Te Waewae Bay western **coastal zone**

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Te Taiao Tonga

Te Waewae Bay western coastal zone

This document summarises scientific information for freshwater and estuarine areas, opportunities for action and the socioeconomic context of the Te Waewae Bay western coastal zone. This area includes rivers and streams that drain directly to the coast west of the Waiau River.

It is one of twelve catchment summaries prepared for Murihiku Southland.

We have collated and presented scientific data at the catchment scale to provide an understanding of freshwater quality and quantity challenges and their underlying factors. We have included an evaluation of the current state of freshwater within the catchment and highlighted the magnitude of change necessary to meet freshwater aspirations.

The information in this document should be considered alongside other information sources, including mātauranga Māori.

Main features

Land area: 29,800ha

Major rivers and streams: Grove Burn, Rowallan Burn, Waikōau River, Hump Burn

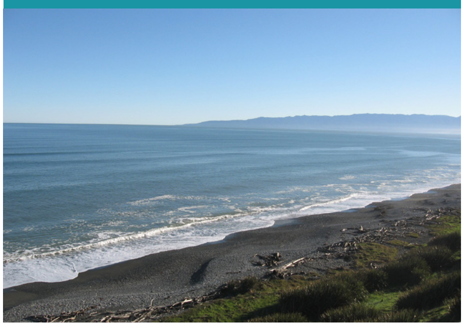
Aquifers: Outside recognised zone

Lakes: None

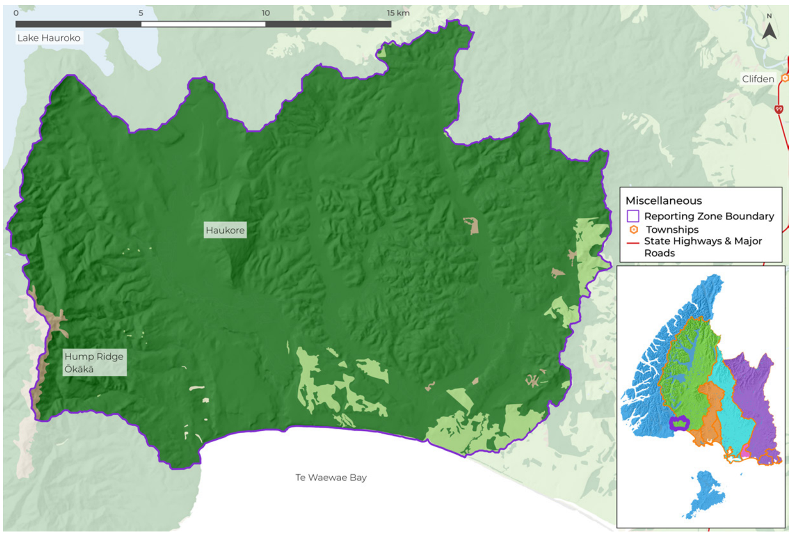
Estuaries: None

Townships: None

Population: Less than 50



Catchment outline



For most attributes, current state is assessed using data from the 2018 – 2022 period.

Key messages

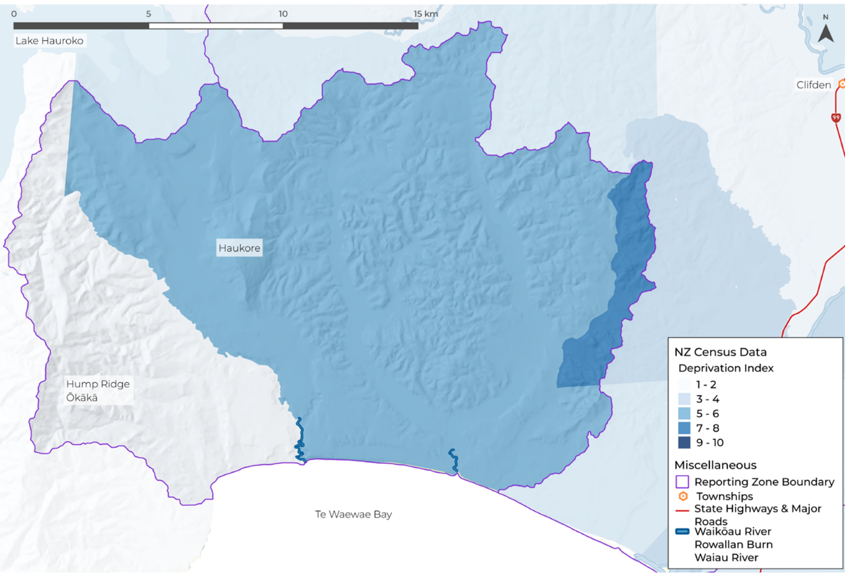
- We have very limited monitoring and modelling information for the Te Waewae Bay western coastal zone. Given the prevalence of forest cover and land use intensity we expect that freshwater health is good overall.
- There are likely to be localised contaminant loss issues associated with the areas of intensive agriculture in the east of the zone adjacent to the Papatotara Coast Road.
- There is a risk that ongoing forest clearance, clear-fell forestry activities and conversion to pasture could lead to increased contaminant losses and compromised freshwater health outcomes.
- Wastewater infrastructure needs to accommodate any tourism development in the area.

Socioeconomic context for action

There are no substantial settlements in the Te Waewae Bay western coastal zone and an estimated population of only around 50 people. The area is, however, situated close to one of the main settlements in the Waiau catchment, Tūātapere, and the area provides access to prominent tourist attractions for Murihiku Southland, including the South Coast and Hump Ridge walking tracks.

Historic socioeconomic shifts later in the 20th century have shaped western Murihiku Southland and the communities in and around the Te Waewae Bay western coastal zone. The impacts of neoliberal deregulation from the 1980s removed agricultural subsidies and export assistance, creating a period of austerity for many farming communities. Other industry declines, such as timber in the Te Waewae/Tūātapere/Longwood Forest area, led to a deterioration of socioeconomic conditions for local dependent townships, driving a population decline. The rise in dairy farming across the region in the 1990s began to improve economic conditions for the wider zone area, ushering in land use change and industry and demographic changes.

Social Deprivation Index



Social Deprivation Index

The Deprivation Index measures socioeconomic deprivation based on census information. It considers income, income benefits, communication access, employment, educational qualifications, home ownership, care support, living space and living conditions.

The population of Te Waewae Bay western coastal zone has remained closely coupled with the agriculture and forestry industries. Domestic and international tourist visitors are increasingly exploring the recreational and scenic opportunities of the catchment.

The area's demographic change and deprivation levels are difficult to ascribe accurately due to a small and sparsely distributed population. Exploring the surrounding area (Longwood Forest SA2) provides some general insights.

Following a general population decline from the 1990s to 2008, the Longwood Forest area has stabilised with small increases in population and ethnic diversity based on census data. The main demographic disparities in this zone are fewer younger people aged 15-29, who often leave for tertiary education or employment opportunities elsewhere in Murihiku Southland, or outside the region, and slightly more people aged over 50.

The Longwood Forest area has relatively affordable housing, yet has shown a decrease in home ownership, that is consistent with the Murihiku Southland region. Ethnic distribution in the area is also reasonably consistent with Southland district figures, with slightly more people identifying as Māori.

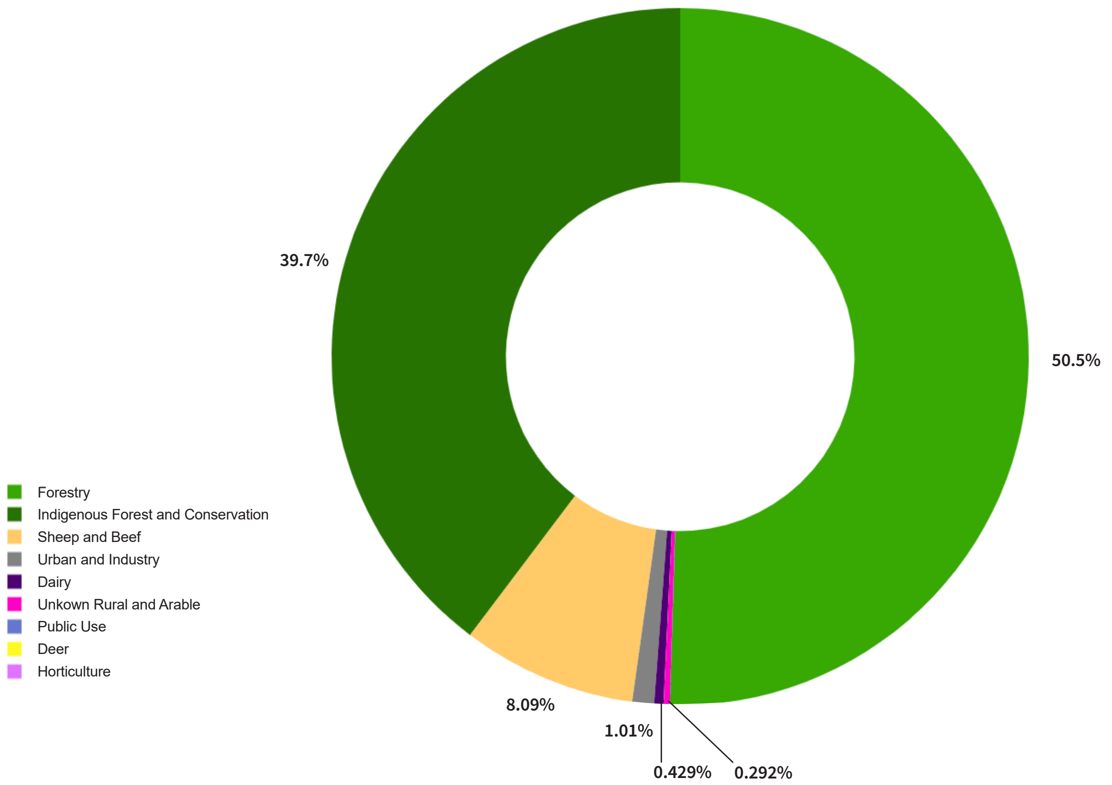
The community in this catchment is small and isolated, which may affect its resilience and capacity to adapt to changes. However, it is closely connected to nearby areas and catchment groups for support.

Catchment overview

The Te Waewae Bay western coastal zone includes the coastal catchments draining the largely forested areas west of the Waiau River. The zone extends from the catchment of the Waikoko Stream, draining the Hump Ridge in the west across to the Grove Burn catchment in the east.

Land use

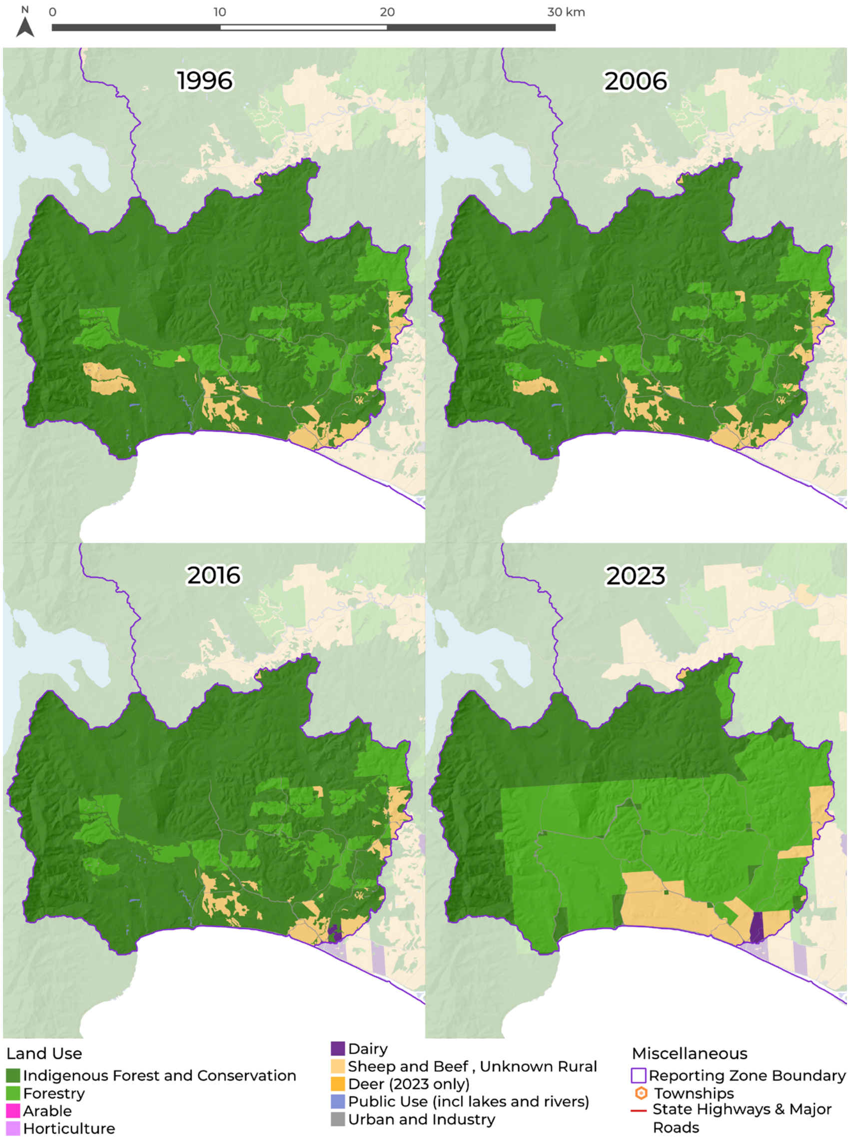
Of the approximately 29,800ha of land in the Te Waewae Bay western coastal zone, the majority is in conservation lands or equivalent (40%) and forestry (50%). Approximately 2,500ha is used for farming, consisting of sheep, beef, dairy and mixed livestock. Approximately 11,800ha is Department of Conservation estate and approximately 12,600ha is Māori Freehold land.



Some changes in land use have occurred in the last 25 years. In particular, the map sequence below shows changes to the harvested forest areas and pastoral land in the zone. There has been some increase in agricultural land use intensity over this time.

The change in the classification of forested freehold land from 2016-2023 largely represents a change in mapping protocol ,rather than a real change in land management. The majority of this land is still indigenous forest.

Historic land use



Please note that these maps and figures are indicative only due to land use class aggregation and differences in mapping methods. In particular, the 2023 map uses a more simplified forest classification. This doesn't necessarily reflect real change in management or forest extent within the Rowallan.

Historic land use

	1996 to 2006	2006 to 2016	2016 to 2023	Overall 1996 to 2023
Pastoral land	↓ 10%	↓ 15%	↑ 112%	↑ 63%
Dairy	None	↑ 55ha	↑ 133%	↑ 128ha
Drystock	↓ 10%	↓ 18%	↑ 111%	↑ 55%

Climate

Understanding climate at a catchment scale helps to explain spatial and temporal variation in water quality and quantity.

Current climate

Te Waewae Bay western coastal zone, like most of coastal Murihiku Southland, is considered a cool-wet climate. It is typified by small variations in seasonal temperature and consistent amounts of rainfall.

Future climate

Possible changes to the future climate of the Te Waewae Bay western coastal zone have been explored through several scenarios based on the representative concentration pathways (RCP) of 4.5 and 8.5. The outputs from these scenarios are summarised in the table.

Precipitation

		RCP 4.5		RCP 8.5	
		Mid 21st century	End of 21st century	Mid 21st century	End of 21st century
Temperature	Daily mean (°C)	↑ 0.5-0.75	↑ 1-1.25	↑ 0.5-0.75	↑ 1.75-2
	Mean minimum (°C)	↑ 0-0.5	↑ 0.5-0.75	↑ 0.25-0.5	↑ 1.25-1.75
	Number of hot days	↑ 0-5	↑ 0-10	↑ 0-5	↑ 5-20
	Number of frosty nights	↓ 0-10	↓ 5-15	↓ 5-15	↓ 10-25
Rainfall	Annual rainfall change (%)	↑ 0-5%	↑ 0-5%	↑ 0-5%	↑ 10-15%
	Number of wet days	166	169	165	168
	5-Day maximum rainfall (mm)	↑ 0-15mm	↑ 0-15mm	↑ 0-15mm	↑ 15-30mm
	Heavy rainfall days	34	34	34	37
	Seasonal changes	Wetter springs	Concentrated to winter/spring	Concentrated to winter/spring	Concentrated to winter and spring

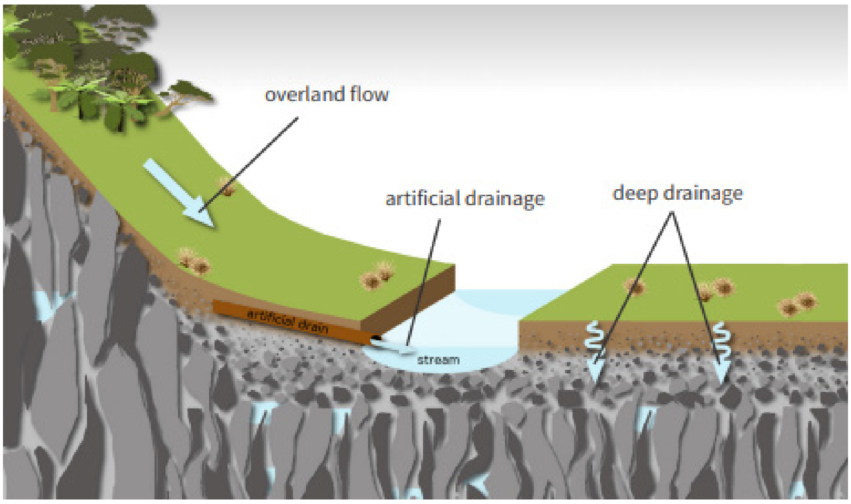
Catchment landscapes and hydrology

The biogeochemical and physical processes occurring within a catchment influence water quality. Understanding hydrology, geology, and soil types within a catchment helps explain variations in catchment yields, water chemistry and water quality outcomes that are independent of land use.

Catchment setting

The Grove Burn, Rowallan Burn, Waikōau River, Hump Burn and Waikoko Stream drain the Hump Ridge and the Rowallan Forest. Much of the area is covered in native vegetation. However, there are large areas of plantation forest in the Grove Burn and Rowallan Burn catchments, and numerous areas have been logged historically.

The forested catchments are characterised by shallow forest soils formed over older Oligocene-Miocene sandstones in the west and younger Miocene-Pliocene sandstones in the east. Sedimentary rocks belong to the Waiau Group.



Conceptual illustration of the hydrological and landscape setting in the eastern coastal pastoral areas of the zone.

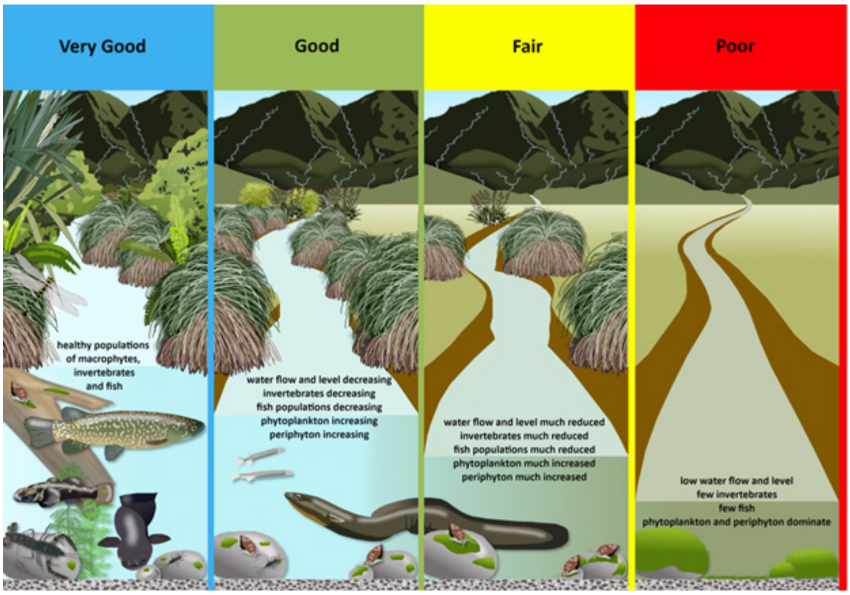
Water flowing from the vegetated headwaters is relatively pristine. Closer to the coast, most of the catchments have higher proportions of forestry and pastoral land. These areas may contribute contaminants, particularly if recent harvest or clearance operations result in sediment mobilisation.

What are the water issues for this catchment?

Freshwater outcomes and how we measure them

Freshwater outcomes can be described from 'very good' to 'poor'. This spectrum helps us understand the current state of the freshwater environment and what we might be trying to achieve in the future. The image below depicts this concept for rivers and streams.

Although many factors contribute to freshwater outcomes, we can only measure some of them to get an understanding of ecosystem health. We measure the aspects of the freshwater environment that can help us define and determine freshwater outcomes. These aspects are called 'attributes'.



Attributes (the things we measure)

Attributes can relate to the ecosystem's physical or chemical environment or biological communities, such as periphyton, macroinvertebrates and fish. The measured state of an attribute tells us about some aspects of the environmental state, and together, they build a picture of the ecosystem's overall health. The more attributes we monitor, the more precise the picture can become.

Attributes may relate to ecosystem health or human health outcomes (e.g. *E. coli* or cyanobacteria concentrations). Some attributes are graded using 'ABCD' categories: A (very good), B (good), C (fair) and D (poor). In some cases, *E. coli* has an additional E (very poor) grade. Other attributes have simple 'pass' or 'fail' grades.

The more attributes with a higher grade, the better the overall ecosystem health. Conversely, the overall ecosystem health is poorer when many attributes have poorer grades.

Hauora target attribute states

In 2020, Environment Southland and Te Ao Mārama Inc (TAMI) approved in principle the use of hauora as a freshwater target to be achieved within a generation. These targets provided the basis for the Regional Forum recommendations on how freshwater aspirations may be achieved.

The concept of hauora encompasses far more than the numeric attributes and targets described here. For simplicity, a reduced number of attribute states are presented in this document as they relate to ecosystem and human health. Hauora is a state of healthy resilience and is generally associated with the A 'very good' and B 'good' attribute states. However, attribute states that support hauora can be anywhere on the scale from A 'very good' to C 'fair', depending on the natural characteristics of that freshwater environment.

The natural characteristics have been differentiated through the use of classes.

We use monitoring results to compare the current attribute state with the hauora target state for different classes in the Te Waewae Bay western coastal zone.

Streams and rivers

River classes

'River classes' group rivers (or parts of rivers) with similar characteristics. Similarities can include natural characteristics of the rivers, such as climate, gradient and flow.

The River classes used in Murihiku Southland are Mountain, Hill, Lowland, Spring-fed, Lake-fed and Natural State.

About 60% of the rivers in the Te Waewae Bay western coastal zone are Lowland, with a small number of Hill rivers and the rest being Natural State rivers

Target states can differ between attributes and between different river classes, which may have different target states for the same attribute.

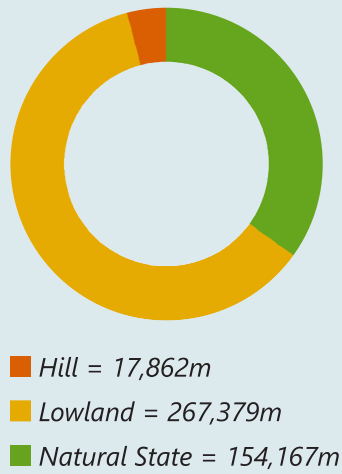
Periphyton is an example of an attribute with different target states for different river classes.

The different target states reflect the differences in natural characteristics for each river class.

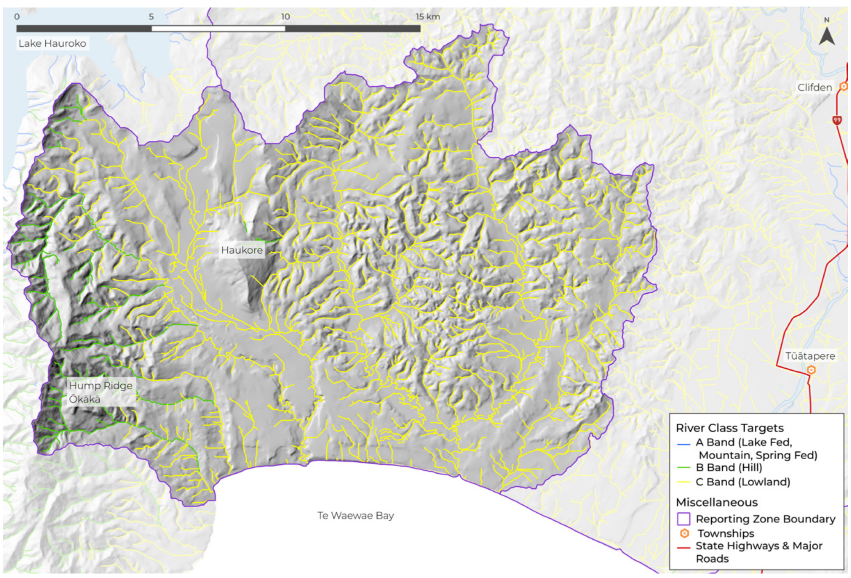
- C target state: Lowland class
- B target state: Hill class
- A target state: Mountain, Spring-fed and Lake-fed classes.

Natural State waterbodies can be identified for management purposes but are assigned attribute targets according to their underlying river classification (displayed here).

Length of river network in each class



River class hauora targets



▲ *The map above shows the distribution of periphyton targets for each river class within the Te Waewae Bay western coastal zone..*

Results for the river classes

Hauora targets and current states for ecosystem and human health attributes are summarised in the table below for the catchment's Lowland and Hill river classes. Table colours correspond to the 'ABCDE' grading for attributes described above. Results show that lowland rivers in the catchment have the most water quality issues.

Current state is assessed using data from the 2018-2022 period.

We have limited information on the current state of rivers in this zone, with information from the Rowallan Burn for a limited number of attributes.

Modelled information shows that almost all streams and rivers in the Te Waewae Bay western coastal zone are in good condition with respect to nitrogen, with only minor reductions required. Some reductions will be required for phosphorus and sediment. However, larger reductions in *E. coli* will be required to achieve hauora targets, especially in the eastern areas of this zone.

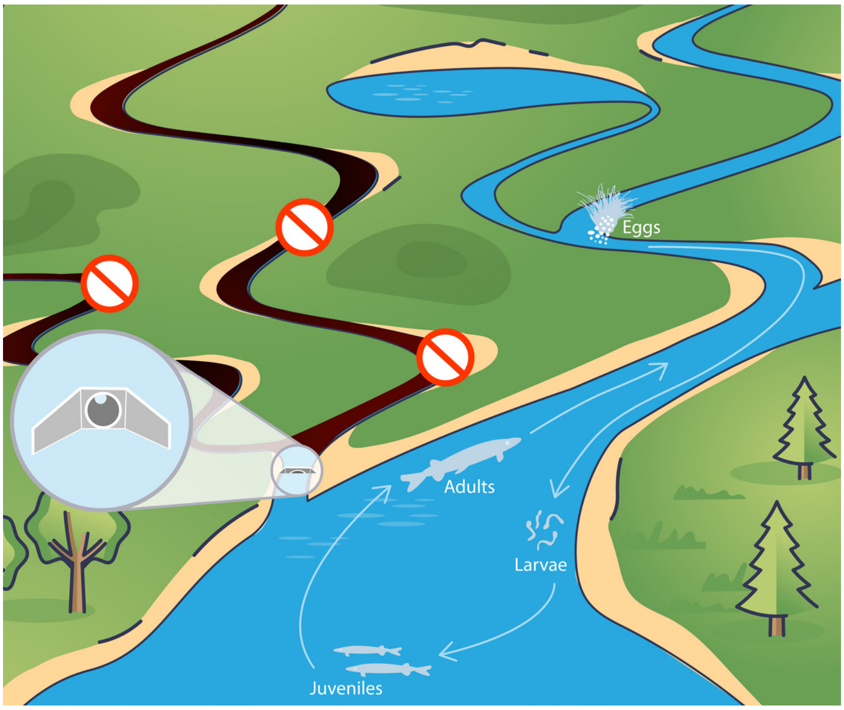
	Lowland		Hill	
Ecosystem health attributes	Hauora target	Current state	Hauora target	Current state
Periphyton	C	-	B	-
Nitrate toxicity	A	-	A	-
Ammonia toxicity	A	-	A	-
Suspended fine sediment	C	-	C	-
Macroinvertebrates (MCI, QMCI)	C	C	B	-
Deposited fine sediment	A	-	A	-
Dissolved reactive phosphorus	B	-	B	-
Water temperature (summer)	C	-	C	-
Human contact attributes				
Benthic cyanobacteria	A	-	A	-
E. coli	A	-	A	-
Visual clarity	B	-	B	-

"-" data not available.

Fish passage

Fish passage barriers obstruct the passage of fish species. This particularly impacts migratory fish species that complete their lifecycles in both freshwater and the ocean, such as tuna/eels, kanakana/pouched lamprey and migratory galaxiids/whitebait. Generally, the closer a barrier is to the coast, the larger the area of habitat that becomes inaccessible to migratory fish, making it a higher priority for restoring passage. Common examples of fish passage barriers include structures like culverts, weirs and dams, while natural features such as waterfalls can also form barriers. Different fish species and life stages have varying climbing and swimming abilities, so a barrier for one species or life stage may not be a barrier for another.

Whitebait lifecycle



In some cases, fish barriers may be desirable to protect populations of non-migratory galaxiids that struggle to co-exist with trout. In these cases, a barrier could be installed or maintained in a specific location to prevent trout from reaching the population of non-migratory fish.

Culverts are the most common fish passage barrier in the Te Waewae coastal zone. When culverts are designed and installed, consideration of fish passage and regular maintenance of structures will help improve fish passage.

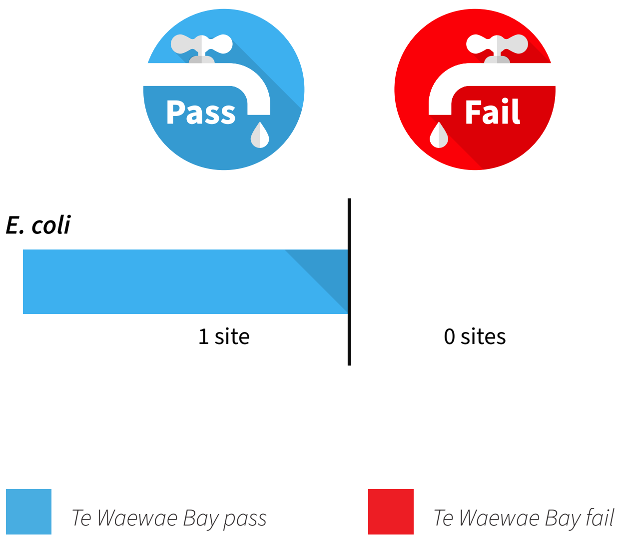
Groundwater

Human consumption – is it safe to drink?

Useable groundwater resources in the Te Waewae Bay western coastal zone are limited. There are several bores in the eastern areas. They range in depth from 10-80m. Groundwater is hosted in Quaternary 4-Quaternary 5 river deposits that infill topography in the underlying tertiary geology.

The presence of pathogens (*E. coli*) and nitrate are the main issues affecting the suitability of potable groundwater for drinking. Target states for groundwater are based on the New Zealand drinking water standards and use a pass/fail assessment system.

Te Waewae Bay western coastal zone groundwater assesment

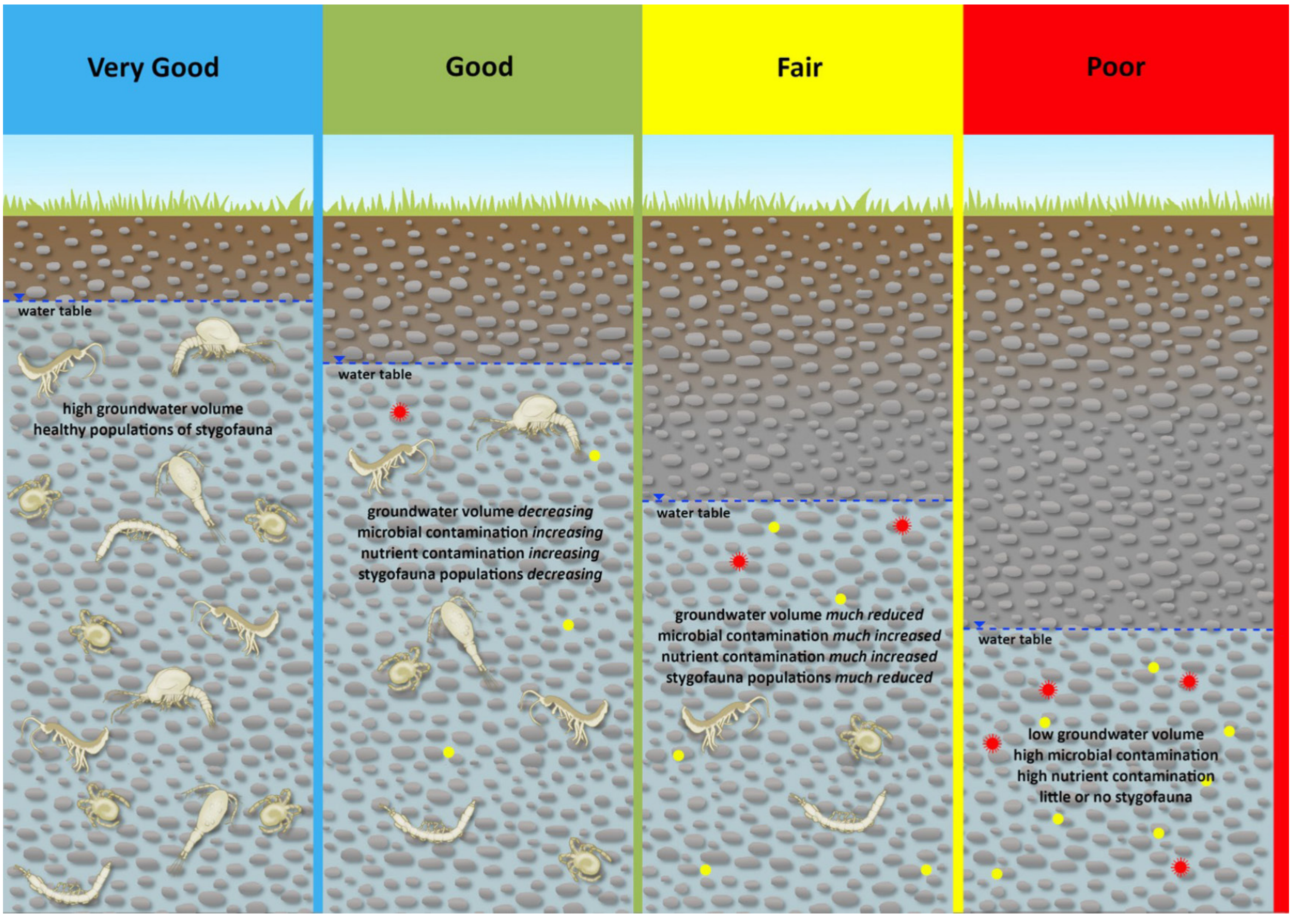


Several monitoring sites exist in the Te Waewae Bay western coastal zone, with one site monitored for *E. coli* and no monitoring sites where nitrates are measured. The site achieves the target state of Pass for *E. coli*.

Ecosystem health

Nitrate concentrations are used to monitor ecosystem health for both groundwater ecosystems and connected surface waterways. Groundwater ecosystem health outcomes are depicted in the following figure. Nitrate is just one factor contributing to overall ecosystem health. Concentrations related to surface water and groundwater ecosystem health outcomes differ from those used in relation to drinking water mentioned above.

There is no monitoring data for nitrate in the Te Waewae Bay western coastal zone. Based on the land use and physical setting, we expect the risk of nitrate contamination of groundwater to be relatively low.


Very Good
Good
Fair
Poor
water table
high groundwater volume
healthy populations of stygofauna
water table
groundwater volume decreasing
microbial contamination increasing
nutrient contamination increasing
stygofauna populations decreasing
water table
groundwater volume much reduced
microbial contamination much increased
nutrient contamination much increased
stygofauna populations much reduced
water table
low groundwater volume
high microbial contamination
high nutrient contamination
little or no stygofauna

Wetlands – how many do we have left?

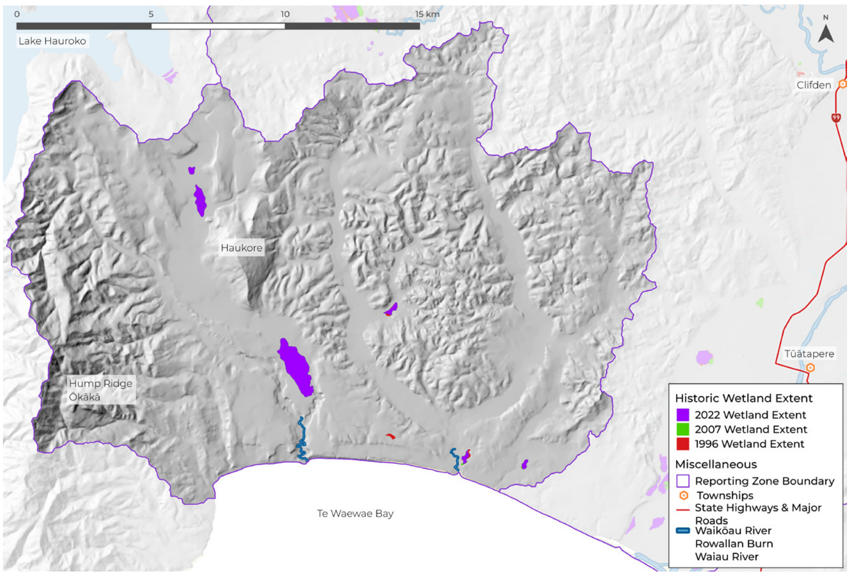
Wetlands and water quality

Wetlands are increasingly being recognised for their functional values within the landscape. For example, their ability to intercept and attenuate agricultural runoff is now recognised as an important contribution to farm nutrient management.

Wetlands purify water through sediment capture and storing nutrients in their soils and vegetation. This is particularly important for the agricultural nutrients nitrogen and phosphorus, which contribute to the eutrophication of receiving environments such as rivers, lakes and estuaries.

For the purposes of this document, wetlands are generally defined as per the Southland Water and Land Plan definition.

Historic wetland extent



▲ *This map shows the wetland extent over three time periods. Wetland areas lost since 1996 and 2007 are shown as the red and green areas respectively.*

The following areas were not included as wetlands in this classification:

- Wet pasture or where water ponds after rain
- Pasture containing patches of rushes less than 50% total cover
- Ponds of any kind unless associated with 0.5 or more hectares of terrestrial wetland.
- Areas of forest unless previoulsy identified as wetland.
- Areas associated with the main active flood channels of rivers.

Current state

There are 186ha of wetlands in the Te Waewae Bay western coastal zone. Most of the wetlands that have been lost were fens, which have mainly been converted to pasture farmland.

	1996 to 2007	2007 to 2022	Overall 1996 to 2022
Change in wetland area	↓ 3% 5 ha	↓ 0% 1 ha	↓ 3% 6 ha

Remaining wetlands

Only six wetlands are identified in the Te Waewae Bay western coastal zone. There are no regionally significant wetlands in this zone. Still, there is one very large fen at 132ha in the lower Waikōau River Valley and two smaller wetlands in the upper Waikōau River Valley on Department of Conservation land. The three other wetlands are all moderately sized fens. Two are close to the coast and surrounded by farmland, while the other is surrounded by indigenous forest.

Of the remaining wetlands not on conservation land, the risk of loss was spread relatively evenly among the risk of loss classes.

	1	2	3	4	5
Risk of loss (1 = low, 5 = high)	33%	17%	17%	33%	0%

Water quantity – how much do we have, and how much are we using?

There is currently no consented surface water or groundwater abstractions in this zone.

How much do we need to reduce contaminants to achieve a state of hauora?

Regional contaminant modelling

We have undertaken contaminant modelling to help us better understand water quality across Murihiku Southland. This modelling utilises monitoring data to estimate water quality in all waterbodies (excluding Fiordland and Islands). This expanded view of water quality allows us to estimate the reductions in contaminant load and concentrations required to achieve the identified target attribute states and to test the impact of different land use scenarios.

For this work, we focused on four main contaminants of concern: nitrogen, phosphorus, sediment, and *E. coli*. Actions taken to reduce the impact of these contaminants on our freshwater systems will have benefits for ecological and human health outcomes.

How much do contaminant loads need to be reduced?

Load is a measure of the total mass of a contaminant (in kg or tonnes) coming from a given area past a given point over time. For example, the total amount of nitrogen delivered to the sea by a river in one year.

We use loads to quantify contaminants here because they describe the amount of contaminants lost over a whole catchment area. It is the land that consequently needs to be managed to reduce those loads. It is important to remember that concentrations (e.g., the mass of the contaminant per litre of water in the waterbody in kg/L) must also be considered. Concentrations in waterbodies are affected by the size of the contaminant load lost from land and the amount of water available to dilute that load. Hence, water takes and climate can affect concentrations too.

Concentrations are the relative amount of contaminant present in a given volume of water at that time. Concentrations are important because they have direct relevance to toxicity attributes as well as ecological processes.

This modelling considers draft targets for the following attributes:

Rivers
Periphyton biomass, nitrate toxicity, dissolved reactive phosphorus, visual clarity, suspended sediment, *E. coli*.

Lakes
Total nitrogen, total phosphorus, phytoplankton.

Estuaries
Macroalgae.

This modelling accounts for loads and concentrations required to achieve target states everywhere for all the above attributes.

Estimated load reductions for the Te Waewae Bay western coastal zone are presented in the table. Load estimates were calculated using sites with ten years of data and relates to the 2017 year.

Contaminant	Total Load (2017 - Best estimate*)	Percentage load reduction required to achieve hauora (Best estimate*)
Total Nitrogen	114 Tonnes/Year	↓ 1% (0-3)
Total Phosphorus	5 Tonnes/Year	↓ 17% (2-37)
Sediment	7,800 Tonnes/Year	↓ 3%
E. coli	3 peta E.coli/Year	↓ 64% (40-85)

These values represent our best estimate. Levels of uncertainty are indicated by the 90% confidence interval shown in brackets where available.

What options do we have to reduce nutrient and sediment loads?

We have modelled different scenarios to indicate how far each may go toward achieving the estimated load reductions required. We have also bundled multiple scenarios to test the effect of combining multiple strategies.

This work is not intended to assess individual properties or activities. Rather, it generalises land use so that we can make some broad catchment scale assessments of the impact of different actions. This can also help give information about the differences between possible allocation approaches.

The results for each of the scenarios modelled are presented on the following page. Explanations of each scenario can be found in our published reports. The coloured table cells indicate how far each scenario achieves the required load reductions.

We have also modelled phosphorus and suspended sediment load reductions under different mitigation options. These results are not presented here but broadly show:

- None of the modelled scenarios achieved phosphorus reductions required to support hauora.The range of reduction achieved was between 0 and 7%. However, all scenarios except 1, 2 and 16, achieved reductions within the uncertainty of the required estimate.
- Implementing existing rules and regulations relating to sediment would achieve a 2% reduction in suspended sediment loads. This is similar to the 3% required to support hauora and within the uncertainty of the modelled estimates.

ID	Scenario	Reduction in nitrogen load (%)	Remaining deficit from target (%)
Individual methods			
1	100% adoption of established farm Good Management Practice (GMP) mitigations	1	0
2	Adoption of all established and developing farm mitigations	4	0
3	Wetlands returned to the same area as existed in 1996	2	0
4	Establishment of wetlands in a way that treats all surface runoff from agricultural land	11	0
5	Establishment of large community wetlands in inherently suitable areas	3	0
6	All wastewater point sources are discharged to land rather than directly to water	2	0
7	Reducing land use intensity on flood prone land	2	0
8	Reducing land use intensity on public land	2	0
9	Destocking (10% reduction drystock, 20% reduction dairy)	3	0
10	Riparian planting (full shading of streams <7m wide)	1 (indirect effect on periphyton)	0
Bundled methods			
11	1996 wetlands returned, wastewater discharged to land (3 + 6)	2	0
12	Established and developing farm mitigations, 1996 wetlands, wastewater to land (2 + 3 + 6)	6	0
13	Established and developing farm mitigations, 1996 wetlands, wastewater to land, repurposing public land (2 + 3 + 6 + 8)	6	0
14	Established and developing farm mitigations, 5% wetlands, wastewater to land, repurposing public land (2 + 4 + 6 + 8)	13	0
15	Established and developing farm mitigations, community wetlands, wastewater to land (2 + 5 + 6)	7	0
16	Established farm mitigations, wastewater to land, plantain on dairy farms, 1996 wetlands, repurposing of ES land, forestry expansion (1 + 6 + 3 + new individual methods)	1	0

Required reductions likely achieved — *Within uncertainty range* — *Deficit remaining*

The results in the table above indicate that all the individual mitigation scenarios we tested would likely achieve the reductions required to support a state of hauora.

Reductions in nitrogen load are small in this zone and could be achieved through various mitigation strategies, including full adoption of existing GMP. However, load reductions required for phosphorus and *E. coli* are larger and will likely require greater effort.

Opportunities for action

We've put together opportunities for action in the Te Waewae Bay western coastal zone to improve the state of freshwater.

Property scale opportunities for action

Property-scale actions should be tailored to the physiographic settings, catchment priorities and broader contexts. In the Te Waewae Bay western coastal zone, to meet hauora targets, small load reductions are required for nitrogen and sediment, and larger reductions are required for phosphorus and *E. coli*.

We can use farm-scale observations, physiographic information and our understanding of water quality to help refine the most relevant actions for a given location or landscape.

Physiographic zones help us to understand better how contaminants move through the landscape. Each zone has common attributes that influence water quality, such as climate, topography, geology and soil type.

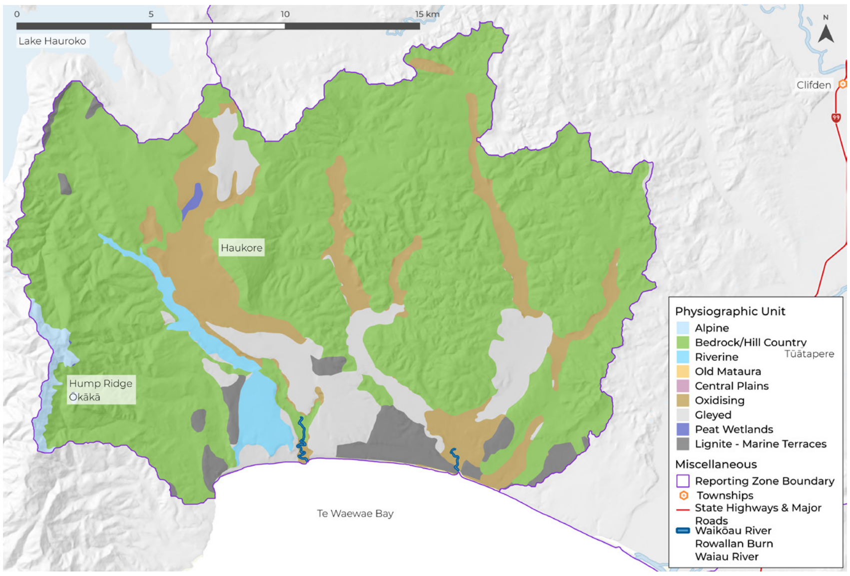
Physiographic zones differ in how contaminants build up and move through the soil, through areas of groundwater and into rivers and streams.

Contaminants can move from the land to waterways via:

- overland flow (or surface runoff)
- artificial drainage, e.g. tile drains and mole pipe drainage
- deep drainage (or leaching) of either nitrogen or phosphorus to groundwater
- lateral drainage (or horizontal movement through soil) of phosphorus and microbes

These key transport pathways for contaminants differ for each physiographic zone. Understanding differences between zones allows for targeted land use and management strategies to be developed to reduce impacts on water quality.

Physiographic zones



Widespread implementation of property actions to improve water quality can have significant co-benefits for catchment hydrology (flood risk and climate change resilience) and biodiversity outcomes.

Te Waewae Bay western coastal zone is predominantly bedrock/hill country zone with smaller areas of gleyed, oxidising and lignite/marine terraces zones.

Property-scale or more resolute physiographic information may be available in some locations. We promote the use of the best information available to identify farm-specific risks and solutions.

The following maps help to identify the most important actions to focus on in different parts of the catchment.

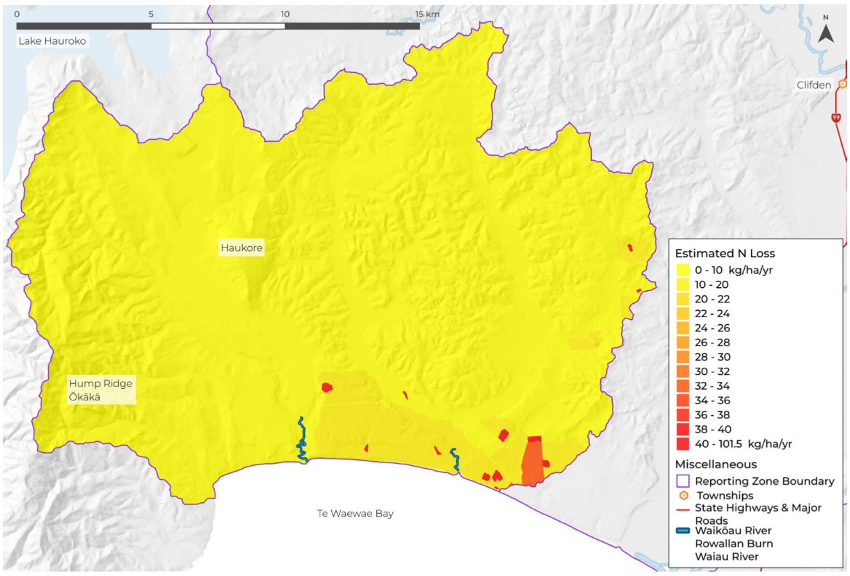
Nitrogen

Small reductions in nitrogen loss would be required across the zone to achieve hauora targets in rivers and streams.

This means reducing nitrogen loss should be a priority in all farm-scale mitigation planning.

Physiographic zones can help to identify what contaminant loss pathways likely need attention in different locations. The excess load map shown here indicates areas where nitrogen loss mitigation should be a particular focus in farm planning.

Estimated nitrogen loss



Nitrogen loss depicted here is an approximation and only differentiated by land use, soil drainage, rainfall/irrigation and slope.

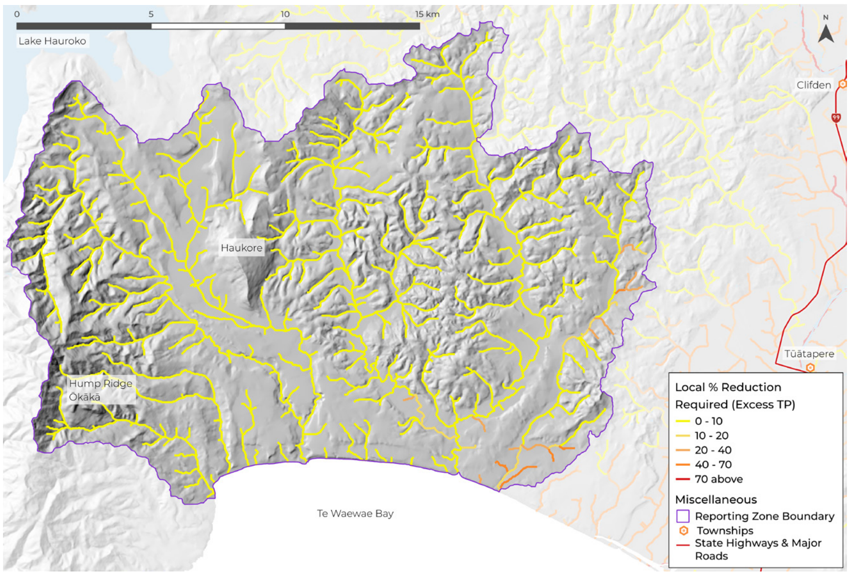
Phosphorus

Over time, reductions are required across the entire catchment area to achieve hauora targets.

This means reducing phosphorus loss should be a priority in all farm-scale mitigation planning.

Physiographic zones can help to identify what contaminant loss pathways likely need attention in different locations. As shown above, the excess load map indicates areas where phosphorus loss mitigation should be a particular focus in farm planning.

Critical excess TP load (%)

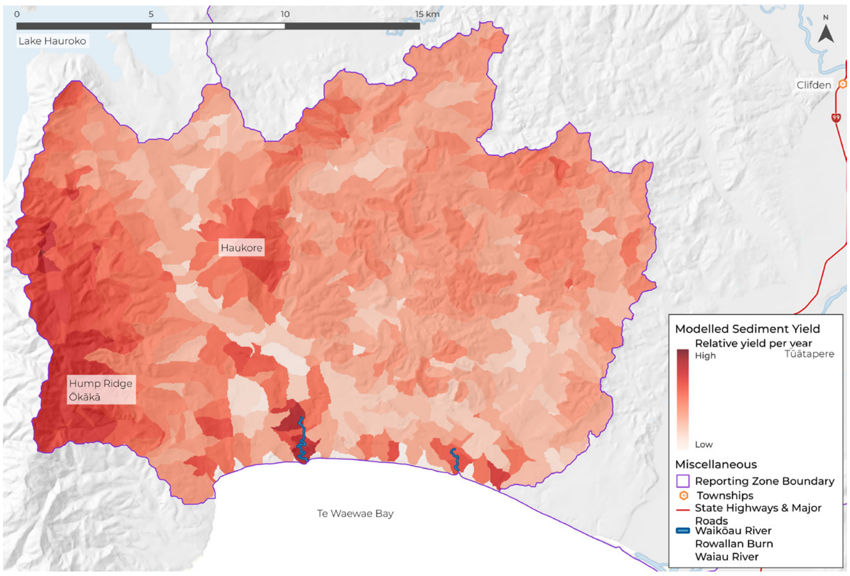


Sediment

The map (right) shows how we expect sediment loss to vary throughout the catchment. Some places in the agricultural landscape are estimated to have higher sediment loss rates. These are primarily areas with more sloping land and soils susceptible to erosion, where stream bank erosion is likely an issue.

Sediment from agricultural land generally poses a greater threat to rivers and lakes as it is often fine grained and carries higher concentrations of nutrients. Agricultural and forestry properties within the shaded darker red areas on the map should specifically look for opportunities and mitigations to reduce sediment loss.

Modelled sediment yield



E. coli

The risk of *E. coli* loss to water depends on landscape type, slope, stock and vegetation. Property-scale assessments should be used to mitigate the highest risk loss pathways on farms.

Urban and industrial opportunities for action

- Target improvements to on-site wastewater disposal systems to reduce the risk of human faecal contamination of freshwater.
- Assess whether wastewater infrastructure meets the needs of tourism operations in the area.
- Incorporate best practice stormwater management methods for urban and tourism developments.

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