Tokanui
coastal zone

Published by Environment Southland, September 2024

environment
SOUTHLAND
REGIONAL COUNCIL
Te Taiao Tonga

Tokanui coastal zone

This document summarises scientific information, opportunities for action and the socioeconomic context for the Tokanui coastal zone, which encompasses the Tokanui River catchment, Haldane Estuary catchment and the coastal areas between Fortrose and Curio Bay.

This is one of twelve catchment summaries prepared for the Murihiku Southland region.

The scientific data presented in this summary has been collated at the catchment scale to provide an understanding of freshwater quality and quantity challenges and their underlying factors. The summary provides an evaluation of the current state of freshwater within the zone and highlights the magnitude of change necessary to meet freshwater aspirations.

Main features

Land area: 22,600ha

Major rivers and streams:
Tokanui River, Waipapa Stream, Waionepu Creek, Waipohatu Stream, Waikopikopiko Stream

Aquifers:
No mapped groundwater zones

Lakes:
The Reservoir, Lake Brunton.

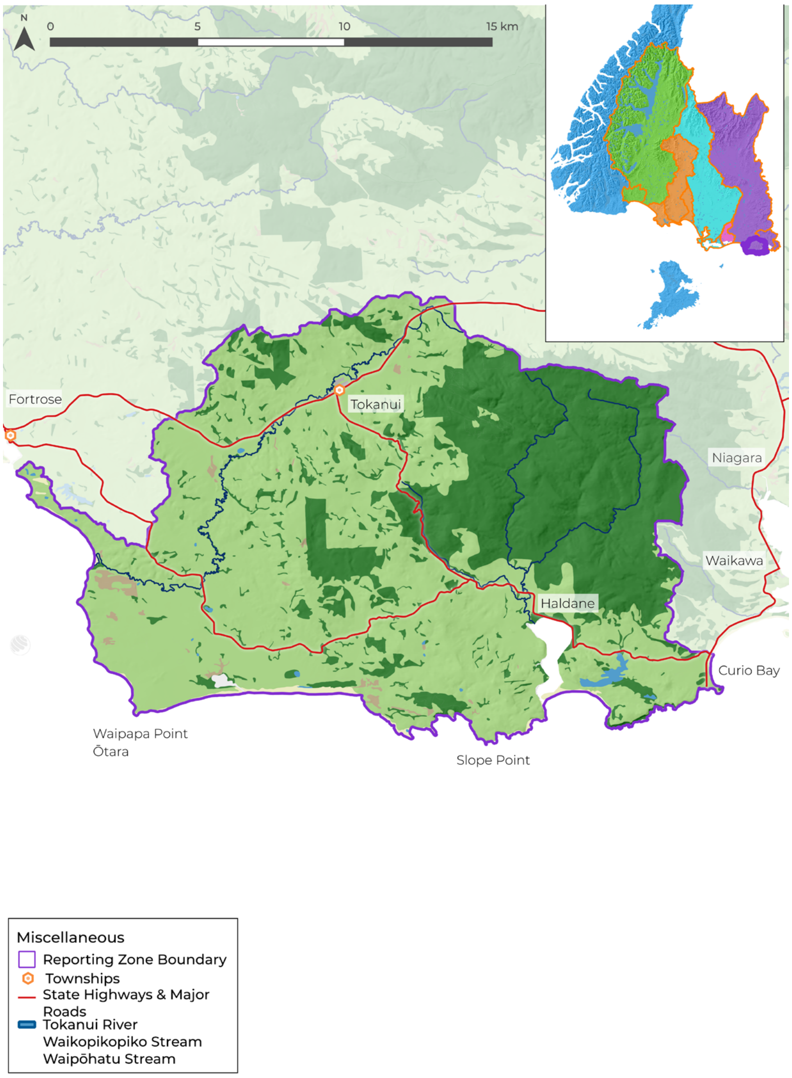
Estuaries:
Tokanui Estuary, Waipapa Estuary, Haldane Estuary, Cook Creek Estuary

Townships:
Tokanui

Population:
Approximately 300

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

Catchment outline



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

Key messages

Issues

- Monitoring indicates that freshwater ecosystem health is poor in many parts of the Tokanui coastal zone. Six of the seven (92%) attributes presented here do not meet hauora targets. Five of the 12 (42%) attributes are graded as currently poor or very poor.
- Monitoring data is available only for the Haldane Estuary, which generally shows good-to-fair condition, though some areas in the upper reaches are experiencing increasing mud content. This change in sediment conditions leads to reduced oxygenation levels. Additionally, the hydrological disconnection of some salt marshes is causing degradation due to reduced saline water penetration, increased fine sediment accumulation, and elevated nutrient levels.
- Modelling indicates that the contaminant load reductions required to achieve hauora targets are relatively small for nitrogen (9%) but much larger for phosphorus (47%), sediment (48%) and *E. coli* (91%).
- Approximately 88 hectares of wetland have been lost since 1996 in the Tokanui coastal zone. A large proportion of the remaining wetlands on non-conservation land are at moderate to moderately high risk of being lost.

Opportunities for action

- Scenario modelling indicates that nitrogen reductions could be achieved through the adoption of improved management practices. It is likely that larger changes are required to achieve the required reductions for the other contaminants.
- Apply property scale mitigations tailored to the physiographic characteristics of the land and the sensitivities of the receiving environments.
- Land use change and deintensification in some areas. This may be through the development of long-term catchment plans, promotion of alternative land use options and diversification, or implementation of regulation that provides clear mechanisms and outcomes regarding contaminant loss reductions.
- Reconnection of hydraulically disconnected saltmarshes and wetlands to protect these ecosystems.

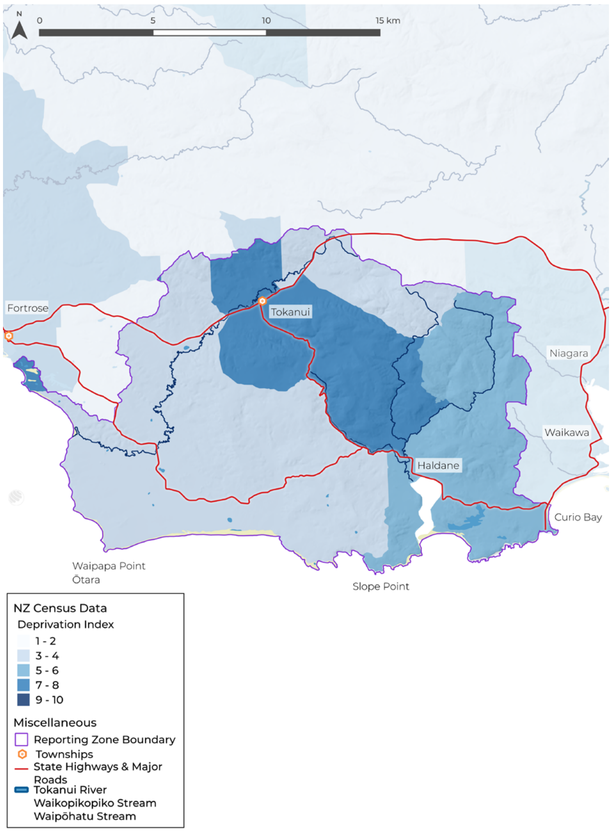
Socioeconomic context for action

The Tokanui coastal zone has a small population (approximately 300) and is one of four catchment zones within the Wyndham-Catlins census-based statistical area (SA2). Therefore, many of the insights provided in this section extend beyond the Tokanui coastal zone.

Historic socioeconomic shifts in the late 20th century have shaped the Wyndham-Catlins area and its catchments. The impacts of neoliberal deregulation from the 1980s removed agricultural subsidies and export assistance, creating a period of austerity for many farming communities in the area. Other industry declines, such as timber, led to a further deterioration of socioeconomic conditions for local dependent townships, driving population decline. The rise in dairy farming in the Tokanui coastal zone and across the region from the 1990s began to reverse economic conditions for the more expansive zone, ushering in land use change and industry and demographic changes. However, populations in the area remain closely associated with agriculture and forestry industries (and, to a lesser extent, fishing), with approximately a third of the population directly involved in these industries and many more indirectly involved.

Following a general population decline from the 1990s until the mid-2000s, the Wyndham-Catlins area experienced steady population growth, peaking in 2020. The main demographic disparity in the zone is the lower number of younger people (aged 15-29), who often leave for tertiary education or employment opportunities outside Murihiku Southlan. This is offset by a higher percentage of middle-aged residents (50-64), compared to other parts of the district.

Social Deprivation Index



The population in Wyndham-Catlins broadly follows regional demographic trends. Unemployment is very low in Murihiku Southland and even lower than average in Wyndham-Catlins.

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.

Although most people in the area were born in New Zealand, ethnicity is changing. The area has lower-than-district average Māori, Asian, and MELAA populations, but these populations are all increasing.

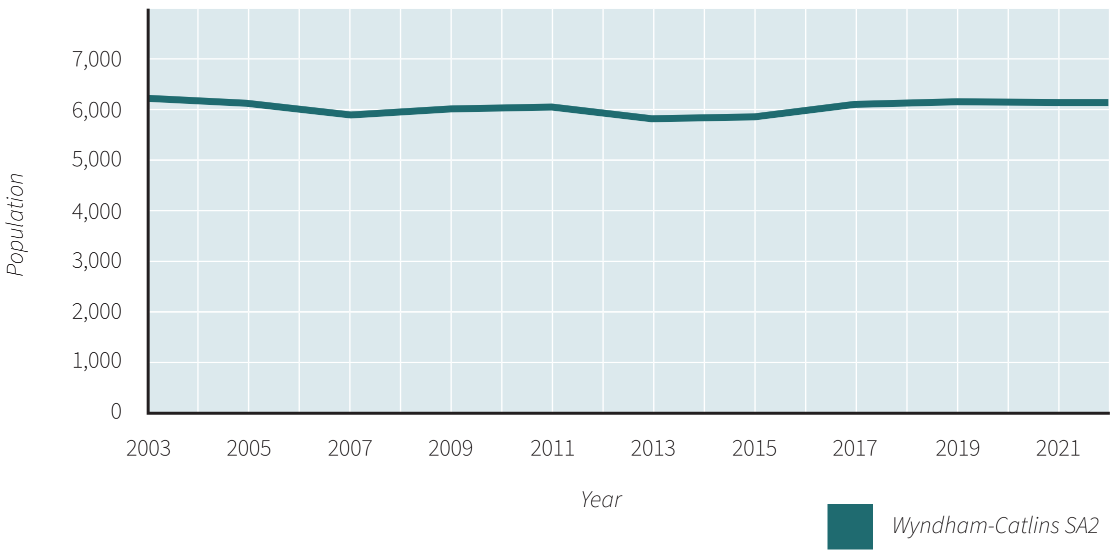
Although housing prices have increased regionally and nationally since 2020, the Murihiku Southland region, including many parts of Wyndham-Catlins, has remained among the most affordable places to buy or rent in New Zealand. Home ownership declined between 2006 and 2018, though the percentage of homeowners remains higher than in other parts of Murihiku Southland.

Although the Southland district area is among the least socioeconomically deprived districts in New Zealand, the Wyndham-Catlins area has some of the more deprived areas in the district, as identified in the 2018 Census, especially around Tokanui Township.

Deprivation trends from 2014 -2024 show that Wyndham-Catlins has experienced increases in crime victimisations (though this is more applicable to Wyndham Township than the rural areas). Higher levels of deprivation tend to correlate with less capacity, fewer resources, and higher vulnerability, along with poorer wellbeing outcomes for communities.

The Tokanui coastal zone, as part of the wider area, generally has lower educational attainment levels than the wider District. However, these are improving over time.

Estimated population trends (Dot Loves Data, 2024)



The Tokanui coastal zone comprises only a portion of the Wyndham-Catlins SA2, so this graph only indicates general population trends in the area.

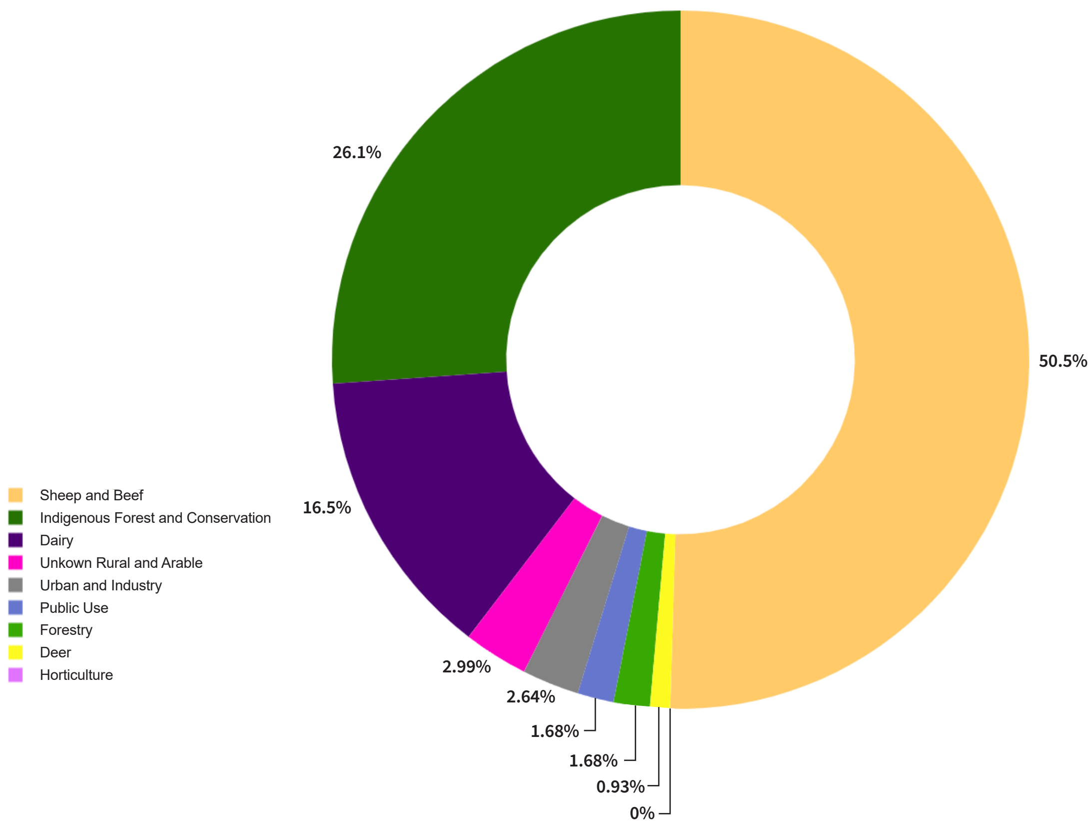
Catchment overview

The Tokanui coastal zone is a small coastal area that begins at the headwaters of several smaller waterways in the Quarry Hills. Larger water bodies flow from the indigenous forested hills through rolling pastureland, eventually reaching the coast at the Haldane Estuary or discharging directly into the sea.

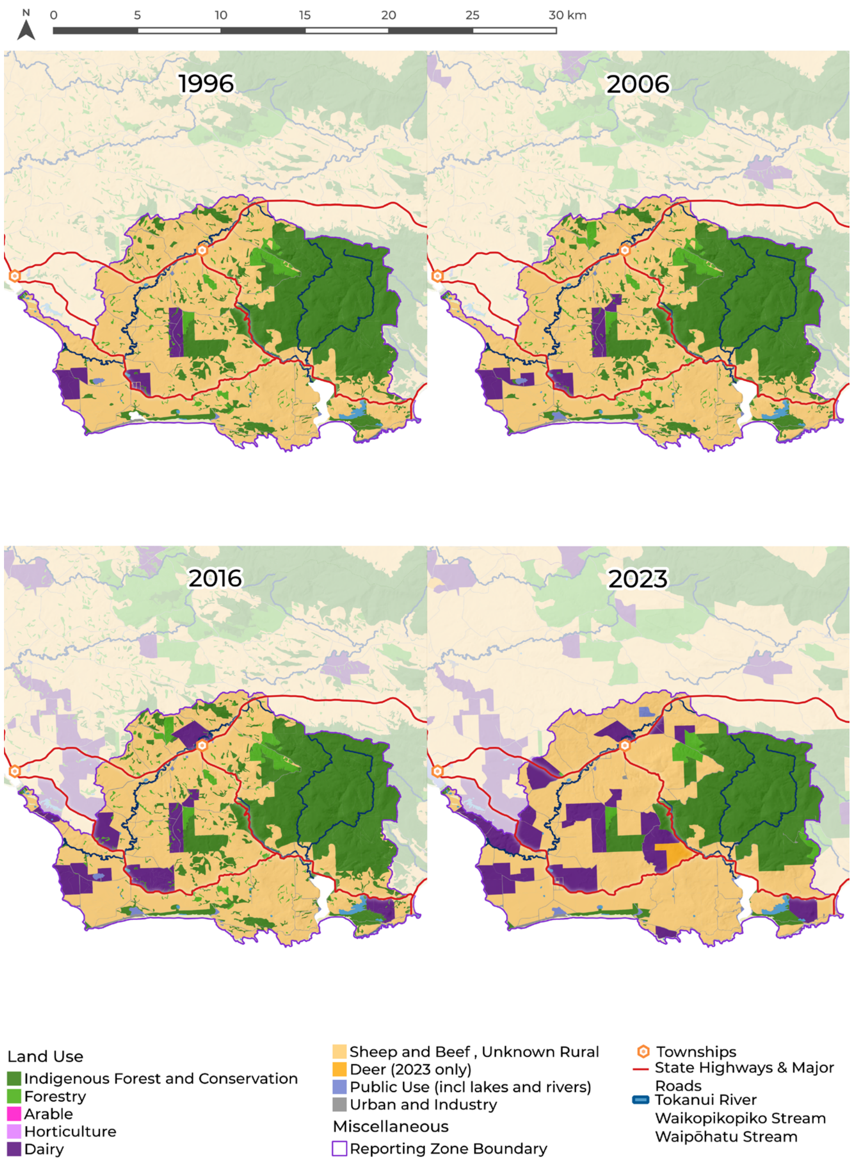
Land use

The Tokanui coastal zone covers approximately 22,600 ha, with 15,100 ha (67%) farmed and 6,000 ha in Department of Conservation estate. Land use is a mix of approximately 50% sheep and beef, 13.5% dairy, 1.8% commercial forestry and 26.9% indigenous forest and conservation.

Over the past 25 years, land use changes have occurred, particularly with the expansion of the dairy sector and the concurrent loss of some forested areas. The overall area of pastoral land has changed little, indicating that most land use shifts have been from drystock to dairy farming. This growth in dairy farming has led to an increase in agricultural intensity and increased pressure on natural resources.



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 classification of forest and some changes shown will not reflect real forest loss.

Historic land use

	1996 to 2006	2006 to 2016	2016 to 2023	Overall 1996 to 2023
Pastoral land	↓ 1%	No change	↑ 13%	↑ 12%
Dairy	↑ 23%	↑ 126%	↑ 80%	↑ 403%
Drystock	↓2%	↓ 7%	↑ 4%	↓ 5%

Climate

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

Current climate

The Tokanui coastal zone can typically be considered to have a cool-wet climate. On average, the mean annual temperatures are 9-12°C, summer in the 12-15°C range and winter between 3-6°C. Typically, the area sees 0-25 nights below 0°C annually.

Rainfall across the Tokanui coastal zone is consistent (1,000-2,000mm/yr). The average number of wet days (>1mm rainfall) ranges from 150-200 per year.

Future climate

Possible changes to the future climate of the Tokanui 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

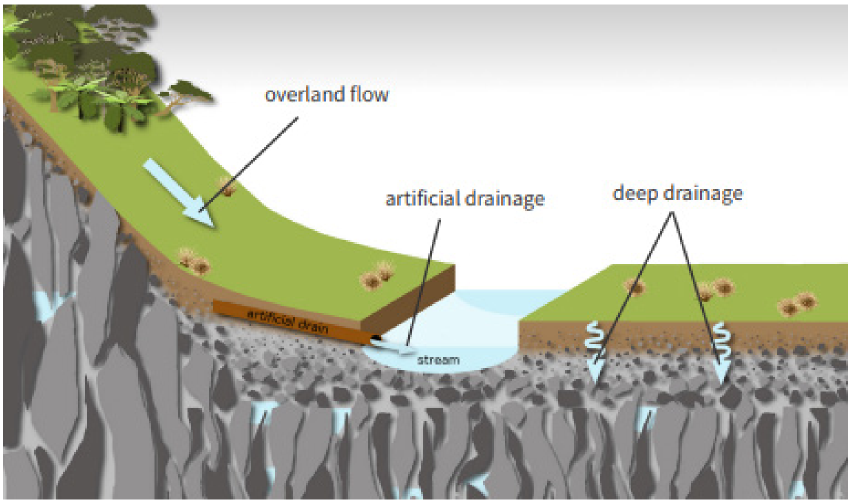
		RCP 4.5		RCP 8.5	
		Mid 21st century	End of 21st century	Mid 21st century	End of 21st century
Temperature	Daily mean (°C)	↑ 0.5-0.75	↑ 0.75-1.25	↑ 0.5-0.75	↑ 1.75-2
	Mean minimum (°C)	↑ 0-0.5	↑ 0.5-0.75	↑ 0.25-0.5	↑ 1.25-1.5
	Number of hot days	↑ 0-5	↑ 0-10	↑ 0-5	↑ 10-25
	Number of frosty nights	↓ 0-10	↓ 5-10	↓ 5-10	↓ 10-20
Rainfall	Annual rainfall change (%)	↑ 0-5%	↑5-10%	↑ 0-5%	↑ 10-15%
	Number of wet days	184	186	184	185
	5-Day maximum rainfall (mm)	↑ 0-15mm	↑ 0-15mm	↑ 0-15mm	↑ 15-30mm
	Heavy rainfall days	46	47	45	52
	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.

Headwaters

The Tokanui River, Waipapa Stream, Waikopikopiko Stream and their tributaries drain the indigenous forested hills of the Catlins, east of Tokanui. Waterways in the headwaters are generally small (< order 4), with median flows of less than 0.5 cumecs, and are well distributed across the drainage area. The hills are underlain by Ferndale Group sandstones of the Murihiku Terrane.



Conceptual depiction of the typical hydrological and landscape setting in the upper catchment hilly areas.

Relatively pristine water from the forested hills flows into the rolling agricultural landscape as it moves down the catchment, where it mixes with localised recharge from surrounding land. Due to soil interactions and the presence of low-intensity agriculture, the water accumulates increased nutrients, sediment and *E. coli*.

Flow lag times in the headwaters are relatively short (hours/days), with limited subsurface flow pathways and steeper topography.

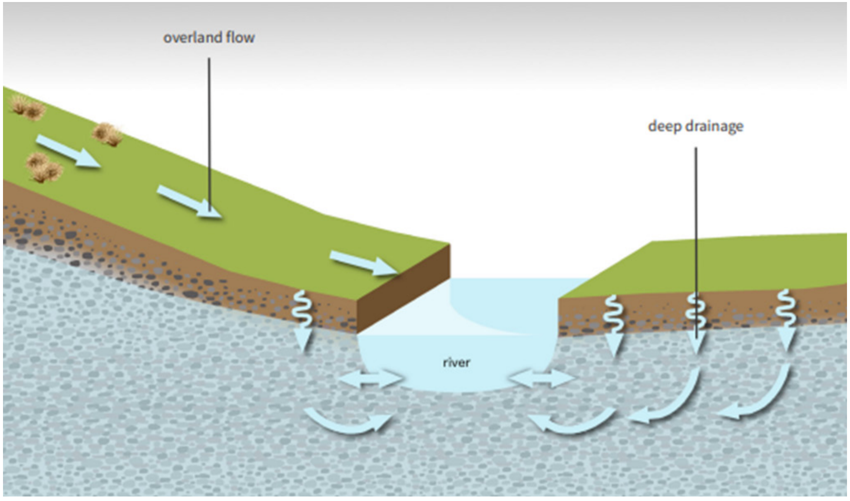
Mid and Lower catchment areas

Further downgradient, rivers and streams flow through agricultural land, where soils are predominantly deep silts with variable drainage. Nutrients, sediment and *E. coli* are transported to the main river and stream channels through overland flow, artificial drains and some shallow groundwater pathways.

Flow pathways and lag times vary greatly. Subsurface groundwater flows are associated with relatively long lag times (years), while modified surface hydrology results in shorter lag times for overland flow and artificial drainage networks.

In the lower parts of the catchments, an increasing proportion of water is derived from the agricultural landscape. This hydraulically modified land quickly transports water and contaminants to streams and rivers.

Near the coast, sandy and peat soils become more common, which are particularly leaky with respect to dissolved contaminants. The Tokanui River, highly sinuous in its lower reaches, discharges to the ocean at the eastern end of Toetoes Bay. Meanwhile, the Waikopikopiko Stream, Waionepu Creek, and their tributaries drain into the Haldane Estuary, which flows into the ocean east of Slope Point.



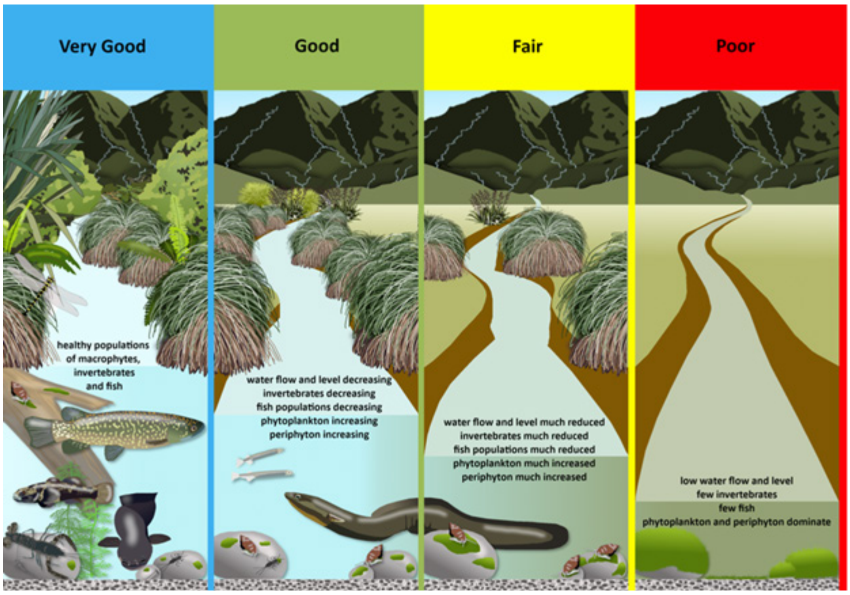
Conceptual depiction of the typical hydrological and landscape setting in the mid-catchment.

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, when many attributes have poorer grades, the overall ecosystem health is poorer.

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 Tokanui 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.

Approximately three quarters of the rivers in the Tokanui coastal zone are classified as Lowland Rivers with the remaining classified as Lake-fed and Natural State rivers.

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

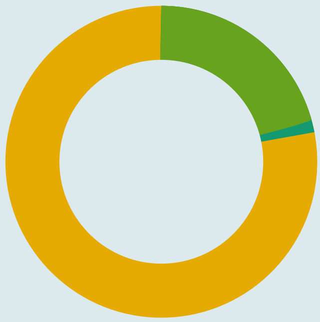
Periphyton is an example of an attribute with different target states for different river classes.

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

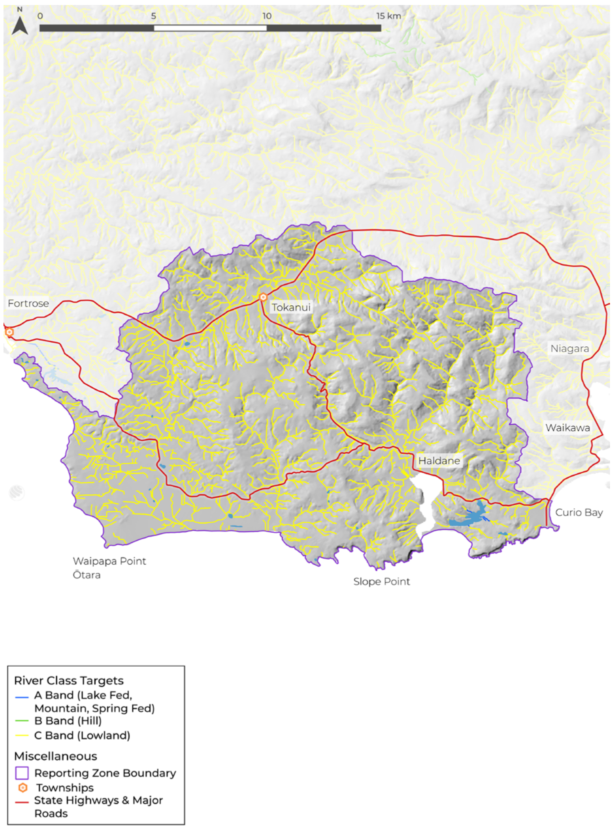


Lake-fed = 1,633m

Lowland = 5,022,064m

Natural State = 10,374m

River class hauora targets



The map shows the distribution of periphyton targets for each river class within the Tokanui 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 Lake-fed river classes. Table colours correspond to the 'ABCDE' grading for attributes described previously. Results show that lowland rivers in the Tokanui coastal zone have the most water quality issues.

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

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

"-" data not available.

Results for streams and rivers monitoring sites

Nitrate toxicity and suspended fine sediment are measures of ecosystem health. For nitrate toxicity, the current state of the monitored sites in the Tokanui coastal zone is very good and good. The current state for suspended fine sediment is poor.

MCI is in fair condition at one site and poor condition at the other site. Both nitrate toxicity and MCI meet the hauora target at one of the two monitored sites in the zone.

For the human contact value of *E. coli*, the monitored sites are in poor condition, with significant improvement required to meet the hauora target.

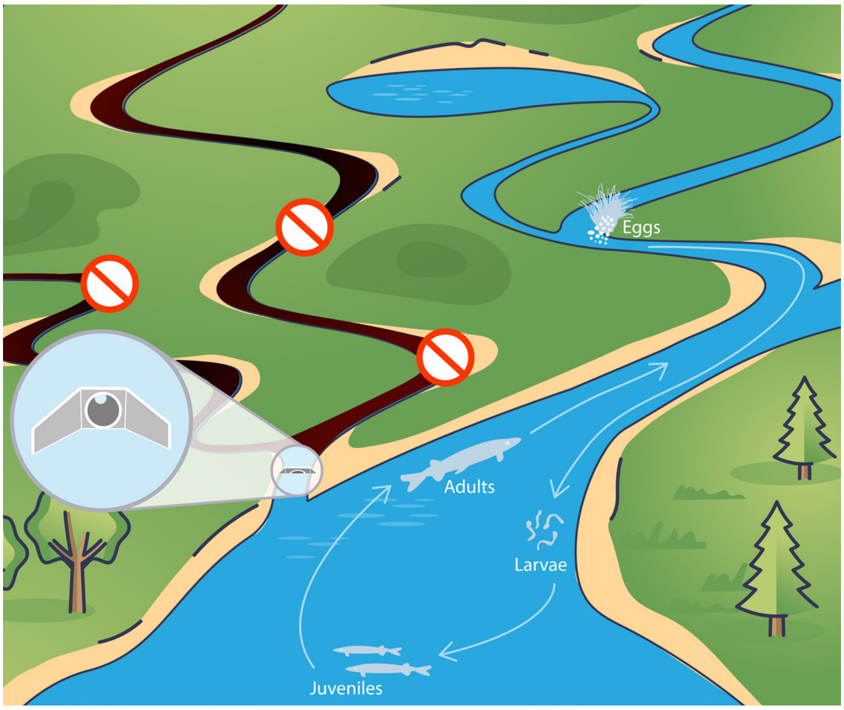
Fish passage

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.

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.

In the Tokanui coastal zone, culverts are the most common type of fish passage barrier. Considering fish passage during the design and installation of structures, along with regular maintenance, will help improve fish passage.

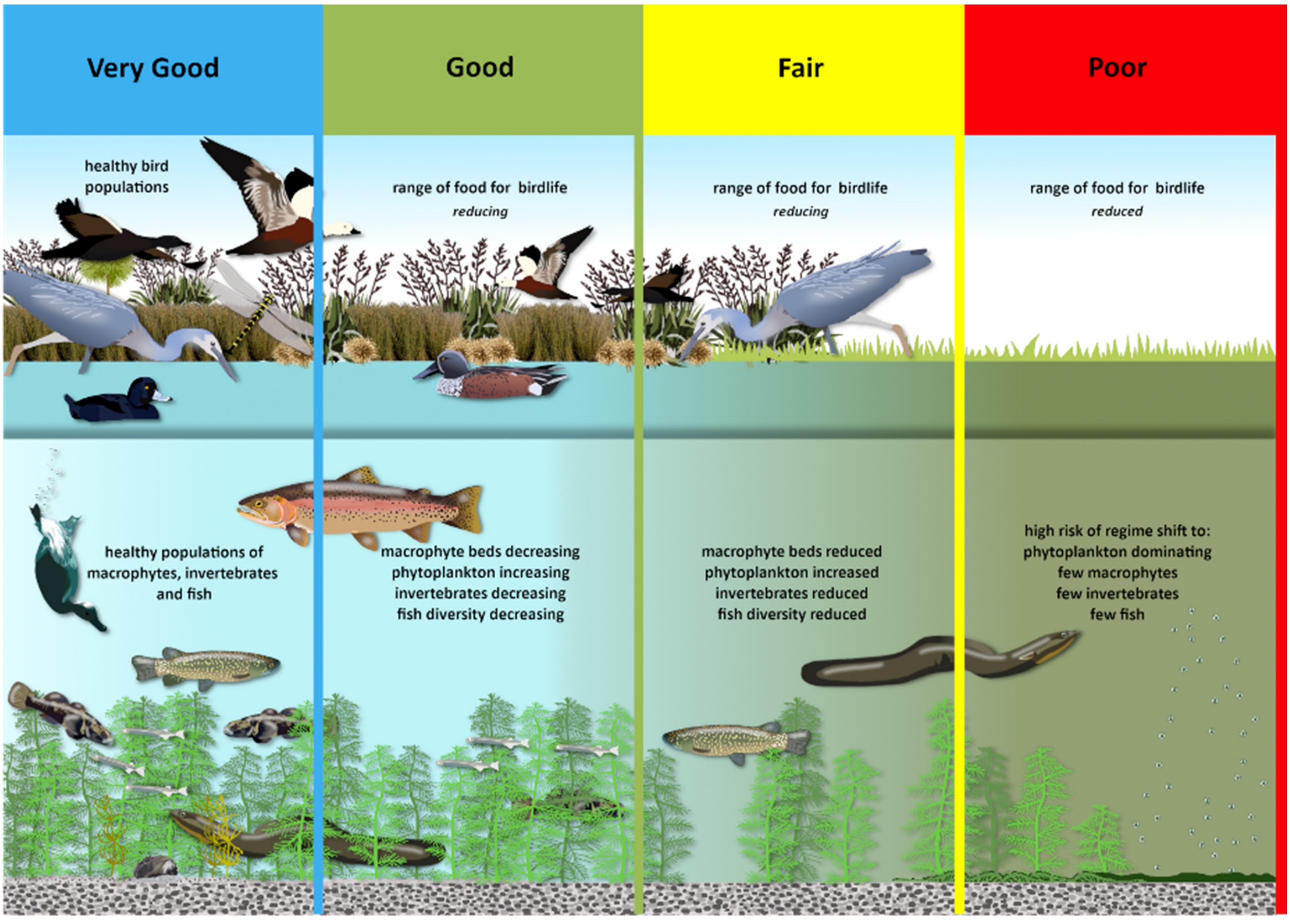
Whitebait lifecycle



Lakes

Lake freshwater outcomes can be described on a spectrum 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 concept is depicted for lakes in the image below.



Although many factors contribute to lake outcomes, we can only measure some to better understand ecosystem health. We measure the aspects of the freshwater environment that can help us define and determine freshwater outcomes.

Lake Brunton and the Reservoir

Lakes are grouped into different classes, and the hauora targets for different attributes can vary between the lake classes.

The Tokanui coastal zone includes two lakes, The Reservoir and Lake Brunton. The Reservoir is a lowland shallow lake, while Lake Brunton is a brackish lake.

Shallow lakes are usually well mixed vertically through the water column. Those in good condition typically have healthy plant communities and good water clarity. Lowland shallow lakes generally experience more pressure from land use than shallow lakes at higher altitudes. When their condition deteriorates, this can be expressed as increased suspended sediment in the water column, loss of aquatic plants (macrophytes), and the quality of lake bottom sediments.

Brackish lakes and lagoons have water with salinity between freshwater and seawater. This lake class includes intermittently open and closed lakes and lagoons (ICOLLs). These can have very different characteristics when in open or closed conditions.

Ecosystem health

Hauora targets and the current state of the monitored lakes in the Tokanui coastal zone are shown in the table.

Monitoring results for Lake Brunton show total nitrogen and total phosphorus are in a 'fair' and 'poor' state, respectively. The trophic state is also in a 'poor' state for phytoplankton. These attributes all fail to achieve the hauora target of 'good'.

For macrophytes (aquatic plants), Lake Brunton achieves the hauora target of 'fair', while The Reservoir is in a 'poor' state and fails to meet the target.

Human contact

Lake Brunton is monitored for *E. coli* and planktonic cyanobacteria, which are in a 'very good' state and achieve the hauora target. These results show that measures for *E. coli* and planktonic cyanobacteria do not limit the suitability of Lake Brunton for recreation.

	Lowland shallow lakes		brackish lakes and lagoons	
Ecosystem health attributes	Hauora target	Current state (The Reservoir)	Hauora target	Current state (Lake Brunton)
Ammonia toxicity (mg/L)	A	A	A	No data
Nitrate toxicity	A	A	A	No data
Total nitrogen	B	C	C	No data
Total phosphorus	B	C	B	No data
Trophic state (Trophic Level Index)	B	C	B	No data
Macrophytes	C	C	B	D
Phytoplankton	B	D	B	No data
Human contact attributes				
E. coli	A	A	A	No data
Planktonic cyanobacteria	A	A	A	-

Groundwater

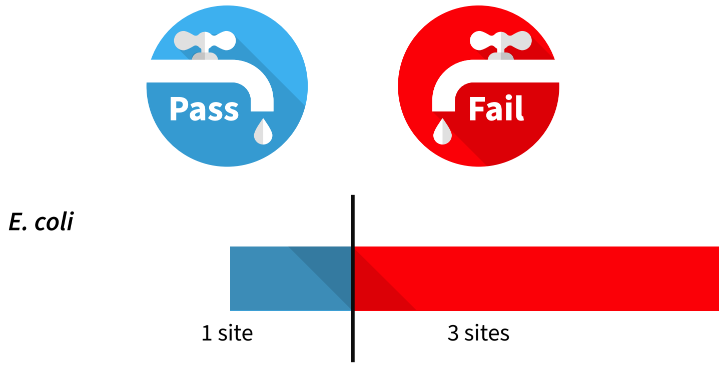
Human consumption – is it safe to drink?

Useable groundwater resources in the Tokanui coastal zone are limited. There are bores that commonly access groundwater at both shallow (<15m) and deeper (50 – 100m) depths. The median well depth is 15m.

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.

Results show that three of four monitored sites in the Tokanui coastal zone fail drinking water standards for *E. coli*.

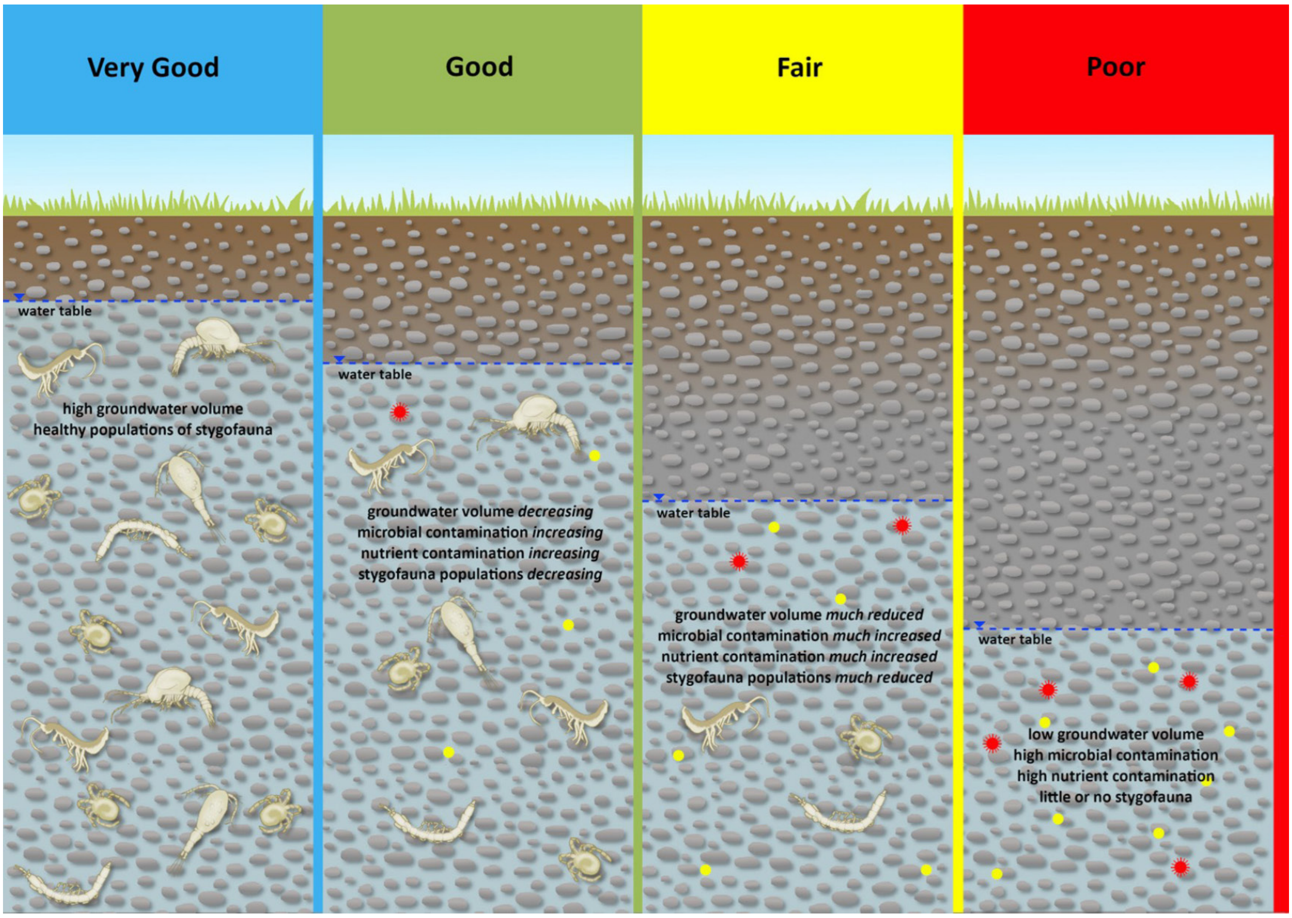
Tokanui coastal zone groundwater assesment



Ecosystem health

Nitrate concentrations are also used to monitor ecosystem health for groundwater ecosystems and connected surface waterways. Groundwater ecosystem health outcomes are represented conceptually in the figure below. Nitrate concentrations are one factor that contributes to overall ecosystem health. Nitrate concentrations related to surface water and groundwater ecosystem health outcomes differ from those used in drinking water mentioned above.

We have no monitoring data or model estimates for nitrate concentrations in the Tokanui coastal zone. Physiographic information suggests that the risk of severe nitrate contamination in this zone is 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.

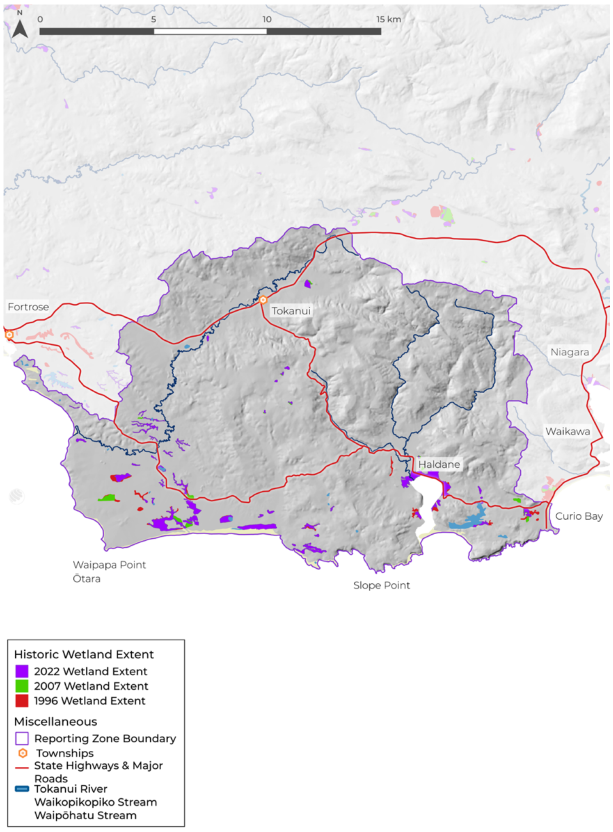
Wetlands purify water through sediment capture and storing nutrients in their soils and vegetation. This is particularly important for the agricultural nutrients nitrogen and phosphorus, which contribute to the eutrophication of receiving environments such as rivers, lakes and estuaries.

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

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.

Historic wetland extent



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

Current state

The current wetland extent for the Tokanui coastal zone is 295 ha. The majority of wetlands lost were bogs, fens and swamps. These have been mainly converted to pasture farmland.

Remaining natural inland wetlands

Two regionally significant wetlands are located in the Tokanui coastal zone: Haldane Estuary and The Reservoir. Haldane Estuary, a medium-sized tidal lagoon, discharges into Haldane Bay at the confluence of the Waikopikopiko and Waionepu Streams, with several saltmarsh wetlands along its boundary. The Reservoir, located east of the estuary, flows into it. Another significant wetland is Lake Brunton, a poorly flushed lagoon surrounded by extensive flax swamp, located west of the zone. Unlike other parts of Murihiku Southland, this area has few large inland wetlands and no bogs.

In the central catchment, small fens and marshes are found in depressions and gullies, while riverine flax swamps exist in the eastern zone. Some of the larger wetlands are adjacent to small lakes, such as Lakes Forest, Charles and Cook. Closer to the coast, Slope Point offers excellent examples of coastal turf.

Many wetlands in this zone face a moderate risk of loss in the near future.

	1996 to 2007	2007 to 2022	1996 to 2022
Change in wetland area	↓ 13% 50 ha	↓ 11% 38 ha	↓ 23% 88 ha

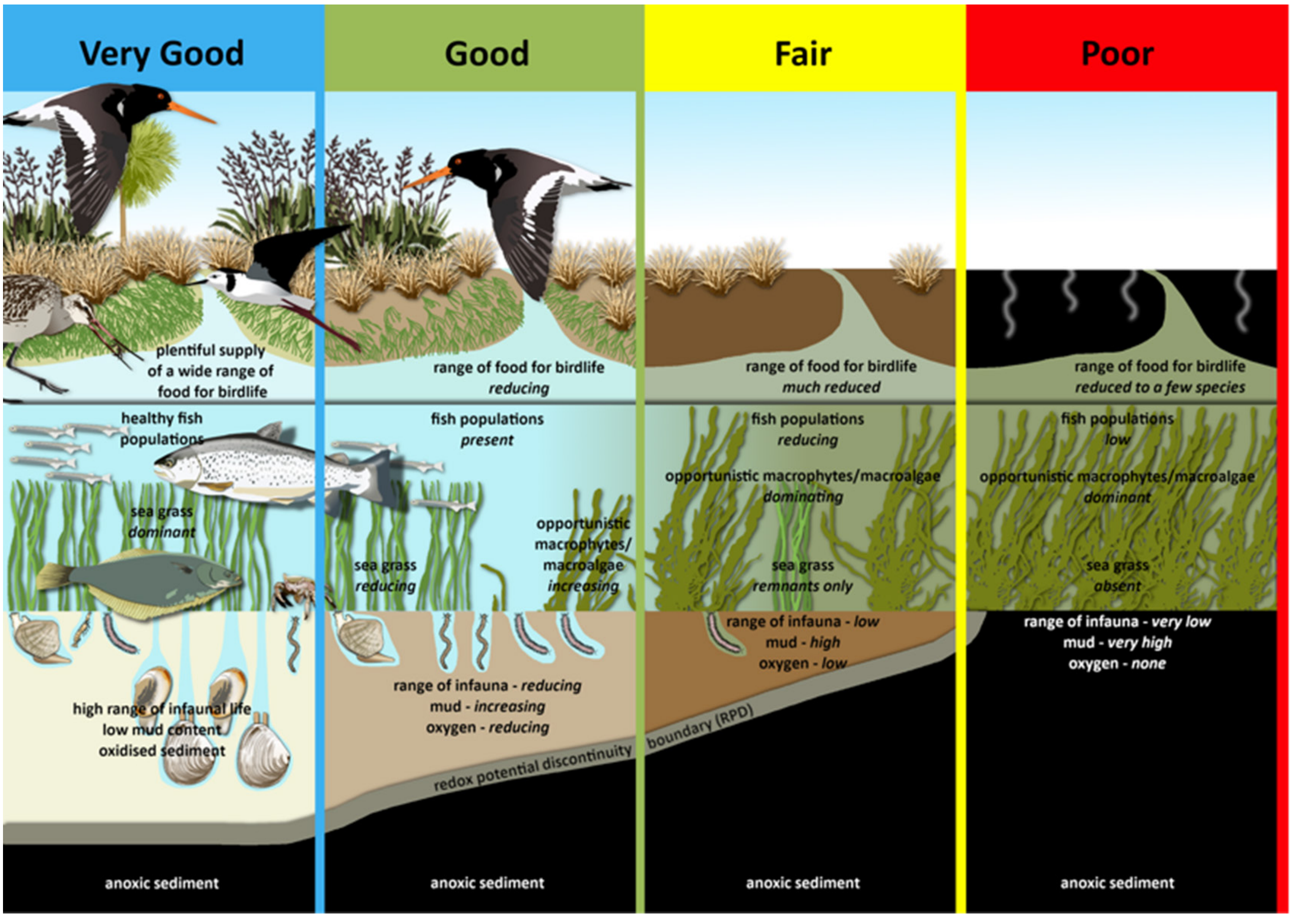
	1	2	3	4	5
Risk of Loss (1 = low, 5 = high)	0%	16%	82%	2%	0%

Haldane Estuary

Haldane River Estuary discharges into Haldane Bay at the terminus of the Waikopikopiko Stream and several smaller waterways. This shallow estuary, with a mean depth of 1-2 m, has extensive tidal flats, with more than 80% exposed at low tide.

Located at the bottom of the catchment, estuaries are vulnerable to eutrophication caused by excess nutrients, sediment and contaminants from inflowing rivers. Estuaries are categorised by their risk of eutrophication, with some more at risk than others. Haldane Estuary, a tidal lagoon estuary, is particularly susceptible, due to its shallow depth, river inputs, large intertidal sand or mud areas, and moderate tidal influence.

We can assess estuarine outcomes on a scale from 'very good' to 'poor,' which helps gauge the health of the freshwater environment and guide future goals. This concept is depicted for estuaries in the image below. Various aspects of the estuarine environment are measured to define and assess these outcomes.



Monitoring indicates a growing mud issue in the Haldane Estuary, with mud-dominated sediment and, therefore, reduced sediment oxygenation in the upper and landward reaches.

The increase in muddy sediment represents a shift in the estuary's ecological condition, as the benthic substrate transitions from firm, sandy, well-oxygenated sediment to a soft, low-oxygen, high-nutrient environment. This change alters the estuarine ecology of the area as the conditions are no longer conducive for a rich number of species that are sensitive to this degradation.

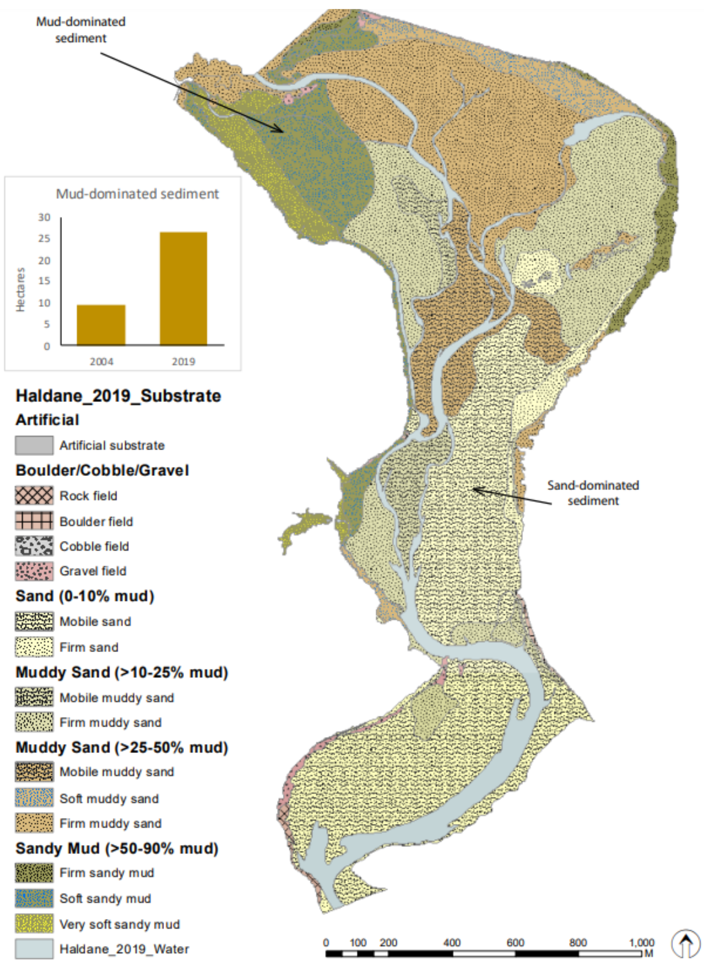
Attribute results vary across the estuary. For example, the upper tidal flats are more prone to mud build-up, elevated nutrients, dense nuisance macroalgae beds, and seagrass loss.

	Tidal lagoon estuary	
Ecosystem health attributes	Hauora target	Current state
Phytoplankton	C	No data
Macroalgae	B	A
Gross eutrophic zone	A	A
Mud content	A	C
Sediment oxygen levels	B	C
Total	A	B
Total arsenic, copper, cadmium, chromium, lead, mercury, nickel and zinc in sediment	A	A

Human contact attributes		
Pathogens – *Enterococci*	A	No data

Overall, the estuary is considered in 'good' to 'fair' condition.

Broadscale mapping of the Haldane Estuary shows low-to-moderate levels of fine sediment accumulating in the lagoon. However, since 2004, there has been a significant (200%) increase in mud-dominated sediment in the upper estuary (2019).



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

Surface water allocation

Surface water abstraction is managed in the Tokanui coastal zone through two types of allocation blocks. A primary allocation block restricts the amount of water that can be taken during low flows with the available allocation 30% of Q95. A secondary allocation block restricts the amount of water that can be taken when flows are above median or mean levels, depending on the time of year (10% of mean flow from December to March and 10% of median flow from April to November).

Stream depletion occurs when groundwater is abstracted in an area that is hydraulically connected to nearby surface waterways, causing a reduction of stream flow. As a result, stream depletion must be accounted for in both surface water and groundwater allocation management. Under the Southland Water and Land Plan, we are required to manage surface water allocation at any point of a surface water network, so allocation totals change along rivers to reflect the balance between the natural addition of water and the abstraction of water. The following allocation figures do not include permitted take estimates.

Groundwater allocation

There is one consented surface water abstraction in the Tokanui coastal zone, of 0.65 l/s for dairying purposes. This consent used approximately half of its consented surface water allocation during the last full season (2022/2023).

There is no continuous flow monitoring 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 the loads and concentrations required to achieve target states everywhere for all the above attributes.

Estimated load reductions for the Tokanui coastal zone are given in the table. Load estimates were calculated using sites with ten years of data and pertain to the 2017 year.

Contaminant	Total Load (2017 - Best estimate*)	Percentage load reduction required to achieve hauora (Best estimate*)
Total Nitrogen	213 Tonnes/Year	↓ 9% (7-12)
Total Phosphorus	9 Tonnes/Year	↓ 47% (25-62)
Sediment	4,800 Tonnes/Year	↓ 48%
E. coli	11 peta *E.coli*/Year	↓ 91% (79-100)

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 required estimated nitrogen load reductions. 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 below. 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. The results are not presented here but broadly show:

- Implementation of scenario 14 (over page) was estimated to achieve the required phosphorus reduction. Furthermore, scenario 4 was estimated to achieve reductions within the uncertainty of the required estimate. The range of reductions across all scenarios was between 0-51%.
- Implementation of the existing rules and regulations relating to sediment was estimated to achieve a 15% reduction in suspended sediment load. This is less than the 48% reduction required to support hauora.

ID	Scenario	Reduction in nitrogen load (%)	Remaining deficit from target (%)
Individual methods			
1	100% adoption of established farm Good Management Practice (GMP) mitigations	7	2
2	Adoption of all established and developing farm mitigations	20	0
3	Wetlands returned to the same area as existed in 1996	1	8
4	Establishment of wetlands in a way that treats all surface runoff from agricultural land	33	0
5	Establishment of large community wetlands in inherently suitable areas	8	1
6	All wastewater point sources are discharged to land rather than directly to water	4	5
7	Reducing land use intensity on flood prone land	1	8
8	Reducing land use intensity on public land	4	5
9	Destocking (10% reduction drystock, 20% reduction dairy)	15	0
10	Riparian planting (full shading of streams <7m wide)	1 (indirect effect on periphyton)	8
Bundled methods			
11	1996 wetlands returned, wastewater discharged to land (3 + 6)	4	5
12	Established and developing farm mitigations, 1996 wetlands, wastewater to land (2 + 3 + 6)	25	0
13	Established and developing farm mitigations, 1996 wetlands, wastewater to land, repurposing public land (2 + 3 + 6 + 8)	30	0
14	Established and developing farm mitigations, 5% wetlands, wastewater to land, repurposing public land (2 + 4 + 6 + 8)	50	0
15	Established and developing farm mitigations, community wetlands, wastewater to land (2 + 5 + 6)	29	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)	17	0

Required reductions likely achieved (green) *Within uncertainty range* (orange) *Deficit remaining* (red)

The table above indicates that several of the individual mitigation scenarios we tested could achieve the reductions required to support a state of hauora. The required reductions in nitrogen load could be achieved through various mitigation strategies. However, the necessary load reductions for phosphorus, sediment and *E. coli* are much larger and will likely require more widespread changes to land use.

Reducing load from pastoral land across the catchment

In addition to the above, we looked at different nitrogen load reduction scenarios for dairy and drystock farms. The purpose of this work was to help show reductions that could be achieved via reductions in loss from drystock and dairy land.

Nitrogen losses vary depending on land use and multiple environmental factors. We used land use, climate, soil type and slope to estimate losses from the land. The percent reductions modelled apply across these estimated losses.

The table shows the load reduction achieved for each combination of simulated reductions. The coloured table cells indicate how far each combination achieves the required load reductions. For example, we can see that a 40% reduction in loss from dairy farms combined with a 20% reduction from drystock farms is predicted to result in an approximately 25% reduction in TN load for the catchment.

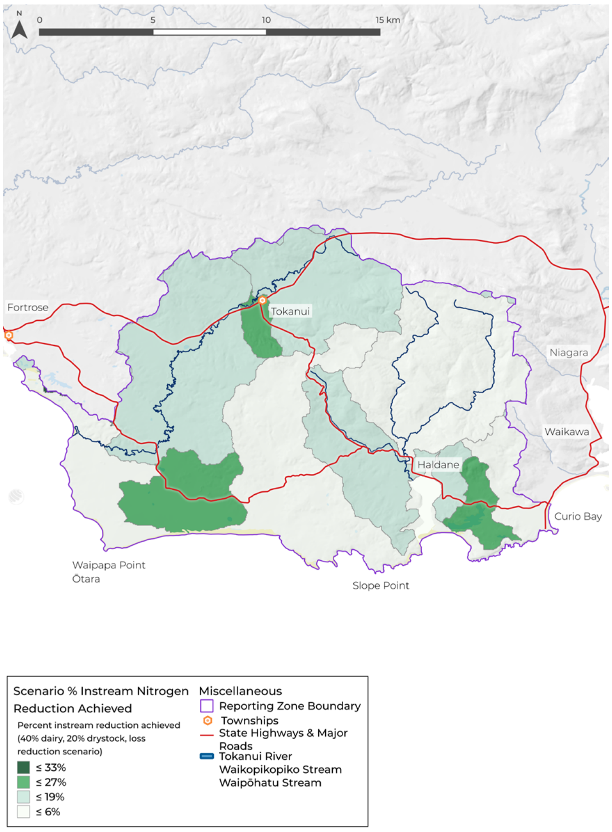
Basin-wide mean % TN reduction, relative to baseline

Drystock loss rate reduction (%)					
80%	48%	55%	61%	68%	74%
60%	36%	43%	49%	55%	62%
40%	24%	31%	31%	43%	50%
20%	12%	18%	25%	31%	38%
0%	0%	6%	13%	19%	26%
	0%	20%	40%	60%	80%

Dairy loss rate reduction (%)

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

Instream nitrogen reduction achieved (%)



The map shows how the modelled nitrogen reductions achieved are predicted to vary spatially across the sub-catchments. It highlights that we might expect if all dairy land reduced nitrogen losses by 40% and drystock by 20%, the largest instream reductions (39%) would be achieved in the darker green sub-catchments.

Opportunities for action

We’ve put together opportunities for action in the Tokanui coastal zone to reduce contaminant loads and improve the state of freshwater.

The catchment

Scale of the problem

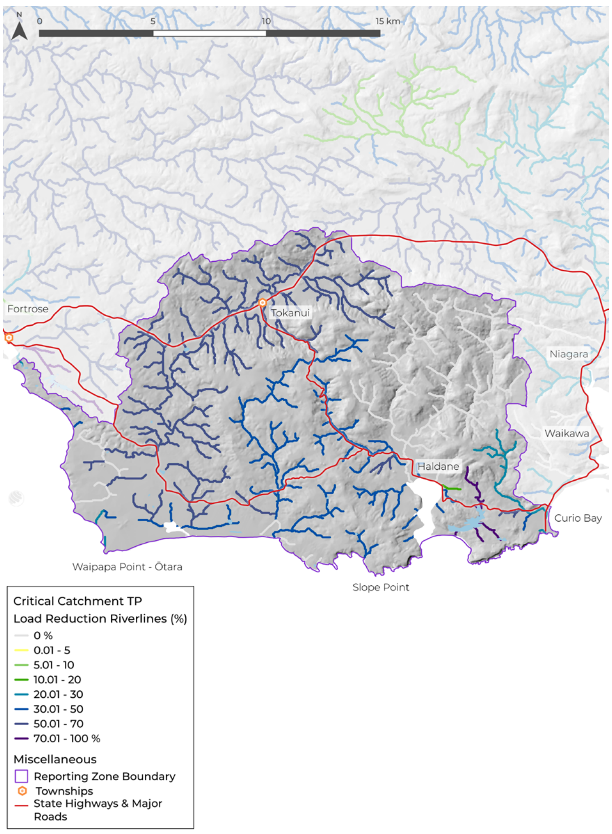
There are extensive areas of land contributing high contaminant loads in this catchment.

The map below shows modelled excess phosphorus load patterns, which help demonstrate the spatial scale of the reductions required. Excess loads depend on the modelled concentrations and all the defined targets, both local and downstream. The critical excess map indicates the magnitude of phosphorus load reductions required to achieve river, lake and estuary targets in the zone.

High phosphorus, sediment and *E. coli* loads may be difficult to mitigate, and implementing improved management practices alone may not achieve the desired outcomes for freshwater and the estuary. Consideration should be given to the potential for large-scale catchment mitigations and changes to how land is used.

In addition, efforts to implement nature-based solutions and slow water flow will likely have multiple benefits for water quality, biodiversity, flood mitigation and catchment resilience.

Critical Excess TP Load (%)



Farm scale opportunities for action

Farm scale actions should be tailored to physiographic setting and catchment priorities. In the Tokanui coastal zone, load reductions are required for all major contaminants (nitrogen, phosphorus, sediment 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:

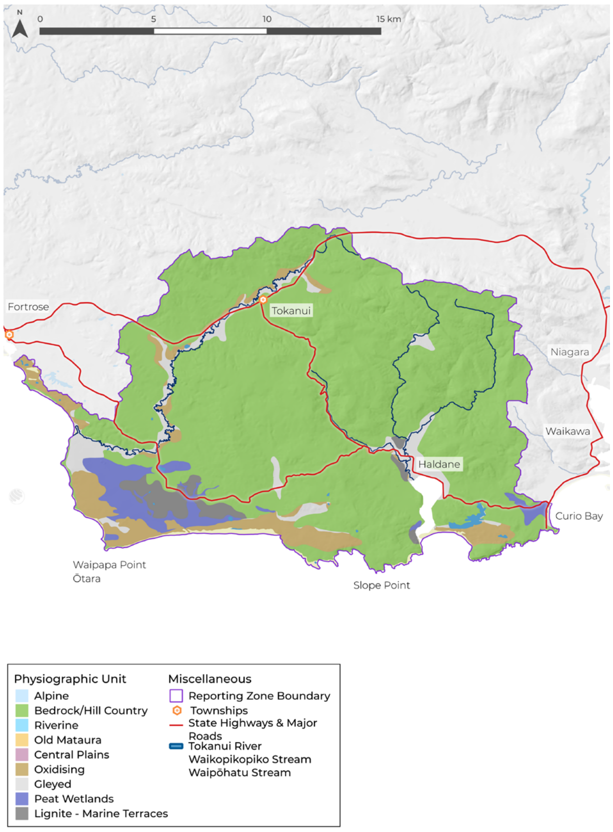
- overland flow (or surface runoff)
- artificial drainage - e.g. tile drains and mole pipe drainage
- deep drainage (or leaching) - of either nitrogen or phosphorus to groundwater
- lateral drainage (or horizontal movement through the soil) - of phosphorus and microbes

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

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.

Farm 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

Physiographic zones



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

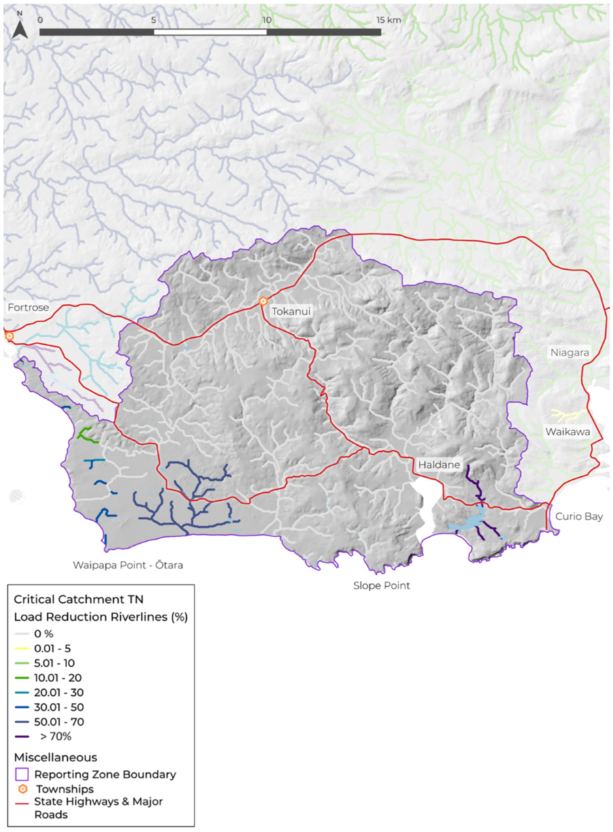
Nitrogen

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

Reducing nitrogen loss should be a priority in all farm-scale mitigation planning.

Determining which mitigations to use will depend on each farm and its circumstances. Physiographic information can help inform what likely contaminant loss pathways need attention in different locations. As shown above, the excess load map indicates where nitrogen loss mitigation should be a particular focus in farm planning. This map indicates the magnitude of nitrogen load reductions needed to achieve all river and estuary targets for the entire catchment area.

Critical catchment TN load reduction (%)



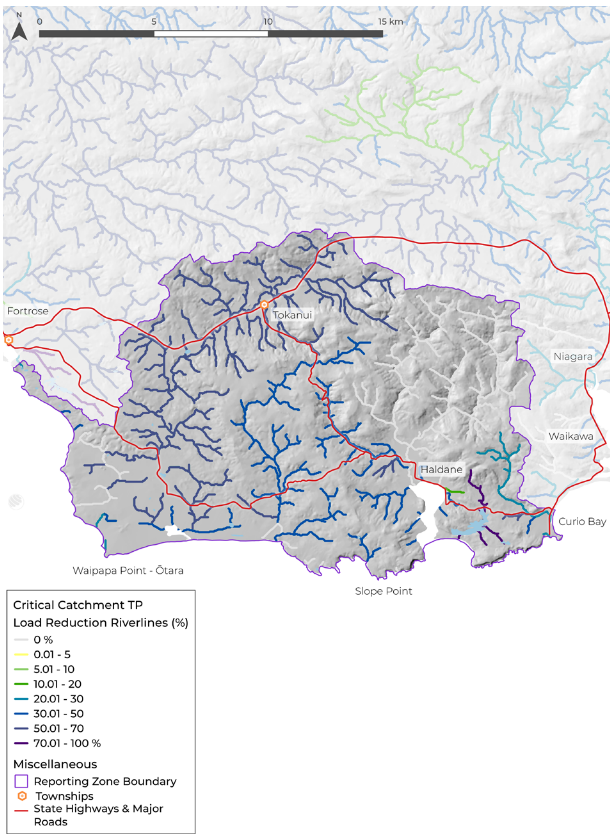
Phosphorus

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

Reducing phosphorus loss should be a priority in all farm-scale mitigation planning.

Determining which mitigations to use will depend on each farm and its circumstances. Physiographic information can help inform what likely contaminant loss pathways need attention in different locations. The excess load map shown here indicates where phosphorus loss mitigation should be a particular focus in farm planning.

Critical catchment TP load reduction (%)



Sediment

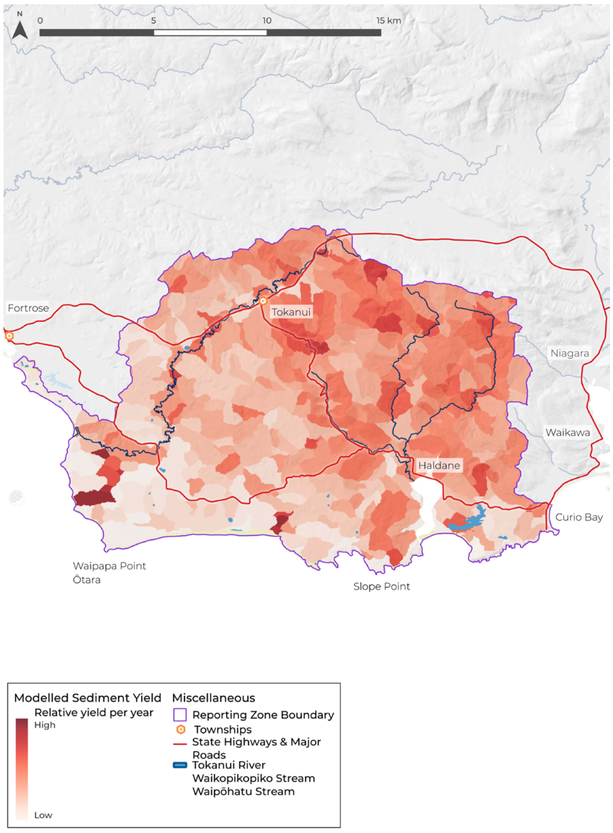
The map (right) shows how we expect sediment loss to vary throughout the catchment.

Some areas of high sediment loss in the upper catchments are associated with natural erosion. Sediment from natural erosion generally impacts waterways less than agricultural land sediment. Agricultural sediments are usually finer and carry higher concentrations of nutrients.

Areas of higher sediment loss rates are shaded darker red in the map. These are generally areas with more sloping land, soils susceptible to erosion, and where stream bank erosion is likely an issue.

Properties within the shaded, darker red areas 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.

Haldane Estuary opportunities for action

- Retirement, protection, and restoration of margins surrounding coastal lakes, lagoons, and estuaries, particularly Haldane Estuary, Lake Brunton, and The Reservoir.
- Focus on wetland protection and restoration, with specific consideration of land use suitability, especially in areas with potentially susceptible organic soils.

Urban and industrial opportunities for action.

- Ensure wastewater and stormwater systems are not cross-connected in municipal infrastructure.
- Target improvements to on-site wastewater disposal systems to reduce the risk of human faecal contamination in freshwater.
- Incorporate best-practice stormwater management methods in urban development.

Published by:
Environment Southland, 2024

Environment Southland | Cnr North Rd & Price St, Invercargill | 0800 76 88 45 | service@es.govt.nz | www.es.govt.nz