



WATER QUALITY AND QUANTITY

1 ACTIVITY OVERVIEW

The Water Quality and Quantity Activity of the Annual Plan includes the work programmes of Horizons Freshwater & Partnerships and Science & Innovation teams.

Horizons' Freshwater & Partnerships Team works closely with other Horizons teams, and people and organisations external to the council, to implement water quality and aquatic habitat improvement works. This work draws on monitoring and research undertaken by Horizons Science & Innovation and Environmental Data teams, along with that of other agencies, to prioritise and focus implementation efforts.

Both programmes actively seek funding from other sources to provide external science advice and facilitate the acceleration of works. These include the **Freshwater Improvement Fund (FIF)** for the Manawatū, Whangaehu and Lake Waipu/Rātana catchments, **Public Waterways Ecosystem Restoration (PWER)** for the Regional Stream Fencing and Riparian Planting programme, enhancing fish populations through Fish Barrier Remediation programme and Horowhenua water quality interventions projects, and the **Community Environmental Fund (CEF)** for the Waikawa Catchment. These are all administered through the **Ministry for the Environment (MfE)**. Funding of science advice through the **Ministry of Innovation, Business and Employment's (MBIE)** Envirolink fund totals approximately \$120,000 per year.

Implementation activities include: riparian fencing and planting for water quality improvement and fish habitat enhancement; identification and enhancement of whitebait spawning habitat and fish passage improvement; sewage treatment plant upgrades; work with horticulture growers; and harvesting of lake weed.

Science activities include monitoring and reporting of water quantity for both surface water and groundwater, and the quality of groundwater, rivers, lakes, estuaries, and the coast. More than 80 popular swim spots are monitored weekly throughout the swimming season from November to April. In addition to guiding implementation programmes, science and research also informs consent decision-making, and policy development and implementation. Communication of science data and information is primarily covered in the Environmental Reporting and Air Quality Monitoring section of this report.

This item presents the Water Quality and Quantity Activity regionally where appropriate and/or for each of the **Freshwater Management Units (FMUs)** that make up the Manawatū-Whanganui region. It integrates the implementation work of the Freshwater & Partnerships

Team, and the water quality and quantity activities of the Science and Innovation & Environmental Data teams. This includes the:

- Regional Water Quality and Quantity Programme;
- Whanganui & Kai Iwi;
- Whangaehu – including the Whangaehu FIF projects;
- Rangitīkei-Turakina – including the Lake Waipu (Rātana) FIF project;
- Manawatū – including the Manawatū River Accord and FIF project;
- Waiopēhu – including the Lake Horowhenua Accord and PWER project, as well as freshwater improvement work with horticulture growers; and
- Puketoi ki Tai – coastal Tararua area.

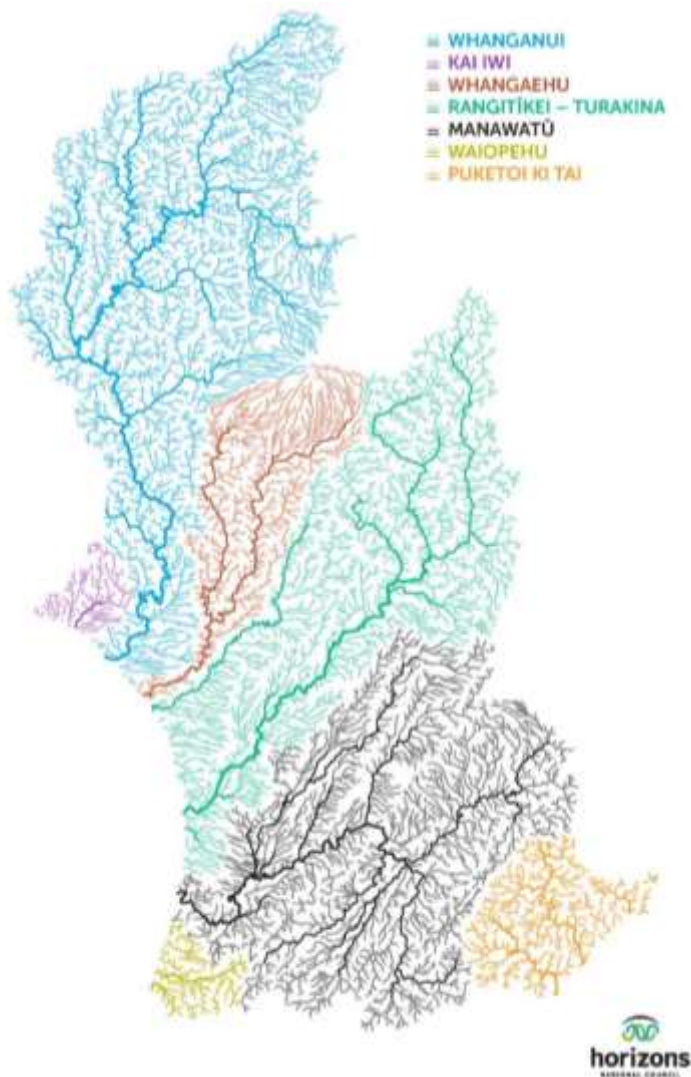


Figure 1: Freshwater Management Units in the Horizons region

The June 2021 Environment Committee report presents information for the period January 2021 to April 2021 in the context of delivery of the programme for the financial year 1 July 2020 to 30 June 2021, including an annual summary of the 2020-21 science monitoring and research activity completed. Due to the timing of this report, many reports had not yet been finalised but all will be made available once finalised.

2 REGIONAL WATER QUALITY AND QUANTITY PROGRAMME

2.1 Regional Freshwater & Partnerships Overview

PROGRESS AGAINST ANNUAL PLAN TARGETS

- 2.1.1 The Freshwater & Partnerships programme links with a range of national and regional policies and strategies. The programme aims to deliver freshwater enhancement work in partnership with others to improve water quality and aquatic health outcomes, and to facilitate community involvement. Some of the work also informs restoration options and seeks to build capacity. The programme delivers work across six key components, each of which includes funding from Central Government. They are:
- Regional freshwater programme, outside the Manawatū and Whangaehu Catchments (includes the Jobs for Nature stream-fencing and riparian-planting programme);
 - Manawatū Accord and Freshwater Improvement Fund project;
 - Whangaehu Catchment Freshwater Improvement Fund project;
 - Enhancing fish populations through fish barrier remediation Jobs for Nature project;
 - Waipu Catchment Freshwater Improvement Fund project to remove the Rātana **waste water treatment plant (WWTP)** discharge from Lake Waipu and irrigate to land, while also developing a restoration plan for Lake Waipu; and
 - Lake Horowhenua Accord and Lake Horowhenua Jobs for Nature project.
- 2.1.2 A summary of progress against Annual Plan targets is presented in this section of the report, and project updates on specific works are presented in the relevant FMU summary.

Table 1: Freshwater & Partnerships programme progress against the 2020-21 Annual Plan targets as at 30 April 2021.

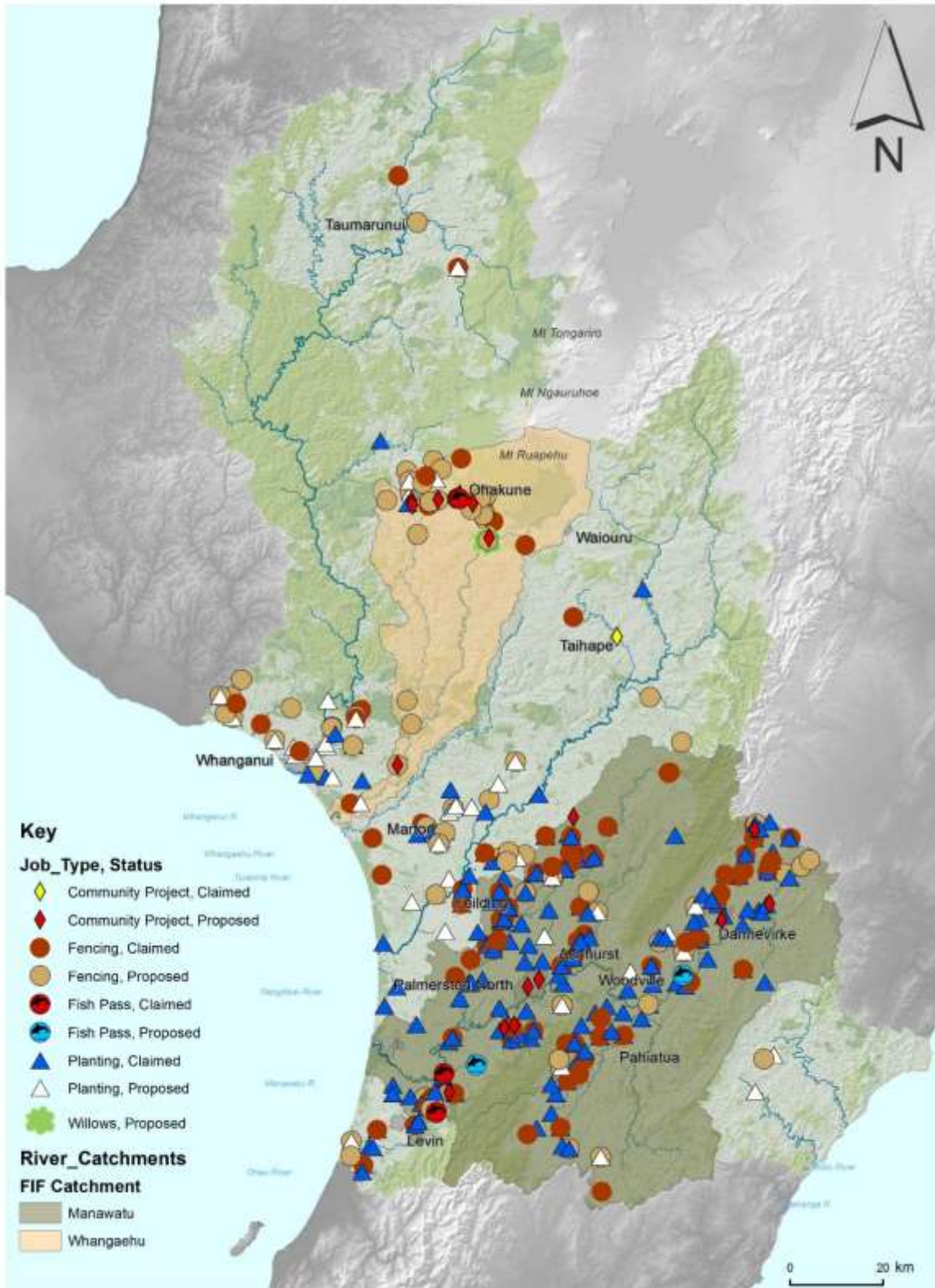
Riparian fencing (km)					Riparian planting			
	Target	Allocated	Complete	% complete	Target	Allocated	Complete	% complete
Regional	12	2.540	2.316	145% ¹	20,000	14,905	15,241	162%
Jobs for Nature²	35	43.687	15.094	43%	35,000	45,245	17,242	49%
Manawatū	50	95.2	64.2	128%	40,000	115,192	104,540	261%
Whangaehu	17	40.35	10.654	63%	3,333	7,237	2,364	71%
Total³	102	178.4	84.944	83%	78,333	182,579	139,387	178%
Fish passes					Community projects			
	Target	Allocated	Complete	% complete	Target	Allocated	Complete	% complete
Regional	1	0	0	0% ⁴	1	1	1	100%
Jobs for Nature	5	5	5	100%	n/a	n/a	n/a	n/a
Manawatū	4	9	3	75%	9	10	2	22%
Whangaehu	2	6	3	150%	3	8	2	67%
Total³	7	20	11	157%	13	21	5	38%

¹ % is based on works completed in both the Regional and Jobs for Nature programmes.

² Currently not an annual plan target however, both the Regional and Jobs for Nature projects count towards the Annual Plan targets for the Regional Freshwater Programme.

³ NB: The totals in these target tables represent an overall total and achieving these totals does not necessarily mean all targets have been met, as it is the individual targets that are in the Annual Plan.

⁴ Captured in the Jobs for Nature reporting for fish passage.



Freshwater Grant Projects to 30 April 2021

Map prepared by L. Ferguson, NRP, 10 May 2021

Figure 2: Freshwater implementation projects for stream fencing, riparian planting, community projects, and fish passes for the 2020-21 financial year (as at 30 April 2021).

JOBS FOR NATURE PROJECTS

- 2.1.3 In July 2020 Council resolved to enter into three Jobs for Nature “Quick-start” projects. These projects are funded through the broad Jobs for Nature Fund, and more specifically are referred to by MfE as Public Waterway Ecosystem Restoration Fund projects.
- 2.1.4 The Deeds of Funding for the Stream Fencing and Riparian Planting programme, and enhancing fish populations through fish barrier remediation, have been signed and the first meetings of the governance groups were during October 2020.
- 2.1.5 During the reporting period the following positions were added to the team as a result of the additional funding:
- A research assistant on a fixed 12-week contract joined the Fish Passage team in March 2021;
 - A recruitment process for a Freshwater Coordinator – Horowhenua FMU and Freshwater Advisor has been completed. The Freshwater Coordinator joins us on 3 May 2021 and the Freshwater Advisor on 5 July 2021; and
 - The recruitment process for two monitoring roles for the Horowhenua FMU water quality interventions project was about to commence.

ENHANCING FISH POPULATIONS THROUGH FISH BARRIER REMEDIATION

- 2.1.6 Quarter 3 of year 1 of this four-year project was recently completed and overall it is on schedule to achieve the deliverables prior to the end of the first project and financial year. Key focus areas for the team have been: stream walking to assess barriers to fish migration, monitoring of fish and kakahi populations, and remediation of identified barriers. Stream walking in the two focus catchments (Waikawa and Ōhau) is now complete (Figure 1), with a total of 350 km walked. Small sections of these catchments were unable to be walked due to dangerous terrain and/or an inability to find landowner contact details and/or the landowner denying Horizons staff entry. Stream walking has continued in the Pohangina Catchment and other small sections of the Manawatū Catchment (Figure 2).

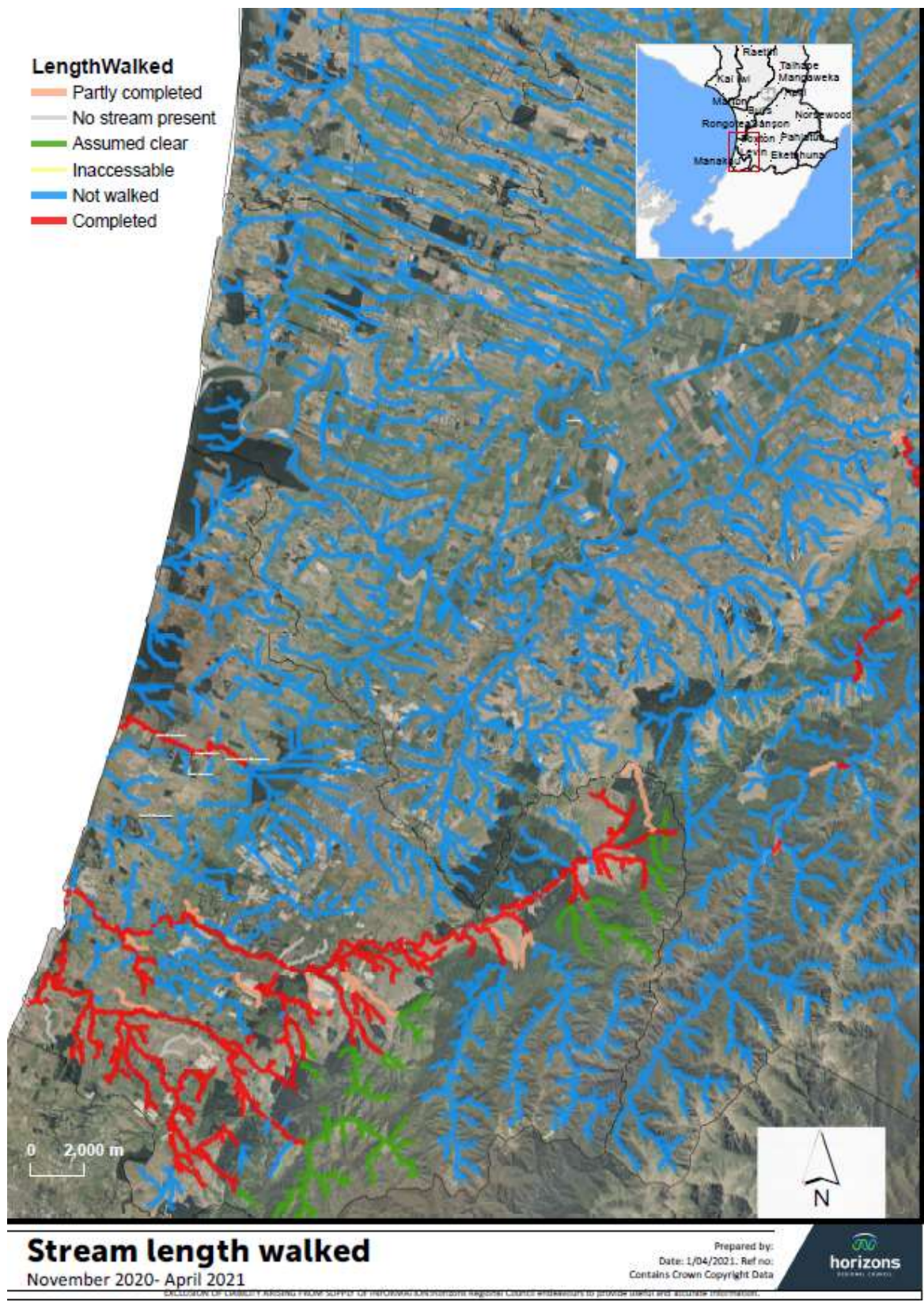


Figure 1: Stream length walked in Ōhau and Waikawa Catchments.

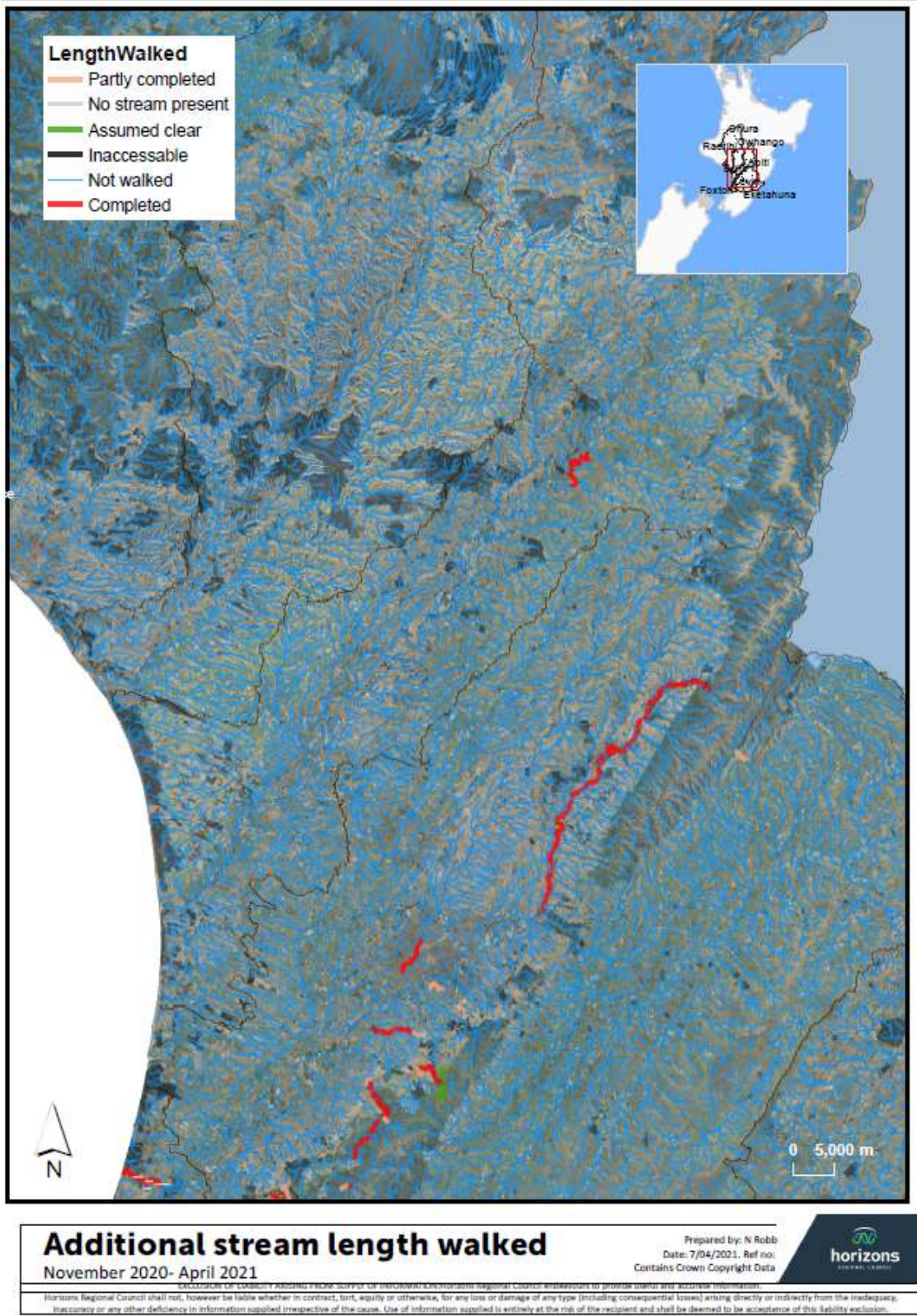


Figure 2: Stream length walked in the Manawatū Catchment

2.1.7 Fish and kākahi (freshwater mussel) monitoring has been progressing well with 24 fishing sites and 12 kakahi sites surveyed (Figure 3). A report on the current state of the region’s fish and kakahi populations by Massey University is set to be completed by the end of this financial year.

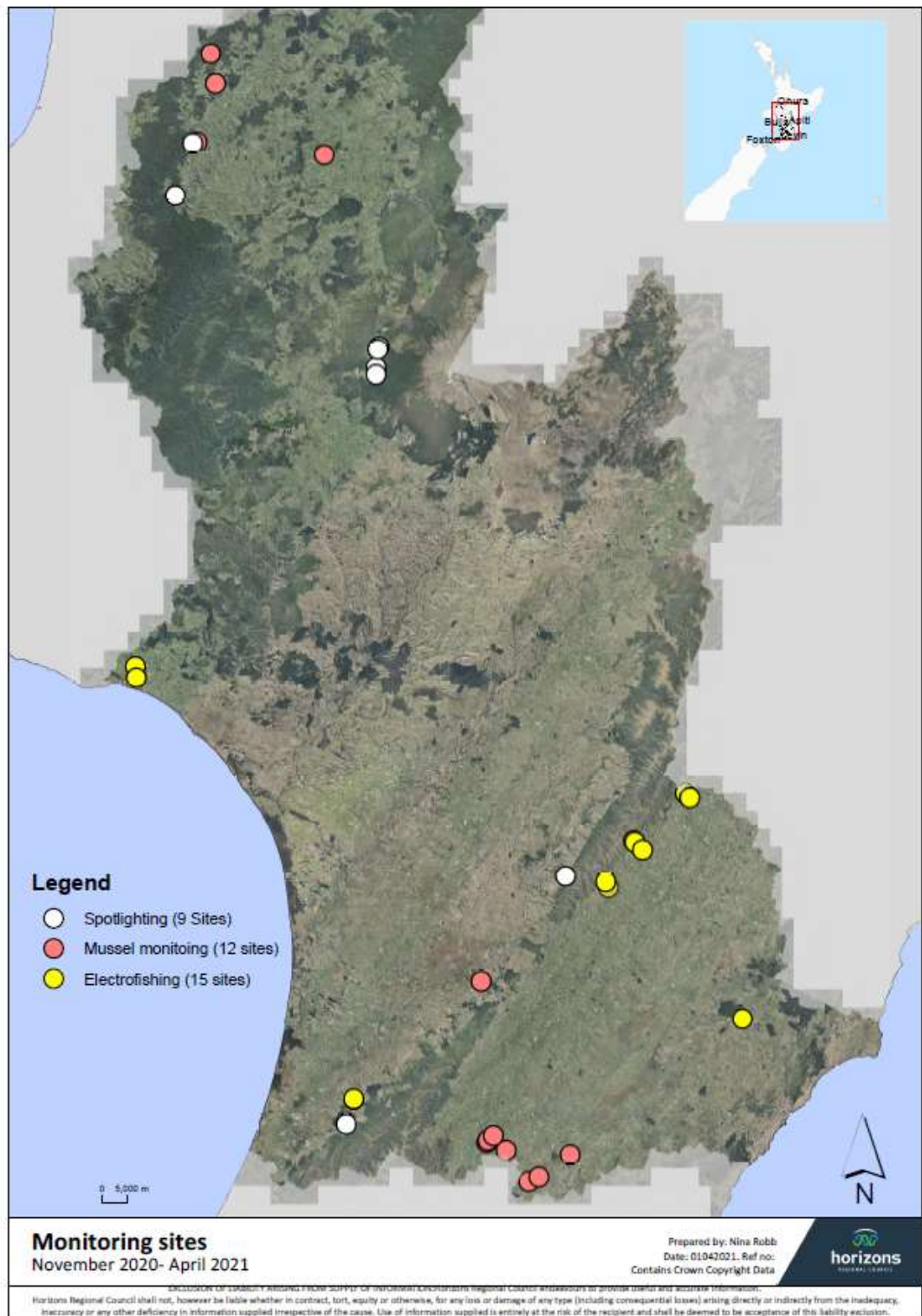


Figure 3: Monitoring sites completed through to the end of Q3. Note: Eleven electrofishing sites have been surveyed on the eastern side of the Manawātū (clumped yellow dots)



Figure 4: Top left: Koaro (*Galaxias brevipinnis*) found while spotlighting in an unnamed tributary of the Ōhau River. Top right: A 'blue' koura found while spotlighting in an unnamed tributary of Makomiko Stream near National Park, Ruapehu District..

2.1.8 The project has a target of five sites this year for barrier remediation and by the end of Q3 all five barriers were remediated, and 512 barrier assessments conducted (Figure 5). These fixes took place in an unnamed tributary of the Mangawhero River (Figure 6) and in the Purua (Figure 7) and Awaru (Figure 8) streams in Whanganui.

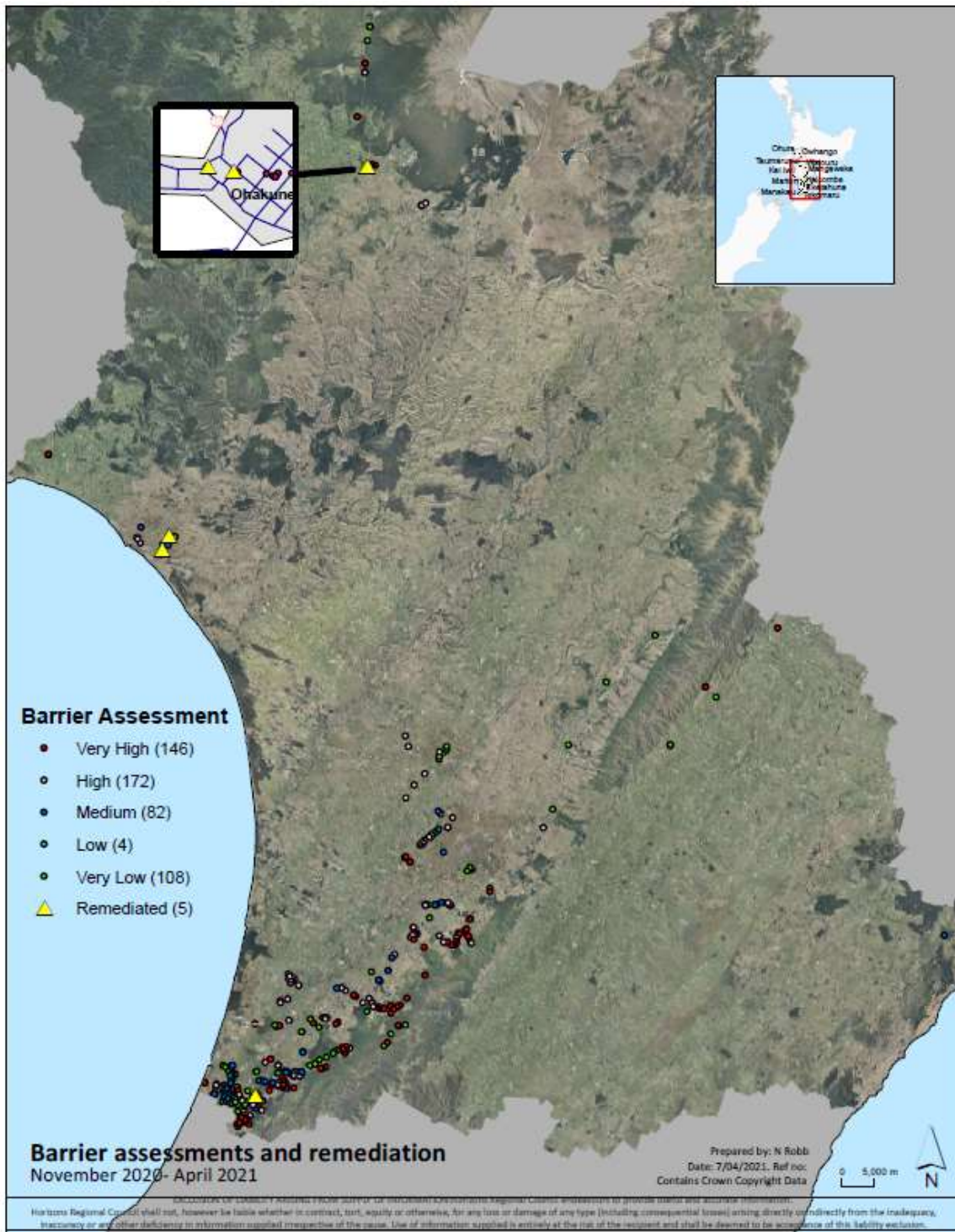


Figure 5: Map showing the five in-stream structures that have been assessed and remediated to date.



Figure 6: Culvert remediations in a tributary of the Mangawhero Stream, Ohakune. Flexi-baffles were installed throughout with mussel rope (top right) attached to the apron of one culvert to allow climbing species to pass.



Figure 7: Left: Large box culvert located in the Awarua Stream, Whanganui, prior to remediation. Right: Remediated culvert with lengths of flexi-baffles and a fish ramp installed.



Figure 8: Culvert remediation, Purua Stream, Whanganui. Flexi-baffles were installed throughout this 195 metre culvert running under SH4 into the Whanganui River.

2.2 Regional Water Quality & Quantity Science Programme Overview

MONITORING PROGRAMMES

2.2.1 Water quality and quantity monitoring is overseen by Horizons Science & Innovation team, but delivered in partnership with the Environmental Data, Consents Monitoring and Freshwater & Partnerships teams. Much of this activity focusses on improving knowledge and understanding of the region's freshwater and coastal environments by monitoring the state of the environment, tracking changes over time and identifying areas of emerging pressure. Water quantity, quality monitoring and biomonitoring programmes encompass:

- River flow at 65 sites, groundwater levels at 192 sites and measurement of water use at more than 350 sites across the region;
- River water quality at 90 SoE sites, 32 discharges and 52 sites located upstream and downstream of discharges;
- Water quality at four coastal and seven estuary sites, and ecological condition and/or sedimentation of five estuaries;
- Groundwater quality at 35 sites;
- Water quality in 17 lakes and submerged plants in approximately eight lakes annually;
- 81 popular swim spots throughout the swimming season from November to April;

- Macroinvertebrates at 95 sites and periphyton at 63 sites.

2.2.2 The monitoring network is undergoing a review in response to national policy requirements, and to better inform decision-making and implementation programmes.

ENVIROLINK RESEARCH

2.2.3 Horizons is one of a number of smaller regional councils that can access funding through the MBIE Envirolink Fund. Approximately \$120,000 of Horizons' applications are successful each year. A number of potential projects have been identified and five advice grants totalling \$110,830 were secured for 2020-21, as shown in Table 1. Further details and links to these reports, where available, can be found in the body of this report.

Table 2: Envirolink-funded projects for Horizons Regional Council in 2020-21.

Envirolink Project	Provider	Value	Deliverable
National Environmental Monitoring Standards (NEMS) macroinvertebrate review	NIWA	\$5,460	Technical advice
Riparian and freshwater plant identification	NIWA	\$10,000	Workshop
Paired laboratory nutrient analysis	NIWA	\$10,000	Technical report
Coastal Marine Area (CMA) mapping of the Horizons Region	NIWA	\$38,737.50	Technical report
Trend analysis and reporting guidance	NIWA	\$46,632.50	Technical report
TOTAL		\$110,830	

2.2.4

TREND ANALYSIS

2.2.5 This project around trend analysis is the largest grant for the year and is a good example of what the Envirolink fund seeks to do i.e., transfer knowledge from science providers to the applied work of regional councils.

2.2.6 Practical guidance for the analysis and reporting of temporal trends in environmental data has been prepared for Horizons on behalf of the regional sector, via an MBIE Envirolink advice grant. The primary purpose of this guidance is to facilitate more consistent and transparent assessment and reporting of trends in freshwater and other environmental data. The emphasis of the work is on freshwater physico-chemical and biological variables. However, the methods are applicable to other environmental variables and domains e.g., lakes, groundwaters, estuaries and coastal waters, for which a suitable time-series record exists.

2.2.7 Trend assessments serve multiple purposes including informing the public about changes in environmental state, assessing the effectiveness of management actions and policies, evaluating relationships between environmental conditions and the factors that influence them i.e., driver or explanatory variables, and providing early warning of environmental problems. Trend assessments are used in New Zealand for regional and national environmental reporting, reflecting regional council responsibilities under Section 35 (2) of the Resource Management Act. Recently, the requirement for trend analysis has been made explicit in the **National Policy Statement for Freshwater Management (NPS-FM)**.

- 2.2.8 These guidelines start by describing three types of application of trend analysis: local, regional and national. Local applications are concerned with maximising information about trends at a single site whereas regional and national applications are concerned about obtaining consistent assessments over many sites. The details of trend analysis and reporting process vary to some extent depending on the type of application.
- 2.2.9 The guidance describes trend analysis in four main steps:
1. acquiring and compiling data,
 2. accounting for confounding factors,
 3. assessing trend direction, rate and confidence in these determinations, and
 4. reporting the results.
- 2.2.10 Trend assessment is a process of building a statistical model of the behaviour of a variable at a site over a time period of interest. based on a series of observations. The guidelines describe methods for detecting and quantifying the two most fundamental aspects of the relationship between the variable and time: the direction i.e., increasing or decreasing and the rate of change e.g., change in concentration per year. In addition, because the observations are subject to random fluctuations and only comprise a sample of the variable's behaviour over the time period, the guidelines also describe methods for quantifying the uncertainties associated with the assessment of trend direction and rate.
- 2.2.11 This guidance is directly applicable for the requirement in Section 3.19(1) of the NPS-FM to characterise trends. However, NPS-FM Sections 3.19(2) and 3.19(3) concern the causes of trends i.e., trend attribution, which was out of scope for this guidance.
- 2.2.12 Reports

Snelder, T., Fraser, C., Larned, S., Whitehead, A. (2021). *Guidance for the analysis of temporal trends in environmental data*. NIWA Client Report 2021017WN, April 2021.

A copy of this report will be provided once available.

STATE OF THE REGIONAL WATER RESOURCE

- 2.2.13 The 2020-21 summer was dry for much of New Zealand, although most of Horizons region experienced near normal rainfall (Figure 9). However, Tararua District experienced low rainfall during the summer, along with Hawkes Bay and other eastern areas. The beginning of autumn saw above-normal rainfall in western Manawatū-Whanganui, leading to above-normal soil moisture conditions. The seasonal outlook for rainfall is about equally likely to be below normal or near normal.

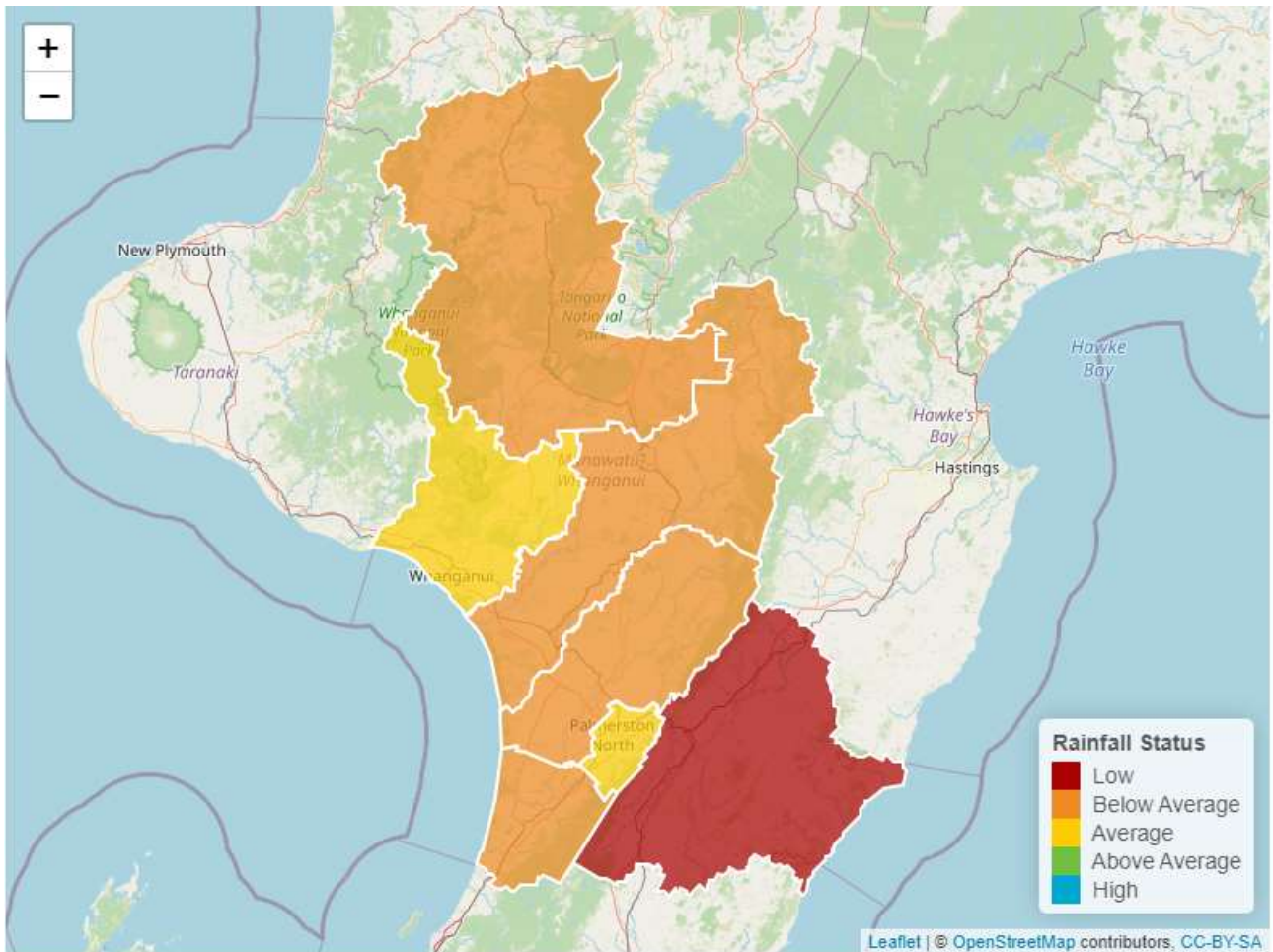


Figure 9 Hydrological status as determined by rainfall quantities during the preceding four months at 10 representative sites, May 2021.

2.2.14 Near normal rainfall during summer has helped support groundwater levels, particularly welcome at a time when water demand is highest (Figure 10). At the beginning of autumn, groundwater levels were showing signs of recharge and only 8% of the bores Horizons monitors were considered low with almost 75% above average or better.

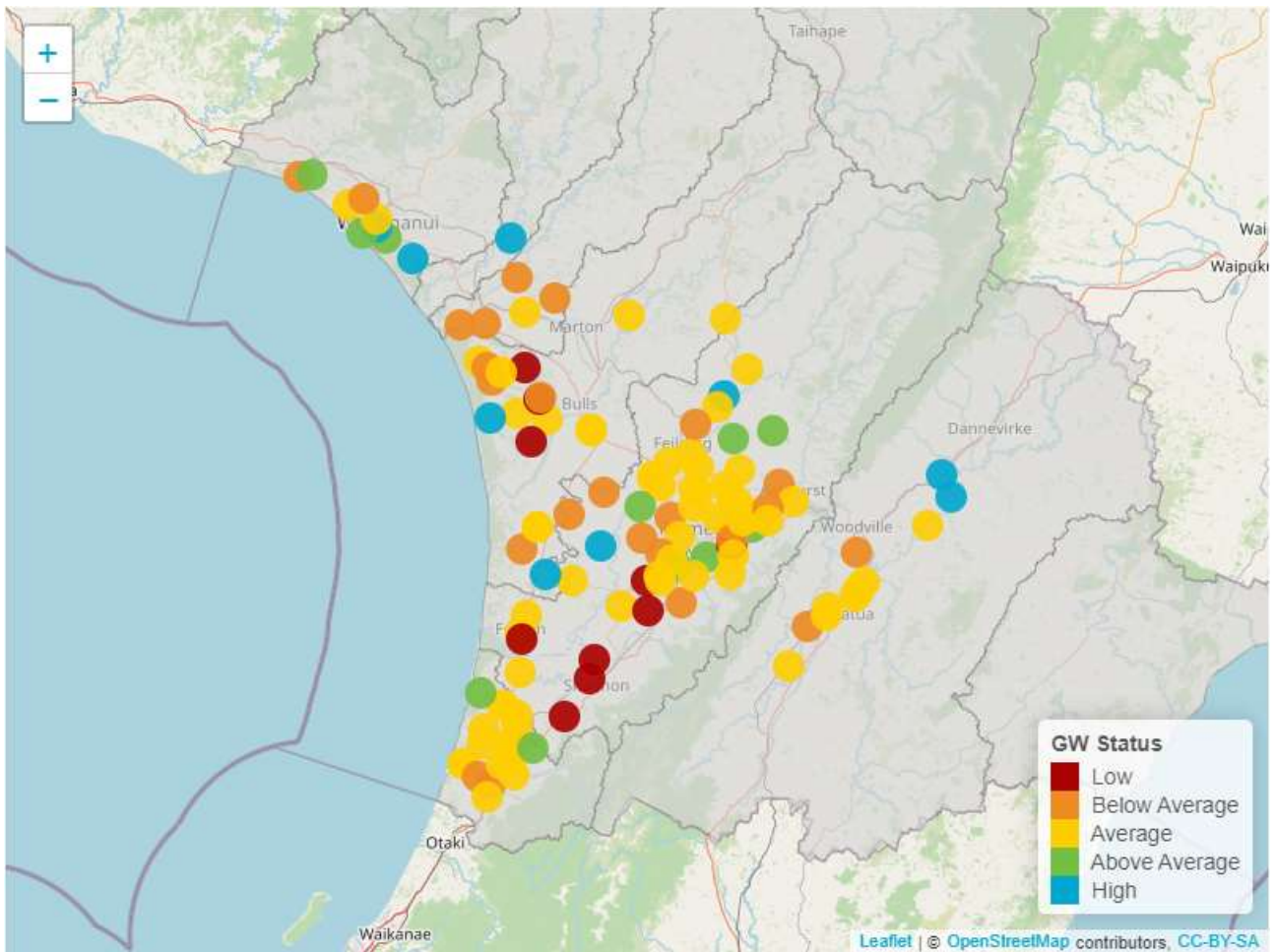


Figure 10: Groundwater level status as determined by monthly monitoring at 130 bores, May 2021.

2.2.15 Summer river flows reached, or have since reached, restriction limits in parts of the region. Lowest levels were reached in late March or early April. Figure 11 shows the river flow status as at 3 May 2021 compared to the same date in 2020.

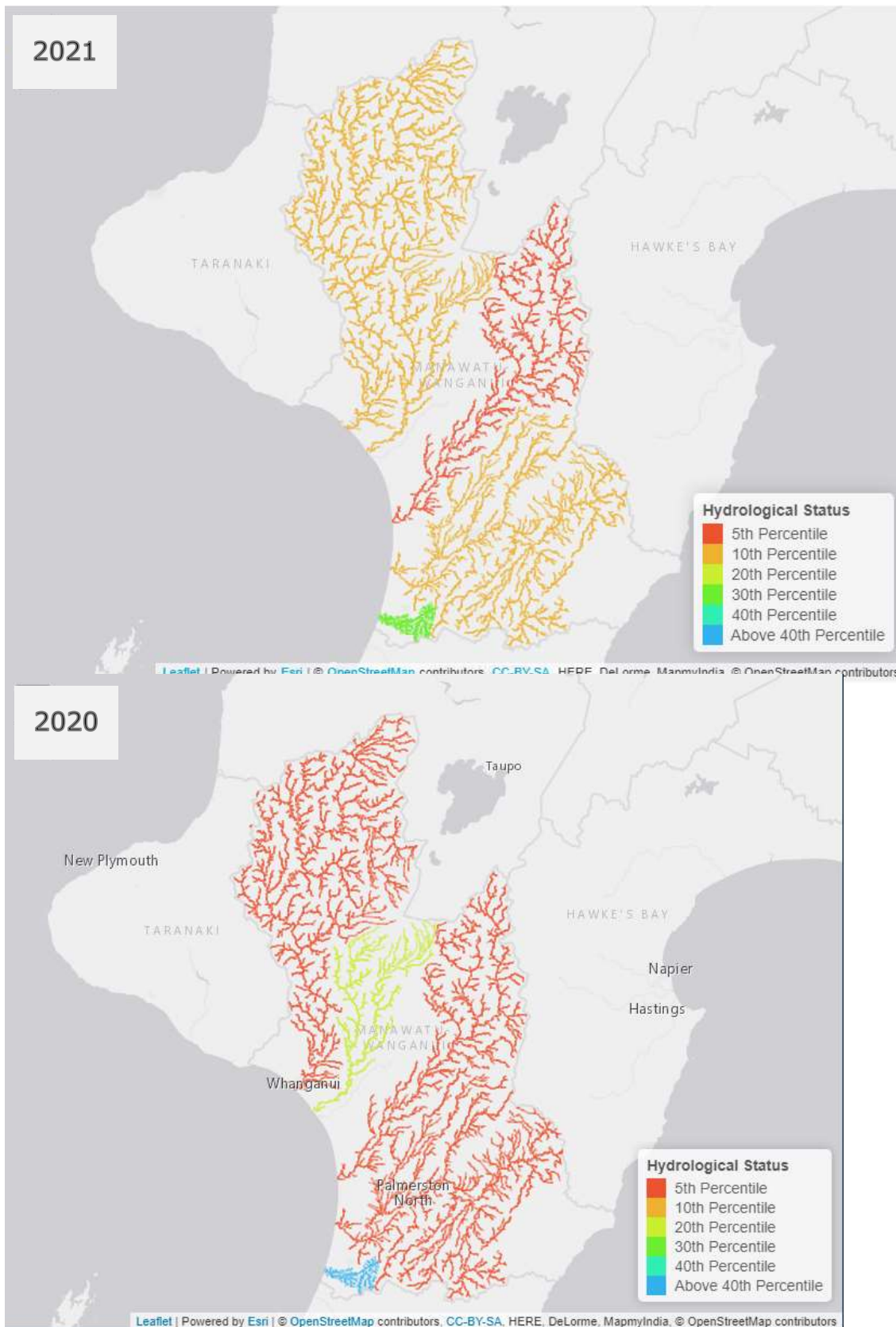


Figure 11: Hydrological status as determined by river flow over the preceding four months at 11 representative sites on 17 May 2021 (top image), compared to the same date in 2020 (bottom image). Flow bands are calculated on a daily scale based on every year in the dataset (1 January 2000 to 31 December 2018) e.g., the 5th percentile flow represents the lowest 5 percent of flows for every 17 May in the dataset.

2.2.16 Table 3 provides an end-of-season summary of the days of low-flow restrictions experienced at flow sites across the Region and the number of consent holders who were affected.

Table 3: End-of-season summary of flow restriction. Days in restriction calculated from 1 November 2020 to 1 May 2021.

Site Name	No. of Consents linked to site	Days in Restriction
Hautapu at Alabasters	2	47
Kai Iwi at Handley Road	1	26
Kumeti at Te Rehunga	1	73
Makakahi at Hamua	1	30
Makino at Boness Road	2	0
Makotuku at Raetihi	1	37
Manakau at SH 1 bridge	3	0
Manawatū at Hopelands	11	46
Manawatū at Teachers College	17	8
Manawatū at Upper Gorge	4	6
Manawatū at Weber Road	6	82
Mangahao at Ballance	1	3
Mangapapa at Troup Rd	1	38
Mangatainoka at Pahiatua Town Bridge	6	0
Mangatoro at Mangaheki Road	1	65
Mangawhero at Pakihi Rd Bridge	11	0
Ōhau at Rongomatane	6	0
Oroua at Almadale Slackline	8	14
Oruakeretaki at S.H.2 Napier	3	14
Pohangina at Mai's Reach	5	3
Rangitikei at Mangaweka	6	25
Rangitikei at McKelvies	14	0
Rangitikei at Onepuhi	11	0
Rangitikei at Pukeokahu	1	13
Raparapawai at Jackson Rd	1	13
Tamaki at Stephensons	4	53
Tamaki at Water Supply Weir	1	79
Tiraumea at Ngaturi	4	7
Tokiahuru at Junction	10	0
Tokomaru at Riverland Farm	4	0
Turakina at Otairi	1	15
Waikawa at North Manakau Road	1	0
Waitangi at Tangiwai	1	48
Whangaehu at Kauangaroa	3	19
Whanganui at Te Maire	4	26

2.2.17 Of the 157 surface-water consents across the region which have low flow restriction conditions, 57% (89) experienced some period of restriction over the low-flow season from 1 November 2020 to 30 April 2021. Thirty of these consent holders experienced 30 or more days in restriction, meaning they had to either cease or substantially decrease their abstraction volumes. The flow site with the largest number of days with flows below minimum flow was Manawatū at Weber Road, recording 82 day of restriction. There are six consents linked to this site.

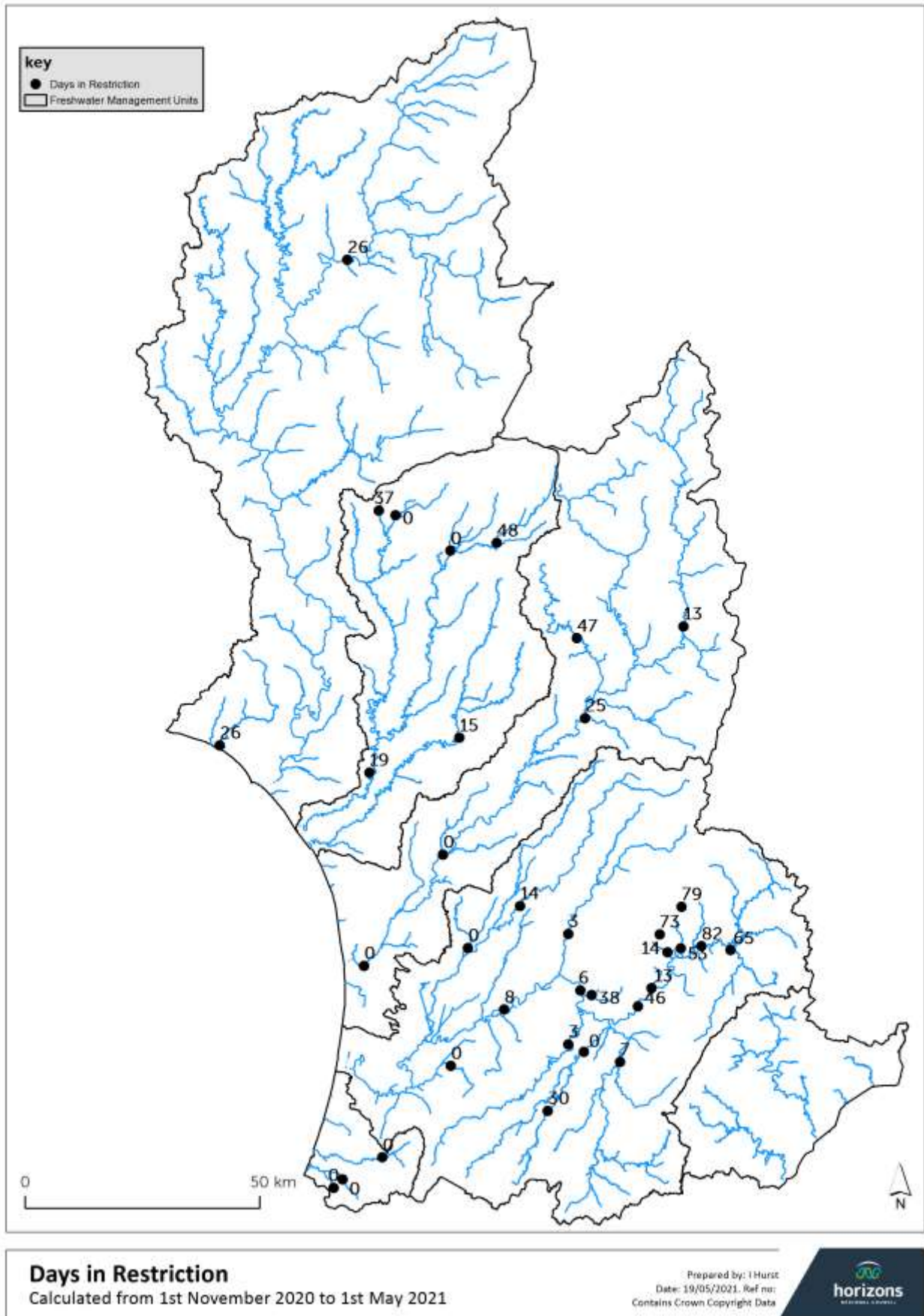


Figure 12: End-of-season summary of flow restriction displayed by location of sites (from Table 3) and the number of days in restriction.

2.2.18 The telemetered water-use programme continues with the programme of annual inspections progressing well. At the time of writing 321 completed, 44 more than last year's total and 45 more than last year at the same time. Work will continue over the winter with a further 280 assessments, many of which are industrial, to be completed. New sites are prioritised over those which power-off over winter. Seventy-nine sites have been upgraded to the new equipment and a further 15 sites require telemetry to be installed, six of which are challenging due to limited network availability and some involving portable pumps. However, the team will endeavour to have them installed before next summer.

2.2.19 Reports

Mercer, R., Mitchell, J., Brown, L., Peet, N., and Roygard, J. (2021). [National Environmental Standard for Stock Exclusion – Implications for Consenting of Water Abstractions](#). Report No 20-158 to the Horizons Regional Council Strategy and Policy Committee, 10 November 2020.

LAKES MONITORING

2.2.20 The ecological condition of eight lakes was assessed during December 2020 using the LakeSPI Submerged Plant Indicators survey method. Rotokawau (known as Virginia Lake in Whanganui) and Hokowhitu (Centennial Lagoon in Palmerston North, were surveyed for the first time while the remaining six lakes (Alice, Dudding, Namunamu, Pauri, Pukepuke Lagoon, and Wiritoa) were last surveyed in 2015-16.

2.2.21 Of the two new lakes, Hokowhitu Lagoon was categorised in excellent condition and Lake Rotokawau in moderate condition. The Hokowhitu Lagoon, while shallow at approximately 2.4 metres, maintained a native plant community extending across the bottom and no impact from invasive weed species. Lake Rotokawau retained elements of native vegetation while also being impacted by the invasive weed *Egeria densa* and an extensive algae bloom was also present at the time of the December survey.

2.2.22 All six lakes re-surveyed in 2020 remained in a stable condition. However, New Zealand's worst submerged weed species, Hornwort (*Ceratophyllum demersum*), was recorded for the first time at LakeSPI sites in Lake Namunamu, near Hunterville, as it continues to spread around the lake.



Photo 1: Photo montage of LakeSPI field sampling (December 2020) in Horizons Region.

2.2.23 LakeSPI has been used to assess the condition of 47 lakes in the Manawatū-Whanganui Region with LakeSPI indices for lakes ranging from 0% (heavily impacted) to 97% (pristine, unimpacted). Eleven lakes were categorised in excellent condition, five in high condition, 18 in moderate condition, eight in poor condition and five as being non-vegetated (Figure 13). The final report will be completed by 31 May 2021. This monitoring will inform assessment of lake state against new water quality attributes required under the 2020 NPS-FM.

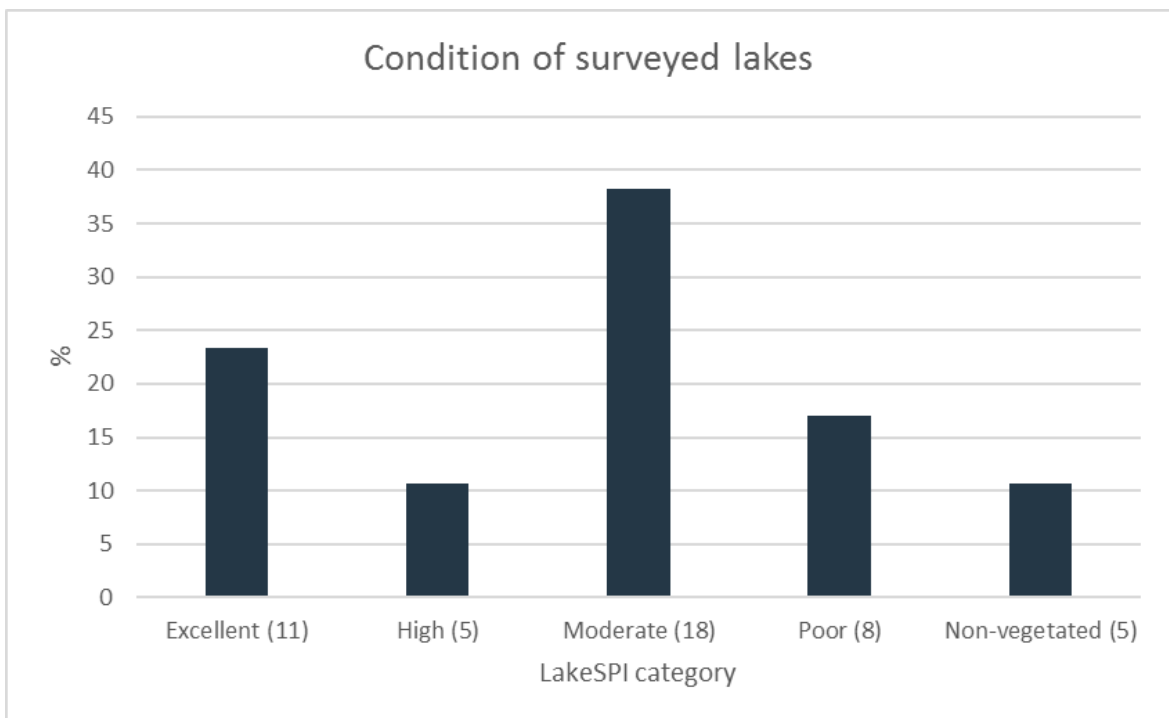


Figure 13: The percentage of surveyed lakes (n=47) that fall into each of the five LakeSPI categories. Numbers in brackets show the number of lakes in each category.

2.2.24 Microplastics are among contaminants of emerging concern for aquatic systems. The **Global Lake Ecological Observatory Network (GLEON)** has begun a study named **Global Lake Microplastics (GALACTIC)**, and Horizons participated by sampling Lake Wiritoa and Lake Pauri, both near Whanganui, in November 2020. The objective is to sample lakes worldwide to identify the occurrence of microplastics in surface water of different freshwater systems based on watershed and lake features e.g., land-use, population and catchment area. Samples were sent to the University of Milano-Bicocca in Italy for processing free of charge. There are now 57 lakes included in the project with 18 analysed so far with techniques ranging from visual identification to Raman Spectroscopy, and analysis was planned to conclude within months. This will lead to a collective research paper drafted by the end of the year, helping to advance global research around microplastics in freshwater systems.

2.2.25 Reports

Burton, T. (2021). *Assessment of 47 lakes in the Manawatū-Whanganui Region using LakeSPI*. NIWA Client Report prepared for Horizons Regional Council. This report will be provided once finalised.

ESTUARY ECOLOGICAL CONDITION MONITORING

- 2.2.26 Ecological condition and/or sedimentation monitoring of five estuaries across four FMUs was conducted by Salt Ecology in December 2020.
- 2.2.27 Fine-scale intertidal monitoring of Whanganui Estuary (Whanganui Kai Iwi FMU) was the culmination of a baseline of three annual ecological surveys undertaken between January 2019 and December 2020. One of the questions raised in the January 2020 survey report was whether the significant sedimentation measured at Site A in January 2020 was a reflection of a change in the catchment e.g., land disturbance, a climatic event that delivered a large pulse of sediment, and/or simply reflected a highly dynamic sedimentary environment. The present survey, which revealed a variable macrofauna community at Site A, coupled with the loss of sediment plates and pegs, suggest that the estuary environment is relatively dynamic and experiences naturally-driven temporal variability consistent with its river-dominated nature.
- 2.2.28 Annual sediment monitoring in the Whangaehu Estuary (Whangaehu FMU) has been undertaken since January 2018 to assess trends in the deposition rate, mud content and oxygenation of intertidal sediments. There are not enough data to calculate the five-year mean sedimentation rate, however the annual changes show the Whangaehu Estuary is highly dynamic and remains under pressure from fine sediments in catchment run-off.
- 2.2.29 Annual sediment monitoring in the Manawatū Estuary (Manawatū FMU) has been undertaken since January 2017 to assess trends in the deposition rate, mud content and oxygenation of intertidal sediments. There are not yet enough data to calculate a five-year mean sedimentation rate but this is due in 2022. The results to date indicate that despite observed erosion, the estuary remains under pressure from sediment impacts, with a macrofaunal community likely dominated by mud-tolerant species – a common situation in New Zealand tidal river estuaries.
- 2.2.30 Synoptic surveys of Ōhau Estuary and Waikawa Estuary (Waiopahu FMU) were conducted in December 2020 to quantify the ecological condition of the subtidal reaches. The survey targeted locations that showed symptoms of nutrient enrichment

i.e., algal blooms and depleted oxygen in stratified areas when previously surveyed in January 2020. The results from December 2020 show some improvement in sediment condition and water quality in both the Ōhau Estuary and Waikawa Estuary compared to January 2020, likely as a consequence of recent flushing following heavy rainfall in the week prior to the most recent sampling. The results show that the estuaries remain under pressure from nutrient and sediment loads and continue to express signs of eutrophication. As recommended in the report, Horizons is undertaking bathymetric surveys of the estuaries to enable accurate delineation of areas likely to stratify, and to inform the development of hydrodynamic models. These models will be used to estimate nutrient concentrations and predict ecological outcomes of future nutrient and sediment management in the catchment, and have been commissioned via the Jobs for Nature Project.

2.2.31 Reports produced

Whanganui and Kai Iwi FMU:

Forrest BM, Roberts KL, Stevens LM. 2021. [Fine Scale Intertidal Monitoring of Whanganui Estuary](#). Salt Ecology Report 065, prepared for Horizons Regional Council, March 2021. 31p.

Whangaehu FMU:

Roberts KL. 2021. [Whangaehu Estuary Sediment Monitoring Short Report](#). Salt Ecology Short Report 004, prepared for Horizons Regional Council, March 2021. 2p.

Manawatū FMU:

Roberts KL. 2021. [Manawatū Estuary Sediment Monitoring Short Report](#). Salt Ecology Short Report 003, prepared for Horizons Regional Council, March 2021. 2p.

Waiopēhu FMU:

Roberts KL, Stevens LM, Forrest BM. 2021. [Synoptic Subtidal Monitoring of Ōhau Estuary, Manawatū](#). Salt Ecology Report 064, prepared for Horizons Regional Council, April 2021. 37p.

Roberts KL, Stevens LM, Forrest BM 2021. [Synoptic Subtidal Monitoring of Waikawa Estuary, Manawatū](#). Salt Ecology Report 063, prepared for Horizons Regional Council, March 2021. 39p.

COASTAL MARINE AREA MAPPING

2.2.32 The CMA of Horizons region encompasses approximately 3,000 km² of territorial sea comprising distinct and separate western and eastern coastlines. Horizons manages the CMA in accordance with its combined Regional Policy Statement and the One Plan, a key objective being to ensure that the natural character and ecosystem processes are maintained while still allowing activities and development. Funded through an MBIE Envirolink Advice Grant, NIWA was commissioned by Horizons to report information on three CMA priority areas identified during a previous Envirolink project:

2.2.33 1. Seafloor biota information for the western and eastern CMAs to describe the likely distribution of biogenic habitat⁵-forming species and the distribution of corals and other vulnerable benthic⁶ species.

⁵ Biogenic habitats are habitats produced by living organisms.

⁶ The benthic zone is the ecological region at the lowest level of a body of water such as an ocean, lake, or stream, including the sediment surface and some sub-surface layers.

- 2.2.34 2. Threatened marine mammal and marine invertebrate distribution information for the western and eastern CMAs.
- 2.2.35 3. Predicted distribution of reef and demersal⁷ (living near the sea floor) fish species in the eastern CMA.
- 2.2.36 The habitat suitability and species occurrence modelling maps provide important information on the potential distribution of vulnerable marine invertebrates (corals), marine mammals, and reef and demersal fish, which allows the identification of important habitats and areas for protection and conservation. In comparison to much of the rest of New Zealand's coastal marine regions there are few data and datasets available on the habitats, fauna and flora of the Horizons CMAs. Considerably more information was available for the western than the eastern CMA, which appears to have a paucity of data on both marine habitat types and associated species diversity.
- 2.2.37 Horizons has a commitment within its Regional Policy Statement and Regional Plan (One Plan) to ensure that the natural character and ecosystem processes are maintained. This includes maintaining the life-supporting capacity and social and economic values of the region's coastal marine area (CMA). This project will inform: future policy development e.g., through identification of probable significant or vulnerable habitats/species that may require specific management; assessment of resource consent applications; and Horizons' SOE reporting for the CMA. It will also build on our existing baseline knowledge of the CMA for the further development of our coastal monitoring programme, which provides the most efficient use of limited resources.
- 2.2.38 Reports produced

Hale, R., Wadhwa, S., Anderson, T., Anderson, O., Hupman, K., Stephenson, F., Lundquist, C., Schnabel, K., and Neil, K. (2021). [*Seafloor habitats and fish, invertebrate and marine mammal diversity in the Horizons Region coastal marine area*](#). NIWA Client Report 2021069NE prepared for Horizons Regional Council, March 2021.

CONTACT RECREATION WATER QUALITY MONITORING

- 2.2.39 Monitoring of 81 popular swim spots around the region began on 1 November 2020. The programme is delivered in collaboration with MidCentral Public Health Service, local councils and Ngā Waihua o Paerangi Trust (formerly Ngāti Rangī Trust). Monitoring results are reported weekly, as they become available, via both Horizons (<http://www.horizons.govt.nz>) and the LAWA (<http://www.LAWA.org.nz>) websites. The 2020-21 contact recreation season ended on 27 April 2021.
- 2.2.40 The 2020-21 contact recreation data is in the process of being finalised, quality coded and analysed before end-of-season data analysis and result dissemination to key stakeholders. As this is the fifth year of the extended contact recreation programme, a five-year dataset will shortly be available and staff can do an analysis of sites across the region. It is anticipated that this will feed into a review of the wider programme. Results across the 2020-21 season were variable. In general, beaches sampled across the region were mostly swimmable with a few exceedances at times. Further re-samples on these occasions, in line with recreational guidelines, did not warrant any beach closures and returned results within the guideline values for

⁷ The demersal zone is the part of the sea or ocean (or deep lake) consisting of the part of the water column near to (and significantly affected by) the seabed and the benthos.

swimmability. River sites sometimes exceeded recreational guidelines for both *E. coli* and potentially toxic algae thresholds across the region. The Mangatainoka River, in particular, was graded unsuitable for swimming at times due to potentially toxic algae levels.

- 2.2.41 Whanganui lakes Wiritoa and Pauri were suitable for swimming for much of the season. Potentially toxic algae monitoring was added to Hokowhitu Lagoon this season, and aside from a brief exceedance over the New Year period the levels were either amber (caution advised) or green (suitable for contact recreation). Monitoring for *E. coli* at Hokowhitu Lagoon began in November 2017.
- 2.2.42 Lake Dudding was deemed unsuitable for swimming and had warning signs erected between 16 November 2020 and 21 January 2021 due to high bio-volumes of potentially toxic algae.
- 2.2.43 Faecal source tracking was planned last season and had to be delayed because of COVID-19. During the 2020-21 season, samples were taken at all lakes monitored for contact recreation, as well as a number of sites along the Wainui Stream (coastal Tararua). Samples were tested for *E.coli* concentrations and those that exceeded the amber alert level for contact recreation (greater than 260 MPN/100 mL), or close to this threshold, were further analysed for human, avian, ruminant markers and a general DNA marker. A summary of results for sites that were able to progress to faecal source tracking can be seen below in Table 3 (lakes) and Table 4 (Wainui Stream). NB: the threshold for the red alert level is 550 MPN/100 mL.

Table 4: Faecal-source tracking results for lake samples during the 2020-21 season

Site	E.coli (MPN/100 mL)	Conclusion
Stormwater drain at lake Pauri	140	Species-specific faecal source not identified
Lake Dudding	620	Faecal source – avian
Hokowhitu Lagoon at Outlet	1,900	Species-specific faecal source not identified

Table 5 Faecal source-tracking results for Wainui Stream during the 2020-21 season

Site	E.coli (MPN/100 mL)	Conclusion
Wainui u/s Wimbledon Stream	1,700	Faecal source – ruminant (50 - 100%)
Wainui d/s Wimbledon Stream	210	Faecal source – ruminant (50 - 100%) plus avian
Wainui u/s Waikopiro Stream	230	Faecal source – ruminant (10 - 50%)
Wainui d/s Waikopiro Stream	340	Faecal source – ruminant (10 - 50%)
Wainui u/s Mangaone Stream	130	Faecal source – ruminant (10 - 50%)
Wainui d/s Mangaone Stream	760	Faecal source – ruminant (50 - 100%)
Wainui u/s Herbertville Town	130	Faecal source – avian plus possibly low level ruminant

- 2.2.44 Further analysis and reporting of the results alongside results from the contact recreation season (including past seasons), land-use and current interventions is underway.

- 2.2.45 Further faecal source sampling on the Ōngarue River (Whanganui FMU) is underway and faecal-source tracking around the Arawhata Stream is planned as part of the wider work programme around Lake Horowhenua.
- 2.2.46 Other work underway includes a review of all of the contact recreation signage across the region and the 'Can I Swim Here?' campaign, ahead of the 2021-22 season. This will include additional information on the risk of drowning, following a coroner's report into a drowning in the region.

PLAN CHANGE 2 SUPPORT

- 2.2.47 Plan Change 2 was focussed on amending implementation issues with the nutrient management framework in the One Plan, including changes to Overseer and the inability to apply for consent if leaching was in excess of One Plan Table 14.2.
- 2.2.48 A team of science staff and external consultants provided support as technical experts to the Plan Change 2 process. Much of the work in the lead up to the plan change was carried out in the 2019-20 financial year. Preparation of evidence, caucusing and appearance before the hearing panel during the 2020-21 financial year.
- 2.2.49 Scientific evidence covered: the impact on water quality from proposed changes to the table; modelling for outcomes as a result of the new rule framework being implemented; soil science and Overseer changes; on-farm management practices; good management practice; and economics.
- 2.2.50 Reports produced

Technical reports related to this process can be found on the Horizons website:
<http://www.horizons.govt.nz/publications-feedback/publications/plan-change-2-documents>

ESSENTIAL FRESHWATER IMPLEMENTATION

- 2.2.51 On 28 May 2020 the Government released the essential freshwater package, which included an amended **National Policy Statement for Freshwater Management (NPS-FM) 2020** and a **National Environmental Standard for Freshwater (NES-FW)**. Oranga Wai - Our Freshwater Future is the way Horizons has chosen to represent the Essential Freshwater package and to allow for cohesion across the freshwater work we undertake.
- 2.2.52 Science staff have been undertaking a gap analysis of requirements of regional councils under both the NES-FW and NPS-FM and are subsequently developing a detailed science work programme for the next four years to support the Oranga Wai process.
- 2.2.53 Part of this development included commissioning LWP to lead a think piece around the role of science in the process and how it can best support the policy team to deliver Oranga Wai. This report was finalised in May 2021 and is available to council.
- 2.2.54 Reports produced

Snelder, T., Harris, S., Norton, N., Robson-Williams, M., Roygard, J., and Matthews, A. (2021). [Horizons Regional Council science plan](#). LWP (landwaterpeople) Client Report 2019-10 prepared for Horizons Regional Council, May 2021.

STATE AND TRENDS OF WATER QUALITY

- 2.2.55 As part of the Oranga Wai process, stocktake documents for each of the identified Freshwater Management Units are being compiled by the policy team. Science staff have been involved in the compilation of scientific information about the catchments, which included updating the state and trends of water quality for the period ending December 2019.
- 2.2.56 LWP were commissioned to undertake this analysis as an update to the 2019 SoE report. The analysis calculated the state of water quality as compared to the NPS-FM 2020 National Objectives Framework and the trend in water quality and biological indicators for both a 10-year and 20-year period. The data from the SoE river physico-chemical and biological monitoring programmes were collated to December 2019 and provided to facilitate this update.
- 2.2.57 The outputs of the analysis were completed by LWP in February 2021 alongside a short technical report outlining the methods used and a brief summary of results. The results of this analysis are being incorporated into the catchment stocktake reports and for updating the catchment summary report cards that were produced following the 2019 SoE Report.
- 2.2.58 Reports produced

Fraser, C., and Snelder, T. (2021). [*Updated State and Trends of River Water Quality in the Manawatū-Whanganui*](#). LWP Client Report 2021-02 prepared for Horizons Regional Council, January 2021.

SUMMER BIOMONITORING PROGRAMMES

- 2.2.59 Summer water quality monitoring includes a range of projects on biological monitoring in the Horizons region, including macroinvertebrate, periphyton and fish monitoring. Much of this monitoring is flow dependant, so low flows and stable weather conditions throughout summer allowed significant progress to be made.
- 2.2.60 Freshwater aquatic macroinvertebrates provide a holistic view of water quality at a point as they are resident in a given water body for several months up to several years at a time. A metric named the **Macroinvertebrate Community Index (MCI)** and its variants measures the taxa composition i.e., which macroinvertebrates are found there, at a site and are used to indicate nutrient enrichment. This monitoring can only be undertaken during low-flow periods.
- 2.2.61 Long-term macroinvertebrate monitoring is critical in measuring our current state and progress against measures in the One Plan and NPS-FM (2020).
- 2.2.62 Sampling for macroinvertebrates was completed by end of March for 95 sites, with all samples sent to laboratories for processing. These results are expected due in the middle of the 2021-22 financial year. All results are displayed on the [LAWA](#) website and are incorporated with relevant state and trends assessments as they are undertaken.
- 2.2.63 Periphyton is the community of alga, cyanobacteria and fungi living on the beds of rivers and streams, and is important as a measure of nutrient enrichment. Both the One Plan and NPS-FM include periphyton measures that the regional council are required to meet.

- 2.2.64 Periphyton monitoring has continued on a monthly basis throughout the 2020-21 financial year at 63 sites. This data either was, or will continue to be, incorporated into state and trend reports for the region's waterways.
- 2.2.65 Freshwater fish monitoring is undertaken yearly at 12 SoE monitoring sites. Surveying, including both electric fishing, and netting and trapping was well progressed at time of writing, with nine of 12 sites planned for the year completed. Results are reported into the **New Zealand Freshwater Fish Database (NZFFDB)** administered by NIWA. They are used in our SoE reporting and will be used in part for assessing Horizons against the NPS-FM fish **Index of Biotic Integrity (IBI)** attribute.
- 2.2.66 Sampling undertaken on behalf of, or in conjunction with, consent holders Tararua District Council and Palmerston North City Council were completed successfully and results forwarded to the consent holders.
- 2.2.67 Surveys for didymo (*Didymosphenia geminata*) are undertaken in November, February and May each year at 14 sites across the region. May sampling had not been undertaken at the time of writing but all prior results were negative.

GROUNDWATER QUALITY MONITORING AND DRINKING WATER MANAGEMENT

- 2.2.68 Horizons monitors groundwater quality in 35 bores around the region on a quarterly basis. The aim of this programme is to monitor the general state and trends of the groundwater resource and is similar to the river water quality monitoring programme. A range of parameters are collected including nutrients, metals, anions and field parameters. Nitrate is most associated with poor groundwater quality.
- 2.2.69 Elevated nitrate is often the result of agricultural land use or wastewater disposal. It is soluble in water and easily transported with groundwater to waterways, where it contributes to the growth of nuisance algae. Nitrate can also cause health issues, particularly for infants, as it can inhibit the ability of red blood cells to release oxygen to tissues (known as methemoglobinemia). To manage potential human health consequences, the **New Zealand Drinking Water Standards (DWSNZ)** sets the **maximum acceptable value (MAV)** for nitrate-nitrogen at 11.3 mg/L to prevent effects on pregnant women and bottle-fed infants.
- 2.2.70 More recently, concern for human health has grown out of a potential link between nitrate and cancer. A Danish study found a link with bowel cancer when nitrate-nitrogen levels were as low as 0.87 mg/L. However, at this stage no **MAV** or limit has been established for cancer as it has been for methemoglobinemia.
- 2.2.71 At our last review of groundwater state and trends in the 2019 SoE report, nitrate concentrations were well below the drinking water standard across most of the region, but elevated in at some sites in Horowhenua and Tararua (Figure 14). Within the region, three of the monitoring bores show concentrations that are above the drinking water standard, including some deeper bores greater than 50 metres deep). Both short-term (five-year) and long-term (10-20 year) trends in nitrate concentrations are generally indeterminate or improving, with only one bore to the north-east of Levin showing a slight degrading trend over five year and a bore near Whanganui showing a small magnitude of degrading long-term trend.

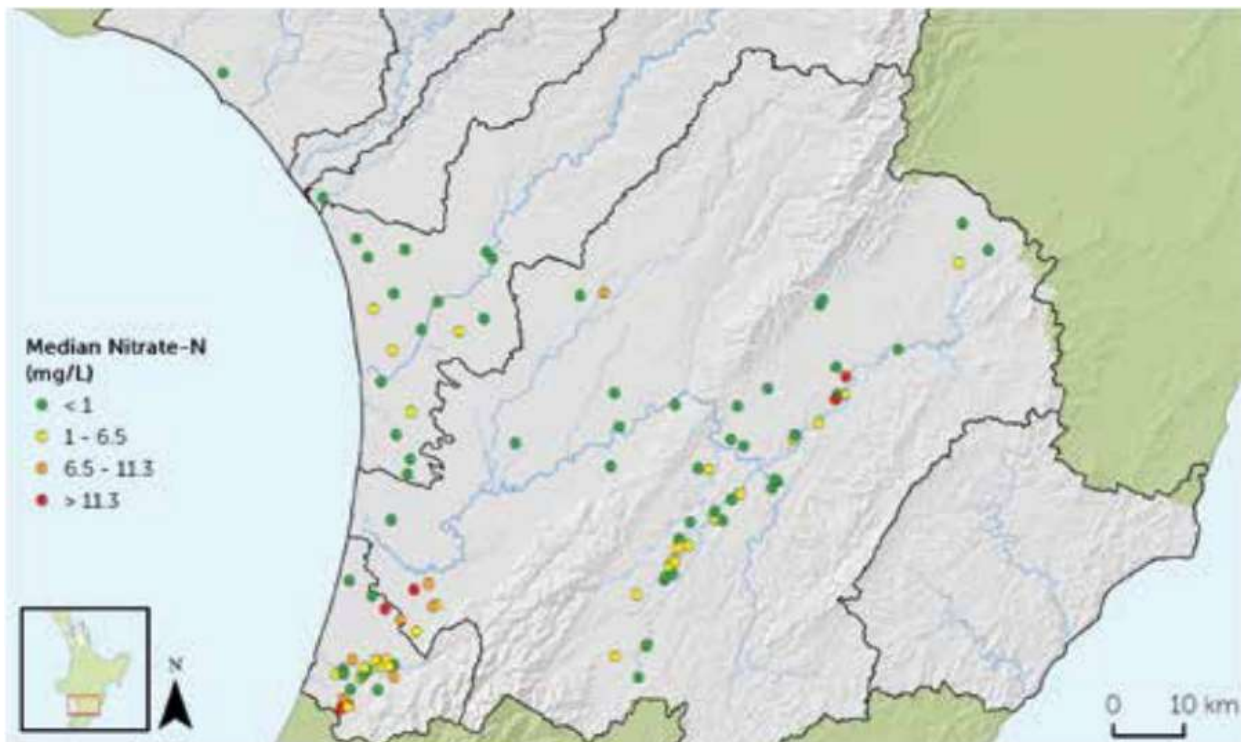


Figure 14: Median nitrate-nitrogen concentrations in bores across Horizons region

- 2.2.72 In addition to considering the effects on groundwater quality of land use and wastewater disposal, it can also be influenced by “reduction-oxidation” (redox) conditions that are distinct to groundwater. Subsurface redox conditions can broadly be described as either reduced where dissolved oxygen is low, or oxidised where dissolved oxygen is abundant. This concept is important because it can be a major driver of how contaminants such as nitrate persist in subsurface environments.
- 2.2.73 Reduced water is typically decades old or more and has less dissolved oxygen and generally lower nitrate concentrations but higher levels of minerals such as iron and manganese. This is because reduced-oxidation water has generally travelled further and had more time to interact with soil and rock particles, changing its chemistry over time. Elevated levels of naturally-occurring heavy metals can make groundwater unsuitable for drinking in some areas.
- 2.2.74 Oxidised water is typically younger, generally days or months through to a few years old. Groundwater in these gravel-rich aquifers tends to move more quickly and water is more oxygenated, with lower concentrations of dissolved metals. These zones are more susceptible to elevated levels of nitrate as they lack the natural conditions to attenuate nitrogen, i.e., denitrification – where nitrate is converted to benign molecular nitrogen in low oxygen environments. Oxygen-rich water generally is found near the surface in shallow aquifers such as in Tararua, but can also occur at depth in gravel and sand basins such as in Horowhenua.

Where drinking water is concerned, both surface water and groundwater are considered “raw water” when they have not received any treatment to make them suitable for drinking. The quality of the raw water must be good enough to produce safe and acceptable drinking water when treated. Once raw water is treated the **Drinking-water Standards for New Zealand (DWSNZ)** standards are applied. According to

New Zealand's *Water Safety Plan Guide*, in many cases it can be better to protect the quality of the raw water than to treat it after it has become contaminated.

- 2.2.75 The provision of drinking water is managed primarily by district or city councils (TAs) but regional councils have a role especially in the management of **source protection zones (SPZ)**. SPZs are used to help assess the level of risk to a drinking water source by identifying three areas, or zones, around a water abstraction point (bores). SPZ I is closest to the abstraction point and activities within it present a high risk; those farthest away, in SPZ III, present a low risk.
- 2.2.76 Horizons has been working with the TAs in our region to assess their drinking water supplies and develop SPZs for each abstraction point. For groundwater abstraction points the primary risk comes from unsecured bores in SPZ I and II that may present a risk to drinking water supplies by allowing pathogens into the aquifer from which raw water is drawn.
- 2.2.77 In addition to the work with TAs, the One Plan (Policy 5-6 (a)) requires that discharges and land-use activities, including diffuse run-off and other land-use activities, affecting surface and groundwater quality are managed to ensure the maintenance of existing groundwater quality and improvement where it is degraded as a result of human activity.

2.3 Regional Land and Fluvial programme

- 2.3.1 This is the annual report for the fluvial component of the land and fluvial monitoring and research activity.

FLUVIAL PROGRAMME

- 2.3.2 The fluvial survey programme has been completed for 2020-21 as part of a long-term survey plan that has been developed cross-organisationally and overseen by the engineering investigations and design team. This project funds cross-section surveys and reports to provide information on the changes in levels due to aggradation and degradation, or river channels and berms to inform river management and decision-making about gravel extraction.
- 2.3.3 The focus for the fluvial programme in 2020-21 was completion of the remaining four catchments in the South-eastern Ruahine area which were paused due to COVID-19 Level 4 and Level 3 restrictions, the Kawhatau Catchment and Rangitikei Catchment fluvial surveys.
- 2.3.4 The Kawhatau and Rangitikei catchment fluvial surveys were carried out using **Light Detection and Ranging (LiDAR)** with the wetted channel being bathymetrically surveyed. The Kawhatau is considered a key gravel resource for the Rangitikei River. **LiDAR** has enabled the survey to extend both upstream and downstream of previous surveys, which focused on gravel extraction beaches only to further our understanding of the fluvial processes occurring throughout the wider catchment. These surveys will inform gravel resource studies for both catchments, due to be completed in the 2021-22 financial year. The **LiDAR** 3-dimensional survey is also being used to help inform the Climate Resilience Rangitikei River Enhancement project below Bulls.

- 2.3.5 Historical aerial imagery orthorectified by removal of distortion across an image because of how the sensor has captured information from above the earth's surface, acquired in 2020-21 will be used to carry out geomorphic analysis to examine the connectivity and sensitivity of the Manawatū and Rangitikei catchments. The historical imagery is a valuable resource for other parts of the organization, including informing coastal erosion and accretion, identification of hazardous activities and industries, land-use change and assessing erosion control susceptibility, and review of river and drainage scheme management.
- 2.3.6 Work is underway with consent planning staff and regional engineers to review best practice guidelines for gravel extraction. Horizons has commissioned Professor Ian Fuller of Massey University to provide recommendations for technical assessments and best-practice guidelines for gravel extraction and monitoring requirements to ensure catchment integrity, habitat and ecosystem health are appropriately monitored. A copy of the report will be made available once finalised.
- 2.3.7 Reports produced

Fuller, I. *Gravel Extraction Habitat Advice*. Massey University, prepared for Horizons Regional Council. This report will be made available once finalised.

LAND PROGRAMME

Soil map coverage - Horowhenua

- 2.3.8 The land programme for the 2020-21 (and 2021-22) is focussed on obtaining S-Map coverage for the lowland area of the Horowhenua FMU. S-Map is the national online geospatial soil information system held and maintained by Manaaki Whenua. It is the only active and consistent soils database across the country. This data will be used to support the Our Freshwater Future – Oranga Wai process and provide more accurate soil information than currently available for catchment modelling. The land science budget is fully allocated to this project over the 2020-21 and 2021-22 years. This project has taken advantage of an opportunity provided by the Ministry for Primary Industries offering funding for two-thirds of the total cost of the project, provided to support the availability of better soil information in areas with highly productive land uses. The land area covers 23,300 ha of lowlands in the Horowhenua FMU. A progress report is due in June 2021, the final shapefiles will be available for internal use in June 2022 and the data will be available publicly online on the Manaaki Whenua S-Map [website](#) in August 2022.

Regional Land use map

- 2.3.9 Over the 2020-21 year, a land use map was updated for the region (funded internally by the Policy and Strategy team). Horizons commissioned Manaaki Whenua – Landcare Research to provide an updated land-use map as well as the provision of a tool to enable Horizons to update land-use information on a regular basis.
- 2.3.10 The land-use classification combines multiple classifications from a range of sources including AgriBase, Land Cover Database v5.0, Horizons Regulatory data, the **Sustainable Land Use Initiative** (SLUI) Whole Farm Plans, and Valuation and ratings data. **A Land Use Management Support System** (LUMASS, an open source spatial modelling tool) model for the automatic update of the land-use classification was developed, which allows us to update the land-use layer as updated input

datasets become available. This map will be used to help inform the Our Freshwater Future process and ongoing support for freshwater accounting.

Sediment Source and Transport

2.3.11 Horizons is a partner in the **Smarter Targeting of Erosion Control (STEC)**, programme led by Manaaki Whenua Landcare Research in partnership with iwi, NIWA, regional councils and stakeholders. Key progress during year three of this five-year programme included continuing the measurement and monitoring of shallow landslides and earthflows, and quantifying the influence of tree planting on slope stability. Advances were made in the development of a **Temporal Erosion and Sediment Transport (TEST)** model to examine the effects of soil erosion on water quality. TEST will characterise where and when soil erosion occurs, what type of sediment is produced and how that sediment moves through catchments.

2.4 Whanganui and Kai Iwi FMU

2.4.1 This financial year, as a part of the freshwater programme, excluding the land programme), 9.432 km of stream fencing and 3,050 riparian plants have been allocated, 5.315 km of stream fencing completed and 1,693 riparian plants planted within the Whanganui Catchment. Some 9.235 km of stream fencing and 3,480 riparian plants have been allocated, and 1.925 km of stream fencing completed along the Kai Iwi and Ototoke streams in the Kai Iwi Catchment.

2.5 Whangaehu FMU

WHANGAEHU FRESHWATER IMPROVEMENT FUND (FIF) PROJECT

- 2.5.1 This programme focuses on the delivery of the Ngā Wai Ora o Te Whangaehu **FIF** project, which focuses on the protection and enhancement of waterways within the Whangaehu Catchment. The main components of the programme are supporting stock exclusion from waterways, riparian enhancement and planting where desirable, aquatic habitat enhancement, supporting industry and community-led initiatives, and a joint project with Ngāti Rangi.
- 2.5.2 With the Whangaehu **FIF** project set to end in June, stream fencing and riparian planting allocations are now fully allocated. Any new landowners and enquiries in this catchment are being signed up under the Jobs for Nature (previously the Regional Freshwater Programme) to enable works to be completed.

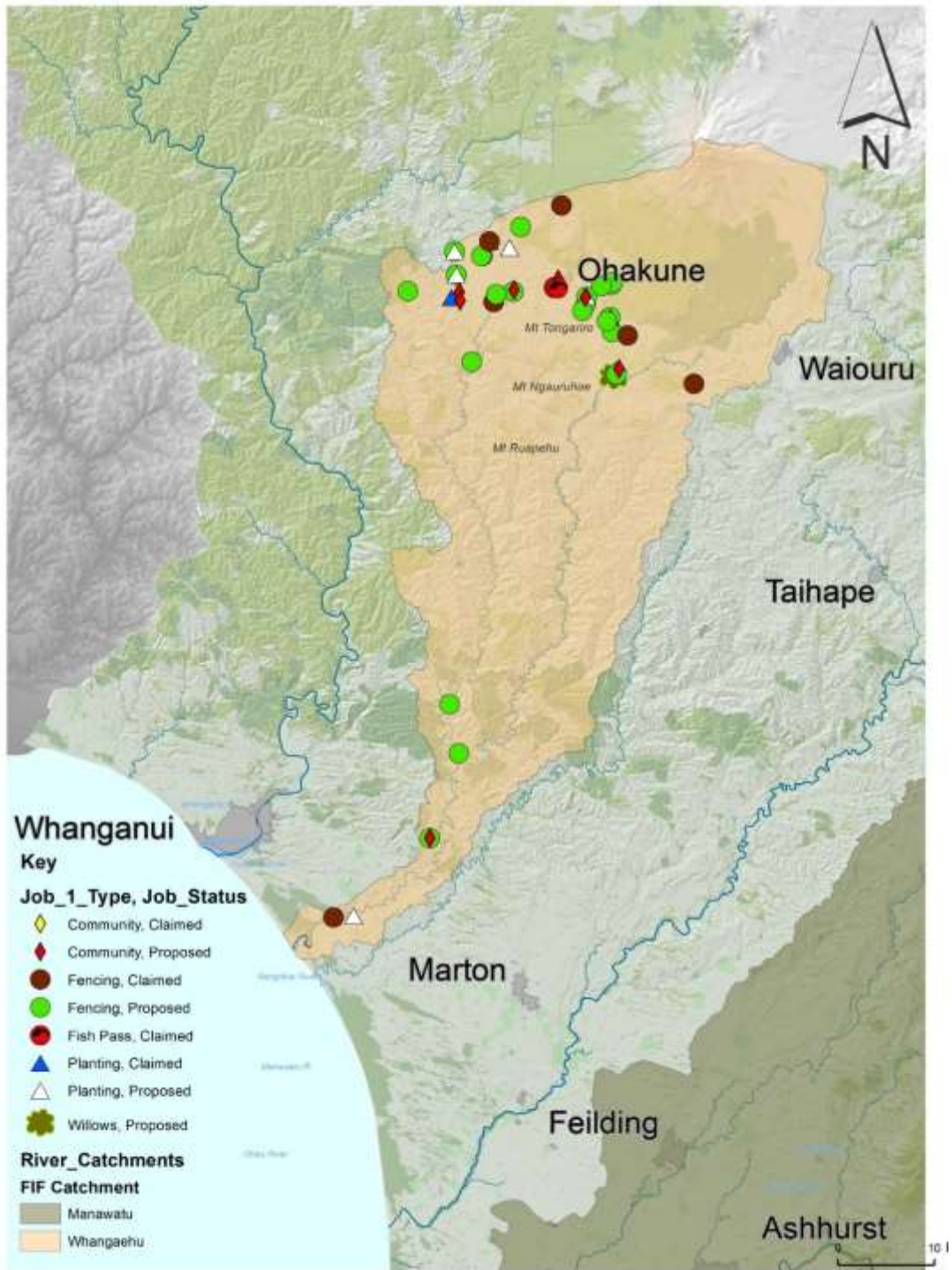


Figure 15: Stream fencing, riparian planting, and community projects that are proposed to be undertaken or have been completed in the Whangaehu Catchment.

2.6 Rangitīkei-Turakina FMU

PFAS MONITORING FOR OHAKEA

- 2.6.1 Horizons has been working with the **New Zealand Defence Force (NZDF)** on the ongoing monitoring of **per- and ploy-fluoroalkyl substances (PFAS)** and related compounds around Ohakea Air Force Base. PFAS are a large group of manufactured compounds that have industrial and consumer applications and have been in firefighting foam used at the base. A monitoring programme was specially designed by Pattle Delamore Partners Ltd this year to monitor the movement of the PFAS plume over time⁸.
- 2.6.2 The first round of sampling was undertaken in September 2020 with preliminary results showing PFAS concentrations either similar to, or slightly below, the ranges previously recorded for existing monitoring locations. These results are in general agreement with the predictions from the groundwater modelling. A copy of the report is now available on Horizons' website and has been shared with the Ohakea Water Contamination Committee and Manawatū District Council. The second round of sampling was undertaken in February 2021 and reporting will follow later this year.
- 2.6.3 Reports produced

PDP (2021) [*Ohakea: Surface Water and Groundwater Monitoring for PFAS, October 2020.*](#)
Pattle Delamore Partners Ltd Client Report prepared for Horizons Regional Council, February 2021.

STREAM FENCING AND PLANTING

- 2.6.4 This financial year the Freshwater and Partnerships Programme has allocated 21.380 km of stream fencing and 38,810 riparian plants within the Rangitīkei – Turakina FMU. To date, 8.491 km of stream fencing has been completed and 23,479 riparian plants planted. Please note this excludes the Land Management Programme works.

FLUVIAL RESEARCH

- 2.6.5 The Kawhatau and Rangitīkei catchment fluvial surveys are reported on in the Land and Fluvial monitoring and research annual report above.

LAKE WAIPU/RĀTANA FRESHWATER IMPROVEMENT FUND (FIF) PROJECT

- 2.6.6 As part of the **FIF** project, Horizons commissioned NIWA to complete a native and pest fish survey of Lake Waipu on 7 and 8 December 2020. This work aims to understand the availability of host species for kakahi (freshwater mussel) recruitment within the lake and the ongoing sustainability of the kakahi population. The native species shortfin and longfin eels, and common bully were found in the lake with the

⁸ PDP (2020) RNZAF Base Ohakea PFAS Investigation: Long Term Monitoring Plan

only introduced species encountered being goldfish. A final report is due before the end of the financial year.

- 2.6.7 Horizons staff have been working with Rangitikei District Council and MfE to update the project plan for the wastewater management component of this project, which is seeking to cease the discharge to water i.e., Lake Waipu and to fully apply the wastewater to land. This includes a meeting held with RDC, MfE, Horizons and landowners in December 2020. The work programme and annual work plan are to be updated to reflect the proposed changes while the end date of the project (June 2023) remains the same.
- 2.6.8 Horizons have continued to work with Rangitikei District Council and the Ministry for the Environment over the year on this project. In May, a further governance group meeting has been held with Councillor Turkington being appointed as Chair of the group.
- 2.6.9 The Ministry for Environment has written to Horizons in May 2021 to identify the delays in the land procurement by Rangitikei District Council for the project. The letter from the Ministry outlines that the project secured \$875,000 of funding in 2017 and that the project Deed was signed in May 2019 for a project commencement 1 July 2019 and expiring 31 December 2023. The letter notes that visit to view land in December 2020 and the subsequent ecological assessment report prepared by Horizons that identified wetland and sand dune systems that deem that site unsuitable. The letter notes that:
- “The Ministry considers this project to have a high delivery risk, given the issues described above and this being year 2 of the project with no major deliverables being provided. As such, the Ministry is requesting Horizons Regional Council to procure suitable land for the project by 30 August 2021. If land is not procured, or close to procurement, the Ministry would like to meet with Horizon's Regional Council and project representatives to discuss alternative options to invest the Ministry's funding to improve the water quality of Lake Waipu, and ensure the needs of Ratana community are met.”*
- 2.6.10 The Ministries request for land procurement is directed to Horizons Regional Council, however has to this point in the project been a responsibility of Rangitikei District Council. Horizons have over the course of the project had a range of meetings with the Chief Executive and project managers at Rangitikei District Council and will continue to work with Rangitikei District Council to advance this project.

2.7 Manawatū FMU

MANAWATŪ FRESHWATER IMPROVEMENT FUND (FIF) PROJECT

- 2.7.1 During this reporting period, work has focused around fish passage projects and preparing for the planting season ahead, including working with nurseries and confirming with landowners that sites are ready for planting.
- 2.7.2 Three fish barriers have been remediated in the Manawatū Catchment using a combination of solutions including baffles, rubber matting and mussel rope, and a small rock & concrete ramp. Figure 16 shows baffles installed through the length of the culvert and rubber matting in combination with mussel rope to overcome the perched-out flow.



Figure 16: This culvert in the Waoku Stream catchment, a sub-catchment to the Koputaroa, had a small perch. This was remedied by placement of rubber matting and mussel rope.

- 2.7.3 During the next two months until the end of the financial year, work will focus on completing claims for riparian fencing and completing community projects including community planting days. The new planting season will commence.
- 2.7.4 The third quarterly report for the year, covering the period December through April, was submitted to MfE and approved.
- 2.7.5 The freshwater team (excluding the fish passage team), attended a constructed wetland workshop and visited two sites in the Tararua District over two days. The workshop was led by experts from Tonkin + Taylor, and covered the main considerations when constructing a wetland, including site suitability, size, appropriate design for pollutants present, planting, and cost.

2.8 Waioupehu FMU

- 2.8.1 The Waioupehu FMU encompasses the Lake Horowhenua and Lake Waiwiri, Waitarere beach, and the Ōhau and Waikawa river catchments. Lake Horowhenua is a taonga for local iwi/hapū and has a degraded state below many national bottom lines for water quality. Toxic cyanobacteria causes the lake to be regularly closed for recreation. The state of the water quality is related to sediment and nutrients entering the lake and the legacy contaminants already present.
- 2.8.2 The Ōhau and Waikawa estuaries also show signs of nutrient enrichment, with **estuary trophic index (ETI)** scores within the moderate and poor categories. These catchments are at risk of further eutrophication as a result of land use. Further investigation is needed to establish the state of health of the Hōkio, Waiwiri and Wairarawa estuaries.
- 2.8.3 The Ōhau River itself is generally in good health, with a number of water quality and ecosystem health attributes achieving NOF Band A or Band B. The Waikawa Stream, and its tributary the Manakau Stream, show mixed results.

WORK TO DATE

- 2.8.4 Work to improve the state of freshwater in Waioupehu FMU has been underway since 2013, with Horizons working in partnership with the Lake Horowhenua Trust, Lake Horowhenua Domain Board, Horowhenua District Council, Horizons Regional Council, and the Department of Conservation as co-signatories to the Lake Horowhenua Accord. Past and ongoing initiatives, and funding, include:
- Installation of a fish pass over the Lake Horowhenua weir to enable fish migration between the sea and the lake (Freshwater Clean-up Fund).
 - Construction of a sediment trap at the bottom of the Arawhata Stream, predicted to reduce sediment phosphorus loads into the lake via streams by more than 25% (Freshwater Clean-up Fund).
 - Lake weed harvesting to reduce cyanobacteria blooms and the toxicity effects of the lake weed on fish in the spring (Freshwater Clean-up Fund).
 - Sediment and erosion control plans for vegetable growers covering 80 percent of the horticultural land in the Arawhata Sub-catchment of the Lake Horowhenua Catchment (Freshwater Clean-up Fund).
 - Riparian fencing of 16 km has been erected and 24,000 plants put in along stream banks by local communities and landowners with support from Horizons and the Freshwater Clean-Up Fund.

- The Future Proofing Vegetable Production project led by LandWISE, which focusses on working with growers in Horowhenua District to develop use of precise nutrient prescription and precise nutrient application, maximise retention of nutrients, and recapture nitrates that move beyond the root zone (Sustainable Farming Fund).

FUTURE FOCUS

2.8.5 The focus for the next few years in the Waiopēhu FMU will be to carry out weed harvesting on Lake Horowhenua, complete the Jobs for Nature Horowhenua FMU water quality interventions project and upgrade our water quality monitoring programme to inform water quality interventions through Jobs for Nature and complete freshwater accounting for the FMU to inform the implementation of the new NPS-FM. There are several current and future work streams that are working towards improved water quality for Lake Horowhenua. The following diagram illustrates how the proposed work programmes dovetail together (Figure 18).

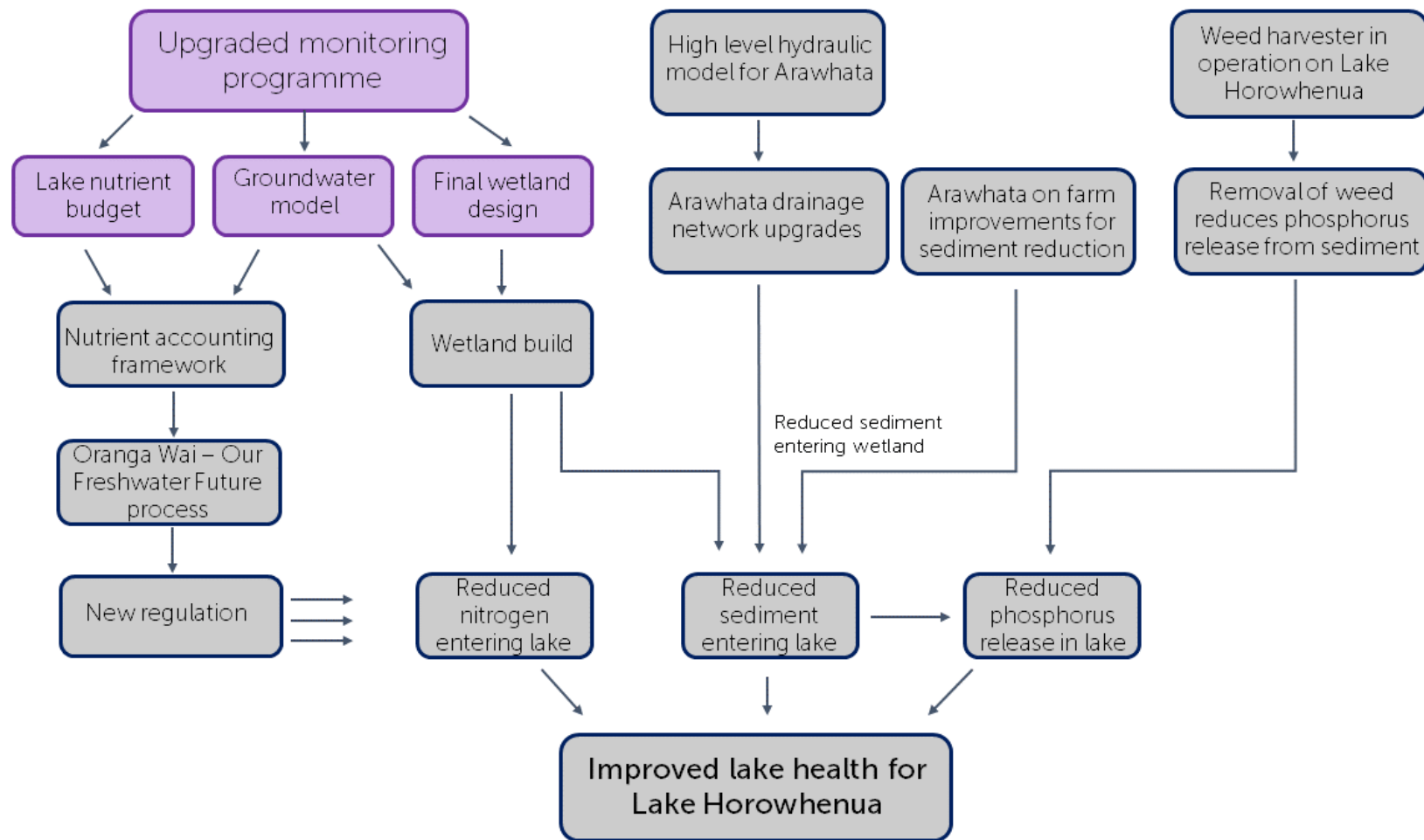


Figure 18. Diagram demonstrating how work streams in the Lake Horowhenua Catchment work towards improved water quality for the lake. Other regulatory activity is also underway for the stormwater consenting process.

WEED HARVESTER

- 2.8.6 Lake weed harvesting was recommended as a key restoration option for Lake Horowhenua and incorporated into the Lake Horowhenua Accord and the Lake Accord Action Plan. Lake weed alters the chemistry of the lake by increasing the pH of the water, lowering the nitrogen concentration and providing a favourable environment for phosphorus release and promoting cyanobacteria blooms. Harvesting weed interrupts this cycle and provides an environment more favourable to fish and other aquatic life, including native lake plants.
- 2.8.7 Construction of the Arawhata boat ramp that will enable launch of the weed harvester onto Lake Horowhenua began in November 2020 and was completed on 12 May 2021.



Figure 19: The Lake Horowhenua boat ramp prior to the removal of the sheet piling and sediment curtain. The current sediment trap and proposed wetland site can be seen in the background.



Figure 20 The Lake Horowhenua boat ramp prior to the removal of the sheet piling and sediment curtain.

FUTURE PROOFING VEGETABLE PRODUCTION

2.8.8 This section summarises the work with the horticulture sector through the Freshwater and Partnerships programme to improve water quality.

2.8.9 The Future Proofing Vegetable Production project is a three year project that commenced in 2018, led by LandWISE, and funded by the MPI Sustainable Farming Fund, Regional Councils (including Horizons) and industry partners. It is focused on developing and testing new production techniques for vegetable growers including precise nutrition prescription, precise application, maximizing retention of nutrients and recapturing nitrate that moves beyond the rootzone. The overall aim is to reduce nutrient leaching and improving efficiency while maintaining production. Through working with the growers in the Arawhata catchment (as well as other focus areas in New Zealand), over the course of the project, LandWISE have identified opportunities to support growers to make more informed nutrient decisions. The following summarise those developments over the past year:

- The use of LandWISE Nutrient Budget by the growers in the crop planning stage to ensure planned fertiliser practice follows industry good practice. An online app version is currently in development.
- Adoption of the Nitrate Quick Test soil test to be used to validate any additional fertiliser applications.
- More regular calibration of the growers' fertiliser equipment has shown that there can be large variability in application and this practice helps to identify issues early.
- Drain monitoring is showing little nitrogen content, indicating any nitrate losses are via groundwater. This makes to construction of nitrate recapture interventions on farm difficult but reinforces our conceptual understanding of nitrate loss pathways in the catchment.

2.8.10 This project is due for completion by June 30 2021.

FRESHWATER IMPROVEMENT FUND

2.8.11 The Freshwater Improvement Fund project for Lake Horowhenua has been put on hold by the Ministry for the Environment and is open for discussion between the Lake Horowhenua Trust and the Ministry for the Environment.

JOBS FOR NATURE

2.8.12 In 2020, a four-year \$12.5 million project was announced for a Horowhenua FMU water quality interventions programme with a focus on remediating nutrients and sediment in the Lake Horowhenua Catchment. This project is funded with \$11.2 million through the Jobs for Nature Covid-19 recovery programme administered through the **Ministry for Environment (MfE)** and co-funded by Horizons with \$1.3 million. One of the major projects is to establish a wetlands complex within the Arawhata Sub-catchment and develop other associated works programmes to inform further interventions within the Horowhenua FMU, with the aim of improving water quality and aquatic health in the catchment.

2.8.13 Key elements of the proposed work programme are:

- Establish a governance group by June 2021.

- Produce reports and modelling of the groundwater and nutrient/sediment pathways and sources within the FMU to refine the placement of interventions for water quality improvement, by June 2024.
- Implement at least one intervention that will result in water quality improvement in the FMU, including designing and building a wetland complex, also by 2024).
- Communicate information on the lake and FMU to iwi/hapū and the wider community.
- Employ one Freshwater Coordinator – Horowhenua FMU, and three monitoring/science staff (3.5 FTEs).

2.8.14 The four-year funding term for this project commenced on July 1 2020 and the Deed of Funding was signed with MfE in February 2021. The following have been carried out in Year 1:

- A workshop with technical experts held in August 2020 to refine information and data gaps.
- Development of an upgraded monitoring programme to support wetland design and wider catchment interventions is being finalised.
- A wetland feasibility study in the Arawhata sub-catchment, including conceptual designs was carried out by Jacobs engineering consultancy.
- The Sedimentation and Drainage Management Plan for the Arawhata sub-catchment has been completed by Tonkin + Taylor.
- The land to be used for the wetland complex has been secured.
- A technical workshop was held on 15 April 2021 with technical experts to discuss the science and research work stream of the project and scope a path forward for final design of the wetland treatment complex.
- The development of a groundwater conceptual model, contracted to environmental consultants Pattle Delamore Partners (PDP), will be available by July 2021.
- The first synoptic survey of the Arawhata and Pātiki streams was completed in February 2021. This involved intensive gauging and water quality sampling on each stream to help characterise flow, water source and nitrate concentrations. A further synoptic survey was planned for May 2021.
- The Horowhenua FMU Freshwater Coordinator and Freshwater Advisor roles have been filled. The two remaining monitoring staff roles are yet to be filled.

MONITORING AND SCIENCE

2.8.15 Lake Horowhenua and its tributaries have been monitored monthly for nutrients, sediment and *E. coli*, and flow since 2013. Water quality state and trends are available on [LAWA](#). Continuous flow and turbidity monitoring at the base of the Arawhata Sub-catchment has been in place since 2018 and continuous flow monitoring was installed on the Pātiki and Mangaroa streams in 2019. There are 17 groundwater level monitoring sites in the Horowhenua Catchment and monthly lake level measurements were recently established for Lake Waiwiri.

- 2.8.16 Between 2016-19, an intensive fortnightly monitoring programme was implemented in the Ōhau and Waikawa catchments to inform nutrient sources and surface water groundwater interactions. This data will be used to inform estuary limit setting, a project now in the scoping stage.
- 2.8.17 The monitoring programme to support the Jobs for Nature project is being refined with the following proposed in addition to the established SoE programme:
- A synoptic survey of the Arawhata, Mangaroa and Pātiki streams. Radon, tritium, nitrate and isotopes will be sampled to establish the groundwater/surface water interactions and determine nutrient sources. This will be carried out each season with the summer survey completed in late February 2021 and the autumn survey planned for May 2021.
 - An extended groundwater monitoring programme for groundwater level and water quality. Additional groundwater bores will be established, particularly in the Arawhata Sub-catchment, to determine groundwater flow and nutrient pathways.
 - Additional continuous flow, nitrate and turbidity surface water sites will be established further up the Arawhata Catchment than the current site at Hōkio Beach Road, to capture high rainfall events and identify nutrient and sediment transport in more specific locations.
 - Addition of nitrogen and oxygen isotope sampling to the current surface water SoE monitoring programme, to help identify sources of nitrate in the Lake Horowhenua tributaries.
 - Nested piezometers will be installed around the perimeter of the lake to establish the groundwater gradient and refine the lake water balance.
- 2.8.18 The conceptual groundwater model for the Horowhenua FMU has been contracted to PDP and the intensive monitoring will help inform a more detailed and refined groundwater model in later years of the project.

Reports produced

Emond, H., Austin, D., Baker, T. J (2021). [Arawhata wetland – conceptual design report.](#)
Jacobs client report prepared for Horizons Regional Council, April 2021

Ferguson, R (2021). [Integrated sediment, nutrient and drainage management plan for the Arawhata Catchment.](#) Tonkin + Taylor client report prepared for Horizons Regional Council.
March 2021.

Staci Boyte
FRESHWATER COORDINATOR (HOROWHENUA FMU)

Mark Mitchell
SCIENTIST – WATER QUALITY (LAKES AND COAST)

Amber Garnett
SCIENTIST – NATURAL RESOURCES

Stephen Collins
SCIENTIST – GROUNDWATER

Mike Patterson
SENIOR SCIENTIST – FRESHWATER

Maree Patterson
SENIOR SCIENTIST – WATER QUALITY

Lizzie Daly
SENIOR SCIENTIST – ECOLOGY

Logan Brown
FRESHWATER & PARTNERSHIPS MANAGER

Jon Roygard
GROUP MANAGER – NATURAL RESOURCES AND PARTNERSHIPS