River, Lake, and Groundwater Quality 2017 to 2022

Background

The Otago Regional Council (ORC) is responsible for managing Otago's water resources. ORC carries out regular water-quality monitoring and ecological assessments, as part of its State of Environment (SoE) programme. This report card is a snapshot of water quality monitoring undertaken between July 2017 and June 2022.

Further detail can be found in 'State and Trends of River, Lake and Groundwater in Otago, 2017-2022'. Water quality monitoring sites are shown in Figure 1.

Each site that has been monitored for nitrate (NNN) and ammonia (NH_4-N) toxicity, dissolved reactive phosphorus (DRP), suspended fine sediment (SFS), *Escherichia coli (E. coli*), periphyton and phytoplankton (Chla), total nitrogen (TN) and total phosphorus (TP) has been graded according to the relevant attribute table and calculation guidance in Appendix 2 of the NPSFM (Table 1).

Each table of Appendix 2 of the NPSFM 2020 defines the ranges for numeric attribute states as four attribute bands, which are designated A to D/E. The attribute bands represent a graduated range of support for environmental values from high (A band) to low (D/E band). For most attributes, the D band represents an unacceptable condition (with the threshold between the C and the D band being referred to as the 'bottom line').

Table 1. Details of the NPS-FM attributes used to grade the state of the river and lake monitoring sites.

NPS-FM Reference – NOF Attribute	Water body type	Calculation guidance	Numeric attribute state description	Units
A2A; Table 1 – Phytoplankton	Lakes		Median of phytoplankton chlorophyll-*a*	mg chl-a m^{-3}
			Annual maximum of phytoplankton chlorophyll-*a*	mg chl-a m^{-3}
A2A; Table 2 – Periphyton	Rivers	Minimum of 3 years of data	92nd percentile of periphyton chlorophyll-*a* for default river class[2]	mg chl-a m^{-2}
			83rd percentile of periphyton chlorophyll-*a* for productive river class[1]	mg chl-a m^{-2}
A2A; Table 3 – Total Nitrogen	Lakes		Median concentration of total nitrogen	mg m^{-3}
A2A; Table 4 – Total Phosphorus	Lakes		Median concentration of total phosphorus	mg m^{-3}
A2A; Table 5 - Ammonia	Lakes and Rivers		Median concentration of Ammoniacal-N	mg l^{-1}
			Maximum concentration of Ammoniacal-N	mg l^{-1}
A2A; Table 6 - Nitrate	Rivers		Median concentration of Nitrate	mg l^{-1}
			95th percentile concentration of Nitrate	mg l^{-1}
A2A.; Table 8 - Suspended fine sediment	Rivers	Median of 5 years of at least monthly samples (at least 60 samples)	Median visual clarity	m
A2A; Table 9 - *Escherichia coli*	Rivers and Lakes	minimum of 60 samples over a maximum of 5 years,	% exceedances over 260 cfu 100 mL^{-1}	%
			% exceedances over 540 cfu 100 mL^{-1}	%
			Median concentration of *E. coli*	cfu 100 ml^{-1}
			95th percentile concentration of *E. coli*	cfu 100 ml^{-1}
A2B; Table 20 - DRP	Rivers		Median concentration of DRP	mg l^{-1}
			95th percentile concentration of DRP	mg l^{-1}

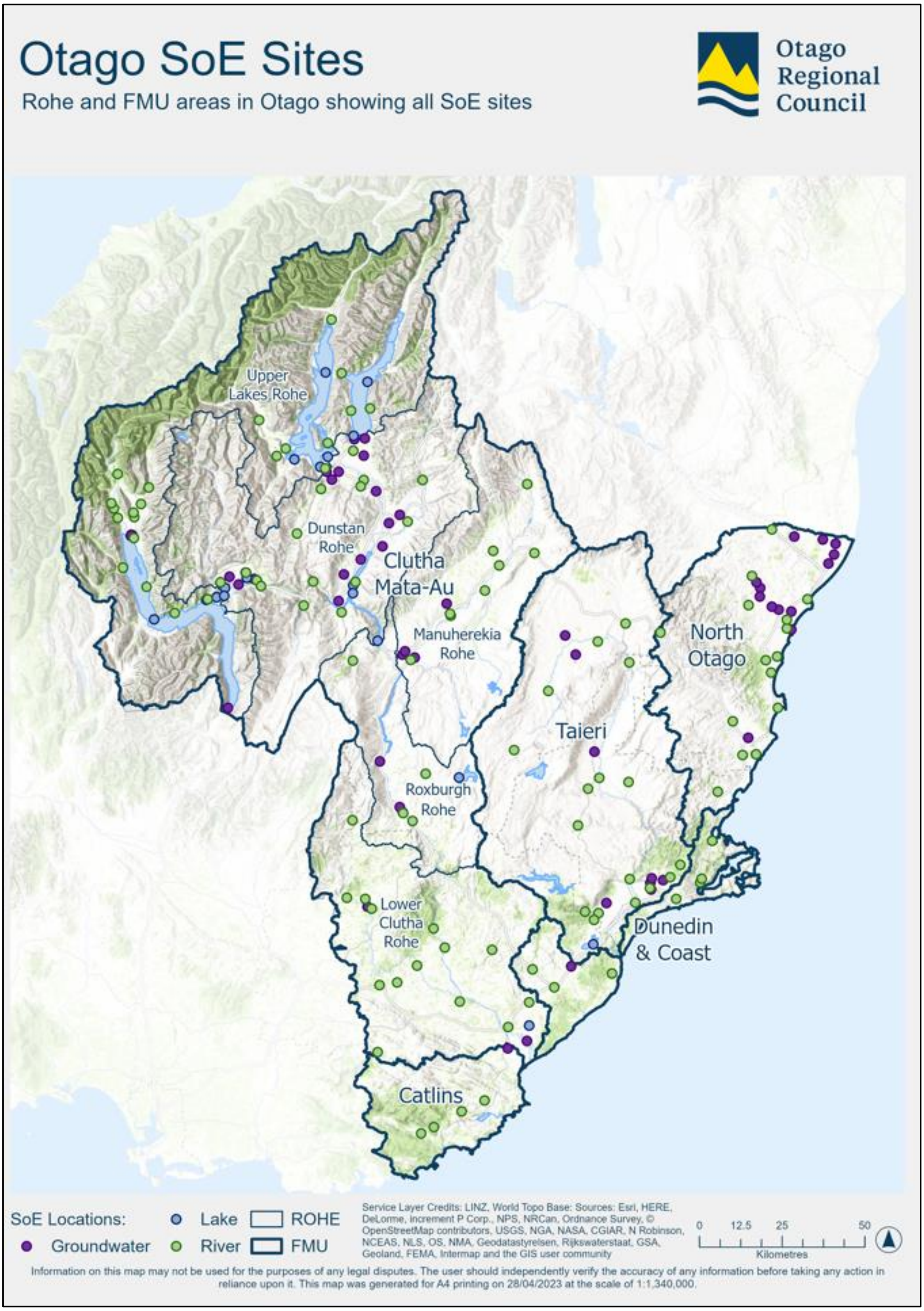


Figure 1: Map of the Otago region showing Freshwater Management Units and monitoring sites.

NITRATE AND AMMONIA TOXICITY

High levels of nitrate-nitrite-nitrogen (NNN) or ammoniacal nitrogen (NH_4-N) in water can create conditions that make it difficult for aquatic insects or fish to survive. Click or tap here to enter text.In Otago rivers, concentrations are generally < 0.03 mg/l for NNN and <2.4 mg/l for NH_4-N. At these concentrations, NNN and NH_4-N are not expected to be harmful to most freshwater species and does not pose a risk for humans. The National Policy Statement – Freshwater Management (NPS-FM) (MfE, 2020) provides a framework for the assessment of the current state for NNN and NH_4-N (NPS-FM, Table 1).

Figure 2 and Figure 3 show nitrate and ammonia toxicity results for Otago.

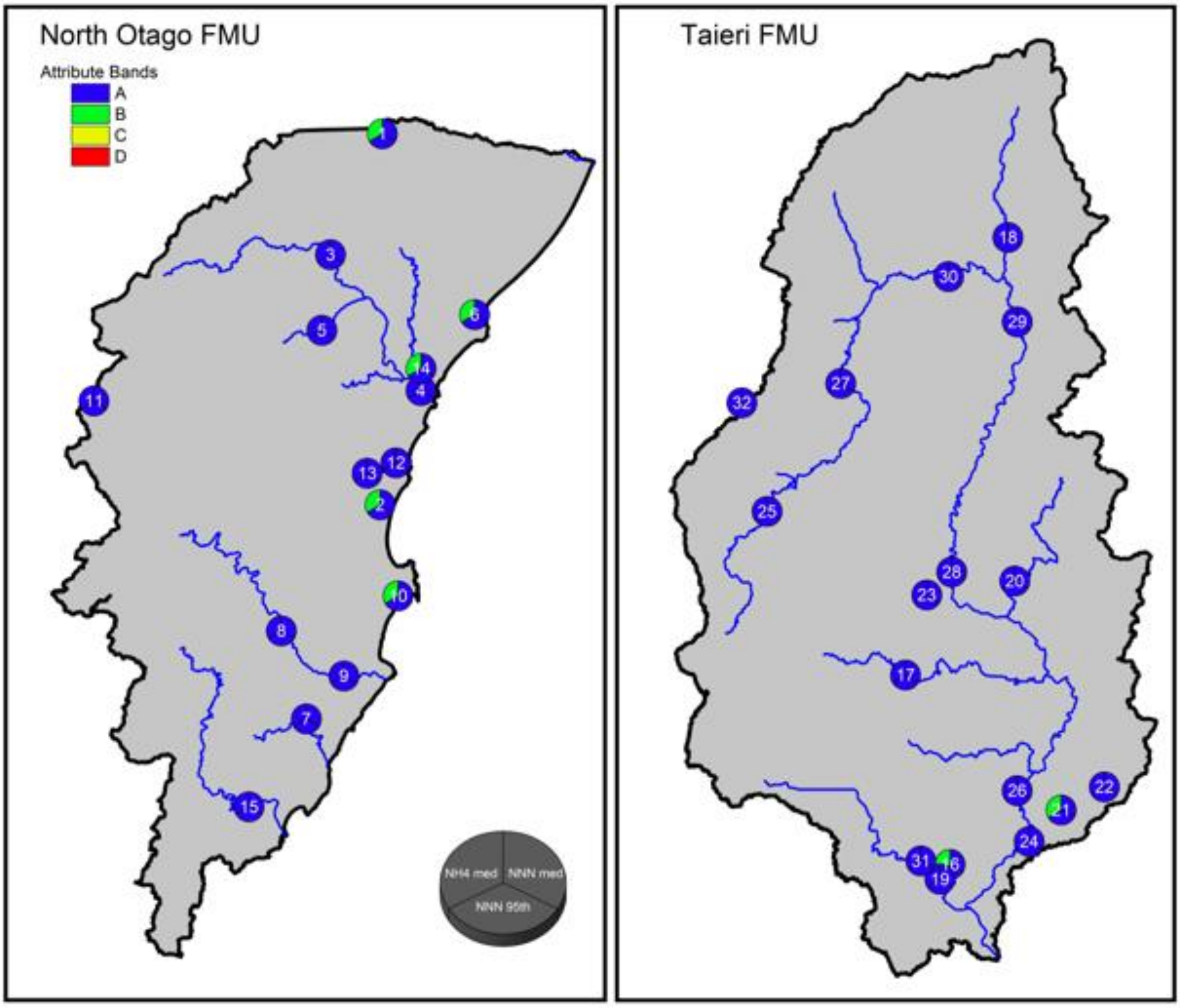


Figure 2: Median Nitrite-Nitrate-Nitrogen (NNN) and Ammonia (NH_4-N) attribute states shown for the North Otago and Taieri FMUs over the 5-year monitoring period from 2017 to 2022. Site numbers are given in Appendix 1.

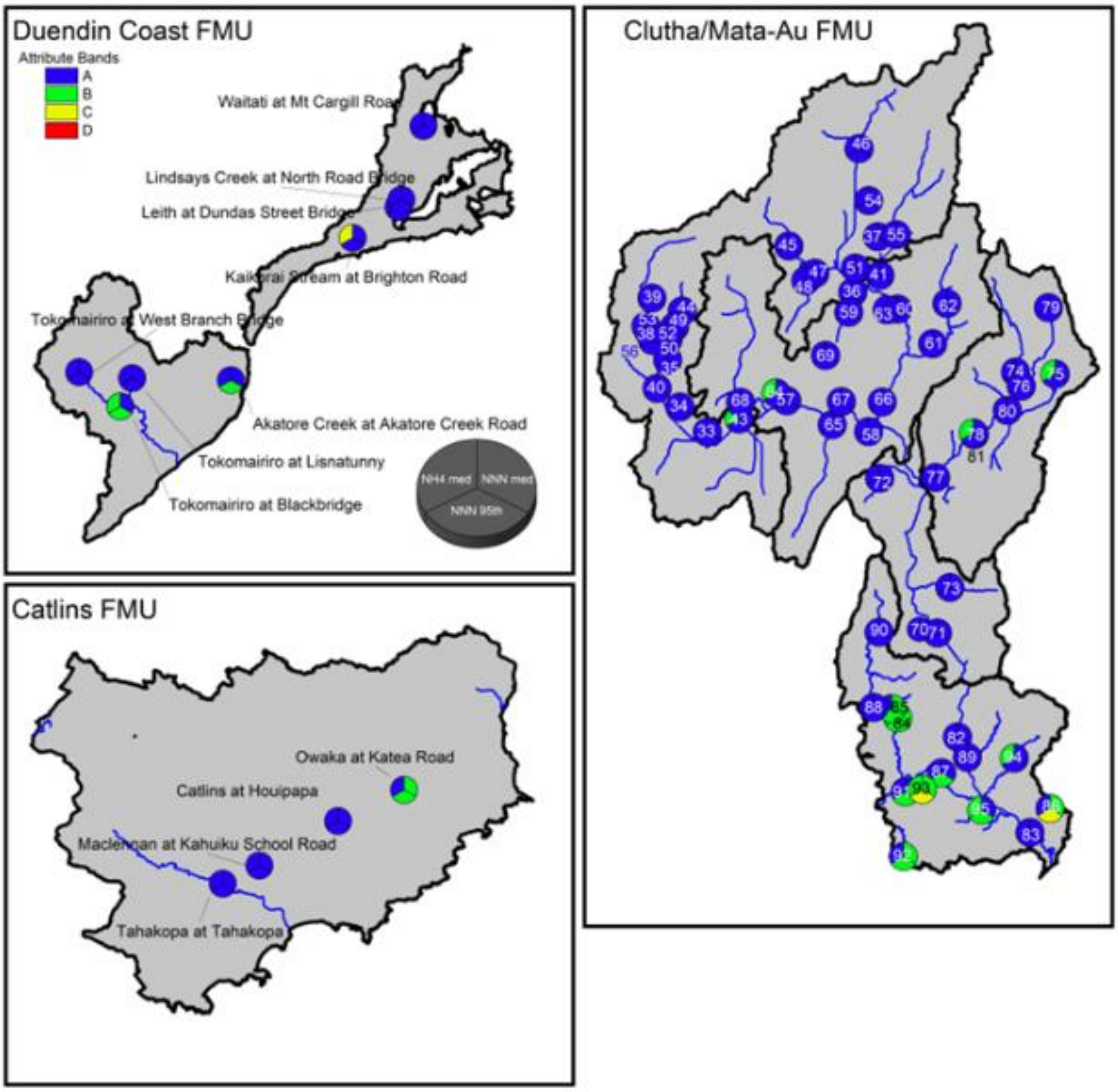


Figure 3: Median Nitrite-Nitrate-Nitrogen (NNN) and Ammonia (NH_4-N) attribute states shown for the Clutha/Mata-Au, Dunedin & Coast and Catlins FMUs over the 5-year monitoring period from 2017 to 2022. Sites that show 5-year median concentrations in the C-band (yellow) fall below the national bottom line. Site numbers are given in Appendix 1.

Sites that are experiencing higher anthropogenic pressures such as intensive farming or urban development generally have higher concentrations of NNN or NH_4-N, however most sites in Otago achieve attribute band 'A'.

The main sources of NNN and NH_4-N are fertilizers, wastewater, and animal waste. NNN and NH_4-N can come from diffuse sources, such as land runoff or point sources, such as wastewater pipes.

Sites that fall below the national bottom line (attribute band C) for the 95th percentile of NNN are Lovells Creek at Station Road (#86) and Wairuna at Millar Road (#93) while the Kaikorai Stream at Brighton Road falls below the national bottom line for NH_4-N.

DISSOLVED REACTIVE PHOSPHOROUS (DRP)

Nutrients in waterways sustain primary production by algae, however, blooms of algae can smother habitat, are aesthetically unacceptable, and are not favourable for swimming. The major nutrients, influencing algal growth, are nitrogen (N) and phosphorous (P).

Most rivers in New Zealand are P limited (McDowell, 2009) therefore algal blooms are more likely to be triggered by excess concentrations of P rather than N. DRP is a form of P that is readily available for uptake by algal cells, allowing for fast algal growth if supply is sufficient (McDowell, 2009).

The NPS-FM (2020) provides a framework for the assessment of the current state for DRP (NPSFM, Table 20). Figure 4 and Figure 5 show DRP results for Otago.

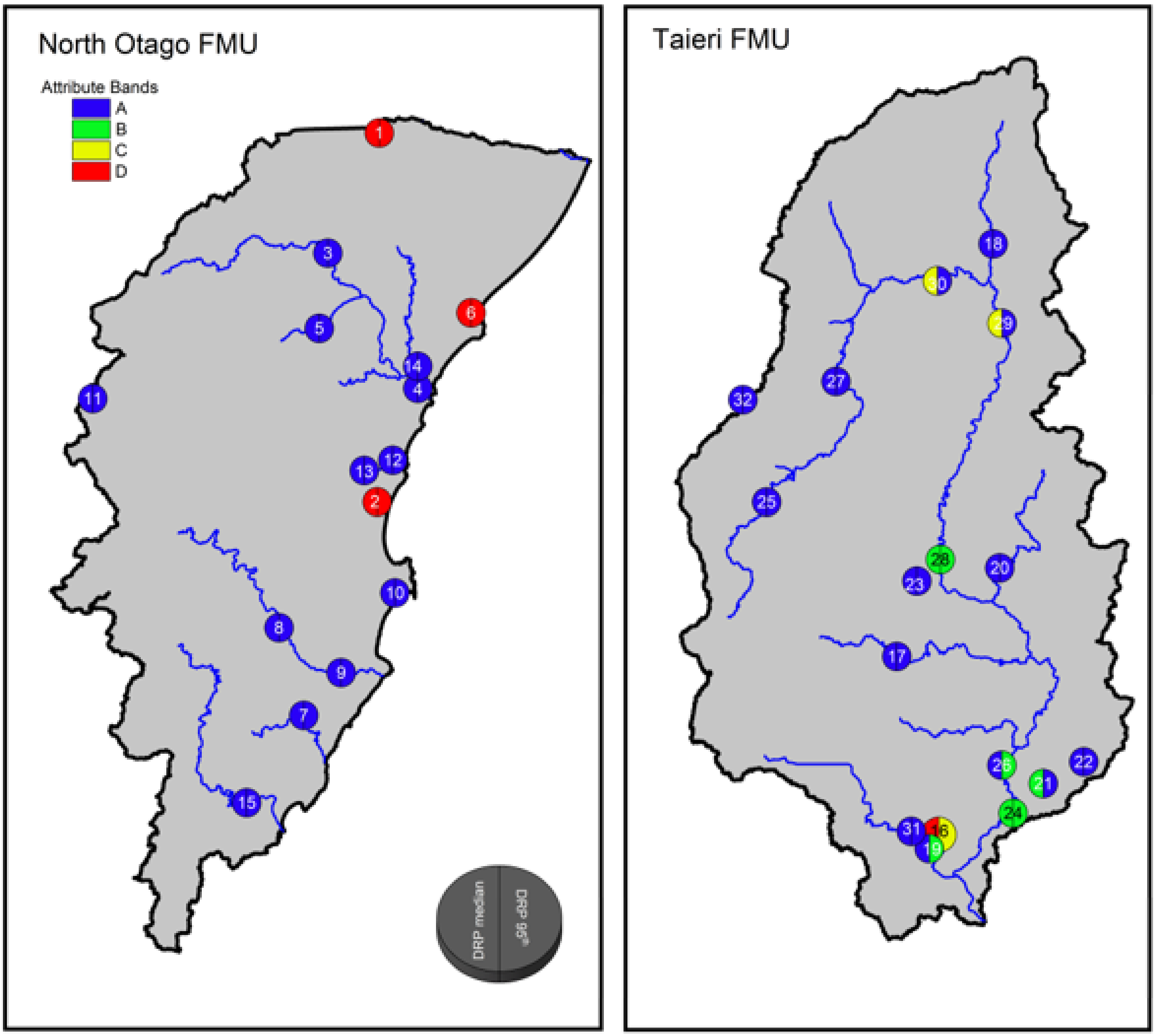


Figure 4: Median dissolved reactive phosphorous (DRP) attribute states shown for the North Otago and Taieri FMUs over the 5-year monitoring period from 2017 to 2022. Site numbers are given in Appendix 1.

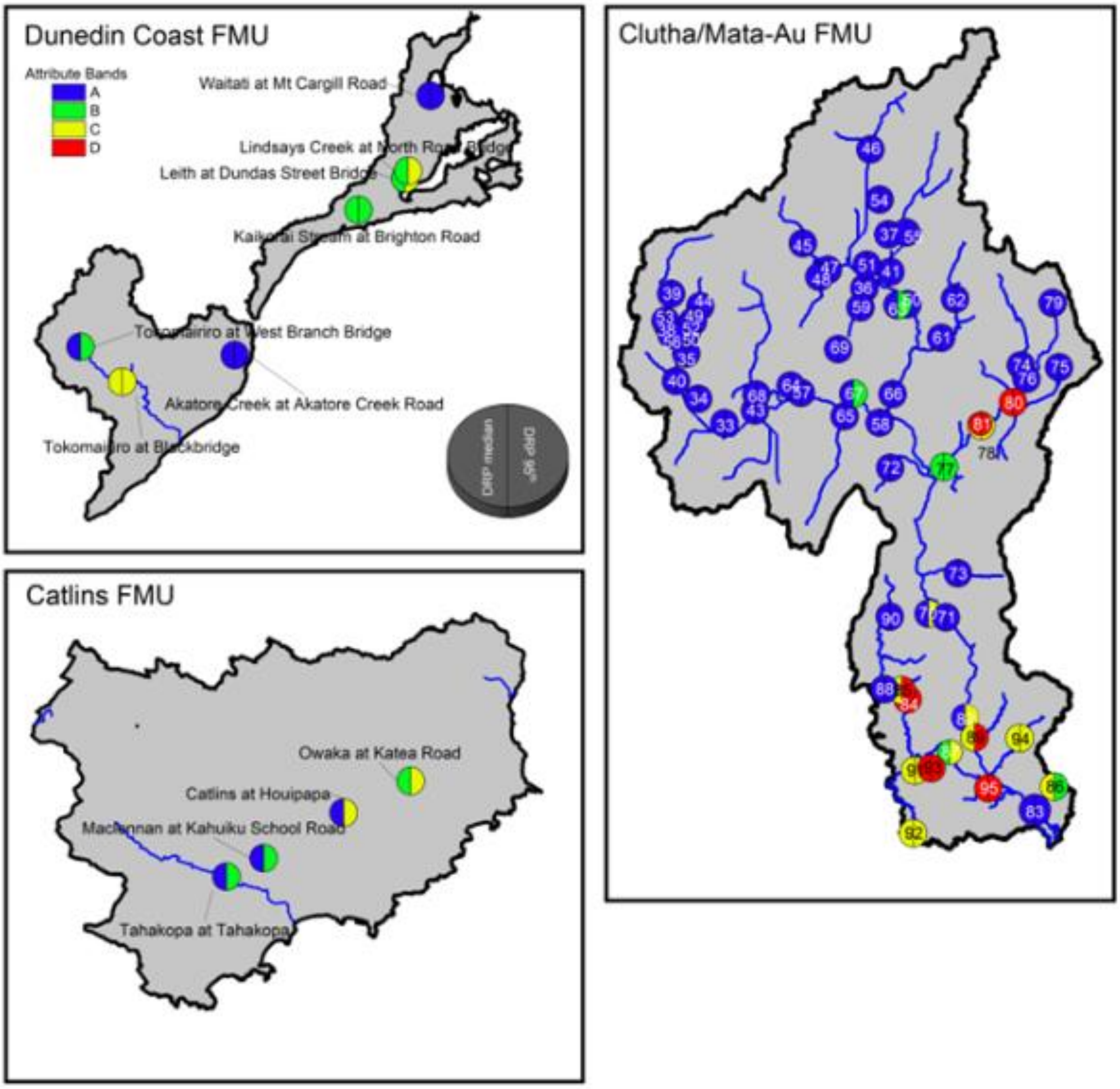


Figure 5: Median dissolved reactive phosphorous (DRP) attribute states shown for the Dunedin & Coast, Catlins and Clutha/Mata-Au FMUs over the 5-year monitoring period from 2017 to 2022. Site numbers are given in Appendix 1.

Sources of DRP can be natural (weathering of rocks or plant decomposition) or from human activities including fertilizer application and waste inputs.

Sites located in the upper reaches generally achieve a DRP attribute band of 'A' (e.g., in the Taieri FMU and North Otago FMU), with lower DRP attribute bands in lower reaches. Most of the Upper Lakes Rohe and Dunstan Rohe achieve an attribute band of 'A'.

The Lower Clutha has more sites in the 'B' to 'D' band. The Manuherekia Rohe has two sites, Thomsons Creek and the Pool Burn, that achieve a 'D' band and DRP concentrations increase from an 'A' band to a 'C' band, between Blackstone and Ophir. Sites that show DRP concentrations at the 'C' and 'D' band are generally influenced by farming and/or urban land uses nearby and upstream of the monitoring site.

SUSPENDED FINE SEDIMENT

Elevated concentrations of suspended fine sediment (SFS) negatively influence benthic environments, fish community composition, and carry nutrients and toxins (Clapcott, 2011, Jones, 2012). In the NPS-FM (Table 8) suspended fine sediment attribute bands for a site are based REC groups described in the New Zealand River Environment Classification (MfE, 2004). Suspended fine sediment is naturally present in all rivers due to the presence of organic substances and the weathering of rocks. The two major rivers in Otago, the Clutha and Taieri, alongside some other rivers in the region, are influenced by natural sources of suspended fine sediment. High loads of glacial flour are present in the Clutha, providing for its unique turquoise colour while natural tannin staining is responsible for the brown colour of the Taieri and some rivers in the Catlins FMU. Human activities that increase the amount of suspended fine sediment include farming or construction. Suspended sediment in Otago is assessed via measurements of turbidity that are then converted to visual clarity (Ballantine, 2014). Sites obtaining attribute band 'D' are below the national bottom line.

Many Otago sites do not meet the national bottom line for suspended sediment. Sites in the Taieri FMU and Catlins FMU are affected by natural tannin staining, and sites in the Clutha FMU are affected by natural sources of glacial flour.

Figure 6 and Figure 7 show SFS results for Otago.

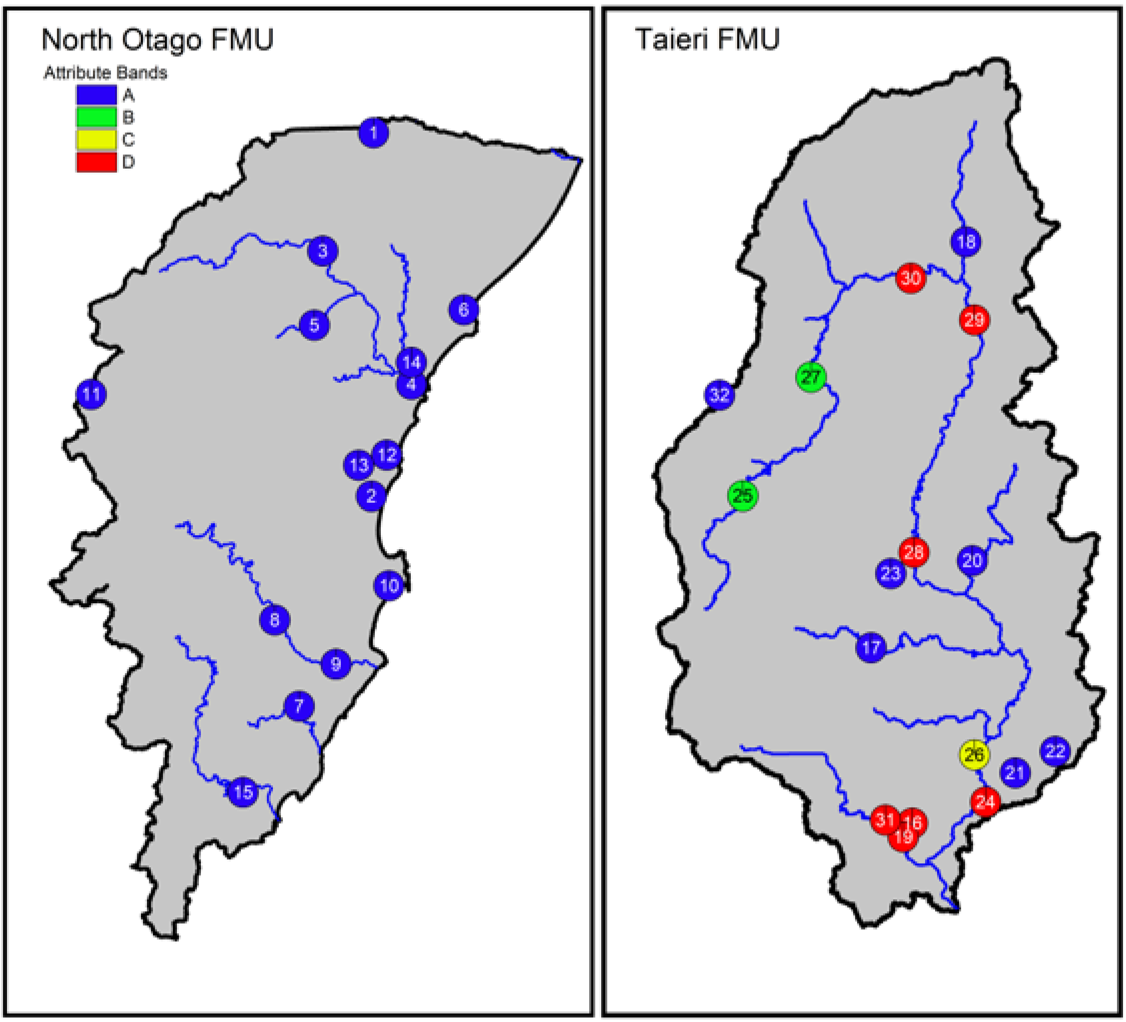


Figure 6: Suspended fine sediment attribute states shown for the North Otago and Taieri FMUs over the 5-year monitoring period from 2017 to 2022. The national bottom line for suspended sediments is set at the bottom of the C-band. Site numbers are given in Appendix 1.

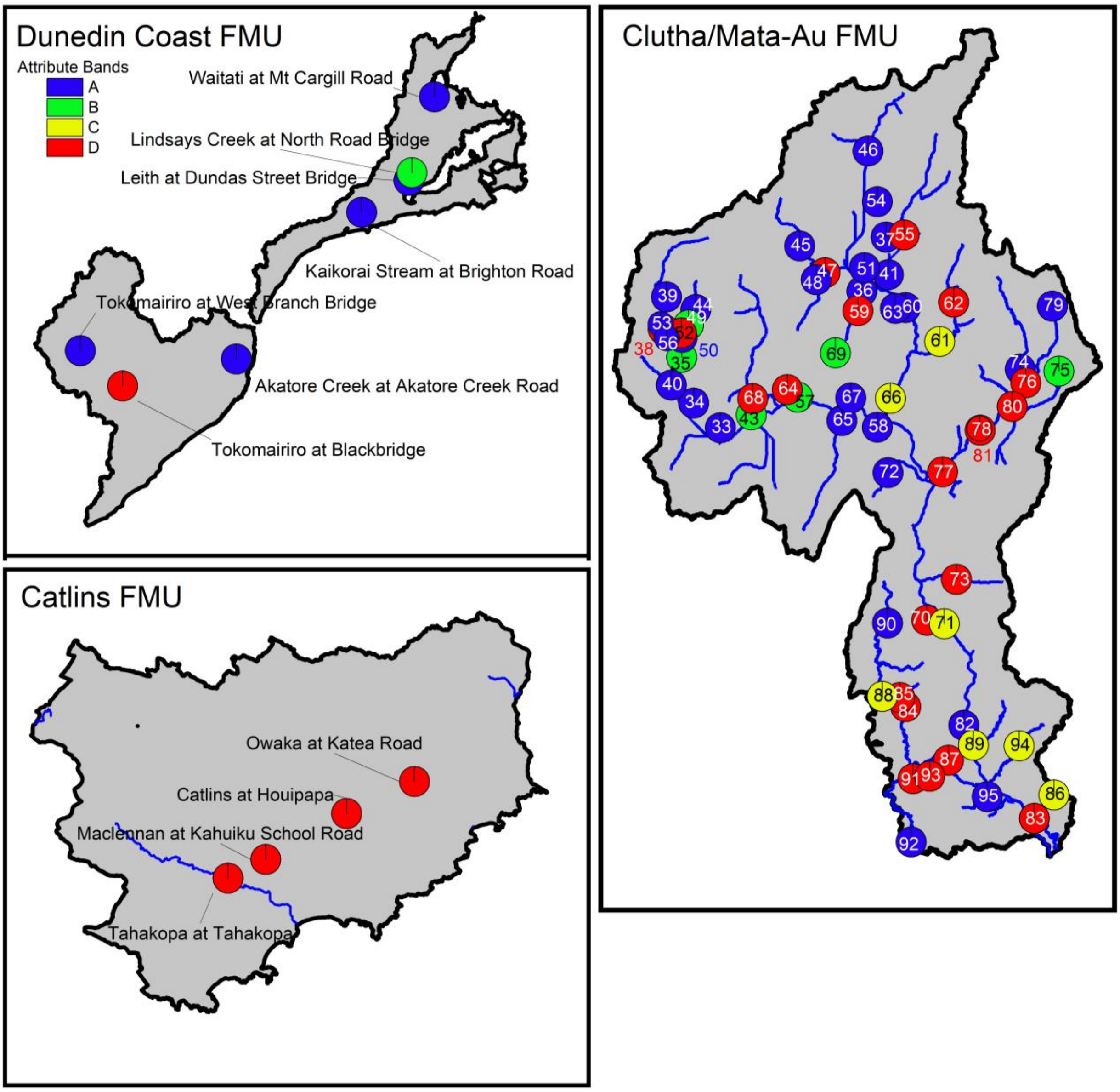


Figure 7: Suspended fine sediment attribute states shown for the Clutha/Mata-Au, Dunedin & Coast, and Catlins FMU over the 5-year monitoring period from 2017 to 2022. The national bottom line for suspended sediments is set at the bottom of the C-band. Site numbers are given in Appendix 1.

ESCHERICHIA COLI

The bacterium *Escherichia Coli* (*E. coli*) is naturally present in animal faeces and freshwater and can reach high concentrations by the addition of wastewater or runoff from agricultural pastures to streams (14). High densities of *E. coli* pose the risk of infection with several diseases, such as gastroenteritis (campylobacter), if the waterbody is used for recreational activities (15) and can diminish the value of Mahinga kai and Mana of the waterway. The NPS-FM (Table 9) uses four different metrics to inform of the current state of *E. coli* in rivers and lakes: *median, 95th percentile, 260 MPN*

(Most Probable Number)/100mL *exceedance, and 540 MPN* (Most Probable Number)/100mL *exceedance*.

While most sites in the Upper Lakes Rohe achieve attribute band 'A', many sites across the Otago region show a poor state for all four *E. coli* statistics. Sites lower in the catchment generally show higher concentrations of *E. coli* than sites closer to the source due to accumulating inputs of bacteria from land runoff or urban sources.

Sites that are most heavily impacted by high *E. coli* densities are clustered around areas with urban (Dunedin) or agricultural land uses (Pomahaka, Lower Clutha, Taieri and North Otago) (Figures 8 and 9). Sources of *E. coli* may also be from gulls/ducks/geese. The Upper Kakanui site is known to have *E. coli* source from red billed gulls roosting in the gorge.

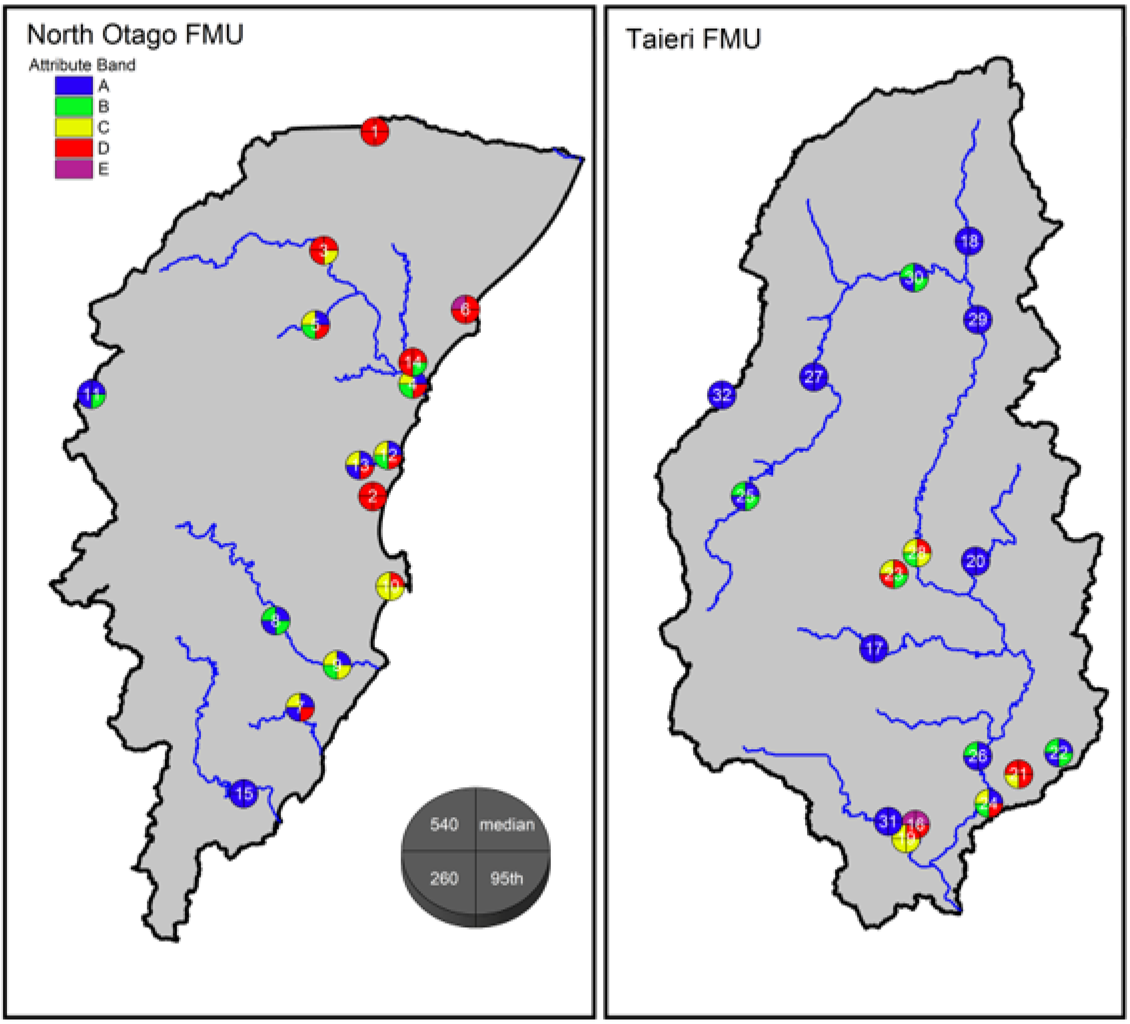


Figure 8: Escherichia Coli (E. coli) attributes (clockwise: median, 95th percentile, 260 exceedance, 540 exceedance North Otago and Taieri FMUs over the 5-year monitoring period from 2017 to 2022. No national bottom line is given for E. coli but sites in the D- and E-band are considered unsafe for recreational activities. Site numbers are given in Appendix 1.

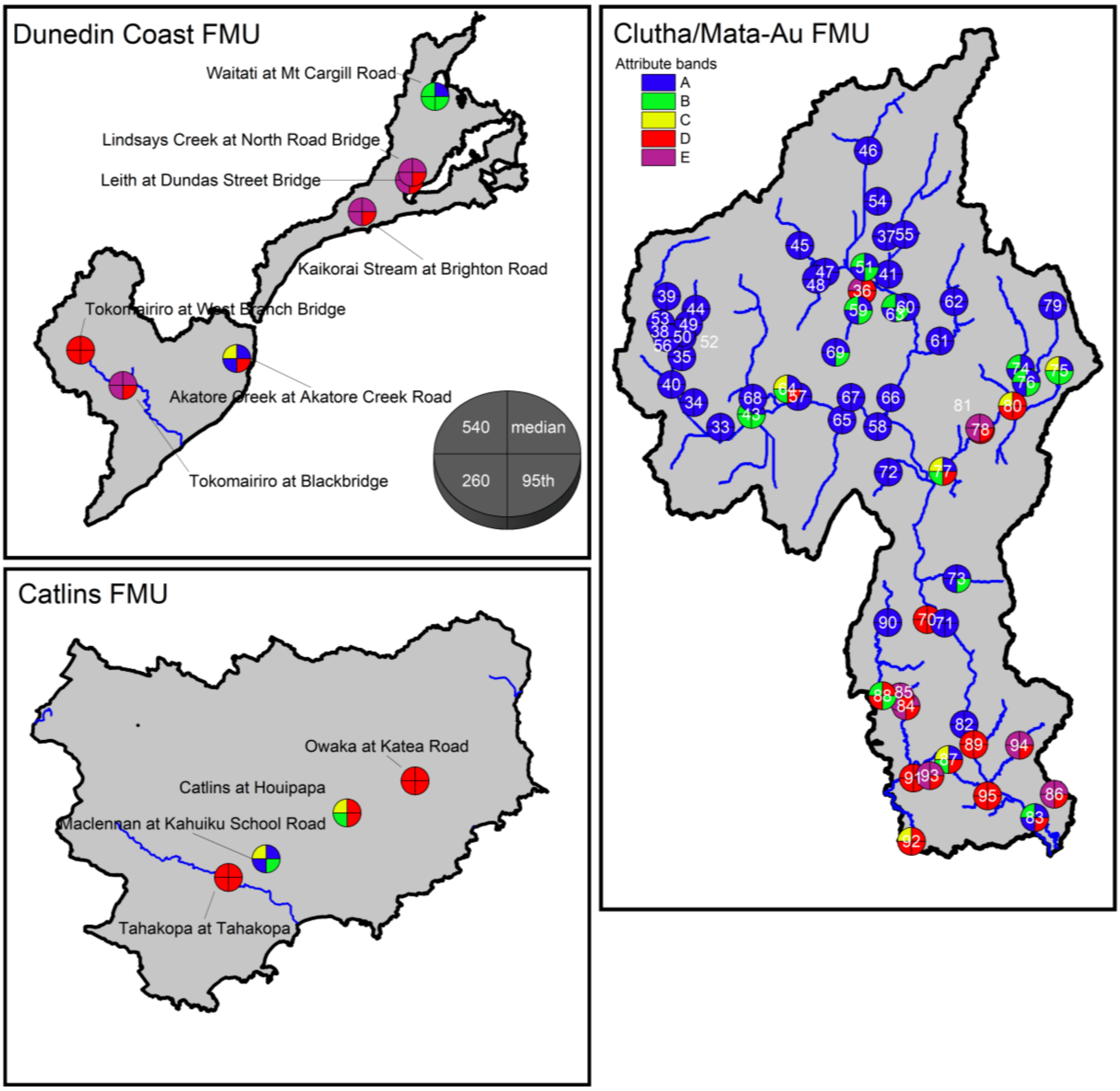


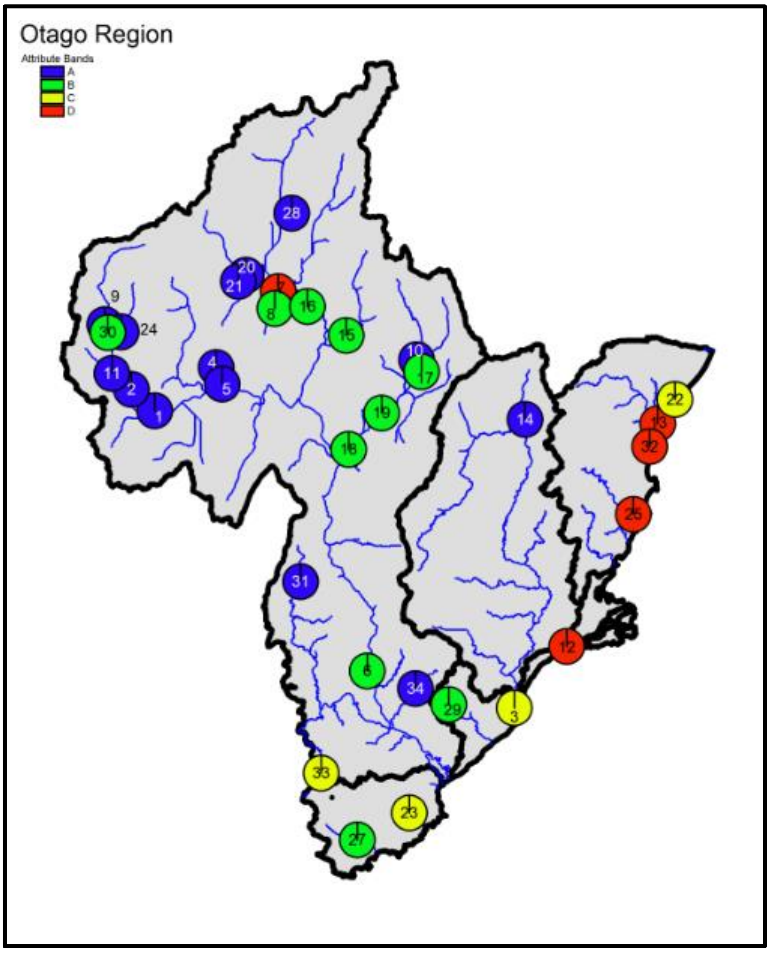
Figure 9: Escherichia Coli (E. coli) attributes (clockwise: median, 95th percentile, 260 exceedance, 540 exceedance shown for the Dunedin & Coast, Catlins and Clutha/Mata-Au FMUs over the 5-year monitoring period from 2017 to 2022. No national bottom line is given for E. coli but sites in the D- and E-band are considered unsafe for recreational activities. Site numbers are given in Appendix 1.

PERIPHYTON- RIVERS

Chlorophyll-*a* (Chl-*a*) concentration is a common method for estimating stream periphyton biomass because all types of algae (including periphyton) contain Chl-*a*, hence, this metric reflects the total amount of live algae in a sample. The trophic state of a water body is the amount of living material (biomass) that it supports. Healthy freshwater ecosystems have low (oligotrophic) to intermediate (mesotrophic) levels of living material and primary production (growth of plants or algae). In combination with other environmental factors such as temperature and light, high levels of nutrients, primarily nitrogen (nitrate) and phosphorus (phosphate), can cause water bodies to become eutrophic. Eutrophic states are associated with periodic high biomass (blooms) of plants or algae, including suspended algae (phytoplankton) in lakes and algae on the beds of streams and rivers (periphyton) (Table 6). The periphyton monitoring programme includes 34 sites and the results are shown in figure 10. Note that periphyton is only monitored at a subset of all sites.

Sites that fall below the national bottom line are either located in urban areas (Bullock Creek at Dunmore Street) or are located at the bottom of streams influenced by upstream agriculture.

Sites in the A- and B-band are often associated with areas of lower anthropogenic pressure.



1	12 Mile Creek at Glenorchy Queenstown Road
2	25 Mile Creek at Glenorchy Queenstown Road
3	Akatore Creek at Creek Road
4	Arrow River at Arrow Gorge Track
5	Arrow River at Morven Ferry Road
6	Blackcleugh Burn at Rongahere Road
7	Bullock Creek at Dunmore Street
8	Cardrona River at Mt Barker
9	Dart River at The Hillocks
10	Dunstan Creek at Beattie Road
11	Greenstone River at Greenstone Station Road
12	Kaikorai Stream at Brighton Road
13	Kakanui River at McCones
14	Kye Burn at SH85 Bridge
15	Lindis River at Ardgour Road
16	Luggate Creek at SH6 Bridge
17	Manuherekia at Blackstone Hill
18	Manuherekia t Galloway
19	Manuherekia at Ophir
20	Matukituki at West Wanaka
21	Motatapu River at Wanaka Mt Aspiring Road
22	Oamaru Creek at SH1
23	Owaka River at Katea Road
24	Precipice Creek at Glenorchy Paradise Road
25	Shag River at Goodwood Pump
26	Silver Stream at Taieri Depot
27	Tahakopa River at Tahakopa
28	The Neck Creek at Meads Road
29	Tokomairiro River at West Branch Bridge
30	Turner Creek at Kinloch Road
31	Upper Pomahaka River at Aitchisons Run Road
32	Waianakarua River at Browns
33	Waipahi River at Waipahi
34	Waitahuna River at Tweeds Bridge

Figure 10: *Periphyton cover shown for the Otago region over the 5-year monitoring period from 2017 to 2022. the national bottom line is at the bottom of the C-band.*

NUTRIENTS – TOTAL NITROGEN (TN) AND TOTAL PHOSPHOROUS (TP)

The growth of algae, forming the basis of food-webs in lakes, is controlled by the amount and availability of nutrients. The major nutrients algae need for growth are nitrogen (N) and phosphorous (P) and the concentrations of these nutrients in freshwater often give an indication for the possible magnitude of algal growth. If nutrients and algal growth is low, lakes are classified as 'oligotrophic'. Conversely, if nutrient concentrations and algal growth are high, to the extent of large surface blooms, the lake is classified as 'eutrophic' or 'hypertrophic'. Lakes with intermediate nutrient levels and algal growth are classified as 'mesotrophic'. Lake nutrient state is based on the concentrations of nitrogen and phosphorus. The NPS-FM (2020) provides a framework for the assessment of the current state for TN and TP (NPSFM, Table 3 and 4).

Lakes in the Upper Lake Rohe (Lake Wakatipu, Lake Wanaka, and Lake Hawea) and Lake Dunstan show the A-band for all monitored attributes, however rapid urban development with associated stormwater and drainage infrastructure is a threat to the lakes water quality.

Lakes in other parts of Otago show a poorer current state, i.e., Lake Hayes achieves the C-band for TN and TP (Figure 12). There are substantial efforts by community groups and ORC to minimise sediment and nutrient inputs into Lake Hayes.

Lake Waihola and Lake Tuakitoto are both shallow wetlands with mainly agricultural activity in their catchments. Shallow lakes commonly have high sediment re-suspension due to wind activity which enriches lake nutrient concentrations. The attribute state for lake TN and TP are shown in Figure 12.

PHYTOPLANKTON - LAKES

Phytoplankton or algal growth depends on the availability of nutrients and other physicochemical factors such as temperature, wave action, light intensity, and pH. The best proxy for phytoplankton growth is the measurement of chlorophyll (Chl-*a*), which is indicative of photosynthetically active cells. Therefore, higher Chl-*a* concentrations (mg/m^3) are equivalent to increased phytoplankton growth (16). The NPS-FM uses Chl-*a* as an indicator of phytoplankton in lakes (NPSFM, Table 1). The attribute state for lake TN and TP are shown in Figure 12.

Lake Tuakitoto is the only monitored lake that falls below the national bottom line for maximum Chl-a concentrations. This indicates that lake ecological communities are at risk of a regime shift to a degraded state.

AMMONIA TOXICITY AND E. COLI

Both attributes are described in the respective section for rivers. All monitored lakes in the Otago region achieve the 'A' band for ammonia toxicity.

Lakes Wakatipu, Wanaka, Hawea, Dunstan, Hayes and Onslow have *E. coli* concentrations in the 'A' band. Lake Tuakitoto and Lake Waihola south show *E. coli* concentrations that make the lakes unsuitable for recreational activities.

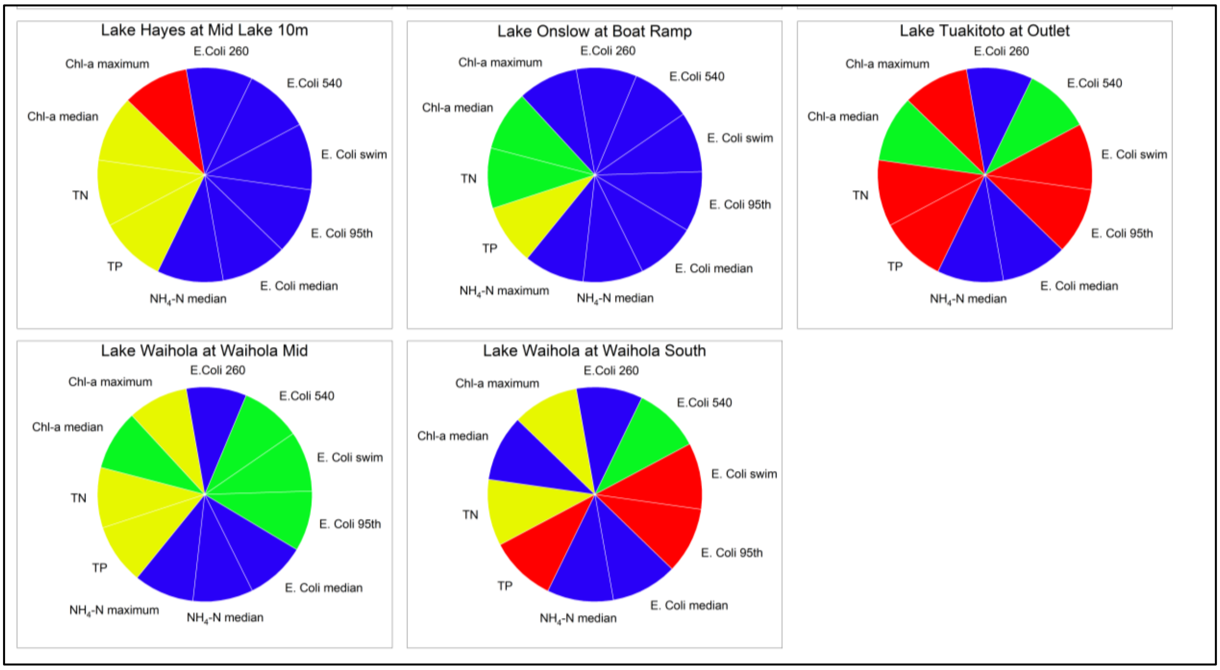


Figure 12: Attribute bands for all lake attributes monitored according to the NPS-FM. All other lakes show achieve 'A' bands for each attribute

GROUNDWATER QUALITY CURRENT STATE

The NPS-FM does not contain attribute tables for groundwater quality. Groundwater quality state was therefore assessed against the Maximum Acceptable Value (MAV) in the Drinking Water Standards for New Zealand (DWSNZ) [Department of Internal Affairs, 2022], following a similar approach to other Regional Councils (e.g., ECan, 2018). This was done due to the wide use of shallow groundwater for drinking and domestic supply across Otago, particularly in rural communities without reticulated water. However, this analysis only provides a general picture of groundwater quality state, and it does not mean whether groundwater in certain FMU/Rohe or bores are safe for domestic supply/drinking. Further information regarding drinking water can be found on the regulator's (Taumata Arowai) website https://www.taumataarowai.govt.nz/

E. COLI

Groundwater is less vulnerable than surface water to contamination by potentially pathogenic microorganisms. However, this risk still exists. Faecal bacteria contamination in groundwater can originate from livestock, wastewater discharges, effluent application, and stormwater discharges, with contamination risk increasing following heavy rainfall. *E. coli* is used as the indicator organism for bacterial contamination. The DWSNZ (2022)-MAV for *E. coli* is <1 MPN (Most Probable Number)/100mL. Groundwater state for E. Coli was assessed by calculating the percentage of exceedances of the MAV for each site over the 5-year reporting period (Figure 14).

The results show groundwater *E. col*i contamination across all of Otago, with exceedances detected in most FMU (although the Catlins and Dunedin & Coast, which did not have any, currently only have one monitoring bore each). The highest percentage of exceedances were measured in the North Otago FMU and persistent exceedances were also recorded in sites in the Taieri FMU, and the Lower Clutha and Roxburgh Rohe (Figure 14). The E. coli is potentially sourced from intensive farming and septic tanks. However, *E. coli* exceedances can also be a site-specific issue, exacerbated by poor bore security (which some SoE bores suffer from), which increases the risk of groundwater contamination. One of the aims of the new Land and Water Regional Plan is to improve bore security through more targeted provisions. The ORC is also currently expanding and upgrading its SoE monitoring bores network, which will help assess whether *E. coli* exceedances are site specific or a wider issue. Nevertheless, it is very important that bore owners maintain good bore security and regularly test their groundwater in an accredited laboratory to ensure that the water quality is suitable for the intended use

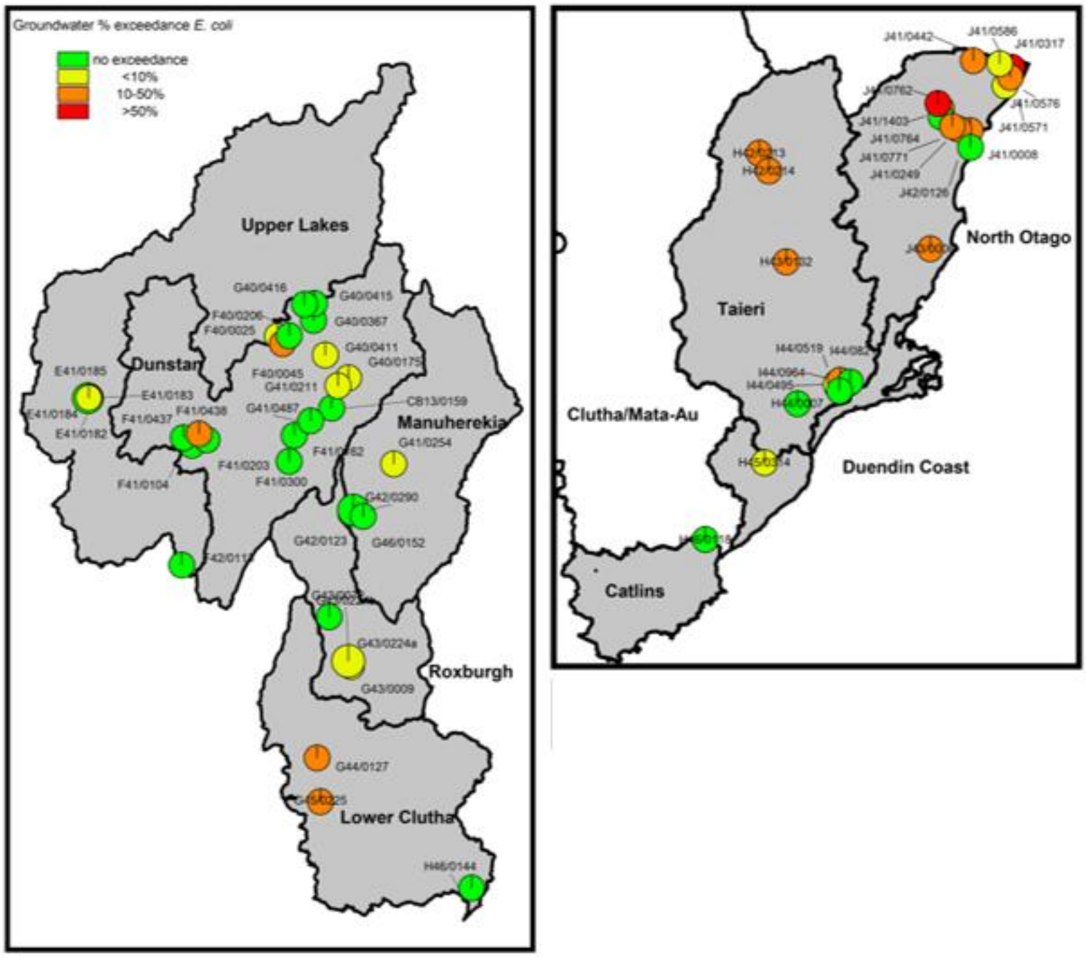


Figure 14: Groundwater E. coli percentage exceedances for SoE sites in the Clutha/Mata-Au (left), Catlins, Dunedin & Coast, Taieri and North Otago (right)

NITRATE

Nitrate (NO_3-N) is a dissolved, inorganic form of nitrogen (N), a key nutrient required for the growth of plants and algae. However, excess nitrate can adversely impact water quality, ecosystem health, and human health (e.g., ORC, 2021). The DWSNZ (2022) MAV for nitrate nitrogen is 11.3mg/L –N. The state of nitrate in groundwater was based on the median nitrate concentrations in the SoE bores. These were classified based on proportions of the DWSNZ (2022) MAV (Figure 15).

The results show wide variability in median groundwater nitrate concentrations across Otago, with generally low concentrations in the Upper Lakes, Dunstan, and Manuherekia Rohe. Higher concentrations were measured in the Roxburgh and Lower Clutha Rohe and the Taieri FMU. The highest concentrations were measured in the North Otago FMU, where concentrations in many sites exceeded the DWSNZ-MAV (Figure 15).

The measured high nitrate concentrations can have adverse impacts on human health and surface water quality, especially in areas with strong groundwater-surface water interaction (e.g., North Otago). High nitrate concentrations can be attributed to land use (intensive dairy farming, market garden, septic tanks), and can also be impacted by geology and aquifer properties (e.g., high permeability soils or slow-moving groundwater). Some of these issues are aimed to be improved with more targeted provisions in the new Land and Water Regional Plan. However, under the current land use and management practiced in some parts of the region it is unlikely that groundwater nitrate concentrations will improve.

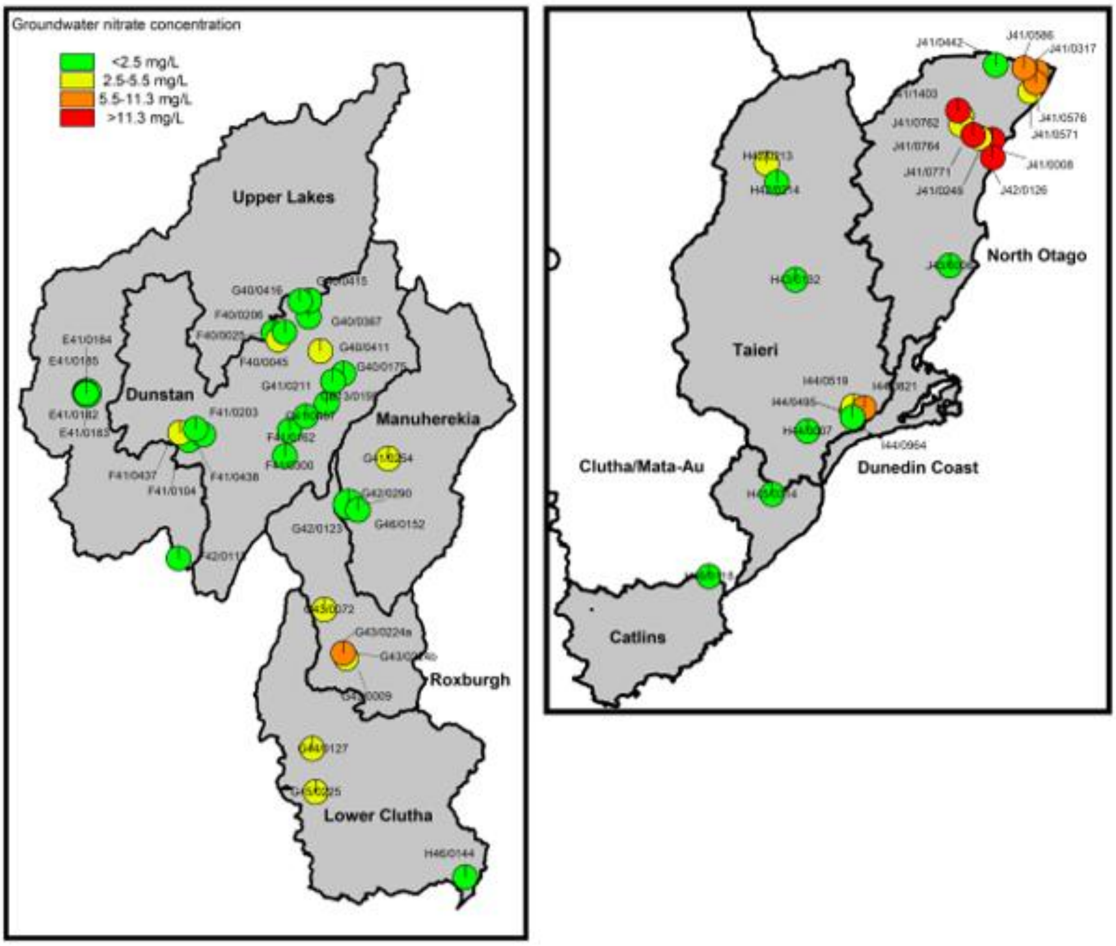


Figure 15: Median groundwater nitrate concentrations for the SoE bores in the Clutha/Mata-Au (left), Catlins, Dunedin & Coast, Taieri and North Otago (right)

DISSOLVED ARSENIC

Arsenic is a toxic, though naturally occurring element, present at low concentrations in soil, water, plants, and animals. Chronic exposure to elevated arsenic is a risk to human health. Arsenic in groundwater can originate from anthropogenic (e.g., sheep dips, treated timber posts) and geological sources, e.g., schist lithology, reduced peat deposits, and volcanic rocks (Piper and Kim, 2006). The DWSNZ (2022)-MAV for arsenic is 0.01mg/L (equivalent to 10 microgram/Litre [µg/L], shown as some laboratories report using this unit). The state of groundwater arsenic concentrations was based on the maximum concentrations and assessed against the DWSNZ- (2022) MAV (Table 10). The spatial variability in maximum arsenic concentrations is shown in Figure 16.

High spatial variability in groundwater dissolved arsenic concentrations was observed across Otago. The highest concentrations were measured in the Upper Lakes Rohe, particularly in Glenorchy and Kingston. High concentrations were also measured in some sites in the Dunstan Rohe, Lower Clutha Rohe, and the Taieri FMU. Conversely, concentrations in the North Otago and most of the Taieri FMU were substantially lower than the DWSNZ (2022)-MAV. However, there was also wide spatial variability on a smaller scale (e.g., Glenorchy) where concentrations in some bores within the same locality exceeding the MAV while concentrations in other nearby bores were below it.

It is likely that the main source for arsenic in Otago groundwater is geological (i.e., not human), and is mainly from weathering of the abundant schist lithology. Arsenic concentrations can also vary due to groundwater reduction/oxidation conditions (i.e., dissolved oxygen concentrations), where low oxygen concentrations can increase arsenic mobility in groundwater. This process, caused by low dissolved oxygen due to discharge from septic tanks, in combination with the local schist lithology, was attributed to the high dissolved arsenic concentrations in some SoE bores in Glenorchy (ORC, 2021).

Due to the high spatial variability in Otago, which can vary on a small spatial scale, it is strongly recommended that bore owners regularly test their groundwater for arsenic to ensure compliance with the DWSNZ. Some laboratory testing suites do not automatically contain arsenic, hence, it strongly advised that this testing is requested specifically.

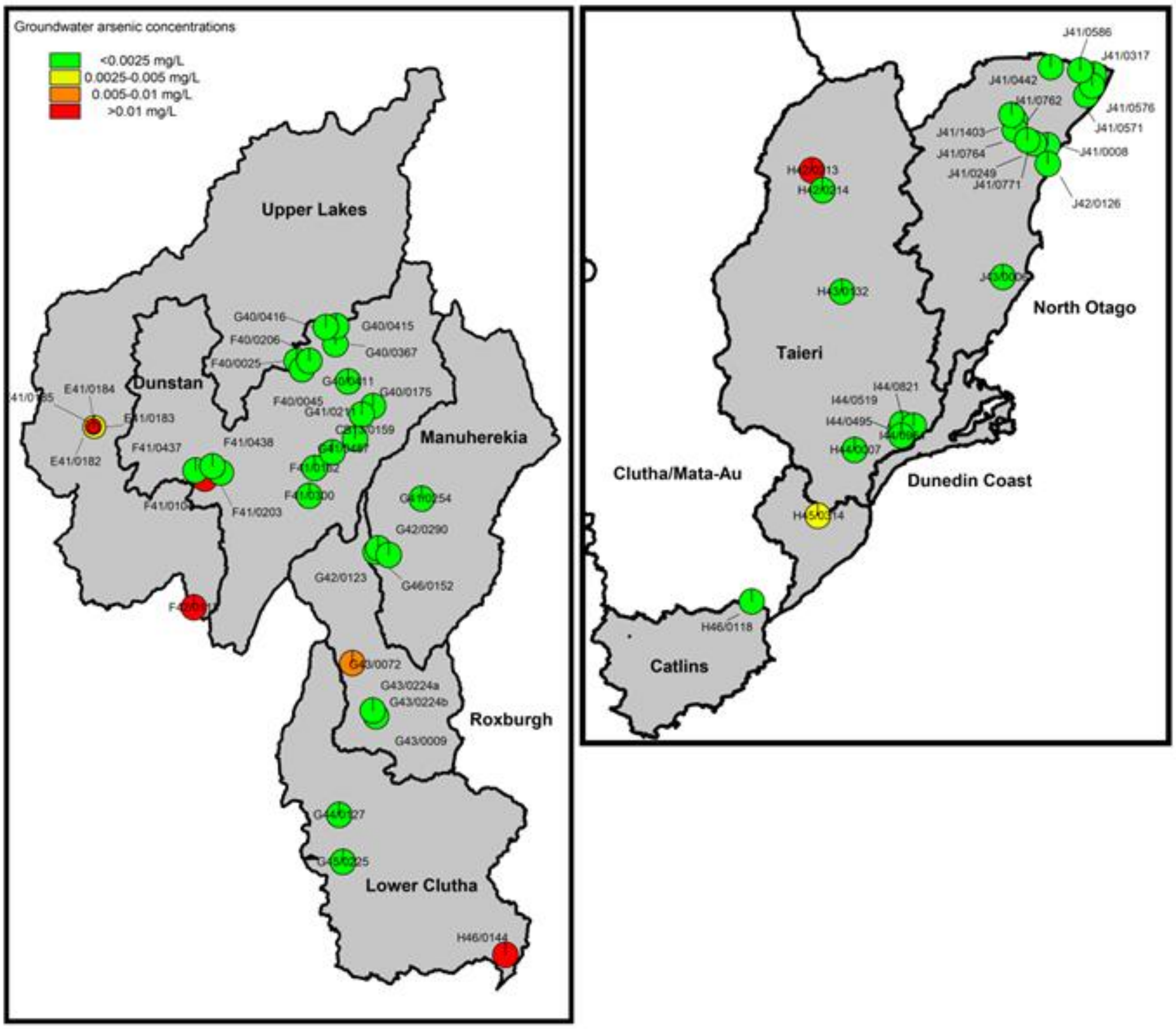


Figure 16: Maximum dissolved arsenic concentrations for the SoE bores in the Clutha/Mata-Au (left), Catlins, Dunedin & Coast, Taieri and North Otago (right) FMU.

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Appendix 1: Site numbers and names for Figures 2 to 9.

Site #	**Site Name**	**Site #**	**Site Name**
1	Awamoko at SH83	49	Ox Burn at Rees Valley Road
2	Kakaho Creek at SH1	50	Precipice Creek at Glenorchy Paradise Road
3	Kakanui at Clifton Falls Bridge	51	Quartz Creek at Maungawera Valley Road
4	Kakanui at McCones	52	Rees at Glenorchy Paradise Road Bridge
5	Kauru at Ewings	53	Scott Creek at Routeburn Road
6	Oamaru Creek at SH1	54	The Neck Creek at Meads Road
7	Pleasant at Patterson Road Ford	55	Timaru at Peter Muir Bridge
8	Shag at Craig Road	56	Turner Creek at Kinloch Road
9	Shag at Goodwood Pump	57	Arrow at Morven Ferry Road
10	Trotters Creek at Mathesons	58	Bannockburn at Lake Dunstan
11	Upper Shag at SH85 Culvert	59	Cardrona at Mt Barker
12	Waianakarua at Browns	60	Clutha at Luggate Br
13	Waianakarua at South Branch SH1	61	Lindis at Ardgour Road
14	Waiareka Creek at Taipo Road	62	Lindis at Lindis Peak
15	Waikouaiti at 200m d/s DCC intake	63	Luggate Creek at SH6 Bridge
16	Contour Channel at No. 4 Bridge	64	Mill Creek at Fish Trap
17	Deep Stream at SH87	65	Nevis at Wentworth Station
18	Kye Burn at SH85 Bridge	66	Quartz Reef Creek at SH8
19	Meggat Burn at Berwick Road	67	Roaring Meg at SH6
20	Nenthorn at Mt Stoker Road	68	Shotover at Bowens Peak
21	Silverstream at Taieri Depot	69	Upper Cardrona at Tuohys Gully Road
22	Silverstream at Three Mile Hill Road	70	Benger burn at Booths
23	Sutton Stream at SH87	71	Clutha at Millers Flat
24	Taieri at Allanton Bridge	72	Fraser at Old Man Range
25	Taieri at Linnburn Runs Road	73	Teviot at Bridge Huts Road
26	Taieri at Outram	74	Dunstan Creek at Beattie Road
27	Taieri at Stonehenge	75	Hills Creek at SH85
28	Taieri at Sutton	76	Manuherekia at Blackstone Hill
29	Taieri at Tiroiti	77	Manuherekia at Galloway
30	Taieri at Waipiata	78	Manuherekia at Ophir
31	Waipori at Waipori Falls Reserve	79	Manuherekia downstream of Fork
32	Whare Creek at Whare Flat Road	80	Poolburn at Cob Cottage
33	12 Mile Creek at Glenorchy Queenstown Road	81	Thomsons Creek at SH85
34	25 Mile Creek at Glenorchy Queenstown Road	82	Blackcleugh Burn at Rongahere Road
35	Buckler Burn at Glenorchy Queenstown Road	83	Clutha at Balclutha
36	Bullock Creek at Dunmore Street Footbridge	84	Crookston Burn at Kelso Road
37	Craig Burn at SH6	85	Heriot Burn at Park Hill Road
38	Dart at The Hillocks	86	Lovells Creek at Station Road
39	Dundas Creek at Mill Flat	87	Pomahaka at Burkes Ford
40	Greenstone at Greenstone Station Road	88	Pomahaka at Glenken
41	Hawea at Camphill Bridge	89	Tuapeka at 700m u/s bridge
42	Kawarau at Chards Rd	90	Upper Pomahaka at Aitchison Runs Road
43	Horn Creek at Queenstown Bay	91	Waipahi at Cairns Peak
44	Invincible Creek at Rees Valley Road	92	Waipahi at Waipahi
45	Leaping Burn at Wanaka Mt Aspiring Road	93	Wairuna at Millar Road
46	Makarora at Makarora	94	Waitahuna at Tweeds Bridge
47	Matukituki at West Wanaka	95	Waiwera at Maws Farm
48	Motatapu at Wanaka Mt Aspiring Road		