



Integrated Assessment Baseline and Scenarios



Healthy Rivers
PLAN FOR CHANGE

Maniapoto Māori Trust Board
Raukawa Charitable Trust
Te Arawa River Iwi Trust

Wai Ora

HE RAUTAKI WHAKAPAIPAI

Tūwharetoa Māori Trust Board
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Integrated Assessment

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Introduction

The Integrated Assessment framework provides the means for the CSG to assess the impact on their selected social, economic cultural and environmental indicators of activities generated through the scenario modelling.

A panel including scientists, social scientists and policy advisors prepared a baseline of information for each of the indicators. The baseline contains quantitative and qualitative data and trends that describe the indicators. Working with members of the CSG, the panel used assessed the impact of the activities generated from the scenario against each indicator. A narrative was recorded, which described the effects of the model generated activities on the baseline for each indicator.

The Integrated Assessment has been completed for four Scenarios, with Scenario 1 having steps of 10%, 25%, 50% and 100% assessed. This booklet contains a summary of each scenario and the assessment of that scenario against each indicator.

Disclaimer: This report has been prepared by the Technical Leaders Group for the Healthy Rivers/Wai Ora project as a reference document, and as such does not constitute Waikato Regional Council policy.

Baseline

Mātauranga Māori

Waitemata (Water clarity)

To be able to see the bottom of a swimming place and to be reassured it is safe and is familiar (intergenerational connection). This could be at the bank of the river or lake and/or in the water. This is likely to be at a human scale, that is, shoulder to feet, approx. 155cm vertically or horizontally 160cm+.

Water clarity is currently measured using a black disc method, which measures the distance of sight (metres) through a collected amount of water. Black disc records for the Waikato River began in early 1995. Significant downward trends in visual clarity were observed at five of the eight sites, namely Ohaaki, Ohakuri, Whakamaru, Waipapa and Tuakau. No downward trend was observed at Narrows, Horotiu and Huntly.

Te Rere (Flow)

Te rere is a measure of the amount of water and speed at a particular point (Cubic metres per second or cumecs). The level and flow of water at a swimming place are important factors that influence the favourability of swimming. A change to levels and flow (significant reduction or significant increase) that makes the river potentially unswimmable may be unacceptable to users. This indicator is measured by flow at monitored sites along the river.

Paemakariri (Temperature)

The expectation that cool water is present at swimming places for its healing qualities as well as life sustaining qualities. This indicator is moderated by contemporary access and use of public and private pools (tepid and thermal) and swimming in seawater which are usually much warmer than lakes and rivers.

The water temperature in the Waikato River is currently monitored at 10 sites. Although trends in water temperature have been observed at six of these sites over the past five years (four increases and two decreases), all of these were slight, with no important improvements or deteriorations in water temperature observed.

He kai pai (Edible food)

The presence of pathogens may be harmful to human health. *E. coli* is a common indicator used for this purpose, however there are others that could be used, such as enterococci and faecal coliforms, all indicators of faecal matter, which is both a health risk and culturally unacceptable. There are a range of diseases or bacteria present in food products derived from fresh water, some of which are tested in commercial food safety. This indicator is measured by *E. Coli* concentrations at monitored sites.

Te nui o ngā kai i te wai (Abundance of fish species – koura)

The quantity of fish species present in waterbodies. It is a measure of abundance; an important indicator of a healthy environment providing sustenance for human populations. Historically, this indicator was linked directly to the survival of iwi along the river. Today, this measure reflects the ability of whānau to collect and provide kai as part of manaakitanga. A range of species have been identified to measure common to most river iwi including tuna, piharau, inanga, kakahi/kaeo, koura/kewai and watercress. The koura is likely to be the favourable indicator species as it is located in tributaries and is sensitive to sediment, one of the 4 contaminants.

Koura

The relative abundance of koura in the rivers is assessed using a combination of quantitative data from the Regional Environmental Monitoring Survey (REMS) and qualitative assessments by experienced people engaged in river assessments, kaitiakitanga and resource use (fishers).

Quantitative data, derived from surveys at 38 sites on streams within the Waikato and Waipa catchments between December 2012 and February 2014, shows that koura numbers are in relative abundance in the Waikato River tributaries from Karāpiro to Ōhakuri and in the Waipa River tributaries. At the other sites surveyed, they were either scarce relative to expectations for the location, or absent or very scarce.



Ngā tarukino me ngā ika rawaho i te wai (Presence of pest weeds and fish)

The number of pest animals (fish) and introduced weeds (except watercress) present in the water. The presence of pest plants and weeds has an effect on acceptability of a place for swimming and mahinga kai.

Mātauranga ki ngā wai kaukau (Knowledge of swimming places)

The knowledge and traditions related to swimming in particular places held by current generations (including the knowledge of the location of swimming places, knowledge of access to the swimming places, knowledge of the history of that place, and the ability to pass on knowledge). The knowledge and experience of swimming is an important consideration in advising and directing people to swim in particular places at a particular time and any concerns that need to be addressed.

Au pūtea (Economic benefit of water)

The impact of the scenarios on businesses reliant directly on water in the Waikato and Waipa that are owned and/or operated by Māori. This would focus on forestry, agriculture, horticulture and fisheries.

Regional ecological monitoring of streams (Mauri)

The overall health of aquatic habitats. The key aspects of this data are the Macroinvertebrate Community Index (MCI) and Macrophytes measures.

MCI

Macroinvertebrates are small organisms that are large (macro) enough to be seen with the naked eye and lack a backbone (invertebrate). They include insects, crustaceans, molluscs, arachnids and annelids that do not have a backbone. MCI is an index that uses macroinvertebrates to monitor and report on stream health in New Zealand. The MCI assigns a score to each species or taxon (from 1 to 10), based on its tolerance or sensitivity to organic pollution, then calculates the average score of all taxa present at a site. Different scores are used for naturally hard - and soft-bottomed streams, to allow for natural habitat effects.

Macrophyte Clogginess

A macrophyte is an aquatic plant that grows in or near water and is either emergent, submergent, or floating. Clogginess refers to the amount of plant cover that is present in the stream channel. In lakes and rivers, macrophytes provide cover for fish and substrate for aquatic invertebrates, produce oxygen, and act as food for some fish and wildlife.

Ecosystem health

Ecosystem health encompasses the type and abundance of freshwater invertebrates in non-tidal wadeable streams, as well as the amount of algal and aquatic plant growth and the quality of the habitat in which organisms live.

Macroinvertebrate Community Index assessments show that stream health is typically good in the tributaries of the Waipa and upper Waikato Freshwater Management Units (FMUs), fair in the lower Waikato tributaries, and fair-to-poor in the mid-Waikato tributaries. Monitoring shows macrophyte channel clogginess levels are excellent in the southern upper-Waikato area, good in both the northern upper-Waikato and Waipa FMUs, and fair in the middle and lower Waikato FMUs. Clogginess is restricted in the Waikato and Waipa natural riverine reaches, and the hydro-lakes, due to their high flows and greater depths and widths, respectively.

Habitat quality also declines markedly with catchment development and is lowest in streams flowing from catchments that have been almost entirely developed for agriculture. Overall, across the five long-term monitoring sites where riparian management has been carried out, there is an overall improving trend for both of these stream health metrics. Stream health would be enhanced by riparian planting, which is not currently included in the scenario modelling.

Riparian (Pareparenga o te wai)

Riparian refers to the margins of waterbodies (i.e. stream banks). They are typically managed for water quality through fencing and/or planting. River and stream riparian areas contribute to ecological integrity and aesthetic appeal, enhance terrestrial biodiversity and act as a 'last line of defence' in controlling contaminant inputs. The access of livestock to riparian areas and streams is a key driver of water quality and riparian condition in the pastoral farming systems that dominate productive land use in the Waikato and Waipa catchments.

There has been a significant increase in the proportion of stream length fenced on both sides of waterways between 2002 and 2012, resulting in an overall increase in proportion fenced across the Waikato Region from 34% to 51%. The increase has been greater along streams on dairy farms (25% increase to 70% in 2012) compared to dry stock farms (7% increase to 29% in 2012). There has been little change in woody vegetation within riparian areas over the last decade.

Wetland (Rohe kōreporepo)

These are permanently or intermittently wet areas, shallow water, and land water margins that support plants and animals that are adapted to wet conditions. Wetlands and floodplains provide water purification, refuge, feeding and breeding homes (or habitat) for aquatic species and homes for water fowl. Wetlands provide a vital function by diluting or diffusing the effects of floods and contaminants (also called flood and contaminant attenuation). Apart from specific wetlands (e.g. Whangamarino) and wetlands around lake margins, they have largely been drained and converted to pasture.

Whangamarino is one of only six wetlands in New Zealand that is recognised as being internationally important. Wetlands were once widespread within the lower Waikato Basin, but today, less than 20 percent of the original freshwater wetlands remain. Many of these are scattered around the catchment and smaller than 50 ha. For example, the once massive 25,840 ha Gordonton peat bog, now consists of a 60 ha remnant. In the lower Waikato basin there is a mosaic of shallow lakes and mineralised swamps all connected to the Waikato River, while the Hamilton basin has a unique assemblage of peat lakes and remnant peat domes. There has been a 92.3% decline in wetland areas, from 202,600 ha historically.

Vibrant Resilient Communities (Ngā hapori manawaroa)

The purpose of this indicator is to show the current levels of vibrancy and resilience in rural communities in the Waikato catchment. For the purposes of the project, community vibrancy focuses on the diversity of employment in the rural areas, food security, population size and structure and levels of deprivation. Community resilience focuses on social connectedness, community pride, volunteering and involvement in recreation.

Food security and affordability

Waikato's domestic vegetable supply is linked with approximately ten other vegetable production nodes across the country that are integrated parts of the domestic food supply chain. Horticulture production in the Waikato River catchment is primarily based in the Lower Waikato catchment. The Pukekawa area is a significant vegetable production area for domestic and export food supply. The horticultural node of Pukekohe/Pukekawa have between 6000 and 7000 hectares in production annually and are unique in the country due to the combination of soil, frost free growing conditions year around, settlement and large local market. Rotations can supply many crops year round, which is unique in New Zealand, due to the frost free conditions.

Population

The population of the Waikato Region has grown steadily over the past twenty-five years, from 325,220 in 1986 to approximately 416,200 in 2012, an increase of 28 per cent. Steady growth is anticipated to continue to 2031. Hamilton City is projected to experience overall gains in all age groups, with all other Territorial Local Authorities (TLAs) expected to see widespread decline across the younger and middle ages. Three TLAs (Otorohanga, South Waikato, and Waitomo) are projected to experience decline in all age groups below 65 years. The changes by age have important implications for the labour market (and educational demand).

Social connectedness and community pride

The Waikato Genuine Progress Indicators measure social connectedness using reported loneliness as the main indicator. A smaller proportion of people living in the Waikato region reported feeling lonely in 2012 than in 2008, an improving trend. The level of community pride expressed in 2013 by people living in the Waikato region was similar to that measured in 2007

Recreation

The majority of adults take part in sport and recreation each week. Weekly participation has grown slightly since 2007/08. While this is a small increase it is a positive change after 10 years with no growth (from 1997 to 2007). Participation is most often in outdoor environments, both in towns and cities (e.g., paths/cycleways and urban parks) and in more natural settings (e.g., waterways, bush and the countryside).

Connectivity

Connectivity is a driver of resilience. Connectivity includes factors such as knowing other people in your community, access to services, internet access, commuting distance to work and remoteness. When pressure comes onto households one way to respond is to diversify, such as one person in the household seeking employment in town. This will be affected by the economic service area of nearby towns, distance to travel to work or how mobile an industry is.

Employment, type and diversity (Momo mahi, mahi kanorau)

This indicator relates to the number of jobs across different sectors and at different levels of skill and responsibility. When employment is affected, this has flow on impacts on many other aspects of society and communities. New opportunities for employment are not generated as part of the modelling outputs. This indicator considers the type and diversity of jobs, new employment opportunities and the geographic spread of employment.

Employment rate and growth

The employment rate in the Waikato region has been on the rise since 2012, and currently sits at around 66%. The total number of employees in the region has increased in recent years, with the growth rates highest in the electricity, water and gas, and dairy manufacturing sectors.

Employment by sector

Businesses and other organisations provide a lot of employment in the Waikato region, and there are substantial numbers of owner-operated businesses and self-employed people.

The largest employment sectors are health and education, wholesale and retail trade, business and finance services, Tourism is also important. Although the dairy sector is an important one for the region, it employs only 4.3% of the regional labour force.

Infrastructure (Hanganga)

The reliable and affordable infrastructure provided to communities and the profile of investment/reinvestment risk for providers – only covers flood protection, energy, waste water and water supply. Affordability relates household incomes to the price of a service or asset, to assess the ability of households to pay. The key area of interest is whether or not the infrastructure remains affordable over time.

Flood protection – lower Waikato

At present, flood protection is provided to 41,000 ha of land in the lower Waikato catchment. This includes 250km of stop banks, 253 floodgates, 66 pump stations, 250km of channels and streams, and 120 pumps. These assets have a collective replacement value of \$108 million.

Water availability

Demand for water from the Waikato River is increasing, with the proportion of water that is allocated through resource consents rising each year since 2007. Water and waste treatment facilities are funded through district and city rates, which are influenced by size of population and property values.

Electricity supply

The Waikato is rich in hydro, geothermal and thermal electricity generation capacity, and supplies around 37%, and if required, up to 50% of New Zealand's electricity each year. Seventy-five per cent of electricity generated in the Waikato region is exported to other regions of New Zealand. New Zealand generates the majority of its electricity from renewable sources, and over the past 10 years, has substantially increased its capacity to do so.

Recreation use (ngā mahi a te rēhia)

The rivers provide for people's recreational use and social needs, are widely used by communities, and are a place to relax, play, exercise and enjoy an active lifestyle. Whether the rivers are safe for recreational use from a health perspective, is gauged through the water quality attributes. It is important that the attributes that affect human health are at acceptable levels.

Types of recreational uses

The main recreational uses of the river, in order of reported frequency, are:

- walking or cycling beside it
- sightseeing, picnicking or camping
- fishing or hunting
- boating or water sports
- kayaking, canoeing and waka ama
- swimming
- gathering kai.

Number of people using the rivers for recreation

Research in 2012-2014 into the number of people using freshwater bodies (which includes rivers, streams, lakes and wetlands) for recreation found that 69% of the survey participants had visited a freshwater body in the Waikato region in the past year. Rivers were the most common type of freshwater site visited (57% of participants), followed by lakes (51 per cent).

How people choose a site

The main factors that affect which freshwater site people chose to visit for recreational purposes are:

- travel cost
- water clarity
- land cover (urban and forest)
- facilities
- accessibility
- development
- perceived site cleanliness
- perceived safety of food gathered
- flow adequacy

Water clarity was found to have a significant positive effect in motivating people to visit a site. Human health risk and ecosystem health measures were found to be not significant themselves in influencing site choice. Travel cost has just as large a negative effect as clarity's positive effect. It means that sites further away are less likely to be visited, all else being equal.



Economic

Value add (whaipanga)

Gross Domestic Product (GDP) is an internationally accepted measure of economic activity. The Regional Economic Model uses 'Net value added' as a proxy for Regional GDP. Both are conceptually similar, with the main difference being how tax of products is treated (i.e. GST). In % terms the difference between the two indicators is less than 2%.

International exports (hokohoko tauwhenua)

The Regional Economic Model uses 'Net international exports' as a proxy for Waikato regional contribution to national exports. The two measures are the same. In the case of the indicator used, the 'net' relates to the aggregated (economy-wide) effects of the scenario.

Employment (MEC) (Ngā mahi)

The Regional Economic Model uses 'Net employment' (unit of measure 'MEC') as a proxy for Total Value of Employment. A Modified Employment Count (MEC) is an indicator that captures both employees and working proprietors.

Modified employment counts (MEC) by sector

The other services sector has the largest net employment impact for the region, with a modified employment count of 72,281. Other major contributors are: wholesale and retail trade; dairy farming; scientific, professional and administrative services; and construction.

Real median weekly income

Median weekly earnings for people in paid employment in the Waikato region are below the national average: \$800 in 2014, compared to \$860 for New Zealand overall.

Scenario 1: Achieving water quality for swimming, taking food and healthy biodiversity

Part 1: Overview of Scenario 1

Equates to restoring and protecting the water quality of the Waikato and Waipa rivers, as required by the Vision and Strategy (swimmable and fishable), with improvement everywhere, even if already meeting minimum acceptable states.

Description

Substantial improvement in water quality for swimming, taking food, and supporting healthy biodiversity. This means swimmable in all seasons for microbes and clarity. Water quality supports ecological health. Some improvement in all attributes.

Attribute targets/limits¹

FMU	Upper Waikato:	Middle Waikato:	Lower Waikato	Waipa:
E. coli	Main stem remains A. Tributaries min B at 95% percentile (95%ile)	Main stem A at Narrows at 95%ile; Horotiu and tributaries B	Main stem and tributaries B at 95%ile	
Clarity	Main stem A to Waipapa tributaries go up 1 band	Main stem B tributaries go up 1 band	C in main stem and tributaries	Upper stem B, lower stem C tributaries go up 1 band
Algae (Chlorophyll a)	A sites improve. B sites to A, C sites to B.	B for med. A for max.	B for median and max; Huntly moves to B for med. and A for max.	
Nutrients				
Total phosphorus:	Maintain where already A, raise to B for rest of river.			
Total nitrogen:	Improve where already A, all sites to Waipapa to A, rest of river to B.			
Ammonia and nitrate:	Improve where already A, other sites go up 1 band.			

Part 2: Integrated assessment

Mātauranga Māori

Waitemata (Water clarity)

Clarity in this scenario will improve; it is expected that water clarity would achieve the B² band in most places.

Te rere (Flow)

Flow is expected to remain static and not be affected by the reductions of the contaminants themselves. It is expected afforestation will decrease the variability of flow, particularly during small to medium sized storm events.

¹ See Appendix 1: Attributes

² See Appendix 1: Attribute tables; Clarity

Paemakariri (Temperature)

Shading of water bodies, particularly tributary streams will see a small decrease in temperature. This scenario includes land use change (conversion to forestry, and riparian management) that will result in a reduction in water temperature at those places. Temperature is also a stressor of native fauna; therefore lower temperatures are an improvement in ecosystem health. Generally, the expectation is that water will be colder in tributaries and that afforestation will reduce temperature.

He kai pai (Edible food)

There is likely to be an improvement or decrease in E.coli through de-intensification, afforestation, and mitigations. The improvements in E.coli will likely improve perceptions of risk to human health.

Te nui o ngā kai i te wai (abundance of fish species – koura)

Fish species have the potential to increase in number. It is expected that numbers and distribution of koura may increase as a result of this scenario.

Ngā tarukino me ngā ika rawaho i te wai (Presence of pest weeds and fish)

Minimal impacts on the presence of pest weeds and fish (i.e. won't reduce their numbers). There is expected to be some reduction of pest weeds that are affected by shading from afforestation but no significant effect on pest fish.

Mātauranga ki ngā wai kaukau (Knowledge of swimming places)

Improved clarity (safety) and reduced E.coli (perceptions of safety) would improve the tendency to go to swimming places and therefore it is assumed that an increase in sharing of knowledge can occur.

Au pūtea (Economic benefit of water)

While there is expected to be some increases in forestry (which has low labour force requirements) and value added industries such as pulp and paper, there will be significant reductions in other primary sectors; horticulture and fruit growing, sheep and beef, and dairy.

Environmental

Regional ecological monitoring of streams (Mauri)

Increased MCI and decreased 'clogginess' caused by macrophytes. There would be an increase in stream habitat but ultimately no net change for fish and eel populations. Depending on the timeframes to achieve the scenario, not much change in eel population will occur in the short term, as habitat will only increase slowly as vegetation grows.

Riparian (Pareparenga o te wai)

The requirement for significant fencing to achieve the targets may need to include different management options, suitable to the land and farm types. This could mean for example omitting sheep from stock exclusion requirements. The fencing of waterways with buffers may increase the public perception of accessible space adjacent to waterways.

Wetland (Rohe kōreporepo)

Increase in base flow and more even base flow as a result of more wetlands would have significant benefits through increased biodiversity, increased customary resources, increased sense of identity and increased food sources.

Social

Vibrant resilient communities (Ngā hapori manawaroa)

Communities that are already in decline will be more affected by a decrease in jobs, which influence population decline and can have a flow on effect to a loss of key services such as schools, healthcare, and shops. The dairy industry is the most affected by the number of job losses in this scenario, and this sector mainly employs people 18-40 years, therefore job losses in this sector will impact on the prime working age population. This is especially so in the Upper Waikato FMU. However, some communities may experience increased vibrancy associated with recreation and related business opportunities.

Employment, type and diversity (Momo mahi, mahi kanorau)

Employment in non-forestry primary industries, particularly dairy farming, would decrease substantially under this scenario. This would affect the type and number of jobs in these sectors, with many of the job losses affecting low-skilled workers who may struggle to find work elsewhere without retraining. The magnitude of the change for the dairy industry means there would be a flow-on effect for the primary service sectors and other services within the economy. There would be a large regional loss of jobs in these sectors, and this would be spread across the FMUs equally. However, there may be little overall change in the diversity of jobs in the region, because of the current diversity of employment.

Infrastructure (Hanganga)

Costs to the urban centres and the rural areas would be more equitable under this scenario, because mitigations would be required for both point source municipal and commercial, and diffuse source rural contaminants. Urban municipal point sources would have to take into account the constraints of council planning timeframes, such as those required by the 10 year long-term plans. Affordability of public infrastructure would decrease for communities, as job losses combine with increased costs and reduced rates with people leaving the area in search of employment. Upgrades required to wastewater treatment and stormwater infrastructure will create particular affordability issues for some communities.

Land-use changes under this scenario are likely to affect hydroelectricity generation negatively, by reducing flows and affecting reliability. Flood protection on the other hand, will benefit from these same changes to flows.

Recreation use (Ngā mahi a te rēhia)

A key outcome of this scenario is making the water safe for use. The creation and placement of buffers and fencing and management of riparian areas will impact on the provision of access. Increased riparian vegetation improves bank stability, which increases safety for recreational and other users. Overall, there may not be much change to access, but there are opportunities to increase the accessibility of the rivers' margins.

Economic

Value add (Whaipāinga)

Value added for the Waikato region decreases by \$623m (3.5%). Value added for Waikato dairy farming decreases by \$265m (16.6%) and for sheep and beef by \$96m (23.5%). These impacts are felt throughout all the FMUs.

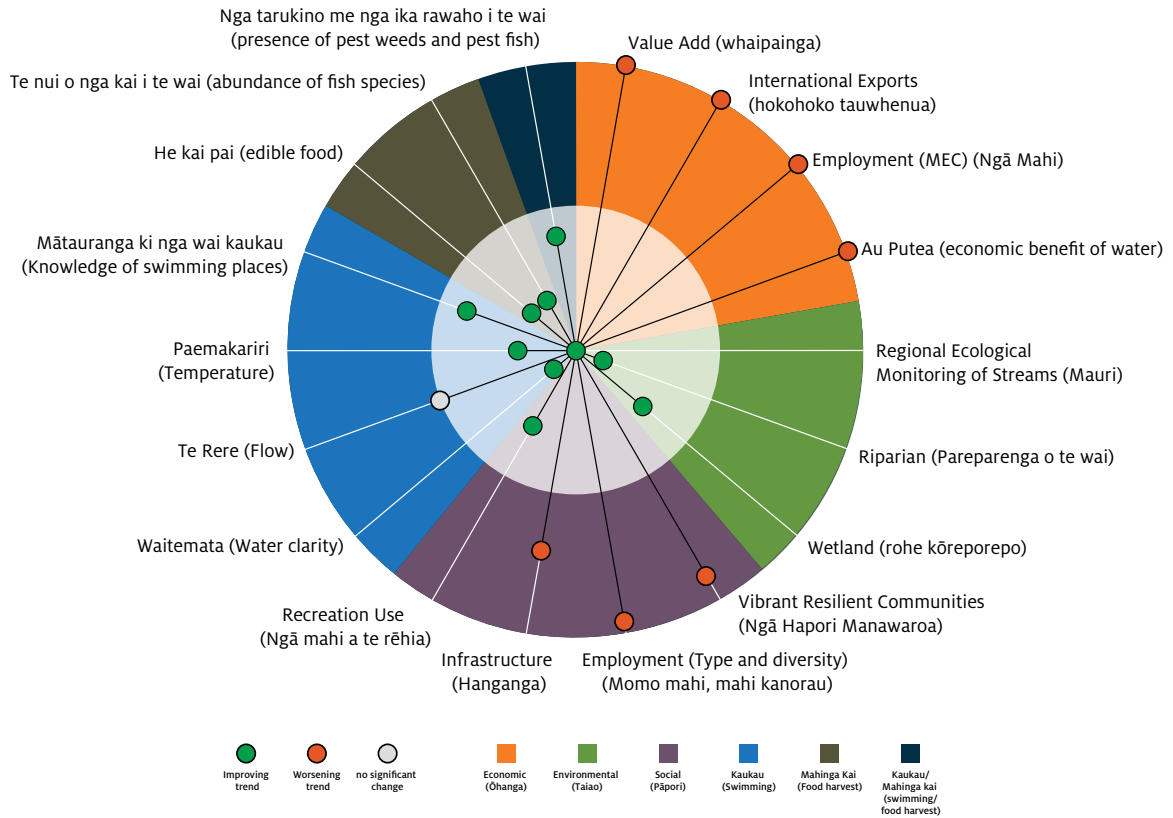
International exports (hokohoko tauwhenua)

Total loss of \$462m of international exports, \$367m of which is from dairy product manufacturing, and \$98m from meat and meat product manufacturing.

Employment (MEC) (Ngā mahi)

Total employment count for the Waikato region decreases by 5,272 (2.4%) including an 11% decrease in dairy farming employment and a 5.7% decrease in sheep and beef employment. Manufacturing and supporting industries are similarly affected. The impacts are felt throughout all the FMUs; unskilled labour will be most affected. This may exacerbate rural population decrease and job losses. Population changes (in both number and age structure) in smaller towns will have a significant impact on rates and ability to pay, and impact on community services.

Scenario 1



Scenario 2: No further degradation and improving to at least minimum acceptable states for all attributes

Part 1: Overview of Scenario 2

Equates to meeting the National Policy Statement for Freshwater Management 2014 requirements and a minimum amount of restoring and protecting the Waikato and Waipa rivers, as required by the Vision and Strategy (swimmable and fishable).

Description

No further degradation and improving to at least minimum acceptable standard for all attributes. This means no degradation where currently A, B, or C band. Focus on lifting any D to C; lift *E. coli* to above minimum acceptable state (MAS) for swimming throughout.

Attribute targets/limits

FMU	Upper Waikato:	Middle Waikato:	Lower Waikato	Waipa:
<i>E. coli</i> No further degradation at any site, and minimum of:	Raise all tributaries to B at 95%ile.	Raise Horotiu and all tributaries to B at 95%ile.	Raise main stem and all tributaries to B at 95%ile.	Raise main stem and all tributaries to B at 95%ile.
Clarity No further degradation at any site, and minimum of C throughout:	Main stem B, tributaries C	Main stem and tributaries C	Raise main stem and all tributaries to C	Maintain where currently B or C, and lift to C where currently D.
Algae (Chlorophyll a)	No further degradation at any site.			
Nutrients				
Total phosphorus:	Maintain where already an A, B, or C; lift Lower river to C.			
Total nitrogen:	No further degradation			
Ammonia and nitrate:	No further degradation			

Part 2: Integrated assessment

Mātauranga Māori

Waitemata (Water clarity)

Clarity in this scenario will improve predominantly in the lower parts of the Waipa and Lower Waikato.

Te rere (Flow)

Flow is expected to remain the same and not be affected by the reductions of the contaminants themselves.



Paemakariri (Temperature)

Shading of water bodies, particularly tributary streams will see a small decrease in temperature. This scenario includes afforestation (forestry and riparian management) that will result in lower water temperatures at those places.

He kai pai (Edible food)

E.coli levels reduce by 25% to 75% across all FMUs. Improvements in *E.coli* will likely improve perceptions of risk to human health.

Te nui o ngā kai i te wai (Abundance of fish species – koura)

Fish species have the potential to increase in number. It is expected that numbers and distribution of koura would increase as a result of this scenario.

Ngā tarukino me ngā ika rawaho i te wai (Presence of pest weeds and fish)

Minimal impacts on the presence of pest weeds and fish in the water. Pest fish such as carp, catfish, gambusia and rudd are very resilient to a range of water quality characteristics. This scenario is not expected to see reductions in their number.

Mātauranga ki ngā wai kaukau (Knowledge of swimming places)

Improved clarity (safety) and reduced *E.coli* (perceptions of safety) would increase the likelihood to go swimming and therefore it is assumed that an increase in sharing of knowledge can occur.

Au pūtea (Economic benefit of water)

While there is expected to be some increases in forestry (which has low labour force requirements) and value added industries such as pulp and paper, there will be significant reductions in other primary sectors; horticulture and fruit growing, sheep and beef, and dairy. This scenario shows approximately 40% reduction in value and 50% reduction in employment (dairy and sheep/beef) with smaller impact on horticulture and fruit growing.

Environmental

Regional ecological monitoring of streams (Mauri)

Some improvement in MCI and decrease in 'clogginess' caused by macrophytes can be expected. Increased forestry may mean increased wood in streams for habitat.

Riparian (Pareparenga o te wai)

This scenario requires significant fencing but may need to include different management options, suitable to the land and farm types. Riparian buffers provide benefits for biodiversity, aesthetics and ecological corridors as well as increasing customary resources.

Wetland (Rohe kōreporepo)

A substantial area would be serviced by constructed wetlands. Forestry can dry out small wetlands but the increase in wetland area would be effective for mitigating the nitrogen load to come. This mitigation would have greater effect when focussed on Waipa, Lower Waikato FMUs for sediment.

Social

Vibrant resilient communities (Ngā hapori manawaroa)

Significant job losses, with greater numbers located in the Upper Waikato FMU.

Employment, type and diversity (Momo mahi, mahi kanorau)

The impact on employment will be approximately 2000 jobs lost across the region. The impact on dairy farming is around 65% of the total job losses, along with the related dairy support and manufacturing sectors. There is a large impact on horticultural jobs with a shift in land use away from horticulture. Some jobs losses would be mitigated by new jobs being created within the region, particularly in forestry, and professional and administrative services. Professional and administrative services are already strong employers for the region, and it is likely some employment increase will come from people retraining and shifting into these fields.

Overall, in the context of total regional employment, the job losses are relatively minimal. In addition, in terms of numbers, the industries where the most jobs will be lost are not major employers. However, it is likely that smaller rural communities, where there has currently been less scope for diversity, will be hardest hit. This is likely to exacerbate existing trends where younger people are moving from rural to urban areas to find work.

Infrastructure (Hanganga)

Costs to the urban centres and the rural areas would be more equitable under this scenario, because mitigations would be required for both point source municipal and commercial, and diffuse source rural contaminants. Urban municipal point sources would have to take into account the constraints of council planning timeframes, such as those set by the 10 year long-term plans. Affordability for communities would decrease, as job losses combine with increased costs. Upgrades required to wastewater treatment and stormwater infrastructure may create affordability issues for some communities.

Recreation use (Ngā mahi a te rēhia)

There is likely to be recreational gains with domestic visitors, who are more likely to be drawn to the rivers if they are known to be clean. Fisher people will also be increasingly drawn to the rivers if they are cleaner, and support greater numbers (and more edible) fish and other aquatic life. For recreational users, and especially fisher people, the nature and quality of access will be paramount, and factors influencing the riparian indicator need to be considered alongside this indicator. Increased recreational use will not be spread evenly across the FMUs. The Lower Waikato FMU is expected to see the greatest increases.

Economic

Value add (Whaipaiinga)

With decreases in the agricultural sectors, the declines in smaller rural towns may accelerate as people move away to seek other opportunities. Loss of population reduces the resilience of communities to deal with external forces such as financial crisis. Value Added for the Waikato Region decreases by \$310m (1.7%).

International exports (Hokohoko tauwhenua)

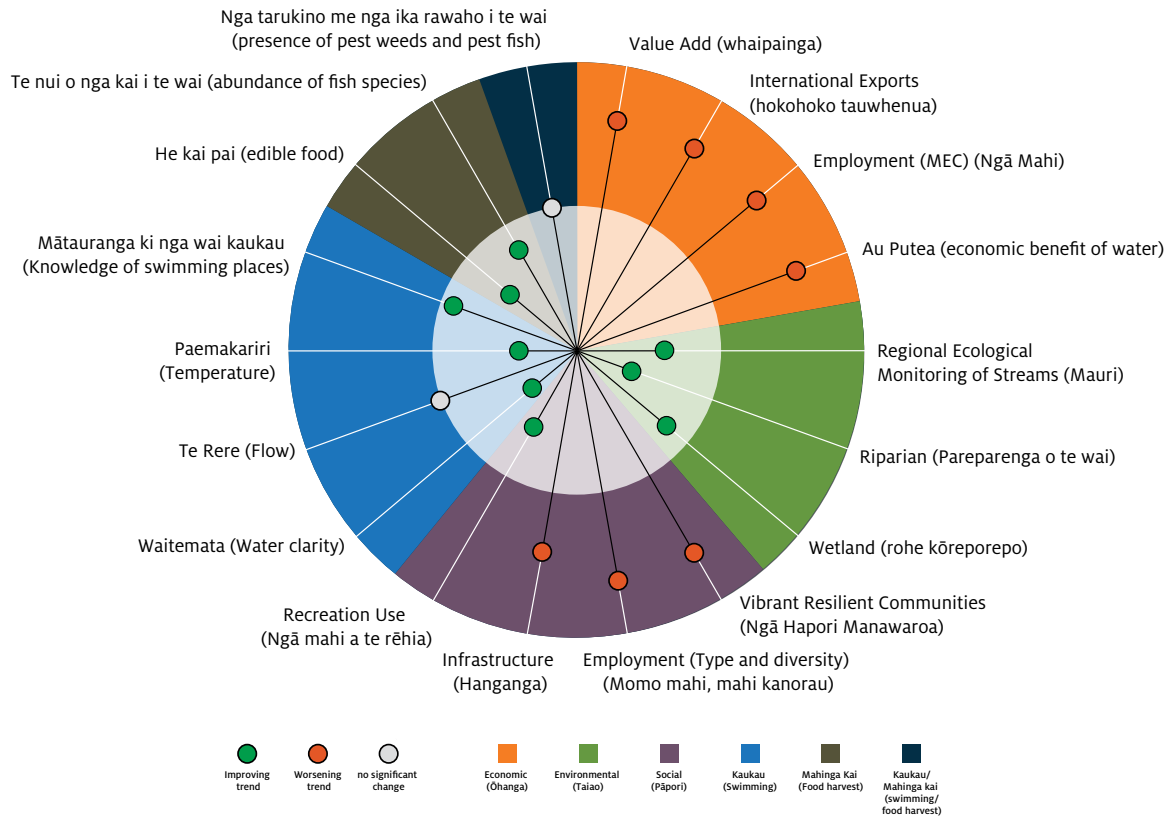
Total loss of \$177m of international exports, \$168m of which is from dairy product manufacturing, and \$16m from meat and meat product manufacturing.

Employment (MEC) (Ngā mahi)

Total employment count decrease of 0.9%, a large number of which is from dairy farming, and significant amount from 'other services'. Biggest impacts being felt in the Lower and Middle Waikato FMUs, Waipa had the most impact in the 'other services' sector. There will be rural population decrease and job losses. Population changes (in both number and age structure) in smaller towns will have a significant impact on rates and ability to pay, and impact on community services.



Scenario 2



Scenario 3: Some general improvement in water quality for swimming, taking food and healthy biodiversity

Part 1: Overview of Scenario 3

Some general improvement in water quality for swimming, taking food, and healthy biodiversity but may not reach minimum acceptable states everywhere.

Description

Some general improvement in water quality for swimming, taking food, and healthy biodiversity. This means some improvement across all attributes. Main stem suitable for swimming in Upper and Middle river, and in parts of Waipa but not Lower river. Lower, middle, and some Waipa river tributaries wadeable, but may not reach swimmable (B at 95%ile).

Attribute targets/limits

FMU	Upper Waikato:	Middle Waikato:	Lower Waikato	Waipa:
E. coli	Tributaries B at 95%ile	Narrows stays at A 95%ile Horotiu gets to B at 95%ile Tributaries B at median but may not be B at 95%ile	Tributaries min B at median. Main stem may not be B 95%ile.	Tributaries A at median, some are B at 95%ile.
Clarity No further degradation at any site, and minimum of:	Main stem B, all tributaries C	Main stem and tributaries C	Main stem and all tributaries C	
Algae (Chlorophyll a)	B, with no further degradation of A sites	B for median and maximum	C but no degradation at Huntly (currently a B for maximum).	
Nutrients				
Total phosphorus:	Maintain where already an A or B Lift C sites in Upper and Middle to B and lift Lower river to C.			
Total nitrogen:	No further degradation; lift to a B for Middle river.			
Nitrate N:	Lift C sites to a B.			
Ammonia:	Lift median to a B.			

Part 2: Integrated assessment

Mātauranga Māori

Waitemata (Water clarity)

Clarity in this scenario will improve, supporting an increase in swimming.

Te rere (Flow)

Flow is expected to remain similar. Afforestation would decrease the variability of flow, particularly during small to medium sized storm events. This scenario suggests conversion to forestry of approximately 17,000ha. The introduction of wetlands as a mitigation to attenuate flows from approximately 360,000ha of land would result in less variability and an increase in base flow.

Paemakariri (Temperature)

Shading of water bodies, particularly tributary streams will see a small decrease in temperature. This scenario includes afforestation (forestry and riparian management) that will result in a reduction in water temperature at those places.

He kai pai (Edible food)

E.coli levels would decrease, therefore perceptions of risk to human health would likely improve.

Te nui o ngā kai i te wai (Abundance of fish species – koura)

Fish species have the potential to increase in number. An increase in natural riparian margin will increase koura, that will result in an increase in food source for trout, tuna, catfish.

Ngā tarukino me ngā ika rawaho i te wai (Presence of pest weeds and fish)

This scenario is not expected to result in the reduction of numbers of pest weeds and fish in water and will therefore have minimal impact..

Mātauranga ki ngā wai kaukau (Knowledge of swimming places)

Improved clarity (safety) and reduced *E.coli* (perceptions of safety) would increase the likelihood to go swimming and therefore sharing of knowledge can occur.

Au pūtea (Economic benefit of water)

There would be land-use change (afforestation) and decreases in land-use intensity. The economic effects of changes in land-use, particularly on Māori landholdings that significantly rely on agriculture, forestry, and horticulture are significant.

Environmental

Regional ecological monitoring of streams (Mauri)

Improvement in MCI and a decrease in 'clogginess' caused by macrophytes can be expected. Increased forestry may mean increased wood in streams for habitat.

Riparian (Pareparenga o te wai)

This scenario requires significant fencing but may need to include different management options, suitable to the land and farm types. Riparian buffers provide benefits for biodiversity, aesthetics and ecological corridors as well as increasing customary resources.

Wetland (Rohe kōreporepo)

Substantial area serviced by constructed wetlands. This mitigation will have greater effect for sediment if focussed on Waipa and Lower Waikato FMUs.

Social

Vibrant resilient communities (Ngā hapori manawaroa)

Significant job losses occur, with greater numbers for the Upper Waikato FMU.

Employment, type and diversity (Momo mahi, mahi kanorau)

The impact on employment will be approximately 2000 jobs lost across the region. The impact on dairy farming is around 65% of the total job losses, along with the related dairy support and manufacturing sectors. There is a large impact on horticultural jobs with a shift in land use away from horticulture. Some jobs losses would be mitigated by new jobs being created within the region, particularly in forestry, and construction. Professional and administrative services are strong employers for the region, and it is likely some employment increase will come from people retraining and shifting into these fields.

Overall, in the context of total regional employment, the job losses are relatively minimal. In addition, in terms of numbers, the industries where the most jobs will be lost are not major employers. However, it is likely that smaller rural communities, where there has currently been less scope for diversity, will be hardest hit. This is likely to exacerbate existing trends where younger people are moving away from rural areas to find work.

Infrastructure (Hanganga)

Reduction in the affordability of the various water infrastructure for consumers and communities, but very little change overall.

Recreation use (Ngā mahi a te rēhia)

There is likely to be recreational gains with domestic visitors. Fisher people will also be increasingly drawn to the rivers if they are cleaner. For recreational users, and especially fisher people, the nature and quality of access will be paramount, and factors influencing the riparian indicator need to be considered alongside this indicator. Greater increases are anticipated in the Middle and Lower Waikato FMUs, with the Waipa FMU expected to experience a slight decrease.

Economic

Value add (Whaipainga)

Value Added for the Waikato Region decreases by \$311m (1.7%). Declines in smaller rural towns will accelerate as people move away to seek other opportunities. If other external forces exist, for example a global financial crises, then towns will be less resilient.

International exports (Hokohoko tauwhenua)

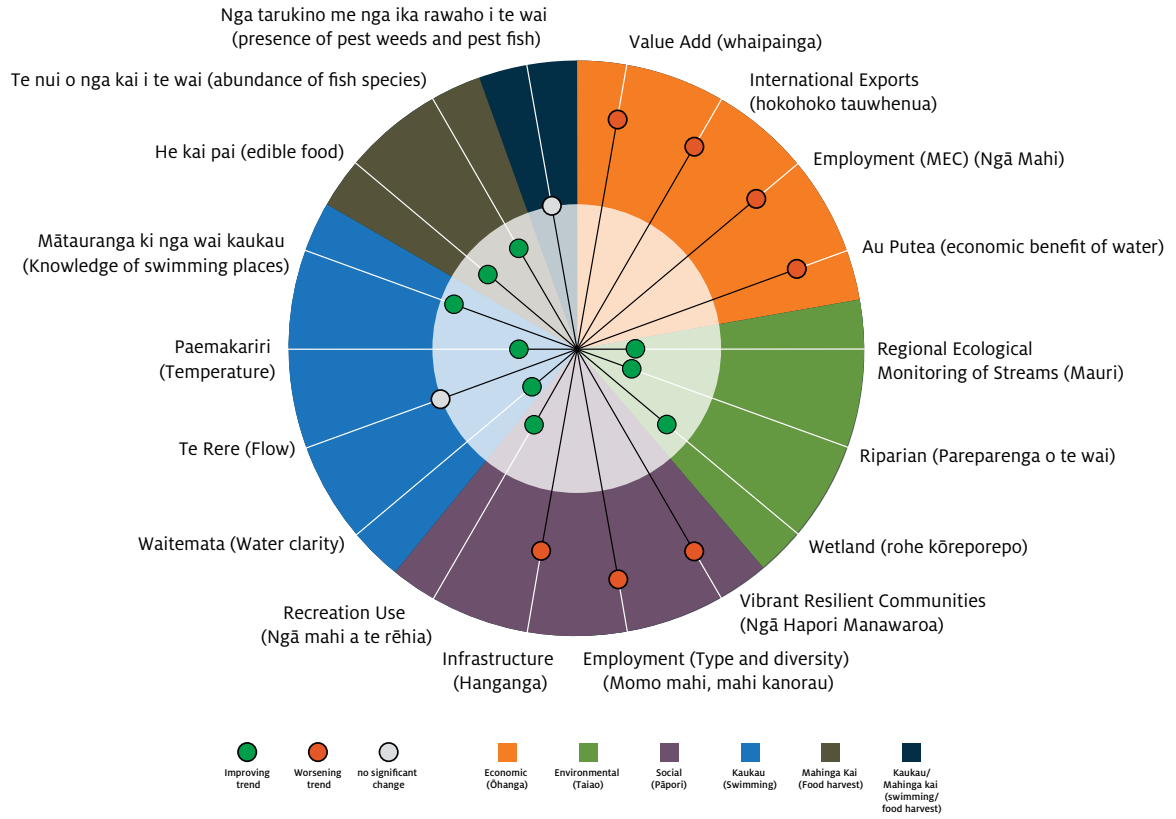
Total loss of \$167m of international exports, \$161m of which is from dairy product manufacturing, and \$14m from meat and meat product manufacturing.

Employment (MEC) (Ngā mahi)

Total employment count decrease of 0.9%, a large number of which is from dairy farming, and significant amount from 'other services'. Effects felt throughout all the FMUs.



Scenario 3



Scenario 4: No further degradation

Part 1: Overview of Scenario 4

No further degradation despite projected nitrogen loads from historical land use that is still stored in groundwater and has yet to reach the river.

Description

No further degradation, in spite of lags.

Means: No drop in current water quality, despite projected nitrogen load currently in groundwater.

Attribute targets/limits

All sites have current state maintained throughout with no further degradation.

Part 2: Integrated assessment

Mātauranga Māori

Waitemata (Water clarity)

Clarity in this scenario would not improve, and this doesn't meet the expectations for swimming for iwi where clarity is below C band.

Te Rere (Flow)

Flow in this scenario is expected to remain similar. It is expected afforestation would decrease the variability of flow, particularly during small to medium sized storm events. This scenario suggests 12,000ha of conversion to forestry in the catchment. The introduction of wetlands will not be significant.

Paemakariri (Temperature)

Shading of water bodies, particularly tributary streams will see a small decrease in temperature.

He kai pai (Edible food)

No change from current state.

Te nui o ngā kai i te wai (Abundance of fish species – koura)

No change from current state

Ngā tarukino me ngā ika rawaho i te wai (Presence of pest weeds and fish)

No reductions in their number.

Mātauranga ki ngā wai kaukau (Knowledge of swimming places)

No change from current state.

Au pūtea (Economic benefit of water)

A modest effect on land-use with decreases in horticulture, fruit growing and dairy. There will be gains in employment in the sheep/beef sector.

Environmental

Regional ecological monitoring of streams (Mauri)

No change from current state.

Riparian (Pareparenga o te wai)

Minor fencing required so no change expected. Little change to current condition of riparian margins expected.

Wetland (Rohe kōreporepo)

A small area would be serviced by newly constructed wetlands.

Social

Vibrant resilient communities (Ngā hapori manawaroa)

Job loss continues negative impact. More keenly felt in upper Waikato FMU.

Employment, type and diversity (Momo mahi, mahi kanorau)

The employment situation is much as it currently is. The greatest impact will be felt by communities in the Upper Waikato FMU, as this is the area with the highest leaching rates, and accordingly the area most targeted for land use change. There will be some lesser impact on lower Waikato communities, with minimal effects in the central area.

Infrastructure (Hanganga)

The impact of this scenario on the reliability and affordability of water and river-related infrastructure would be minimal.

Recreation use (Ngā mahi a te rēhia)

Not much change is anticipated in this scenario, as the water quality stays essentially the same.

Economic

Value add (Whaipainga)

For the Waikato Region a decrease of \$97m (0.5%) in Value Add is expected. Most of this decrease is from the dairy farming and dairy product manufacturing sectors. While there are some effects felt in the Middle Waikato FMU with a reduction in the value of dairy product manufacturing, most of the effects are felt in the Upper Waikato FMU. To maintain the current levels of water quality, which this scenario requires, the upper Waikato has to do the most to account for nitrogen lag. This is likely to affect smaller towns particularly in the southern Waikato.

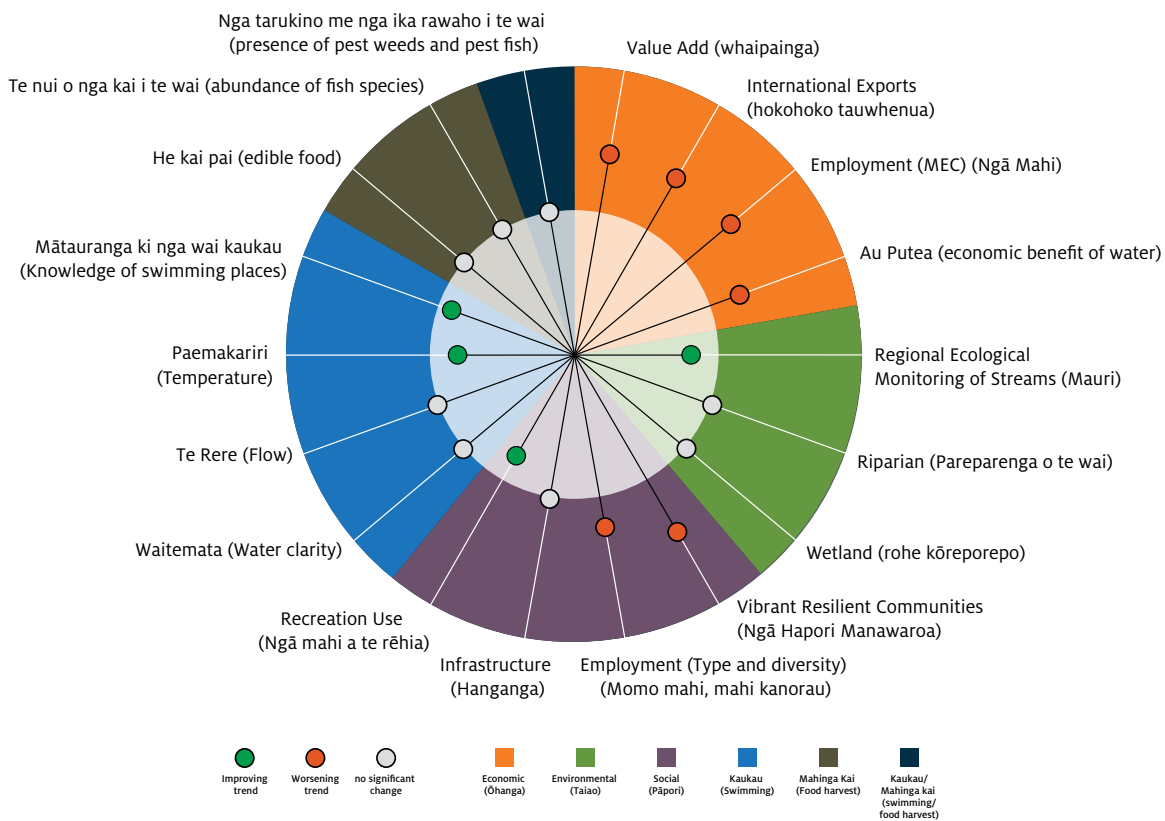
International exports (Hokohoko tauwhenua)

Total loss of \$116m of international exports, including a loss of \$117m in the dairy product manufacturing, and small losses and gains in other primary and related industries. This is most strongly felt in the Middle Waikato FMU.

Employment (MEC) (Ngā mahi)

Total employment count decrease of 0.5%, a large number of which is from dairy farming. Biggest impacts being felt in the Upper Waikato FMU. Region-wide this could be a similar impact to a sustained (3 years or more) low dairy payout. Most of the job losses will be to unskilled workers, who are less employable elsewhere.

Scenario 4



'Stepping stones' to achieving water quality for swimming, taking food and healthy biodiversity

Part 1: Overview

Different levels (e.g. 10%, 25%, 50% of total change required) on pathway to achieving Scenario 1 (to get an idea of what change over time would look like).

Description

Each step represents the percentage change towards meeting the water quality attribute limit or target set by the scenario. Substantial improvement in water quality for swimming, taking food, and supporting healthy biodiversity. This means swimmable in all seasons for microbes and clarity. Water quality supports ecological health. Some improvement in all attributes.

Attribute targets/limits

FMU	Upper Waikato:	Middle Waikato:	Lower Waikato	Waipa:
E. coli	Main stem remains A. Tributaries min B at 95% percentile (95%ile)	Main stem A at Narrows at 95%ile; Horotiu and tributaries B	Main stem and tributaries B at 95%ile	
Clarity	Main stem A to Waipapa tributaries go up 1 band	Main stem B tributaries go up 1 band	C in main stem and tributaries	Upper stem B, lower stem C tributaries go up 1 band
Algae (Chlorophyll a)	A sites improve. B sites to A, C sites to B.	B for med. A for max.	B for median and max; Huntly moves to B for med. and A for max.	
Nutrients				
Total phosphorus:	Maintain where already A, raise to B for rest of river.			
Total nitrogen:	Improve where already A, all sites to Waipapa to A, rest of river to B.			
Ammonia and nitrate:	Improve where already A, other sites go up 1 band.			

Part 2: Integrated assessment

Mātauranga Māori

Waitemata (Water clarity)	
10%	Water clarity begins to improve across all FMUs.
25%	Water clarity improves across all FMUs with the exception of parts of the Upper, Middle and Lower Waikato FMUs.
50%	
100%	Clarity in this scenario will improve as mitigations are employed over time. It is expected that water clarity would achieve the B band in most places. The number of breaches ³ of the limit generally increases as and where mitigation options are limited.

Te rere (Flow)	
10%	Having sufficient water to swim in and reducing high and low flows for all steps is expected to remain static. It is expected afforestation and edge of field mitigations will decrease the variability of flow, particularly during small to medium sized storm events. The introduction of wetlands for this step to service approximately 360,000ha would cause less variability and an increase in base flow.
25%	
50%	
100%	

³ Refer to glossary definition of "Breach"

Paemakariri (Temperature)

10%	Shading of water bodies, particularly tributary streams will see a small decrease in temperature. For each of the steps (10%, 25%, 50% and 100%) a gradual but minimal improvement is proposed. This step includes land use change (conversion to forestry, and riparian management) that will result in a reduction in water temperature at those places. Temperature is also a stressor of native fauna, therefore lower temperatures are an improvement in ecosystem health. Generally, the expectation is afforestation and shading vegetation will reduce temperature in tributaries especially streams where water is shallower and narrow and that and this will have flow some on effect on the main stem.
25%	
50%	
100%	

Mātauranga ki ngā wai kaukau (Knowledge of swimming places)

10%	The assessment of changes in knowledge requires detail of personal, whānau, hapū, Iwi and collective knowledge, therefore assessment within the timeframe and scope of this project is unlikely to be achieved. This indicator is likely to be significantly improved by factors outside the scope of this project, these being availability and access to knowledgeable people, dedicated learning programmes and restoration projects and ongoing research and data collection.
25%	
50%	
100%	

He kai pai (Edible food)

10%	There is likely to be an improvement or decrease in E.coli through de-intensification, afforestation, and mitigations. Kai collected in contemporary times from the catchments is cooked, reducing risk of human health risk from <i>E.coli</i> and other pathogens. Therefore the improvements in E.coli will likely improve perceptions of risk to human health. As the steps become more stringent it is proposed there is a gradual improvement in this indicator. This indicator does not include or consider effects of heavy metals such as arsenic, mercury, zinc and copper that may come from both natural (geothermal) and industrial/urban waste sources. Heavy metals, particularly concentrated in sediment (Ohakuri) and reduced nutrients may reduce the release of heavy metals in anoxic stratified water.
25%	
50%	
100%	

Te nui o ngā kai i te wai (Abundance of fish species – koura)

10%	It is expected that numbers and distribution of koura may increase slightly as a result of riparian management and afforestation. This scenario increases food complexity and habitat variation that enhances resilience and places for koura to hide from predators.
25%	
50%	
100%	

Ngā tarukino me ngā ika rawaho i te wai (Presence of pest weeds and fish)

10%	There is no expected change in pest weed and pest fish populations as a result of afforestation and shading from revegetation on riparian margins. These measures would take some time to provide shading and effect on pest weeds.
25%	
50%	
100%	There is expected to be some reduction of pest weeds and watercress in tributaries that are affected by shading from afforestation and riparian management (that includes planting) and further decreases as a result of nutrient reductions.

Au pūtea (Economic benefit of water)

10%	There would be land-use change (afforestation) and decreases in land-use intensity. These result in significant impacts on value and employment. As the scenarios become more stringent the trends for this indicator gradually decline.
25%	
50%	Whilst there is expected to be some increases in forestry (which has low labour force requirements) and value added industries such as pulp and paper, these would occur after some time (maturity of forestry for harvest).
100%	There will be significant reductions in other primary sectors; horticulture and fruit growing, sheep and beef, dairy and this in turn will affect benefits to beneficial owners. See the Employment and Value Add indicators for further detail.

Environmental

Regional ecological monitoring of streams (Mauri)

10%	A modest increase in MCI, little in the Upper Waikato FMU, less in the Middle and Lower Waikato FMU and more in the Waipa FMU. Further stock exclusion will reduce grazing on macrophytes, and depending on the state of the riparian environment there may be an increase in shade which will reduce macrophyte growth. Overall not much net change in macrophytes (clogginess). The effect is only in small tributaries.
25%	More setbacks for drystock will result in slightly greater MCI, little in the Upper Waikato FMU, less in the Middle and Lower Waikato FMU and more in the Waipa FMU. There are edge of field mitigations in the forms of wetlands that will support greater macroinvertebrate communities.
50%	Further increases in setbacks for drystock at this stage will result in slightly greater MCI, little in the Upper Waikato FMU, less in the Middle and Lower Waikato FMU and more in the Waipa FMU. There are more edge of field mitigations (wetlands), that will support greater macroinvertebrate communities. Bunds and wetlands help at peak flow by reducing overall flow, which benefits MCI.
100%	An increased MCI and decreased 'clogginess' caused by macrophytes. There would be an increase in stream habitat but will ultimately be no net change for fish and tuna populations. Depending on the timeframes to achieve the step, not much change in tuna population will occur short term, as habitat will only increase slowly as vegetation grows. This step may affect sediment as banks change from grass to vegetation.

Riparian (Pareparenga o te wai)

10%	Dairy accord streams are almost complete, so the scope for improvement is in the non-accord and drystock streams. All of the change in riparian is for dairy farms at this step. Same for buffers.
25%	Half of the drystock fencing required for the scenario is completed.
50%	Two thirds of drystock fencing required for the scenario is completed.
100%	Effective riparian management is an important consideration for all land based sectors and is required to achieve the attribute targets. As a Mātauranga Māori indicator, the riparian margin also plays an important role in the acceptability of a place to swim. A number of mitigations such as buffers and fencing are employed at an early stage thus providing immediate enhancement.

Wetland (Rohe kōreporepo)

10%	Very small increase in wetland area (465 Ha), about 15% of the total area required to achieve this step.
25%	Still a relatively small increase overall (723 Ha).
50%	The area in wetlands represents a 10% increase on existing area. By this step about 80% of the wetlands for this scenario would be constructed.
100%	This represents a 16% increase on current wetland area, and a 1.2% increase of historic total area. Increase in base flow and more even base flow as a result of more wetlands would have significant benefits through increased biodiversity, increased customary resources, increased sense of identity and increased food sources.

Social

Vibrant resilient communities (Ngā hapori manawaroa)

10%	<p>The Upper Waikato FMU has the highest level of impact in terms of jobs losses. That impacts most particularly on Tokoroa and the surrounding areas, which has existing high levels of deprivation and so a change will have a compounding effect for that community.</p> <p>The Waipa FMU overall has negligible loss in jobs. The losses are seen mainly in dairy product manufacturing and agricultural and forestry support, which may have a rural town impact. There is a gain in sheep, beef and grain job numbers. This indicates a low level of shift between jobs in different industries rather than a loss from the Waipa FMU to other areas.</p> <p>The Lower and Middle Waikato FMUs both have a medium level of impact in terms of job losses. This may impact negatively more in the Lower Waikato FMU as it has a lower employee count to start with.</p>
25%	<p>The Upper Waikato FMU has the highest level of impact in terms of jobs losses. That impacts most particularly on Tokoroa and the surrounding areas.</p> <p>The Waipa FMU has the lowest level of impact in terms of job losses. This may mean a lower level of impact on the towns of Te Kūiti, Ōtorohanga, and Waitomo and the surrounding areas, which already have existing high levels of deprivation. The Lower and Middle Waikato FMUs both have a medium level of impact in terms of job losses. This may impact negatively more in the Lower Waikato FMU as it has less employment to start with.</p>
50%	<p>The Upper Waikato FMU has the highest level of impact in terms of jobs losses. That impacts most particularly on Tokoroa and the surrounding areas. The Lower and Middle Waikato FMUs both have a medium level of impact in terms of job losses. The Waipa FMU has the lowest level of impact in terms of job losses.</p>
100%	<p>The Middle Waikato FMU has a much larger employee base than the other FMUs, so a decrease in jobs for the Upper Waikato, Lower Waikato and Waipa FMUs will mean those communities may be more severely impacted than a similar number of jobs lost from the Middle Waikato FMU.</p> <p>From a social perspective time and support reduces the negative social impacts and assists people to make transition. Support could be, for example, research and development grants, land purchases, funding, extension, advice, business development grants, education and training initiatives or infrastructure subsidies. Support measures become critical to assist the change and reduce unintended negative consequences.</p> <p>Communities that are already in decline will be more affected by a decrease in jobs, which influence population decline and can have the flow on effect of a loss of key services such as schools, healthcare, stores and shops. Providing levels of service and infrastructure relies on having a large enough rateable population base. Working age population brings employment and children to an area. Some communities may experience increased vibrancy associated with recreation and related business opportunities, for example Karāpiro or Ngāruawahia.</p>

Employment, type and diversity (Momo mahi, mahi kanorau)

10%	The employment situation remains much as it currently is. Because the required shift in employment is small, there is less incentive to innovate. The greatest impact will be felt by communities in the upper Waikato, as this area has higher nitrogen leaching rates, and accordingly is the area most targeted for mitigations. There will be some lesser impact on lower Waikato communities, with minimal effects in the central areas. Primarily dairy and horticulture job losses. Overall little change in diversity of employment in the catchment.
25%	Continued trend for greater job losses in upper Waikato. Affecting dairy farming, horticulture but also sheep, beef and grain. Overall little change in diversity of employment in the catchment.
50%	
100%	<p>Employment in non-forestry primary industries, particularly dairy farming, would decrease substantially under this step. This would affect the type and number of jobs in these sectors, with many of the job losses affecting low-skilled workers who may struggle to find work elsewhere without retraining. The magnitude of the change for the dairy industry means there would be a flow-on effect for the primary service sectors and other services within the economy. An increase in employment in forestry, and wood and paper manufacturing, would result in an increase in the numbers of people working in these industries.</p> <p>The Middle Waikato FMU would experience different effects to the other FMUs, due to its predominantly urban population and focus on manufacturing and processing jobs.</p> <p>There may be little overall change in the diversity of jobs in the catchment. Existing and ongoing land use changes in the northern part of the catchment, primarily due to urbanisation, are already having an impact on employment patterns, which will probably be hastened by this step.</p>

Infrastructure (Hanganga)

10%	Overall, the impact of this step on the reliability and affordability of water and river-related infrastructure would be minimal.
25%	The impact expected is some reduction in the reliability and affordability of the various water infrastructure for consumers and communities.
50%	
100%	<p>Costs to the urban centres and the rural areas would be more equitable under this step, because mitigations would be required for both point source municipal and commercial, and diffuse source rural contaminants. Urban municipal point sources would have to take into account the constraints of council planning timeframes, such as those set by the 10 year long-term plans.</p> <p>Affordability for communities would decrease, as job losses combine with increased costs. Upgrades required to wastewater treatment and stormwater infrastructure will create particular affordability issues for some communities.</p> <p>Land-use change to reach this step is likely to affect hydroelectricity generation negatively, by reducing flows and affecting reliability. There is a possibility that this step will impact on the industry's international competitiveness. Flood protection on the other hand, will benefit from these same changes to flows.</p>

Recreation use (Ngā mahi a te rēhia)

10%	No change in recreation use. Inability to reach clarity attribute target with current mitigations may have localised negative effect.
25%	
50%	
100%	<p>Access will depend on how riparian areas are managed, when fences and buffers are included as mitigations. It will be important to plan for and factor into any mitigation, such as shifts in land use, the requirement for access and the need to enable it, for example by providing gates, stiles, boat ramps etc.</p> <p>Overall, there may not be much change to access, but there are opportunities to increase the accessibility of the rivers' margins if these margins are used for reserves.</p>

Economic

Value add (Whaipainga)

10%	The overall effect on Value Add in the region is relatively small, but still negative. The largest effect is felt in the losses in the dairy farming and processing sectors. The biggest gain comes from the forestry industry.
25%	
50%	The overall effect is a reduction in Value Add in the region, however it is relatively small. The largest effect is felt in the losses in Horticulture, dairy farming and processing sectors, losses in the value added also occur from sheep and beef. The biggest gain comes from the forestry and associated processing industries.
100%	Value added for the Waikato region decreases by 3.0%, with a significant impact on Horticulture 40.5% Value added for Waikato dairy farming decreases by 15.1% and for sheep and beef by 16.2%. These impacts are felt throughout all the FMUs. The large reduction in Horticulture will have flow on impacts for local domestic supply of leafy greens that will be felt throughout New Zealand.

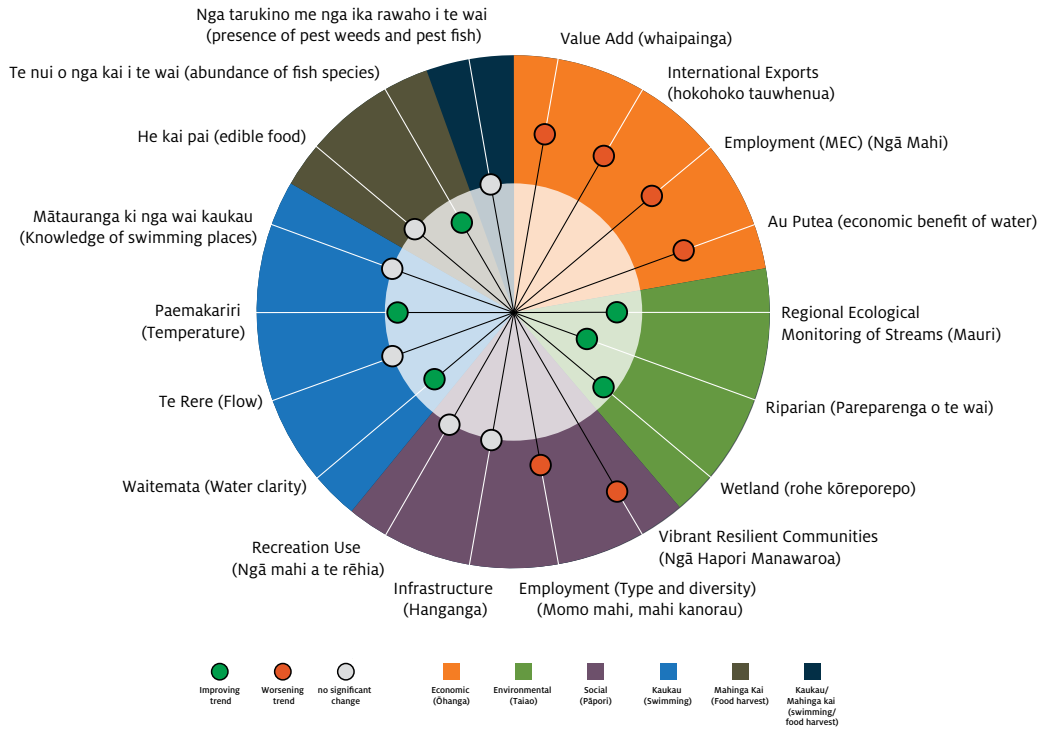
International exports (Hokohoko tauwhenua)

10%	Total loss of \$110m of net international exports, relative to the baseline, in the Waikato region. This total includes a loss of \$139m in dairy product manufacturing and gains of \$14m in meat and meat product manufacturing, and \$15m in wood and paper manufacturing in the Upper Waikato.
25%	Total loss of \$163m of net international exports, relative to the baseline, in the Waikato region. This total includes a loss of \$184m in dairy product manufacturing and gains of \$8m in meat and meat product manufacturing, and \$17m in wood and paper manufacturing in the Upper Waikato.
50%	Total loss of \$192m of net international exports, relative to the baseline, in the Waikato region. This total includes losses of \$205m in dairy product manufacturing, and \$9m in horticulture. Gains are made in wood and paper manufacturing (\$15m) and in meat and meat product manufacturing (\$8m).
100%	Total loss of \$406m of net international exports, relative to the baseline, in the Waikato region. This total includes losses of \$370m in dairy product manufacturing, \$29m in horticulture, and \$20m from meat and meat product manufacturing. Gains are only made in the forestry (\$3m) and wood and paper manufacturing (\$18m) exports. The large impact on dairy product manufacturing is mostly in the Middle Waikato FMU, and some in the Waipa FMU, due to the location of processing plants. The horticulture impact is mostly occurring in the Lower Waikato FMU.

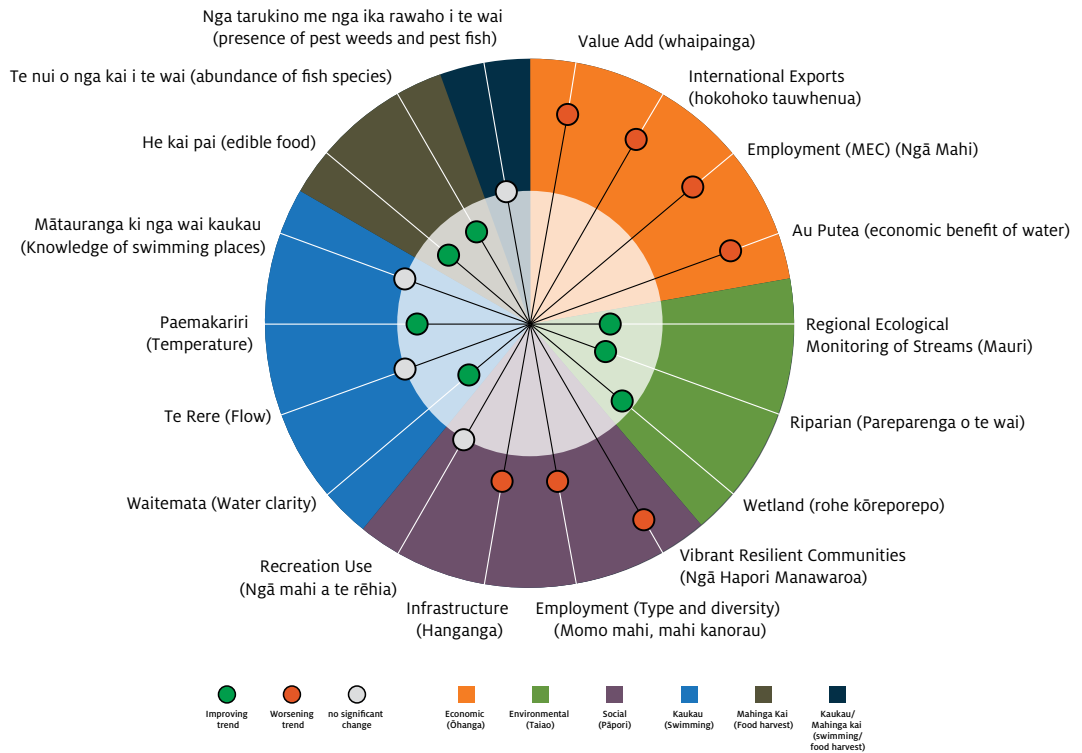
Employment (MEC) (Ngā mahi)

10%	The largest impact from employment loss is in dairy farming, and the majority of this loss occurs in the Upper Waikato FMU. Similarly the largest gain is in forestry in the Upper Waikato FMU.
25%	
50%	The largest impact from employment loss is in dairy farming, and the majority of this loss occurs in the Upper Waikato FMU. Similarly the largest gain is in forestry in the Upper Waikato FMU. Dairy product manufacturing, especially in the Middle Waikato FMU, and horticulture, especially in the Lower Waikato FMU suffer from significant job losses.
100%	Total employment count for the Waikato region decreases by 2.3%. The largest percentage employment decreases are felt in horticulture, dairy farming, and dairy processing. The impacts are felt throughout all the FMUs; unskilled labour will be most affected. The largest employment sectors in the Waikato region are health and education (in 'other services'), wholesale and retail trade, and business and finance services. These largest employment sectors are relatively unaffected compared to primary industries.

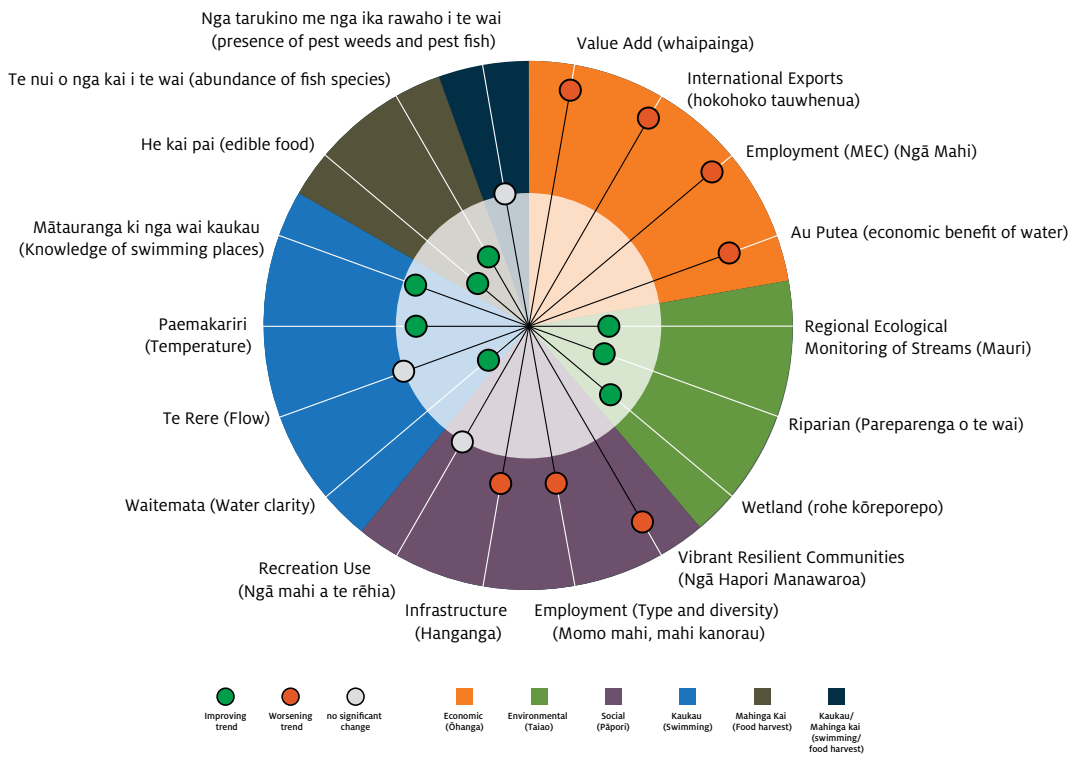
10 per cent



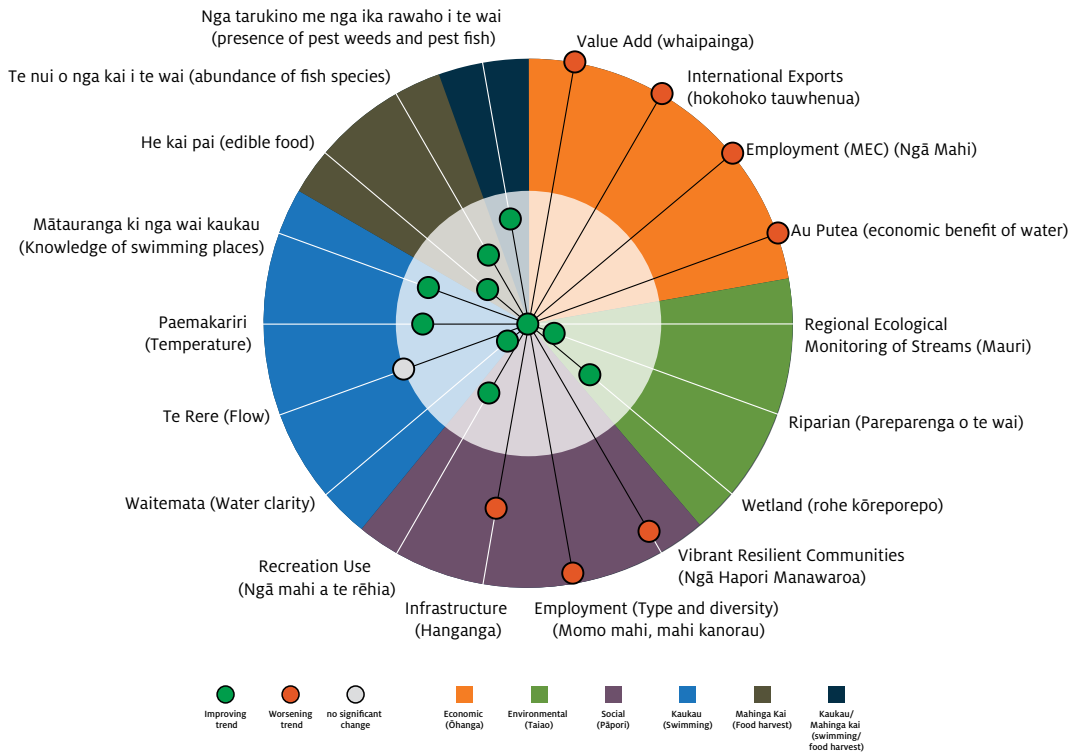
25 per cent



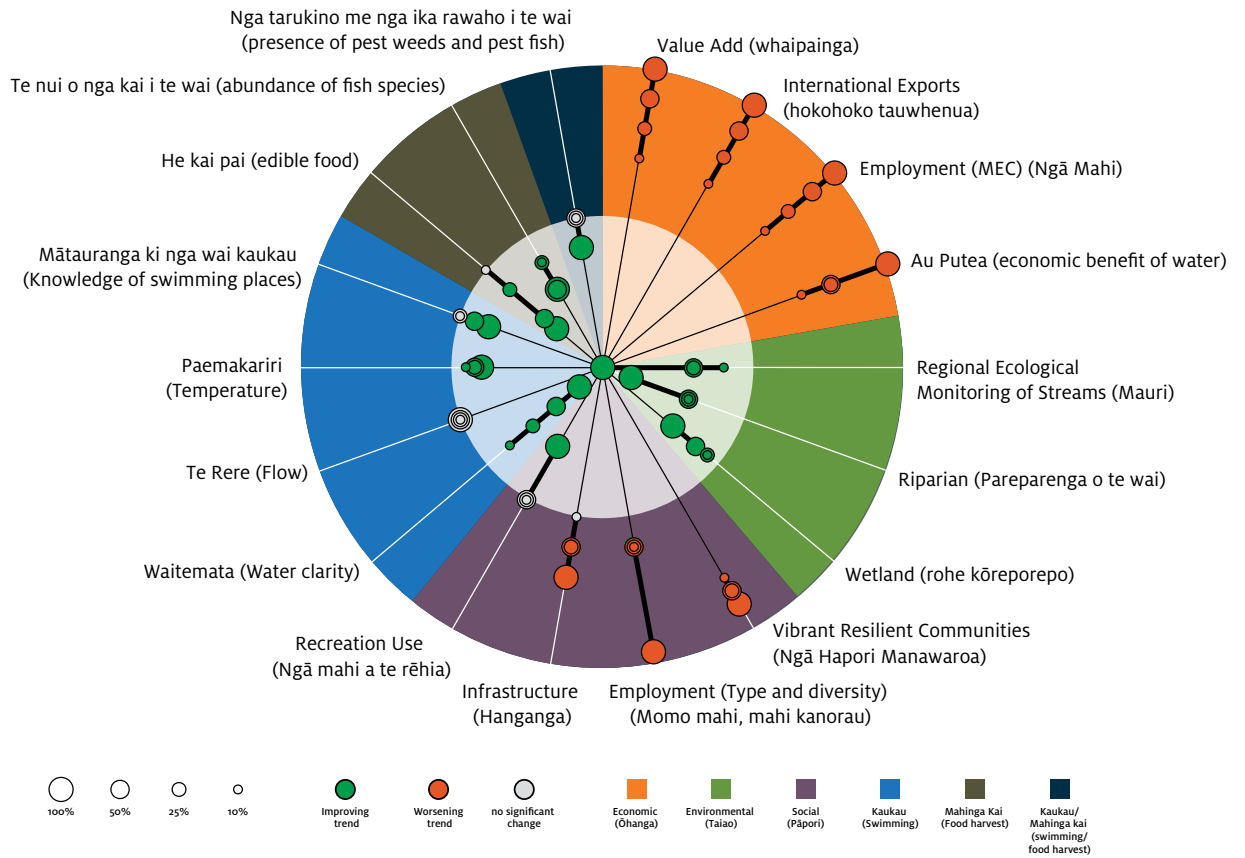
50 per cent



100 per cent



Combined



Glossary

Attribute is a measurable characteristic of fresh water, including physical, chemical and biological properties, which support particular values.

Breach means the attribute limit or target is unable to be met using the mitigation or land-use change parameters define by the model, for a particular sub-catchment, for the scenario being modelled.

Collaborative Stakeholder Group (CSG) comprises 24 members and represents stakeholders and the wider community in Healthy Rivers: Plan for Change/Wai Ora: He Rautaki Whakapaipai.

Freshwater Management Unit (FMU) is the water body, multiple water bodies or any part of a water body determined by the regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management purposes.

Upper Waikato - Waikato River from Huka Falls to Lake Karapiro

Middle Waikato - Waikato River from Lake Karapiro to Ngaruawahia

Lower Waikato - Waikato River from Ngaruawahia to Port Waikato

Waipa - The entire Waipa River catchment to Ngaruawahia

Nb: there are also four lake FMUs that were not assessed as part of the integrated assessment; Riverine lakes, Peat lakes, Dune lakes and Volcanic lakes.

Inanga means Common galaxias (*Galaxias maculatus*).

Indicator is an area of interest related to but not always directly affected by the four contaminants but whose state may be affected by the outcome of the project. Each one is based on quantitative and/or qualitative information.

Kaitiakitanga means guardianship, stewardship or trusteeship.

Kakahi/kaeo means New Zealand freshwater mussel (*Echyridella menziesi*).

Koura/kewai means Freshwater Crayfish (*Paranephrops planifrons*).

Macroinvertebrate means those animals that have no backbone and can be seen with the naked eye and includes insects, crustaceans, molluscs, arachnids and annelids. They inhabit all types of running waters, from fast flowing mountain streams to slow moving muddy rivers.

Macroinvertebrate Community Index (MCI) is an index where macroinvertebrates are used for monitoring and reporting on stream health in New Zealand.

Macrophyte means an aquatic plant that grows in or near water and is either emergent, submergent, or floating.

Mahinga kai/Hauanga kai means garden, cultivation or food-gathering place.

Manaakitanga means the process of showing respect, generosity and care for others.

Piharau means New Zealand Lamprey (*Geotria australis*).

Riparian is the zone or area of interface between land and a river or stream.

Scenario means a set of water quality targets and limits based on the attribute tables in the National Objectives Framework (contained in the National Policy Statement on Freshwater Management), and attributes chosen as part of the Waikato Objectives Framework.

Tuna means New Zealand longfin eel (*Anguilla dieffenbachii*), Shortfin eel (*Anguilla australis*) and the sporadically naturally introduced Australian Longfin eel (*Anguilla reinhardtii*).

Wetland includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions.

Appendix 1: Attribute tables

E. coli (95th Percentile)

Attribute	E. Coli*		
Attribute Unit	E. Coli/100mL (number of E. Coli per hundred millilitres)		
Attribute State	Numeric Attribute State	Sampling Statistic	Narrative Attribute State
A	≤ 260	95th percentile	People are exposed to a low risk of infection (up to 1% risk) when undertaking activities likely to involve full immersion.
B	> 260 and ≤ 540	95th percentile	People are exposed to a moderate risk of infection (less than 5% risk) when undertaking full immersion.
Minimum Acceptable State	540		
C	> 540 and ≤ 1000	Annual median	People are exposed to a high risk of infection (greater than 5%) from contact with water during activities likely to involve immersion.
D	> 1000	Annual median	

*Escherichia Coli

Clarity

Attribute	Water Clarity	
Attribute Unit	M (Measured using Secchi Disc in lakes and horizontal black disc in rivers)	
Attribute State	Numeric Attribute State	Narrative Attribute State
A	≥ 3	Water clarity is deemed excellent for swimming
B	≥ 1.6 and < 3	Water clarity is deemed suitable for swimming
C	≥ 1.1 and < 1.6	Water clarity is deemed marginally suitable for swimming
Minimum Acceptable State	1.1	
D	< 1.1	Water clarity is deemed unsuitable for swimming

Chlorophyll a

Attribute	Phytoplankton		
Attribute Unit	mg/m ³ (milligrams chlorophyll-a per cubic metre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median	Annual Maximum	
A	≤2	≤10	Lake ecological communities are healthy and resilient, similar to natural reference conditions
B	>2 and ≤5	>10 and ≤25	Lake ecological communities are slightly impacted by additional algal and plant growth arising from nutrients levels that are elevated above natural reference conditions.
C	>5 and ≤12	>25 and ≤60	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrients levels that are elevated well above natural reference conditions.
National Bottom Line	12	60	
D	>12	>60	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state, due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom of deep water lakes.

Total Nitrogen

Attribute	Total Nitrogen (Trophic state)		
Attribute Unit	mg/m ³ (milligrams per cubic metre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median	Annual Maximum	
	Seasonally stratified and Brackish*	Polymictic	
A	≤160	≤300	Lake ecological communities are healthy and resilient, similar to natural reference conditions
B	> 160 and ≤350	> 300 and ≤500	Lake ecological communities are slightly impacted by additional algal and plant growth arising from nutrients levels that are elevated above natural reference conditions.
C	> 350 and ≤750	> 500 and ≤800	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrients levels that are elevated well above natural reference conditions
National Bottom Line	750	800	
D	> 750	> 800	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state, due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom of deep water lakes.

* intermittently closing and opening lagoons (ICOLs) are not included in brackish lakes.

Total Phosphorus

Attribute	Total Phosphorus (Trophic state)	
Attribute Unit	mg/m ³ (milligrams per cubic metre)	
Attribute State	Numeric Attribute State	Narrative Attribute State
	Annual Median	
A	≤10	Lake ecological communities are healthy and resilient, similar to natural reference conditions
B	>10 and ≤20	Lake ecological communities are slightly impacted by additional algal and plant growth arising from nutrient levels that are elevated above natural reference conditions.
C	>20 and ≤50	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrients levels that are elevated well above natural reference conditions
National Bottom Line	50	
D	>50	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state, due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.




Nitrate

Attribute	Nitrate (Toxicity)		
Attribute Unit	mg NO ₃ -N/L (milligrams nitrate-nitrogen per litre)		
Attribute State	Numeric Attribute State	Narrative Attribute State	
	Annual Median	Annual 95th percentile	
A	≤1.0	≤1.5	High conservation value system. Unlikely to be effects even on sensitive species.
B	>1.0 and ≤2.4	>1.5 and ≤3.5	Some growth effect on up to 5% of species
C	>2.4 and ≤6.9	>3.5 and ≤9.8	Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.
National Bottom Line	6.9	9.8	
D	>6.9	>9.8	Impacts on growth of multiple species, and starts approaching acute impact level (i.e. risk of death) for sensitive species at higher concentrations (>20mg/L)

Ammonia

Attribute	Nitrate (Toxicity)		
Attribute Unit	mg NO ₃ -N/L (milligrams nitrate-nitrogen per litre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	Annual Median*	Annual Maximum*	
A	≤0.03	≤0.05	99% species level protection: No observed effect on any species tested
B	>0.03 and ≤0.24	>0.05 and ≤0.40	95% species protection level: Starts impacting occasionally on the 5% most sensitive species
C	>0.24 and ≤1.30	>0.40 and ≤2.20	80% species protection level: starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species)
National Bottom Line	1.30	2.20	
D	>1.30	>2.20	Starts approaching acute impact level (i.e. risk of death) for sensitive species

* based on pH 8 and temperature of 20°C.

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Healthy Rivers
PLAN FOR CHANGE

Maniapoto Māori Trust Board
Raukawa Charitable Trust
Te Arawa River Iwi Trust

Wai Ora

HE RAUTAKI WHAKAPAIPAI

Tūwharetoa Māori Trust Board
Waikato Raupatu River Trust
Waikato Regional Council