5 Surface Water Quality

5.1 Surface Water Quality: Main Points

Pressures

- There are more than 1000 consented discharges to surface water or land subject to resource consents in Northland that have the potential to result in the contamination of surface water.
- Farm dairy effluent treatment systems are by far the most numerous point source discharges to surface waters and land in Northland. Presently, 51% of systems discharge to land.
- Over the last few decades, through industry amalgamations and improvements in wastewater treatment, pressure on Northland's waterways from industrial discharges have decreased significantly.
- During the last decade municipal sewage treatment systems have been progressively upgraded in an effort to reduce the environmental effects of these discharges.
- Approximately 45% of Northland's population rely on septic tanks with ground soakage fields to dispose of wastewater. Potential problems exist where tanks are poorly maintained or where the density of septic tanks is high.
- Agricultural land use is the most significant source of non-point source pollution in Northland. However, it is not known to what extent agricultural runoff contributes to the total pollution loading of the region's rivers and streams.
- The Northland Regional Council receives notification of approximately 180 incidents affecting inland waterways each year.
- Currently, the Council has little information on the extent of riparian margins in the Northland region. Currently, 53% of the Northland region is used for pastoral agriculture; most stream banks in agricultural areas have been cleared of their vegetation to create pasture.

State

- Water quality in the Northland region varies greatly from pristine in upper native forest catchments through to highly impacted in modified lowland catchments. Aquatic ecosystem guidelines are regularly not met in developed areas, including the Wairua, Whakapara, Mangakahia, Awanui and Waitangi Rivers.
- Lowland rivers and streams are often unsuitable for swimming. Higher levels of disease-causing organisms are found in catchments with high-intensity land use.
- Specific studies have shown that waterways in both the Ruawai and Te Kopuru areas are degraded as a result of intensive agricultural activity. In the Ruawai area, waterways are severely degraded.
- River water is safe most of the time for stock to drink. However, bacteria levels increase during and after rainfall due to runoff events. Notably, some sites do exceed the guideline and could be considered a risk to stock.
- Ecosystem health in native forested catchments is excellent. However at all other sites habitat quality is moderately poor to poor. Lowland streams, especially in agricultural and urban areas, have poor ecosystem health.
- Of the 35 or so native species of freshwater fish found in New Zealand, 20 are known to inhabit the Northland region. Exotic fish are widespread, with 10 known species found in Northland.

Responses

- The Revised Proposed Regional Water and Soil Plan for Northland includes specific water quality guidelines for the protection of different water uses.
- Resource consents are required for point source discharges to water and land, also where there is significant potential for adverse effects.
- Consent compliance monitoring programmes assess the effect of the discharges on the environment.
- State of the Environment monitoring programmes have been implemented to assess the state of river water quality and ecology and how that changes with time.
- Northland Regional Council supports several streamcare groups that are involved in riparian planting, weeding and removing rubbish from waterways.

5.2 Introduction to Surface Water Quality in Northland

The management of water quality in surface waters and lakes is a major issue in Northland. Water quality in the Northland region varies greatly from pristine in upper native forest catchments through to highly impacted in modified lowland catchments. Water quality information is important for anyone intending to drink, swim, or provide water for livestock. It is also important for ensuring the survival of fish and other aquatic life.

5.3 Regional Policy Statement Objectives

The Regional Policy Statement contains a range of objectives relating to the quality of Northland's surface fresh water resources. These objectives seek to maintain, and where possible improve, surface water quality in the Northland region.

The Regional Policy Statement objectives state:

- **The maintenance and enhancement of the water quality of natural water bodies and coastal waters in Northland to be suitable, in the long term, for the purposes listed below:**
  - **Lakes, rivers and streams – aquatic ecosystems, contact recreation, water supplies, aesthetic and cultural purposes.**

- **The reduction in the quantity of contaminants that impact on water quality entering lakes, rivers and streams.**

5.4 Surface Water Quality Issues

The following is a summary of the significant water quality issues of the region:

- The adverse effects of pollution on the uses and values of water bodies, and coastal waters including their life-supporting capacity for indigenous flora and fauna, water supplies, food gathering and marine farming, spiritual, recreational and aesthetic values.

- The degradation of the mauri (life force) and wairua (spirit) of water bodies and adverse effects on kaimoana, due to pollution.

- Pollution of water bodies from point-source discharges of contaminants, particularly from sewage treatment and disposal, cowsheds, and agricultural product processing.

- Pollution of rural water bodies (including the coastal waters those water bodies flow into) from contaminants in non-point source discharges and stormwater runoff, including sediment from earthworks and vegetation clearance, wetland drainage, stock effluent, residue from agrichemicals, leachate from contaminated sites and dumped rubbish and dead stock.)

- Pollution of urban water bodies with contaminants from stormwater runoff from roads and car parks, industrial and trade premises, disposal of industrial and household waste into stormwater systems, sediment from earthworks, sewage overflows and leachate from contaminated sites.

- The sensitivity of closed water bodies and coastal waters to the adverse effects of water pollution.
- The effects on water quality of existing land use, major land use changes, large scale water abstraction, clearance of riparian margins and drainage.

5.5 Pressures Affecting Surface Water Quality

The **key pressures** affecting water quality in Northland are point source discharges, non-point (diffuse) source discharges and agricultural land use. Point sources are direct discharges of water from a fixed source (such as from a waste water treatment system). Non-point source discharges are those that do not come from a single source (such as agricultural runoff from farmland).

5.5.1 Point-Source Discharges

As of May 2001 there were more than 1000 point source discharges authorised by resource consents in Northland with the potential to result in the contamination of surface water. These include discharges directly to water and also those to land (where there is potential for runoff to contaminate surface water). Table 5 shows the approximate number and type of consented discharges to land and surface water in Northland.

Table 5: Consented discharges to land and surface water in Northland

Use	Discharges to surface water	Discharges to land
Agricultural (dairy + piggery)	195	5
Earthworks (sediment)	43	39
Food Industry	24	11
Flood Control	2	0
Horticultural	11	0
Non-food industry	67	42
Quarries	47	35
Power generation	5	3
Sewage	33	339
Stormwater	92	2
Landfill leachate	7	4
Other discharges	26	4
Total	**552**	**484**

Some of the major point source discharges are discussed in more detail below.

Farm Dairy Effluent Discharges

At the end of May 2001 there were 1409 farm dairy effluent treatment systems in the region. These are by far the most numerous point source discharges to surface waters and land in Northland.

Dairying contributes significantly to the Northland economy, but the challenge is to minimise its environmental effects. Dairyshed treatment pond effluent has the potential to have significant impacts on receiving waters, particularly in areas of numerous discharges or low river flows. Potential adverse effects include:

- Increased nutrient loadings promoting nuisance biological growths.
- High ammonia levels that are toxic to fish.
- Microbial contamination of waterways rendering them unsuitable for drinking and contact recreation use.

- Suspended solids resulting in the reduction of water clarity and smothering of aquatic life.

As shown in Map 4, the majority of farm dairy effluent discharges are concentrated in the Whangarei and Kaipara Districts. Areas particularly under pressure include the Ruawai flats and flood plains of the Northern Wairoa River catchment, including the Hikurangi swamp and Kaihu, Mangakahia and Wairua/Mangere river tributaries. The floodplains and coastal flats associated with the lower Awanui River and the Waipu/Pohuenui river system are subject to intensive dairy farming, as is the Kaikohe/Ohaeawai area and Bay of Islands catchment.

Historically, many discharges of farm dairy effluent in Northland were untreated and discharged directly to waterways. During the 1980s, one of the Northland Regional Council's predecessors conducted a campaign to have all farm dairy effluent treated before discharge. This was largely a successful campaign with the vast majority of farms installing treatment systems (mostly ponds or barrier ditches).

Oxidation Ponds

Surveys conducted by the Northland Regional Council during the early 1990s concluded that a prevalent lack of maintenance of treatment systems was leading to poor quality discharges and many pond systems were considered outdated and inadequate for current herd sizes (Northland Regional Council, 1992).

While pond systems considerably reduce the levels of contaminants discharged to water compared with untreated effluent, significant contaminants are still present. Even well maintained pond or long ditch treatment systems can have major adverse impacts on the water quality of streams, particularly where there is a cumulative effect of several discharges. Recently, a study by Northland Regional Council in cooperation with Ngatiwai Resource Management Unit has shown poor ecosystem health in sites downstream of farm dairy effluent discharges in the Wairua catchment (Senner, 2000).

Sludge application to land

Treatment systems that irrigate effluent to pasture can return the nutrients to the soil rather than waterways. In areas where this method of treatment is practicable, it is the preferred treatment system by the Northland Regional Council as it

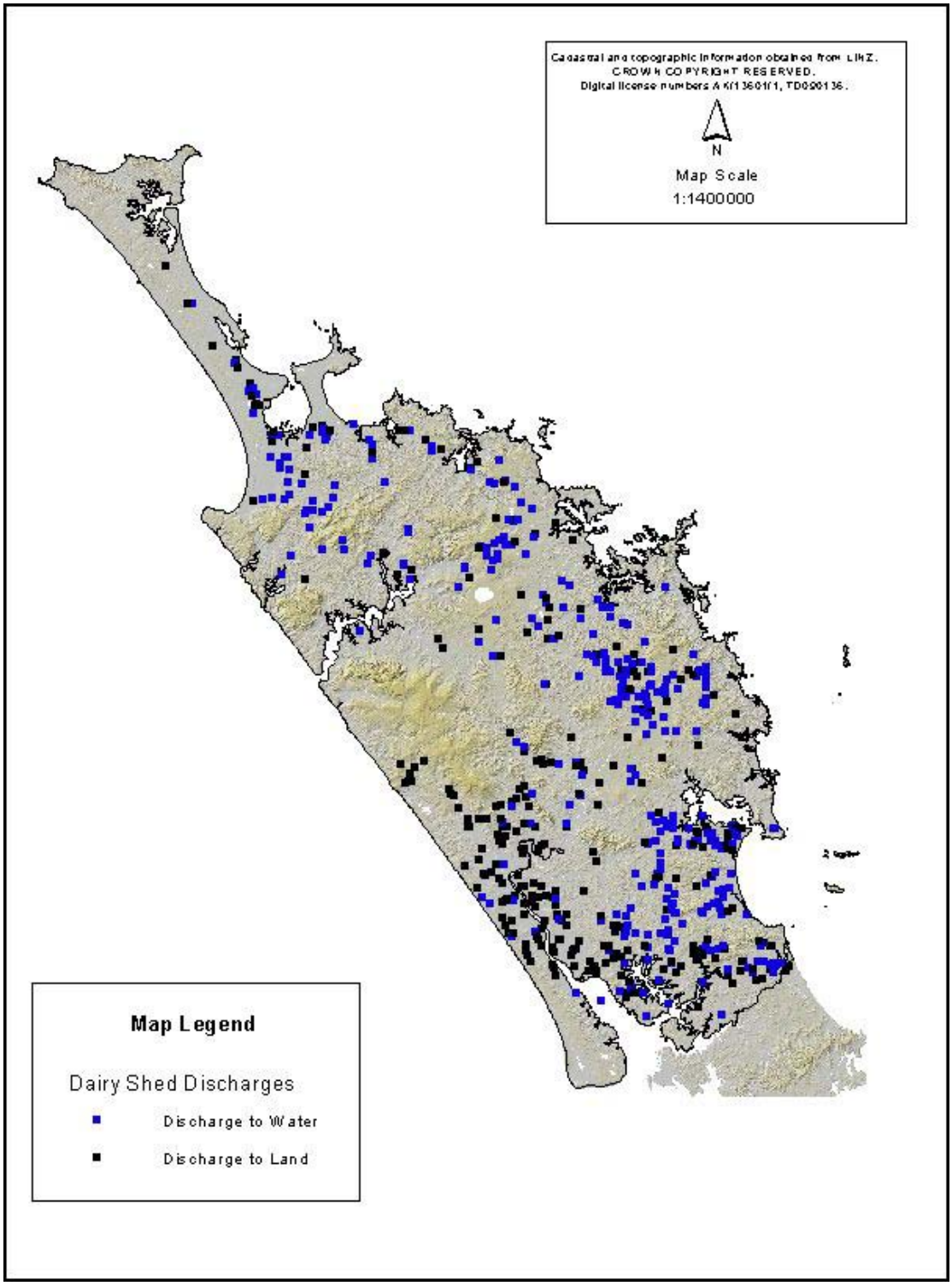
is less likely to affect water quality than discharging treated wastes to surface water.

Prior to 1995, resource consents were only automatically required for farm dairy effluent discharges located in the Bay of Islands. However, in 1995 the Council released section I of its Proposed Regional Water and Soil Plan for Northland. This includes regional rules that cover agricultural discharges, including those from animal effluent treatment and disposal systems. The intent of these rules is to promote the discharge of animal effluent to land, where practicable, rather than to water and thereby reduce the impact of animal effluent discharges on surface water quality.

The Council has been progressively requiring farmers to obtain resource consents for animal effluent treatment and disposal systems that discharge to water. Under these rules, discharges from animal effluent treatment and disposal systems to land are permitted subject to compliance with various conditions. Discharges to water either directly or indirectly are either controlled or discretionary and therefore require resource consents.

These rules and associated objectives and policies have resulted in an increasing number of discharges to land rather than surface water. Nevertheless, high proportions of animal effluent treatment and disposal systems still discharge to surface water.

In the 2000/01 year, there were a total of 712 dairy farms with land-based discharges while a further 697 discharge to water (51% discharge to land).



Map 4: Farm Dairy Effluent Discharges in Northland[1]

Industrial Discharges

Historically, industrial discharges (such as dairy factories and meat-processing industries) have been a major contributor to localised contamination of surface water

[1] Map is indicative of the density of FDE discharges in Northland (not all FDE sites are shown).

quality in Northland. Some still existing industrial works were sited and constructed at a time when little importance was placed on waste treatment.

However, through industry amalgamations there are now few major discharges from industry to water or land in Northland.

As of May 2001 there were 105 consented industrial discharges in Northland. Table 6 summarises them by discharge type.

Table 6: Consented industrial discharges in Northland 2001

Use	Discharges to surface water	Discharges to land
Food industry	20	9
Earthworks	0	2
Non-food industry	14	28
Mineral products	6	1
Power generation	3	3
Stormwater	4	1
Landfill leachate	1	3
Water supply	5	0
Other	3	2
Total	56	49

Sewage Waste Discharges

A significant historical pressure on waterways exerted by the human population has been the disposal of human waste. As of May 2001 there were 372 discharges authorised by resource consent for the treatment of sewage in Northland, 91% of those discharges were to land. In developed urban areas, most sewage waste is treated through wastewater treatment plants. Most treatment systems have oxidation ponds or mechanical treatment plants, and many discharge to wetlands for additional treatment. Treated effluent is then discharged to land or into rivers or estuaries, with the potential for contamination of surface water.

Ahipara oxidation pond

Possible effects on water quality include:

- Increased nutrient levels (leading to proliferation of algal growth)
- High bacteria numbers (increased human health risk)
- High levels of ammonia (toxic to fish)
- Lowered dissolved oxygen
- Discoloration of surface waters

- Degraded macroinvertebrate communities.

Over the last decade, treatment systems have been progressively upgraded in an effort to reduce the environmental effects of these discharges. Table 7 describes the current municipal sewage discharges of the region and their method of treatment.

Table 7: Municipal Sewage Discharges 2001

Community	Treatment Method	Receiving Environment
Ahipara	Oxidation ponds, then to constructed wetland	Final effluent discharged to catchment drain
Kaitaia	Oxidation ponds	Final effluent discharged to Awanui River
Awanui	Activated sludge, then to constructed wetland	Final effluent discharged to Awanui River
Hihi	Activated sludge, then to constructed wetland	Final effluent discharged to catchment stream
Taipa	Oxidation ponds, then to constructed wetland	Final effluent discharged to catchment drain, then to Parapara River
Kaeo	Oxidation ponds, then to constructed wetland	Final effluent discharged to Kaeo River
Kerikeri	Activated sludge, then to natural wetland at Waitangi forest	Natural wetland drains to Kerikeri inlet
Paihia	Oxidation ponds, then to natural wetland	Natural wetland drains to Kerikeri inlet
Hikurangi	Oxidation ponds, then to constructed wetland	Final effluent to Mangahahuru Stream
Ngunguru	Oxidation ponds, then to constructed wetland	Final effluent to unnamed stream
Whangarei	Activated sludge with disinfection, then to constructed wetland	Final effluent to Limeburners creek, Whangarei Harbour
Ruakaka	Oxidation ponds, then to constructed wetlands	Final effluent discharged to land (sandhills)
Waipu	Oxidation ponds, then to constructed wetland	Final effluent discharged to land (sandhills)
Kaiwaka	Oxidation ponds, then to wetland	Final effluent discharged to Kaiwaka River
Maungaturoto	Oxidation ponds	Final effluent discharged to Otamatea estuary, Kaipara Harbour
Te Kopuru	Oxidation ponds, then to constructed wetlands	Final effluent discharged to Wairoa River, Kaipara Harbour
Dargaville	Oxidation ponds, then to constructed wetland	Final effluent discharged to Wairoa River, Kaipara Harbour
Opononi	Oxidation ponds, then to constructed wetland	Hokianga Harbour
Kohukohu	Septic tank overflow collected then piped to an oxidation pond, then to constructed wetland	Hokianga Harbour
Rawene	Oxidation ponds, then to wetland	Hokianga Harbour
Kawakawa	Oxidation ponds, then to wetland	Kawakawa River
Portland	Oxidation ponds, wetland	Tokotoki creek drains to Whangarei Harbour
Whatawhiwhi	Aerated pond, wetland to dispersal drain	Karikari swampland
Russell	Treatment system, UV disinfection to deep bores	Russell Groundwater
Rangiputa	Oxidation ponds to ground via soakage pond	Catchment of Lake Rotokawau
Kaikohe	Oxidation pond, then to constructed and natural wetlands	Final effluent discharged to Wairoro Stream

Septic Tanks

Approximately 45% of Northland's population dispose of their sewage on-site, mainly using septic tanks and soakage trenches or holes. If properly maintained and in areas of low population density the environmental effects are minimal, however, potential problems exist where the density of septic tanks is high, or where effluent soakage is poor or excessive.

Septic tank effluent can potentially contaminate groundwater with excess nutrients, bacteria, and viral pathogens. There are some coastal areas where sandy soils allow effluent to contaminate groundwater. Conversely, areas where clay soils or hard pans prevent adequate soakage, resulting in surface discharges and runoff of effluent.

A recent report summarising extensive monitoring undertaken by the Northland Regional Council has shown that at times bacterial contamination in drains, streams and shellfish in the Mangawhai area can be high, particularly after moderate to heavy rain (Northland Regional Council, 2001). As the area is largely unsewered and residential, the likely cause was concluded to be seepage from septic tanks.

Population centres still dependent on septic tanks for sewage treatment include:

- Mangawhai Heads and Village
- Moerewa
- Oakura
- Opua (partial)
- Paparoa
- Ruawai

5.5.2 Non-Point Source Discharges

Non-point source discharges are diffuse sources of contaminants that originate from large areas of land, and cannot be traced to one single fixed point of origin. Non-point source pollution occurs when rainfall washes animal effluent, sediments, nutrients and other pollutants into streams, rivers and lakes. Pollution of groundwater can also occur when contaminants are leached through the soil into groundwater. Non-point source discharges include

- stormwater runoff
- sediment from earthworks and vegetation clearance
- stock effluent
- residue from fertiliser and agrichemicals
- leachate from contaminated sites

Agricultural Land Use

Approximately 53% of land in Northland is used for pastoral agriculture (Land Cover Database, 1996) and grazed by stock, as a result agriculture is the most significant source of non-point source pollution. Major contaminants of concern include:

- organic matter (sourced from faecal contamination)
- sediment (as a result of deforested slopes converted to pasture and bare land)
- nutrients (sourced from dung and urine, excess fertiliser)
- pathogens (disease-causing organisms sourced from dung and urine)

These are largely washed off the land during rainfall, but direct livestock access to streams can also degrade water quality by both damaging stream banks and directly excreting in waterways.

Dairy cow herd

Beef and dairy cattle farming are a major component of the Northland agricultural base, with around 930,000 head of stock at June 1999 (Statistics New Zealand, 1999). Dung and urine from livestock are a major source of nutrients (nitrogen and phosphorous), pathogens and oxygen-consuming organic matter.

Stock numbers provide an indication of the effluent loading into surface water. As shown in Table 8, total numbers of sheep have decreased from about 1.3 million in 1990 to 600,000 in 1999. At the beginning of the 1990s beef cattle numbers stood at 592,000, rose to a peak of 610,000 in 1991 and have been in a decline to reach a low of 544,000 in 1999.

Deer numbers in Northland have more than doubled between 1996 and 1999, from 11,000 to 28,000.

In 1990 there were 369,000 dairy cattle in Northland. Numbers declined to a low of 356,000 in 1993, peaked at 402,000 in 1996 and in 1999 there were 387,000 dairy cattle. However, in recent years there has been a trend towards fewer herds, but with larger herd sizes and increased localised concentrations in livestock numbers.

Table 8: Northland stock numbers ('000) (1990-1999)

Year	Sheep	Dairy Cattle	Beef Cattle	Deer
1990	1,294	369	592	14
1991	1,118	363	610	17
1992	943	361	587	15
1993	851	356	583	16
1994	814	357	574	18
1995	780	395	588	16
1996	706	402	544	11
1999	584	387	543	28

NB: All numbers have been rounded to the closest thousand. All numbers are in thousands of stock units.

Greater numbers of livestock per hectare can lead to greater dung and urine loading on pasture with an increased possibility for organic matter, nutrients and pathogens to enter surface and groundwater.

Stock drinking from a stream can foul water and damage banks

Most of Northland's lowland rivers typically exhibit elevated levels of both phosphorous and nitrogen. Studies have shown that in some intensively farmed catchments (such as Ruawai and Te Kopuru) nutrient levels in waterways are high and waterways are highly impacted from agricultural landuse (Northland Regional Council, 1997).

5.5.3 Water Pollution Incidents

An environmental incident can be defined as "**pollution or an unauthorised activity (contrary to the RMA) that may have an adverse effect on the environment**". Members of the public, people in industry and Council staff report environmental incidents to the Northland Regional Council.

The Northland Regional Council receives notification of approximately 180 incidents affecting inland waterways each year.

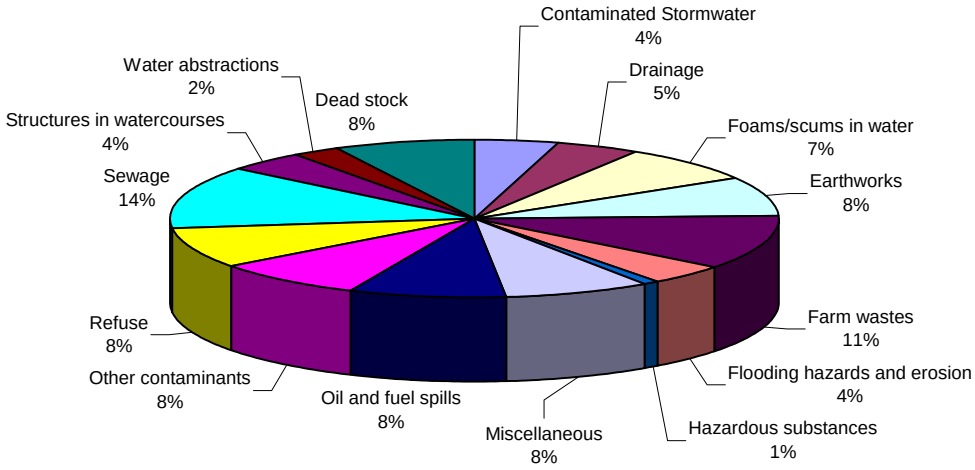


Figure 18: Proportion of environmental incidents reported for inland waterways for the period November 1993 – March 2001.

The various categories of environmental incidents give an indication of the types and proportion of pressures on Northland's surface water quality.

The most common incidents that are reported involve sewage, farm wastes (farm dairy effluent and other farm-related wastes), earthworks (sediment in waterways), refuse, oil and fuel spills and other contaminant discharges.

Environmental incidents give a good indication of those pressures on water quality that are of concern to the public. However, there is likely to be a number of undetectable pressures that are not represented in the environmental incidents that are reported to the Council.

5.5.4 Riparian Vegetation

Changes in land use over the last 150 years has resulted in drastic alterations to the character of Northland's rivers and streams. The removal of riparian vegetation (vegetation growing alongside streams and rivers) in particular has resulted in problems relating to erosion, flooding, increased stream temperature and a reduction in habitat for aquatic life in general.

The importance of riparian vegetation has been widely recognised for its ability to filter diffuse contaminants from runoff, increase bank stability, reduce water temperatures and provide habitat for aquatic life (Boffa Miskell, 1999).

Currently, we have little information on the extent of riparian margins in Northland. In the more natural catchments of the Waipoua, Whirinaki, Waipapa, Mangamuka and Punaruku rivers it can be assumed that significant amounts of near-pristine riparian habitat exists. Currently outside of conservation lands and pristine catchments, macroinvertebrate communities give us the best assessment of aquatic habitat in Northland.

Stream bank erosion and lack of riparian vegetation within the Manganui River catchment

5.6 State of Surface Water Quality

The quality of surface water is described in terms of its current state (based on the most recent four years of data). Standardised monitoring programmes have not been operating for long enough to determine whether the state of water quality is changing through time, it is hoped that Northland Regional Council will be able to report on this in the near future.

Unless specified, water quality sites referred to in this report are shown in map 6 (regional water quality network sites).

5.6.1 Are Northland's Rivers and Streams Suitable for Swimming?

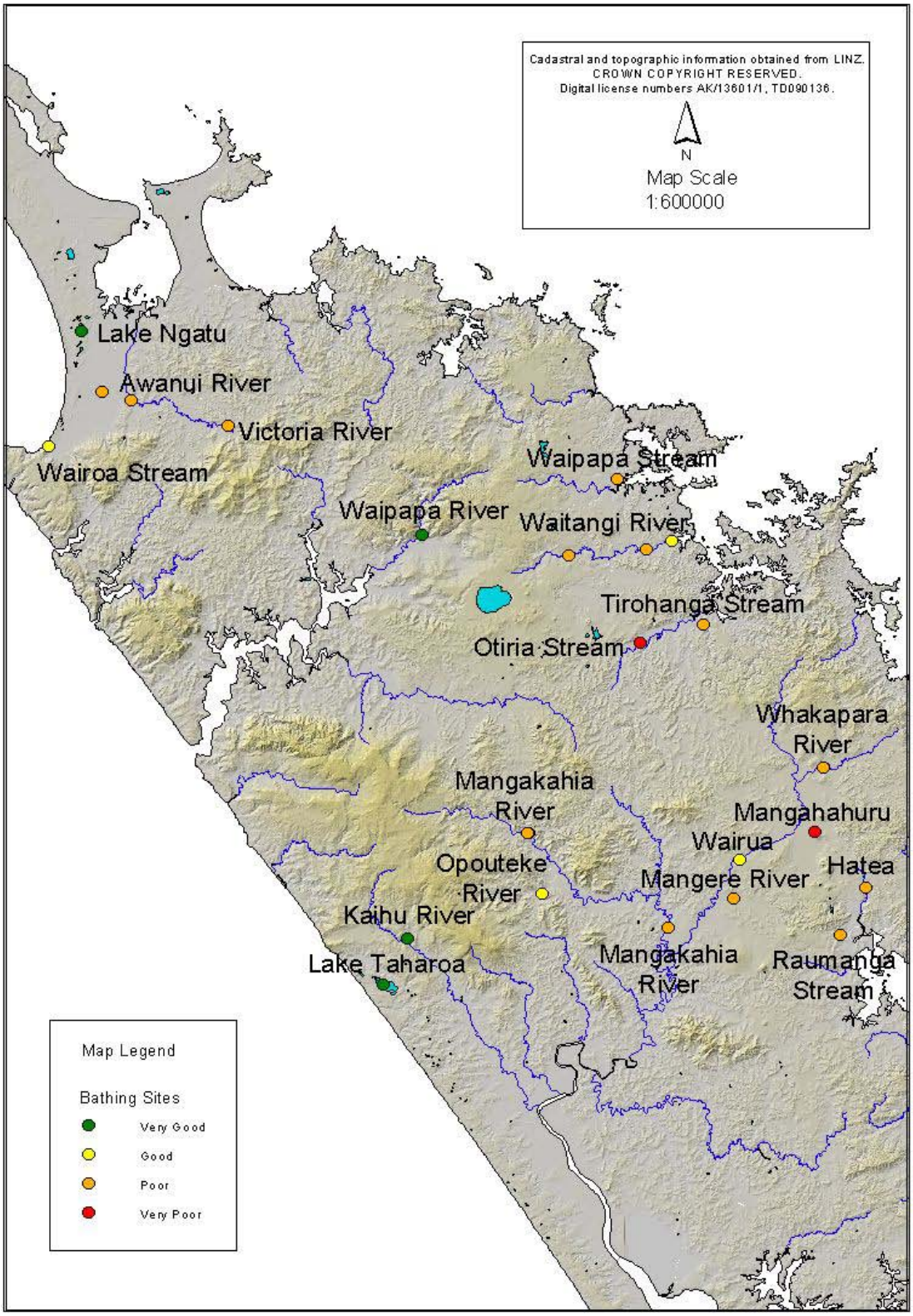
NRC monitors levels of the bacteria '*E. coli*' in surface water that are associated with disease-causing organisms. *E. coli* is an indicator of contamination from human and animal waste. By monitoring *E. coli* levels in freshwater, an assessment can be made on whether the water is suitable for contact recreation (swimming).

Monitoring has shown that there are excessive *E. coli* levels present in many Northland rivers and streams (. High *E. coli* levels are indicative of a potential health risk. Illness risk to people swimming varies between sites as shown in map 5.

Sites that are considered to be unsafe for bathing include the Mangahahuru Stream, located in the Hikurangi drainage scheme and the Otiria Stream at Otiria. The site on the Mangahahuru stream is located downstream of the Hikurangi Township sewage treatment system and the Kauri Dairy Factory effluent disposal area. Discharges from these sources, in association with runoff from non-point sources, make these waterways unsafe for bathing.

Otiria, like most sites that show elevated levels of *E. coli*, is in an area where there are no specific point source discharges of contaminants. What is clear is that *E. coli* levels are higher in catchments with high-intensity land use. Although it is often difficult, if not impossible, to pinpoint the specific sources of faecal contamination, probable sources are related to non-point source pollution, septic tank seepage and faecal material from runoff or stock wading in streams.

The lakes monitored had excellent water quality for contact recreation (this includes Lake Taharoa in the Kai Iwi group and Lake Ngatu on the Aupouri Peninsula).



Map 5: Freshwater Bathing Sites

5.6.2 Are Northland's Rivers and Streams Suitable for Aquatic Life?

Dissolved Oxygen

An adequate supply of dissolved oxygen is essential for the survival of aquatic life. A deficiency in this area is a sign of an unhealthy river. There are a variety of factors affecting levels of dissolved oxygen. The atmosphere is the main source of dissolved oxygen in river water. Oxygen diffuses naturally into river water, and waves and tumbling water also mix atmospheric oxygen with river water. Oxygen is also produced by rooted aquatic plants and algae as a product of photosynthesis.

Overall, 92% of all samples collected at sites throughout Northland between the years 1996 - 2000 complied with the dissolved oxygen standard of 80% saturation.

Dissolved oxygen levels in rivers and streams varies throughout Northland. Levels in upper catchments (such as the upper Mangakahia) are generally high as the result of turbulent, well-aerated waterways and low organic loading. Some lowland river sites show depressed dissolved oxygen levels. Sites in the Wairua catchment (including the Whakapara River) consistently record low values. This catchment includes the Hikurangi drainage scheme.

As expected, dissolved oxygen levels vary seasonally at all sites, with a general trend towards higher levels in winter and lower levels in summer. More importantly, dissolved oxygen levels vary over a daily cycle as the result of aquatic plant photosynthesis/respiration and stream temperature.

A recent study by Northland Regional Council involved 24-hour monitoring of dissolved oxygen levels in the Mangere River of the Wairua catchment. One-off monthly sampling had identified the lower reaches of the river as having dissolved oxygen levels that often did not meet the recommended guideline.

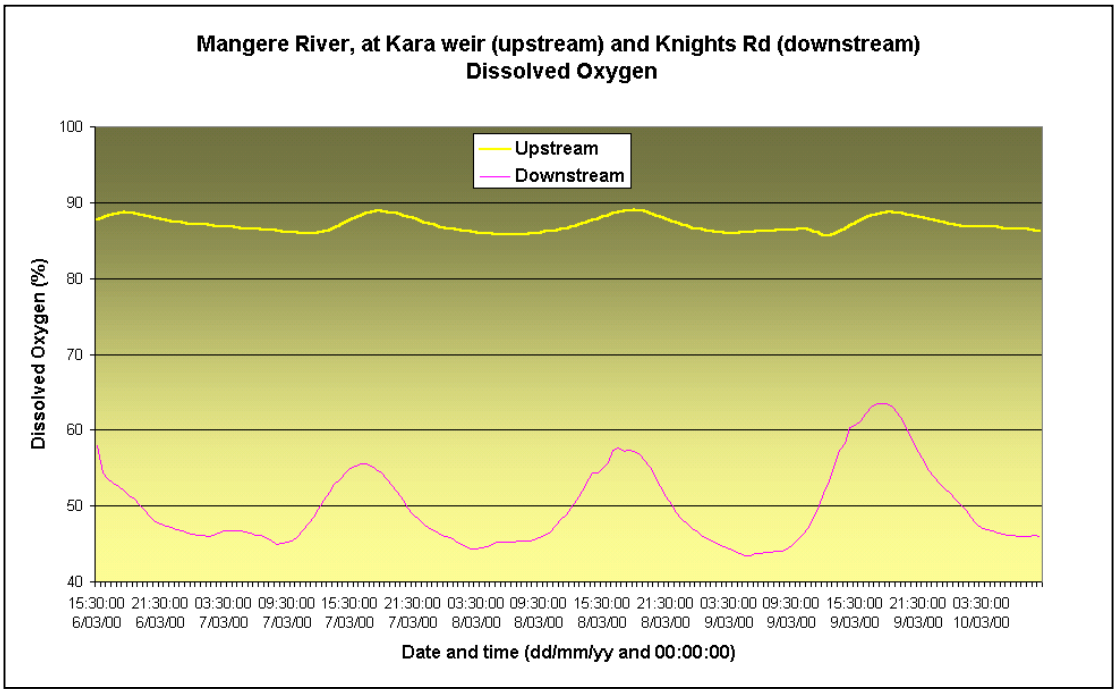


Figure 19: 24-hour dissolved oxygen levels for upstream and downstream sites on the Mangere River

As shown in Figure 19, dissolved oxygen levels varied considerably over a 24-hour period, with the variation becoming greater further down the catchment. The furthest downstream site in this study (Mangere River at Knight's Road) exhibited dissolved oxygen levels well below the guideline for protection of aquatic ecosystems. The lowest levels were recorded around dawn.

This is largely due to the fact that aquatic plants use up oxygen at night, while producing oxygen during the day. Variations in water temperature also affect dissolved oxygen levels. This leads to significant changes in dissolved oxygen levels throughout the daily cycle.

The low dissolved oxygen levels observed downstream are the result of the numerous farm dairy effluent discharges within the catchment, and diffuse agricultural runoff.

pH

The pH of river water is the measure of how acidic or basic the water is on a scale of 0-14. It is a measure of hydrogen ion concentration. Extremes in pH can make a river inhospitable to life. Low pH is especially harmful to immature fish and insects. Acidic water also speeds the leaching of heavy metals harmful to fish. Geology within the river catchment generally influences the pH of rivers and streams.

Overall, 94% of all samples collected at sites throughout Northland between the years 1996 – 2000 were within the normal range of 6.5 – 9.0. Sites that had the lowest compliance with the guideline range included those in the Whakapara and Wairua Rivers of the Wairua catchment. Non-compliances had pH values generally lower than the guideline values, which could adversely affect aquatic life.

Temperature

Temperature is an important parameter for fish spawning and the physiology of aquatic life. Colder water can also hold more oxygen. Water temperature is affected by climate and industrial discharges, but can also be affected by the amount of vegetation providing stream shading.

Overall, 100% of all samples collected at sites throughout Northland between the years 1996 – 2000 were below the maximum temperature of 25^{O}C recommended for the protection of aquatic life.

Some types of aquatic life are more sensitive to increases in temperature than others. Research by Quinn and Hickey (1990) found that the aquatic macroinvertebrates stoneflies and mayflies were scarce where the maximum river temperatures exceeded 19 and 21.5 ^{0}C, respectively. These temperatures are commonly reached in Northland rivers and streams during summer, especially where shading has been removed through the loss of riparian vegetation.

Nutrients

Phosphorus and nitrogen are important nutrients for plant growth. However, high levels of nutrients contribute to algal growths and eutrophication processes. Excessive algal growths degrade recreational and aesthetic values, as well as impacting on aquatic life habitat.

Overall, only 51% of all samples were less than the guideline value of 0.03 gm^{-3} for dissolved reactive phosphorus (DRP). For nitrogen, only 36% of samples were below the guideline value of 0.1 gm^{-3} for dissolved inorganic nitrogen (DIN). Levels greater than these values can promote nuisance algal growths in rivers and streams.

Most catchments have DIN concentrations high enough to promote excessive algal growths. Levels are regularly high in developed catchments, including the Wairua, Whakapara, Mangakahia, Awanui and Waitangi Rivers. In some rivers, such as the Mangere and Mangahahuru, levels are extremely high. It is likely that a significant proportion of nitrogen is derived from point and non-point agricultural sources.

Some site-specific studies (Northland Regional Council, 1997) have shown that waterways in both the Ruawai and Te Kopuru areas are degraded as a result of intensive agricultural activity. In the Ruawai area, waterways are severely degraded.

Nitrogen levels also increase downstream of industrial and municipal sewage point source discharges.

DRP levels vary both between catchments and within lengths of rivers. This is largely the result of assimilation of phosphorus further down the river and the impact of point source discharges (such as dairyshed oxidation ponds). Sites with elevated DRP levels are sited both within intensively farmed catchments and below major point source discharges.

Like nitrogen, non-point agricultural sources also contribute phosphorus. As phosphorus binds strongly to soil, it is largely assumed high levels are linked to land use and erosion. Site averages show that between 30-70% of total phosphorus is bound to particles, with an average of 51% for all sites. This tells us that land use practices are vitally important for managing phosphorus levels, but also that other sources of phosphate (point source discharges) continue to contribute to elevated levels.

Ammonia

High levels of ammonia can be toxic to aquatic life under certain pH and temperature conditions. Ammonia levels in all samples from larger rivers throughout the region are well below levels considered to be toxic, at conservative levels of pH and temperature.

Ammonia levels are slightly elevated in some rivers. In the Mangere River higher levels are related to the cumulative effect of dairyshed effluent discharges and runoff. Elevated levels in the Awanui River are associated with effluent from the Kaitaia oxidation ponds.

However, higher levels that may be toxic to aquatic life are sometimes found in smaller streams in dairy farming areas, particularly downstream of farm dairy effluent discharges.

Turbidity

Turbidity is a measure of the 'cloudiness' of water, which is generally an indication of the amount of sediment in water. High turbidity reduces the amount of light penetrating into water that would be available for aquatic life. It makes it difficult for fish to see prey, and reduces the ability of plants to photosynthesise. There are no published guidelines for turbidity, but it is generally considered that turbidity should be less than 5 NTU to support plant life. High turbidity also makes water less attractive to swim in.

Overall, 48% of samples met this criterion. Sites ranged from 11% compliance at the Wairua River (Purua) site to 86.5% compliance at the Victoria River (Thompson's Bridge).

Lowland rivers surrounded by intensive land use (such as the Mangere, Awanui, Whakapara and Wairua) all showed consistently high levels of turbidity.

5.6.3 Are Northland's Rivers and Streams Suitable for Stock Water/Irrigation?

Faecal Contamination

A number of disease-causing organisms can be transmitted by faecally-contaminated water to livestock. Faecal coliform bacteria levels give an indication of the risk of the presence of disease-causing organisms that may be present in water.

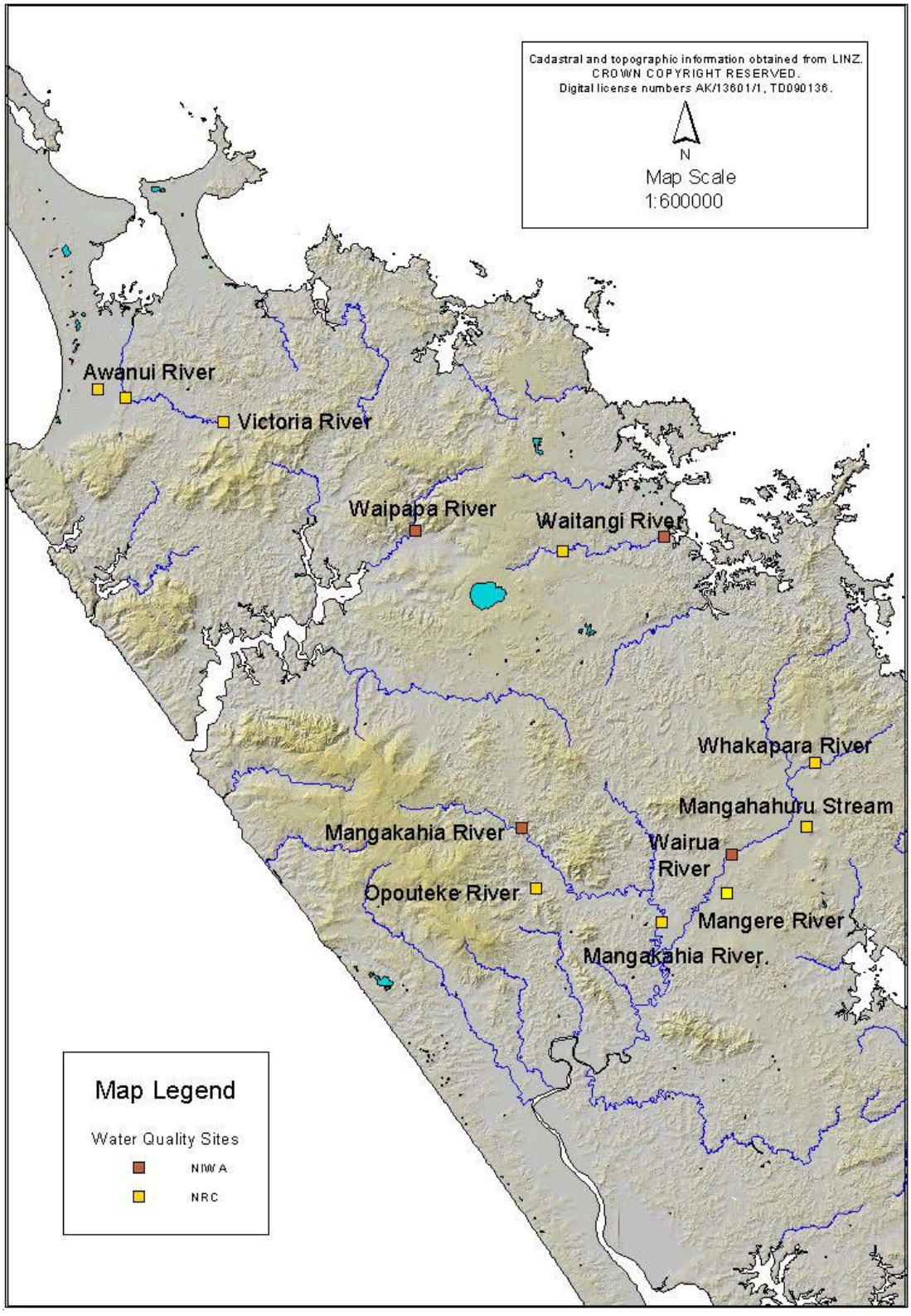
Most rivers are safe most of the time for stock to drink from. However, faecal coliform levels increase during and after rainfall due to runoff events. Overall, across all sites monitored, Northland rivers showed a median faecal coliform concentration of 370 n/100 mL (compared to the median guideline value of 600 n/100 mL). Notably, some sites do exceed the guideline and could be considered a risk to stock. These include the Mangahahuru Stream (median of 1600 n/100 mL) and the lower Awanui River (median of 1100 n/100 mL).

The Revised Proposed Regional Water and Soil Plan lists a guideline for faecal coliform bacteria in terms of the median and the eighty percentile values for stock water and irrigation purposes. The guideline requires five samples to be taken over a 30-day period. Although the data analysed here does not meet this frequency (only one sample in 30 days), four years of data has been compiled and medians calculated from that.

Nitrate

High levels of nitrate can be toxic to stock. Altogether, 79% of samples met the guideline value of less than 0.5 gm^{-3}-N. Sites of concern are primarily located in the Wairua catchment, particularly the Mangere (14% compliance) and Wairua (42% compliance) Rivers.

Sources of nitrate are likely to be dairy shed effluent discharges and non-point source agricultural runoff in these catchments.



Map 6: Regional Water Quality Network Sites

5.7 State of Freshwater Ecosystems

5.7.1 Stream Macroinvertebrates

Macroinvertebrates include the insects, snails, crustaceans, and worms that live in rivers and streams. Macroinvertebrates are abundant in shallow, stony areas but they also live on plants and debris in rivers and streams.

Macroinvertebrates show varying degrees of sensitivity to water quality and the condition of habitat. Because of this sensitivity, they are good indicators of the state of fresh water ecosystems.

Habitats are uniquely characterised by their own macroinvertebrate community. High quality, gravel bottomed streams sheltered by native forest are typically dominated by the larvae of mayflies, stoneflies, and caddisflies. Snails, typical fly larvae, and worms dominate polluted streams and rivers, particularly those in lowland catchments influenced by urban or agricultural land use.

***Zephlebia* mayflies are generally indicative of high water quality** Steve Moore

Northland Regional Council uses four standard protocols to assess water quality and habitat opportunities. These are species richness, species abundance, the macro-invertebrate community index (MCI) and the quantitative macroinvertebrate community index (QMCI) (Boffa Miskell, 2001). The Council has assessed macroinvertebrate communities at 21 sites throughout the region since 1996. The Ngatiwai Trust Board Resource Management Unit also conducts regular macroinvertebrate surveys.

Ecosystem health is shown at sites throughout the region in Map 7. Generally, ecosystem health is excellent in forested headwaters, but declines further downstream.

From the regional water quality state of the environment monitoring programme three sites appear better than others in terms of ecosystem health. The upper Victoria River and the Waitangi River sites show moderate ecosystem health – both are upstream 'unimpacted' sites. The Waipapa River at Puketi Forest shows excellent ecosystem health, reflecting its 100% native forest catchment.

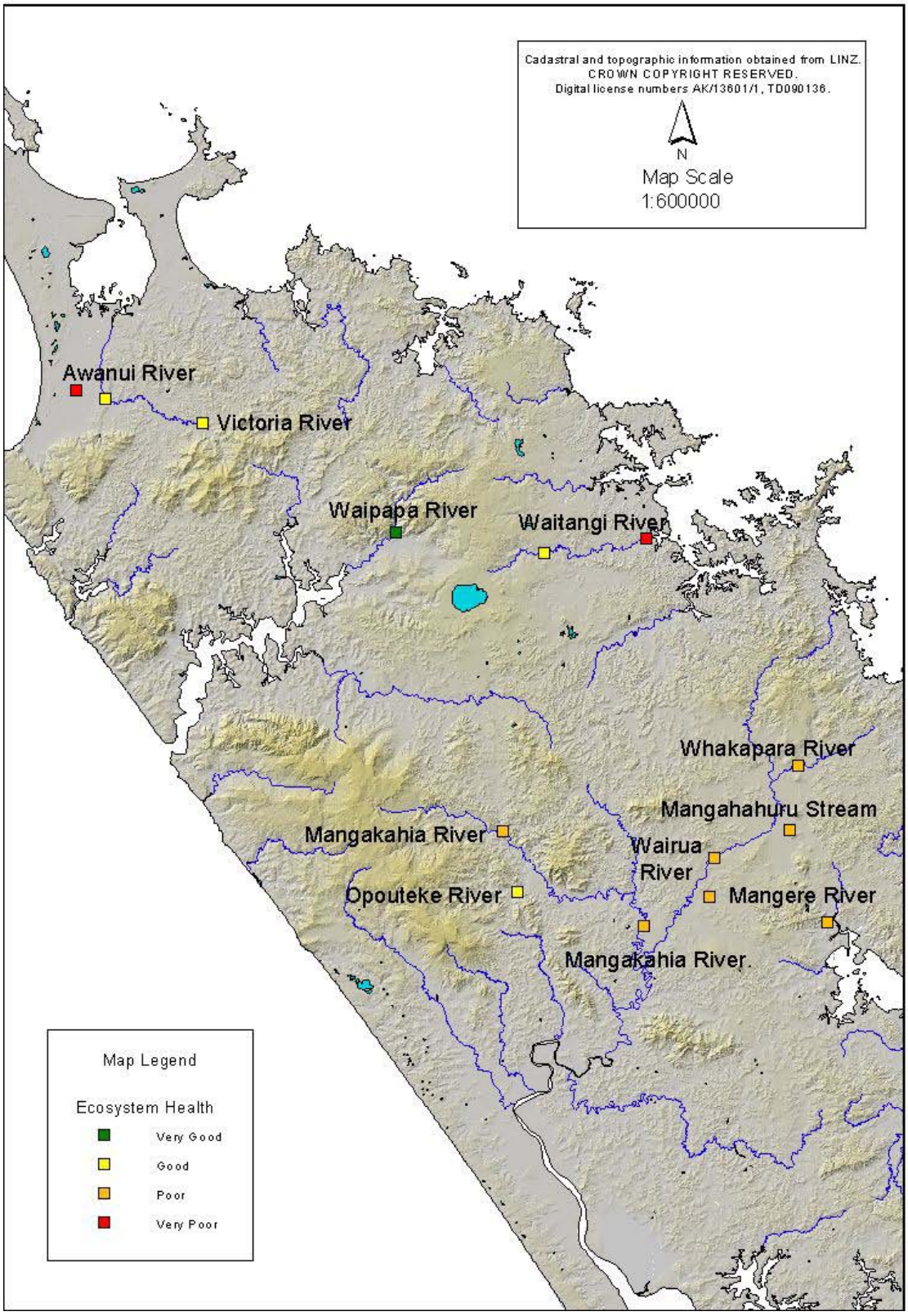
At all other sites ecosystem health is moderately poor to poor. Lowland streams, especially in agricultural and urban areas, have poor ecosystem health.

A study of Northland waterways by Collier (1995) confirmed the importance of native riparian vegetation in providing suitable habitat for sensitive macroinvertebrates. Riparian vegetation provides habitat for breeding adults, shade to keep stream

temperatures low, and filters contaminants from runoff before it enters the stream or river. The same study found poor habitats related to the extent of pastoral development in the catchment.

Lowland streams in agricultural catchments generally provide poor to very poor habitats because of the large loads of silt, excessive algal growths and high levels of organic pollution.

Potamopyrgus **snails are widespread in Northland and can tolerate many water quality conditions** Steve Moore



Map 7: Macroinvertebrate diversity and ecosystem health in Northland rivers

5.7.2 Freshwater Fish

Of the 35 or so native species of freshwater fish found in New Zealand, 20 are known to inhabit the Northland region (NIWA, 2001). Exotic fish are widespread, with 10 known species found in Northland (refer Table 9).

Table 9: Freshwater Fish recorded in the Northland region

Common Name	***Scientific Name***
Native Fish	
Yelloweyed mullet	*Aldrichetta forsteri*
Shortfin eel	*Anguilla australis*
Longfin eel	*Anguilla dieffenbachii*
Kahawai	*Arripus trutta*
Torrentfish	*Cheimarrichtyphys fosteri*
Koaro	*Galaxias brevipinnis*
Banded kokopu	*Galaxias fasciatus*
Dwarf inanga	*Galaxias gracilis*
Inanga	*Galaxias maculatus*
Shortjaw kokopu	*Galaxias postvectis*
Lamprey	*Geotria australis*
Crans bully	*Gobiomorphus basalis*
Common bully	*Gobiomorphus cotidianus*
Giant bully	*Gobiomorphus gobioides*
Bluegill bully	*Gobiomorphus hubbsi*
Redfin bully	*Gobiomorphus huttoni*
Estuarine triplefin	*Grahamina sp.*
Grey mullet	*Mugil cephalus*
Black mudfish	*Neochanna diversus*
Northland mudfish	*Neochanna heleios*
Koura	*Paranephrops sp.*
Common smelt	*Retropinna retropinna*
Exotic Fish	
Catfish	*Ameiurus nebulosus*
Goldfish	*Crassius auratus*
Koi carp	*Cyprinus carpio*
Mosquitofish	*Gambusia affinis*
Silver carp	*Hypopthalmicthys molitrix*
Rainbow trout	*Oncorhynchus mykiss*
Brown trout	*Salmo trutta*
Rudd	*Scardinius erythrophthalmus*
Tench	*Tinca tinca*
Grass Carp	*Ctenopharyngodon idella*

Source: New Zealand Freshwater Fish Database

The distribution of freshwater fish species in Northland can largely be explained by a number of factors, which include:

- The deliberate and unintentional introduction and transfer of exotic fish by humans.
- Habitat availability.
- Loss of migratory pathways.

Native Fish

Habitat availability and loss of migratory pathways limit native fish distribution throughout the region. Many of New Zealand's native species are diadromous; that is, they must migrate between freshwater and the sea in order to complete their life cycles. Barriers such as waterfalls, low flow and weirs largely affect their distribution. These diadromous species include eels, lamprey, torrentfish, banded Kokopu, and Koaro.

Blue-gilled bully

Some species such as common smelt, Koaro, and banded Kokopu (not always migratory) are non-migratory and can form their own land locked populations. The dwarf inanga is found in only 13 lakes near Dargaville, and does not co-exist with other galaxiid species. Dwarf inanga populations have declined over the last 30 years, and it is now considered to be a threatened species.

Other major threats to native fish include the loss of habitat, principally riparian margins, and degraded water quality. Some native species are also caught for human consumption. These include eels, whitebait, and freshwater crayfish (Koura). Juveniles of Inanga, Koaro and the Kokopu species contribute largely to the whitebait fishery; Inanga being the most important species, making up to 95% of the whitebait catch in Northern New Zealand.

Exotic Fish

Exotic fish are found throughout the region. Both rainbow and brown trout occur in Northland, as for at least 50 years there were releases of these species into various waterways throughout the region. Self-sustaining populations now exist in some upper catchments and lakes (Poynter, 1992).

Mosquitofish were introduced to the waters of the North Island during the 1930s to control mosquito larvae, and appear to have become widespread in Northland (Chisnall and Boothroyd, 1999). The carnivorous behaviour of this fish has caused some problems with the conservation of some native species (ie. the dwarf inanga and black mudfish).

Koi carp have also been recently found in Northland. They present a high risk to waterways as their feeding habits include sucking up and expelling material from the bottom and banks, greatly increasing the turbidity of the water. This makes waterways unattractive, reduces the abundance of aquatic plants, and can render the water unsuitable for swimming or even drinking by livestock.

Catfish are found sporadically throughout the region, whereas goldfish are more widely distributed.

5.8 Response to Surface Water Quality Issues

5.8.1 Northland Regional Council

The Northland Regional Council has produced two policy documents for the management of Northland's freshwater resources. The **Regional Policy Statement** provides an overview of resource management issues in Northland, including those with regard to surface water quality. It contains objectives, policies and methods to achieve the integrated management of Northland's environment.

The **Revised Proposed Regional Water and Soil Plan for Northland** includes specific water quality guidelines for different purposes. These include:

- aquatic ecosystems
- contact recreation
- fisheries
- water supply
- stock water and irrigation

The Plan also includes rules that control the extent and type of discharges to freshwater and land, rules pertaining to land disturbance activities and streamside management areas.

Major point source discharges to water and land require **resource consent** from the Northland Regional Council. Attached to the resource consent are **conditions**. These conditions may include provisions for effective waste treatment systems, management plans for the use of treatment systems, limits for the concentration of contaminants that are allowed to be discharged and monitoring programmes that assess the effect of the discharges on the environment.

It is also recognised that some activities are permitted (no consent required), provided the effects do not compromise the objectives of the Regional Policy Statement and Water and Soil Plan or cause any significant adverse effects.

State of the Environment monitoring programmes have been implemented to assess the state of river water quality and ecology and how that changes with time.

Northland Regional Council has the following ongoing surface water monitoring projects:

- Regional Water Quality Network (RWQN) – Implemented during 1996 with the purpose to provide information about river water quality in the Northland Region so that baseline levels and water quality trends can be monitored. Thirteen sites are sampled on a monthly basis for physico-chemical parameters in conjunction with NIWA. In addition sites are analysed on a six-monthly basis for macroinvertebrates (ecosystem health).
- Freshwater Contact Recreation Survey - During the summer of 1999/2000 the Council initiated a survey to assess the baseline water quality at several of Northland's popular freshwater swimming sites. Sampling occurs over the

summer period between December and February at 13 sites (different to RWQN) over the Northland region.

- Waiarohia Stream macroinvertebrate monitoring – The Waiarohia Stream in Whangarei is sampled six-monthly for macroinvertebrates in an ongoing monitoring programme to assess the health of its aquatic habitat.

Prior to 1996 water quality monitoring in Northland involved short-term specific studies. These projects focused on **specific catchments**, and were designed to better understand background water quality in these areas, often in conjunction with the preparation of catchment or water quality management plans.

5.8.2 Other Responses

Northland Regional Council supports several streamcare groups (link to http://www.nrc.govt.nz/land/care_groups.shtml). These are involved in riparian planting, weeding, and removing rubbish from waterways. Riparian vegetation filters runoff before it enters streams, improves habitat for aquatic life, provides shade and reduces water temperature. One such streamcare group is involved in the Waiarohia restoration project (refer case study).

The Council also produces a series of pamphlets entitled Land Beside Water (link to http://www.nrc.govt.nz/lakes.rivers.and.streams/streamside_management.shtml) designed to offer helpful advice to the community on streamside management.

Schools are also targeted through the Council's environmental education (link to http://www.nrc.govt.nz/environmental.education/index.shtml) programme. Each year more than 40 school visits are undertaken by Regional Council staff throughout Northland. A significant number of these involve water quality and streamside management education.

Children participating in a stream health education programme