

WAIKATO RIVER HEALTH AND WELLBEING – AN ANALYSIS OF TRENDS FOR SELECTED INDICATORS

Report Summary

This report on the Waikato River was prepared by NIWA for the Waikato River Authority's Five-Year Report to the Crown and River Iwi. The report provides an interim assessment of a subset of Report Card indicators.

INTRODUCTION

The trends report, summarised in this document, analyses 650 trends from a combination of indicators and sites in the Waikato catchment over the 10-year period of 2010 – 2019. These indicators link to three of the Waikato River Report Card taura: experience, ecological integrity, and water quality. Of the 650 trends 25% (161) were improving, 45% (295) were deteriorating and 30% (194) were as likely improving as deteriorating.

The trend analysis shows that despite the many actions that have been taken to improve the health of the Waikato River, 'deteriorating' and 'as likely improving as deteriorating' trends dominate this report. There are strong signals of widespread deterioration in the water quality indicators, particularly *E. coli*, dissolved oxygen, and total nitrogen, but also some signals of improvement in water clarity, water temperature, chlorophyll *a*, arsenic, and total phosphorus. Because ecological indicators were measured once annually, resulting in a smaller data set compared to water quality indicators, many trends in ecological indicators were categorised 'as likely improving as deteriorating'. There were more deteriorating trends for macroinvertebrates indicators, a common measure of ecological health. However, there were more improving than deteriorating trends for other ecological indicators such as macrophyte (% native cover), periphyton (% long filaments), and riparian (vegetation protection score) indicators.

While this trend analysis followed current best practice and methods, the reader should interpret the data with caution because short term trends are known to be influenced by statistical sampling errors and natural fluctuations in environmental drivers, such as

- flow and climate cycles, and
- time lags in the recovery of water quality and ecosystem health following mitigation and restoration.

The full report is available at: www.niwa.co.nz/wra-report

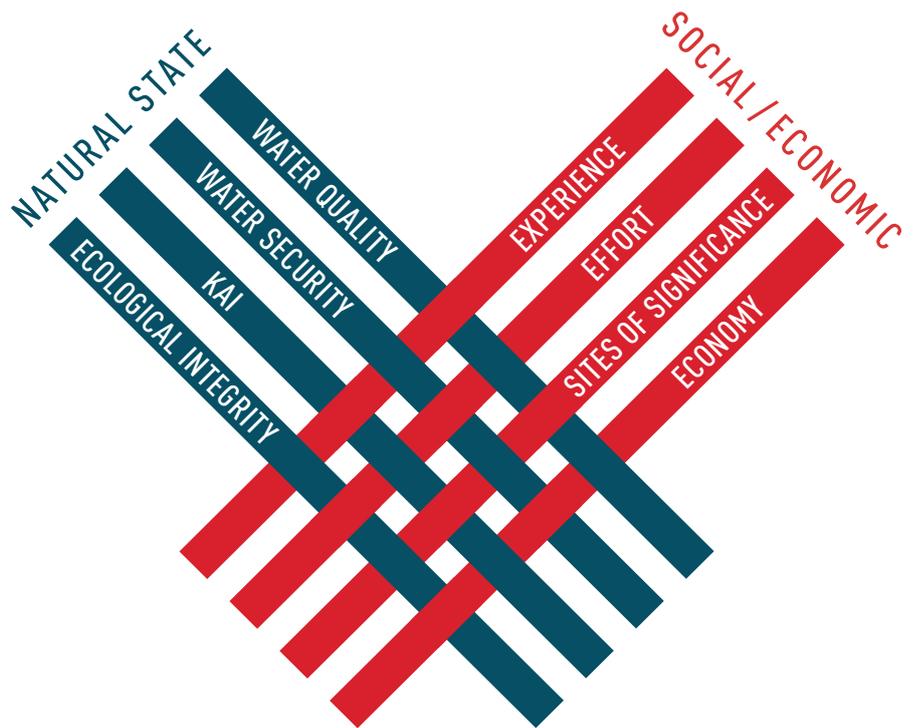
THE WAIKATO RIVER REPORT CARD

Environmental report cards are a means to pull together several indicators into a combined score to communicate the state, health and wellbeing of a waterway.

In 2016 Waikato Raupatu River Trust, Waikato River Authority (WRA), NIWA and Diffuse Sources Ltd prepared report cards for the Waikato River catchment. The framework underpinning the report card steps beyond focusing only on biophysical or natural state evaluations approaches and provides a space for cultural and social monitoring information to be incorporated as it becomes available in the future. Thus, the Waikato River Report Card is unique – both nationally and internationally.

The pilot Waikato River Report Card was designed to communicate the state of the cultural, social, environmental, and economic health and wellbeing of the catchment and is linked to the vision set out in Te Ture Whaimana – The Vision and Strategy. The Report Card is divided into sections or themes that are key elements of importance of the Awa to Waikato communities, and for guiding its restoration. These are called ‘taura’ (threads or strands), where the taura are ‘plaited’ (taura whiri) by the Report Card to communicate the state of the Awa.

There are eight taura or strands that contribute to the report card score.



These taura (key themes) are underpinned by Waikato River Iwi values and captures the aspirations of Te Ture Whaimana – The Vision and Strategy.

- **Water quality** – Our land use practices and land development support water that is safe to drink and physically interact with;
- **Water security** – Our land use practices and land development supports communities and taonga species having access to life-sustaining supplies of water;
- **Kai** – Our kai are healthy and have a strong whakapapa, are safe to eat, locally abundant and can be harvested according to our traditional practises;
- **Ecological integrity** – Our taonga species have access to healthy habitats, protected from adverse effects due to adjacent land use, and enhance our associated practices;
- **Experience** – We have a flourishing and nurturing connection with the river, and we are empowered to pursue and maintain our positive interaction;
- **Effort** – Communities, businesses and individuals are engaged in comprehensive contaminants control and rehabilitation to achieve Te Ture Whaimana;
- **Sites of significance** – Our sites of significance are forever recognised and celebrated as areas of historical and cultural importance and are safe for us to interact with and support a healthy Awa; and
- **Economics** – Communities are prosperous, as shown by high levels of employment, housing affordability, gross domestic product and income equality.

WRA expressed that the Report Card “will serve as an enduring measure of our progress” with the next Report Card due to be delivered in 2025.

INTERIM ASSESSMENT OF TRENDS FOR A SELECTION OF INDICATORS

The next Report Card is not due until 2025 (covering a 10-year period). In preparation for the WRA's Five-Yearly Report, NIWA was engaged to provide an interim assessment of trends in indicators since the 2015 Report Card.

Trend analyses were conducted for 20 indicators. The indicators assessed link with three report card taura: Water Quality (WQ), Ecological Integrity (EI) and Experience (E).

Indicators include water clarity (black disc), *E.coli*, total nitrogen (TN), total phosphorus (TP), phytoplankton (chlorophyll *a*), dissolved oxygen (DO), water temperature, ammoniacal nitrogen (NH₄), arsenic (As), macroinvertebrates (MCI, QMCI, %EPT abundance, % EPT taxa), periphyton (cover of long filaments, cover of thick mats), macrophytes (channel clogged by macrophytes, exotic cover, native cover) and riparian health (channel shade, riparian vegetation protection, riparian width).

The trend analyses were restricted to those Report Card indicators where suitable datasets were available.

Datasets collated from long-term records gathered by the Waikato Regional Council (WRC) and NIWA, include:

- Waikato River Water Quality Monitoring Programme
- Regional Rivers Water Quality Monitoring Programme
- National River Water Quality Network, and
- Regional Ecological Monitoring of Streams Programme

Five- and 10-year trend periods were chosen to align with the WRA's reporting cycles. This summation focuses on the 10-year period from 2010 – 2019.

The trends presented are for the Waikato River mainstem and its tributary streams. It does not report on trends for lakes in the Waikato River catchment.

To help communicate the spatial variability in the results the trends data analyses were grouped into five zones and 10 Report Card Units (RCUs) covering the Waikato River mainstem and tributaries (see map on page 5):

1. Huka to Ōhakuri – Mainstem (OW), tributaries (OWT)
2. Ōhakuri to Karāpiro – Mainstem (KW), tributaries (KWT)
3. Waipā – Mainstem (Wp), tributaries (WpT)
4. Mid Waikato (Karāpiro to Ngāruawāhia) – Mainstem (MW), tributaries (MWT)
5. Lower Waikato (Ngāruawāhia to Te Puāha) – Mainstem (LW), tributaries (LWT).

Trends are reported as improving, deteriorating or as likely improving as deteriorating.

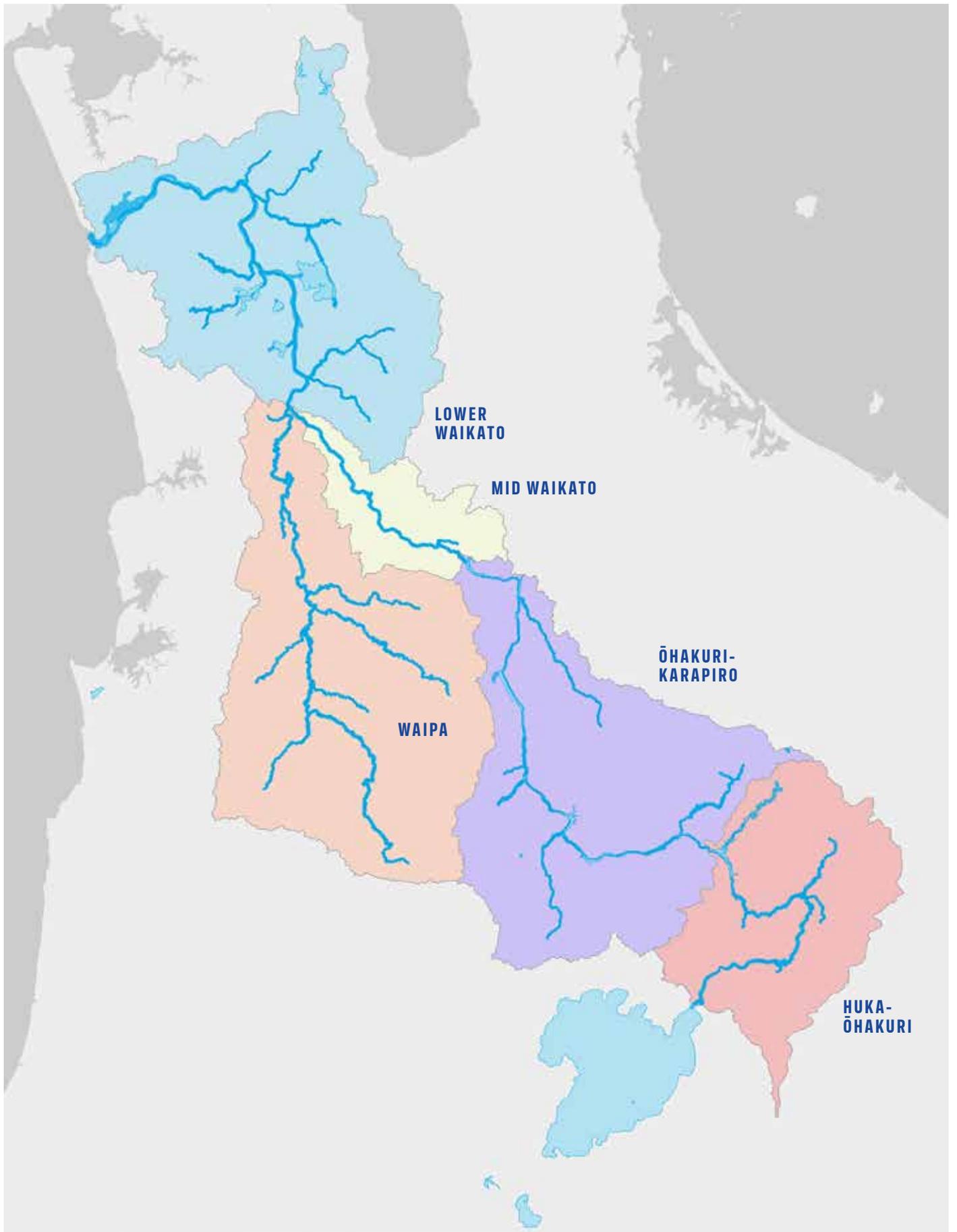
The causes of these trends has not been considered in this report nor has the current state of indicators.

A 'trend' is an upwards or downwards shift over time.

Use data with caution

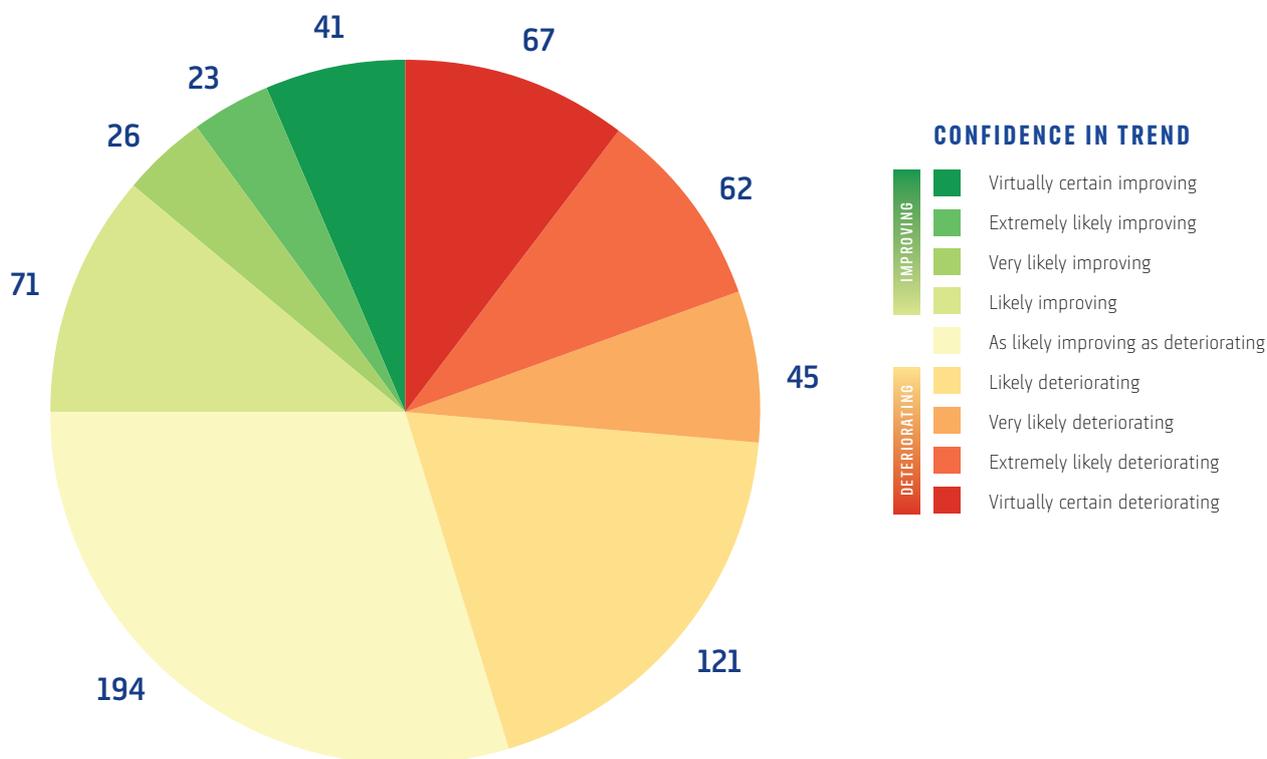
Trend analyses followed current best practice and the methods used by the Ministry for the Environment and Statistics New Zealand to assess state and trends under the Environmental Reporting Act 2015.

Despite this, the reader should take note of the limitations in performing trend analyses on a relatively short-term environmental dataset. Short-term (up to and including 10-years) trends are known to be influenced by both statistical sampling errors and natural fluctuations in environmental drivers, such as flow and climate cycles, and should be interpreted with caution.



The Waikato-Waipā River catchment showing the five zones used to collate the results of the trends analysis.

HIGH-LEVEL LOOK AT THE WAIKATO RIVER HEALTH FOR 2010-2019



To provide a high-level summary of trends in the Waikato River and its tributaries we combined the results of the analyses for all 20 indicators into a pie graph.

650 trends were identified from a combination of indicators and sites over the 10-year period.

The trend analysis showed a high level of spatial and temporal diversity in improving and deteriorating trends for the 20 indicators.

- 25% (161 of 650) of the trends were improving trends.
- 45% (295 of 650) were deteriorating trends.
- 30% (194 of 650) were as likely improving as deteriorating trends.

Water quality indicators were dominated by deteriorating trends, with exceptions being the dominance of improving trends for water clarity, arsenic, and chlorophyll *a*.

Ecological indicators were dominated by deteriorating trends or as likely improving as deteriorating trends.

The trend analysis undertaken here provides some mixed signals in terms of changes in the health of the river and its tributaries. There are strong signals of widespread deterioration in the water quality indicators but also some signals of improvement. Overall, there is more deterioration happening than improvement. Again, however, caution needs to be taken in drawing conclusions from such short-term trends.

Furthermore, it must be noted that trend analysis provides information on change over time alone. It does not test or attribute connection, or even association with potential drivers of change either natural or from human activities.

How to read the pie chart

The pie graph allows data to be presented in a circular manner where each piece of the pie represents the proportional fraction of the whole. In this report the site trends for each confidence category are tallied and then displayed as a proportion of the total number of sites showing trends for that indicator. The colour of the segments indicates the confidence that the trend is improving or deteriorating, with the number of sites in each category noted on the outside of the pie.

Waikato River catchment 10-year trend by indicator

TAURA	INDICATOR	10-YEAR TREND (2010-19)			NO. OF TRENDS
		% deteriorating	% improving	% as likely improving as deteriorating	
WATER QUALITY					
E & WQ	Water clarity (black disc)	36%	52%	12%	50
E & WQ	<i>E. coli</i>	50%	19%	31%	42
WQ	Total nitrogen (TN)	67%	17%	17%	60
WQ	Total phosphorus (TP)	40%	40%	20%	58
WQ	Phytoplankton (Chlorophyll <i>a</i>)	0%	70%	30%	10
EI	Dissolved oxygen (DO)	71%	13%	16%	62
EI	Water temperature	47%	26%	27%	62
EI	Ammoniacal nitrogen	52%	13%	35%	62
EI	Arsenic (As)	0%	100%	0%	10
ECOLOGY					
Macroinvertebrates					
EI	MCI	41%	8%	41%	22
EI	QMCI	68%	18%	13%	22
EI	% EPT abundance	77%	9%	13%	22
EI	% EPT taxa	59%	14%	27%	22
Periphyton					
EI	Cover of long filaments	14%	29%	57%	21
EI	Cover of thick mats	19%	10%	71%	21
Macrophytes					
EI	Channel clogged by macrophytes	15%	15%	70%	20
EI	Exotic cover	25%	15%	60%	20
EI	Native cover	5%	15%	80%	20
Riparian health					
EI	Riparian vegetation protection	27%	41%	22%	22
EI	Riparian width	55%	27%	18%	22

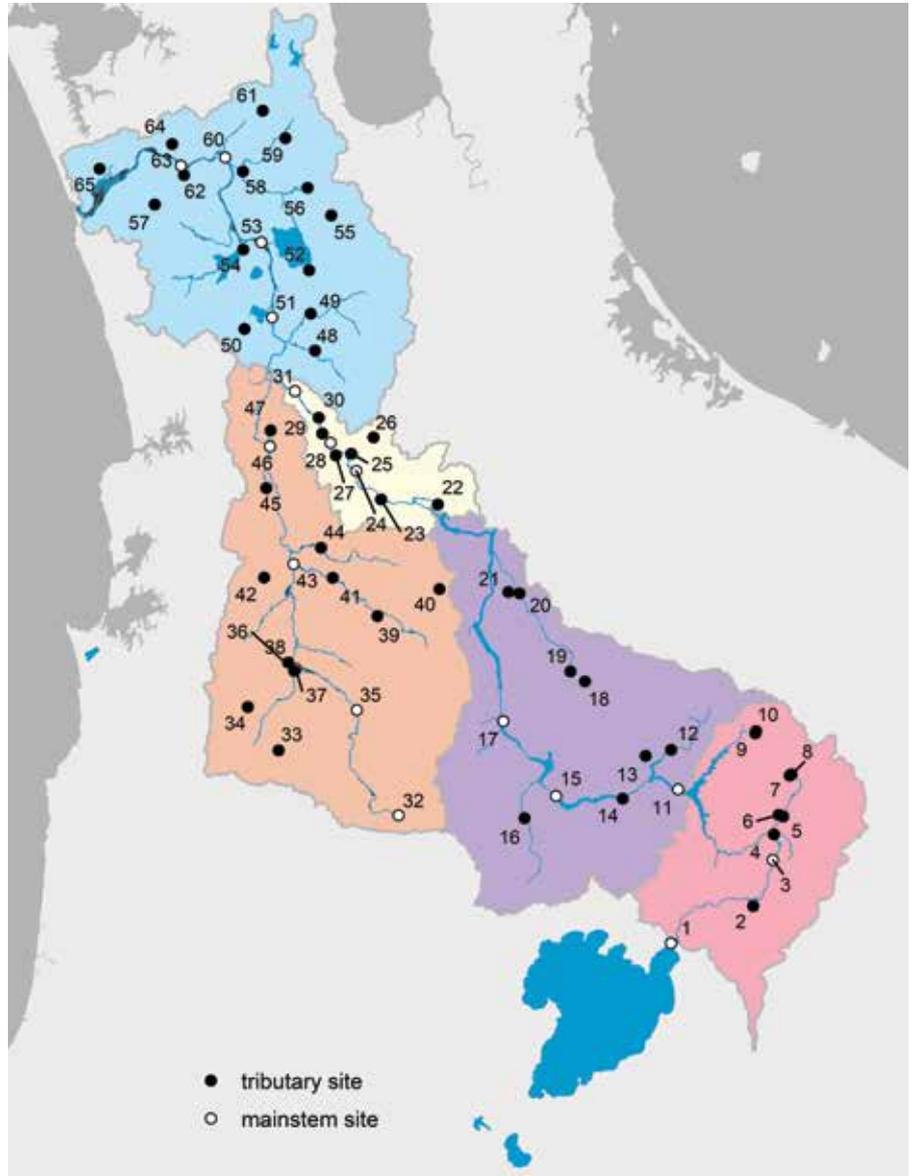
Taura: Experience (E), water quality (WQ) and ecological integrity (EI).

WATER QUALITY

River water quality is assessed using a variety of physical (water clarity and water temperature), chemical (nitrogen, phosphorus, ammoniacal nitrogen, arsenic, chlorophyll *a*, dissolved oxygen), and bacterial (*E. coli*) indicators.

The direction and confidence in trends showed a high level of variation in improving and deteriorating trends between indicators, sites, and RCUs. Over the 10-year period from 2010-2019:

- **Water clarity** (black disc) showed a mix of improving and deteriorating trends, with 52% of sites (26 of 50) improving and 36% deteriorating (18 of 50). The remaining 12% (6 of 50) were as likely improving as deteriorating. Improving and deteriorating trends were spread across all RCUs
- ***E. coli*** showed deteriorating trends in 50% (21 of 42) of sites, with only 19% (8 of 42) improving and 31% (13 of 42) as likely improving as deteriorating. Deteriorating trends were primarily in the upper catchment RCUs
- **Total nitrogen (TN)** showed 67% (40 of 60) of trends deteriorating, although there were also 17% (10 of 60) as likely improving as deteriorating trends and 17% (10 of 60) improving trends. The majority of deteriorating trends were in the upper catchment RCUs
- **Total phosphorus (TP)** trend directions and confidence were mixed, with 40% improving (23 of 58) and 40% deteriorating trends (23 of 58). The remaining 20% (12 of 58) of sites had as likely improving as deteriorating trends. Improving and deteriorating trends were spread across all RCUs
- **Chlorophyll *a*** showed improving trends at most main river sites (70%: 7 of 10) with 30% (3 of 10) as likely improving as deteriorating. Sites with improving trends were in the lower catchment RCUs
- **Dissolved oxygen (DO %)** showed deteriorating trends at 71% (44 of 62) of sites, with only 13% (8 of 62) improving trends and 16% (10 of 62) as likely improving as deteriorating trends. Deteriorating trends were spread across all RCUs



Monitoring site locations

Sixty-two Water Quality Monitoring sites were utilised to assess the trends for the nine water quality indicators. However, due to data processing restrictions the number of sites used varied between each indicators (refer to page 17 of the full report for more information on the data processing).

- **Water temperature** showed deteriorating trends at 47% (29 of 62) of sites. The remaining trends were split between 26% (16 of 62) improving trends and 27% (17 of 62) as likely improving as deteriorating trends. Improving trends were primarily in upper catchment RCUs
- **Ammoniacal nitrogen** showed deteriorating trends at 52% (32 out of 62) of sites, with 13% (8 out of 62) improving and the remaining 35% (22 out of 62) as likely improving as deteriorating. Deteriorating trends were more common in lower catchment RCUs
- **Arsenic** showed improving trends at all 10 main river sites.

WATER QUALITY TRENDS

416 water quality trends were identified for the 2010-2019 time period.

All trends have been clustered under three categories (deteriorating, improving, and as likely improving as deteriorating) and grouped by Report Card Unit (RCU) so you can see the spatial distribution. The number of site/indicator combination in each category is shown as a percentage of the total.

Water quality indicators were dominated by deteriorating trends across all RCUs except Huka to Ōhakuri mainstem, Karāpiro to Ngāruawāhia tributaries and Ngāruawāhia to Te Puāha mainstem.

Summary of the nine water quality indicators presented by Report Card Unit (RCU) over a 10-year period from 2010 to 2019.

The number of sites used in these assessments varied between indicators.

RCU	% Deteriorating trend	% Improving trend	% As likely improving as deteriorating trend	No. of trends
Huka to Ōhakuri	27%	35%	38%	26
Huka to Ōhakuri tributaries	52%	37%	11%	46
Ōhakuri to Karāpiro	50%	39%	11%	18
Ōhakuri to Karāpiro tributaries	70%	20%	10%	60
Karāpiro to Ngāruawāhia	44%	44%	11%	18
Karāpiro to Ngāruawāhia tributaries	31%	40%	29%	42
Waipā	44%	20%	36%	25
Waipā tributaries	52%	22%	26%	69
Ngāruawāhia to Te Puāha	35%	46%	19%	26
Ngāruawāhia to Te Puāha tributaries	56%	16%	28%	86



To explore the 416 water quality trends in more detail check out the graphic on the following page.

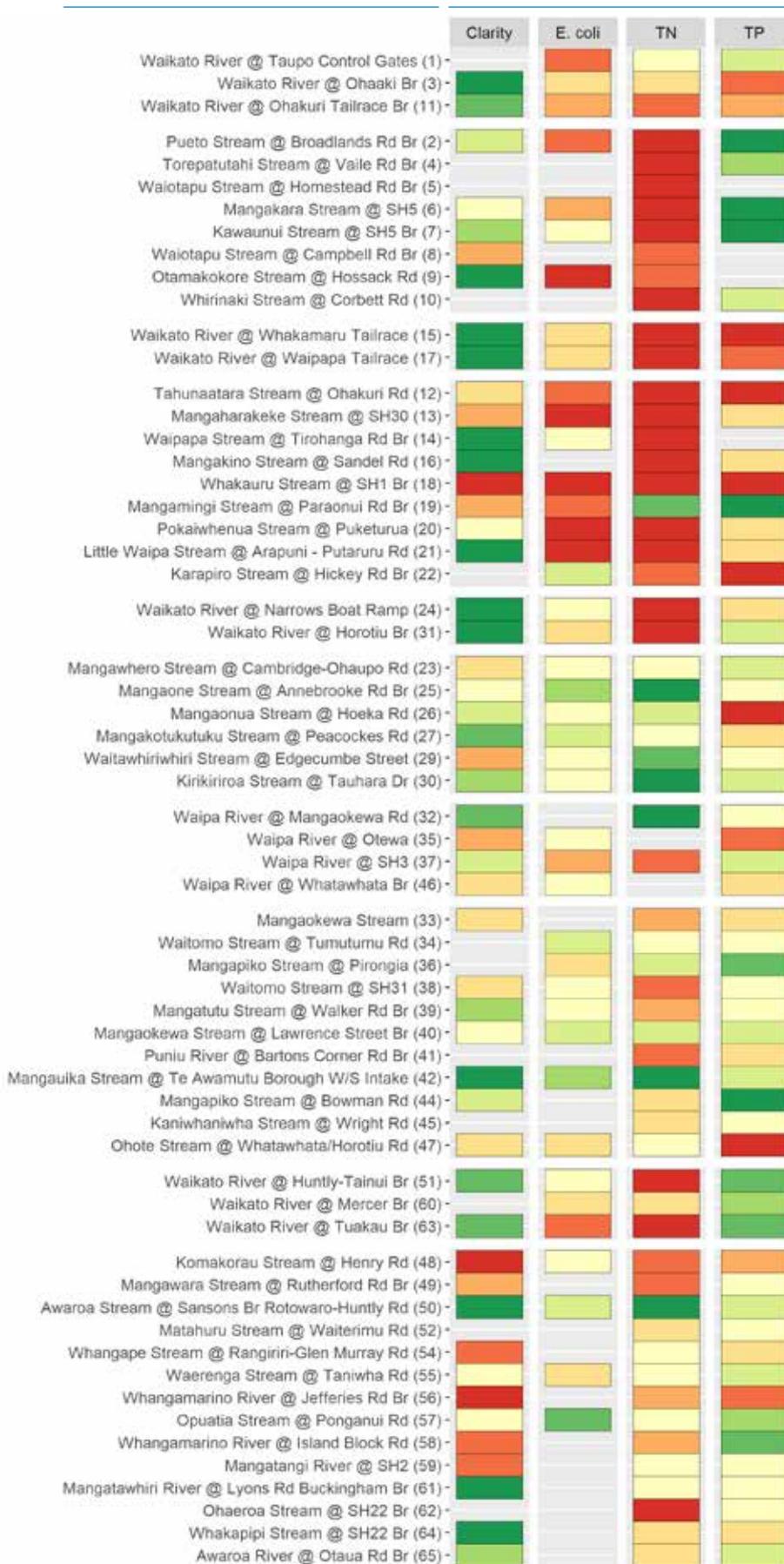
WATER QUALITY TRENDS

Monitoring sites

This graphic displays all 416 water quality trends that were identified for the 2010-2019 time period.

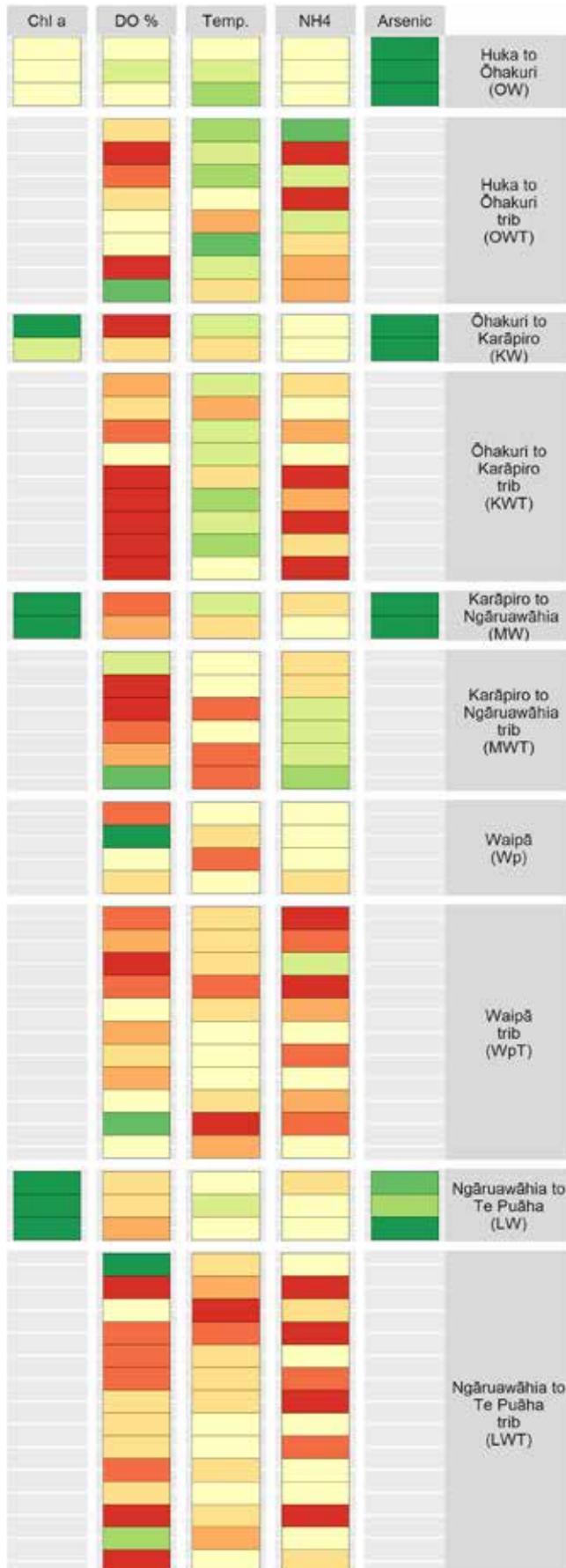
Water quality indicators include:

- Water clarity (black disc)
- *E.coli*, total nitrogen (TN)
- Total phosphorus (TP)
- Phytoplankton (Chlorophyll a)
- Dissolved oxygen (DO)
- Water temperature, ammoniacal nitrogen (NH₄), arsenic (As).



Indicators

Report Card Units (RCU)

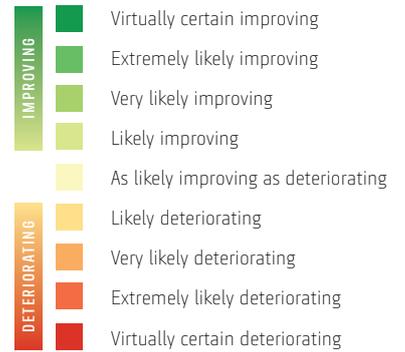


How to read the heatmap

Heatmaps have a panel for each RCU/indicator combination, with individual sites listed longitudinally on the y-axis from upstream to downstream along the length of the Waikato River. Tributaries are ordered by where they join the river mainstem. Each cell represents a single site (site name listed down the left y-axis). The colour of each cell indicates the confidence in the trend.

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CONFIDENCE IN TREND

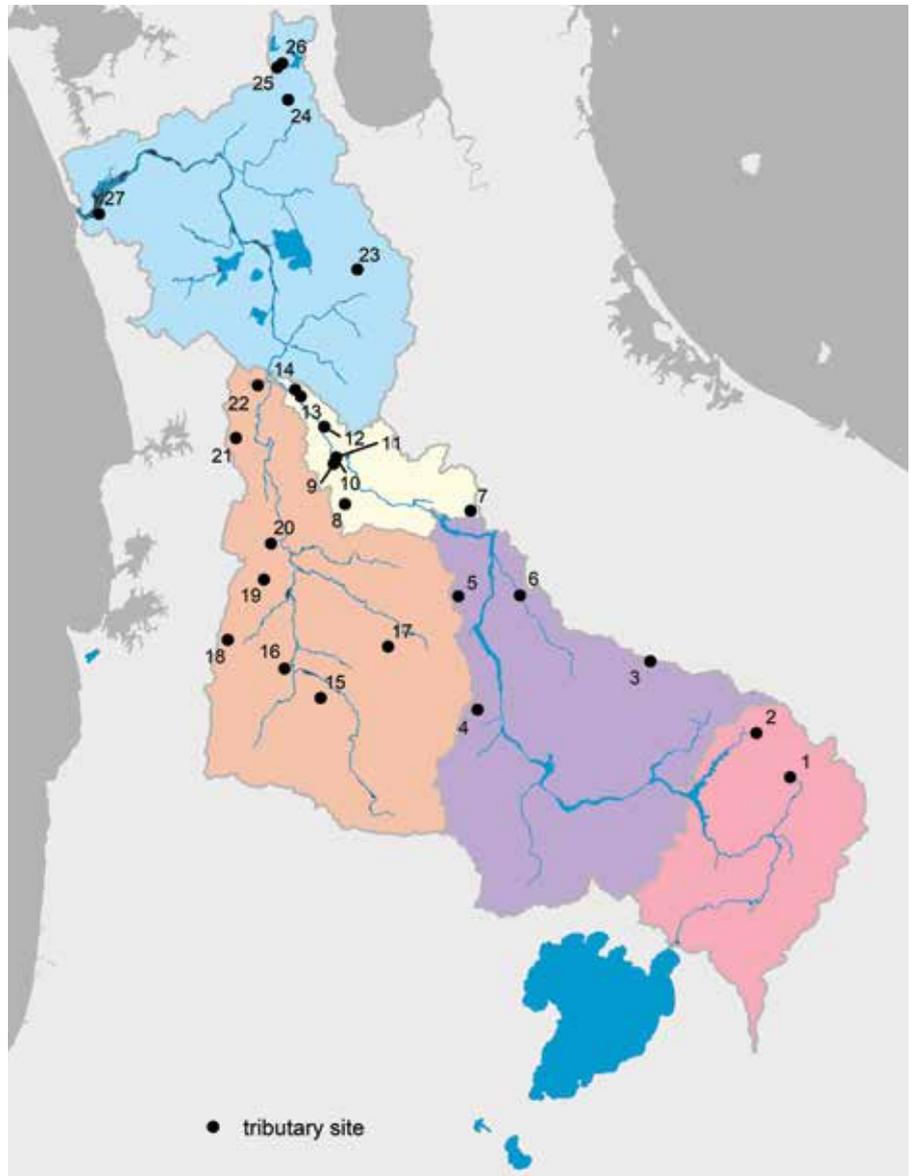


ECOLOGY

Freshwater ecological values are assessed with a variety of biological indicators, including benthic macroinvertebrates, and cover by aquatic plants (macrophytes) and algae (periphyton). Cover of riparian vegetation is also used as an ecological indicator of habitat quality. Ecological indicators are monitored at tributary sites only.

The direction and confidence in trends varied between indicators, sites, and RCUs. In addition, because ecological indicators were only measured once annually, resulting in a smaller data set compared to water quality indicators, many trends were categorised “as likely improving as deteriorating.” Over the 10-year period from 2010-2019:

- **MCI** showed 41% (9 of 22 sites) of trends as likely improving as deteriorating. Eighteen percent (4 of 22) of MCI trends in this time period were improving and 41% (9 of 22) were deteriorating
- **QMCI** trends were 68% (15 of 22 sites) deteriorating, with 18% (4 of 22) improving and 13% (3 of 22) as likely improving as deteriorating
- Percent **EPT abundance** showed 77% (17 of 22 sites) deteriorating trends, with only 9% (2 of 22) improving and 13% (3 of 22) as likely improving as deteriorating
- Percent **EPT taxa** trends were mixed, with more than half (59%: 13 of 22 sites) deteriorating, 14% (3 of 22) improving, and 27% (6 of 22) as likely improving as deteriorating
- **Periphyton long filament cover** showed predominately (57%: 12 of 21 sites) as likely improving as deteriorating trends, followed by 29% (6 of 21 sites) improving trend and 14% (3 of 21) deteriorating trends
- **Periphyton thick mat cover** showed as likely improving as deteriorating trends at 71% (15 of 21) of sites. There were two improving trends (10%) and 19% (4 of 21 sites) deteriorating trends
- **Macrophyte channel clogginess** showed predominately as likely improving as deteriorating trends (70%: 14 of 20 sites), along with 15% (3 of 20) improving trends and 15% (3 of 20) deteriorating trends



Monitoring site locations

Twenty-six Ecological Monitoring sites were utilised to assess the trends for the 11 ecological indicators. However, due to data processing restrictions the number of sites used varied between each indicators (refer to page 17 of the full report for more information on the data processing).

- Percent **cover of exotic macrophytes** showed slightly more deteriorating (25%: 5 of 20 sites) than improving (15%: 3 of 20 sites) trends. However, the majority of trends (60%: 12 of 20 sites) were as likely improving as deteriorating
- Percent **cover of native macrophytes** showed mostly as likely improving as deteriorating trends (80%: 16 of 20 sites). In addition, 15% (3 of 20) of trends were improving and one (5%) was deteriorating
- **Riparian vegetation protection** scores showed improving trends in 41% (9 of 22) of sites, deteriorating trends in 27% (6 of 22) of sites, and as likely improving as deteriorating trends in 22% (7 of 22) of sites
- **Riparian width** scores showed 55% (12 of 22 sites) deteriorating trends, followed by 27% (6 of 22) improving trends and 18% (4 of 22) as likely improving as deteriorating trends.

ECOLOGY TRENDS

234 ecological trends were identified for the 2010-2019 time period.

All trends have been clustered under three categories (deteriorating, improving, and as likely improving as deteriorating) and grouped by Report Card Unit (RCU) so you can see the spatial distribution.

The number of site/indicator combination in each category is shown as a percentage of the total.

Ecological indicators were dominated by deteriorating or as likely deteriorating as improving trends across all RCUs except Karāpiro to Ngāruawāhia tributaries.

Summary of ecological indicators presented by Report Card Unit (RCU) over a 10-year period from 2010 to 2019.

The number of sites used in these assessments varied between indicators.

RCU	% Deteriorating trend	% Improving trend	% As likely improving as deteriorating trend	Total no. of trends
Huka to Ōhākuri tributaries	41%	18%	41%	22
Ōhākuri to Karāpiro tributaries	46%	11%	43%	28
Karāpiro to Ngāruawāhia tributaries	35%	30%	35%	77
Waipā tributaries	39%	10%	51%	61
Ngāruawāhia to Te Puāha tributaries	33%	20%	48%	46

To explore the 234 ecology trends in more detail check out the graphic on the following page.



ECOLOGY TRENDS

This graphic displays all 234 ecological trends that were identified for the 2010-2019 time period.

Ecological indicators have been grouped under the following four headings and include:

Macroinvertebrate

- Macroinvertebrate Community Index (MCI)
- Quantitative Macroinvertebrate Community Index (QMCI)
- Percent of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) abundance (%EPT abun)
- Percent Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa (% EPT taxa)

Macrophytes

- Percentage of the channel clogged by macrophytes (% channel clog)
- Percentage of exotic cover
- Percentage of native cover

Periphyton

- Percentage cover of long filaments (% long filaments)
- Percentage cover of thick mats (% thick mats)

Riparian health

- Riparian vegetation protection (Vegetation score)
- Riparian width (Riparian width score).

Monitoring sites

	Macroinvertebrates			
	MCI	QMCI	% EPT abun.	% EPT taxa
Kawaunui Stream @ SH5 Br (1)-	Orange	Orange	Orange	Orange
Whirinaki Stream @ Corbett Rd (2)-	Orange	Yellow	Orange	Orange
Mokaihaha Stream @ Galaxy Rd (3)-	Orange	Red	Red	Red
Mangawhio Stream Trib @ Taupaki Rd (4)-	Orange	Red	Orange	Orange
Otautora Stream Trib (5)-	Yellow	Red	Orange	Orange
Pokaiwhenua Stream @ Putaruru Rd (6)-	Green	Green	Green	Yellow
Kaiwhitwhiti Stream @ Tiverton Downs Farm (7)-	Grey	Grey	Grey	Grey
Mystery Creek @ Bardoul Farm (8)-	Red	Orange	Orange	Yellow
Mangakotukutuku Stream @ Pelorus Street (9)-	Yellow	Orange	Orange	Orange
Mangakotukutuku Stream @ Waterford Rd (10)-	Orange	Red	Red	Orange
Mangakotukutuku Stream @ Peacocks Rd (11)-	Yellow	Orange	Orange	Orange
Bankwood Stream @ Emerald Tce (12)-	Yellow	Green	Green	Green
Waikato River Trib (unnamed) @ River Rd Sth Pa (13)-	Orange	Green	Orange	Yellow
Waikato River Trib (unnamed) @ Lake Rd (14)-	Red	Green	Orange	Red
Mangawhero Stream Trib @ Mangawhero Rd (15)-	Grey	Grey	Grey	Grey
Waitomo Stream @ Waitomo Valley Rd (16)-	Yellow	Orange	Orange	Red
Mangatutu Stream @ Lethbridge Rd (17)-	Yellow	Orange	Orange	Orange
Purangirangi Stream @ Oamaru Rd (18)-	Yellow	Red	Red	Green
Mangauika Stream (19)-	Green	Red	Yellow	Green
Mangakara Stream @ Pirongia bushline (20)-	Orange	Orange	Orange	Yellow
Whakakai Stream @ Whatawhata (21)-	Orange	Orange	Orange	Red
Firewood Creek Trib @ Walkway 2nd Br (22)-	Yellow	Yellow	Orange	Red
Mangatea Stream Trib @ Tate Property (23)-	Green	Orange	Red	Yellow
Mangatangi River @ Stubbs Rd (24)-	Green	Orange	Yellow	Orange
Mangatawai Stream @ SH1 Br (25)-	Yellow	Orange	Red	Red
Milnes Stream @ Mangatangi Hill Rd (26)-	Grey	Grey	Grey	Grey
Waikato River Trib @ Tuakau/Port Waikato (27)-	Yellow	Orange	Red	Yellow

Indicators

Report Card Units (RCU)

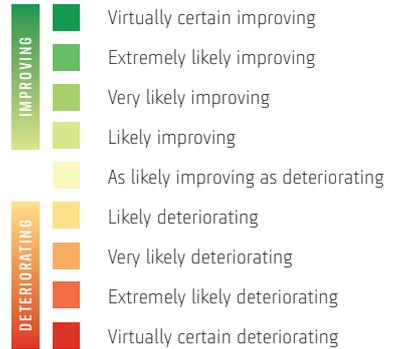


How to read the heatmap

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The colour of each cell indicates the confidence in the trend.

CONFIDENCE IN TREND





NIWA
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For more information
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