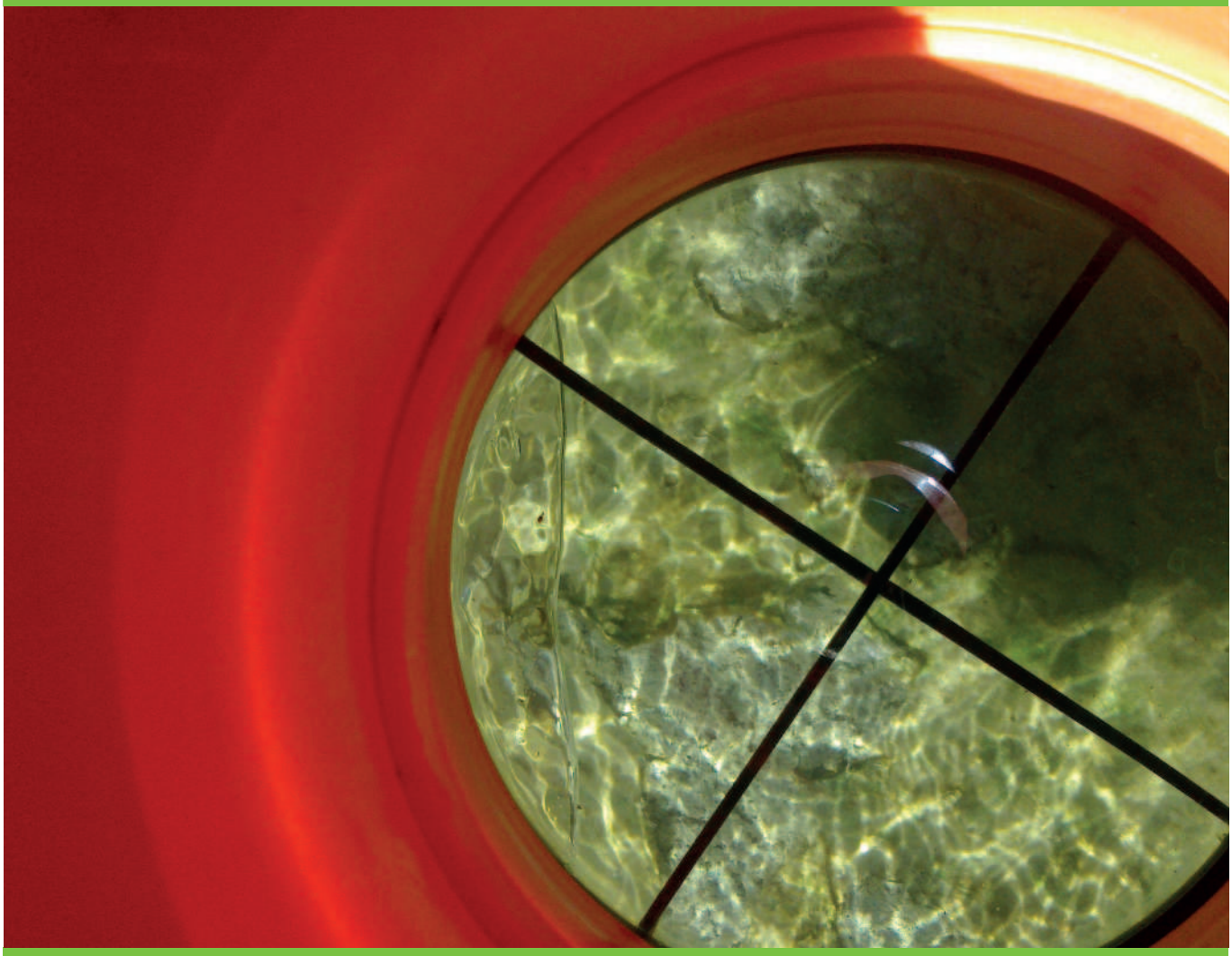
Recreational Waters Surveillance Report 2013/2014



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Cover Photo: View scope view of the Otara River

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Position: Water Science Manager

Date: 16 September 2014

Executive summary

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). The 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. Due to the public health risk from cyanobacteria (blue-green algae) the programme also includes the monitoring of benthic cyanobacteria (*Phormidium*) in rivers and streams.

The main objective of this report is to report on the bathing suitability of approximately 80 river, lake and marine sites over the 2013/2014 bathing season. 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), orange (cautionary mode) and red (unsafe mode) to denote risk.

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.

The results of the 2013/2014 bathing surveys show that most sites in the Bay of Plenty are generally suitable for bathing. However, the Suitability for Recreation Grading (SFRG) system, highlights that there is some risk to bathers using river and stream, as they are more vulnerable to pathogen loading from rainfall runoff. For example, 95% of lake sites are graded ‘very good’ or ‘good’ while 25% of river sites are graded ‘very good’ or ‘good’.

The table below shows the status of monitored bathing sites against the New Zealand Microbiological Water Quality Guidelines (Red/Action Mode). Generally, lake sites show the highest quality overall against this guideline, 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 NZ Microbiological Water Quality Guidelines (MfE/MoH 2003).

		Rivers	Lakes	Marine
Samples less than the Red/Action Mode	2013/14	97.6%	100%	99.1%
	Last five years	94.2%	99.8%	98.2%

River and stream sites showed improved levels of faecal contamination compared to the previous seasons, with only 2.3% of results above the Orange/Alert Mode and 2.3% above the Red/Action Mode.

Open coastal sites typically have excellent water quality with only one site exceeding the Orange/Alert Mode in 2013/2014. Eleven of the 18 estuarine sites reached the Orange/Alert Mode in 2013/14, but only 11% of the estuarine sites are graded ‘poor’ (none are graded ‘very poor’).

The 2013/14 *E.coli* data was compared with the NPS for Freshwater National Objective Framework attributes for human health. All sites rate highly (i.e. very safe) for secondary contact recreation activities, but eight sites are below the minimal acceptable standard for primary contact recreation.

Shellfish at one estuarine site (pipi in Waiotahi Estuary) were found to have *E.coli* levels above safe consumption guidelines. Monitoring of the Waiotahi Estuary continues to show that elevated bacteria levels occurred in pipi after rainfall.

Phormidium was generally only found at alert levels at two new sites in the Whakatane River, Ruatoki and Waikirikiri. Two sites on the Waimana River also reached alert levels for *Phormidium* coverage. Blooms persisted for just over three weeks before a flushing event removed them.

The bathing and shellfish monitoring programme does not specifically identify the factors causing faecal contamination. However, it does highlight areas where more detailed investigation should be carried out. Targeted studies can then be used to address more specific water quality issues. One recommendation is to investigate faecal contamination sources in the catchment that do not meet the National Objectives Framework (NOF) minimum acceptance state. Use of microbial source tracking techniques may help delineate potential sources, but modelling and loading investigation are also likely to be required to ascertain relative contribution within these catchments.

A further recommendation is made to develop a predictive warning system for high risk sites, rather than rely on weekly monitoring, which is often out of date before a warning can be initiated. A predictive model would be developed by undertaking event sampling and analyses of sites with adjacent flow/level and rainfall monitoring. A model would then be used to provide an early warning system of elevated pathogen levels in rivers.

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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). The 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. Due to the public health risk from cyanobacteria (blue-green algae) the programme also includes the monitoring of benthic cyanobacteria (*Phormidium*) in rivers and streams.

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.
- Regional Water and Land Plan.
- Regional Coastal Environmental Plan.
- Regional Policy Statement.

Due to the public health risk from cyanobacteria (blue-green algae) the programme also includes the monitoring of benthic cyanobacteria (*Phormidium*) in rivers and streams. This report summarises the annual recreational waters survey monitoring results for the 2013/2014 season and also presents recent shellfish monitoring results.

1.2 Legislative framework and responsibilities

The National Policy Statement (NPS) for Freshwater Management (2014) has the objective to safeguard the health of people and communities, at least as affected by secondary contact with freshwater. The NPS has a National Objectives Framework (NOF) which sets thresholds for numeric attributes, ranked into four bands (A-D), defining water quality for "human" (and "ecosystem") health (MfE, 2014) (Table 1).

Table 1 The National Objective Framework – values and related attributes for lakes and rivers (summarised from MfE, 2014).

Value	Attribute state (E.coli/100 ml)			
	A	B	C (Bottom-line)	D
Numeric state	≤260	>260 and ≤ 540	>540 and ≤1000	>1000
Human health for secondary* contact (annual median)	Very low risk of infection (<0.1%) secondary exposure	Low risk of infection (up to 1%) secondary exposure	Moderate risk of infection (<5.0%) from secondary exposure	High risk of infection (>5.0%) from secondary exposure
Human health for primary** contact (95th Percentile)	Low risk of infection (up to 1%) primary exposure	Moderate risk of infection (<5.0%) from primary exposure. **Minimum Acceptable State**		

*Secondary activity occasional immersion and some ingestion: e.g. boating; wading.
**Primary likely to involve full immersion.

The agencies with responsibilities related to recreational water quality are regional councils, 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 Guidelines (MfE/MoH 2003) provide a recommended framework for 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.

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 80 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 the 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 to help identify causes so remedial action can be initiated.
- Set the foundation for water quality accounting in freshwater management units and to assist in the identification of values of each freshwater management unit.

The bathing surveillance monitoring sites are shown in the maps that follow (Figure 1.1).

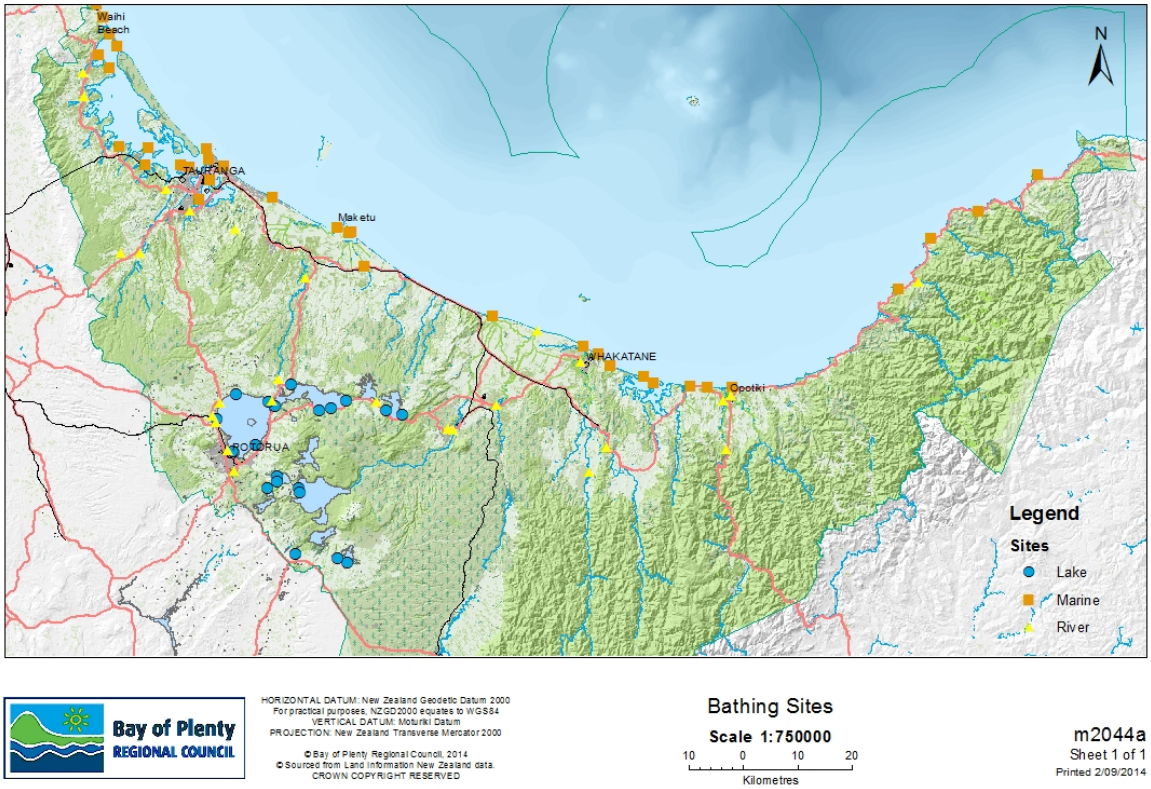

Figure 1.1 Bathing surveillance sites, Bay of Plenty.

Part 2: Microbiological guidelines, indicators and gradings

2.1 Introduction

If human or animal faecal matter finds its way into recreational waters, 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 variable concentrations.

The impacts of pathogenic micro-organisms on human health are most 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).

Indicator micro-organisms are used to assess recreational water quality, as it is difficult and impractical to measure all potentially pathogenic micro-organisms. 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. Two indicator bacteria 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). Research relating illness to indicator bacterial levels has been used to develop guideline levels for which a tolerable risk to healthy people is established. The Microbiological Guidelines provide gradings (see section 2.4) and trigger levels which can be used by water managers and the public, to assess the potential 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 implemented.

2.2 Sampling and analysis

Sampling and analyses where performed in accordance with established internal procedures. Most analyses were performed by the Regional Council laboratory.

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 1986 EPA-821-R-97-004	1 cfu/100 ml

Sampling occurred between 8:00 am and 6:00 pm and was undertaken by either wading or by use of a sample pole. Sterile 500 ml polyethylene bottles were used to sample water at a representative location in the water column. Water quality analyses were completed using the methods in Table 2.1. All samples were stored and returned within the time period stipulated by the methods.

Shellfish were collected by hand and placed in plastic bags with immediate cool storage in a chilly bin. The samples were then transported to the laboratory within six hours.

Shellfish were analysed for escherichia coli, enterococci and faecal coliforms. The most probable number (MPN) method was used for faecal coliform and enterococci analysis (APHA 2005), and *E.coli* analysis (APHA 1985).

2.3 Microbiological water quality guidelines

Comparison of monitoring results with the microbiological guidelines over a bathing season, provides water managers with a tool for water quality assessment to be used in conjunction with beach grades. Beach grading provides an analysis of the suitability of recreation over time, using combined information on 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 different modes are listed in Table 2.2.

Table 2.2 Surveillance, alert and action levels for fresh and marine 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 and ≤ 280	Increased monitoring, identify possible sources
Red/Action	Two consecutive single samples > 280	Public warnings, increased monitoring, source investigation

Surveillance mode indicates there is an acceptable risk to recreational water users. Should waters be found to be in *Alert Mode* then there is an increased risk of illness if contact is made with recreational waters. *Action Mode* indicates 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 the microbiological guidelines and issuing of health warnings will be dependent on the circumstances surrounding any contamination event.

2.4 Bathing surveillance grading

The New Zealand Microbiological Water Quality Guidelines outline a process to grade the suitability of marine and fresh waters for recreational use. A 'Suitability for Recreation Grade' (SFRG) is generated from the combination of a qualitative assessment, of the susceptibility of a recreational site to faecal contamination and direct measurements of the appropriate bacteriological indicator at the site. The SFRG describes the general risk of faecal contamination at a site at any given time.

A beach grading is made up of two components:

- The *Sanitary Inspection Category (SIC)* composed of five ratings from very low to very high dependent upon the presence and potential effect of faecal contaminant sources. It generates a measure of the susceptibility of a water body to faecal contamination from potential water quality risk factors close to swimming spots such as sewage outfalls, stormwater drains, stock in waterways and run-off from land; and

- Historical microbiological results, which generate a *Microbiological Assessment Category (MAC)*, which provides a measurement of the 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'. Grades help determine whether ongoing monitoring are required and provides the basis for telling people whether or not the 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) (Appendix 1), 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 can be allocated. Catchment Checklists have been surveyed by respective councils and the Regional Council in 2014 to update the Sanitary Inspection Category. The SIC 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 the grading system uncomplicated and user friendly. The only room for interpretation is within the CAC when determining microbiological hazards.

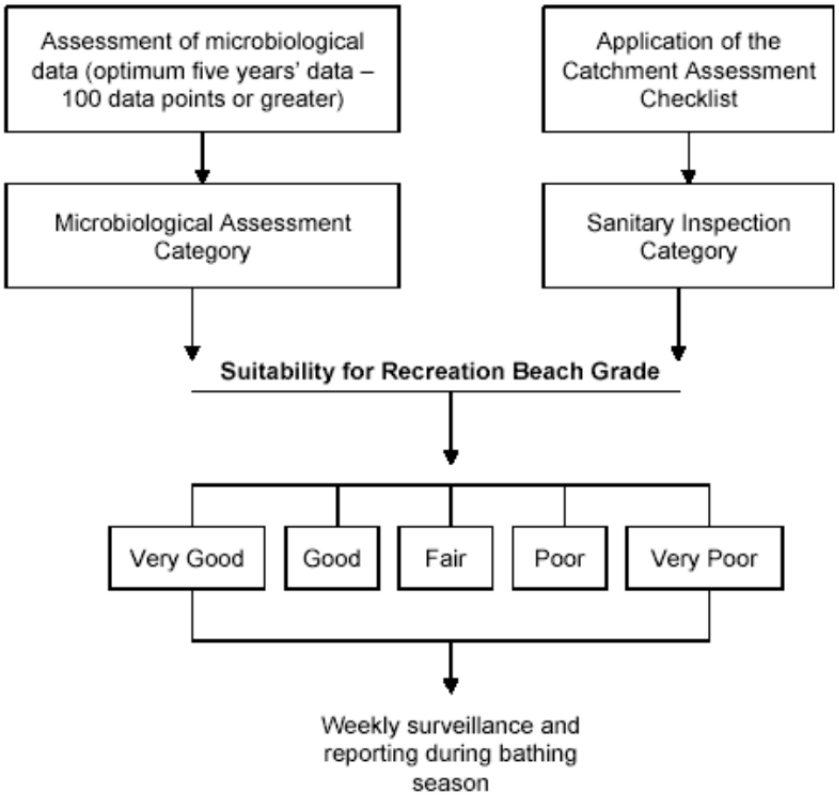

Figure 2.1: Components used to grade a beach (from MfE and MoH, 2003)

The MAC is calculated as the 95 percentile of the last five years of historic faecal indicator bacteria data. Enterococci are the preferred indicator bacteria in marine waters and *Escherichia coli* (*E.coli*) are the indicator bacteria analysed for in freshwaters. Ideally, at least 20 samples taken weekly over the bathing season over a five year period, to provide at least 100 sample points for the MAC. This has not occurred for all Bay of Plenty sites and 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 2013/2014 microbiological water quality results, are summarised in Appendix 1 based on the last five years data.

2.5 Additional risk to recreational users

The Bay of Plenty Regional Council monitors a number of freshwater sites that experience blooms of potentially toxic blue-green algae. These include several of the Rotorua Lakes and the Kaituna River. When monitoring indicates the high risk to water users, a health warning or health advisory is issued for the affected area. Media releases, websites and recorded telephone messages also provide the public with information on the status of these sites.

Monitoring for the mat-forming cyanobacteria *Phormidium,* occurs in a number of Bay of Plenty rivers, including the Rangitāiki, Whakatāne, Otara and Waimana, Uretara Stream and Te Rereatukahia streams. The beds of these rivers and streams can support substantial mats of this toxin producing algae, particularly at times of low flow. The mats may contain neurotoxins that are highly toxic to humans and animals. New Zealand studies have shown that at times of high biomass, *Phormidium* can also produce high levels of free toxins in the water (Heath 2009).

The Microbiological Water Quality Guidelines do not include guidance on the risk posed by potentially toxic algal blooms. Interim New Zealand Guidelines for cyanobacteria are given in MfE/MoH (2009).

Part 3: Recreational waters surveillance and grading results 2013/2014

3.1 Recreational surveillance monitoring

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. 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 2013 and ran until the end of March 2014. Approximately 80 sites around the region were monitored with sites sampled weekly or once every two weeks.

The results of the water quality analyses are generally available after 24-hours and these are then posted onto the Bay of Plenty Regional Council website[1]. Media releases also help keep the public informed of the situation with regards to recreational water quality.

If orange or red modes are flagged, these results are directly communicated to Toi Te Ora Public Health and the relevant district council. Follow-up sampling then occurs within a 24-hour period. Should a water quality problem be found to be recurring, Toi Te Ora Public Health have the responsibility to decide if a public health warning needs to be issued. If a warning, is required Toi Te Ora Public Health will initiate media releases and inform the district council of the need for warning signs and any further monitoring.

3.2 Results

The detailed results of the monitoring are presented in tabular form in Appendix 1. These tables give information on the percentile (P) value, MAC score, SIC score, SFRG, and a conservative interim grade where applicable. Grades and MAC scores are based on the last five years of data from October 2009 to March 2014. The Suitability for Recreation Grades (SFRG's) are presented in Figure 3.1 and 3.2.

Note that some SFRG grades are provisional as the microbiological data has not reached an optimum level, according to the New Zealand Microbiological Water Quality Guidelines. The data does 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.

The grading system shows that 85% of lake sites are graded 'very good' or 'good' and five percent 'poor'. Forty six point four percent of river sites are graded 'poor' or 'very poor', but only 11.1% of estuarine sites were graded 'poor' and 38.9% 'fair'. Most (93.3%) of the open coastal sites have been graded as 'good' or 'very good' and only one site graded as 'fair'.

[1] http://www.boprc.govt.nz/environment/water/swimming-water-quality/

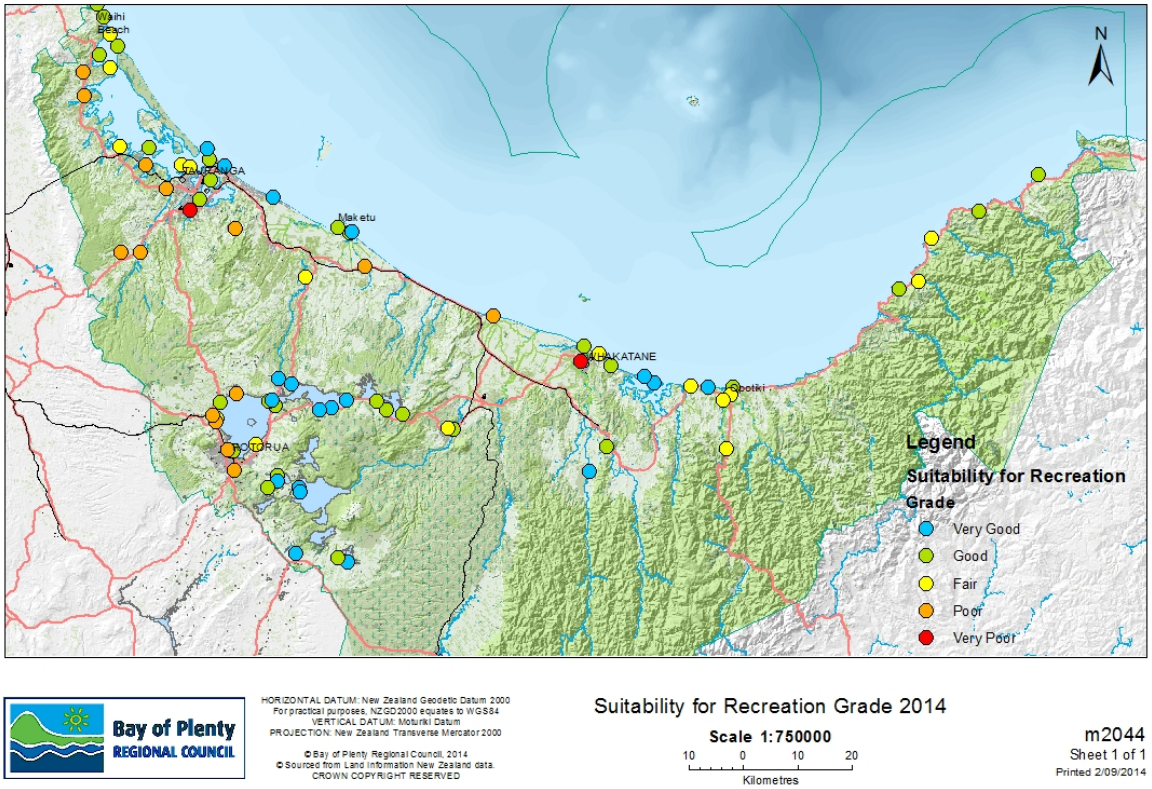

Figure 3.1 Suitability for Recreation Grades, 2013/14.

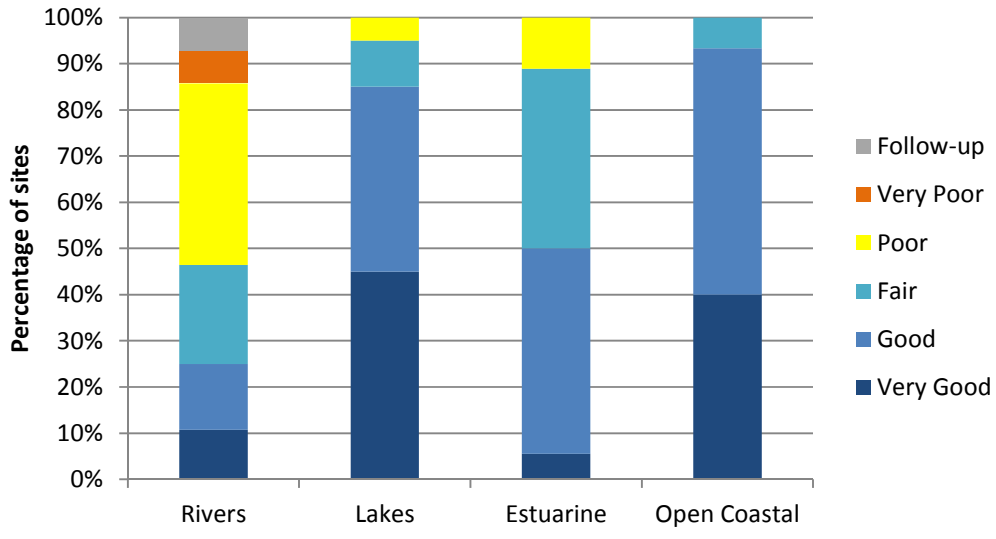

Figure 3.2 Comparison of the results for the Suitability for Recreation Grade (SFRG).

Table 3.1 also shows the status of monitored bathing sites in the Bay of Plenty against the NZ Microbiological Water Quality Guidelines (Red/Action Mode). Generally lake sites showed the highest quality overall against this guideline, followed by marine and river sites.

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

		Rivers	Lakes	Marine
Samples less than the Red/Action Mode	2013/14	97.6%	100%	99.1%
	last 5 Years	94.2%	99.8%	98.2%

More detailed results are presented in the following sections, showing the percentage of samples at each site that exceeded guideline levels throughout the 2013/2014 season. The five yearly 95-percentile and median (50-percentile) data are also presented to give a longer-term perspective.

3.3 River and stream sites

River and stream sites were monitored on a weekly or two-weekly basis.

Figure 3.2 shows the range of *E.coli* results recorded at each site, ranked in order of percentage of samples over the Red/Action Mode for the 2013/14 season. Of the 29 sites monitored, ten had instances where the Orange/Alert Mode was exceeded and eight of these had results over 550 *E.coli* cfu/100 ml (Red/Action Mode). This an improvement on two seasons ago, where 20 sites exceeded the Orange/Alert Mode and 17 sites exceeded the Red/Action Mode.

Two seasons prior, the Rotorua Streams, the Ngongotahā and Waiteti topped the list with the highest exceedances. Exceedance were generally lower thanks to two relatively dry summers, which has accentuated several Tauranga streams as those with more prevalent contamination issues. The Wairoa Tuapiro and Uretara all had exceedance in early November 2013 thanks to a sizable rain event. Several small rainfall events are likely to have contributed to exceedances in the Waimapu but a Red/Action Mode exceedance that occurred at the end of March 2014 is unexplained.

Figure 3.3 shows 12 sites 95 percentile data are higher than the Red/Action Mode guideline. These can be classed as the highest priority sites for investigation and action, however, exceedances over the 95th percentile guideline, predominantly occur with events that generate surface runoff when swimming is less likely to occur. Median values are also plotted in Figure 3.3 and this gives a measure of the average risk of infection to water uses (particularly primary users, i.e. full immersion use). No median values were over the Orange/Alert Mode, indicating that on average, all rivers over the 2013/14 season where suitable for swimming.

Comparison of the 2013/14 *E.coli* data with the NOF attributes shows that all rivers meet the ‘A’ category (very low risk of infection), for activities with occasional immersion and some ingestion of water (such as wading and boating). Twenty nine percent of sites do not meet the minimum acceptable criteria for full immersion activities (i.e. greater than five percent risk of infection), 64% rated ‘A’ and seven percent rated ‘B’. The 2013/14 season was unusual due to low rainfall. Comparison of the last five years of data indicates that 50% of river sites do not meet the minimum acceptable criteria for full immersion activities.

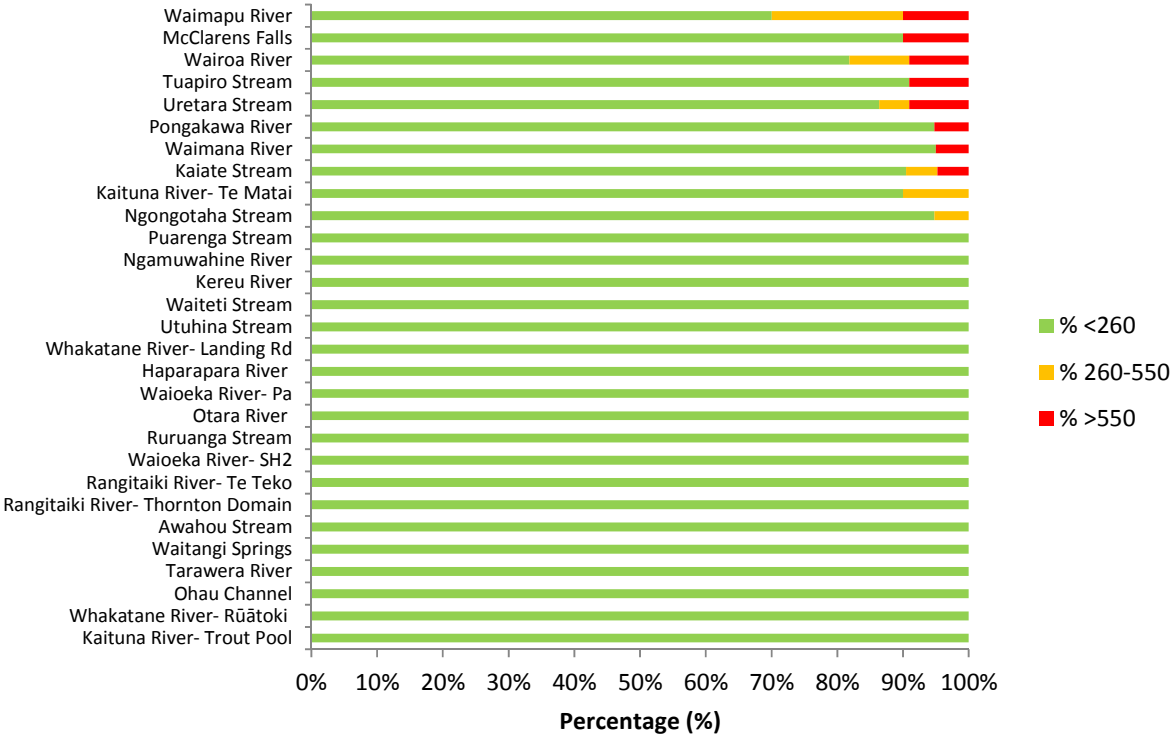

Figure 3.2 *River and stream E.coli levels compared against each of the modes in the NZ Microbiological Water Quality Guidelines (MfE/MoH 2003), 2013/2014 bathing season.*

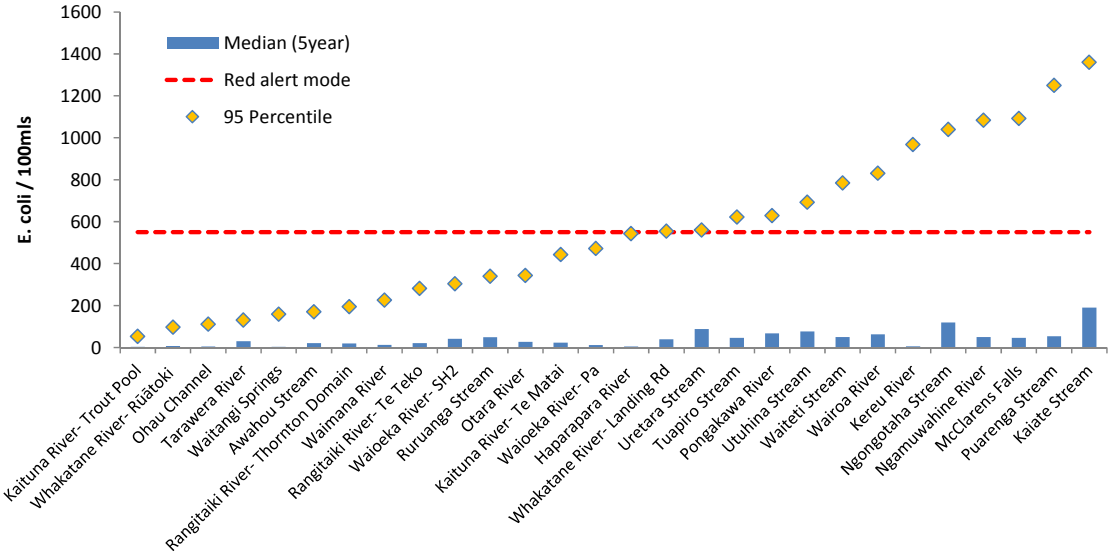

Figure 3.3 *Ninety five-percentile and median E.coli concentrations, river and stream sites over the past five years.*

3.3.1 Lake sites

Sampling occurred at 20 lake sites once every two weeks.

One site reached the Orange/Alert Mode during the 2013/2014 season (Figure 3.4), Ngongotahā in Lake Rotorua. No Red/Action Mode results occurred. These results are thought to be due to strong prevailing winds disturbing the sediments in the shallow littoral zone.

The median *E.coli* concentrations for lake sites were generally below 15 cfu/100 ml indicating a low level of faecal contamination overall (Figure 3.5).
Lake Rerewhakaaitu at Brett Road had the highest median *E.coli* concentrations of the lake sites (12.5 cfu/100 ml), although the site did not have any samples above the Orange/Alert Mode.

Comparison of the 2013/14 *E.coli* data with the NOF attributes shows that all lakes meet the 'A' category (very low risk of infection) for activities with occasional immersion and some ingestion of water (such as wading and boating). A similar result occurred for full immersion activities (primary activities, i.e. greater than five percent risk of infection), with one site being in the 'B' category.

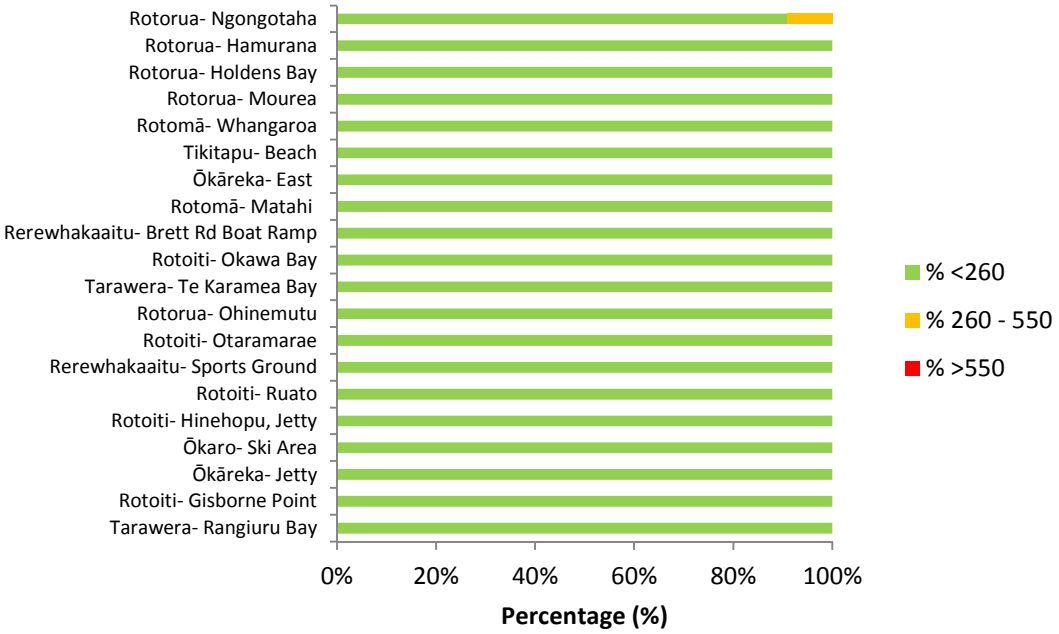

Figure 3.4 Lake E.coli levels compared against each of the modes in the NZ Microbiological Water Quality Guidelines (MfE/MoH 2003), 2013/2014 bathing season.

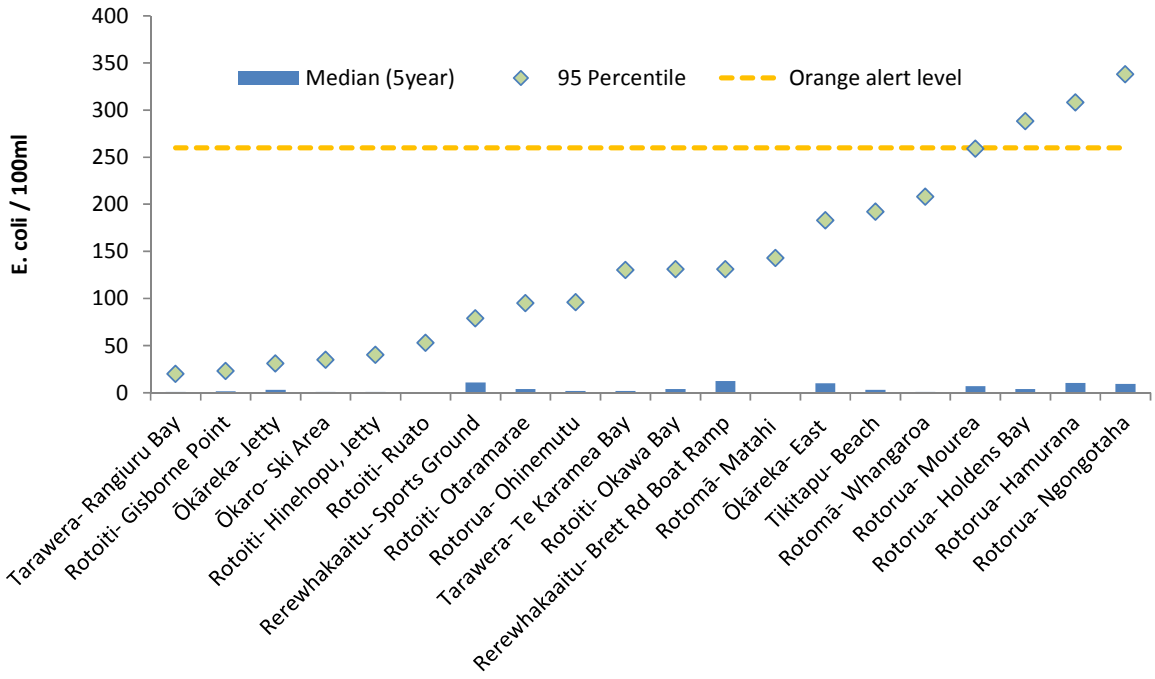

Figure 3.5 Ninety five-percentile and median results of E.coli concentrations, lake sites over the past five years.

3.3.2 Marine sites

Open coastal

Of the 15 open coastal marine sites, five were monitored weekly and the others every second week.

Figure 3.6 shows the percentage of enterococci results at each site that exceeded the microbiological guideline levels ranked in order. No sites reached the Red/Action Mode (two consecutive samples greater than 280 enterococci/100 ml). The Orange/Alert Mode was only reached at Waihi Beach (at 3 Mile Creek), where the surf receives a higher than average bacterial loading from the creek.

All 15 open coastal sites had median enterococci concentrations below 5 cfu/100 ml in 2013/2014 and over the last five years, indicating a low level of contamination (Figure 3.7). Maraetai Bay near Te Kaha still has the highest 95th percentile, potential due to a contamination event several years ago, but since this time the water quality has been good.

Overall, the open coastal waters have very low levels of contamination, as indicated by the enterococci indicator bacteria levels over the past five years (Figure 3.7).

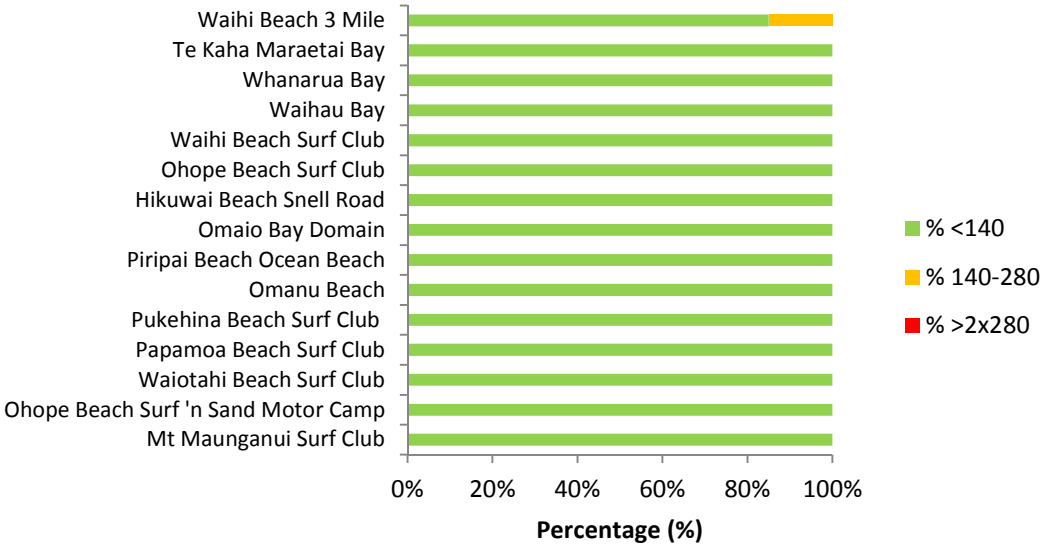

Figure 3.6 *Coastal marine enterococci levels compared against each of the modes in the NZ Microbiological Water Quality Guidelines (MfE/MoH 2003), 2012/2013 bathing season.*

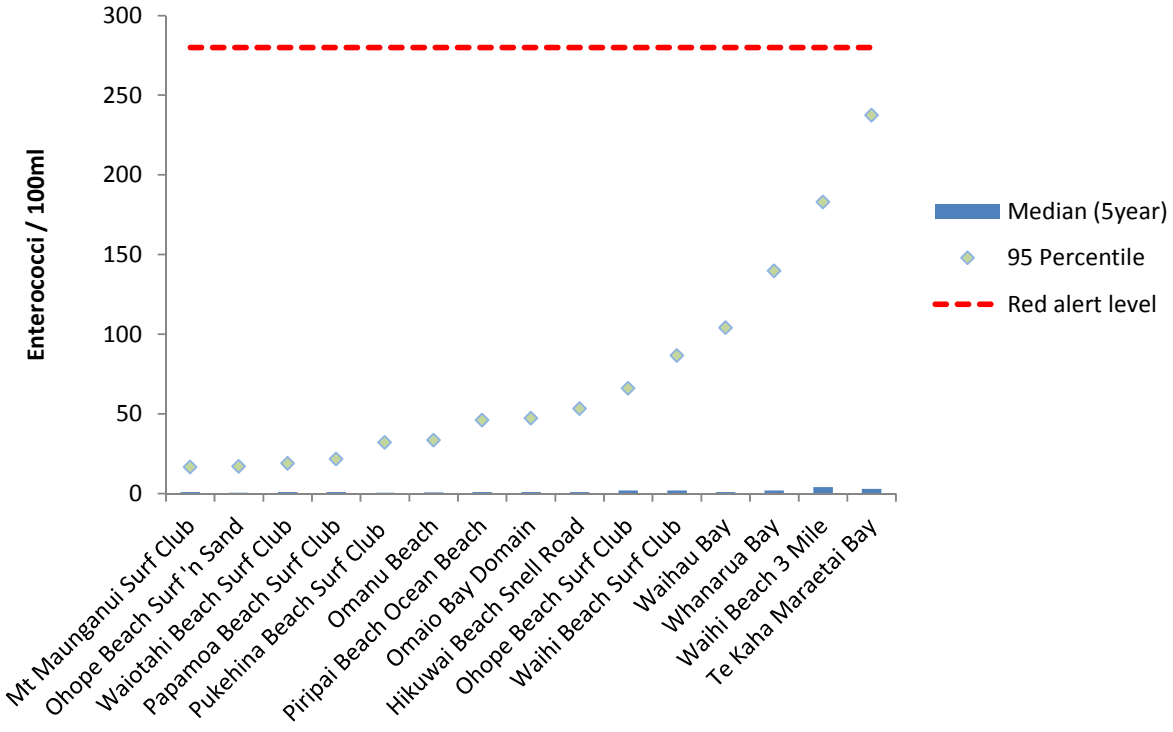

Figure 3.7 *Ninety five-percentile and median results of enterococci concentrations, coastal marine sites over the past five years.*

Estuarine

Eleven of the 18 estuarine sites reached the Orange/Alert Mode during the season (Figure 3.8), and one site (Pahoia Beach) reached the Red/Action Mode. Median enterococci concentrations were generally well below the Orange/Alert Mode, with the highest median level being 44.5 cfu/100 ml at Tarawera River Estuary (Figure 3.9).

Athenree and Otumoetai are the only two sites with 95th percentiles over the Red/Action mode (Figure 3.9) over the last five years. This indicates a greater than five percent risk of contact with infectious organisms. It is unclear what could be adding to the bacterial load at Athenree, as the community is reticulated, however, the Waiau Stream enters the harbour nearby and may contribute to the bacteria load particularly during times of flood. Otumoetai is influenced by the Waiora River which can also have elevated bacterial levels when in flood. This site can also be influenced by sewage infrastructure overflows that happen on occasion.

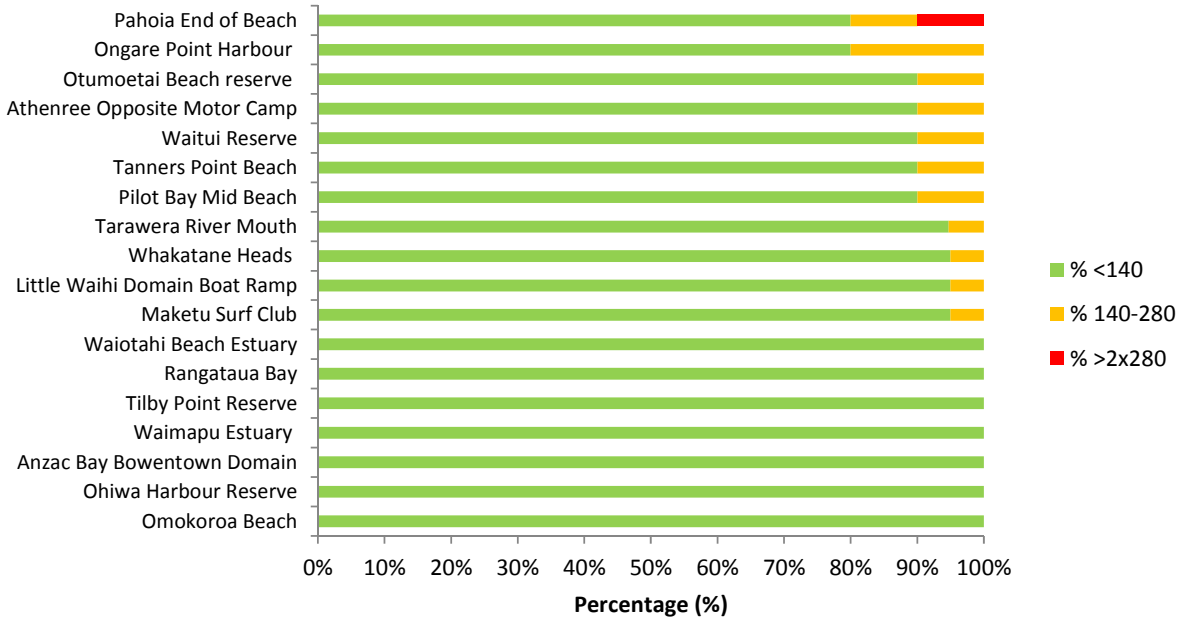

Figure 3.8 Estuarine marine enterococci levels compared against each of the modes in the NZ Microbiological Water Quality Guidelines (MfE/MoH 2003), 2013/2014 bathing season.

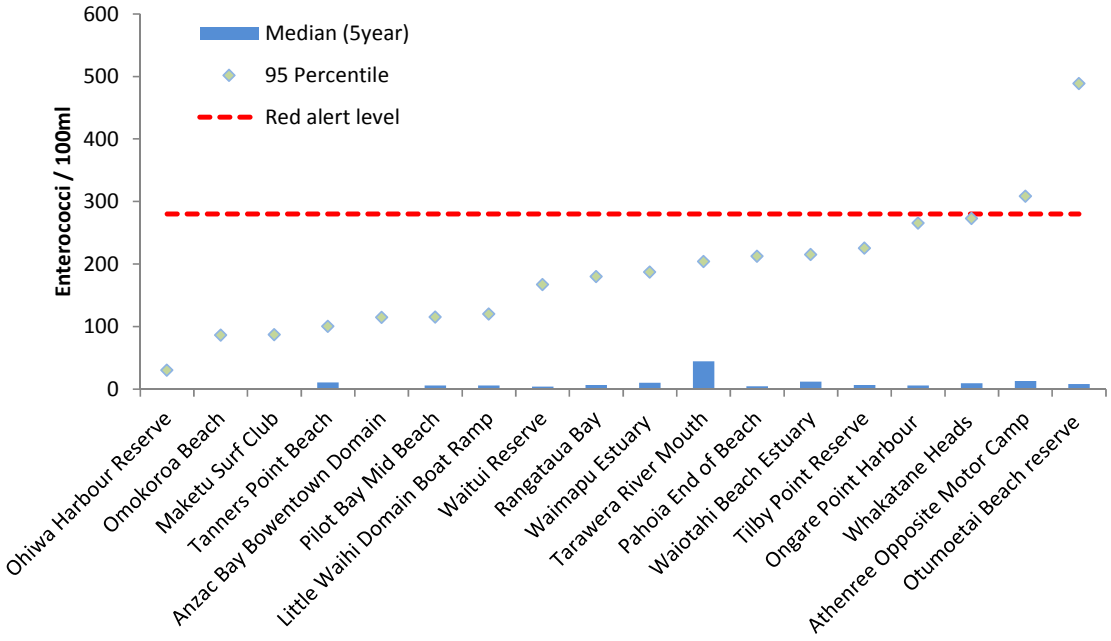

Figure 3.9 Ninety five-percentile and median results of enterococci concentrations, estuarine marine sites over the past five years.

Part 4: Shellfish

4.1 Sampling and analysis

Collection of shellfish occurred at a number of open coastal and estuarine sites from 2012 to 2014. At each site, sampling was conducted over a 20 m transect of the shellfish bed/area. A minimum of 24 individual shellfish were taken per site to make up at least 200 g of flesh. The species sampled were:

- Cockle *(Austrovenus stuchburyi)*; found throughout muddier intertidal and sub-tidal areas, only abundant in harvestable numbers at a few locations.
- Pipi *(Paphies australis);* often abundant around the mouth of the estuaries but extend to sandy areas of the inner estuary.
- Oyster *(Tiostrea chilensis lutria);* commonly found cemented to rocks or mangroves in the intertidal zone.
- Tuatua *(Paphies subtriangulata);* found on open coastal beaches, most commonly in the surf zone.

Shellfish were analysed for *E.coli*, faecal coliforms and enterococci and the results expressed as MPN (most probable number) per 100 g of flesh.

The standard used for shellfish quality for consumption is based on the 'Ministry of Health Microbiological Reference Criteria for Food' (1995). This standard is listed in the 13th schedule of the Regional Coastal Environment Plan. To comply with the standard faecal coliform levels in flesh should be less than 330 MPN/100 g, and levels from 230 to 330 MPN/100 g are marginally acceptable.

Microbiological limits have also been specified by NZFSA (2006)[2]. Faecal coliform limits have been used historically for shellfish quality assessment but these have been changed in recent years in favour of *E.coli*. Faecal coliform and enterococci are not exclusively indicative of faecal contamination, where *E.coli* are. The criteria for safe shellfish consumption using *E.coli* is a median MPN of less than 230 per 100 g and no more than 10% of the samples must exceed an MPN of 700 per 100 g.

4.2 Results

Table 4.1 and 4.2 gives the results for shellfish sampled over the 2012/13 and 2013/14 summers.

Faecal coliform concentrations in shellfish were found to be over the MoH safe consumption guideline (330 MPN/100g) in pipi from the Waiotahi, Ohiwa and Waihī estuaries. Most other sites were well within safe consumption limits, although Maketu estuary did have an elevated enterococci reading.

The levels of *E.*coli found in pipi from the Waiotahi Estuary were much lower than faecal coliform levels. Median *E.coli* concentrations over the past few seasons are below the guideline level of 230 *E.coli*/100 g and less than 10% of samples were over 700 *E.coli*/100 g. Runoff events explain most of the elevated readings but it is unexplained why faecal coliform levels are often much higher than *E.coli.* It may be there are other bacteria (von Sperling, 2007), non-faecal in origin, accumulating in shellfish. As *E.coli* are the preferred indicator of faecal contamination, it may be that

[2] New Zealand Food Safety Animal Products (Specifications for Bivalve Molluscan Shellfish) Notice 2006.

faecal contamination is less than expected on these occasions. This has also occurred on one occasion for a Ohiwa Harbour sample also. Monitoring faecal coliform and *E.coli* concentration in shellfish waters may be advisable to better develop data on the relationship between thermotolerant bacteria (*E.coli* and faecal coliforms).

Table 4.1 Shellfish indicator bacteria results. Samples exceeding the MoH guideline are indicated in red/bold.

Site		Date Sampled	Shellfish type	*E.coli* (MPN/100g)	ENT (MPN/100g)	FC (MPN/100g)
Waiotahi Estuary	Reserve	12/09/12	Pipi	26	110	280
Waiotahi Estuary	Reserve	10/10/12	Pipi	**2700**	1700	**9200**
Waiotahi Estuary	Reserve	30/10/12	Pipi	33	280	350
Waiotahi Estuary	Reserve	12/11/12	Pipi	**460**	22	460
Waiotahi Estuary	Reserve	29/11/12	Pipi	170	110	**920**
Waiotahi Estuary	Reserve	13/01/13	Pipi	2	33	2
Waiotahi Estuary	Reserve	24/01/13	Pipi	1	1	13
Waiotahi Estuary	Reserve	12/02/13	Pipi	21	14	220
Waiotahi Estuary	Reserve	08/12/13	Pipi	80	18	**3500**
Waiotahi Estuary	Reserve	13/02/14	Pipi	7	210	11
Ōhiwa Harbour	Uretara Channel	13/01/13	Pipi	120	130	**1700**
Ōhiwa Harbour	Uretara Channel	13/02/14	Pipi	2	33	21
Ohope Beach	Moana Road	13/01/13	Tuatua	5	350	5
Ohope Beach	Moana Road	13/02/14	Tuatua	7	21	27
Ohope Beach	West End	13/01/13	Tuatua	17	49	79
Maketu Estuary	Opposite boat ramp	24/01/13	Pipi	1	1200	180
Maketu Estuary	Opposite Boat Ramp	26/02/13	Pipi	2	13	4
Maketu Estuary	Opposite boat ramp	02/04/13	Pipi	8	240	27
Maketu Estuary	Opposite boat ramp	28/11/13	Pipi	2	14	49
Maketu Estuary	Opposite boat ramp	11/12/13	Pipi	2	33	70
Maketu Estuary	Mid-estuary	26/02/13	Cockles	110	170	140
Waihi Estuary	Main Channel	24/01/13	Pipi	1	1	79
Waihi Estuary	Main channel	28/11/13	Pipi	140	59	**540**
Waihi Estuary	Main channel	11/12/13	Pipi		350	**540**
Waihi Estuary	Main channel	29/01/14	Pipi	6	11	180

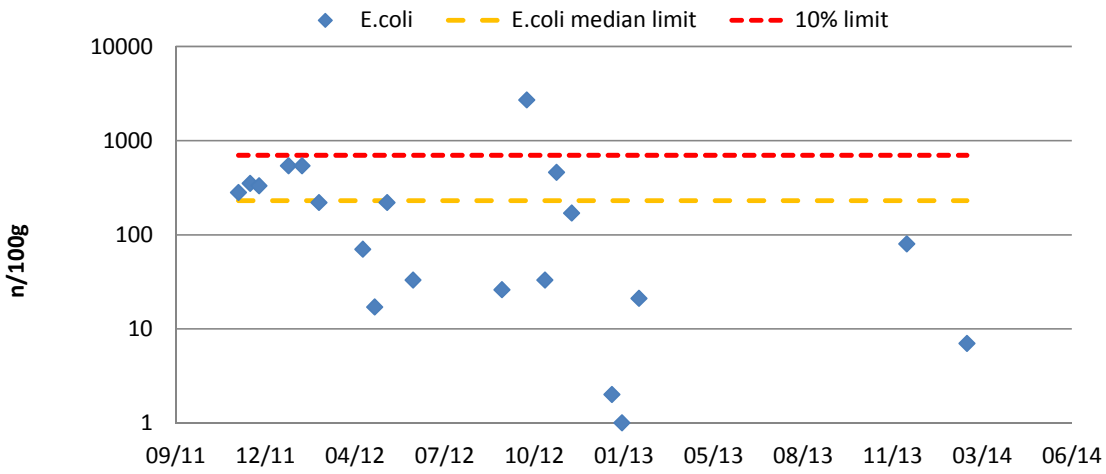

Figure 5.1 *Indicator bacteria levels in pipi, Waiotahi Estuary. Limits shown are from the NZ Food Safety Authority (NZFSA 2006).*

Tauranga Harbour shellfish were not heavily monitored, as resource efforts were directed towards the more eastern estuaries, as heath warning for paralytic shellfish poisons were in place along the Western Bay of Plenty for the majority of last two seasons. Elevated faecal coliform and enterococci results were detected in various locations in December 2012 but *E.coli* levels were low. This is similar to some results from Waiotahi Estuary and as explained above, may be a result of other bacteria such as *Enterobacter* or *Klebsiella* (i.e. bacteria not originating from a faecal origin).

Table 4.2 *Tauranga Harbour shellfish indicator bacteria results. Samples exceeding the MoH guideline are indicated in red/bold.*

Site		Date Sampled	Shellfish type	*E.coli* (MPN/100g)	ENT (MPN/100g)	FC (MPN/100g)
Tauranga Harbour	Tilby Point	11/12/12	Pipi	17	180	**1600**
Tauranga Harbour	Pilot Bay	11/12/12	Pipi	12	1600	**35000**
Tauranga Harbour	Pio's Beach	11/12/12	Cockle	13	70	240
Tauranga Harbour	Pio's Beach	27/03/14	Cockle	22	5	**540**
Tauranga Harbour	Pio's Beach – Yellow Point	11/12/12	Pipi	4	4600	**13000**
Tauranga Harbour	Waipu Bay	11/12/12	Cockle	7	350	110
Tauranga Harbour	Te Puna Estuary	28/03/14	Oysters	5	2	5
Tauranga Harbour	Te Puna 2	31/03/14	Horse Mussel	33	5	110

Examination of only *E.coli* results for shellfish flesh samples shows that only Waiotahi Estuary showed two results where levels would be deemed unsafe for consumption. However, other indicator results (faecal coliform and enterococci) do indicate a heightened risk at other times.

Part 5: River algae monitoring programme

5.1 Introduction

Rivers and lakes are monitored over the summer-autumn period for blue-green algae (cyanobacteria).

Blue-green algae are widespread throughout New Zealand. Lake and rivers in the Bay of Plenty are at times affected by free living algal blooms (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.

Phormidium is a benthic mat-forming cyanobacteria that can proliferate during periods of sustained river low flows, and form expansive black/brown leathery mats across large areas of river bed (Wood and Heath, 2010). *Phormidium* produces a potent neurotoxin and has been linked worldwide with dog and stock deaths (Heath, 2009). While ingestion of the mats is the most direct route of exposure, there is one account in the international literature of dog deaths occurring after they drank from a bloom affected river.

Stable substrate provides attachment points for these cyanobacteria and other algae and for this reason blooms are most often associated with cobbled river beds. However, investigation following the death in 2007 of a dog near the Rangitāiki River revealed that *Phormidium* can also form continuous mats over pumice beds after prolonged low-flow events. This is significant for a number of rivers in the Bay of Plenty.

When extensive mats of blue-green algae are found, a warning may be issued by the health authority. This will advise the public not to drink or use affected water and to keep away from the areas affected.

When a warning is issued, the district council places signs at major public access points. Updated information on warnings is also posted on the Bay of Plenty Regional Council and Toi Te Ora Public Health websites.

5.2 Monitoring method

Monitoring involves estimating the percentage cover of cyanobacteria at five points along four transects. Transects begin downstream and progress upstream to avoid disturbance to areas not yet surveyed. A transect is made across the river, if shallow, or to a maximum depth of 0.6 m, for larger, deeper rivers. A mean percentage cover is generated for each site using cover estimates at all 20 points.

The sites monitored include river entry points of known recreational value. River reaches that contain optimum habitat for *Phormidium*, and that are shown perennially to support large mats, are also monitored as these provide a comparative measure of mat development (even if they receive little recreational use).

5.3 Phormidium - monitoring framework

An early warning system is operated on the Whakatāne and Rangitāiki Rivers based on telemetered flow recorders[3]. The status level for the Whakatāne River is also used to represent the situation in the Waimana River. As each alert level is reached, a range of actions follow, potentially culminating in health warnings, if and when mat cover reaches or exceeds 50% cover (Table 5.1). The alert level framework generally follows that given in the interim 'New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters' (MfE/MoH 2009).

A network of river users also informs the council when *Phormidium* is present at levels that may require field measurements.

Table 5.1 Alert level framework in place for Phormidium.

Alert level	Trigger	Action
Phormidium Surveillance (green mode)	Up to 20% coverage of potentially toxigenic cyanobacteria attached to substrate	Undertake fortnightly surveys between spring and autumn at representative locations in the water body, where known mat proliferations occur and where there is recreational use
Phormidium Yellow Alert	No flush in last 14 days	Continue to monitor the situation
Phormidium Orange Alert	Flow <10-percentile	Begin field assessments. If coverage of potentially toxigenic cyanobacteria 20−50%, notify the public health unit and Increase sampling to weekly
Phormidium Red Alert	Phormidium mat covering ≥50% of the bed	Immediately notify the public health unit. Health warning instated. If municipal water takes are at risk, SPATT may be established to monitor for free toxins

5.4 Results

River levels started declining towards summer low levels in late November, often indicating an increase in the potential for *Phormidium* build up over the summer months. Not all assessments were recorded as initial assessments were observational, only to ascertain if *Phormidium* was indeed present.

Phormidium was first observed in the Waimana and Whakatane rivers in late November 2013. No orange or red alert levels were reached in the Waimana River, but persistent *Phormidium* growth at orange and red alert coverage occurred in the Whakatāne initially at Ruatoki and then was also investigated and found further upstream at Waikirikiri. River warnings were posted by Whakatane District Council in February 2014. Blooms persisted for just over three weeks before a flushing event removed them.

No other sites reached orange or red alerts, although at Sapphire Springs in the Te Rereatukahia Stream and in the Waimana at Wardlaw Glade, some transects had one fifth to one third stream bed coverage. *Phormidium* coverage was generally present in fast flowing water on larger cobble sized substrate.

[3] The telemetered flow recorder sites are based around established gauging stations at Valley Road (Whakatāne River) and Te Teko (Rangitāiki River).

River/stream	Site	No. of Assessments	*Phormidium* mat covering		
			Max % cover	# Orange Alerts (20-50% cover)	# Red Alerts (>50% cover)
Waimana River	Kirkbride Road	4	5	0	0
	Lowe Road	1	11	0	0
	Mid-Way	3	30	1	0
	Wardlaw Reserve	4	34	1	0
Otara River	East Bank	1	6	0	0
	Gault Road	1	21	0	0
	McMillan Road	1	0	0	0
	Wharawhara Road	1	0	0	0
	Browns Bridge	1	1	0	0
	End Gow Road	1	3	0	0
Whakatane River	Pekatahi	12	35	0	0
	Reid Memorial Reserve	11	21	0	0
	Ruatoki Bridge	12	79	3	3
	Waikirikiri	8	48	3	0
Rangitaiki River	Edgecumbe	2		0	0
	Edgecumbe Sub-station	2		0	0
	Murupara Bridge	2		0	0
Te Rereatukahia	Sapphire Springs	3	20	0	0
	SH2 Bridge	3	1	0	0

Photos a) Phormidium, Otara River; b) Phormidium, Waimana River

Part 6: Summary discussion and recommendations

The results of the 2012 to 2014 bathing surveys show that most sites in the Bay of Plenty are mostly suitable for bathing. The Suitability for Recreation Grading (SFRG) results were improved over previous years, due to the inclusion of the last two years data, which have had minimal influence from rainfall induced runoff.

Suitability for Recreation Grades show that the highest risk to recreational water users continues to be in Bay of Plenty rivers, and only a low risk of encountering water borne pathogens in monitored lakes. 85% of lake sites graded 'very good' or 'good' while 46% of river sites are graded 'poor' or 'very poor'. This is consistent with previous monitoring and reflects the greater vulnerability of rivers and streams, to diffuse and point source discharges of contaminants sourced from faecal material.

Open coastal sites typically have excellent water quality with only one site exceeding the Orange/Alert Mode in 2013/2014. Most (93%) of the open coastal sites have been graded as 'good' or 'very good' under the SFRG system and just under seven percent of these sites are graded 'fair'. Eleven of the 18 estuarine sites reached the Orange/Alert Mode in 2013/14, but only 11% of the estuarine sites are graded 'poor' (none are graded 'very poor') with higher faecal contamination levels due to the enclosed nature of estuaries and river influences.

The 2013/14 season for the rivers in this drought influenced summer showed that 2.3% of results reached the Orange/Alert Mode and 2.3% reached the Red/Action Mode. Of the over 1160 samples analysed for indicator bacteria, only 2.8% activated the Orange/Alert Mode and 0.9% the Red/Action Mode.

The 2013/14 *E.coli* data was compared with the NPS for Freshwaters National Objective Framework (NOF) attributes for human health. Results for rivers and lakes are shown in Table 6.1. All sites rate highly (i.e. very safe) for secondary contact recreation activities, but eight sites are below the minimal acceptable standard for primary contact recreation in rivers.

Table 6.1 Percentage river and lake sites in the National Objective Framework attributes banding, based on 2013/14 data.

Value	Attribute State (*E.coli*/100 ml) for Rivers				
	A	B	C	(Bottom-line)	D
Numeric state	≤260	>260 and ≤ 540	>540 and ≤1000		>1000
Human health for secondary* contact (annual median)	100%	0%	0%		0%
Human health for primary** contact (95th Percentile)	64%	7%	29% **Below Minimum Acceptable State**		
	Attribute State (*E.coli*/100 ml) for Lakes				
Numeric state	≤260	>260 and ≤ 540	>540 and ≤1000		>1000
Human health for secondary* contact (annual median)	100%	0%	0%		0%
Human health for primary** contact (95th Percentile)	95%	5%	0% **Below Minimum Acceptable State**		

*Secondary: activity occasional immersion and some ingestion: e.g. boating; wading. **Primary: likely to involve full immersion.

Some concerns about using and reporting microbiological water quality risks with the SFRG have been raised by the public health sector and by territorial authorities. Potential problems include not taking into account cyano-bacterial growths or risk of blooms; confusion with the grading and regular microbial results reporting; and consistency with other regions at the national reporting level.

Ministry for the Environment are aware of some of these issues and will be looking at revising the Microbiological Water Quality Guidelines (2003), but there is also now a requirement for comparison with attributes in the NOF as per the NPS for Freshwater. Further guidance on how to apply the NOF for human health attributes is pending. This, along with revised microbiological guidelines will guide future recreational water monitoring programmes.

Shellfish in pipi from Waiotahi Estuary were found to have faecal bacteria levels above safe consumption guidelines on some occasions. No other sites had *E.coli* results above recommended guideline levels for safe consumption, but some sites did have elevated faecal coliform and enterococci levels which may indicate some risk to human health if these shellfish were ingested uncooked.

Phormidium reached alert status in two rivers, the Whakatane and the Waimana, and at two different sites in each. Other sites were found to have coverage near to the interim recreational threshold.

6.1 Recommendations

The bathing and shellfish monitoring programme does not specifically identify the factors causing faecal contamination. However, it does highlight areas where more detailed investigation should be carried out. Targeted studies are used to address these more specific water quality issues. Recommendations for future targeted investigations are made below:

- Develop predictive warning system for high risk sites. Undertake event sampling and analyses of sites with adjacent flow/level and rainfall monitoring, to provide an early warning system of elevated pathogen levels in rivers.

- Investigate faecal contamination sources in the catchment that do not meet NOF minimum acceptance state: Uretara; Waimapu; Kaiate; Wairoa; Mclarens Falls; Pongakawa; and Waimana. Use of microbial source tracking techniques may help delineate potential sources, but modelling and loading investigation are also likely to be required to ascertain relative contribution within these catchments.

The Proposed Regional Coastal Plan stipulates the use of indicator bacteria testing as per the Microbiological Water Quality Guidelines (2003), for assessing shellfish contamination or the health risk associated with consumption. Hence it is recommended that water testing in conjunction with the recreational surveillance waters programme, be undertaken in favour of shellfish flesh testing.

Part 7: References

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Appendices

Appendix 1a – Suitability for recreation grading - Grades for marine sites

District	Site	Description	BOP Site Number	P	MAC	SIC	SFRG	% samples less than the Red/Action Mode 2013/2014
Opotiki	Hikuwai beach end of Snell Road	Hikuwai	160005	53.2	**B**	Moderate	**Good**	100
Opotiki	Omaio Bay Domain	Omaio	160004	47.2	**B**	Moderate	**Good**	100
Opotiki	Te Kaha Beach Maraetai Bay	Te Kaha	160003	237.3	**C**	Very Low	**Fair**	100
Opotiki	Waihau Bay	Waihau	160001	104.0	**B**	Very Low	**Good**	100
Opotiki	Waiotahi Beach Estuary	Waiotahi Estuary	160008	215.0	**C**	Moderate	**Fair**	100
Opotiki	Waiotahi Beach Surf Club	Waiotahi	160007	18.9	**A**	Low	**Very Good**	100
Opotiki	Whanarua Bay	Whanarua Bay	160002	139.6	**B**	Very Low	**Good**	100
Tauranga	Mt Maunganui Ocean Beach Surf Club	Mount	160025	16.6	**A**	Very Low	**Very Good**	100
Tauranga	Omanu Beach	Omanu Surf Club	900096	33.5	**A**	Very Low	**Very Good**	100
Tauranga	Otumoetai Beach reserve end of beach	Otumoetai	160021	488.3	**C**	Moderate	**Fair**	100
Tauranga	Papamoa Beach Surf Club	Papamoa	160026	21.6	**A**	Very Low	**Very Good**	100
Tauranga	Pilot Bay mid beach	Pilot Bay	160024	115.0	**B**	Moderate	**Good**	100
Tauranga	Rangataua Bay	Maungatapu	160049	180.0	**B**	Moderate	**Good**	100
Tauranga	Tilby Point Reserve	Tilby Point	160020	225.5	**C**	Moderate	**Fair**	100
Tauranga	Waimapu Estuary Motel-Motor Camp	Waimapu	160019	187.0	**B**	Low	**Good**	100
WBOP	Anzac Bay Bowentown Domain	Anzac Bay	160028	114.5	**B**	Very Low	**Good**	100
WBOP	Athenree Opposite Motor Camp	Athenree	160030	308.5	**C**	Low	**Fair**	100
WBOP	Little Waihi Domain Boat Ramp	Little Waihi	160016	120.0	**B**	Moderate	**Good**	100
WBOP	Maketu Surf Club	Maketu	160017	86.9	**B**	Moderate	**Good**	100
WBOP	Omokoroa Beach	Omokoroa	160022	86.4	**B**	Very Low	**Good**	100
WBOP	Ongare Point Harbour View Road	Ongare Point	160032	265.1	**C**	Low	**Fair**	100
WBOP	Pahoia end of beach	Pahoia	160023	212.4	**C**	Low	**Fair**	90
WBOP	Pukehina Beach Surf Club	Pukehina	160170	32.0	**A**	Very Low	**Very Good**	100
WBOP	Tanners Point Beach	Tanners Point	160031	100.3	**B**	Very low	**Good**	100
WBOP	Waihi Beach Surf Club	Waihi Beach	160027	86.5	**B**	Low	**Good**	100
WBOP	Waihi Beach	3 Mile Creek	900077	183.0	**B**	Moderate	**Good**	100
WBOP	Waitui Reserve	Te Puna	160293	167.0	**B**	High	**Poor**	100
Whakatane	Ohiwa Harbour Reserve Boat Ramp	Ohiwa	160009	30.0	**A**	Very Low	**Very Good**	100
Whakatane	Ohope Beach Surf Club	Ohope 2	160011	66.0	**B**	Moderate	**Good**	100
Whakatane	Ohope Beach Surf 'n Sand Motor Camp	Ohope 1	160010	16.9	**A**	Very Low	**Very Good**	100
Whakatane	Piripai Beach Ocean Beach	Piripai	160014	46.0	**B**	Very Low	**Good**	100
Whakatane	Whakatane Heads oceanside of boat ramp	Whakatane	160013	273.0	**C**	Moderate	**Fair**	100
Whakatane	Rivermouth	Tarawera River	110125	204.0	**C**	High	**Poor**	100

Appendix 1b – Suitability for recreation grading - Grades for river and stream sites

District	Site	Description	BOP Site Number	P	MAC	SIC	SFRG	% samples less than the Red/Action Mode 2013/2014	NOF Secondary (& Primary) Attribute 2013/2014
Kawerau	Ruruanga Stream	Cricket Pavilion	160111	340	C	Moderate	**Fair**	100	A (A)
Kawerau	Tarawera River	Boyce Park	160110	131	B	Very Low	**Good**	100	A (A)
Opotiki	Haparapara River	Omaio d/s SH35 bridge	160100	543	C	Low	**Fair**	100	A (-)
Opotiki	Otara River	d/s SH 35 bridge	160101	343	C	Moderate	**Fair**	100	A (A)
Opotiki	Waioeka River	Bend near Waioeka Pa	160102	472	C	Moderate	**Fair**	100	A (A)
Opotiki	Waioeka River	SH 2 bridge	160103	303	C	Moderate	**Fair**	100	A (A)
Rotorua	Awahou Stream	Glouster Road	160118	170	B	Very Low	**Good**	100	A (A)
Rotorua	Kaituna River	Trout Pool Road	160112	53	A	Very Low	**Very Good**	100	A (A)
Rotorua	Ngongotaha Stream	Railway Bridge	160114	1040	D	Moderate	**Poor**	100	A (B)
Rotorua	Ohau Channel	SH 33 bridge	160119	111	A	Very Low	**Very Good**	100	A (A)
Rotorua	Puarenga Stream	Whakarewarewa	160113	1250	D	Moderate	**Poor**	100	A (A)
Rotorua	Utuhina Stream	Lake Road	160117	692	D	Moderate	**Poor**	100	A (A)
Rotorua	Waitangi Springs	Lake Rotoehu	160120	158	A	Moderate	**Good**	100	A (A)
Rotorua	Waiteti Stream	Ngongotaha	160115	784	D	Moderate	**Poor**	100	A (A)
Tauranga	Waimapu River	Greerton Park Footbridge	160150	1505	D	High	**Very Poor**	90	A (<MC)
Tauranga	Wairoa River	Bethlehem	160122	830	D	Moderate	**Poor**	91	A (<MC)
WBOP	Kaituna River	Te Matai Rail Bridge	160129	443	C	Moderate	**Fair**	100	A (A)
WBOP	Ngamuwahine River	At reserve	160125	1083	D	Moderate	**Poor**	100	A (A)
WBOP	Tuapiro Stream	McMillan Road	160126	622	D	Moderate	**Poor**	91	A (<MC)
WBOP	Uretara Stream	Henry Road Ford	210004	560	D	Moderate	**Poor**	91	A (<MC)
WBOP	Wairoa River	Below McLaren Falls Dam	160124	1092	D	Moderate	**Poor**	90	A (<MC)
WBOP	Kaiate Stream	Kaiate Falls	160130	1360	D	Moderate	**Poor**	95	A (<MC)
WBOP	Pongakawa River	SH 2 Bridge	110030	628	D	Moderate	**Poor**	95	A (A)
Whakatane	Rangitaiki River	Te Teko	110018	282	C	Very Low	**Fair***	100	A (A)
Whakatane	Rangitaiki River	Thornton Domain	160109	195	B	High	**Poor***	100	A (A)
Whakatane	Waimana River	Waimana Gorge Picnic Area	160105	226	B	Very Low	**Good**	95	A (<MC)
Whakatane	Whakatane River	Landing Road Bridge	160106	554	D	High	**Very Poor**	100	A (A)
Whakatane	Whakatane River	Ruatoki Bridge	110010	97	A	Very Low	**Very Good**	100	A (A)

*Originally graded as “Follow up”; <MC = does not meet minimum criteria

Appendix 1c – Suitability for recreation grading - Grades for lake sites

Site	Description	Site No.:	P	MAC	SIC	SFRG	% samples less than the Red/Action Mode 2013/2014	NOF Secondary (& Primary) Attribute 2013/2014
Lake Rotoma	Matahi Lagoon Road, beach	160050	143	B	Very Low	**Good**	100	A (A)
Lake Rotoma	Whangaroa	160052	208	B	Very Low	**Good**	100	A (A)
Lake Rotoiti	Hinehopu, jetty	160053	40	A	Very Low	**Very Good**	100	A (A)
Lake Rotoiti	Gisborne Point	160054	23	A	Very Low	**Very Good**	100	A (A)
Lake Rotoiti	Ruato	160055	53	A	Very Low	**Very Good**	100	A (A)
Lake Rotoiti	Okawa Bay	160056	131	B	Very Low	**Good**	100	A (A)
Lake Rotoiti	Otaramarae	160058	95	A	Very Low	**Very Good**	100	A (A)
Lake Okareka	East end of dwellings	160061	183	B	Very Low	**Good**	100	A (A)
Lake Okareka	Jetty	160062	31	A	Very Low	**Very Good**	100	A (A)
Lake Tikitapu	Beach	160063	192	B	Very Low	**Good**	100	A (A)
Lake Tarawera	Rangiuru Bay	160072	20	A	Very Low	**Very Good**	100	A (A)
Lake Tarawera	Te Karamea Bay	160291	130	A	Very Low	**Very Good**	100	A (A)
Lake Rotorua	Mourea	160065	259	B	Very Low	**Good**	100	A (A)
Lake Rotorua	Holdens Bay	160066	288	C	Moderate	**Fair**	100	A (A)
Lake Rotorua	Ohinemutu	160068	96	A	Moderate	**Good**	100	A (A)
Lake Rotorua	Ngongotaha	160069	338	C	Low	**Fair**	100	A (B)
Lake Rotorua	Hamurana	160070	308	C	High	**Poor**	100	A (A)
Lake Okaro	Ski area	160073	35	A	Very Low	**Very Good**	100	A (A)
Lake Rerewhakaaitu	Brett Road boat ramp	160079	131	B	Very Low	**Good**	100	A (A)
Lake Rerewhakaaitu	Sports ground	160078	79	A	Very Low	**Very Good**	100	A (A)