.7, and minimal reductions achieved by filtration through the aquifer. The total log reduction distribution ranges between 4.1 and 7.2.

The nearest downgradient receptor is bore M35/9627 which is located 37 m from the site boundary (Figure 5). The tool shows that the probability of the *E. coli* concentration exceeding the MAV (<1 MPN/100 mL) at the bore as a result of the proposed development is 0.04 %. The probability of the *E. coli* concentration exceeding the MAV will decrease with distance from the site as transport through the aquifer increases. As such, the probability of *E. coli* concentrations exceeding the MAV (<1 MPN/100 mL) at the public drinking water supply bores located greater than 1 km downgradient is expected to be 0 %.

The nearest cross-gradient receptor is bore M35/3220 which is 40 m from the site, perpendicular to the groundwater flow direction. The tool shows that the probability of the *E. coli* concentration exceeding the MAV (<1 MPN/100 mL) at the bore as a result of the proposed development is 0 %. In reality, the soak pits and SMA basins are likely to have an underlying filter media or soil. This was not included in the modelling due to uncertainty of the media type and depth. The media would provide further reductions to bacterial concentrations.

Based on the above, private bores and public drinking water supply bores are unlikely to be adversely affected as a result of the stormwater discharge.

6.3 Metals and Hydrocarbons

Table 4 below shows the expected concentrations for metals that are present in the stormwater runoff. The metals concentrations presented below have been derived from several sources of information as presented in the associated stormwater management technical assessment (PDP, 2025). These concentrations represent the stormwater runoff prior to treatment. As discussed in the associated stormwater management technical assessment, these concentrations are expected to further reduce through the treatment process prior to disposal to ground. The expected total metal concentrations have been compared to the relevant MAV, AV, and Schedule 8 LWRP groundwater quality limits in the following table.

Table 4: Stormwater concentrations for total metals (mg/L)

Parameter	Expected Concentration[1]	DWSNZ 2022 MAV[2]	Taumata Arowai 2022 AV[3]	Schedule 8 LWRP[4]
Chromium	0.0023	0.05	-	0.0025
Copper	0.015	2	≤ 1	1
Lead	0.0037	0.01	-	0.005
Zinc	0.67	-	≤ 1.5	

Notes:

1. *1.Expected metal concentrations from NIWA Urban Runoff Quality Information System (2012), and provided in Table 1, Appendix A of Stormwater Management Technical Assessment (PDP, 2025).*
2. *Water Services (Drinking Water Standards for New Zealand) Regulations 2022 health based Maximum Acceptable Value (MAV).*
3. *Taumata Arowai Aesthetic Values for Drinking Water Notice 2022.*
4. *Schedule 8 CLWRP groundwater quality limits set to <50 % of the MAV.*

As shown in the table above, the expected total concentrations in the untreated stormwater runoff for chromium, copper, lead and zinc are all well below the relevant MAV and/or AV prior to treatment. The expected concentrations are also below the Schedule 8 LWRP groundwater quality limits which are < 50 % of the MAV. The concentrations of metals can be expected to reduce further post treatment based on the basins and treatment devices achieving the removal rates presented in Table 1 of the stormwater management technical assessment.

The DWSNZ 2022 does not set MAVs for total petroleum hydrocarbons (TPH) or total polycyclic aromatic hydrocarbons (PAH). The literature cited in the stormwater management technical assessment notes that concentrations of TPH and PAH were typically below the detection limits of the respective tests.

Additionally, the proprietary treatment devices proposed to be installed on the individual lots have estimated TPH and PAH removal rates of 90 % to 100 %.

Recommendations for stormwater monitoring have been provided to Carters Group Ltd in a separate document.

As such, no effects on groundwater users from metals or hydrocarbons are expected as a result of the discharge.

7.0 Mounding Assessment

Post development, stormwater disposal to ground will be concentrated at stormwater basins and at roof soak pits on individual lots, rather than spread across the site as in the pre-development case. This means there will likely be localised mounding of the groundwater table beneath the disposal areas. If the mounding is too great, then the ability for stormwater to be adequately disposed of can be compromised. This section describes the PDP assessment of mounding due to stormwater disposal from the proposed stormwater design.

Infiltration testing (Tetra Tech Coffey, 2024) for the development indicated that infiltration rates of 600 mm/hr are expected to be achievable across the site with sufficient embedment into the gravel layer. Permeable strata limits groundwater mounding from stormwater discharges. It is expected that any change in groundwater levels will be localised around the locations of the stormwater basins and soak pits, and will primarily be for short durations following storm events.

The key issue of concern would be if the stormwater discharge caused groundwater levels to rise to or near to the base of the stormwater disposal infrastructure, therefore reducing the capacity of the systems to discharge to ground. This is considered unlikely based on the high reported infiltration rates in this area and the expected depth to groundwater (11.5 to 19 m bgl). It is recommended that a suitably qualified geotechnical expert is to be engaged to observe that construction of disposal systems (soak pits) is such that the systems are sufficiently embedded into the gravel layer within the “target soakage layer” (Tetra Tech Coffey, 2024).

7.1 Methodology

Mounding assessments have been undertaken using the solution developed by Hunt (2012) to simulate mounding within an unconfined aquifer. The assessments included the following components:

- Long-term mounding effects due to infiltration of stormwater from individual lots as well as from roadways across the site via infiltration basins (assessed using an annual average rainfall of 650 mm/year).

- Short-term mounding due to a 24-hour 2% AEP storm event, due to infiltration of stormwater from individual lots across the site and from roadways across the site via infiltration basins.

The mounding was assessed across rectangular areas for each of the proposed SMAs (Figure 7), which have infiltration basin dimensions of 37 m x 37 m (1,369 m^2) and 44 m x 43 m (1,892 m^2).

For the scenarios assessing infiltration of stormwater from individual lots, the approximate dimensions of the whole subdivision were used (rather than assessing individual lot soak pits), with simplified dimensions of 694 m x 694 m. This assessment excludes the SMA catchment areas which are assessed for each SMA described above.

7.2 Mounding Assessment Results

Based on potential aquifer parameters from nearby pumping tests and the soakage tests undertaken by Tetra Tech Coffey, mounding was assessed for a range of transmissivities from 3,500 m^2/day to 500 m^2/day. The mounding estimates are provided in Table 4.

Transmissivity values are available from the ECan well database for pumping tests conducted in the wider area. The tests indicate that the gravelly strata in the area is generally highly permeable with transmissivities of 1,200 to 3,500 m^2/day (Section 2.3.2). It is considered that transmissivities in the order of this range are most likely to be representative of conditions on site.

While the infiltration rates cannot be directly converted to hydraulic conductivity, they can be used to give an indication of hydraulic conductivity. The geotechnical investigation undertaken by Tetra Tech Coffey indicates an expected average infiltration rate of 600 mm/hour across the site (or 14.4 m/day). Assuming that the infiltration rate could be proportional to hydraulic conductivity, assuming a hydraulic gradient of 1, and based on the thickness of the Riccarton Gravels and typical groundwater levels, a ball-park transmissivity of approximately 500 m^2/day can be estimated. It is noted that this transmissivity value is expected to be conservatively low, and the lower transmissivity value from the nearby aquifer test data is more realistic (i.e. 1,200 m^2/day). However, a lower bound transmissivity of 500 m^2/day has also been included to add conservatism to the assessment, along with the range of transmissivity values derived from the nearby aquifer tests.

Given the distance between the two SMA infiltration basins (~180 m), the groundwater mounding from each basin is not expected to intersect during a 24-hour rainfall event based on the modelling results. As such, the contribution of mounding for each individual infiltration basin has been summed with the mounding from the individual lots separately (given the individual lots are widely distributed, so the mounding effect can be superimposed on the mounding effect from each of the SMAs). The annual groundwater mounding effects are more widespread, and as such, the mounding contribution has been summed for all disposal sources for this scenario. The results are presented in the following table.

Table 5: Mounding Estimates

Mounding contribution	Mounding (m)		
	T = 3,500 m^2/day	T = 1,200 m^2/day	T = 500 m^2/day
Annual mounding from SMA North	0.013	0.036	0.080
Annual mounding from SMA East	0.021	0.057	0.126
Annual mounding from individual lots	0.121	0.292	0.583
24-hour 2% AEP event – SMA North	0.34	0.83	1.65
24-hour 2% AEP event – SMA East	0.55	1.32	2.60
24-hour 2% AEP event – individual lots stormwater	0.92	1.06	1.07
Combined SMA North + Lots (24 h rainfall)	**1.26**	**1.89**	**2.72**
Combined SMA East + Lots (24 h rainfall)	**1.47**	**2.38**	**3.67**
Total combined mounding (Annual)	**0.16**	**0.39**	**0.79**

The cumulative mounding effect in a 24-hour rainfall event under the lowest transmissivity scenario at SMA East is approximately 3.67 m. For SMA North the mounding is expected to be up to around 2.72 m. Given the shallowest depth to groundwater is estimated to be 11.5 m and the infiltration basins are expected to be up to around 5 to 6 m deep, the short-term mounding 24-hour 2% AEP storm event is not expected to impact the ability for stormwater to infiltrate into the strata below. Similarly, the cumulative long-term mounding effects for all disposal points on an annual basis is approximately 0.8 m which is not expected to cause any issues for stormwater disposal.

As stated above, transmissivity of the gravelly strata is more likely to be in the range of 1,200 to 3,500 m^2/day. The results for these scenarios indicate that mounding is not expected to be a concern, with mounding during a 24-hour 2% AEP storm event between 1.47 and 2.38 m at SMA East and between 1.26 and 1.89 m at SMA North.

Overall, the results indicate that mounding at the site is not expected to be of concern.

8.0 Summary

This report describes the potential effects of stormwater discharge on downgradient groundwater receptors, specifically domestic supply bores. In addition, we have assessed the ability for the disposal of stormwater at the site through the unsaturated zone to groundwater.

Groundwater contaminant transport modelling was completed for bacteria using the ESR Microbial Risk Assessment tool for modelling bacteria. Concentrations of bacterial contamination such as *E. coli* are expected to have a 0.04 % chance of exceeding recommended guidelines in the closest downgradient domestic supply bore. Downgradient public water supply bores are not likely to be affected. Concentrations of metals are not expected to exceed the MAV in domestic supply bores downgradient of the stormwater discharge locations, based on the untreated metal concentrations meeting or being less than the relevant MAV and/or AV.

The mounding assessments undertaken indicate that the disposal of stormwater to ground at the site is not expected to be inhibited by groundwater mounding effects.

9.0 References

Hunt, B. (2012). *Groundwater Analysis Using Function.xls.* Christchurch: University of Canterbury.

Microbial Risk Assessment Tool. (n.d.). Retrieved from ESR: https://mra-tool-nz.streamlit.app/

Tetra Tech Coffey. (2025). *Geotechnical Assessment Report - Ryans Road Fast Track.*

Appendix A: Bore Logs

Appendix B: Qualifications of Report Contributors

Table B1: Report Contributors Qualifications and Experience	
Eoghan O'Neill	Eoghan is a Technical Director with Pattle Delamore Partners Ltd and has been employed in that capacity since October 2012. He is a Chartered Professional Engineer with approximately 25 years' experience in the planning and design of wastewater, water supply and stormwater infrastructure. He holds Bachelor of Engineering and Master of Engineering Science degrees awarded by University College Dublin. Much of Eoghan's experience is related to the planning of infrastructure to facilitate development in New Zealand. He has prepared and presented evidence to Plan Change Hearings, Resource Consent Hearings and the Environment Court on numerous occasions
Carl Steffens	Carl is a Technical Director – Water Resources at Pattle Delamore Partners Ltd. His qualifications are Post Graduate Diploma in Science (Engineering Geology) and Bachelor of Science (Geology) from the University of Canterbury and he is a member of the New Zealand Hydrological Society. With over 20 years of professional work experience as a hydrogeologist, Carl specialises in groundwater assessments and has broad experience in hydrogeological field testing, monitoring and sampling, data interpretation/analysis, analytical and numerical modelling and reporting. Carl has prepared Assessment of Environmental Effects (AEE) reports for consent applications and reviewed applications of others on behalf of regional councils throughout NZ. He has presented evidence as an expert witness at various hearings, including for arbitration disputes.

Table B1: Report Contributors Qualifications and Experience	
Nic Love	Nic is a Service Leader (Hydrogeologist) in the Water Resources team at Pattle Delamore Partners Ltd. He holds the qualifications of Bachelor of Science (Geology) and a Professional Master of Engineering Geology (PMEG), both from the University of Canterbury, and is a member of the New Zealand Hydrological Society. Much of Nic's experience has related to groundwater resource investigations in alluvial aquifers, including assessments of environmental effects for resource consent applications. Nic's work experience relevant to this application includes the analysis and interpretation of numerous pumping tests, assessments of contaminant transport in groundwater, and groundwater mounding assessments for consent applications to authorise the discharge of stormwater or wastewater to land. He has been involved with a large number of groundwater investigations and resource consent applications within the Canterbury region, including the local Christchurch area in which this application is situated. Therefore, he is very familiar with the local hydrogeology of the area.
Alesha Watkins	Alesha is an Environmental Scientist in the Water Resources team at Pattle Delamore Partners Ltd. She holds a Bachelor of Science (Technology) in Earth Sciences from the University of Waikato and is a member of the New Zealand Hydrological Society. Alesha has over five years' experience in environmental monitoring and compliance across roles in consulting and local government. She has been involved with water quality investigations and assessments of contaminant transport in groundwater. She has undertaken technical reviews of resource consent applications for discharges to land on behalf of regional councils and has prepared Assessment of Environmental Effects (AEE) reports.