0.0 RIVER WATER QUALITY IN TASMAN - STATE AND TRENDS

Report To:	Operations Committee
Meeting Date:	6 April 2023
Report Author:	Trevor James, Senior Resource Scientist Freshwater & Estuarine Ecology; Jonathan McCallum, Environmental Monitoring Officer
Report Number:	0.0

PRESENTATION

Jonathan McCallum and Trevor James will make a presentation to the Operations Committee on River Water Quality in Tasman.

1 Summary

1.1 Council has been monitoring river water quality mostly quarterly from 2000 to 2016 and since then sampling has been monthly at 29 sites. This report focusses on assessments of trends over 5 years and 15 years up to June 2021 and only for the following attributes: total ammonia, nitrate, dissolved reactive phosphorus, *E.coli,* water clarity and macro-invertebrates. Unlike the trend information found on Land, Air, Water Aotearoa (LAWA) - River Quality, the analysis in this report allows for the effect of flow on water quality. Flow can have a major bearing on trends. This report does not cover information on periphyton/algae, fine sediment, from our semi-continuous water quality monitoring for dissolved oxygen and water temperature, nor does it cover other aspects of river health such as habitat, or freshwater ecology including fish.

1.2 Over the five year time period to 2021, there were more degrading trends in water chemistry and water clarity than there were improving trends. For the majority of 'very likely degrading' trends (the worst category), the rate of degradation was slow. There was a general pattern that rate of degradation occurred at monitoring sites with higher median nutrient concentrations. For specific attributes:

- For Total Ammonia and Dissolved Reactive Phosphorus (DRP), there were more sites with improving trends than degrading trends over the longer 15 year time period. For ammonia, this likely to be due to on-going stock exclusion provisions and for DRP likely to relate to reduced fine sediment discharges.
- It is encouraging that there are fewer sites with degrading faecal indicator bacteria levels over the five years pre 2021, compared to over the 15 years pre 2021.
- For macro-invertebrates there were seven sites that were degrading five with no trend and three that were improving (the rest had no trend assessed).

1.3 While Tasman District is blessed with generally very good water quality largely due to the high proportions of most catchments with large areas in natural vegetation, this report is focussed on those rivers and catchments that are degraded, or degrading reasonably fast. The reason for this is to achieve a focus on the job at hand to improve these waterways. Eight of the smaller rivers in the programme were in a particularly poor state, often across all, or most, of the attributes and often had degrading trends. These are Reservoir Creek (Richmond), Borck Creek (Richmond), Neimann Creek (Waimea Plains), Tasman Stream (Tasman), Moutere River, Motupipi River (near Takaka), Powell Creek (tributary of the Motupipi) and Murchison Creek (also known at Neds Creek, in Murchison). In addition to these sites there is concern for the rate of degradation of *E.coli* in the Motueka at Woodstock, Sherry (in the upper Motueka) for macro-invertebrate community index, *E.coli* in Riuwaka and nitrate in the lower Wai-iti (even though these sites are in the B band at this time).

1.4 While the Council River Water Quality Monitoring Programme is limited by its spatial coverage (only 29 sites), this can be overcome with modelling. A project is under way to develop a macro-invertebrate community index model that will allow us to understand the attribute state (particular band) of each segment of stream in our district.

1.5 Action plans are required to be developed under the [National Policy Statement for Freshwater Management 2020 Amended February 2023 | Ministry for the Environment] where a deteriorating trend in water quality is identified and confirmed to be the "*result of something other than a naturally occurring process*"(cl 3.19 and 3.20). This will be a substantial exercise and one which will require considerably more investigation (including contaminant source tracking) to determine the cause of the degraded water quality state.

2 Draft Resolution

1. **That the Operations Committee receives the report *Water quality trends in rivers of Tasman – Analyses of data ending in 2021*.**
2. **That the Operations Committee approve work on a plan for producing a series of Action Plans for each Freshwater Management Unit.**

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3 Purpose

3.1 The overall purpose of this river water quality monitoring is to inform Council and our community about the state and trends of a range of attributes. Thereby we can understand how successful we have been as a community in achieving the purpose of the Resource Management Act - the sustainable management of our natural and physical resources. Council is required to undertake this monitoring under s35 of the RMA.

3.2 Sites in this "State of the Environment" river water quality monitoring programme are mostly located at the downstream end of catchments where there is a higher risk of cumulative impacts of multiple stressors (such as discharges of contaminants). Three sites represent 'reference condition' and have very low impact from human land use.

4 Introduction

4.1 Rivers and streams are a vital part of Tasman's landscapes, forming an integral part of our lifestyles and livelihoods. Wai-māori (freshwater) provides a home for aquatic plants and animals and resources we consume. Wai-ora (pure water) is a source of life and wellbeing. Over 14,000 kilometers of rivers and streams weave through the landscapes of Tasman, from small streams to large rivers, from intermittently flowing to large constantly-flowing spring-fed streams.

4.2 Tasman District is fortunate to have relatively few water quality issues compared to other parts of New Zealand, assisted by the District's large rivers having a significant proportion of indigenous forest in their headwaters. In these large rivers, any inputs of contaminants from developed land are substantially diluted by the large volume of high-quality water from upstream. The main problems with water quality are found in small streams whose catchments contain a large proportion (>50%) of intensively developed land. Previous river water quality reports for Tasman (2005, 2010 and 2015) show sites with pastoral and urban land cover have higher concentrations of disease-causing organisms, greater quantities of deposited fine sediment and lower water clarity than sites with indigenous forest or exotic forest land cover (Environmental monitoring reports | Tasman District Council). In 2015 it was reported that almost a third of streams draining low elevation land (mostly unshaded and in pastural or horticultural land use) have unacceptably low dissolved oxygen and high water temperature (based on measurements). Dissolved oxygen (DO) is fundamental to the survival of aquatic life (for "breathing").

4.3 Under the National Policy Statement for Freshwater Management (NPS-FM), regional councils including Tasman District Council are required to monitor freshwater and respond to degradation (National Policy Statement for Freshwater Management 2020 Amended February 2023 | Ministry for the Environment). An important component of this work is to assess and report on trends in water quality over time. Where rivers and streams are degraded or degrading, Tasman District Council must then investigate the causes and take action to halt or reverse the degradation.

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4.4 The National River Water Quality Network (NRWQN) NIWA has been sampling three sites in our region (two on the Motueka River and one on the Buller) since 1989 and has maintained a monthly sampling schedule. The TDC river water quality monitoring programme started a decade later, in 1999, with a quarterly schedule (four times per year) at over 60 sites.

4.5 An internal review of the TDC river monitoring programme was carried out in 2016. Changes to the programme were made to better align with national level reporting requirements and increase the ability to detect trends in the long term. As a result of this review, the frequency of sampling at river water quality sites was increased from four times per year (quarterly sampling) to 12 times per year (monthly sampling) at 26 sites. With the NRWQN sites this is a total of 29 sites. There was also a shift from dry weather sampling (waiting at least three days after rain) to all-weather sampling. These changes in sampling design must be considered when assessing trends in Tasman District Council river water quality data.

4.6 The sampling design changes in 2016 introduce confounding factors when assessing long-term trends in water quality. In particular, by switching to all-weather sampling, there is a greater chance of rainfall-induced runoff influencing water quality. Rainfall increases runoff, where contaminants (faecal matter, nutrients or fine sediment) are delivered to waterways from paddocks and hard surfaces. At the same time, rainfall has a dilution effect, where increasing river flows reduce the concentration of a contaminant. The combination of these two processes, runoff and dilution, leads to different patterns between river flow and water quality at different monitoring sites. For the same water quality parameter, the relationship with river flow may be positive, negative or non-monotonic (positive for some flow values then switching to negative, for example).

4.7 A statistical method called ‘flow adjustment’ can be used to remove some of the influence of river flow on water quality observations. This is the first time this method has been used to analyse the TDC river water quality data. Flow adjustment involves fitting a statistical model describing the relationship between river flow and water quality at a particular monitoring site. Flow adjustment has been used in national-level reporting of trends in New Zealand rivers and it can increase the statistical power of the trend assessments.

4.8 Land, Air, Water Aotearoa (LAWA) - River Quality collate and analyse environmental monitoring data from New Zealand regional and unitary councils, including Tasman District Council. On an annual basis, LAWA releases summary statistics describing the current state and trends in water quality at each monitoring site. To date, the LAWA trend assessment methods do not include flow adjustment. This is partly because river flow is not measured at all water quality monitoring sites in New Zealand. However, flow information is available for all water quality monitoring sites in Tasman.

4.9 Drivers of water quality trends occur at the catchment scale and at broader spatial scales. Within a catchment, a trend may be the direct result of human activity (for example, increased urbanisation, a shift in land-use, removal of point-source discharges). At this scale, biological or geological processes may also be important (for example, increased abundance of waterfowl, increased sediment inputs from a landslide).

4.10 At a broader, global scale, water quality trends may result from climate variability, with cycles over years, decades or longer. Distinguishing between different drivers of water quality trends can be difficult. One difficulty arises from the interaction between climate

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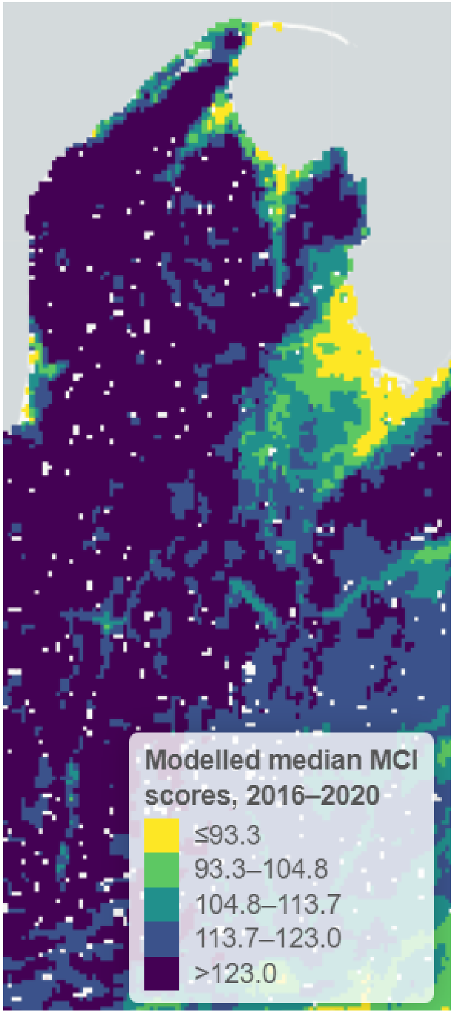
variability and other drivers, amplifying or counteracting the effects on water quality. The strength of the El Niño–Southern Oscillation (ENSO) climate pattern may well have a strong influence on river water quality.

4.11 The River Water Quality Monitoring Programme (RWQMP) continues to shed useful light on the key river water quality problems/issues found in the Tasman District, particularly the issues on various type of waterways, and seasonal aspects of these issues.

4.12 The limitations of spatial coverage of the 29 sites in Tasman can be somewhat overcome by modelling. This is the most effective way to determine the state of rivers across the whole region. However, currently modelling is only sufficiently reliable for the attributes of macro-invertebrates (Macro-invertebrate Community Index or MCI) and water clarity. Macro-invertebrate indicators are an important indicator of the over-all health of a waterway as they integrate the effects of many water quality attributes over many weeks prior to sampling. Macro-invertebrate models for 2016-2020 for all data across Aotearoa show that 17% of rivers had a MCI in the D band (see Figure 1, to the right. Source: [River water quality: macroinvertebrate community index | Stats NZ]).



A similar national model provided in 2014 showed that 1% of all streams (~150km) and 3% of pastoral streams had a MCI below 80 MCI units (i.e. poor water quality). We are currently undertaking extra sampling of macro-invertebrates with the purpose of developing a regional model that will be much more spatially accurate.

This report only discussed six attributes of our RWQMP: nitrate-N, total ammonia, dissolved reactive phosphorus, water clarity, *E.coli* and macro-invertebrates. Unfortunately we did not have enough resources to include analysis of all the other attributes in the programme (e.g. dissolved oxygen, temperature, fine sediment with the bed, periphyton/algae).

Table 1 below shows the numeric attribute state bands for rivers, as set under the NPS-FM.

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Table 1. Numerical attribute states for each water quality attribute for the protection of river ecosystem health, aesthetics, and human health. All these standards come from the National Policy Statement on Freshwater Management, 2020. Figures in bold are the national bottom line.

Attribute	Statistic	Units	Attribute State				
			A	B	C	D	E
Water clarity[1]	Median (monthly over 5 years)	m	≥2.95	2.95 – 2.57	2.57 – 2.22	<2.22	-
Ammonia-N	Annual median	g/m³	≤0.03	0.03 – 0.24	**0.24** - 1.3	>1.3	-
	Annual maximum	g/m³	≤0.05	0.05 - 0.4	**0.4** - 2.2	>2.2	-
Nitrate-N	Annual median	g/m³	≤1.0	1.0 - 2.4	**2.4** – 6.9	>6.9	-
	Annual 95th percentile	g/m³	≤1.5	1.5 - **3.5**	3.5 - 9.8	>9.8	-
Dissolved reactive phosphorus	Median (monthly over 5 years)	g/m³	≤0.006	0.006 – 0.01	0.01 – 0.018	>0.018	-
	95th percentile	g/m³	≤0.021	0.021 – 0.03	0.03 – 0.054	>0.054	-
E. coli	Annual median	CFU/100 ml	≤130	≤130	≤130	≤130	>260
	95th percentile	CFU/100 ml	≤540	≤1000	≤1200	≤1200	≤1200
Macro-invertebrates	MCI	N/A	≥130	110 - 130	90 - 110	<**90**	-

A detailed technical report is available explaining the analysis and results in much more detail.

5 Results and Discussion

Trends

5.1 There were a mix of improving and degrading trends across all water quality attributes. For the Nitrate-N and Water Clarity attributes, the proportion of improving and degrading trends appear similar over five years and 15 years. For the Total Ammonia, DRP and *E. coli* attributes, however, there were considerable differences in the proportion of monitoring sites with degrading trends between the five and 15 year time periods.

[1] For Suspended Sediment Class 3 which represents most of our river classes in this programme.

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5.2 Over the five year time period, there were more degrading trends in water chemistry and water clarity than there were improving trends. For Total Ammonia and Dissolved Reactive Phosphorus, there were more sites with improving trends than degrading trends over the longer 15 year time period. It is encouraging that there are fewer sites with degrading faecal indicator bacteria levels over the five years pre 2021, compared to over the 15 years pre 2021. For the majority of 'very likely degrading' trends (the worst category), the rate of degradation was slow. There was a general pattern that the rate of degradation was higher at monitoring sites with higher median nutrient concentrations.

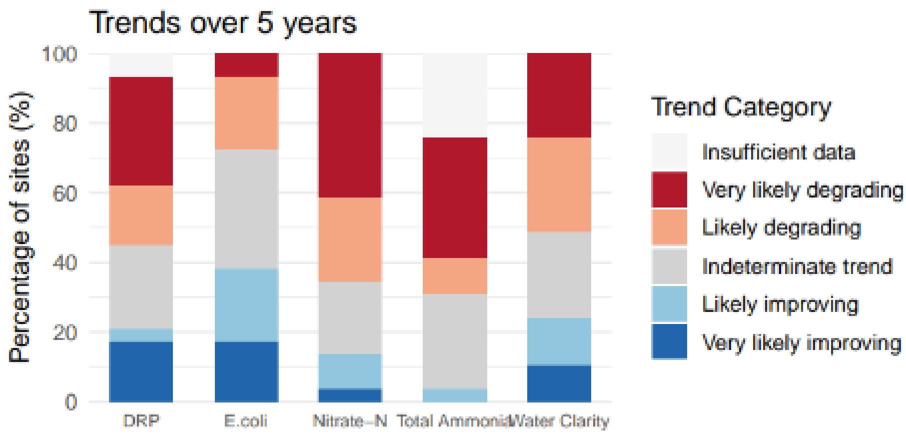

Figure 2. Percentage of sites in each trend category for the five year time period, July 2016 to June 2021.

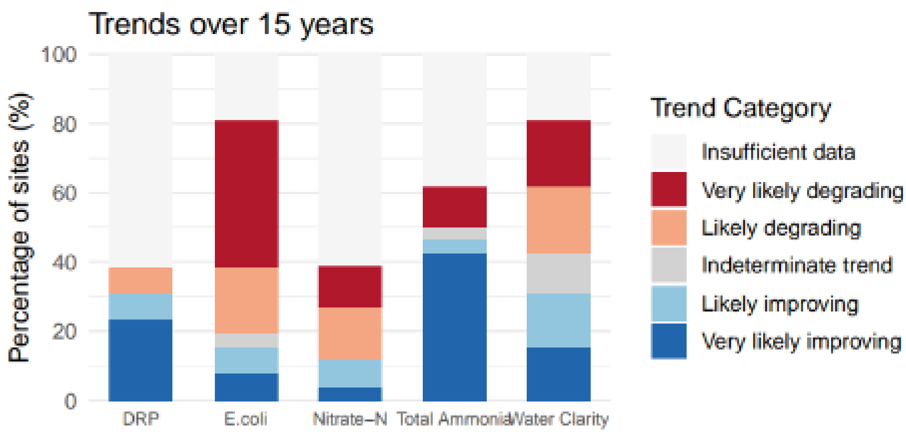

Figure 3. Percentage of sites in each trend category for the fifteen year time period, July 2016 to June 2021.

5.3 While some waterways have significantly improved since the last reporting period, in a general sense many of the same issues remain.

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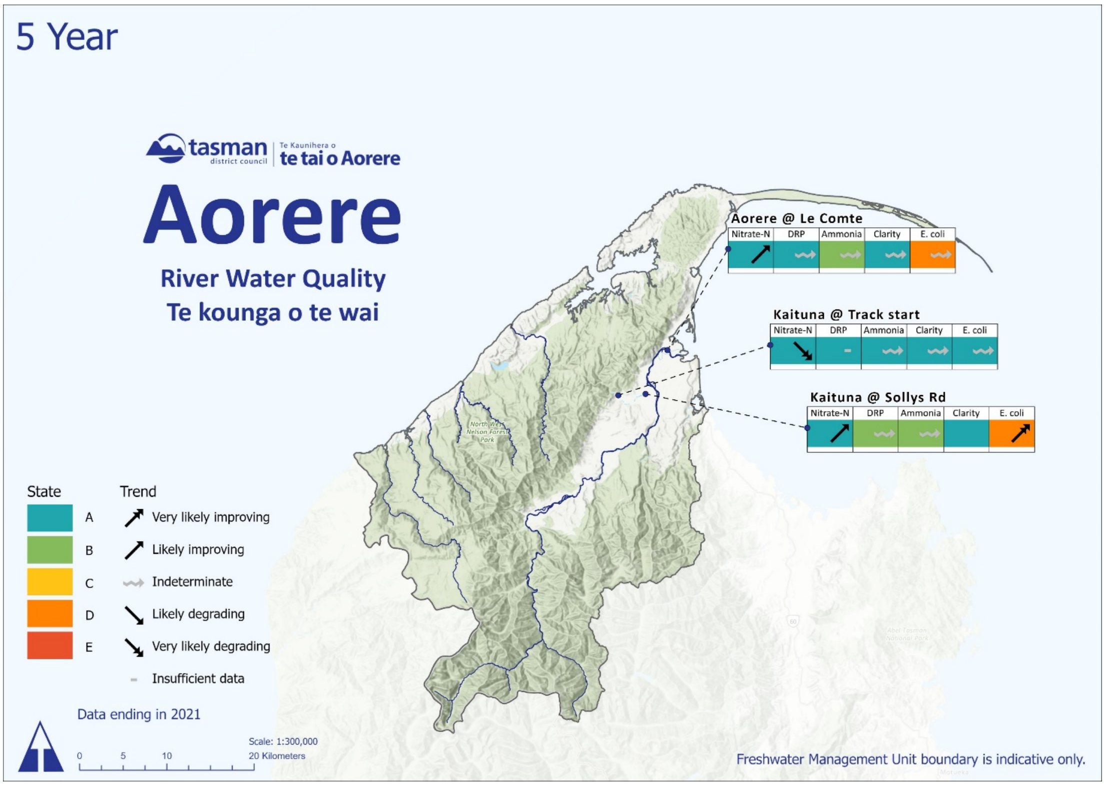
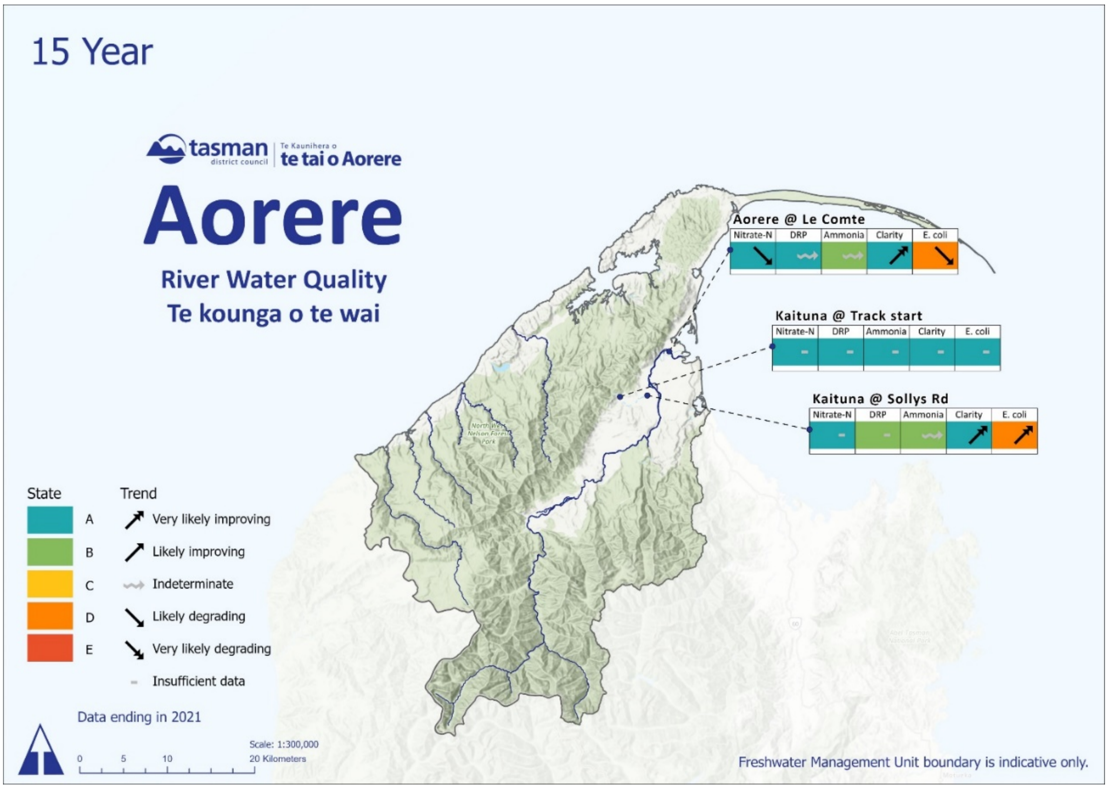
Figures 4a-l: Maps of state and trend for most of Tasman's Freshwater Management Units (except Abel Tasman) and monitoring sites in the river water quality monitoring programme. Trends are flow adjusted.





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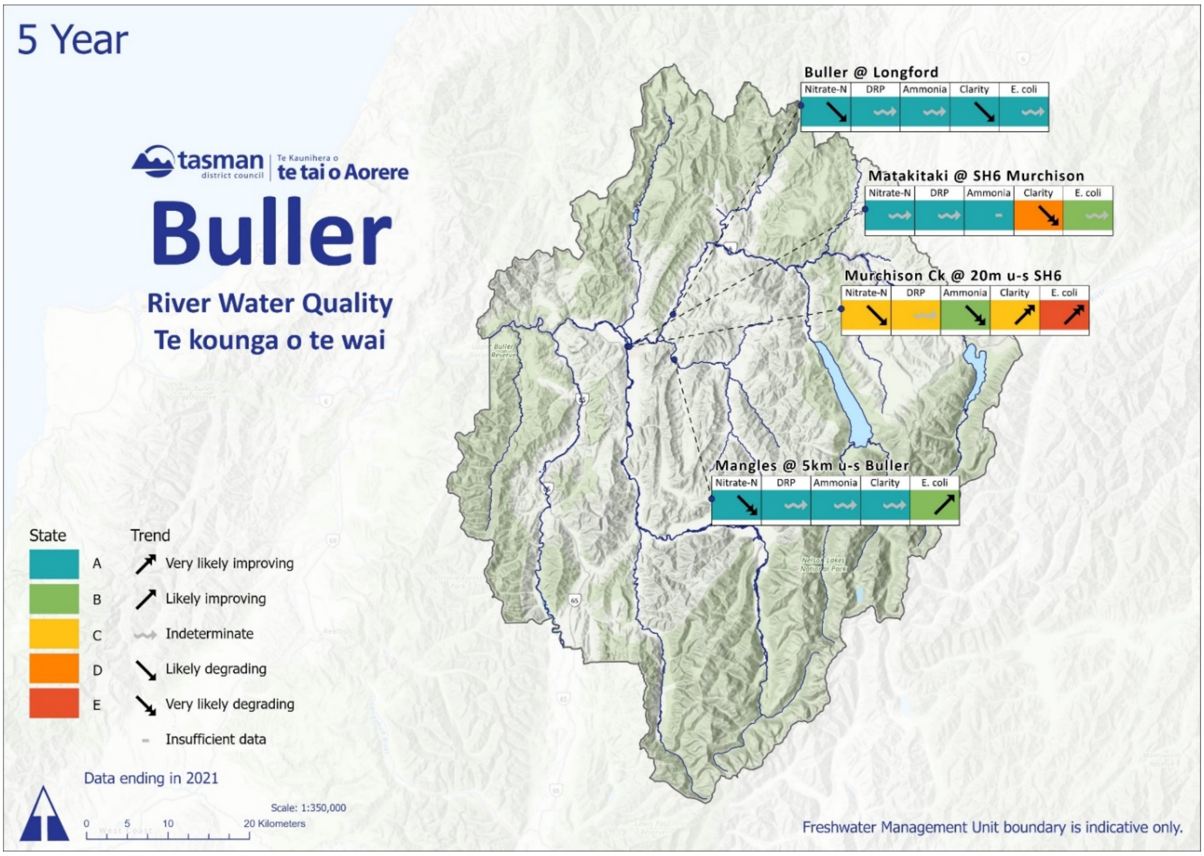

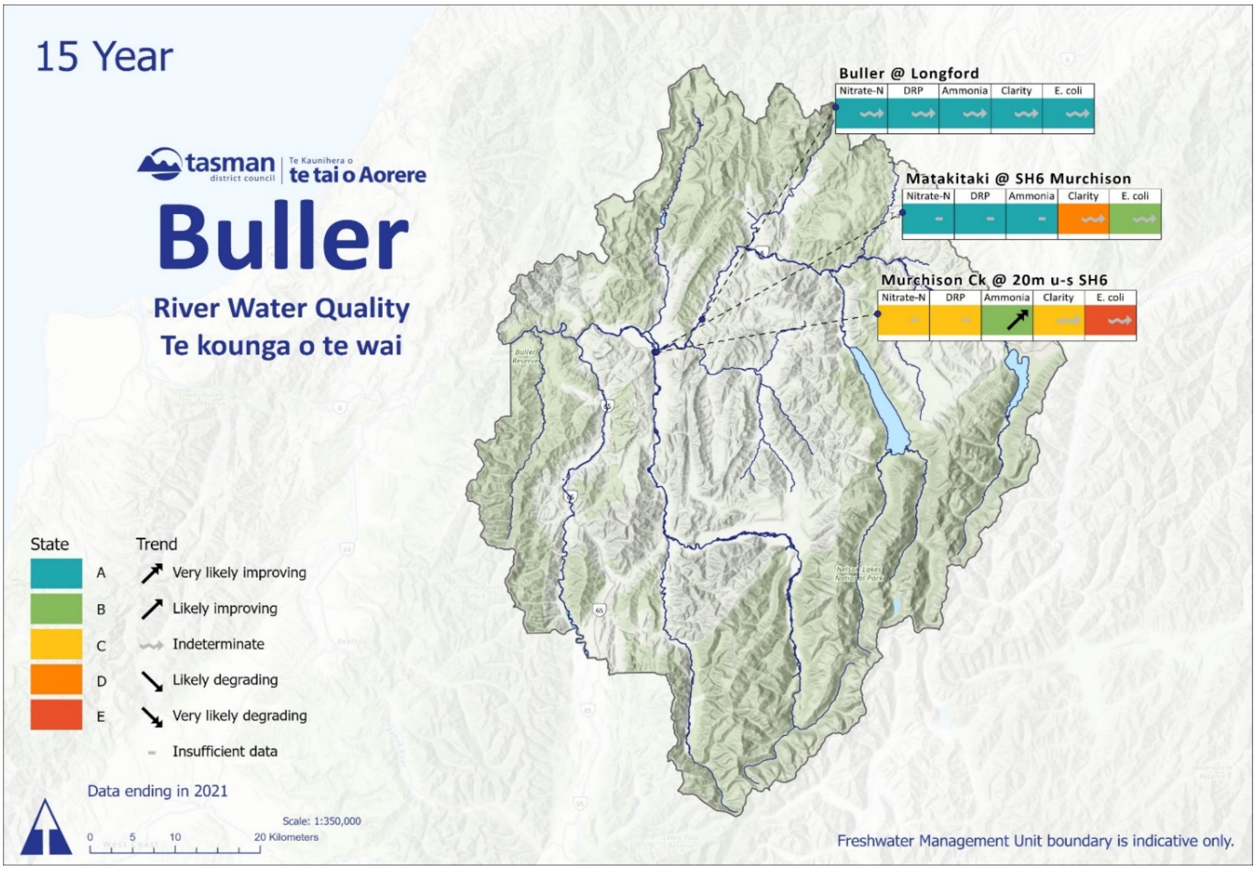

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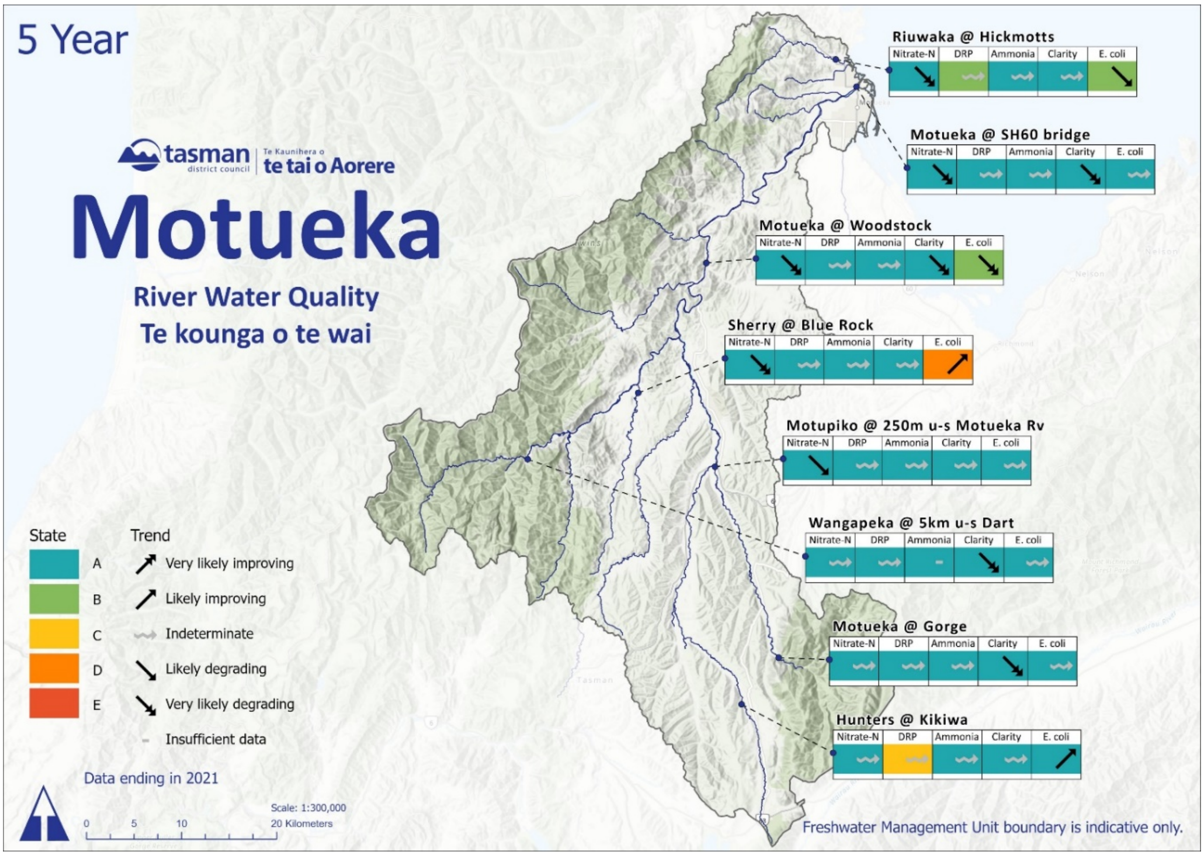

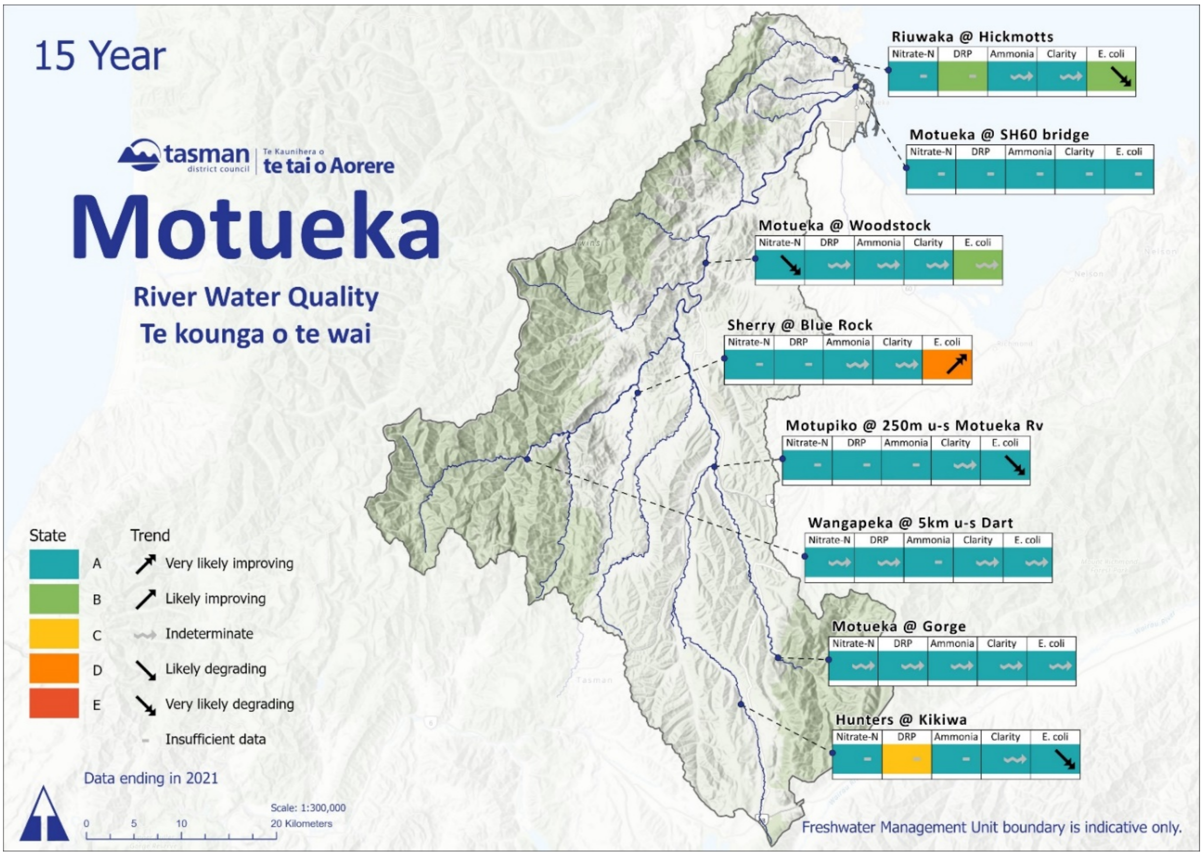

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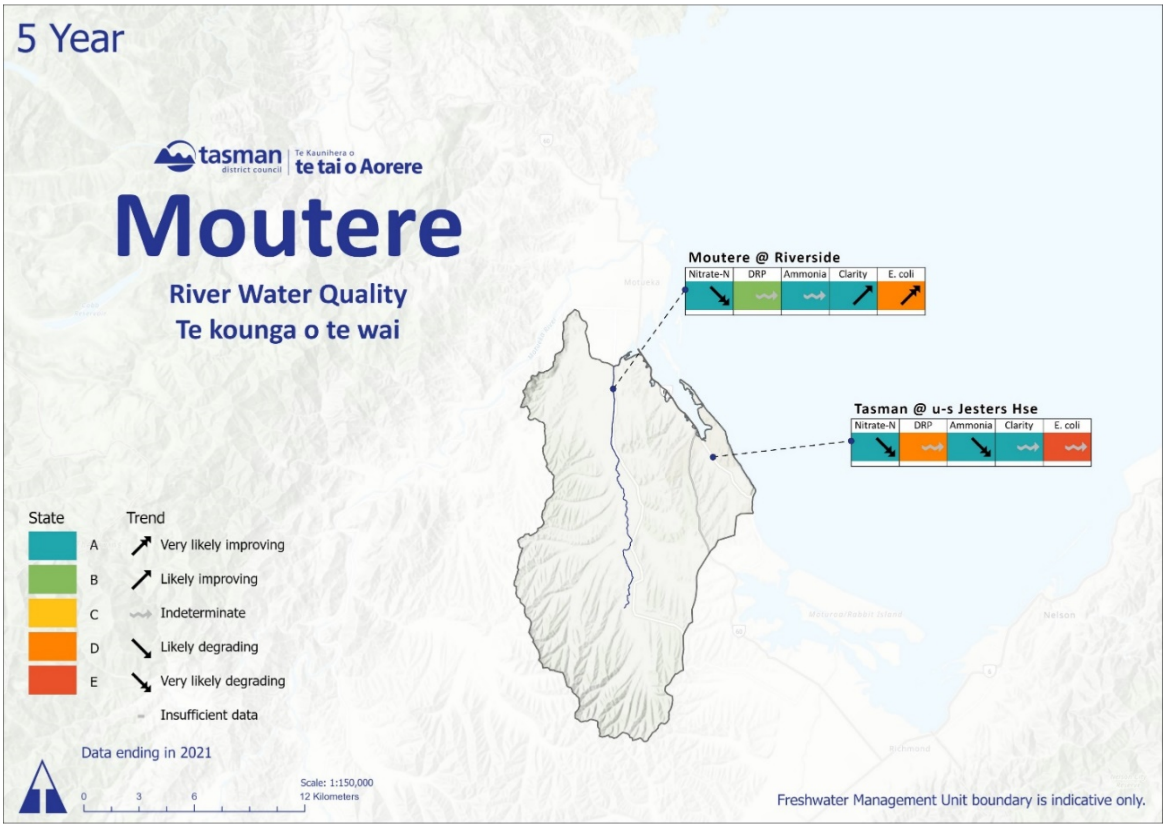

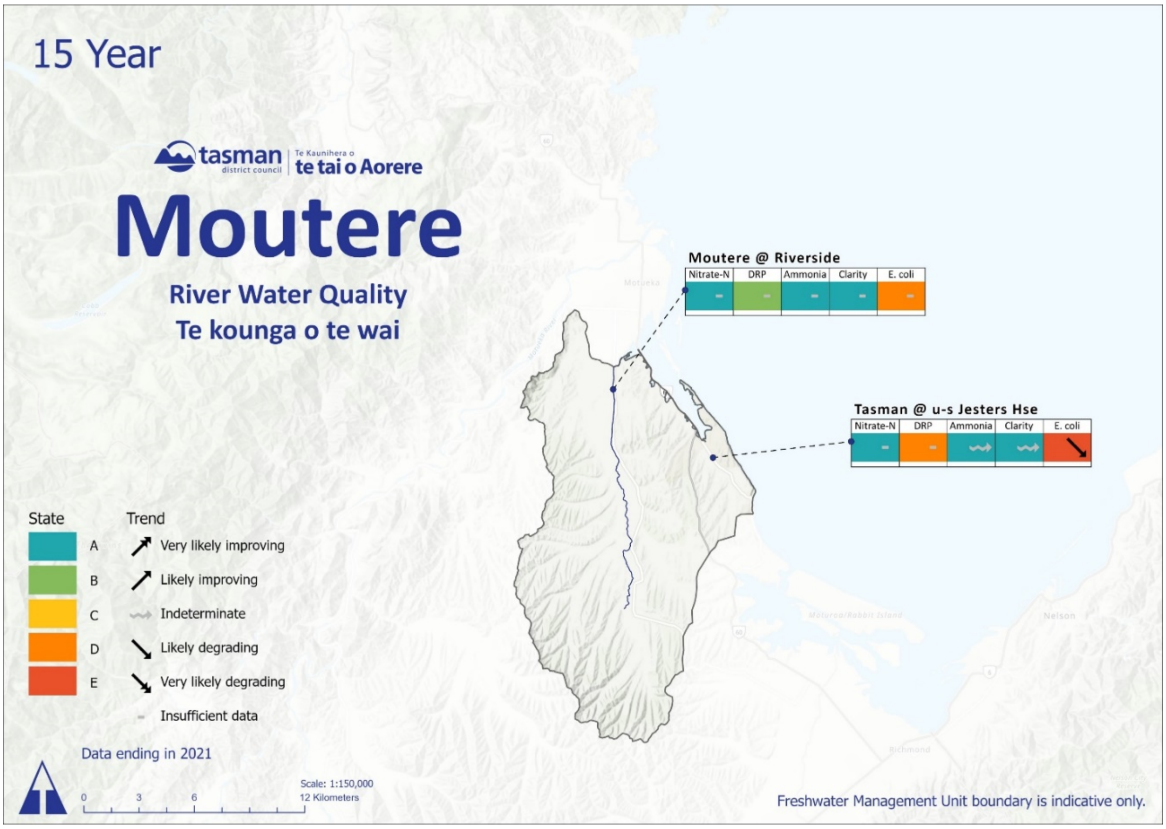

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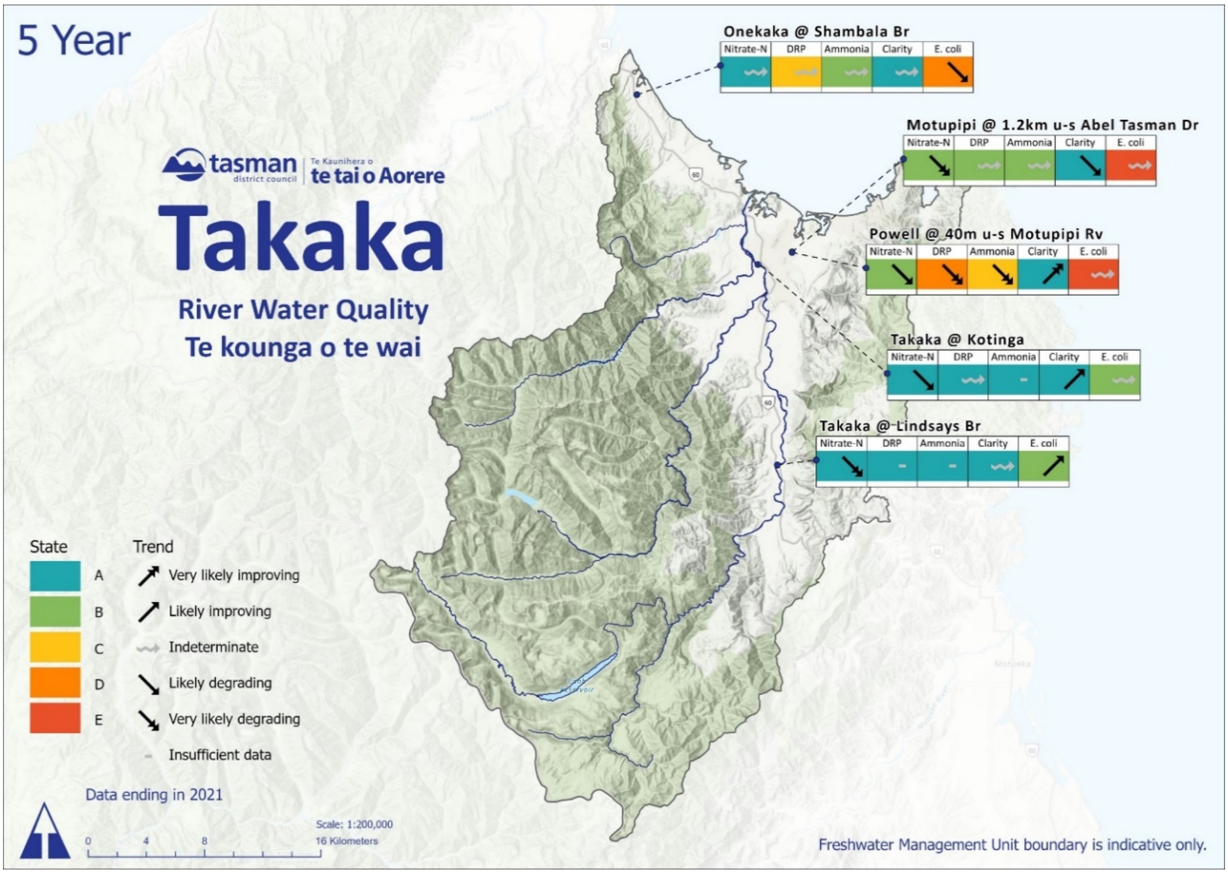

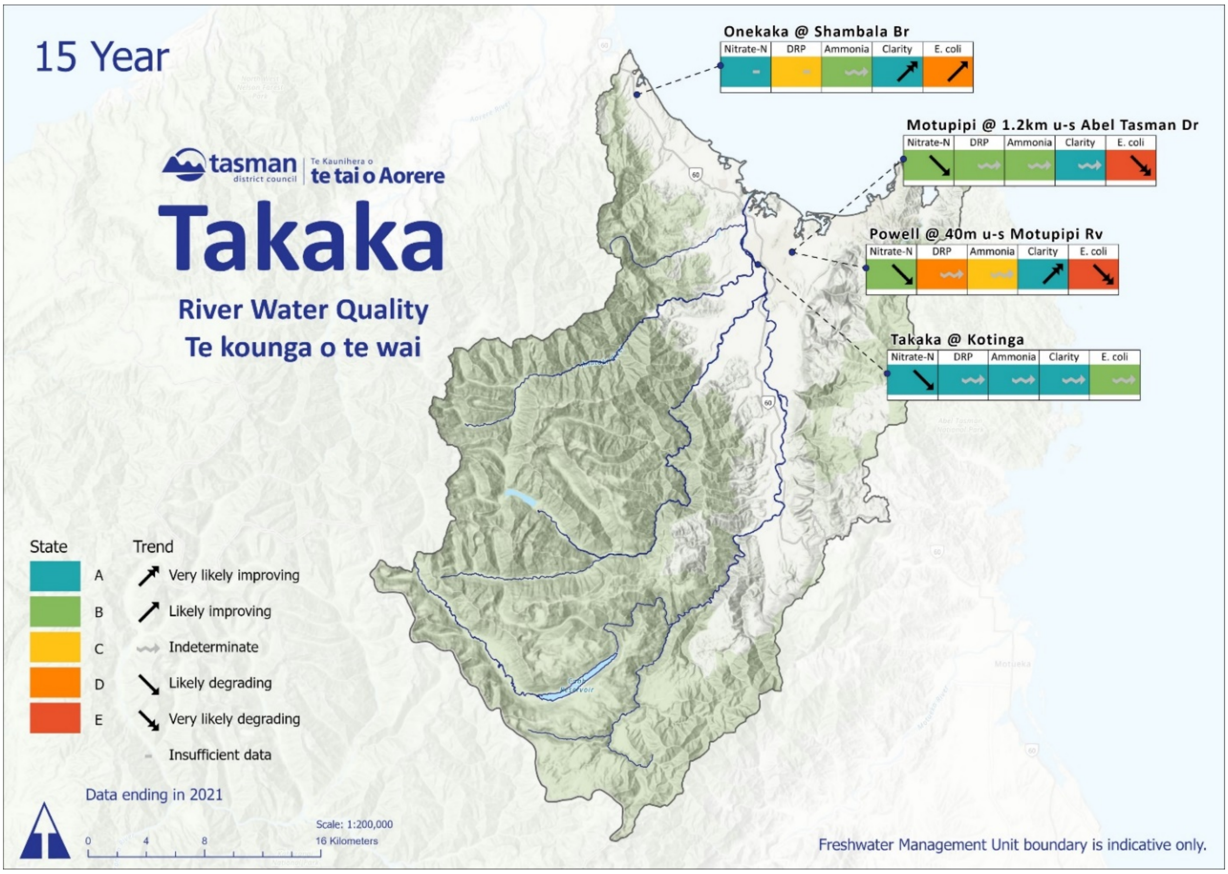

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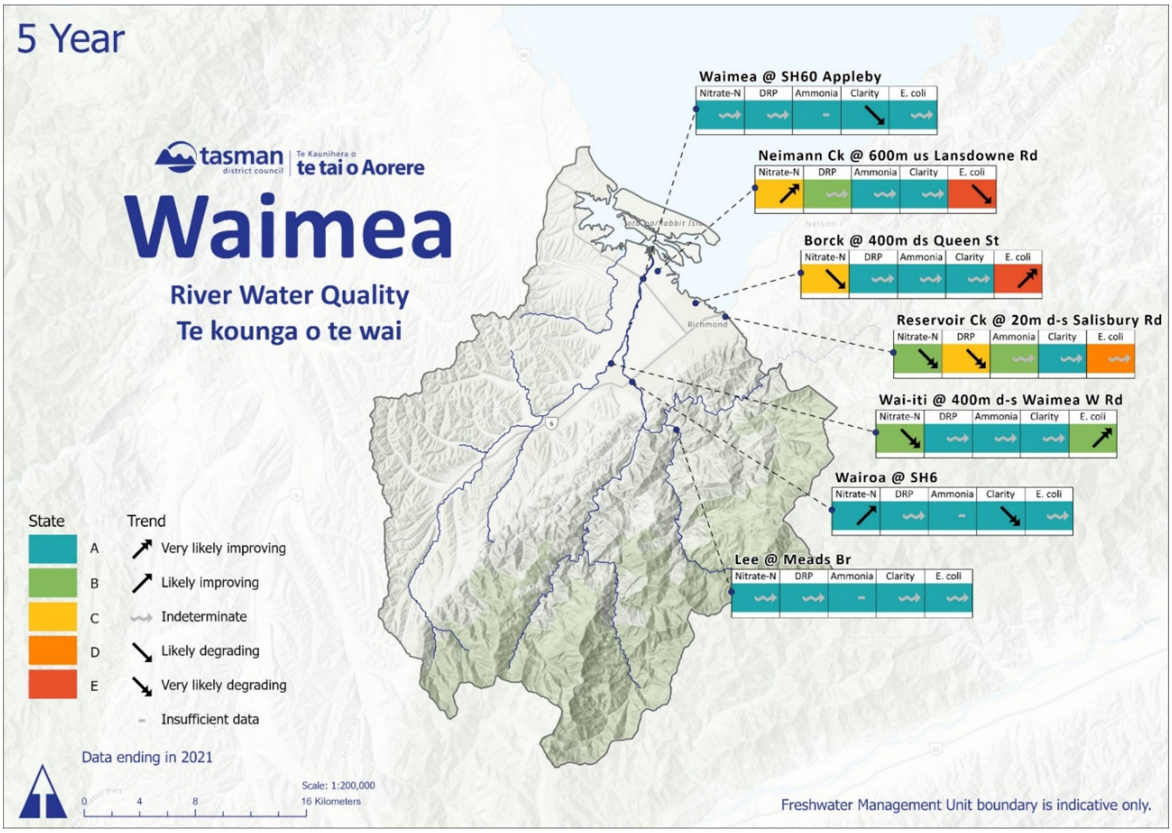

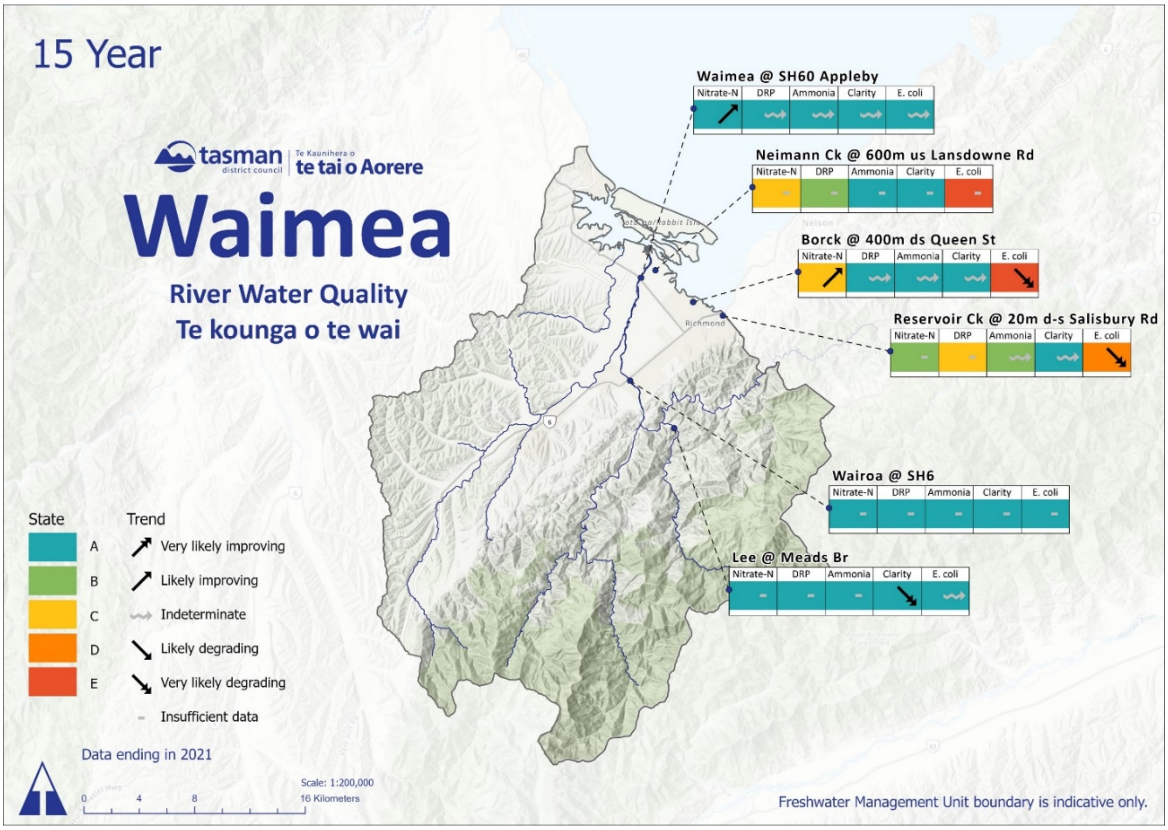

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5.4 Under the NPS-FM, Tasman District Council ‘must (a) investigate the cause of the trend and (b) consider the likelihood of the deteriorating trend, the magnitude of the trend, and the risk of adverse effects on the environment’. To fulfill this responsibility, an approach is needed to prioritise trend results for further investigation. Although the development of a prioritisation framework is beyond the scope of this report, three components are proposed:

Prioritise very likely degrading trends. Trends classified as very likely degrading have greater than 90% confidence in trend direction, compared to likely degrading trends which have greater than 67% confidence in trend direction.

Set a minimum trend rate - the rate of change in the water quality attribute per year. This is needed because very likely degrading trends can have a trend rate close to zero. By setting a minimum trend rate, these less informative trend results can be filtered out. Using knowledge of the data collection methods, the proposed minimum trend rates are 0.001 g/m3 per year for Total Ammonia, Nitrate-N and DRP; 1 cfu/100ml per year for E. coli and -0.1 m per year for water clarity.

Focus on the B band or lower. In general, the risk of adverse effects on the environment is lowest for waterways in the A band of the NPS-FM. Waterways with attribute bands of ‘B’ or lower should have higher priority when investigating water quality trends. Waterways with one or more attributes below the National Bottom Line of the NPS-FM have the highest priority for further investigation.

Table 2: **High priority trend results for further investigation.** These trend results were Very Likely Degrading, with a trend rate greater than chosen thresholds and the associated attribute band was B or lower.

FMU	Site	Degrading trend	Band
Buller	Matakitaki @ SH6 Murchison	Water Clarity (5 yrs)	D
Buller	Murchison Ck @ 20m u-s SH6	Total Ammonia (5 yrs)	B
Motueka	Motueka @ Woodstock	E.coli (5 yrs)	B
Motueka	Riuwaka @ Hickmotts	E.coli (15 yrs)	B
Takaka	Motupipi @ 1.2km u-s Abel Tasman Dr	E.coli (15 yrs)	E
Takaka	Motupipi @ 1.2km u-s Abel Tasman Dr	Nitrate-N (5 yrs)	B
Takaka	Powell @ 40m u-s Motupipi Rv	DRP (5 yrs)	D
Takaka	Powell @ 40m u-s Motupipi Rv	E.coli (15 yrs)	E
Takaka	Powell @ 40m u-s Motupipi Rv	Total Ammonia (5 yrs)	C
Waimea	Borck @ 400m ds Queen St	E.coli (15 yrs)	E
Waimea	Reservoir Ck @ 20m d-s Salisbury Rd	DRP (5 yrs)	C
Waimea	Reservoir Ck @ 20m d-s Salisbury Rd	E.coli (15 yrs)	D
Waimea	Reservoir Ck @ 20m d-s Salisbury Rd	Nitrate-N (5 yrs)	B
Waimea	Wai-iti @ 400m d-s Waimea W Rd	Nitrate-N (5 yrs)	B

For MCI, degrading trends are apparent at the following sites: Powell, Riuwaka, Motueka at Woodstock, Sherry, Reservoir, Borck and Buller. MCI appears to be improving at Moutere, Tasman and Murchison (Neds).

State

5.5 Analysis of the attribute state (as opposed to trends) compared to the NPS-FM confirms the following:

5.5.1 Urban streams (Reservoir, Borck and Murchison) have the poorest macro-invertebrate (MCI) condition.

5.5.2 Smaller rural streams (e.g. Powell, Motupipi, Tasman, Neimann, Moutere) continue to feature in the group of waterways with the poorest water quality. Run-off or leaching of nutrients, sediment and disease-causing organisms (*E.coli*) play a part here, along with limited riparian buffers, particularly in key ‘funnel points’ into the waterway from critical source areas.

5.5.3 Spring-fed creeks (Borck, Neimann, Motupipi and Murchison) are fed from aquifers with very high nitrate concentrations and are in a poor state. With the long residence time in groundwater these sites are unlikely to recover any time soon. There is good evidence for high levels of nitrogen leaching through soils under horticulture land use. Even if this leaching is reduced significantly, it is likely to be 15-20 years or more until nitrate concentrations in the affected spring-fed streams reduce to acceptable levels. The prolific growth of aquatic plants (including the pest plant, water celery) result in very low summertime dissolved oxygen concentrations and high levels of organic-rich sediment on the bed. Within the next 10-20 years riparian plantings will provide shading and suppress aquatic plant growth along parts of these streams. However, this does not address the nitrate toxicity issue.

5.6 There are eight sites that stand out as having particularly poor water quality state: Murchison, Neimann, Borck, Reservoir, Tasman, Moutere, Motupipi and Powell (see Table 3 below). These are all smaller waterways with intensive landuse in their catchments. Many of these sites fail to meet water quality standards over a range of attributes. These waterways are listed in Table 1 and discussed in turn below.

Table 3: Sites with greatest need to investigate and improve. Median values quoted. Ranked from 1 (at the top) as most degraded to 8 as least degraded):

Rank	Ammonia (g/m³)	Dissolved Reactive Phosphorus (g/m³)	Nitrate (g/m³)	*E.coli* (cfu/100ml)	MCI
1	Powell 0.03 ↑	Tasman 0.05 ↑	Borck 7	Murchison 825	Reservoir
2	Murchison 0.02	Reservoir 0.02	Murchison 5	Powell 800 ↑	Borck ↑
3	Motupipi 0.015 ↑	Moutere 0.01	Neimann 4	Tasman 800	Tasman
4	Tasman 0.015 ↑	Powell 0.01 ↑	Powell 1.2 ↑	Borck 800 ↑	Powell ↑
5	Kaituna Sollys 0.01	Motupipi 0.01 ↑	Motupipi 1.2 ↑	Neimann 700	Moutere
6		(Hunters)	Reservoir 1.2 ↑		
7			Wai-iti 1.1 ↑		
8			Sherry 0.6 ↑		

Median concentrations are listed after the site name.
Purple-shaded sites have all five attributes in the top five worst in the region.
Red-shaded sites have four attributes in the top five worst in the region.
Orange-shaded sites have three attributes in the top five worst in the region.
Yellow-shaded sites have two attributes in the top six worst in the region.
Upward-pointing arrows show degrading trends.

The following sites are listed in order of magnitude of the issue and the number of issues (note: median and 95th percentile values quoted are from July 2016 to February 2023):

5.6.1 Powell Creek, Motupipi catchment, near Takaka. This small tributary of the Motupipi near Takaka is dominated by intensive pastoral farming (90%) on clay soils. The creek has many smaller tributaries branching like a tree over the landscape.

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Powell Ck, March 2023

On the positive side, this creek has improving water clarity. It seems like this might be the result of fewer land disturbance activities without sediment and erosion controls. However, this site experiences very high *E.coli* concentrations (in the E band; median 485 *E.coli*/100ml and 95th percentile 20,500 *E.coli*/100ml) and ‘very likely degrading’. These very high peak concentrations (by far the highest in the monitoring programme) indicate gross faecal contamination of this waterway at times. The effect of high faecal load from Powell Creek and Motupipi is felt at Rototai Beach, a site that is popular for swimming for locals. Monitoring at Rototai Beach since 2018 shows that this site is unsuitable for swimming (above 280 *Enterococc*i/100ml) about 25% of the time.

While phosphorus and nitrate-N are in the B band, they are ‘likely degrading’. These moderately elevated nutrient concentrations, along with those in the Motupipi, could be the cause of algal blooms in the lower tidal section of the river and the extinction of seagrass in the upper Motupipi Inlet. Total ammonia concentrations are generally low, but highest during low flows.

This could mean that discharges, such as from septic tanks or effluent or direct discharges of urine from farm animals in waterways, are not being diluted as much as they would at higher flows.

Fencing around 10-15 years ago has probably contributed to a reduction of ammonia (by removing urine discharges direct to the waterway). However, there is still unfenced parts of this catchment and much of the fencing is very close to the bank edge and there are very limited buffers around funnel points (where discharges from runoff from the land concentrated). This limits the attenuation of nutrients, disease-causing organisms and other contaminants discharged to the stream. In an effort to address these issues, Council and landowners, with funding from the Freshwater Improvement, have installed two wetlands in Berkett Creek, a tributary of Powell Creek. Monitoring has been conducted on Berkett Creek prior to the wetland installation and will begin again in winter 2024. Freshwater Farm Plans should be a useful tool to partner with landowners to target key improvement areas. At least one unbridged stock crossing exists in the catchment.

MCI is in the D band, below the national bottom line for macroinvertebrates.

5.6.2 Tasman Valley Stream, near Tasman. High *E.coli* concentrations have been a major problem in this creek since monitoring began in 2005 (median 495 *E.coli*/100ml and 95th percentile 2485 *E.coli*/100ml). This has continued despite most of the cattle being removed from the catchment in about 2015. Several investigations have been undertaken in the catchment to narrow down the tributaries and sections of the stream that have the highest *E.coli*. Human faecal sources are prevalent in this catchment. Given the likelihood of a failing septic system in this waterway, support from compliance is now needed to oversee a plumber-drainlayer to check septic tanks in the catchment, particularly in these areas where the concentrations are highest.

Total Ammonia concentrations appear to be improving and are in the A band.

MCI is in the D band, below the national bottom line for macroinvertebrates.

Tasman at u-s Jesters Hse, Oct 2022

5.6.3 Murchison (Neds) Creek, in Murchison. As reported in 2015 and in 2010, this creek continues to have the highest median *E.coli* of any monitored creek in the region (median 825 *E.coli*/100ml and 95th percentile 7820

E.coli/100ml). However, *E.coli* is "very likely improving" in the last 5 years. This coincides with fencing that Council assisted with in this catchment in 2016 (however, there are still a lot of unfenced smaller tributaries). *E.coli* and total ammonia appears to be generally much higher in April and lower in winter over the last 5 years. This suggests that either cows are grazed off site in winter, or there is a source of fresh effluent or stock in waterways that is not diluted as much as it would be at higher winter flows. The groundwater also appears to be contaminated with disease-causing organisms as we find high *E.coli* concentrations close to the spring sources of this creek. The creek also has heavy deposits of fine sediment (see photo).

Nitrate is in the B band (trend not assessed) and Total Ammonia appears to be 'very likely improving. Nitrate appears to be predominantly from a groundwater source as such concentrations decrease as flow increases. Water clarity is 'likely degrading'. The source of sediment remains unknown.

MCI is in the C band, indicating moderate organic pollution or nutrient enrichment. This site improved up from D to C band (potentially due removal of the direct disturbance from stock as mentioned above) but has had no further improvement in the last five years.

5.6.4 Reservoir Creek, Richmond. *E.coli* concentrations at this site are in the E band due to a 95th percentile of 2240 *E.coli*/100ml (median 240 *E.coli*/100ml) and 'very likely degrading'. There appears to be no relationship to flow suggesting multiple or intermittent sources such as sewer leaks or wildfowl. These sources are both confirmed by genetic testing.

Water clarity is 'likely degrading' but in the A band. Water clarity decreases (degrades) very quickly with increased flow from baseflow (most dramatic of any site). However, after the initial increase in flow water clarity changes little as flow increases. This may be due to the degrading bed which is dominated by subsoil clay or out-of-stream sources of readily erodible soil. With the Kingsland forest going into permanent forest cover (and much of that being native forest) there will be a much lower risk of water clarity reductions and clogging of the stream bed with fine sediment following forest harvest.

Investigations into the source of the high *E.coli* have been proceeding in three Richmond streams over the past six months. There is a possibility of build-up and growth of *E.coli* from wild fowl in bottom sediments of Templemore Pond and other ponds e.g. Stillwater Creek upstream Hill St. Given the very low and improving total ammonia concentrations, it seems unlikely that there are direct sewage discharges due to cross-connections. In the last 5-10 years land disturbance due to housing development has been an issue. Stream bank erosion, mostly collapse of banks due to down-cutting due to larger storm events, is very evident along this waterway. Major erosion events occurred in December, 2011, 2013 and August 2022.

Nitrate-N concentrations are in the B band for nuisance periphyton growth and are 'very likely degrading'. Both Reservoir and the Wai-iti River site had the highest rate of increase in nitrate-N across all sites (0.135 g/m3 per year). Nitrate-N concentrations are much higher in July each year (2.7-3.5g/m^3 vs <2.6g/m^3), possibly due to increasing leaching rates due the reduced plant uptake.

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MCI is in the D band and 'very likely degrading' over the 15 year term. This is common for urban streams throughout Aotearoa and the world and is usually related to much higher peak flows due to large proportions of the catchment covered with impervious surface and zinc, copper and other contaminants from roads, roofs and many other chemical products used in residential and industrial areas.

Reservoir Ck at 20m d-s Salisbury Rd, Dec 2022

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1.1 **5.6.5 Borck Creek, in Richmond**. Consistently high levels of Nitrate-N are found in Borck Creek. Two studies (reports currently in draft) may shed some light on the source(s) of nitrate contamination to this waterway. One provides updated model (SPASMO - Soil Plant Atmosphere System Model) outputs based on detailed data of land-use, land activity (including fertiliser application rates), soils, groundwater and other factors. The other study is an updated analysis of the groundwater of the Waimea Plains by our Science Officer, Melanie Westley. However, there is a possibility that the major source(s) of nitrate contamination to the Hope Unconfined Aquifer are isolated to one or a few particular unauthorised discharges to groundwater e.g. via soak pits. The reason this is suggested is that between 2010 and 2012 following the ceasing of a stock truck wash to groundwater, nitrate-N concentrations declined from a median around 7 g/m^3 to about 4g/m^3. Unfortunately from 2012-2015 these concentrations returned to the previous levels. While this may be coincidence, it does give some hope that, with some investigation, significant contaminant sources may be found and removed leading to significant improvement. With new policy on the horizon, extra staff resources in compliance compared to five years ago and with new catchment facilitators on board, this may be able to happen. Both nitrate and total ammonia concentrations seem to be consistently higher in June-July which is consistent with the time of year when plant uptake is the least. Potentially the growing of winter crops on Ranzau soils could be the cause. Water clarity is ‘likely degrading’.

MCI is in the D band and is assessed as ‘likely degrading’. The high nitrate-N concentration is likely to be part of the reason for this, along with fine sediment discharges (including from earthworks associated subdivisions and individual lots).

Borck at 400m ds Queen St, Dec 2022

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5.6.6 Motupipi River, near Takaka. *E.coli* concentrations are in the E band, below the national bottom line (median 315 *E.coli*/100ml and 95th percentile of 7675 *E.coli*/100ml) and 'very likely degrading'. There are some very high spikes at this site (up to 22,000 *E.coli*/100ml; 9 of the highest *E.coli* concentrations found at this site were after 2015). Some old septic tanks have been found to be discharging directly to tributary drains.

Dissolved Reactive Phosphorus was shown to improve up to 2015 but has since been 'likely degrading'. The largest spike in DRP (0.043 g/m^3) in the last five years appears to be the first high flow events after the removal of some of the legacy of contaminated sediment from the waterway in March 2021. This value is still below national standards and since then all results are under 0.02g/m^3. DRP peaks mostly occur in February when flows are lowest and the release from the sediment is likely to be highest.

While nitrate-N is in the B grade it is 'likely degrading'. This catchment would be a priority to do nitrate source tracking. There are farms in critical upper parts of this catchment that have not responded to encouragement of environmental improvement like others. One farm in the catchment has critical source areas such as laneways, a silage pit, one stream crossing of a tributary that need further work. With the regulatory requirement for Freshwater Farm Plans we hope that the less willing landowners will also make the changes required to improve water quality. This behaviour is not reflective of most landowners in the catchment who are doing great work protecting this waterway.

MCI is in the D band, below the national bottom line for macroinvertebrates.

5.6.7 Neimann Creek, Waimea Plains. Being fed from an aquifer with very high nitrate concentrations. Nitrate-N concentrations in Neimann Ck are improving over five years (Trend rate -0.58 g/m3 per year). Nitrate concentration does not change much with increase in flow. Phosphorus (DRP) is much lower in spring and summer which is probably due to uptake from aquatic plant uptake.

While *E.coli* is in the E band (median 410 *E.coli*/100ml and 95th percentile of 2260 *E.coli*/100ml) faecal source tracking has failed to identify a likely source (not human or farm animals and few wildfowl), as have investigations of any obvious contaminant pathways. *E.coli* concentrations are much lower in winter and tend to have higher concentrations in Nov-Dec. *E.coli* do not survive long in groundwater, so the source(s) are likely to be close by. This could indicate pukeko as this is their main breeding season and many pukeko have been observed nesting along this waterway. There are no pukeko markers available for faecal source tracking. Pukeko control has been undertaken in this area in 2021-22, which seems to have resulted in improving *E.coli* concentrations.

This is the only site in the programme that gets clearer as flow increases. This means that there is limited influence from run-off.

The prolific growth of aquatic plants (including the pest plant, water celery) result in very low summertime dissolved oxygen concentrations. Within the next 10-20 years riparian plantings are likely to provide shading to the point that the aquatic plants will be expected to no longer be a significant problem. It is hoped that dissolved oxygen concentrations will improve as a result also.

Various options to improve the water quality at this creek have been considered such as bark dentification wall used to intercept and treat groundwater. As well as being expensive to install it could exacerbate the dissolved oxygen issue unless an expensive nano-bubble generator was deployed at the site. The cheapest and most effective method to improve water quality at this creek is piping water of good quality from the Council bore field near the Waimea river, not far away. Increased flows in the creek are also likely to have a substantial benefit on the health of the creek.

Neimann at 600m us Lansdowne Rd, Dec 2022

5.6.8 Moutere River at Riverside. *E.coli* for this river is in the D band (median 170 *E.coli*/100ml and 95th percentile of 1500 *E.coli*/100ml) but appears stable. While nitrate-N is in the B band, there are sufficient nutrients for extensive growth of algae. MCI is very low at the Riverside site and throughout most of the Moutere catchment. This is most likely due to high water temperature, high cover of filamentous green algae and fine sediment clogging in the bed (see report to Council 2018).

While MCI is in the D band and 'likely improving' over the 10 year term. Hopefully this is marking a positive turn in the health of this waterway.

5.7 The sites described below are also of concern but not yet a major issue. Most of these sites are on larger rivers, that have the benefit of more dilution by clean headwater streams.

5.7.1 Takaka at Kotinga. While *E.coli* is in the B band, it is “very likely degrading’ over the last 15 years. However, trends over the last 5 years are ‘likely improving’. Along with this nitrate-N is ‘likely degrading’ over the last 15 years (even though it is in the A band for nuisance periphyton growth). Water clarity is much lower in winter (5-8m) compared to summer (8-11m). This could partly be the greater proportion of flow entering groundwater in the mid reaches of the Takaka River. The Takaka River at Lindsay’s Bridge site near upper Takaka appears to experience more sampling events (about 60% more) when *E.coli* was higher than at the Kotinga site. The opposite is true for nitrate where the Kotinga site almost always has higher concentrations (median is about 54% greater).

Cow numbers have been very stable over the last 15 years and there is a trend to using less fertiliser. Given the farm environmental plans for dairy farms have been in place in this catchment since about 2017, practices will have improved. The practice of winter grazing/cropping in the catchment has decreased in the last 5-7 years which may be reflective in *E.coli* concentrations improving in the last five years whereas they were “very likely degrading” over the last 15 years.

MCI in the B band. No trends.

5.7.2 Aorere River. *E.coli* and nitrate-N concentrations at the Le Comte site near the mouth are 'likely degrading', but water clarity, DRP and Total Ammonia are all 'very likely improving'. A lot of expense and effort was put in in this catchment from 2005 to 2015 for stream fencing and effluent system upgrades to reduce faecal loads. *E.coli* concentrations tend to increase with higher flows suggesting that the source(s) is mobilized by rain run-off e.g. from dairy shed or races (the strongest relationship of this nature of any site). The concentrations of these contaminants appear to be improving in the Kaituna (a major tributary of the Aorere) which suggests major sources elsewhere in the catchment.

Cow numbers in this catchment have been very similar for the last 15 years. Intensive winter grazing/cropping was common on a few big farms in 2015-17 but is not nearly as prevalent now (based on information from aerial over-flights).

MCI is in the B band. No trends.

5.7.3 Motueka River at Woodstock. Nitrate levels are rising in the Motueka river. For Motueka at Woodstock, total oxidised nitrogen was consistently 'very likely degrading' across all time periods assessed, from 5 years to 30 years. The trend is also 'very likely degrading' at the Gorge site even though 98% of the land area of the catchment upstream is in a natural state. However, total oxidized nitrogen is rising six times faster at the Woodstock site and appears to be degrading faster in the last 5-10 years (see Figure 5 below). Filamentous green algae growth is already an issue at times in this river and is likely to get worse if this trend continues.

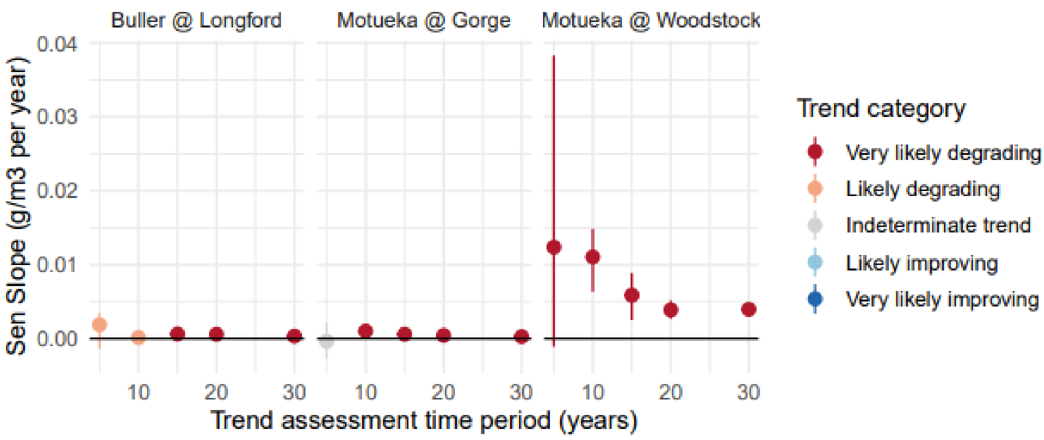

Figure 5: Total oxidised nitrogen trend rate for each trend assessment time period. Error bars are 90 percent confidence intervals around the trend rate (Sen slope).

The macro-invertebrate index (MCI) is in the C band at the Woodstock site and 'very likely degrading'. The same pattern is occurring at the Gorge, so this could be partly related to natural causes such as the runoff of heavy metals from dissolution from the ultramafic geology in the headwaters. Interestingly the MCI is also ‘very likely degrading’ in Hunters Creek which is in native bush.

5.7.4 Sherry River, Wangapeka catchment. After the considerable improvement in *E.coli* concentrations from about 2005-2012 (partly due to bridging of the stock crossings and fencing of waterways) there was a long period of no further improvement despite being close to achieving the swimmability goal of the catchment group. However, in 2017-18 there was a step change decrease (“very likely improvement”) in *E.coli* and increase (“very likely degrading”) in nitrate after this time. This was soon after one dairy farm with consistent poor practice sold and the land converted to hops In addition, the *E.coli* concentrations peaked in 2017-18 during the conversion process when fences were decommissioned and cows were allowed in waterways (anon, pers.comm.). The actions carried out by many farmers throughout the catchment are acknowledged. The freshwater farm plans in the catchment were also updated in 2018. Nitrate-N concentrations are much more variable in March of each year (0.15-0.6g/m^3). This may be due to leaching from irrigation.

E.coli much higher in Oct-Dec than July-Aug (p15m). Oct is the highest peak even in the last 5 years and median similar to the last 15 years. This coincides with peak discharges from dairying and sheep farming.

MCI is ‘very likely degrading’ at this site over both the 10 and 15 year period. There is a possibility this could be related to fine sediment discharges from forestry in the upper part of this catchment based on observations of erosion of landings and other earthworks. Sediment source tracking would be useful to confirm this. While forest harvesting has progressively occurred across the upper catchment we know relatively little about soil loss from forestry practices in this catchment.

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Sherry at Blue Rock, March 2023

5.7.5 Riuwaka River. Even though *E.coli* concentrations are in the B band, it is 'very likely degrading'. At this stage we do not know why. While MCI is in the B Band, it is 'likely degrading' over the last 10 years ('very likely degrading' over the last 15 years).

5.7.6 Hunter Creek, Upper Motupiko catchment is in the C band for phosphorus (median DRP 0.013 g/m3). This could either be natural as the catchment for this creek is almost all in native bush, or it could be due to wild pigs working over the ground. Pig numbers are relatively high in this catchment according to landowners nearby. *E.coli* is much higher at this site than any other reference site. According to the landowners the pattern appears consistent with pig numbers.

5.7.7 Buller River at Longford. While *E.coli* is in the A band at this site for *E.coli* and nitrate-N, trends show these attributes to be 'likely degrading'. MCI is in the C band and 'very likely degrading' over both the 10 and 15 year term.

5.7.8 The **Wai-iti River** site had increasing levels of nitrate-N over 5 years (trend rate 0.136 g/m3 per year). This is the highest rate of increase after Borck Creek.

6 Recommendations

6.1 With so many catchments with often complex water quality issues and a large effort that is required to determine the causes, it will be important that Council consider increasing budgets for: 1. investigating the major causes of poor water quality state and 2. producing action plans for waterways and catchments in a degraded state or with 'very likely degrading' trends (as required by the NPS-FM). These investigations would best involve a combination of intensive synoptic sampling along waterways in a catchment and land-based investigations for likely surface (runoff) and subsurface (leaching) pathways for discharge of contaminants to waterways.

6.1.1 Synoptic surveys can employ various methods for contaminant source tracking and will likely involve cooperation with various research institutes.

6.1.2 While many 'critical source areas' (activities with high risk of contaminant discharge to water) on farms, forests or orchards are often relatively obvious, some will require new and advanced methods, particularly when understanding both runoff and loss through different soils. For contaminant loss from run-off, better identification of the pathways and funnel-points into waterways is needed. A physiographical approach (see LandscapeDNA) shows promise for contaminant loss through soil (usually by leaching) and is being employed in the Takaka Valley in an attempt to determine the major pathways of nitrogen to the Arthur Marble Aquifer. Such an approach is $40/ha and so would have to be applied to priority catchments such as Murchison Creek, Burton Ale/James Cutting Creeks (near Collingwood), Motupipi and Waimea.

6.1.3 Sediment is arguably the contaminant likely to be causing the greatest adverse effect on aquatic ecosystems – not only rivers, but the coastal environment as well. This is a reflection of land use disturbance being prevalent across the region. While in the River Water Quality Monitoring Programme we sample fine sediment with the gravel bed (resuspendable solids) and within the water column (turbidity and water clarity), we don't have any programme to track that to the source. Sediment source tracking using compound-specific isotopes has been used in the Waimea and Moutere catchments and found pine forestry and large-scale sub-soil disturbance to be a major component of such sediment. Further use of this method throughout major catchments is recommended. While implementation of freshwater farm plans are likely to improve water quality and reduce contaminant loss risk, it only applies to pastural and horticultural land uses and not forestry. The use of freshwater farm plans to reduce sediment load within a catchment may therefore be limited. The forestry company OneFortyOne Ltd is four years into a five-year paired catchment study in the upper Tadmor catchment comparing the efficacy of 'best practice' methods to standard practice for controlling sediment loss.

6.1.4 Increasing the level of partnering with catchment groups interested in river water quality monitoring is suggested. Ministry for the Environment funding provided to the Motueka Catchment Collective and Council for this purpose is expected to yield useful results.

6.2 That Council increases its effort in practical measures to enhance river health. Council's Catchment Enhancement Fund is working well to help landowners address the major water quality issues (report to Council expected within the next 6 months). However, this fund is limited by what can be achieved with current resources (annual budget of $100k from 2018/19-2020/21 and ~$50k 2021/22-2022/23 – recognising the contribution to the Freshwater Improvement Fund projects for natural and constructed wetlands and fish passage).

6.3 While not part of the analysis for this report, it would be useful to determine the extent to which climate patterns (Southern Oscillation Index, SOI) amplify or counteract the observed trends in water quality. Quantifying the influence of the SOI should be part of the process to develop action plans in response to degrading trends.

7 Attachments

Nil

Appendices

Nil