

2021/22 Groundwater quality monitoring

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For the latest available results go to the [Greater Wellington environmental data hub](#).

This [web report](#) may be cited as: GW 2022. Groundwater quality monitoring report 2021/22. Greater Wellington.

Programme overview

Groundwater in the Wellington region is used extensively for drinking water, stock supply, irrigation and industry. Groundwater also provides baseflow to rivers, streams and wetlands, or forms natural springs or seeps where it discharges at the ground's surface. The protection of these surface water ecosystems requires careful management of the quality and quantity of the underlying groundwater.

To assist with the sustainable management of groundwater resources in the Wellington region, Greater Wellington conducts regular monitoring of groundwater quality at 81 sites across the region, shown on the map below. Three key indicators of groundwater contamination (typically arising from land use intensification and/or on-site wastewater disposal systems) are presented in this report:

- [Nitrate-nitrogen](#) - a key indicator of groundwater contamination typically arising from land use intensification and/or on-site wastewater disposal systems. Nitrate in groundwater can affect its quality for drinking-water supply. The Drinking Water Standard New Zealand (DWSNZ) sets a Maximum Acceptable Value (MAV) for nitrate at 50 mg/L (equivalent to nitrate-nitrogen of 11.3 mg/L), based on a risk to bottle-fed babies ([MoH, 2018](#)).
- [E. coli bacteria](#) - a key indicator of groundwater contamination by microorganisms, some of which can cause diseases. Faecal bacteria from livestock, onsite wastewater discharges, stormwater and other sources can contaminate groundwater. Any detection of 1 cfu/100 ml exceeds the DWSNZ ([MoH, 2018](#)).
- [Saline intrusion](#) - a key indicator for seawater contamination in coastal wells. The difference in conductivity between seawater and fresh groundwater is very marked, making it a useful indicator.
- [Chemistry](#) - Major ion chemistry can provide information about the recharge sources of the groundwater, residence time in the aquifer and groundwater flow patterns.

Monitoring network

Groundwater quality monitoring wells are spread across the region, with the total number of wells in each of the five Whaitua (main river) catchments listed below:

- Ruamāhanga - 50 (7 of which are not included in this report due to 3-yearly sampling).
- Kāpiti Coast - 15.
- Te Whanganui-a-Tara (Wellington and Hutt Valley) - 14.
- Wairarapa Coast - 1.
- Te Awarua-o-Porirua - 1.

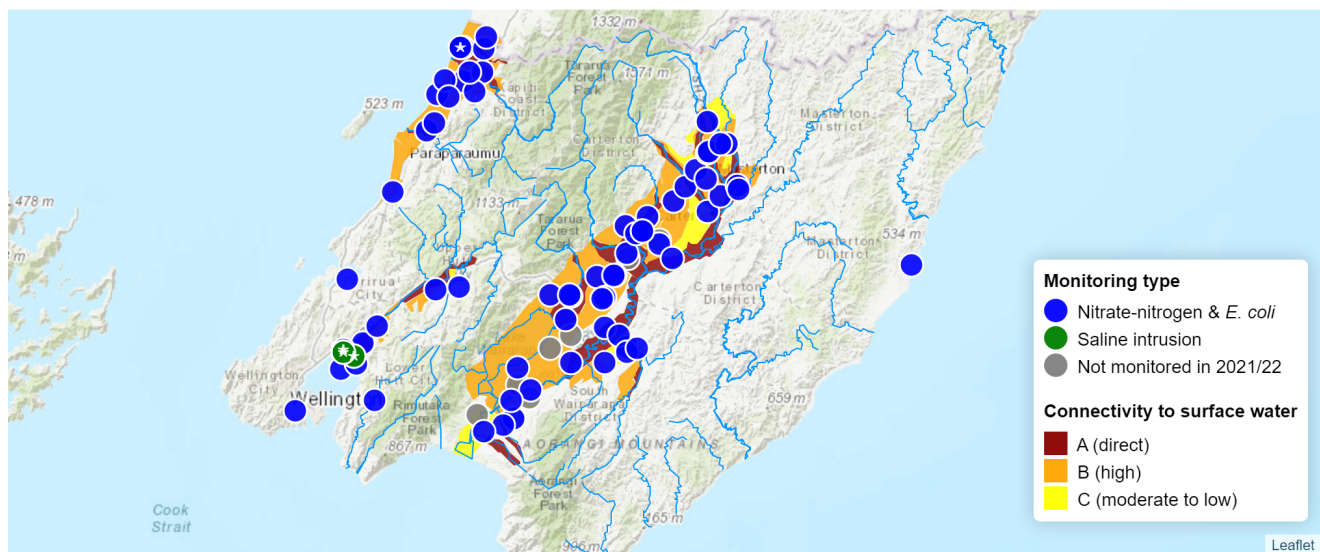


Figure 1: Locations of groundwater quality monitoring sites. See the [methods](#) section for more information on the monitoring network and each “Connectivity to surface water” category. *Note: circles marked with a star (*) have two bores in the same location at different depths.*

More information on each site including bore depth and monitoring frequency can be found in the [Appendix Monitoring details](#) table.

Monitoring data

Full monitoring data is downloadable in the [Resources](#) section and additional information for each nitrate-nitrogen & *E. coli* site is available at [Land and Water Aotearoa \(LAWA\)](#). The video at this link explains LAWA groundwater information further: <https://www.youtube.com/embed/dlg6s6tUAiA>.

Methods

Analytical methods

Table 1: Water quality sampling methods and detection limits.

Variable	Method	Detection limit
Nitrate + nitrite nitrogen	Total oxidised nitrogen. Automated cadmium reduction, Flow injection analyser. APHA 4500-NO ₃ - I (Modified) 22nd Ed. 2012	0.001 mg/L
Nitrite nitrogen	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₃ - I (Modified) 22nd Ed. 2012	0.002 mg/L
Nitrate nitrogen	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N	0.001 mg/L
E. coli	APHA 9222G 22nd Ed. 2012	1 cfu/100mL
Dissolved calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017	0.05 mg/L
Dissolved magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017	0.02 mg/L
Dissolved potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017	0.05 mg/L
Dissolved sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017	0.02 mg/L
Bicarbonate	Calculation: from alkalinity and pH. APHA 4500-CO ₂ D 23rd ed. 2017	1.0 mg/L
Chloride	Filtered sample, Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017	0.5 mg/L
Sulphate	Filtered sample, Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017	0.5 mg/L
pH	pH meter. APHA 4500-H ⁺ B 23rd ed. 2017	0.1 pH units
Total alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017	1.0 mg/L as CaCO ₃

Groundwater connectivity

The Greater Wellington [proposed Natural Resources Plan](#) (Chapter 4) provides management categories for differing levels of hydraulic connectivity of groundwater to surface water. See section 2.3 of [Wairarapa Valley groundwater resource investigation](#) for more detail.

Category A: Direct hydraulic connectivity

Category A includes areas of the hydrogeological system which exhibit direct connectivity with surface water. Stream flow depletion occurs shortly following the commencement of groundwater abstraction with the depletion effect increasing to a level close to the overall pumping rate and dissipating quickly once pumping stops. As a consequence, a high proportion of the overall volume of groundwater pumped effectively represents induced flow loss from local surface waterways. Due to the immediacy of impact, groundwater abstraction from Category A aquifers can be considered analogous to direct surface water abstraction and managed in terms of the environmental flow and water level regimes established for hydraulically connected surface waterbodies.

Category B: High hydraulic connectivity

Category B includes those areas of the hydrogeological system where groundwater abstraction may potentially result in significant impacts on surface water but where pumping regulation does not always provide an effective option for mitigating direct stream depletion effects. Category B represents the transition between indirect and direct stream depletion effects where it may be appropriate to manage groundwater takes in terms of either surface water or groundwater allocation depending on localised factors (e.g. local aquifer hydraulic parameters, abstraction rate and location of pumping with respect to surface waterbodies).

Category C: Moderate to low hydraulic connectivity

Category C covers those areas of the hydrogeological system where groundwater abstraction may contribute to an overall reduction in baseflow discharge at a catchment scale but where active regulation of pumping does not provide effective mitigation of potential effects on surface water. Cumulatively, these takes are more appropriately managed at a catchment or sub-catchment scale through the establishment of volumetric abstraction limits.

Sampling notes

During the 2021/22 monitoring period, seven wells were only sampled two or three times. Brief explanations on missed samples are listed below:

- R27/1137: June 2022 - non-operational pump system requiring an upgrade
- S25/5125: December 2021 – difficulties with the pump
- S25/5256: September and December 2021 - no power to the pump
- S27/0571: June 2022 – pump removed for maintenance
- T26/0003: December 2021 – power outage at the pump
- T26/0099: March 2022 – no access to the pump
- T27/0156: December 2021 - sampling discontinued due to poor well performance; replaced by BP33/0056

Twelve saline intrusion, annual, and/or three yearly frequency wells were additionally sampled out of schedule for the GNS Science led research programme [Te Whakaheke o Te Wai](#):

- September 2021: S26/0705
- November 2021: R27/7215, R27/7153, R27/7154, R27/7215
- March 2022: BQ33/0032, R25/5100, R25/5135, S25/5200, S26/0568, S27/0442, S27/0344

Four wells have been added to the GQSoE monitoring network:

- BP33/0056, BP33/0057, BP34/0229, BP34/0236

Previous changes to Groundwater Quality State of the Environment (GQSoE) network and monitoring frequency:

- S27/0156 has been officially removed from the GQSoE network and replaced by BP33/0056 in 2021/22
- BN32/0062, BN32/0063, and BN33/0032 were added to the GQSoE network in 2020/21.
- BQ31/0041 and BP32/0102 were added to the GQSoE network in 2019/20.
- The following ten confined bores have been reduced to annual sampling as they have not shown seasonal variation or significant trends over an extended period: R25/5100, S25/5200, R25/5135, S26/0568, S27/0495, S27/0435, S27/0442, S27/0607, S27/0588, S27/0594.
- An additional ten confined bores have been reduced to three-yearly sampling as; they have not shown seasonal variation, long term monitoring indicates that water quality at these bores is similar to annual/quarterly sites, and age dating suggests groundwater at these bores have mean residence times greater than 100 years: S27/0585, S27/0615, BQ33/0032, S27/0602, S27/0268, S27/0283, S27/0344, S26/0576, S27/0433, S26/0705.
- The following bores have been officially removed from the GQSoE network due to loss of access: Removed 2018/19 - R25/5164, S26/0756, S27/0846, S27/0614. S26/0824 was decommissioned and replaced with BP34/0216 in December 2019.

Results

Each results section presents maps of monitoring results benchmarked against groundwater quality guidelines where applicable. Full tabulated data for each guideline are available in the [Appendix data tables](#) section.

Groundwater nitrate-nitrogen concentrations

A key indicator of groundwater contamination typically arising from land use intensification and/or on-site wastewater disposal systems. Nitrate-nitrogen in groundwater can affect its quality for drinking-water supply. See the [LAWA factsheet](#) for more information. Switch tabs below to look at different nitrate-nitrogen measures.

Human health

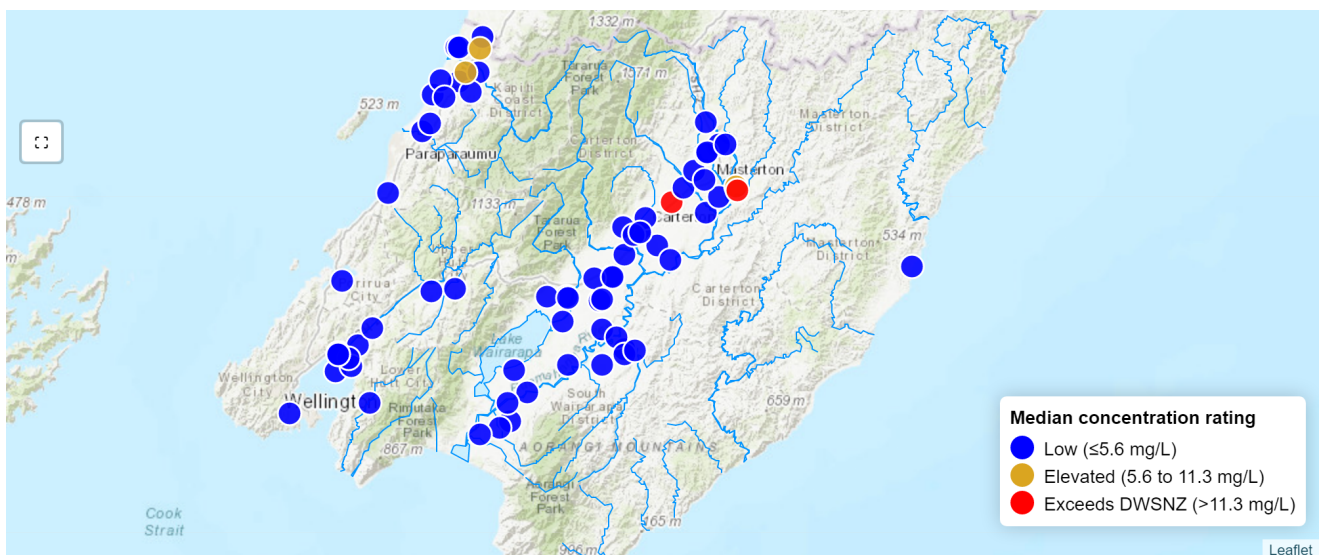


Figure 2: Groundwater nitrate-nitrogen concentrations are evaluated in terms of likely human influence, as excess concentrations can have negative health effects. Bores with annual median concentrations above the [Drinking Water Standard New Zealand \(DWSNZ\)](#) Maximum Acceptable Value (MAV) of 11.3 mg/L are flagged as ‘Exceeds DWSNZ’, and concentrations above half of this MAV are highlighted as ‘Elevated’.

Ecosystem health

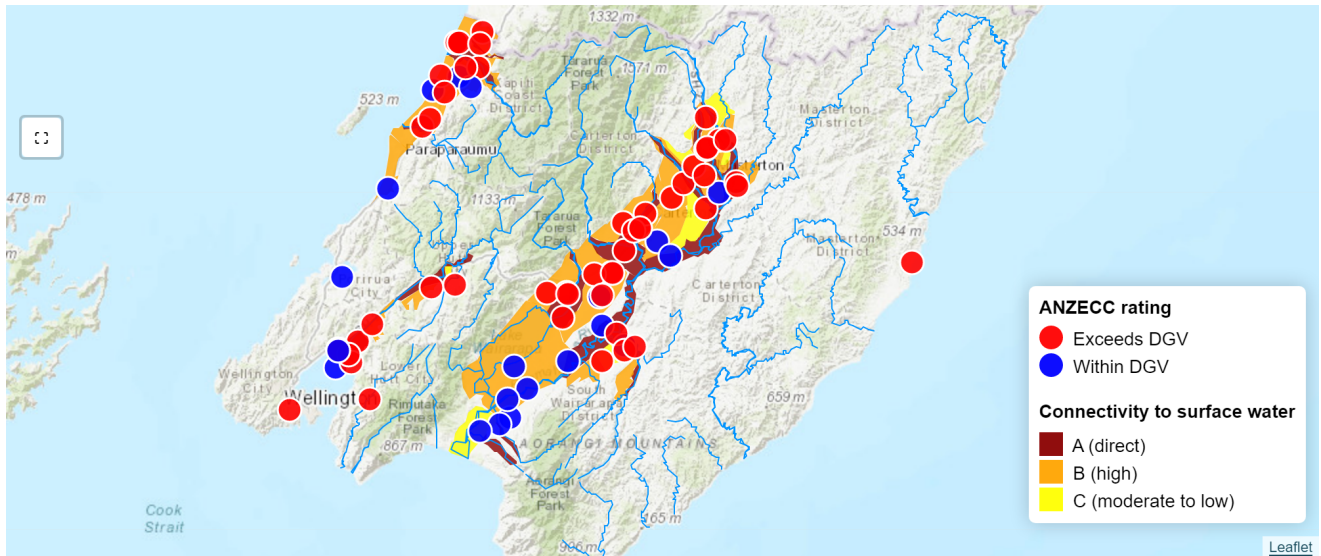


Figure 3: Groundwater discharges from aquifers into a number of surface water bodies throughout the region and there is the potential that groundwater high in nitrate-nitrogen could contribute to the decline of surface water quality. The [2000 Australia New Zealand Guidelines for Fresh and Marine Water Quality](#) (ANZECC) define default guideline values (DGVs) for the 80th percentile of nitrate-nitrogen based on second-level [River Environment Classification](#) (REC) class reference conditions. Groundwater within Connectivity Category A (direct) that has 80th percentile nitrate-nitrogen concentrations above the guideline is the highest risk to ecosystem health in the surface water system. See [groundwater connectivity](#) for more information on surface water connectivity categories.

Aquatic toxicity

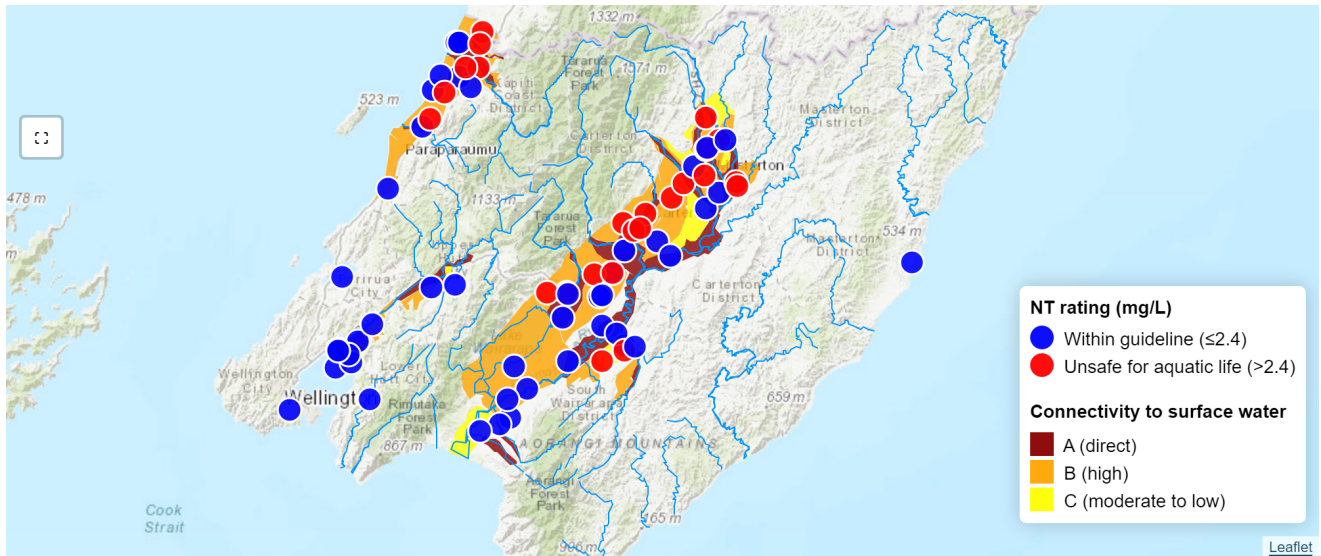


Figure 4: The [National Policy Statement on Freshwater Management \(NPS-FM\)](#) requires regional councils to identify water quality limits to manage values of our aquatic ecosystems. The nitrate toxicity (NT) threshold is calculated at 2.4 mg/L for annual median nitrate-nitrogen concentrations. This is within the guideline described by [Hickey, 2013](#) as ‘Chronic - slightly to moderately disturbed systems (95% protection)’. Freshwater water systems connected to groundwater above this threshold are deemed unsafe for aquatic life. Groundwater within Connectivity Category A (direct) that has median annual nitrate-nitrogen concentrations above the guideline is the highest risk to aquatic life in the surface water system. See [groundwater connectivity](#) for more information on surface water connectivity categories.

Detection of *E. coli* bacteria

A key indicator of groundwater contamination by microorganisms, some of which can cause diseases. Faecal bacteria from livestock, onsite wastewater discharges, stormwater and other sources can contaminate groundwater. See the [LAWA factsheet](#) for more information.

Drinking Water Standards New Zealand

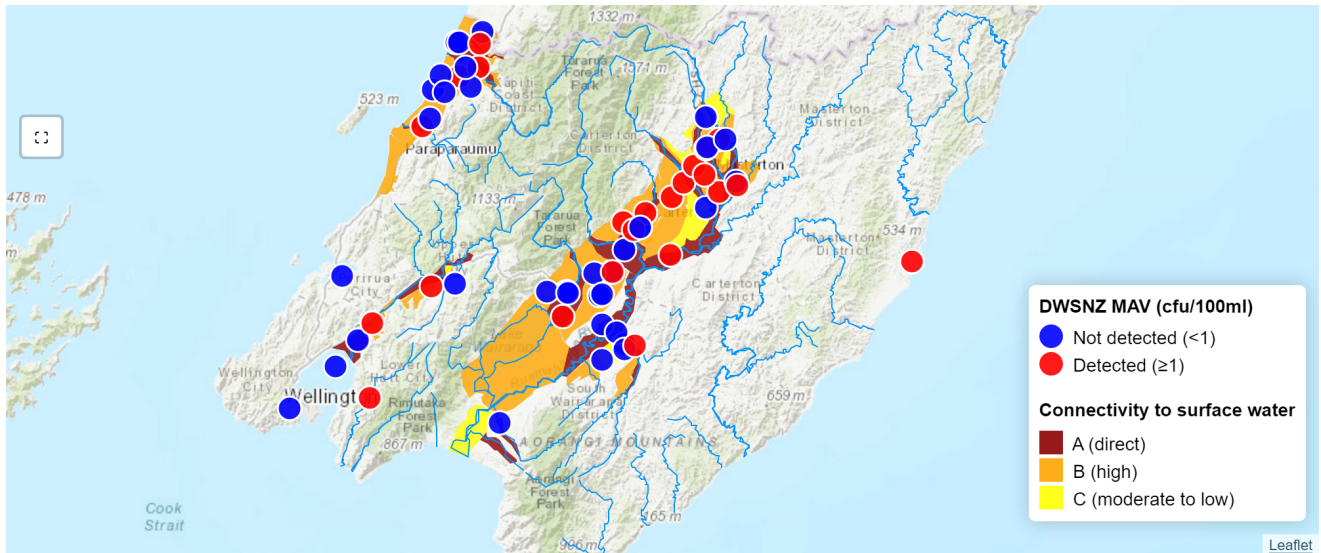


Figure 5: The [Drinking Water Standard New Zealand \(DWSNZ\)](#) uses *E. coli* as an indicator of faecal contamination in drinking water. For drinking water supplies, *E. coli* counts should be below the Maximum Acceptable Value (MAV) of <math><1\text{ cfu}/100\text{ ml}</math>. Groundwater within Connectivity Category A (direct) that has maximum counts above the guideline is the highest risk to drinking water safety in the surface water system. See [groundwater connectivity](#) for more information on surface water connectivity categories.

Saline intrusion

A key indicator for seawater contamination in coastal wells. The difference in conductivity between seawater and fresh groundwater is very marked, making it a useful indicator. See the [LAWA factsheet](#) for more information.

The charts below show daily average conductivity in $\mu\text{S}/\text{cm}$ () with warning thresholds in dashed red () set by GWRC that may reflect the onset of saline intrusion. See the [monitoring details](#) table for more information on the bores below.

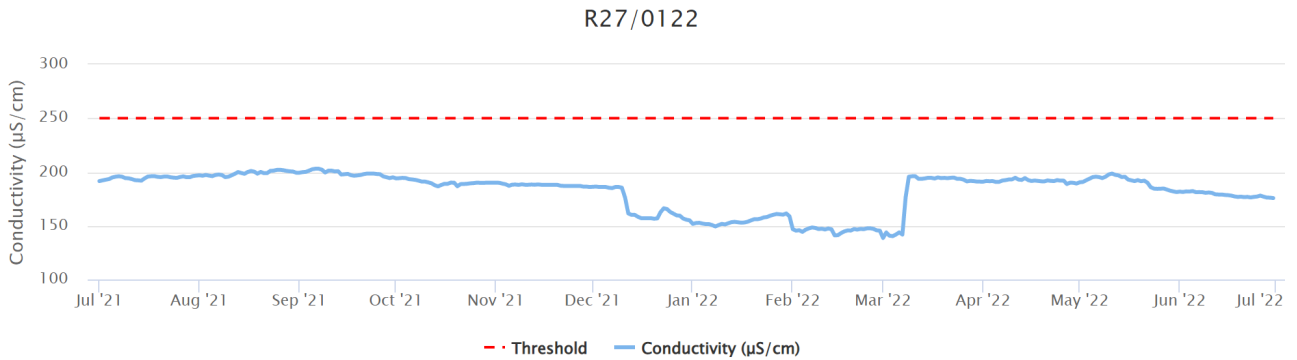


Figure 6: Saline intrusion results for Te Whanganui-a-Tara shallow groundwater bore R27-0122, the warning threshold is $250 \mu\text{S}/\text{cm}$.

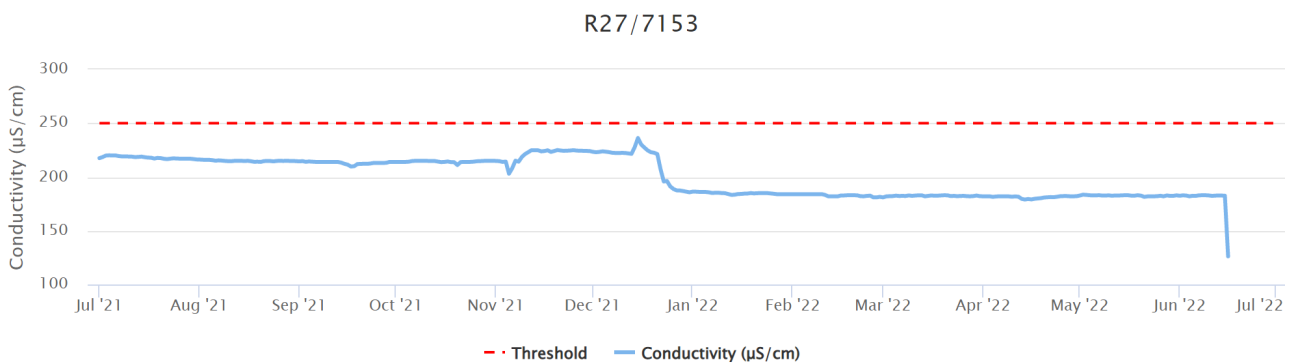


Figure 7: Saline intrusion results for Te Whanganui-a-Tara deep groundwater bore R27-7153, the warning threshold is $250 \mu\text{S}/\text{cm}$.

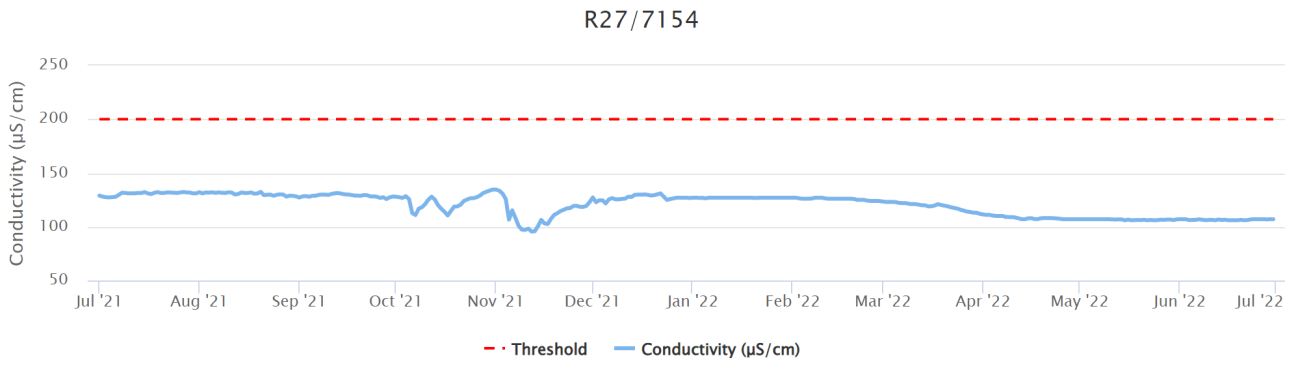


Figure 8: Saline intrusion results for Te Whanganui-a-Tara shallow groundwater bore R27-7154, the warning threshold is 200 µS/cm.

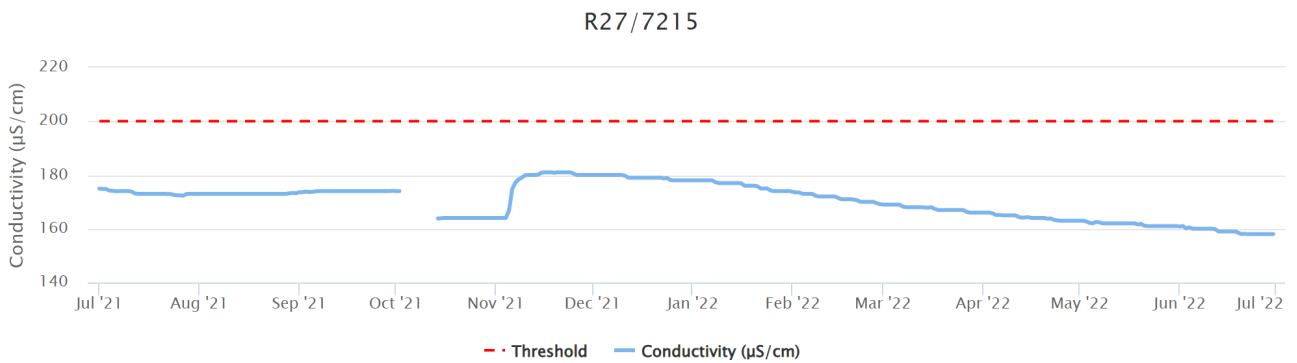


Figure 9: Saline intrusion results for Te Whanganui-a-Tara deep groundwater bore R27-7215, the warning threshold is 200 µS/cm.

Major ion chemistry

Groundwater chemistry is commonly dominated by the major cations calcium, magnesium, potassium and sodium, and the major anions bicarbonate, chloride and sulphate. These ions are derived from soil, rocks and minerals in the aquifer as water passes through them, as well as from anthropogenic sources such as fertilisers, and human and animal wastes.

Chloride has a drinking water Guideline Value of 250 mg/L, above which it may cause noticeable taste and corrosion ([MoH, 2018](#)). See the [LAWA factsheet](#) for more information. Calcium and magnesium are the main components of water hardness. High hardness can cause scale deposition in plumbing and pipe work, while low hardness can be a cause of corrosion.

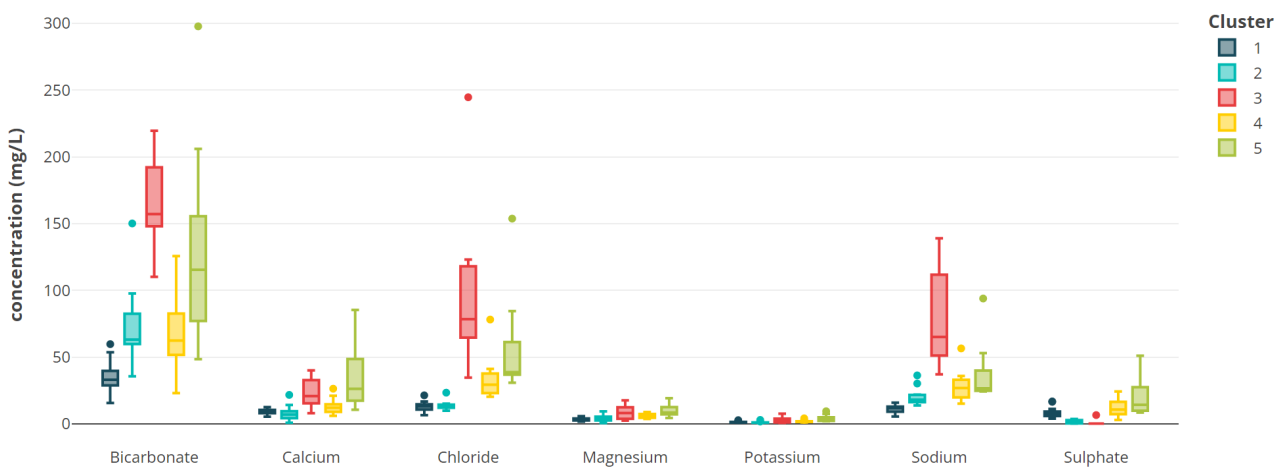


Figure 10: Using site median concentrations of these major ions, sites have been assigned into groups of similar chemical make-up using hierarchical cluster analysis (HCA). These groupings reflect recharge sources (river vs rain), land use, aquifer geology, location and the length of time the water has been underground. The range of concentrations for each group are shown in the box plot below. For a full description of the HCA technique and and more in-depth analysis of groundwater chemistry in the Wairarapa see [Daughney et al. \(2009\)](#).

Map of major ion chemistry

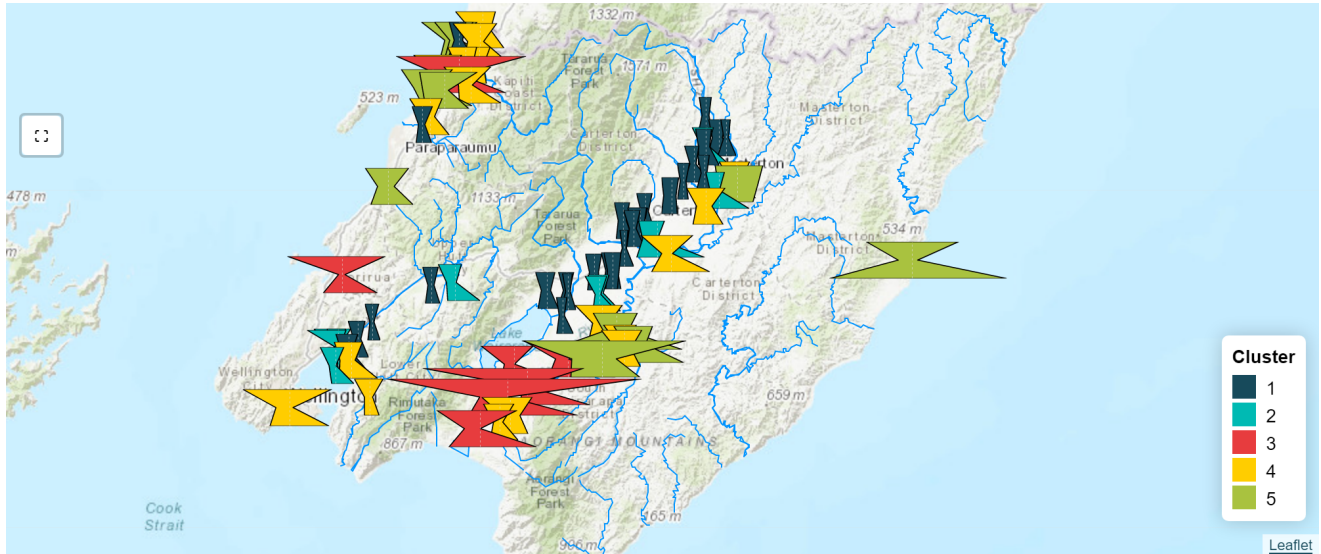


Figure 11: Sites on the map are presented in the form of Stiff plots, which are a graphical representation of the cation and anion make-up of the water sample. This allows quick assessment of similarities in groundwater chemistry across the region.

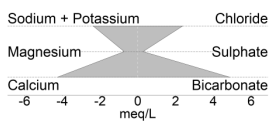


Figure 12: The shape of the plots are defined in milliequivalents per litre, which are a function of the concentrations, the molar mass of each component and their respective ionic charge.

Resources

Access to monitoring data

Full monitoring data for the 2021/22 monitoring season can be downloaded from the [latest Groundwater quality monitoring report](#) and data for other time periods can be accessed using the [GWRC live data viewer](#). Please read the [disclaimer](#) before using this information.

Useful links

- [National Environmental Monitoring Standards: Water Quality Part 1 - Sampling, Measuring, Processing and Archiving of Discrete Groundwater Quality Data](#)
- [Drinking Water Standard New Zealand](#)
- [Australian and New Zealand Guidelines for Fresh and Marine Water Quality](#)
- [Nitrate Toxicity Effects on Freshwater Aquatic Species](#)
- [Land and Water Aotearoa \(LAWA\) Groundwater](#)

References

ANZECC 2018. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, The Guidelines*. Australian and New Zealand Environment and Conservation Council. Agriculture and Resource Management Councils of Australia and New Zealand, Canberra.

Daughney, C.J., Guggenmos, M., McAlister, D., Begg, J., Jackson, B. 2009. *Assessment of groundwater and surface water chemistry in the Upper and Lower Wairarapa Valley*. GNS Science Report 2009/21. 33p.

Hickey, CW. 2013. *Updating nitrate toxicity effects on freshwater aquatic species*. Prepared for Ministry of Building, Innovation and Employment: Funded by Envirolink. NIWA Client Report No: HAM2013-009

Ministry of Health. 2018. *Drinking-water Standards for New Zealand 2005 (revised 2018)*. Ministry of Health, Wellington.

Appendix

Monitoring details

Table A1: Monitoring site information.

Whaitua	Site code	Monitoring frequency	Groundwater connectivity	Depth
Ruamāhanga	BQ33/0032	3-yr	Unknown	71.5m
Kāpiti Coast	R25/5100	annual	B (high)	48.2m
Kāpiti Coast	R25/5135	annual	B (high)	93.27m
Kāpiti Coast	R25/5164	removed		N/A
Kāpiti Coast	R25/5165	quarterly	B (high)	8.0m
Kāpiti Coast	R25/5190	quarterly	B (high)	5.0m
Kāpiti Coast	R25/5233	quarterly	A (direct)	18.7m
Kāpiti Coast	R26/6503	quarterly	B (high)	14.8m
Kāpiti Coast	R26/6587	quarterly	A (direct)	12.96m
Kāpiti Coast	R26/6624	quarterly	B (high)	10.2m
Te Whanganui-a-Tara	R27/0122	continuous - conductivity	B (high)	26.2m
Te Whanganui-a-Tara	R27/0320	quarterly	B (high)	114.6m
Te Whanganui-a-Tara	R27/1137	quarterly	B (high)	20.4m
Te Whanganui-a-Tara	R27/1171	quarterly	B (high)	23.2m
Te Whanganui-a-Tara	R27/1180	quarterly	B (high)	39.0m
Te Whanganui-a-Tara	R27/1182	quarterly	B (high)	38.0m
Te Whanganui-a-Tara	R27/1183	quarterly	B (high)	25.0m
Te Whanganui-a-Tara	R27/1265	quarterly	B (high)	48.3m
Te Whanganui-a-Tara	R27/6418	quarterly	Unknown	8.0m
Te Whanganui-a-Tara	R27/6833	quarterly	Unknown	24.5m
Te Whanganui-a-Tara	R27/7153	continuous - conductivity	B (high)	34.0m
Te Whanganui-a-Tara	R27/7154	continuous - conductivity	B (high)	45.1m
Te Whanganui-a-Tara	R27/7215	continuous - conductivity	B (high)	56.9m
Kāpiti Coast	S25/5125	quarterly	A (direct)	10.0m
Kāpiti Coast	S25/5200	annual	B (high)	45.8m
Kāpiti Coast	S25/5256	quarterly	B (high)	30.78m
Kāpiti Coast	S25/5322	quarterly	B (high)	27.0m
Ruamāhanga	S26/0117	quarterly	A (direct)	4.1m
Ruamāhanga	S26/0223	quarterly	B (high)	9.92m
Ruamāhanga	S26/0299	quarterly	B (high)	8.1m
Ruamāhanga	S26/0439	quarterly	C (moderate to low)	11.5m
Ruamāhanga	S26/0457	quarterly	A (direct)	6.06m
Ruamāhanga	S26/0467	quarterly	A (direct)	6.2m
Ruamāhanga	S26/0568	annual	B (high)	45.0m
Ruamāhanga	S26/0576	3-yr	B (high)	31.0m
Ruamāhanga	S26/0705	3-yr	C (moderate to low)	27.4m
Ruamāhanga	S26/0756	removed		19.0m
Ruamāhanga	S26/0762	quarterly	A (direct)	9.5m
Ruamāhanga	S26/0824	removed		20.6m

Whaitua	Site code	Monitoring frequency	Groundwater connectivity	Depth
Ruamāhanga	S26/0846	removed	A (direct)	39.3m
Ruamāhanga	S27/0009	quarterly	B (high)	10.5m
Ruamāhanga	S27/0070	quarterly	B (high)	14.6m
Ruamāhanga	S27/0136	quarterly	B (high)	20.4m
Ruamāhanga	S27/0156	quarterly	B (high)	20.7m
Ruamāhanga	S27/0202	quarterly	B (high)	4.88m
Ruamāhanga	S27/0268	3-yr	C (moderate to low)	58.4m
Ruamāhanga	S27/0283	3-yr	B (high)	19.0m
Ruamāhanga	S27/0299	quarterly	A (direct)	17.4m
Ruamāhanga	S27/0344	3-yr	A (direct)	16.0m
Ruamāhanga	S27/0389	quarterly	C (moderate to low)	17.85m
Ruamāhanga	S27/0396	quarterly	A (direct)	17.0m
Ruamāhanga	S27/0433	3-yr	C (moderate to low)	44.6m
Ruamāhanga	S27/0435	annual	C (moderate to low)	44.0m
Ruamāhanga	S27/0442	annual	C (moderate to low)	177.7m
Ruamāhanga	S27/0495	annual	C (moderate to low)	37.5m
Ruamāhanga	S27/0522	quarterly	C (moderate to low)	21.0m
Ruamāhanga	S27/0571	quarterly	C (moderate to low)	32.0m
Ruamāhanga	S27/0585	3-yr	C (moderate to low)	42.0m
Ruamāhanga	S27/0588	annual	A (direct)	11.7m
Ruamāhanga	S27/0594	annual	C (moderate to low)	44.0m
Ruamāhanga	S27/0602	3-yr	C (moderate to low)	60.95m
Ruamāhanga	S27/0607	annual	C (moderate to low)	38.0m
Ruamāhanga	S27/0615	3-yr	Unknown	18.2m
Ruamāhanga	S27/0681	quarterly	A (direct)	5.0m
Ruamāhanga	T26/0003	quarterly	B (high)	5.5m
Ruamāhanga	T26/0087	quarterly	C (moderate to low)	36.0m
Ruamāhanga	T26/0099	quarterly	B (high)	15.0m
Ruamāhanga	T26/0206	quarterly	C (moderate to low)	28.7m
Ruamāhanga	T26/0259	quarterly	A (direct)	6.1m
Ruamāhanga	T26/0332	quarterly	C (moderate to low)	13.4m
Ruamāhanga	T26/0413	quarterly	C (moderate to low)	23.3m
Ruamāhanga	T26/0430	quarterly	B (high)	0m
Ruamāhanga	T26/0489	quarterly	B (high)	54.0m
Ruamāhanga	T26/0538	quarterly	B (high)	9.0m
Wairarapa Coast	T27/0063	quarterly	Unknown	3.6m
Kāpiti Coast	BN33/0032	quarterly	B (high)	12.0m
Kāpiti Coast	BN32/0063	quarterly	B (high)	30.0m
Kāpiti Coast	BN32/0062	quarterly	B (high)	5.0m
Ruamāhanga	BP34/0216	quarterly	B (high)	17.7m
Te Whanganui-a-Tara	BQ31/0047	annual	Unknown	48.0m
Te Awarua-o-Porirua	BP32/0103	annual	Unknown	49.0m
Ruamāhanga	BP33/0056	quarterly	B (high)	14.0m
Ruamāhanga	BP33/0057	quarterly	B (high)	8.2m
Ruamāhanga	BP34/0229	quarterly	A (direct)	8.5m
Ruamāhanga	BP34/0236	quarterly	B (high)	6.9m

Data tables

See the respective [methods](#) and [results](#) sections for more information on guidelines and groundwater connectivity categories presented in the following tables.

Groundwater nitrate-nitrogen concentrations

Table A2: Nitrate-nitrogen results evaluated in terms of human health.

Whaitua	Site code	No. samples	Concentration rating	Median (mg/L)
Kāpiti Coast	BN32/0062	4	Low (≤5.6 mg/L)	1.36
Kāpiti Coast	BN32/0063	4	Low (≤5.6 mg/L)	0.657
Kāpiti Coast	BN33/0032	4	Low (≤5.6 mg/L)	3.98
Te Awarua-o-Porirua	BP32/0103	1	Low (≤5.6 mg/L)	0.002
Ruamāhanga	BP33/0056	4	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	BP33/0057	4	Low (≤5.6 mg/L)	3.42
Ruamāhanga	BP34/0216	4	Low (≤5.6 mg/L)	5.05
Ruamāhanga	BP34/0229	4	Low (≤5.6 mg/L)	4.29
Ruamāhanga	BP34/0236	4	Low (≤5.6 mg/L)	1.85
Te Whanganui-a-Tara	BQ31/0047	1	Low (≤5.6 mg/L)	0.824
Ruamāhanga	BQ33/0032	1	Low (≤5.6 mg/L)	<0.002
Kāpiti Coast	R25/5100	2	Low (≤5.6 mg/L)	<0.002
Kāpiti Coast	R25/5135	2	Low (≤5.6 mg/L)	<0.02
Kāpiti Coast	R25/5165	4	Low (≤5.6 mg/L)	0.675
Kāpiti Coast	R25/5190	4	Low (≤5.6 mg/L)	3.50
Kāpiti Coast	R25/5233	4	Low (≤5.6 mg/L)	1.52
Kāpiti Coast	R26/6503	4	Low (≤5.6 mg/L)	0.002
Kāpiti Coast	R26/6587	4	Low (≤5.6 mg/L)	0.918
Kāpiti Coast	R26/6624	4	Low (≤5.6 mg/L)	2.50
Te Whanganui-a-Tara	R27/0320	4	Low (≤5.6 mg/L)	<0.002
Te Whanganui-a-Tara	R27/1137	3	Low (≤5.6 mg/L)	1.79
Te Whanganui-a-Tara	R27/1171	4	Low (≤5.6 mg/L)	<0.002
Te Whanganui-a-Tara	R27/1180	4	Low (≤5.6 mg/L)	0.853
Te Whanganui-a-Tara	R27/1182	4	Low (≤5.6 mg/L)	0.665
Te Whanganui-a-Tara	R27/1183	4	Low (≤5.6 mg/L)	0.290
Te Whanganui-a-Tara	R27/1265	4	Low (≤5.6 mg/L)	0.073
Te Whanganui-a-Tara	R27/6418	4	Low (≤5.6 mg/L)	1.29
Te Whanganui-a-Tara	R27/6833	4	Low (≤5.6 mg/L)	0.820
Te Whanganui-a-Tara	R27/7153	1	Low (≤5.6 mg/L)	1.24
Te Whanganui-a-Tara	R27/7154	1	Low (≤5.6 mg/L)	0.114
Te Whanganui-a-Tara	R27/7215	1	Low (≤5.6 mg/L)	<0.02
Kāpiti Coast	S25/5125	3	Low (≤5.6 mg/L)	4.18
Kāpiti Coast	S25/5200	2	Low (≤5.6 mg/L)	<0.002
Kāpiti Coast	S25/5256	2	Elevated (5.6 to 11.3 mg/L)	6.94
Kāpiti Coast	S25/5322	4	Elevated (5.6 to 11.3 mg/L)	8.45
Ruamāhanga	S26/0117	4	Low (≤5.6 mg/L)	4.20

Whaitua	Site code	No. samples	Concentration rating	Median (mg/L)
Ruamāhanga	S26/0223	4	Exceeds DWSNZ (>11.3 mg/L)	11.7
Ruamāhanga	S26/0299	4	Low (≤5.6 mg/L)	3.54
Ruamāhanga	S26/0439	4	Low (≤5.6 mg/L)	2.96
Ruamāhanga	S26/0457	4	Low (≤5.6 mg/L)	0.769
Ruamāhanga	S26/0467	4	Low (≤5.6 mg/L)	2.65
Ruamāhanga	S26/0568	2	Low (≤5.6 mg/L)	<0.02
Ruamāhanga	S26/0705	1	Low (≤5.6 mg/L)	4.07
Ruamāhanga	S26/0762	4	Low (≤5.6 mg/L)	<0.02
Ruamāhanga	S27/0009	4	Low (≤5.6 mg/L)	3.84
Ruamāhanga	S27/0070	4	Low (≤5.6 mg/L)	1.74
Ruamāhanga	S27/0136	4	Low (≤5.6 mg/L)	4.33
Ruamāhanga	S27/0156	1	Low (≤5.6 mg/L)	0.516
Ruamāhanga	S27/0202	4	Low (≤5.6 mg/L)	2.50
Ruamāhanga	S27/0299	4	Low (≤5.6 mg/L)	0.444
Ruamāhanga	S27/0344	1	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0389	4	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0396	4	Low (≤5.6 mg/L)	0.665
Ruamāhanga	S27/0435	1	Low (≤5.6 mg/L)	0.002
Ruamāhanga	S27/0442	2	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0495	1	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0522	4	Low (≤5.6 mg/L)	3.27
Ruamāhanga	S27/0571	3	Low (≤5.6 mg/L)	4.44
Ruamāhanga	S27/0588	1	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	S27/0594	1	Low (≤5.6 mg/L)	<0.02
Ruamāhanga	S27/0607	1	Low (≤5.6 mg/L)	0.002
Ruamāhanga	S27/0681	4	Low (≤5.6 mg/L)	0.484
Ruamāhanga	T26/0003	3	Low (≤5.6 mg/L)	4.04
Ruamāhanga	T26/0087	4	Low (≤5.6 mg/L)	1.80
Ruamāhanga	T26/0099	3	Low (≤5.6 mg/L)	2.98
Ruamāhanga	T26/0206	4	Low (≤5.6 mg/L)	2.03
Ruamāhanga	T26/0259	4	Low (≤5.6 mg/L)	1.58
Ruamāhanga	T26/0332	4	Low (≤5.6 mg/L)	0.779
Ruamāhanga	T26/0413	4	Low (≤5.6 mg/L)	<0.002
Ruamāhanga	T26/0430	4	Low (≤5.6 mg/L)	2.67
Ruamāhanga	T26/0489	4	Elevated (5.6 to 11.3 mg/L)	8.58
Ruamāhanga	T26/0538	4	Exceeds DWSNZ (>11.3 mg/L)	11.4
Wairarapa Coast	T27/0063	4	Low (≤5.6 mg/L)	0.648

Table A3: Nitrate-nitrogen results evaluated in terms of ecosystem health.

Whaitua	Site code	Connectivity	No. samples	ANZECC rating	DGV	80th percentile
Kāpiti Coast	BN32/0062	B (high)	4	Exceeds DGV	0.195	1.76
Kāpiti Coast	BN32/0063	B (high)	4	Exceeds DGV	0.195	0.758
Kāpiti Coast	BN33/0032	B (high)	4	Exceeds DGV	0.195	4.07
Te Awarua-o-Porirua	BP32/0103	Unknown	1	Within DGV	0.195	0.002
Ruamāhanga	BP33/0056	B (high)	4	Within DGV	0.195	0.008

Whaitua	Site code	Connectivity	No. samples	ANZECC rating	DGV	80th percentile
Ruamāhanga	BP33/0057	B (high)	4	Exceeds DGV	0.195	4.14
Ruamāhanga	BP34/0216	B (high)	4	Exceeds DGV	0.195	5.24
Ruamāhanga	BP34/0229	A (direct)	4	Exceeds DGV	0.265	4.64
Ruamāhanga	BP34/0236	B (high)	4	Exceeds DGV	0.195	2.82
Te Whanganui-a-Tara	BQ31/0047	Unknown	1	Exceeds DGV	0.195	0.824
Ruamāhanga	BQ33/0032	Unknown	1	Within DGV	0.265	<0.002
Kāpiti Coast	R25/5100	B (high)	2	Within DGV	0.195	<0.002
Kāpiti Coast	R25/5135	B (high)	2	Within DGV	0.195	0.008
Kāpiti Coast	R25/5165	B (high)	4	Exceeds DGV	0.195	1.82
Kāpiti Coast	R25/5190	B (high)	4	Exceeds DGV	0.195	3.53
Kāpiti Coast	R25/5233	A (direct)	4	Exceeds DGV	0.195	1.69
Kāpiti Coast	R26/6503	B (high)	4	Within DGV	0.065	0.005
Kāpiti Coast	R26/6587	A (direct)	4	Exceeds DGV	0.195	1.70
Kāpiti Coast	R26/6624	B (high)	4	Exceeds DGV	0.065	2.61
Te Whanganui-a-Tara	R27/0320	B (high)	4	Within DGV	0.065	0.003
Te Whanganui-a-Tara	R27/1137	B (high)	3	Exceeds DGV	0.065	1.80
Te Whanganui-a-Tara	R27/1171	B (high)	4	Within DGV	0.065	<0.002
Te Whanganui-a-Tara	R27/1180	B (high)	4	Exceeds DGV	0.065	0.935
Te Whanganui-a-Tara	R27/1182	B (high)	4	Exceeds DGV	0.065	0.683
Te Whanganui-a-Tara	R27/1183	B (high)	4	Exceeds DGV	0.065	0.312
Te Whanganui-a-Tara	R27/1265	B (high)	4	Exceeds DGV	0.065	0.087
Te Whanganui-a-Tara	R27/6418	Unknown	4	Exceeds DGV	0.170	1.51
Te Whanganui-a-Tara	R27/6833	Unknown	4	Exceeds DGV	0.170	1.02
Te Whanganui-a-Tara	R27/7153	B (high)	1	Exceeds DGV	0.065	1.24
Te Whanganui-a-Tara	R27/7154	B (high)	1	Exceeds DGV	0.065	0.114
Te Whanganui-a-Tara	R27/7215	B (high)	1	Within DGV	0.065	<0.02
Kāpiti Coast	S25/5125	A (direct)	3	Exceeds DGV	0.195	4.52
Kāpiti Coast	S25/5200	B (high)	2	Within DGV	0.170	0.003
Kāpiti Coast	S25/5256	B (high)	2	Exceeds DGV	0.195	6.97
Kāpiti Coast	S25/5322	B (high)	4	Exceeds DGV	0.195	8.59
Ruamāhanga	S26/0117	A (direct)	4	Exceeds DGV	0.170	4.65
Ruamāhanga	S26/0223	B (high)	4	Exceeds DGV	0.195	12.0
Ruamāhanga	S26/0299	B (high)	4	Exceeds DGV	0.195	4.21
Ruamāhanga	S26/0439	C (moderate to low)	4	Exceeds DGV	0.065	3.07
Ruamāhanga	S26/0457	A (direct)	4	Exceeds DGV	0.195	1.25
Ruamāhanga	S26/0467	A (direct)	4	Exceeds DGV	0.195	3.01
Ruamāhanga	S26/0568	B (high)	2	Within DGV	0.195	0.008
Ruamāhanga	S26/0705	C (moderate to low)	1	Exceeds DGV	0.195	4.07
Ruamāhanga	S26/0762	A (direct)	4	Within DGV	0.195	<0.02
Ruamāhanga	S27/0009	B (high)	4	Exceeds DGV	0.065	4.15
Ruamāhanga	S27/0070	B (high)	4	Exceeds DGV	0.195	2.27
Ruamāhanga	S27/0136	B (high)	4	Exceeds DGV	0.195	4.72
Ruamāhanga	S27/0156	B (high)	1	Exceeds DGV	0.195	0.516
Ruamāhanga	S27/0202	B (high)	4	Exceeds DGV	0.195	2.67
Ruamāhanga	S27/0299	A (direct)	4	Exceeds DGV	0.195	0.453
Ruamāhanga	S27/0344	A (direct)	1	Within DGV	0.195	<0.002
Ruamāhanga	S27/0389	C (moderate to low)	4	Within DGV	0.195	<0.002

Whaitua	Site code	Connectivity	No. samples	ANZECC rating	DGV	80th percentile
Ruamāhanga	S27/0396	A (direct)	4	Exceeds DGV	0.170	0.779
Ruamāhanga	S27/0435	C (moderate to low)	1	Within DGV	0.195	0.002
Ruamāhanga	S27/0442	C (moderate to low)	2	Within DGV	0.170	<0.002
Ruamāhanga	S27/0495	C (moderate to low)	1	Within DGV	0.195	<0.002
Ruamāhanga	S27/0522	C (moderate to low)	4	Exceeds DGV	0.195	3.30
Ruamāhanga	S27/0571	C (moderate to low)	3	Exceeds DGV	0.195	4.64
Ruamāhanga	S27/0588	A (direct)	1	Within DGV	0.087	<0.002
Ruamāhanga	S27/0594	C (moderate to low)	1	Within DGV	0.195	<0.02
Ruamāhanga	S27/0607	C (moderate to low)	1	Within DGV	0.195	0.002
Ruamāhanga	S27/0681	A (direct)	4	Exceeds DGV	0.265	0.519
Ruamāhanga	T26/0003	B (high)	3	Exceeds DGV	0.265	4.37
Ruamāhanga	T26/0087	C (moderate to low)	4	Exceeds DGV	0.195	2.34
Ruamāhanga	T26/0099	B (high)	3	Exceeds DGV	0.195	3.01
Ruamāhanga	T26/0206	C (moderate to low)	4	Exceeds DGV	0.195	2.10
Ruamāhanga	T26/0259	A (direct)	4	Exceeds DGV	0.265	2.09
Ruamāhanga	T26/0332	C (moderate to low)	4	Exceeds DGV	0.195	0.813
Ruamāhanga	T26/0413	C (moderate to low)	4	Within DGV	0.195	<0.002
Ruamāhanga	T26/0430	B (high)	4	Exceeds DGV	0.195	3.53
Ruamāhanga	T26/0489	B (high)	4	Exceeds DGV	0.195	8.99
Ruamāhanga	T26/0538	B (high)	4	Exceeds DGV	0.195	13.7
Wairarapa Coast	T27/0063	Unknown	4	Exceeds DGV	0.195	0.945

Table A4: Nitrate-nitrogen results evaluated in terms of aquatic toxicity.

Whaitua	Site code	Connectivity	No. samples	NT rating	Median (mg/L)
Kāpiti Coast	BN32/0062	B (high)	4	Within guideline (≤ 2.4)	1.36
Kāpiti Coast	BN32/0063	B (high)	4	Within guideline (≤ 2.4)	0.657
Kāpiti Coast	BN33/0032	B (high)	4	Unsafe for aquatic life (> 2.4)	3.98
Te Awarua-o-Porirua	BP32/0103	Unknown	1	Within guideline (≤ 2.4)	0.002
Ruamāhanga	BP33/0056	B (high)	4	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	BP33/0057	B (high)	4	Unsafe for aquatic life (> 2.4)	3.42
Ruamāhanga	BP34/0216	B (high)	4	Unsafe for aquatic life (> 2.4)	5.05
Ruamāhanga	BP34/0229	A (direct)	4	Unsafe for aquatic life (> 2.4)	4.29
Ruamāhanga	BP34/0236	B (high)	4	Within guideline (≤ 2.4)	1.85
Te Whanganui-a-Tara	BQ31/0047	Unknown	1	Within guideline (≤ 2.4)	0.824
Ruamāhanga	BQ33/0032	Unknown	1	Within guideline (≤ 2.4)	<0.002
Kāpiti Coast	R25/5100	B (high)	2	Within guideline (≤ 2.4)	<0.002
Kāpiti Coast	R25/5135	B (high)	2	Within guideline (≤ 2.4)	<0.02
Kāpiti Coast	R25/5165	B (high)	4	Within guideline (≤ 2.4)	0.675
Kāpiti Coast	R25/5190	B (high)	4	Unsafe for aquatic life (> 2.4)	3.50
Kāpiti Coast	R25/5233	A (direct)	4	Within guideline (≤ 2.4)	1.52
Kāpiti Coast	R26/6503	B (high)	4	Within guideline (≤ 2.4)	0.002
Kāpiti Coast	R26/6587	A (direct)	4	Within guideline (≤ 2.4)	0.918
Kāpiti Coast	R26/6624	B (high)	4	Unsafe for aquatic life (> 2.4)	2.50
Te Whanganui-a-Tara	R27/0320	B (high)	4	Within guideline (≤ 2.4)	<0.002
Te Whanganui-a-Tara	R27/1137	B (high)	3	Within guideline (≤ 2.4)	1.79

Whaitua	Site code	Connectivity	No. samples	NT rating	Median (mg/L)
Te Whanganui-a-Tara	R27/1171	B (high)	4	Within guideline (≤ 2.4)	<0.002
Te Whanganui-a-Tara	R27/1180	B (high)	4	Within guideline (≤ 2.4)	0.853
Te Whanganui-a-Tara	R27/1182	B (high)	4	Within guideline (≤ 2.4)	0.665
Te Whanganui-a-Tara	R27/1183	B (high)	4	Within guideline (≤ 2.4)	0.290
Te Whanganui-a-Tara	R27/1265	B (high)	4	Within guideline (≤ 2.4)	0.073
Te Whanganui-a-Tara	R27/6418	Unknown	4	Within guideline (≤ 2.4)	1.29
Te Whanganui-a-Tara	R27/6833	Unknown	4	Within guideline (≤ 2.4)	0.820
Te Whanganui-a-Tara	R27/7153	B (high)	1	Within guideline (≤ 2.4)	1.24
Te Whanganui-a-Tara	R27/7154	B (high)	1	Within guideline (≤ 2.4)	0.114
Te Whanganui-a-Tara	R27/7215	B (high)	1	Within guideline (≤ 2.4)	<0.02
Kāpiti Coast	S25/5125	A (direct)	3	Unsafe for aquatic life (> 2.4)	4.18
Kāpiti Coast	S25/5200	B (high)	2	Within guideline (≤ 2.4)	<0.002
Kāpiti Coast	S25/5256	B (high)	2	Unsafe for aquatic life (> 2.4)	6.94
Kāpiti Coast	S25/5322	B (high)	4	Unsafe for aquatic life (> 2.4)	8.45
Ruamāhanga	S26/0117	A (direct)	4	Unsafe for aquatic life (> 2.4)	4.20
Ruamāhanga	S26/0223	B (high)	4	Unsafe for aquatic life (> 2.4)	11.7
Ruamāhanga	S26/0299	B (high)	4	Unsafe for aquatic life (> 2.4)	3.54
Ruamāhanga	S26/0439	C (moderate to low)	4	Unsafe for aquatic life (> 2.4)	2.96
Ruamāhanga	S26/0457	A (direct)	4	Within guideline (≤ 2.4)	0.769
Ruamāhanga	S26/0467	A (direct)	4	Unsafe for aquatic life (> 2.4)	2.65
Ruamāhanga	S26/0568	B (high)	2	Within guideline (≤ 2.4)	<0.02
Ruamāhanga	S26/0705	C (moderate to low)	1	Unsafe for aquatic life (> 2.4)	4.07
Ruamāhanga	S26/0762	A (direct)	4	Within guideline (≤ 2.4)	<0.02
Ruamāhanga	S27/0009	B (high)	4	Unsafe for aquatic life (> 2.4)	3.84
Ruamāhanga	S27/0070	B (high)	4	Within guideline (≤ 2.4)	1.74
Ruamāhanga	S27/0136	B (high)	4	Unsafe for aquatic life (> 2.4)	4.33
Ruamāhanga	S27/0156	B (high)	1	Within guideline (≤ 2.4)	0.516
Ruamāhanga	S27/0202	B (high)	4	Unsafe for aquatic life (> 2.4)	2.50
Ruamāhanga	S27/0299	A (direct)	4	Within guideline (≤ 2.4)	0.444
Ruamāhanga	S27/0344	A (direct)	1	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0389	C (moderate to low)	4	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0396	A (direct)	4	Within guideline (≤ 2.4)	0.665
Ruamāhanga	S27/0435	C (moderate to low)	1	Within guideline (≤ 2.4)	0.002
Ruamāhanga	S27/0442	C (moderate to low)	2	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0495	C (moderate to low)	1	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0522	C (moderate to low)	4	Unsafe for aquatic life (> 2.4)	3.27
Ruamāhanga	S27/0571	C (moderate to low)	3	Unsafe for aquatic life (> 2.4)	4.44
Ruamāhanga	S27/0588	A (direct)	1	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	S27/0594	C (moderate to low)	1	Within guideline (≤ 2.4)	<0.02
Ruamāhanga	S27/0607	C (moderate to low)	1	Within guideline (≤ 2.4)	0.002
Ruamāhanga	S27/0681	A (direct)	4	Within guideline (≤ 2.4)	0.484
Ruamāhanga	T26/0003	B (high)	3	Unsafe for aquatic life (> 2.4)	4.04
Ruamāhanga	T26/0087	C (moderate to low)	4	Within guideline (≤ 2.4)	1.80
Ruamāhanga	T26/0099	B (high)	3	Unsafe for aquatic life (> 2.4)	2.98
Ruamāhanga	T26/0206	C (moderate to low)	4	Within guideline (≤ 2.4)	2.03
Ruamāhanga	T26/0259	A (direct)	4	Within guideline (≤ 2.4)	1.58
Ruamāhanga	T26/0332	C (moderate to low)	4	Within guideline (≤ 2.4)	0.779

Whaitua	Site code	Connectivity	No. samples	NT rating	Median (mg/L)
Ruamāhanga	T26/0413	C (moderate to low)	4	Within guideline (≤ 2.4)	<0.002
Ruamāhanga	T26/0430	B (high)	4	Unsafe for aquatic life (> 2.4)	2.67
Ruamāhanga	T26/0489	B (high)	4	Unsafe for aquatic life (> 2.4)	8.58
Ruamāhanga	T26/0538	B (high)	4	Unsafe for aquatic life (> 2.4)	11.4
Wairarapa Coast	T27/0063	Unknown	4	Within guideline (≤ 2.4)	0.648

Detection of *E. coli* bacteria

Table A5: *E. coli* bacteria results benchmarked against Drinking Water Standards New Zealand guidelines.

Whaitua	Site code	Connectivity	No. samples	DWSNZ MAV	No. ≥ 1 cfu/100ml	Max cfu/100ml
Kāpiti Coast	BN32/0062	B (high)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	BN32/0063	B (high)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	BN33/0032	B (high)	4	Not detected (<1)	0	<1.0
Te Awarua-o-Porirua	BP32/0103	Unknown	1	Not detected (<1)	0	<1.0
Ruamāhanga	BP33/0056	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	BP33/0057	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	BP34/0216	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	BP34/0229	A (direct)	4	Detected (≥ 1)	1	10.0
Ruamāhanga	BP34/0236	B (high)	4	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	BQ31/0047	Unknown	1	Not detected (<1)	0	<1.0
Kāpiti Coast	R25/5100	B (high)	2	Not detected (<1)	0	<1.0
Kāpiti Coast	R25/5135	B (high)	1	Detected (≥ 1)	1	1.0
Kāpiti Coast	R25/5165	B (high)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	R25/5190	B (high)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	R25/5233	A (direct)	4	Not detected (<1)	0	<1.0
Kāpiti Coast	R26/6587	A (direct)	4	Detected (≥ 1)	1	9.0
Kāpiti Coast	R26/6624	B (high)	4	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	R27/1137	B (high)	3	Detected (≥ 1)	1	3.0
Te Whanganui-a-Tara	R27/1171	B (high)	2	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	R27/1180	B (high)	4	Not detected (<1)	0	<1.0
Te Whanganui-a-Tara	R27/1183	B (high)	4	Detected (≥ 1)	1	1.0
Te Whanganui-a-Tara	R27/6418	Unknown	4	Detected (≥ 1)	2	410.0
Te Whanganui-a-Tara	R27/6833	Unknown	4	Not detected (<1)	0	<1.0
Kāpiti Coast	S25/5125	A (direct)	3	Detected (≥ 1)	3	320.0
Kāpiti Coast	S25/5200	B (high)	2	Not detected (<1)	0	<1.0
Kāpiti Coast	S25/5256	B (high)	2	Not detected (<1)	0	<1.0
Kāpiti Coast	S25/5322	B (high)	4	Detected (≥ 1)	1	3.0
Ruamāhanga	S26/0117	A (direct)	4	Detected (≥ 1)	2	80.0
Ruamāhanga	S26/0223	B (high)	4	Detected (≥ 1)	4	47.0
Ruamāhanga	S26/0299	B (high)	4	Detected (≥ 1)	1	1.0
Ruamāhanga	S26/0439	C (moderate to low)	4	Detected (≥ 1)	1	60.0
Ruamāhanga	S26/0457	A (direct)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S26/0467	A (direct)	4	Detected (≥ 1)	2	7.0
Ruamāhanga	S26/0705	C (moderate to low)	1	Not detected (<1)	0	<1.0
Ruamāhanga	S26/0762	A (direct)	4	Detected (≥ 1)	1	2.0
Ruamāhanga	S27/0009	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0070	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0136	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0156	B (high)	1	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0202	B (high)	4	Detected (≥ 1)	1	20.0
Ruamāhanga	S27/0299	A (direct)	4	Detected (≥ 1)	1	14.0

Whaitua	Site code	Connectivity	No. samples	DWSNZ MAV	No. ≥ 1 cfu/100ml	Max cfu/100ml
Ruamāhanga	S27/0344	A (direct)	1	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0389	C (moderate to low)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0396	A (direct)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0522	C (moderate to low)	4	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0571	C (moderate to low)	3	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0588	A (direct)	1	Not detected (<1)	0	<1.0
Ruamāhanga	S27/0681	A (direct)	4	Detected (≥ 1)	2	3.0
Ruamāhanga	T26/0003	B (high)	3	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0087	C (moderate to low)	4	Detected (≥ 1)	1	1.0
Ruamāhanga	T26/0099	B (high)	3	Detected (≥ 1)	1	4.0
Ruamāhanga	T26/0206	C (moderate to low)	4	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0259	A (direct)	4	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0332	C (moderate to low)	4	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0413	C (moderate to low)	4	Detected (≥ 1)	2	14.0
Ruamāhanga	T26/0430	B (high)	4	Detected (≥ 1)	2	210.0
Ruamāhanga	T26/0489	B (high)	4	Not detected (<1)	0	<1.0
Ruamāhanga	T26/0538	B (high)	4	Detected (≥ 1)	2	50.0
Wairarapa Coast	T27/0063	Unknown	4	Detected (≥ 1)	3	20.0

Saline intrusion

Monthly average saline intrusion results for four Te Whanganui-a-Tara groundwater bores.

Table A6: Shallow groundwater bore R27-0122, the warning threshold is 250 $\mu\text{S}/\text{cm}$.

Month	Mean conductivity ($\mu\text{S}/\text{cm}$)	# warning exceedances
2021-07	194.6	0
2021-08	198.9	0
2021-09	198.8	0
2021-10	190.4	0
2021-11	187.8	0
2021-12	168.4	0
2022-01	154.8	0
2022-02	146.0	0
2022-03	181.4	0
2022-04	191.7	0
2022-05	190.9	0
2022-06	178.8	0

Table A7: Deep groundwater bore R27-7153, the warning threshold is 250 $\mu\text{S}/\text{cm}$.

Month	Mean conductivity ($\mu\text{S}/\text{cm}$)	# warning exceedances
2021-07	218.1	0
2021-08	215.0	0
2021-09	213.2	0
2021-10	214.3	0
2021-11	220.8	0
2021-12	213.6	0
2022-01	184.8	0
2022-02	182.9	0
2022-03	182.4	0
2022-04	181.3	0
2022-05	182.6	0
2022-06	179.1	0

Table A8: Shallow groundwater bore R27-7154, the warning threshold is 200 $\mu\text{S}/\text{cm}$.

Month	Mean conductivity ($\mu\text{S}/\text{cm}$)	# warning exceedances
2021-07	130.7	0
2021-08	130.7	0
2021-09	128.9	0
2021-10	123.2	0
2021-11	112.2	0
2021-12	127.1	0
2022-01	126.9	0
2022-02	125.8	0
2022-03	119.1	0
2022-04	108.4	0
2022-05	106.6	0
2022-06	106.5	0

Table A9: Deep groundwater bore R27-7215, the warning threshold is 200 $\mu\text{S}/\text{cm}$.

Month	Mean conductivity ($\mu\text{S}/\text{cm}$)	# warning exceedances
2021-07	173.4	0
2021-08	173.0	0
2021-09	173.9	0
2021-10	165.0	0
2021-11	177.4	0
2021-12	179.1	0
2022-01	176.2	0
2022-02	171.5	0
2022-03	167.6	0
2022-04	164.3	0
2022-05	161.8	0
2022-06	159.1	0

Groundwater chemistry: major ion concentrations

Table A10: Median concentrations for the 2021/2022 year, HCA clusters and water types. The water type describes the dominant ionic constituents of the groundwater at each site.

Site code	Median Bicarbonate (mg/L)	Median Calcium (mg/L)	Median Chloride (mg/L)	Median Magnesium (mg/L)	Median Potassium (mg/L)	Median Sodium (mg/L)	Median Sulphate (mg/L)	Cluster	Watertype
BN32/0062	112.5	17.4	38.1	7.57	4.93	40.0	10.2	5	Na-Ca-HCO ₃ -Cl
BN32/0063	67.2	12.6	30.8	4.42	3.54	24.8	9.85	5	Na-Ca-HCO ₃ -Cl
BN33/0032	69.8	8.36	24.2	7.89	1.08	33.7	19.8	4	Na-Mg-HCO ₃ -Cl
BP32/0103	110.2	19.8	78.5	2.43	0.694	65.2	6.61	3	Na-Ca-Cl-HCO ₃

Site code	Median Bicarbonate (mg/L)	Median Calcium (mg/L)	Median Chloride (mg/L)	Median Magnesium (mg/L)	Median Potassium (mg/L)	Median Sodium (mg/L)	Median Sulphate (mg/L)	Cluster	Watertype
BP33/0056	61.9	7.78	13.8	3.10	0.845	18.1	3.01	2	Na-Ca-HCO3-Cl
BP33/0057	29.3	11.1	14.6	2.61	1.64	10.6	7.72	1	Ca-Na-HCO3-Cl
BP34/0216	35.6	9.28	13.8	4.68	1.18	14.1	8.91	1	Na-Ca-Mg-HCO3-Cl
BP34/0229	45.2	12.6	14.6	4.79	1.35	12.9	8.39	1	Ca-Na-Mg-HCO3-Cl
BP34/0236	32.1	9.94	15.3	3.99	1.58	12.6	16.6	1	Na-Ca-Mg-HCO3-Cl-SO4
BQ31/0047	125.7	21	78.1	8.94	1.44	56.5	8.08	4	Na-Ca-Cl-HCO3
BQ33/0032	57.1	10.8	41.2	5.13	1.87	34.4	24.3	4	Na-Ca-Cl-HCO3
R25/5100	127.8	10.7	36.9	12.57	9.47	33.2	8.49	5	Na-Mg-HCO3-Cl
R25/5135	146.8	32.8	123.0	13.22	1.41	74.1	<0.5	3	Na-Ca-Cl-HCO3
R25/5165	33.0	7.52	39.9	3.88	2.97	32.4	19.6	4	Na-Cl-HCO3
R25/5190	77.1	20	61.3	14.13	7.38	26.2	9.03	5	Mg-Na-Ca-Cl-HCO3
R25/5233	48.8	12.4	13.0	3.38	1.65	11.9	9.03	1	Ca-Na-HCO3-Cl
R26/6503	82.5	19	39.3	7.14	3.68	26.6	15.3	5	Na-Ca-Mg-HCO3-Cl
R26/6587	33.0	7.64	21.4	2.90	1.21	13.8	6.87	1	Na-Ca-Cl-HCO3
R26/6624	63.2	8.99	23.1	6.10	1.58	25.6	11	4	Na-Mg-Ca-HCO3-Cl
R27/0320	63.2	4.18	23.4	2.23	0.724	30.2	2.54	2	Na-HCO3-Cl
R27/1137	30.4	7.48	14.1	2.78	1.44	12.0	6.9	1	Na-Ca-Mg-HCO3-Cl
R27/1171	59.5	4.38	15.2	4.40	1.77	18.1	<0.5	2	Na-Mg-HCO3-Cl
R27/1180	38.2	8.59	14.6	3.40	1.22	12.9	7.8	1	Na-Ca-Mg-HCO3-Cl
R27/1182	83.5	12.9	20.3	7.40	1.84	19.7	8.78	4	Na-Ca-Mg-HCO3-Cl
R27/1183	26.9	5.44	12.6	1.93	0.895	9.8	3.93	1	Na-Ca-HCO3-Cl
R27/1265	40.0	4.54	14.5	2.67	0.924	14.8	3.57	2	Na-Ca-HCO3-Cl
R27/6418	31.0	6.08	26.0	3.76	2.28	18.7	7.11	4	Na-Mg-Ca-Cl-HCO3
R27/6833	83.2	8.32	11.8	5.83	0.797	20.9	2.37	2	Na-Mg-Ca-

Site code	Median Bicarbonate (mg/L)	Median Calcium (mg/L)	Median Chloride (mg/L)	Median Magnesium (mg/L)	Median Potassium (mg/L)	Median Sodium (mg/L)	Median Sulphate (mg/L)	Cluster	Watertype
HCO3									
R27/7153	59.7	10.7	16.8	4.87	1.3	15.3	7.3	1	Na-Ca-Mg-HCO3-Cl
R27/7154	35.6	4.36	14.4	2.64	1.05	13.8	3.67	2	Na-Ca-Mg-HCO3-Cl
R27/7215	80.4	0.857	14.4	0.66	2.95	36.3	<0.5	2	Na-HCO3-Cl
S25/5125	23.0	6.35	20.9	4.49	4.17	15.2	10.5	4	Na-Mg-Ca-Cl-HCO3
S25/5200	98.9	12.5	37.8	8.22	1.33	32.8	3.3	4	Na-Mg-Ca-HCO3-Cl
S25/5256	33.2	10.2	20.5	6.02	1.53	21.6	17.2	4	Na-Ca-Mg-Cl-HCO3-SO4
S25/5322	82.6	17.5	31.9	8.33	2.3	33.0	8.65	4	Na-Ca-Mg-HCO3-Cl
S26/0117	31.4	9.58	14.2	3.54	2.79	11.4	7.99	1	Na-Ca-Mg-HCO3-Cl
S26/0223	18.3	12	13.6	5.78	1.2	13.0	11.1	1	Ca-Na-Mg-Cl-HCO3
S26/0299	16.6	7.76	12.3	2.62	1.01	8.5	6.41	1	Ca-Na-Mg-Cl-HCO3
S26/0439	33.3	8.38	13.0	3.74	1.09	11.8	8.3	1	Na-Ca-Mg-HCO3-Cl
S26/0457	31.2	8.82	6.6	1.70	0.965	5.5	4.62	1	Ca-Na-HCO3-Cl
S26/0467	34.9	7.77	12.2	3.05	2.05	11.8	6.09	1	Na-Ca-Mg-HCO3-Cl
S26/0568	150.1	21.7	12.8	9.40	1.19	22.0	<0.5	2	Ca-Na-Mg-HCO3
S26/0705	42.3	9	12.0	4.07	1.13	15.9	9.32	1	Na-Ca-Mg-HCO3-Cl
S26/0762	124.1	20.8	40.3	6.13	1.94	35.9	2.99	4	Na-Ca-HCO3-Cl
S27/0009	40.2	10.8	16.1	4.20	1.52	15.0	9.51	1	Na-Ca-Mg-HCO3-Cl
S27/0070	28.7	9.18	8.6	1.88	0.929	7.2	5.75	1	Ca-Na-HCO3-Cl
S27/0136	16.6	7.95	15.0	3.65	1.16	11.6	11.3	1	Na-Ca-Mg-Cl-HCO3-SO4
S27/0156	60.9	7.07	12.9	3.06	0.821	17.7	2.17	2	Na-Ca-HCO3-Cl
S27/0202	15.7	8.09	16.1	3.69	1.25	11.1	16.8	1	Na-Ca-Mg-Cl-SO4-HCO3
S27/0299	37.8	7.29	8.2	2.75	0.821	8.3	4.12	1	Ca-Na-Mg-HCO3-Cl

Site code	Median Bicarbonate (mg/L)	Median Calcium (mg/L)	Median Chloride (mg/L)	Median Magnesium (mg/L)	Median Potassium (mg/L)	Median Sodium (mg/L)	Median Sulphate (mg/L)	Cluster	Watertype
HCO3-Cl									
S27/0389	81.5	11.8	22.4	5.12	1.33	25.5	6.61	4	Na-Ca-HCO3-Cl
S27/0396	206.0	66.8	37.6	8.23	2.21	26.7	27.6	5	Ca-Na-HCO3-Cl
S27/0435	157.1	14	34.7	6.32	4.49	37.1	<0.5	3	Na-Ca-HCO3-Cl
S27/0442	196.4	7.96	103.1	2.98	1	124.2	<0.5	3	Na-HCO3-Cl
S27/0495	151.2	20.8	63.6	8.08	2.1	52.8	<0.5	3	Na-Ca-HCO3-Cl
S27/0522	118.4	32.5	153.7	19.21	2.31	93.9	34.6	5	Na-Ca-Mg-Cl-HCO3
S27/0571	51.7	13.7	32.7	5.94	1.66	28.2	16.3	4	Na-Ca-Mg-Cl-HCO3
S27/0588	60.4	10.6	26.8	4.27	1.57	19.6	7.3	4	Na-Ca-HCO3-Cl
S27/0594	179.2	32.7	67.7	10.02	2.5	50.7	<0.5	3	Na-Ca-HCO3-Cl
S27/0607	219.6	40.1	244.6	17.64	7.61	139.0	<0.5	3	Na-Cl-HCO3
S27/0681	155.5	48.6	32.4	6.12	1.93	24.8	26.1	5	Ca-Na-HCO3-Cl
T26/0003	22.2	9.42	11.2	2.98	0.938	8.9	8.35	1	Ca-Na-Mg-HCO3-Cl
T26/0087	53.7	12	9.2	2.93	1.2	11.8	4.88	1	Ca-Na-HCO3
T26/0099	44.1	8.4	10.5	5.14	1.15	12.7	9.53	1	Na-Mg-Ca-HCO3-Cl
T26/0206	69.0	9.87	11.5	4.28	0.853	18.4	2.56	2	Na-Ca-Mg-HCO3-Cl
T26/0259	34.6	10	7.9	1.88	0.948	6.9	5.74	1	Ca-Na-HCO3-Cl
T26/0332	56.1	14.2	36.4	6.29	1.25	23.7	15.2	4	Na-Ca-Mg-Cl-HCO3
T26/0413	97.7	14.2	9.8	5.94	0.96	15.9	0.58	2	Ca-Na-Mg-HCO3
T26/0430	32.5	10.1	9.3	2.57	1.46	8.8	5.94	1	Ca-Na-Mg-HCO3-Cl
T26/0489	61.6	26.4	25.1	4.51	1.67	19.9	13.6	4	Ca-Na-HCO3-Cl
T26/0538	48.5	36.9	46.5	12.31	4.45	24.3	51	5	Ca-Na-Mg-Cl-SO4-HCO3
T27/0063	297.7	85.3	84.4	8.75	2.27	53.1	13.4	5	Ca-Na-HCO3-Cl