RIVERS AND STREAMS

SUMMARY 2007-08

OVERVIEW

- The Northland Regional Council (NRC) undertakes water quality sampling at a number of freshwater sites across the region.
- The most popular freshwater bathing sites are sampled for 12 weeks over the summer months as part of the Recreational Bathing Water Quality Programme.
- Samples are taken once a week from each site and analysed for illness causing bacteria (*E. coli*). Sites are graded depending on levels of bacteria - green for 'safe', amber for 'caution' or red for 'unsafe'.
- Results are published at the end of each week on the NRC website, and are forwarded to the district councils and Northland District Health Board.
- A number of rivers and streams across the region are also sampled as part of the River Water Quality Monitoring Network (RWQMN).
- Samples are taken from each site once a month and analysed for a range of parameters. At the end of the year, sites are graded from best to worst water quality based on the season's results.

PERFORMANCE TARGETS

Continue to implement and improve a prioritised State of the Environment (SOE) monitoring programme and monitor compliance with, and the effects of, the exercise of resource consents and Regional Plans by:	**Target Achieved:**
➢ Operating a region-wide water quality network for the measurement, recording and reporting of river, lake and groundwater quality trends	✓
➢ Carrying out sampling and reporting on summer coastal and freshwater bathing water quality	✓
➢ Reporting to the Council annually on environmental monitoring activities within three months of the end of the financial year	**Ongoing**
➢ Making the results from the annual SOE monitoring programmes available on the Council's website at www.nrc.govt.nz	✓

SUMMARY OF RESULTS 2007-08

- During 2007-08, 19 freshwater sites were sampled for the Recreational Bathing Water Quality Programme.
- The median result was calculated at the end of the survey season for all 19 sites. Nine sites had a median score indicating that they were 'safe' for recreational use; six sites had an amber or 'caution' score and four sites had a median score indicating that they were "unsafe" for recreational use.
- The Suitability for Recreation Grade (SFRG) has been calculated for 16 freshwater sites with sufficient data. Of these 16 sites, eight have an interim SFRG of "poor" and eight have an interim SFRG of "very poor".
- Ten sites were added to the RWQMN in 2007-08, bringing the total number of sites in this network to 34.
- The river rated as having the best water quality in 2007-08 was the Waipoua River. The river rated as having the worst water quality was the Manganui River.

INTRODUCTION

Northland has an abundance of rivers and streams, many of which are relatively short with small catchments. The Wairoa River is Northland's largest river, draining a catchment area of 3650 km^2 (29% of Northland's land area). Most of the major rivers in the region flow into enclosed harbours, rather than discharging to the open coast, which has significant implications for coastal water quality.

The Northland Regional Council (NRC) carries out State of the Environment (SOE) monitoring on a number of rivers and streams throughout Northland to measure water quality, identify significant environmental issues and to monitor trends in water quality over time.

The **Recreational Bathing Water Quality Programme** is a joint project run by NRC, the District Health Board and the three District Councils; Whangarei, Far North and Kaipara. The programme monitors water quality at a number of the region's most popular coastal and freshwater swimming spots for 12 weeks over the summer months. Samples are taken once a week from each site and analysed for illness causing bacteria. The results are compared to water quality guidelines issued by the Ministry for the Environment (MfE) to establish whether or not sites are safe for recreational use.

The results from the programme are posted weekly on the NRC website - http://www.nrc.govt.nz/swimming - to allow the general pubic to make an informed decision about where to swim. Results are also passed to each of the District Councils and the District Health Board, who undertake investigation and take action in instances of non-compliance. During the 2007-08 summer season, NRC sampled water quality at 19 freshwater bathing sites. The results from this monitoring are presented in the Recreational Bathing Water Quality section of this report.

The **River Water Quality Monitoring Network** (RWQMN) involves the monitoring of water quality and macroinvertebrate biota in an increasing number of rivers around Northland. During 2007-08, 34 sites were included in the network, of which four are part of the National River Water Quality Network. Water quality at each site is monitored monthly for a range of parameters and stream macroinvertebrates are surveyed annually. The majority of sites in the network now have sufficient data for long-term trend analysis. The 2007-08 results and long-term trends in water quality are presented in the River Water Quality section below.

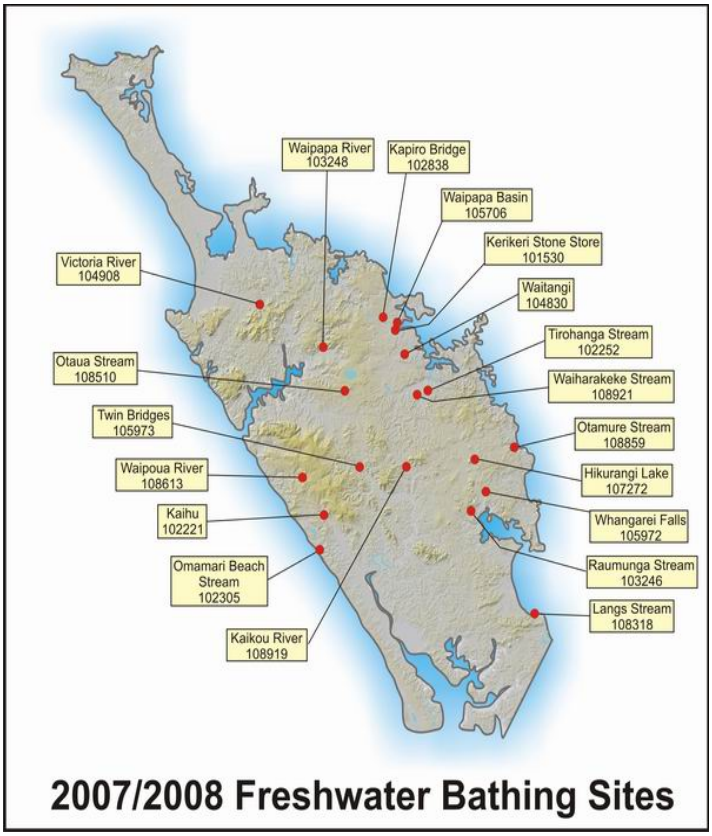
Photo: Waipoua River in Waipoua Forest

RECREATIONAL BATHING WATER QUALITY

The Recreational Bathing Water Quality Programme is a joint project run by NRC, in conjunction with Kaipara, Whangarei and the Far North district councils and the Northland District Health Board (DHB). The programme involves sampling water quality at a number of the most popular freshwater and coastal swimming sites around Northland for 12 weeks over the summer months. For results from coastal sites, please refer to the 'Coast' section of the Annual Monitoring Report.

Freshwater quality in rivers and streams is not always safe for recreational use (such as swimming or contact sports), as waterways can sometimes become contaminated with illness causing bacteria. These bacteria can enter the water after an 'environmental incident', such as a sewage spill, during periods of prolonged or heavy rainfall, when contaminants off the land (such as livestock effluent or wild animal dung) get washed into waterways or where there is a persistent source of pollution, such as a leaking septic tank.

During the 2007-08 summer season, 19 freshwater swimming sites around Northland were monitored. Samples were collected from each site on a weekly basis and analysed for the pollution indicator bacteria *Escherichia coli* (*E. coli*). The methodology used follows that recommended in the '*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas'* developed jointly by MfE and the Ministry of Health (MoH).



The results for each site are compared to the guidelines issued by MfE. Each week, sites are given a grading based on the levels of bacteria present – green for 'safe for recreational use', orange for 'caution' or red for 'unsafe for recreational use'. These gradings and results are posted at the end of each week on the NRC website - http://www.nrc.govt.nz/swimming.

Results are also forwarded to each of the district councils and the DHB on a weekly basis. However, in the event of a 'caution' or 'unsafe' result, the relevant district council and DHB is informed of the result within 24 hours of the sample entering the NRC lab. This ensures that follow-up action is swift, for example, further sampling and that warning signs are erected promptly, where necessary, in order to minimise any potential risk to human health.

The table below gives the guideline values for microbiological water quality in relation to recreational bathing and the recommended actions to be taken by district councils.

***E. Coli* count (cells/100mL)**	**Status**	**Suggested follow up**
Less than or equal to 260	Acceptable/Safe	▪ No response necessary – continue weekly sampling
Greater than 260 but less than or equal to 550	Alert/Caution	▪ Increase sampling to daily ▪ Undertake sanitary survey to isolate source of bacterial contamination
Greater than 550	Action/Unsafe	▪ Increase sampling to daily ▪ Undertake sanitary survey ▪ Erect warning signs ▪ Inform public through the media that a public health risk exists

Results 2007-08

The results from 2007-08 show that most freshwater sites were safe for recreational use during dry weather but, after heavy and/or prolonged rainfall, bacterial levels became greatly elevated for several days.

Some sites, such as Otamure Bay Stream, were generally unsafe for recreational use regardless of weather conditions. Other sites, such as Lake Waro, were suitable for recreational use throughout the sampling period. Water quality at Lake Waro has improved over the last two summer seasons since water fowl numbers were reduced.

The table below gives the median *E. coli* results for each site for the 2007-08 survey season. Median results give an indication of the average water quality at each site. However, it must be remembered that samples are only taken once a week for a 12 week period from each site and the result on the day can be greatly influenced by a single rainfall event.

District	**Site Name**	**Site Number**	**Median Result**
WDC	Otamure Bay Stream	108859	**1467**
WDC	Lake Waro	107272	**31**
WDC	Whangarei Falls	105972	**624**
WDC	Raumanga Stream	103246	**529**
WDC	Kaikou River	108919	**413**
WDC	Langs Beach Stream	108318	**842**
FNDC	Waiharakeke	108921	**569**
FNDC	Waipapa River Basin	105706	**74**
FNDC	Kerikeri Stone Store	101530	**175**

District	Site Name	Site Number	Median Result
FNDC	Waitangi @ Lily Pond	104830	**292**
FNDC	Tirohanga Stream	102252	**231**
FNDC	Kapiro Stream (Purerua Rd)	102838	**272**
FNDC	Waipapa River (Puketi)	103248	**82**
FNDC	Waipoua River	108613	**74**
FNDC	Twin Bridges	105973	**231**
FNDC	Otaua stream	108510	**271**
FNDC	Victoria River	104908	**288**
KDC	Kaihu River	102221	**86**
KDC	Omamari Beach Stream	102305	**218**

Suitability for Recreation Grade

Using the guidelines developed by MfE, an interim Suitability for Recreation Grade (SFRG) can be given to all sites with at least five seasons survey data. Although these grades provide an indication of a sites general suitability for use, the grading system has not been designed to take into account Northland's high rainfall. This means that the interim grades tend to overstate the health risks at some sites, for example, despite Lake Waro returning consistently good water quality results for the last two summer seasons, its interim grade is still 'poor' based on the guidelines.

District	Location	Interim SFRG
WDC	Otamure Bay Stream	**Very poor**
WDC	Lake Waro	**Very poor**
WDC	Whangarei Falls	**Very poor**
WDC	Raumanga Stream	**Poor**
WDC	Kaikou River (Pipiwai)	**Poor**
WDC	Langs Beach Stream	**-**
FNDC	Waiharakeke	**Very poor**
FNDC	Waipapa Stream (Basin)	**Poor**
FNDC	Kerikeri River	**Very poor**
FNDC	Waitangi River	**Very poor**
FNDC	Tirohanga Stream	**Poor**
FNDC	Kapiro Stream	**Poor**
FNDC	Waipapa River (Puketi)	**-**
FNDC	Waipoua River	**Poor**
FNDC	Twin Bridges	**Poor**
FNDC	Otaua Stream	**Very poor**
FNDC	Victoria River	**-**
KDC	Kaihu River	**Very poor**
KDC	Omamari Beach Stream	**Poor**

RIVER WATER QUALITY

River Water Quality Monitoring Network

NRC also undertakes freshwater quality monitoring through the regional River Water Quality Monitoring Network (RWQMN). The network involves the monitoring of water quality and macroinvertebrate biota in an increasing number of rivers around Northland.

In 2007-08, the network included 34 sites spread across the region. These sites are shown on the map below. Four of these sites are part of the National River Water Quality Network, which is monitored by staff from the National Institute of Water and Atmospheric Research (NIWA) (Waipapa River in Puketi Forest, Waitangi River at Watea, Mangakahia River at Titoki and Wairua River at Purua).

Ten new sites were added to the network in 2007-08. These sites are located in river systems not previously monitored on the network, including the Paparoa and Waipao Stream and the Hakaru, Ngunguru, Waipapa, Kerikeri, Utakura, Oruru, Waimamaku and Mangamuka rivers. These rivers were added in order to improve coverage over a range of river types, based on geology, source and land cover/catchment type.

Map: RWQMN Sites in Northland, 2007-08
(Pink = sites monitored by NIWA, Purple = site to be added in 2008-09)

Monthly water quality sampling is carried out at each site in the network and samples are analysed for a range of chemical and physical parameters. These are shown in the table below. The purpose of the network is to provide information about the current state of Northland's rivers, and to look at long-term trends in water quality over time.

Most results are compared to the New Zealand trigger values for the protection of aquatic environments, found in the '*Australian and New Zealand Guidelines for Fresh and Marine Water Quality*' (ANZECC 2000). It is important to note that the trigger values are used to assess the risk of adverse effects on an ecosystem and when results are outside trigger values, further investigation may still be required to determine whether or not this is having an adverse effect on the aquatic environment.

Two sets of trigger values are used by NRC to analyse results; one for upland rivers, which only includes one site in the network (Waipoua River), and one for lowland rivers (as shown in the table below). Levels of the indicator bacteria *E. coli* are compared to the '*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational areas*' (see the **Recreational Bathing Water Quality** section above). Dissolved Oxygen is measured against the minimum recommended by the Regional Water and Soil Plan for Northland, which is of 6 mg/L.

Parameter	**Guideline trigger values (NZ lowland rivers)**	**Guideline trigger values (NZ upland rivers)**
Temperature (Degrees Celsius)	-	-
Dissolved oxygen (mg/L)	> 6*	> 6*
Dissolved oxygen (% Saturation)	98 - 105	99 – 103
Conductivity (mSm)	-	-
Water clarity (m)	> 0.6	> 0.8
Turbidity (NTU)	< 5.6	< 4.1
E. coli (n/100mL)	< 550^	< 550^
Dissolved reactive phosphorus(mg/L)	< 0.01	< 0.009
Total phosphorus (mg/L)	< 0.033	< 0.026
Ammoniacal nitrogen (mg/L)	< 0.021	< 0.01
Total nitrogen (mg/L)	< 0.614	< 0.295
pH	7.2 – 7.8	7.3 – 8.0

* accepted level of dissolved oxygen (mg/L)
^ *E. coli* guideline for recreational bathing in freshwater

The results for each river from 2007-08 are detailed in the following sections. Over half of the rivers in the network now have enough data to begin long-term trend analysis. Some of the trends are discussed in more detail later in this report (Trends in Water Quality). In addition, the results from the annual macroinvertebrate monitoring for 2007-08 are discussed in the Macroinvertebrate Monitoring section.

River Water Quality Results

Rivers have been ranked from best to worst using the results from 2007-08 for a range of parameters (i.e. highest to lowest water clarity, or least to most nitrogen).

The order of sites from overall best water quality to worst has changed in the last financial year, partly due to the addition of 10 new sites in 2007-08. Waipoua River

was again ranked the best however the Manganui River outranked the Mangere River this year as the worst.

As in previous years, the ranking of sites is linked to catchment land use. The best sites have catchments dominated by native forest, moving through to sites with a mix of forestry, native forest and agriculture. The worst sites have catchments dominated by intensive agricultural land use. Some sites have been shown with equal ranking, as it was difficult to differentiate between them.

Ranking	Site	River system	Land use
1	Waipoua River	Waipoua	Native forest
2	Opouteke River	Wairua/Mangakahia	Forestry/native forest
3	Mangakahia at Twin Bridges	Wairua/Mangakahia	Agriculture/forestry
4	Waipapa at Forest Ranger	Waipapa	Native forest
5	Kaihu River at gorge	Wairua	Agriculture/forestry
6	Mangahahuru at Main Road	Wairua	Forestry
7	Waimamaku River	Waimamaku	Agriculture
8	Victoria River	Victoria/Awanui	Agriculture/native forest
9	Waipapa Stream at Kerikeri	Waipapa	Agriculture
9	Kerikeri River	Kerikeri	Agriculture
11	Mangamuka River	Mangamuka	Agriculture/native forest
12	Waitangi at Watea	Waitangi	Agriculture/native forest
12	Waitangi at Waimate North	Waitangi	Agriculture/native forest
14	Waiarohia at Second Ave	Waiarohia	Urban
15	Whakapara River	Wairua	Agriculture
16	Waiarohia at Whau Valley Rd	Waiarohia	Agriculture/native forest
17	Waipao Stream	Wairua	Agriculture
18	Mangakahia at Titoki	Wairua/Mangakahia	Agriculture
18	Ngunguru River	Ngunguru	Agriculture/forestry/native
20	Kaeo River	Kaeo	Agriculture
21	Punakitere River	Punakitere	Agriculture
22	Oruru River	Oruru	Agriculture
23	Waiotu River at SH 1	Wairua	Agriculture
23	Awanui at FNDC water take	Victoria/Awanui	Agriculture
25	Mangahahuru at Apotu Rd	Wairua	Agriculture
25	Waiharakeke	Kawakawa	Agriculture
27	Paparoa Stream	Paparoa	Agriculture
28	Hakaru River	Topuni	Agriculture/forestry
29	Wairua River at Purua	Wairua	Agriculture
30	Utakura River	Utakura	Agriculture
31	Awanui at Waihue Channel	Victoria/Awanui	Agriculture
32	Mangere River at Knights Rd	Wairua	Agriculture
33	Ruakaka River	Ruakaka	Agriculture
34	Manganui River	Manganui	Agriculture

Waipoua River

The Waipoua River originates in and flows through Waipoua Forest, on the West Coast of Northland. The river cuts through volcanic soils and has a predominantly native forest catchment. The Waipoua River site is the only site in the network that is classified as "hill elevation" by the '*River Environment Classification'* (NIWA & MfE 2004) and therefore the results have been compared to the trigger values for an upland river. The Waipoua River is the closest to pristine condition of all the rivers in the network.

Results for 2007-08 for the Waipoua River site are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines for the 12 sampling occasions. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	**Median**	**Range**	**% compliance with guideline**
Temperature (deg. cel.)	13.45	10 - 18.1	-
Dissolved oxygen (mg/L)	10.6	7.7 - 11.7	100
Dissolved oxygen (% Sat.)	101.6	69.4 - 106.2	50
Conductivity (mSm)	8.0	6.1 - 19	-
Water clarity (m)	2.3	1.17 - 2.77	100
Turbidity (NTU)	2.9	2 - 8	67
E. coli (n/100mL)	36	5 - 789	92
Dissolved reactive phosphorus (mg/L)	0.005	0.005 - 0.01	67
Total phosphorus (mg/L)	0.02	0.005 - 0.03	67
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.27	92
Total nitrogen (mg/L)	0.1	0.123 - 0.321	83
pH	7.25*	3.4 - 7.6	50

The results for 2007-08 show that Waipoua River remains in a relatively pristine condition. The medians of all parameters, except for pH, were within the relevant guideline for an upland river. The median pH of 7.25 is slightly under the range of 7.3 to 8 for an upland river and only complied on 50% of sampling occasions.

However, compliance with guidelines for single samples has been an issue this year, with half of the parameters not complying on four or more sampling occasions. In 2006-07, most parameters met the guidelines on either 11 or 12 sampling occasions.

Trend analysis for this site shows that there is an increasing trend in total phosphorus and dissolved reactive phosphorus, which is of concern. This could be attributed to intensification of farming on the outskirts of the catchment or it could be attributed to an increase in earth movement, such as slips, in the catchment.

Opouteke River

The Opouteke River drains from predominantly exotic forestry (pine forest), through a small area of pasture, before reaching the Mangakahia River. The only pastoral land use upstream of the sampling site is a sheep and beef farm, although dairy farms do occur further downstream. Acidic volcanic rocks make up the underlying geology.

Results for 2007-08 for the Opouteke River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.6	11.2 - 24.1	-
Dissolved oxygen (mg/L)	10.05	7 - 11.9	100
Dissolved oxygen (% Sat.)	107.5*	64.5 - 114.2	8
Conductivity (mSm)	12.8	9.7 - 23.7	-
Water clarity (m)	2.07	0.33 - 3.65	83
Turbidity (NTU)	2.9	1 - 40	67
E. coli (n/100mL)	195	10 - 1022	92
Dissolved reactive phosphorus (mg/L)	0.005	0.005 - 0.01	100
Total phosphorus (mg/L)	0.021	0.005 - 0.04	92
Ammoniacal nitrogen (mg/L)	0.01	0.005 - 0.1	92
Total nitrogen (mg/L)	0.267	0.128 - 0.912	92
pH	8.0*	7.2 - 8.4	50

As in previous years, dissolved oxygen concentrations (% saturation) are often elevated in Opouteke River. Median for pH also fell outside the guidelines.

During 2007-08, phosphorus levels met the guidelines on 11 out of 12 sampling occasions. In previous years, they exceeded guideline trigger values on 5 or more occasions. The trend analysis on the 13 years data available for Opouteke River shows that dissolved reactive and total phosphorus levels are decreasing.

Like many of the other sites in the RWQMN, there is a significant increasing trend in pH in Opouteke River (i.e. trend analysis indicates that this site is becoming more alkaline). This could be a detrimental trend at this site, as pH is often above the 7.2 to 7.8 trigger value range.

Photo: Opouteke River

Mangakahia River at Twin Bridges

The Mangakahia River originates from Matarua Forest and flows southwest until it reaches the Wairua River. There are two sites on the Mangakahia River in the network; one at Twin Bridges and the other at Titoki Bridge, in the lower reaches. The Twin Bridges lie at the confluence of the Awaroa and Mangakahia Rivers. The sampling site is directly downstream of this confluence. The upstream catchment is a mixture of plantation forestry, and beef and sheep farming, with a acidic, volcanic underlying geology.

Results for 2007-08 for Twin Bridges on the Mangakahia River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.6	11.7 - 24.1	-
Dissolved oxygen (mg/L)	10.3	6.8 - 12	100
Dissolved oxygen (% Sat.)	106.1*	63.6 - 117	25
Conductivity (mSm)	10.4	7.7 - 21.1	-
Water clarity (m)	1.44	0.49 - 3.26	83
Turbidity (NTU)	4.2	1 - 42.1	58
E. coli (n/100mL)	185	20 - 1782	75
Dissolved reactive phosphorus (mg/L)	0.008	0.005 - 0.013	83
Total phosphorus (mg/L)	0.030	0.01 - 0.047	58
Ammoniacal nitrogen (mg/L)	0.01	0.005 - 0.04	92
Total nitrogen (mg/L)	0.247	0.134 - 0.784	75
pH	7.8*	7.2 - 8.4	58

Results from 2007-08 show that the two sites on the Mangakahia River had the second highest temperature of all the RWQMN sites. On 16 January 2008, temperature reached 24.1°C (Waiarohia Stream at Second Ave had the highest). It is generally thought that freshwater ecosystems, particularly fish and macroinvertebrate communities, are likely to be detrimentally effected if water temperatures exceed 25°C. It is likely that temperature exceeds this at Twin Bridges at certain times of the day during the summer months.

During 2007-08, phosphorus levels in the Mangakahia River were lower than in previous years. Dissolved reactive phosphorus values met the guidelines on 10 out of 12 sampling occasions compared to three in 2005-06. Trend analysis shows that there is a significant decreasing trend in both dissolved reactive phosphorus and total phosphorus in this river.

The median of dissolved oxygen (percentage saturation), and pH were also above the recommended guideline. The high dissolved oxygen levels occur in summer during lower flows, when photosynthesis rates by plants are greater. There is also an increasing trend in pH at this site.

Waipapa River

The Waipapa River originates in and flows through Puketi forest in central Northland, meandering through farmland until it reaches the upper Hokianga Harbour. The sampling site is in the upper reaches and therefore the catchment above it is predominantly indigenous forest, with some small areas of exotic forest in the headwaters. The geology of the Waipapa River is soft sedimentary (siltstones and mudstones). Similarly to the Waipoua River site, this site is in near pristine condition. The Waipapa site is one of four sites in Northland that are part of the National River Water Quality Network administered by NIWA.

Results from 2007-08 for the Waipapa River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Note: Dissolved reactive phosphorus and ammoniacal nitrogen results were only available for six sampling occasions (July 2007 – December 2007). An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.5	11.3 - 19.9	-
Dissolved oxygen (mg/L)	9.6	8.4 - 10.8	100
Dissolved oxygen (% Sat.)	96.2*	93.3 - 97.9	0
Conductivity (mSm)	11.77	9.01 - 13.1	-
Water clarity (m)	1.86	0.215 - 3.62	83
Turbidity (NTU)	3.6	1.52 - 7.3	58
E. coli (n/100mL)	98.5	9.6 - 517.2	100
Dissolved reactive phosphorus (mg/L)	0.006	0.004 - 0.007	100
Total phosphorus (mg/L)	0.011	0.009 - 0.032	100
Ammoniacal nitrogen (mg/L)	0.003	0.002 - 0.004	100
Total nitrogen (mg/L)	0.113	0.077 - 0.307	100
pH	7.52	7.31 - 7.69	100

Results for 2007-08 show that the Waipapa River remains in a relatively pristine state. The medians of all parameters, except dissolved oxygen (% saturation) met their relevant guidelines. Seven parameters complied with their respective guidelines on all 12 sampling occasions; dissolved oxygen (mg/L), *E. coli*, dissolved reactive phosphorus, total phosphorus, ammoniacal nitrogen, total nitrogen and pH.

Long-term trends indicate that nitrate nitrogen, ammoniacal nitrogen, dissolved reactive phosphorus and total phosphorus are declining in this river. However, there are also long term trends indicating that pH is increasing (the water is becoming more alkaline) and conductivity is increasing. It is unknown at this stage whether increasing pH is a positive or negative trend.

Kaihu River

The Kaihu River originates in native forest to the west of Trounson Kauri Park and drains into the Wairoa River in Dargaville. The catchment is a mix of exotic and indigenous forestry, agriculture and horticulture but dairy farming is the predominant land-use. Kaihu River is one of six sites in the network that have volcanic acidic geology.

The results from 2007-08 for the Kaihu River site are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	14.6	11.4 - 20.1	-
Dissolved oxygen (mg/L)	10.3	8.1 - 11.2	100
Dissolved oxygen (% Sat.)	100.7	75 - 108.5	67
Conductivity (mSm)	11.4	8.8 - 22	-
Water clarity (m)	1.76	0.41 - 3.24	92
Turbidity (NTU)	4.7	1 - 41	58
E. coli (n/100mL)	181	52 - 6867	83
Dissolved reactive phosphorus (mg/L)	0.01*	0.005 - 0.02	67
Total phosphorus (mg/L)	0.03	0.005 - 0.085	75
Ammoniacal nitrogen (mg/L)	0.01	0.005 - 0.42	83
Total nitrogen (mg/L)	0.477	0.194 - 1.738	67
pH	7.3	6.9 - 7.6	75

The results from 2007-08 indicated that some water quality parameters were outside of guideline values at this site on some occasions. The median for dissolved reactive phosphorus fell outside of its recommended guideline.

During 2007-08, spikes in *E. coli*, nitrogen and phosphorus were associated with increased flow and turbidity. This contamination is most likely the result of run-off from pastoral and/or forestry land use within the catchment during heavy rainfall events.

Trend analysis on five years of water quality data collected for the Kaihu River shows that there is an improving trend in water clarity. Dissolved oxygen (% and mg/l) is decreasing however it is not yet known if decreasing dissolved oxygen is a positive or negative trend.

Photo: The Kaihu River sampling site

Mangahahuru Stream at Main Road

The Mangahahuru Stream, which begins in *Pinus radiata* forest to the southeast of Hikurangi, is a small tributary of the Wairua River. The sampling site is located in the upper catchment and therefore the predominant land use in this area is exotic forestry. The site was added to the RWQMN in 2005-06 as a representative of a river system on hard, sedimentary rock surrounded by exotic forestry. It provides a good comparison to the Mangahahuru Stream site at Apotu Road.

Results from 2007-08 are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with the relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	14.9	10.7 - 18.8	-
Dissolved oxygen (mg/L)	9.9	8.9 - 11.3	100
Dissolved oxygen (% Sat.)	95.7*	92.1 - 101.8	25
Conductivity (mSm)	9.45	7.8 - 29.1	-
Water clarity (m)	1.15	0.39 - 1.77	91
Turbidity (NTU)	5.75*	4.8 - 39	50
E. coli (n/100mL)	184	63 - 2282	75
Dissolved reactive phosphorus (mg/L)	0.01*	0.01 - 0.06	67
Total phosphorus (mg/L)	0.03	0.01 - 0.11	58
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.04	83
Total nitrogen (mg/L)	0.297	0.127 - 0.752	92
pH	7.1	6.7 – 7.3	17

The results from 2007-08 indicate that water quality at the Mangahahuru Stream at Main Road is only slightly impacted with medians of most parameters meeting their respective guideline values.

During 2007-08, nutrient levels were higher than previous years. This is especially apparent for phosphorus. Dissolved reactive and total phosphorus met the guideline values on every sampling occasion in 2005-06, however in 2007-08, both parameters exceeded guideline values on four or more sampling occasions. This may be due to fertiliser application within the forestry blocks.

There is not yet sufficient data to undertake trend analysis for this site.

Waimamaku River

The Waimamaku River begins north of the Waipoua forest and flows west through Waimamaku township, eventually reaching the West Coast south of the Hokianga Harbour. The catchment is dominated by indigenous forest in the upper reaches and is mainly pastoral in the lower catchment. The sampling site is located in the lower reaches of the river, after it passes through Waimamaku.

The results for 2007-08 are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Please note, this site was only sampled on 9 occasions in 2007-08 (sampling began in October 2007). An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.3	11.9 - 23	-
Dissolved oxygen (mg/L)	9.6	7.1 - 10.6	100
Dissolved oxygen (% Sat.)	101.8	65.7 - 107.3	56
Conductivity (mSm)	11	8 - 21.2	-
Water clarity (m)	1.9	0.66 - 2.95	100
Turbidity (NTU)	2.9	1 - 10.7	78
E. coli (n/100mL)	723*	74 - 2187	44
Dissolved reactive phosphorus (mg/L)	0.01*	0.005 - 0.03	78
Total phosphorus (mg/L)	0.024	0.01 - 0.03	100
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.06	78
Total nitrogen (mg/L)	0.277	0.136 - 0.544	100
pH	7.6	7.1 - 8	78

The results from 2007-08 for the Waimamaku River indicate that water quality is good in this river. The medians for the majority of parameters were within relevant guidelines, except for *E. coli* and dissolved reactive phosphorus. Bacteria levels (*E. coli*) were high and exceeded guideline values on 8 out of 9 sampling occasions. Water clarity, dissolved oxygen (mg/L), total nitrogen and phosphorus concentrations met the guidelines on all sampling occasions.

There is not yet sufficient data to undertake trend analysis for this site.

Victoria River

The Victoria River begins in native forest in the Mangamuka Ranges, and runs north through pasture before joining the Awanui River near Kaitaia. The site is located approximately two kilometres downstream of the forest, in pastoral land use; however the upstream catchment is dominated by indigenous forest. The geology of this site is classified as volcanic acidic in the '*River Environment Classification'* (NIWA & MfE 2004).

The results for 2007-08 for the Victoria River site are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	14.8	10.1 - 18.7	-
Dissolved oxygen (mg/L)	9.7	7.8 - 11.3	100
Dissolved oxygen (% Sat.)	95.1*	82.9 - 108.3	17
Conductivity (mSm)	15.7	11.5 - 17.4	-
Water clarity (m)	1.3	0.6 - 3.2	100
Turbidity (NTU)	1.20	1 - 47	67
E. coli (n/100mL)	232	73 - 601	83
Dissolved reactive phosphorus (mg/L)	0.020*	0.01 - 0.021	9
Total phosphorus (mg/L)	0.030	0.019 - 0.09	64
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.01	100
Total nitrogen (mg/L)	0.228	0.104 - 1.142	83
pH	7.6	7.1 - 7.8	92

Results for 2007-08 indicate that water quality in the Victoria River is, for the most part, excellent. The medians for the majority of parameters are within relevant guidelines and most met their relevant guidelines on 10 or more sampling occasions. Dissolved oxygen (%) and dissolved reactive phosphorus are the parameters of most concern as relevant guidelines were not met on 9 or more sampling occasions.

Long-term trend analysis of data for the Victoria River site shows a positive decreasing trend in both dissolved reactive and total phosphorus levels. However, there are significant long term trends indicating that pH, total nitrogen (organic nitrogen) and dissolved oxygen (% saturation) are increasing and water clarity is decreasing. It is likely that the increased trend in dissolved oxygen is positive as current values are low but trends in water clarity and total nitrogen are of greater concern.

Waipapa Stream at Kerikeri Inlet

The Waipapa Stream is fed by Lake Manuwai and flows east out into the Kerikeri Inlet. The stream passes through a mixture of land use types, including pastoral, horticulture (orchards) and lifestyle blocks. The underlying geology is predominantly acidic volcanic.

The results from 2007-08 are summarised in the table below. These include the median, range and percentage of sampling occasions that comply with relevant guidelines. Please note that this site was only sampled on 11 occasions in 2007-08 (sampling began August 2007). An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	17.4	12.9 - 22	-
Dissolved oxygen (mg/L)	9.5	7.4 - 11.5	100
Dissolved oxygen (% Sat.)	98.5	84.9 - 109.2	36
Conductivity (mSm)	8	6.8 - 28.8	-
Water clarity (m)	1.87	0.45 - 2.85	90
Turbidity (NTU)	2.7	1 - 18.2	82
E. coli (n/100mL)	183	31 - 4884	91
Dissolved reactive phosphorus (mg/L)	0.01*	0.005 - 0.03	82
Total phosphorus (mg/L)	0.03	0.005 - 0.075	73
Ammoniacal nitrogen (mg/L)	0.01	0.005 - 0.16	91
Total nitrogen (mg/L)	0.612	0.342 - 1.092	55
pH	6.9*	3.4 - 7.3	18

Results from 2007-08 indicate that water quality at the Waipapa Stream site is generally good, with peaks in nutrients and turbidity occurring during times of high flows.

During 2007-08, the medians for the majority of parameters met their relevant guidelines, except dissolved reactive phosphorus and pH. Dissolved oxygen (mg/l) was the only parameter to meet the guidelines on all sampling occasions. Water clarity, bacteria and ammoniacal nitrogen levels only failed to meet recommended guidelines on one occasion.

There is not yet sufficient data to undertake trend analysis for this site.

Kerikeri River, Stone Store Bridge

The Kerikeri River originates to the east of the Puketi Forest, and flows east into the Kerikeri Inlet. The catchment contains a range of land use, including pastoral, horticulture (orchards), agriculture (crops) and forestry (pine plantations). There are small areas of indigenous forest in the headwaters.

The results from 2007-08 are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Please note that this site was only sampled on 11 occasions in 2007-08 (sampling began August 2007). An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.7	12.4 - 21.3	-
Dissolved oxygen (mg/L)	9.7	8.6 - 13.2	100
Dissolved oxygen (% Sat.)	101.4	88.9 - 123.5	70
Conductivity (mSm)	7.9	6.9 - 30	-
Water clarity (m)	2.11	0.6 - 2.66	100
Turbidity (NTU)	2.8	1 - 26	64
E. coli (n/100mL)	472	98 - 8164	55
Dissolved reactive phosphorus (mg/L)	0.02*	0.005 - 0.06	36
Total phosphorus (mg/L)	0.03	0.016 - 1.2	55
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.21	73
Total nitrogen (mg/L)	0.762*	0.512 - 1.343	27
pH	7.3	7 - 7.4	82

During 2007-08, the medians for the majority of parameters met their relevant guidelines, except dissolved reactive phosphorus and total nitrogen. Dissolved oxygen (mg/l) and water clarity were the only parameters that met the guideline on all sampling occasions.

Bacterial levels (*E. coli*) exceeded the guideline value for recreational bathing of 550/100ml on six out of 11 sampling occasions. This is concerning and indicates that there is a more persistent source of *E. coli* in the upper catchment, such as a leaking septic tank, stock with access to the river or farm dairy discharge. Restricting stock access to the river, managing point-source discharges and maintaining septic tanks in this area would benefit water quality in this river.

This is the first year this river has been monitored as part of the RWQMN. There is not yet sufficient data to undertake trend analysis for this site.

Mangamuka River

The Mangamuka River begins in the Mangamuka Forest. The river then flows south into the upper reaches of the Hokianga Harbour. In the lower reaches, the river passes through pastoral land however the upper catchment is dominated by indigenous forest. The sampling site is located upstream of the confluence between the Mangamuka and Iwitaua Stream.

Results for 2007-08 are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Please note that this site was only sampled on 11 occasions in 2007-08 (sampling began August 2007). An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	14.9	10.3 - 18.8	-
Dissolved oxygen (mg/L)	9.2	7.8 - 10.9	100
Dissolved oxygen (% Sat.)	93.8*	80.7 - 100.5	18
Conductivity (mSm)	16	10.7 - 17.8	-
Water clarity (m)	1.6	0.9 - 3.4	100
Turbidity (NTU)	1	1 - 25	70
E. coli (n/100mL)	272	86 - 2282	82
Dissolved reactive phosphorus (mg/L)	0.03*	0.03 - 0.04	0
Total phosphorus (mg/L)	0.046*	0.033 - 0.073	10
Ammoniacal nitrogen (mg/L)	0.005	0.005	100
Total nitrogen (mg/L)	0.121	0.084 - 0.852	91
pH	7.5	6.9 - 7.7	91

During 2007-08, dissolved oxygen (mg/l), water clarity and ammoniacal nitrogen were the only parameters that met the guidelines on all sampling occasions. Dissolved reactive phosphorus did not meet the relevant guideline on any occasion, which is concerning as the majority of the catchment is native forest.

This is the first year this river has been monitored as part of the RWQMN. There is not yet sufficient data to undertake trend analysis for this site.

Waitangi River at Watea

The Waitangi River originates in the middle of Northland and flows east, where it joins the coast at Waitangi. There are two sites on the Waitangi River that form part of the RWQMN; one at Waimate North and the other at Watea near Waitangi. The catchments of both sites are dominated by pastoral farming. However, the geology of the upstream site at Waimate North is predominantly volcanic acidic, while the site at Watea is dominated by hard sediments.

Unlike many of Northland's rivers, a buffer strip of riparian vegetation exists along the banks of the majority of the Waitangi River. The Watea site on the Waitangi River is one of four sites in Northland that are part of the National River Water Quality Network administered by NIWA.

The results from 2007-08 for this site are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Note: Dissolved reactive phosphorus and ammoniacal nitrogen results were only available for six sampling occasions (July 2007 – December 2007). An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	18	12.3 - 23.2	-
Dissolved oxygen (mg/L)	9.7	8.3 - 11.1	100
Dissolved oxygen (% Sat.)	101.9	96.2 - 109.6	75
Conductivity (mSm)	11.3	9.68 - 13.5	-
Water clarity (m)	0.94	0.125 - 2.75	58
Turbidity (NTU)	5.1	0.8 - 42.3	50
E. coli (n/100mL)	292	56 - 2419	67
Dissolved reactive phosphorus (mg/L)	0.007	0.004 - 0.015	67
Total phosphorus (mg/L)	0.027	0.015 - 0.136	67
Ammoniacal nitrogen (mg/L)	0.007	0.003 - 0.028	83
Total nitrogen (mg/L)	0.622*	0.226 - 1.175	42
pH	7.5	6.9 - 7.8	75

During 2007-08, water quality at the Watea site on the Waitangi River was similar to that at the Waimate North site. The median for total nitrogen was the only parameter outside of the recommended guidelines. However, like the Waimate site, compliance with the guidelines for most parameters has fallen this year.

Again, bacterial contamination is the most concerning result with *E. coli* levels exceeding the relevant guideline of 550 *E. coli*/100ml on eight out of 12 sampling occasions. Total nitrogen also had poor compliance, with levels exceeding 0.614 mg/l on seven sampling occasions.

Based on data from October 1996 to December 2007, the trend analysis shows that there are no significant trends for any of the parameters at this site.

Waitangi River at Waimate North

The Waitangi River originates just east of Lake Omapere, and flows into the Bay of Islands. There are two sites on Waitangi River in the RWQMN; one in the upper to mid reaches at Waimate North and the other in the lower reaches at Watea. At the Waimate North site, the catchment is a mix of beef, sheep and dairy farming, with significant areas of indigenous forest in the headwaters. The underlying geology is predominantly acidic volcanic.

The results for 2007-08 for the Waitangi River at Waimate North are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.1	11.6 - 19.5	-
Dissolved oxygen (mg/L)	9.6	8.8 - 11.3	100
Dissolved oxygen (% Sat.)	95.3*	91.1 - 104.3	25
Conductivity (mSm)	9.55	4.2 - 31.5	-
Water clarity (m)	0.9	0.3 - 2.2	64
Turbidity (NTU)	6.1*	2.8 - 44	42
E. coli (n/100mL)	446	275 - 2063	67
Dissolved reactive phosphorus (mg/L)	0.01*	0.005 - 0.02	64
Total phosphorus (mg/L)	0.03	0.015 - 0.065	58
Ammoniacal nitrogen (mg/L)	0.0075	0.005 - 0.15	67
Total nitrogen (mg/L)	0.5775	0.472 - 1.042	58
pH	6.9*	6.7 - 7.1	0

Results from 2007-08 indicate that water quality in the Waitangi River at Waimate North has deteriorated. Results from 2007-08 indicate elevated levels of nutrients, increased turbidity and decreasing water clarity. In the past, nutrient levels and water clarity have met their relevant guidelines on most sampling occasions at this site.

The median for turbidity and pH were not within accepted guidelines this year.

Trend analysis on 10 years of data for this site shows that there is a significant increase in water clarity and a decrease in dissolved reactive and total phosphorus. These are positive trends.

There is also an increasing trend in pH; however, it is not yet known whether an increase in pH at this site is beneficial or detrimental, however, it is likely that an increase in pH is beneficial, as pH levels this year were often below the optimum pH range for the protection of aquatic ecosystems.

Waiarohia Stream at Second Ave

Waiarohia Stream is a small stream originating from Pukenui Forest and the Western Hills in Whangarei. The upper catchment is mainly indigenous forest with some exotic forestry. The stream flows through a small area of low intensity farmland and lifestyles block, before it reaches residential housing and the central business area of Whangarei. This site is located in the central business area and was added to the RWQMN in 2005-06 to look at urban influences on water quality. Results for this site can be compared to the upstream site in Whau Valley.

The results from 2007-08 for the Waiarohia Stream site at Second Ave are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	18.65	13.6 - 25.5	-
Dissolved oxygen (mg/L)	10.3	8.1 - 12.1	100
Dissolved oxygen (% Sat.)	105.7	87.2 - 121.8	25
Conductivity (mSm)	21.9	2.5 - 31.8	-
Water clarity (m)	1.59	0.4 - 2.67	92
Turbidity (NTU)	5.6*	2 - 24	50
E. coli (n/100mL)	434	121 - 1789	58
Dissolved reactive phosphorus (mg/L)	0.01*	0.01 - 0.017	75
Total phosphorus (mg/L)	0.03	0.01 - 0.05	67
Ammoniacal nitrogen (mg/L)	0.01	0.005 - 0.27	92
Total nitrogen (mg/L)	0.632*	0.292 - 0.982	50
pH	7.4	6.8 - 7.8	92

Results from 2007-08 indicate that water quality at this site is average, with half of the parameters meeting their respective guidelines on eight or more sampling occasions.

Bacteria levels are often elevated at this site with levels higher than the recreational bathing guideline of 550 *E. coli*/100 mL on five occasions. The highest temperature of all the RWQMN sites was recorded at this site on 16 January 2008 (25.5°C). It is commonly accepted that water temperatures of greater then 25°C are potentially harmful or even lethal for aquatic life.

During 2007-08, dissolved reactive phosphorus, total nitrogen and turbidity were also elevated and did not meet their relevant guidelines. The source of nutrient and bacterial contamination in this stream is likely to be surrounding, small scale pastoral farming and is probably related to stock access to the stream. The overuse of fertiliser in residential gardens could also contribute to the increase in nitrogen.

There is not yet sufficient data to undertake trend analysis for this site.

Whakapara River

The Whakapara River originates from the ranges east of Hikurangi and Whakapara, eventually joining the Waiotu River, forming the headwaters of the greater Wairua River. The river cuts through hard sediments formed from faulted greywacke, along a relatively low gradient. The site is located in a beef and sheep farm near State Highway one, with an upstream catchment dominated by forested hills and pastoral farming.

The results for 2007-08 for the Whakapara River site are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.0	11.7 - 20.4	-
Dissolved oxygen (mg/L)	9.6	7.3 - 10.8	100
Dissolved oxygen (% Sat.)	93.1*	75.9 - 111	17
Conductivity (mSm)	9.0	5 - 29.8	-
Water clarity (m)	1.0	0.22 - 1.84	73
Turbidity (NTU)	7.7*	2.9 - 119	17
E. coli (n/100mL)	181	20 - 8664	83
Dissolved reactive phosphorus (mg/L)	0.027*	0.02 - 0.054	0
Total phosphorus (mg/L)	0.05*	0.037 - 0.183	0
Ammoniacal nitrogen (mg/L)	0.01	0.005 - 0.13	58
Total nitrogen (mg/L)	0.542	0.155 - 1.746	58
pH	6.8*	6.4 - 7.3	25

During 2007-08, the medians for five parameters did not meet their relevant guidelines. Both total phosphorus and dissolved reactive phosphorus did not meet guideline values on any of the sampling occasions. Turbidity, dissolved oxygen (%) and pH failed to meet their respective guidelines on most sampling occasions.

Significant long term trends in Whakapara River include increasing water clarity and decreasing dissolved reactive and total phosphorus trends, which are all seen as positive trends. There is an increasing trend in dissolved oxygen (%), which could be related to an increase in the biomass of oxygen weed and other macrophytes in the river. It is unknown whether this is a negative or positive trend, as dissolved oxygen levels can be both below and above the optimum range for the protection of aquatic ecosystems.

There is also an increasing trend in pH, which is likely to be beneficial as the pH is often below the optimum range for aquatic life.

Waiarohia Stream at Whau Valley Road

Waiarohia Stream is a small stream originating from Pukenui Forest and the Western Hills in Whangarei. The upper catchment is mainly indigenous forest with some exotic forestry. The stream flows through a small area of low intensity farm land (mostly lifestyle blocks), before it reaches residential housing and the central business area of Whangarei. This site is located upstream of the majority of residential housing in the upper catchment of the Waiarohia Stream.

The results from 2007-08 for the Waiarohia Stream site at Whau Valley Road are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.4	12.8 - 21.1	-
Dissolved oxygen (mg/L)	9.9	7.9 - 10.7	100
Dissolved oxygen (% Sat.)	98.0	84.6 - 120.5	25
Conductivity (mSm)	23.5	13.5 - 39.2	-
Water clarity (m)	0.95	0.4 - 1.76	83
Turbidity (NTU)	6.55	3.2 - 42	42
E. coli (n/100mL)	391	5 - 2382	67
Dissolved reactive phosphorus (mg/L)	0.017*	0.01 - 0.02	25
Total phosphorus (mg/L)	0.04*	0.02 - 0.08	33
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.21	92
Total nitrogen (mg/L)	0.597	0.362 - 0.972	58
pH	7.3	6.8 - 7.7	67

Results from 2007-08 highlight several areas of concern in the Waiarohia Stream. Compliance with guideline values is poor for dissolved oxygen (%), turbidity, and dissolved reactive and total phosphorus. Phosphorus levels are higher and fail to meet recommended guideline values on more occasions than the downstream site at Second Ave.

The source of nutrient and bacterial contamination is likely to be surrounding, small-scale pastoral farming and could be related to stock access to the stream.

There is not yet sufficient data to undertake trend analysis for this site.

Waipao Stream, Draffin Road Bridge

The Waipao Stream was added to the RWQMN in 2007-08. The Waipao Stream begins as the Kauritutahi Stream to the west of Mangatapere (the Kauritutahi Stream becomes Waipao as it flows west towards Poroti). At Poroti, a number of springs feed into the stream and the stream itself eventually feeds into the Wairua River. The catchment of the stream is largely agricultural and includes high production farmland, orchards, crops and some small lifestyle blocks.

The 2007-08 results for Waipao Stream are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Please note that this site was only sampled on 10 occasions in 2007-08. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	17	13.4 - 19.4	-
Dissolved oxygen (mg/L)	9.95	8 - 12.4	100
Dissolved oxygen (% Sat.)	102	83.6 - 135.1	40
Conductivity (mSm)	18.15	17.3 - 20.8	-
Water clarity (m)	1.81	0.42 - 2.86	90
Turbidity (NTU)	3.25	1 - 14.3	80
E. coli (n/100mL)	700*	384 - 2481	20
Dissolved reactive phosphorus (mg/L)	0.03*	0.02 - 0.049	0
Total phosphorus (mg/L)	0.055*	0.03 - 0.136	10
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.11	80
Total nitrogen (mg/L)	3.0195*	2.184 - 3.842	0
pH	7.35	7 - 8.1	80

Limited conclusions can be drawn from the data collected in 2007-08, as this was the first year of sampling at this site. However, it is apparent from the results that dissolved and total phosphorus, total nitrogen, and *E. coli* levels are elevated in the Waipao Stream.

The median for total nitrogen is significantly higher than the guideline value of 0.614 mg/l. Nitrogen could be entering the stream through runoff from surrounding agricultural land or could be naturally occurring, leaching from volcanic soils in the catchment.

E.coli, dissolved reactive phosphorus and total nitrogen did not meet the relevant guidelines on eight or more of the sampling occasions.

As the site was only added to the network in 2007, there is not yet sufficient data for the site to undertake trend analysis.

Mangakahia River at Titoki

The Mangakahia River originates in native bush near Waipoua Forest and flows southwest until it reaches the Wairua River. There are two sites on the Mangakahia River; one mid catchment at Twin Bridges and the other at Titoki Bridge in the lower reaches. By the time the Mangakahia River reaches the settlement of Titoki, surrounding land use is predominantly beef and dairy farming, with an underlying geology of acidic volcanic rock. This site is one of four sites in Northland that are part of the National River Water Quality Network, administered by NIWA.

The results from 2007-08 for the Mangakahia River site at Titoki Bridge are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Note: Dissolved reactive phosphorus and ammoniacal nitrogen results were only available for six sampling occasions (July 2007 – December 2007). An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	17.2	12.1 - 24.1	-
Dissolved oxygen (mg/L)	9.2	6.9 - 10.4	100
Dissolved oxygen (% Sat.)	95.7*	73.3 - 101.7	17
Conductivity (mSm)	13.5	7.78 - 16.5	-
Water clarity (m)	0.50*	0.05 - 1.7	42
Turbidity (NTU)	8.30*	3.5 - 23.3	36
E. coli (n/100mL)	262	80 - 2419	75
Dissolved reactive phosphorus (mg/L)	0.008	0.006 - 0.011	83
Total phosphorus (mg/L)	0.029	0.012 - 0.283	58
Ammoniacal nitrogen (mg/L)	0.015	0.01 - 0.03	83
Total nitrogen (mg/L)	0.301	0.1 - 1.22	92
pH	7.3	6.73 - 7.93	67

The results from 2007-08 indicate that water in the Mangakahia at Titoki is of moderate quality. The medians for turbidity, water clarity and dissolved oxygen (% saturation) did not meet their respective guidelines. The peaks in nutrients, turbidity and bacterial levels are related to increased/high flow.

Trend analysis on data from October 1996 to May 2006 indicates there is an increasing trend in total kjeldahl nitrogen (the sum of organic nitrogen, ammonia and ammonium) but not in total or ammoniacal nitrogen.

Photo: Mangakahia River at Titoki

Ngunguru River

The Ngunguru River originates in Waipaipai to the west of the Tutukaka Coast and flows through the Glenbervie forest out into the Ngunguru Estuary. Half of the catchment is pastoral, with the rest a mixture of *Pinus radiata* forest and indigenous forest. The site is situated in the lower reaches of the river just before the river becomes saline.

The 2007-08 results for the Ngunguru River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Please note, this site was only sampled on nine occasions in 2007-08. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.7	12.6 - 21	-
Dissolved oxygen (mg/L)	9.3	7.7 - 10.4	100
Dissolved oxygen (% Sat.)	96.6*	86.2 - 100.2	22
Conductivity (mSm)	10.5	3.11 - 38.6	-
Water clarity (m)	0.91	0.31 - 1.98	78
Turbidity (NTU)	12.7*	3.8 - 102	33
E. coli (n/100mL)	457	122 - 3873	67
Dissolved reactive phosphorus (mg/L)	0.014*	0.01 - 0.02	33
Total phosphorus (mg/L)	0.035*	0.02 - 0.084	44
Ammoniacal nitrogen (mg/L)	0.020	0.005 - 0.08	67
Total nitrogen (mg/L)	0.294	0.174 - 1.072	89
pH	6.9*	6.8 - 7.2	11

The results from 2007-08 indicate that the Ngunguru River has moderate water quality. Dissolved oxygen (mg/l) was the only parameter to comply with its guideline value on all sampling occasions.

PH only met its recommended guideline on one out of nine sampling occasions. Dissolved oxygen (%), turbidity, total and dissolved phosphorus also appear to be an issue at this site, with their medians for 2007-08 falling outside the relevant guideline value.

Trend analysis cannot yet be undertaken for this site as there is insufficient data.

Kaeo River

The Kaeo River begins north of Waipapa and flows north into the Whangaroa Harbour. Approximately half of the catchment is indigenous forest and scrub, with the remainder in pine forestry or pastoral farming. The underlying geology of the river is soft sediments. The site is located below the township of Kaeo, just before the influence of salt water.

The results from 2007-08 for the Kaeo River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Please note that this site was only sampled on 11 occasions in 2007-08. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	17	11.2 - 23.2	-
Dissolved oxygen (mg/L)	8.7	7.6 - 10.1	100
Dissolved oxygen (% Sat.)	87.6*	81.2 - 118	9
Conductivity (mSm)	12.6	6.4 - 14.4	-
Water clarity (m)	0.7	0.3 - 1.6	78
Turbidity (NTU)	7.5*	3.9 - 88	18
E. coli (n/100mL)	656.5*	262 - 1274	36
Dissolved reactive phosphorus (mg/L)	0.008	0.005 - 0.015	80
Total phosphorus (mg/L)	0.030	0.01 - 0.077	80
Ammoniacal nitrogen (mg/L)	0.010	0.005 - 0.03	82
Total nitrogen (mg/L)	0.262	0.168 - 0.802	82
pH	7.1*	6.9 - 7.3	27

The results from 2007-08 indicate that water quality in the Kaeo River is moderate, with most parameters meeting their respective guidelines on eight or more sampling occasions. However, the median for dissolved oxygen (%), turbidity, *E. coli* and pH exceeded the relevant guideline value.

Trend analysis cannot yet be undertaken for this site as there is insufficient data.

Punakitere River at Taheke

The Punakitere River originates from a wetland to the southwest of Kaikohe and is a major tributary of the Waima River (which flows into the Hokianga Harbour). The catchment is predominantly agricultural land use with an underlying geology of soft sediments.

The results from 2007-08 for the Punakitere River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.6	11.8 - 21.4	-
Dissolved oxygen (mg/L)	9.9	6.3 - 10.7	100
Dissolved oxygen (% Sat.)	98.7	58.6 - 109.2	42
Conductivity (mSm)	12.3	9.1 - 23.5	-
Water clarity (m)	0.92	0.24 - 2.52	67
Turbidity (NTU)	11.7*	2.4 - 122	25
E. coli (n/100mL)	480	195 - 17329	67
Dissolved reactive phosphorus (mg/L)	0.03*	0.01 - 0.071	8
Total phosphorus (mg/L)	0.065*	0.03 - 0.196	8
Ammoniacal nitrogen (mg/L)	0.020	0.005 - 0.08	58
Total nitrogen (mg/L)	0.83*	0.276 - 1.612	17
pH	7.4	7 - 8	50

The results from 2007-08 indicate that the Punakitere River suffers from significant nutrient overloading, with medians for turbidity, dissolved reactive phosphorus, total phosphorus and total nitrogen all exceeding their respective guidelines. Run-off from surrounding land-use is the most likely source of nutrient and bacterial contamination in the Punakitere River.

Both dissolved reactive and total phosphorus only met their recommended guideline on one occasion.

Trend analysis on seven years data shows that there is a decreasing trend in ammoniacal nitrogen for the Punakitere River. There is also a slight decrease in total nitrogen however this trend is not significant.

Photo: Punakitere River

Oruru River, Oruru Road

The Oruru River originates from the Otangaroa forest and flows north through indigenous forest and scrub. In the lower catchment, the river meanders through pastoral dominated land eventually flowing out into the Taipa River. Underlying geology is dominated by volcanic acidic rock, with some areas of soft sediments.

The results for 2007-08 for the Oruru River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Please note that this site was only sampled on 11 occasions in 2007-08. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.8	12.5 - 21.8	-
Dissolved oxygen (mg/L)	8.1	6.9 - 10.3	100
Dissolved oxygen (% Sat.)	84.0*	73.3 - 96.9	0
Conductivity (mSm)	16.2	10.2 - 17.7	-
Water clarity (m)	0.7	0.4 - 1.3	67
Turbidity (NTU)	8.3*	3.3 - 112	27
E. coli (n/100mL)	301	86 - 4884	73
Dissolved reactive phosphorus (mg/L)	0.021*	0.02 - 0.032	0
Total phosphorus (mg/L)	0.042*	0.03 - 0.143	10
Ammoniacal nitrogen (mg/L)	0.005	0.005 - 0.05	73
Total nitrogen (mg/L)	0.288	0.125 - 1.092	73
pH	7*	7.1 - 7.7	82

The results from 2007–08 indicate that water quality in the Oruru River is highly impacted, with the medians for dissolved oxygen (%), turbidity, pH, and total and dissolved phosphorus all exceeding their recommended guideline values.

Dissolved oxygen (percentage) and dissolved reactive phosphorus did not meet the relevant guideline values on any of the 11 sampling occasions.

Trend analysis cannot yet be undertaken for this site as there is insufficient data.

Waiotu River at SH1

The Waiotu River is a hard sediment bottomed river derived from a predominantly agricultural catchment. The river originates from the hills to the northeast of State Highway one, between Kawakawa and Whangarei, and runs into the Whakapara River to form the greater Wairua River.

The results from 2007-08 for the Waiotu River site are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with the relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.9	11.5 - 20.1	-
Dissolved oxygen (mg/L)	9.0	7.1 - 10.7	100
Dissolved oxygen (% Sat.)	90.3	73.3 - 98.8	17
Conductivity (mSm)	9.9	8 - 30.7	-
Water clarity (m)	0.89	0.32 - 1.66	73
Turbidity (NTU)	9.45*	4.3 - 33	17
E. coli (n/100mL)	384	74 - 4106	75
Dissolved reactive phosphorus (mg/L)	0.023*	0.02 - 0.121	0
Total phosphorus (mg/L)	0.065*	0.03 - 0.123	8
Ammoniacal nitrogen (mg/L)	0.030*	0.005 - 0.14	42
Total nitrogen (mg/L)	0.617*	0.234 - 1.737	50
pH	6.8*	6 - 7.3	17

Results from 2007-08 indicate that water quality in the Waiotu River is highly impacted, with the medians for the majority of parameters not meeting their respective guidelines. Dissolved reactive phosphorus exceeded its ANZECC trigger values on all 12 sampling occasions. Total phosphorus only met its respective guidelines once.

For the majority of parameters, the medians from 2007-08 are higher than those recorded in 2006-07, in particular total nitrogen and turbidity.

Trend analysis on data collected for this site suggests that there is an increasing trend in turbidity.

Photo: Waiotu River

Awanui River at FNDC water take

The Awanui River originates from Raetea Forest (Mangamuka's) and meanders north for a significant distance through pasture and the Kaitaia Township, eventually flowing into the Rangunu Harbour. There are 3 sites in the network on the Awanui River system; one in the upper reaches on Victoria River, one in the mid reaches at the FNDC water take and one in the lower reaches directly above Waihue channel.

The FNDC water take from the Awanui River is adjacent to State Highway 1, just south of Kaitaia. Land use in the upstream catchment is predominantly pastoral, with some semi-forested tributaries, for example, the Victoria River. The river's geology is soft sediments.

The results from 2007-08 for the Awanui River at the FNDC water take are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.8	12.1 - 21.5	-
Dissolved oxygen (mg/L)	8.6	6.4 - 9.8	100
Dissolved oxygen (% Sat.)	82.5*	71.8 - 98.4	8
Conductivity (mSm)	18.9	15.1 - 22.7	-
Water clarity (m)	0.70	0.3 - 2	70
Turbidity (NTU)	8.25*	2.3 - 51	17
E. coli (n/100mL)	207	20 - 3873	67
Dissolved reactive phosphorus (mg/L)	0.02*	0.02 - 0.045	0
Total phosphorus (mg/L)	0.05*	0.02 - 0.13	18
Ammoniacal nitrogen (mg/L)	0.018	0.005 - 0.05	50
Total nitrogen (mg/L)	0.330	0.119 - 2.552	75
pH	7.55	7.1 - 7.9	67

As for the previous two years, results from 2007-08 indicate that nitrogen concentrations at this site are satisfactory on most occasions, however dissolved oxygen (% saturation), phosphorus and turbidity failed to meet the relevant guidelines on 10 or more sampling occasions. Some of these elevated results coincided with high flows and therefore are most likely the result of surface run-off from surrounding land during rainfall events.

Improved riparian management, for example, restricting stock access to waterways in this catchment will assist in improving water quality. Better maintenance of septic tanks in the catchment may also reduce contamination.

A potential source of phosphorus is inefficiently applied fertiliser. Peaks in phosphorus generally occur in autumn when fertiliser is typically applied. Accurate nutrient budgeting and appropriate application can reduce the amount of fertiliser wasted in run-off, which then enters streams.

Trend analysis for 12 years of water quality data shows that there is a decreasing trend in ammoniacal nitrogen, and dissolved reactive and total phosphorus at this site. These are all beneficial trends and may already be the result of improved land management practices in the catchment.

Mangahahuru Stream at Apotu Road

The Mangahahuru Stream, which begins in *Pinus radiata* forestry southeast of Hikurangi, is a small tributary of the Wairua River. Other than the exotic forestry in the headwaters, the catchment is predominantly agricultural land use, with an increasing number of lifestyle blocks. The underlying geology is hard sedimentary.

The results for 2007-08 for the Mangahahuru Stream at Apotu Road are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with the relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.2	11.7 - 20.1	-
Dissolved oxygen (mg/L)	9.9	5.4 - 11.4	92
Dissolved oxygen (% Sat.)	95.3*	55.9 - 115	17
Conductivity (mSm)	11.5	8.7 - 32.3	-
Water clarity (m)	0.85	0.26 - 1.8	73
Turbidity (NTU)	8.25*	3.6 - 64	17
E. coli (n/100mL)	573*	109 - 5794	50
Dissolved reactive phosphorus (mg/L)	0.029*	0.019 - 0.052	0
Total phosphorus (mg/L)	0.075*	0.037 - 0.143	0
Ammoniacal nitrogen (mg/L)	0.03*	0.005 - 0.07	50
Total nitrogen (mg/L)	0.651*	0.372 - 1.402	50
pH	6.9*	6.2 - 7.3	25

The results from 2007-08 indicate that water quality in the Mangahahuru Stream is highly impacted, with the medians of most parameters exceeding their guideline values. The stream has high levels of nutrients and *E. coli* bacteria.

In 2007-08, both total and dissolved phosphorus exceeded guideline values on all sampling occasions. Dissolved oxygen (%) levels are of particular concern, as there are large variations with the lowest observed reading being 55.9 mg/l and the highest being 115 mg/l. It is likely these variations are due to large amounts of oxygen weed at the site.

The most likely source of contamination at this site is surface run-off from surrounding land, as spikes in contamination are associated with high river flows after rainfall events. Poorly maintained septic tanks, stock access to the stream and point source consented discharges, such as the Hikurangi Oxidation Pond, may also contribute.

Trend analysis on data for the site indicates positive (improving) trends for water clarity, ammoniacal nitrogen, nitrate nitrite nitrogen, and dissolved reactive and total phosphorus in the Mangahahuru Stream. There is also an increasing trend in pH, which in this case is a positive trend, as pH at this site is often below the optimum range for aquatic life.

There are some negative trends for the Mangahahuru Stream, including increasing conductivity and dissolved oxygen (percentage).

Waiharakeke River at Stringer Road

The Waiharakeke River is a major tributary of the Kawakawa River, which flows into the Waikare Inlet in the Bay of Islands. The Waiharakeke River originates in the Motatau Forest and flows North through a mixture of pine forestry, pastoral land and indigenous forest, before reaching Moerewa. The underlying geology is hard sedimentary.

The results from 2007-08 for the Waiharakeke River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with the relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.95	11.1 - 20.7	-
Dissolved oxygen (mg/L)	9.4	8.3 - 10.9	100
Dissolved oxygen (% Sat.)	95.0*	91.7 - 101.3	8
Conductivity (mSm)	15.0	7.9 - 33.1	-
Water clarity (m)	0.65	0.27 - 1.36	64
Turbidity (NTU)	11.35*	4.9 - 50	8
E. coli (n/100mL)	574*	160 - 3873	50
Dissolved reactive phosphorus (mg/L)	0.02*	0.01 - 0.113	8
Total phosphorus (mg/L)	0.06*	0.04 - 0.115	0
Ammoniacal nitrogen (mg/L)	0.015	0.005 - 0.17	75
Total nitrogen (mg/L)	0.518	0.178 - 1.717	58
pH	7.3	6.9 - 7.7	75

The results from 2007-08 indicate that the Waiharakeke Stream is a moderately impacted waterway, with poor dissolved oxygen (%) concentrations and high phosphorus, *E.coli* and turbidity levels.

Total phosphorus exceeded its relevant guideline value on every sampling occasion. Turbidity and dissolved reactive phosphorus only met their recommended guideline once. Dissolved oxygen (mg/l) was the only parameter that met its relevant guideline on all sampling occasions.

Trend analysis cannot yet be undertaken for this site as there is insufficient data.

Paparoa Stream

The Paparoa Stream is a soft sediment-bottomed stream, which is set in a catchment dominated by high production farmland, with pockets of pine forestry and native bush. The stream flows west into an arm of the Kaipara harbour. The site is located in the park in Paparoa Township.

The results from 2007-08 for Paparoa Stream are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Please note that this site was only sampled on 11 occasions in 2007-08. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.8	11.4 - 21.2	-
Dissolved oxygen (mg/L)	8.8	6.2 - 10.3	100
Dissolved oxygen (% Sat.)	88.9*	70.2 - 96.3	0
Conductivity (mSm)	27.4	19.6 - 468.2	-
Water clarity (m)	1	0.3 - 1.7	82
Turbidity (NTU)	6*	3.8 - 38	45
E. coli (n/100mL)	857*	134 - 6131	27
Dissolved reactive phosphorus (mg/L)	0.03*	0.01 - 0.051	18
Total phosphorus (mg/L)	0.07*	0.05 - 0.163	0
Ammoniacal nitrogen (mg/L)	0.02	0.01 -0.05	64
Total nitrogen (mg/L)	0.522	0.194 -1.821	64
pH	7.4	6.9 -7.8	91

The results from 2007-08 indicate that the Paparoa Stream is affected by high phosphorus and *E.coli* concentrations. Dissolved oxygen (%) is also an issue with levels exceeding the recommended ANZECC guideline values on all sampling occasions. High algal biomass in the stream during the summer months is the most likely cause of low oxygen levels.

During 2007-08, total phosphorus also failed to comply with its relevant guidelines on all sampling occasions. Dissolved reactive phosphorus and E. coli only complied two and three times, respectively, through the year. The most likely source of *E. coli* and phosphorus in this catchment is run-off from pastoral land and poorly maintained septic tanks. Fencing stock out of waterways, riparian planting in the catchment and maintaining septic tanks would reduce the amount of contaminants entering the stream.

Trend analysis cannot yet be undertaken for this site as there is insufficient data.

Hakaru River

The Hakaru River originates in native bush and pine forestry in the Brynderwyn hills and flows south through farmland until it reaches the Topuni River. The Topuni River feeds into an arm of the Kaipara harbour. The underlying geology in the catchment is a mixture of volcanic acidic, and hard and soft sedimentary rock. The site is located at the bottom of the catchment, above the saline influence.

The results for 2007-08 for Hakaru River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Please note that this site was only sampled on 10 sampling occasions in 2007-08. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.6	12.3 - 20.4	-
Dissolved oxygen (mg/L)	9.9	8.5 - 11.3	100
Dissolved oxygen (% Sat.)	101.05	91.8 -106	50
Conductivity (mSm)	18.15	15.1 - 18.9	-
Water clarity (m)	0.81	0.28 - 1.24	80
Turbidity (NTU)	10.75*	7.2 - 50	0
E. coli (n/100mL)	384	134 - 7701	80
Dissolved reactive phosphorus (mg/L)	0.065*	0.04 - 0.174	0
Total phosphorus (mg/L)	0.139*	0.09 - 0.23	0
Ammoniacal nitrogen (mg/L)	0.045*	0.01 - 0.2	50
Total nitrogen (mg/L)	0.759*	0.372 - 1.791	30
pH	7.65	7.3 - 8.2	80

The results for 2007-08 indicate that water quality in the Hakaru River is highly impacted, with high levels of nutrients and turbidity. The medians for both total and ammoniacal nitrogen were also above the guideline values of 0.021mg/L and 0.614 mg/L respectively.

Turbidity, dissolved reactive and total phosphorus exceeded their respective guideline values on all sampling occasions. This relatively poor water quality can be linked to runoff from surrounding agricultural land use.

Trend analysis cannot yet be undertaken for this site as there is insufficient data.

Wairua River at Purua

The Wairua River above Whangarei flows west into the Kaipara Harbour. It is one of the major tributaries of the greater Wairoa River. The catchment upstream of the sampling site is predominantly pastoral. The river cuts through hard sediments along a low gradient. The Wairua River site at Purua is one of four sites in Northland that are part of the National River Water Quality Network administered by NIWA.

The results for 2007-08 for the Wairua River at Purua are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with the relevant guidelines. Note: Dissolved reactive phosphorus and ammoniacal nitrogen results are only available for July 2007 to December 2007. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	17.7	12.2 - 22.9	-
Dissolved oxygen (mg/L)	8.7	5.2 - 9.9	92
Dissolved oxygen (% Sat.)	88.4*	56.3 - 116.9	8
Conductivity (mSm)	12	10.1 - 13	-
Water clarity (m)	0.49*	0.15 - 1.95	42
Turbidity (NTU)	14.5*	5 - 33	8
E. coli (n/100mL)	83	26 - 2419	75
Dissolved reactive phosphorus (mg/L)	0.024*	0.017 - 0.077	0
Total phosphorus (mg/L)	0.072*	0.032 - 0.244	8
Ammoniacal nitrogen (mg/L)	0.061*	0.024 - 0.203	0
Total nitrogen (mg/L)	0.867*	0.172 - 2.163	33
pH	6.8*	6.3 - 7.8	17

The results from 2007-08 indicate that the Wairua River is a highly impacted waterway, with poor dissolved oxygen levels, poor water clarity, elevated phosphorus and nitrogen levels and low pH. This relatively poor water quality is a result of intensive surrounding agricultural land use.

Low dissolved oxygen (% saturation) is a likely result of large macrophyte beds in the river.

Trend analysis on data from October 1996 to December 2007 indicates several positive trends, including decreasing nitrate nitrogen and total nitrogen. There is also a trend suggesting that pH is increasing. This is likely to be a beneficial trend for this site as pH is often below the optimum range for the protection of aquatic ecosystems.

Utakura River at Rangiahua Road Bridge

The Utakura River is fed by Lake Omapere, to the north of Kaikohe, and flows west into the Waihou River arm of the Hokianga Harbour. The catchment is dominated by farmland with areas of native forest, pine forest and manuka scrub.

The results from 2007-08 for the Utakura River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with relevant guidelines. Please note that this site was only sampled on 10 occasions in 2007-08. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	17.1	12.1 - 22.1	-
Dissolved oxygen (mg/L)	7.8	5.6 - 10.2	80
Dissolved oxygen (% Sat.)	83.9*	53.3 - 94.9	0
Conductivity (mSm)	10.9	9.5 - 21.1	-
Water clarity (m)	0.465*	0.37 - 0.75	10
Turbidity (NTU)	35.75*	19.9 - 74	0
E. coli (n/100mL)	508	331 - 5475	60
Dissolved reactive phosphorus (mg/L)	0.020*	0.01 - 0.058	30
Total phosphorus (mg/L)	0.096*	0.05 - 0.17	0
Ammoniacal nitrogen (mg/L)	0.020*	0.005 - 0.05	70
Total nitrogen (mg/L)	0.693*	0.452 - 1.232	30
pH	7.0*	6.6 - 7.2	10

The results for 2007-08 indicate that water quality in the Utakura River is severely impacted, with the medians of the majority of parameters not meeting the recommended guideline values.

In 2007-08, dissolved oxygen (%), turbidity and total phosphorus exceeded their relevant guideline values on all sampling occasions, and water clarity and pH exceeded on nine out of 10 occasions.

Trend analysis cannot yet be undertaken for this site as there is insufficient data.

Awanui River at Waihue Channel

This site is the lowest of three sites on the Awanui River system and is located directly downstream of the discharge from the Kaitaia oxidation ponds and upstream of the Waihue Channel. At this point, the Awanui River has flowed through more than 30km of agricultural land and the Kaitaia Township. The '*River Environment Classification'* identifies this site as a low elevation river with soft sediment geology and pastoral land use.

The results from 2007-08 for the Awanui River site at Waihue Channel are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with the relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.7	12.5 - 22.3	-
Dissolved oxygen (mg/L)	8.5	4.7 - 9.3	83
Dissolved oxygen (% Sat.)	83.3	50.5 - 107	0
Conductivity (mSm)	19.7	15.1 - 24.2	-
Water clarity (m)	0.50*	0.3 - 1.2	10
Turbidity (NTU)	10.25*	6.2 - 51	0
E. coli (n/100mL)	263	63 - 2613	75
Dissolved reactive phosphorus (mg/L)	0.050*	0.01 - 0.12	9
Total phosphorus (mg/L)	0.125*	0.08 - 0.209	0
Ammoniacal nitrogen (mg/L)	0.020	0.005 - 0.1	67
Total nitrogen (mg/L)	0.741*	0.185 - 1.495	33
pH	7.5	7.1 - 8.5	75

The results from 2007-08 indicate that water quality at this site on the Awanui River is severely impacted. The medians for dissolved oxygen (% saturation), water clarity, turbidity, total nitrogen, and dissolved reactive and total phosphorus did not meet their respective guidelines.

Consistently high phosphorus levels at this site are of particular concern. The source of this phosphorus is likely to be run-off from pastoral land use within the catchment but the Kaitaia oxidation pond discharge directly upstream could also be a source.

Long term trend analysis at this site indicates that turbidity, dissolved reactive phosphorus, total phosphorus and ammoniacal nitrogen are all declining. However, there is a significant increasing trend in conductivity.

Mangere River at Knights Road

The Mangere River is a low-lying, sluggish tributary to the Wairua River, which flows through a mostly intensive agricultural catchment. The river begins as the Mangere Stream, which flows east out of the Pukenui forest near Whangarei. It becomes a river on the flats before joining the Wairoa River just west of Kokopu. For the most part, soft sedimentary rocks make up the underlying geology.

The results from 2007-08 for the Mangere River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with the relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	15.15	11.5 - 20.2	-
Dissolved oxygen (mg/L)	8.4	6.4 - 9.7	100
Dissolved oxygen (% Sat.)	83.4*	67.5 - 91	0
Conductivity (mSm)	16.65	15.6 - 18.2	-
Water clarity (m)	0.90	0.15 - 1.31	75
Turbidity (NTU)	7.65*	1 - 33	25
E. coli (n/100mL)	876*	435 - 24192	17
Dissolved reactive phosphorus (mg/L)	0.065*	0.03 - 0.318	0
Total phosphorus (mg/L)	0.11*	0.07 - 0.494	0
Ammoniacal nitrogen (mg/L)	0.065*	0.01 - 0.35	17
Total nitrogen (mg/L)	1.200*	0.232 - 3.062	8
pH	7.0*	6.6 - 7.5	42

The Mangere River is one of the most impacted rivers in the regional network. Results from 2007-08 indicate that dissolved oxygen (%), turbidity, bacterial (*E. coli*), nitrogen and phosphorus levels are often above their recommended guideline values.

Dissolved oxygen is an issue at this site, as levels are consistently below the guideline range. Further investigation is due to be undertaken at this site to ascertain the diurnal oxygen patterns.

Long term trend analysis for this site indicates some positive trends. These include decreasing nitrate/nitrite nitrogen, total nitrogen, dissolved reactive phosphorus, total phosphorus and increasing water clarity. There is also an increasing trend in pH which, at this site, is likely to be beneficial as the pH is often below the optimum range for aquatic life.

Ruakaka River at Flyger Road

The Ruakaka River catchment is relatively small and runs east from Ruakaka forest to Bream Bay. The catchment is dominated by pastoral land with areas of the upper catchment native bush. The underlying geology at the site is mainly soft sediments.

The results from 2007-08 for the Ruakaka River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with the relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	14.65	11.3 - 18.5	
Dissolved oxygen (mg/L)	8.45	5.9 - 9.9	92
Dissolved oxygen (% Sat.)	84.8*	62.9 - 90.6	0
Conductivity (mSm)	22.1	19.8 - 24.9	
Water clarity (m)	0.57*	0.3 - 0.76	42
Turbidity (NTU)	19.2*	11.4 - 47	0
E. coli (n/100mL)	412	226 - 9804	67
Dissolved reactive phosphorus (mg/L)	0.103*	0.05 - 0.14	0
Total phosphorus (mg/L)	0.175*	0.11 - 0.304	0
Ammoniacal nitrogen (mg/L)	0.045*	0.005 - 0.16	8
Total nitrogen (mg/L)	0.946*	0.478 - 2.324	8
pH	7.15*	6.7 - 7.5	50

The Ruakaka River is a highly impacted river, with poor water clarity and high nutrient levels. Results from 2007-08 indicate that dissolved oxygen (%), turbidity, water clarity, nitrogen and phosphorus levels are above their recommended guideline values on most sampling occasions.

Trend analysis cannot yet be undertaken for this site as there is insufficient data.

Manganui River at Mitaitai Road

The Manganui is a major tributary into the Wairoa River, flowing from the western fringes of the Marertu forest to join the Wairoa just east of Dargaville. The river runs through extremely low gradient, predominantly pastoral land, with some exotic forestry blocks scattered through the catchment. The underlying geology at the site is soft sediments.

The results from 2007-08 for the Manganui River are summarised in the table below. These include the median, range and percentage of sampling occasions that complied with the relevant guidelines. An asterisk in the table below denotes a median value outside the recommended guideline.

Parameter	Median	Range	% comply with guideline
Temperature (deg. cel.)	16.8	12.3 - 23.9	-
Dissolved oxygen (mg/L)	7.5	5.1 - 9	83
Dissolved oxygen (% Sat.)	80.6*	51 - 101	8
Conductivity (mSm)	21.0	12.4 - 23.3	-
Water clarity (m)	0.6*	0.2 - 0.97	50
Turbidity (NTU)	10.7*	6 - 114	0
E. coli (n/100mL)	833*	20 - 11199	45
Dissolved reactive phosphorus (mg/L)	0.05*	0.03 - 0.075	0
Total phosphorus (mg/L)	0.109*	0.05 - 0.21	0
Ammoniacal nitrogen (mg/L)	0.04*	0.005 - 0.08	42
Total nitrogen (mg/L)	0.62*	0.118 - 2.01	42
pH	7.2	6.8 - 8.2	50

Water quality in the Manganui River has been heavily impacted by surrounding land use. The Manganui River is the worst river in the network based on water quality. In 2007-08, the medians of eight parameters did not meet their respective guideline values.

High levels of all nutrients, in particular dissolved reactive and total phosphorus, indicate that agricultural run-off is the source of contamination in the Manganui catchment. In 2007-08, the median for both dissolved and total phosphorus was above the respective guideline trigger values.

Elevated levels of phosphorus are usually a sign that fertiliser, which has been applied to land, is not being absorbed by the soil but is being washing off the land during rainfall events and entering waterways. Another possible source of phosphorus is soil erosion in the riparian management zone. Better riparian management and more efficient fertiliser application would reduce the amount of phosphorus in waterways.

During 2007-08, dissolved oxygen (%) was not within the optimum range for the protection of aquatic ecosystems on 11 out of the 12 sampling occasions. These levels of dissolved oxygen are to be expected in a slow moving water body with a low gradient, such as the Manganui River.

Trend analysis on seven years of data for this site indicates that there are positive decreasing trends in nitrite/nitrate nitrogen (NNN) and ammoniacal nitrogen levels. However, there are negative increasing trends in dissolved reactive phosphorus and temperature. Temperature is increasing at a rate of 0.44 Degrees Celsius per year.

Trends in Water Quality

Long-term trend analysis was carried out using a Seasonal Kendall test, which eliminates any seasonal influence on the results. The table below shows water quality trends for 18 of the RWQMN sites that have five or more years data. The start of the dataset for trend analysis for each site is shown in brackets under the site name. The end date for the four NIWA sites is December 2007.

Only significant trends are shown. Significant trends are those with at least a 95% confidence level i.e. 95% likelihood that the trend is "real". It must be highlighted that 5 years data is a *minimum* for carrying out long term trend analysis and that these trends are likely to change as more data becomes available.

In the table below, an 'up' arrow indicates an increasing trend, a 'down' arrow indicates a decreasing trend; a green arrow indicates a positive trend and a red arrow indicates a negative trend. A blue arrow has been used where it is not yet known if the trend is positive or negative.

There were no significant trends at a 95% confidence level for *E. coli* at any of the sites. Many of the sites could not have trend analysis done for ammoniacal nitrogen, as too many results were found to be below detection limits. These are shown as NA in the table below. Some sites had insufficient data for certain parameters to carry out trend analysis. These are shown as ID in the table.

Note: the decreasing trend marked with an asterisk for the four NIWA sites is for nitrate (NO_3) only, not NNN.

Conductivity

Conductivity (COND) is a measure of the amount of ions in the water column and can be used as in indicator of nutrient enrichment. There is an increasing trend in conductivity at three sites; Awanui River at Waihue channel, Mangahahuru at Apotu Road and Waipapa at Forest Ranger. Although this is usually an indication of increasing nutrient enrichment in a water body, most of these sites have a positive downward trend in nutrient levels. These results will therefore require further analysis and investigation.

Dissolved Oxygen

There is an increasing trend in dissolved oxygen (DO) at Mangahahuru at Apotu Road, Whakapara River and Victoria River and a decreasing trend at Kaihu River and Waipoua River. The decreasing trend in the Waipoua and Kaihu River is likely to be a negative trend as the DO at these sites is below the optimum range for aquatic ecosystem health.

The increasing trend at Mangahahuru, Whakapara and Victoria could also be a negative trend as although DO is required for freshwater fauna to survive, an extremely high DO during the day could indicate that DO lags during the night or early morning. Mangahahuru at Apotu Road and Whakapara River sites are both dominated by *Egeria densa* (oxygen weed), which produces copious amounts of oxygen during the day whilst photosynthesising but not at night, which leads to huge diurnal variations in oxygen levels.

Water Clarity

Trend analysis indicates that water clarity has increased (improved) at six sites; Kaihu River, Mangahahuru Stream, Mangere River, Waipapa River, Waitangi at Waimate and Whakapara River. Water clarity in the Kaihu River has had a significant change of 18 cm per year. The improvement in water clarity at these sites could be a

result of increased riparian planting or better land management in the surrounding catchments, which would both result in decreased run-off entering rivers and streams. An improvement in the quality of point-source discharges in these catchments may also be a factor. Water clarity at the Victoria River has a decreasing trend of 5 cm per year, which may be due to land use changes in the catchment.

Bacterial Contamination

No sites have a significant trend in bacterial levels (*E. coli*). This is an improvement as historically, the Mangere River had an increasing (negative) trend in *E. coli*.

Nutrients

In general, nutrient levels are showing decreasing trends at the majority of sites, including decreasing dissolved reactive phosphorus, ammoniacal nitrogen, nitrite/nitrate nitrogen and, in turn, total nitrogen and phosphorus. This could be as a result of improving farm management practices throughout the region, including increased stock exclusion from waterways, riparian planting and better fertiliser application. It also could be as a result of better quality point source discharges, for example, discharges of farm dairy effluent or those from oxidation ponds. However, many of the sites with decreasing trends still have very high nutrient levels and there is therefore still a long way to go before desirable levels are met.

Nutrient levels are of concern in the Waipoua River as both dissolved reactive and total phosphorus levels are increasing. This could be as a result of land movement activity in the catchment.

PH

Trend analysis shows an increasing trend in pH at eight of the 18 sites analysed. This trend is beneficial at the majority of sites as pH is generally below the optimum range of 7.2 to 7.8 for aquatic life. An increase in pH should therefore be of benefit to aquatic ecosystems.

MACROINVERTEBRATE MONITORING

Different stream macroinvertebrates (aquatic animals such as insects, worms and snails) show different responses to changes in their environment, such as water quality or low flows, and different species show different tolerances to pollution. Macroinvertebrates are good indicators of local conditions because they tend to stay in one place and are affected by the environmental conditions over an extended period of time, unlike water quality results which tend to be spot measurements, i.e. that exact point in time. Also, stream macroinvertebrates are the best indicator of the life supporting capacity of a stream or river, as they are usually near the middle of the food chain and an important component of stream ecosystems.

This section summarises the results from the February/March 2008 round of macroinvertebrate monitoring, undertaken at four Waiarohia Stream sites, 32 RWQMN sites, and five rivers both upstream and downstream of consented activities in Northland.

The monitoring was carried out following the standard protocol developed by the NZ Macroinvertebrate working group in 2001; *'Protocols for sampling macroinvertebrates in Wadeable streams' (Stark et al. 2001[1])*. Four standard biotic indices were calculated to assess water quality and biological health at the sites:

- Species richness;
- Macroinvertebrate Community Index (MCI);
- Semi Quantitative Macroinvertebrate Community Index (SQMCI); and
- The percentage of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa (%EPT taxa).

Photo: Macroinvertebrate sampling in the Waipoua River

[1] Stark, J.D.; Boothroyd, I.K.G.; Harding, J.S.; Maxted, J.R. and Scarsbrook, M.R. (2001). **Protocols for sampling macroinvertebrates in wadeable streams.** New Zealand Macroinvertebrate Working group Report No. 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No. 5103, 57p.

Biotic Indices Results

The table below shows the four biotic index scores for all sites monitored in 2008. MCI, SQMCI and %EPT taxa have been colour-coded to show the range in water quality or degradation at each site. For example, red indicates poor water quality and a severely degraded site, orange and yellow indicate moderate water quality and green indicates good water quality or a stream still in a relatively 'pristine' state (very little impact from humans).

Waiarohia Sites

Site description	Species richness	MCI	SQMCI	%EPT taxa
Rust Ave Bridge	24	79.2	3.03	20.8
Russell Road Bridge North	28	91.4	4.08	32.1
Kamo tributary	7	60	3.89	0.0
Whau Valley Road	23	91.3	3.73	30.4

RWQMN Sites

Site description	Species richness	MCI	SQMCI	%EPT taxa
Waipoua @ SH12 Rest area	29	135.2	8.21	72.4
Opouteke @ Suspension Bridge	20	88	3.55	35
Mangakahia @ Twin bridges	19	88.4	3.1	36.8
Waipapa @ Forest Ranger	29	126.2	6.49	55.2
Kaihu @ gorge	24	86.7	2.73	29.2
Mangahahuru @ Main Road	28	100.7	6.05	35.7
Waimamaku @ SH12	24	106.7	3.56	50
Victoria @ Thompsons Bridge	26	118.5	6.28	50
Waipapa @ Kerikeri	8	97.5	4.99	25
Kerikeri @ Stone Store	20	84	3.28	30
Mangamuka @ Iwitaua Road	20	101	6.6	50
Waitangi @ Waimate North	29	93.8	5.07	31.0
Waitangi @ Watea	17	80	3.67	11.8
Whakapara @ Cableway	22	79	4.02	22.7
Waipao @ Draffin Road	15	98.7	4.2	53.3
Mangakahia @ Titoki	18	86.3	4.25	33.3
Ngunguru @ Waipoka Road	2	90	4.5	0
Kaeo @ Dip Road	7	122.9	6.04	42.9
Punakitere @ Taheke Recorder	24	93.3	4.57	45.8
Oruru @ Bowling club	11	83.6	4.16	27.3
Waiotu @ SH1	11	86	3.54	45.5
Awanui @ FNDC water take	20	95	4.09	45
Mangahahuru @ Apotu Road	13	76.7	3.77	30.8
Waiharakeke @ Foot Bridge	6	104	4.01	50
Paparoa @ Foot Bridge	11	89.1	4.55	9.1
Hakaru @ U/S of SH1	19	72.6	4.17	21.1
Wairua @ Purua	13	80	4.47	15.4
Utakura @ Horeke Road	8	92.5	4.18	25
Awanui @ Waihue channel	5	105	4.16	40
Mangere @ Knights Road	22	72.4	4.22	9.1
Ruakaka @ Flyger Road	22	102.7	4.97	40.9
Manganui @ Permanent station	13	83.1	4.17	15.4

Resource Consent Sites

Site description	Species richness	MCI	SQMCI	%EPT taxa
Dam downstream	15	68	3.14	13.3
Dam upstream	20	123	7.15	50
Oxidation pond A downstream	18	71.8	3.45	5.6
Oxidation pond A upstream	10	84.4	3.93	10
Meat works downstream	12	86.7	4.21	16.7
Meat works upstream	6	104.0	4.01	50
Oxidation pond B downstream	17	107.1	3.58	52.9
Oxidation pond B upstream	17	103.5	5.89	52.9
Quarry downstream	14	108.6	4.73	35.7
Quarry upstream	11	90.9	3.77	18.2

Interpretation of MCI & SQMCI (Boothroyd & Stark 2000[2])

Interpretation	MCI score	SQMCI score
Clean water	>120	>6.0
Doubtful quality or possible mild pollution	100-119	5.0-5.99
Probable moderate pollution	80-99	4.0-4.99
Probable severe pollution	<80	<4.0

Colour codes for %EPT taxa

>60% EPT taxa
40 – 59.9% EPT taxa
20 – 39.9 % EPT taxa
Less than 20% EPT taxa

[2] Boothroyd, I and Stark, J. (2000). **Use of invertebrates in monitoring.** *In*: Collier, K.J.; Winterbourn, M.J. *eds*. New Zealand stream invertebrates: ecology and implications for management. New Zealand Limnological Society, Chirstchurch. Pp. 344 373.

Macroinvertebrate Results Summary

Waiarohia Stream Sites
As for 2007, the results from 2008 indicate that three of the Waiarohia Stream sites; at Rust Ave Bridge, at the Northern Russell Road Bridge and Whau Valley Road, have macroinvertebrate communities associated with moderate to degraded water quality. The results for the small tributary that flows from Kamo into Waiarohia Stream indicate a macroinvertebrate index score indicative of a severely degraded stream with poor water quality.

River Water Quality Monitoring Network Sites
Based on MCI and SQMCI values, macroinvertebrate results for 2008 indicated clean water at four RWQMN sites; Waipoua River at SH12 rest area, Waipapa River in Puketi Forest, Victoria River at Thompsons Bridge, and Mangamuka River at Iwiatua Road Bridge. This is consistent with the water quality results for these sites. The MCI results also indicated clean water for the Kaeo River at Dip Road however caution should be taken with low diversity communities such as this.

Macroinvertebrate results for 2008 indicate that the following sites are severely impacted and/or have poor water quality:

- Hakaru River upstream of SH1
- Mangahahuru River at Apotu Road
- Mangere River at Knights Road
- Whakapara River at Slipway

Trend analysis on 22 of the 32 RWQMN sites sampled shows that stream health is increasing in the Waipoua River based on MCI and SQMCI results. However, four sites - Waiarohia Stream at Whau Valley Road, Punakitere River at Taheke Recorder, Opouteke River at Suspension Bridge and Waiotu River at SH1 Bridge - appear to have decreasing stream health.

Resource Consent Sites
In 2008, macroinvertebrate communities upstream and downstream of the discharges of two oxidation ponds, one dam, one quarry and one meatworks were sampled.

The results show a difference in macroinvertebrate communities upstream and downstream of the two oxidation ponds. The macroinvertebrate index scores downstream of both discharges indicated poorer water quality and more degradation when compared to the upstream samples. However, some of this difference could be attributed to changes in surrounding land use. Results for the dam site also indicated poorer stream health downstream of the discharge when compared to upstream.

Macroinvertebrate results for the meatworks and quarry consent sites indicate that these discharges are having a limited impact on water quality and stream health.