DRAFT Freshwater Plan Change

Background Information Summary Report

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Northland REGIONAL COUNCIL
Te Kaunihera ā rohe o Te Taitokerau

Contents

Introduction

Purpose

This document provides a summary of some of the evidence and information that has been used to inform development of the Draft Freshwater Plan Change, particularly as this relates to:

- The draft changes to our Regional Policy Statement, incorporating Te Mana me te Mauri o Te Wai and our long-term vision; and
- Draft freshwater regional plan provisions; and
- the freshwater attributes that Council will monitor and manage as per Appendix 2A and 2B of the National Policy Statement for Freshwater Management 2020 (NPS-FM).

This document is a summary only. It should be read in conjunction with DRAFT Tāngata Whenua Provisions Workshop Report and the Vision, Values and Objectives Report. It provides advice and recommendations that Council received from the Tāngata Whenua Water Advisory Group endorsed by Te Taitokerau Māori and Council working party (TTMAC), also used to inform the draft Freshwater Plan Change.

Background

The National Policy Statement for Freshwater Management 2020 (NPS-FM) requires council to engage with tāngata whenua and communities to identify values for freshwater and develop a vision and environmental outcomes for freshwater[1]. It also requires (among other things) that:

- The concept of Te Mana o te Wai that is applied to all freshwater management and prioritises: first the health and well-being of water bodies and freshwater ecosystems, second the health needs of people, and third the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.
- Four compulsory values for freshwater are managed – ecosystem health, human contact, threatened species and mahinga kai.
- Freshwater is improved to meet national bottom lines (essentially standards for freshwater) where these are specified for freshwater attributes2 and to environmental outcomes for freshwater.

Outcomes are to be achieved through the management of attributes for freshwater set out in the NPS-FM or otherwise identified by council. The management of freshwater attributes is through a combination of limits / rules on resource use in the regional plan and the implementation of action plans.

The NPS-FM came into force on 3 September 2020. NRC has since been developing the information base to implement the NPS-FM. To give effect to this NPS-FM, NRC must change the Regional Plan for Northland to incorporate rules and policies that will enable us to achieve the outcomes for freshwater and meet the national bottom lines set in the NPS-FM.

The Draft Freshwater Plan has been developed over the course of two years, being prepared by specialists and scientists at Northland Regional Council with advice and feedback from tāngata whenua, government, industry, environmental groups, and communities.

Two groups in particular have guided the development of the draft Freshwater Plan Change:

[1] A summary of the process required by the NPS-FM is in Appendix 1.

[2] Attributes means a measurable characteristic (numeric, narrative, or both) that can be used to assess the extent to which a particular value is provided for

- **Tāngata Whenua Water Advisory Group (TWWAG)**
  Established in 2020, the group comprises tāngata whenua technical experts that whakapapa to Te Taitokerau with a wide range of freshwater kaitiaki expertise and experience. They have provided detailed advice and recommendations for developing the draft Freshwater Plan.
- **Primary Sector Liaison Group:**
  Made up of representatives from primary sector industry organisations, this group has provided a report outlining the issues and challenges facing the primary sector and some initial ideas about the plan.

The Draft Freshwater Plan is now out for public consultation – this consultation is an informal process that will provide feedback to inform the development t of the Proposed Freshwater Plan Change. The Resource Management Act 1991 (RMA) requires that NRC notify a Proposed Freshwater Plan Change to implement the NPS-FM by 31 December 2024.

NPS-FM Values and Attributes

The NPS-FM includes compulsory values (Appendix 1A of the NPS-FM) and associated 22 attributes that must be managed (Appendix 2A and 2B of the NPS-FM), as summarised in the table below.

Table 1. NPS-FM freshwater values and attributes (compulsory) as they apply to lakes and rivers.

Value	Attribute	Waterbody	Measure/metric
Ecosystem health	Phytoplankton	Lakes	mg cl-*a*/m^3 (milligrams chlorophyll-*a* per cubic metre)
	Periphyton	Rivers	mg cl-*a*/m^2 (milligrams chlorophyll-*a* per square metre)
	Total nitrogen	Lakes	mg/m^3 (milligrams per cubic metre)
	Total phosphorous	Lakes	mg/m^3 (milligrams per cubic metre)
	Ammonia (toxicity)	Rivers & Lakes	mg NH_4-N/L (milligrams ammoniacal-nitrogen per litre)
	Nitrate (toxicity)	Rivers	mg NO_3-N/L (milligrams nitrate-nitrogen) per litre
	Dissolved reactive phosphorus	Rivers	DRP mg/L (milligrams per litre)
	Dissolved Oxygen	Rivers	Mg/L (milligrams per litre)
	Suspended fine sediment	Rivers	m (meters of visual clarity)
	Deposited fine sediment	Rivers	% fine sediment cover
	Submerged plants (Native Condition Index)	Lakes	Index score and % of maximum potential score
	Submerged Plant (Invasive Impact Index)	Lakes	Index score and % of maximum potential score
	Macroinvertebrates	Rivers	Macroinvertebrate Community Index (MCI) score; Quantitative Macroinvertebrate Community Index (QMCI) score
			Macroinvertebrate Average Score Per Metric (ASPM)

Value	Attribute	Waterbody	Measure/metric
	Fish	Rivers	Fish Index of Biotic Integrity
	Lake-bottom dissolved oxygen	Lakes	mg/L (milligrams per litre)
	Lake-bottom dissolved oxygen Lakes	Seasonally stratifying lakes	mg/L (milligrams per litre)
	Ecosystem metabolism	Rivers	g O2 m-2 d-1 (grams of dissolved oxygen per square metre per day)
Human contact	*Escherichia coli* (E. coli)	Lakes and rivers	*E. coli*/100mL (number of *E. coli* per hundred millilitres)
	Escherichia coli (E. coli) during the bathing season	Primary contact sites in lakes and rivers	95th percentile of *E. coli*/100 mL (number of E. coli per hundred millilitres)
	Cyanobacteria - planktonic	Lakes and rivers	Biovolume mm^3/L (cubic millimetres per litre
Threatened species	To be determined	Lakes and rivers	To be determined
Mahinga kai	To be determined	Lakes and rivers	To be determined

NRC has also identified additional attributes that we think are needed to manage freshwater in Northland. These are:

Table 2. Additional freshwater attributes specific to Northland Regional Council as they apply to lakes and rivers.

Value	Attribute	Waterbody	Measure/metric
Ecosystem health	Water temperature	Rivers	Degree Celsius
	Heavy metals (Cu and Zn)	Rivers	Ug/L (micrograms per litre of sample)
	Plastic/Litter	Stormwater traps	Density per m^2
	Lake trophic level index (TLI) - a combined measure of nutrients, water clarity and algae.	Lakes	A score
	Rivers – Rapid Habitat Assessment	Rivers	A score
	Lakes Exotic fish Score	Lakes	A score

The draft plan change also includes attributes for tāngata whenua values for freshwater that have been included on the advice of TWWAG and TTMAC. The attributes are not covered in this report, but a summary is provided here.

In many cases attributes in the NPS-FM sets minimum standards compulsory attributes. These are referred to as the ‘bottom line’, and our baseline states (our current state of our freshwater environments) must be improved over time to meet this bottom line. Where our baseline states are above the bottom line for any particular attribute, we are required to at least maintain that baseline state. NRC has identified the baseline state for most of the NPS-FM attributes (there are a number where we do not yet have sufficient data to identify the baseline state) – these are available here: https://www.nrc.govt.nz/environment/new-freshwater-rules/the-freshwater-plan/our-freshwater-baseline-states/

The baseline state shows that rivers and lakes in Northland do not meet bottom lines for key attributes in the NPS-FM and that significant improvement is required. Where improvement in freshwater is required, NRC must set target attribute states to:

- meet Te Mana o Te Wai hierarchy of priorities (Clause 1.3(5) of the NPS-FM)
- achieve long term vision(s) for freshwater.
- objectives / outcomes for freshwater
- national bottom lines[3] for freshwater attributes set in the NPS-FM or regional plan.

The regulatory methods (i.e. limits and rules) to improve the state of attributes in waterbodies are limited but in many cases, methods can influence the state of multiple attributes – for example requiring stock to be excluded from riparian margins of rivers would likely have co-benefits in terms of:

- reducing *E. coli* contamination of water from livestock faecal matter (through reducing stock access and increasing setbacks),
- reducing sediment reduction through a riparian vegetation acting as a filter and
- improving habitat health as measured by macroinvertebrates due to increased shade/cooler water temperatures.

Structure of this Report

This report summarises the evidence prepared and presented for some freshwater attributes, including:

- *E. coli*;
- Sediment;
- Nutrients in rivers (*e.g.* Dissolved Reactive Phosphorous, nitrate toxicity, ammonia toxicity, and periphyton);
- Lake nutrients (*e.g.* Total Nitrogen, Total Phosphorous, Ammonia toxicity, phytoplankton, and Lake TLI);
- Habitat in rivers (*e.g.* fish IBI, macroinvertebrate community indices (MCI), and rapid haitat assessment);
- Lakes habitat (*e.g.* exotic fish, exotic submerged plants, and native submerged plants);
- Water quantity (flows/levels and allocation); and
- Attributes with insufficient data to determine baseline and target states.

Text that is green and underlined is a website link that can be clicked on to navigate to a particular report or website that is part of the Draft Freshwater Plan Change consultation process.

[3] Bottom lines are standards for the state of freshwater that must be met – the NPS-FM sets out national bottom lines for a number of attributes. Bottom lines can also be set for other attributes for freshwater identified at a regional scale.

Attribute: Escherichia coli *(E. coli)*

What is it?

Escherichia coli (E. coli) is a coliform bacterium of the genus *Escherichia* that is often found in the gastrointestinal tract of mammals and birds. *E. coli* is generally used to cover a massive range of strains or subtypes with different genetic makeups. When found in freshwater, it is an indication that animal faeces and/or human wastewater is present within the catchment.

E. coli on its own can cause illnesses in humans and animals, resulting from ingestion of *E. coli* and the subsequent growth of this bacteria within the gut. Ingested *E. coli* can cause an accumulation of toxins, which leads to the shedding of intestinal walls and diarrhea.

In the context of the NPS-FM and our monitoring of water quality, *E. coli* is used as an indicator species for the presence of faecal matter within the catchment, and subsequently the presence of other pathogens including other bacteria, virus, protozoans, and even parasitic worms (helminths). The presence of *E. coli* in water is measured to quantify the risks of getting sick from contact with water (such as swimming and gathering or eating mahinga kai).

It is a compulsory attribute in the NPS-FM and relates to human contact values for freshwater.

How does it affect values for freshwater?

Faecal contamination in our waterbodies is a widespread problem in Northland, caused by diffuse discharges such as runoff from pastureland or point-source discharges. Discharges from farm dairy effluent (FDE) and wastewater treatment plants have a more localised impact on *E. coli* concentrations in waterbodies (Muirhead et al., 2023).

Faecal contamination of our waterbodies is unacceptable to tāngata whenua. High *E. coli* concentrations mean there is a greater risk of illness from contact with freshwater, which affects the ability of people to use water for drinking, food preparation, swimming, or the ability to collect and consume mahinga kai from freshwater. Freshwater sources of faecal contamination also impact the ability to safely swim and collect shellfish in some of our estuaries and harbours.

Our coastal state of the environment monitoring shows that some sites in our estuaries and harbours exceed the coastal water quality standards for faecal contamination for recreation or shellfish collection (Griffiths 2021). The following areas are of particular concern, either because of the degree of faecal contamination, or because they are popular sites for recreation or shellfish gathering:

- Hātea River, Whangārei;
- Aurere Estuary;
- Waitangi Estuary;
- Hokianga;
- Ruakākā Estuary; and
- Waipū Estuary.

The 2021 Coastal Annual Report Cards document (link below) provides a full summary of coastal water quality at our monitoring sites:

https://www.nrc.govt.nz/resource-library-summary/research-and-reports/coastal/coastal-water-quality/annual-report-cards-coastal-2021/

Where is it measured?

The *E. coli* attribute applies to rivers, lakes and freshwater bathing sites during the bathing season. There are four 'metrics' for *E. coli* used in the NPS-FM:

- a maximum or 95th percentile;
- a median;
- % exceedances >540/100ml; and
- % exceedance >260/100ml.
- NRC runs a recreation bathing and discrete water quality monitoring programmes that measure *E. coli* at multiple freshwater rivers and lakes. LAWA, SafeSwim and NRC Environmental data hub presents this data for the public.

How do we measure up?

The NPS-FM requires that council identify the baseline state for attributes – this is essentially our starting point for tracking progress. For more information on the baseline states for freshwater attributes please see: https://www.nrc.govt.nz/environment/new-freshwater-rules/the-freshwater-plan/our-freshwater-baseline-states/

The baseline state for *E. coli* shows that 94% of our monitored sites in rivers are in a **poor** or **very poor** state (D and E band in terms of the NPS-FM bands), with 3% of sites in a fair state and only 3% of sites in a 'good' state. We do not have sufficient data for lakes other than at bathing sites. For bathing sites nine out of 12 are poor.

Table 3. Baseline state for E. coli for monitored sites in rivers.

Attribute	Human Contact *E. coli* (rivers & lakes)*				
Band	**A**	**B**	**C**	**D**	**E**
% river sites	0%	3%	3%	37%	57%
% lake sites	Insufficient data to assess baseline state until the end of 2027				
Attribute	Primary contact sites *E. coli* (rivers & lakes)				
Band	**Excellent**	**Good**	**Fair**	**Poor**	
No. of sites	2	1	0	9	

*The Human Contact *E. coli* attribute has four metrics (Appendix 1 this document). The lowest band status across these four metrics determines the 'overall' band status for this attribute.

We have also modelled *E. coli* for rivers which shows similar results – the modelled baseline state for the 4th order and greater rivers (based on modelled data for E. coli using our SOE data) is in Table 4.

Table 4. Baseline state for E. coli for rivers as modelled based on river length.

Band	A	B	C	D	E
% River Length (m)	0%	0.1%	0.2%	52%	48%

Figure 1 on the following page shows monitored and modelled results for *E. coli* in Northland's rivers. https://www.nrc.govt.nz/environment/new-freshwater-rules/the-freshwater-plan/our-freshwater-baseline-states/

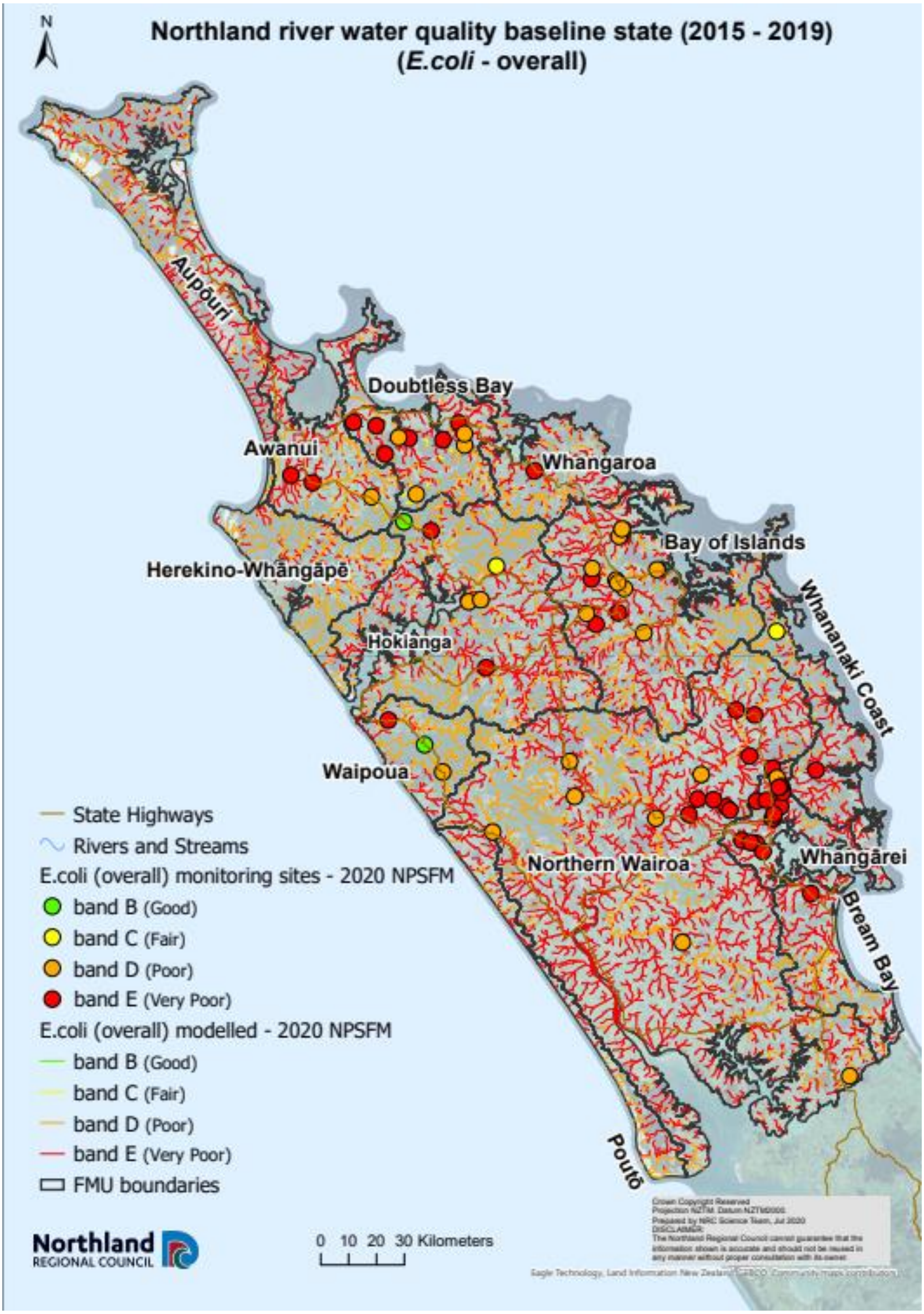


Figure 1. Northland river water quality baseline state (2015 - 2019) (E. coli - overall).
https://www.nrc.govt.nz/media/oxthec2y/20220628-map-baseline-state-ecoli-overall.pdf

What do we know about sources?

E. coli contamination results primarily from the discharge of faecal matter to freshwater environments. The primary sources in Northland include farm animals, waterfowl, and – to a lesser extent – humans. The highest concentrations of *E. coli* come from pastoral agricultural land as run-off into waterbodies during rainfall, livestock having access to waterbodies, and from discharges of animal effluent (including effluent storage ponds). Diffuse sources of contamination from pastoral agriculture, especially from headwater catchments, were identified as the key drivers of baseline state of *E. coli* in Northland. For more detail please see:

https://www.nrc.govt.nz/media/svbp5rnk/a-review-of-river-microbial-water-quality-data-in-the-northland-region.pdf

Naturalised *E. coli*

Research in Northland has identified the low-level presence of naturalised *E. coli* in Northland rivers. Naturalised *E. coli* is a term used to describe non-faecal strains of *Escherichia spp.* that will be "counted" in routine *E. coli* testing methods but are not related to recent faecal contamination. However, more recent work conducted nationally has shown that naturalised *E. coli* are more likely to be identified in more pristine waters and the *E. coli* counts in contaminated waters are dominated by *E. coli* strains from faecal sources.

There is no scientific justification for "discounting" the presence of naturalised *E. coli* concentrations measured in water samples – and the NPS-FM does not make any distinction between naturalised and other sources of *E. coli*.

What can we do about it?

There are a range of land use management practices that can be implemented to control diffuse discharges of *E. coli* into water. Discrete discharges of contaminated water can be further managed through engineering and the use of biological systems to reduce risks of human contact with *E. coli.* These include, but are not limited to:

- Excluding stock from freshwater bodies;
- Riparian planting;
- Afforestation of pasture on highly erodible land;
- Constructing wetlands in 1st order/headwater catchments in pasture;
- Establishing detention bunds in headwater catchments;
- Reducing / eliminating Farm Dairy Effluent (FDE) discharges into water;
- Reducing / eliminating municipal wastewater and domestic wastewater discharges to water;
- Upgrading onsite domestic effluent-disposal systems or replace with a community reticulated system;
- Pest control (*e.g.* waterfowl, goats, possums, pigs, and mustelids);
- Increased compliance and monitoring to ensure rules are implemented in a timely fashion;
- Support, incentives, and/or subsidies for stock exclusion fencing and riparian planting;
- Monitoring to assess the effectiveness of the rules and action plans in achieving our target attribute states;
- Further research to better identify critical source areas for faecal contamination; and
- Supporting and promoting the uptake of low-irrigation dairy wastewater systems.

Excluding stock from waterbodies and introducing riparian setbacks, establishment of wetlands in headwater catchments, phasing out farm dairy wastewater discharges to water, and tighter controls on human wastewater discharges are the key mitigation that we think will help reduce faecal contamination in our waterbodies.

NRC commissioned NIWA to model effectiveness of mitigations for improving Northland's water quality. In this model, stock exclusion from lowland (land with slope <15 degrees) waterbodies decreased *E. coli* loads by 15% from baseline state. However, 85% of national *E. coli* loads are estimated to come from steeper slopes/hill country and stock exclusion from hill country rivers would also be effective**.**

NRC has developed a draft freshwater plan change that includes draft rules changes and a draft Action Plan that include measures to reduce faecal contamination (as measured by *E. coli* concentrations) in fresh and coastal waters.

Key rule changes in the draft freshwater plan change are summarised below:

Stock exclusion

Excluding stock from the margins of waterbodies is effective in reducing *E. coli* levels as it restricts direct discharge of faecal matter to water and vegetation in riparian margins filter out contaminant run-off**.** Council has not confirmed changes to existing regional rules for stock exclusion and is instead consulting on a range of options – please see: *Have Your Say on Stock Exclusion*.

Farm dairy effluent

- Requiring resource consent as a controlled activity for existing discharges to land; **Rationale** – the standards and terms of permitted activity rules do not enable application of 'bespoke' controls to be applied that recognise the range of farm systems, land / soil types, rainfall and varying sensitivity of receiving environments. Controlled activity status would enable conditions of consent to be 'tailor-made' to suit each farm system and location. All FDE disposal to land would require consent (unless already consented).
- Requiring resource consent as a discretionary activity for new farm dairy effluent discharges to land. **Rationale** – the NPS-FM requires that water quality be at least maintain and that E. coli concentrations in freshwater are reduced. Council therefore may need to decline new applications for farm dairy effluent discharges if they would degrade water quality or ecosystem health.
- Prohibiting new and existing discharges to water from 1 January 2030. **Rationale**: the discharge of animal (and human) effluent to water is a major concern for tāngata whenua and there is an ongoing move away from discharge of treated dairy effluent to water by regional councils and the wider farming industry. Best management practices for FDE in New Zealand is to apply FDE to land (https://www.dairynz.co.nz/publications/environment/farm-dairy-effluent-design-standards-and-code-of-practice/; Muirhead et al., 2023). The 2030 date would allow time for farmers to invest in changes to their disposal systems.

Domestic (household) wastewater

- Prohibiting new and existing discharges of treated domestic wastewater to water. **Rationale** – the discharge of effluent to water (especially human effluent) is abhorrent to Māori. Such discharges are also high risk given potential pathogen load as treatment is unlikely to receive the same rigour or oversight as municipal wastewater treatment and discharges. There are very few consented discharges of domestic wastewater to water (six in total across the region, excluding those for municipal wastewater water discharges). The current discretionary activity status is considered too permissive and given there are alternative options (i.e. disposal to land) it is considered appropriate to prohibit these discharges.

Wastewater treatment plant discharges

- Prohibiting new municipal wastewater treatment plant discharges to water and applying non-complying activity status to the renewal of existing treatment plant discharges to water. **Rationale –** while there are localised rather than widespread impacts from wastewater treatment plant discharges, the discharge of human wastewater to water is abhorrent to Māori.

The draft rule changes are available here: *DRAFT Freshwater Plan Change*.

Action Plans are a requirement of the NPS-FM and set out other (non-RMA) methods to improve the state of *E. coli* in freshwater. NRC has developed a draft Action Plan – actions for *E. coli* are summarised below:

- Maintaining and improving existing actions and activities currently undertaken by NRC,
- Ongoing monitoring and compliance of existing wastewater and production land discharges,
- Increasing resources for monitoring and compliance,
- Implementing the Freshwater Farm Plan process, complimenting consent monitoring and enabling collaboration between Council and landowners,
- Council funding to support stock exclusion, riparian planting, and wetland restoration, and
- Advocacy and the consideration of consent application subsidies and rate reductions for rural landowners implementing actions.

The draft Action Plan is available here: *DRAFT Action Plan*.

What improvement are we aiming for?

The Government has set a national target of making at least 90% of New Zealand's specified rivers (4^{th} stream order or greater[4]) and lakes (with a perimeter of 1.5 km or more) swimmable by 2040 (i.e., in the A-C band) with an interim target of at least 80% of these rivers and lakes swimmable by 2030 (Appendix 3 in the NPS-FM).

Improving the state of *E. coli* attributes across Northland will take time. The NPS-FM requires that where improvement in the baseline state is needed, that council set target attribute states showing progressive improvement. Council has identified target attribute states for *E. coli* in Table 5 and Table 6 – these show the improvement over time compared with the baseline state[5] that we think can be achieved through the combination of rules and actions set out in the Draft Freshwater Plan Change and draft Action Plan. The target states apply to rivers and bathing sites (we have insufficient data for lakes). In summary, the target is to have all sites in a C Band (Fair state) or better by the end of 2050.

Table 5. Draft target states for the E. coli attribute in rivers.

Human contact: rivers					
Timeframes	**Band A**	**Band B**	**Band C**	**Band D**	**Band E**
Baseline (2015-2019)	0%	3%	3%	37%	57%
End of 2035	0%	0%	10%	50%	40%
End of 2040	10%	30%	40%	20%	0%
End of 2050	20%	30%	50%	0%	0%

[4] Rivers with 4^{th} stream order or greater (based on NIWA River Environment Classification or REC) represent mainstems of our bigger rivers (e.g., Wairoa, Hātea, Utakura). There are an estimated 1840 kms of these rivers.

[5] The baseline state is essentially our starting point and is based on data from the period 2015-2019.

Table 6. Draft target states for E. coli attribute in primary contact sites.

Human contact: primary contact sites					
Timeframes	**Excellent**	**Good**	**Fair**	**Poor**	
Baseline 2016/17- to 2020/21 bathing seasons	2	1	0	9	
End of 2035	2	2	4	5	
End of 2040	2	2	9	0	
End of 2050	2	6	5	0	

What would it cost?

The key tools for reducing sources of *E. coli* are stock exclusion, riparian setbacks and managing discharges to land/water. Excluding stock from waterways and their margins is one of the more effective tools to reduce *E. coli* and also has co-benefits in reducing other contaminants in particular sediment, however the costs can be high. Council wants to gain feedback before developing rules for stock exclusion. A discussion document looking at options and costs is available here: *The DRAFT Freshwater Plan Change: Have Your Say*. NRC has also prepared a background document summarising the benefits of riparian setbacks and vegetated margins along waterbodies.

The Draft Freshwater Plan Change includes new rules for the discharge of farm dairy effluent and human wastewater – the potential costs of these rule changes have been estimated below:

- Note: We have not costed rule changes prohibiting the discharge of treated domestic (household) wastewater discharges to water – there are very few consents issued for this activity in Northland (6 in total) and costs would vary depending on circumstances.
- We have estimated costs for prohibiting municipal wastewater treatment plant discharges to water and requiring all 25 treatment plants to discharge to land instead. However, the draft rule changes only prohibit **new** discharges of municipal wastewater treatment plant discharges to water – the rules would not require existing treatment plants to shift to land disposal.

Table 7. Cost estimates to include the new rules for the discharge of farm dairy effluent and human wastewater.

Topic	Description of costing	Total cost over 30 years	Average annual total cost over 30 years	Average annual cost per unit over 30 years	Average annual cost per unit as a % of farm operating profit before tax	Proportion of total cost incurred in first 5 years
Remove permitted activity rule for FDE discharge to land	Cost for the ~180 dairy farms operating under the permitted rule to obtain a controlled activity RC[4]	\$4.5 - 6.3 million	\$0.15 - 0.22 million	\$1k - 1.3k per dairy farm operating under permitted	0.5 - 1.0% of average dairy farm	10% - 15%

Topic	Description of costing	Total cost over 30 years	Average annual total cost over 30 years	Average annual cost per unit over 30 years	Average annual cost per unit as a % of farm operating profit before tax	Proportion of total cost incurred in first 5 years
Prohibit discharge of treated farm wastewater to surface and groundwater	Costs for the ~540 dairy farms currently operating with a discharge consent to move to land application only. Greater cost estimated for the ~136 dairy farm without land application currently.	$100 - 150 million	$3.3 - 5.0 million	Ranges from $3k – 4k for farms already with land application to $16K-$24K for those with no land application currently	Ranges from 2% of average dairy farm already with land application to 9 - 14% for those with no land application currently	40% - 45%
Prohibit discharge of municipal wastewater to water	Costs for transitioning the 25 WWTP that currently discharge to water to land discharge only[5]	$1.1 - 1.7 billion[6]	$38 - 55 million	$650 - 950 per connection	Represents about 1% of median household income	80 - 85%

Attribute: Suspended Fine Sediment

What is it?

Sediment comprises two attributes within the NPS-FM: suspended fine sediment (measured by visual clarity) and deposited fine sediment (which is the thickness of fine sediments accumulated on the bottom of rivers). Together, these are indicative of sediment loss from streambanks and land.

Erosion is a significant issue in Northland, with about 20% of the Region's land area classified as Erosion Prone Land on the current regional plan maps. Much of this land is currently in pasture. Due to the shallow rooting systems of pasture grasses, and the ongoing physical erosion caused from stock movement, topsoils in pasture are more prone to erosion during rain events. While this may be limited in an acute sense, as these activities are widespread, sediment loads within receiving environments become very high during rainfall events, exceeding natural ranges.

Deforestation, earthworks and land preparation are contributing factors that can result in large-scale erosion events, for instance a landslide or slump occurring post-harvest of a pine plantation.

Suspended sediments of concern are primarily silts, clays, and other fine particles that are easily transported by water and deposited to downstream environments, including the coastal marine waters. The NPS-FM has a suspended sediment classification system that is derived from River Environment Classification (REC) groups (NPS-FM Appendix 2C Tables 23 and 26). REC variables are grouped into climate, topography, and geology. Northland has 3 of the 4 classes (classes 1 – 3), which includes all suspended clustered REC groups except for "Cold-Wet, Lowland Soft Sedimentary" (CW_Low_SS).

How does it affect values for freshwater?

Sedimentation of streams and rivers cause a range of issues for freshwater values, including freshwater and marine biodiversity decline and reduced fish abundance. Connected with this are habitat degradation, loss of amenity and natural character due to water clarity reduction, and silty deposits on stream beds. Sedimentation in water bodies smothers macrophytes important to ecosystem function. It affects ability to gather mahinga kai, and suitability for swimming Turbid and silty waters can limit the ability to effectively treat water supplies (especially UV treatment) and can also be detrimental to pumping equipment, limiting the availability of suitable water supply for human consumption and stock water within degraded catchments.

Heavy metals can also sometimes 'hitch a ride' with sediment particles through adsorption due to their natural geochemistry. Heavy metals naturally occur at noticeable levels within much of Northland's volcanic soils, though industrial activities and road use also contribute to heavy metal discharges to our waterways, particularly Zinc (Zn), Copper (Cu), and Lead (Pb) to a lesser extent. These are managed through the 'Other Contaminant' attributes discussed further below in this summary report.

Figure 2: Low water clarity at Northern Wairoa rivers, October 2023

Where is it measured?

Under the National Policy Statement for Freshwater Management 2020 (NPS-FM) (NZ Govt. 2022), the Government has set a compulsory freshwater value of Ecosystem Health with five biophysical components that all must be managed (water quality, water quantity, habitat, aquatic life, ecological processes). There are several compulsory attributes in the NPS-FM that we need to measure and monitor to help manage the 'Ecosystem Health' value in our region. Two of these attributes relate to sediment:

- Suspended fine sediment (rivers) (Table 8, NPS-FM) (Appendix 4 this document), applies to the water quality component of Ecosystem Health. Note that visual clarity is the metric used to assess this attribute.
- Deposited fine sediment (rivers) (Table 16, NPS-FM) (Appendix 4 this document), applies to the habitat component of Ecosystem Health.

The suspended fine sediment attribute is measured using water clarity tubes and black disc.

How do we measure up?

The sediment attribute bands range from A (Excellent) to D (Poor), with the national bottom line set between C and D bands. We have used data from our State of the Environment (SOE) monitoring for the five-year period from 2015-2019 to determine the baseline state for our rivers (67 monitoring sites) (refer Table 8).

This data shows 15% of our river sites are below the bottom line for suspended sediment. However, samples are taken at regular monthly intervals, and predominantly during base flow conditions, whereas most of the sediment is exported during high flow events. Hence, the issue of suspended sediment in our rivers is likely to be underestimated.

Although we won't have sufficient data to know our baseline state for deposited fine sediment until 2027, around 40% of our river SOE sites are classified as 'soft-bottomed' (>50% coverage of deposited fine sediment), indicating that deposited fine sediment is also an issue in our rivers.

Figure 3. A clarity tube is used to measure water clarity.

Table 8. Length and proportion of the stream network in each attribute band by suspended sediment class (note there are no class 4 segments in Northland). (Neverman & Smith 2023).

Attribute State: Suspended fine sediment (visual clarity)					
Band	**A (Excellent)**	**B (Good)**	**C (Fair)**	**BOTTOM LINE**	**D (Poor)**
% (no. of river sites)	55% (37)	17% (11)	13% (9)		15% (10)

*Note that the methodology and disc size used by NRC to measure visual clarity differed slightly from NEMS. However, it is considered that this would have minimal impact on sites close to, or below the bottom line. Having recognised the NPS-FM (2020) requirement to use 'best available information', we felt that the data was robust enough for the purpose of calculating baseline.

Figure 4 overleaf shows these data points geographically across Northland, along with modelled visual clarity for intermittent and permanent streams also colour coded to match the Attribute Bands.

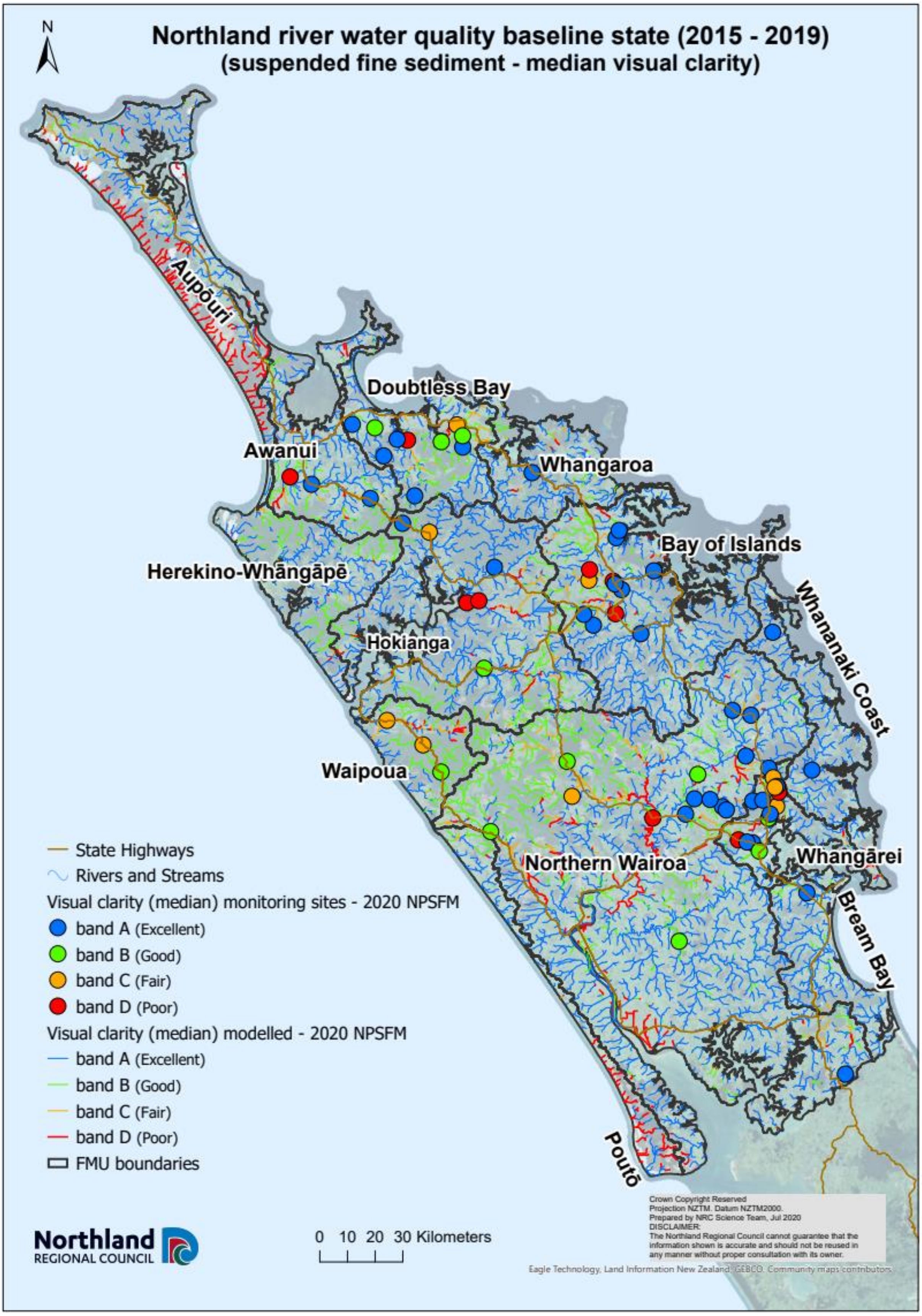
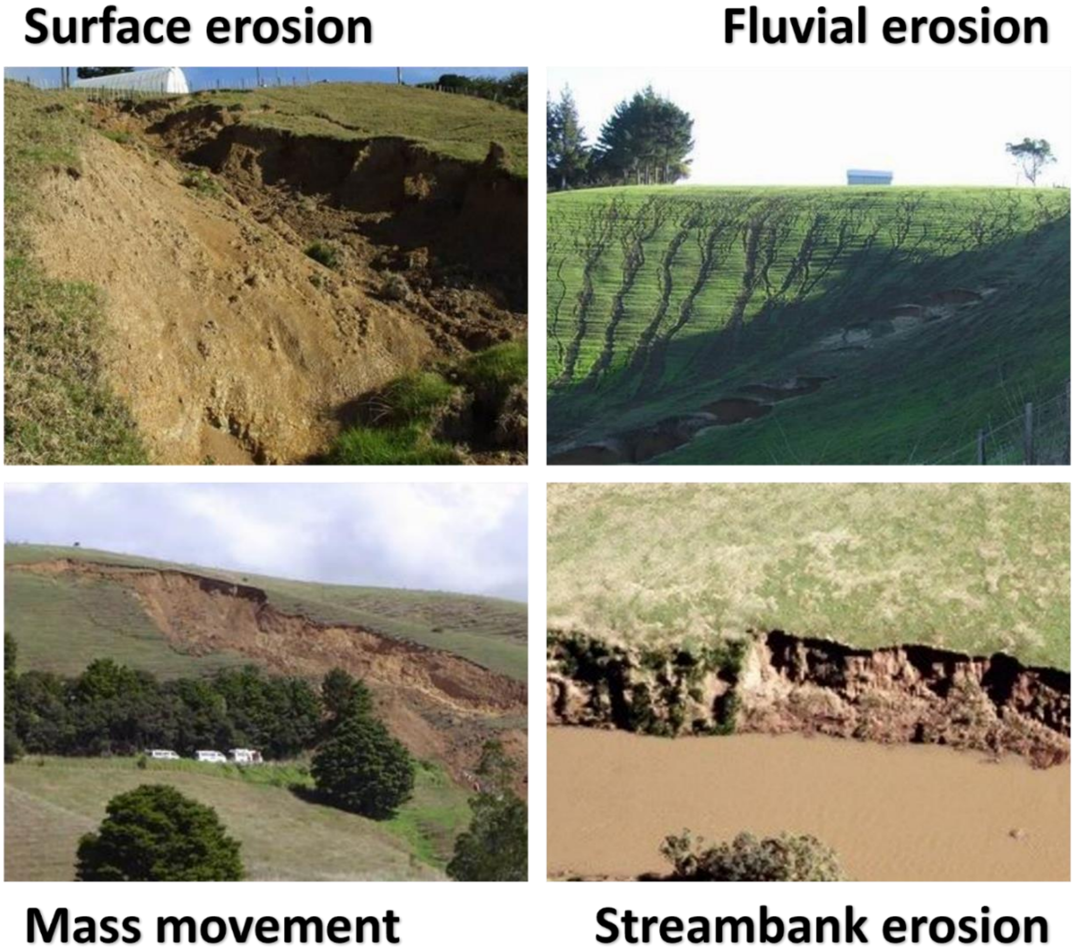


Figure 4. Northland river quality baseline state (2015 - 2019) (suspended fine sediment - median visual clarity).

What do we know about sources?

Sediments wash into streams, rivers, and lakes from their contributing catchments. In our region, the two main contributing sources of sediment to water bodies and downstream receiving environments are from land-based mass erosion and streambank erosion. While the major source of sediment loss comes from steep, highly erodible land, there is the potential for further loss from highly productive flatter land through overland flow and run-off. Most of the sediment is transported downstream during high flow and flood events. Northland's geology complicates our understanding of potential sources due to naturally occurring weak geology, steep slopes, fine clays, and low-permeability soils. We do know that acute sources, such as large-scale deforestation and plantation harvesting, earthworks, mass landslides, and uncontrolled land preparation can result in large deposits of sediment into water bodies in a single event. More diffuse sources, such as from animal grazing of marginal hill country, unfettered stock access to water bodies, and urban stormwater runoff exacerbates erosion rates and results in ongoing degradation of receiving waters. The removal of riparian vegetation to enable grazing up to the edge of riverbanks has also led to an increase in streambank erosion.



The proportion of land-based and streambank erosion varies across Northland. For example it is estimated that in the Kaipara catchment, approximately 52% of sediment comes from land-based erosion (i.e., landslide, gully, earthflow, and surficial erosion), and 48% was from streambank erosion (Daigneault et al., 2017). In the Whangārei Harbour catchment it is estimated that 85% of sediment loads are from land-based erosion and 15% from streambank erosion (Daigneault & Samarasinghe 2015).

What can we do about it?

Sediment entering waterbodies is increased by the grazing of steep marginal land and riparian margins – stock access to waterbodies can also disturb beds of lakes and rivers and remobilise sediment. A range of interventions are being considered to reduce sediment from critical source areas and to improve streambank resilience, including:

- Updating regional plan maps of land vulnerable to erosion
- Options for rules on excluding stock from freshwater bodies and their margins and areas identified on draft maps of highly erodible land;
- New requirements for setbacks from waterbodies for activities such as vegetation clearance, land preparation and forestry planting and harvesting;
- new requirements for vegetation clearance within riparian margins and on areas mapped as highly erodible land; and
- We also want to encourage the retention and establishment of trees on marginal pastoral land.
- Public awareness and advocacy for sediment sources and mitigation.

Council commissioned NIWA to undertake modelling on effectiveness of measures to reduce sediment, nitrogen, phosphorus and *E. coli*. The scenarios modelled included:

- Stream fencing
- Riparian planting
- Establishing trees on highly erodible land in pasture – about 50,000ha across the region (Note: the draft maps of Highly Erodible Land 1 and 2 were not available at the time of modelling).
- Constructing wetlands in 1st order catchments in pasture
- Establishing detention bunds in headwater catchments

The results and modelled scenarios are set out below in Figure 5:

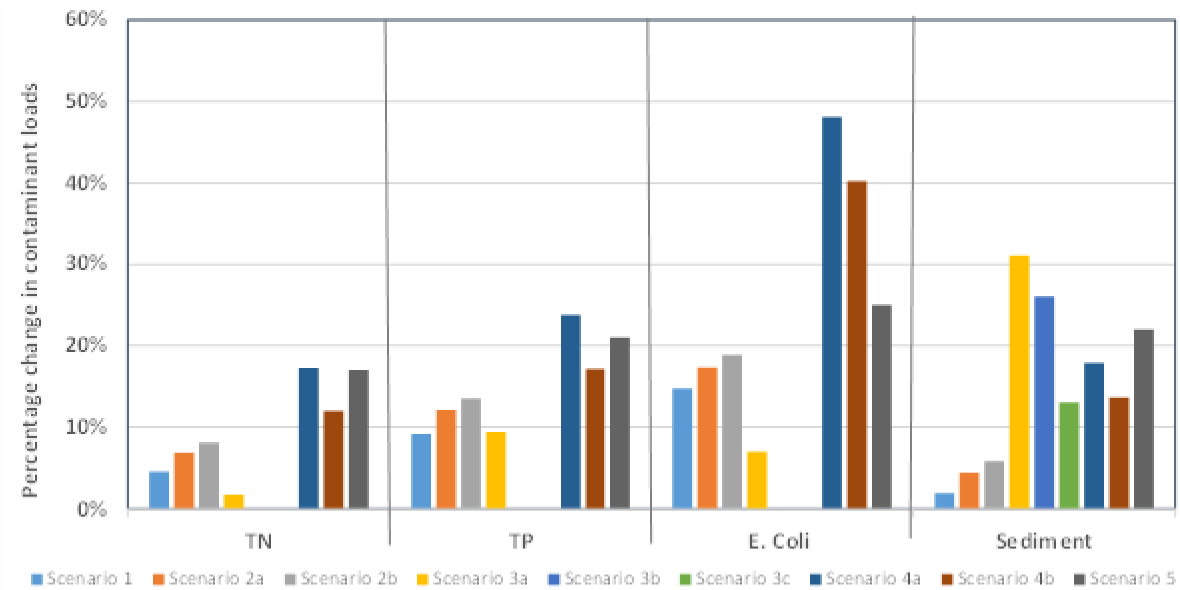


Figure 5: Effectiveness of the modelled scenarios in reducing contaminant loads. These improvements are not cumulative: i.e., each mitigation improvement is assessed against the modelled baseline state. (See Semadeni-Davies et al, 2021 and Semadeni-Davies, 2022 for further details.) Scenario 1 = fencing; Scenario 2 = a) fencing + plant new fencing; b) plant all unplanted stream segments; Scenario 3 = highly erodible land a) afforestation into permanent forest cover b) afforestation into plantation forest c) space planting; Scenario 4 = constructed wetlands a) upper: 5% catchment area in wetlands b) lower: 2% area in wetlands); Scenario 5 = detention bunds.

NRC also undertook some costings[6] for each scenario to identify which were most cost-effective shown in figure below. The results indicate the most cost-effective mitigations are planting trees on existing pastural highly erodible land, detention bunds and establishing wetlands were most effective at reducing sediment loads and that planting trees on existing highly erodible land in pasture was estimated to be the most cost-effective and efficient mitigation for reducing sediment loads.

Note: the area of highly erodible land used in the modelling (about 50,000ha) is considerably less than the total area in draft maps of Highly Erodible Land 1 and Highly Erodible Land 2.

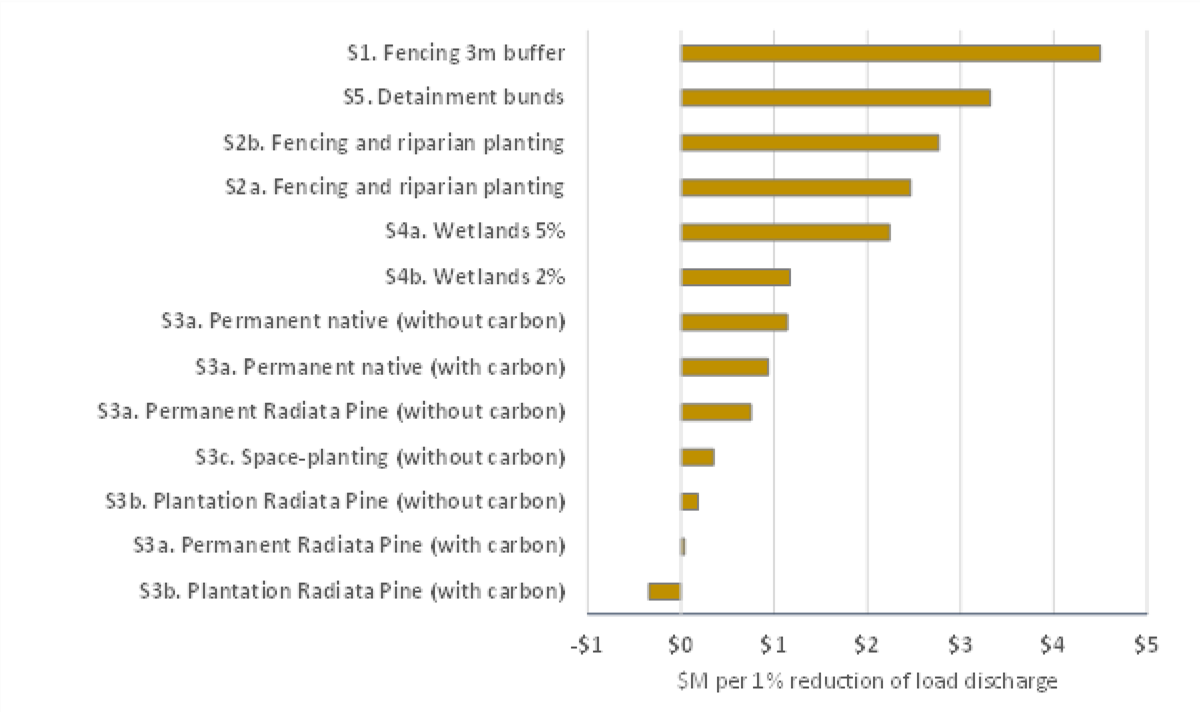


Figure 6: For the NIWA modelling of mitigation effectiveness, NRC undertook cost analysis.

Rule Changes

The key tools for reducing sediment are managing the scale and location of land disturbance (such as earthworks, vegetation clearance and land preparation) and activities in riverbeds disturbance and excluding stock from critical source areas for sediment. To date, Council has identified draft freshwater plan change rules for addressing sedimentation issues that include:

- tighter controls on permitted earthworks, land preparation and vegetation clearance activities in areas identified on maps of highly erodible land
- Tighter controls on the disturbance of riverbeds
- Controls on the extent of vegetation clearance in riparian margins
- updated maps of 'Highly Erodible Land' that could replace the existing 'Erosion Prone Land' maps in the regional plan.

The Resource Management (Stock Exclusion) Regulations 2020 require the exclusion of livestock from water bodies, including wetlands, providing for stock crossings via either bridge or culvert crossings, or through finite and managed stock crossings through the waterbodies. There are also stock exclusion rules in the Regional Plan - NRC is currently considering further provisions that would build on these national regulations and regional rules given this is a key tool in managing a range of freshwater attributes including sediment. New stock exclusion rules have not been confirmed and are being consulted on separately. See: Have Your Say on Stock Exclusion.

[6] Costing analysis of the NIWA water quality mitigation scenarios for Northland Updated 20221101.pdf

Highly Erodible Land Definitions and Maps

We have an opportunity to improve our mapping of land at risk from erosion. The existing regional plan maps Erosion Prone Land based on Land Use Capability (LUC class). We have identified new GIS map layers based on slope – these are more refined and are able to better predict erosion potential of land as slope is a key factor in erosion risk in Northland. We have identified two draft maps of Highly Erodible Land – Highly Erodible Land 1 (high risk) and Highly Erodible Land 2 (severe risk). These are compared with the current LUC based approach in Table 9 below.

Table 9. Proposed classifications of erodible land provisions.

Classification		Definition	Area	Rules
Erosion Prone Land (existing regional plan map)	EPL	*Land defined as Land Use Capability (LUC) units 6e17, 6e19, 7e1 – 7e10, 8e1 – 8e3, and 8s1. The LUC units are generally depicted in the NZ Land Resource Inventory (NZLRI) and are also shown in NRC Maps.*	252,409ha (about 20% of the region)	Controls on earthworks and land preparation
Highly Erodible Land 1 (high risk)	HEL1	Land with a slope between 25 and 35 degrees	155,000ha (about 12% of the region) 122,000ha in woody vegetation and 33,500ha in pasture	Draft rules being considered: Controls on earthworks, vegetation clearance and land preparation. We are also asking for feedback on excluding stock from these areas
Highly Erodible Land 2 (severe risk)	HEL2	Land with a slope >35 degrees	91,120 (about 7.2% of the region) 81803ha in woody vegetation and 9,317ha in pasture	Draft rules being considered: Tighter controls on earthworks, vegetation clearance and land preparation. We are also asking for feedback on excluding stock from these areas

We are seeking feedback on this change in approach to identifying land vulnerable to erosion. The draft maps of highly erodible land can be seen in the map viewer.

Action Plans

Action plans are required by the NPS-FM 2020 so that regional councils can support the rules and achieve specific attribute target states. The following actions will contribute to sedimentation mitigation as well as multiple target attribute objectives. We are recommending that one freshwater action plan be developed for Northland – the actions related to managing sediment are summarised below:

- Increased compliance effort (stock exclusion, land disturbance, forestry activity, targeting areas above sensitive receiving environments (such as swimming sites/drinking water supplies).
- Support for stock exclusion fencing of waterbodies (rivers, lakes, wetlands), such as incentives and subsidies.
- Support for riparian planting and maintenance.
- Support for planting highly erodible land.

- Support to establish new wetlands and restore degraded wetlands particularly in headwater catchments and critical source areas.
- Mitigation effectiveness monitoring to better ascertain the effectiveness of any interventions/mitigations (and timeframes) in achieving target attribute states.
- Undertake research to identify where in the region naturally occurring processes may prevent us from getting above bottom lines e.g., highly erodible geologies with very fine clays.
- Undertake research on the effectiveness of setbacks to mitigate the effects of a range of activities e.g., land disturbance.
- Long-term shift to models that can estimate changes through time for more accurate modelling of contaminants such as nutrients, sediment and *E. coli*. Sediment data monitoring is needed to collect enough information for modelling.
- Developing and implementing NRC's soil conservation strategy.
- Collaboration with Kaipara Moana Remediation Programme and supporting uptake of the programme by landowners. Investigate feasibility and cost of extending KMR critical sediment source mapping across the rest of Northland.

What improvement are we aiming for?

The proposed methods to reduce erosion and transport of suspended sediment into waterbodies will take years to implement due to the:

- scale and cost of changes required,
- physical works and resources necessary to implement the changes, and
- time it takes for vegetation to establish and grow on riparian margins and highly erodible land.

During this time, further erosion as well as land that is currently subject to active erosion will continue to generate sediment that will be transported to waterbodies. Given this, the draft target attribute state for suspended fine sediment shows progressive improvements out to the year 2110.

Table 10. Draft target attribute states for suspended fine sediment.

Timeframe	Band A	Band B	Band C	Band D
Baseline (2016-2019)	55% (n=37)	17% (n=11)	13% (n=9)	15% (n=10)
2030	55%	17%	18% (HC) 15% (LL)	10% (HC) 13% (LL)
2040	55%	17%	28% (HC) 15%(LL)	0% (HC) 13% (LL)
2050	55%	30% (HC) 17% (LL)	15% (HC) 18% (LL)	0% (HC) 10% (LL)
2060	55%	45% (HC) 17% (LL)	0% (HC) 18% (LL)	0% (HC) 10% (LL)
2070	55%	45% (HC) 17% (LL)	0% (HC) 21% (LL)	0% (HC) 7% (LL)
2090	55%	45% (HC) 17% (LL)	0% (HC) 24% (LL)	0% (HC) 4% (LL)
2110	55%	45% (HC) 17% (LL)	0% (HC) 28% (LL)	0% (HC) 0% (LL)

What would it cost?

Stock exclusion and management of activity on highly erodible land and riparian margins are the key regulatory mitigations for reducing sediment. While rules for stock exclusion have not confirmed, we have set out some options for stock exclusion (including excluding stock from areas identified as highly erodible Land 1 and 2) in a discussion document – See *Have Your Say on Stock Exclusion.*

This includes as an appendix a companion report with estimated costs: 'A costing of the options to support "The draft Freshwater Plan Change: Have your say on stock exclusion" report'.

We have not costed draft changes to rules for land disturbance such as tighter controls on earthworks or new rules on vegetation clearance – these are likely to be strongly linked to the cost of obtaining resource consents and could vary significantly with location and scale.

Attribute: other water quality attributes

What are they?

The primary contaminants of concern that affect Northland's freshwater health discussed above are *E. coli* and sediment, however there are other water quality attributes that are required to be managed in the NPS-FM. Council has also identified several additional attributes that it considers relevant to the management of freshwater health in Northland. These attributes are listed below:

Table 11. NPS-FM and Northland specific water quality attributes for rivers and lakes.

NPS-FM attributes	
Rivers	**Lakes**
Ammonia (toxicity)	Total nitrogen
Nitrate (toxicity)	Total phosphorus
Dissolved reactive phosphorus	Ammonia (toxicity)
Periphyton biomass or benthic algae	Phytoplankton
Dissolved oxygen (DO)	Lake-bottom dissolved oxygen
Ecosystem metabolism (EM)	Cyanobacteria (planktonic) – lakes and lake fed rivers
Northland specific (non-NPS-FM)	
Rivers	**Lakes**
Water temperature	Lake trophic level index (TLI) - a combined measure of nutrients, water clarity and algae.
Heavy metals (Cu and Zn)	
Plastic / Litter (density per m^2)	

The Northland specific attributes have been chosen to address known issues within our waterbodies that are not immediately addressed by the mandatory NPS-FM attributes.

TWWAG has also proposed other attributes of relevance that can be found in the report *Te Mana me te Mauri o te Wai: A Discussion Document for Te Tai Tokerau*.

How do these attributes affect values for freshwater?

Compulsory NPS-FM Attributes

Nutrients (Nitrogen and Phosphorous)

Nutrients (Nitrogen (N) and Phosphorous (P)) within our waterbodies are naturally occurring and required for the growth of plants and algae native to our ecosystems.

Nitrogen is the most common pure element within our atmosphere. It forms a key ingredient in a range of chemical compounds (nitrates, nitrites, and ammonia) found in natural metabolic processes (urine and faeces) as well as in artificial fertilisers.

Similarly, phosphorous compounds occur naturally in all known living organisms and is widely found throughout our soils and minerals. Due to Northland's volcanic geology, naturally occurring phosphate minerals are abundant in many of our soils, resulting in naturally high levels of dissolved reactive phosphorous (DRP) in our waterbodies.

Where these nutrients are found in high concentrations, this can lead to excessive plant and algae growth, resulting in adverse impacts on ecosystem health and declines in aquatic macroinvertebrate communities when compared to our rivers in near-pristine state. Monitoring shows that where we have volcanic soils, highly erodible steep terrain, and poorly drained soils in lowland areas, DRP concentrations in about 33% of our 67 river monitoring sites are in band D of the NPS-FM (very poor).

On the other hand, nitrate nitrogen (NO_3-N) concentrations in most of our sites are low compared to the national standards for toxicity, which is also true for ammoniacal nitrogen (NH_4-N). This is due to the bulk of total nitrogen (TN) loads in Northland rivers being comprised of organic nitrogen, reflecting the influence of poorly drained soils in lowland floodplains on Northland's river water quality (Rissmann and Pearson, 2020).

Benthic Algae (periphyton biomass)

Periphyton is a term that applies to species of algae, including filamentous algae, that grow on rocks and other substrates within waterbodies, utilising sunlight and nutrients (nitrogen and phosphorous). An abundance of periphyton indicates elevated levels of these nutrients that encourage algal growth.

During the summer months, with low flows and warmer water temperatures, periphyton growth can outcompete indigenous freshwater flora and form dense mats, blocking sunlight and reducing dissolved oxygen levels in water. Where flushing events or periphyton die off cause this growth to loosen from its substrate, the biomass flows downstream, affecting stream health and ecosystems, damaging in-stream structures and infrastructure and decreasing biodiversity. Monitoring indicates that the majority of river sites (~95%) comply with NPS-FM standards for the periphyton attribute, but prolific algal growth is common in some rivers, including the Wairua River.

The proposed measures to increase shading of and reduce nutrient run-off into our rivers and streams are anticipated to also reduce benthic algae growth, aiming to have all of our rivers above the national-bottom line by the end of 2035.

Cyanobacteria

Under the NPS-FM, cyanobacteria is measured in lakes and lake fed rivers (Biovolume mm3/L or cubic millimetres per litre). Like benthic algae, it thrives in eutrophic environments. High nutrient levels combined with specific environmental conditions can lead to rapid cyanobacteria growth, or blooms, which can suddenly and significantly degrade lake environments and cause aquatic species to die off. Such blooms have similar smothering effects as benthic algae but can also lead to the production of harmful toxins and/or rapid oxygen depletion that can cause permanent habitat loss, resulting in significant challenges for ecological rehabilitation.

Figure 7. Cyanobacteria in Lake Ōmāpere, with planktonic (free-floating) species (left) and benthic species (right).

Northland's shallow lakes are more prone to such effects due to the greater influence of sunlight and air temperature on the smaller volumes of water. Dune lakes have the added vulnerability of having minimal flushing. Lake Ōmāpere is a prime example of our lakes' vulnerability. While Northland's largest lake by area, its depth only ranges between 1.5 and 2.5m and as such its water temperature can rise rapidly, encouraging cyanobacteria blooms along with its high nutrient levels. Figure 8 overleaf summarises NRC's cyanobacteria monitoring results for Lake Ōmāpere 2023 up to September. These show that for most of the year, cyanobacteria are present at levels within the lake that pose health risks for contact recreation.

Guidelines

Surveillance: Suitable for recreational use. Cyanobacteria biovolume does not exceed 0.5mm3/L.
Alert: Caution advised for recreational use. Cyanobacteria biovolume is between 0.5 to < 10 mm3 /L.
Action: Unsuitable for recreational use. Cyanobacteria biovolume is ≥10 mm3/L.

Latest Results
Cyanobacteria biovolume (mm3/L)

Lake Ngatu	11/09/2023	0.004
Lake Omapere	21/09/2023	15.000
Lake Rotopokaka (Coca cola)	18/04/2023	0.004
Lake Waiparera	18/04/2023	1.400
Lake Waro	17/04/2023	0.004

Season Results - 2023
Cyanobacteria biovolume (mm3/L)

Lake Omapere	9/01/2023	1.600
	19/01/2023	10.000
	25/01/2023	6.100
	10/02/2023	18.000
	24/02/2023	14.000
	8/03/2023	13.000
	22/03/2023	0.090
	19/04/2023	3.900
	17/05/2023	1.100
	15/06/2023	0.042
	20/07/2023	26.000
	17/08/2023	1.900
	21/09/2023	15.000

Figure 8. NRC Monitoring of cyanobacteria levels in Lake Ōmāpere in 2023.

We are continuing to monitor cyanobacteria in our lakes and lake-fed rivers. At this stage we do not have sufficient data to set a baseline state, but anticipate having enough data by the end of 2025.

Dissolved Oxygen

Aquatic flora and fauna rely on dissolved oxygen within water for metabolic respiration. Just as we require air to breathe, aerobic aquatic organisms use dissolved oxygen to breathe and enable their biological systems to produce energy and incorporate nutrients. In a stable environment, aquatic plants and algae will absorb sunlight and CO_2 to produce energy and oxygen through photosynthesis, which oxygenates the water and enables aquatic animals and bacteria to breathe. Rapidly moving streams are also typically highly oxygenated due to the gas exchange that occurs with the air above.

Lakes, due to a generally lack of directional flow and lack of sub-surface interaction with air, rely on oxygenated water flowing into the lakes and the production of oxygen from aquatic flora and algae. Following large algal blooms, there is a high risk of mass die-off, where the bloom rapidly consumes nutrients, their population explodes to an unsustainable level, and then dies, causing smothering of aquatic plants, creating floating mats of dead and decaying biomatter, and encouraging the growth of bacteria that consume decaying plants and algae. These bacteria, as their populations boom, will also rapidly consume dissolved oxygen through their own metabolic processes, reducing the available supply for fish and aquatic invertebrates.

This rapid decline in dissolved oxygen levels thus lead to further mass die-offs of our desired native flora and fauna. While this chain reaction can occur within a short span of time, the effects can be much longer lasting, creating a ‘dead zone’ that renders parts of lakes incapable of supporting life. Rehabilitating oxygen depleted areas is extremely difficult, as benthic aquatic plant populations can take years to reestablish and endemic fish species are already being outcompeted by pest fish.

Our best use of time and resources is to prevent dissolved oxygen levels from decreasing in the first place. At this time, we do not have sufficient information to determine the baseline state for dissolved oxygen in our rivers and lakes; however, we are continuing to gather data and anticipate that these can be set by the end of summer 2023/2024.

NRC Proposed Additional Attributes

Water temperature

Prior to human settlement, Northland was densely vegetated with canopy cover over much of our streams and riverbanks. This shading maintained relatively cool water temperatures within which native flora and fauna evolved over millions of years to thrive in these conditions. As our landscapes rapidly changed from forest canopy to open pasture, urban areas, and road side verges, water temperatures within our streams and lakes have become more prone to heating from sun exposure and shallow runoff. Along with other ecosystem pressures, the variable range in water temperatures reduce the resiliency of our native aquatic species and encourage introduced pest species from warmer climates to become established.

The NPS-FM does not require regional councils to set baseline states for water temperature; however, we have included this attribute to protect our indigenous aquatic species and to assist in the reduction of periphyton / algae growth in Northland's rivers. We anticipate that sufficient data to form a baseline state will be obtained following continuous water temperature monitoring around the region by the end of summer 2023/2024.

Heavy metals

Heavy metals are inorganic elements that can cause acute toxicity in flora and fauna, sometimes at low concentrations, and can also lead to bioaccumulation in organisms that incorporate these elements into their biological processes (molluscs). Key contaminants of concern generally include zinc, lead, arsenic, boron, copper and chromium. Certain elements may be naturally higher in volcanic catchments due to higher natural background levels in these soils, though there can also be direct correlations with discharges from industrial activities and stormwater discharges.

The NPS-FM does not require regional councils to set baseline states for heavy metals, but NRC has observed through historical monitoring that there are high concentrations of dissolved copper (Cu) and zinc (Zn) in urban catchments, mostly from stormwater runoff. Routine monitoring of heavy metals started in 2022 at all State of the Environment sites for urban and rural catchments, and this will continue through to 2027 in order to establish a baseline state for these heavy metals.

Lake Trophic Levels

Trophic levels describe the ability of a lake to sustain life in terms of nutrient loading, dissolved oxygen levels, periphyton biomass, and water clarity. As described above, periphyton, warmer temperatures and high nutrient loads can cause rapid declines in dissolved oxygen levels. As lakes are not subject to continuous flows like a river or stream, lake environments can become stratified with different stressors at different depths. For example, oxygen levels drop at the bottom of lakes during summer due to these pressures, resulting in stresses on aquatic life and the release of phosphorous in lake-bed sediments.

Lake Trophic Levels are not a mandatory attribute under the NPS-FM; however, Northland has exceptional circumstances compared to the rest of New Zealand, given our subtropical climate and abundance of dune lakes with no outlet that have added vulnerability to eutrophication. Eutrophication is the worst Lake Trophic Level, indicating that nutrient loading (usually phosphorous), sedimentation, and high temperatures have caused cyanobacteria blooms and dramatic reductions in dissolved oxygen.

Plastics

Plastics, including Styrofoam, have been found in high densities through shoreline surveys, monitoring of litter traps within stormwater catchpits, and within a Gross Pollutant Trap (GPT) trial within the Hātea River. Results of these surveys indicate that plastics comprise more than 70% of the litter surveyed, and shows that there are six high risk land uses:

- Fast food restaurants;
- Retail shopping areas;
- Hospitals;
- Playgrounds / skateparks;
- Car parks; and
- Transport, postal, and warehousing areas.

An estimated 13.2 million litter items and 9.4 million plastic items are discharged from the six main urban stormwater networks in Northland every year, as identified in the Proposed Northland Regional Plan (October 2023) Rule C.6.4.1 Table 10:

Table 12. Identified urban stormwater networks as per Rule C.6.4.1 of the Northland Regional Plan.

Far North District	Whangārei District	Kaipara District
Kaitāia Kaikohe Kerikeri Paihia Waipapa - Haruru	One Tree Point - Marsen Cove Ruakākā Waipū Whangārei City	Dargaville Mangawhai - Mangawhai Heads

Litter is not a mandatory NPS-FM attribute; however, given it has been identified as a major contaminant of Northland's waterbodies, new rules are being considered in the draft Freshwater Plan Change to manage litter generation. There is insufficient data at this time to set a baseline state, but ongoing monitoring and efforts to reduce littering will be included in our freshwater action plans.

Groundwater Quality

Groundwater is also subject to contamination, primarily from nutrients and heavy metals that leach into the soils and aquifers from stormwater runoff. The primary effect is the fouling of this groundwater and preventing its use as a resource for drinking water supply. There are localised areas of elevated levels of nitrate nitrogen within Northland (median value below the NZ Drinking Water Standards).

There is also a trend of elevated dissolved reactive phosphorous, which occurs across Northland largely indicative of our volcanic soils within certain areas.

NRC monitoring of chloride within coastal aquifers shows that there is currently low risk of existing saline intrusion in general, though there is a fine balance between maintaining sufficient freshwater levels within the aquifer to maintain its equilibrium with salt water and enabling small coastal communities to abstract groundwater for drinking supply.

How do we measure up?

The tables below summarise how Northland's rivers and lakes measure up against:

- the NPS-FM attribute scoring framework (A – D, with A being Excellent and D being Very Poor); and
- the national bottom lines (where our baseline states have been set and where a national bottom line has been set).

Rivers and Streams

Red = national bottom line

Table 13. Compulsory and proposed freshwater quality attributes for rivers.

Attribute		A	B	C	D
Compulsory NPS-FM attributes	Ammonia (toxicity)	92%	8%	**0%**	**0%**
	Nitrate (toxicity)	94%	6%	**0%**	**0%**
	Dissolved reactive phosphorus	8%	22%	37%	33%
	Periphyton	41%	41%	13%	**5%**
	Dissolved oxygen	Insufficient end of 2023-2024 summer			
	Ecosystem metabolism	Insufficient end of 2023-2024 summer			
	Cyanobacteria (planktonic)	Insufficient data until end of 2025			
Proposed additional attributes	Water temperature	Insufficient data until end of 2023-2024 summer			
	Plastic / litter	Data available by the end of 2026			
	Heavy metals (Cu and Zn)	Insufficient data until end of 2026			

More than 60% of lakes are in fair to good water quality, with just over 30% in a eutrophic state.

Table 14. Compulsory and proposed freshwater quality attributes for lakes.

Attribute		A	B	C	D
Compulsory NPS-FM attributes	Total nitrogen	7%	33%	45%	**15%**
	Total phosphorus	26%	41%	33%	**0%**
	Ammonia (toxicity)	96%	4%	**0%**	**0%**
	Phytoplankton	19%	33%	26%	**22%**
	Lake-bottom dissolved oxygen	Insufficient data until end of 2024			
	Cyanobacteria (planktonic)	Insufficient data until end of 2025			
Proposed additional attributes	Lake trophic level index or Lake TLI (combined measure of nutrients, water clarity and algae)	4%	7%	52%	**37%**

What do we know about sources?

Rural Production Land

Along with *E. coli* and sediment, rural production land activities are the primary source of elevated nutrients in Northland's freshwater bodies. These inputs can be due to direct discharges (such as livestock access to waterways or discharges of farm wastewater) and run-off from pastoral or arable land use, including as a result of fertiliser application. Other sources include nutrients in human wastewater discharges from on-site systems and larger municipal treatment plants, and where stormwater treatment ponds attract large numbers of waterfowl. Sediment loss due to erosion within our volcanic soils can also transport dissolved reactive phosphorus (DRP) which is naturally high in such geologies.

The nature of rural production also requires the displacement of native vegetation with crops and pasture. Where topography is challenging, reduced riparian setbacks and production on steep land exacerbates the transport of contaminants to our waterways.

The loss of riparian vegetation also contributes to increased water temperature and subsequent growth of periphyton in rivers and cyanobacteria in lakes.

Figure 9. Brown and green cyanobacteria on a river bottom, October 2022.

Urban Stormwater

Our urban stormwater catchments are the primary source of heavy metals and plastics.

Trace metals such as copper (Cu) and zinc (Zn), and hydrocarbons from petrol and oil accumulate, on our road surfaces, including parking lots and service stations. These contaminants are flushed into our stormwater systems and streams during rain events and can accumulate on riverbanks and riverbeds.

Plastics, being the primary litter contaminant, are transported to our freshwater networks via illegal tipping, littering, or accidentally from overflowing public rubbish bins. Stormwater discharges from urban catchments are another key source. Weather-related events, such as high wind and overland flows, can also transport litter into our streams.

Industrial and Trade Activities

Industrial and trade activities generate similar contaminants to our urban areas, but in greater concentrations and can potentially include industrial wastewater generated as byproducts of an industrial process.

Northland's industries include clusters of activities within specific catchments (such as Port Road in Whangārei, Marsden Point, Waipapa, and Dargaville), as well as large manufacturing and processing sites that are generally isolated (such as Golden Bay Cement in Portland and AFFCO in Moerewa).

Where industries are located within existing urban catchments, there has been a historical lack of clarity regarding the responsibility of the discharge of industrial trade waste and runoff where sites are serviced by a public stormwater network. For example:

- if an industrial site discharges directly to a stream or coastal waters, there is a clear need for a discharge consent by the industry;
- if an industrial site discharges into the stormwater network owned and maintained by a Territorial Authority, the discharge to a stream or the coast occurs at the 'end of the pipe', at which point it would be the responsibility of the network discharge operator.

In summary key sources are:

Diffuse sources

- Overland flow/ run-off from developed pastoral land, erosion-prone land in extensive or intensive land-use with high connectivity to waterways, particularly following extreme weather events (e.g., high intensity rainfalls or prolonged dry spells) (Rissmann and Pearson 2020)
- Volcanic geology (e.g., basalt) in steep terrain, reducing landscape setting such as anoxic wetland soils, poorly drained soils in lowland pasture (Rissmann and Pearson 2020)
- Application of synthetic and organic fertiliser, Farm Dairy Effluent (FDE) to pasture, generating runoff from poorly drained or saturated soils, and potentially leaching into groundwater – tends to be localised rather than widespread
- Land use dominated by plantation forestry and other primary production land use (e.g., orchards, vineyards) – nutrient release and increased erosion after harvesting, fertiliser application after harvesting, change in lake water level
- Stormwater runoff from impervious surfaces (e.g., industrial premises, housing development, road networks) in urban catchments

Point sources

- Wastewater treatment plant discharges to water
- Wastewater treatment system passes during rain events
- Storm water discharges to water, particularly in urban catchments
- FDE discharges to water
- Industrial discharges
- Leachate from current and closed landfills
- Farm infrastructure/practices with high connectivity to water bodies e.g., stock drinking troughs, races, wintering pads
- Direct discharge of other toxic chemicals (e.g., agrichemicals, paint, pharmaceuticals, other industrial by-products)

What can we do about it?

Rural production land/activity

The key issues arising from rural production activity related to these attributes are similar to those for sediment and *E. coli*. Stock exclusion reduces direct discharges and providing vegetation on riparian margins provides a filtering function limiting run-off and provides for cooler water temperatures reducing the likelihood / frequency of nuisance algae blooms. Given nutrients can 'travel' with sediment (particularly DRP), the management of land disturbance activity especially in critical source areas such as highly erodible land can limit concentration in waterbodies. The better management of agricultural and human wastewater and requiring setbacks from waterbodies for fertiliser application are other mitigations that can reduce nutrient loads from production land.

Urban Stormwater and Litter

Northland's three district councils currently discharge urban stormwater through their public networks without any treatment. While the current rules require resource consents for our main urban areas, the rules are relatively new and most urban networks remain unconsented. We expect consent processes to improve the quality of stormwater discharges through conditions of consent and tools such as catchment management plans; however, we think targeted methods to reduce gross pollutants would be of immediate benefit and draft rules include new requirements for installation of gross pollutant traps within stormwater catchpits at high-risk sites, such as large parking lots at fast-food retailers. As a controlled activity, this will afford council the ability to control effects arising from gross pollutants on wahi tapu, mahinga kai, and sites of significance. Northland Regional Council is continuing to work with our district councils to improve the performance of their networks.

Figure 10. Example of a LittaTrap (proprietary device) installed within an existing roadside stormwater drain. These provide an additional filter that traps smaller pieces of litter that would otherwise flow through the grate.

Industrial and Trade Activities

Discharges from sites are currently a discretionary activity. It is proposed to increase this activity status to non-complying and clarifying that the discharge of stormwater from such sites also require resource consent.

The policy framework is proposed to encourage discharges to land and discourage discharges to water. Further to this, a new policy will require that discharge consents contribute toward achieving target attribute states for receiving waterbodies.

Data Collection

Many of these 'other' attributes identified above are known to have adverse effects on our freshwater values, but to what extent is still unknown due to the lack of sufficient data. This data will continue to be collected and analysed through to 2026 for the range of attributes with subsequent actions to follow to improve their attribute states as appropriate.

What improvement are we aiming for?

Proposed target attribute states – Rivers and Streams

Red = national bottom line

Table 15. Proposed target attribute states for rivers and streams for water quality attributes with defined baselines.

Timeframes	A	B	C	D
Attribute: Ammonia (toxicity)				
Baseline	92%	8%	**0%**	**0%**
End of 2035	92%	8%	**0%**	**0%**
End of 2040	94%	6%	**0%**	**0%**
End of 2050	96%	4%	**0%**	**0%**
Attribute: Dissolved reactive phosphorus or DRP				
Baseline	8%	22%	37%	33%
End of 2035	8%	22%	40%	30%
End of 2040	8%	24%	45%	23%
End of 2050	10%	25%	45%	20%
End of 2060	10%	25%	50%	15%
End of 2070	10%	25%	55%	10%
End of 2080	10%	30%	60%	0%
Attribute: Nitrate (toxicity)				
Baseline	94%	6%	0%	0%
End of 2035	94%	6%	0%	0%
End of 2040	95%	5%	0%	0%
End of 2050	96%	4%	0%	0%
Attribute: Periphyton biomass (benthic algae)				
Baseline	41%	41%	13%	5%
End of 2035	41%	41%	18%	0%
End of 2040	45%	45%	10%	0%
End of 2050	45%	50	5%	0%

Proposed target attribute states – Lakes

Red = national bottom line

Table 16. Proposed target attribute states for lakes for water quality attributes with defined baselines.

Timeframes	A	B	C	D
Attribute: Total nitrogen				
Baseline	7%	33%	45%	**15%**
End of 2035	10%	30%	50%	**10%**
End of 2040	10%	30%	55%	**5%**
End of 2050	10%	30%	60%	**0%**
Attribute: Total phosphorus				
Baseline	26%	41%	33%	**0%**
End of 2035	26%	44%	30%	**0%**
End of 2040	28%	44%	28%	**0%**
End of 2050	30%	45%	25%	**0%**
Attribute: Ammonia (toxicity)				
Baseline	96%	4%	**0%**	**0%**
End of 2035	96%	4%	**0%**	**0%**
End of 2040	96%	4%	**0%**	**0%**
End of 2050	98%	2%	**0%**	**0%**
Attribute: Phytoplankton (algae)				
Baseline	19%	33%	26%	**22%**
End of 2035	19%	33%	28%	**20%**
End of 2040	19%	33%	33%	**15%**
End of 2050	19%	33%	38%	**10%**
End of 2060	20%	45%	35%	**0%**
Attribute: Lake trophic level index or Lake TLI				
	Very Good	**Good**	**Fair**	**Poor**
Baseline	4%	7%	52%	**37%**
End of 2035	4%	7%	54%	**35%**
End of 2040	4%	7%	59%	**30%**
End of 2050	5%	6%	65%	**20%**
End of 2060	5%	15%	70%	**10%**
End of 2070	10%	20%	70%	**0%**

What would it cost?

We have not estimated total costs of draft rules for the management of these attributes, largely because the key rule changes that would improve these attributes (such as nutrients) are addressed by measures to reduce *E. coli* and sediment (e.g. stock exclusion, erosion control, discharge management, *etc.*). These costs are covered in the stock exclusion consultation document or in the section on *E. coli* above. In terms of stormwater networks, the cost of gross pollutant traps is relatively low at about $500 each – there are also minor installation and maintenance costs.

Attributes for aquatic habitat, life, and ecological processes

What are they?

These are a group of attributes in the NPS-FM that describe key elements of ecosystem health value, including habitat quality, aquatic life and ecological processes in freshwater bodies.

Related NPS-FM attributes (not covered elsewhere) are:

- **Native submerged plants (lakes)**

  Submerged native plants in lakes indicate ecological health. Lakes with high ecological condition generally have a littoral zone with a high number and diversity of native aquatic plants, and an absence or low number of invasive aquatic plants of the lake.

- **Invasive submerged plants (lakes)**

  An indicator of the degree of impact from invasive weed species

- **Fish (wadable rivers)**

  Fish Index of Biotic Integrity is an indication of fish diversity and abundance reflects presence or absence of fish barriers and suitable fish habitat

- **Macroinvertebrates (wadable rivers)**

  Collectively this refers to animals lacking a backbone, and large enough to see without the aid of a microscope, including insects, crustaceans (e.g., crayfish), molluscs (e.g., snails), and various groups of worms. Macroinvertebrates are the main food source of fish. They are used as an indicator of river health. There are three metrics used in the NPS-FM - Macroinvertebrate Community Index (MCI), Quantitative Macroinvertebrate Community Index (QMCI), and Macroinvertebrate Average Score Per Metric (ASPM).

- **Deposited fine sediment (wadable rivers)**

  A measure of the amount of fine sediment on riverbeds.

- **Water quantity**

  (The extent and variability in the level or flow of water) is also a key attribute for ecosystem health in our lakes and rivers. This attribute is covered in a separate section below.

Note: There are no NPS-FM attributes for groundwater or wetlands.

Council has also identified two additional attributes that would be beneficial in Northland – these are:

- **Rapid Habitat Assessment (RHA)**

  A survey from the bank that gives a broad overview of the suitability of the habitat for invertebrates and fish. This provides a more comprehensive assessment of habitat quality in our rivers.

- **An exotic fish attribute for lakes**

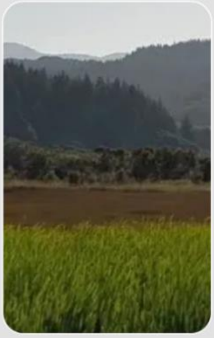
  Exotic fish have the potential to impact on lake ecosystem health and to significantly alter freshwater communities and ecosystem processes – they can also worsen water quality and are a particular concern in dune lakes.

What do we know about aquatic ecosystems in Northland?

Northland's lakes, rivers and streams provide habitat for a wide range of native birds, fish, invertebrates and aquatic and wetland plants, some of which are only found in Northland. Many of these are taonga species for tāngata whenua. A number of our native freshwater species are threatened (3 fish, 5 birds, 2 molluscs and 11 plants).

There are multiple threats to freshwater biodiversity, ranging from direct impacts such as habitat loss or disturbance to ongoing stressors such as poor water quality, pest plants and animals, and the risks posed by climate change such as reduced flows / water levels. Loss of wetland extent is particularly significant in Northland with original extent estimated to have been reduced from 35% to 3.2 % by area.

Managing freshwater biodiversity is complex given the many variables that influence the state and the variable sensitivity of habitats / waterbodies. The wide range of Northland's freshwater habitats such as streams, rivers, aquifers, lakes, dune lakes and wetlands are very varied because of differences in topography, climate, water flows, geology and distance from the coast. Therefore, the aquatic life in the region is extremely varied and includes many significant ecological values such as habitat for a range of threatened species that depend on freshwater.



Habitat

Since human arrival wetland area has decreased from a third to about 3% of Northland.

Wetlands types include swamp, bog, marsh, wet heathland, fen, saltmarsh and ephemeral habitat.

Gumland and dune lakes in Northland are internationally rare.

Sedimentation, degraded water quality and reduced connectivity impact aquatic habitats.

Birds & Bats

40% of NZ birds are classified as threatened or at risk of extinction.

In Northland these include freshwater dependant species such as bittern, brown teal, fernbird, marsh crake and dabchick.

Both New Zealand's endemic bat species are threatened, found in Northland, and associated with freshwater habitat.

Fish & Frogs

Northland has 23 native fish and many depend on good connectivity.

>50% of Northland fish are endemic.

Dune lake *Galaxias* and Northland mudfish are only found here.

Shortjaw kokopo and lamprey are found in our region and threatened.

Forest streams in the Brynderwyn hills area provide Hochstetter's frog habitat.

Invertebrates

These are animals that lack a backbone.

~131 freshwater taxa are found in Northland.

Taxa sensitive to pollution- stoneflies, mayflies, caddisflies are more common in forested streams

Taxa more tolerant of pollution- snails, segmented worms are more common in non-forested areas

Freshwater mussel, and mayfly *Zephlebia* found here are threatened species

Plants

Our region is home to rare plant communities including characean algae meadows that are globally rare.

Quillwart once found commonly in Lake Ōmāpere is now extinct in the wild.

Other examples of stark decline of native aquatic plants are the tiny *Trithuria* and bladderwart *Utriculairia*. These declines coincide with water quality declines.

https://www.nrc.govt.nz/media/alqdjmzx/nativefishinnorthlandrivasreport20.pdf

Macroinvertebrates

There is a minimum of ~131 freshwater macroinvertebrate taxa in Northland according to NRC's annual macroinvertebrate data. The actual number of taxa (types of species) will be much greater than that presented in the data as they are often identified to a higher level than species. In general, taxa sensitive to pollution and disturbance (e.g., stoneflies, mayflies, and caddisflies) are more common and abundant in forested streams at higher elevations and farther from the coast whereas taxa more tolerant of pollution and disturbance (e.g., snails, segmented worms, etc.) are more common and abundant in non-forested areas and/or at lower elevations near the coast.

Aquatic plants

Northland lakes and wetlands are home to a range of rare or representative communities of plants. For instance, intact native characean (freshwater algae) meadows still found in many Northland lakes are regarded as globally rare. Aquatic and wetland plants are over-represented in Nationally Threatened and At Risk: Declining lists in comparison to terrestrial species. Of particular concern in Northland are three plants listed as Nationally Critical.

Freshwater habitats

Prior to the arrival of humans, 35 percent of Northland was in wetlands (453,250 ha), now reduced to 14,291 ha. Northland is one of the most impacted regions in New Zealand with only 3.2 % of its wetland area left, which is less than the national average of 10%. Around 75% of Northland wetlands are smaller than 10ha with only three larger than 500ha. A range of different types of wetlands can be found in Northland e.g., marsh, swamp, seepage, fen, bog, and gumland. Each type provides its own unique habitat and associated biodiversity. In particular, the gumland wetland is ranked as 'Nationally endangered' and Northland supports nearly all the remaining viable gumland habitat. Once common, only 5% of this type of wetland remains in Northland. Bogs and fens are also rare wetland types in Northland (NRC Biodiversity Team, 2023 & other references).

Another special freshwater ecosystem in Northland is our dune lakes. This type of lake is internationally rare. Many are found in New Zealand, with the Northland region home to the highest number of dune lakes in the country, around 350 dune lakes greater than 0.5 ha in size and up to 50,000 years old (Forester and Baillie 2022).

How do we measure up?

Council has identified the baseline state for most of the attributes applied to habitat, aquatic life and ecological process. Macroinvertebrates are a key indicator of aquatic ecosystem health in rivers – our baseline state assessment shows our rivers are impacted with over 50% of sites in a D state and below the national bottom line (Figure 11).

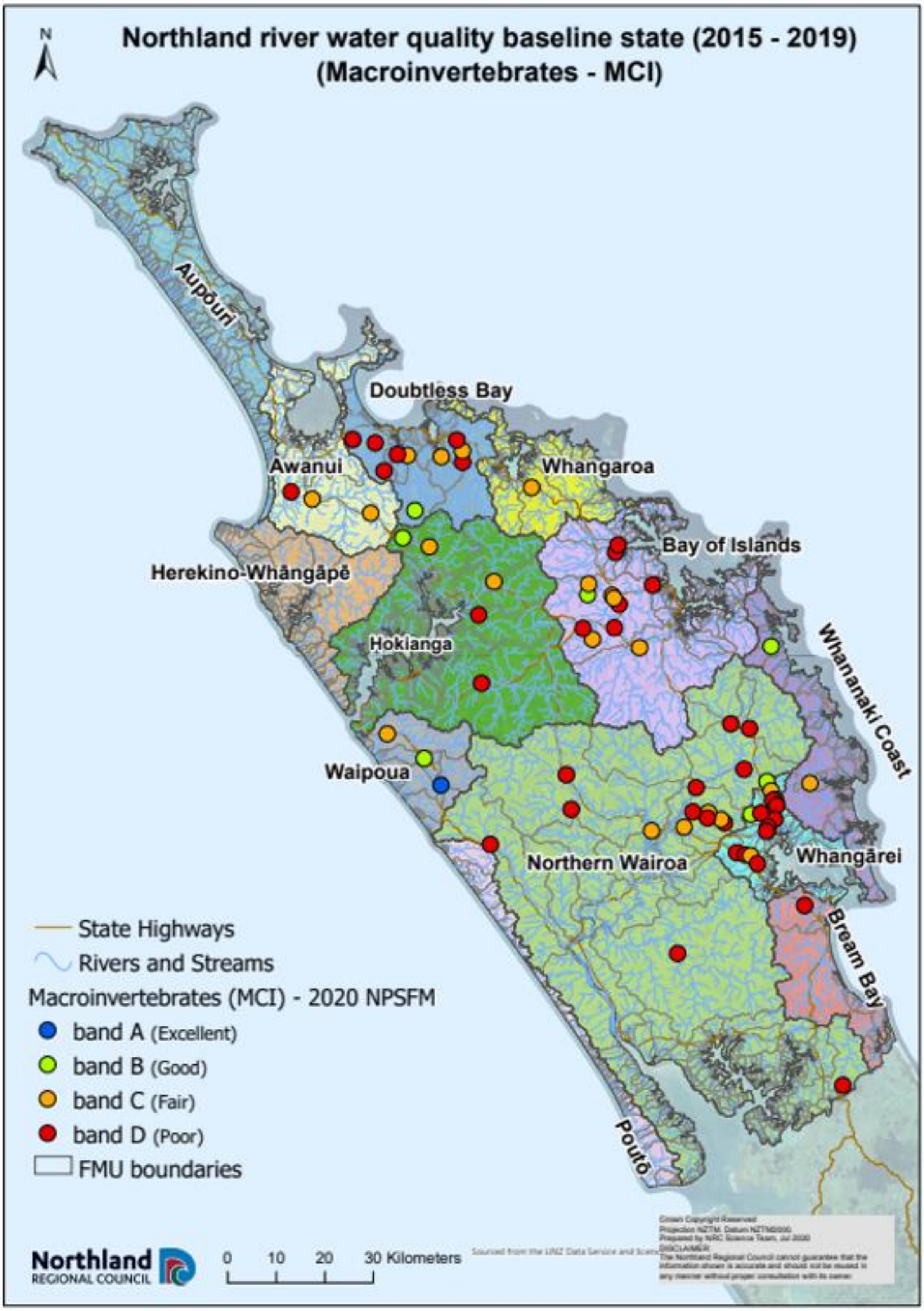


Figure 11. Baseline state for macroinvertebrates (MCI) in Northland.

The baseline state for these ecosystem health attributes is shown Table 7 overleaf.

Table 17. Assessment of baseline states of biodiversity values in lakes and rivers.

NPS-FM Compulsory Attributes – baseline state					
Band	**A (%)**	**B (%)**	**C (%)**	Bottom line	**D (%)**
Submerged plants (native species lakes) n=26	15.5	50	19		15.5
Submerged plants (invasive species lakes) n=26	38	24	38		0
Fish IBI (wadable rivers) n = 20	65	20	10		5
Macroinvertebrates MCI (wadable rivers) n=66	1	11	33		55
Macroinvertebrates QMCI (wadable rivers) n=66	4	9	17		70
Macroinvertebrates (ASPM) (wadable rivers) n=66	4	23	20		53
Deposited fine sediment (wadable rivers)	Insufficient data until the end of 2027				
NRC proposed attributes – baseline state					
Number of sites	**Excellent**	**Good**	**Fair**	Bottom line	**Poor**
Rapid habitat assessment (rivers) n=39	15	57	28		0
	A: Unimpacted	**B: Slightly impacted**	**C: Moderately impacted**		**D: Severely impacted**
Exotic fish (lakes) n=27	45	41	7		7

What impacts on these attributes?

There are multiple interacting factors that affect aquatic ecosystem health – including water temperature, dissolved oxygen, riparian shading, flows / levels and habitat connectivity. Sediment or turbidity, dissolved oxygen, temperature, nutrients, riparian plants, substrate composition, and water level, of the freshwater body affect its biodiversity as do reduced connectivity and pest species. As our environment is intricately connected and interdependent. It is challenging to pin down one key driver or cause. A holistic approach to identify multiple important factors is used. [7][8]

Loss of wetland extent is particularly significant in Northland with original extent reduced from 35% to 3.2 % by area. Dune lakes are internationally rare and considered 'globally imperilled'. They are at risk from pest species (e.g. invasive weeds, exotic finfish and shellfish) and development. Declines in water quality, and nutrient enrichment of lakes cause loss of rare and threatened aquatic plants. Aquatic pest plants such as hornwort, bladderwort, *egeria* and *lagarosiphon* displace native species or weed out oxygen 'drowning' native aquatic plants and animals. Adding to the battle, exotic fish, such as grass carp, gambusia, and gold clam, can vigorously change the ecosystem of a lake or river. They stir up sediment, increase nutrient levels, and algal concentrations.

In rivers, sediment and nutrient enrichment from pastoral lands interfere with macroinvertebrate diversity and abundance. Northland has seen cyclic weather events of drought and floods in the past decade. Invertebrate recovery and resilience to catastrophic weather events is affected by water quality and sediment, which in turn affects fish abundance and health. Weirs, dams, diversions, and culverts if not engineered appropriately can act as a barrier or impede fish passage. Fish barriers interfere with availability of spawning and feeding habitat. Other species depend on fish passage

[7] https://www.nrc.govt.nz/resource-library-summary/research-and-reports/rivers-and-streams/drivers-of-macroinvertebrate-communities-in-northland-streams/

[8] https://www.nrc.govt.nz/resource-library-summary/research-and-reports/rivers-and-streams/ecological-health-of-stream-invertebrate-communities-in-northland

such as Kākahi / Kāeo (Freshwater mussels) that have a unique life cycle that relies on fish to be successful. The Kākahi larvae attach themselves to a host fish (e.g. kōaro, tuna, bullies, banded kōkopu) and are parasites on the fish host until transforming completely into a juvenile mussel and dropping off the fish. Of the 20 native river fish in Northland, only 2 are non-migratory (black and Northland mudfish).

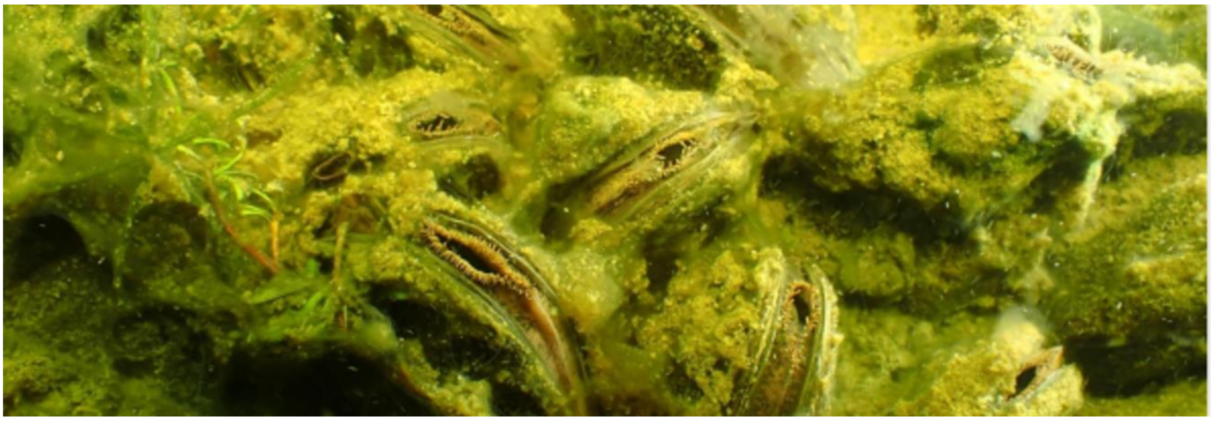


Figure 12.Kakahi smothered by benthic algal growth in freshwater lakes.

In summary, the pressures on our freshwater biodiversity and freshwater habitats are many, and most face multiple pressures, primarily from human activities. These pressures include:

- Loss of/degraded/fragmented habitat (in-stream and riparian) from human activities e.g., riparian vegetation clearance, wetland drainage and modification to beds of rivers and lakes,
- Degraded water quality (all water bodies: rivers, lakes, wetlands, groundwater),
- Excess nutrients (nitrogen and phosphorus) can cause algal blooms and excessive plant growths,
- Barriers to fish passage including physical, thermal and chemical barriers,
- Elevated sediment smothering habitat and restricting the ability of fish to feed,
- Modified flow regimes – especially reduced flushing flows or sustained low flows in rivers,
- Stock access to water bodies disturbing habitats and riparian margins,
- Elevated water temperature and disruption to dissolved oxygen regimes,
- In-stream bed/lakebed disturbance, stream bank disturbance,
- Riparian vegetation disturbance/removal,
- Constrained /straightened stream channels/drainage,
- Depleted supply of woody debris,
- Pests (mainly aquatic weeds and pest fish) - competition for habitat, predation and long-term impacts on water quality,
- Climate change, including more extreme weather events, floods, impacts of increased droughts.

What can we do about it?

A range of combination of actions are most likely to produce maximum benefits for aquatic ecosystem health attributes, but there are some that are likely to be effective across multiple attributes. For example stock exclusion reduces nutrient inputs and disturbance of river and lake beds and vegetated riparian margins filter run-off (e.g. sediment and nutrients), provide shading (create cooler temperatures) and provide habitat, including spawning sites. Council is seeking feedback on options for stock exclusion from margins of waterbodies, wetlands and highly erodible land For more detail see *Have Your Say on Stock Exclusion*. Council is also seeking feedback on draft maps of highly erodible land – these can be seen here.

Possible mitigations for the biodiversity attributes, based on the most likely key pressures discussed above.

- Fencing of waterbodies (including wider setback distances)
- Riparian restoration and planting
- Removing fish barriers
- Pest fish & weed control
- Aquatic pest pathway management including prevent the spread campaigns (public education and working with waterbody users)
- Re-establishing connectivity (in-stream and riparian)
- More protection for important sites (e.g. inanga spawning sites)
- Wetland establishment, maintenance and restoration
- Controlling bed/riparian disturbance
- Tighter controls on the location of plantation forestry
- Targeted floodplain restoration
- Sediment reduction including controls on land disturbance on highly erodible land
- Better management of discharges to reduce nutrient concentrations
- Environmental flows and levels, including minimum and flushing flows (see below)

Council has identified potential changes to rules to protect and improve aquatic ecosystem health. These are summarised below.

Draft Rule changes

- Tighter controls on riverbed disturbance and more protection for important sites (such as Inanga spawning sites
- Tighter controls on vegetation clearance in riparian areas and on highly erodible land
- Tighter controls on land disturbance on highly erodible land
- Controls on plantation forestry including larger setbacks from rivers and in high value dune lake catchments
- Tighter controls on farm dairy and human wastewater discharges.

Action plans

In addition, council is required to develop action plans to complement changes to regional rules and deliver on outcomes for freshwater. Under the NPS-FM, an action plan may describe both regulatory and non-regulatory measures, must identify the environmental outcomes/target attribute states it is supporting, must be developed in consultation with communities and tāngata whenua, and must be published as soon as practicable and reviewed within 5 years of publishing. Key actions council has identified include:

- support for stock exclusion fencing and riparian planting,
- support for establishing new wetlands and wetland monitoring programme,
- implementation of a threatened species monitoring programme
- development and implementation of a Fish Passage Action Plan (partly funded by MFE),
- assess effectiveness of all mitigations
- increased compliance effort
- support public awareness and outreach

What improvement are we aiming for?

The NPS-FM requires that council identify target states for attributes where improvement is required to meet national bottom lines or to meet freshwater outcomes. We think the combination of changes to regional rules and action plans will deliver improvement in aquatic ecosystem health attributes. The draft target states are detailed in Table 18.

Table 18. Baseline and target states for freshwater biodiversity attributes in lakes and rivers.

NPS-FM Compulsory Attributes – baseline state					
Submerged plants (native) (lakes n=26)					
Timeframes	**A (%)**	**B (%)**	**C (%)**	Bottom line	**D (%)**
Baseline (2016-2020)	15.5	50	19		15.5
End of 2035	26	45	22		7
End of 2040	33	41	22		4
End of 2050	41	37	22		0
Submerged plants (invasive species (lakes n=26)					
Baseline (2016-2020)	38	24	38	Bottom line	0
End of 2035	48	22	30		0
End of 2040	52	26	22		0
End of 2050	56	26	18		0
Fish IBI (wadable rivers) (n = 20)					
Baseline (2015-2019)	65	20	10	Bottom line	5
End of 2035	65	20	15		0
End of 2040	65	25	10		0
End of 2050	65	30	5		0
Macroinvertebrates (wadable rivers) MCI (n=66)					
Baseline (2015-2019)	1	11	33	Bottom line	55
End of 2035	2	10	38		50
End of 2040	2	20	38		40
End of 2050	2	30	58		10
End of 2060	7	50	43		0
Macroinvertebrates (QMCI) (wadable rivers) (n=66)					
Baseline (2015-2019)	4	9	17	Bottom line	70
End of 2035	4	9	27		60
End of 2040	4	16	30		50
End of 2050	4	26	40		30
End of 2060	4	46	50		0
Macroinvertebrates (ASPM) (wadable rivers n=66)					
Baseline (2015-2019)	4	23	20	Bottom line	53
End of 2035	4	23	23		50
End of 2040	4	23	43		30
End of 2050	4	33	43		20
End of 2060	4	46	50		0

NRC proposed attributes					
Rapid habitat assessment (rivers) (n = 39)					
Timeframes	**Excellent**	**Good**	**Fair**		**Poor**
Baseline (2016-2021)	15	57	28	Bottom line	0
End of 2035	15	57	28		0
End of 2040	15	65	20		0
End of 2050	20	70	10		0
End of 2060	20	75	5		
Exotic fish (lakes) – last 20 years data (n=27)					
Timeframes	**A**	**B**	**C**		**D**
Baseline	45	41	7	Bottom line	7
End of 2035	45	45	3		7
End of 2040	45	48	0		7
End of 2050	45	48	0		7

Note: we do not have sufficient data to set the baseline state or targets for deposited sediment.

The targets and timeframes recognise that:

- The macroinvertebrate attributes are the most challenging given the baseline states are comparatively poor. There are multiple variables affecting macroinvertebrate attributes that are affected by multiple variables (such as water quality, temperature, riparian cover etc) so can be more complex and require a range of mitigations to be implemented before attributes states improve. The timeframes for target states therefore extend to 2060.
- Re-establishing riparian margins is a key tool in achieving target states for ecosystem health but will take a long time (decades if not more) to achieve.
- Once established invasive plants in lakes can be difficult to eradicate and can require constant effort to control reinvasions.
- Target states for Exotic Fish do not shift the D band sites (2 lakes / 7% of the 27 lakes) given the intractability of managing multiple pest fish, the size of these lakes and absence of tools. The lack of tools available to manage Gambusia also means shifting B band lakes to A band is not possible at this time.
- Climate change may also improve conditions for existing species / new invasives which could affect timeframes.
- Achieving target attributes states will be reliant on mitigations being supported and implemented in a timely fashion e.g. stock exclusion and riparian planting.
- Mitigations will need to be targeted given resourcing available and therefore some areas may necessarily take longer to improve.

What would it cost?

We have not estimated total costs of draft rules for the management of these attributes – this is largely because the key rule changes that would improve the state of a number of these attributes (such as macroinvertebrates) are addressed by measures to reduce *E. coli* and sediment – the main costs of which are covered in the stock exclusion consultation document or in the section on *E. coli* above.

Attribute: Water Quantity

What is it?

The water quantity attribute describes the extent and variability of water levels and flow rates within our freshwater bodies, including surface water and groundwater. It is one of the 5 biophysical components of the compulsory freshwater values of Ecosystem Health in the NPS-FM. Given it affects most freshwater values it can be considered a 'master' attribute for freshwater.

The Proposed Regional Plan (PRP) water quantity provisions (rules on taking water and environmental flows, levels and allocation limits) have recently been confirmed through the Environment Court and are designed to protect in-stream ecosystem health. At this stage, we do not have any additional information to indicate the approach in the PRP requires significant change through the draft freshwater plan change. However, the NPS-FM requires an assessment of how the current water quantity regime in the PRP gives effect to the Te Mana of te Wai hierarchy (the requirement to put the health and well-being of waterbodies and ecosystem first). This assessment is underway and will be available to inform development of the Proposed Freshwater Plan Change to be publicly notified in late 2024.

How does it affect values for freshwater?

Water is a taonga, a resource critical to all people for their health and well-being. Access to drinking water is a basic human right and the availability of a reliable and secure source of water is essential to our cultural, social and economic well-being.

Surface water quantity determines the depth of water within freshwater bodies as well as the lateral extent of the bodies and their interfaces with surrounding land (*e.g.* riparian margins in river systems, wetland forebays, and littoral zones in lakes). It is often within these interfacing margins where much of the biodiversity within aquatic habitats is found.

Together, these properties determine different ecological habitats and the subsequent flora and fauna that establish within these environments. Environmental Flows and Levels describe the levels at which habitats can provide for the natural flora and fauna within the ecosystem.

Ensuring adequate water flow and levels in waterbodies is important for numerous reasons:

- Safeguarding the wellbeing and ecosystem health of water bodies.
- Flushing flows are important for reducing algae and build-up of fine sediment (reduced flows can degrade aquatic life and lower amenity and recreational values).
- Maintaining water temperature and dissolved oxygen (low flows in streams can lead to higher temperatures and less dissolved oxygen)
- Preventing overload of contaminants (less water can mean higher concentration of contaminants)
- Allowing for navigation and recreational use.
- Providing food for drift-feeding fish and enabling fish passage.
- Providing cues for fish migration and spawning.
- Opening river mouths.

Where is it measured?

Water quantity is measured within our lakes, rivers, wetlands, and groundwater aquifers.

Water flow rates are measured in a number of rivers using flow gauges – see: https://www.nrc.govt.nz/environment/environmental-data/environmental-data-hub/?moduleId=5&collectionId=19

Flow rates are primarily influenced by water quantity, topography, and riverbed morphology, though temporary changes do occur due to weather events and human activities.

There are two key factors in managing water quantity: minimum flows/levels and allocation limits. They work together to protect waterbody values as well as security of supply for users. Minimum flows/levels specify the minimum amount of water that must remain in the waterbody; they are also used in consent conditions to direct when takes must be reduced or cease. Allocation limits cap the amount (volume) of water that can be extracted through consents or permitted activities (both are typically expressed as a percentage of flow in a river, or of groundwater recharge).

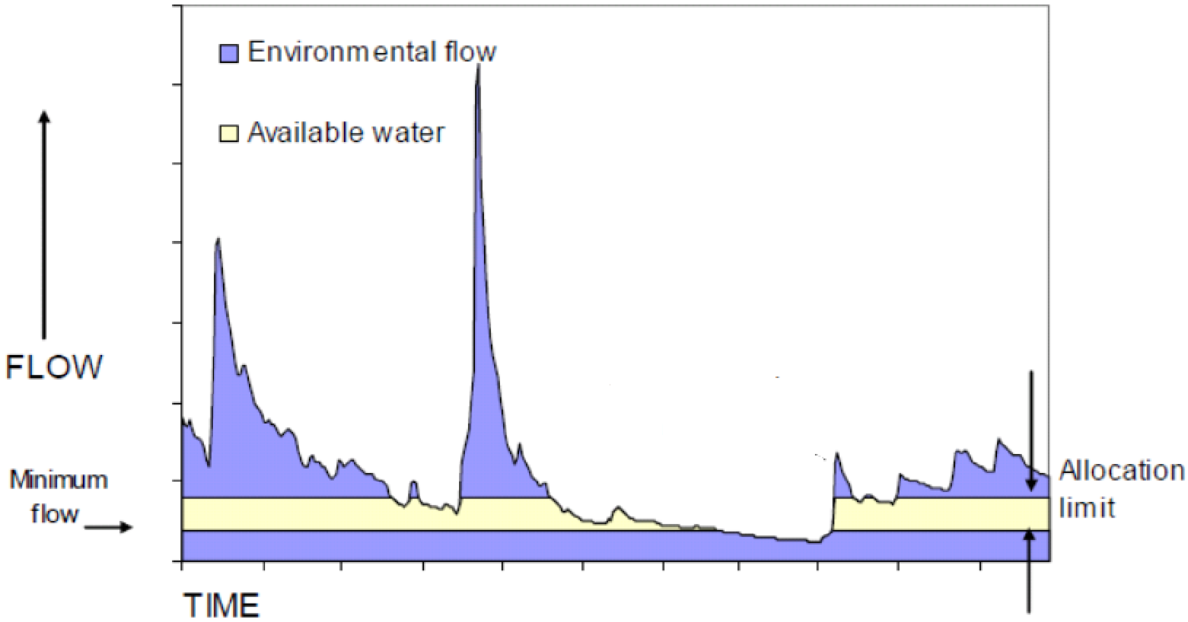


Figure 13. Minimum river flows and allocation limits - example for water available for consumptive takes.

The Regional Plan framework identifies Freshwater Management Units (FMU) for various water body types for managing water quantity (refer Table 19). These reflect the different characteristics of water bodies and their sensitivity to extraction - minimum flows and allocation limits vary for each FMU accordingly.

Table 19. Water quantity Freshwater Management Units (FMU).

Rivers	Lakes / wetlands	Aquifers
Outstanding rivers	Deep lakes (> 10 metres in depth)	Aupōuri aquifer
Coastal rivers	Shallow lakes (≤ 10 metres in depth)	Coastal aquifers
Small rivers	Dune lakes	Other aquifers
Large rivers	Natural wetlands	

The allocation limits and minimum flows set in the Proposed Regional Plan are based on:

- a percentage of the 7 day mean annual low flow in rivers
- a percentage of annual average recharge in aquifers
- change in level for lakes and wetlands
- Specific volumetric limits have been set for the Aupouri aquifer.

How do we measure up

There are areas of full allocation in the region where no more water can be allocated (except during high flows). There are 35 surface water catchments that are fully allocated in accordance with limits in the Regional Plan – these cover approximately 10% of the Northland region.

Seventeen catchments of these catchments are fully allocated as a result of consented takes, and the remaining 18 fully allocated catchments is due to estimates of stock and dairy permitted/unconsented water takes. For groundwater 11 of our 63 mapped aquifers are fully allocated in accordance with the current regional plan limits.

In fully allocated areas we cannot allocate further water takes below median flows other than for new registered drinking water takes. High flow harvest (taking water above when the river is above median flow) is a consent pathway within fully allocated areas.

The level of surface and groundwater allocation can be viewed here: https://www.nrc.govt.nz/your-council/about-us/council-projects/new-regional-plan/indicative-water-quantity-allocation-maps/

Table 20. Water takes authorised by resource consents.

Consent Type	No. of Consents	No. of Locations Authorised by Consent	Water Volume by source (million metres^3 per year)
Dam water take	77	79	138.12
Groundwater take	310	368	22.4
Durface water take (incl. lakes)	177	179	70.18
Total	**566**	**628**	**230.7**

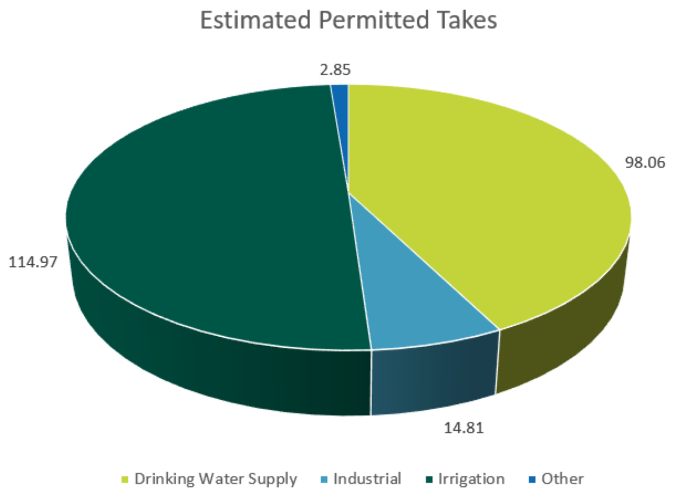


Figure 14. Breakdown of estimated permitted water takes.

Permitted takes:

- Estimated at 15% of the total volume for surface water
- About 20% for groundwater

The existing policy within the Proposed Regional Plan (PRP) is generally well aligned with the NPS-FM, but will require some modifications to fully give effect to the new policy regime, including:

- Assessing how the PRP framework delivers on Te Mana o te Wai hierarchy;
- Whether the current framework provides for the aspirations of tāngata whenua
- Whether our regional limit exceptions for new registered drinking water takes as a non-complying activity is appropriate;
- Whether we require a maximum volume cap/limit for high-flow harvesting;
- Our FMUs were determined in 2017, prior to the NPS-FM and outside of the required consultative structure involving tāngata whenua and communities.

While there we do not have evidence of major concerns with the current regime for water quantity, the draft freshwater plan change provides an opportunity for any issues to be raised and addressed as needed.

What do we know about the issues?

- Some catchments are fully allocated, with others having more than 75% of available flow allocated, decreasing availability of water for further uses and reducing environmental resilience for fully allocated streams;
- Changes in water use intensity in some catchments may lead to future allocation issues as towns grow, grazed land is converted to dairy or horticulture, and new commercial forests are planted;
- Cultural values over and above the existing environmental flows are not always addressed through the existing allocation regime; and
- Weather extremes and projected climate change impacts continue to present uncertainty and risks associated with water availability.

Specific issues are discussed in more detail below.

Surface Waterbodies

Water quantity in surface waterbodies is determined by catchment size, climate, stream and river morphologies, and affected by human activities which include water abstractions, land uses, and discharges. The evolving use of agricultural land in Northland is resulting in increased water use requirements in an already vulnerable period of climate change and extreme weather events.

Permanent diversion and damming, which result in more physical changes to the extents of freshwater bodies in particular, could lead to permanent biodiversity loss. For example, reclamations of waterbodies will not only impact the riverbed or lakebed at the location of the reclamation, but it will also affect water levels through displacement and subsequent flow rates upstream and downstream of the reclamation. Wetlands are particularly sensitive to such changes due to the specifically adapted flora and fauna that form wetland biomes.

Groundwater Aquifers

Groundwater aquifers are formed within strata of earth with more porosity and permeability than its surrounding soil and rock types. Aquifers are recharged slowly by rainfall and can affect river, lake, and wetland levels where aquifers contain springs and upwells. Confined aquifers, which may be located further below ground level and have less connectivity to surface water, recharge more slowly and are typically less influenced by variations in weather conditions.

Coastal aquifers, including the Aupouri Aquifer (beneath the Aupouri Peninsula) have the added complexity of interfacing with saline waters from the sea. Salt water has a higher density than freshwater, and the reduction in fresh groundwater levels could result in the permanent intrusion of saltwater into the aquifer, reducing the volume of freshwater available or rendering the supply unsuitable for resource use. Sea level rise adds to the vulnerability of coastal aquifers.

Furthermore, prolonged periods of drought reduce aquifer recharge rates and subsequent supply in the long term while coinciding with increased water needs.

Due to the variability of geology and practical difficulty in obtaining empirical data across the region, much of our groundwater resources has been crudely quantified using models, utilising data from existing production wells and test bores. More focus has been placed on coastal aquifers and the Aupouri Aquifer due to the vulnerability to saltwater intrusion.

Cultural Impacts regarding water use and allocation

The existing water allocation system employs a 'first-in, first-served' hierarchy. Where there is water available for allocation, it is allocated based on the resource consent process and prioritises providing for existing water uses that are authorised by existing consents. This means that in fully allocated catchments, new activities that require water use will likely not be able to progress until currently allocated water becomes available – either through expired or surrendered consents.

TWWAG has identified the foreseeable issue arising in the coming years of lack of water availability in catchments where it coincides with the return of land to tāngata whenua through the Waitangi Tribunal process and the resulting influx of water resource demand. To provide for this likely future demand, while balancing the cultural and environmental values associated with water flows and levels in rivers and lakes, can be difficult and uncertain in our current first-in-first-served regime.

What can we do about it?

As water quantity is largely determined through availability within the catchment minus water abstractions and diversions, limits are typically put into place to prevent water levels and flows from decreasing below the environmental flows and levels. Policies, rules, and the subsequently required resource consents enable water use while managing these environmental values through discretion during the decision-making process and conditions of consent for granted applications.

In practice, our current policy framework enables water takes and diversions during times of ample water quantity and restricts or prohibits water takes and diversions during periods of low water quantity. Water supplies need to be quantified in order to create an acceptable limit of water to allocate for potential use, while also determining what minimum flow is required to provide for natural ecosystem health.

Water quantity is managed through the environmental flow/level and allocation limits regimes set in the Regional Plan that ensure sufficient water remains in waterbodies to protect their values. Council also includes conditions on consents for water takes that require people to cease taking when minimum flows or levels are reached. Council can also use water shortage directions requiring that water takes cease or reduce during dry periods to protect freshwater bodies.

Water storage projects – can lessen impacts from extreme events while providing increased water supply for more efficient use, resilience, and wellbeing.

Promotion of water use efficiency (fully allocated catchments and district council supply networks).

Targeted Water Allocation Policy

Following the consideration of recommendations by TTWAG, NRC is considering a new Targeted Water Allocation Policy that would apply to water that is not currently allocated. This policy aims to reserve 20% of currently unallocated water to give effect to Te Mana me te Mauri o te Wai – increasing resilience of waterbodies to protect and enhance environmental, amenity, and cultural values associated with using our lakes and rivers. While this policy is region-wide, each catchment will retain its existing water allocation regime, and the targeted policy would only apply to the currently unallocated water within each catchment.

Figure 15 demonstrates how this policy would apply to water available for allocation in two hypothetical catchments. In Example A, there is currently 10.0m^3/s of unallocated flow. With the targeted policy, 20% of the 10.0m^3/s flow (*i.e.* 2.0m^3/s) would be 'set aside'. New water take applications would 'take' from the remaining 8.0m^3/s until this becomes allocated. Further takes from the reserved 2m^3/s can be accessed through the resource consent process but would need to be for the purposes of environmental or cultural enhancement, otherwise a financial contribution to an environmental and cultural enhancement fund would be required. It is noted that the draft plan does not yet include rules pertaining to financial contributions.

Example B works in the same manner, though due to the lower volume of water currently unallocated (2.0m^3/s), the targeted 20% is correspondingly lower (0.4m^3/s).

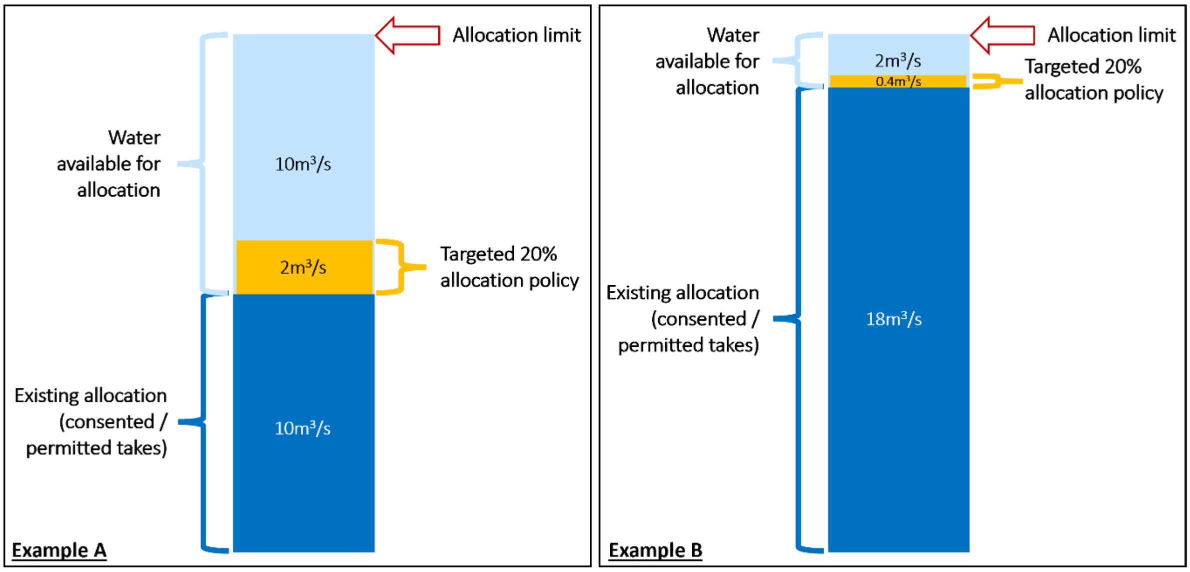


Figure 15. Examples of how the Targeted Water Allocation Policy could apply to existing water allocation schemes.

What improvement are we aiming for?

There are a range of recommendations from TWWAG, changes to the existing policy framework, and actions being considered:

- Reserving 20% of allocable water for:
  - Environmental enhancement;

  Domestic use for Marae and papakāinga, Māori wellbeing, and development of Māori owned land (This is a policy recommendation from TWWAG that is the subject of a discussion document – see: *Have Your Say: Targeted Water Allocation Policy.*

- Changes to the resource consent requirements:
  - A policy regarding consents for bottled water;
  - Requiring Cultural Impact Assessments for consents for activities affecting wai, including water takes;
- Improve wording of catchment and aquifer allocation policies to:
  - protect from saline intrusion;
  - add matters of discretion on cumulative effects, maintenance of flushing flows and mahinga kai, wāhi tapu, sites of significance, and ability to undertake cultural activities;
  - Apply a 'sinking lid' to the allocation of water in the Mangere catchment - meaning that as water take consents expire, the allocation levels decrease to the PRP limits, as is done elsewhere;
  - delete obsolete time-limited rules to authorise existing takes;
  - reduce ambiguity in wording of bore rules and aligning activity status within fully allocated catchments (from permitted to discretionary);
- Introduce controls on afforestation in areas sensitive to hydrological changes (high value lakes);
- Update policy on 'avoiding over allocation and 'minimum flows/levels' to align with the FW outcomes.

If implemented, these policy changes will provide more certainty over water resource supply, further protect environmental values, and increase Council's ability to control water use – particularly in fully allocated catchments and aquifers.

What would it cost?

The draft changes to water quantity provisions are relatively minor and therefore have not been costed.

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