BAY OF PLENTY REGIONAL COUNCIL
TOI MOANA

Recreational Waters Surveillance Report

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Executive summary

The Bay of Plenty Regional Council (BOPRC) undertakes annual water quality surveys of popular recreational (bathing) sites and shellfish collection areas over the warmer months (October to March). These surveys assist in identifying the risk to public health from faecal contamination in these areas. This information is then used by public health and local authorities to advise the community on the suitability of water for bathing or shellfish collection.

The objective of this report is to present the contact recreation suitability of approximately 60 river, lake and marine sites over the 2016/2017 bathing season; and the state of faecal contamination of shellfish at popular shellfish areas.

A three tiered surveillance framework has been adopted to help signal when recreational waters are potentially at risk to users based on the New Zealand Microbiological Water Quality Guidelines. The system uses the colours green (safe mode), orange (cautionary mode) and red (unsafe mode) to denote risk to bathers. The suitability for recreation grading (SFRG) is used to analyse the suitability of sites for recreation over time, using a combination of information from microbiological bathing survey results and catchment characteristics.

Two indicator bacteria are used to assess the risk of faecal contamination in recreational waters. These are:

- Freshwaters – *Escherichia coli* (*E. coli*), and
- Marine waters – Enterococci.

Cyanobacteria (blue-green algae) are also monitored in the more eutrophic lakes and a similar three tiered warning system is used to signal when cyanobacteria biovolumes reach volumes that pose a health risk to recreational water users.

The results from the 2016/2017 bathing surveys show that most sites in the Bay of Plenty are generally suitable for swimming. However, the 'Suitability for Recreation Grading' (SFRG) highlights that there is some risk to recreational water users using rivers and streams, as they are more vulnerable to pathogen loading from runoff after rainfall events. For example, 92% of lake sites were graded 'very good' or 'good', while 24% of river sites were graded 'very good' or 'good'.

The table below shows the status of monitored bathing sites for 2016/2017 against red/action mode of the New Zealand Microbiological Water Quality Guidelines. Generally, lake sites show the highest quality overall, followed by marine and river sites.

Table 1 *Percentage of samples from monitored bathing sites with indicator bacteria levels less than the Red/Action Mode, as defined by the New Zealand Microbiological Water Quality Guidelines Ministry for the Environment (MfE)/Ministry of Health (MoH) 2003).*

		Rivers	Lake	Marine
Samples less than the Red/Action Mode	2016/2017	91.3%	97.1%	99.6%
	Last 5 years	94.4%	98.8%	98%

River and stream sites had lower levels of faecal contamination compared to the previous season. In 2016/2017, only ten percent of the results were above the Orange/Alert Mode and 5% results were above the Red/Action Mode.

Open coastal sites had excellent water quality with no sites reaching the Red/Action Mode in 2016/2017. Eight of the 15 estuarine sites reached the Orange/Alert Mode in 2016/2017 and no estuarine sites were graded 'poor' or 'very poor'.

The 2016/2017 *E. coli* data was compared to the National Objectives Framework (NOF) attributes for human health given in the National Policy Statement for Freshwater Management (NPS-FM). 25 of the 33 freshwater sites were rated as 'A' or 'blue' band - the safest category for swimming, five were in 'B' or 'green' band, and three in 'D' or 'orange band. The 'D' band indicates that there is an elevated risk of infection with swimming. To reduce risk of infection from microbial organisms, the message to recreational water users is to avoid swimming for at least 2-3 days after heavy of prolonged rainfall, even for sites with good water quality.

Faecal coliform concentrations from popular shellfish gathering sites revealed that three of the 10 sites monitored did not meet the Microbiological Water Quality Guideline levels for safe consumption of shellfish. These sites were Tauranga Harbour at Tilby Point, Waiotahe Estuary and Tauranga Harbour at Bowentown.

Blue-green (cyanobacteria) blooms resulted in health warnings being issued by Toi Te Ora for lakes Rotoehu and Ōkaro. Lakes Rotoiti, Tarawera and Rotorua reached orange alert levels for some sites over the 2016/2017 summer.

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Part 1:

Introduction

1.1 Overview

The Bay of Plenty Regional Council undertakes annual water quality surveys of popular recreational (bathing) sites and shellfish beds over the warmer months (October to March). These surveys assist in identifying the risk to public health from faecal contamination at these areas. The information is then used by public health and local authorities, to advise the community on the suitability of water for bathing or shellfish consumption.

There are a number of regional plans that have objectives based on a contact recreation standard. These are:

- On-site Effluent Treatment (OSET) Regional Plan,
- Operative Regional Natural Resources Plan,
- Regional Coastal Environmental Plan,
- Regional Policy Statement.

Planktonic cyanobacteria (blue-green algae) are also monitored in lakes due to the public health risk they present. This report summarises the annual recreational waters survey monitoring results for the 2016/2017 season and also presents recent shellfish monitoring results.

1.2 Legislative framework and responsibilities

The National Policy Statement for Freshwater Management (NPS-FM) (2014) has the objective to safeguard the health of people and communities. The NPS-FM has a National Objectives Framework (NOF) which sets thresholds for numeric attributes, ranked into five bands (A-E), defining water quality for “human” (and “ecosystem”) health (Ministry for the Environment, (MfE), 2014) (see section 2.3).

The agencies responsible for managing recreational water quality for the community are the regional council, district councils, district health boards and the medical officer of health. There is no legislation dictating which agency is responsible for recreational bathing monitoring, but under the Health Act (1956) and the Resource Management Act (1991), local agencies and the health authority have defined responsibilities.

The Microbiological Water Quality Guidelines (MfE/MoH 2003) provide a recommended framework of roles and responsibilities of the agencies involved in recreational water quality monitoring. Based on this framework, a protocol for monitoring and reporting has been developed for the Bay of Plenty.

1.3 Recreational water quality objectives

The objectives of the Bay of Plenty Regional Council’s recreational water quality monitoring programme are to:

- Assess the suitability of approximately 60 river, lake and marine sites in the Bay of Plenty for contact recreation.
- Provide information on the suitability of shellfish for human consumption.
- Assist in safeguarding the life-supporting capacity of water, including public health.

- Provide a mechanism to determine the effectiveness of regional plans.
- Provide information for State of the Environment monitoring, regionally and nationally.
- Assist in identifying areas of poor water quality and help to identify the causes of this so remedial action can be initiated.
- Set the foundation for water quality accounting in freshwater management units and assist in the identification of values of each freshwater management unit.

The bathing surveillance sites that were monitored in 2016/2017 are shown in Figure 1.1.

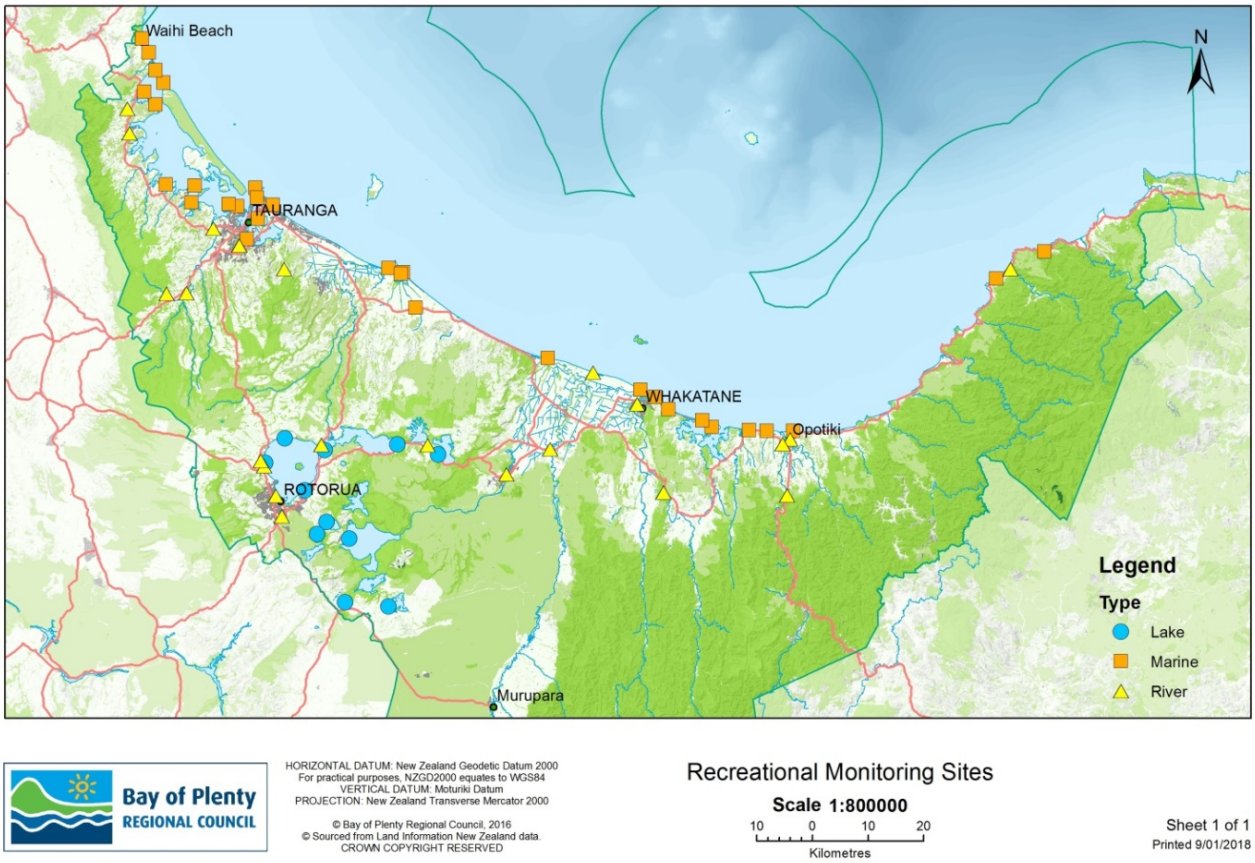


Figure 1.1 Bathing surveillance monitoring sites for the 2016/2017 season, Bay of Plenty.

Part 2:

Microbiological guidelines, indicators and grading

2.1 Introduction

If human or animal faecal matter finds its way into waters of recreational value, there is a risk that water users will be exposed to a diverse range of pathogenic (disease causing) micro-organisms. A variety of organisms are present in faecal matter such as viruses, bacteria, protozoa (single cell organisms), and helminths (nematodes). These can reach water bodies via a variety of pathways and in varying concentrations.

The impacts of pathogenic micro-organisms on human health are commonly manifested as gastro-enteritis, but other common illnesses include respiratory problems and skin rashes. Serious illness can also be attributed to infection from pathogens contained in waters, for example, hepatitis A, giardiasis, cryptosporidiosis, campylobacteriosis and salmonellosis (MfE/MoH, 2003).

As it is difficult and impractical to measure all potentially pathogenic micro-organisms in water, indicator micro-organisms are used to assess recreational water quality. Indicator micro-organisms give an indirect measure of pathogen levels. The bacteriological indicators chosen are associated with the gut of warm blooded animals and are common in faecal matter. While these indicator bacteria are not generally harmful themselves, they do indicate the presence of harmful pathogens. Bay of Plenty Regional Council uses two indicator bacteria which are commonly used in recreational waters:

- freshwaters – *Escherichia coli (E. coli),* and
- marine waters – Enterococci.

The use of these two indicators is stipulated in the New Zealand Microbiological Water Quality Guidelines (MfE/MoH 2003; hereafter referred to as the microbiological guidelines). Research that relates illness to indicator bacterial levels has been used to develop guideline levels for these indicator bacteria which are based on the tolerable risk to healthy people. The guidelines provide a method to grade recreational waters (see section 2.4) and trigger levels which can be used by water managers and the public to assess the potential health risk of using recreational waters. Single water sample results can be compared to guideline values to help determine if a health alert or other action should be undertaken.

2.2 Sampling and analysis

Before the start of the bathing season, a monitoring plan was designed and circulated for comment to Toi Te Ora Public Health and the district councils (Ōpōtiki, Kawerau, Rotorua, Western Bay and Tauranga). The criteria for selection of sites included whether they were high-use bathing locations and whether there was known contamination risk. Other sites have been included at the request of the community.

Monitoring began in late October 2016 and ran until the end of March 2017. Surface water samples were collected weekly or once every two weeks from approximately 60 sites across the Bay of Plenty region. Sampling occurred between 8:00 am and 3:30 pm and was completed by either wading or use of a sample pole. Sterile 200 ml polyethylene bottles were used to sample water at a representative location in the water column.

Water sampling and analyses were performed in accordance with established internal procedures. Most analyses were performed by the Regional Council laboratory. Water quality analyses were completed using the methods specified in Table 2.1.

Table 2.1 Methods used for analysis of water samples

Parameter (abbreviation)	Method	Detection limit/units*
Escherichia coli (*E. coli*)	Membrane filtration (APHA 2005)	1 cfu/100 ml
Faecal coliform (FC)	Membrane filtration (APHA 2005)	1 cfu/100 ml
Enterococci (Ent)	Method No 1600, USEPA 1985 EPA-821-R-97-004	1 cfu/100 ml

*cfu/100 ml = colony forming unit/100 ml

2.3 Microbiological guidelines

The microbiological guidelines provide the framework for assessing the health risk associated with faecal contamination of water. There are two tiers to the guidelines. The first tier is used to compare weekly monitoring results with the microbiological guidelines over a bathing season, providing water managers with a tool for assessing more immediate health risk to the public. The second tier is a site grading providing an analysis of the suitability for recreation over time, using a combination of information from microbiological bathing survey results and catchment characteristics.

A three-tiered management framework has been adopted to help signal when recreational waters are potentially at risk to users. The system uses the colours green (safe mode, 'surveillance'), orange (cautionary mode, 'alert') and red (unsafe mode, 'action') to denote the level of risk to users. The indicator bacteria levels and recommended management responses to these modes are listed in Table 2.2. This framework is used to assess the weekly health risk of recreational waters as individual sample results are obtained.

Table 2.2 Surveillance, alert and action modes for fresh and marine waters used in the three tiered management framework for weekly assessment of health risk of recreational waters (MfE/MoH, 2003).

Mode	Guideline - freshwaters (*E. coli* count in colony forming units per 100 mL)	Recommended management response
Green/Surveillance	Single sample ≤ 260	Routine monitoring.
Orange/Alert	Single sample > 260 and ≤ 550	Increased monitoring, identify possible sources.
Red/Action	Single sample > 550	Public warnings, increased monitoring, source investigation.

Mode	Guideline - marine (Enterococci count in colony forming units per 100 ml)	Recommended management response
Green/Surveillance	Single sample ≤ 140	Routine monitoring.
Orange/Alert	Single sample > 140	Increased monitoring, identify possible sources.
Red/Action	Two consecutive single samples > 280	Public warnings, increased monitoring, source investigation.

Surveillance mode (green) indicates that there is an acceptable risk to recreational water users. Should waters be found to be in *Alert Mode* (*orange)* then there is an increased risk of illness if contact is made with recreational waters. *Action Mode (red)* indicates that waters pose an unacceptable health risk to recreational water users. In such a case, the health authority will assess the risk to public health and if necessary, issue health warnings in conjunction with local authorities. Use of microbiological guidelines and the issuing of health warnings are dependent on the circumstances surrounding any contamination event.

2.4 Bathing surveillance grading

The microbiological guidelines outline a process to grade the suitability of marine and fresh waters for recreational use. A 'Suitability for Recreation Grade' (SFRG) is generated through a combination of qualitative assessment of susceptibility of recreational sites to faecal contamination and by direct weekly measurement of appropriate bacteriological indicators at the site. The alert and action levels described above provide a real time indication of the changing risk over a bathing season. In contrast, the SFRG describes the risk of faecal contamination at a given site over several bathing seasons.

The SFRG is made up of two components (Figure 2.1):

- The Sanitary Inspection Category (SIC) is composed of five ratings from very low to very high, which are dependent upon the presence and potential effect of faecal contaminant sources. It generates a measure of susceptibility of a water body to faecal contamination from potential water quality risk factors close to swimming spots, such as sewage outfalls, storm water drains, stock in waterways and run-off from land, and
- Historical microbiological results (weekly indicator bacteria monitoring results) are used to generate the Microbiological Assessment Category (MAC), which provides a measurement of actual water quality over time.

These two combined give an overall 'Suitability for Recreation Grade' (SFRG) (Figure 2.1), which describes the general condition of a site at any given time, based on both risk and indicator bacteria counts. The five grades in the SFRG range from 'Very Good' to 'Very Poor'. These grades help determine whether ongoing monitoring is required, and provide the basis for telling people whether or not water is suitable for recreational use from a public health perspective. If there is an incompatibility between the SIC and the MAC, (this may be due to limited data) then a 'Follow Up' grade is given.

The Sanitary Inspection Category is developed from a 'Catchment Assessment Checklist' (CAC) (see MfE and MoH, 2003) which explores land use, water use and characteristics, microbiological hazards, discharges, littoral drift, climatic influences, and other influences present in the catchment of the beach under analysis. Once a CAC is completed, a 'Sanitary Inspection Category' (SIC) can be allocated. Catchment checklists have been surveyed by respective councils and the Regional Council in 2014 to update the SIC. The SICs have been calculated using the Bathewatch software developed by MfE.

The grading system developed by MfE and MoH is prescriptive with a view to keeping it uncomplicated and user friendly. The only room for interpretation is within the CAC when determining microbiological hazards.

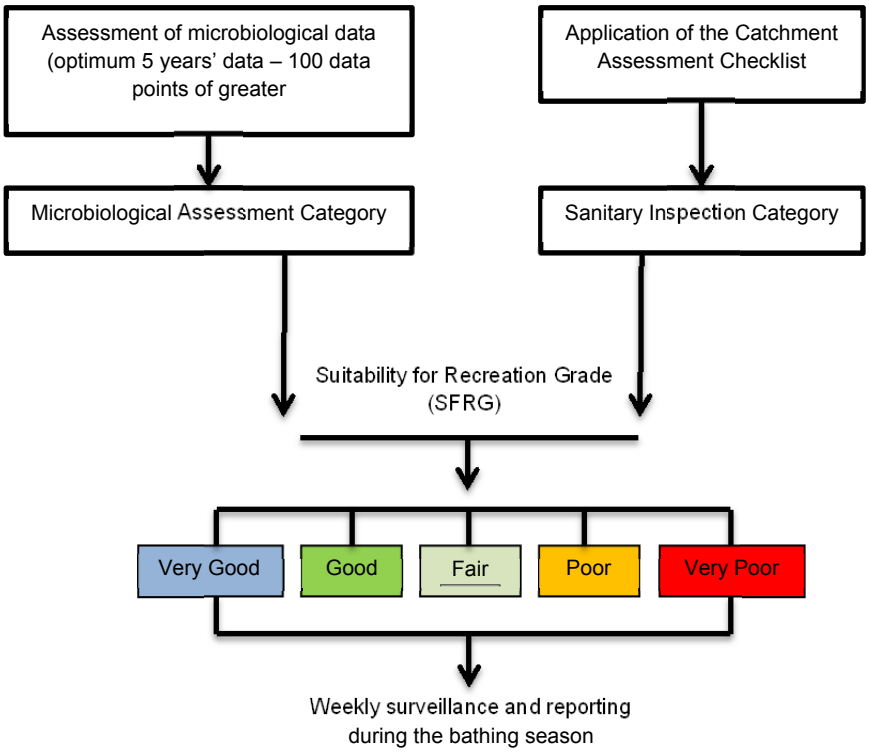


Figure 2.1 *Components of the Suitability for Recreation Grade (SFGR) (from MfE and MoH, 2003).*

The MAC is calculated as the 95th percentile of the last five years of historic faecal bacteria indicator data. Enterococci is the preferred indicator bacteria for marine waters and Escherichia coli (*E. coli*) is the indicator bacteria for freshwaters. Ideally, at least 20 samples collected from each site on a weekly basis during a bathing season, over a five year period to provide at least 100 sample points, are required for the MAC assessment. This has not occurred for all Bay of Plenty sites, so MAC evaluations are based on available data.

The SFRG's have been determined for recreational sites in the Bay of Plenty region since 2005. Updated SFRG's incorporating the 2016/2017 microbiological water quality results are summarised in Appendix 1, which are based on the last five year's data.

2.5 National Policy Statement for Freshwater (NPS-FM)

There are a series of tests involved in establishing the bands (attribute states) for rivers from Blue to Red in the National Objectives Framework (NOF) as outlined in the NPS-FM (2014). The table below shows the bands and the metrics that define them.

Table 2.3 *The bands and attribute states for the E. coli recreation attribute as outlined in the s National Policy Statement for Freshwater (MfE, 2017).*

Category	**Percentage of exceedances over 540 *E. coli* per 100 ml**	**Percentage of samples above 260 *E. coli* per 100 ml**	**Median: *E. coli* per 100 ml**	**95th percentile: *E. coli* per 100 ml**	**Narrative risk descriptor**
What it means	How often the river exceeds the acceptable threshold for swimming	How often the river goes over the point where additional monitoring is needed at primary contact sites	The mid-point (i.e. half the time *E. coli* is lower than this, half the time it is higher)	*E. coli* only rarely goes past this point (only 5% of the time)	Risk of Campylobacter infection (based on *E. coli* indicator)

Category	Percentage of exceedances over 540 *E. coli* per 100 ml	Percentage of samples above 260 *E. coli* per 100 ml	Median: *E. coli* per 100 ml	95th percentile: *E. coli* per 100 ml	Narrative risk descriptor
A (Blue)	<5%	<20%	≤130	≤540	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk) The predicted average infection risk is 1%*
B (Green)	5-10%	20-30%	≤130	≤1000	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk) The predicted average infection risk is 2%*
C (Yellow)	10-20%	20-34%	≤130	≤1200	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk) The predicted average infection risk is 3%*
D (Orange)	20-30%	>34%	>130	>1200	20-30% of the time the estimated risk is ≥50 in 1,000 (>5% risk) The predicted average infection risk is >3%*
E (Red)	>30%	>50%	>260	>1200	For more than 30% of the time the estimated risk is ≥50 in 1,000 (>5% risk) The predicted average infection risk is >7%*

* The predicted average infection risk is the overall average infection to swimmers based on a random exposure on a random day, ignoring any possibility of not swimming during high flows or when a surveillance advisory is in place (assuming that the *E. coli* concentration follows a lognormal distribution). Actual risk will generally be less if a person does not swim during high flows.

1 Attribute state should be determined by using a minimum of 60 samples over a maximum of 5 years, collected on a regular basis regardless of weather and flow conditions. However, where a sample has been missed due to adverse weather or error, attribute state may be determined using samples over a longer timeframe.

2 Attribute state must be determined by satisfying all numeric attribute states.

The NPS-FM states that the attribute state should be determined by using a minimum of 60 samples over a maximum of 5 years, collected on a regular basis regardless of weather and flow conditions. However, where a sample has been missed due to adverse weather or error, attribute state may be determined using samples over a longer timeframe (MfE, 2017).

Part 3:

Recreational waters microbiological surveillance and grading results 2016/2017

3.1 Overview

Based on the SFRG grading system, 91.7% of lake sites were graded ‘very good’ or ‘good’, and 8.3% were graded ‘poor’. Of the river sites, 33.3% were graded ‘poor’. This is an improvement of 18.9% from previous 2015/2016 grading.

85.7% of all estuarine sites were graded as ‘good’ or ‘very good’ and no estuarine sites were graded ‘poor’ or ‘very poor’. These results are a considerable improvement compared to the 2015/2016 season where 16.7% of estuarine sites were graded ‘poor’ or ‘follow up’. Almost all of the open coastal sites (90%) were graded as ‘good’ or ‘very good’, with the remaining 10% graded as ‘fair’.

Detailed results of the monitoring are presented in tabular form in Appendix 1. These tables give information on the 95th percentile value, MAC score, SIC score, SFRG and a conservative interim grade where applicable, as well as NOF banding. The SFRG’s are presented in Figure 3.1 and 3.2.

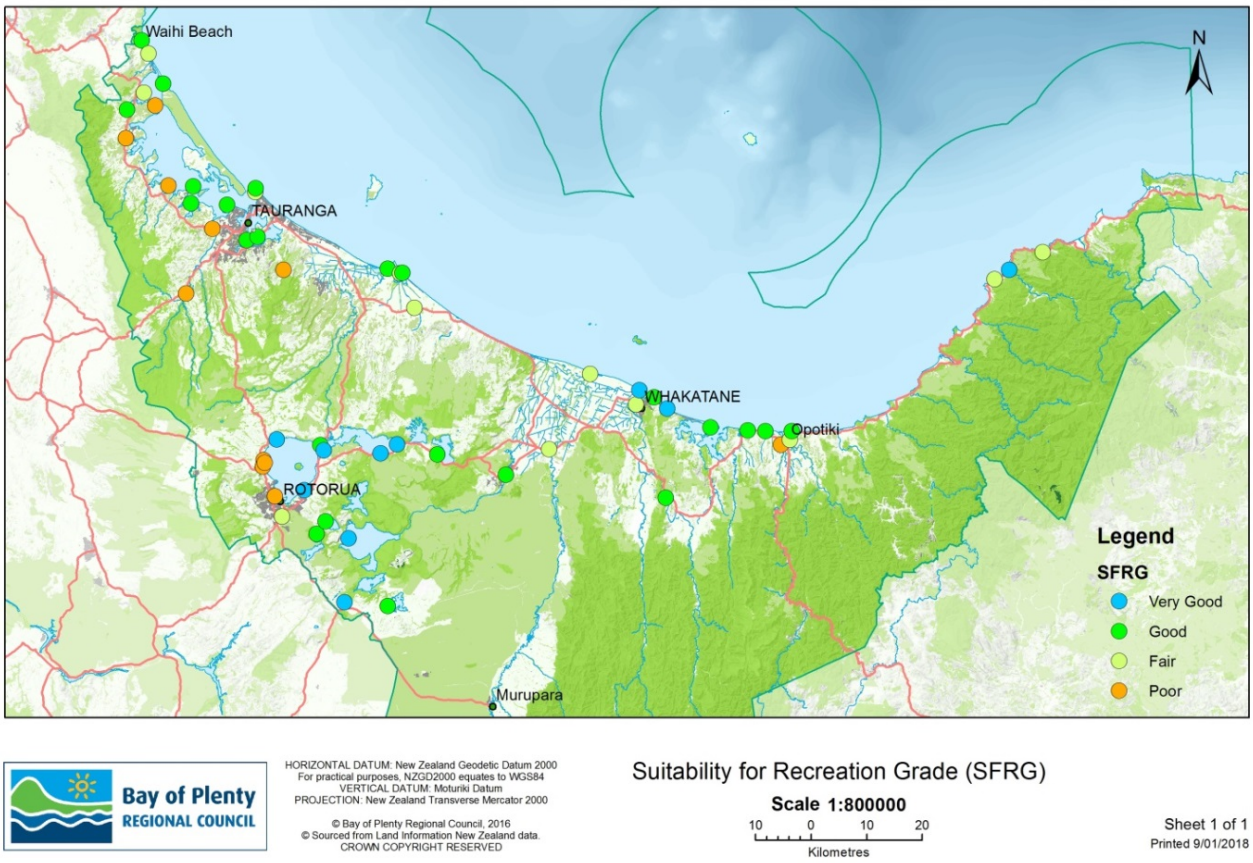


Figure 3.1 *Suitability for Recreation Grades for Bay of Plenty contact recreation monitoring sites, 2016/2017.*

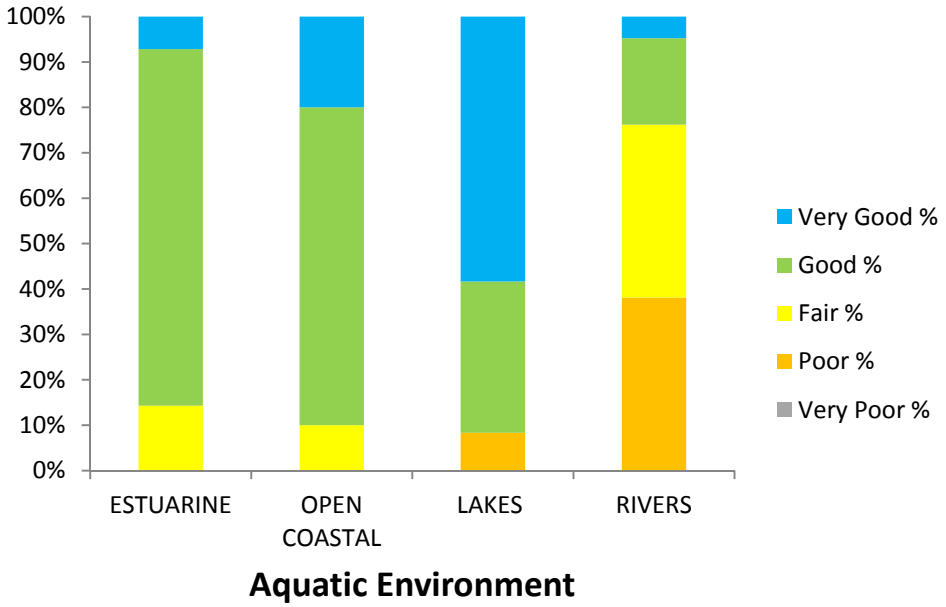


Figure 3.2 *Comparison of the 2016/2017 results for the SFRG across aquatic environments.*

The status of monitored contact recreation sites in the Bay of Plenty against the microbiological guidelines (Red/Action Mode) are presented in Table 3.1. Marine sites showed the highest quality overall against the guidelines, followed by lake and river sites.

Table 3.1 *Percentage of weekly samples from monitored bathing sites with indicator bacteria levels less than the Red/Action Mode, as defined by the New Zealand Microbiological Water Quality Guidelines (MfE/MoH 2003).*

		Rivers	Lake	Marine
Samples less than the Red/Action Mode	2016/2017	91.3%	97.1%	99.6%
	Last 5 Years	94.4%	98.8%	98%

More detailed results of the percentage of samples at each site that exceeded guideline levels throughout the 2016/2017 season are presented in the following sections (3.2 – 3.4). The five yearly 95th percentile and median (50th percentile) data are also presented to give a longer-term perspective.

3.2 River and stream sites

River and stream sites were monitored on a weekly or bi-weekly basis. Figure 3.3 shows the range of *E. coli* results recorded at each site for the 2016/2017 season. Sixteen of the 23 sites monitored had instances where the Orange/Alert Mode was reached. Seventeen river sites had results of over 550 *E. coli* cfu/100 ml (Red/Action Mode). In comparison to last season, there was a reduction in the number of sites reaching Orange/Alert Mode. However, the number of sites exceeding Red/Action Mode has increased.

During the 2016/2017 season, Kaiate Stream had the highest exceedances and these generally occurred in the absence of rainfall events. During the 2016/2017 season only 15% of samples taken from the Kaiate Stream were over 550 *E. coli* cfu/100 ml (Red/Action Mode) (Figure 3.3). This is a large reduction compared to the 60% of samples from the 2015/2016 season that reached Red/Action Mode. Catchment surveys continue to delineate critical source areas of faecal contamination. These will be reported on in the near future.

The Ngongotahā, Uretara and Utuhina Streams and the Wairoa River and Waioeka River at the State Highway 2 Bridge also had a number of exceedances. These were generally caused by rainfall events throughout the summer season.

The 95th percentile data for eight of the 22 monitoring sites are higher than the Red/Action Mode guideline when data from the last five years (2012–2017) is analysed (Figure 3.4). These sites should be classed as the highest priorities for investigation and action. However, exceedances over the 95th percentile guideline predominantly occur with rainfall events that generate surface runoff, when swimming is less likely to occur. Median values are also plotted in Figure 3.4 and this gives a measure of the average risk of infection to water uses (particularly primary contact). No median values were over the Orange/Alert Mode, indicating that on average, most rivers over the 2012-2017 seasons were suitable for swimming.

The comparison of data with the NOF attributes (Table 3.2) shows most sites (>60%) fall into the ‘A’ band (1% risk of infection), and 19% of sites were rated as ‘B’ band. No sites fell into the ‘C’ or ‘E’ bands, but 14.3% of the sites were in ‘D’ band, indicating that they are unsuitable at times for full immersion activities.

There have been several changes to site names or sampling frequency over the past five years. Samples from the Waioeka at Mouth of Gorge were collected up until March 2014 and did not resume until November 2015. For this reason, the past five year’s data includes data from November 2011. The site Whakatāne at Rūātoki was added to the monitoring programme from October 2012. However, it was not sampled during the 2014/2015 bathing season, so results for this site are based on four years of collected data. Lake Rerewhaakaiitu has had a site name change from Brett Road Boat Ramp to Homestead Arm.

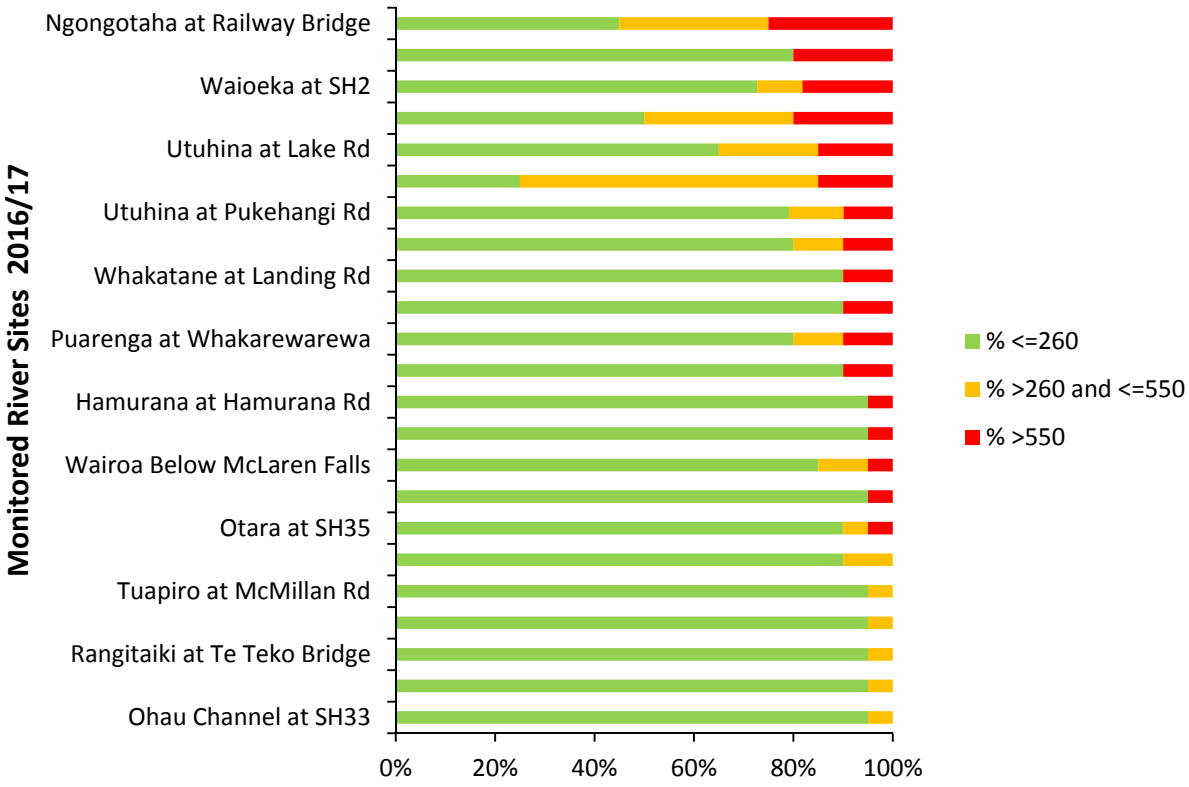


Figure 3.3 *Percentage of samples from river and stream sites with E. coli concentrations (cfu/100* ml*) in each of the modes in the Microbiological Water Quality Guidelines (MfE/MoH 2003), 2016/2017 bathing season.*

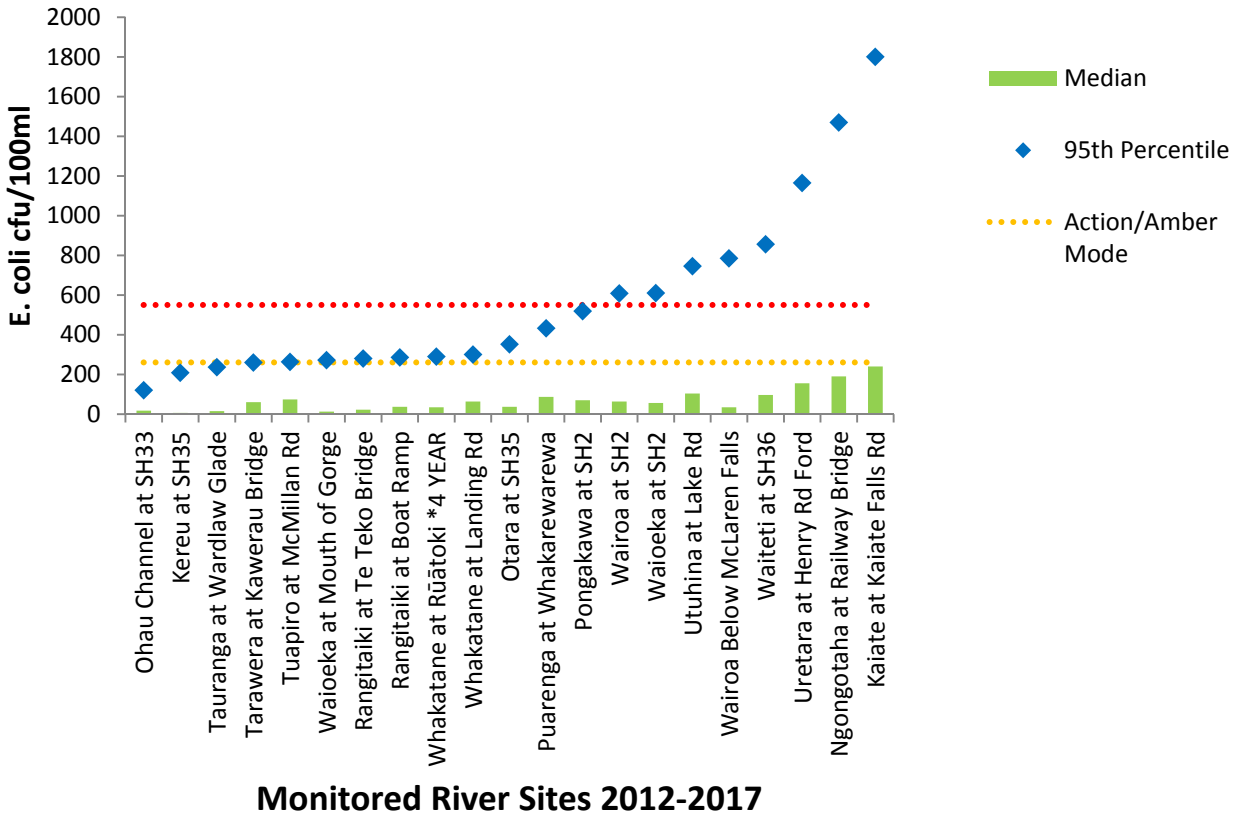


Figure 3.4 *95th percentile and median E. coli concentrations at river and stream sites over the past five years.*

Table 3.2 *The percentage of river sites falling within each band specified in the NOF for E. coli, based on 2012-2017 data (n=21).*

NOF Band	A	B	C	D	E
Average infection risk	1%	2%	3%	>3%	>7%
% sites	66.7	19.1	0	14.3	0

3.3 Lake sites

Sampling occurred at 12 lake sites, most on a weekly and two on a bi-weekly basis. Both sites monitored at Lake Rotorua reached Red/Action mode during this year's season; the Hamurana site went into red alert twice and Ngongotaha reached red alert on four different occasions. Lake Rotomā at Whangaroa reached the Red/Alert Mode once during the 2016/2017 season (Figure 3.5).

Lake Rotorua at Ngongotaha was the only site all season that had a 95th percentile exceed the Red/Action Mode guideline (Figure 3.6). Seven sites did not have *E. coli* concentrations exceed 10 cfu/100 ml, indicating a low level of faecal contamination overall (Figure 3.6).
Lake Rerewhakaaitu at Homestead Arm had the highest annual median *E. coli* concentrations of lake sites (31.5 cfu/100 ml).

Comparison of the 2016/2017 *E. coli* data with the NOF attributes (Table 3.3) shows that all but one lake site met the 'A' band (very low risk of infection) for full immersion activities (primary activities, i.e. greater than 5% risk of infection). Lake Rotorua at Ngongotaha did not meet the national bottom line (C band) – it was also the only site to drop to a lower band from the previous season where it fell into 'B' band during 2015/2016.

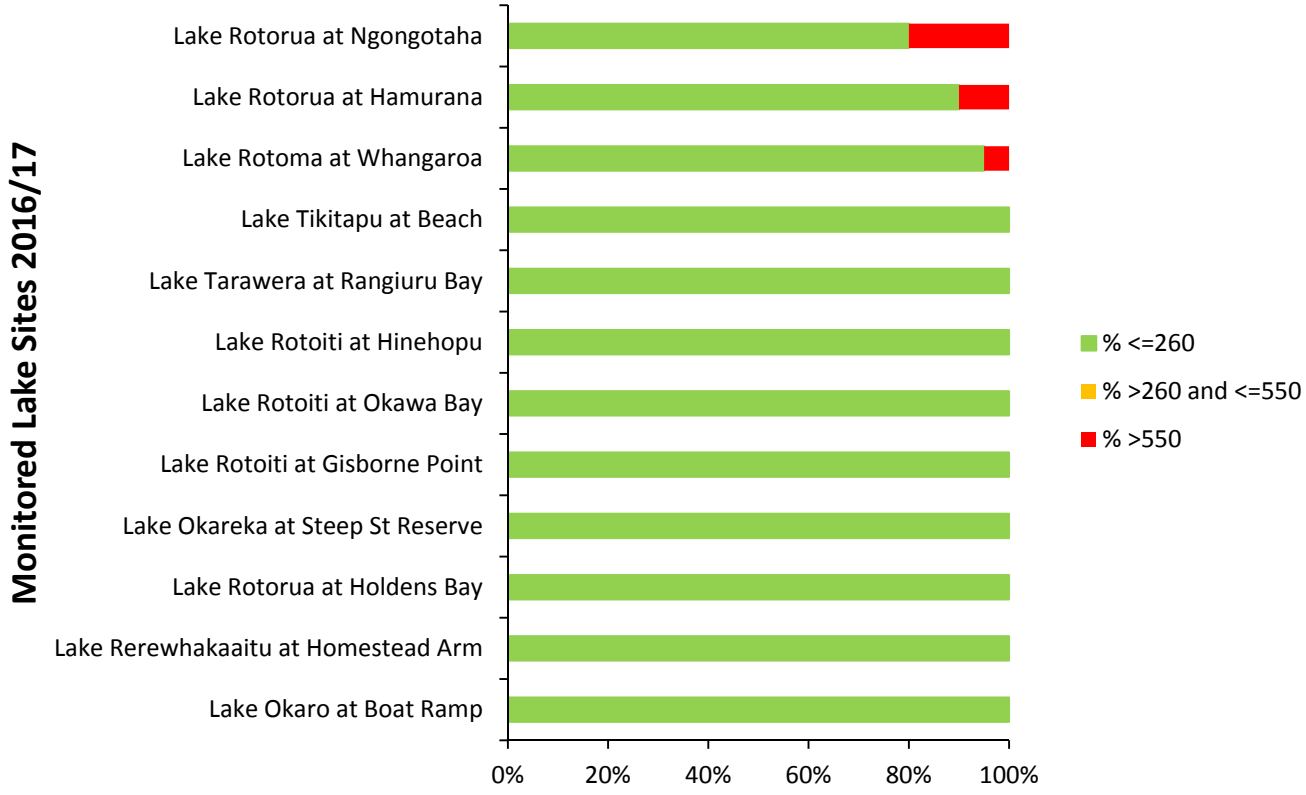


Figure 3.5 *Percentage of samples from lake sites with E. coli concentrations (cfu/100* ml*) in each of the modes in the Microbiological Water Quality Guidelines (MfE/MoH 2003), 2016/2017 bathing season.*

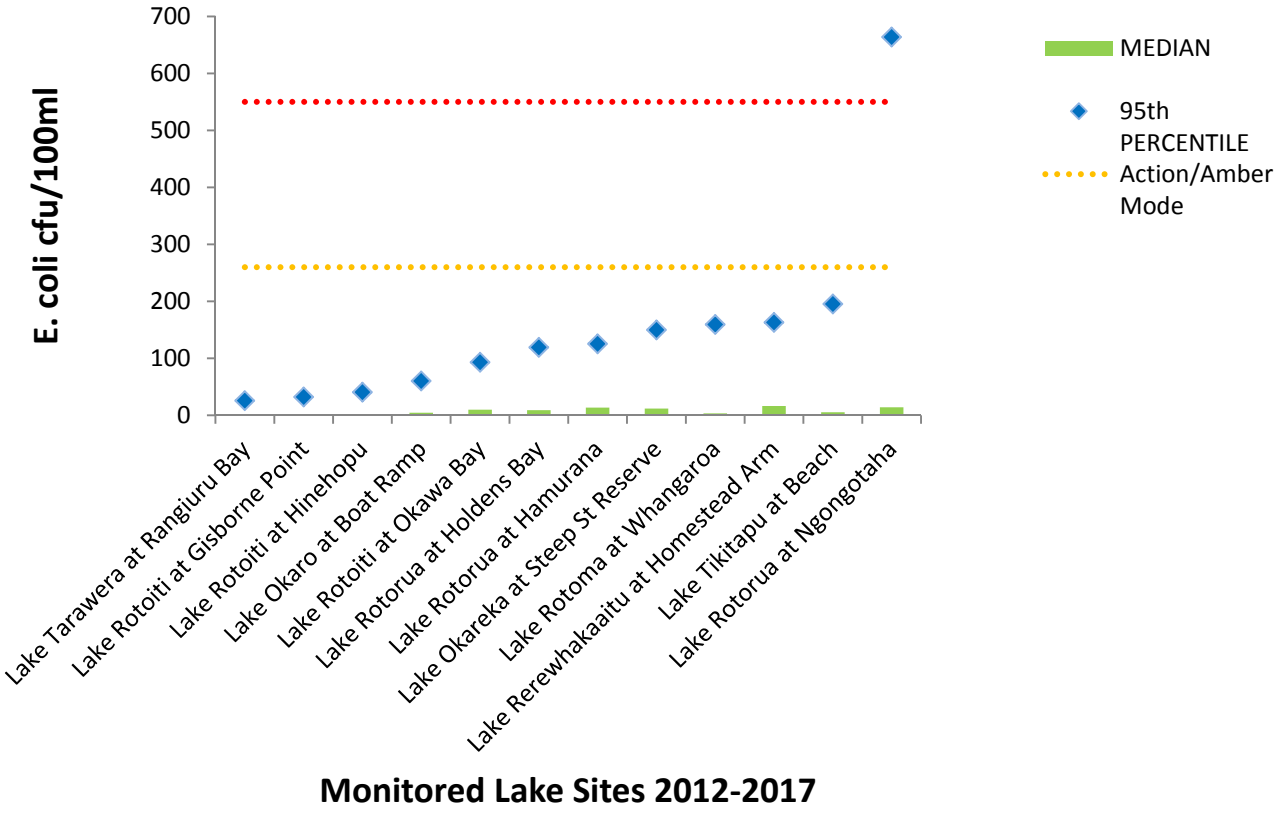


Figure 3.6 *95th percentile and median results of E. coli concentrations for lake sites over the past five years.*

Table 3.3 *The percentage of lake sites falling within each band specified in the NOF for E. coli, based on 2012-2017 data.*

NOF Band	A	B	C	D	E
Average infection risk	1%	2%	3%	>3%	>7%
% sites	91.7	18.3	0	0	0

3.4 Marine sites

3.4.1 Open coastal

The open coastal marine monitoring sites were sampled on a weekly basis. Figure 3.7 shows the percentage of samples at each site with enterococci concentrations that exceeded the microbiological guideline levels ranked in order. No sites breached the Red/Action mode. Waihī Beach at Surf Club and Waihī Beach at 3 Mile Creek were the only sites to reach Orange/Alert Mode. Both sites were re–sampled the following day and returned to Green/Safe Mode.

Wharanua Bay and Waihī Beach at 3 Mile Creek are the only two sites that have a 95th percentile to exceed the Orange/Alert Mode over the past 5 years (Figure 3.8).

All 12 open coastal sites had median enterococci concentrations below 5 cfu/100 ml in both 2016/2017, and the last five years (Figure 3.8). This indicates a low level of enterococci indicator bacteria contamination overall for marine coastal waters in the Bay of Plenty.

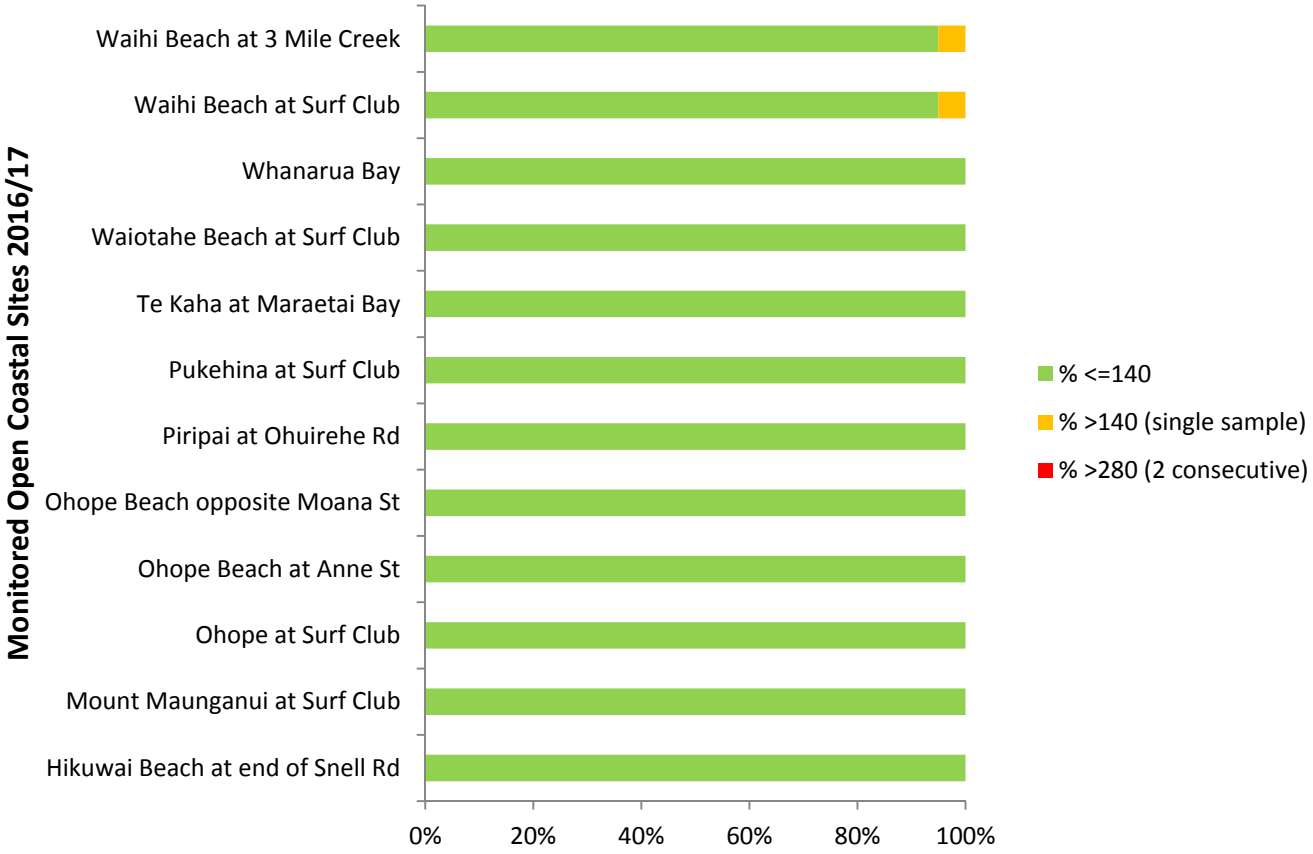


Figure 3.7 *Percentage of samples from open coastal marine sites with enterococci concentrations in each of the modes in the Microbiological Water Quality Guidelines (MfE/MoH 2003), 2016/2017 bathing season.*

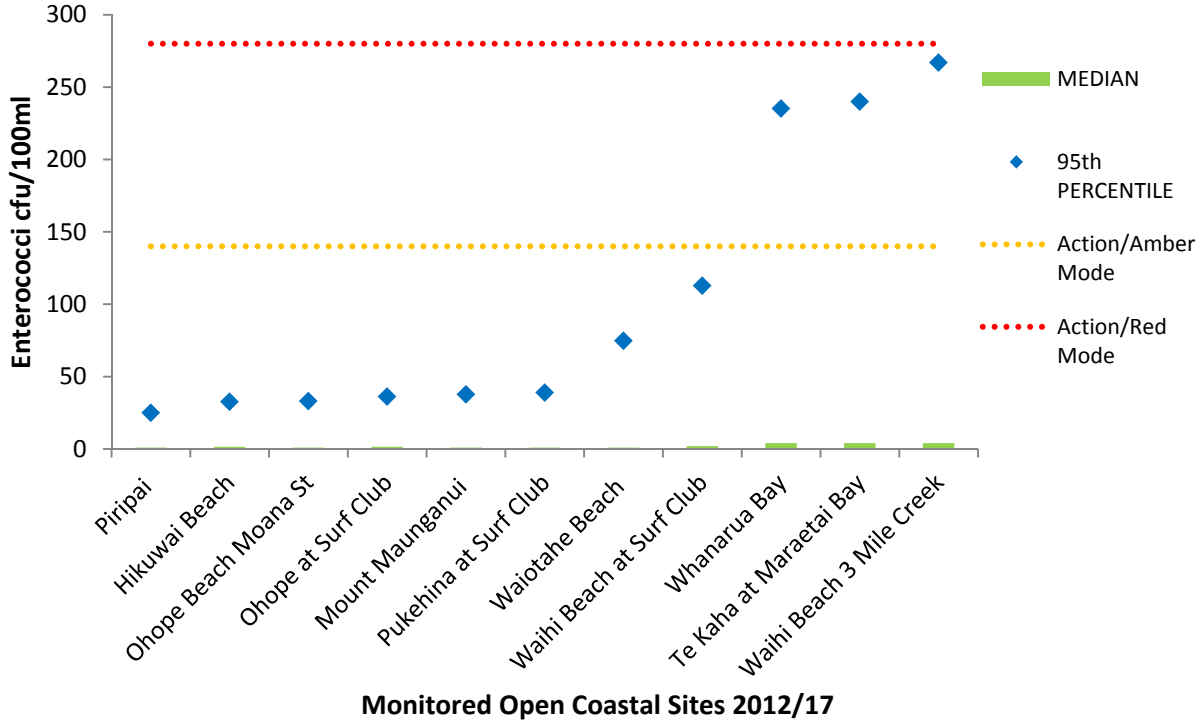


Figure 3.8 *95th percentile and median results of enterococci concentrations, coastal marine sites over the past five years.*

3.4.2 Estuarine

Eight of the 15 estuarine sites reached Orange/Alert Mode during the 2016/2017 season (Figure 3.9). Tauranga Harbour at Waimapu Bridge was the only site to reach Red/Action Mode – this only occurred on one occasion throughout the 2016/2017 season. Whakatane at the Heads had the highest median enterococci concentration of all estuarine sites over the last five years, at 13 cfu/100 ml (Figure 3.19).

Tauranga Harbour at Pahoia Beach Road was the only site to exceed the 95th percentile Red/Action limit over the last 5 years with an enterococci value of 357 cfu/100 ml (Figure 3.10). This result indicates a greater than five percent risk of contact with infectious organisms.

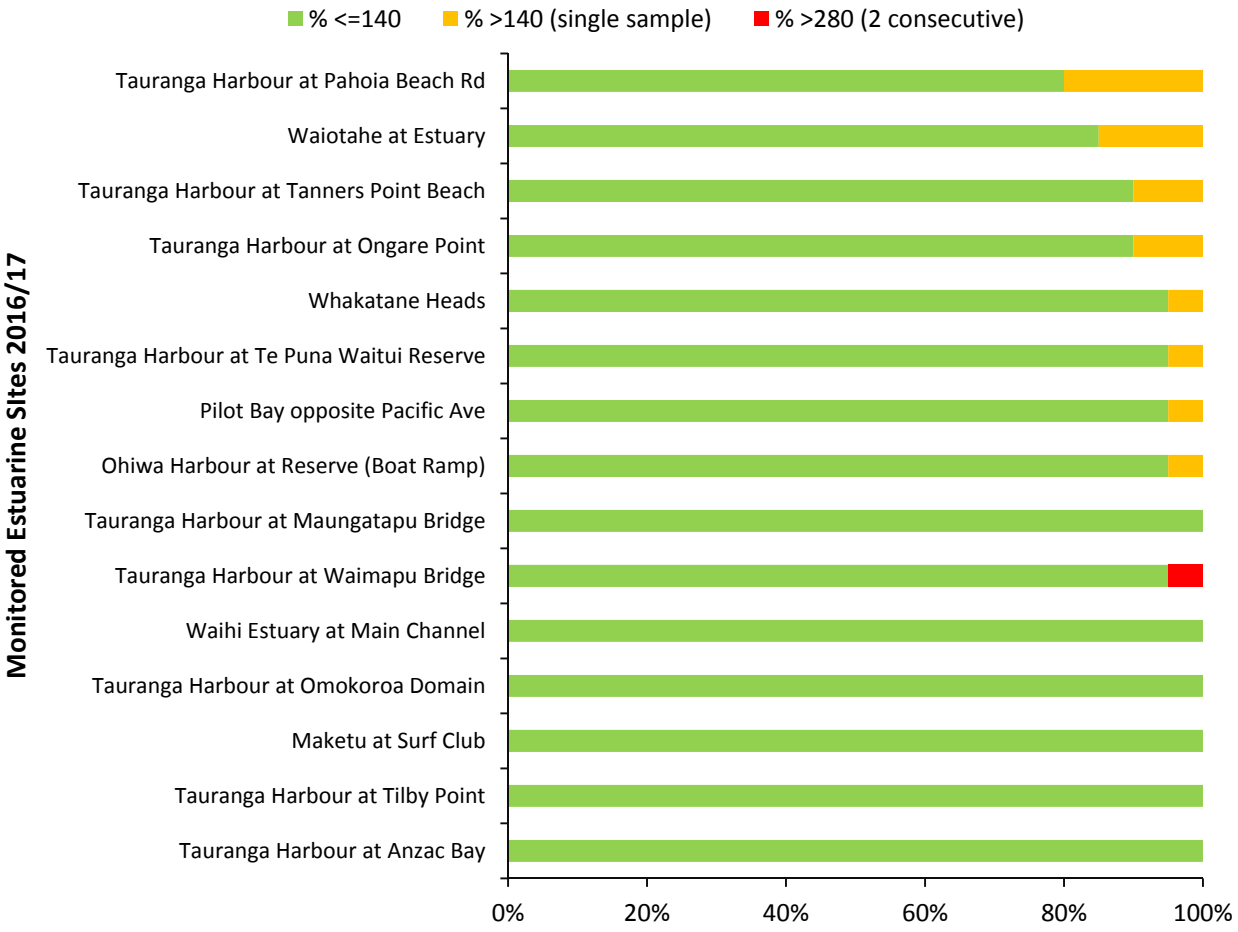


Figure 3.9 *Percentage of samples from estuarine sites with enterococci concentrations in each of the modes in the New Zealand Microbiological Water Quality Guidelines (MfE/MoH 2003), 2016/2017 bathing season.*

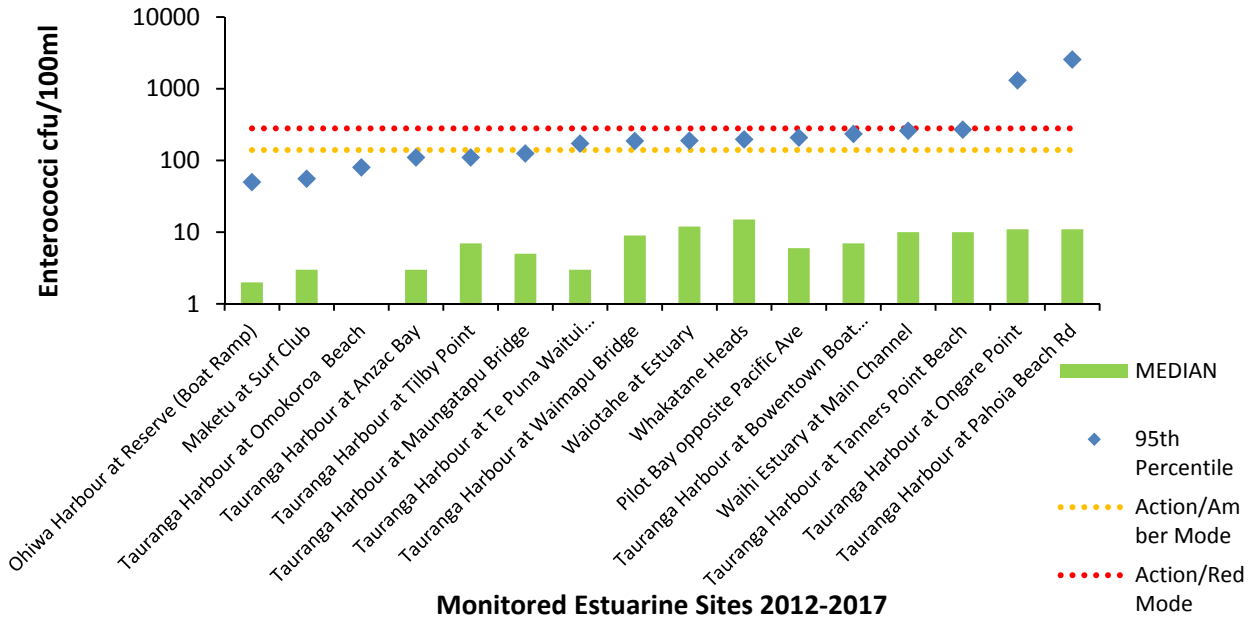


Figure 3.10 *95th percentile and median results of enterococci concentrations, estuarine marine sites over the past five years.*

Part 4:

Catchment surveys

Several catchments that have persistent elevated indicator bacteria results have been the subject of additional monitoring and investigation to ascertain the potential causes of elevated indicator bacteria.

4.1 Waiōtahe Estuary

Waiōtahe Estuary is a popular swimming and recreational area in the eastern Bay of Plenty. A health warning was issued by Toi Te Ora for the consumption of shellfish, namely pipi (*Paphies australis*) in October 2017. The warning was issued because monitoring records showed a history of unsafe levels of *faecal coliform* bacteria at Te Ahiaua (Waiōtahe pipi beds). See section 5.0 for shellfish monitoring results.

The warning is specifically related to eating shellfish and there are no concerns around other recreational uses. With a small population and 13 dairy farms in the catchment, run-off from surrounding farmland is seen as the most likely cause of faecal contamination.

4.1.1 Catchment description

The Waiōtahe Catchment is relatively long and narrow (Figure 4.1). With an area of 148 km^2 it is c.30 km long and only 4-5 km wide for a considerable length of the catchment. Very steep hill country covers 19% of the land in the upper catchment; this is also where the majority of indigenous forest still remains. Steep hill country is the largest land type within the catchment at 44% hosting forestry practices and some native bush cover. Rolling hill country is mainly pastoral extending over 29% of the middle to lower catchment. Alluvial plains cover 14% of the lower catchment and are mainly converted to dairy farms. This low lying land is prone to flooding and is part of the Waiōtahe drainage system. Native dune species cover 0.1% of the catchment - all growing near the Waiōtahe River mouth and Waiōtahe Spit.

The Waiōtahe River is the main waterbody of the catchment and is fed by six main tributary streams. The course of the river veers towards the Kutarere arm of Ohiwa Harbour, passing only c.1.5 km from the harbour before flowing north-east into the Waiōtahe Estuary. The very lower reaches of the river flow through flat paddocks adjacent to State Highway 2 and then into the Waiōtahe Estuary.

The Waiōtahe Estuary is monitored from October to March during the bathing season. Enterococci levels are tested to assess the swimming water quality of the Waiōtahi Estuary, and faecal coliforms are monitored to assess the safety of shellfish consumption (see section 5.0). Elevated levels of faecal contamination within the estuary over the past few years provided the motivation behind catchment surveys by undertaken by the Bay of Plenty Regional Council during 2017. These surveys were conducted with the purpose to ascertain if elevated results were originating from any particular source. Drains within the lower catchment which directly flow into the estuary were sampled on a weekly basis (Figure 4.3). These drains were tested for *E. coli* contamination as they are a freshwater source to the estuary.

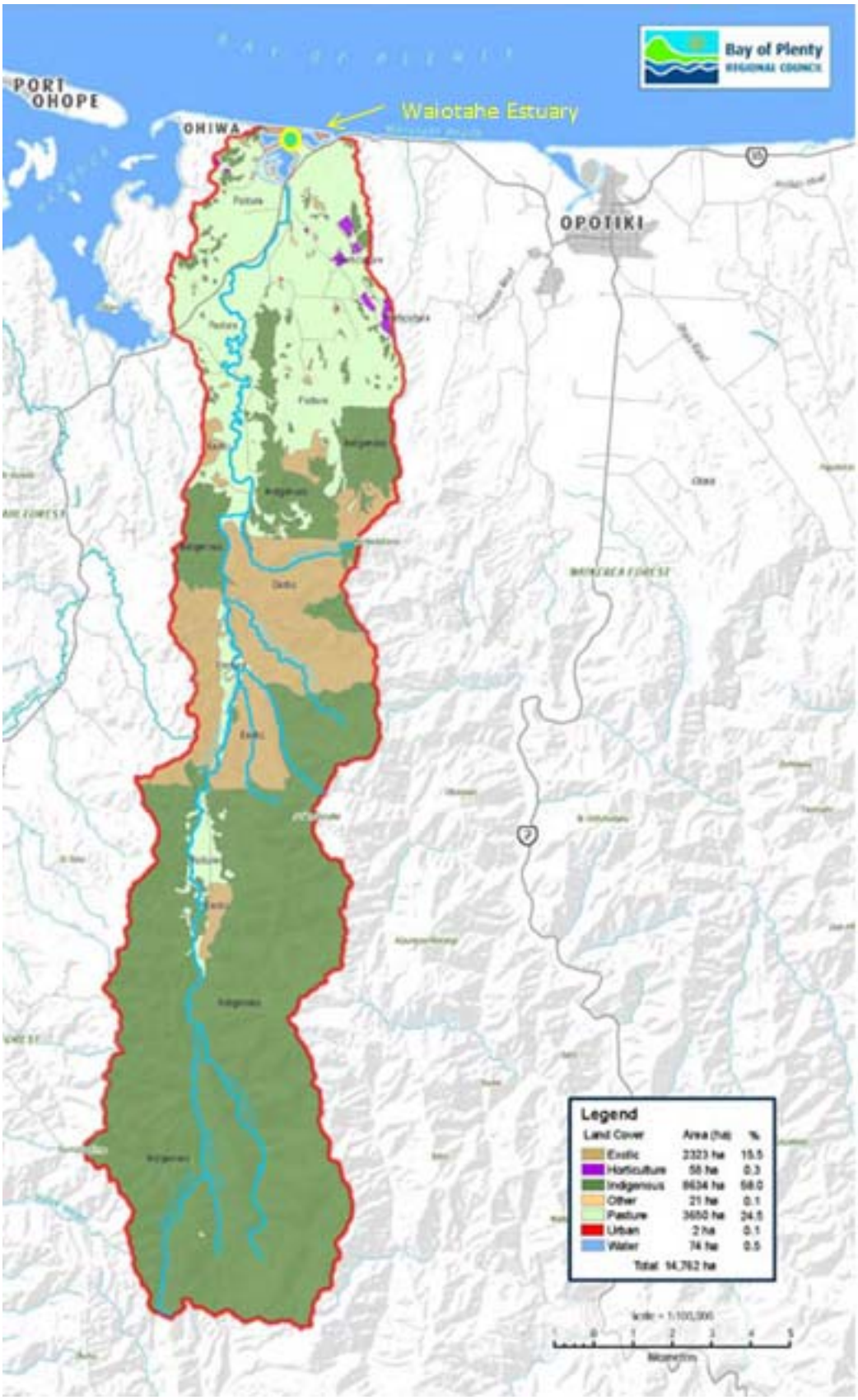


Figure 4.1 *Waiōtahe Catchment identifying land classification and the monitoring site of the Waiōtahe Estuary.*

4.1.2 Waiotahi results

Enterococci levels for the 2016/2017 bathing season (Figure 4.2) only exceeded the safe guideline level of >140 cfu/100 ml three times over the course of the monitoring programme. If samples did enter Amber/Action Mode the water was resampled within a 24 hour period and enterococci concentrations quickly returned to levels within the safe guidelines for recreational activities. A high level of 4,600 cfu/100 ml was collected on the 27/3/2017.

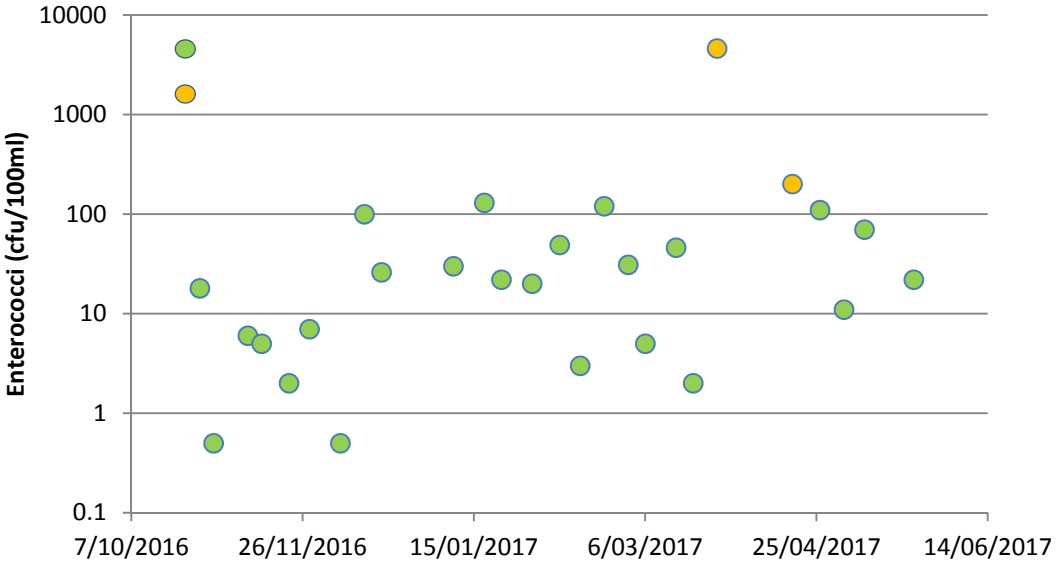


Figure 4.2 *Enterococci levels (cfu/100 ml) in water samples from the Waiōtahe Estuary collected during the 2016/2017 sampling period.*

Median *E. coli* concentrations for sites in the lower Waiōtahe catchment are shown in Figure 4.3, over the sampling period January to May 2017. Results showed elevated *E. coli* concentrations in some farm drains. Further catchment wide monitoring of *E. coli* concentrations shows the wider distribution of *E. coli* concentrations (Figure 4.4). Catchment wide monitoring will help to delineate hot spots of faecal contamination, helping to further target future mitigation measures to reduce faecal contamination in the catchment.

A drain sampled at Ohiwa Harbour Road, stands out as a potential significant contributor to the high levels of faecal contamination in the estuary with seven out of nine samples in amber or red alert mode for swimming. The Waiōtahe River downstream of the drain at Verall Road entered Red Alert/Action Mode once over the course of sampling. The Verall Road drain had the highest *E. coli* result from a single sample over the survey period of 3,900 cfu/100 ml. The main drain also had one sample over the Red Alert/Action Mode, and is the largest outflow into the estuary of all the surrounding drains.

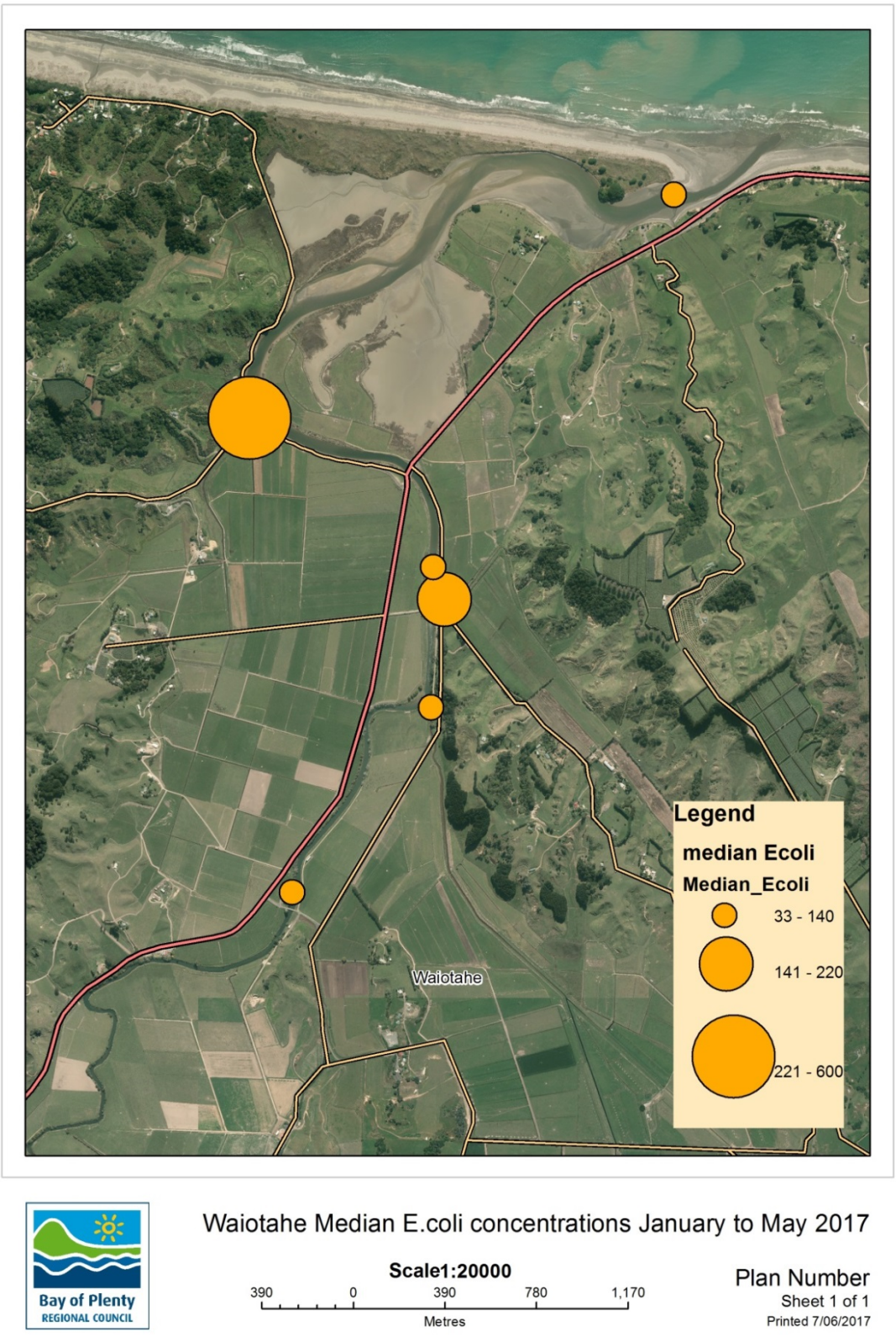
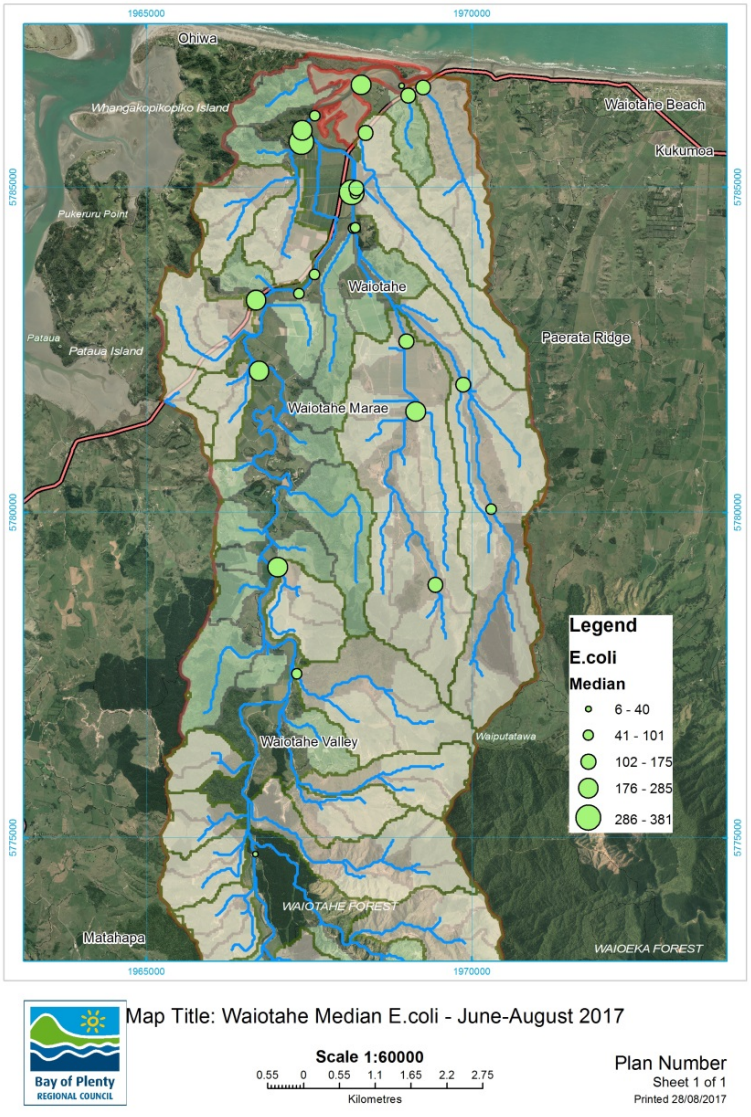


Figure 4.3 *Median E. coli concentrations for river and drain sites in the lower Waiōtahe catchment for samples collected from January to May 2017.*



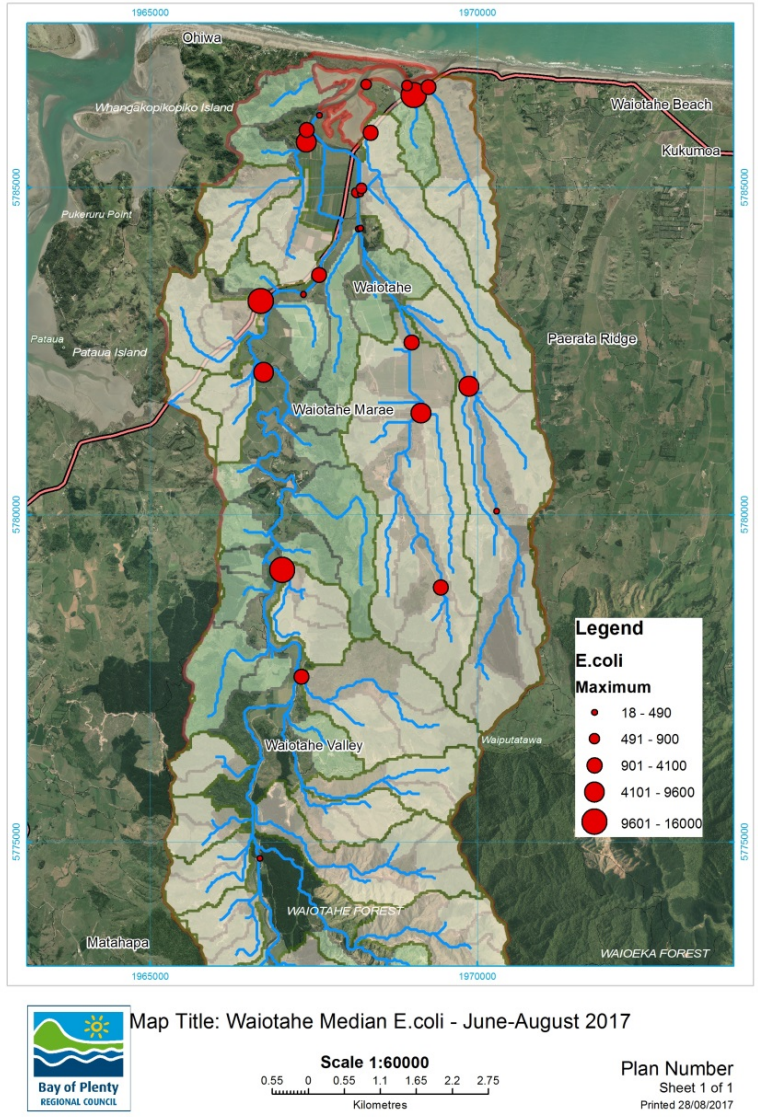


Figure 4.4 Median and maximum E. coli concentrations the Waiōtahe catchment in samples collected from June to August 2017.

4.1.3 Faecal source tracking

Results of recent faecal source tracking carried out on water samples from the Waiōtahe catchment point to ruminant animals as the likely cause of faecal contamination in the estuary.

Faecal source tracking (also known as DNA testing for the source of the contamination) takes advantage of the presence of a range of microorganisms in faeces which are specific to their animal hosts. The presence of certain microorganisms indicates the source or likely animal host of the faecal contamination. Faecal source tracking extracts the total DNA from a water sample and examines it for DNA from these source-specific microorganisms. Markers specific for humans, herbivores, dogs and avian populations are available.

Six sites distributed across the lower catchment were analysed for the DNA markers that separate human, ruminant (cow) and avian (bird) faeces. Results in the estuary showed weak evidence of a ruminant source. The DNA results are categorised from weak to strong. Two sites in the Waiōtahe River showed weak to moderate ruminant sources. Drain results had weak to moderate ruminant sources and one drain had a strong ruminant source. Avian sources were also found in most locations. There was no detectable contamination from human sources. Results conclude that the main types of bacteria found were from ruminants (cows, sheep, deer or goats) with an avian influence at several locations.

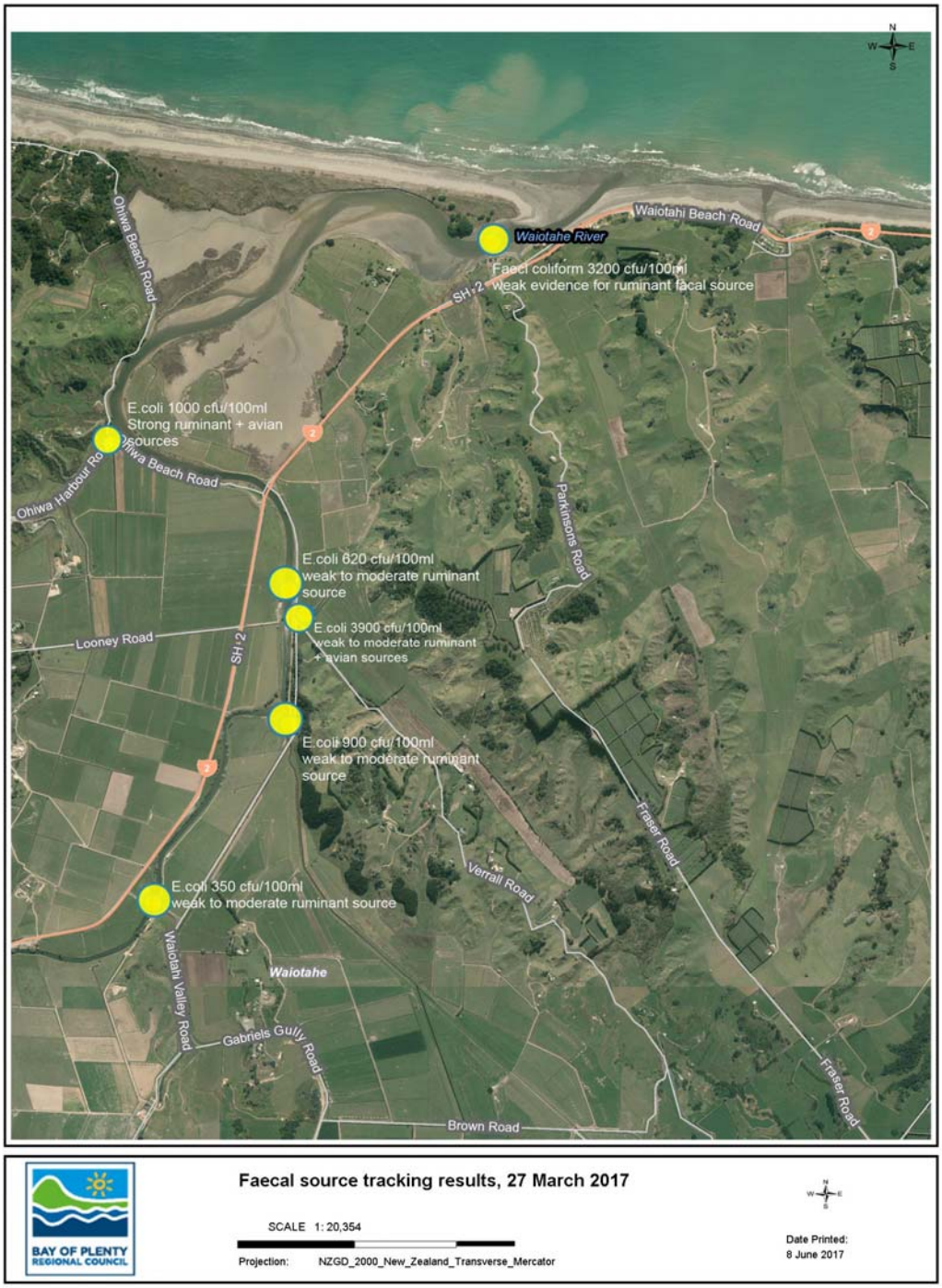


Figure 4.5 Maximum E. coli concentrations and faecal source tracking results for river and drain sites in the lower Waiōtahe Catchment, January to May 2017.

4.1.4 Discussion and recommendations

Initial catchment surveys have shown variable results for faecal contamination throughout the catchment, with no one definitive source being found. Faecal contamination has been found to be temporally and spatially variable, a result that is typical of diffuse source contamination. The tidal influence of the estuary stretches far upstream into the low lying drainage areas, which does confounds the variability of faecal contamination due to dilution effects and saline flocculation.

Council has embarked on collection of 12 months of *E. coli* data concentration coupled with collection of hydrometric data to highlight faecal contamination hotspots within the catchment. This data will need to be coupled with information on critical source area and faecal contaminant pathways.

Results and analysis of data collected will be used to explore the following areas:

- Measured hotspots.
- Predicted hotspots based on land-use and landform characteristics.
- Multi-variance analysis to relate sub catchment factors (slope, land cover, soils, stock density, riparian management, distance from estuary) with *E. coli* concentrations.
- Correlation of flow and *E. coli* concentrations, and turbidity, flow and *E. coli* concentrations.
- Estimation of sub catchment *E. coli* loads with rainfall/discharge.
- Estimation of *E. coli* runoff concentrations with changing grazing history (requires farm stock details).
- Correlation of catchment *E. coli* concentrations/loads with shellfish and shellfish water faecal indicator concentrations.
- Contribution of drainage network to *E. coli* loading in the Waiōtahe River and estuary.
- Sources of *E. coli.*

Council is working with landowners, local iwi and hapū, and other stakeholders to reduce the impact of land use on this valued kaimoana source.

4.2 Ngongotahā Stream

The Ngongotahā Stream is monitored during the bathing season near the railway bridge, just downstream of the town centre. Consistent elevated *E. coli* concentrations above the amber mode bathing guideline level since 2016 (Figure 4.6) have resulted in health advisory notices being put in place.

The only discharge consents in the catchment are for onsite wastewater treatment systems, a jet boat operation and various stormwater discharges within the urban area. There is a wildlife park at the top of the catchment as well as various other tourism ventures and a trout rearing facility which attracts visitors. However, most of the catchment is a mixture of pastoral lands and forestry.

Catchment surveys were undertaken by Rotorua Lakes Council and Bay of Plenty Regional Council during 2016, to ascertain if elevated faecal indicator bacteria results were originating from any particular source (Figure 4.7). Faecal Source Tracking, as described in section 4.1, has also been used to help track sources of contamination in the Ngongotahā Catchment.

Faecal Source Tracking results from samples collected at the railway bridge site in December 2015 (two dates) and from three sites in April 2016 (railway bridge, State Highway 5, and No. 715 Ngongotahā Road) only returned positive results for ruminant sources. The other markers tested for were avian and human. These results imply that no leakage from seepage infrastructure of septic tanks is impacting the stream. More likely the faecal contamination is from stock, referred as a diffuse source contamination.

Catchment survey data have shown variable results throughout the catchment, with no one definitive source being found. Catchment surveys show faecal contamination to be temporally and spatially variable, a result that is typical of diffuse source contamination.

Relationships between faecal indicator bacteria, rainfall and flow are variable for the Ngongotahā Stream. Although strong rainfall events can result in elevated *E. coli* concentrations in the stream, there is no clear seasonal relationship. Stream sediment may hold a reservoir of indicator bacteria which are moved on by a combination of critical flow in the lower part of the stream and stream bed disturbance. The stream is popular with anglers and could be often disturbed by trout fishing activity. Potentially, there may be naturalised populations of *E. coli* within stream sediments. Both of these possibilities could be tested with sediment sampling and by testing the relationship of *E. coli* versus suspended sediment.

Following the 2015/2016 report recommendations, sediment sampling for *E. coli* was undertaken accompanying further water quality sampling across six sites through the Ngongotaha Catchment (Figure 4.8). This was conducted to identify levels of *E. coli* accumulating in streambed sediments. *E. coli* concentrations in sediments increased moving lower down in the catchment. There was no apparent correlation between *E. coli* concentrations in sediment and those in the water column.

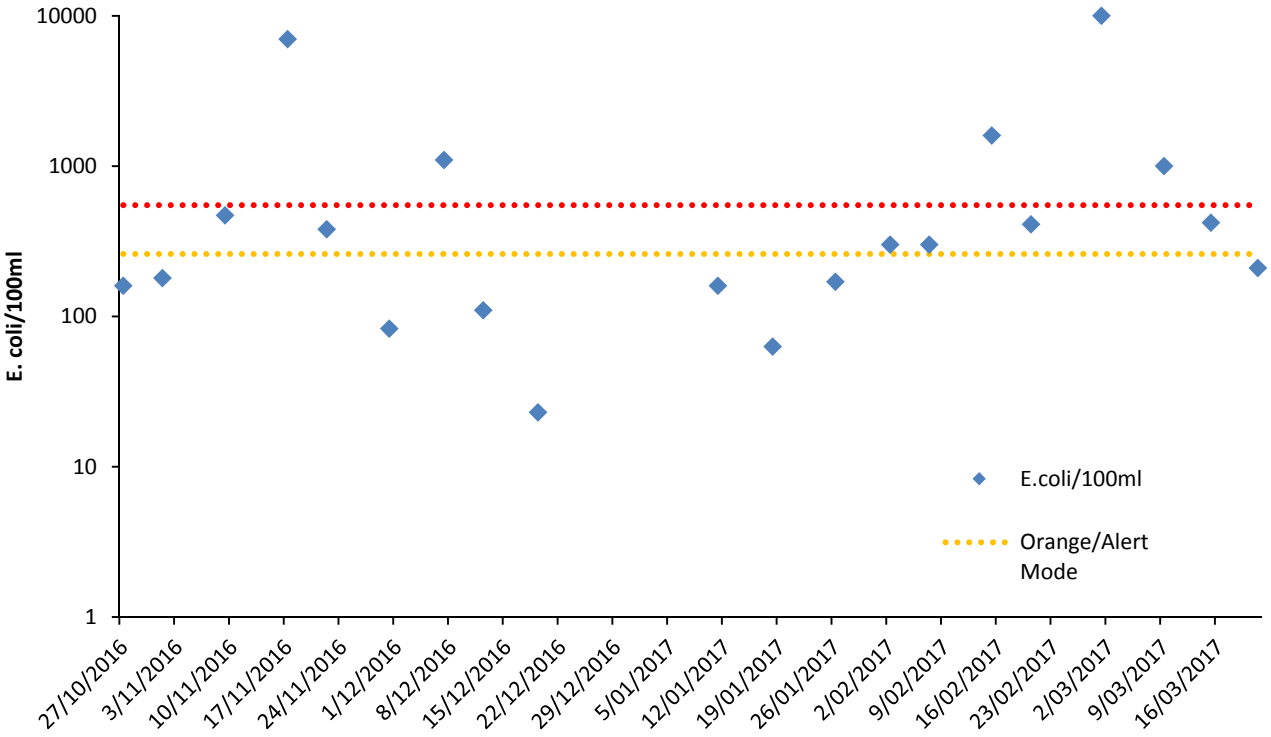


Figure 4.6 *E. coli concentrations at Ngongotahā Stream railway bridge site over the 2016/2017 bathing season, in relation to amber and red alert modes under the Microbiological Water Quality Guidelines (MfE/MoH, 2003).*

Figure 4.7 *E. coli concentrations, lower Ngongotahā Catchment in water samples collected in December 2016.*

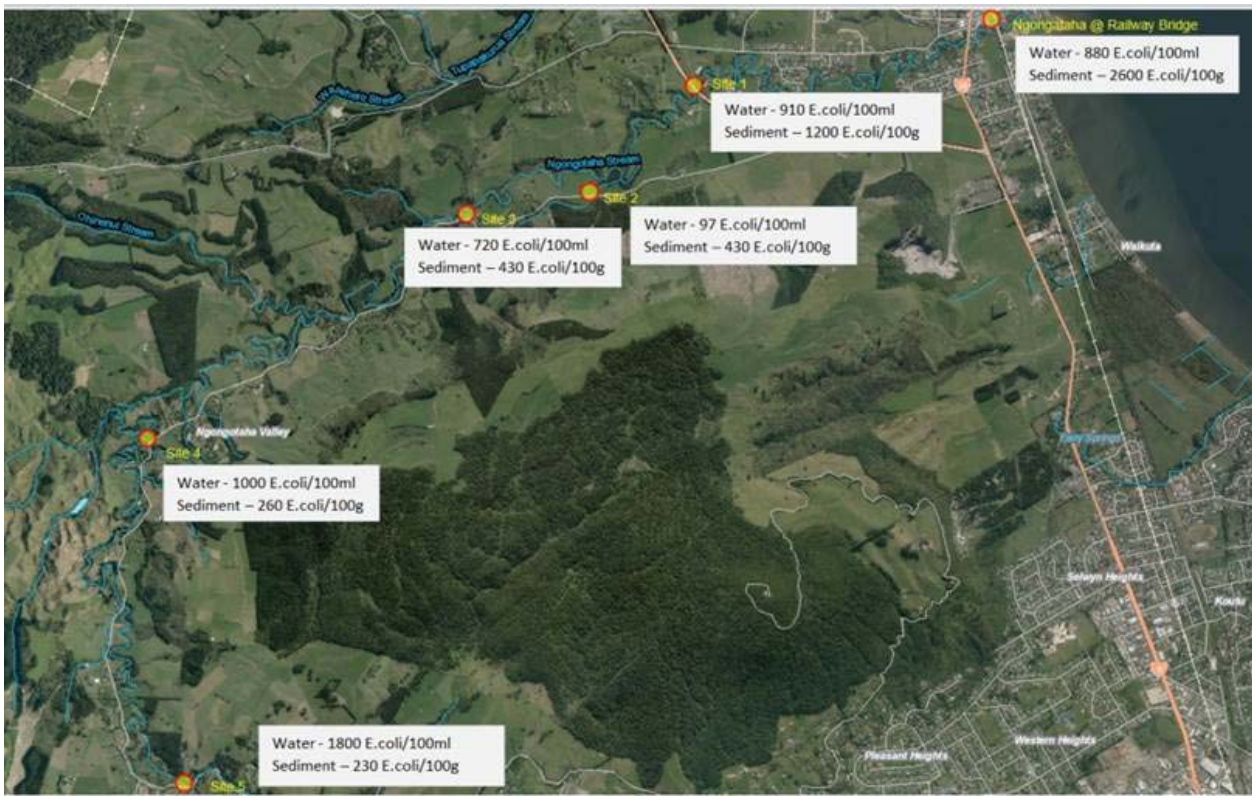


Figure 4.8 *E. coli concentrations in water and sediment samples, Ngongotahā Catchment, 1 March 2017.*

4.2.1 Discussion and recommendation

The Ngongotahā Stream has been the focus of riparian planting and fencing of waterway in pastoral areas as part of the Kaituna restoration scheme embarked in the 1970s. There may be a question around the longevity of this programme, as faecal contamination becomes an increasing issue. Like Kaiate Falls, there may be a number of potential mechanisms contributing to the bacterial loading other than surface run-off. It may be that sub-surface contributions of *E. coli* are bypassing the riparian protection areas, or that reservoirs of *E. coli* are building up in the stream sediments and feeding the water column. This may be exacerbated with stream bed disturbance events.

Monitoring to examine the impact of stream bed disturbance is recommended, along with testing of 'naturalised *E. coli* populations'. This term refers to *E. coli* populations that do not derive directly from faecal sources and that has evolved without host contact for a sufficiently long time to demonstrate reproducible characteristics.

Monitoring for the presence of campylobacter or cryptosporidium could also be a course of action. This would help to determine the prevalence of these disease causing organisms in relation to indicator bacteria concentrations, and potentially quantify the real health risk to recreational water users.

Part 5:

Shellfish and recreational gathering waters

5.1 Guidelines, sampling and analysis

Nine of the 27 open coastal and estuarine surveillance sites are regarded by communities as desirable shellfish gathering locations. Accordingly, water samples from these sites are additionally analysed for Faecal Coliforms (FC), which are suitable microbiological indicators for sanitary safety with regards to public shellfish consumption. Faecal coliforms have a stronger correlation with health risks associated with eating shellfish than enterococci (MfE/MoH, 2003), making them a useful indicator. The FC values specified in the microbiological guidelines indicate the likely presence of pathogenic bacteria, protozoa and viruses.

The guidelines for safe shellfish consumption are as follows:

- The median FC content should not exceed a Most Probable Number (MPN) of 14/100 ml, and
- No more than 10% of samples should exceed a MPN of 43/100 ml.

Compliance with these guidelines does not ensure that shellfish in the waters will be safe for consumption as they do not account for biotoxins. However, they do provide a useful management tool to assess the risk to human health. The sampling and analysis for FC is described in section 2.2.

5.2 Results

Results for the shellfish sampled over the 2016/2017 bathing season are presented in Figures 5.1 and 5.2.

Tauranga Harbour at Tilby Point and Waiotahe Estuary were found to exceed the safe consumption guidelines as described above (Figure 5.1). While a health advisory on taking shellfish from Tilby Point has been in place for several years, a new advisory was put in place for the first time at Waiotahe Estuary. Efforts are now focusing on tracking the source of faecal contamination (see section 4.1).

Bowentown at Tauranga Harbour also just exceeded the guideline of the median (14 faecal coliforms per 100 ml) at 17.5 faecal coliforms per 100 ml, and 20% of samples exceeding the greater than 43/100 ml guideline. From February 2017, the Tuapiro Stream level increased significantly due to large rainfall events. The streams and rivers in neighbouring catchments would have also been affected in a similar way. The heightened rainfall in these areas would be responsible for increased surface runoff into stream systems, providing a higher freshwater flow of contaminated water into the Tauranga Harbour. Further monitoring of the shellfish water beyond the standard season indicated that faecal indicator bacteria levels had dropped, but results indicate that there is still the potential for contamination with moderate to heavy rainfall events.

A much higher number of sites were above the 10% threshold during the 2016/2017 season (Figure 5.2). The higher number of rain events that occurred over the season compared to the previous couple of years is likely to have driven greater rates of faecal contamination

The combination of measures indicate that shellfish are likely to be contaminated microbiologically at three sites some of the time, elevating the risk of human health impacts if shellfish are consumed. Highest risks sites have been noted as Waiotahe Estuary and Tilby Point.

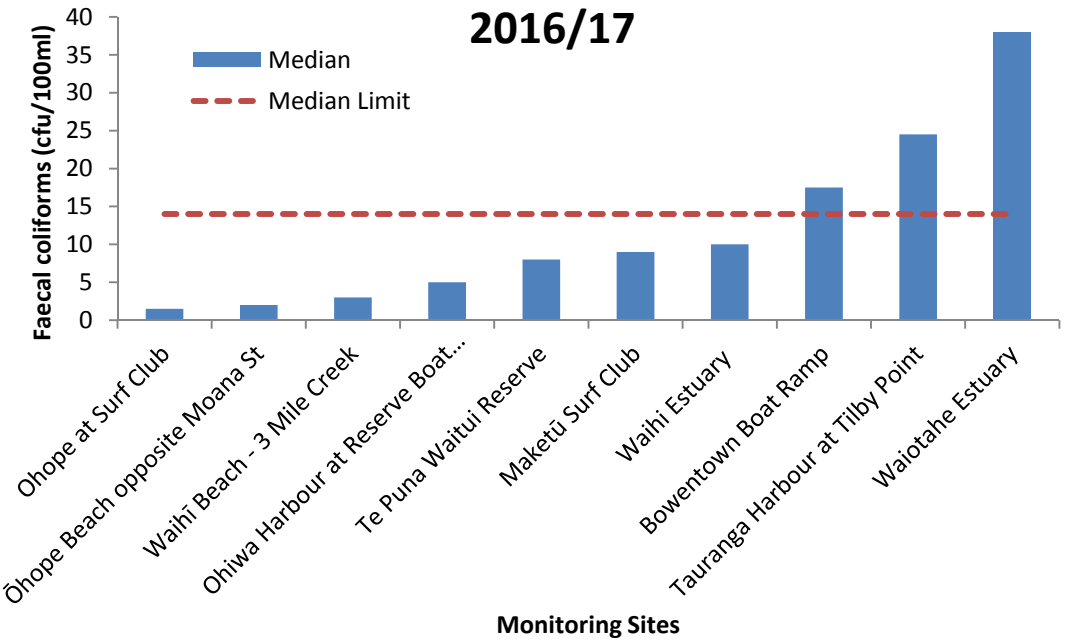


Figure 5.1 *Median faecal coliform concentrations at shellfish gathering locations for the 2016/2017 season and guideline median limit for safe shellfish consumption.*

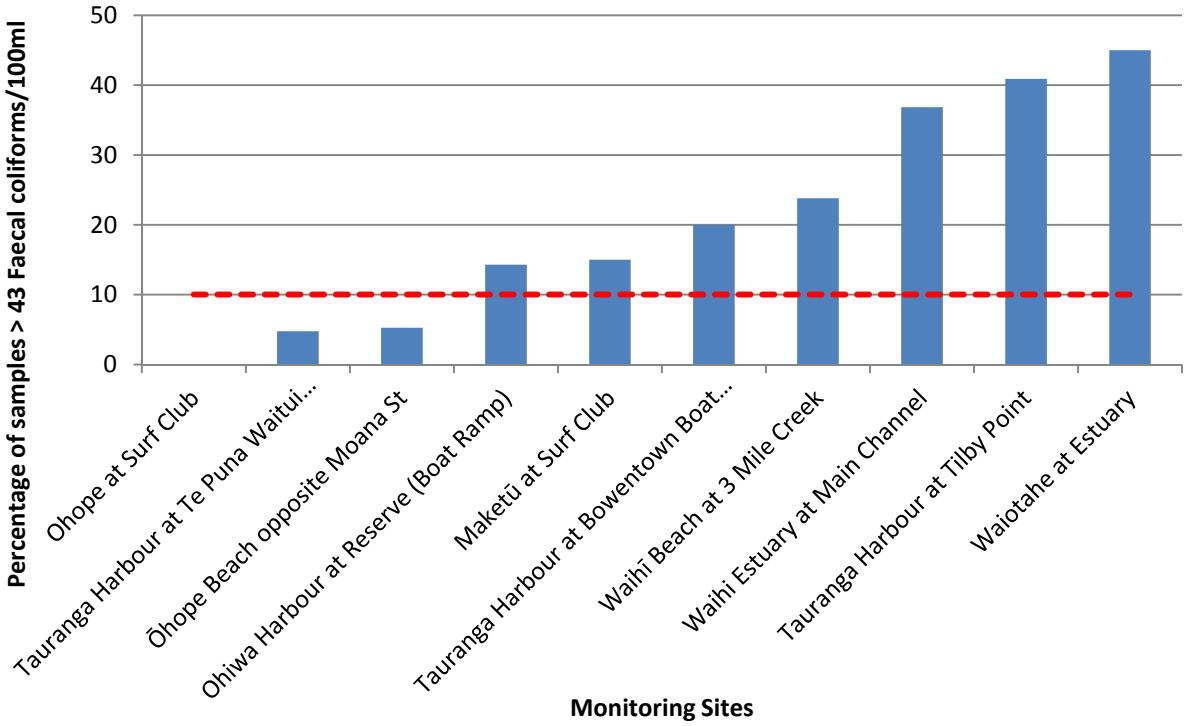


Figure 5.2 *Percentage of samples at shellfish gathering locations in the 2016/2017 season exceeding the limit of 43 cfu/100* ml *stipulated by the Microbiological Water Quality Guidelines (MfE/MoH 2003) for the 13 marine sites.*

Part 6:

Lake algae monitoring programme

6.1 Introduction

Blue-green algae are widespread throughout New Zealand. Lakes and rivers in the Bay of Plenty are affected by free living algal blooms at times (leading to soupy looking water or surface scums) or blooms of attached 'benthic' algae (often in the form of mats covering the river bed). These blooms may or may not be toxic.

The presence of toxin producing blue-green algae species (cyanobacteria) and the occurrence of blooms within the Rotorua Lakes is a natural phenomenon. Blooms can also occur in the 'cleaner' (oligotrophic/lower nutrient) lakes (including Lakes Tarawera and Okataina). Although, a number of the lakes have a history of cyanobacteria blooms that are significantly influenced by artificially elevated nutrient enrichment. The intensity of blooms can be increased by anthropogenic inputs of nutrients from human activities when the environmental conditions are favourable for the species (i.e. calm weather, high temperatures, low amount of mixing between the Epilimnion (surface) and Hypolimnion (bottom) layers of the lake, limited out flow, shallow conditions).

The Bay of Plenty Regional Council cyanobacteria monitoring programme was set up in 1997 after blooms exceeded levels safe for drinking and recreation in four of the Rotorua lakes (Lakes Okaro, Rotoiti, Rotorua, and Rotoehu). Blooms have occurred in these lakes on an almost annual basis since 1997. In addition, at least two other lakes and the Kaituna River are intermittently affected by blooms. The monitoring programme has now been tailored to anticipate and pre-empt periods of heightened bloom activity. In the periods with anticipated bloom activity the frequency of monitoring increases to enables timely health warnings. However, during the anticipated bloom time periods swimming may still be safe, provided bloom activity remains at low levels.

The cyanobacteria monitoring programme targets areas where the public is likely to have the greatest exposure to cyano-toxins (either through immersion, consumption or inhalation of water affected by cyano-toxins or irritants). The Medical Officer of Health (MO) relies on cell counts provided by Bay of Plenty Regional Council along with the results of toxicity tests, to determine whether cyanobacteria blooms pose a public health risk. The cell count generates the information to determine whether a site's sample has exceeded a given cyanobacteria biovolume threshold indicating that a health warning is required. The biovolume thresholds are based on the potential health risk of that amount of cyanobacteria and the warnings indicate it is no longer safe to use the lake water for swimming, drinking, and watersports.

A number of blue-green algae are known to produce cyano-toxins. These include the cyclic peptides (*microcystin* and *nodularin*), alkaloids (cylindrospermopsin, anatoxins and saxitoxins) and lipopolysaccharides (LPS) (Wood, 2004). Microcystin and its various analogues are the most prevalent cyano-toxin in the Rotorua lakes and therefore also potentially the most harmful. There are numerous documented cases of toxicity and fatalities in wild and domestic animals from *Microcystis* blooms in stock drinking water supplies.

6.2 Monitoring methods

There are around 13 sites in the Rotorua lakes region that are to be sampled on a weekly basis. This may vary depending on health status of the lakes (if blooms are present, etc.).

- Lake Rotoehu – Kennedy Bay, Ōtautū Bay and Te Pohea.
- Lake Rotoiti – Hinehopu, Okawa Bay, Te Weta Bay, Okere Arm, Otaramarae.
- Kaituna River – Trout Pool at Ōkere Falls.
- Lake Rotorua – Ōhau Channel, Hamurana, Ngongotahā, Holdens Bay.
- Lake Ōkaro – Boat ramp.
- Lake Tarawera – the Landing, Hot Water Beach, Lake Tarawera Outlet (Te Tapahoro).

Sampling involves taking five integrated samples from different locations around the sampling site (around 1 m apart) and subsampling an 80 to 100 ml aliquot from a pooled sample. The sample is fixed with lugols iodine. Visual observations at the site (such as time, water clarity, wind direction) are also recorded.

Samples are analysed using the Axiovert 100 microscope using whole plate or random colony counts depending on cyanobacteria colonies present. Cell counts are entered to a database and converted to biovolume for reporting purposes.

6.3 Guidelines and reporting framework

Results are reported weekly on the Bay of Plenty Regional Council website as well as The Land and Water Aotearoa (LAWA) website. If alert level is reached, a range of actions follow, potentially culminating in health warnings if blooms reach the biovolumes listed in Table 6.1. The alert level framework used by Bay of Plenty Regional Council follows that given in the interim 'New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters' (MfE/MoH 2009). Once an alert level (orange/red) is detected the Medical Officer of Health (MoH) of Toi Te Ora Public Health is informed immediately. The MoH will update their website, undertake any media warnings and instruct the relevant territorial authority to post warning signs.

*Table 6.1 Alert – level framework for planktonic cyanobacteria (when using biovolume not cell/*ml*)*

Alert level	Actions
Surveillance (green mode) The biovolume equivalent for the combined total of all cyanobacteria material does not exceed 0.5 mm^3/L.	• Undertake weekly or fortnightly visual inspection and sampling of water bodies where cyanobacteria are known to proliferate between spring and autumn.
Alert (amber mode) 0.5 to < 10 mm^3/L total biovolume of all cyanobacterial material.	• Increase sampling frequency to at least weekly. • Notify the public health unit. • Multiple sites should be inspected and sampled.
Action (red mode) ≥ 10 mm^3/L total biovolume of all cyanobacterial material.	• Continue monitoring as for alert (amber mode). • If potentially toxic taxa are present consider testing samples for cyanotoxins. • Notify the public of a potential risk to health.

One of the attributes within the NPS-FM (2014) is the national objectives framework (NOF) human health value. This can be measured by observation of planktonic cyanobacteria. The attribute bands scale lake cyanobacteria levels through a ranking system of A to D, where B band is not applicable (Table 6.2). These bands are based either on biovolume or cell count of cyanobacteria, using the 80th percentile of a site over a three year period to compare with the bands numerical thresholds. The results for this can be found in section 6.4.6.

Table 6.2 Cyanobacteria attribute state from NPS-FM (2014).

Value	Attribute state (*E. coli*/100 ml)			
	A	B	C	D
Numeric state 80th percentile*.	≤0.5 mm^3/L bio-volume, or ≤500 cells/mL.	N/A	>0.5 and ≤1.8 mm^3/L toxic cyanobacteria biovolume, or >0.5 and ≤10 mm^3/L total cyanobacteria.	>1.8 mm^3/L toxic cyanobacteria biovolume, OR 10 mm^3/L total cyanobacteria.
Human health for secondary* contact (annual median).	Risk exposure from cyanobacteria is no different to that in natural conditions (from any contact with fresh water).		Low risk of health effects from exposure to cyanobacteria (from any contact with fresh water).	Potential health risks (e.g. respiratory, irritation and allergy symptoms) exist from exposure to cyanobacteria (from any contact with fresh water).

*80th percentile must be calculated using a minimum of 12 samples collected over three years.

6.4 Results

6.4.1 Lake Ōkaro

Over the 2016/2017 summer period Lake Okaro cyanobacteria were present at amber alert levels when summer monitoring began in November 2016. Red alert levels were reached for a few weeks in December and January and again in February, resulting in health warnings being used by Toi Te Ora. Blooms ceased in March 2017.

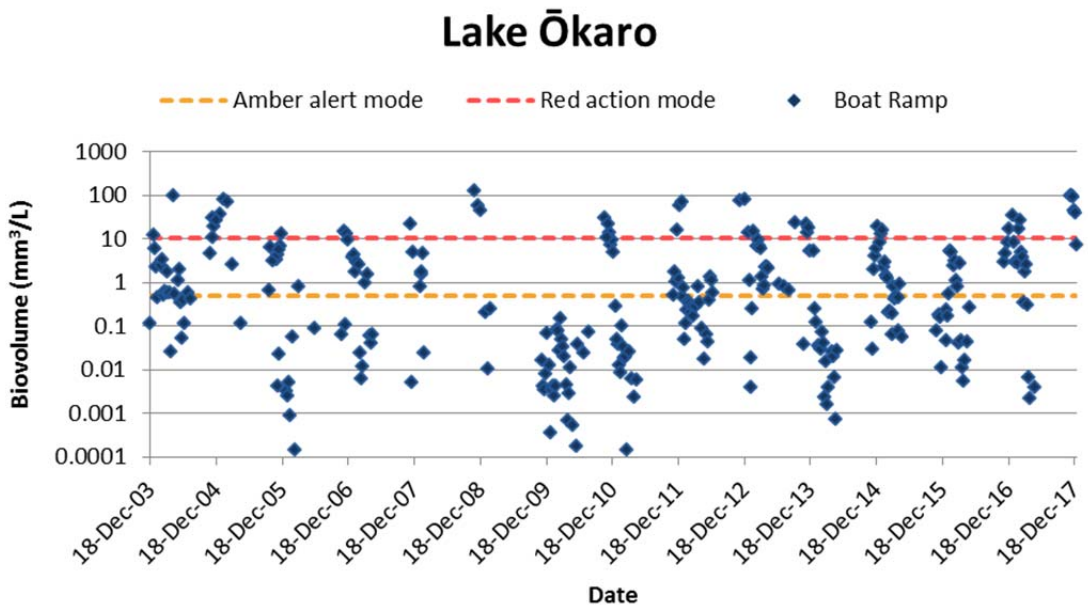


Figure 6.1 *Total cyanobacteria biovolume sampled at Lake Ōkaro boat ramp, 2003 to 2017.*

6.4.2 Lake Rotoehu

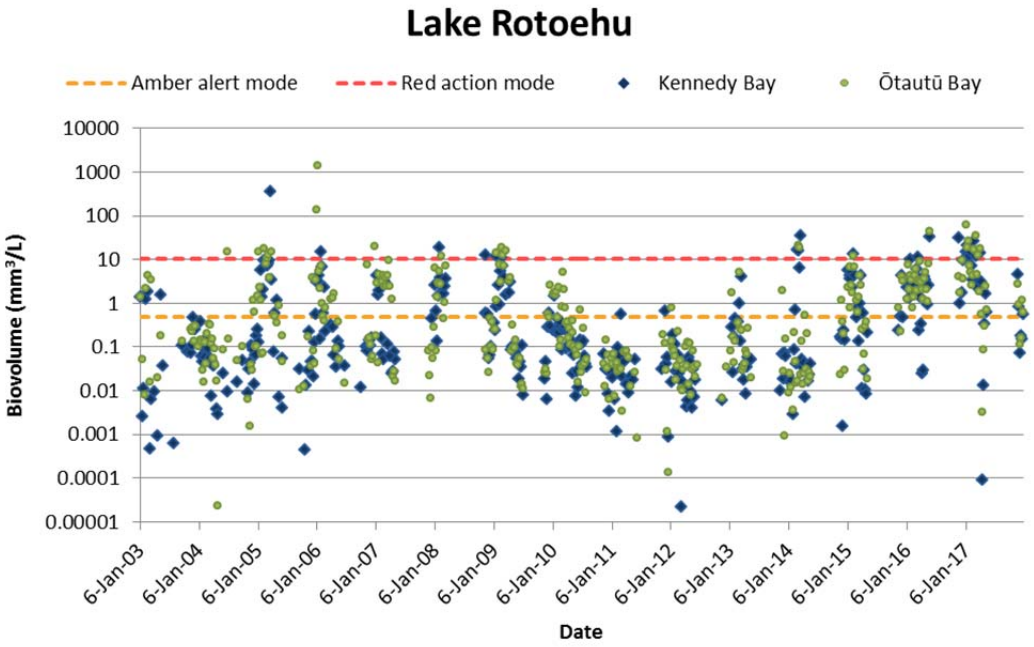


Figure 6.2 *Total cyanobacteria biovolume, sampled at Ōtautū Bay and Kennedy Bay of Lake Rotoehu, 2003 to 2017.*

6.4.3 Lake Rotorua

Cyanobacteria levels remained relatively low in 2016/2017, similar to the previous summer. Also, like the previous summer, amber alert levels occurred in late January early February, but red alert levels did not. Consequently, no cyanobacteria health warnings were issued for the lake.

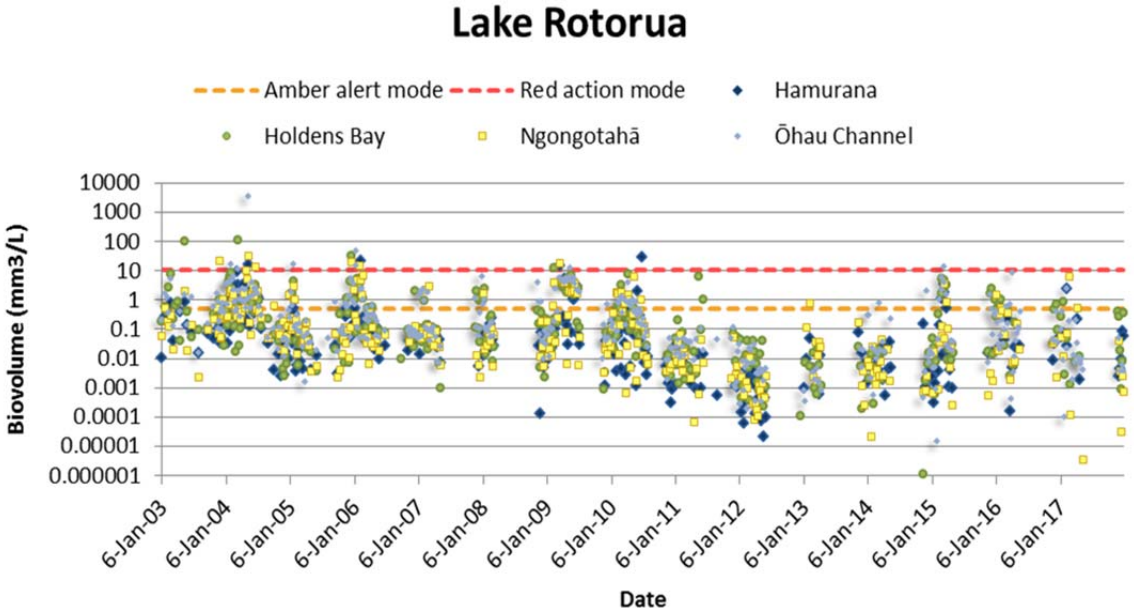


Figure 6.3 Total cyanobacteria biovolume, sampled at Holdens Bay, Ngongotahā, Hamurana and Ōhau Channel, Lake Rotorua, 2003 to 2017.

6.4.4 Lake Rotoiti

Cyanobacteria concentrations were similar to the previous season with orange alert levels at the height of summer, but no red alerts. After that time biovolume of cyanobacteria was below orange alert levels.

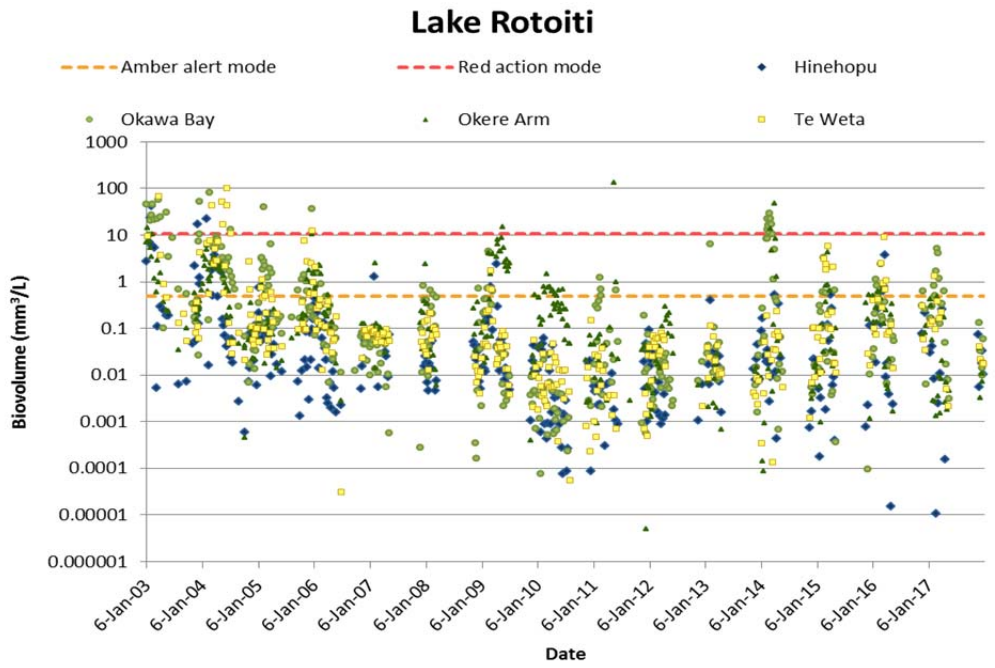


Figure 6.4 Total cyanobacteria biovolume, sampled at Hinehopu, Okawa Bay, Okere Arm and Te Weta Bay, Lake Rotoiti, 2003 to 2017.

6.4.5 Lake Tarawera

Cyanobacteria biovolumes triggered amber alert levels at hot water beach in January through to March, with amber alert level being reached at Stoney Point for three weeks from the end of January into February. No health warnings were necessary in the 2016/2017 season.

6.4.6 Comparison with NOF

Over the past four years, no lakes are below the national bottom line for this human health value in band D (Table 6.3). Hot spots for persistent blooms of blue-green algae (cyanobacteria) are Lake Ōkaro, Lake Rotoehu and Okawa Bay in Lake Rotoiti.

Table 6.3 NOF banding results for Total Cyanobacteria (planktonic) biovolumes in Rotorua Te Arawa lakes, 2014 to 2017.

Lake/site	**NOF band**	**80th percentile biovolume** (mm^3/L)
Lake Ōkaro at Boat Ramp	C	5.120
Lake Rotorua at Hamurana	A	0.046
Lake Rotorua Holdens Bay	A	0.380
Lake Rotorua at Ngongotahā	A	0.057
Ōhau Channel	A	0.311
Lake Rotoiti at Okawa Bay	C	1.122
Lake Rotoiti at Okere Arm	A	0.368
Lake Rotoiti at Otaramarae	A	0.127
Lake Rotoiti at Te Weta	A	0.289
Lake Rotoiti at Hinehopu	A	0.117
Lake Rotoehu at Otautu	C	5.249
Lake Rotoehu at Kennedy Bay	C	6.434
Trout Pool	A	0.134

Part 7:

Summary discussion

A relatively wet summer season compared to previous seasons (Figure 7.1) resulted in an increase in the number of exceedances of the microbiological water quality guidelines for some sites in the 2016/2017 bathing season. Most sites in the Bay of Plenty still remained suitable for bathing over this period.

Based on the SFRG, 91.7% of lake sites are graded ‘very good’ or ‘good’, with 8.3% graded ‘poor’. 33.3% of river sites were graded ‘poor’, an improvement of 18.9% compared to the previous grading.

Compared to the freshwater NOF attribute for *E. coli,* 91% of river and lake sites with appropriate monitoring records are suitable for swimming. 9.1% of sites fell into the ‘D’ band (orange), indicating an elevated risk of infection form microbial pathogens to recreational users.

No estuarine sites were graded ‘poor’ or ‘very poor’ based on the SFRG, and 85.7% of sites were graded as ‘good’ or ‘very good’. This result is a considerable improvement compared to the 2015/2016 season. Almost all of the open coastal sites (90%) were graded as ‘good’ or ‘very good’, with the remaining 10% graded as ‘fair’.

The SFRG grading shows that rivers continue to pose the highest risk to recreational water users, and that there is only a low risk of encountering water-borne pathogens in monitored lakes. This is consistent with previous monitoring and reflects the greater vulnerability of rivers and streams to diffuse and point source discharges due to contaminants sourced from faecal material.

Note that some SFRG grades are provisional as the microbiological data has not reached an optimum level according to the microbiological guidelines. The data does, however, provide useful information to allow an assessment of the risk to recreational users of waterways. Follow up grades are also assigned where not enough data has been collected, or the catchment assessment is not consistent with the indicator bacteria results. The grading system can be biased by only one or two elevated results, as these push the percentile figures upwards. Such results can be more frequent in years where monitoring has coincided with rainfall events.

Based on the microbiological guidelines and weekly monitoring results for 2016/2017, the open coastal sites have excellent water quality with none reaching the Red/Action Mode in 2016/2017. Tauranga Harbour at Waimapu Bridge was the only site to reach Red/Action Mode in 2016/2017. During the 2016/2017 bathing season, 10.3% of samples from rivers reached the Orange/Alert Mode and 8.4% reached the Red/Action Mode. Many of these can be explained by heavy rainfall events.

Comparison with the NPS-FM NOF attribute state for swimming water quality over the last five years (2012-2017) showed that 76% of freshwater sites fell into the ‘A’ or ‘B’ band categorised as suitable for swimming most of the time. The rest of sites fell into the ‘D’ band indicating a greater risk of infection with immersion at these sites, particularly after rainfall events. The message enforced through media campaigns and through web sites is to avoid swimming for at least 2-3 days after heavy of prolonged rainfall, even for sites with good water quality.

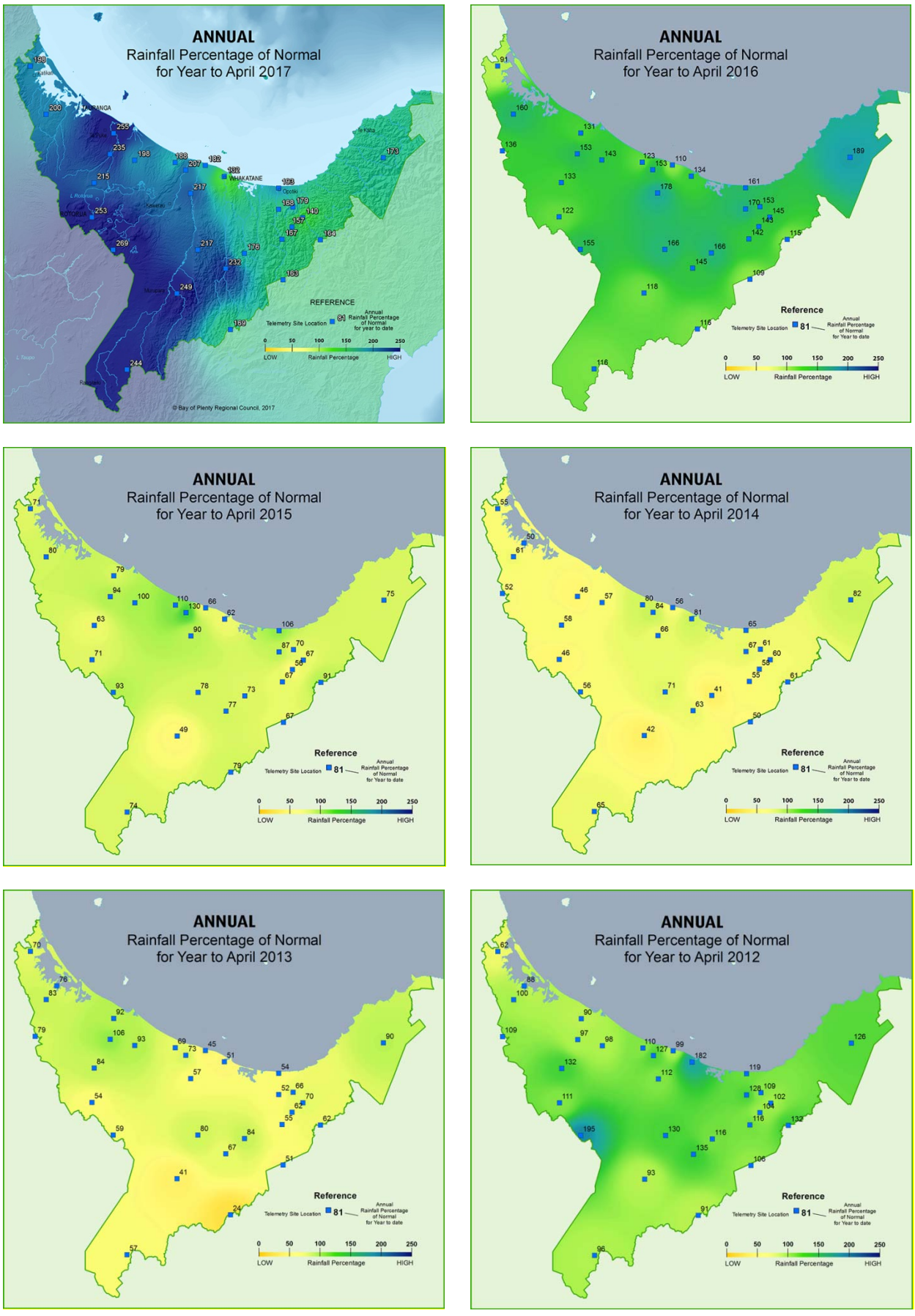


Figure 7.1 Annual rainfall percentage of normal for years 2012 to 2017.

Shellfish samples collected from three estuarine sites exceeded the guideline levels for human consumption. Having elevated faecal coliform and enterococci levels indicates some risk to human health if these shellfish are ingested uncooked.

Blue-green (cyanobacteria) blooms resulted in health warnings being issued by Toi Te Ora Public Health for Lakes Rotoehu and Ōkaro. Lakes Rotoiti, Tarawera and Rotorua reached orange alert levels for some sites over the 2016/2017 summer.

Part 8:

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Appendices

Appendix 1a:

Suitability for recreation regarding – grades for river and stream sites

DISTRICT	SITE DESCRIPTION	SITE ID	MEAN	MEDIAN	95th PERCENTILE	MAC	SIC	SFRG	% OF SAMPLES <ACTION/RED MODE	NOF ATTRIBUTE
Kawerau	**Tarawera at Kawerau Bridge**	IK558876	94.3	60	260	B	Very Low	Good	98%	Blue
Ōpōtiki	**Kereu at SH35**	RO629568	191.1	6	208.5	A	Very Low	Very Good	98%	Blue*
Ōpōtiki	**Otara at SH35**	NL683503	138.4	37	352	C	Moderate	Fair	97%	Blue
Ōpōtiki	**Waioeka at SH2**	NL517414	206	56	610	D	Moderate	Poor	94%	Green
Ōpōtiki	**Waioeka at Mouth of Gorge**	NK608503	91.5	12.5	272	C	Moderate	Fair	96%	Blue*
Rotorua	**Ngongotaha at Railway Bridge**	EL192023	490.7	190	1470	D	Low	Poor	82%	Orange
Rotorua	**Ohau Channel at SH33**	FL230406	37	17	120	A	Moderate	Good	100%	Blue
Rotorua	**Puarenga at Whakarewarewa**	EK537123	185.5	87	432	C	Very Low	Fair	96%	Blue
Rotorua	**Utuhina at Lake Rd**	EK405487	204.1	104	745	D	Moderate	Poor	92%	Green
Rotorua	**Waiteti at SH36**	EL139134	231.5	96.5	856	D	Moderate	Poor	94%	Green
TCC	**Wairoa at SH2**	DP281304	162	63	608	D	Moderate	Poor	95%	Blue
WBOP	**Kaiate at Kaiate Falls Rd**	EO564565	527.4	240	1800	D	Moderate	Poor	76%	Orange
WBOP	**Pongakawa at SH2**	GN922883	130.9	70	519	C	Moderate	Fair	97%	Blue
WBOP	**Tuapiro at McMillan Rd**	BR748451	160.7	74	263	B	Moderate	Good	98%	Blue
WBOP	**Uretara at Henry Rd Ford**	BQ723939	478.3	155	1165	D	Moderate	Poor	90%	Orange
WBOP	**Wairoa Below McLaren Falls**	CO809137	132.6	34	784.5	D	Moderate	Poor	93%	Green

DISTRICT	SITE DESCRIPTION	SITE ID	MEAN	MEDIAN	95th PERCENTILE	MAC	SIC	SFRG	% OF SAMPLES <ACTION/RED MODE	NOF ATTRIBUTE
Whakatāne	**Rangitaiki at Te Teko Bridge**	JL348334	55.7	22	280	C	Very Low	Fair	98%	Blue
Whakatāne	**Rangitaiki at Boat Ramp**	KM083686	82.6	37	285.5	C	Moderate	Fair	99%	Blue
Whakatāne	**Tauranga at Wardlaw Glade**	LK445461	180.6	15	236.5	B	Moderate	Good	96%	Blue
Whakatāne	**Whakatane at Landing Rd**	KM909138	107.1	63	300	C	Moderate	Fair	96%	Blue
Whakatāne	**Whakatane at Rūātoki *4 YEAR**	LK082095	249.5	34.5	290	C	Moderate	Fair	98%	Blue*

*less than 60 samples (>50)

Appendix 1b:

Suitability for recreation grading – grades for lake sites

SITE DESCRIPTION	SITE ID	MEAN	MEDIAN	95th PERCENTILE	MAC	SIC	SFRG	% OF SAMPLES <ACTION/RED MODE	NOF ATTRIBUTE
Lake Okaro at Boat Ramp	FI660574	21	5	60.3	A	Very Low	Very Good	99%	Blue
Lake Rerewhakaaitu at Homestead Arm	GI442508	42	17	163.0	B	Very Low	Good	99%	Blue
Lake Rotorua at Hamurana	EL438512	64	14	125.5	A	Very Low	Very Good	96%	Blue
Lake Rotorua at Ngongotaha	EL224087	114	14	664.0	D	Very Low	Poor	94%	Green
Lake Rotorua at Holdens Bay	EK935598	26	9	119.3	A	Very Low	Very Good	100%	Blue
Lake Okareka at Steep St Reserve	FK325034	35	12	150.0	B	Very Low	Good	100%	Blue
Lake Rotoiti at Gisborne Point	GL314263	8	2	32.2	A	Very Low	Very Good	100%	Blue
Lake Rotoiti at Okawa Bay	FL289316	23	10	93.0	A	Very Low	Very Good	100%	Blue
Lake Rotoiti at Hinehopu	GL606421	10	1	40.6	A	Very Low	Very Good	100%	Blue
Lake Tarawera at Rangiuru Bay	FJ737728	8	1	25.8	A	Very Low	Very Good	100%	Blue
Lake Tikitapu at Beach	FJ157807	28	6	195.5	B	Very Low	Good	100%	Blue
Lake Rotoma at Whangaroa	HL337241	26	4	159.5	B	Very Low	Good	99%	Blue

*__Note:__ Numerical results and MAC are based on *E. coli* data.

Appendix 1c:

Suitability for recreation grading – grades for marine sites

SITE DESCRIPTION	SITE ID	MEAN	MEDIAN	95th PERCENTILE	MAC	SIC	SFRG	% OF SAMPLES < 280 n/100 ml
Waihi Beach at Surf Club	CS010698	21.2	2.0	112.8	B	Very Low	Good	98%
Waihi Beach at 3 Mile Creek	CS131458	222.9	3.0	267.0	C	Very Low	Fair	96%
Tauranga Harbour at Anzac Bay	CR395919	79.0	15.9	110.0	B	Moderate	Good	100%
Tauranga Harbour at Athenree/Bowentown	CS292034	163.6	7.0	234.0	C	Low	Fair	96%
Tauranga Harbour at Tanners Point Beach	CR054756	164.4	10.0	269.0	C	Very Low	Fair	96%
Tauranga Harbour at Ongare Point	CR253528	392.8	11.0	1310.5	D	Low	Poor	95%
Tauranga Harbour at Pahoia Beach Rd	CQ490084	428.5	11.0	2560.0	D	Very Low	Poor	91%
Tauranga Harbour at Te Puna Waitui Reserve	CP895761	26.4	3.0	172.5	B	Moderate	Good	98%
Tauranga Harbour at Omokoroa Domain	CQ940066	11.9	1.0	80.1	B	Moderate	Good	99%
Tauranga Harbour at Tilby Point	DP547739	34.4	7.0	110.0	B	Moderate	Good	97%
Tauranga Harbour at Waimapu Bridge	DP896097	36.6	7.0	187.5	B	Moderate	Good	99%
Pilot Bay opposite Pacific Ave	EP057968	38.4	6.0	208.0	C	Very Low	Fair	97%
Tauranga Harbour at Maungatapu Bridge	EP095164	25.6	5	125.0	B	Low	Good	99%
Mount Maunganui at Surf Club	EQ065035	5.6	1.0	37.8	A	Moderate	Good	100%
Maketu at Surf Club	GO441583	9.4	3.0	55.8	B	Very Low	Good	100%

SITE DESCRIPTION	SITE ID	MEAN	MEDIAN	95th PERCENTILE	MAC	SIC	SFRG	% OF SAMPLES < 280 n/100 ml
Waihi Estuary at Main Channel	GO661503	137.5	10.0	260.0	C	Very Low	Fair	96%
Pukehina at Surf Club	GO701513	7.0	1.0	39.0	A	Moderate	Good	100%
Piripai at Ohuirehe Rd	KM969398	5.1	1.0	25.0	A	Very Low	Very Good	100%
Whakatane Heads	LM237268	42.6	15.0	197.0	B	Moderate	Good	98%
Ohope at Surf Club	LM474063	6.6	1.0	36.2	A	Very Low	Very Good	100%
Ohiwa Harbour at Reserve (Boat Ramp)	ML251726	9.9	2.0	50.0	B	Very Low	Good	100%
Waiotahe at Estuary	ML922670	139.0	12.0	189.0	B	Moderate	Good	96%
Waiotahe Beach at Surf Club	NL243661	21.2	2.0	74.8	B	Very Low	Good	100%
Hikuwai Beach at end of Snell Rd	NL713661	6.8	1.0	32.6	A	Moderate	Good	100%
Te Kaha at Maraetai Bay	RO364396	175.8	4.0	240.0	C	Low	Fair	96%
Whanarua Bay	SO235884	166.1	4.0	235.3	C	Moderate	Fair	96%