Aparima and Pourakino **catchment**

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Te Taiao Tonga

Aparima and Pourakino catchment

This document summarises scientific information, opportunities for action, and the socioeconomic context of the Aparima and Pourakino catchment, which drain into the Jacobs River Estuary.

It is one of twelve catchment summaries prepared for the Muruhiku Southland region.

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: 157,000ha

Major rivers and streams:
Aparima, Pourakino, Ōtautau

Aquifers:
Lower Aparima, Upper Aparima

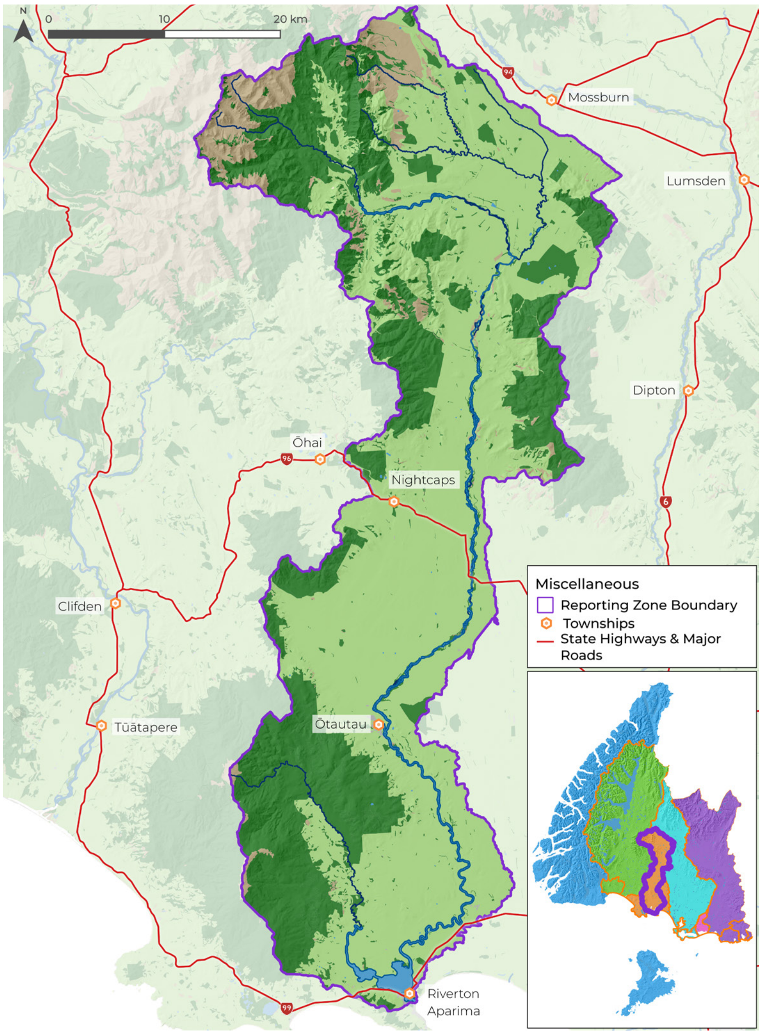
Lakes:
None

Estuaries:
Jacobs River

Townships:
Ōtautau, Riverton, Ōhai, Nightcaps

Population:
Approximately 5,000

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 Aparima and Pourakino catchment. Eight of the 12 (66%) river attributes do not meet hauora targets. Furthermore, 6 of the 12 (50%) attributes are currently graded as ‘poor’ or ‘very poor’.
- The Jacobs River Estuary is classified as eutrophic. In addition, the build-up of muddy sediment has resulted in poor ecosystem health, particularly in the estuary's upper reaches.
- Modelling indicates large contaminant load reductions are required to achieve desired freshwater and estuary outcomes. Waterbody load reductions are needed for nitrogen (46%), phosphorus (43%), sediment (22%) and *E. coli* (74%).
- There are several areas within the Aparima and Pourakino catchment where groundwater is highly contaminated with nitrogen. This means groundwater is unsafe to drink in some places.
- Approximately 650ha of wetlands have been lost since 1996 in the Aparima and Pourakino catchment. Of the remaining wetlands not on conservation land, 40% are at moderately high risk of being lost.

Opportunities for action

- Implement property-scale mitigations and best possible management practices tailored to the specific agricultural system, physiographic characteristics of the land and the sensitivities of the receiving environments.
- Consider opportunities to facilitate land use change that reduces environmental impact or encourages deintensification over time. This may be through developing long-term catchment plans and catchment projects, pilots and promotion of alternative land use options, or implementation of regulation.
- Target the restoration of marginal estuary vegetation, including herb fields, wetlands, and salt marshes and salt-tolerant shrub banks. Focus on areas of historic loss, such as the Pourakino Arm and the Northern Flats.
- Remove nuisance macroalgae from new growth areas, areas where macroalgae is causing increased mud deposition near seagrass beds or marshlands and the fringes of current sediment deposition zones.
- Undertake targeted improvements to urban and industrial wastewater and stormwater systems and disposal, including on-site wastewater disposal systems.

Active restoration techniques, will only improve the estuary's long-term condition if contaminant inputs to the estuary are reduced significantly.

Socioeconomic context for action

Historic socioeconomic shifts in the later part of the 20th century have shaped the communities in western Murihiku Southland, including in the Aparima and Pourakino catchment. The impacts of neoliberal deregulation from the 1980s removed agricultural subsidies and export assistance, creating a period of austerity for many farming communities.

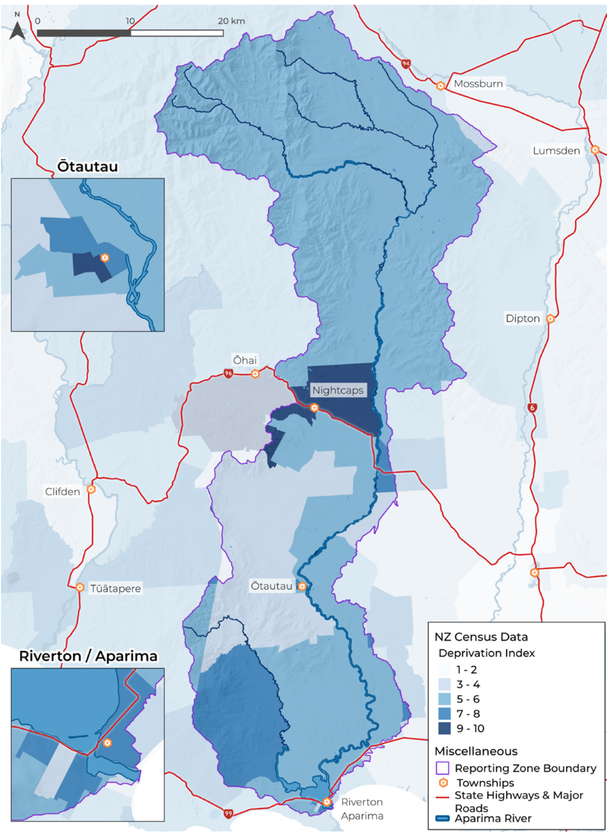
Other industry declines, such as coal extraction in the Ōhai-Nightcaps area and the timber industry in the Tūātapere/ Longwood Forest area, led to a deterioration of socioeconomic conditions for local dependent townships, driving population decline.

The rise in dairy farming across the region in the 1990s began to improve economic conditions for the catchment, ushering in land use change and industry and demographic changes. However, populations in the Aparima and Pourakino catchment remain closely associated with the agriculture, forestry and fishing industries. In the 2018 Census, nearly one-third of the population of Ōhai-Nightcaps and Ōtautau were involved in these industries, while in Riverton, one in twenty people were engaged in agriculture, forestry or fishing.

Following a general population decline from the 1990s to the mid-2000s, the Aparima and Pourakino catchment and Muruhiku Southland generally have shown steady increases in both population and ethnic diversity in the region. The main demographic disparity in the catchment over this period is fewer younger people aged 15-29. People from this demographic often leave for tertiary education or employment opportunities elsewhere in Muruhiku Southland or outside the region.

While house prices have increased regionally and nationally since 2020, Muruhiku Southland, predominantly inland western Murihiku Southland tends to be more affordable for rent and ownership than elsewhere in New Zealand.

Social Deprivation Index



Over the last three decades, Riverton has broadly followed regional demographic trends, although Riverton's population increase started slightly later than elsewhere. Since 2020, however, there has been a slight downturn in population. Riverton has the highest percentage of people aged over 65 and more expensive housing than the Ōtautau and Ōhai-Nightcaps areas. It has a higher Māori population but lower ethnic diversity than elsewhere in the Southland District Council area.

The population of Ōtautau has fluctuated since the early 2000s. This may be partly due to the transient nature of agricultural (dairy farm) workers with younger families moving in and out of the area. The area also has

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.

comparatively higher numbers of working-aged people in their 30s and a higher number of younger children than in the district. While Ōtautau has comparably affordable housing, the area has seen a decrease in home ownership.

Ethnic diversity is comparable to that of the Southland district.

Ōhai-Nightcaps has followed different population trends than the wider Southland district. Population decline slowed in the late 2000s. After an initial recovery in the early 2010s, the population went back into decline and has only shown signs of a moderate increase since 2020. This increase was likely due to the post-COVID-19 housing boom and the relative affordability of renting or purchasing a home in the area at that time.

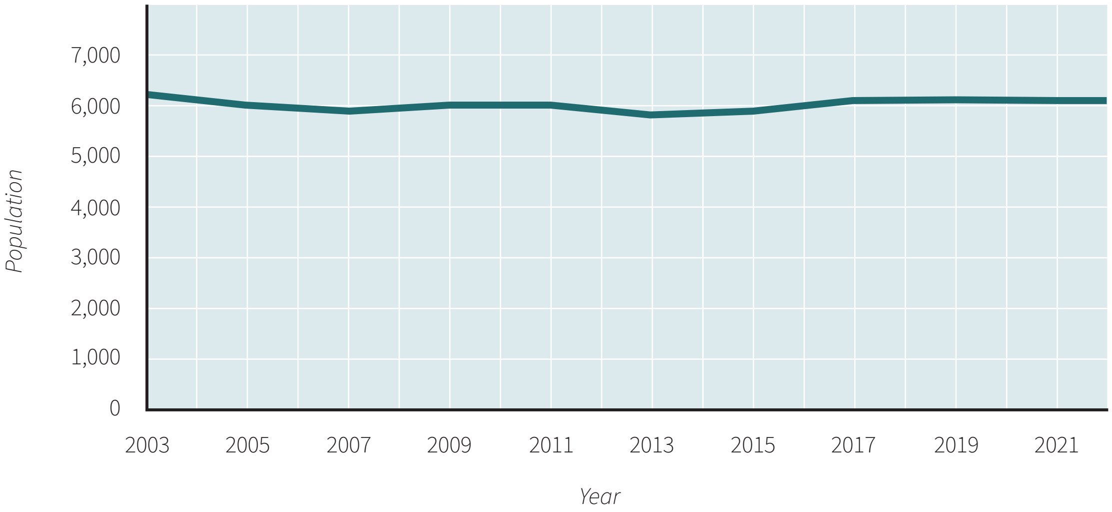
The age distribution in Ōhai-Nightcaps is consistent with the wider Southland district, except there is no decrease in young people aged 15-29. Like Riverton, Ōhai-Nightcaps has a higher percentage of Māori within the population when compared to the Southland district as a whole. It has a small but increasingly ethnically diverse population.

Although Southland district is among the least socioeconomically deprived areas in New Zealand, the Aparima and Pourakino catchment zones, except the Mossburn SA2 zone, contain some of the district's most deprived areas.

Deprivation trends from 2014 -2023 show that Riverton has shifted back and forth between moderate and higher levels of deprivation Ōtautau has experienced some increases in deprivation, while Ōhai-Nightcaps has experienced consistently higher levels of deprivation in the region.

Pockets of higher levels of deprivation (7-9 on the index) are mainly concentrated within closely settled areas of the SA2. Higher deprivation correlates with less capacity to cope with the effects of environmental risks, fewer resources, higher vulnerability and poorer community wellbeing outcomes.

Aparima-Pourakino catchment estimated population trends 2000 – 2023 (Dot Loves Data, 2024)



This graph is based on combined estimated populations for the Riverton, Ōtautau and Ōhai-Nightcaps statistical areas. Note that the totals include additional areas outside the catchment, so this shows approximate population trends, not a total catchment population.

Summary

- The local economy relies heavily on intensive agriculture, which increases environmental, economic, social, and cultural risks from industry or regulatory changes.
- Higher deprivation levels in some settlements could result in less community resilience and poorer wellbeing outcomes.
- Lower education attainment levels in some areas may reduce the capacity to adapt to economic, technological, and environmental changes.

Established catchment groups, such as Aparima Community Environment (ACE), provide a support system for members and may facilitate adaptation to external pressures and challenges.

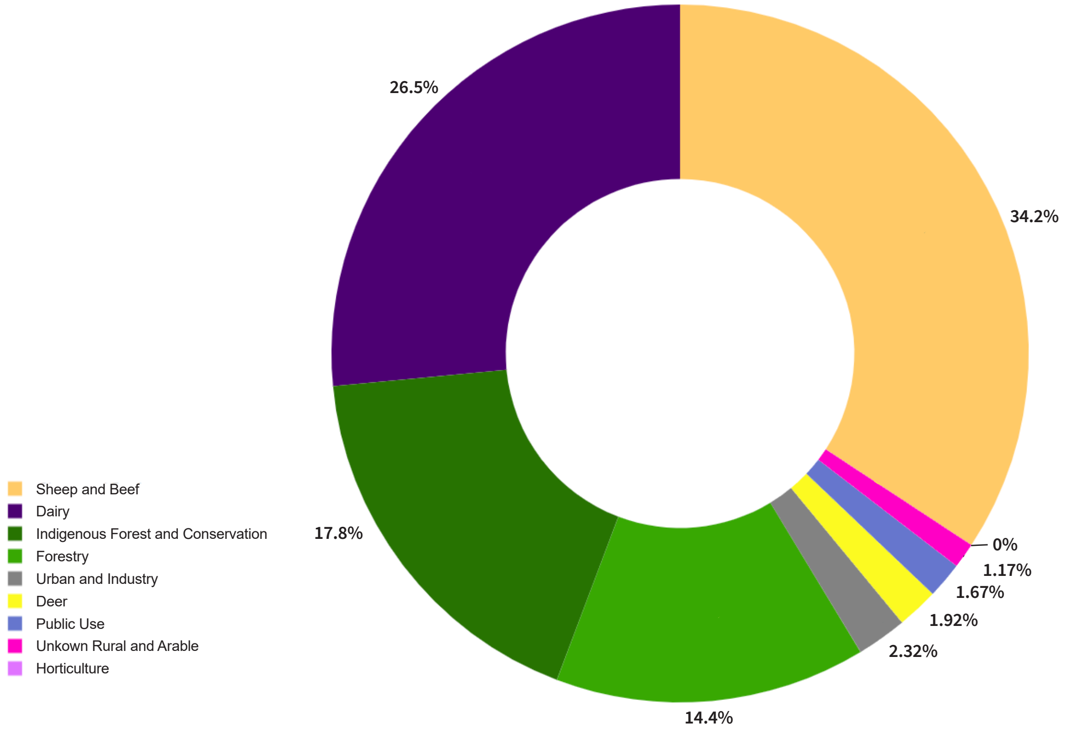
Catchment overview

The Aparima catchment extends from the Tākitimu Mountains west of Mossburn to the Jacobs River Estuary at Riverton/Aparima. The headwaters start in alpine, native tussock and forested land, while the mid and lower reaches are within largely pastoral farmland on the plains.

The Pourakino catchment drains the eastern slopes of the Longwood Ranges. It is short and steep and discharges into the western arm of the Jacobs River Estuary.

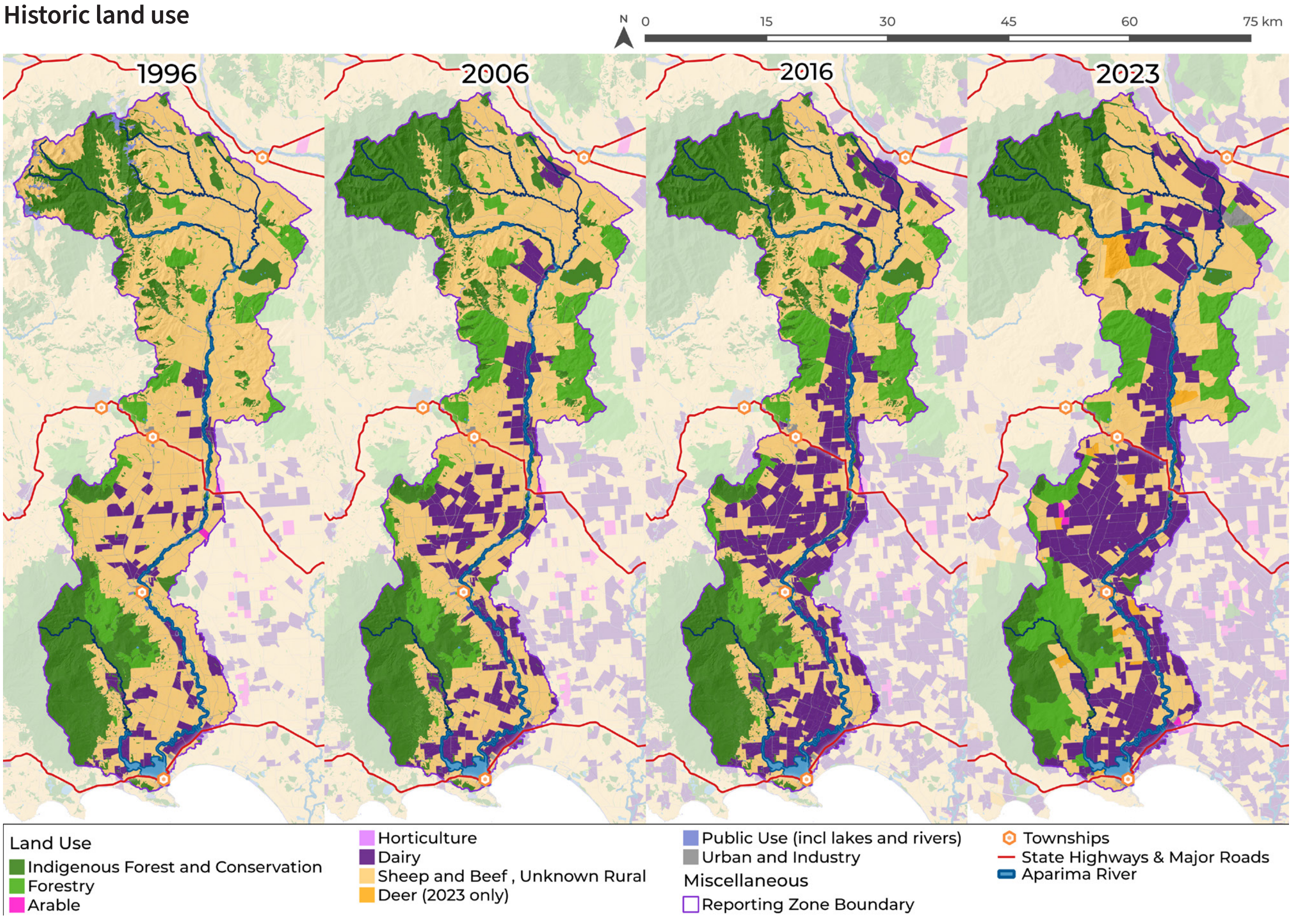
Land use

The Aparima and Pourakino catchment covers 157,000 hectares of land. About 98,140 ha (63%) is used for farming. Approximately 28,000 ha is Department of Conservation estate and approximately 80 ha is Māori Freehold Land. Land use is a mix of approximately 34.4% sheep and beef, 26.4% dairy, 14.4% commercial forestry and 17.7% indigenous forest and conservation.



Large changes in land use have occurred in the last 25 years, in particular, the growth of dairy farming. The total pastoral land area change has been limited, indicating most of the land use change has been a shift from drystock to dairy farming. The development of dairy farming represents an increase in agricultural land use intensity. This has resulted in an increase in contaminant loss and 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 methodologies.

Historic land use

	1996 to 2006	2006 to 2016	2016 to 2023	Overall 1996 to 2023
Pastoral land	↓ 10%	↓ 4%	↑ 8%	↓ 2%
Dairy	↑ 120%	↑ 70%	↑ 22%	↑ 360%
Drystock	↓ 21%	↓ 19%	↓ 1%	↓ 40%

Climate

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

Current climate

The Aparima and Pourakino catchment is typically considered to have a cool-wet climate. The average mean annual temperatures range from 10-11°C, falling between 12-15°C in summer and 3-6°C in winter. Typically, the area experiences 25-50 nights below 0°C annually.

Rainfall across the Aparima and Pourakino catchment is variable. The western areas and headwaters receive higher annual average rainfall (1,100-2000 mm/yr) than the eastern and central Aparima areas (800-1,100 mm/yr). This difference is due to orographic rainfall and an associated rain shadow effect. The average number of wet days per year (>1mm rainfall) ranges from 150-200, with slightly less in the central and eastern parts of the area. The heaviest rainfall events are typically seen in the coastal/southern part of the catchment.

Future climate

Potential changes to the future climate of the Aparima and Pourakino catchment have been examined in a regional study exploring scenarios for two Representative Concentration Pathways (RCPs): 4.5 and 8.5, representing lower and higher carbon emissions, respectively. These potential changes are summarised in the following 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 - 1	↑ 1.75 - 2.5
	Mean minimum (°C)	↑ 0 - 0.5	↑ 0.5 - 1	↑ 0.25 - 0.75	↑ 1.25 - 1.75
	Number of hot days	↑ 0-10	↑ 0-20	↑ 0-15	↑ 0 - 40
	Number of frosty nights	↓ 5-15	↓ 10-25	↓ 5-15	↓ 15 - 50
Rainfall	Annual rainfall change (%)	↑ 0 - 10	↑ 0 - 10	↑ 0 - 5	↑ 5 - 20
	Number of wet days	↑ 5 - ↓ 5	↑ 5 - ↓ 5	↑ 5 - ↓ 5	↑ 5 - ↓ 10
	5-Day maximum rainfall (mm)	↑ 15 - ↓ 15	↑15 - 0	↑ 15 - ↓ 15	↑30 - 0
	Heavy rainfall days	↑ 2 - ↓ 2	↑ 2 - ↓ 2	↑ 2 - ↓ 2	↑ 2 - 0
	Seasonal changes	Wetter springs	Concentrated to winter/spring	Concentrated to winter/spring	Concentrated to winter/spring

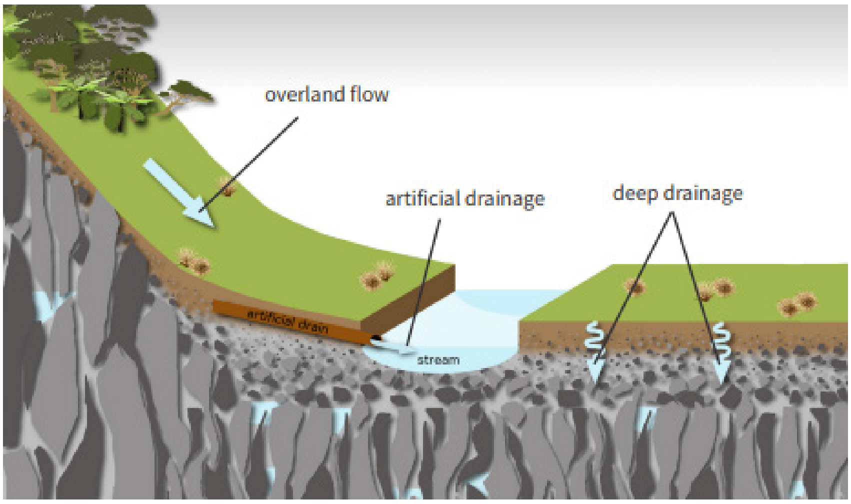
Catchment landscapes and hydrology

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

Headwaters

Rain falling in the headwaters (above 400m elevation) of the Aparima and Pourakino catchment flows down the slopes of the eastern Takitimu Mountains (Aparima) or eastern Longwoods (Pourakino). These mountains are mostly covered in native vegetation. They are characterised by thin organic forest soils formed on clastic sedimentary bedrocks (Takitimu) and intrusive igneous rocks (Longwoods) belonging to the Murihiku and Brook Street Terranes, respectively.

Waterways in the headwaters are small (< order 4) with median flows less than one cumec.

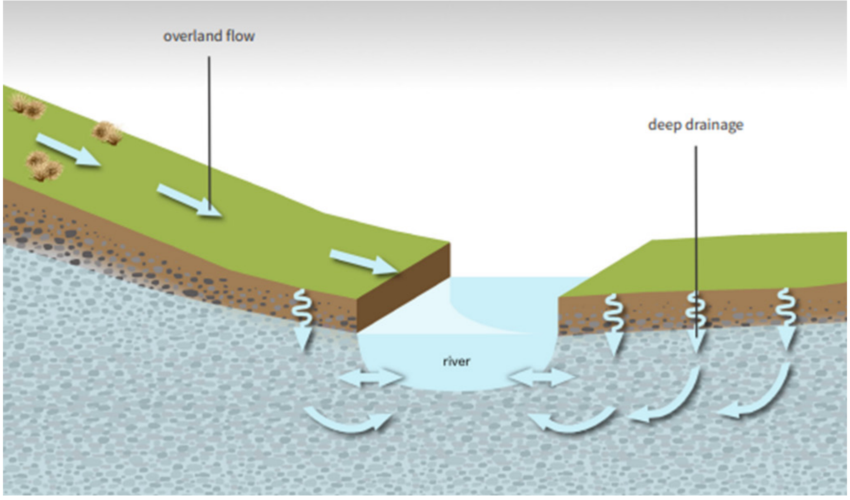


▲ *Conceptual illustration of the typical hydrological and landscape setting in the upper catchment hill country areas.*

Relatively pristine water from the headwater hills flows to the bottom of the headwater valleys through recent alluvial gravel deposits. As water flows through these deposits, it mixes with localised recharge water from the surrounding land. Flow lag times in the upper catchment are relatively short (hours/days), with limited subsurface flow pathways and steeper topography.

Low-intensity agriculture in the headwater valleys contributes to the accumulation of nutrients, sediments and *E. coli* in the water flowing through them.

Mid catchment



▲ *Conceptual illustration of the typical landscape setting and contaminant loss/flow pathways in the mid catchment.*

Further downgradient rivers, and streams flow into broadening valleys over rolling and flatter topography. Thicker and older alluvial gravel layers are adjacent to the river channel and line the width of the river valleys.

Many gravel layers lining the alluvial valleys are saturated with groundwater, a mix of localised land recharge and river water. These groundwater resources are important for contributing to local stream and river flows and for abstraction for human use.

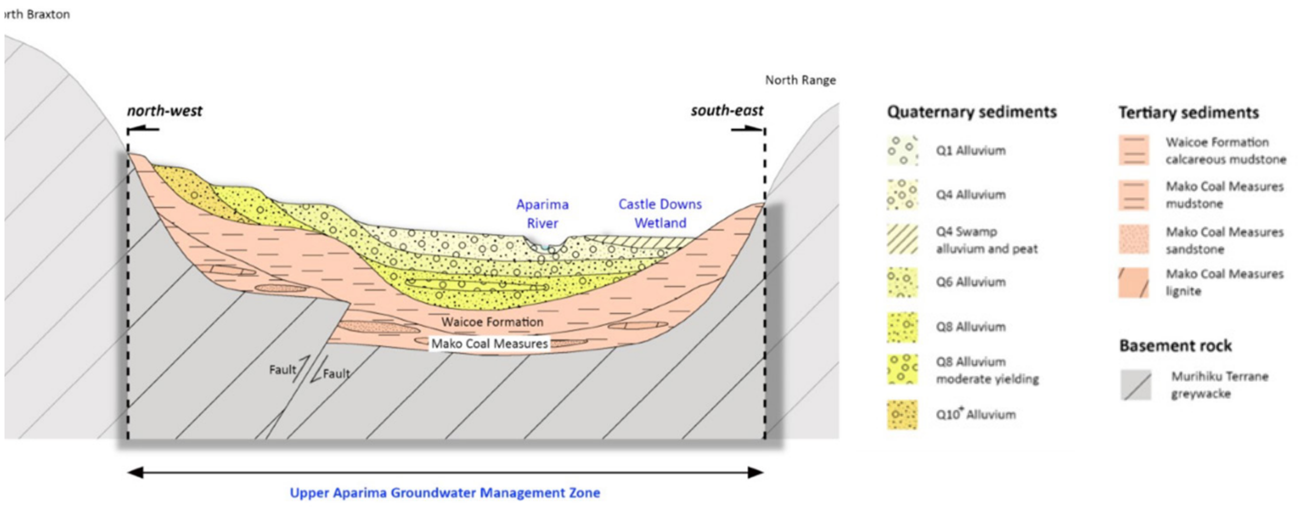
Older sandstones, mudstones, and limestones underlie these various layers of alluvial gravel. In the mid-reaches of the river catchment, more water is derived from localised recharge, natural and artificial drains and temporary overland flow pathways.

Extensive drainage and stream modification on agricultural land has resulted in water moving more rapidly through the landscape. Water on the flatter alluvial plains interacts with the soils in intensive agricultural landscapes and carries nutrients, sediment, *E. coli* and other contaminants.

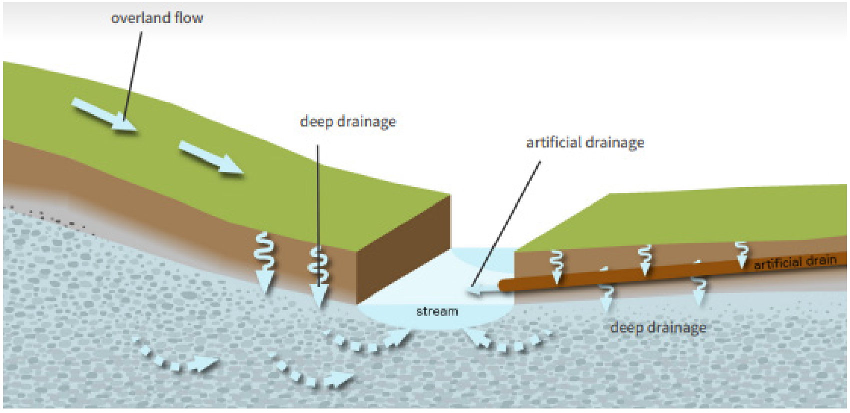
Flow pathways and lag times can vary greatly. Relatively long lag times (years) are associated with subsurface groundwater flows, while the modified surface hydrology results in short lag times for overland flow and artificial drainage networks.

Adjacent to the Aparima River, soils consist of recent fluvial shallow, stony and well-drained soils. Further from the river, older, more poorly drained pallic soils occur, deposited by windblown sediment and interspersed with waterlogged gley soils in the middle of the catchment. The distribution of these soil types impacts water flow pathways and how contaminants are transported.

Hydrological concept diagram



Lower catchment

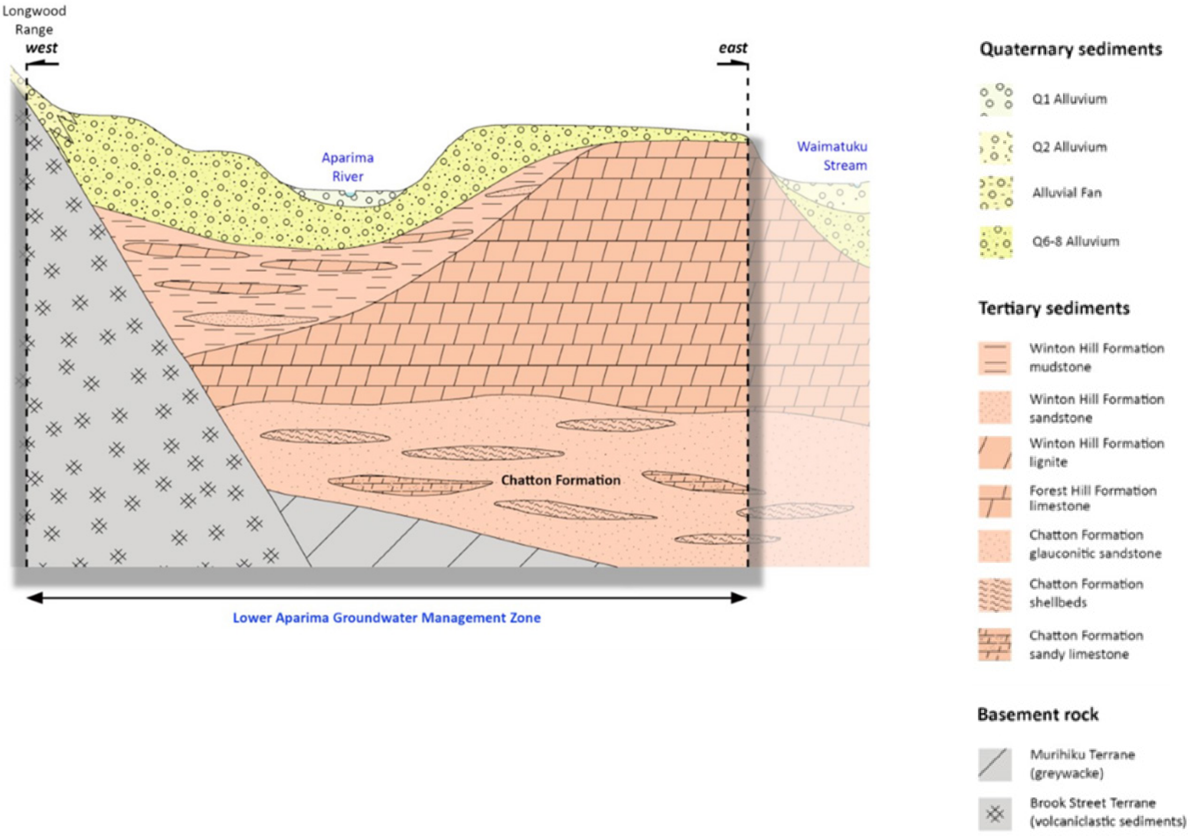


Conceptual illustration of the hydrogeological setting in the lower Aparima catchment.

Rivers and streams in this lower catchment area flow across predominantly flat topography and are larger and slower. The lower Aparima and Pourakino catchment is characterised by an increasing proportion of water derived from the intensive agricultural landscape. This hydraulically modified land rapidly carries water and contaminants downgradient to streams and rivers.

Finally, the river channels and groundwater flows carry this water and its accumulated contaminants to the bottom of the catchment and the Jacobs River Estuary. For the Aparima, brackish or higher salinity water seems to decrease within the first kilometre upstream of the river estuary confluence. The Pourakino is still reasonably high in salinity at the Centre Road bridge before shifting more towards freshwater over the next kilometre upstream. In the Estuary, the hydraulic conditions and tidal movement cause the deposition and accumulation of sediment and other associated contaminants within certain parts of the estuary.

Hydrological concept diagram

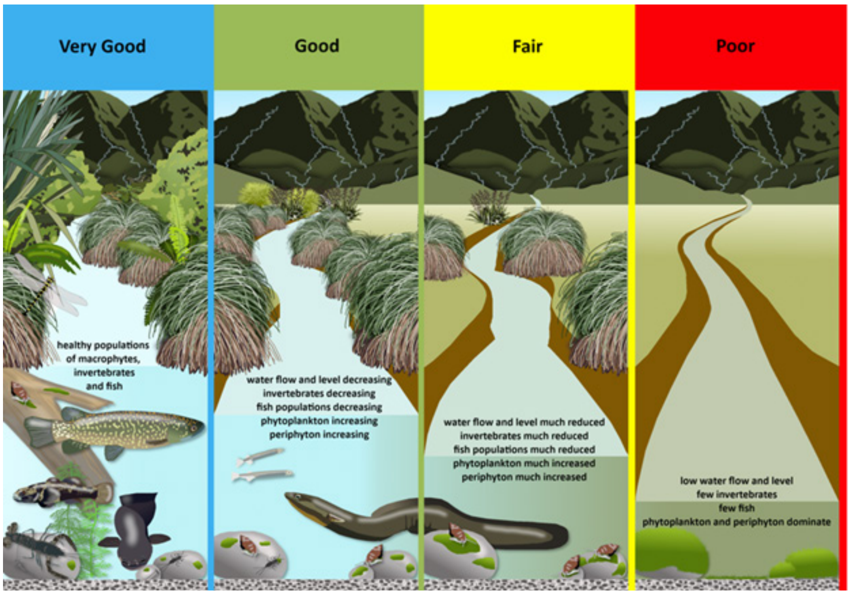


What are the water issues for this catchment?

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 Aparima and Pourakino catchment.

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 Muruhiku Southland are: Mountain, Hill, Lowland, Spring-fed, Lake-fed and Natural State.

About two-thirds of the Aparima and Pourakino catchment rivers are classified as Lowland. The rest are Hill, Natural State and Spring-fed.

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.

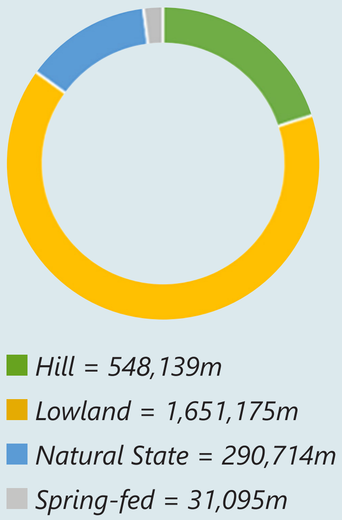
The different target states reflect the differences in natural characteristics for each river class.

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

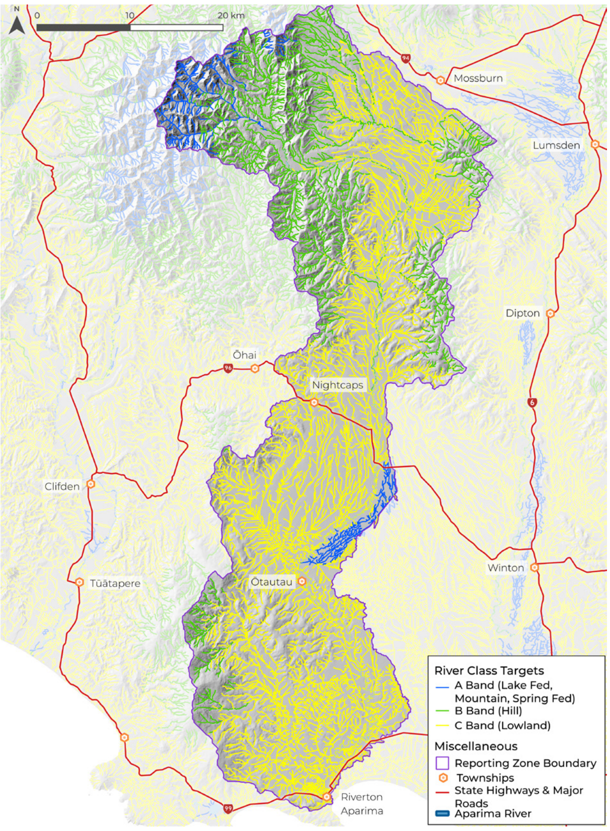
Natural State waterbodies can be identified for management purposes but are assigned attribute targets according to their underlying river classification (displayed here).

The map shows the distribution of periphyton targets for each river class within the Aparima and Pourakino catchment.

Length of river network in each class



River class hauora targets



Comparison of current state to targets for river classes

Hauora targets and current states for ecosystem and human health attributes are summarised in the table below for the catchment's Lowland, Hill and Spring-fed river classes. Table colours correspond to the 'ABCDE' grading for attributes described previously. 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.

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

"-" no data available.

There are no long-term monitoring sites of spring-fed or lake-fed waterbodies in the Aparima and Pourakino catchment.

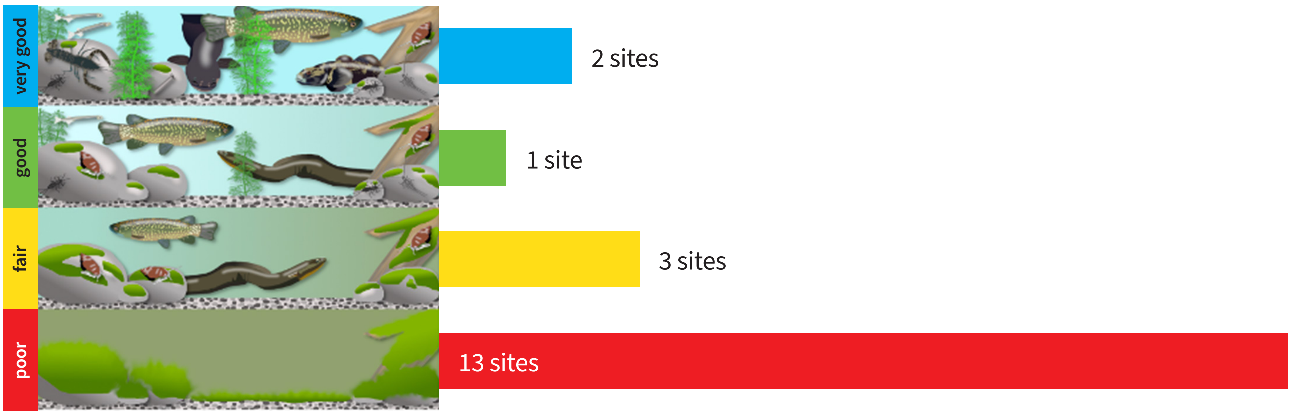
Periphyton case study

Periphyton is the algae and 'slime' that grows on the streambed and forms the base of the food web in rivers. In some rivers, periphyton is essential for a healthy ecosystem. However, elevated nutrients and light levels can promote excessive periphyton growth. This 'nuisance' periphyton has detrimental effects, such as smothering fish and invertebrate habitat, and can cause greater variation in dissolved oxygen concentrations.

Routine monitoring results for periphyton in Lowland rivers and streams are 'fair' for this catchment, which meets the hauora target. The periphyton grading is calculated from data over three or more years. It allows for periodic, short-term nuisance periphyton blooms, which are a natural part of the ecosystem but can be detrimental to ecosystem health as they become more frequent.

However, a more extensive one-off survey indicated that many sites within the Aparima and Pourakino catchment may have a 'poor' rating at certain times of the year. The survey results showed that 13 of the 19 monitored sites (68%) were 'poor' when the survey was done.

Number of sites

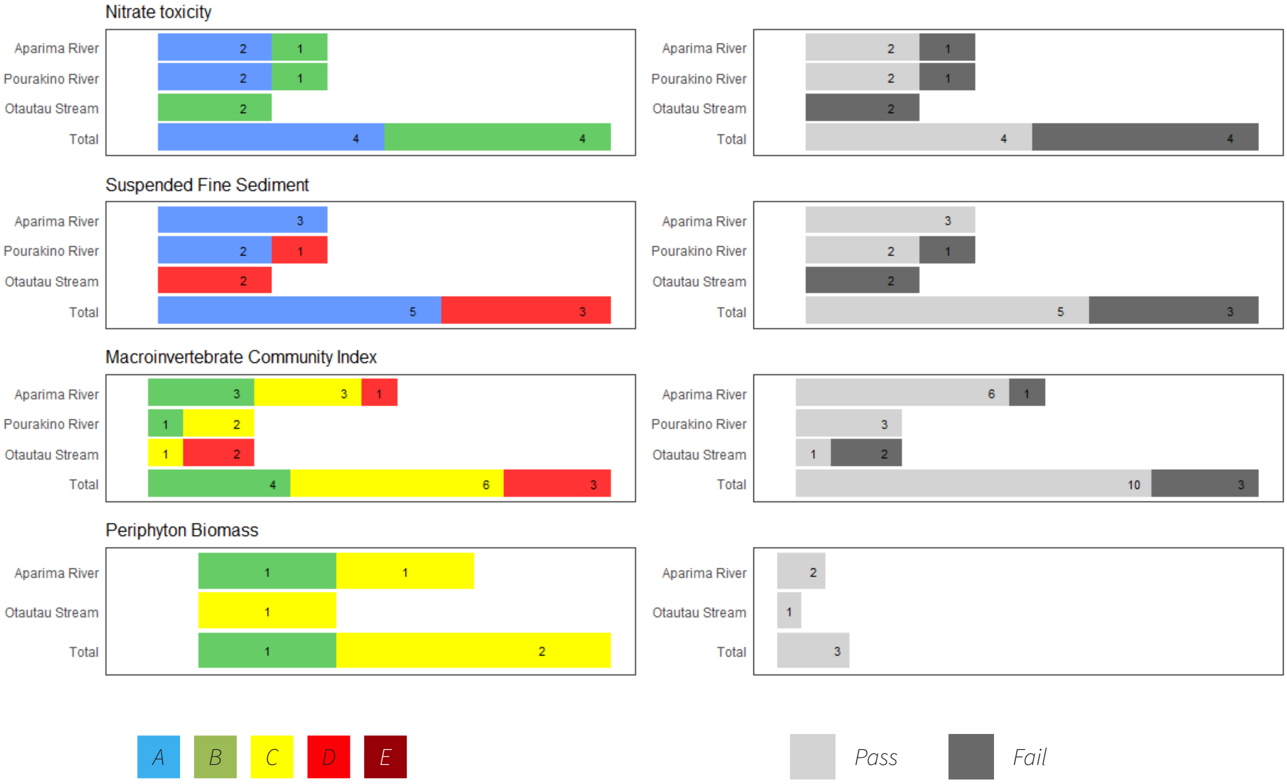


Comparison of current state to targets for individual monitored streams and rivers

Ecosystem health

The Aparima River, Ōtautau Stream and Pourakino River results for nitrate toxicity, suspended fine sediment, macroinvertebrate community index and periphyton biomass are given on the following page. The number of sites that meet hauora targets is also provided (on the following page). Results show the Ōtautau Stream to be in generally poor condition.

The Dissolved Inorganic Nitrogen (DIN) attribute bands are set lower than nitrate toxicity to recognise that nitrate has effects, such as promoting excessive plant growth, before it reaches levels toxic to aquatic life. Dissolved Reactive Phosphorus (DRP) is another nutrient that can support excessive plant growth. The Ōtautau Stream is in poor condition, with all monitored sites falling into the D band for both DIN and DRP, while in the Aparima and Pourakino Rivers, site states range from A to D bands for DIN and A to B bands for DRP.


Nitrate toxicity

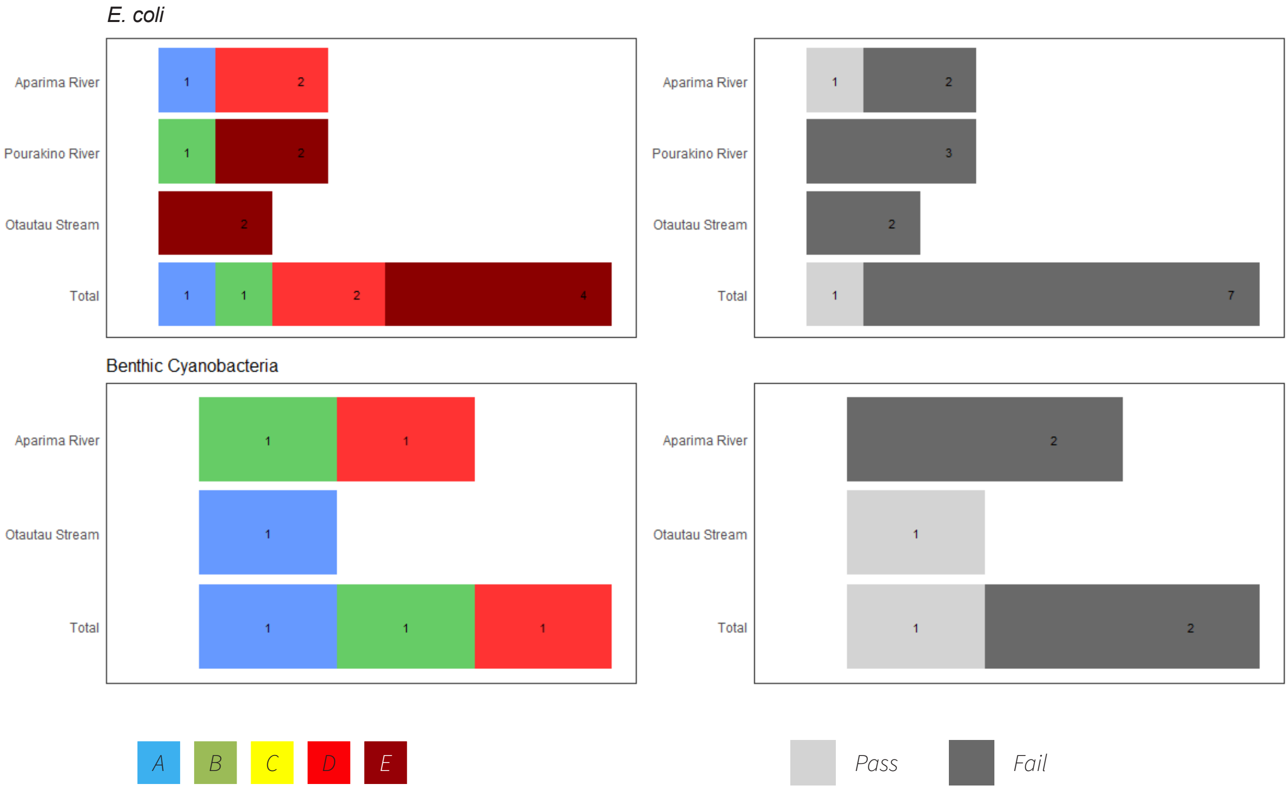
Suspended Fine Sediment

Macroinvertebrate Community Index

Periphyton Biomass

Human health/contact

Only one site in the Aparima River meets the target for *E. coli*. Sites in the Ōtautau Stream, Pourakino River and the lower Aparima River have poor or very poor states for *E. coli*.

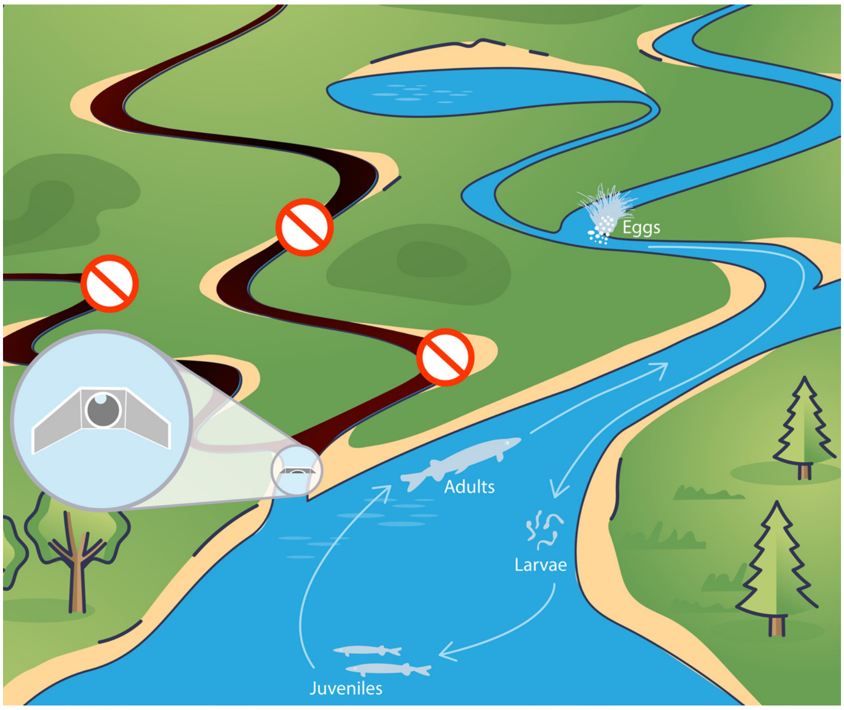

E. coli

Benthic Cyanobacteria

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 Aparima and Pourakino catchment. When culverts are designed and installed, consideration of fish passage and regular maintenance of structures will help improve fish passage.

The mainstream of both rivers is relatively free of barriers, with most occuring in the smaller tributaries and waterways of the catchment.

Groundwater

Human consumption – is it safe to drink?

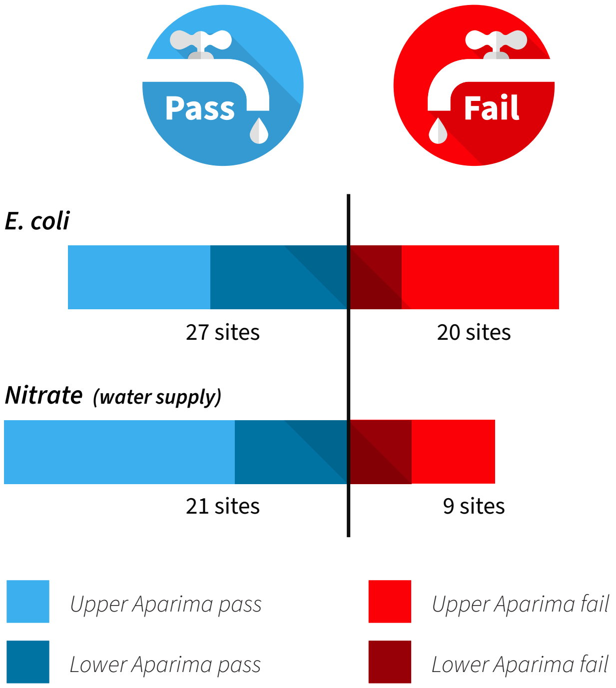
Groundwater in the Aparima and Pourakino is typically 4m-16m deep. The median bore depth is 20 meters. Most utilised groundwater is hosted in Quaternary 1-Quaternary 8 alluvial deposits in the mid and lower catchment areas.

The main contaminants affecting the suitability of potable groundwater for drinking are pathogens (*E. coli*) and nitrate.

Target states for groundwater are based on the New Zealand drinking water standards and use a pass/fail assessment system.

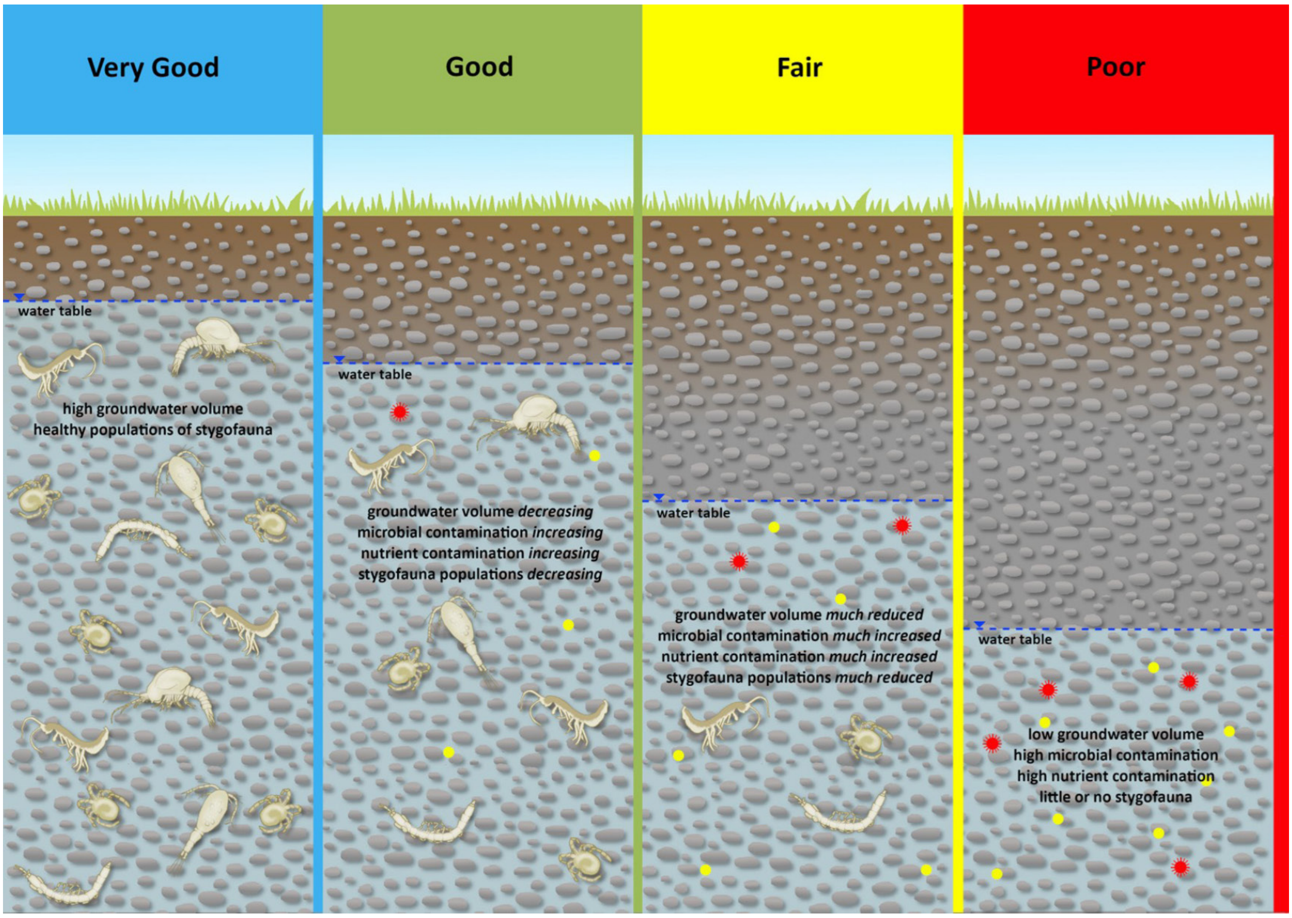
The results illustrated show that a large proportion of monitored sites in the Upper Aparima Groundwater Management Zone (GMZ) fail drinking water standards for *E. coli*. The number of sites with high nitrate levels (fail) is also higher in the Upper Aparima GMZ.

Aparima groundwater assesment

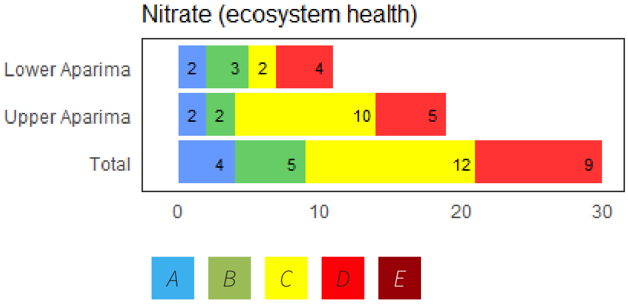


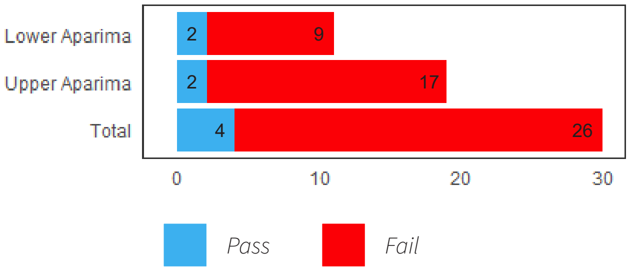
Ecosystem health

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



Results show that most monitored sites fail to achieve the hauora target of ‘very good’ and that approximately two-thirds of sites are graded as either ‘fair’ or ‘poor’.



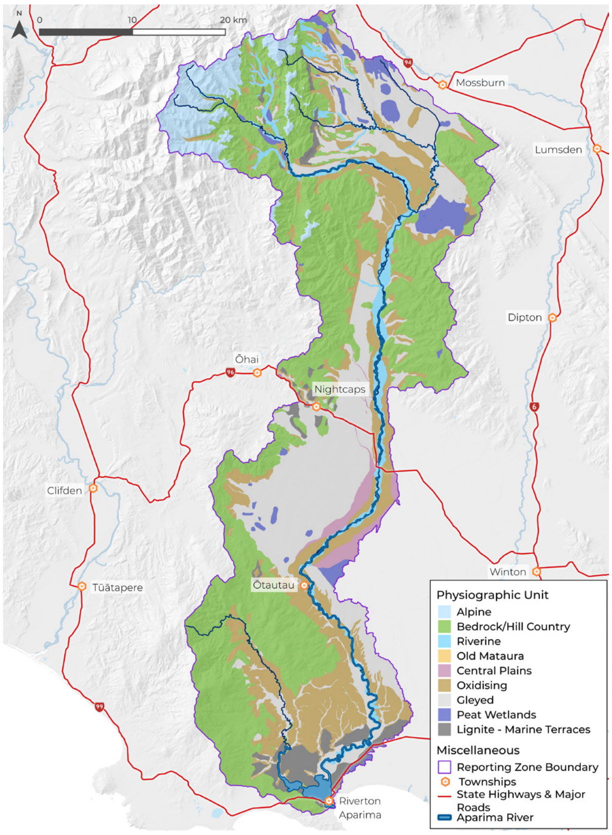


Groundwater contamination ‘hotspots’

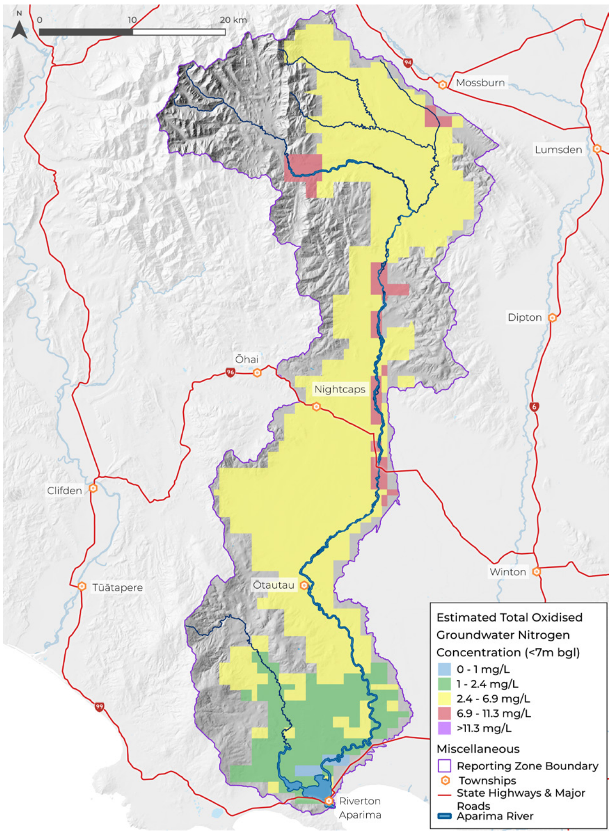
There are several areas within the Aparima and Pourakino catchment where the groundwater is highly contaminated with nitrogen. We call these ‘hotspots’. Hotspots have been identified through sampling and modelling and are shown in red on the map below (right). In addition to the hotspots, the Aparima and Pourakino catchment exhibits elevated nitrate concentrations across much of the catchment (areas coloured yellow). These elevated nitrogen concentrations impact groundwater ecosystem health and contribute to contamination and eutrophication in surface water environments.

The maps below highlight areas susceptible to groundwater contamination due to the overlying land use and the natural characteristics of the soils and geology.

Physiographic zones



Groundwater nitrogen concentrations



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.

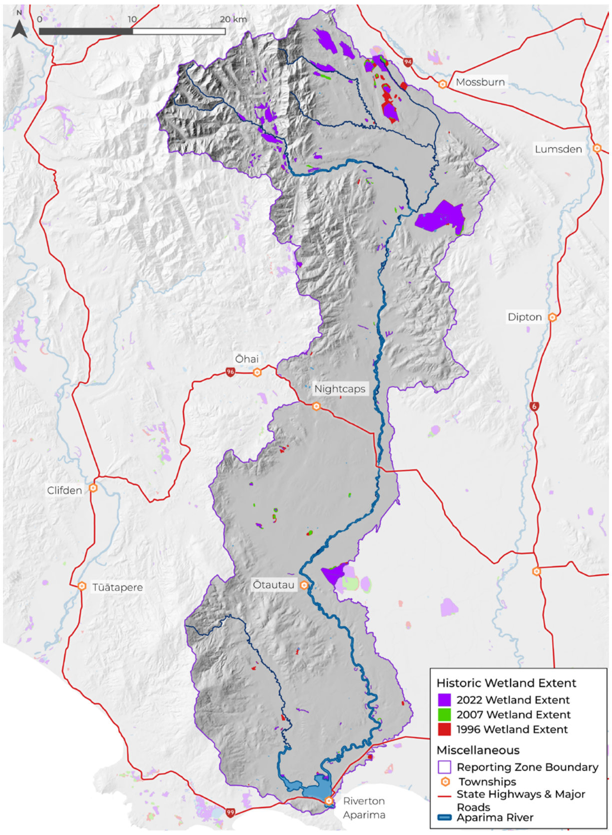
The following areas were not included as wetlands in this classification:

- 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.

Current state

The current total wetland extent for the Aparima and Pourakino catchment is 3119 ha. There has been a moderate loss of wetland in the catchment, with the majority of lost wetlands turned into high-producing exotic grassland.

Historic wetland extent



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

	1996 to 2007	2007 to 2022	Overall 1996 to 2022
Change in wetland area	↓ 12% 469 ha	↓ 6% 186 ha	↓ 17% 654 ha

Remaining wetlands

Several large areas of bog and fen wetland with organic peat soils are present in the upper catchment. The Castle Downs Swamp bog wetland is the largest inland wetland in the Aparima and Pourakino catchment and is predominately vegetated with wire rush (Empodisma minus).

Several large bogs and fens occur in the upper reaches of the Aparima adjacent to Waterloo, Hamilton, Centre and Green Burns near the Takitimu Mountains.

Other wetlands to note are the Bayswater Peatland, located in the mid-catchment area east of Ōtautau, and the Jacob River Estuary, which comprises large areas of mudflats and is an important habitat for birds, fish and invertebrates.

Of the remaining wetlands not on conservation land, there is a moderate risk of losing more soon, with 40% in the moderately high-risk category.

	1	2	3	4	5
Risk of Loss (1 = low, 5 = high)	19%	13%	23%	40%	4%

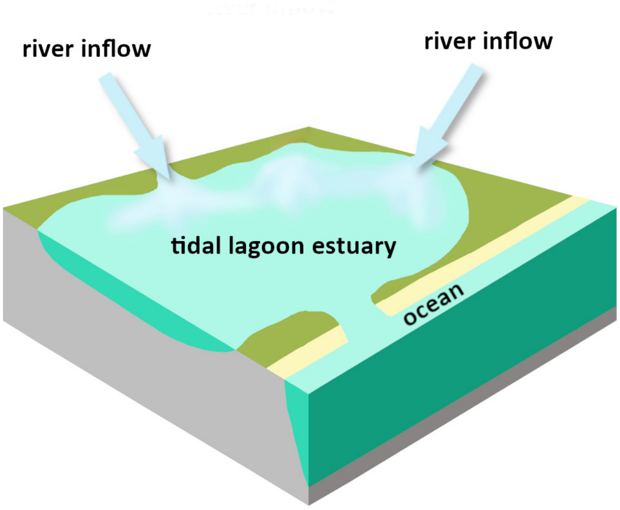
Jacobs River Estuary

Jacobs River Estuary is located at the confluence of the Pourakino and Aparima rivers and discharges to the sea at Riverton.

Located at the bottom of the catchment, estuaries are at risk of eutrophication from excess nutrients and sediment from inflowing rivers. Some estuaries are more at risk of eutrophication than others and are grouped into categories according to their risk of eutrophication.

Jacobs River Estuary is a 'tidal lagoon estuary'.

Tidal lagoon estuaries are at high risk of eutrophication as they are typically shallow, fed by rivers, have large intertidal areas of sand or mud and are moderately influenced by tidal flow.



Sediment and nutrients

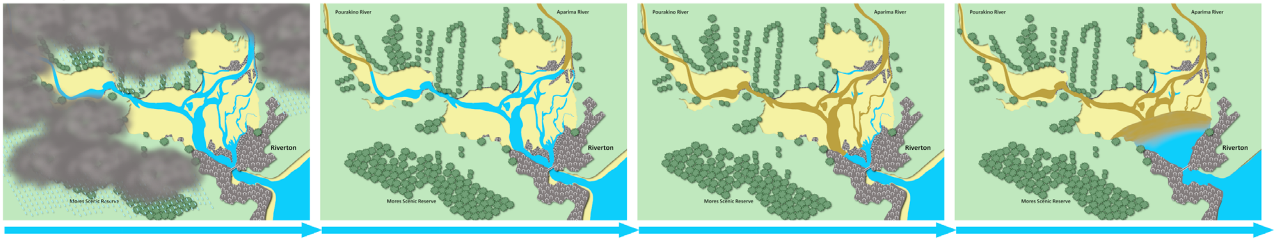
Sediment and nutrients are the main ecosystem health issues for Jacobs River Estuary. They are carried down through the catchment's waterways and enter the estuary via the Pourakino and Aparima rivers. The accumulation of sediment and nutrients results in the growth of nuisance macroalgae and the development of eutrophic zones.

Jacobs River Estuary - sediment movement and build up

The following is a pictorial showing sediment movement into the Jacobs River Estuary following a rainfall event. In this example, sediment is carried down the main rivers, before mixing and moving with the incoming tide. Tidal movement 'pushes' sediment to the upper reaches of the estuary where it settles and builds up over time.

Estuary sediment is depicted as predominantly sand (yellow) before the rainfall event, representing estuary sediments before the build up of mud over time. Current patterns of sediment deposition and areas of mud are depicted by areas of dark brown (mud) and lighter brown (sand and mud). Brief descriptions of sediment movement are provided for the different stages of tidal flow.

Incoming tide



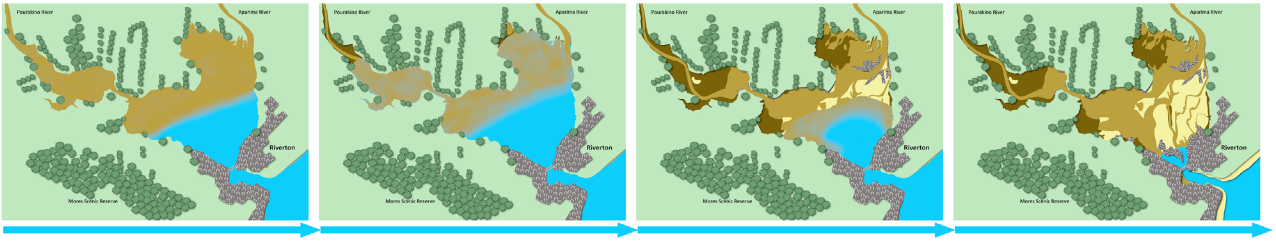
Heavy rainfall event in catchment
Sediment from developed parts of the catchment flows into rivers.
Picture shows low tide. Estuary sediment in this picture is predominantly sand (yellow). This represents estuary sediments before the build-up of muddy areas.

Sediment in rivers
River water carries high sediment load (brown).
Picture shows low tide.

Sediment in rivers
Sediment in river water is carried into estuary.
Picture shows low tide.

Sediment movement - incoming tide
The mixing of sea water and freshwater results in salinity-driven settling of fine sediment out of suspension. Sediment is then pushed back up the estuary with the incoming tide.
Low energy tidal movement into the upper reaches of the estuary results in sediment settling in these areas.

Outgoing tide



Sediment deposition in estuary
High sediment deposition, especially in the upper reaches of the estuary.
Note that during a very heavy rainfall event the whole estuary may turn brown.
Picture shows high tide.

Sediment deposition in estuary
High sediment deposition.
Picture shows a receding tide. Areas of mud (dark brown) are becoming exposed as the tide recedes.

Sediment deposition in estuary
High sediment deposition.
Picture shows a receding tide. Areas of mud (dark brown) and areas of mud and sand (light brown) are becoming exposed as the tide recedes.

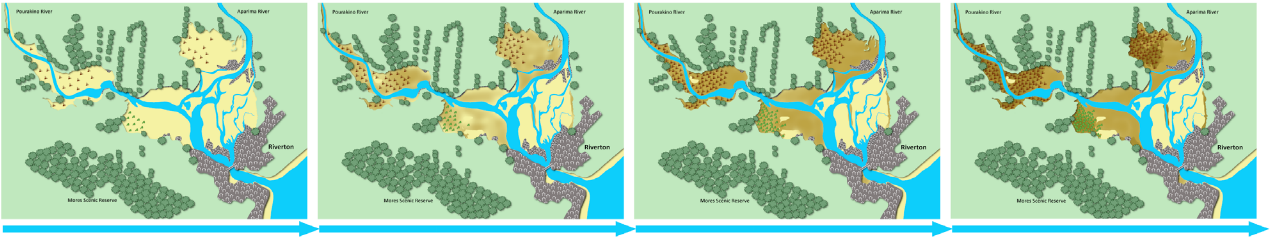
Areas of mud have built up over time
Areas of mud have been exacerbated by growth of macroalgae in these areas, which decrease water movement and allow for further settling of sediments. Wave energy in the lower parts of the estuary prevent muddy areas from developing.

Jacobs River Estuary - macroalgal growth and collapse

The following is a pictorial showing the relationship between sediment build up and the growth of nuisance macroalgae (seaweed) in Jacobs River Estuary over time. As sediment builds up in the estuary and areas of mud develop, the area and density of nuisance macroalage in the estuary also increases. *Gracillaria* (brown) and *Ulva* (green) are the main nuisance macroalgal types. Their presence in high densitites impacts estuary health by displacing areas of seagrass, and reducing habitat for a range of invertebrates and fish.

Estuary sediment is depicted as predominantly sand (yellow) at the begining of the sequence, representing estuary sediments before the build up of mud over time. The progressive build up of muddy areas and areas of mud and sand over time are represented by areas of dark brown (mud), and light brown (mud and sand).

Sediment build-up and nuisance macroalgal growth



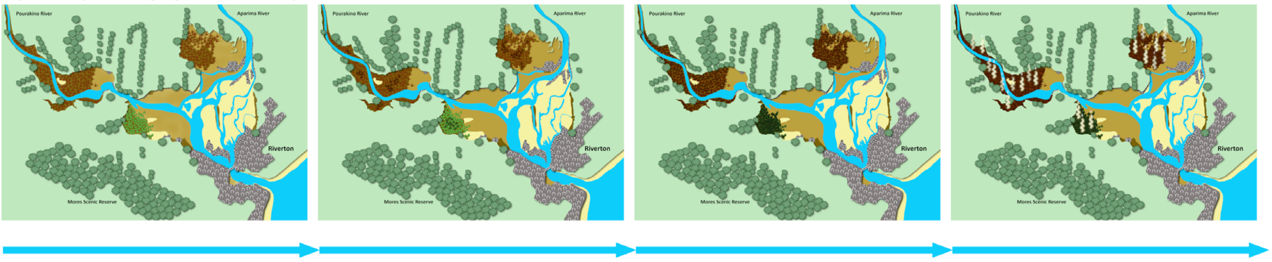
Background sediment and macroalgal growth
Low mud content in sediment.
Low density macroalgal growth.
Brown seaweed = *Gracilaria*
Green seaweed = *Ulva*

Sediment and macroalgal growth increase
Sediment builds up in upper reaches of the estuary.
Macroalgal growth increases in density.

Sediment and macroalgal growth increase
Sediment builds up in upper reaches of the estuary.
Macroalgal growth increases in area and density.

Sediment and macroalgal growth increase
Areas of mud develop in upper reaches of the estuary.
Macroalgal growth increases in area and density.
Increased macroalgal growth results in increased sediment deposition, due to reduced water flow.
This further fuels macroalgal growth and sediment deposition.

High density macroalgal growth and collapse



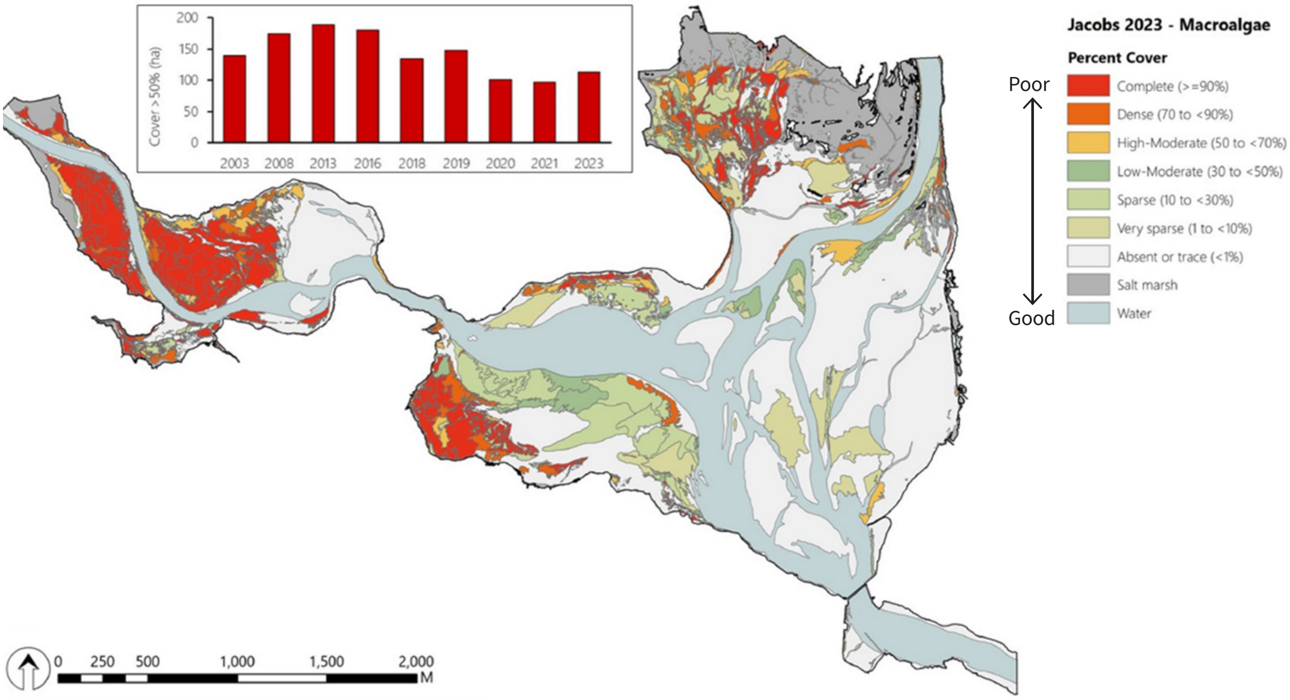
Areas of mud establish
Dense macroalgal growth traps increasing amounts of sediment, which in turn fuels more macroalgal growth.
Sediment oxygen becomes depleted and sensitive macroinvertebrates are lost from these areas.

Mud deepens
Areas of mud increase in depth.
Oxygen in sediment continues to deplete.
Very high density macroalgal growth, with some areas of macroalgal die-off.
More macroinvertebrates are lost from these areas.

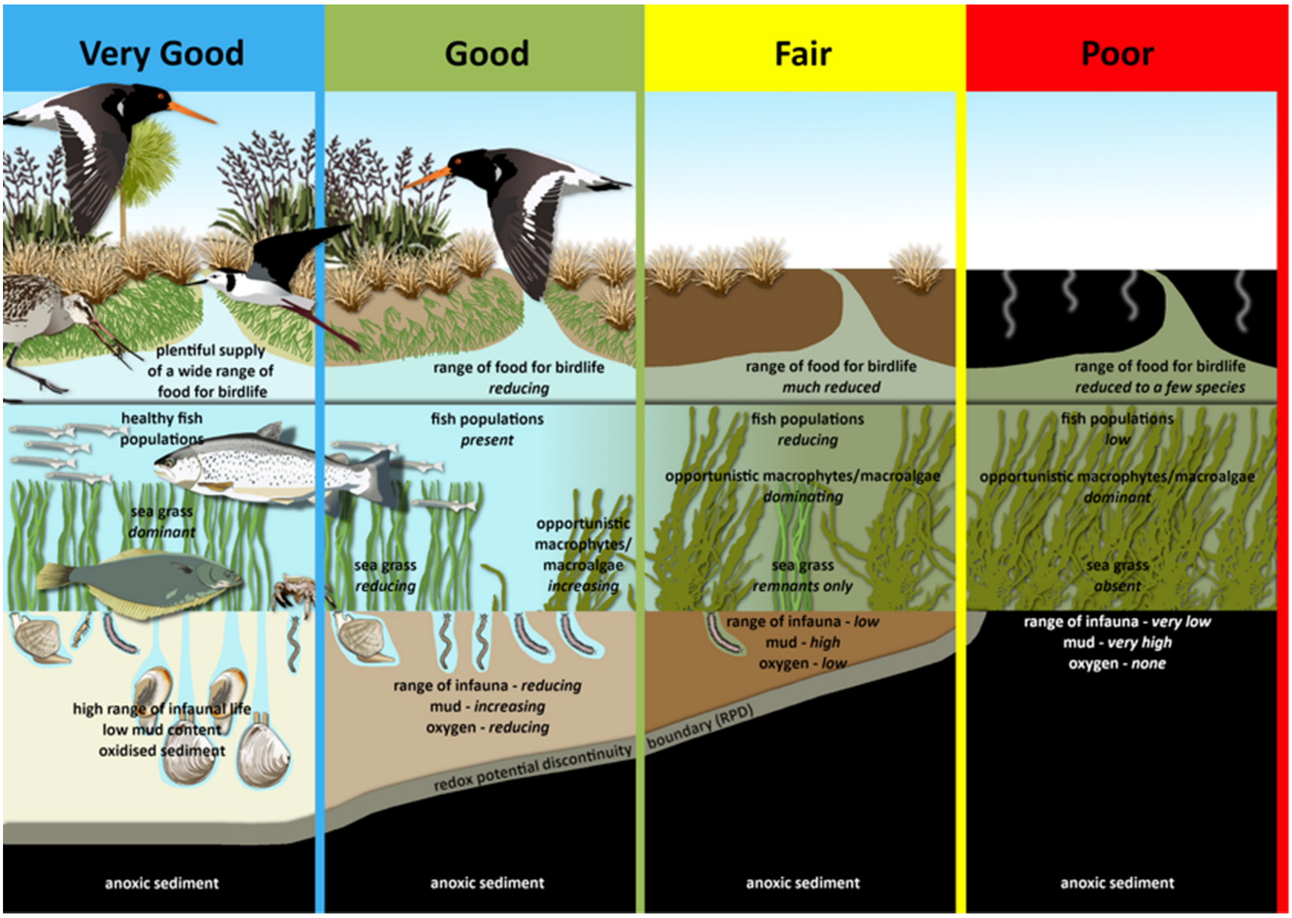
Deep, low oxygen mud
Very high macroalgal density.
Increasing areas of macroalgal die-off due to low oxygen levels in sediment.
Low oxygen conditions in sediment produce sulfide, which is toxic to life.

Extensive macroalgal die-off
Die-off results in high organic loading and further deterioration of sediment conditions.
Some poor health macroalgae remain.
The cycle of macroalgal growth and die-off will repeat when sediment quality improves.

Because of the process outlined above, there are specific areas within the estuary where the condition is particularly poor due to sediment and nutrient accumulation. These include areas of the Pourakino Arm, Southern Flats and Northern Flats, as depicted in the map below, which shows the macroalgae percent cover. Broadscale mapping of the benthic environment across the Jacobs River Estuary shows large tracts of the Pourakino Arm are almost completely covered in nuisance algae, and patches of the Aparima Arm are starting to become the same



Estuary health outcomes can range from 'very good' to 'poor'. Using an outcome spectrum can help us understand the state of the freshwater environment and what we might be trying to achieve in the future. The concept is depicted for estuaries in the image below. We measure various aspects of the estuarine environment that can help us define and determine estuary outcomes.



Comparison of current state to targets for Jacobs River Estuary

Monitoring results show that the main issues for Jacobs River Estuary are pathogens (human health) and high levels of nitrogen and sediment (mud). Parts of the estuary also have dense beds of nuisance macroalgae. Heavy metals are not an issue for this estuary.

High levels of nitrogen and sediment fuel the growth of nuisance macroalgae (seaweeds like *Agarophyton* and *Ulva*), which crowd out and displace seagrass beds. Seagrass also struggles to grow in areas where sediment has a high mud content.

Results for attributes vary spatially across the estuary. For example, the upper tidal flats are more at risk of mud build-up, high nutrients, dense nuisance macroalgae beds and seagrass loss.

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

Human health attributes		
Pathogens – *Enterococci*	A	D
Pathogens – *Enterococci* at popular bathing sites	A	B

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

Surface water allocation

Surface water takes are managed through two types of allocation blocks. A primary allocation block restricts the amount of water that can be taken during low flows (allocation available is 30% of Q95). A secondary allocation block restricts the amount of water that can be taken when flows are above mean or median 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, reducing stream flow. As a result, it has to be accounted for in both surface water and groundwater allocation management. Under the pSWLP, 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.

When analysed at the Thornbury monitoring site, 44% of the primary allocation block had been allocated. Most of the primary allocation is used for irrigation (90%), with other uses including dairy (2.3%), industrial (1.1%) and municipal (6.6%).

	Primary allocation (% of limit)	Effective secondary allocation -Summer (% of limit)	Effective secondary allocation - Remainder of year (% of limit)
Aparima River at Dunrobin	45	70	109
Aparima River at Thornbury	44	41	66
Ōtautau Stream at Ōtautau	0.9	0.4	0.8
Hamilton Burn at Waterloo Road	6	1	3

Site	Primary allocation (l/s)		Secondary allocation – Summer - 1 Dec - 31 Mar (l/s)			Secondary allocation – Remainder of year - 1 Apr - 31 Nov (l/s)		
	Minimum flow (Q95, l/s)	Most consecutive days below Q95	Mean (l/s)	Average days below mean (Summer period)	Most consecutive days below mean (Summer period)	Median (l/s)	Average days below median (remainder of year period)	Most consecutive days below median (remainder of year period)
Aparima River at Dunrobin	1,560	29 (2013)	8,023	97	69 (2001)	5,134	100	37 (2009)
Aparima River at Thornbury	3,627	47 (1999)	23,880	104	114 (2022)	14,570	91	58 (1990)
Ōtautau Stream at Ōtautau	536	25 (2022)	4,285	67	121 (2017)	1,993	66	39 (2009)
Hamilton Burn at Waterloo Road	265	39 (1999)	3,284	107	93 (2023)	1,422	121	41 (1999)

There are no sites in this catchment with a fully allocated primary block. However, the Aparima River and Dunrobin's secondary allocation between April and the end of November is close to fully allocated (98%).

Surface water allocation is complex and varies by location. For location or consent-specific information, please contact Environment Southland.

Monitoring data from the 2022/2023 season provided by consent holders show that surface water use is generally less than 10% of the total volume allocated. The range can vary, with irrigators using approximately 2-16%, municipal 41%, industry 3-94%, and dairy 14-45% of their consented allocation.

Most surface water abstractions are subject to minimum flow requirements, meaning they must cease abstraction when flow thresholds are reached.

	Surface water use (%) (22/23 season)
Industrial	2-16
Municipal	41
Industrial	3-94
Dairy	14-45

Groundwater allocation

Most groundwater allocation thresholds are set using a proportion of annual rainfall recharge to aquifers, varying depending on the aquifer type.

Groundwater takes can be highly connected to surface waters, impacting on stream and river flows. These takes are managed by stream depletion allocations. Depending on the degree of stream depletions, the groundwater take may be subject to the same restrictions as a surface water take.

In the Aparima and Pourakino catchment, there are two Groundwater Management Zones: the Upper Aparima, which has 10% allocation; and the Lower Aparima, which has 7% allocation.

Most of the allocated groundwater is consented for dairy (58%), with other uses including irrigation (7.5%), industrial dewatering (25%) and municipal (10%).

	Groundwater allocated (%) (22/23 season)
Upper Aparima	10
Lower Aparima	7

	Groundwater use (%) (22/23 season)
Dairy	49-59
Irrigation	55
Stockwater	Unknown
Dewatering	25
Municipal	Unknown
Industrial	37

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 Muruhiku 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 focus 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.

The table below presents estimated load reductions for the Aparima and Pourakino catchment.

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	1,291 Tonnes/Year	↓ 46% (24-67)
Total Phosphorus	43 Tonnes/Year	↓ 43% (11-75)
Sediment	67,300 Tonnes/Year	↓ 22%
E. coli	62 peta E.coli/Year	↓ 74% (38-93)

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 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.

The results in the table above indicate that none of the individual mitigation scenarios we tested would fully achieve the reductions required to support a state of hauora. This is because the reductions are very large and will likely require more widespread changes to how land is used rather than maintaining the status quo and relying on implementing mitigations.

Some of the bundled methods tested either achieve the best estimate of reductions required or are within the uncertainty range for that estimate. The bundle that achieves the required reductions relies on the theoretical nitrogen removal from the full establishment of wetlands to treat runoff from all agricultural land. This mitigation may not be practical in a manner that would achieve this scale of reductions.

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

- Implementation of scenario 14 (over page) is estimated to achieve the phosphorus reductions required. Furthermore, scenarios 2, 4, 5, 12, 13, and 15 are all estimated to achieve reductions within the uncertainty of the required estimate. The range of reductions across all scenarios was 0-50%.
- Implementating existing rules and regulations relating to sediment is estimated to achieve an 11% reduction in suspended sediment load delivered to the Estuary. This is less than the required 22% reduction 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	12	🟥 34
2	Adoption of all established and developing farm mitigations	30	🟧 16
3	Wetlands returned to the same area as existed in 1996	2	🟥 44
4	Establishment of wetlands in a way that treats all surface runoff from agricultural land	36	🟧 10
5	Establishment of large community wetlands in inherently suitable areas	11	🟥 35
6	All wastewater point sources are discharged to land rather than directly to water	0	🟥 46
7	Reducing land use intensity on flood prone land	2	🟥 44
8	Reducing land use intensity on public land	1	🟥 45
9	Destocking (10% reduction drystock, 20% reduction dairy)	22	🟥 24
10	Riparian planting (full shading of streams <7m wide)	1 (indirect effect on periphyton)	🟥 45
Bundled methods			
11	1996 wetlands returned, wastewater discharged to land (3 + 6)	2	🟥 44
12	Established and developing farm mitigations, 1996 wetlands, wastewater to land (2 + 3 + 6)	32	🟧 14
13	Established and developing farm mitigations, 1996 wetlands, wastewater to land, repurposing public land (2 + 3 + 6 + 8)	34	🟧 12
14	Established and developing farm mitigations, 5% wetlands, wastewater to land, repurposing public land (2 + 4 + 6 + 8)	55	🟩 0
15	Established and developing farm mitigations, community wetlands, wastewater to land (2 + 5 + 6)	38	🟧 8
16	Established farm mitigations, wastewater to land, plantain on dairy farms, 1996 wetlands, repurposing of Environment Southland land, forestry expansion (1 + 6 + 3 + new individual methods)	20	🟥 26

🟩 *Required reductions likely achieved*

🟧 *Within uncertainty range*

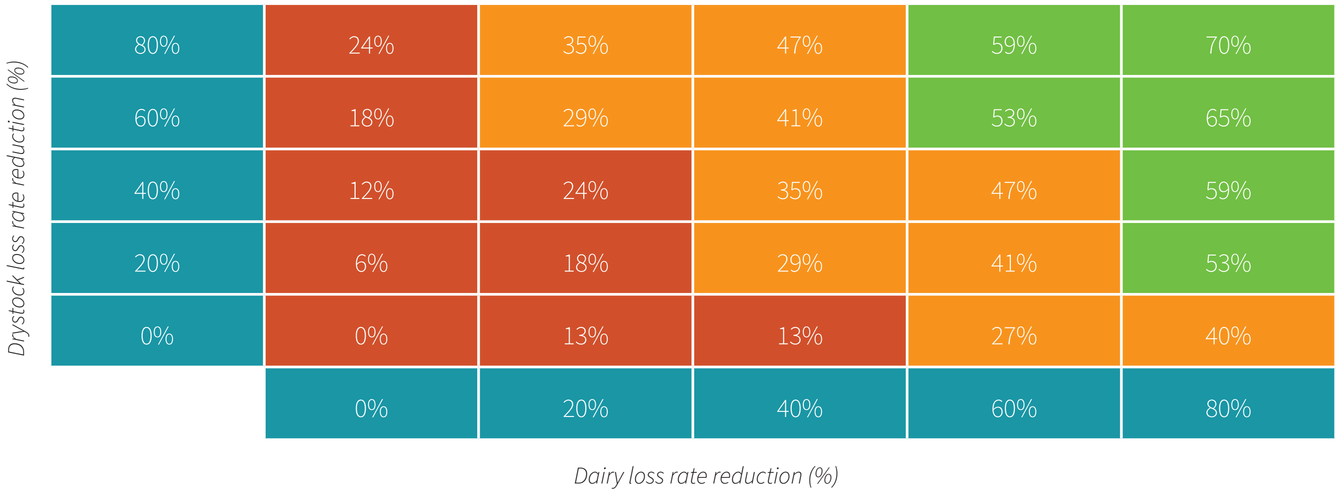
🟥 *Deficit remaining*

Reducing load from pastoral land across the catchment

We also examined the effect of different nitrogen load reduction scenarios for dairy and dry stock farms on the overall catchment load. The purpose of this work was to help show the 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 estimated losses from the land using land use, climate, soil type, and slope. The percent reductions modelled apply across these estimated losses.

The table shows the overall catchment load reduction achieved (coloured cells) for each combination of simulated reductions on dairy and drystock farms (grey cells). For example, we can see that a 40% reduction in loss from dairy farms combined with a 20% reduction from drystock farms will result in an approximately 29% reduction in the instream TN load across the catchment.

Basin-wide mean % TN reduction, relative to baseline



Drystock loss rate reduction (%)

80%	24%	35%	47%	59%	70%
60%	18%	29%	41%	53%	65%
40%	12%	24%	35%	47%	59%
20%	6%	18%	29%	41%	53%
0%	0%	13%	13%	27%	40%
	0%	20%	40%	60%	80%

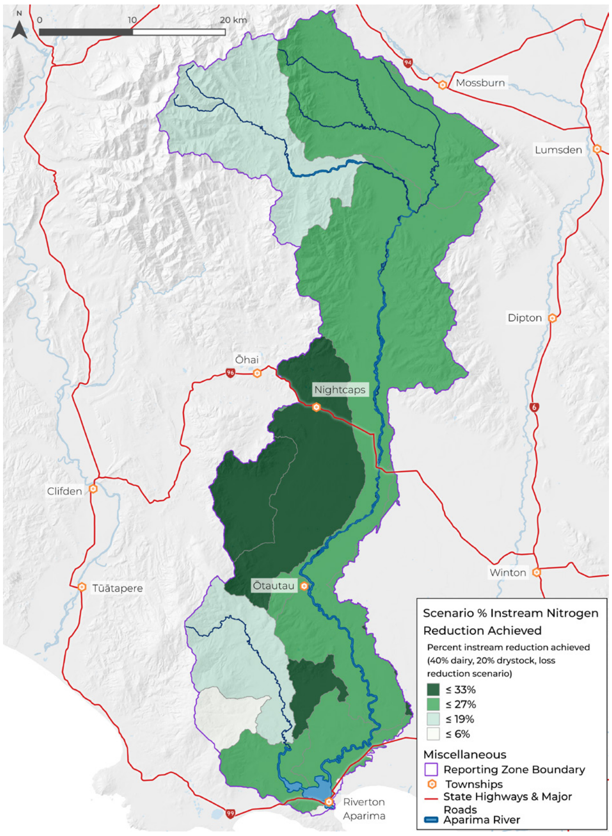
Dairy loss rate reduction (%)

🟩 *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 larger percentage reductions (up to 33%) achieved in some smaller sub-catchments, but the majority of the catchment area achieves a 19% or less reduction under that scenario.*

Opportunities for action

We've put together opportunities for action in the Aparima and Pourakino catchment to reduce contaminant loads and improve the state of freshwater.

The catchment

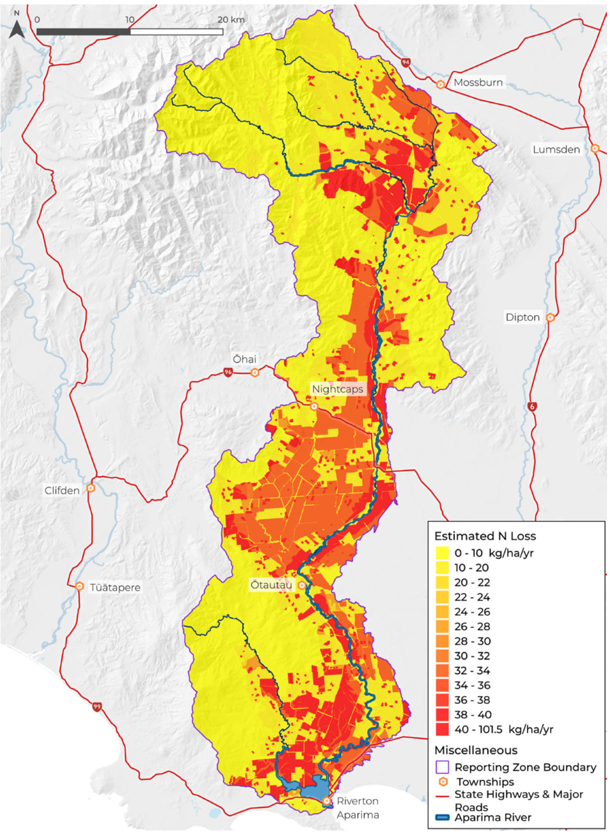
Scale of the problem

The following map set shows the spatial distribution of intensive land use and the associated estimated nitrogen loss, the modelled in-stream nitrogen concentrations (using monitoring data) and the modelled excess nitrogen load patterns across the catchment. These maps help to demonstrate the spatial scale of the reductions required. Excess loads depend on the modelled concentrations and all the defined targets, both local and downstream. This load excess map indicates the magnitude of nitrogen load reductions to achieve all river and estuary targets for the entire catchment area.

High nitrogen loads may be difficult to mitigate, and improved management practices alone are unlikely to 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.

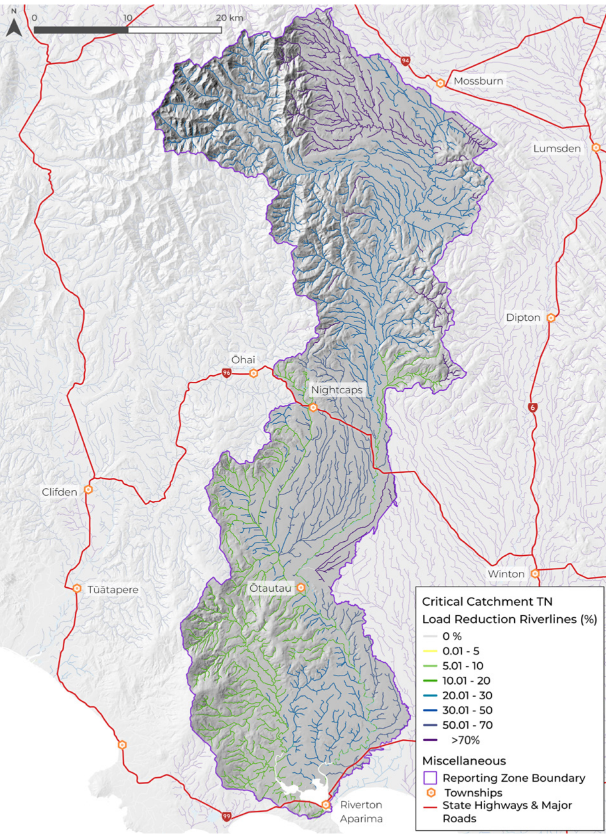
Large nitrogen reductions over large spatial areas will likely require changes to land use over a long period. This might be through exploring and adopting different land uses or technological advances in farm systems and management. In addition, because the hydrology of the catchment has been extensively modified through stream channel straightening and artificial drainage, efforts to implement nature-based solutions and slow water flow are likely to have multiple benefits for water quality, biodiversity, flood mitigation and catchment resilience.

Estimated nitrogen loss

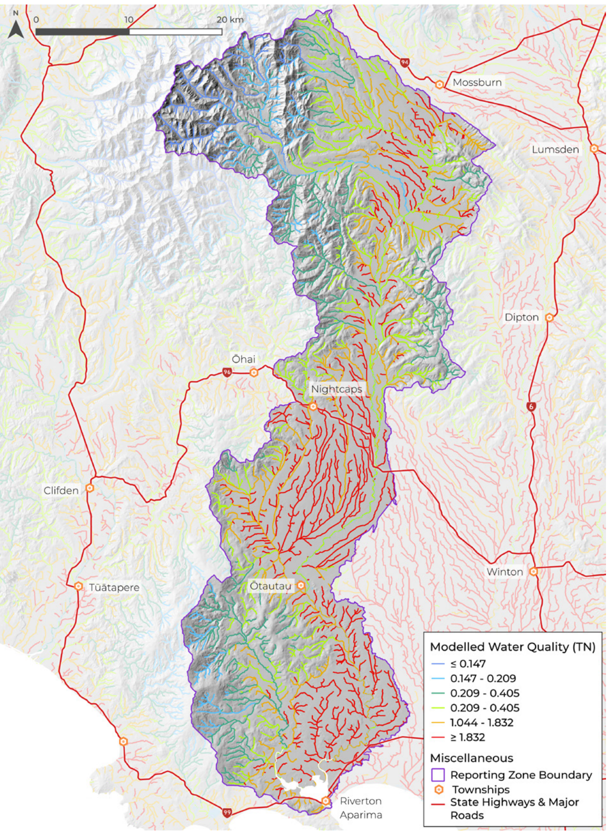


▲ *Nitrogen loss in this graphic is an approximation and is only differentiated by land use, soil drainage, rainfall/irrigation, and slope.*

Critical catchment TN load reduction (%) riverlines



Modelled water quality (Total Nitrogen)



Farm scale opportunities for action

Farm-scale actions should be tailored to the physiographic setting and catchment priorities. In the Aparima and Pourakino catchment, 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.

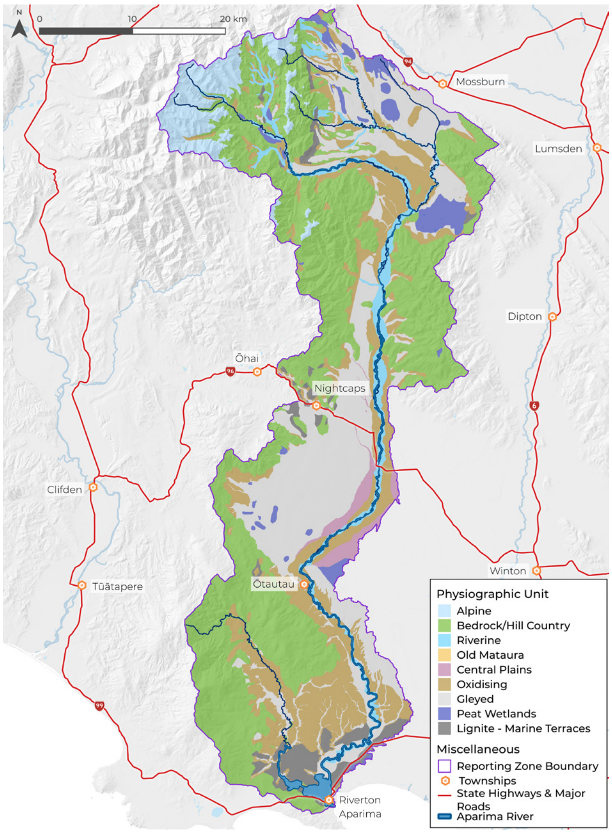
Physiographic information helps us to better understand how contaminants move through the landscape. Each zone has common attributes that influence water quality, such as climate, topography, geology and soil type.

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

Physiographic zones



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

The Aparima and Pourakino catchment consists of four main physiographic units: gleyed, bedrock/hill country, lignite/marine terraces and central plains. Smaller areas of alpine, riverine, peat wetlands and oxidising units are also spread across the Aparima.

Some locations may have farm-scale or more resolute physiographic information. We promote using the best available information to identify farm-specific risks and solutions.

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

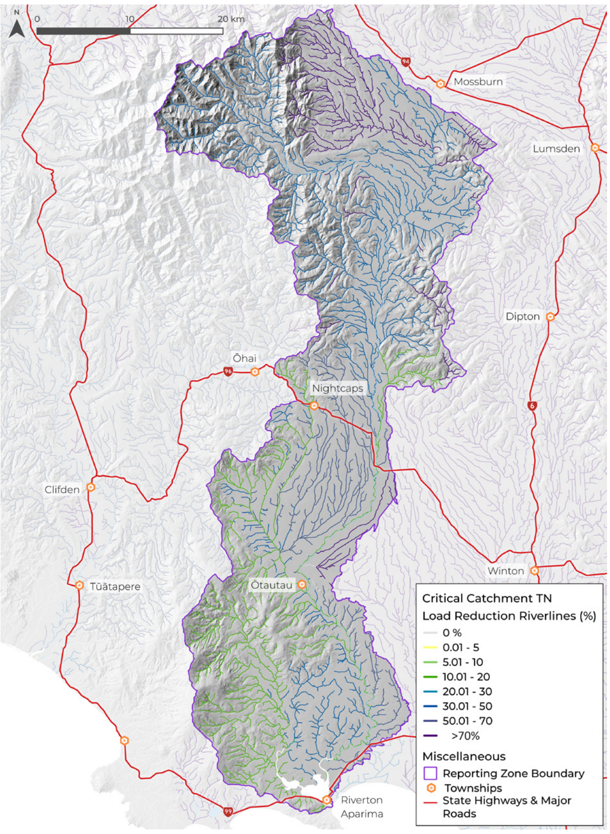
Nitrogen

Over time, widespread load reductions will be required to achieve hauora targets.

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

Physiographic zones can help identify what contaminant loss pathways likely need attention in different locations. As shown above, the excess load map shows parts of the catchment where nitrogen loss mitigation should be a particular focus in farm planning to reduce excess nitrogen loads. 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 (%) riverlines



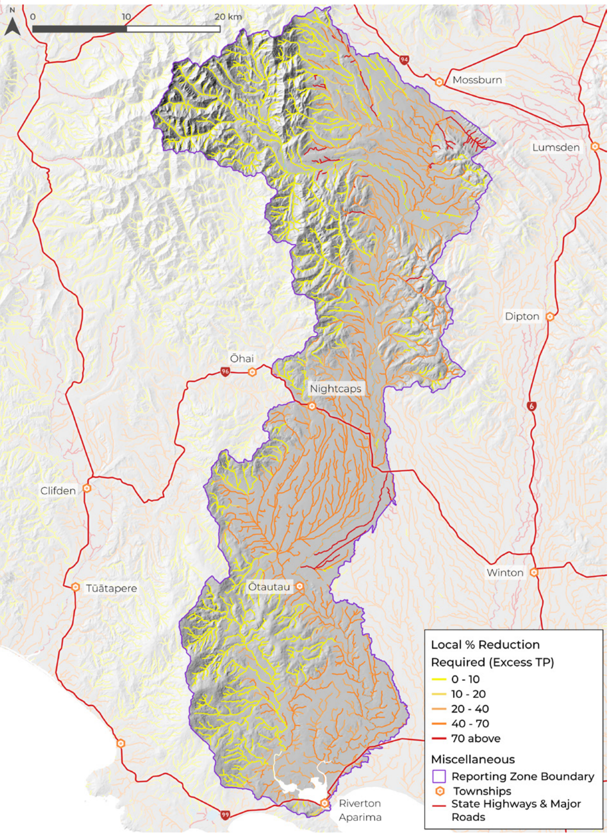
Phosphorus

Over time, widespread load reductions will be required to achieve hauora targets.

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

Determination of which mitigations to use will depend on each farm and its circumstances. Physiographic information can help inform what contaminant loss pathways most likely need attention in different locations. The excess load map shown here indicates where phosphorus 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 excess TP load (%)



Sediment

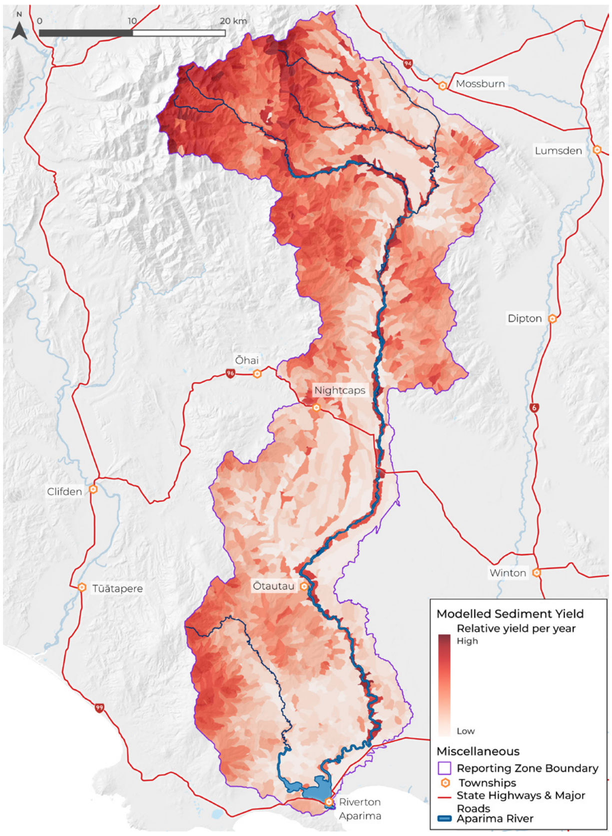
The map (right) shows how we expect sediment loss to vary throughout the catchment.

Some areas of high sediment loss in the upper catchment 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.

Jacobs River Estuary – opportunities for action

Overall, the Jacobs River Estuary is in poor condition. However, specific areas within the estuary are particularly poor due to sediment and nutrient accumulation. These areas include the Pourakino Arm, Southern Flats, and Northern Flats.

Active restoration may include:

- Removal of nuisance macroalgae from:
  - areas of new growth
  - areas where macroalgae is smothering seagrass
  - the fringes of current sediment deposition zones
- Targeted restoration of marginal vegetation, such as herbfields, wetlands, saltmarshes and salt tolerant shrub banks. Targeted restoration should focus on areas of historic loss, such as the Pourakino Arm and the Northern Flats.

The wider estuary would benefit from:

- riparian planting
- habitat improvement
- establishing appropriate vegetated buffers
- addressing point source contaminant inputs

Groundwater – opportunities for action

Areas of highly contaminated groundwater will likely require targeted nitrogen action via management and changes in farm systems. Areas within the Oxidising, Old Mataura and Riverine physiographic zones that are also shaded yellow and red in the physiographic map shown previously are likely high-risk areas. In these locations, landowners should implement management plans focusing on key pathways and the stockpile of property scale actions that target nitrogen loss via deep drainage.

E. coli contamination of groundwater and groundwater drinking supplies is widespread across the Aparima and Pourakino catchment, and Muruhiku Southland.

Actions to reduce *E.coli* to groundwater:

- Ensure good well-head protection is in place for all bores, especially bores used for drinking water.
- Carefully consider the proximity of contamination point sources to bores, e.g. septic tanks, stock sheds and effluent storage.
- Carefully consider effluent application on freely draining soils or soils with a high likelihood of bypass flow (cracks or conduits that may allow effluent to flow directly to groundwater).

Urban and industrial – opportunities for action

- Removal/improvement of wastewater and stormwater discharges from Riverton, Nightcaps and Wairio townships.
- Ensure that wastewater and stormwater are not cross-connected in municipal systems.
- Target improvements to on-site wastewater disposal systems to reduce the risk of human faecal contamination of freshwater.
- Urban development incorpora tes best practice stormwater management methods.

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