Technical Memo
Ridgeburn – Arrowtown Junction

Water Supply Servicing Strategy
Gibbons Co

TO:	Cameron Hodgson	**REF:**	J7120
FROM:	GWE Consulting Ltd	**DATE:**	24 February 2026

1. STATEMENT OF EXPERIENCE AND QUALIFICATIONS

GWE's nominated key personnel bring strong technical, managerial, and sector-specific expertise across the water and wastewater industry. Their combined experience covers project management, treatment process design, compliance, investigations, and delivery of water sector infrastructure across New Zealand.

1.1 Nominated Key Personnel for Ridgeburn

This report has been prepared by GWE Consulting's senior water and wastewater specialists, who bring extensive experience in water quality compliance, treatment planning, and wastewater process engineering across New Zealand.

Maria Johnson – Technical Project Manager

Maria is a Technical Project Manager with over 17 years' of experience in the Water Industry and a previous 2 years' experience in Research and Development.

Maria has worked on a variety of projects for Watercare Services Limited for both the Operations and Infrastructure departments. As a Water Quality Analyst, she has worked on a number of water quality and compliance related projects, including automation of all of Watercare water quality compliance data and reports. She was also in charge of the company grading process before and after the integration with the local networks. As a Water Treatment Planner and Project Manager, she carried out planning investigations for the upgrade and development of water treatment facilities to meet current and foreseeable future business needs and progress planned capital works through their project definition and development phases to the point of business case justification.

At Harrison Grierson, she has worked on a number of water and wastewater treatment infrastructure upgrades. She project managed successfully a large number of projects and led the Water Team.

Areas of Expertise:

- Project coordination and management.
- Stakeholder relationship.
- Process design of water treatment plants and water supply infrastructure.
- Water Services Act 2021 and associated 2022 Drinking Water Standards and Rules.

Paul Han – Intermediate Water and Wastewater Engineer

Paul is an Intermediate Water and Wastewater Engineer with a first-class Bachelor of Civil and Environmental Engineering (Hons) degree from the University of Auckland. Paul has over 4 years of New Zealand experience working on a diverse range of water and wastewater treatment projects.

Areas of Expertise:

- On-site and Municipal wastewater treatment plant management and design.
- Mass balance, process modelling and measuring plant performance for water and wastewater treatment plants.
- Proficient user of BIOWIN for designing Wastewater Treatment Plant models.
- Discharge consent applications for commercial and domestic wastewater.
- Water supply treatment design and engineering.

2. EXECUTIVE SUMMARY

This Technical Memorandum has been prepared by GWE Consulting Ltd and authored by its nominated water and wastewater specialists. It outlines the proposed water supply servicing strategy for the Ridgeburn Development at Arrowtown Junction. The assessment summarises water demand, available supply, preliminary water quality, a high-level treatment approach, and key consenting considerations to support future approvals.

Potable water is proposed to be primarily sourced from two groundwater bores with a combined estimated yield of approximately 1,728 m^3/day (≈20 L/s), which exceeds the estimated peak daily demand of approximately 2,006 m^3/day. This confirms that the development can be reliably serviced with allowance for staged growth, operational variability, and maintenance. Supplementary options, including rainwater harvesting and potential abstraction from the Kawarau River, may be considered at later stages to enhance system resilience.

Preliminary water quality testing indicates elevated iron, manganese, aluminium, hardness, turbidity, and occasional *E. coli*, with arsenic identified as a potential contaminant of concern in the Ridgeburn area. Current sampling indicates arsenic concentrations below 50% of the Maximum Acceptable Value. A centralised, staged Water Treatment Plant incorporating filtration, softening and/or ion exchange, and

disinfection (UV and chlorination) is proposed to achieve Drinking Water Quality Assurance Rules compliance. Minor treatment residuals will be directed to the site wastewater treatment system for treatment and disposal, with no direct discharge to land or water anticipated and no additional discharge consents expected, subject to confirmation during detailed design.

3. INTRODUCTION AND PURPOSE

The purpose of this memo is to outline the water quality and quantity for the supply of the Ridgeburn Development. The assessment aligns with Council demand parameters to support the water take consent application, ensure the accuracy of reported usage, and confirm that no unaccounted losses or unusual consumption will be occurring.

4. WATER SUPPLY STRATEGY

4.1 Water Supply

The water supply strategy for Ridgeburn prioritises self-sufficiency and sustainable resource management. Potable water will be sourced from two groundwater bores, with one bore expected to yield up to 600 m^3/day and the other providing 1,128 m^3/day to meet the development demand. In combination, the bores are reasonably expected to deliver up to 1,728 m^3/day (≈20 L/s) based on preliminary pump testing conducted by Terra Aqua Consultants and as further supported by the WGA hydrogeological assessment report.

In addition to groundwater, alternative sources such as rainwater harvesting could supplement the supply if required in future. The potential for incorporating rainwater harvesting within the building design and available site area will also be evaluated and confirmed as part of the overall water supply strategy. The final analysis, including confirmed yields and potential supplementation options, will be presented in the Groundwater Supply Technical Memorandum prepared by Terra Aqua Consultants Ltd.

4.2 Water Demand

A detailed analysis of water demand was undertaken using peak-occupancy assumptions provided by the client. Design allowances are based on:

- Residential demand: 250 L/person/day (Queenstown Lakes District Council Land Development and Subdivision Code of Practice).
- Commercial demand: 15 L/m^2/day with 1 person per 15 m^2 (Watercare Code of Practice for Land Development and Subdivision) Community demand: Based on 4.5 L/flush toilets and 4.5 L/use basins, with an assumed usage rate of 4 uses per hour over an 11-hour operational day, plus a nominal allowance for general tap use.
- Peaking Factor of 2.0 (Watercare Code of Practice for Land Development and Subdivision)

- Based on these assumptions, the total peak daily demand is estimated at 2,006 m^3/day as per table below:

Table 1: Peak Water Demand for Ridgeburn Development

FACILITY TYPE	PEAK DAILY DEMAND (m^3/DAY)
Residential	1,815
Commercial	183
Community	8
Total	2,006

4.3 Water Supply-Demand Balance and Supply Philosophy

Comparing supply and demand shows that while the available groundwater yield (1,728 m^3/day) is slightly below the estimated peak-day demand of 2,006 m^3/day, the system can still reliably service the development due to the inclusion of onsite reservoir storage.

The peak-day demand incorporates a peaking factor of 2, meaning the average (normal) demand is approximately 1,003 m^3/day**.** Under normal operating conditions, the groundwater supply is sufficient to meet demand and recharge the reservoir.

To buffer short-term differences between peak demand and bore yield, the system incorporates reservoir storage. The correct indicative storage volumes are:

- 2-day storage: ~2,000 m^3
- 4-day storage: ~4,000 m^3
- 7-day storage: ~7,000 m^3

This analysis confirms that no additional water sources are required, providing the groundwater bores perform at their estimated yields. The supply philosophy prioritises self-sufficiency, resilience, and sustainable resource management.

Table 2: Water Supply vs Demand Balance Summary

RESIDENTIAL DEMAND (m^3/DAY)	COMMERCIAL DEMAND (m^3/DAY)	COMMUNITY DEMAND (m^3/DAY)	TOTAL DEMAND (m^3/DAY)	GROUNDWATER SUPPLY (m^3/DAY)	SURPLUS/SHORTFALL (m^3/DAY)
1,815	183	8	2,006	1,728	**-278**

Overall, the development's water supply strategy supports a supply of water primarily sourced from groundwater. Confirmation of the acceptability of this approach particularly in relation to QLDC's water-supply policies and requirements will be sought and documented as part of the final assessment.

5. TREATMENT PROCESS

5.1 Raw Water Quality

Groundwater and stream water quality testing was conducted on 20th November for Bore 140, and 3rd December for Bore 5. These results are consistent with typical regional groundwater quality and can be effectively managed using industry-standard treatment processes.

The key parameters exceeding the Drinking Water Quality Assurance Rules (DWQAR) Maximum Acceptable Values (MAV) or Aesthetic Guidelines (GV) are summarised in the following table:

Table 3: Key Groundwater Quality Parameters Exceeding MAV

PARAMETER	BORE (NO.5) (mg/L)	BORE (NO. 140) (mg/L)	MAV (mg/L)	GV (mg/L)
E.Coli	Compliant	1	<1 per 100 mL	-
Turbidity	7.7	26	-	≤5
Aluminium	Compliant	0.464	<1	≤ 0.1
Iron	0.5	1.9	-	≤ 0.3
Manganese	0.041	0.116	0.4	≤ 0.04 (Staining) ≤ 0.1 (Taste)
Hardness	344	403	-	≤ 200 (Scale deposition, scum formation) 100–300 (Taste threshold (Ca; counter ion dependent))

QLDC has advised GWE that arsenic is likely to be present in the Ridgeburn area. Current water quality samples indicate arsenic levels are below 50% of the MAV. Further sampling will be undertaken during the future design stages to ascertain arsenic concentrations. If detected at levels requiring treatment, arsenic will be removed using ion exchange as part of the water treatment process. The treatment process at Ridgeburn will generate small volumes of waste streams primarily from softener regeneration, ion exchange brine, and media and cartridge filter backwash. These waste streams are expected to be low in volume (approximately 2-5%) relative to total supply but may contain elevated concentrations of hardness, iron, manganese, suspended solids and potentially arsenic.

Any such discharge will be directed to the wastewater treatment system for treatment and disposal, rather than discharged directly to land or the receiving environment. Given the minor volumes involved and containment within the existing wastewater treatment and disposal framework, no separate discharge to land or water is anticipated.

Groundwater and surface water testing indicate elevated levels of iron, manganese, aluminium, hardness, turbidity, and occasional E. coli, exceeding DWQAR MAVs or aesthetic guidelines. Iron (up to 1.9 mg/L) and manganese (up to 0.116 mg/L) exceed staining and taste thresholds, requiring removal to prevent discoloration and taste issues. Aluminium (0.464 mg/L) exceeds aesthetic limits, and hardness (344 and 403 mg/L as $CaCO_3$) is above scale deposition thresholds. Turbidity is elevated (up to 26 NTU), and E. coli was detected at 1 cfu/100 mL in some samples.

Treatment will consist of pre-filtration, ion exchange or softening for iron, manganese, aluminium, and hardness, multi-stage filtration to reduce turbidity, and disinfection (UV and/or chlorination) to ensure health and aesthetic compliance. This approach is expected to deliver potable water meeting the requirements of the DWQAR and associated standards.

5.2 Water Treatment

A high-level treatment process suitable for Ridgeburn is as follows:

1. Media Filtration
2. Softener
3. Ion exchange
4. Cartridge filtration (5–20 micron)
5. UV disinfection
6. Chlorination for secondary disinfection
7. Treated water storage tanks
8. Booster pumps and private distribution network

A centralised Water Treatment Plant (WTP) will be located within the site. The system can be scaled or staged to match development growth.

It is proposed that residuals from the water treatment process be pumped to the on-site wastewater treatment system for treatment and disposal. Expected contaminant concentrations and volumes of residuals will be confirmed during future design stages.

5.3 WTP PFD and Layout

Please refer to Appendix B for the full process flow diagram of the water treatment process of Ridgeburn development.

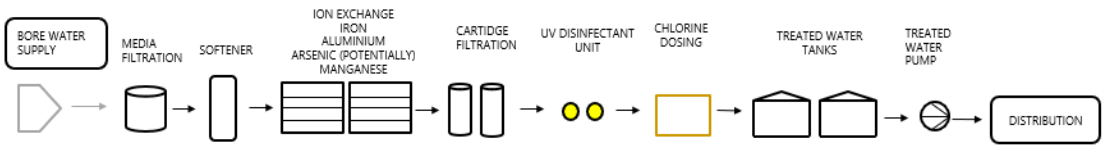


Figure 1: Schematic of Ridgeburn Water Treatment Process

6. DESIGN CONSIDERATIONS

The Ridgeburn water supply system will be designed to comply with all relevant statutory requirements, regulatory frameworks, and industry best practice guidance. Key design considerations include the following:

- The design will meet the requirements of the Water Services Act 2021 and the Drinking Water Quality Assurance Rules 2022, administered by Taumata Arowai. These establish the standards for safe potable water supply, treatment performance, monitoring, and compliance obligations.
- The bore source and headworks will be designed to appropriately respond to identified flood risk. Final engineering design will confirm mitigation measures to ensure the source take is adequately protected from inundation during a 1-in-100-year flood event (or greater, as required). Potential mitigation measures include raising the borehead above the design flood level or constructing a fully sealed below-ground borehead configuration to prevent ingress of floodwaters. These measures will ensure protection of source water quality and continuity of supply.
- Supply risk, including potential loss of supply due to extreme flood events, will be addressed through appropriate engineering controls and incorporated into the Water Safety Plan and Source Water Risk Management Plan, as required under the Water Services Act framework. The final design will demonstrate that continuity of supply is achieved through resilient borehead construction and, where necessary, contingency provisions.
- The design will comply with Queenstown Lakes District Council Land Development and Subdivision Code of Practice and Auckland Regional Council TP58, which sets out requirements for water supply infrastructure including reticulation layout, storage capacity, fire-fighting provision, and demand allowances.
- Where applicable, the design approach will be informed by to ensure alignment with recognised engineering guidance for infrastructure planning and servicing considerations.
- Building consent will be obtained for all relevant structures, including water storage tanks, treatment plant buildings, and pump stations. These structures will be designed to meet applicable Building Code and safety requirements.

This section identifies the primary regulatory and technical frameworks that will inform the Ridgeburn water supply design. It does not represent an exhaustive list of statutory approvals. Specific consents and regulatory approvals will be confirmed during the detailed design and formal consenting process.

7. SUGGESTED CONDITIONS OF CONSENT

The proposed monitoring and testing associated with the operation and maintenance of the water supply treatment system is entirely prescribed by the Water Services Act 2021 and associated 2022 DWQAR and Standards and will not be subject to consent conditions.

Abstraction of the groundwater will be in line with the water take consent application.

A separate consent will be sought during the construction and commissioning of the water treatment plant to ensure statutory requirements are met (e.g. noise, discharges to the environment, etc.).

8. LIMITATIONS

This report has been prepared for the sole benefit of **Gibbons Co** as our Client, and their appointed representatives, according to their instructions, for the specific objectives described herein. This report is qualified in its entirety and should be considered in the light of our Terms of Engagement with the Client and the following:

a. Data or opinions contained within the report may not be used in other contexts or for any other purpose without our prior review and written agreement. Any reliance will be at the parties' sole risk.

b. No responsibility is assumed for inaccuracies in reporting by the information providers. In no event, regardless of whether GWE 's consent has been provided, does GWE accept any liability, whether directly or indirectly, for any liability or loss suffered or incurred by any third party to whom this report is disclosed placing any reliance on this report, in part or in full.

c. GWE has relied on information provided by the Client and by third parties to produce this document and arrive at its conclusions. GWE has not verified information provided (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy, or completeness of such information.

Prepared by:	**Reviewed and Approved by:**
	
Paul Han	Maria Johnson
Intermediate Engineer	Water Sector Lead

enc Appendix A: Water Supply-Demand Balance Calculation
Appendix B: PFD of Ridgeburn Water Treatment
Appendix C: Water Quality Results
Appendix D: Groundwater Supply Technical Memo, Terra Aqua Consultants Limited

Https://Gweconsult.Sharepoint.Com/Sites/Activeprojects/LD/Gibbons Co-Groundwater Expert-J7299/05-WS/04-Reports/TM01v6 FINAL-Ridgeburn Arrowtown Junction Water Supply.Docx

APPENDIX A

WATER SUPPLY-DEMAND BALANCE CALCULATION

V3	GWE 22 December 2025
PROJECT TITLE:	Gibbons Co - Groundwater Expert
OBJECTIVE:	Determine the supply/demand

	Name		Sign		Date
Prepared	P. Han		PH		24/02/2026
Checked	M. Johnson		MJ		24/02/2026
Approved					

input data
Demand
Water Storage
Groundwater

* Source TP58 On-Site Wastewater Systems 2004 paper Fig 6.1
** Water NZ Waterloss guidelines
*** BRANZ fact sheet
**** used 50 m2 per person for dry retail, 15 L per m2 of net floor area

FILE LOCATION

https://gweconsult.sharepoint.com/sites/ActiveProjects/LD/Gibbons Co-Groundwater Expert-J7299/05-WSI/02-Investigation/[Water Demand vs Supply Balance calcs V2.xlsx]Supply-Demand Balance

Occupancy Assumptions for Commercial Buildings

Facility	Assumption	NO. OF PEOPLE
Commercial Area (2120 m²)	1 person per 15 m² (dry commercial)	-
Supermarket (2000 m²)	Supermarkets use *flow per area* , not people → 15 L/m²/day	Use 0 people and calculate water from area
Residential Houses	250 L/Person/day, Meterd water Supply, WELS fitting, Water Reduction flxtures,	

Table 1: Groundwater Bore supply and Development Capacity Check

FACILITIES	NET UNIT AREAS m²			NO. OF PEOPLE	NO. OF RESIDENTIAL DWELLINGS/HOTEL ROOMS	FLOW ALLOWANCE (L/DWELLING/DAY) & (L/ROOMS/DAY)	FLOW ALLOWANCE (L/PERSON/DAY)	Water Requirement m3/day	Peaking Factor	Peak Daily Demand (m3/day)	GROUNDWATER COLLECTION	WATER RESERVOIR STORAGE (2 DAYS)	WATER RESERVOIR STORAGE (4 DAYS)	WATER RESERVOIR STORAGE (7 DAYS)	Additional Water Source Required?
	Gross Floor Area (GFA)	Front of House (FOH) & Retail	Back of House (BOH) & Services								1728m3/day				
TYPE 1 - Housing											1728	1450.2	2900.4	5075.7	No
House and Land				3630	1030	3 people per dwelling	250	907.5	2.0	1815.0					
Affordable housing					180										
TYPE 2 - Commercial Buildings									2.0						
Workspace and Retail	2650	2120	530	141.3333333			65	9.2	2.0	18.4					
Day Care (Children)	750	490	260	100			45	4.5	2.0	9.0					
Day Care (Staff)				13			50	0.65	2.0	1.3					
Gym/Community Hall	450	370	80	50			100	5.0	2.0	10.0					
Supermarket (Retail)	2500	2000	300				15	30.0	2.0	60.0					
Supermarket (Staff)				5			50	0.25	2.0	0.5					
Supermarket (Office)	300	240					65	1.0	2.0	2.1					
Hotel (Visitor)	8950				202	180		36.4	2.0	72.7					
Hotel (Staff)				10			50	0.5	2.0	1.0					
Retail	450	360	90				65	0.5	2.0	0.9					
Woolshed Bar and Pizzeria	300	240	60				15	3.6	2.0	7.2					
TYPE 3 - Community Buildings									2.0						
Farmhouse (Neighbourhood A)		170	170	4.5 L Toilet & 4.5 l Basin - 4 use per hr, 11hrs a day + nominal tap use		900		0.9	2.0	1.8					
Hay Barn Bike Facilities (Neighbourhood D)		224	224			900		0.9	2.0	1.8					
WWTP and Property Maintenance Facilities (No Permanent Occupancy)		70	70			2000		2.0	2.0	4.0					
Community Park Changing Rooms (Neighbourhood D)				1			50	0.05	2.0	0.1					
TOTAL								**1002.9**		**2005.8**	**1728**	**1450.2**	**2900.4**	**5075.7**	

Table 2: Supply-Demand Summary

Total Demand (m3/day)	**1002.90**
Groundwater available (m3/day)	**1728.00**
Shortfall/Surplus (m3/day)	**725.10**

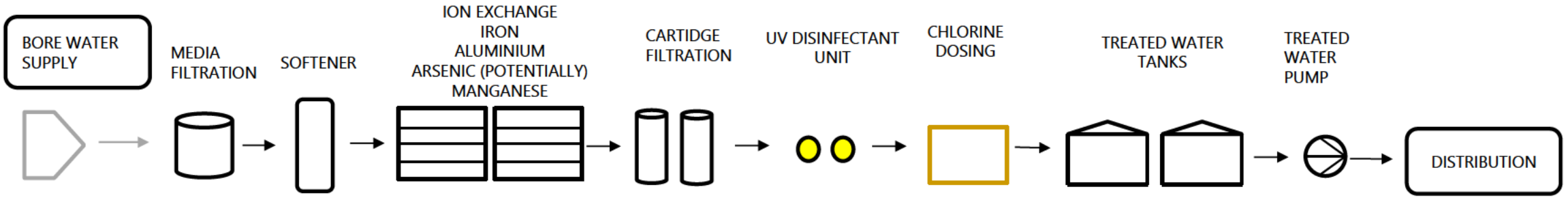
Table 3: Peak Supply-Demand Summary

Total Demand (m3/day)	**2005.81**
Groundwater available (m3/day)	**1728.00**
Shortfall/Surplus (m3/day)	**-277.81**

APPENDIX B

PFD OF RIDGEBURN WATER TREATMENT

PROCESS FLOW DIAGRAM – Gibbons Co - Groundwater Expert



APPENDIX C
WATER QUALITY RESULTS

Food & Water Testing

ANALYTICAL REPORT

REPORT CODE	AR-25-NC-037598-01	REPORT DATE	10/12/2025

Attention Gibbons Co
Cameron Hodgson
6 Vladuck Harbour Avenue
Level 2
1010 Auckland
NEW ZEALAND
Phone 00642108851148
Email [redacted]

Contact for your orders: James Thornton
Submission Reference: Bore sample
Order code: EUNZCH-00237134

SAMPLE CODE	817-2025-00115076		
Sample Reference	Groundwater 2852-140		
Reception Date & Time:	20/11/2025 13:03	**Reception temperature:**	7.9 °C
Analysis Started on:	20/11/2025	**Analysis Ending Date:**	10/12/2025
Product Type	ground water, raw water	**Sampler(s)**	David Whyte
Sampled Date & Time	20/11/2025 08:25		

		RESULTS		LOQ
⑨NC03Q	**Turbidity in Water by Nephelometry**			
	Turbidity	26	NTU	0.1
NC03R	**Nitrate-Nitrogen in Water by Discrete Analyser Calculation (Trace)**			
	Nitrate nitrogen	<0.01	mg/l	0.01
NC04E	**Chloride in Water by Discrete Analyser**			
	Chloride (Cl)	<5	mg/l	5
NC04H	**Nitrite Nitrogen (as N) by Discrete Analyser**			
	Nitrite Nitrogen as N	<0.01	mg/l	0.01
⑨NC05C	**Conductivity in Water by Portable Electrode**			
	Conductivity	864	µsecond/cm	5
NC0AE	**Total Suspended Solids in Water by Gravimetry**			
	Suspended Solids	14.1	mg/l	2.5
⑨NC0AK	**Ammoniacal Nitrogen by Discrete Analyser**			
	Ammonia nitrogen	0.01	mg/l	0.01
④NC217	**Alpha and Beta Particle Radioactivity**			
	Total Alpha Concentration	0.080	Bq/l	N/A
	Total Beta Concentration	0.27	Bq/l	N/A
②NW003	**Total Alkalinity**			
	Alkalinity total	267	mg CaCO3/l	1
②NW006	**Fluoride**			
	Fluoride	0.11	mg/l	0.02
②NW009	**Bromide**			
	Bromide	0.05	mg/l	0.02
②NW011	**Sulphate**			
	Sulphate	211	mg/l	0.02
②NW030	**Total Hardness**			
	Hardness	403	mg CaCO3/l	1
②NW08B	**Temperature**			

		RESULTS		LOQ
②NW08B	**Temperature**			
	Temperature	22.1	°C	0.1
②NW109	**Dissolved Iron**			
	Iron (Fe)	0.006	mg/l	0.005
②NW113	**Dissolved Manganese**			
	Manganese (Mn)	0.119	mg/l	0.0005
②NW147	**Total Aluminium**			
	Aluminium	0.464	mg/l	0.005
②NW148	**Total Antimony**			
	Antimony (Sb)	<0.002	mg/l	0.002
②NW149	**Total Arsenic**			
	Arsenic (As)	0.004	mg/l	0.002
②NW150	**Total Barium**			
	Barium (Ba)	0.025	mg/l	0.005
②NW153	**Total Boron**			
	Boron (B)	<0.05	mg/l	0.05
②NW154	**Total Cadmium**			
	Cadmium (Cd)	<0.001	mg/l	0.001
②NW156	**Total Calcium**			
	Calcium (Ca)	101	mg/l	0.1
②NW157	**Total Chromium**			
	Chromium (Cr)	0.007	mg/l	0.001
②NW159	**Total Copper**			
	Copper (Cu)	0.006	mg/l	0.002
②NW160	**Total Iron**			
	Iron (Fe)	1.9	mg/l	0.1
②NW161	**Total Lead**			
	Lead (Pb)	<0.001	mg/l	0.001
②NW163	**Total Magnesium**			
	Magnesium (Mg)	36.4	mg/l	0.1
②NW164	**Total Manganese**			
	Manganese (Mn)	0.116	mg/l	0.001
②NW165	**Total Mercury**			
	Mercury (Hg)	<0.001	mg/l	0.001
②NW167	**Total Nickel**			
	Nickel (Ni)	0.004	mg/l	0.001
②NW168	**Total Potassium**			
	Potassium (K)	2.4	mg/l	0.1
②NW169	**Total Selenium**			
	Selenium (Se)	<0.005	mg/l	0.005
②NW171	**Total Sodium**			
	Sodium (Na)	11.8	mg/l	0.1
②NW195	**pH (Tested beyond 15 minute APHA holding time)**			
	pH	8.2		0.1
②NW199	**Sulphide**			
	Sulphide	0.6	mg/l	0.2
②NW203	**Silica**			
	Silica (SiO2)	13.8	mg/l	0.02

	RESULTS		LOQ
②NW210 **Total Non-Purgeable Organic Carbon**			
Total Organic Carbon	0.6	mg/l	0.1
②NW331 **Colour**			
Colour	<5	Colour unit	5
③NW339 **Total Dissolved Solids**			
Total dissolved Solids	425	mg/l	1
②NW352 **Hydrogen Sulphide**			
Sulphide	<0.05	mg/l	0.05
②NW581 **Uranium - Total**			
Uranium (U)	0.005	mg/l	0.001
③NW671 **Dissolved (NP) Organic Carbon**			
Carbon	0.5	mg/l	0.1
⑤NW801 **Radon-222 Concentration**			
radioactivity	3.1	Bq/l	1.9
ZMLZ6 **Enumeration of Escherichia coli and Total Coliforms by Membrane Filtration**			
Escherichia coli	<1	cfu/100 ml	1
Total Coliforms	<1	cfu/100 ml	1

LIST OF METHODS

NC03Q **Turbidity in Water by Nephelometry:** APHA 24th Edition 2130 B mod.
* Test was performed at 142 Esk Street, Invercargill

NC03R **Nitrate-Nitrogen in Water by Discrete Analyser Calculation (Trace):** Calculated, Calculation [(Nitrate-N + Nitrite-N) - Nitrite-N]
* Test was performed at 142 Esk Street, Invercargill

NC04E **Chloride in Water by Discrete Analyser:** APHA 24th Edition 4500-Cl E
* Test was performed at 142 Esk Street, Invercargill

NC04H **Nitrite Nitrogen (as N) by Discrete Analyser:** APHA 24th Edition 4500-NO2- B
* Test was performed at 142 Esk Street, Invercargill

NC05C **Conductivity in Water by Portable Electrode:** APHA 24th Edition 2510 B
* Test was performed at 142 Esk Street, Invercargill

NC0AE **Total Suspended Solids in Water by Gravimetry:** APHA 24th Edition 2540 D
* Test was performed at 142 Esk Street, Invercargill

NC0AK **Ammoniacal Nitrogen by Discrete Analyser:** ISBN 0117516139 mod.
* Test was performed at 142 Esk Street, Invercargill

NC217 **Alpha and Beta Particle Radioactivity:**

NW003 **Total Alkalinity:** APHA 24th Edition 2320 B

NW006 **Fluoride:** APHA 24th Edition 4110 B

NW009 **Bromide:** APHA 24th Edition 4110 B

NW011 **Sulphate:** APHA 24th Edition 4110 B

NW030 **Total Hardness:** APHA 24th Edition 2340 B

NW08B **Temperature:** APHA 24th Edition 2550 B

NW109 **Dissolved Iron:** APHA 24th Edition 3125 B mod.

NW113 **Dissolved Manganese:** APHA 24th Edition 3125 B mod.

NW147 **Total Aluminium:** APHA 24th Edition 3125 B mod.

NW148 **Total Antimony:** APHA 24th Edition 3125 B mod.

NW149 **Total Arsenic:** APHA 24th Edition 3125 B mod.

NW150 **Total Barium:** APHA 24th Edition 3125 B mod.

NW153 **Total Boron:** APHA 24th Edition 3125 B mod.

NW154 **Total Cadmium:** APHA 24th Edition 3125 B mod.

NW156 **Total Calcium:** APHA 24th Edition 3125 B mod.

NW157 **Total Chromium:** APHA 24th Edition 3125 B mod.

NW159 **Total Copper:** APHA 24th Edition 3125 B mod.

NW160 **Total Iron:** APHA 24th Edition 3125 B mod.

NW161 **Total Lead:** APHA 24th Edition 3125 B mod.

NW163 **Total Magnesium:** APHA 24th Edition 3125 B mod.

NW164 **Total Manganese:** APHA 24th Edition 3125 B mod.

NW165 **Total Mercury:** APHA 24th Edition 3125 B mod.

NW167 **Total Nickel:** APHA 24th Edition 3125 B mod.

NW168 **Total Potassium:** APHA 24th Edition 3125 B mod.

NW169 **Total Selenium:** APHA 24th Edition 3125 B mod.

NW171 **Total Sodium:** APHA 24th Edition 3125 B mod.

NW195 **pH (Tested beyond 15 minute APHA holding time):** APHA 24th Edition 4500-H B

NW199 **Sulphide:** APHA 24th Edition 4500-S^{2-} B, C, F

NW203 **Silica:** APHA 24th Edition 3120 B mod.

NW210	**Total Non-Purgeable Organic Carbon:** APHA 24th Edition 5310 B	NW331	**Colour:** APHA 24th Edition 2120 C
NW339	**Total Dissolved Solids:** Internal Method, Gravimetry	NW352	**Hydrogen Sulphide:** APHA 24th Edition 4500 S2 H
NW581	**Uranium - Total:** APHA 24th Edition 3125 B mod.	NW671	**Dissolved (NP) Organic Carbon:** APHA 24th Edition 5310 B,C
NW801	**Radon-222 Concentration:** Method of the subcontractor (subcontract)	ZMLZ6	**Escherichia coli-Total Coliforms E [IVC] <1 >80 cfu/100 ml (0) MI Agar-F:** SMEWW 9222K; APHA 24th Edition * Test was performed at 142 Esk Street, Invercargill

Signature

Tonia Bulling Head of Southern Laboratory (K T P)

David Hoekendijk Team Lead Eurofins ELS Limited

EXPLANATORY NOTE

①Test is not accredited
②Test is subcontracted within Eurofins group and is accredited
③Test is subcontracted within Eurofins group and is not accredited
④Test is subcontracted outside Eurofins group and is accredited
⑤Test is subcontracted outside Eurofins group and is not accredited
⑥Test result is provided by the customer and is not accredited
⑦Tested at the sampling point by Eurofins and is not accredited
⑧Tested at the sampling point by Eurofins and is accredited
⑨Test is RLP accredited
⑩Test is subcontracted within Eurofins group and is RLP accredited

N/A means Not Applicable
Not Detected means not detected at or above the Limit of Quantification (LOQ)
LOQ means Limit of Quantification and the unit of LOQ is the same as the result unit
✗ (Unsatisfactory) means does not meet the specification
✓ (Satisfactory) means meets the specification
MAV means Maximum Allowable Value

The Customer acknowledges and accepts that: (a) where Eurofins is not responsible for sampling, the test result(s) in this report apply only to the sample as received. Customer is solely responsible for the sampling process and warrants that the sample provided to Eurofins is representative of the lot / batch from which the samples were drawn; and (b) Eurofins expresses no opinion and accepts no liability in respect of the Customer's production process or homogeneity of the product.
The tests are identified by a five-digit code, their description is available on request.
Accreditation does not apply to comments or graphical representations.
Unless otherwise stated, all tests in this analytical report (except for subcontracted tests) are performed at Unit 1/74 Glenda Drive, Frankton, Queenstown.
The laboratory is not responsible for the information provided by the customer which can affect the validity of the results, for example: sampling information such as date/time, field data etc.
Eurofins may subcontract the performance of part or all of the Services to a third party and the Customer authorises the release of all information necessary to the third party for the provision of the Services.
All samples become the property of Eurofins to the extent necessary for the performance of the Services.
Eurofins will not be required to store samples and may destroy or otherwise dispose of the samples or return the samples to the Customer (at the Customer's cost in all respects) immediately following analysis of the samples.
If the Customer pays for storage of the samples Eurofins will take commercially reasonable steps to store the samples for the agreed period in terms of industry practice.
The Eurofins water sampling service follows methodology based on AS/NZS 5667 and / or best practice to collect and transport samples that are fit for the purpose of analytical testing. The laboratory is not responsible for sampling activities unless explicitly indicated by the statement "Sampled by Eurofins" on the report for water samples.
The Customer acknowledges that the Services are provided using the current state of technology and methods developed and generally applied by Eurofins and involve analysis, interpretations, consulting work and conclusions. Eurofins shall use commercially reasonable degree of care in providing the Services.
This report is produced and issued on the basis of information, documents and/or samples provided by, or on behalf of, the Customer and solely for the benefit of the Customer who is responsible for acting as it sees fit on the basis of this report. Neither Eurofins nor any of its officers, employees, agents or subcontractors shall be liable to the Customer nor any third party for any actions taken or not taken on the basis of this report nor for any incorrect results arising from unclear, erroneous, incomplete, misleading or false information provided to Eurofins.
The Customer shall not alter any report or other Output provided to the Customer by Eurofins or misrepresent the contents of such Outputs in any way. The Customer shall be entitled to make copies for its internal purposes only.
The Customer may only reproduce or publish any report or document provided to the Customer by Eurofins in full without alteration. Eurofins' name, logo or service marks, or any other means of identification cannot be used in any publication by the Customer, unless the Customer has obtained the prior written consent of Eurofins.
Eurofins shall have no liability for any indirect or consequential loss including, without limitation, loss of production, loss of contracts, loss of profits, loss of business or costs incurred from business interruption, loss of opportunity, loss of goodwill or damage to reputation and cost of product recall (including any losses suffered as a result of distribution of the Customer's products subject of the Services prior to the report being released by Eurofins). It shall further have no liability for any loss, damage or expenses arising from the claims of any third party (including, without limitation, product liability claims) that may be incurred by the Customer.
Eurofins General Terms and Conditions apply.

END OF REPORT

EUROFINS ELS LIMITED IS A MINISTRY FOR PRIMARY INDUSTRIES RECOGNISED LABORATORY UNDER SECTION 101 OF THE ANIMAL PRODUCTS ACT:1999.

Food & Water Testing

ANALYTICAL REPORT

REPORT CODE	AR-25-NC-038777-01	REPORT DATE	18/12/2025

Attention Gibbons Co
Cameron Hodgson
6 Vladuck Harbour Avenue
Level 2
1010 Auckland
NEW ZEALAND
Phone 00642108851148
Email [redacted]

Contact for your orders: James Thornton
Submission Reference: bore sample
Order code: EUNZCH-00238655

SAMPLE CODE	817-2025-00120204		
Sample Reference	Groundwater B5 Bore		
Reception Date & Time:	03/12/2025 12:00	**Reception temperature:**	11.1 °C
Analysis Started on:	03/12/2025	**Analysis Ending Date:**	18/12/2025
Product Type	ground water, raw water	**Sampler(s)**	David Whyte
Sampled Date & Time	03/12/2025 09:10		

		RESULTS		LOQ
⑨NC03Q	**Turbidity in Water by Nephelometry**			
	Turbidity	7.7	NTU	0.1
NC03R	**Nitrate-Nitrogen in Water by Discrete Analyser Calculation (Trace)**			
	Nitrate nitrogen	<0.01	mg/l	0.01
NC04E	**Chloride in Water by Discrete Analyser**			
	Chloride (Cl)	<5	mg/l	5
NC04H	**Nitrite Nitrogen (as N) by Discrete Analyser**			
	Nitrite Nitrogen as N	<0.01	mg/l	0.01
⑨NC05C	**Conductivity in Water by Portable Electrode**			
	Conductivity	719	µsecond/cm	5
NC0AE	**Total Suspended Solids in Water by Gravimetry**			
	Suspended Solids	<2.5	mg/l	2.5
⑨NC0AK	**Ammoniacal Nitrogen by Discrete Analyser**			
	Ammonia nitrogen	0.07	mg/l	0.01
④NC217	**Alpha and Beta Particle Radioactivity**			
	Total Alpha Concentration	0.357	Bq/l	N/A
	Total Beta Concentration	0.42	Bq/l	N/A
②NW003	**Total Alkalinity**			
	Alkalinity total	278	mg CaCO3/l	1
②NW006	**Fluoride**			
	Fluoride	0.07	mg/l	0.02
②NW009	**Bromide**			
	Bromide	0.04	mg/l	0.02
②NW011	**Sulphate**			
	Sulphate	102	mg/l	0.02
②NW030	**Total Hardness**			
	Hardness	344	mg CaCO3/l	1
②NW08B	**Temperature**			

		RESULTS		LOQ
②NW08B	**Temperature**			
	Temperature	20.4	°C	0.1
②NW109	**Dissolved Iron**			
	Iron (Fe)	<0.005	mg/l	0.005
②NW113	**Dissolved Manganese**			
	Manganese (Mn)	0.0392	mg/l	0.0005
②NW147	**Total Aluminium**			
	Aluminium	<0.005	mg/l	0.005
②NW148	**Total Antimony**			
	Antimony (Sb)	0.003	mg/l	0.002
②NW149	**Total Arsenic**			
	Arsenic (As)	<0.002	mg/l	0.002
②NW150	**Total Barium**			
	Barium (Ba)	0.040	mg/l	0.005
②NW153	**Total Boron**			
	Boron (B)	0.12	mg/l	0.05
②NW154	**Total Cadmium**			
	Cadmium (Cd)	<0.001	mg/l	0.001
②NW156	**Total Calcium**			
	Calcium (Ca)	96.0	mg/l	0.1
②NW157	**Total Chromium**			
	Chromium (Cr)	<0.001	mg/l	0.001
②NW159	**Total Copper**			
	Copper (Cu)	<0.002	mg/l	0.002
②NW160	**Total Iron**			
	Iron (Fe)	0.5	mg/l	0.1
②NW161	**Total Lead**			
	Lead (Pb)	<0.001	mg/l	0.001
②NW163	**Total Magnesium**			
	Magnesium (Mg)	25.4	mg/l	0.1
②NW164	**Total Manganese**			
	Manganese (Mn)	0.041	mg/l	0.001
②NW165	**Total Mercury**			
	Mercury (Hg)	<0.001	mg/l	0.001
②NW167	**Total Nickel**			
	Nickel (Ni)	0.010	mg/l	0.001
②NW168	**Total Potassium**			
	Potassium (K)	3.8	mg/l	0.1
②NW169	**Total Selenium**			
	Selenium (Se)	<0.005	mg/l	0.005
②NW171	**Total Sodium**			
	Sodium (Na)	32.8	mg/l	0.1
②NW195	**pH (Tested beyond 15 minute APHA holding time)**			
	pH	7.6		0.1
②NW199	**Sulphide**			
	Sulphide	<0.2	mg/l	0.2
②NW203	**Silica**			
	Silica (SiO2)	13.3	mg/l	0.02

		RESULTS		LOQ
②NW210	**Total Non-Purgeable Organic Carbon**			
	Total Organic Carbon	0.5	mg/l	0.1
②NW331	**Colour**			
	Colour	<5	Colour unit	5
③NW339	**Total Dissolved Solids**			
	Total dissolved Solids	353	mg/l	1
②NW352	**Hydrogen Sulphide**			
	Sulphide	<0.05	mg/l	0.05
②NW581	**Uranium - Total**			
	Uranium (U)	0.009	mg/l	0.001
③NW671	**Dissolved (NP) Organic Carbon**			
	Carbon	0.4	mg/l	0.1
⑤NW801	**Radon-222 Concentration**			
	radioactivity	6.2	Bq/l	1.9
ZMLZ6	**Enumeration of Escherichia coli and Total Coliforms by Membrane Filtration**			
	Escherichia coli	<1	cfu/100 ml	1
	Total Coliforms	1	cfu/100 ml	1

LIST OF METHODS

NC03Q **Turbidity in Water by Nephelometry:** APHA 24th Edition 2130 B mod.
* Test was performed at 142 Esk Street, Invercargill

NC03R **Nitrate-Nitrogen in Water by Discrete Analyser Calculation (Trace):** Calculated, Calculation [(Nitrate-N + Nitrite-N) - Nitrite-N]
* Test was performed at 142 Esk Street, Invercargill

NC04E **Chloride in Water by Discrete Analyser:** APHA 24th Edition 4500-Cl E
* Test was performed at 142 Esk Street, Invercargill

NC04H **Nitrite Nitrogen (as N) by Discrete Analyser:** APHA 24th Edition 4500-NO2- B
* Test was performed at 142 Esk Street, Invercargill

NC05C **Conductivity in Water by Portable Electrode:** APHA 24th Edition 2510 B
* Test was performed at 142 Esk Street, Invercargill

NC0AE **Total Suspended Solids in Water by Gravimetry:** APHA 24th Edition 2540 D
* Test was performed at 142 Esk Street, Invercargill

NC0AK **Ammoniacal Nitrogen by Discrete Analyser:** ISBN 0117516139 mod.
* Test was performed at 142 Esk Street, Invercargill

NC217 **Alpha and Beta Particle Radioactivity:**

NW003 **Total Alkalinity:** APHA 24th Edition 2320 B

NW006 **Fluoride:** APHA 24th Edition 4110 B

NW009 **Bromide:** APHA 24th Edition 4110 B

NW011 **Sulphate:** APHA 24th Edition 4110 B

NW030 **Total Hardness:** APHA 24th Edition 2340 B

NW08B **Temperature:** APHA 24th Edition 2550 B

NW109 **Dissolved Iron:** APHA 24th Edition 3125 B mod.

NW113 **Dissolved Manganese:** APHA 24th Edition 3125 B mod.

NW147 **Total Aluminium:** APHA 24th Edition 3125 B mod.

NW148 **Total Antimony:** APHA 24th Edition 3125 B mod.

NW149 **Total Arsenic:** APHA 24th Edition 3125 B mod.

NW150 **Total Barium:** APHA 24th Edition 3125 B mod.

NW153 **Total Boron:** APHA 24th Edition 3125 B mod.

NW154 **Total Cadmium:** APHA 24th Edition 3125 B mod.

NW156 **Total Calcium:** APHA 24th Edition 3125 B mod.

NW157 **Total Chromium:** APHA 24th Edition 3125 B mod.

NW159 **Total Copper:** APHA 24th Edition 3125 B mod.

NW160 **Total Iron:** APHA 24th Edition 3125 B mod.

NW161 **Total Lead:** APHA 24th Edition 3125 B mod.

NW163 **Total Magnesium:** APHA 24th Edition 3125 B mod.

NW164 **Total Manganese:** APHA 24th Edition 3125 B mod.

NW165 **Total Mercury:** APHA 24th Edition 3125 B mod.

NW167 **Total Nickel:** APHA 24th Edition 3125 B mod.

NW168 **Total Potassium:** APHA 24th Edition 3125 B mod.

NW169 **Total Selenium:** APHA 24th Edition 3125 B mod.

NW171 **Total Sodium:** APHA 24th Edition 3125 B mod.

NW195 **pH (Tested beyond 15 minute APHA holding time):** APHA 24th Edition 4500-H B

NW199 **Sulphide:** APHA 24th Edition 4500-S^{2-} B, C, F

NW203 **Silica:** APHA 24th Edition 3120 B mod.

NW210	**Total Non-Purgeable Organic Carbon:** APHA 24th Edition 5310 B	NW331	**Colour:** APHA 24th Edition 2120 C
NW339	**Total Dissolved Solids:** Internal Method, Gravimetry	NW352	**Hydrogen Sulphide:** APHA 24th Edition 4500 S2 H
NW581	**Uranium - Total:** APHA 24th Edition 3125 B mod.	NW671	**Dissolved (NP) Organic Carbon:** APHA 24th Edition 5310 B,C
NW801	**Radon-222 Concentration:** Method of the subcontractor (subcontract)	ZMLZ6	**Escherichia coli-Total Coliforms E [IVC] <1 >80 cfu/100 ml (0) MI Agar-F:** SMEWW 9222K; APHA 24th Edition * Test was performed at 142 Esk Street, Invercargill

Signature

Tonia Bulling Head of Southern Laboratory (K T P)

Holly Mc Bride Laboratory Analyst Eurofins ELS Limited

Megan Cordiner Laboratory Analyst Eurofins ELS Limited

David Hoekendijk Team Lead Eurofins ELS Limited

EXPLANATORY NOTE

①Test is not accredited
②Test is subcontracted within Eurofins group and is accredited
③Test is subcontracted within Eurofins group and is not accredited
④Test is subcontracted outside Eurofins group and is accredited
⑤Test is subcontracted outside Eurofins group and is not accredited
⑥Test result is provided by the customer and is not accredited
⑦Tested at the sampling point by Eurofins and is not accredited
⑧Tested at the sampling point by Eurofins and is accredited
⑨Test is RLP accredited
⑩Test is subcontracted within Eurofins group and is RLP accredited

N/A means Not Applicable
Not Detected means not detected at or above the Limit of Quantification (LOQ)
LOQ means Limit of Quantification and the unit of LOQ is the same as the result unit
✗ (Unsatisfactory) means does not meet the specification
✓(Satisfactory) means meets the specification
MAV means Maximum Allowable Value

The Customer acknowledges and accepts that: (a) where Eurofins is not responsible for sampling, the test result(s) in this report apply only to the sample as received. Customer is solely responsible for the sampling process and warrants that the sample provided to Eurofins is representative of the lot / batch from which the samples were drawn; and (b) Eurofins expresses no opinion and accepts no liability in respect of the Customer's production process or homogeneity of the product.
The tests are identified by a five-digit code, their description is available on request.
Accreditation does not apply to comments or graphical representations.
Unless otherwise stated, all tests in this analytical report (except for subcontracted tests) are performed at Unit 1/74 Glenda Drive, Frankton, Queenstown.
The laboratory is not responsible for the information provided by the customer which can affect the validity of the results, for example: sampling information such as date/time, field data etc.
Eurofins may subcontract the performance of part or all of the Services to a third party and the Customer authorises the release of all information necessary to the third party for the provision of the Services.
All samples become the property of Eurofins to the extent necessary for the performance of the Services.
Eurofins will not be required to store samples and may destroy or otherwise dispose of the samples or return the samples to the Customer (at the Customer's cost in all respects) immediately following analysis of the samples.
If the Customer pays for storage of the samples Eurofins will take commercially reasonable steps to store the samples for the agreed period in terms of industry practice.
The Eurofins water sampling service follows methodology based on AS/NZS 5667 and / or best practice to collect and transport samples that are fit for the purpose of analytical testing. The laboratory is not responsible for sampling activities unless explicitly indicated by the statement "Sampled by Eurofins" on the report for water samples.
The Customer acknowledges that the Services are provided using the current state of technology and methods developed and generally applied by Eurofins and involve analysis, interpretations, consulting work and conclusions. Eurofins shall use commercially reasonable degree of care in providing the Services.
This report is produced and issued on the basis of information, documents and/or samples provided by, or on behalf of, the Customer and solely for the benefit of the Customer who is responsible for acting as it sees fit on the basis of this report. Neither Eurofins nor any of its officers, employees, agents or subcontractors shall be liable to the Customer nor any third party for any actions taken or not taken on the basis of this report nor for any incorrect results arising from unclear, erroneous, incomplete, misleading or false information provided to Eurofins.
The Customer shall not alter any report or other Output provided to the Customer by Eurofins or misrepresent the contents of such Outputs in any way. The Customer shall be entitled to make copies for its internal purposes only.
The Customer may only reproduce or publish any report or document provided to the Customer by Eurofins in full without alteration. Eurofins' name, logo or service marks, or any other means of identification cannot be used in any publication by the Customer, unless the Customer has obtained the prior written consent of Eurofins.
Eurofins shall have no liability for any indirect or consequential loss including, without limitation, loss of production, loss of contracts, loss of profits, loss of business or costs incurred from business interruption, loss of opportunity, loss of goodwill or damage to reputation and cost of product recall (including any losses suffered as a result of distribution of the Customer's products subject of the Services prior to the report being released by Eurofins). It shall further have no liability for any loss, damage or expenses arising from the claims of any third party (including, without limitation, product liability claims) that may be incurred by the Customer.
Eurofins General Terms and Conditions apply.

END OF REPORT

EUROFINS ELS LIMITED IS A MINISTRY FOR PRIMARY INDUSTRIES RECOGNISED LABORATORY UNDER SECTION 101 OF THE ANIMAL PRODUCTS ACT:1999.

APPENDIX D
GROUNDWATER SUPPLY TECHNICAL MEMO, TERRA AQUA CONSULTANTS LIMITED

Terra Aqua Consultants Limited

31 Oxford Street, Fairfield, Hamilton 3214

Mob: 021 664 559

11 December 2025

Technical Memo on Groundwater Supply

Ridgeburn – Arrowtown Junction

Cameroon Hodgson final via email

Attention: Cameron

Subject: Groundwater supply for development

The purpose of this memo is to outline the groundwater supply options for the Ridgeburn Development. This follows a drilling programme focused on suitable drilling targets as identified by geophysical methods summarised in a report prepared by Aquifer Mapping[1]. This identified five potential locations targeting the Morven Aquifer and the Kawarau alluvial ribbon aquifer. Some deeper target zones were also identified within the schist rock (unnamed aquifer).

1.1 Potential aquifers

The area in general has potential shallow aquifers which comprise of shallow alluvial deposits of silty gravels sitting on top of schist rock. One such system is known as the Morven Aquifer, formed from glacial outwash and alluvial gravels. This is often targeted by shallow (< 30m deep) bores and wells (up to 1000mm in diameter) to supply domestic and stock water. These types of aquifers are typically low yield and are commonly in direct contact with surface water bodies. Recharge is by rainfall, snow melt and interaction with surface water bodies. Within the area mapped as Morven Aquifer, there are numerous bores and wells indicated on the Otago Regional Council maps website.

Given the limited mapped extent of this aquifer and the limited recharge volumes it is unlikely to be a suitable target for the developments water requirements.

The Kawarau ribbon alluvial aquifer is a sequence of narrow elongated aquifers along the margins of the Kawarau River. These are formed from glacial and river deposited gravels which are typically “cleaner” with less silt fines than the gravels forming the Morven Aquifer.

Schist Rock which underlies the gravel deposits can produce suitable yields if the hole intersects a suitable fracture system.

1.2 Results of drilling

Drilling focussed on the five targets identified by the geophysical report. The target depths ranged between 50 and 100m with predicted sustainable yields of between 1.9 to 2.5 L/s. Drilling started at location 8 and the hole did not produce any significant water down to a depth of 100m.

Similar results were found at the next two locations drilled (89 and 122[2]).

[1] Geophysical Aquifer Modelling Queenstown Survey 2025.

[2] Numbers from the geophysical report.

The next location drilled was 140 and this produced a reasonably promising airlift yield. This was developed and then a submersible pump installed to conduct a step test and a constant rate test[3]. Results are reported below. Water quality samples were collected towards the end of the constant rate testing and submitted to Eurofins for analysis. GWE are reporting this information.

Following the success of 140, it was determined that a potentially better location was not far away (Hole 5) and this was drilled to a depth of 100m. There was a thin layer of silts overlying a sequence of gravels and then schist rock was encountered at a depth of approximately 31m. Drilling continued to a depth of 100m, and several “soft” zones were encountered indicating potential fracture zones. The most significant zone was encountered between 41 to 43m with a large (for Otago standards) flow of water resulted.

The hole was developed and then a submersible pump installed to conduct a step test and 24-hour constant rate test. Results were very promising indeed. The flow rate was limited due to the bore construction, with only one casing string installed to 33m meaning the pump could not be lower than 38m.

Results are reported below. Water quality samples were collected towards the end of the constant rate testing and submitted to Eurofins for analysis. GWE are reporting this information.

1.3 140 test results

The analysis of the drawdown data confirm that this bore has the potential to supply at up to 600 m^3/d.

The constant rate data is summarised in Figure 1. The slightly irregular drawdown plot is due to small flucuations in flow rate over the 24-hour period. Flow fluctuated between 7.2 and 6.25 l/s. Based upon this data the aquifer here has a late time transmissivity calculated at 105.5 m2/d for the drawdown and 88.8 m2/d for the recovery data shown in Figure 2.

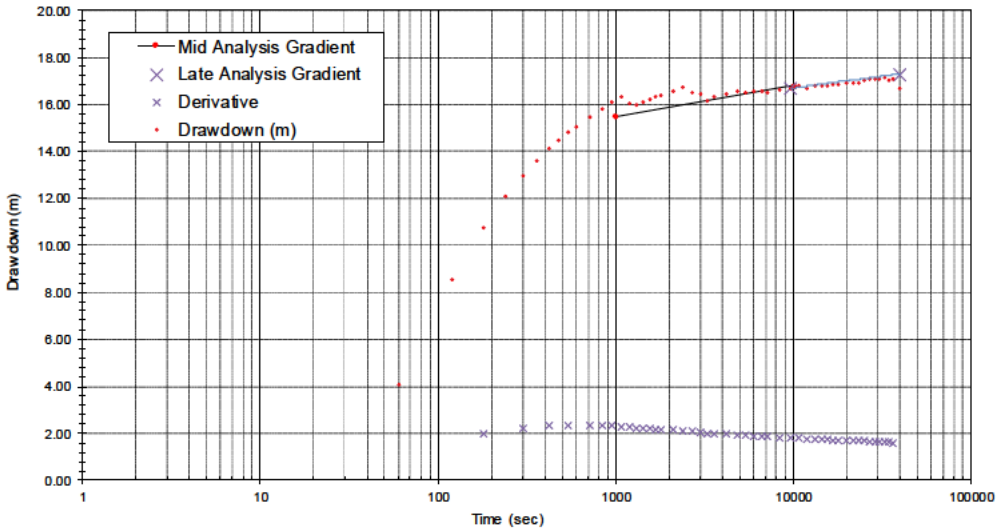
1.4 Hole 5 test results

The analysis of the drawdown data confirm that this bore has the potential with a suspended 150mm diameter casing installed to a depth of 60+m to supply at up to 1,128 m^3/d.

The constant rate data (manual readings only avaliable to date) is summarised in Figure 3. Based upon this data the aquifer here has a late time transmissivity calculated at 211 m^2/d for the drawdown and 76 m^2/d for the recovery data shown in Figure 4.

[3] Testing was done by South Drill and the data provided to Terra Aqua Consultants Limited for analysis.

Cooper-Jacob Analysis Drawdown in 140



Conditions for Analysis

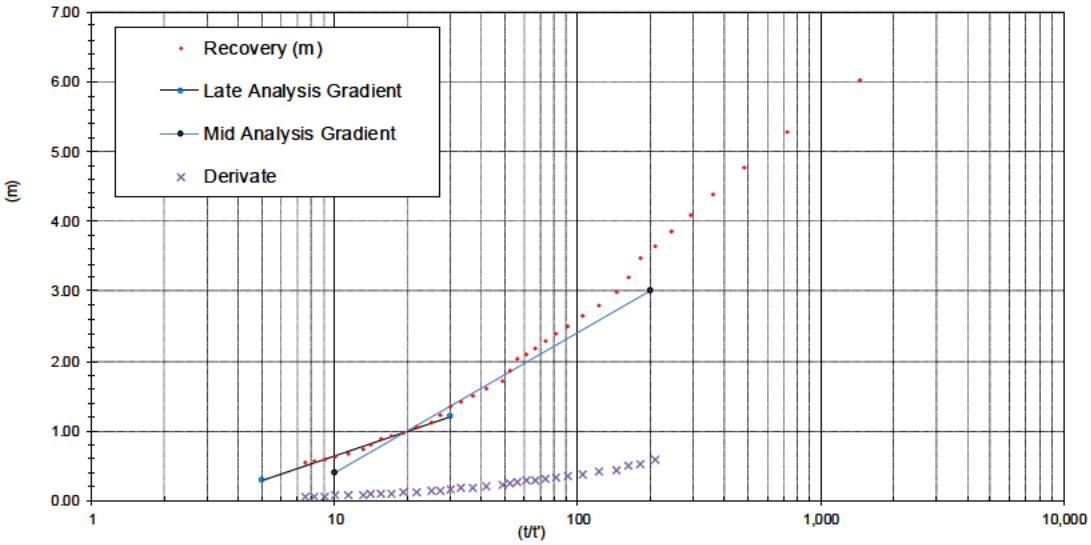
if $t > 25r_c^2/T$ well storage is neglected.	273 seconds	
If $t < cS/20$ then leakage is negligible.	89 seconds	(c assumed at 1,000 days)

INPUTS

Parameter	Source	Symbol	Value	Unit
Flow Rate	Measured	Q =	561.6	$m^3 d^{-1}$
Casing Diameter	Measured	d_c =	0.200	m
Annulus Diameter	Measured	d_w =	0.250	m
Screen / Open Hole Length	Measured	L =		m
Depth Information				
Depth to Water Level	Measured		9.22	m
Top of Aquifer	From drill log		34.4	m
Base of Aquifer / Hole	From drill log		37.4	m
Aquifer Thickness	Calculated	b =	3	m
Transmissivity (Mid)	Calculated	T =	79.07	$m^2 d^{-1}$
Transmissivity (Late)	Calcuated	T =	105.53	$m^2 d^{-1}$
Hydraulic Conductivity	Calcuated	k =	26.36	m/d
Storativity	Estimated	S =	2.07E-05	
Mid Analysis Gradient				
(t_1,s_1)	Measured	1000	15.5	
(t_2,s_2)	Measured	10000	16.8	
Drawdown per log cycle	Calculated	Δs	1.300	
Late Analysis Gradient				
(t_1,s_1)	Measured	9680	16.7	
(t_2,s_2)	Measured	40000	17.3	
Drawdown per log cycle	Calculated	Δs	0.974	

Figure 1 Drawdown in 140.

Cooper-Jacob Analysis Recovery in 140



Conditions for Analysis

if t' > $25r_c^2/T$ well storage is neglected.	4 minutes	
If t < cS/20 then leakage is negligible.	1 minutes	(c assumed at 1,000 days)

INPUTS

Parameter	Source	Symbol	Value	Unit
Flow Rate	Measured	Q =	561.6	$m^3 d^{-1}$
Casing Diameter	Measured	d_c =	0.200	m
Annulus Diameter	Measured	d_w =	0.250	m
Screen / Open Hole Length	Measured	L =	0.000	m

Depth Information

Depth to Water Level	Measured		9.22	m
Top of Aquifer	From drill log		34.4	m
Base of Aquifer / Hole	From drill log		37.4	m
Aquifer Thickness	Calculated	b =	3	m
Late Transmissivity	Calculated	T =	88.84	$m^2 d^{-1}$
Mid Transmissivity	Calculated	T =	51.45	$m^2 d^{-1}$
Hydraulic Conductivity	Calcuated	k =	2.96E+01	m/d
Storativity	Estimated	S =	2.07E-05	

Late Analysis Gradient

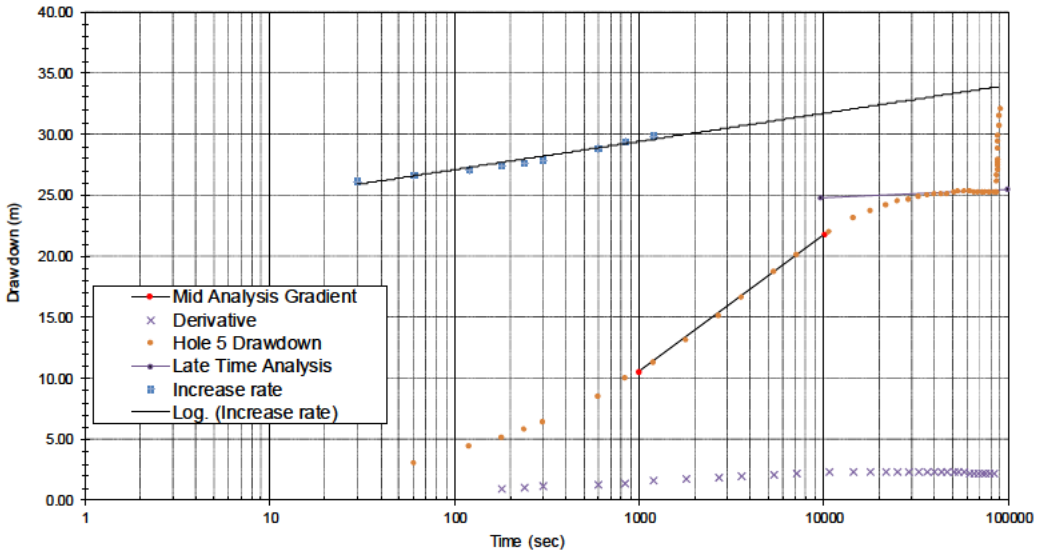
(t_1,s_1)	Measured	30	1.2
(t_2,s_2)	Measured	5	0.3
Drawdown per log cycle	Calculated	Δs	1.157

Mid Analysis Gradient

(t_1,s_1)	Measured	200	3
(t_2,s_2)	Measured	10	0.4
Drawdown per log cycle	Calculated	Δs	1.998

Figure 2 Recovery data for 140

Cooper-Jacob Analysis Drawdown in H5



Conditions for Analysis

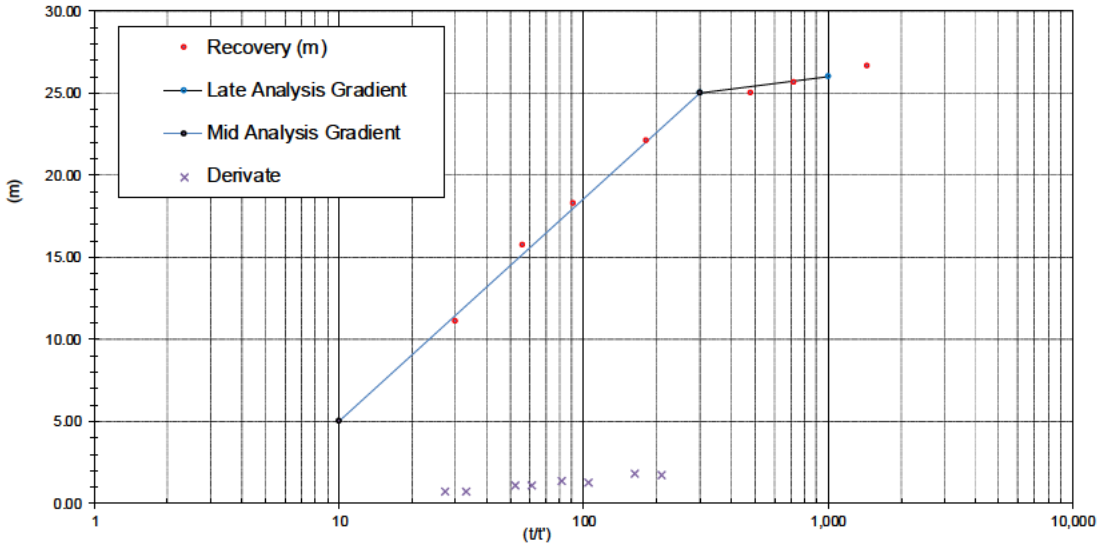
if $t > 25r_c^2/T$ well storage is neglected.	1663 seconds	
If $t < cS/20$ then leakage is negligible.	1,698 seconds	(c assumed at 1,000 days)

INPUTS

Parameter	Source	Symbol	Value	Unit
Flow Rate	Measured	Q =	794.9	$m^3 d^{-1}$
Casing Diameter	Measured	d_c =	0.200	m
Annulus Diameter	Measured	d_w =	0.250	m
Screen / Open Hole Length	Measured	L =	57.000	m
Depth Information				
Depth to Water Level	Measured		-0.28	m
Top of Aquifer	From drill log		43	m
Base of Aquifer / Hole	From drill log		100	m
Aquifer Thickness	Calculated	b =	57	m
Transmissivity (Mid)	Calculated	T =	12.99	$m^2 d^{-1}$
Transmissivity (Late)	Calcuated	T =	210.85	$m^2 d^{-1}$
Hydraulic Conductivity	Calcuated	k =	0.23	m/d
Storativity	Estimated	S =	3.93E-04	
Mid Analysis Gradient				
(t_1,s_1)	Measured	1000	10.6	
(t_2,s_2)	Measured	10000	21.8	
Drawdown per log cycle	Calculated	Δs	11.200	
Late Analysis Gradient				
(t_1,s_1)	Measured	9680	24.8	
(t_2,s_2)	Measured	100000	25.5	
Drawdown per log cycle	Calculated	Δs	0.690	

Figure 3 Drawdown data for Hole 5.

Cooper-Jacob Analysis Recovery in H5



Conditions for Analysis

if t' > $25r_c^2/T$ well storage is neglected.	5 minutes	
If t < cS/20 then leakage is negligible.	28 minutes	(c assumed at 1,000 days)

INPUTS

Parameter	Source	Symbol	Value	Unit
Flow Rate	Measured	Q =	794.9	$m^3 d^{-1}$
Casing Diameter	Measured	d_c =	0.200	m
Annulus Diameter	Measured	d_w =	0.250	m
Screen / Open Hole Length	Measured	L =	57.000	m
Depth Information				
Depth to Water Level	Measured		-0.28	m
Top of Aquifer	From drill log		43	m
Base of Aquifer / Hole	From drill log		100	m
Aquifer Thickness	Calculated	b =	57	m
Late Transmissivity	Calculated	T =	76.09	$m^2 d^{-1}$
Mid Transmissivity	Calculated	T =	10.75	$m^2 d^{-1}$
Hydraulic Conductivity	Calcuated	k =	1.33E+00	m/d
Storativity	Estimated	S =	3.93E-04	
Late Analysis Gradient				
(t_1,s_1)	Measured	1000	26	
(t_2,s_2)	Measured	300	25	
Drawdown per log cycle	Calculated	Δs	1.912	
Mid Analysis Gradient				
(t_1,s_1)	Measured	300	25	
(t_2,s_2)	Measured	10	5	
Drawdown per log cycle	Calculated	Δs	13.540	

Figure 1 Recovery data for Hole 5

1.5 Neighbouring bores

As indicated in section 1.1 there are many private bores and wells installed into the Morven Aquifer. Fortunately for this development the potential water supply bores are located over 1,500m away form any of them and the two aquifers are not in direct hydraulic connection. They are separated by a considerable difference in elevation and separated by an unknown number of low permeability zones (schist rock with no interconnected fractures). As such no further analysis is required to show that there are no effects on these bores from pumping in 140 and Hole 5.

The Kawarau ribbon alluvial aquifer bores are also unlikely to suffer from any interference drawdown effects from pumping at 140 and Hole 5. Table 1 summarises the known construction details of the bores within this aquifer and within 1,757 and 3,486m of Hole 5. Hole 5 is located 245m south of 140.

In Table 1 the yellow highlight indicates bores that are downstream from 140 and the green indicates bores that are upstream of Hole 5. The term up and down stream refers to the flow direction of the Kawarau River.

Table 1. Locations and known construction details of neighbouring bores

Bore ID or Address	NZTM		Distance (m)	Depth (mbg)	Cased to (mbg)	Diameter (mm)	Screen or open hole length (m)	Screen diameter (mm)	SWL (mbg)	Avaliable water column (m)	
	mE	mN									
CC11/0177	1271628	5008525	244.9	41.8	34.4	200	7.4	168	25.53	6.87	Bore 140
CC11/0178	1271231	5008467		50							Bore 122
CC11/0179	1271668	5009522		50							Bore 89
CC11/0180	1272647	5009985		100							Bore 15
CC11/0181	1272786	5009808		100							Bore 8
Hole 5	1271404	5008426	0.0	100	33	200	67	NA	-0.28	31.28	
Neighbouring bore distances from Hole 5											
F41/0532	1273128	5008087	1757.0	34.29	30.29	150	4	138	7.06	21.23	Barn Hill Limited
CC11/0117	1273382	5008013	2020.7	12	10.5				5.67	2.83	MSL Quad Limited
F41/0150	1272735	5009957	2028.7	11		1000	11				Eden J
CC11/0119	1273384	5007930	2041.2	48			48		2.23	2.23	MSL Quad Limited
F41/0369	1268710	5007912	2742.6	6.5			6.5		2.23	2.23	Sardis Nominees (No 2) Limited
F41/0331	1268667	5007619	2853.5	12	9		3		2.31	4.69	Lake Hayes Estate LImited
F41/0147	1268236	5007274	3371.0				0				Russell Jones
CC11/0109	1268131	5007226	3486.0	10.4			10.4		4.14	4.14	District Council

Given the differences in elevation, depths, horizontal distance between the bores and the fact that the water from Bore 5 is not from the Kawarau alluvial ribbon aquifer but the schist rock it is considered unlikely that any significant drawdown effects will be seen in any of the identified neighbouring bores.

1.6 Water quality

The water quality has been determined through detailed analysis of samples from both bores and from the Kawarau River. Visually the water from both bores looks to be very good, although clearly it has elevated iron and manganese levels.

Photograph 1 High turbidity water during the step test on 140.

Photograph 2 Much clear and lower turbidity water near end of constant rate test in 140

Photograph 3 Low turbidity water from Hole 5 near end of constant rate test.

1.7 Conclusion

In conclusion, there is probably sufficient data (from a combination of data logger and manual readings) to do an adequate preliminary analysis. However, given that the construction of Hole 5 will be altered before a production pump is installed the indicated volume and flow rate should be viewed with caution at this point. It can be said however, that the development can be potentially supply with groundwater at this point.

Terra Aqua Consultants Limited

David Whyte

Principal Hydrogeologist