Groundwater Take Assessment

Tauriko West - Tupenga

WWLA1621 | Final

24 July 2026

Tauriko West - Tupenga

Project no:	WWLA1621
Revision:	Final
Date:	24 July 2026
Client name:	CMW Geosciences
Project manager:	Jon Williamson
Author(s):	Asanka Thilakerathne
File name:	G:\Shared drives\Projects\CMW Geosciences\WWLA1621_Tauriko West_Groundwater Assessment\Deliverables\Reports\Groundwater Take\Final\WWLA Report_Groundwater Take Effect Assessmenet_Final_240726.docx

Williamson Water & Land Advisory

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New Zealand
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Qualifications, Experience and Code of Conduct

The qualifications and experience of the author and technical director/reviewer of this report are summarised below. We confirm that we have read the Code of Conduct for Expert Witnesses contained in the Environment Court of New Zealand Practice Note 2023 and we agree to comply with it. We confirm that the issues addressed in this report are within our area of expertise, except where we state that we are relying on the evidence or advice of another person. We have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this report.

Report Author

Asanka Thilakerathne is an Intermediate Hydrogeologist. He has been employed at WWLA since February 2024 and has 13 years of professional experience as a Hydrogeologist. His expertise includes groundwater management, groundwater modelling, geophysical exploration, groundwater recharge, borehole construction and test pumping.

Asanka's qualifications include a Bachelor of Science in Geology from University of Peradeniya, Sri Lanka, completed in 2007 and a Master of Science in Hydrogeology and Environmental Management from the Technical University of Darmstadt in Germany completed in 2013. He also holds a certificate in Numerical Groundwater Modelling from IHE Delft Institute for Water Education in Netherlands, completed in 2019.

Signed: [redacted] **Date:** 24 July 2026

Report Reviewer

Jonathan (Jon) Williamson is the Managing Director of WWLA with over 31 years of professional experience in New Zealand and Australia. He holds a BSc in Earth Science and an MSc (Tech) 1st Class Honours in Hydrology and Geology from the University of Waikato. His career includes 15 years in senior roles at SKM (now Jacobs) and extensive international consultancy in the mining and municipal sectors.

Jon specialises in hydrogeology, hydrology, and stormwater engineering. His project experience includes technical reviews and expert dewatering, groundwater, surface water and wetland impact assessments for high-profile infrastructure such as the Puhoi to Warkworth, and Otaki to North of Levin highways, Victoria Park Motorway Tunnel, the Waterview Motorway Tunnel, and Central Interceptor Sewage scheme. He has provided specialist assessments for numerous major mines (including Oceana Gold, Rotowaro Coal, Pike River Coal, and Southland Lignite) and large-scale quarries (such as Drury, Kings, Taharoa, and Ihumatao).

Signed: [redacted] **Date:** 24 July 2026

Contents

1. Introduction

1.1 Overview

Williamson Water & Land Advisory (WWLA) was commissioned to prepare this groundwater take assessment report for the Tauriko West - Tupenga project (the Project).

The assessment supports a resource consent application to Bay of Plenty Regional Council (BOPRC) for the temporary take and use of groundwater during construction. The groundwater take is sought for a maximum daily volume of 900 m^3/day, with a maximum annual take of 160,000 m^3/year, to provide construction water for the Project.

Four bores are proposed to be installed along the Project route to supply groundwater for use during construction works. The proposed bore locations shown in **Figure 1** are approximate only and will be refined during detailed design and construction planning. The indicative bore locations have been determined with consideration of potential construction access requirements and the availability of land for associated storage tanks. Bores 2 and 3 are located in close proximity, with a separation distance of approximately 125 m.

1.2 Applicant and Property Details

Table 1. Indicative Bore Locations and Property Details.

Bore Location	Bore 1	Bore 2	Bore 3	Bore 4
Site address	4 Redwood Lane	n/a	n/a	764 State Highway 29
Site area (ha)	3.43	2.94	2.4	32.26
Legal Description	Lot 2 DPS 70631	Section 12 SO 476780	Section 13 SO 476780	Pt Allotment 86 Te Papa PARH
Easting	1871014	1873809	1873929	1872887
Northing	5817139	5819134	5819105	5818562

1.3 Background

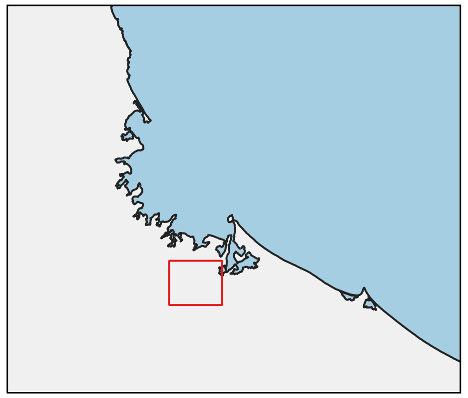
The indicative bore specimen design details are included in **Appendix A** and comprise the following:

- a bore casing diameter of 150 mm;
- a casing depth of 80 m (cement grouted in place); and
- an open hole from 80 m to the base of bore, which is anticipated to be up to 180 m (subject to nature of materials encountered).

Map Title:
Location Map

Project:
Tauriko West Groundwater Take

Client:
CMW Geosciences



Legend

- Indicative Bores
- Land Parcels
- Centerline SH29
- Centerline SH29A

Top Level Basemap Data

- Roads
- State Highway
- Rivers/Streams
- Lake/Pond
- Wetlands (mapped)

Data Provenance
Aerial Imagery from Land Information New Zealand

Drawn by: Asanka Thilakerathne
09/07/2026

Layout & Project File
Surface Water

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Figure 1

2. Environmental Setting

2.1 Site Location and Description

The surrounding land uses comprise a mix of urban residential, horticultural, lifestyle, agricultural, and industrial/commercial activities. Existing residential dwellings are located on both sides of the proposed road corridor, and further residential development is proposed within the Tauriko West Urban Growth Area (**Figure 1**).

2.2 Geology

A detailed description of the geology of the area is provided in the Tauriko West Groundwater Assessment Report[1]. In summary, the Project area is situated within the Tauranga Basin, which is a complex structural depression partially infilled by a sequence of terrestrial and estuarine sediments, and overlying volcanic ashes. The surface geology is mapped by Geological and Nuclear Sciences[2] as presented in **Figure 2.** Recent geotechnical drilling data[3] indicates that the overlying materials at the indicative bore locations consist predominantly of sand, with minor interbedded layers of clay and silt.

[1] Preliminary Groundwater Assessment, Tauriko West - Tupenga (WWLA1621) ,02 July 2026.
[2] Leonard, G.S.; Begg, J.G.; Wilson, C.J.N. (compilers) 2010. Institute of Geological & Nuclear Sciences 1:250 000 geological map 5. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences Limited.

[3] BECA geotechnical borehole logs SH29 Tauriko West

Map Title:
Geology Map

Project:
Tauriko West Groundwate Take

Client:
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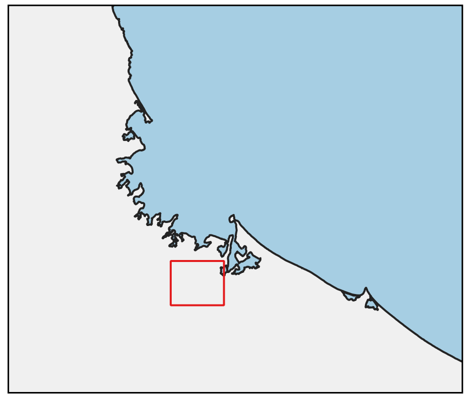

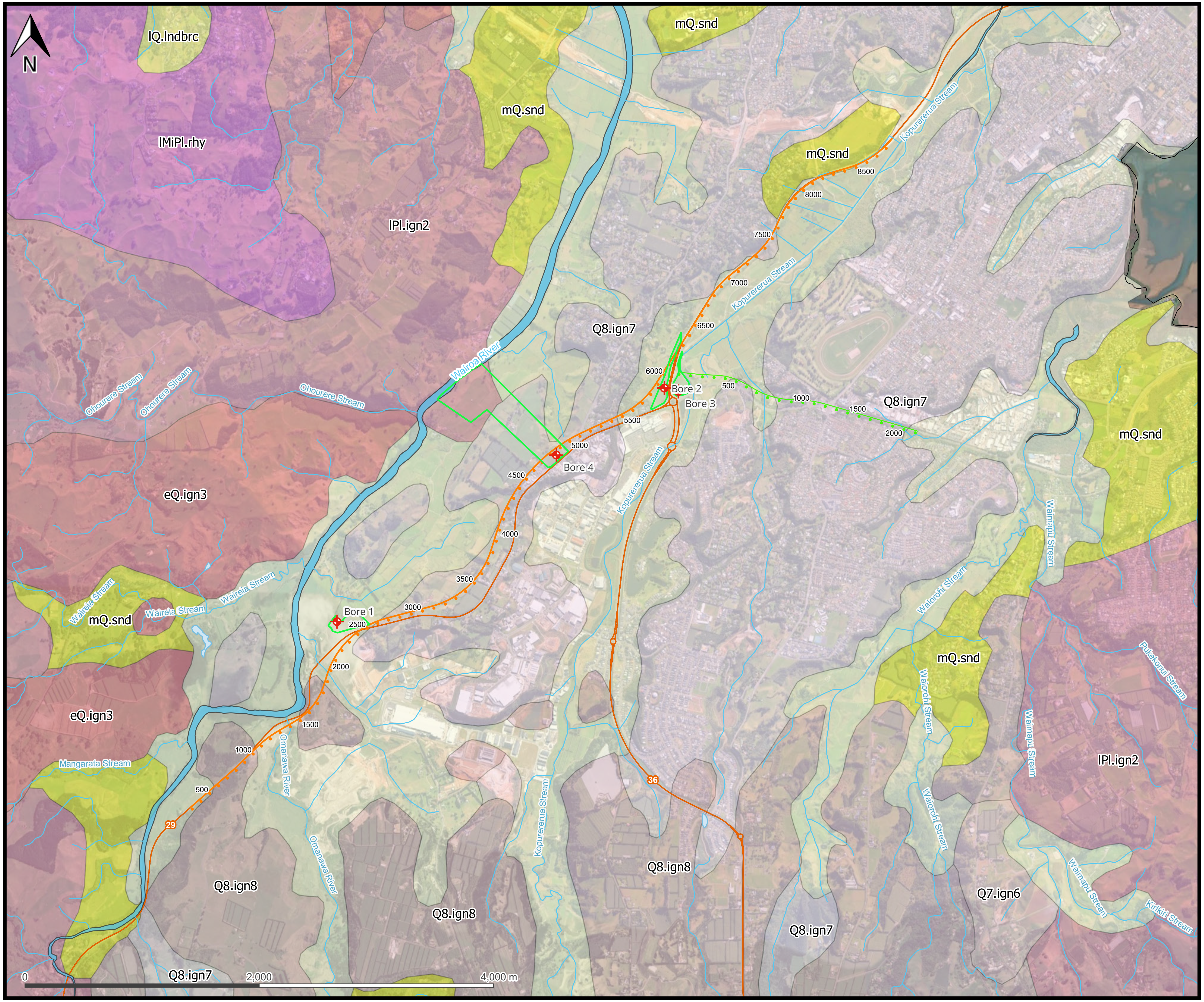

Legend

Indicative Bores	
Land Parcels	
Centerline SH9	
Centerline SH29A	

Top Level Basemap Data

State Highway	
Rivers/Streams	
Lake/Pond	

Geological Units

Q1.alvgvl (gravel)	
Q8.ign7 (ignimbrite)	
Q8.ign8 (ignimbrite)	
eQ.ign3 (ignimbrite)	
lPl.ign2 (ignimbrite)	
mQ.snd (gravel)	

Data Provenance
Aerial Imagery from Land Information New Zealand

Drawn by: Asanka Thilakerathne
07/07/2026

Layout & Project File
Surface Water

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Figure 2

2.3 Geomorphology

The Tauriko area is characterised by gently undulating to rolling topography comprising volcanic ash-derived terraces and dissected hills. The landforms have developed through a combination of volcanic deposition, tectonic uplift, and fluvial erosion. Stream valleys and localised alluvial deposits occur along waterways, while elevated terrace surfaces dominate the surrounding landscape. These geomorphic features are typical of the western Tauranga area and reflect the influence of the wider Taupō Volcanic Zone.

The Project traverses gently rolling terrain. Along SH29, ground elevations range from a maximum of approximately 62.4 mAMSL to a minimum of about 0.7 mAMSL. Along SH29A, elevations range from approximately 46.3 mAMSL to 3.4 mAMSL

2.4 Hydrogeology

The hydrogeology of the Tauriko area is influenced by a sequence of volcanic and sedimentary deposits that form generally low- to moderate-yield groundwater systems. The area is underlain predominantly by weathered rhyolitic tephra, ignimbrite, and alluvial deposits associated with the Wairoa River catchment, overlying older sedimentary basement rocks. A detailed description of the hydrogeological characteristics of the area is provided in the Tauriko West Groundwater Assessment Report[4].

2.5 Surface and Groundwater Connectivity

2.5.1 Wetlands

The wetlands identified for the Project[5] are shown in **Figure 1**. A total of 38 wetlands have been mapped, and their potential connectivity to the groundwater system has been assessed using the criteria summarised in **Table 2**.

Depth to groundwater was determined by comparing LiDAR-derived ground surface elevations with simulated post-construction groundwater levels extracted from the groundwater model developed for the Project.

The assessed wetlands and their inferred groundwater connectivity are summarised in **Table 3**. Of the 38 wetlands, 21 are considered groundwater fed and a further 8 are consider potentially groundwater fed.

Table 2. Wetland Classification.

Depth to Groundwater	Wetland Type
<1 mBGL	Groundwater fed wetland
1 - 3 mBGL	Potentially groundwater fed wetland1
>3 mBGL	Surface water fed wetland

Table 3. Wetland Connectivity to Groundwater or Surface Water Systems.

Wetland	Area (m²)	Surface Elevation (mAMSL)	Pre-construct Groundwater Level (mAMSL)	Depth to Groundwater (m)	Wetland Classification
Wetland 13	336,009	1.41	1.24	0.17	Groundwater Fed
Wetland 13	30,213	2.58	2.38	0.20	Groundwater Fed
Wetland 13	142,253	2.61	2.31	0.29	Groundwater Fed
Wetland 11	413	4.18	3.88	0.30	Groundwater Fed
Wetland 15a	33,707	3.57	3.16	0.41	Groundwater Fed

[4] Preliminary Groundwater Assessment, Tauriko West - Tupenga (WWLA1621) ,02 July 2026.
[5] Boffa Miskel, SH29 Tauriko West Improvements, Wetland Values, Rev.2, 19 June 2026.

Wetland	Area (m²)	Surface Elevation (mAMSL)	Pre-construct Groundwater Level (mAMSL)	Depth to Groundwater (m)	Wetland Classification
Wetland 10a.2	2,458	3.49	3.08	0.41	Groundwater Fed
Wetland 6	3,889	15.33	14.90	0.43	Groundwater Fed
Wetland 14b	5,104	3.06	2.62	0.44	Groundwater Fed
Wetland 14a	4,602	3.40	2.93	0.47	Groundwater Fed
Wetland 10a.1	9,396	4.28	3.77	0.52	Groundwater Fed
Wetland 9a	546	9.91	9.34	0.57	Groundwater Fed
Wetland 10b	4,577	3.45	2.85	0.59	Groundwater Fed
Wetland 10a.5	771	3.89	3.26	0.63	Groundwater Fed
Wetland 10a.4	309	3.45	2.82	0.63	Groundwater Fed
Wetland 15b	3,872	3.52	2.87	0.65	Groundwater Fed
Wetland 12	375	3.09	2.40	0.68	Groundwater Fed
Wetland 16	1,979	3.57	2.84	0.73	Groundwater Fed
Wetland 10a.3	774	3.48	2.75	0.74	Groundwater Fed
Wetland 3a	873	11.63	10.89	0.74	Groundwater Fed
Wetland 2a	327	5.28	4.47	0.81	Groundwater Fed
Wetland 5d	4,537	14.08	13.25	0.83	Groundwater Fed
Wetland 9a	11,020	8.34	7.21	1.13	Potential Groundwater Fed
Wetland 12	212	4.27	2.82	1.44	Potential Groundwater Fed
Wetland 5a	328	16.12	14.64	1.48	Potential Groundwater Fed
Wetland 1	4,658	6.59	5.08	1.51	Potential Groundwater Fed
Wetland 4	2,811	14.85	13.05	1.80	Potential Groundwater Fed
Wetland 2b	894	7.79	5.95	1.84	Potential Groundwater Fed
Wetland 5b	93	19.06	16.07	2.99	Potential Groundwater Fed
Wetland 9b	1,812	12.09	9.10	2.99	Potential Groundwater Fed
Wetland 8	1,813	17.49	14.27	3.22	Surface Water fed
Wetland 5c	459	21.02	17.06	3.96	Surface Water fed
Wetland 3b	81	19.98	15.56	4.42	Surface Water fed
Wetland 17a	697	7.42	Not Available	Not Available	Not Available
Wetland 7d	444	27.00	16.43	10.57	Surface Water fed
Wetland 7b	104	26.12	14.37	11.75	Surface Water fed
Wetland 17b	655	11.90	Not Available	Not Available	Not Available
Wetland 7c	190	27.96	15.38	12.58	Surface Water fed
Wetland 7a	208	28.73	12.97	15.76	Surface Water fed

The potential effects of groundwater abstraction from the proposed bores on the 29 groundwater fed or potentially groundwater supported wetlands has been assessed in **Section 4.1.3**.

2.5.2 Streams

The nearest streams to bores 1, 2, 3, and 4 are located approximately 215 m, 200 m, 110 m, and 170 m from the respective bore sites (**Figure 3**). Based on the local geological conditions, streams located near bore 1 and

4 are considered likely to be ephemeral, which means they experience periods of no flow during summer periods. The Kopurererua Stream near bore 2 and 3 is a perineal stream. The occurrence of thin low permeability clay rich paleosols within the area is likely to restrict hydraulic connectivity between the deeper groundwater and surface water features, but is unlikely to be prevalent enough to separate shallow groundwater from surface water.

2.6 Surrounding Bore and Water Take

A review of bore logs provided from the BOPRC database[6] for bores confirmed there are 28 bores within 1 km radius of the indicative bore locations (**Figure 3**). The bore logs also indicate some of them are constructed for geotechnical investigations (**Table 4**).

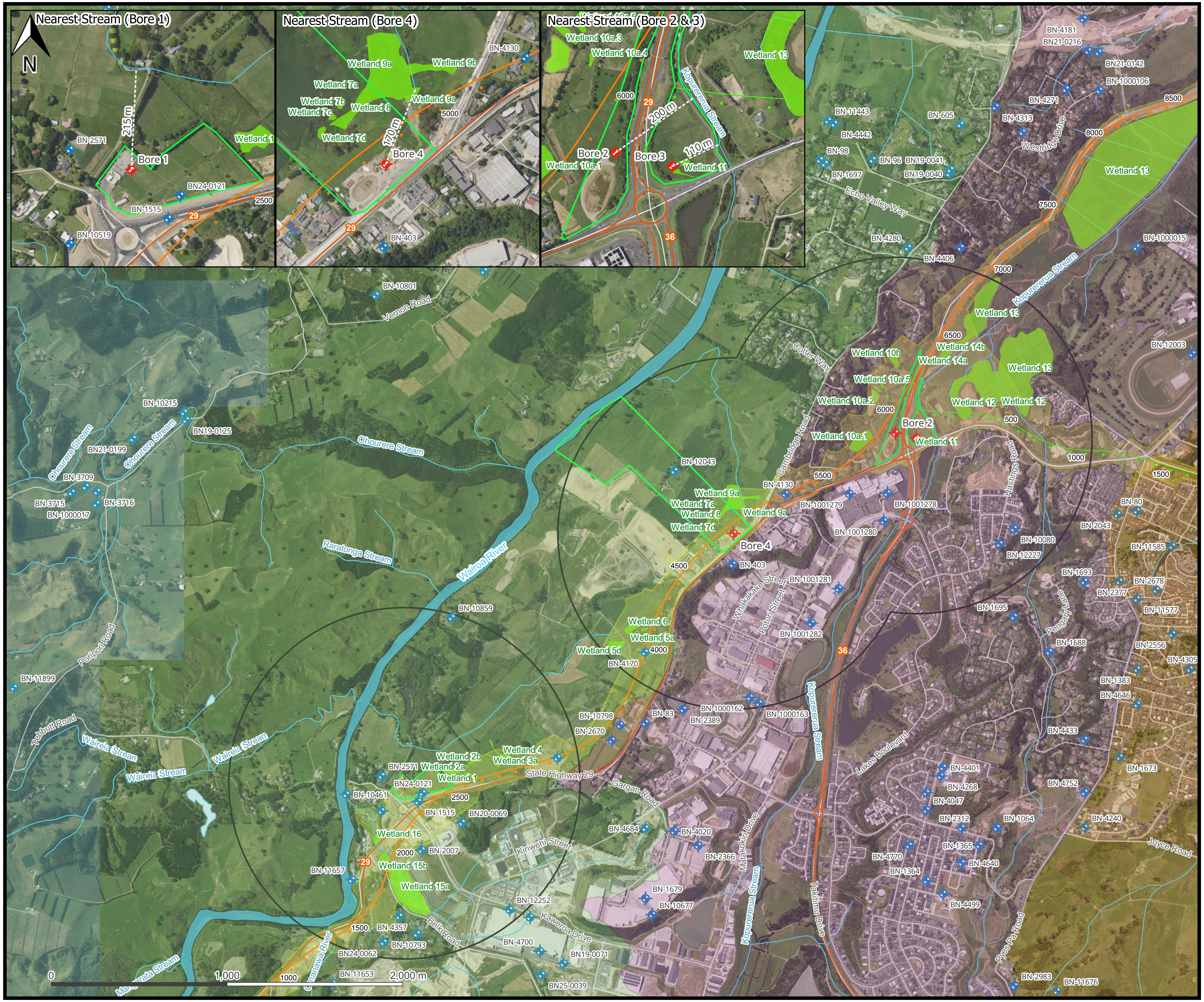
The potential effects of the proposed groundwater take on other groundwater users are discussed further in **Section 4.1.1.2.** Based on information obtained from the BOPRC groundwater database, all of the 28 bores listed below are classified as cold-water bores. Bores BN-1515, BN-4130, BN-4170, BN-4434, and BN24-0121 are located within the Project designation footprint and are expected to be acquired as part of the Project.

Table 4. Details of the Bores within 1 km Radius of Proposed Production Bores

Council Bore ID	Depth (m)	Diameter (mm)	Static Water Level (mBGL)	Drilling Date	Nearest Bore.		Bore Use	Designation Footprint
					Indicative Bore	Distance (m)		
BN24-0121	186	100	8.7	19/06/2024	Bore 1	117	Production	Yes
BN-1515	134	100	10.4	7/09/1983	Bore1	130	Production	Yes
BN-2571	73	100	11	18/04/1991	Bore 1	137	N/A	No
BN-403	100	100	10.67	25/08/1979	Bore 4	176	N/A	No
BN-10519	48	100	1.5	6/06/2003	Bore 1	204	N/A	No
BN24-0168	5	50	3.34	19/11/2024	Bore 3	329	Geotechnical	No
BN-10461	21	100	3.4	10/11/2002	Bore 1	337	N/A	No
BN-1001278	26	N/A	2.6	23/09/2013	Bore 2	346	Geotechnical	No
BN-4130	N/A	N/A	N/A	4/10/1983	Bore 4	372	N/A	Yes
BN-2007	90	100	3.6	11/01/1986	Bore 1	392	N/A	No
BN20-0069	28	100	15.9	26/05/2020	Bore 1	397	Production	No
BN-1001279	18	0	3.2	23/09/2013	Bore 2	435	Geotechnical	No
BN-12043	232	100	49	11/12/2012	Bore 4	490	Production	No
BN-1001280	17	N/A	4.1	24/09/2013	Bore 2	506	Geotechnical	No
BN-11657	73	N/A	4	22/01/2009	Bore 1	625	Production	No
BN-1001282	19	N/A	4.1	25/09/2013	Bore 4	676	Geotechnical	No
BN-1001281	18	N/A	4.6	25/09/2013	Bore 4	676	Geotechnical	No
BN-10080	63	100	36	16/11/2000	Bore 3	758	Production	No
BN-4357	N/A	N/A	0	9/07/1984	Bore 1	758	N/A	No
BN-12227	64	100	35.6	20/02/2012	Bore 3	767	Production	No

[6] Email conversation – [redacted], Environmental Data Analys, Bay of Plenty Regional Council (23 March 2026).

Council Bore ID	Depth (m)	Diameter (mm)	Static Water Level (mBGL)	Drilling Date	Nearest Bore.		Bore Use	Designation Footprint
					Indicative Bore	Distance (m)		
BN-4170	49	75	21	6/10/1985	Bore 4	843	N/A	Yes
BN-10793	26	100	3.9	14/08/2007	Bore 1	860	N/A	No
BN-4434	75	N/A	17	16/07/1983	Bore 1	883	N/A	Yes
BN24-0062	144	100	37.25	24/06/2024	Bore 1	913	Production	No
BN-12252	28	100	18	11/03/2013	Bore 1	936	Production	No
BN-1000162	12	50	5.8	7/09/2014	Bore 4	937	Investigation	No
BN-1000163	12	50	5.9	7/09/2014	Bore 4	977	Investigation	No
BN-10859	50	100	16	20/06/2004	Bore 1	981	Production	No



Map Title:
Surrounding Bores and Groundwater Management Zones

Project:
Tauriko West Groundwater Take

Client:
CMW Geosciences

Legend

- Indicative Bores
- Surrounding Bores
- 1 km Buffer
- Land Parcels
- Centerline SH29
- Centerline SH29A

Top Level Basemap Data

- Roads
- State Highway
- Rivers/Streams
- Lake/Pond
- Wetlands (mapped)
- Project Designation Extent

Groundwater Management Units

- Kopurererua-Otumoetai
- Waimapu-Tauranga
- Wairoa Lower

Data Provenance
Aerial Imagery from Land Information New Zealand

Drawn by: Asanka Thilakerathne
09/07/2026

Layout & Project File
Surface Water

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Figure 3

3. Description of Proposed Activity

3.1 Overview

It is proposed to abstract up to 900 m³/day, with an annual take of up to 160,000 m³/year of groundwater from four bores (refer Section **1.3**) within the Wairoa Lower and Kopurererua-Otumoetai Groundwater Management Zones to provide construction water for the Project mainly during the driest months of the year (November to April). However, flexibility is required for the occasional dry period that may occur outside these months, and this can be managed within the annual volume limit.

3.2 Water Use Requirement and Efficiency

An annual groundwater allocation of 160,000 m³/year is sought to supply water for the construction activities, including dust suppression and irrigation of landscape planting.

The Project has an estimated peak daily water demand of approximately 225 m³/day from each bore, equivalent to an abstraction rate of approximately 2.6 L/s.

The Project recognises the importance of efficient water use and minimising wastage. Accordingly, the following water conservation measures will be implemented:

- ***Regular maintenance*** – Pumping systems and other water-use infrastructure will be regularly inspected and maintained to minimise leaks and optimise operational efficiency.
- ***Water monitoring*** – Each groundwater take will be fitted with a volumizing water meter at the bore headworks. The Contractor responsible for the bore will measure the meter daily when in use and maintain a record of the meter readings.
- ***Water storage*** – Approximately 2,000 m³ of storage capacity will be provided near each bore location to ensure an adequate water supply for construction activities and to provide operational flexibility.

4. Assessment of Effects

This section details the assessment of effects associated with the proposed groundwater take. This assessment also outlines the measures that are proposed to appropriately manage potential adverse effects.

4.1 Resource and Allocation Availability

According to the BoPRC web-based Indicative Groundwater Availability and Consented Allocation mapping[7], Bores 1 and 4 are located within the Wairoa Lower Groundwater Management Zone, while Bores 2 and 3 are located within the Kopurererua–Otumoetai Groundwater Management Zone, both of which are situated within the Tauranga Moana Freshwater Management Unit (FMU) (**Figure 3**).

Table 5 summarises the groundwater allocation information applicable to the proposed abstraction. Following the granting of the proposed groundwater take, the remaining allocable groundwater volume is estimated to be approximately 19,224,000 m³ within the Wairoa Lower Groundwater Management Zone and 8,080,000 m³ within the Kopurererua–Otumoetai Groundwater Management Zone.

Given the substantial groundwater allocation available within both management zones, the proposed abstraction represents a very small proportion of the allocable resource. Accordingly, the effects of the proposed take on groundwater resource availability are considered to be very low.

Table 5. Allocation Limits of Wairoa Lower and Kopurererua-Otumoetai Groundwater Management Zones.

Description	Wairoa Lower	Kopurererua-Otumoetai
Groundwater Unit Code	TM-G-999	TM-G-994
Available Allocation (m^3/y)	22,824,000	10,405,000
Allocated Groundwater (m^3/y)	3,520,000	2,245,000
Allocation Remaining (m^3/y)	19,304,000	8,160,000
Allocated Groundwater (%)	15.4	21.6
Tauriko West Project		
Bores	Bore1 and Bore 4	Bore 2 and Bore 3
Requested Allocation (m^3/y)	80,000	80,000
Remaining Allocation (m^3/y)	19,224,000	8,080,000

4.1.1 Effects on Groundwater

To assist in the assessment of pumping effects of the proposed water take, an analytical groundwater model was developed to simulate the groundwater response from the proposed maximum annual abstraction rate of 160, 000 m^3/annum. The modelling methodology and results are detailed in **Appendix B**, and the effects predicted by the model are summarised in the following sections.

4.1.1.1 Groundwater Drawdown

The groundwater drawdown from each bore was modelled separately. The individual drawdowns were then combined to calculate the effects of each bore together to estimate the total groundwater drawdown when all four bores operate simultaneously. Each bore was modelled pumping continuously for 178 days at the maximum abstraction rate of 225 m³/day. Details of the analytical model setup, assumptions, and hydraulic parameters adopted for the assessment are provided in **Appendix B**.

Figure 5 presents a contour map of the maximum simulated drawdown in the deep aquifer production zone from pumping of all four bores combined. The predictive modelling indicates a maximum drawdown of 20.6 m

[7] https://maps.boprc.govt.nz/datasets/BOPRC::groundwater-management-unit-primary/explore?location=-37.850453%2C176.254814%2C11

within the deep aquifer adjacent to Bores 2 and 3. The greater drawdown at these locations is due to hydraulic interference between the two bores, which could be spaced approximately 125 m apart.

Predicted maximum drawdown adjacent to Bores 1 and 4 is approximately 17.8 m and 18.0 m, respectively. The marginally lower drawdown at these locations reflects the absence of significant hydraulic interference with each other.

Within the shallow aquifer the maximum predicted drawdown is approximately 0.26 m, extending to a distance of approximately 1 km from Bores 2 and 3. Predicted drawdown decreases progressively with increasing distance from the pumping bores. After 178 days of pumping, model results show only 0.26 m of shallow aquifer or water table drawdown adjacent to the bore, with a the 0.05 (50 mm) drawdown contour extending 1,800 m from the bore.

4.1.1.2 Effect on Other Groundwater Users

Following the exclusion of geotechnical and investigation bores (**Table 4)**, a total of 20 existing bores located within a 1 km radius of the proposed abstraction sites were identified for the effect assessment. Available information for these bores, including bore depth, casing depth, static water level (SWL), and the maximum predicted drawdown, is summarised in **Table 6**.

The available drawdown (defined as the height of the water column above the pump intake) was estimated, and the remaining available drawdown under the proposed pumping scenario (cumulative pumping of four bores) was calculated. For the purposes of this assessment, it was assumed that pumps are installed within the cased section of each bore, unless the static water level was within 2 m of the casing base, in which case, it was assumed the available drawdown was to within 4 m of the total bore depth (assuming the pump was placed near the bottom of the bore).

Key findings are as follows:

- ***Bore BN-403*** – is predicted to incur a potential drawdown of 2 m. The bore is unusual in that it has a SWL of 10.7 mBGL, a casing depth of 12.2 mBGL, but a total depth of 100 mBGL. Given the above, it is unlikely the pump is residing in the casing, therefore we have calculated available drawdown is 85.3 m, hence the remaining available drawdown is 83.3 m. This is considered a very low potential effect.
- ***Bore BN-12252*** – is predicted to incur a potential drawdown of 0.1 m. However, because of the bore configuration it only has 2.5 m of available drawdown to begin with, meaning that 4% of the available drawdown may be lost and 2.4 m is predicted to remain. This is considered a very low potential effect.

As mentioned above, Bores BN-1515, BN-4130, BN-4170, BN-4434, and BN24-0121 are located within the Project designation footprint. Accordingly, any effects on these should not be considered as effects on neighbouring groundwater users, as they will no longer be available for private groundwater abstraction.

Overall, the drawdown effects predicted on neighbouring groundwater users due to the proposed groundwater take range from 0.2 to 21% of the available drawdown, and therefore sufficient available drawdown is expected to remain in surrounding bores. Accordingly, the effects of the proposed groundwater abstraction on existing groundwater users are considered to be very low.

Table 6. Simulated Drawdown in Shallow Bores Within 1 km.

Bore ID	Nearest Indicative Bore		Bore Depth	Casing Depth	SWL	Submergence[1]	Drawdown From Proposed Combined Take[2]	Maximum Potential Impact	Remaining Available Drawdown
	Bore	Distance (m)	m	m	mBGL	m	m	%	m
BN24-0121	Bore 1	117	186	48	8.7	37.8	2.7	7.7	35.1
BN-1515	Bore 1	130	134	45.7	10.4	33.8	2.5	8.1	31.3

Bore ID	Nearest Indicative Bore		Bore Depth	Casing Depth	SWL	Submergence[1]	Drawdown From Proposed Combined Take[2]	Maximum Potential Impact	Remaining Available Drawdown
	Bore	Distance (m)	m	m	mBGL	m	m	%	m
BN-2571	Bore 1	137	73	32.5	11.0	20.0	2.4	13.9	17.6
BN-403	Bore 4	176	100	12.2	10.7	85.3	2.0	2.5	83.3
BN-10519	Bore 1	204	48	30	1.5	27.0	1.7	6.7	25.3
BN-10461	Bore 1	337	21	13	3.4	8.1	1.0	13.8	7.1
BN-4130	Bore 4	372	*<u>80</u>*	*<u>30</u>*	**21.0**	7.5	1.3	21.0	6.2
BN-2007	Bore 1	392	90	39	3.6	33.9	0.8	2.4	33.1
BN20-0069	Bore 1	397	28	22.5	15.9	5.1	0.8	18.4	4.3
BN-12043	Bore 4	490	232	71.7m	49.0	21.2	0.6	2.9	20.6
BN-11657	Bore 1	625	73	32.5	4.0	27.0	0.3	1.2	26.7
BN-10080	Bore 3	758	63	58	36.0	20.5	0.4	1.8	20.1
	Bore 2	866							
BN-4357	Bore 1	758	*<u>80</u>*	*<u>30</u>*	**6.0**	22.5	0.2	0.9	22.3
BN-12227	Bore 3	767	64	55	35.6	17.9	0.4	2.0	17.5
	Bore 2	866							
BN-4170	Bore 4	843	49	*<u>30</u>*	**21.0**	7.5	0.2	2.4	7.3
BN-10793	Bore 1	860	26	19.5	3.9	14.1	0.1	0.9	14.0
BN-4434	Bore 1	883	*<u>75</u>*	*<u>30</u>*	**17.0**	11.5	0.1	1.2	11.4
BN24-0062	Bore 1	913	144	89.4	37.3	50.7	0.1	0.2	50.5
BN-12252	Bore 1	936	28	22	18.0	2.5	0.1	4.0	2.4
BN-10859	Bore 1	981	50	30	16.0	12.5	0.1	0.7	12.4

Table Notes:

<u>Italic Underline</u> - Value unknown and assumed based on surrounding bores.

Bold - Interpolated SWL.

1. Assumed to be 1.5 m higher than the casing depth

2. Assumes continuous pumping at 900 m^3/d for 178 days from four bores

4.1.2 Stream Depletion Effects

Potential effects on nearby surface water bodies were assessed by calculating the portion of the groundwater abstraction derived from each hydrogeological layer represented in the model (**Figure 6**). To provide a conservative assessment of potential stream depletion, it was assumed that all water sourced from Model Layer 1 contributes directly to stream depletion.

Model results indicate that, after 178 days of continuous pumping, approximately 5.2% of the total abstraction is derived from Layer 1. This equates to a cumulative stream depletion effect of approximately 46.8 m^3/day (0.54 L/s) across all four bores, or approximately 11.7 m^3/day (0.14 L/s) per individual bore.

A groundwater take is generally considered to be sourced from groundwater where less than 40% of the abstracted water is derived from indirectly connected surface water bodies following a prolonged period of pumping. As the modelled stream depletion represents only 5.2% of the total abstraction, the proposed take is considered to be a groundwater take for consenting purposes, and the surface water allocation provisions are not triggered.

To contextualise the physical impact on the nearby streams, mean annual low flow (MALF) values for streams nearest to the proposed bore locations were obtained from NIWA's NZ River Maps web application. **Table 7** summarises the predicted stream depletion relative to the respective stream MALFs, which range from 0.04% to 7.4 % near the proposed bore locations.

Overall, the predicted stream depletion effects are considered very low.

Table 7. Impact on Streams

Indicative Bore	Distance to Nearest Stream (m)	MALF of Stream Segments (m^3/day)	Stream Depletion Effect (m^3/day)	% of stream depletion
Bore 1	215	571	11.7	2.05%
Bore 2	200	159	11.7	7.36%
Bore 3	110	59184	23.4	0.04%
Bore 4	170	59184	23.4	0.04%

Furthermore, i) the model does not account for recharge and ii) the assumed pumping rate of 900 m^3/day represents a conservative scenario, which is unlikely to occur continuously over the 178-day period. Therefore, given the estimated effect on MALF is less than the default surface water take allocation in the Table 13 of Policy 66 of the Bay of Plenty Regional Natural Resources Plan (60% MALF), no adverse effects on aquatic habitats are considered likely.

On this basis any stream depletion effects arising from the proposed take are considered to be very low.

4.1.3 Effects on Wetlands

As described above, the assessment assumes that the combined drawdown in Model Layer 1 is fully transmitted to the mapped wetlands. **Table 8** presents the predicted cumulative drawdown at each of the 38 mapped wetlands. The distance to each wetland was measured from the centre of the wetland to the nearest proposed bore.

Whilst wetland 17a and 17b are located outside the model domain, at the boundary of the model the maximum drawdown was 0.06 m. Therefore, drawdown at these wetlands through extrapolation of the distance-drawdown profile from the model is anticipated to be 0.01 m. This level of drawdown is considered negligible.

The greatest predicted drawdown of 0.43 m occurs at Wetland 11, which is located closest to Bore 3 (**Figure 3**). This is because Bore 3 is situated approximately 22 m from the centre of the wetland. Wetland 11 has an area of approximately 413 m^2 and is identified as having low ecological value, presumably because of the intermittency of water supply. The model, which provides a conservative “high” groundwater table assessment indicated groundwater within the wetland lies about 0.3 mBGL (**Table 3**).

Palustrine and fen wetlands in New Zealand typically experience natural seasonal water table fluctuations ranging from 0.3 m to over 1.0 m. Hence, given the highest groundwater table is 0.3 mBGL likely to only be at this high level for a short period of time and, for much of the year the wetland would experience deeper groundwater levels up to 1.3 mBGL (i.e. for much of the time the land will be drier), which may explain the low ecological value[8]. The level of drawdown is well within the seasonal range and is therefore not expected to result in any material change to the wetland’s hydrology, condition or ecological function.

Accordingly, the potential effects of the proposed groundwater abstraction on wetlands are assessed as very low.

[8] Boffa Miskel, SH29 Tauriko West Improvements, Wetland Values, Rev.2, 19 June 2026.

Table 8. Combined Layer 1 Drawdown Effect on Wetlands

Indicative Bore	Nearest Wetland (m)	Distance to Nearest Wetland (m)	Combined Layer 1 Drawdown Effect on Wetlands (m)
Bore 3	Wetland 11	21.75	0.43
Bore 4	Wetland 8	130.41	0.18
Bore 4	Wetland 7d	147.95	0.17
Bore 4	Wetland 7c	150.70	0.17
Bore 4	Wetland 7b	155.80	0.16
Bore 4	Wetland 9a	157.56	0.16
Bore 4	Wetland 7a	197.52	0.13
Bore 2	Wetland 10a.1	200.92	0.20
Bore 4	Wetland 9a	201.58	0.13
Bore 2	Wetland 10a.4	206.57	0.21
Bore 4	Wetland 9b	226.90	0.12
Bore 2	Wetland 10a.2	236.82	0.17
Bore 2	Wetland 10a.3	270.78	0.15
Bore 2	Wetland 10a.5	287.22	0.14
Bore 1	Wetland 1	309.52	0.07
Bore 1	Wetland 16	350.56	0.06
Bore 1	Wetland 2a	358.35	0.06
Bore 1	Wetland 2b	422.86	0.04
Bore 2	Wetland 10b	427.92	0.07
Bore 1	Wetland 15b	454.68	0.04
Bore 3	Wetland 12	485.69	0.05
Bore 3	Wetland 14a	493.08	0.05
Bore 3	Wetland 12	518.22	0.04
Bore 1	Wetland 3a	524.30	0.02
Bore 1	Wetland 3b	579.10	0.02
Bore 1	Wetland 4	584.92	0.02
Bore 3	Wetland 14b	604.10	0.03
Bore 1	Wetland 15a	614.13	0.02
Bore 3	Wetland 13	641.58	0.02
Bore 4	Wetland 5c	744.75	0.01
Bore 4	Wetland 6	776.88	0.00
Bore 4	Wetland 5b	780.81	0.00
Bore 4	Wetland 5a	817.83	0.00
Bore 3	Wetland 13	826.39	0.01
Bore 4	Wetland 5d	924.65	0.00
Bore 1	Wetland 17b	1694.20	0.00
Bore 1	Wetland 17a	1768.52	0.00
Bore 3	Wetland 13	2009.83	0.00

4.1.4 Saline Intrusion Effects

The simulated pumping water level is predicted to decline to approximately 24 m below mean sea level (mBMSL). However, the nearest estuary is located approximately 3 km from the proposed Bore 3 and the no drawdown is predicted beyond 1.7 km from Bore 2 and 3, which means that pressure is maintained at the coast to prevent inland migration of saline water.

Groundwater levels below sea level are not uncommon; however, sustained pumping at these levels can increase the potential for saline intrusion where a hydraulic connection exists between the production aquifer and coastal water bodies, or adjacent marine sediments. A detailed assessment of the potential for saline intrusion is provided in **Section B.8** of **Appendix B**.

The proposed bore will likely be cased to a depth of 80 m using impermeable casing materials, providing vertical isolation of the deeper production aquifer from shallow groundwater and surface water features, including the estuary and coastal marine environment. In addition, the substantial separation distance between the bore and the estuary, together with the presence of intervening geological materials, is expected to further limit the potential for hydraulic connection with the coast and saline groundwater.

Accordingly, the risk of saline intrusion associated with the proposed abstraction is considered to be low.

4.1.5 Ground Settlement Effects

Land settlement effects have the potential to occur when compressible layers within the ground are dewatered.

For this proposal the maximum drawdown occurs at depth in the non-welded ignimbrite, which are very stiff and of low compressibility. There are potentially compressible units within the shallow profile, however, these are typically thin (less than 1 m thick) and are not subject to appreciable drawdown (< 0.3 m). Therefore, no subsidence is anticipated for the deeper pumping aquifer or those above, hence ground settlement effects will be very low.

5. Conclusion

The proposed abstraction of groundwater will supply water for the Project, to be used for construction activities including dust suppression.

Based on the findings of this assessment, the environmental effects associated with the proposed groundwater take on groundwater, stream depletion, wetlands, saline intrusion and ground settlement are expected to be very low.

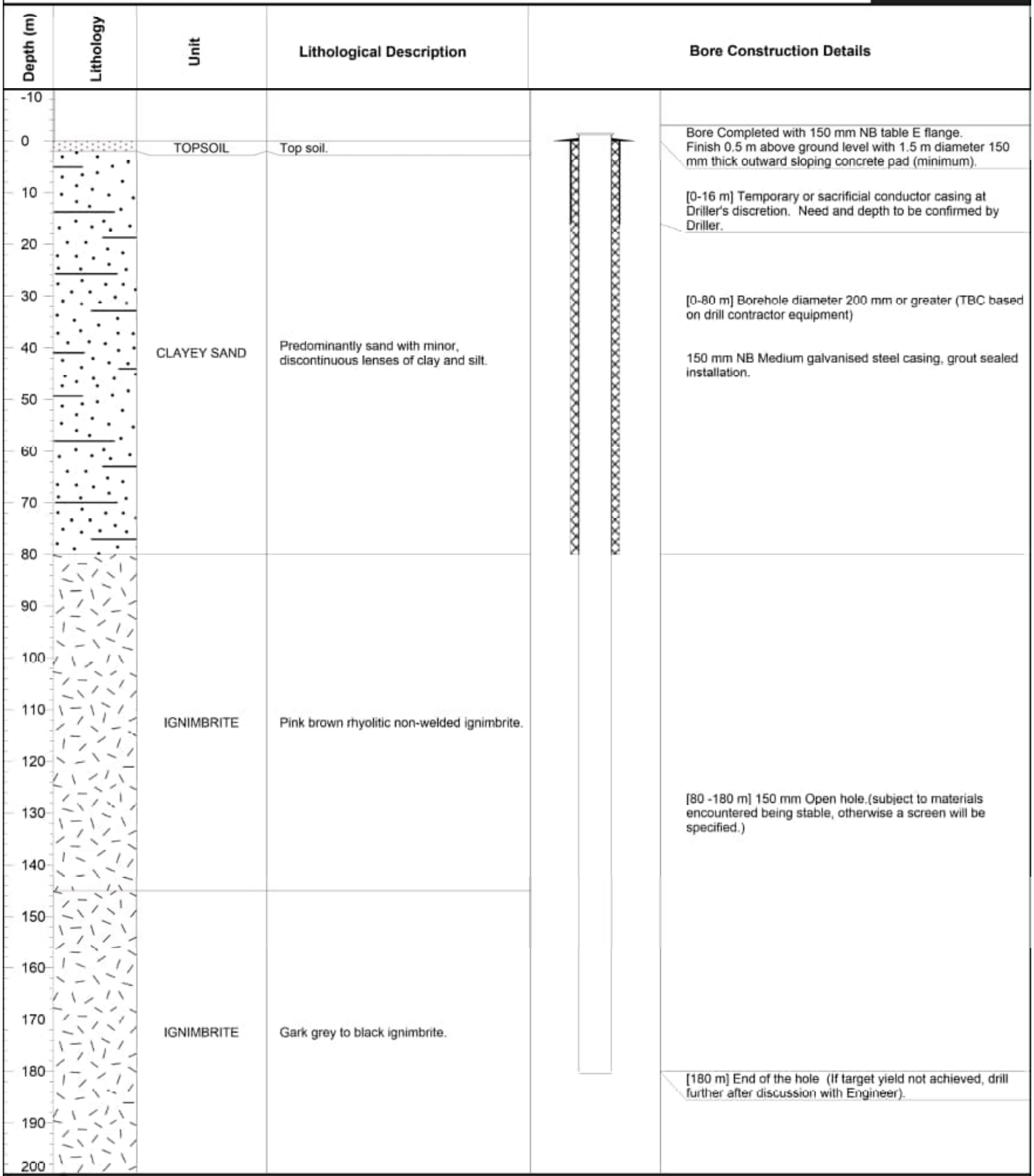
Appendix A. Bore Specimen Designs

Production Bore Specimen Design | **Bore:** Tauriko West - Groundwater Take

Project Name: Tauriko West | **Location:** Location 1 to 4
Project Number: WWLA 1621 | **Designer:** Asanka Thilakerathne

BORE DRILLING DETAILS

Drilling Company: TBD | **Diameter (mm):** 150 | **Depth (m):** 180
Drilling Date: TBD | **Easting (m):** | **Northing (m):**
Drilling Method: Rotary Mud | **Ground Elev.(approx.):**



Grainsize Classification (mm):

Boulders	Cobbles	Gravel			Sand			Silt			Clay
		Coarse	Medium	Fine	Coarse	Medium	Fine	Coarse	Medium	Fine	
200	60	20	6	2	0.6	0.2	0.06	0.02	0.006	0.002	

Appendix B. Groundwater Response Modelling

B.1 Introduction

This assessment used the Feather & Williamson Analytical Model (FWM), calibrated to measured flow and drawdown during test pumping, to simulate the proposed groundwater take in order to evaluate the potential effects on groundwater conditions.

B.2 Feather Williamson Analytical Model

The Feather and Williamson Model (FWM) is an analytical solution for drawdown calculation in a multi-layer aquifer system. By assigning the hydrogeologic parameters and thicknesses of individual layers based on the documented geology, drawdown is calculated for each individual layer the inverse Laplace transform of the groundwater flow equation. The model is available as freeware at https://www.wwla.kiwi/softwaredetail/fwm and we encourage Council staff or appointed peer reviewers of this application to download the software and confirm/test sensitivity of our predictions if desired.

Utility of the FWM is often compared to the Theis model, and the following comparison is provided.

- The Feather-Williamson Model (FWM) computes the drawdown through multiple layers in the bore.
- This approach is more accurate than Theis due to consideration of storage and leakage effects from overlying and underlying layers;
- The model provides a similar response to that of a numerical model.

The FWM has been used widely throughout New Zealand for groundwater take applications and has passed scrutiny through the technical review process at Northland Regional Council, Auckland Council, Waikato Regional Council, Bay of Plenty Regional Council, Hawkes Bay Regional Council, Gisborne District Council and Greater Wellington Regional Council by virtue of numerous consents being granted in these regions.

Furthermore, it has recently been used in the Bay of Plenty region for the following consents, without any concerns:

- ACG Tauranga Property Limited - Pye Pe School; Tauranga;
- Stratum Consulting – Groundwater take for retirement village in Papamoa;
- Jace Investment Limited – Groundwater take for Mount Pac n Cool Cooling Tower Project;
- Jace Investment Limited – Groundwater take for Rangiuru Business Park;
- Heatherlea Resthome Limited – Groundwater for geothermal take.

B.3 Analytical Model Set-up

The FWM analyses for the proposed project bores were developed using stratigraphic information derived from geological logs from surrounding bores provided by BOPRC[9]. For modelling purposes, it was assumed that the geological conditions are consistent across the four proposed bores, as they are located within approximately 3 km of each other. Consequently, the same stratigraphic profile was adopted for all four bores.

The layers above the static groundwater level were not explicitly represented in the FWM, as they occur within the unsaturated zone. The saturated section of the model consists predominantly of clayey silt and ignimbrite units.

To incorporate anisotropy within the model, zone beneath the water table to the base of the casing was subdivided into two model layers (Layer 1 and Layer 2). An additional layer (Layer 4) was introduced beneath

[9] Email conversation – s9(2)(a) [redacted], Environmental Data Analys, Bay of Plenty Regional Council (23 March 2025).

the production zone (Layer 3) to account for any vertical leakage due to depressurisation of the pumping zone. Each model layer was assumed to be laterally homogeneous across the model domain.

The model was therefore defined using four layers, while the hydraulic parameters, transmissivity and storativity, were set to be representative of the bulk material represented by the given layer of the FWM model. The thickness and material descriptions represented by each of the model layers are summarised below:

- ***Layer 0:*** The unsaturated zone extending from the surface to 10 mBGL. This layer intersects topsoil and silt layers.
- ***Layer 1:*** Predominantly sand with minor, discontinuous lenses of clay and silt.10 to 20 mBGL, representing the upper portion of the cased interval.
- ***Layer 2:*** Predominantly sand with minor, discontinuous lenses of clay and silt from 20 to 80 mBGL , representing the lower-cased interval and acting as a hydraulic separation between shallow groundwater and the production aquifer.
- ***Layer 3:*** Non-welded ignimbrite layer from 80 to 180 mBGL, representing the primary production aquifer zone.
- ***Layer 4:*** Welded ignimbrite layer from 180 to 230 mBGL, included as a lower boundary layer to account for any vertical upward seepage.

B.4 Model Calibration

The FWM was calibrated by parameters based on the aquifer hydraulic parameters for the geologic units in the development area, within the range of reported values[10] and values used for groundwater model development[11] **Table 9**.

Table 9. Hydrogeologic Parameterisation in the FWM.

Model Layer	Transmissivity (m^2/day)	Storativity (-)	Thickness (m)	Depth at base (mBGL)	Anisotropy Kh:Kv (-)	Horizontal conductivity (m/s)	Geologic unit
0	--	--	10	10	--	-- n/a	Unsaturated Zone
1	0.875	0.025	10	20	10	$1.01x10^{-06}$	Predominantly sand with minor, discontinuous lenses of clay and silt (Blank casing)
2	3	0.06	60	80	10	$5.78x10^{-08}$	Predominantly sand with minor, discontinuous lenses of clay and silt (Blank casing)
3	16	0.01	100	180	10	$1.85x10^{-06}$	Non Welded Ignimbrite (Production Zone)
4	5	0.004	50	230	10	$1.16x10^{-06}$	Welded Ignimbrite (Underlying Rock)

B.5 Proposed Pumping Scenario

Maximum water requirement for a day is 900 m^3/day, therefore the model was simulated 178 days of continuous pumping at a rate of 225 m^3/day for each individual bore, such that the total abstraction was equal to the annual take of 160,000 m^3/annum from four bores that is specified in the application (**Section 3.2**).

[10] CMW, 2025. Takitimu North Link Stage 2 State Highway 2, Tauranga Groundwater Impact Assessment Report Prepared for New Zealand Transport Agency Waka Kotahi TGA2016-0318BU Rev 4, 17 February 2025.

[11] WWLA, 2026. Draft Preliminary Groundwater Assessment, Tauriko West - Tupenga WWLA1621 | Rev. 619 June 2026

The following details assure that the simulation is conservative:

- The annual abstraction occurs over a period of 178 consecutive days, so that maximum effect is simulated; whereas in practice the maximum abstraction would not occur on a daily basis; and

- The model does not include recharge.

B.6 Groundwater Drawdown

The analysis assumed 178 days of continuous pumping, representing the maximum expected drawdown scenario for induvial bores (**Figure 4**). The drawdown output for each bore was then combined using the principle of superposition to evaluate the cumulative drawdown effects of the four proposed production bores.

The results of the cumulative analysis are summarised below;

Bore 1: The predicted maximum drawdown is 17.8 m within the deeper aquifer. Hydraulic interference with other proposed bores is expected to be none.

Bores 2 and 3: The predicted maximum cumulative drawdown is 20.6 m within the deeper aquifer. These two bores are located approximately 125 m apart, resulting in hydraulic interference between them.

Bore 4: The predicted maximum drawdown is 18.0 m within the deeper aquifer. Minor hydraulic interference with Bore 2 and 3 is expected.

The magnitude of drawdown decreases towards the ground surface, with only approximately 0.26 m of drawdown predicted to propagate to the surface. This attenuation is consistent with the substantial casing depth of the bores and the relatively low hydraulic conductivity of the overlying strata.

Furthermore, it is noted that all potential drawdown calculated by the model is a conservative estimate due to the rainfall recharge not being included in the FWM model.

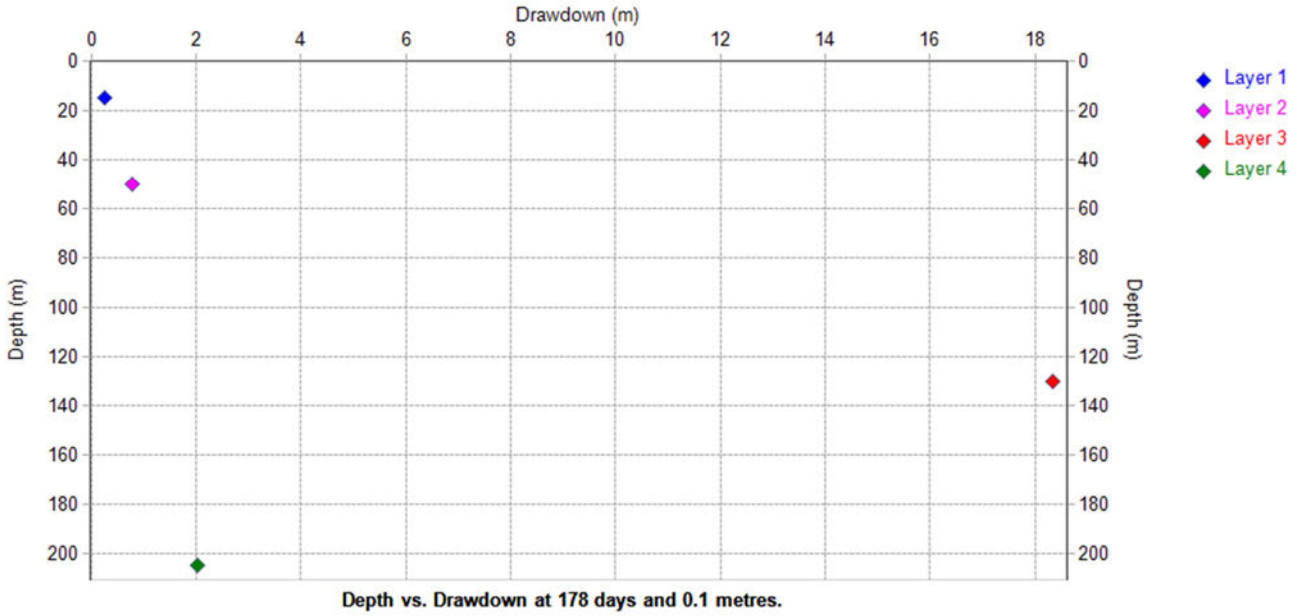


Figure 4. Simulated drawdown in each model layer at the proposed bores (Individual).

The lateral extent of drawdown in the production zone is presented in **Figure 5**. The drawdown is greatest in close proximity to the Bores 2 and 3, reducing with distance, implicating that bore interference effects will only occur within close proximity to the bore and other groundwater users will not be effected. Simulation results indicate that after 178 days of continuous pumping (with no recharge), the 0.2 m combined drawdown contour in Model Layer 3 will be at approximately 1 km from the pumping bores.

Map Title:

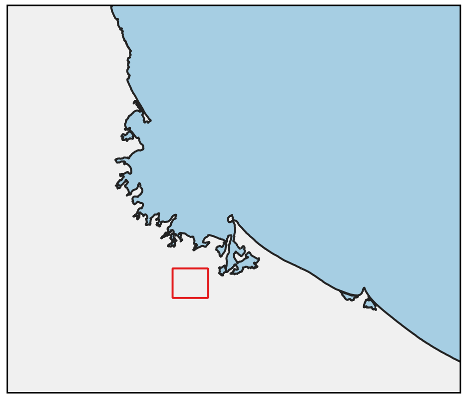
Maximum Simulated Combined Drawdown

Project:

Tauriko West Groundwater Take

Client:

CMW Geosciences



Legend

- Indicative Bores
- Surrounding Bores within 0.2 m Drawdown Zone
- 1 km Buffer
- Land Parcels
- Centerline SH29
- Centerline SH29A

Top Level Basemap Data

- Roads
- State Highway
- Rivers/Streams
- Lake/Pond
- Wetlands (mapped)

Data Provenance

Aerial Imagery from Land Information New Zealand

Drawn by: Asanka Thilakerathne

07/07/2026

Layout & Project File

Surface Water

WILLIAMSON WATER & LAND ADVISORY

Figure 5

B.7 Surface Water Connectivity

The FWM calculates the percentage of pumped groundwater derived from each layer in the model, as shown in **Figure 6**. The key features to note from this analysis are as follows:

- As pumping begins, 100% of the pumped water is derived from the production zone (Layer 3);
- Over time, the contribution of Layer 3 gradually decreases while and the Layer 2 contribution increases;
- After 178 days of continues pumping, contribution of Layer 2 and Layer 3 is respectively, 39% and 41%, as the cone of depression migrates upwards. The FWM has been simulating the maximum pumping scenario, therefore this magnitude of abstraction is unlikely to occur;
- After 178 days of continuous pumping, Layer 1 contributes 5.2% of the total flow from the bore.

For assessing the potential groundwater and surface water effects, it is assumed that Layer 1 is hydraulically connected with surface water bodies.

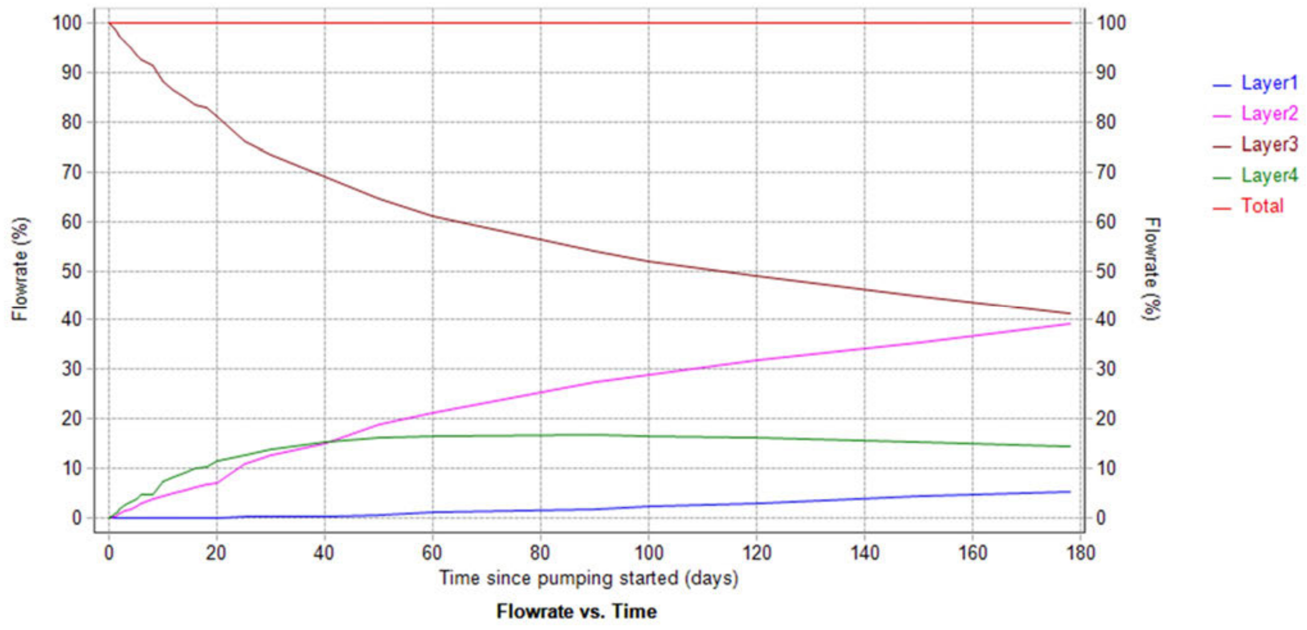


Figure 6. Flow partitioning of abstracted groundwater within the FWM layers.

The implications of this analysis for surface water depletion are discussed in the assessment of hydrological effects in **Section 4.1.2.**

B.8 Saline Intrusion Analysis

Bore 3 is the closest of the proposed bores to the estuary and is located approximately 3 km inland from the estuary. Ground elevation at the site is approximately 4.4 mAMSL, and groundwater levels measured in nearby bores indicate a static water level of approximately 10 mAMSL.

Potential for saline intrusion is influenced by factors such as the hydraulic characteristics and continuity of alternating geological units, drawdown at the bore and at the coast, distance to the coast, temporal pumping patterns, and duration of pumping in totality.

The proposed bores will be cased to a depth of 80 m using impermeable casing materials, providing vertical isolation of the deeper aquifer from shallow groundwater and surface water features, including the estuary and coastal marine environment.

Under the maximum pumping scenario, the FWM predicts a drawdown of approximately 18 m at the production zone of Bore 3, resulting in a groundwater level of approximately 6.2 m below mean sea level (mBMSL). This is unlikely to result in temporary or permanent saline intrusion because:

- Pressure at the estuary 3 km from the bore is unaffected by pumping; and
- Pumping will be highly seasonal in practice and only required during dry times when dust could develop from construction activities, hence drawdown is transient; and
- The abstraction is for a temporary durance being only required for the duration of the Project construction, which is approximately 10 years (including enabling works).

B.9 Land Settlement Analysis

Land settlement can occur where groundwater abstraction results in dewatering and consolidation of compressible geological materials. The maximum modelled drawdown associated with the proposed abstraction is predicted to occur within the production zone, which comprises non-welded ignimbrite. Overlying the production zone are alluvial deposits consisting of sand with minor, discontinuous lenses of clay and silt.

Clay, silt, and peat are generally more compressible than sand and therefore have a greater potential to undergo consolidation in response to reductions in pore water pressure. However, the magnitude of any resulting settlement is dependent on factors such as the thickness, continuity, and geotechnical properties of these materials, together with the extent and duration of groundwater level decline.

The model indicates that drawdown is largely confined to the deeper production aquifer and is expected to cause insignificant dewatering of the shallow alluvial deposits predominantly consists with sand. Accordingly, the potential for measurable land subsidence resulting from the proposed groundwater abstraction is considered to be very low.

B.10 Conclusion

WWLA has developed a modelling application for proposed production bores for the Project. A 4- layer modelling approach was used in FWM. Primary geologic units are represented with simulated abstraction sourced from the production zone within the area.

The model was applied to simulate the maximum abstraction that is being sought in the proposal, amounting to 900 m^3/day or 160,000 m^3/year, which equates to 178 days of pumping at the maximum rate. Model results were used to support an assessment of groundwater effects in terms of the potential level of impact on neighbouring groundwater users, and potential saline intrusion or land settlement resulting from the proposed take.