MARLBOROUGH DISTRICT COUNCIL

Recreational Water Quality Report 2015-2016

Technical Report No: 16-003
May 2015

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MDC Technical Report No: 16-003

ISSN 1179-819 (Online)

ISBN 978-1-927159-68-2 (Online)

File Reference/Record No: E370-007-001/1698371

May 2016

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Executive Summary

Twelve coastal beaches and nine river sites were sampled weekly from the beginning of November 2015 until the end of March 2016. Samples were analysed for the concentration of faecal indicator bacteria. The results were assessed according to national guidelines in order to determine if water quality was safe for recreational activities such as swimming and surfing.

At six sites faecal indicator bacteria concentrations were within safe levels for all samples taken. These sites included Marfells Beach, Pukatea/Whites Bay, Ngakuta Bay and the Wairau River at Blenheim Rowing Club. Unusually low levels of indicator bacteria compared to previous years at the two Waikutakuta/Robin Hood Bay sampling sites were attributed to the build-up of a natural temporary sand bar that filtered the water of streams flowing into the bay.

At most other sites, at least one of the samples taken had indicator bacteria levels above the national guideline values. The majority of these samples were taken during or shortly after rainfall or were associated with river floods. However, at a number of sites, elevated faecal bacteria concentrations were also observed during dry weather. In Momorangi Bay, for example, problems with the sewerage system caused two separate sewage spills that affected water quality in the bay.

Faecal contamination of the Taylor River during dry weather has been a problem in the past and was further investigated, but the sources of occasionally very high concentrations of faecal bacteria at low flows remain uncertain.

The sampling results for all sites were analysed together with results from previous summer seasons to determine trends in indicator bacteria concentrations. Additionally, a grading system was applied that allows the assessment of overall recreational water quality, the SFR Grades. These grades were last reviewed in 2014, but trend analysis showed a significant change in recreational water quality at a number of sites and the SFR Grades were again reviewed as part of this document. Additionally, for most of the sites that were added to the program in 2012, sufficient data has now been collected to allow assignment of interim SFR Grades. The current grades for all sites monitored are shown in the table below. For comparison the table also shows the 2014 SFR Grades.

	Site	2014 SFR Grade	2016 SFR Grade (current)
Coastal Sites	Moetapu Bay	no Grade	no Grade
	Mistletoe Bay	Very Good	Fair
	Anakiwa	Good	Fair
	Momorangi Bay	Fair	Poor
	Ngakuta Bay	Fair	Good
	Governors Bay	no Grade	Good*
	Picton Foreshore	Poor	Fair
	Waikawa Bay	Good	Good
	Waikutakuta/Robin Hood Bay East	no Grade	Very Good*
	Waikutakuta/Robin Hood Bay West	no Grade	Good*
	Pukatea/Whites Bay	Very Good	Very Good
	Marfells Beach	Very Good	Very Good
River Sites	Rai Rv at Rai Falls	Very Poor	Poor
	Te Hoiere/Pelorus Rv at Pelorus Bridge	Good	Good
	Te Hoiere/Pelorus Rv at Totara Flat	Poor	Fair
	Wairau Rv at State Highway Six	no Grade	Fair*
	Wairau Rv at Ferry Bridge	Fair	Fair
	Wairau Rv at Blenheim Rowing Club	Good	Good
	Taylor River at Riverside	Very Poor	Very Poor
	Ōpaoa River at Elizabeth St Bridge	Fair	Fair
	Waihopai River at Craiglochart #2	Fair	Poor

* interim

Table 1: Previous (2014) and new (2016) SFR Grades for the sites monitored as part of the Recreational Water Quality Program.

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1. Introduction

Marlborough has a number of beautiful beaches and rivers that are popular with visitors and local residents during the warmer months of the year. Swimming, boating, surfing and fishing are only a few of the many water based recreational activities that take place in the region. However, accidental ingestion of water can result in illness when faecal bacteria concentrations in the water are high. The risk of infection is highest for activities such as swimming and surfing.

Campylobacteriosis and Cryptosporidiosis are two of the most common gastrointestinal illnesses associated with water use. These illnesses often cause vomiting, stomach cramps and diarrhoea from two to ten days after infection. The potentially long delay between infection and the first symptoms means that the source of infection can be difficult to determine. Nevertheless, in 2014, over 50% of Campylobacteriosis cases and over 30% of Cryotosporidiosis cases in New Zealand had recreational water contact as a risk factor for the infection [1].

In order to allow us to evaluate the risk to water users, council takes weekly water samples from the most popular beaches during the summer months. The samples are analysed for faecal indicator bacteria and results are assessed according to national guidelines published by the Ministry for the Environment [7].

This report presents the results for the samples taken during the summer season of 2015/2016 and investigates long term trends for faecal indicator bacteria concentrations where possible. It also presents a review of SFR Grades, which are a valuable way of gauging the overall recreational water quality of a site.

It is important to note that the Recreational Water Quality program is exclusively focused on health based risks associated with faecal contamination and results are not reflective of the general water quality of a site, the presence of toxic algae or other risks associated with a site (eg; high water flows or strong currents).

2. Recreational Water Quality Monitoring

The recreational water quality of twelve coastal beaches and nine river sites was monitored from the beginning of November 2015 until the end of March 2016. Samples were taken weekly, usually at the beginning of each week, independent of weather conditions and tide levels. Hill Laboratories in Blenheim was contracted to measure the indicator bacteria concentrations in the samples. Bacteria levels were determined as MPN counts using Enterolert for Enterococci and Colilert for E. coli after up to 24 hour incubation at 41^{o}C and 35^{o}C respectively.

As soon as analysis results were received from the laboratory, the indicator bacteria concentrations were assessed according to the Microbiological Water Quality Guidelines. The guidelines are described in more detail in the following sections.

In order to provide the public with up-to-date information, the results are also displayed on the Marlborough District Council website (www.marlborough.govt.nz). This is done in the form of a map based application with direct links to our data base. This ensures that information is accessible to the public as soon as the laboratory results are electronically transferred into the data base. The same information can also be viewed in a slightly different format on the LAWA website (www.lawa.org.nz).

3. The Microbiological Water Quality Guidelines

In 2003 the Ministry for the Environment (MfE) and the Ministry of Health (MoH) published a Guideline document, a framework for the monitoring of the microbiological water quality of recreational areas [7]. The document provides general recommendations in regard to the management of recreational water quality and guideline values allowing the assessment of results from individual samples. The document also presents a method to evaluate the overall bacterial risk at a site, not just at the time a sample is taken, the Suitability for Contact Recreation Grade (SFR Grade). This grade takes into account the risks of faecal contamination from the surrounding areas and the sampling results over a five year period.

3.1. Guideline values for individual samples

Measuring the concentrations of all microorganisms that can be hazardous for the health of water users is both difficult and expensive. A more cost effective approach is the use of indicator bacteria. These are comparatively easily measured and are generally present when water is contaminated with harmful organisms such as Salmonella, Campylobacter, Giardia or Cryptosporidium. High concentrations of indicator bacteria are a sign that the water is potentially contaminated with human sewage or animal faeces, which results in an increased health risk associated with the use of the water body for recreational activities, such as swimming.

Two different indicator bacteria are used depending on the type of water that is being monitored. Freshwater samples are analysed for the concentration of E. coli, while Enterococci are the preferred indicator bacterium for coastal samples. The 2003 Guideline document provides two guideline values for each of the two indicator bacteria. Based on these guidelines, sample results are categorised into three “Modes”, which allow a decision to be made on whether the water can be considered safe for contact recreation. Table 1 outlines these “Modes” and their meaning as well as the actions that need to be taken as a result. In this report, the lower limit for the Alert Mode is referred to as the Alert Guideline, which corresponds to concentrations of 260 E. coli/100mL and 140 Enterococci/100mL. The upper limit for the Alert Mode (lower limit of the Action Mode) is referred to as the Action Guideline and corresponds to concentrations of 550 E. coli/100mL and 280 Enterococci/100mL.

Mode	Freshwater E. coli/100mL	Coastal Enterococci/100mL	Meaning	Required Action
Green Mode	<260	<140	**Safe** for contact recreation	Conitue routine monitoring
	260	140	**Alert Guideline**	
Alert Mode	260 - 550	140 - 280	**Increased risk** for health	Investigate possible causes and increase sampling frequency if no cause can be found, otherwise continue routine sampling
	550	280	**Action Guideline**	
Action Mode	>550	>280	**Unsafe** for conctact recreation	Increase sampling frequency and warn the public that the beach is considered unsafe (Warning signs)

Table 2: Modes and the corresponding Guidelines as outlined by the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas [7].[1]

If indicator bacteria concentrations are above the Alert or Action Guideline possible causes are considered and the District Health Board is informed. A joint decision is made on how to proceed. Usually, warning signs are erected at sites with unsafe levels of indicator bacteria. The sites are then sampled more frequently until indicator bacteria concentrations have returned to safe levels and warning signs can be removed. A flowchart outlining the process is shown in Appendix 3.

[1] For coastal samples the Action Mode is usually only applied after concentrations in two consecutive samples exceed 280 Enterococci/100mL; however if a high number of people is expected to visit the beach (i.e. during holiday periods), a precautionary approach is taken and warning signs are erected after only one exceedance.

3.2. Suitability for Contact Recreation Grades (SFR Grades)

Although, individual results provide information about the recreational water quality of a site for the date and time a sample was taken, water quality is inherently variable and can quickly change within very short time frames, especially as a result of rainfall (see Section 4). This is particularly a problem for the measurement of E. coli or Enterococci concentrations, because there are currently no methods to monitor these bacteria in real-time. Due to the incubation methods currently used, there is a minimum 18-hour delay before the result of a sample can be known. Additionally, the sampling frequency is limited by practicality and budget constraints, which means we cannot sample often enough to ensure that every occasion when water quality is unsafe can be notified. For that reason, the main purpose of the sampling program is the analysis of the results of several years of sampling to obtain a general picture of the recreational water quality of a site. The results of this analysis are expressed in a grading system, the Suitability for Contact Recreation Grades or SFR Grades.

The Grades are based on a 'reasonable risk' approach in regard to the possibility of contracting water borne diseases associated with faecal contamination when pursuing recreational activities in and around the water.

The SFR Grade is the combination of a catchment assessment (Sanitary Inspection Category, SIC) and an assessment of the Microbiological Water Quality (Microbiological Assessment Category, MAC).

The catchment assessment is primarily focused on potential sources of faecal contamination. SICs based on this assessment range from Very Low, Low, Moderate, High to Very High (Risk). Sites surrounded by bush and forest are given a SIC of Very Low. Low intensity agriculture in the catchment results in a SIC of Low. Categories of High and Very High are given to sites likely to directly receive treated or untreated sewage or run-off from high-intensity agriculture.

The MAC is derived from the Enterococci or E. coli concentrations in routine samples taken from a site over five consecutive summers. MACs range from A to D (Table 3) and are based on the upper 95th percentile (95%ile) calculated with the Hazen method.

MAC (Microbiological Assessment Category)	**Coastal**	**Freshwater**
	Enterococci/100mL*	E. coli/100mL*
A	<41	<131
B	41 - 200	131 - 260
C	201 - 500	261 - 550
D	>500	>550

* upper 95th Percentile (95%ile) of routine sampling over 5 consecutive summers

Table 3: Microbiological Assessment Categories (MAC).

The SIC and the MAC for a site are then combined into the SFR Grade (Table 4). The Grades range from Very Good, Good, Fair, Poor to Very Poor. Table 5 outlines the definitions for the individual Grades.

SFR Grade (Suitability for Contact Recreation Grade)		**MAC** (Microbiological Assessment Category)			
		A	B	C	D
SIC (Sanitary Inspection Category)	Very Low	Very Good	Very Good	*	*
	Low	Very Good	Good	Fair	*
	Moderate	*	Good	Fair	Poor
	High	*	*	Poor	Very Poor
	Very High	*	*	*	Very Poor

* unexpected result (further investigation is necessary)

Table 4: Deriving SFR Grades from the MAC and SIC categories.

SFR Grade	Meaning
Very Good	Considered satisfactory for swimming at all times.
Good	Satisfactory for swimming most of the time with exceptions following rainfall.
Fair	Generally satisfactory for swimming. Caution should be taken during periods of high rainfall and swimming avoided if water is discoloured.
Poor	Swimming should be avoided, particularly by the very young, the very old and those with compromised immunity.
Very Poor	Generally swimming is not recommended.

Table 5: Suitability for Contact Recreation Grades (SFR Grades) and their meaning.

The SFR Grades for the sites currently sampled were last reviewed in the Recreational Water Quality Report for the 2013/2014 summer season. The recreational water quality of some sites has changed significantly since and SFR Grades were again reviewed as part of this report. Most of the new sites that were added as a result of a site usage survey in 2012 have been sampled for four summer seasons. This is one season short of the five-year requirement for the assignment of a SFR Grade, but the guideline document allows the designation of 'interim' SFR Grades for incomplete datasets. This means, we now have SFR Grades for nearly all sites that are currently monitored as part of the Recreational Water Quality program.

4. Influence of Rainfall

Rainfall greatly influences recreational water quality at the majority of sites monitored. Even small rainfall events can wash animal droppings from pastures, roofs, roads and other surfaces into rivers and coastal waters. In urban areas run-off from hard surfaces picks up bird droppings, dog faeces, and other contaminants and is collected in the stormwater system, which is discharging directly into the local waterways. Larger rainfall events can also cause septic tanks to overflow if these are not properly sealed or maintained.

It is generally recommended not to not go swimming for 48 hours after rainfall, particularly in waterways that are known to be affected by rural or urban run-off.

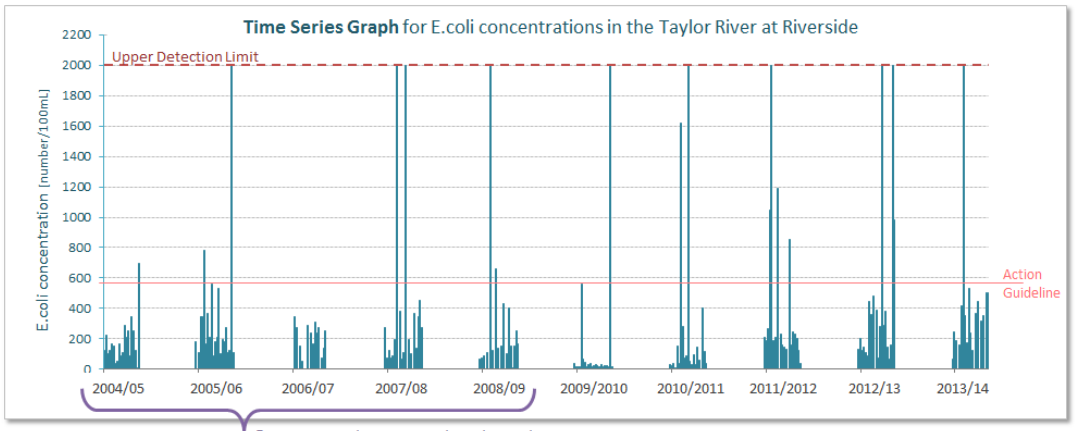
5. Results

The following chapters present the results for this summer as well as changes of faecal bacteria concentrations over time (long-term trends). Where appropriate, sites are grouped into sets of two or three sites. For each group the concentration of faecal indicator bacteria in the samples taken from each site during the 2015/16 summer is shown, together with rainfall and flow data recorded at nearby sites. This allows the results to be viewed with regard to rainfall and flood events. A map shows the location of the sampling sites as well as the rainfall and/or flow recorder. For sites with longer monitoring records, the changes over time are shown using the 5-year-95%ile (MAC) values (Figure 2), which are also used for the calculation of the SFR Grades (see Section 3.2).[2]

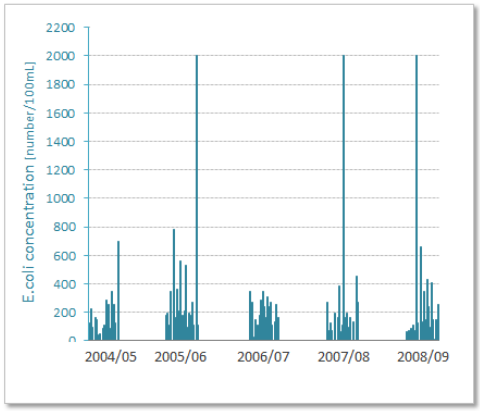
Summary tables showing the numerical results for all samples taken this season can be found in the Appendices. Additionally, Appendix 2 contains graphs showing the compliance history and box and whiskers plots for sites that have been monitored for more than three years.

▶ Figure 1: Creation of 5-Year-95%ile Graphs, used to display long-term trends.

[2] Note that in previous reports, the calculation of the upper 95%ile for the analysis of trends used the Excel method instead of the Hazen method. The Hazen method gives generally slightly higher results. For consistency in regard to SFR Grades, this report uses the Hazen method to show trends. Consequently, there are slight differences to trend graphs in previous report.



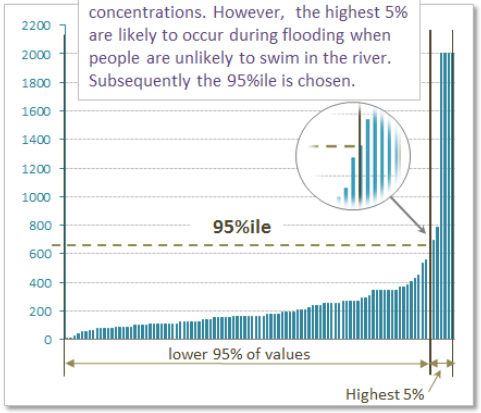
Because results are weather dependent there is substantial variation between summer seasons, therefore the data from five summers is combined



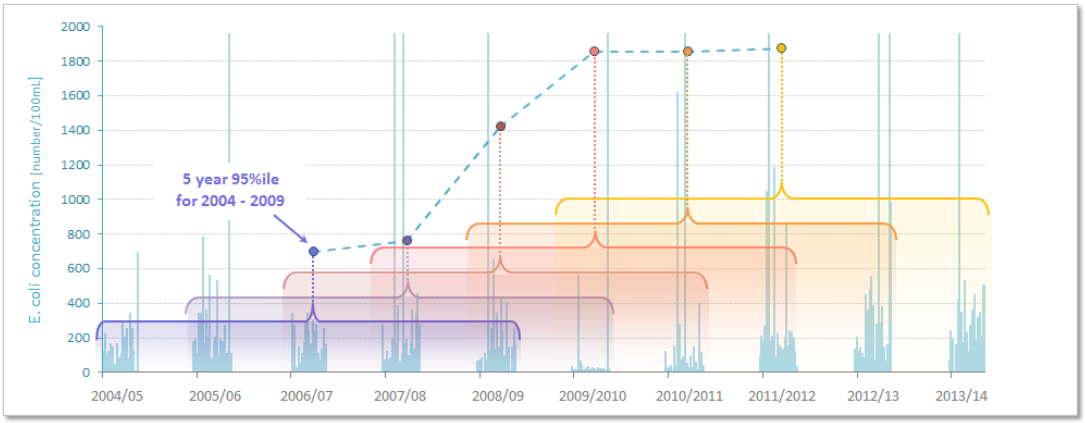
The data is ranked (ordered) based on the E. coli concentration values

to find the 95 Percentile (95%ile)

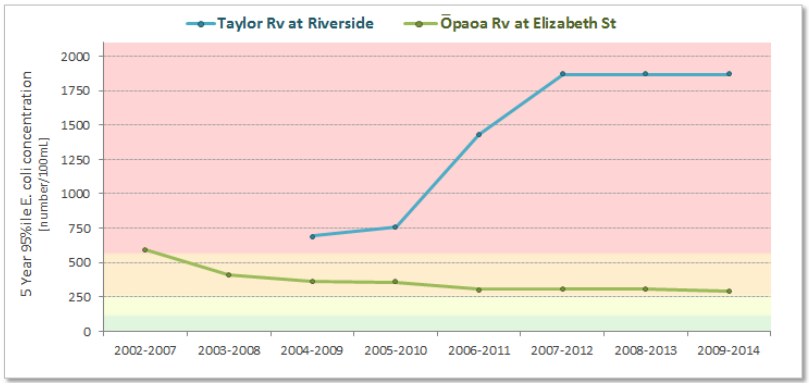
The purpose of the program is to assess if the water is safe for contact recreation, therefore, the focus is on high E. coli concentrations. However, the highest 5% are likely to occur during flooding when people are unlikely to swim in the river. Subsequently the 95%ile is chosen.



The 95%iles for all 5 year intervals are calculated



The change over time (Trend) can now be seen and compared with that of other sites



To put the values into context, the background colouring of the graph is based on the Microbiological Assessment Categories (MAC) used for the grading of sites (SFR Grade).

MAC Category

D
C
B
A

5.1. Moetapu Bay

Sites

Moetapu Bay is the only site in the Pelorus Sound/Te Hoiere currently monitored as part of the program. It was added only recently after an aerial survey in 2012 identified it as a possible high-use area. There are several beaches along the wider bay and monitoring was initially carried out at the small DoC campground (Figure 2). However, field observations showed that the Double Bay Reserve had generally more visitors. The higher use combined with greater residential development around Double Bay Reserve mean that the risk of a person becoming ill from waterborne diseases is greater at this site. Subsequently, monitoring at the DoC campground was discontinued and is now carried out at the Double Bay Reserve only.

Moetapu Bay is located in close proximity to the mouth of the Te Hoiere/Pelorus River and water quality is impacted when the river is in flood.

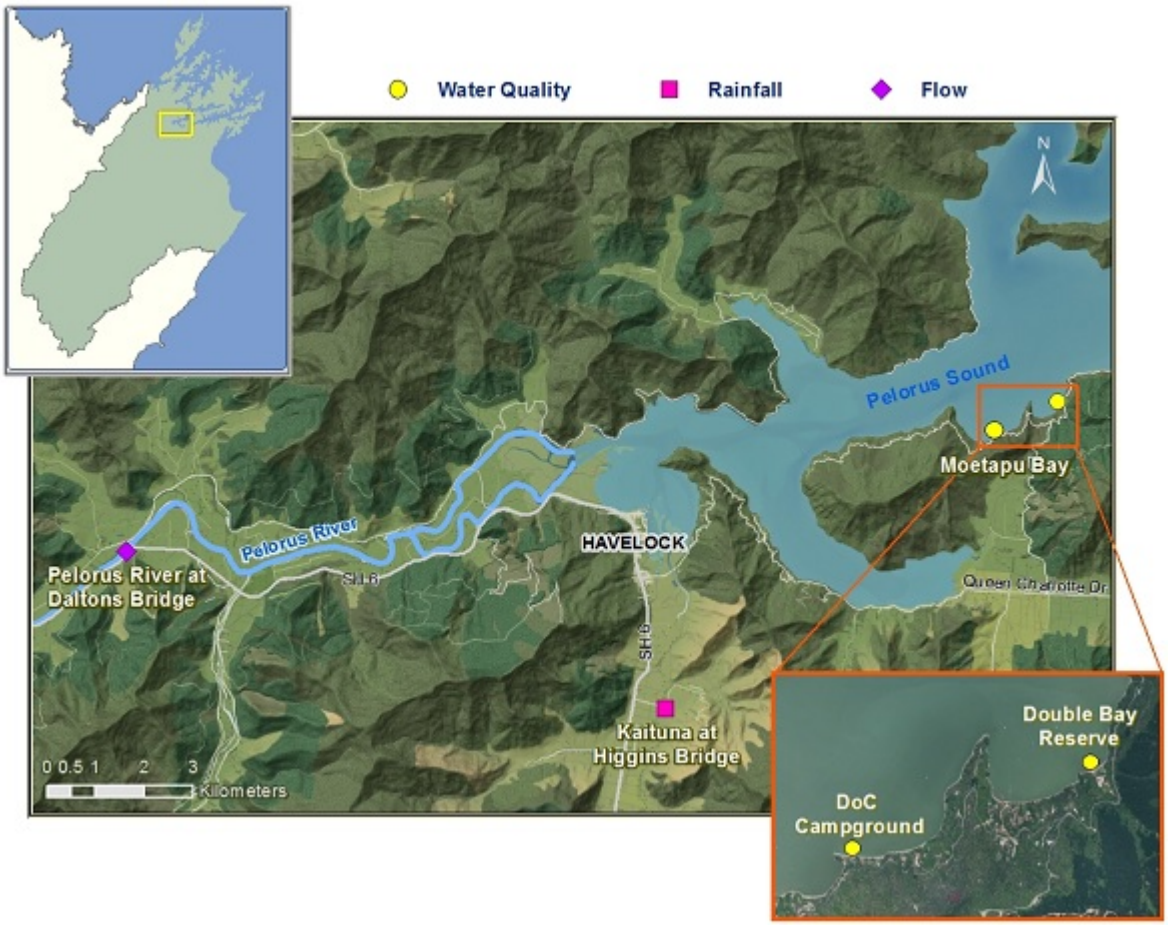


Figure 2: Location of the Moetapu Bay sampling sites, the (simulated[3]) Te Hoiere/Pelorus River flow recorder and the Kaituna raingauge.

Results

During the summer period of 2015/2016, high levels of Enterococci were generally associated with flood flows in the Te Hoiere/Pelorus River. The effects of these floods appear to last for prolonged periods of more than a week. This was particularly the case following the largest flood in February 2016 (Figure 3). The Enterococci concentration in the first sample taken after the event was extremely high, with a value of nearly 20,000 Enterococci/100ml. Although the concentration peaks in the following samples were generally declining, a large variability in results was evident. Further analysis

[3] The flow is simulated based on data from flow recorders further upstream.

of the data revealed that the highest Enterococci concentrations were associated with high tides (see Figure 4). Overseas research has shown that beach sand can be a significant source for faecal bacteria with the highest concentrations found just above the highest wave up-rush [8]. Field observations indicate an increased amount of fine sediment on the beach following the flood event and the water was slightly turbid when samples with high Enterococci concentrations were taken. It can therefore be assumed that sediment deposited during the Te Hoiere/Pelorus River floods is a significant source of contamination with faecal bacteria in Moetapu Bay.

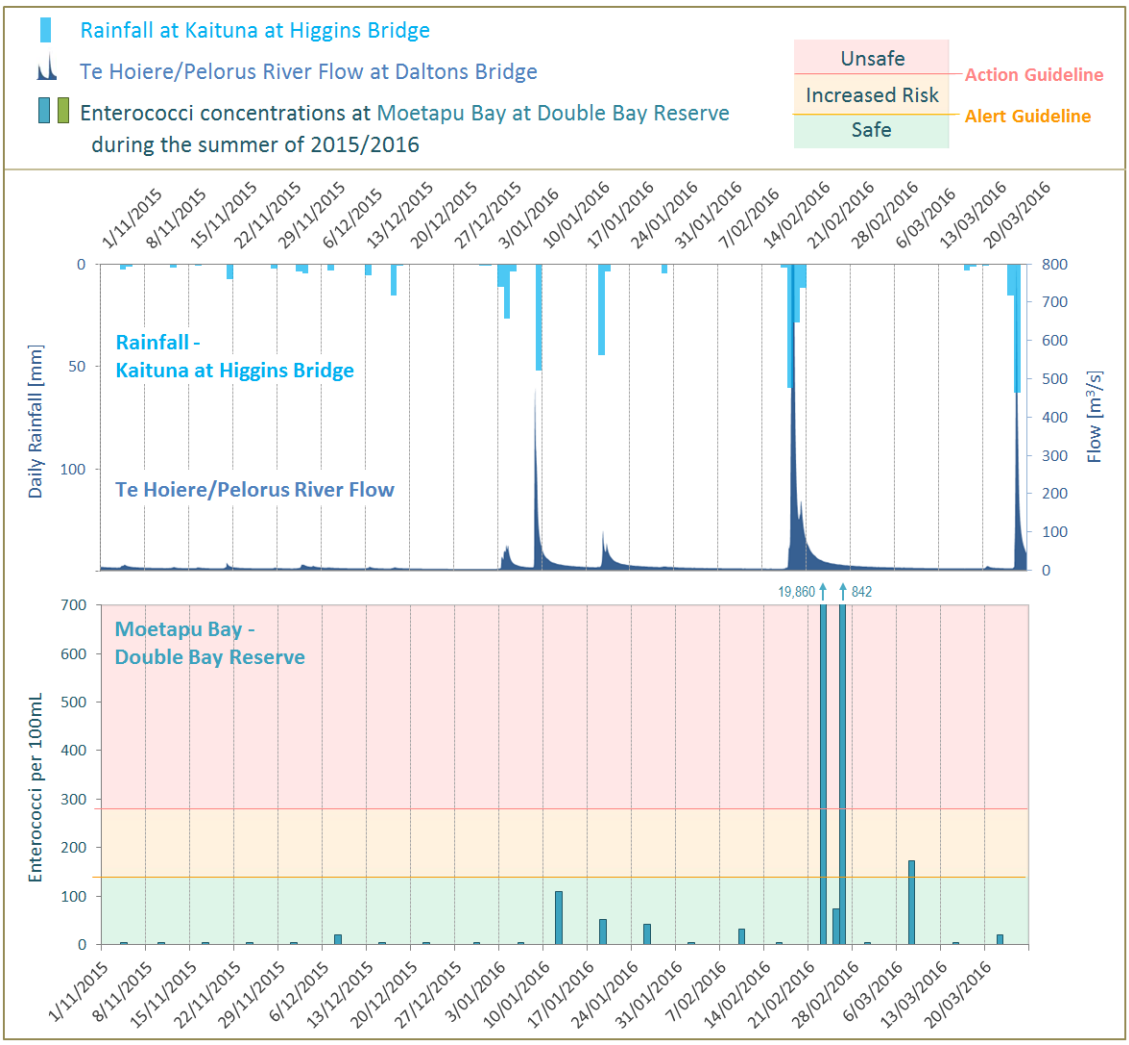


Figure 3: Results for Moetapu Bay – Double Bay Reserve for the summer season of 2015/2016.

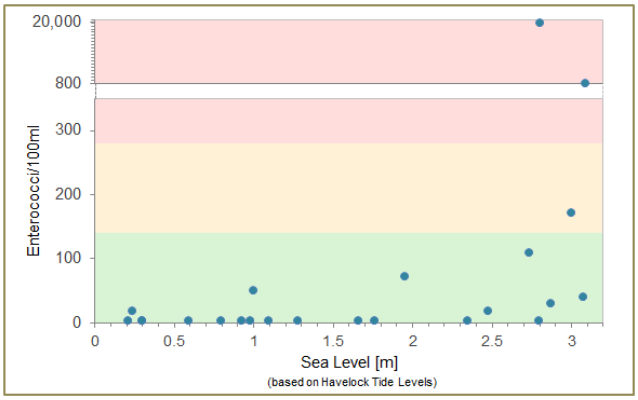


Figure 4: Changes of Enterococci concentrations with Tide height (Sea Level) during the 2015/2016 summer season.

Three samples from Moetapu Bay were taken during rainfall[4], but were not associated with significant flooding of the Te Hoiere/Pelorus River. The largest of these rainfall events in January (19/01/2016) resulted in a substantial inflow of freshwater from a stream flowing into the bay at the sampling site. Although faecal bacteria levels were elevated, concentrations did not exceed the guidelines. This indicates that local sources in the catchment appear to have a minor impact on recreational water quality. However, the site has only been sampled for a relatively short period (two summers) and future results will show if this is a consistent pattern. The small amount of monitoring data also means that Moetapu Bay is the only site in the program that could not be given a SFR Grading.

5.2. Anakiwa and Mistletoe Bay

Sites

Anakiwa is located in the innermost part of the Queen Charlotte Sound/Totaranui. The microbiological water quality is influenced by the surrounding residential development and large numbers of birds (ie; oystercatcher, swans and ducks). Water quality is expected to also be influence by Linkwater Stream and Ada Creek. These two streams drain pastoral land and flow into the Sound 2 km from the Anakiwa sampling site. Monthly monitoring of Linkwater Stream has shown that its water quality is marginal and E. coli concentrations are frequently high [6]. The council has conducted a catchment-wide investigation of the water quality in Linkwater Stream and Ada Creek to identify sources of faecal contamination. Results of this investigation are expected to be published by the end of the year.

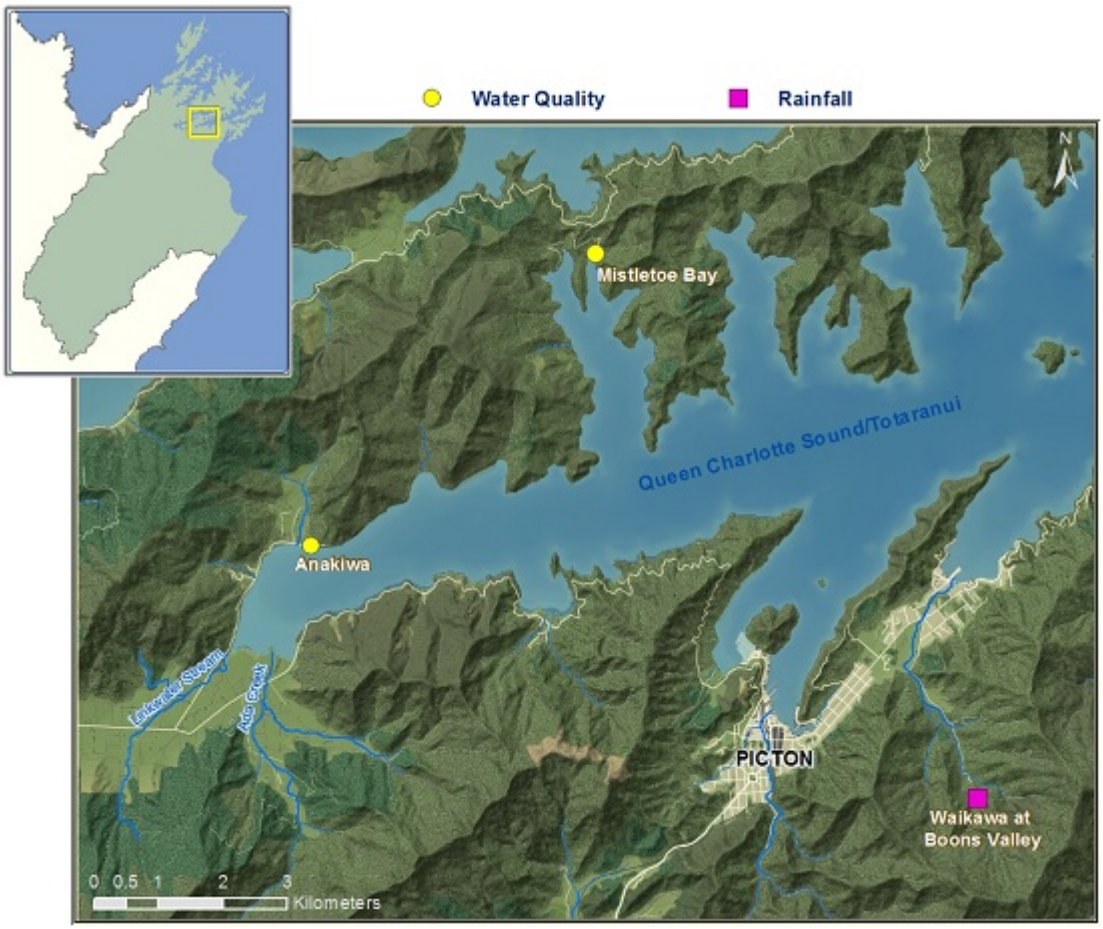


Figure 5: Location of the Anakiwa and Mistletoe Bay sampling sites and the Waikawa rain gauge.

[4] Field notes indicate that it was raining at the site.

Compared to Anakiwa, Mistletoe Bay has few possible sources of faecal contamination. The enclosed Bay is surrounded by bush-clad hills. The buildings of the Mistletoe Bay Trust are the only residential developments in the immediate catchment.

Results

The only exceedance of a guideline in Anakiwa this summer occurred during rainfall, but Enterococci concentrations did not reach unsafe levels (Figure 6). The long-term trend shows a slight, but steady increase in Enterococci concentrations since the last SFR Grade was determined in 2014 (Figure 7). As a result the 5-year 95%ile Enterococci concentration for Anakiwa is now within the C band of the MAC and the SFR Grade had to be lowered from 'Good' to 'Fair'.

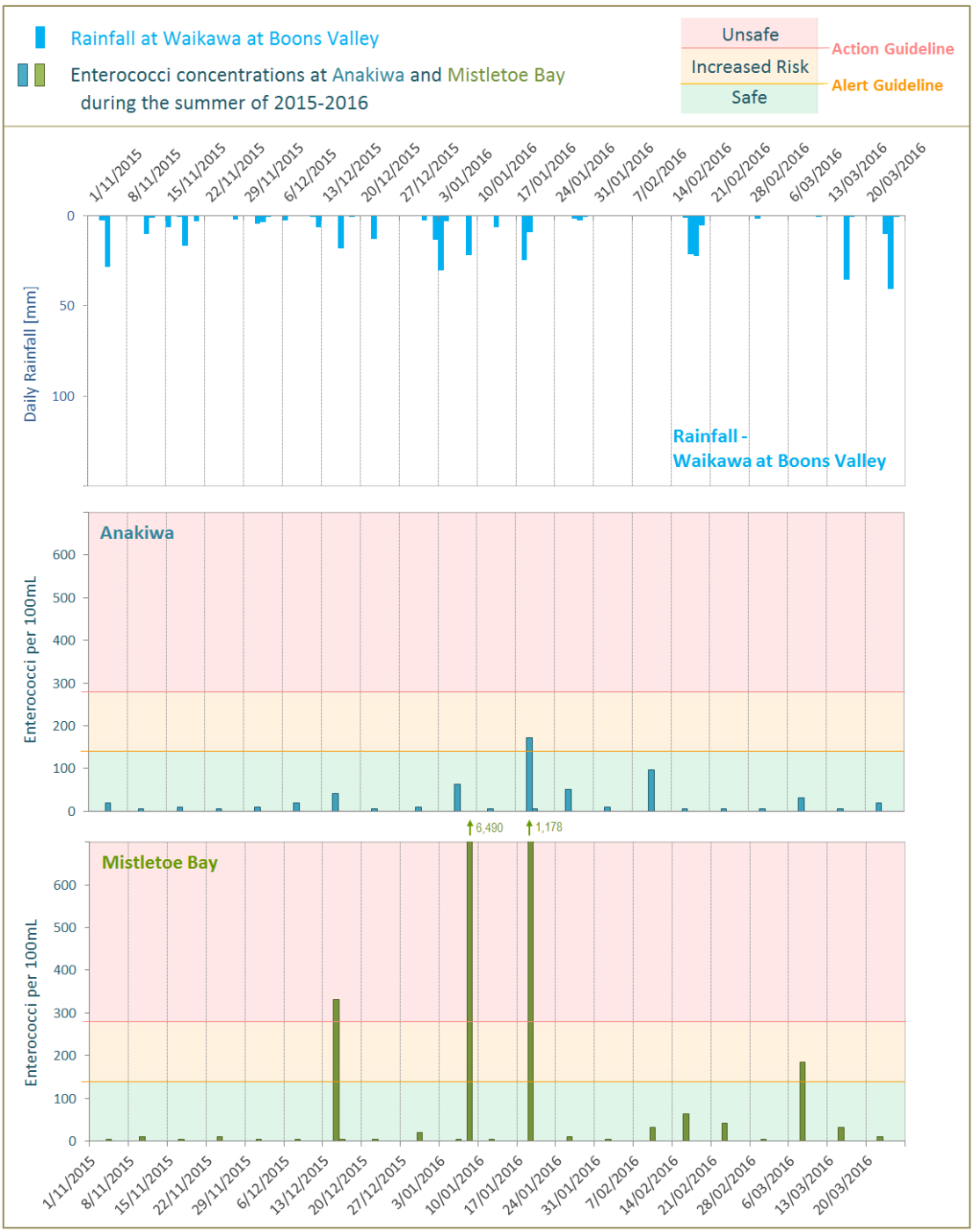


Figure 6: Enterococci concentrations measured in Anakiwa and Mistletoe Bay for the 2015/2016 summer season.

Unlike Anakiwa, Mistletoe Bay had a number of guideline exceedances this year (Figure 6), with some of the highest Enterococci concentrations measured so far. Results from previous summer seasons had shown that there were unusually high faecal bacteria concentrations during and shortly after rainfall events. Despite the relatively limited residential development, Enterococci concentrations associated with rainfall are usually higher in Mistletoe Bay compared to Anakiwa. This prompted a targeted investigation that was carried out during heavy rainfall on the 8th of January and resulted in the highest Enterococci concentration measured at this site (6,490 Enterococci/100 ml). In addition to the bay itself, the outlets of two streams flowing into the bay were sampled. Faecal bacteria concentrations in the stream samples were well above guideline levels, indicating that the streams were a significant source of faecal contamination. All three samples were also analysed for genetic markers, specific to different animal species. Possums and Ruminants (most likely goats) were a source in all samples, which is not surprising considering the large amount of native bush cover in the catchment. Human sources were also found in all three samples. This is a concern, as studies suggest that faecal contamination from human sources poses the greatest health risk to recreational users [1]. Wildfowl (ie; ducks) was only detected in the sea sample, which means that ducks have a negligible impact on water quality.

In an attempt to narrow down the location of contamination sources, several sites along the streams were sampled during rainfall on 19 January 2016. Again, all samples had Enterococci concentrations well above guideline levels, but concentrations were particularly high in and downstream of a pond through which one of the streams flows. Efforts to reduce faecal contamination will initially concentrate on this pond. We are currently working with the Mistletoe Bay Trust on finding the contamination source.

The 5-year 95%ile Enterococci concentrations in Mistletoe Bay have been below those of Anakiwa in the past, but have risen to values well within the C Band of the MAC. As a result, the SFR Grade for Mistletoe Bay had to be adjusted from a previously ‘Very Good’ grade to a ‘Fair’ grade.

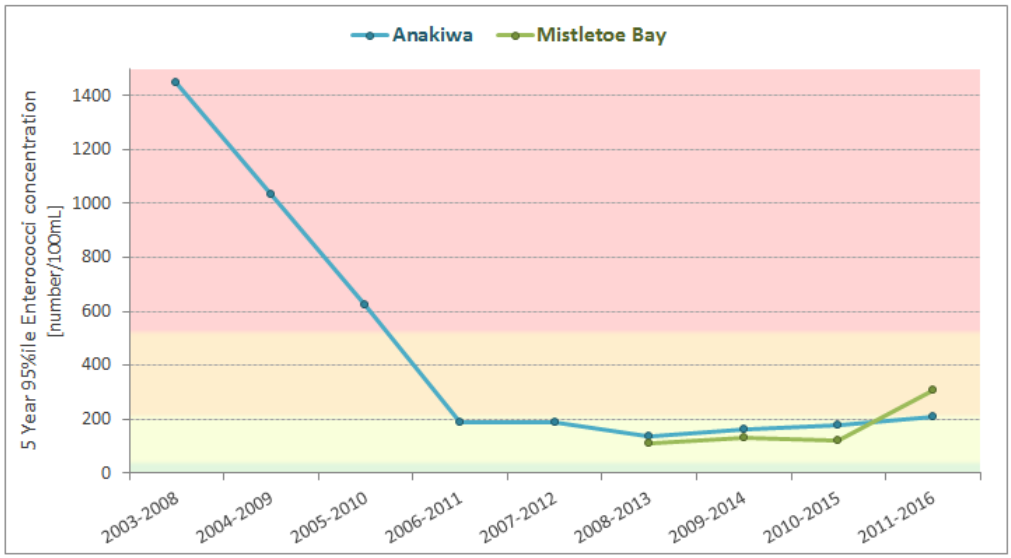


Figure 7: The 5-year 95%ile Enterococci concentrations for Anakiwa and Mistletoe Bay.

5.3. Momorangi, Ngakuta and Governors Bay

Sites

Momorangi Bay, Ngakuta Bay and Governors Bay are neighbouring bays in the Queen Charlotte Sound/Totaranui. Ngakuta Bay is the largest and most enclosed bay in this group and also has the greatest amount of residential development in the catchment. There are nearly 100 houses and holiday homes compared to less than 20 in Momorangi Bay and none in Governors Bay. Momorangi Bay, however, has a very popular campground, which attracts more visitors during the summer months than the other two bays combined.

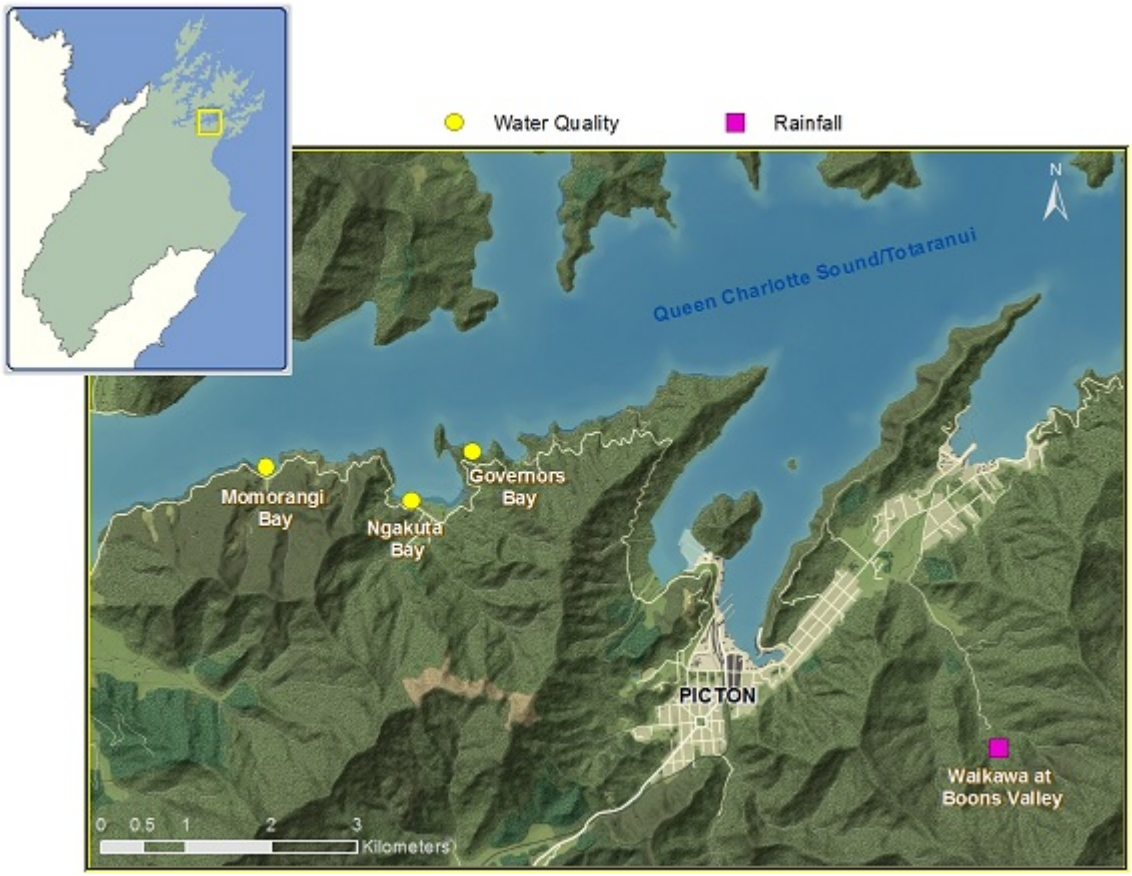


Figure 8: Map showing the sampling sites at Momorangi Bay, Ngakuta Bay and Governors Bay, as well as the rainfall recorder at Boons Valley.

Results

This is the second summer that problems with the sewerage system have troubled the managers of the DoC campground of Momorangi Bay. Following upgrades of the toilet and shower facilities in the months before the previous summer season, Enterococci concentrations in the bay were sporadically exceeding guideline levels during dry weather conditions. Consequently, warnings signs were erected and stayed in place for most of December 2014 and January 2015. An investigation showed that the measured bacteria levels were linked to tide levels. This was likely due to the shift of the actual point the sample was taken (ie; how far out from the shore). Further sampling also showed that the highest concentrations were confined to a relatively small area on the eastern side of the main beach. Investigation by DoC staff identified a leaking pipe joint in that area as the most likely source, which was consequently repaired.

This summer, operational issues were the cause of two sewerage overflows. The first occurred in mid-December 2015 and the reason was eventually identified about two weeks later. A pump had not been turned back on after the sewerage system was serviced, which caused a sewage holding tank to overflow. A level alarm will prevent a repeat of this situation in the future.

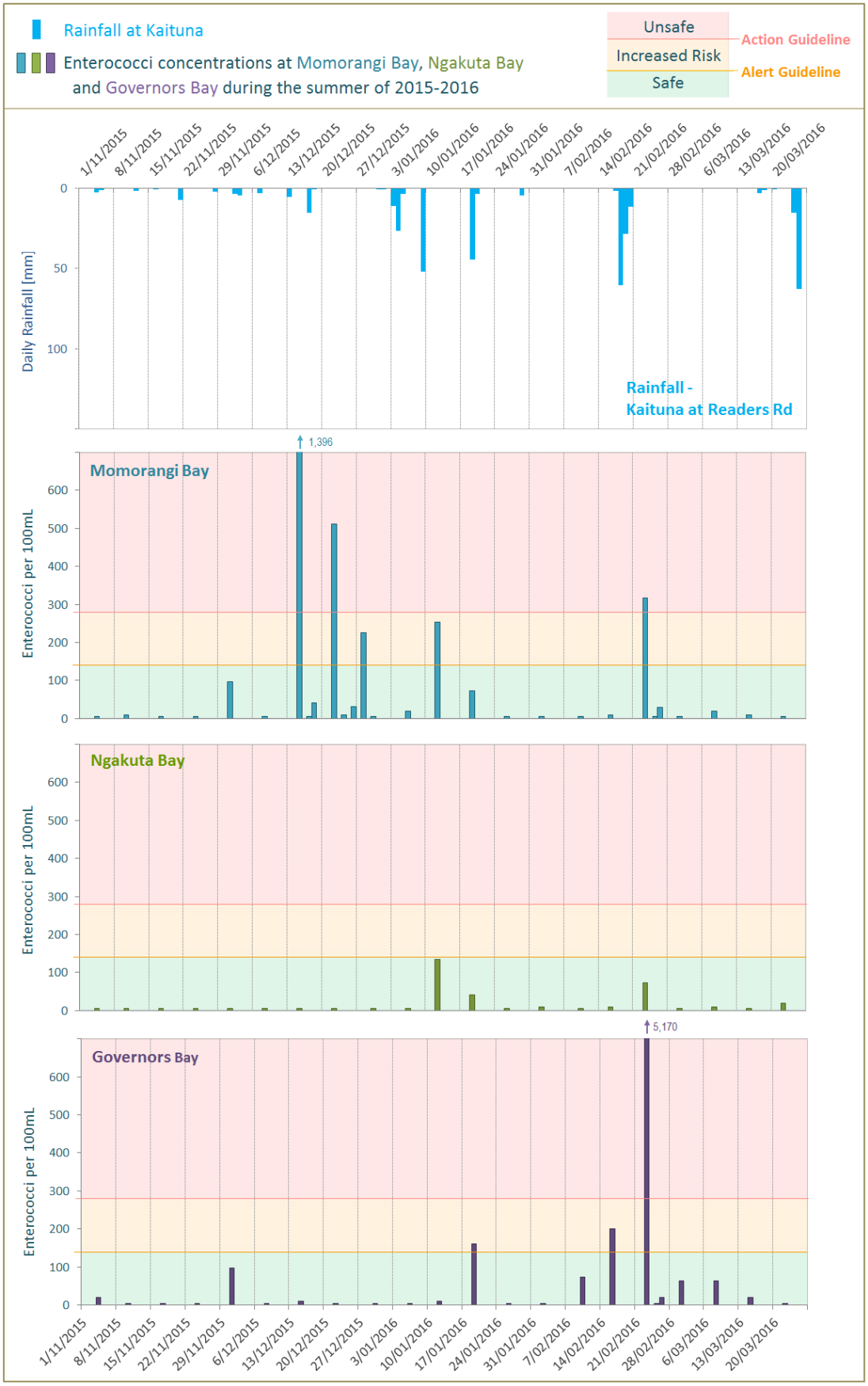


Figure 9: Enterococci concentrations at Momorangi By, Ngakuta Bay and Governors Bay.

Another sewerage overflow at Momorangi Bay in January 2016 was caused by irresponsible behaviour of resident campers and fortunately was of short duration.

The investigation into the two sewerage overflows also revealed another source of contamination. It became clear that in the cover of night some of the campers were emptying their campervan toilets into the streams. The camp managers are now handing out flyers to every new visitor, informing them that the disposal of the content of campervan toilets is not allowed anywhere in Momorangi Bay. The nearest authorised disposal facilities are located in Havelock and Picton, but conversations with campers made clear that some were reluctant to temporarily pack-up in order to dispose their waste in a responsible manner. It is unclear what portion of the increased Enterococci concentrations can be attributed to the illegal dumping of campervan toilet waste. Aside from the introduction of additional faecal bacteria and pathogens into the streams and the bay, campervan toilets also contain chemicals that prevent microbial activity and odour. These chemical are also likely to have a negative effect on the ecology in the streams. The Momorangi Bay campground has recorded some of the highest visitor numbers this year and with overseas visitor numbers forecast to be increasing, this issue will need to be dealt with. A possible option currently considered by DoC is allowing the disposal of this waste into a designated holding tank that will be emptied on a regular basis.

High Enterococci concentrations in late February (Figure 9) were likely related to localised heavy rainfall in the area in the preceding days. Although Waikawa recorded a relatively small amount of rain for the event (50.5 mm), raingauges to the west logged significantly larger rainfall amounts (eg; Rai Falls: 183.5mm). Enterococci concentrations were particularly high in Governors Bay, the highest value measured since monitoring began in 2012. In previous years, most guideline exceedances in Governors Bay were observed during dry weather conditions. This season however, all guideline exceedance were associated with rainfall. Apart from a DoC toilet, there are no other buildings in the catchment of the bay and wildlife sources are unlikely to result in Enterococci concentrations as high as those observed in March. The latest trend of increased Enterococci concentrations during and shortly after rainfall events needs to be investigated in future summer seasons.

Enterococci concentrations in Ngakuta Bay have been below guideline levels for the whole summer season, in fact, this is the third summer that Enterococci levels have not exceeded the guidelines. After elevated Enterococci concentrations in the years between 2010 and 2013 in Ngakuta Bay, bacteria levels have been declining in recent years. As a result the SFR Grade improved from ‘Fair’ to ‘Good’.

The problems with the Momorangi Bay sewerage system during the last two summer seasons have resulted in the reversal of the positive trend of reduced Enterococci concentrations in the years before (Figure 10). As a result, Momorangi Bay now has a SFR Grade of ‘Poor’, down from ‘Fair’.

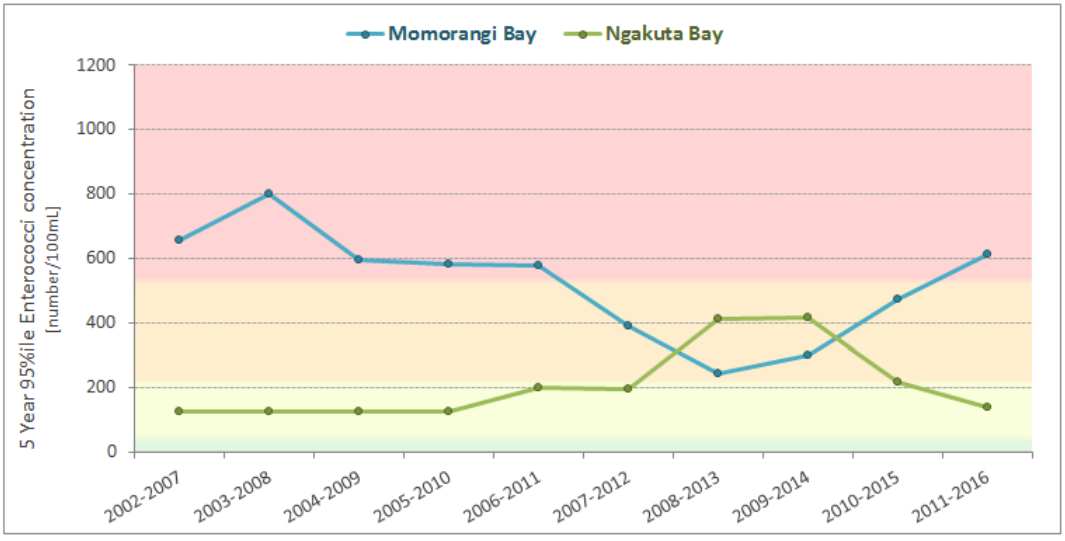


Figure 10: 5-year 95%ile Enterococci concentrations at Momorangi Bay and Ngakuta Bay.

The interim SFR Grade for Governors Bay is currently 'Good', but it might have to be downgraded if Enterococci concentrations continue to exceed guideline values on several occasions during a single summer season.

5.4. Picton Foreshore and Waikawa Bay

Sites

The Picton Foreshore is a relatively small beach area. Nevertheless, the close proximity to the Picton town center, the information center, the aquarium and a large playground make it a popular destination for local residents and visitors. The Picton Maritime Festival and other events result in large numbers of visitors to the beach. Waikawa Bay, on the other hand, is predominantly used by local residents.

The water quality of the Picton Foreshore and Waikawa Bay are both influenced by the urban environment that surrounds these sites. The substantially greater amount of residential development of the Picton Township is reflected in the generally poorer water quality at the Picton Foreshore.

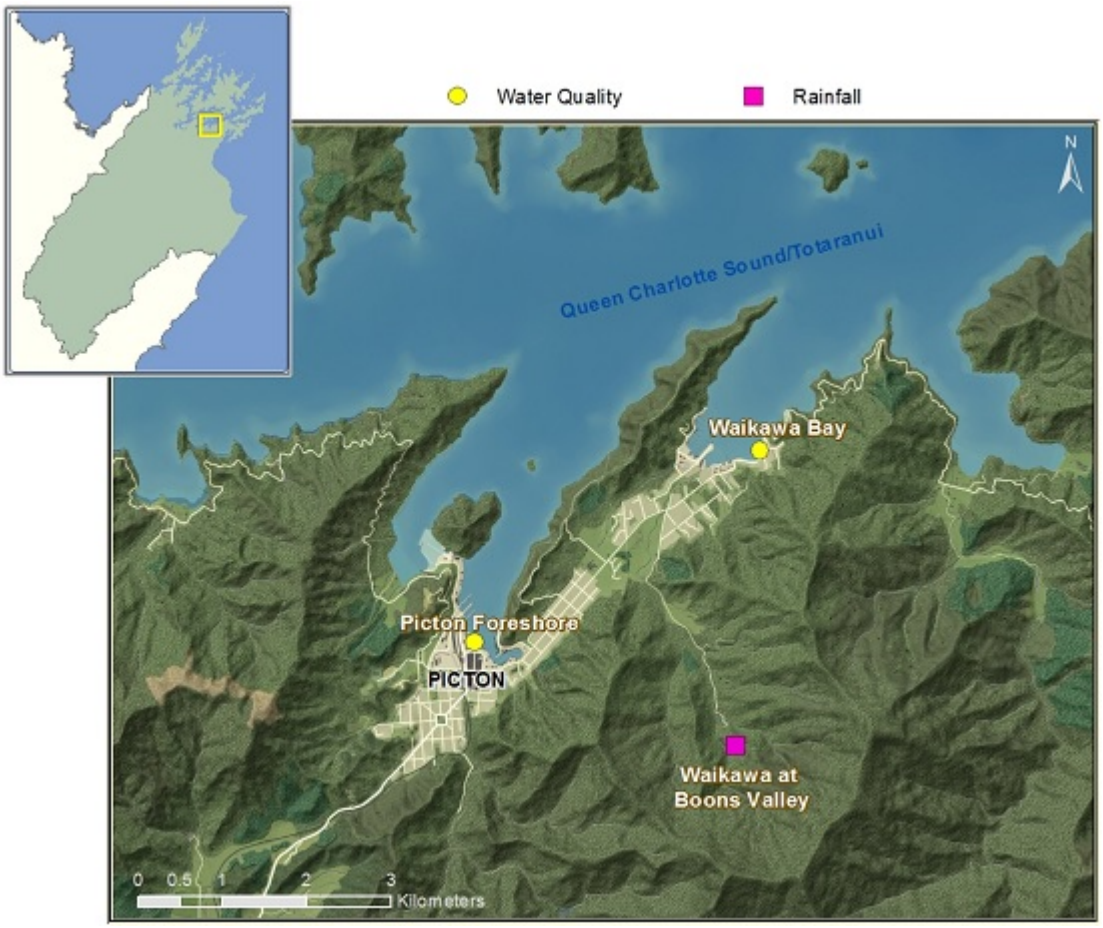


Figure 11: Locations of the Picton Foreshore and Waikawa Bay sampling sites as well as the rainfall recorder at Boons Valley.

Results

There were a number of guideline exceedances observed at the Picton Forshore this summer (Figure 12). An exceedance of the Alert Guideline in the first sample taken in November 2015 and an exceedance of the Action Guideline in January 2016 were both associated with rainfall in the area. The last two exceedances of the Action Guideline in March 2016 however, occurred during dry weather conditions. There have been dry weather exceedances in the past, but their sporadic nature makes investigating the source(s) difficult.

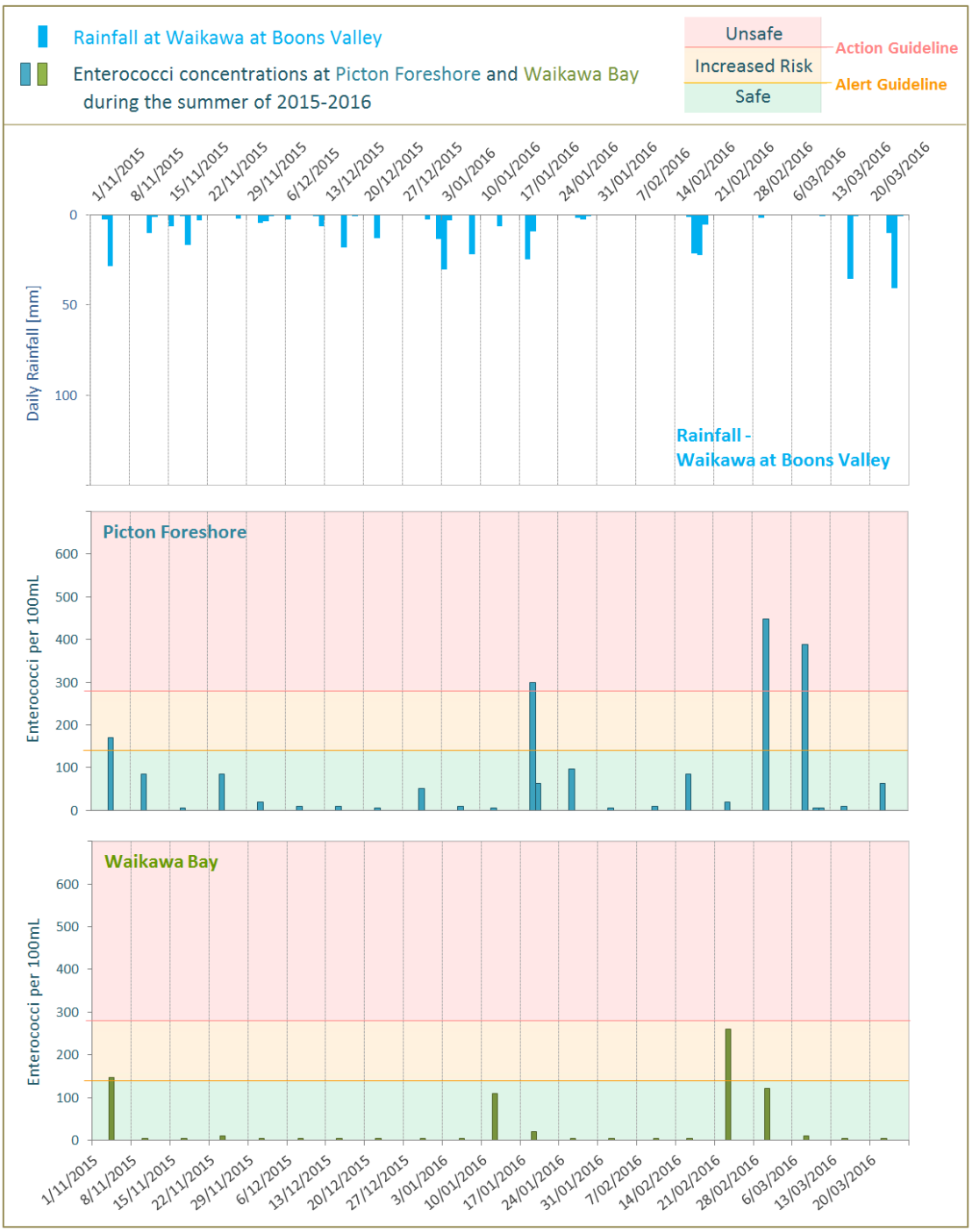


Figure 12: Enterococci concentrations at the Picton Foreshore and in Waikawa Bay during the summer season 2015/2016.

One possible source are faecal bacteria from previous contamination events that have survived within the beach sand, as was the case at Moetapu Bay (see Section 5.1). If that was occurring at Picton Foreshore, the highest Enterococci concentrations should coincide with high tide levels. However, the exact opposite was observed with increasing concentrations at low tides (Figure 13, left graph). In order to determine if this was a consistent pattern, results from the previous two seasons were analysed for tidal patterns, but no consistent relationship between elevated Enterococci concentrations and sea levels was observed (Figure 13, right graph).

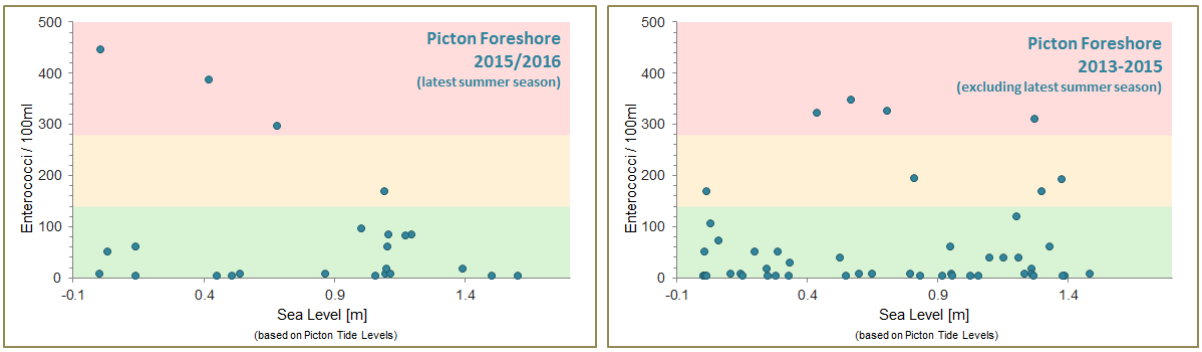


Figure 13: Enterococci concentrations at Picton Foreshore in relation to the sea level (tide) for the 2015/2016 season (left graph) and previous seasons (right graph).

Overall, Enterococci concentrations in Picton Foreshore have been declining in recent years and appear to have stabilised at a lower level (Figure 14). As a result the Picton Foreshore now has a SFR Grade of 'Fair', a considerable improvement from the SFR Grade of 'Very Poor' five years ago. This is the result of significant upgrades to the Picton sewerage system and detective work by council eliminating sewer damage and cross connections between the stormwater system and private sewerage connections in Picton.

In Waikawa Bay, Enterococci concentrations remained within levels considered safe for contact recreation during the whole of the summer season. Nevertheless, two samples exceeded the Alert Guideline. The first sample of the season with Enterococci concentrations slightly above the guideline was taken during rainfall. The second exceedance in mid-February was likely linked to localised heavy rainfall in some parts of the sounds the days before the sample was taken and coincided with high Enterococci concentrations at Governors Bay and Momorangi Bay.

There has been relatively little change in Enterococci concentrations since monitoring began in Waikawa Bay in 2002 and the relatively good recreational water quality is reflected in the SFR Grade of 'Good'.

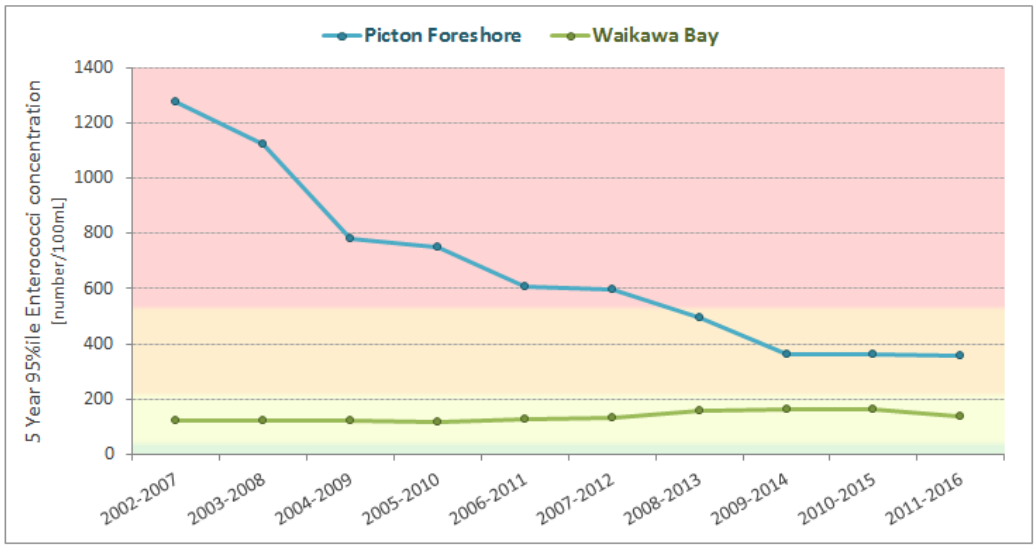


Figure 14: The 5-year upper 95%ile Enterococci concentrations for Picton Foreshore and Waikawa Bay.

5.5. Pukatea/Whites Bay and Waikutakuta/Robin Hood Bay

Sites

Pukatea/Whites Bay and Waikutakuta/Robin Hood Bay are located along the upper East Coast of the region. Pukatea/Whites Bay is one of the most popular beaches in Marlborough. A DoC campground is the only human impact in the bay and consequently water quality is generally very good. Waikutakuta/Robin Hood Bay, located only a few kilometres north of Pukatea/Whites Bay also offers a campground, but has a much larger catchment. Several streams flow into the bay. The largest, Stace Creek, drains 90ha of pasture, which has a potential to affect the water quality in the bay. Waikutakuta/Robin Hood Bay is sampled at two sites, a surf beach on the Southwest side of the Bay and a swimming beach on the Northeast side, which is also used to launch boats.

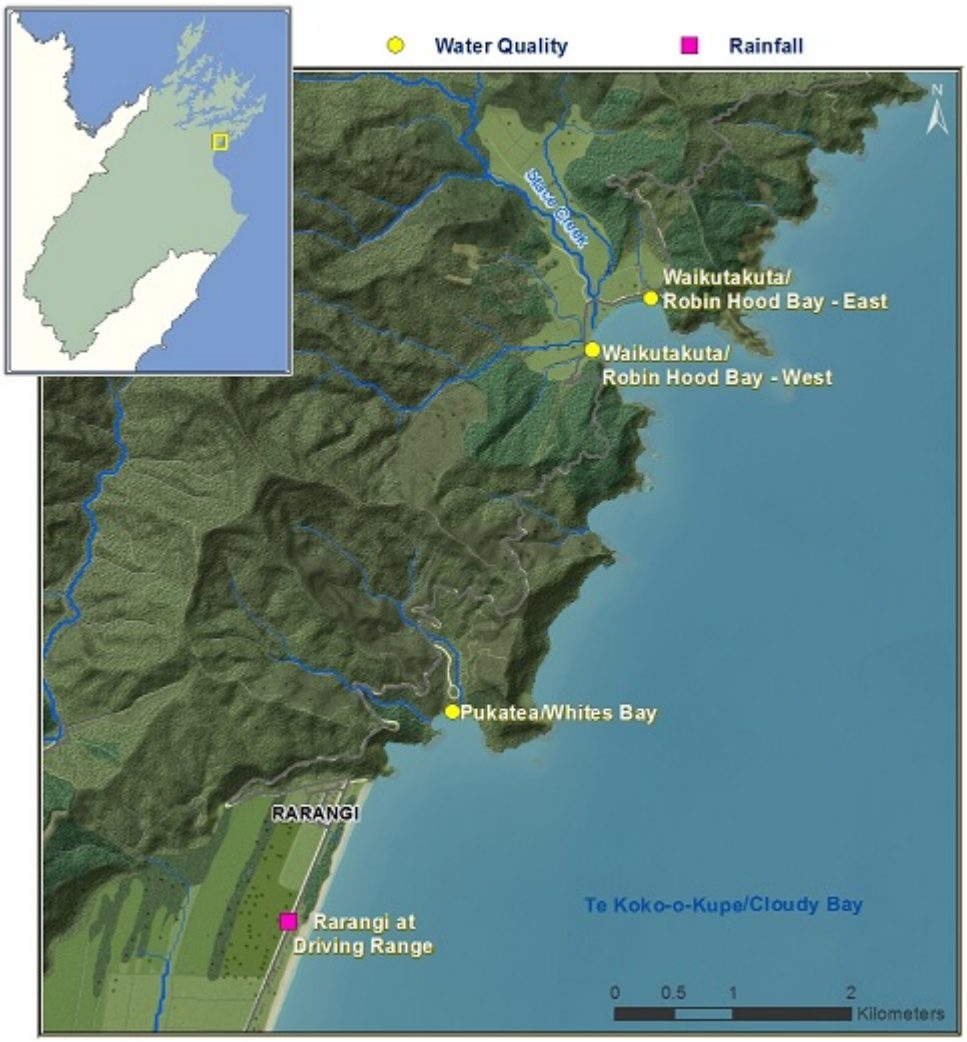


Figure 15: Locations of the Puketea/Whites Bay sampling site and the two Waikutakuta/Robin Hood Bay sampling sites, as well as the Rarangi rainfall recorder.

Results

Enterococci concentrations in Pukatea/Whites Bay have again been very low during the whole summer season (Figure 16). The last sample with Enterococci concentrations above the Action Guideline was taken more than three years ago. Despite the large number of visitors each summer Pukatea/Whites Bay remains one of the sites with the best recreational water quality in the region. This is reflected in the SFR Grade of 'Very Good' and little change in MAC values observed over the years (Figure 17)

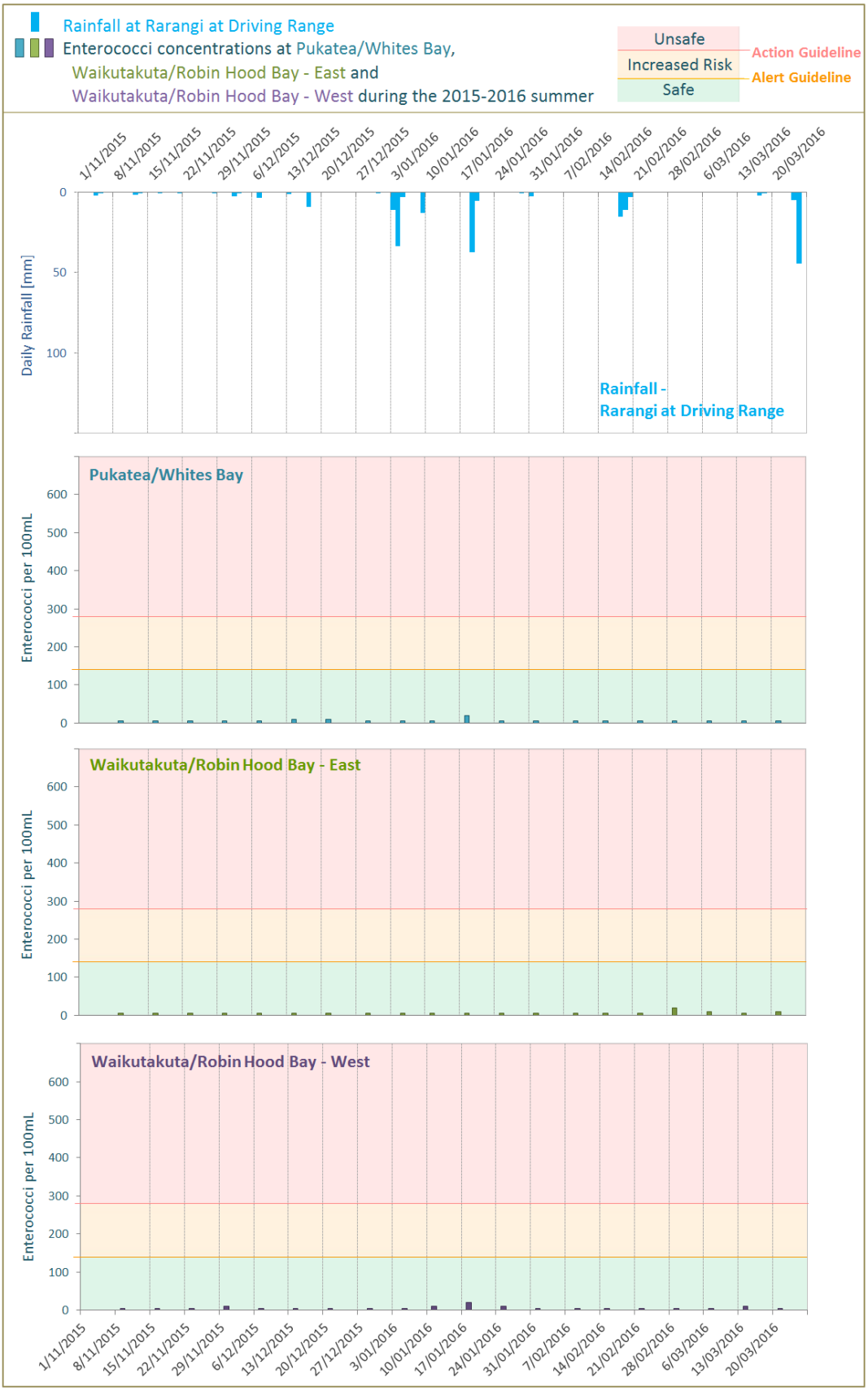


Figure 16: Enterococci concentrations in Pukatea/Whites Bay and Waikutakuta/Robin Hood Bay during the summer season 2015/2016.

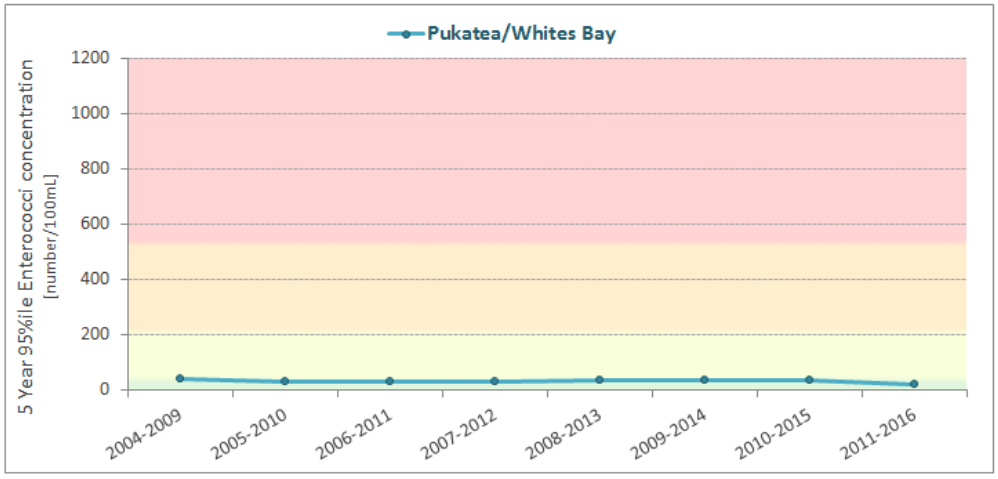


Figure 17: The 5-year upper 95%ile Enterococci concentrations for Pukatea/Whites Bay.

Enterococci concentrations were also extremely low in Waikutakuta/Robin Hood Bay this summer. This is the second summer season with Enterococci concentrations consistently close to the detection limit. When monitoring of the two sites began in 2012, Enterococci concentrations were exceeding guideline levels during rainfall. This was likely caused by run-off from the pastoral catchments of Stace Creek and other smaller creeks. During longer dry spells a gravel and sand bar builds up along the beach eventually blocking off the direct flow of the creeks into the bay (Figure 18). Subsequently, the sand bar filters the creek water, removing some of the microbiological organisms, including faecal bacteria, resulting in improved water quality. There have been no large floods removing the sand bar in the last two summers and this natural filtering system remained in place for most of the time. This is likely the cause for the very low Enterococci concentrations observed. Anecdotal evidence also suggests that there have been significantly fewer cattle on the pastures adjacent to Stace Creek.

Both Waikutakuta/Robin Hood Bay sites have 5-year 95%ile values within the B band of the MAC categories. However, the West site is located in close proximity to the outflow of Stace Creek and therefore has a greater potential for faecal contamination from the pastoral land use in the catchment. As a result the Western site has an interim SFR Grade of ‘Good’, while Waikutakuta/Robin Hood Bay – East has an interim SFR Grade of ‘Very Good’.

Figure 18: Arial Photograph showing the gravel and sand bar (light pink shading) at Waikutakuta/Robin Hood Bay blocking the flow of Stace Creek and a other smaller creeks.

5.6. Marfells Beach

Site

Marfells Beach is the most southern sampling site, located on the lower East Coast of the region. There are no large rivers or streams flowing into the sea close to the site. Consequently, the surrounding low intensity pastoral farming has little effect on water quality. A popular DoC campground is located next to the beach and there are usually more than 100 seagulls on the beach.

Figure 19: Map showing the location of the Marfells Beach sampling site and Flaxbourne rainfall recorder.

Results

Enterococci concentrations at Marfells Beach were again low during the summer months (Figure 20) and have remained below guideline levels since the only exceedance observed for this site occurred more than 5 years ago. The large size of the beach combined with the exposure to the open sea mean that potential local sources, such as the large number of seagulls, have little impact on recreational water quality. Together with Pukatea/Whites Bay, Marfells beach has the best recreational water quality of all sites monitored as part of the program.

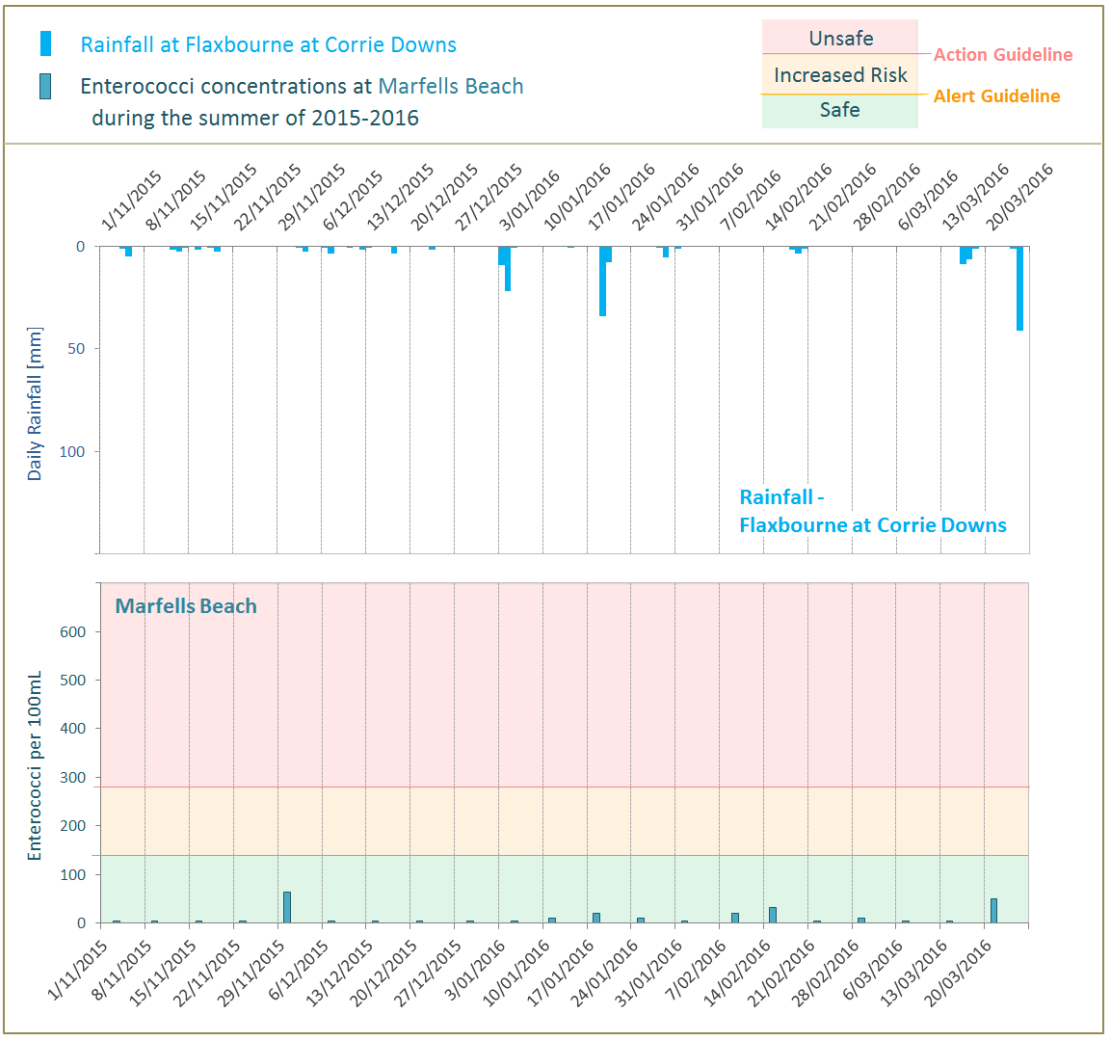


Figure 20: Enterococci concentrations at Marfells Beach during the 2015/2016 summer season.

The 5 year-95%ile Enterococci concentrations have been consistently low since monitoring began in 2007 (Figure 21) and the site has maintained a SFR Grade of 'Very Good'.

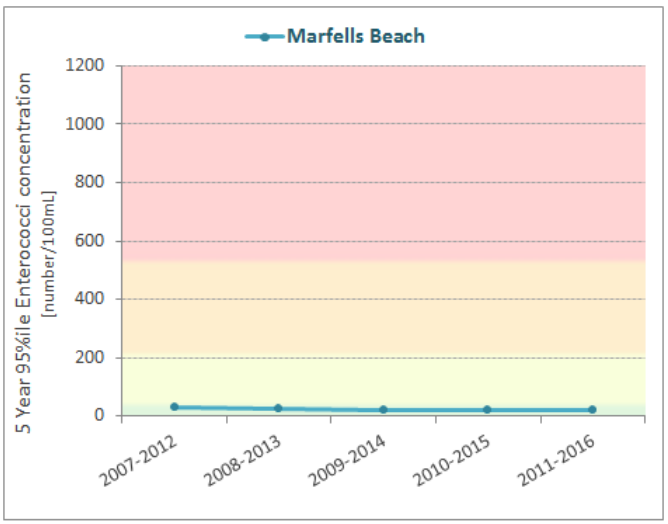


Figure 21: 5-year upper 95%ile Enterococci concentrations for Marfells Beach.

5.7. Rai River and Te Hoiere/Pelorus River

Sites

The Te Hoiere/Pelorus River has two popular swimming sites that are sampled as part of the Recreational Water Quality program, Pelorus Bridge and Totara Flat. The Rai River, which is sampled at the Rai Falls, flows into the Te Hoiere/Pelorus River between the two sites, approximately 300m upstream of Totara Flat. Subsequently, water quality at Totara Flat is strongly influenced by the water quality of the Rai River.

Figure 22: Locations of the Te Hoiere/Pelorus and Rai River sampling sites as well as nearby rainfall and flow recorders.

Results

All exceedances of guideline levels for the sites on the Rai and Te Hoiere/Pelorus Rivers observed this summer season were linked to rainfall in the catchments on the day the samples were taken (Figure 23). In the past, E. coli concentrations in the Rai River were occasionally exceeding guideline levels during dry conditions also. This was of concern, because it made the assessment of the risk of potential faecal contamination difficult, as the water usually appeared quite clear. The elimination of most dairy crossings and increased fencing to prevent dairy cattle accessing the waterways, have resulted in a significant reduction in E. coli concentrations (Figure 23). Most importantly, E. coli concentrations are now consistently below guideline levels during dry weather. Nevertheless, E.coli levels remain generally elevated when compared to levels observed in the Te Hoiere/Pelorus River so more improvement is possible.

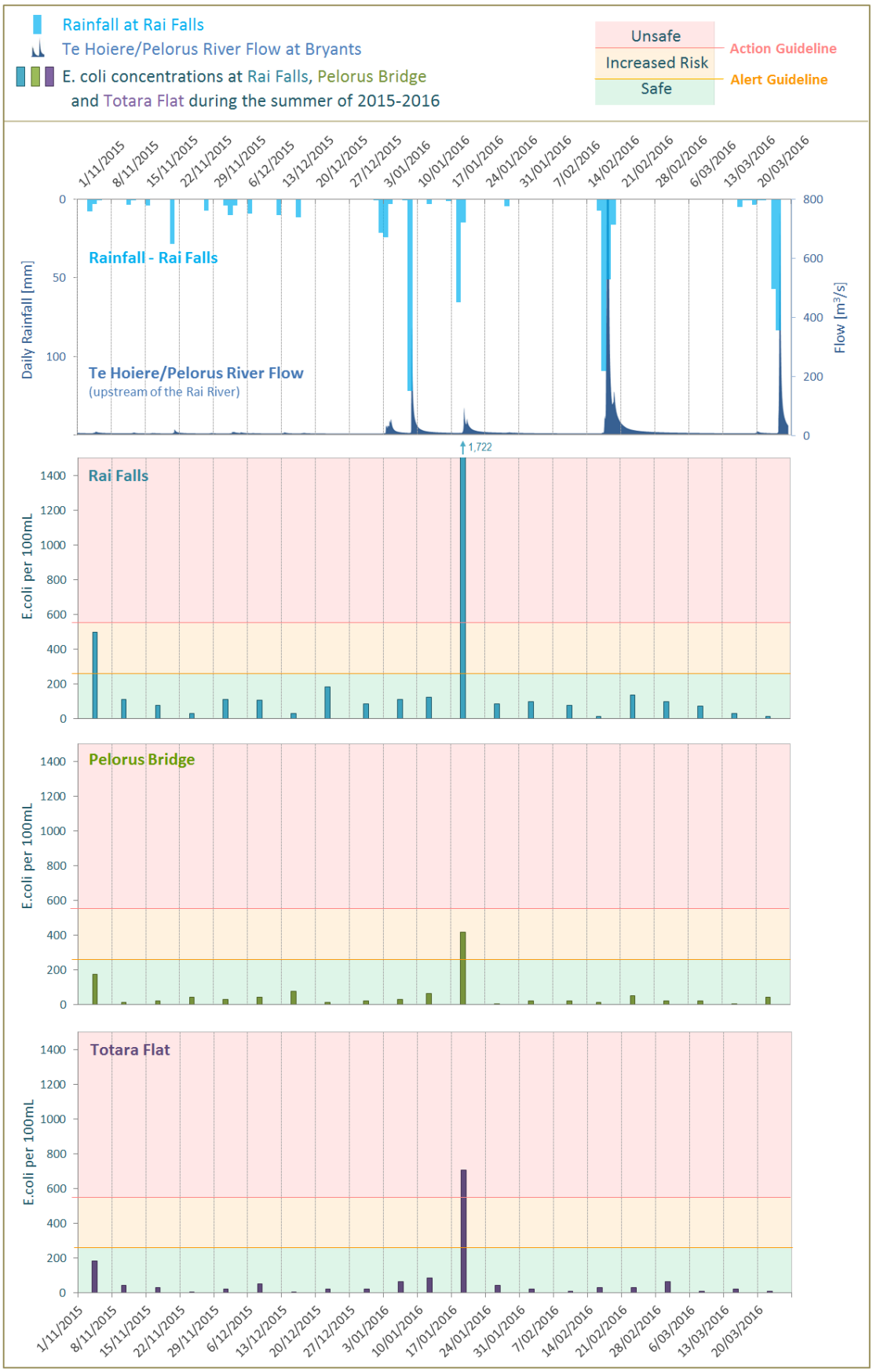


Figure 23: E. coli concentrations in the Rai and Te Hoiere/Pelorus Rivers during the summer season 2015/2016.

As outlined in earlier reports, the reduction in E. coli concentrations in the Rai River have led to improved recreational water quality in the Te Hoiere/Pelorus River at Totara Flat downstream of the confluence of Rai River.

The lower E. coli concentrations at Rai Falls and Totara Flat observed in recent years are reflected in lower 5-year 95%ile values (Figure 24). As a result the SFR Grades of both sites have improved, from 'Very Poor' to 'Poor' for the Rai Falls and from 'Poor' to 'Fair' for Totara Flat. The recreational water quality of the Te Hoiere/Pelorus River at Pelorus Bridge remains good, which is reflected in the SFR Grade of 'Good' for this site.

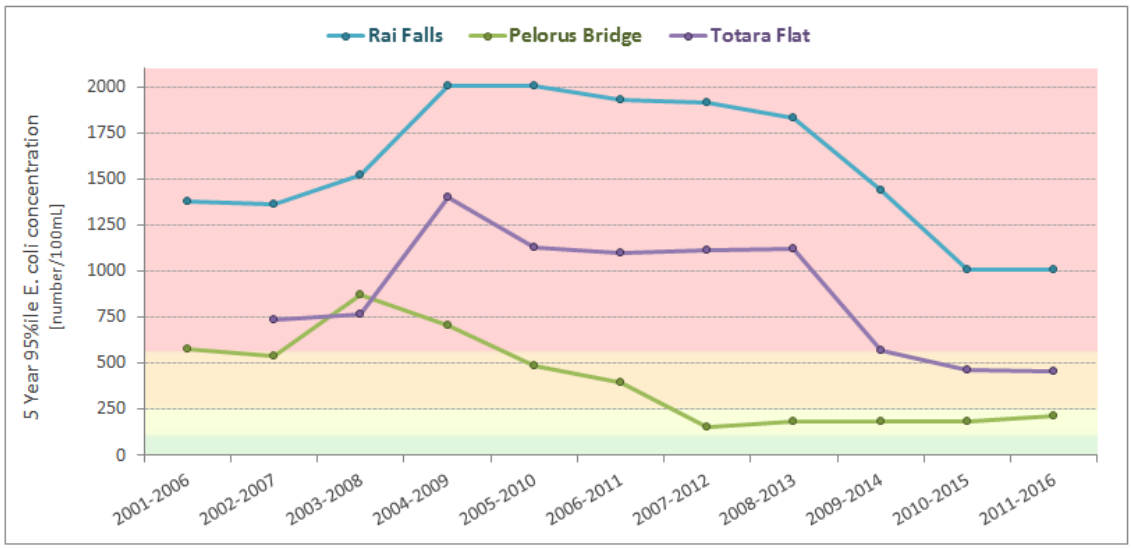


Figure 24: 5-year upper 95%ile E. coli concentrations of the Rai and Te Hoiere/Pelorus River sampling sites.

Figure 25: Te Hoiere/Pelorus River at Pelorus Bridge.

5.8. Waihopai River

Site

The Waihopai River swimming hole at the Craiglochart #2 Bridge is particularly popular with local residents. Often there will be nobody at the site when samples are taken, but it is known that school groups and families use the site frequently, especially in the weekends. Over a quarter of the catchment area has been converted to pasture, but grazing is mostly of low intensity.

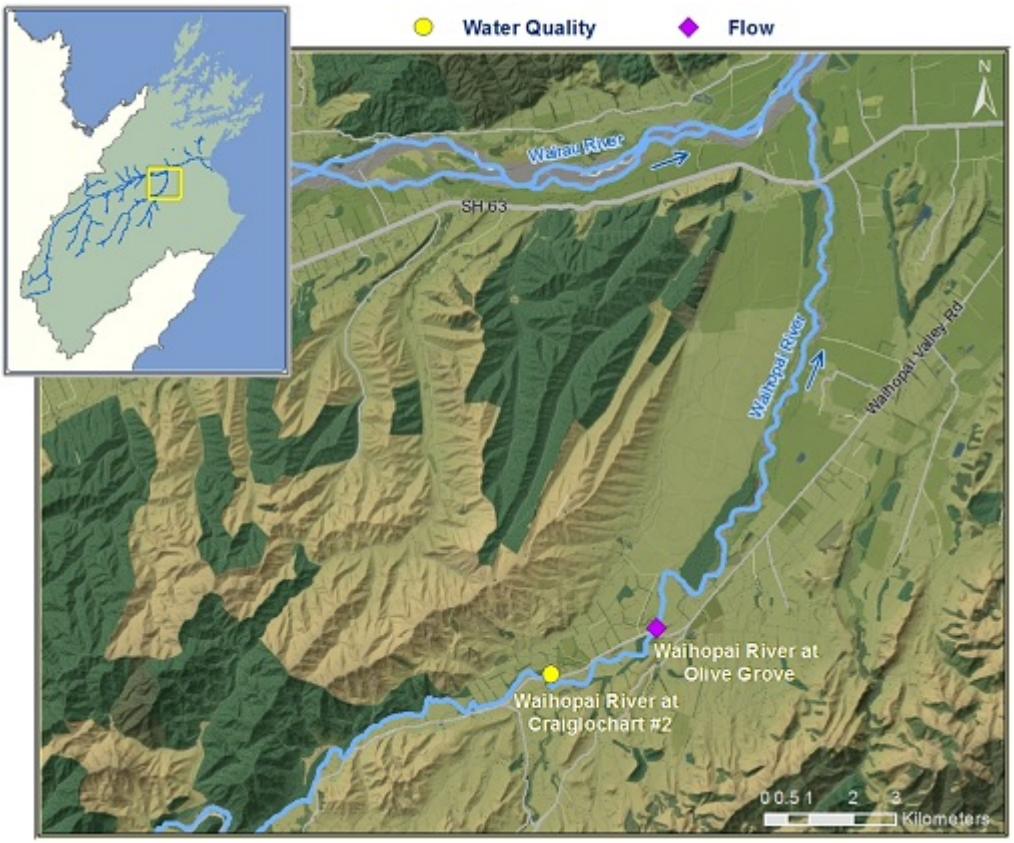


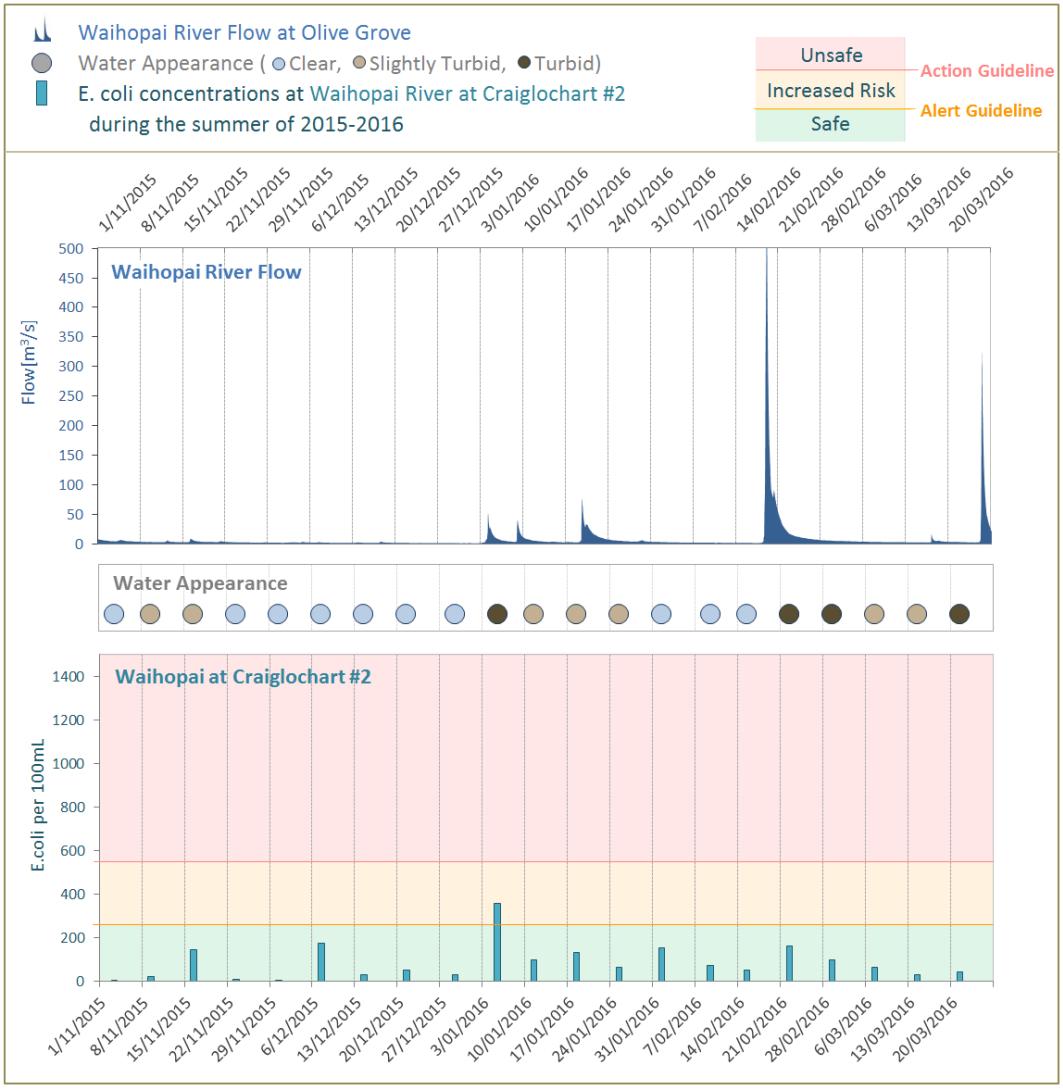
Figure 26: Location of the Waihopai River sampling site and the flow recorder.

Results

The only sample with E. coli concentration above guideline levels was taken during a small fresh in early January (Figure 27, top). The water was turbid when the sample was taken (Figure 27) and it is unlikely the site was used for swimming at the time. The Waihopai catchment is prone to localised heavy rainfall in the form of thunderstorms that often only affects relatively small parts of the catchment. Rainfall in an area of pastoral farming is likely to result in higher E. coli concentrations when compared to an area dominated by shrub and tussock. This is the reason for the large variation in E. coli concentrations following rainfall events in the Waihopai River.

Generally, there is no clear relationship between the water appearance and the concentration of E. coli at this site. Due to a relatively high proportion of mudstone in the geology, large parts of the catchments are naturally prone to erosion. Heavy rainfall frequently causes small slips along the banks of the river. The material from these slips is very fine and causes turbid water for the whole length of the river downstream. Additionally, because the slip material is usually removed relatively slowly by the river, the water stays turbid for extended periods after the rain has cease. Therefore, while the duration of rainfall can be quite short, the river is turbid for much longer.

The 5-year 95%ile values have been showing an increasing trend after many years of decreasing E. coli concentrations (Figure 27, bottom). The relatively low E. coli levels observed during this summer season have resulted in a slight reversal of the trend, back to lower levels. Nevertheless, the site now has a MAC within the D band, resulting in a SFR Grade of ‘Poor’ (previously ‘Fair’).



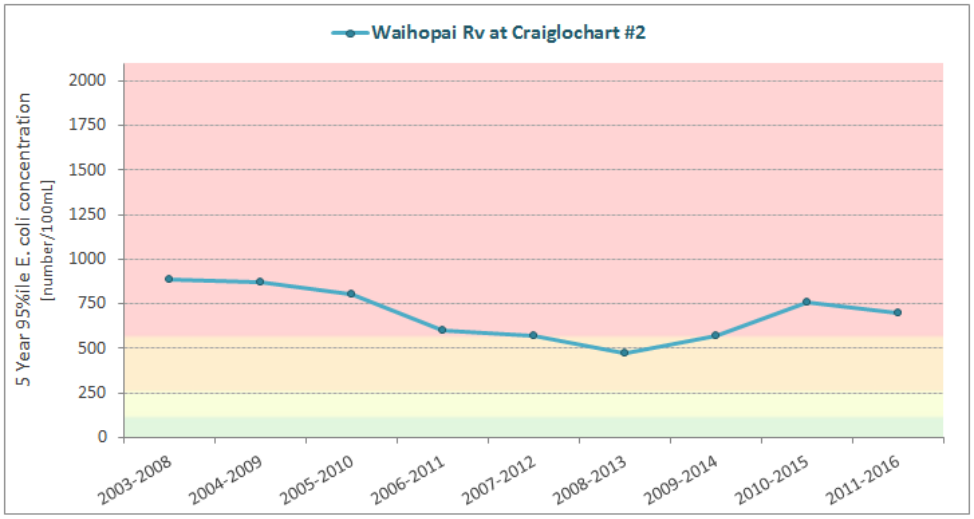


Figure 27: Top: E. coli concentrations in the Waihopai River at Craiglochart #2 during the 2015/2016 summer season (also shown is the water appearance as noted during sampling); Bottom: 5-year upper 95%ile E. coli concentrations for the same site.

5.9. Wairau River

Sites

There are three sites located along the Wairau River that are sampled as part of the Recreational Water Quality program. The two sites located furthest downstream, Ferry Bridge and Blenheim Rowing Club, have been part of the program for some time, while the site at the State Highway Six Bridge was added relatively recently as a result of a beach usage survey carried out in 2012 [3].

Figure 28: Location of the three Wairau River sampling sites and the Wairau River flow recorder.

Results

This summer, exceedances of guideline levels in the Wairau River occurred exclusively at the site located at Ferry Bridge. None of the exceedances were related to increased river flows or rainfall and did not coincide with higher E. coli concentrations at the other Wairau River sites. This strongly points to local sources as the predominant cause. However, E. coli concentrations are too low for genetic analysis, which would narrow down investigative efforts. Without this information, the most likely sources are associated with the behaviour of some of the recreational users themselves. It is not uncommon to find rubbish, including used nappies, at the site close to the water's edge and, on occasion, in the water itself. Additionally, dogs are frequently seen at the site and faeces can sometimes be found in close proximity to the water. This is not a new problem, but this summer has been the worst in regard to non-rainfall related exceedances. Fortunately, E. coli concentrations were within levels considered safe for contact recreation in all samples taken, but it is possible that unsafe levels were reached in the days between sampling occasions.

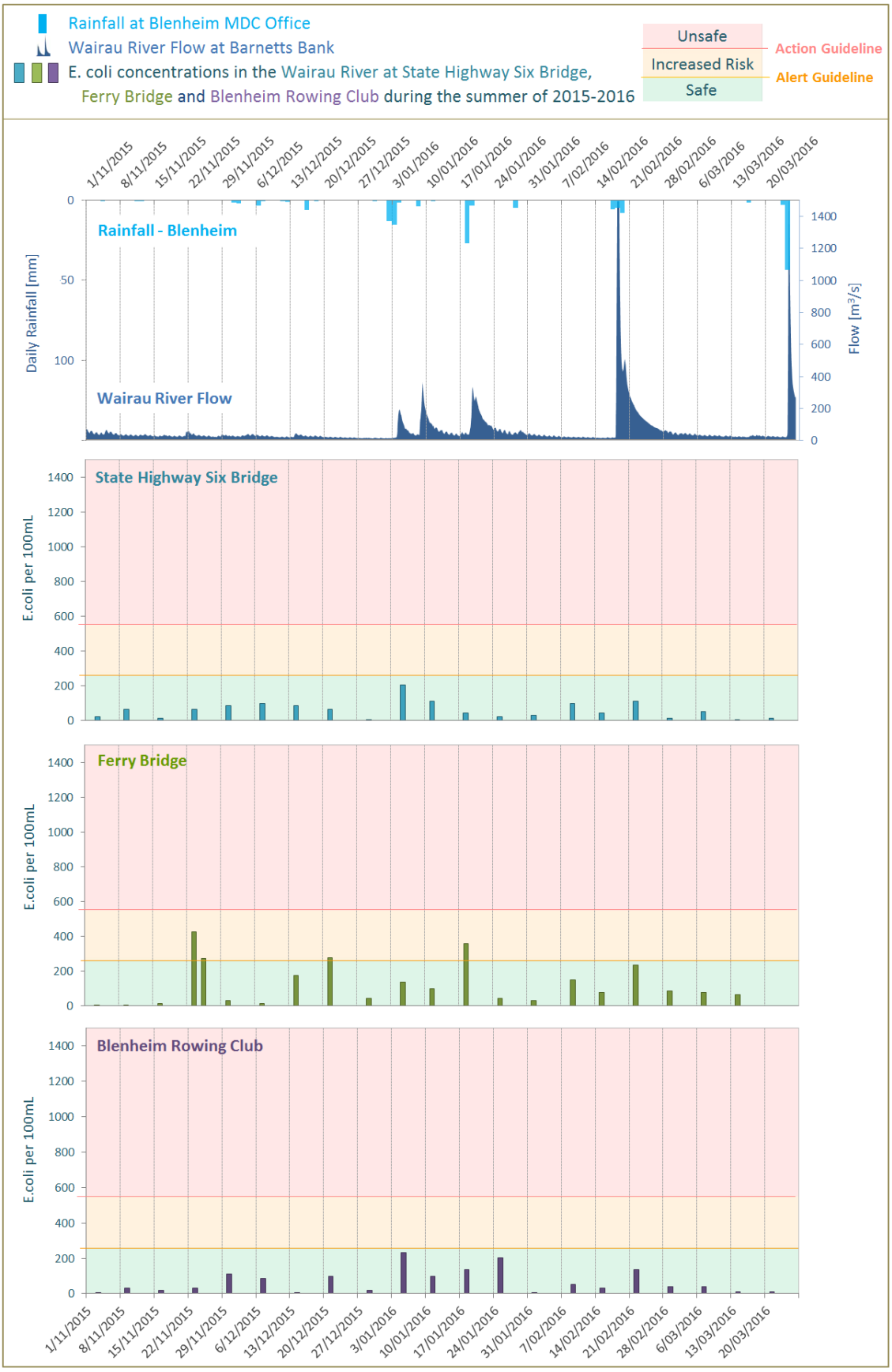


Figure 29: E. coli concentrations at the three Wairau River sampling sites during the 2015/2016 summer season.

The generally higher E. coli concentrations at Ferry Bridge are reflected in the higher 5-year 95%ile (Figure 30) and subsequently a lower SFR Grade of 'Fair', compared to a SFR Grade of 'Good' for the Wairau River at Blenheim Rowing Club. The interim SFR Grade for the SH6 site is 'Fair', mainly due to higher E. coli concentrations in the early years of sampling. During the last two summer seasons E. coli concentrations at the SH6 site have been considerably lower and are now comparable to those observed at the Blenheim Rowing Club.

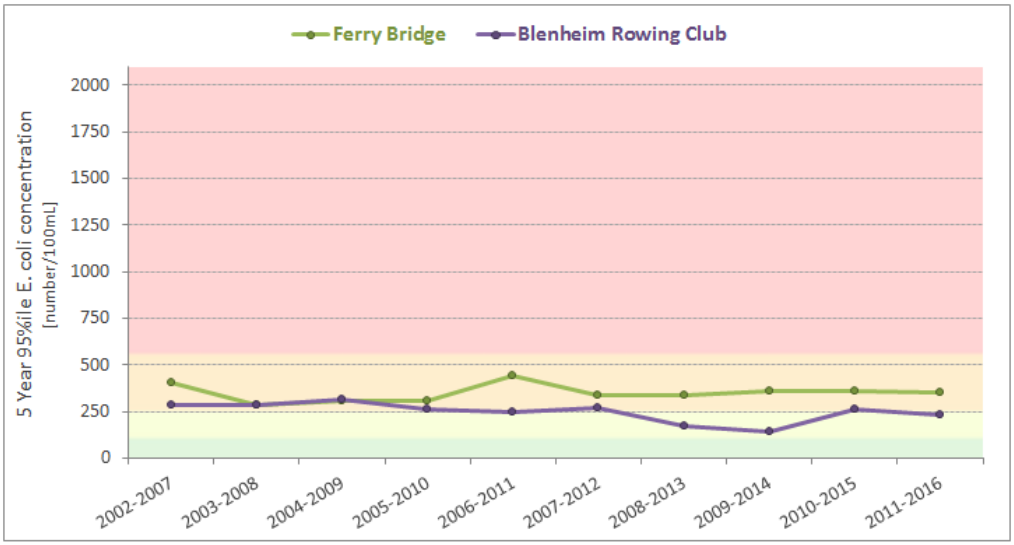


Figure 30: 5-year upper 95%ile E. coli concentrations for the Wairau River at Ferry Bridge and Blenheim Rowing Club.

Figure 31: Lower Wairau River near the Blenheim Rowing Club.

5.10. Taylor River and Ōpaoa River

Sites

The Taylor River at Riverside is one of the popular features of the Blenheim town centre with a small amphitheatre-type area providing a shaded resting place with a view of the Taylor River. It is also a popular spot to feed ducks and an access point to the Riverside Park with walkways along and across the Taylor River.

The Ōpaoa River at Elizabeth St Bridge is sampled as a representative site for primarily private access of the river from the many properties located along its banks, but public access is possible in a number of areas and both, the Ōpaoa and Taylor River are popular for relaxing kayaking trips.

Both sampling sites are located in Blenheim and are therefore heavily influenced by their urban environment. Although both rivers also flow through rural areas, the agricultural land use in the catchment appears to have limited impact on the recreational water quality at the sites.

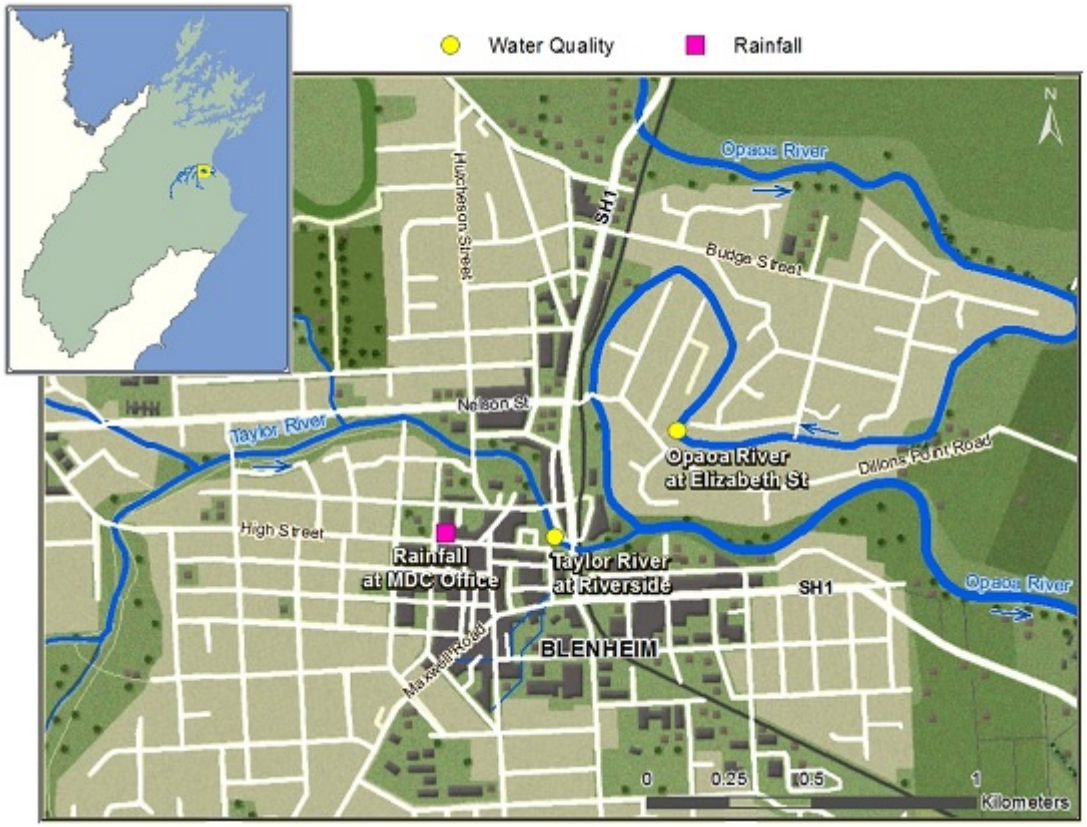


Figure 32: Location of the Taylor River and Ōpaoa River sampling sites as well as the Blenheim MDC rainfall recorder.

Results

High concentrations of faecal bacteria in the Taylor River mainly occurred during low flows and warning signs were placed around the site for most of the second half of the summer. Unsafe E. coli concentrations in the Taylor River during long dry spells have been a regular occurrence in recent summers. Nonetheless, the sample with the highest E. coli concentration was taken in mid-January during rainfall, which was washing dog and duck faeces from the banks into the waterway. Unfortunately the amount of rain that fell during the event was not enough to stop the development of low flow conditions and further exceedances of the E. coli guidelines later in the month (Figure 33).

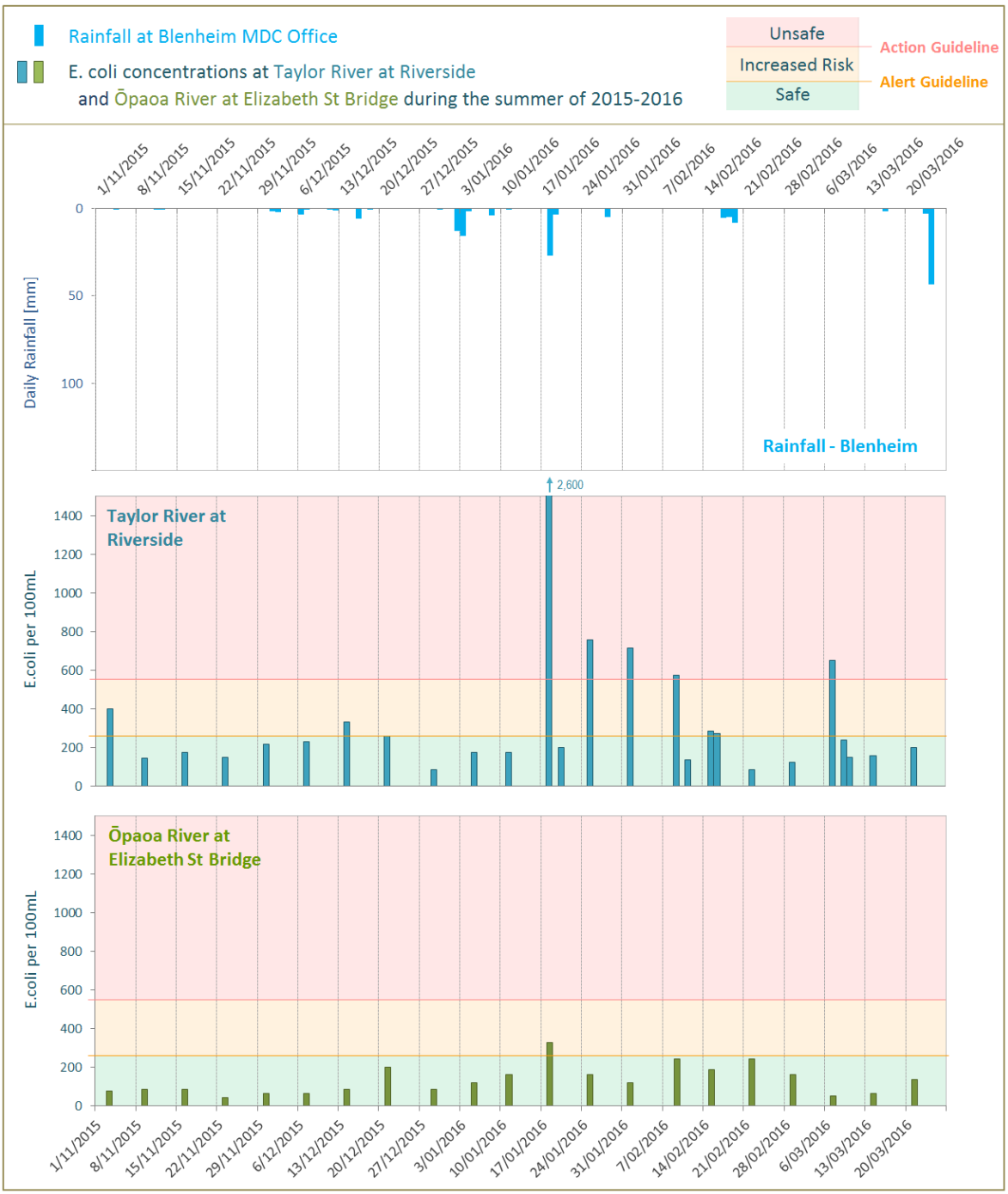


Figure 33: E. coli concentrations in the Taylor River at Riverside and Ōpaoa River at Elizabeth St Bridge during the 2015/2016 summer season.

Figure 34 shows the results of additional investigative sampling that was carried out during low flow conditions in January 2015 (previous summer season) and in February 2016. In order to narrow down the source of faecal contamination around the Riverside area, samples from a number of upstream sites as well as a downstream site were taken within a short time period. This part of the Taylor River is affected by tide levels. Although saltwater does not reach this far upstream, the water level and to a degree the flow direction is influenced. This means that upstream as well as downstream sources can potentially influence water quality at the site.

Unfortunately, the investigations did not manage to capture events with recreational water quality unsafe for contact recreation. Nevertheless, the results give some insight into general patterns of E. coli concentrations. Average bacteria concentrations (Figure 34, thick lines) appear to show

consistent patterns with lower values immediately upstream and downstream of the Riverside site. This strongly points to local sources at or very close to the Riverside sampling site. However, the results for the individual sampling runs (Figure 34, thin lines) also show that this pattern is not very consistent. It can also be seen that the Riverside site shows the greatest range of E. coli concentrations, indicating a highly variable source.

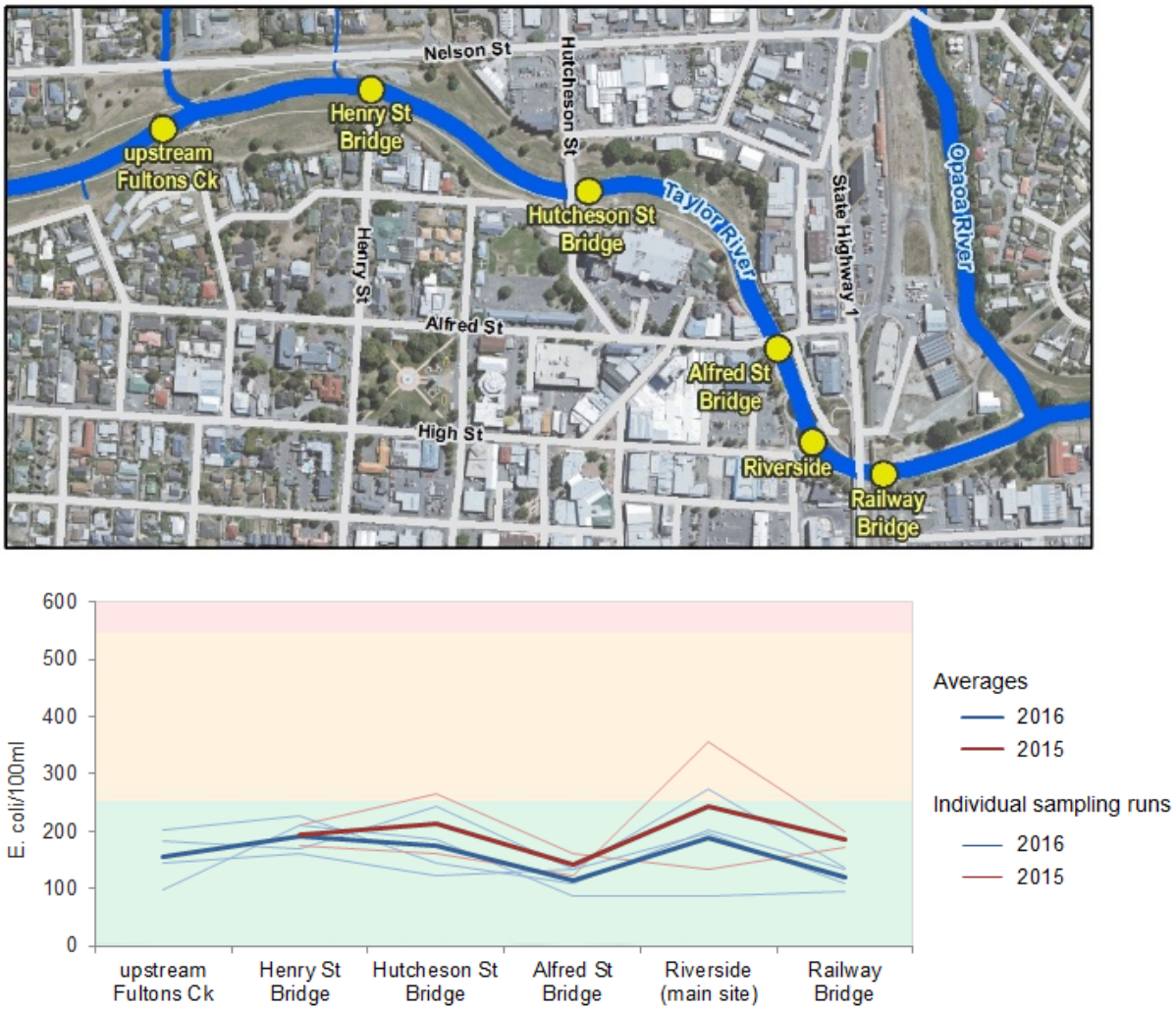


Figure 34: Results of additional sampling of site upstream and downstream of the Riverside sampling site. The sampling was conducted during low flow conditions in January 2015 and February 2016.

The results of these investigations, together with field observations point to ducks as the main source of faecal contamination at the Riverside site. The site is a popular duck feeding spot and although duck numbers are not extremely high (30-60), the birds are concentrated in a relatively small area of the river. Results of genetic source tracking of samples with similar E. coli concentrations carried out in 2013 [5][5] support this idea.

Nevertheless, it is still unclear, if unsafe recreational water quality is also a result of duck faeces as the E. coli concentrations in the investigations have been less than half of those observed in samples exceeding the Action Guideline. Ducks have resided on the Taylor River for quite some time, but the very high E. coli concentrations during low flows are a relatively recent occurrence, marked by a sharp increase in the 5-year 95%ile E. coli concentrations after 2010 (Figure 35). Further studies are

[5] The genetic analysis of bacteria and bacteroids in the sample found dogs and ducks were the main source of faecal contamination at the site.

necessary to answer this question in order to allow suitable management of the poor recreational water quality of the Taylor River. The Taylor River at Riverside is now the only site monitored as part of the Recreational Water Quality program with a SFR Grade of 'Very Poor'.

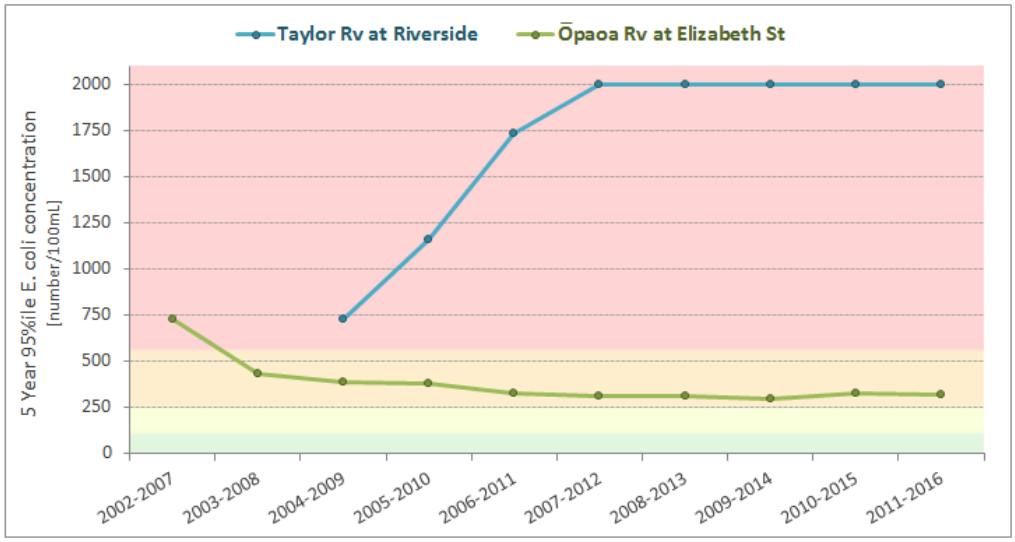


Figure 35: 5-year 95%ile E. coli concentrations in the Taylor River at Riverside and the Ōpaoa River at Elizabeth St Bridge.

In the Ōpaoa River at Elizabeth St, E. coli concentrations were generally elevated, which is consistent with observations in previous summers. Nevertheless, E. coli concentrations at this site rarely reach unsafe levels, which can be seen from the results of this summer season with no exceedences of the Action Guideline. The 5-year 95%ile E. coli concentrations in the Ōpaoa River at Elizabeth St have not changed significantly in recent years (Figure 35). The site has a SFR Grade of 'Fair'.

6. Result Summary

More than half of the 21 sites monitored as part of the Recreational Water Quality program had faecal indicator bacteria concentrations that were below unsafe levels in all samples taken (Figure 36). As in previous years, most of the sites with good recreational water quality were coastal beaches, in particular Marfells Beach and Pukatea/Whites Bay. The two sites monitored in Waikutakuta/Robin Hood Bay had very low faecal bacteria concentrations, which were significantly lower than in 2012/2013 when monitoring of these sites began. This can mainly be attributed to the build-up of a sand bar blocking to flow of creeks into the bay. This sandbar filters the creek water, providing a natural mitigation of the impact of farming in the catchment. In the earlier years, the sand bar was frequently removed during flood flows, which is likely to re-occur in the future. This means that the very good recreational water quality in Waikutakuta/Robin Hood Bay is potentially only temporary in nature.

Another site with improved recreational water quality has been Ngakuta Bay. This is the third year that none of the samples taken from this bay had Enterococci concentrations above guideline levels. This is reflected in the improvement of the SFR Grade from 'Fair' to 'Good' (Figure 37).

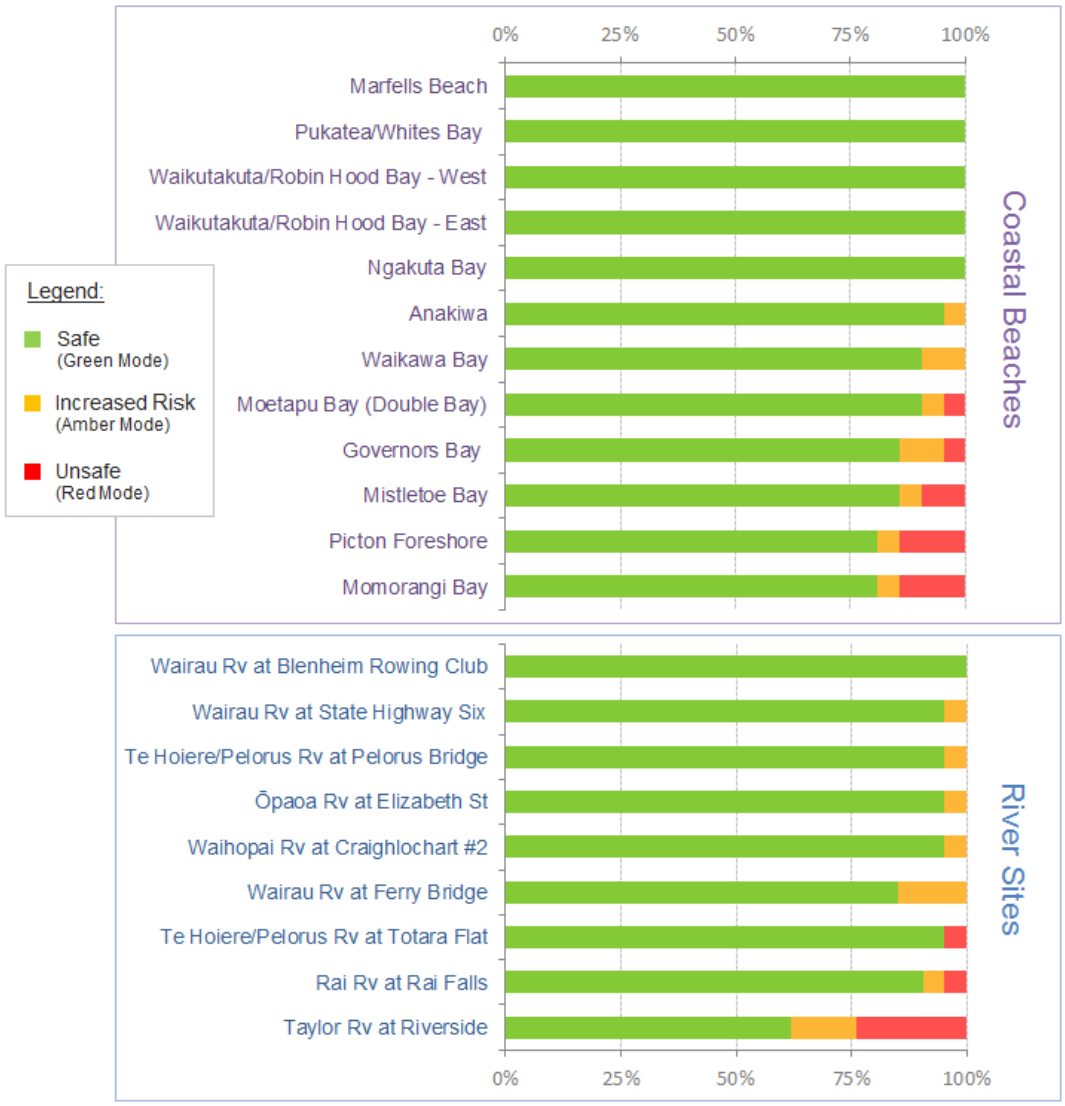


Figure 36: Percentage of routine samples within the different Modes (Green =Safe, Amber = Increased Risk, Red = Unsafe) for all sites sample during the 2015/2016 summer season.

Anakiwa and Mistletoe Bay were two coastal sites for which the review of the SFR Grades resulted in a lower grade. Both Anakiwa and Mistletoe Bay now have a SFR Grade of 'Fair'. While Enterococci concentrations in Anakiwa have only slightly increased, faecal bacteria concentrations in Mistletoe Bay have risen significantly. Very high concentrations are mainly observed during and shortly after rainfall events. Investigations at the site found, that Enterococci concentrations are particularly high in, and downstream of a pond connected to one of the streams flowing into the bay. The Mistletoe Bay Trust is currently working on eliminating this source of contamination.

Exceedances of guideline levels in Moetapu Bay were the result of a large Te Hoiere/Pelorus River flood. Although, faecal bacteria concentrations in the river had dropped relatively quickly following the flood, Enterococci concentrations at Moetapu Bay continued to occasionally exceed guideline levels. The data analysis showed that the highest concentrations were associated with high tides pointing to fine sediment deposited along the beach during the flood event as the source of the long lasting faecal contamination.

The two coastal sites with the worst recreational water quality were Picton Foreshore and Momorangi Bay. This is the second summer that problems with the sewerage system of the Momorangi Bay campground have caused high Enterococci concentrations. The bay now has the lower SFR Grade of 'Poor', a decline from the previous 'Fair' grade.

The 2014 review of SFR Grades resulted in Picton Foreshore gaining a SFR Grade of 'Poor', up from a 'Very Poor' grade. Additional upgrades and repairs to the Picton sewerage system have resulted in further decreases of Enterococci concentrations in recent years, reflected in the results of this year's review. Picton Foreshore now has a SFR Grade of 'Fair'.

Of the river sites sampled as part of the program, only the Wairau River at Blenheim Rowing Club had E. coli concentrations consistently below guideline levels. Five of the other river sites had elevated E. coli levels indicating an increased risk, but not unsafe recreational water quality. Only three sites had at least one sample with unsafe E. coli concentrations.

The worst recreational water quality was observed in the Taylor River at Riverside. This site is now the only site in the program with a SFR Grade of 'Very Poor'. Investigations point to local sources, most likely ducks, for slightly elevated E. coli concentrations, but it is still unclear if other sources contribute to the very high concentrations occasionally observed during low flows.

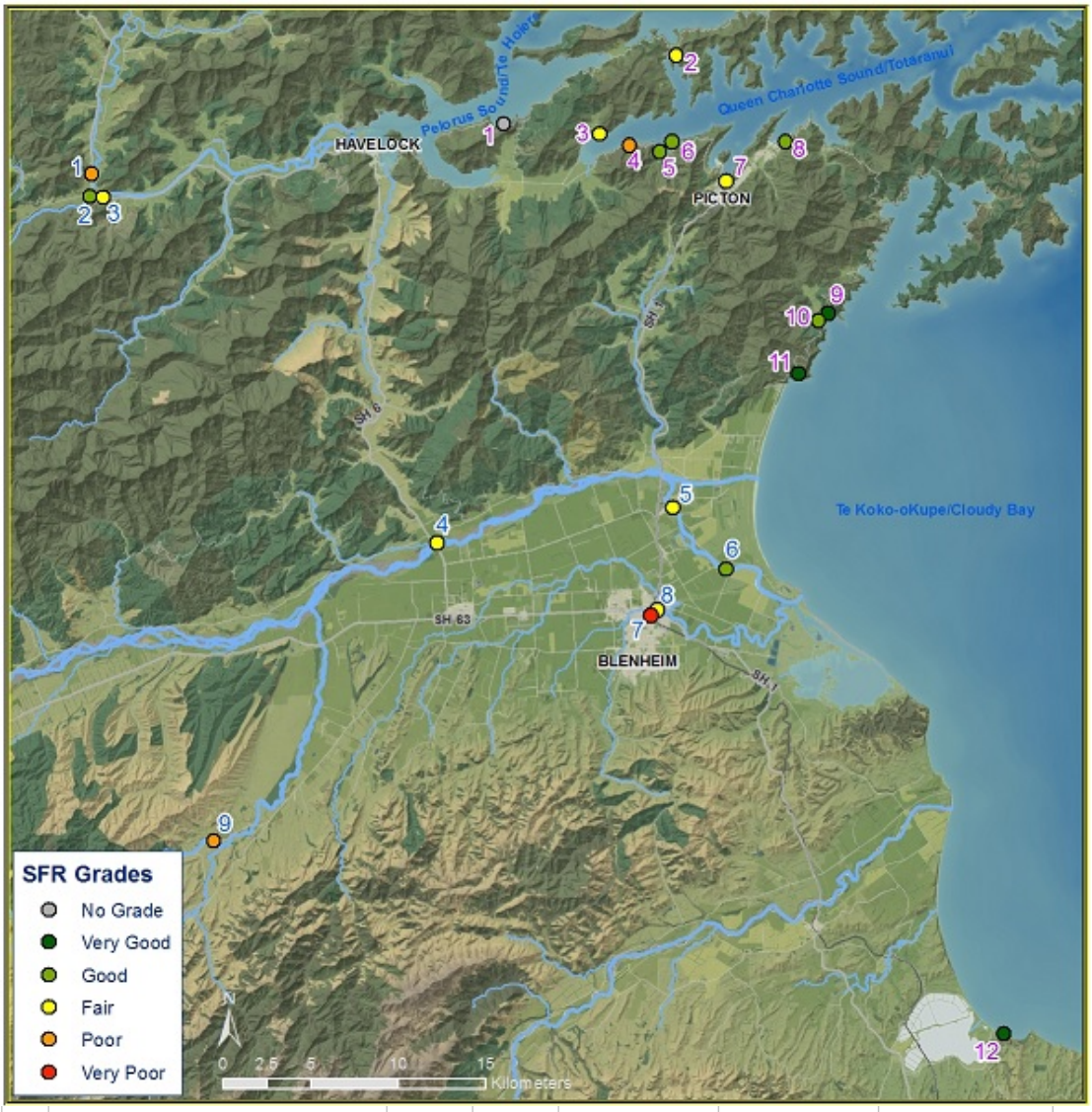
High E. coli levels in the Rai River at Rai Falls are predominantly a result of agricultural land use in the catchment, which is dominated by the dairy industry. The recent efforts of keeping stock out of waterways have resulted in a significant reduction of faecal contamination of the Rai River, so guideline levels are now exceeded only during rainfall event. The improvement is reflected in the change of SFR Grades from 'Very Poor' to 'Poor' for the Rai River at Rai Falls and from 'Poor' to 'Fair' for Te Hoiere/Pelorus River at Totara Flat, located downstream of the confluence with the Rai River.

E. coli concentrations in the Waihopai River at Craiglochart #2 had been declining in the past, but have since risen again. Consequently, the SFR Grade for this site was lowered from 'Fair' to 'Poor'.

Many of the sites that were added to the recreational water quality program as a result of a site usage survey in 2012 have now been sampled for four consecutive summers. This means that interim SFR Grades could be assigned as part of the grade review. The new sites have a range of SFR Grades. Governors Bay and Waikutakuta/Robin Hood Bay West have an interim grade of 'Good', while Waikutakuta/Robin Hood Bay East is graded 'Very Good'. The only new river site, Wairau River at State Highway Six, has an interim SFR Grade of 'Fair'.

Due to the change of site locations in Moetapu Bay from the DoC campground to the Double Bay Reserve last year, we do not yet have enough data to assign a grade to this site.

▶ Figure 37: SFR Grades for all sites monitored as part of the Recreational Water Quality program. Also shown are the changes since the last review in 2014.



Type	No.	Site	Easting	Northing	SIC (Sanitary Inspection Category)	MAC (Microbiological Assessment	SFR Grade (Suitability for Contact Recreation Grade)	Change# (from 2014)
Coastal Sites	1	Moetapu Bay	1671600	5432100	insufficiant data			
	2	Mistletoe Bay	1681470	5436007	Moderate	C	Fair	↓
	3	Anakiwa	1677073	5431495	Moderate	C	Fair	↓
	4	Momorangi Bay	1678817	5430879	Moderate	D	Poor	↓
	5	Ngakuta Bay	1680514	5430489	Low	B	Good	↑
	6	Governors Bay*	1681310	5431030	Low	B	Good	-
	7	Picton Foreshore	1684298	5428815	Moderate	C	Fair	↑
	8	Waikawa Bay	1687695	5431090	Low	B	Good	-
	9	Waikutakuta/Robin Hood Bay East*	1690115	5421285	Very Low	B	Very Good	-
	10	Waikutakuta/Robin Hood Bay West*	1689595	5420930	Low	B	Good	-
	11	Pukatea/Whites Bay	1688425	5417793	Very Low	A	Very Good	-
	12	Marfells Beach	1700194	5380089	Very Low	A	Very Good	-
River Sites	1	Rai Rv at Rai Falls	1648018	5429266	Moderate	D	Poor	↑
	2	Te Hoiere/Pelorus Rv at Pelorus Bridge	1648077	5428091	Low	B	Good	-
	3	Te Hoiere/Pelorus Rv at Totara Flat	1648262	5427731	Moderate	C	Fair	↑
	4	Wairau Rv at State Highway Six*	1667780	5408150	Moderate	C	Fair	-
	5	Wairau Rv at Ferry Bridge	1681274	5410163	Moderate	C	Fair	-
	6	Wairau Rv at Blenheim Rowing Club	1684319	5406605	Moderate	B	Good	-
	7	Taylor River at Riverside	1680023	5403987	High	D	Very Poor	-
	8	Ōpaoa River at Elizabeth St Bridge	1680393	5404310	Moderate	C	Fair	-
	9	Waihopai River at Craiglochart #2	1655029	5391098	Moderate	D	Poor	↓

* these sites have been monitored less than 5 years, the SFR Grade is therefore interim only
\# the background colours show the previous SFR Grades

7. References

1. ESR (2015) *Human health risks of faecal pollution from different sources: A review of the literature.* Report prepared for Environment Canterbury, Report No: CSC15019
2. ESR (2005) *Notifiable Diseases in New Zealand: Annual Report 2014*. Porirua, New Zealand
3. MDC (2012) *Recreational Water Quality Report 2011-12*. Marlborough District Council, Technical Report 12-013
4. MDC (2013a) *Recreational Water Quality Report 2012-13*. Marlborough District Council, Technical Report 13-006
5. MDC (2013b) *Investigation into High E. coli Concentrations in the Taylor River during Low Flows*. Marlborough District Council, Technical Report 13-007
6. MDC (2014) State of the Environment Surface Water Quality Monitoring Report. Marlborough District Council, Technical Report 14-006
7. MfE/MoH (2003) *Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas.* Ministry for the Environment
8. Solo-Gabriele H.M. et al. (2016) *Beach sand and the potential for infectious disease transmission: observations and recommendations*. Journal of the Marine Association of the United Kingdom 96(1), 101-120

8. Appendices

8.1. Appendix 1: Results for the 2015/2016 summer season

Results are Enterococci concentrations for coastal sites and E. coli concentrations for river sites, both in MPN/100mL

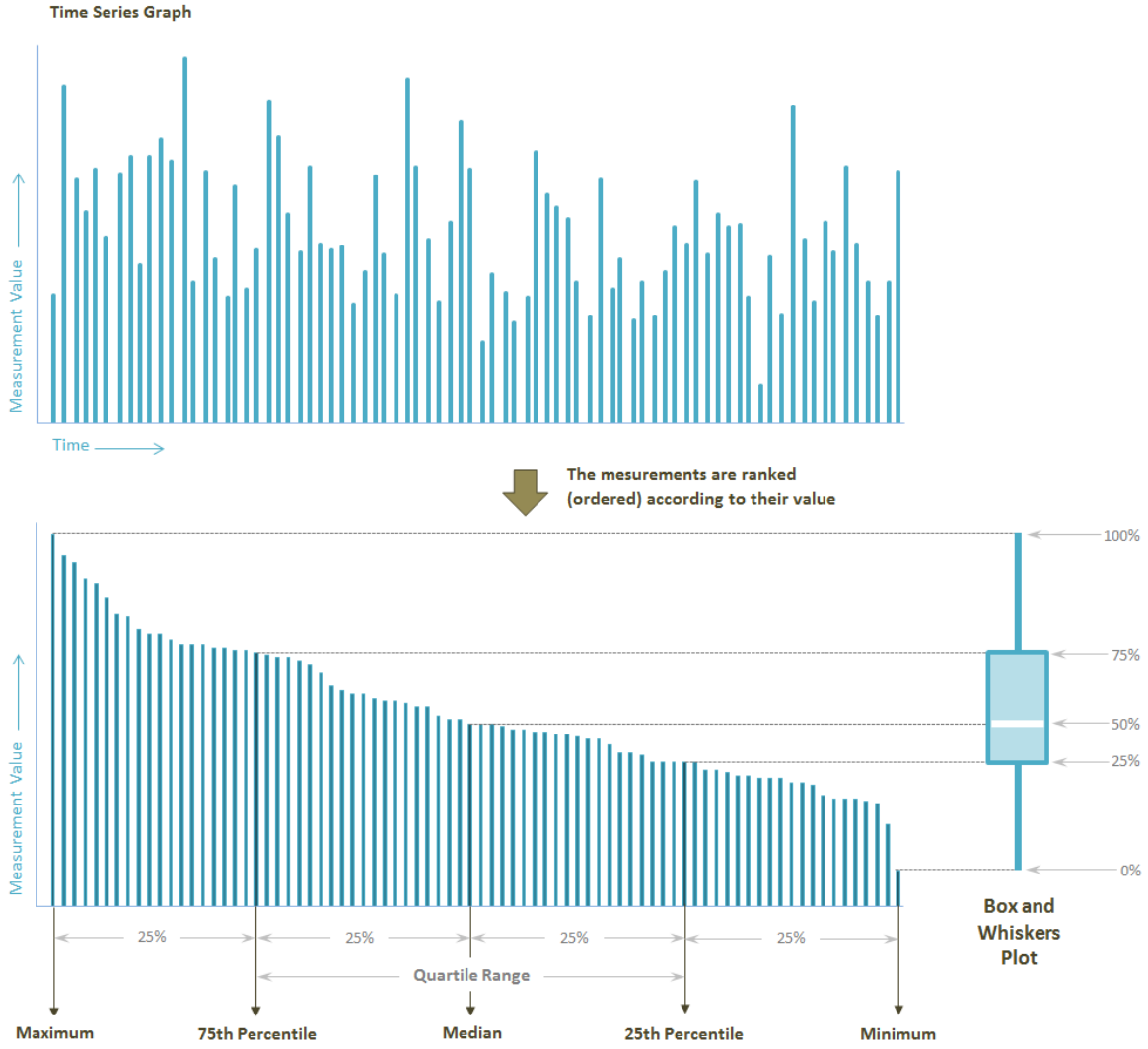
Site Type	Week	Sample Date	Rai Falls	Pelorus Rv at Pelorus Bridge	Pelorus Rv at Totara Flat	Waihopai Rv at Craiglochart #2	Wairau Rv at State Highway Six	Wairau Rv at Ferry Bridge	Wairau Rv at Blenheim Rowing Club	Taylor Rv at Riverside	Opaoa Rv at Elizabeth St
River	1	03/04 Nov 2015	496	173	183	<10	20	<10	<10	399	75
	2	09/10 Nov 2015	109	10	41	20	63	<10	31	145	84
	3	16/17 Nov 2015	74	20	31	145	10	10	20	173	85
	4	23/24 Nov 2015	31	41	<10	10	63	426	31	146	41
	Follow-up	25 Nov 2015						272			
	5	30 Nov/01 Dec 2015	109	31	20	<10	86	31	110	216	63
	6	07/08 Dec 2015	107	41	52	173	97	10	84	228	63
	7	14/15 Dec 2015	31	74	<10	30	86	175	<10	331	86
	8	21/22 Dec 2015	183	10	20	52	62	275	96	259	201
	9	29/30 Dec 2015	85	20	20	30	<10	41	20	86	85
	10	05/06 Jan 2016	109	31	63	359	203	135	231	173	120
	11	11/12 Jan 2016	121	63	84	98	108	98	97	173	161
	12	18/19 Jan 2016	1,722	414	706	134	41	355	134	2,600	327
	Follow-up	20 Jan 2016								201	
	13	25/26 Jan 2016	85	<10	41	63	20	41	201	754	161
	14	01/02 Feb 2016	98	20	20	153	30	31	<10	712	121
	15	09/10 Feb 2016	74	20	10	74	97	146	52	573	243
	Follow-up	11 Feb 2016								134	
	16	15/16 Feb 2016	10	10	30	52	41	74	31	282	187
	Follow-up	16 Feb 2016								86 - 676*	
	17	22/23 Feb 2016	134	52	31	160	110	233	135	86	243
	18	29 Feb/01 Mar 2016	97	20	63	98	10	84	41	121	160
	19	07/08 Mar 2016	72	20	10	63	52	74	41	650	52
	Follow-up	09 Mar 2016								201 - 275*	
	Follow-up	10 Mar 2016								148	
	20	14/15 Mar 2016	31	<10	20	31	<10	63	10	158	63
	21	21/22 Mar 2016	10	41	10	41	10		10	201	135

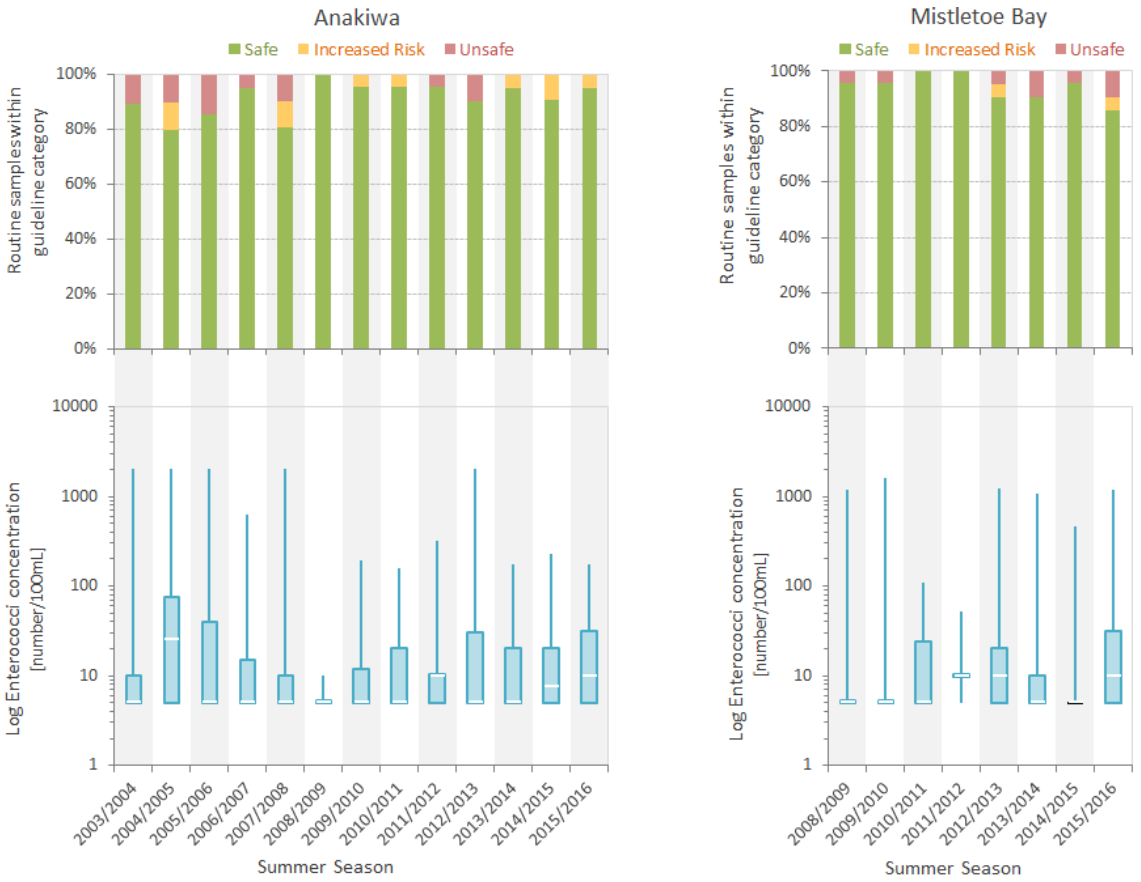
* several samples taken

Site Type	Week	Sample Date	Anakiwa	Mistletoe Bay	Moetapu - Doubel Bay	Momorangi Bay	Ngakuta Bay	Governors Bay	Picton Foreshore	Waikawa Bay	Pukatea/ Whites Bay	Waikutakuta/ Robin Hood Bay East	Waikutakuta/ Robin Hood Bay West	Marfells Beach
Coastal	1	03/04 Nov 2015	20	<10	<10	<10	<10	20	171	146	<10	<10	10	<10
	2	09/10 Nov 2015	<10	10	<10	10	<10	<10	85	<10	<10	<10	<10	<10
	3	16/17 Nov 2015	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	4	23/24 Nov 2015	<10	10	<10	<10	<10	<10	84	10	<10	<10	<10	<10
	5	30 Nov/01 Dec 2015	10	<10	<10	97	<10	97	20	<10	<10	<10	10	63
	6	07/08 Dec 2015	20	<10	20	<10	<10	<10	10	<10	<10	<10	<10	<10
	7	14/15 Dec 2015	41	331	<10	1,396	<10	10	10	<10	10	<10	<10	<10
	Follow-up	17 Dec 2015		<10		<10								
	Follow-up	18 Dec 2015				41								
	8	21/22 Dec 2015	<10	<10	<10	512	<10	<10	<10	<10	10	<10	<10	<10
	Follow-up	24 Dec 2015				10								
	Follow-up	26 Dec 2015				31								
	Follow-up	28 Dec 2015				226								
	9	29/30 Dec 2015	10	20	<10	<10	<10	<10	52	<10	<10	<10	<10	<10
	10	05/06 Jan 2016	63	<10	<10	20	<10	<10	10	<10	<10	<10	<10	<10
	Follow-up	08 Jan 2016		6,490										
	11	11/12 Jan 2016	<10	<10	110	253	134	10	<10	110	<10	<10	10	10
	12	18/19 Jan 2016	173	1178	52	74	41	160	299	20	20	<10	20	20
	Follow-up	20 Jan 2016	<10						63					
	13	25/26 Jan 2016	52	10	41	<10	<10	<10	97	<10	<10	<10	10	10
	14	01/02 Feb 2016	10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10
	15	09/10 Feb 2016	97	31	31	<10	<10	73	10	<10	<10	<10	<10	20
	16	15/16 Feb 2016	<10	63	<10	10	10	201	85	<10	<10	<10	<10	31
	17	22/23 Feb 2016	<10	41	19,860	318	74	5,170	20	259	<10	<10	<10	<10
	Follow-up	25 Feb 2016			73	<10		<10						
	Follow-up	26 Feb 2016			842	30		20						
	18	29 Feb/01 Mar 2016	<10	<10	<10	<10	<10	63	448	122	<10	20	<10	10
	19	07/08 Mar 2016	31	185	173	20	10	63	388	10	<10	10	<10	<10
	Follow-up	10 Mar 2016							<10					
	Follow-up	11 Mar 2016							<10					
	20	14/15 Mar 2016	<10	31	<10	10	<10	20	10	<10	<10	<10	10	<10
	21	21/22 Mar 2016	20	10	20	<10	20	<10	63	<10	<10	10	<10	50

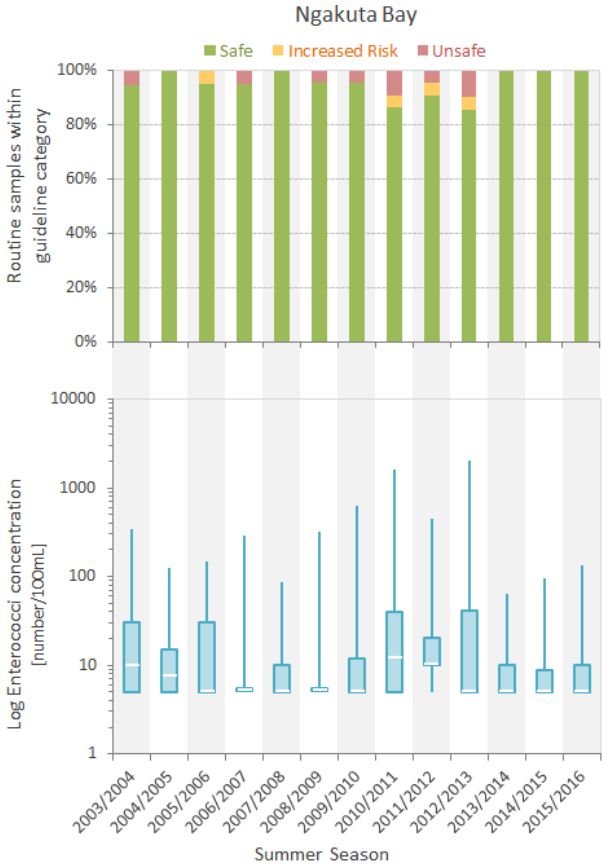
8.2. Appendix 2: Levels of compliance and Box and Whiskers plots

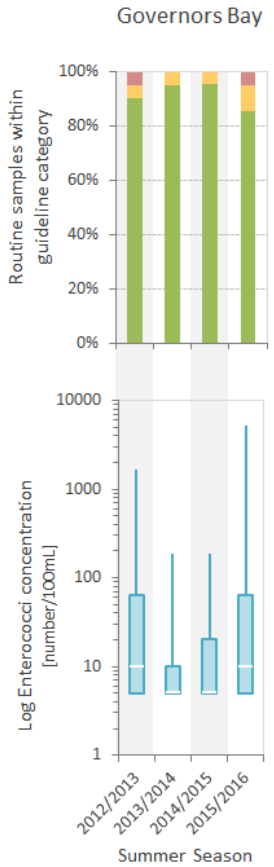
The Plots were created from the results of the routine sampling only. The first figure shows how Box and Whiskers Plots are created. Note that concentrations in the Box and Whiskers Plots for the actual sample results are on a logarithmic scale and only sites with a minimum of 4 years of record are shown.

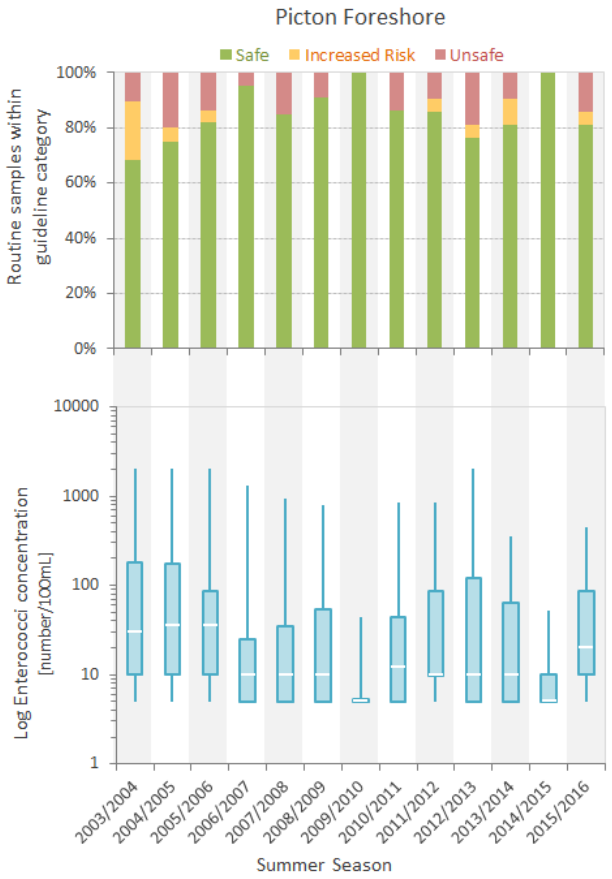


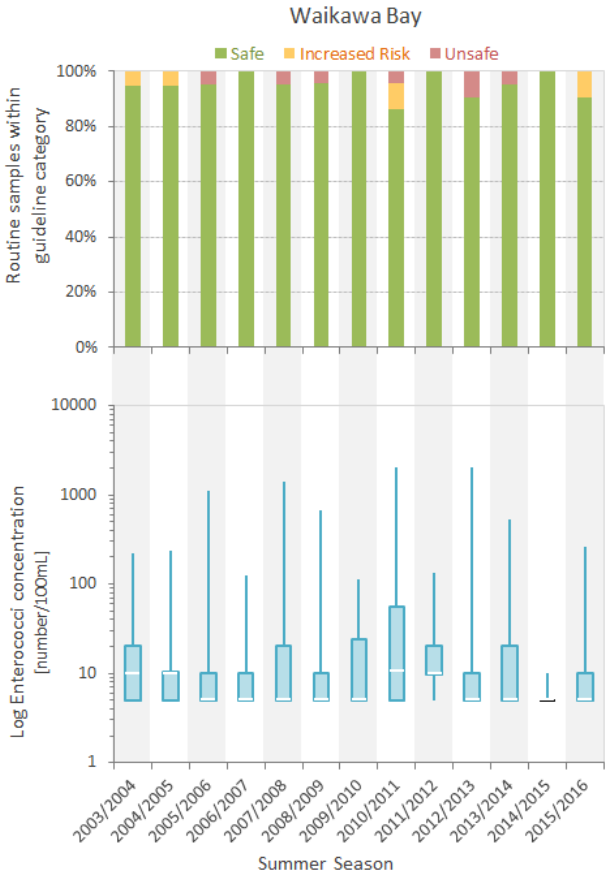

Anakiwa
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season
Mistletoe Bay
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Momorangi Bay
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Ngakuta Bay
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Governors Bay
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Picton Foreshore
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Waikawa Bay
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
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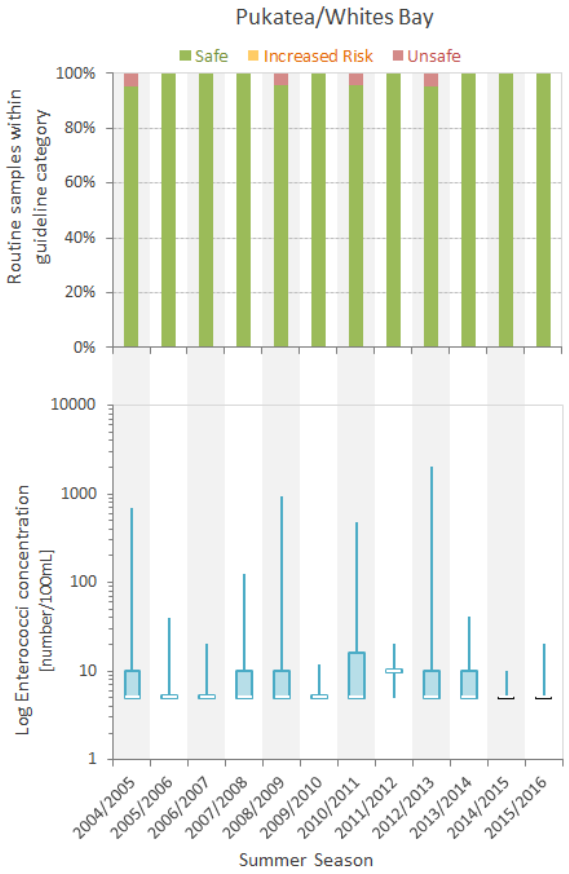
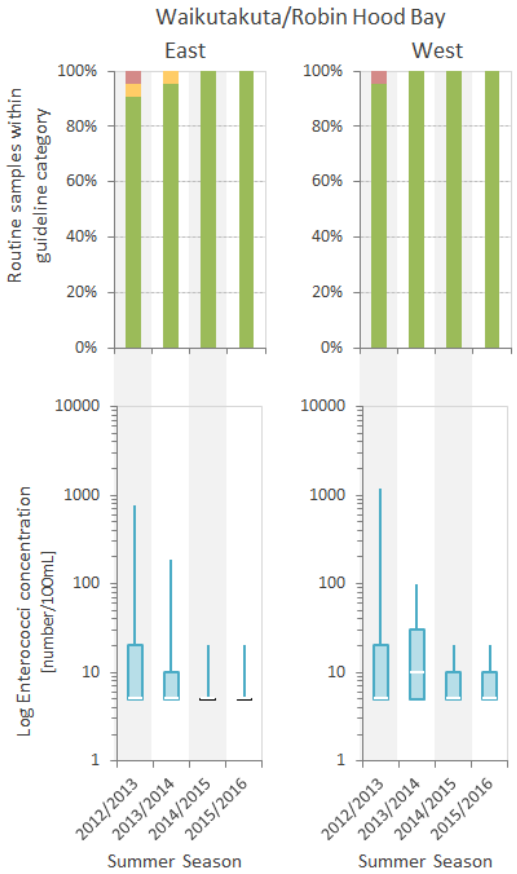
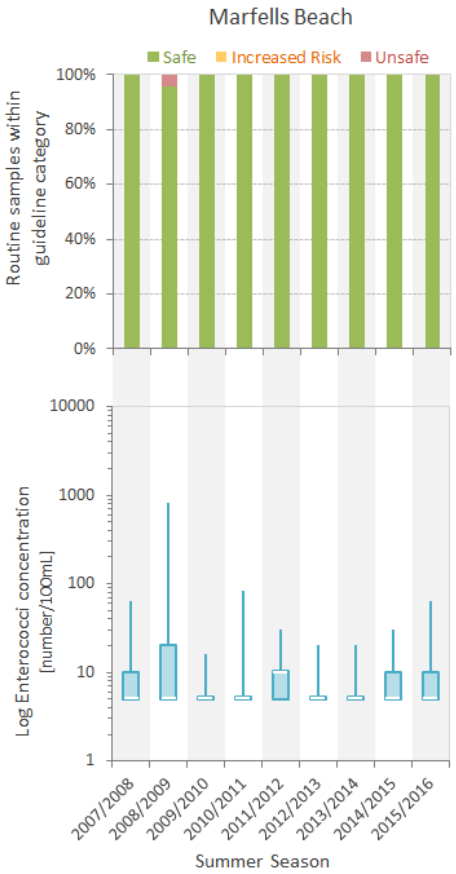
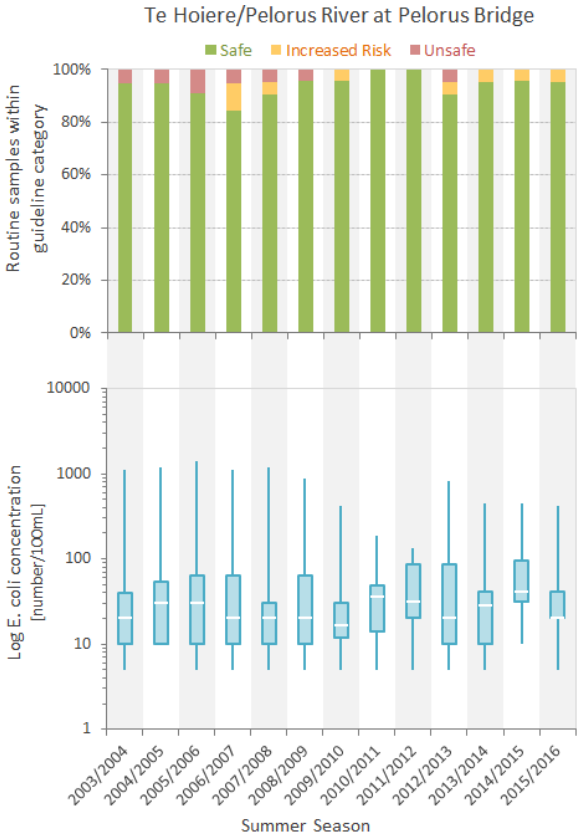
2014/2015
2015/2016
Summer Season


Pukatea/Whites Bay
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Waikutakuta/Robin Hood Bay
East
West
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Marfells Beach
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log Enterococci concentration [number/100mL]
10000
1000
100
10
1
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Te Hoiere/Pelorus River at Pelorus Bridge
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
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1
2003/2004
2004/2005
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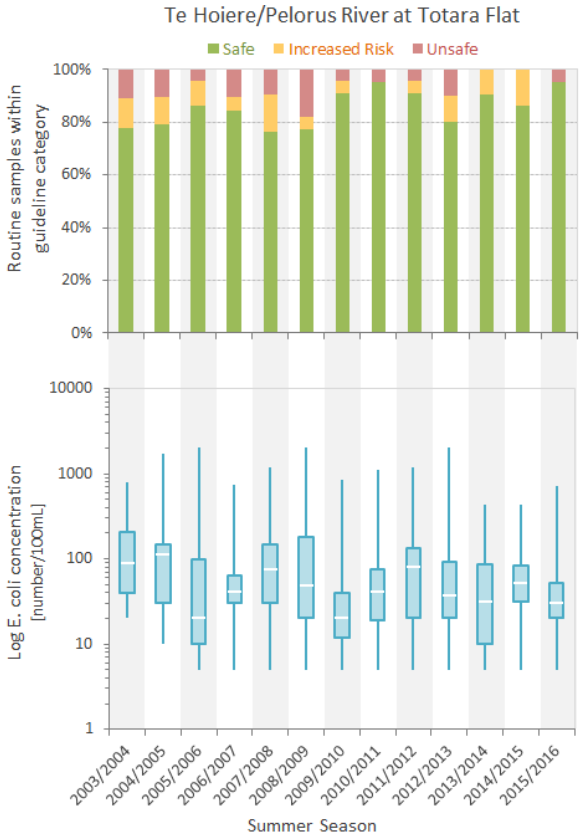
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Te Hoiere/Pelorus River at Totara Flat
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
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2010/2011
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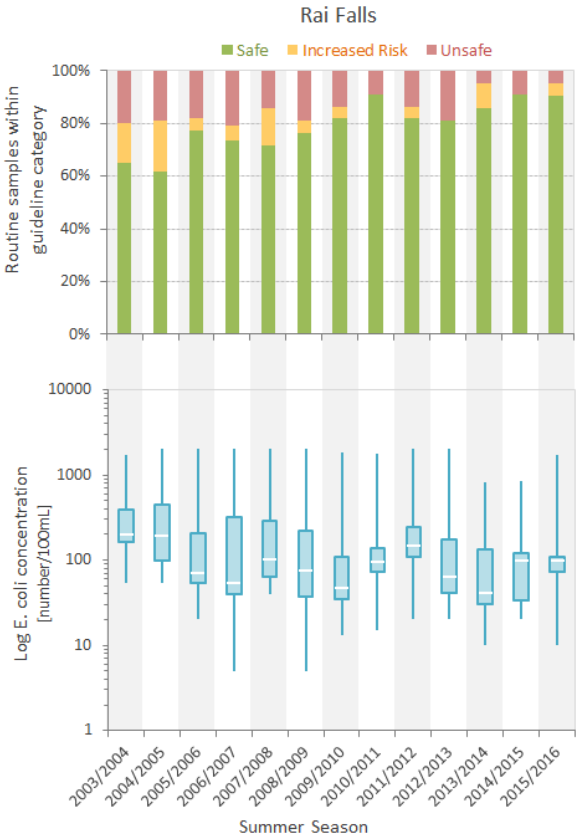
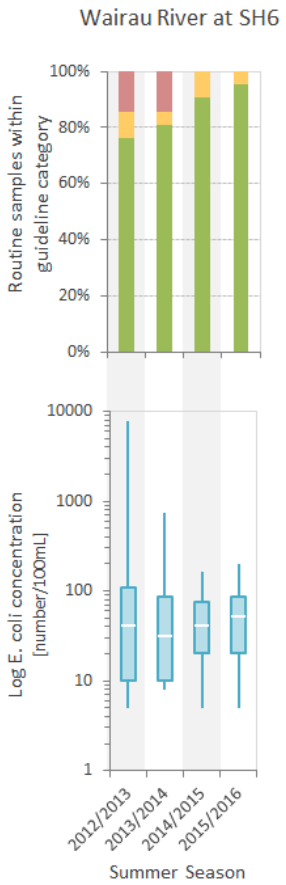
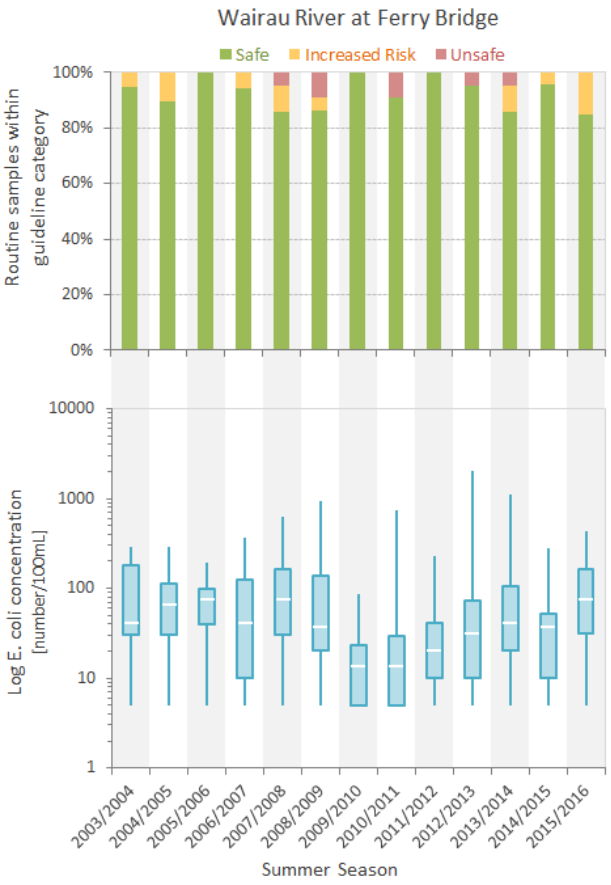
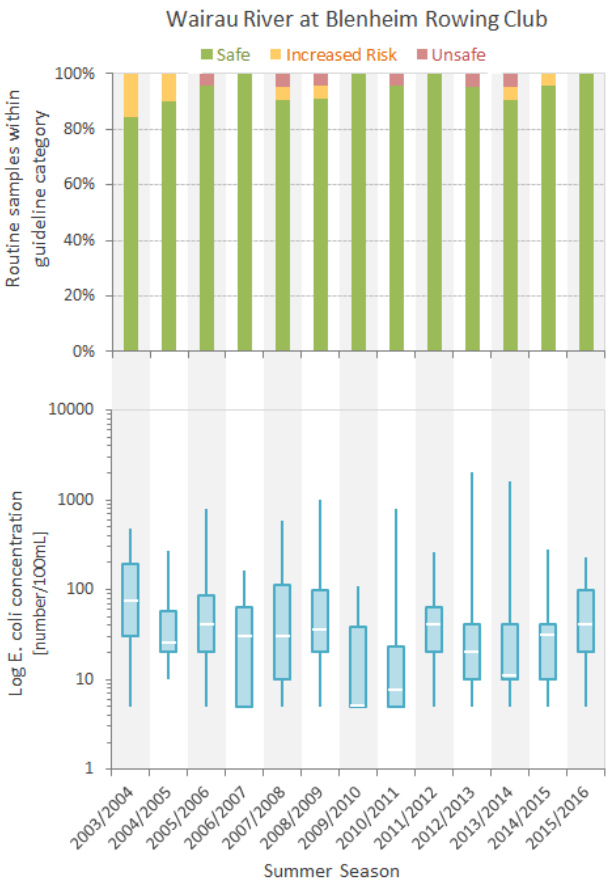
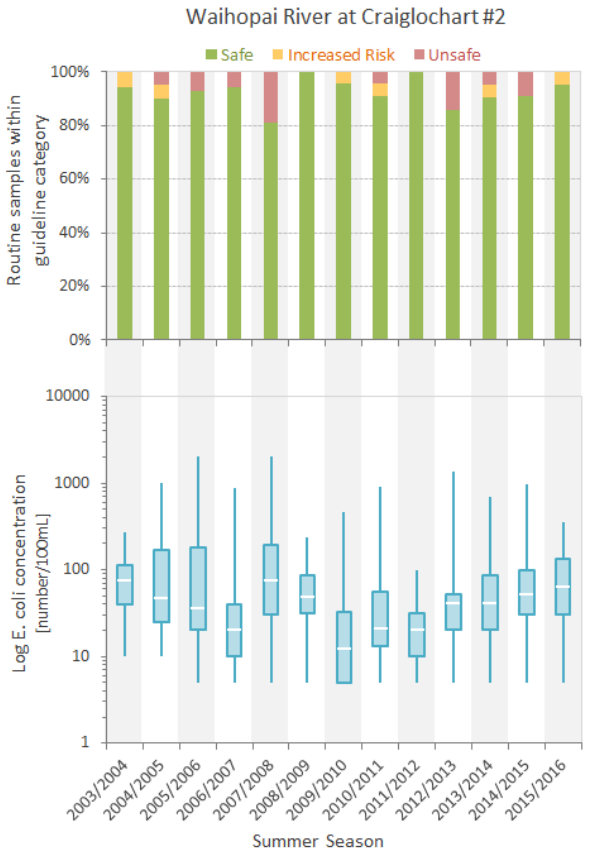
2013/2014
2014/2015
2015/2016
Summer Season


Rai Falls
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season

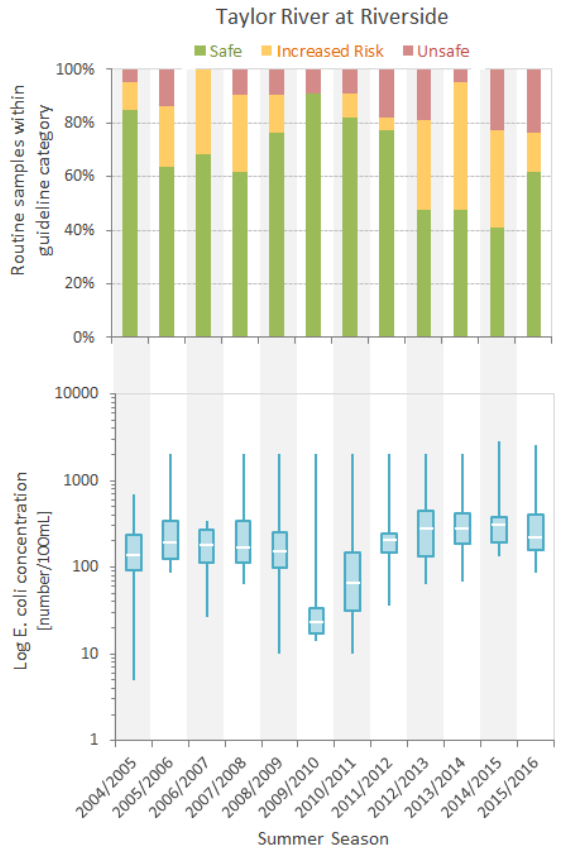

Wairau River at SH6
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Wairau River at Ferry Bridge
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Wairau River at Blenheim Rowing Club
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Waihopai River at Craiglochart #2
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Ōpaoa River at Elizabeth St
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season


Taylor River at Riverside
Safe
Increased Risk
Unsafe
Routine samples within guideline category
100%
80%
60%
40%
20%
0%
Log E. coli concentration [number/100mL]
10000
1000
100
10
1
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
2013/2014
2014/2015
2015/2016
Summer Season

8.3. Appendix 3: Management procedure for exceedances of bathing water guidelines