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Technical report

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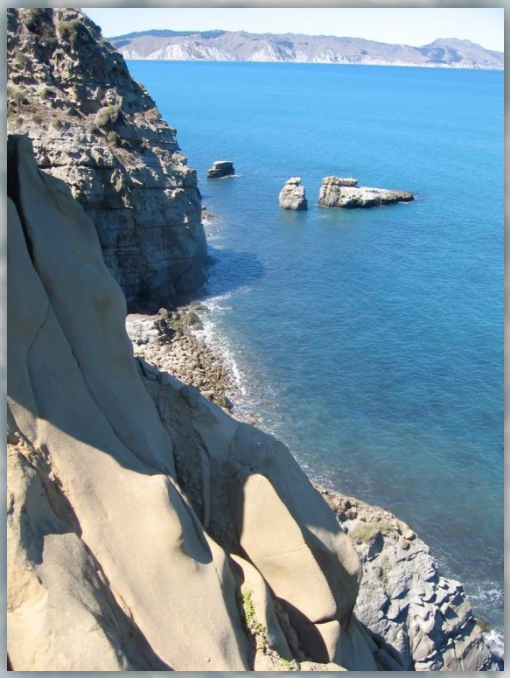

Recreational Water Quality in Hawke's Bay

Review of the 2008-2009 Recreational Water Quality Monitoring Programme

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Environmental Management Group
Technical Report

Environmental Science

Recreational Water Quality in Hawke's Bay: A Review of the 2008-2009 Recreational Water Quality Monitoring Programme

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EXECUTIVE SUMMARY

Thirty sites were monitored as part of the 2008/09 Recreational Water Quality Monitoring Programme undertaken by Hawke's Bay Regional Council. The sites were sampled and analysed on a weekly basis for faecal indicator bacteria counts. This annual summer programme enables Council to assess the microbiological water quality of popular bathing areas, and elucidate trends in water quality throughout the region. The selected sites include both marine and freshwater popular bathing locations – including one lake, in addition five sites were monitored to determine the suitability of areas for shellfish gathering. Results were compared with the Ministry for the Environment and Ministry of Health Microbiological Water Quality Guidelines (2003).

The sites can be distinguished as follows:

- fourteen marine sites (*Enterococci* bacteria)
- four freshwater rivers (*Escherichia coli* bacteria)
- eleven estuarine/lagoon/tidal freshwater sites (*Enterococci* /*Escherichia coli* bacteria)
- one freshwater lake (*Escherichia coli* bacteria)
- five marine sites for shellfish gathering (Faecal coliforms)

All fourteen marine sites in Hawke's Bay attained a 100% level of compliance with the Ministry two-consecutive exceedance guideline during the 2008/09 season.

Of the five freshwater (including one lake) sites sampled, three achieved 100% compliance with **action** mode Ministry guidelines.

This season eleven estuarine and/or freshwater sites (where a tidal influence may render them brackish), were also tested for both E.*coli* and *Enterococci* levels. This was undertaken to ensure the parameter tested was giving a true indication of the state of that particular site. When exceedances for both parameters (*E.coli and Enterococci*) are combined then of the eleven sites where both are tested all achieved 100% compliance with the **action** mode *two-consecutive exceedance guideline*. Four of the eleven sites achieved 100% compliance for the **action** mode *single exceedance guideline,* three each achieved 95% and 90% respectively and one, Puhokio Stream achieved just 60% (note this site was sampled every two weeks).

In addition to the recreational water quality sites, five sites were monitored to assess the quality of waters at shellfish gathering sites. All five of the shellfish gathering sites monitored in Hawke's Bay were 100% compliant with Ministry guidelines for biological water.

High levels of compliance with Ministry guidelines at all sites may reflect the extensive dry weather experienced throughout the season.

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LIST OF ABBREVIATIONS

HBRC	Hawke's Bay Regional Council
MfE	Ministry for the Environment
MoH	Ministry of Health
PHU	The Public Health Unit
RMA	Resource Management Act
SFRG	Suitability for Recreation Grade

1.0 INTRODUCTION

Hawke's Bays coastal waters, freshwater lakes and rivers, are frequently used for a range of recreational activities. However, the suitability of these areas for contact recreation can be compromised through contamination by human and animal faecal matter, which may carry harmful, illness causing pathogens[1].

In order to monitor the risk associated with contact recreation, Hawke's Bay Regional Council (HBRC) undertake an annual Recreational Water Quality Monitoring Programme in collaboration with Territorial Local Authorities (TLA's) and the Public Health Unit of the Hawke's Bay District Health Board (PHU). Monitoring is carried out at 30 sites throughout the region to assess the bacteriological water quality of areas used for contact recreation. The results are then correlated with the Ministry for the Environment (MfE) and Ministry of Health (MoH) guidelines (2003).

The aims of the programme are to:

- Determine the suitability of the coastal, estuarine and freshwater sites for recreational use;
- Assist in safeguarding public health and the environment;
- Identify trends in water quality;
- Identify current state; and
- Identify any problems and target investigations to those areas requiring mitigation, remediation or further study.

1.1 Legislative Responsibility

Two main sources of legislation define the monitoring required to assess the water quality of areas used for contact recreation - the Resource Management Act (1991) and the Health Act (1956). Responsibility for overseeing these Acts is shared between Regional Councils (the RMA), Territorial Local Authorities (RMA and Health Act), and the District Health Boards (the Health Act). The 'Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas' have outlined various approaches to the delegation of duties between the involved agencies (MoH & MfE, 2003).

The approach currently used in Hawke's Bay is similar to that outlined in the guidelines. Hawke's Bay Regional Council has taken responsibility as the lead agency for this monitoring, and undertakes all routine monitoring and the facilitation of follow-up sampling when necessary. The territorial local authorities have responsibility for erecting warning signs and undertaking sanitary surveys when required. The Public Health Unit, through its health protection officers and Medical Officer of Health, have responsibility for informing the public (via a press release and/or location signage) when an exceedance of the guidelines has occurred. Updated results are also available from the PHU safe swimming line, and the HBRC website.

[1] These can include gastro-enteritis, respiratory illnesses, Hepatitis A, giardiasis, cryptosporidium, campylobacterosis, and salmonellosis (*from* MfE and MoH, 2003).

METHODOLOGY

1.2 Site Selection Criteria

The sites that are monitored as part of the recreational water quality programme are selected according to a number of criteria. Each site is either:

- A popular recreational site;
- An area classified as 'Contact Recreation' (Class CR) under the Regional Coastal Environment Plan (HBRC, 2008)
- A site that will assist in determining the state of the environment;
- A site that will identify trends in coastal, estuarine and fresh water quality; and/or
- A site selected in co-operation with TLA's and the Hawke's Bay District Health Board.

1.3 Sampling and Notification

The programme for the 2008/2009 summer consisted of 30 sites between Mahanga and Porangahau Beaches. These sites are commonly used for recreational purposes (i.e. swimming, water skiing, rowing etc.) and include freshwater, estuarine/tidal and marine sites throughout the region (see Appendix 1). These sites were unchanged from the 2007/2008 season.

Sampling was undertaken in accordance with MoH & MfE guidelines (2003), and undertaken on a weekly basis, with the exception of two sites, Clive River and Puhokio Stream. Samples were collected at these sites every two weeks due to the fact that they have permanent signs erected and have attained full grading of 'Very Poor' under the MoH & MfE Suitability for Recreation grading system. Sampling was scheduled for Monday of each week for a 20-week period over the summer season (November – March). Samples were collected in accordance with the sampling procedures outlined in sections D2 and E2 of the guidelines (MoH & MfE, 2003) and kept chilled until laboratory analysis. Associated environmental information was collected for each site at the time of sampling, including temperature, turbidity and the number of users at each site.

Samples were analysed for the indicator bacteria *Enterococci* in marine waters, *Escherichia coli* and/or *Enterococci* in brackish or freshwater (with a tidal influence), and faecal coliforms in shellfish gathering waters. The dual testing of indicator bacteria for brackish or freshwater (with a tidal influence) was undertaken to ensure the tested parameter appropriately correlated to the risk of adverse health effects. *Enterococci* survival rate is higher than *E.coli* in saline waters and therefore may give a better indication of *actual* bacterial levels in brackish environments and therefore the potential risk. Where conductivity readings taken at the time of sampling indicated a freshwater environment (<10 mS/cm) then the lab analysis was conducted for *E.coli* only.

Rainfall measurements were collected from localised rain gauges to determine whether significant rainfall had preceded sampling. Significant rainfall was determined to be 10mm recorded at any catchment rainfall station(s) for that site on that day, or up to three days prior. If sample results exceeded guideline values, the rainfall data was then reviewed to assist in identifying whether exceedances were related to high rainfall episodes. If it could be shown that rainfall coincided with an exceedance then those rainfall related exceedances occurring in fresh and brackish water systems were not re-sampled as a previous study has shown bacteria levels to reach guideline values within three days under these conditions (Stansfield, 2002). Follow-up sampling was conducted for all exceedances (including rainfall related) in marine waters in order to determine the level of compliance against MfE & MoH guidelines.

In the event of a non-rainfall related **alert** level exceedance, follow-up sampling was conducted daily until results were within guideline values (see section 2.4 Guidelines). For non-rainfall related **action** level exceedances, daily follow-up sampling was undertaken, signs erected, and warnings against swimming were issued by PHU press releases. Results were also available from the PHU 'SwimSafe' telephone line, and from the HBRC website.

1.4 Indicator Bacteria

The Recreational Water Quality Programme aims to assess the suitability of areas for contact recreation (*see* Section 1). To achieve these objectives it is necessary to determine whether sites have been subject to contamination from human or animal faecal matter that may compromise the

health and safety of people using the area. As it is not feasible to analyse water samples for the range of pathogenic organisms that can cause illness, bacteria that are specific to the gut of warm-blooded animals are used to indicate whether faecal material is present in the water. The levels of this indicator can be used to provide an assessment of the relative risk of illness.

The most common illness from swimming in contaminated water is gastroenteritis, but recent evidence indicates that respiratory illness and skin infections are also common. These illnesses can be caused by a wide range of pathogenic organisms including viruses, bacteria and protozoa (such as salmonella, campylobacter, cryptosporidium, and giardia) (MfE & MoH, 2003).

1.5 Guidelines

All sampling and evaluation of results was undertaken in accordance with the 'Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas' (MoH & MfE, 2003; Table 1).

Table 1: Water quality guidelines for marine and freshwater recreational areas (from MoH/MfE, 2003)

Response Level	Marine Water cfu *Enterococci* /100 mL Single Sample	Freshwater cfu *E. coli* /100 mL Single Sample
Surveillance Mode	< 140	< 260
Alert/Amber Mode	140 – 280	260 – 550
Action/Red Mode	> 280*	> 550

* Two consecutive samples taken within 24hrs exceeding 280-*Enterococci*/100 mL is required before the Action Mode is initiated

When water quality falls within the limits of the 'surveillance mode', this indicates that the risks of illness from bathing are acceptable. If the water quality falls into the 'alert' categories, this indicates an increased risk of illness from bathing, but still within the acceptable range. This signals agencies to conduct follow-up sampling of the site in order to monitor whether contamination levels increase to the 'action' level. If the water quality should enter the 'action' category (for marine sites, this involves two consecutive samples exceeding the upper limit), then the water poses an unacceptable health risk from bathing. At this point, signs are erected at the bathing site, and the public informed that it is unsafe to swim at that site.

The recreational shellfish-gathering bacteriological guideline values were also obtained from the 'Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas' (MoH & MfE, 2003; Section F). These state that the median level of faecal coliform content should not exceed a Most Probable Number (MPN) of 14/100ml, and that no more than 10% of samples should exceed a MPN 43/100ml for the season.

1.6 Annapolis Protocol / Beach Grading

The MfE and MoH (2003) guidelines move away from simple reactive monitoring to a risk based management approach for recreational waters. This is done by combining an assessment of the potential inputs of contaminated water to a site with an assessment of the historical monitoring from the site to generate a 'Suitability For Recreation Grade' (SFRG), which can be used to advise the public of the most suitable sites for swimming, and other recreation activities. For a full description of the grades see section 4.2.5 and Appendix 4.

1.7 Data Analysis

Monitoring information from the last nine seasons was analysed to determine whether any significant trends were detectable in the microbiological water quality of sites associated with the Recreational Water Quality Monitoring programme. Whilst data could not be corrected for flow, nor was it possible to remove the effect of variable weather which can impact on bacterial levels, it was considered that the long-term nature of the data set might be of sufficient length as to buffer the data from these effects.

Data from the previous nine seasons was collated and any follow-up samples removed from the data set. Temporal trend analysis was carried out using NIWA's water quality trends software. All statistical tests involving pairwise comparisons were reconfirmed using the False Discovery Rate test recommended in McBride (2005).

Results were identified as significant if they meet the following criteria:

1) It was significant at 95%;
2) The slope equated to a change of >1% per year change in the variable concerned; and
3) The overall change for the time period concerned exceeded current laboratory detection limits.

Individual site results and false discovery results for the P-values can be found in appendix 6.

2.0 SAMPLING SITES

Thirty sites were sampled between Mahanga and Porangahau Beaches (Figure 1) (*see* Appendix 1 for site descriptions). A number of these sites have peak usage over a 2-4 week period (around Christmas and New Year). Additionally, as many of these sites are remote from large population centres, the size of their communities can increase by several orders of magnitude for the Christmas and New Year period. Much of the accommodation in these areas is in campgrounds and Baches, and most often the predominant wastewater treatment system is individual septic tanks.

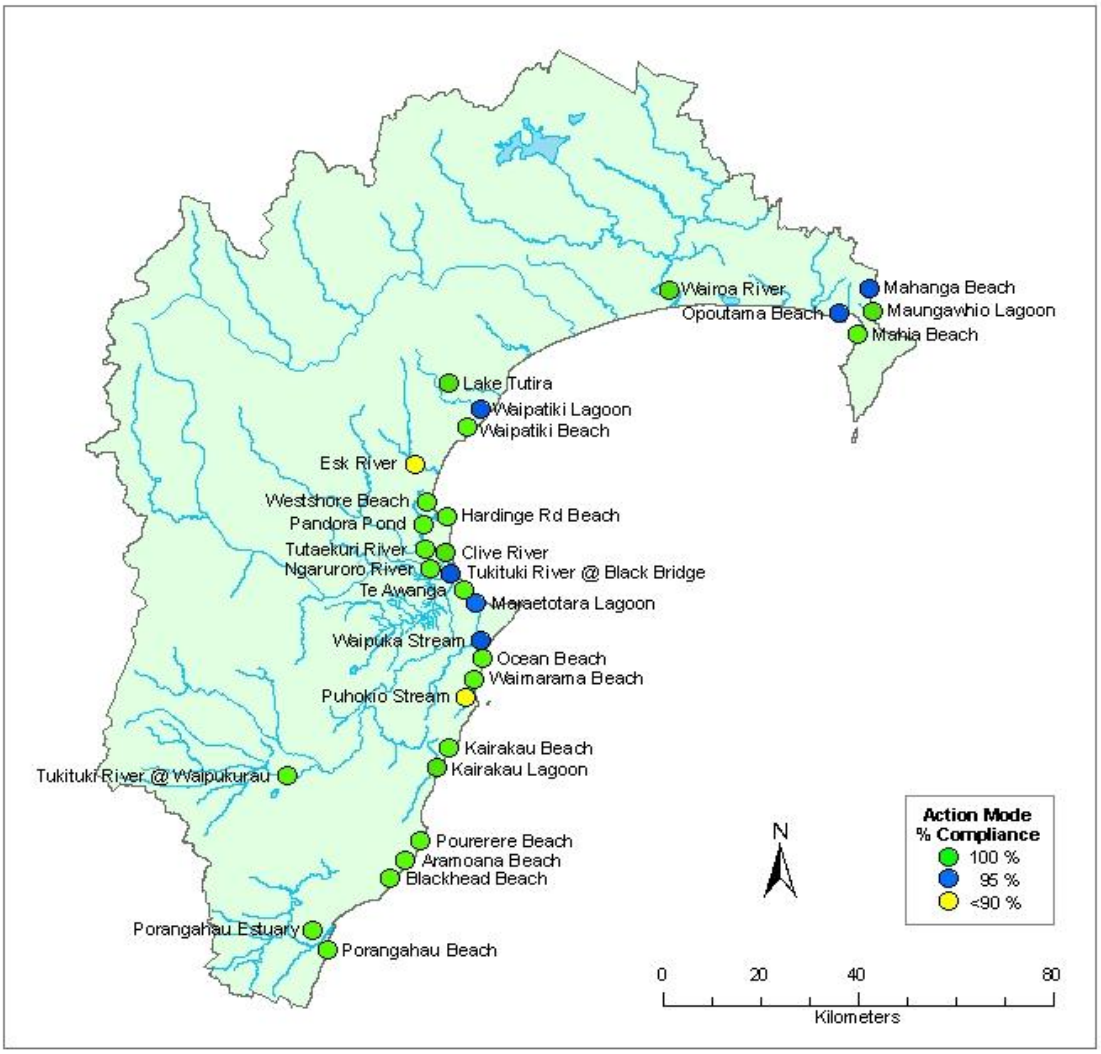


Figure 1: Map of sites included in the 2008/09 Recreational Water Quality Monitoring Programme including level of compliance with MfE & MoH action level guidelines (Marine action mode compliance based on a two consecutive sample exceedance).

3.0 RESULTS

3.1 Monitoring Results

A summary of the sampling results for each site is shown in the tables below. Detailed results can be found in graph and table form in appendices 2 and 3 respectively.

3.1.1 Marine Recreational Sites

Marine waters within Hawke's Bay have water quality suitable for contact recreation. All fourteen sites sampled achieved 100% compliance with the **action** mode *two-consecutive exceedance* guideline. Twelve of the fourteen marine sites sampled (Aromoana, Blackhead, Hardinge Road, Kairakau, Mahia, Ocean, Porangahau, Pourerere, Te Awanga Coastal, Waimarama, Westshore and Waipatiki beach) achieved 100% compliance with the more stringent **action** mode *single sample exceedance* guideline (Table 2). Of the two that did not comply, (Mahanga – 910 cfu/100ml and Opoutama - 400 cfu/100ml). Both sites had returned to background levels by the second sample. These results indicate that none of the marine sites sampled appear to have any significant microbiological water quality issues.

Table 2: Range of *Enterococci* results at the marine sites and compliance with guidelines 2008/09

Site	Minimum	Maximum	*Enterococci* % compliance with:		
			Alert Mode	Action Mode Single Sample	Action Mode Two-Consecutive Exceedance Guideline
	cfu *Enterococci* /100ml	cfu *Enterococci* /100ml	140 cfu *Enterococci* /100ml	280 cfu *Enterococci* /100ml	280 cfu *Enterococci* /100ml
Aromoana Beach	<1	12	100	100	100
Blackhead Beach	<1	13	100	100	100
Hardinge Rd Beach	<1	160	95	100	100
Kairakau Beach	<1	32	100	100	100
Mahanga Beach	<1	910	95	95	100
Mahia Beach	<1	240	95	100	100
Ocean Beach	<1	250	95	100	100
Opoutama Beach	<1	400	95	95	100
Porangahau Beach	<1	5	100	100	100
Pourerere Beach	<1	22	100	100	100
Te Awanga Coastal	<1	36	100	100	100
Waimarama Beach	<1	53	100	100	100
Waipatiki Beach	<1	180	95	100	100
Westshore Beach	<1	65	100	100	100

The two **action** mode single-sample exceedances discussed above occurred on the same day and coincide with rainfall events of 41mm recorded the day prior to sampling. As such it is reasonable to assume they are related to an influx of surface flow bearing land based contaminants. The sites were re-sampled and were shown to have returned to below guideline levels by the second sample. In addition to the two **action** mode single-sample results, six exceedances of the **alert** mode occurred. None of these exceedances were considered related to rainfall. All six re-samples had returned to below guideline values by the second sample.

Of the six *total* exceedances (of both the action and alert level) for the 08/09 season, five occurred on the same sampling run. All exceedances for the season at marine sites occurred within a two week period at the height of the holiday season (5th and 12th Jan). This is at a time when recreational beach use is at its most intensive with corresponding pressure on septic tanks and waste water disposal systems. These results indicate that exceedance events in marine waters in Hawke's Bay tend to be short-lived, and that even results of non-rainfall related events generally return to below guideline

values before the two-consecutive sample action level as defined by MfE and MoH (2003) are reached.

3.1.2 Freshwater Recreational Sites

Freshwater and estuarine recreational areas in Hawke's Bay had generally good water quality throughout the bathing season (Table 3). Of the five sites sampled, three sites; Lake Tutira, Tukituki at SH2 Waipukarau and Tutaekuri at Pakowhai Bridge achieved 100% compliance with Ministry guidelines for *E. coli* at the **action** mode level of 550 cfu/100ml; while the Esk and Ngaruroro Rivers each achieved 95% compliance of the **action** mode.

Table 3: Range of *E.coli* results at Freshwater sites and compliance with guidelines 2008/09

Site	Minimum	Maximum	Alert Mode	Action Mode
	cfu *E. coli*/100ml	cfu *E. coli*/100ml	260 cfu *E. coli*/100ml	550 cfu *E. coli*/100ml
Esk River @ Eskdale Park	10	1050	90	95
Lake Tutira @ Camping Ground	<1	210	100	100
Ngaruroro River @ Chesterhope	5	880	90	95
Tukituki River @ SH2 Waipukurau	1	420	95	100
Tutaekuri River @ Pakowhai Bridge	19	380	95	100

For the **alert** mode level of 260 cfu/100ml, just one site, Lake Tutira, had 100% compliance for the 08/09 season. The remaining four sites were evenly divided between 90% and 95% compliance (Table 3). However, it should be noted that while Lake Tutira had 100% compliance for *E. coli* it was closed to recreational swimming for the majority of the 08/09 season due to a cyanobacteria algal bloom. While the regional Council is responsible for conducting sampling the responsibility for closure rests with the Public Health Unit (see Section 1.1). The results from the algal bloom sampling will be discussed in a subsequent report.

In total there were six exceedances of the water quality guidelines reported from routine sampling of freshwater sites in 08/09 season for *E. coli* (see Appendix 3). Within that total of six, half occurred on the 12th January and were attributed to a rainfall event (alert mode only). These results indicate the adverse effect that heavy rainfall can have on the microbiological water quality of Hawke's Bays rivers. Of the remaining three exceedances *not* related to rainfall, two were re-sampled and had returned to back ground levels by the second sample. This appears to be the typical result expected from re-sampling of Hawke's Bay waters. The third sample was unable to be collected on the next day but had returned to background levels at the next sampling run.

4.1.3 Estuarine and Freshwater (with a tidal influence) Recreational Sites

This season also introduced dual sampling for *Enterococci and E. coli* at eleven selected estuarine or freshwater sites where tidal fluctuations periodically render them brackish. This was undertaken to ensure that the pathogen tested for, gave a true 'picture' or indication of water health at these recreational sites. The rationale behind this is that *E. coli* survival rates are much reduced in brackish water (Anderson *et al*, 1979) whereas *Enterococci* are more tolerant and remain as indicators of faecal contamination even when the tide is 'in' at the sampling points (Donnison, 1998 in Stansfield, 2003).

Therefore the indicator (*Enterococci* or *E. coli*) selected for as correct would be determined by the conductivity value. For conductivity values over 10,000 µS/cm water was considered brackish and Enterococci taken as the more appropriate indicator of water bacterial counts. *Enterococci* are not considered an appropriate indicator of faecal contamination in fresh water as it also has a possible vegetative source whereas *E. coli* is almost exclusively from the gut of mammals (MfE & MoH, 2003).

At all sites there was 100% compliance with the **action** mode *two-consecutive exceedance* guideline for *Enterococci* (Table 4). However just three sites stayed under the **green** mode surveillance level of 140 cfu/100ml. Of the sites that strayed into **alert** mode the counts were sufficient to also place them into **action** mode *single sample*. Of the total eleven sites, three were 100% compliant, four were 95% compliant, 3 were 90% compliant and one site the Tukituki at Black Bridge was 85% compliant. All exceedances were either resampled (except at Puhokio Stream – as already explained) or attributed to rainfall events (see Appendix 3). In all cases Enterococci counts had returned to background levels by the following sample.

Table 4: Range of *Enterococci* results at Freshwater (with a tidal influence) / Estuarine sites and compliance with guidelines 2008/09

Site	Mean Electrical Conductivity in µS/cm	Minimum	Maximum	*Enterococci* % compliance with:		
				Alert Mode	Action Mode Single Sample	Action Mode Two-Consecutive Exceedance
		cfu *Enterococci* /100ml	cfu *Enterococci* /100ml	140 cfu *Enterococci* /100ml	280 cfu *Enterococci* /100ml	280 cfu *Enterococci* /100ml
Clive River @ SH2 Bridge	15047	<1	700	95	95	100
Kairakau Lagoon	27338	<1	60	100	100	100
Maraetotara Lagoon	375	<1	410	95	95	100
Maungawhio Lagoon	37171	<1	320	95	95	100
Pandora Pond	47000	<1	57	100	100	100
Porangahau Estuary	41972	<1	17	100	100	100
Puhokio Stream @ Waimarama	4587	<1	920	90	90	100
Tukituki River @ Black Bridge	654	<1	750	85	85	100
Waipatiki Lagoon	3450	<1	540	95	95	100
Waipuka Stream @ Ocean Beach	25977	<1	570	90	90	100
Wairoa River @ Ski Club	6172	<1	220	90	90	100

Compliance rates for the same sites but based on *E.coli* counts are as follows; seven of the eleven sites achieved 100% compliance with the **action** mode, with the remainder at 95% except Puhokio Stream which achieved 85% compliance (Table 5).For the more stringent **alert** mode six achieved 100% compliance for the 08/09 season and four achieved 95% compliance while Puhokio Stream achieved just 75%.

Table 5: Range of *Ecoli* results at Freshwater (with a tidal influence) / Estuarine sites and compliance with guidelines 2008/09

Site	Mean Electrical Conductivity in µS/cm	Minimum	Maximum	*E. coli* % compliance with:	
				Alert Mode	Action Mode
		cfu *E. coli*/100ml	cfu *E. coli*/100ml	260 cfu *E. coli*/100ml	550 cfu *E. coli*/100ml
Clive River @ SH2 Bridge	15047	<1	420	95	100
Kairakau Lagoon	27338	<1	230	100	100
Maraetotara Lagoon	375	20	560	95	95
Maungawhio Lagoon	37171	<1	47	100	100
Pandora Pond	47000	<1	52	100	100
Porangahau Estuary	41972	1	5	100	100
Puhokio Stream @ Waimarama	4587	<1	970	75	85
Tukituki River @ Black Bridge	654	12	62	100	100
Waipatiki Lagoon	3450	<1	510	95	95
Waipuka Stream @ Ocean Beach	25977	1	780	95	95
Wairoa River @ Ski Club	6172	13	150	100	100

Comparison of compliance rates for the two indicator parameters is interesting and reveals that selecting the most appropriate parameter is necessary to give a true indication of overall suitability for recreation at a particular site. However this must also be considered in the context of salinity values at the time of sampling. For example, testing of *E.coli* only at the Puhokio Stream can be misleading as it indicates 90% compliance with action mode Ministry guidelines for recreation; but if the indicator sampled for is Enterococci then this drops to just 85% compliance for the action and 75% for alert mode (Table 6). However if conductivity values are considered in conjunction then it becomes apparent that over the course of the sampling season the waters at this site were predominantly fresh in which case Enterococci becomes an unreliable indicator due to its possible source options (i.e vegetation)

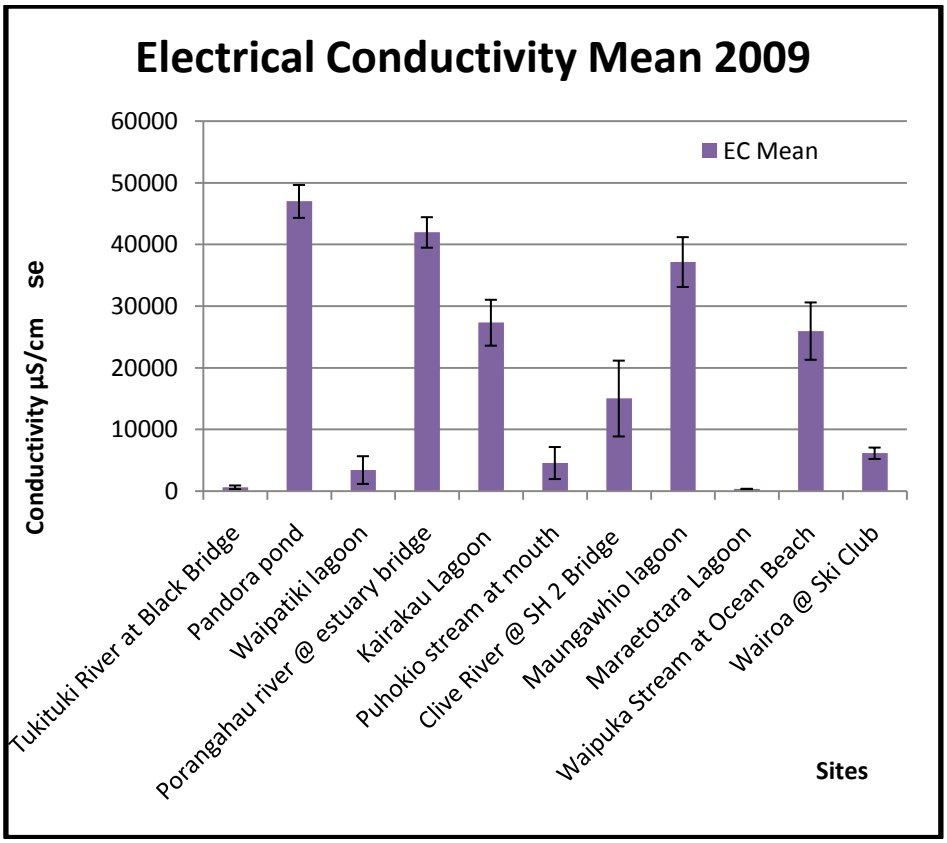
Similarly Maungawhio Lagoon and Wairoa are 100% compliant for *E.coli* but reveal exceedances if the indicator parameter is Enterococci (see Figure 2 for conductivity means at these sites). The appropriate indicator for these and other sites will be discussed below.

Table 6: Comparison of *E.coli* and *Enterococci* compliance rates at Freshwater (with a tidal influence) and Estuarine sites for 2008/09

Site	Mean Electrical Conductivity in µS/cm	*E. coli* % compliance with:		*Enterococci* % compliance with:		
		Alert Mode	Action Mode	Alert Mode	Action Mode Single Sample	Action ModeTwo-Consecutive Exceedance Guideline
		260 cfu *E. coli*/100ml	550 cfu *E. coli*/100ml	140 cfu *Enterococci* /100ml	280 cfu *Enterococci*/ /100ml	280 cfu *Enterococci*/10 0ml
Clive River @ SH2 Bridge	15047	95	100	95	95	100
Kairakau Lagoon	27338	100	100	100	100	100
Maraetotara Lagoon	375	95	95	95	95	100
Maungawhio Lagoon	37171	100	100	95	95	100
Pandora Pond	47000	100	100	100	100	100
Porangahau Estuary	41972	100	100	100	100	100
Puhokio Stream @ Waimarama	4587	75	85	90	90	100
Tukituki River @ Black Bridge	654	100	100	85	85	100
Waipatiki Lagoon	3450	95	95	95	95	100
Waipuka Stream @ Ocean Beach	25977	95	95	90	90	100
Wairoa River @ Ski Club	6172	100	100	95	100	100

The above table (Table 6) reveals that at the estuarine sites (where the salinity is consistently high - Waipatiki, Kairakau, and Maraetotara lagoons, Pandora Pond and Poragahau estuary) exceedances for both indicators correlate quite well – that is, when there is an exceedance for E.*coli* there is similarly an exceedance for *Enterococci.* However at the all freshwater sites (Clive, Wairoa and Tukituki River, Puhokio and Waipuka Stream) and one estuarine site (with low salinity due to a protective gravel bar - Maungawhio) the results between indicators vary. Therefore while it appears either indicator (E.*coli* or *Enterococci*) will give the same picture of suitability for recreation at the estuarine sites (where the salinity is consistently high), when it comes to the freshwater sites the indicator parameter tested for, and relied on, may have to be determined based on conductivity/salinity levels.

Figure 2: The electrical conductivity mean for each site over the 2008/09 season



After analysing the results from the 2008/09 sampling and based on the electrical conductivity means from each site (Figure 2) the following have been determined as the most appropriate indicator for each site for the 2009/10 season (see Table 7). While it is felt this method will give a more robust indication of suitability for recreation it is also acknowledged this will have an implication on the long term trends due to the (at some sites) change in indicators.

Table 7: The preferred indicator for the 2009/10 season based on results from 2008/09

Site	Preferred Indicator
Clive River @ SH2 Bridge	Both / with conductivity values to determine the most appropriate
Kairakau Lagoon	Both / with conductivity values to determine the most appropriate
Maraetotara Lagoon	E.coli
Maungawhio Lagoon	Enterococci
Pandora Pond	Enterococci
Porangahau Estuary	Enterococci
Puhokio Stream @ Waimarama	E.coli
Tukituki River @ Black Bridge	E.coli
Waipatiki Lagoon	E.coli
Waipuka Stream @ Ocean Beach	Both / with conductivity values to determine the most appropriate
Wairoa River @ Ski Club	Both / with conductivity values to determine the most appropriate

4.1.4 Shellfish Gathering Sites

In addition to the recreational bathing water sampling, five sites where monitored to assess their suitability for shellfish gathering (Figure 3). The sites where chosen from areas identified as having significant shellfish populations based upon information from discussions with TLA's and the Hawke's Bay District Health Board.

All of the five sites sampled were within end of season guideline values. The guidelines stipulate that no more than 10% of samples can exceed a faecal coliform MPN (Most Probable Number) value of 43/100ml. The results for Te Awanga, Kairakau and Waipatiki were very good with 0% of samples exceeding a faecal coliform MPN of 43/100ml. Ahuriri Estuary had 5% of samples exceeding a MPN of 43/100ml - still well within guidelines; while Mahia came close to non-compliance having exactly 10% of samples that exceeded a faecal coliform MPN value of 43/100ml. This is an improvement on the previous season where four of the five sampled sites achieved compliance with Ministry guidelines. This could be a reflection of the generally below average rainfall rate in Hawke's Bay for the 2008/09 season (see Appendix 4).

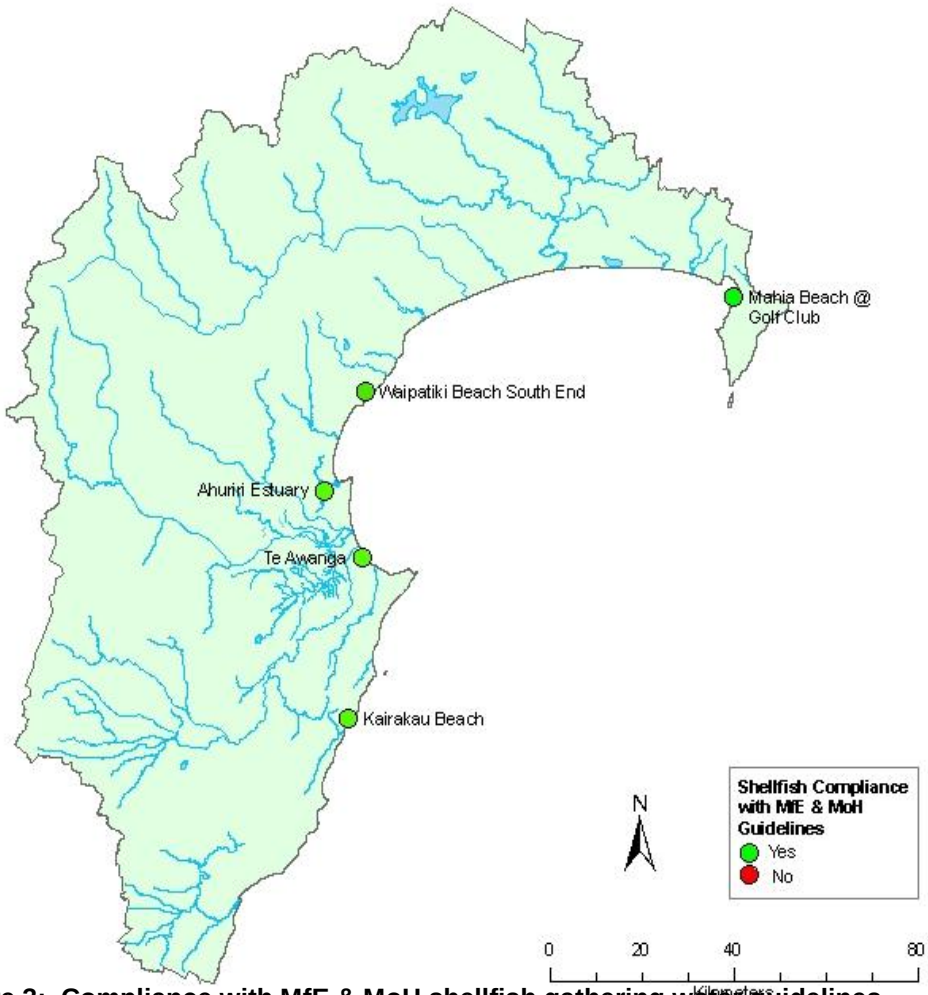


Figure 3: Compliance with MfE & MoH shellfish gathering water guidelines.

4.2 Long-term trends

Comparison of the current seasons results with that of previous years, to detect changes and trends in the microbial water quality of Hawke's Bays waters, is hindered by changing guideline values, sampling techniques (e.g. depth of sampling within the water column), and variable weather which can all impact on bacterial levels. However, it was considered that statistical analysis of water quality trends could be viable using data from the previous nine seasons due to the consistent sampling methodology over this timeframe. While the data cannot be corrected for flow, and it is not possible to remove the effect of variable weather which can impact on bacterial levels, it was considered that the duration of the data set is sufficient to buffer these effects.

4.2.4 Trend Detection

With the exception of Mahia Beach which showed decreased bacterial counts over the last nine seasons, there has been no significant trend in the bacterial levels of other marine sites suggesting that microbiological water quality in marine waters is fairly stable (Table 8).

Table 8: Trend analysis for sites between 2000 and 2009 (decreasing trends correspond to decreases in the level of bacteria and thus increases in water quality).

Site Name	Trend	Slope	Significant	*N*
Blackhead Beach	No Trend			170
Clive River @ SH2 Bridge	Decrease	-4.39642 E.coli (cfu/100ml)	Yes	161
Esk River @ Eskdale Park	No Trend			179
Hardinge Road Beach	No Trend			169
Kairakau Beach	No Trend			169
Kairakau Lagoon	Decrease	-4.86804 E.coli (cfu/100ml)	Yes	179
Lake Tutira @ Camping Ground	No Trend			180
Mahanga Beach	No Trend			110
Mahia Beach	Decrease	-2.71992 Enterococci (cfu/100ml)	Yes	180
Maraetotara Lagoon	Decrease	-1.97 E.coli (cfu/100ml)	Yes	180
Maungawhio Lagoon	No Trend			160
Ngaruroro River @ Chesterhope	No Trend			179
Ocean Beach	No Trend			169
Opoutama Beach	No Trend			170
Pandora Pond	No Trend			180
Porangahau Beach	No Trend			159
Pourerere Beach	No Trend			129
Puhokio	Decrease	-3.73979 E coli (cfu/100ml)	Yes	161
Tukituki River @ Black Bridge	Decrease	-3.05689 E.coli (cfu/100ml)	Yes	159
Tukituki River @ SH2 Waipukurau	No Trend			160
Tutaekuri River @ Pakowhai Road Bridge	Decrease	-2.85627 E.coli (cfu/100ml)	Yes	180
Waimarama Beach	No Trend			170
Waipatiki Lagoon	Decrease	-2.87666 E.coli (cfu/100ml)	Yes	180
Wairoa River	Decrease	-3.35319 E.coli (cfu/100ml)	Yes	180
Waipatiki Beach	No Trend			170
Waipuka Stream @ Ocean Beach	No Trend			180
Westshore Beach	No Trend			170

Eight of the freshwater and estuarine sites showed significant decreases in bacterial numbers (based on *E.coli*) including Kairakau Lagoon, Maraetotara lagoon, Waipatiki lagoon, Puhokio Stream, Tukituki River at Blackbridge, Wairoa River, Clive River and the Tutaekuri River at Pakowhai Bridge (Table 7).

Ongoing land management and increased awareness of preventing stock access in streams may be starting to have observable effects in water quality. In addition it should be noted that occasionally the indicator sampled for does not illustrate the whole picture. As an example, the Clive River at SH2 Bridge and the Wairoa River at the Ski Club, were 100% compliant in 08/09 for *E.coli* and yet both showed exceedances for Enterococci. These results are the first from the new dual sampling regime.

Dual sampling of these sites will continue to be conducted and the appropriate indicator then selected based on conductivity readings, to enable better detection of health risk.

4.2.5 Suitability for Recreation Grades

The Suitability for Recreation Grade (SFRG) is assessed using data from the previous five years. As Aramoana,Te Awanga and Porangahau Estuary sites have only been in the programme since the 2005-06 season, insufficient information exists to grade them with total confidence. However they can be assigned an interim grade. This interim grade will be reassessed and a full grade included in the 2009/10 report. Overall grades for the SFRG for the past five years, for all other sites, were reviewed with the inclusion of the 2008/09 data and are presented in Table 9. For a full description of the grades see appendix 4.

Table 9: Comparison of SFRG's for 2008/09

Site Name	SFRG 2009	SFRG 2008	SFRG 2007	SFRG 2006	Comments
Aramoana Beach	Very good	Ungraded	Ungraded	Ungraded	Interim Grade only
Blackhead Beach	Very good	Very Good	Very Good	Follow-up/Fair	Unchanged
Clive River	Very poor	Very Poor	Very Poor	Very Poor	Unchanged
Esk River	Fair	Fair	Fair	Poor	Unchanged
Hardinge Road Beach	Good	Good	Good	Good	Unchanged
Kairakau Beach	Very good	Good	Good	Good	Improved - Change in MAC from B-A, 95%ile from 42 to 31
Kairakau Lagoon	Poor	Poor	Poor	Poor	Unchanged
Lake Tutira	Very Poor	Very Poor	Very Poor	Very Poor	Unchanged
Mahanga Beach	Very Good	Very Good	Very Good	Very Good	Unchanged
Mahia Beach	Good	*Good*	Very Good	Follow-up/Fair	Manually altered from Very Good to Good due to some issues with septic tanks particularly after heavy rain.
Maraetotara Lagoon	Poor	Poor	Poor	Poor	Unchanged
Maungawhio Lagoon	Good	Poor	Fair	Poor	Improved - Change in MAC from D-B, 95%ile from 685 to 162
Ngaruroro River	Fair	Fair	Fair	Good	Unchanged
Ocean Beach	Very Good	Very Good	Very Good	Very Good	Unchanged
Opoutama Beach	Good	Fair	Poor	Fair	Improved - Change in MAC from C to B, 95%ile from 210 to 106
Pandora Pond	Good	Good	Good	Good	Unchanged
Porangahau Beach	Very Good	Very Good	Very Good	Very Good	Unchanged
Porangahau Estuary	Good	Ungraded	Ungraded	Ungraded	Interim Grade only – manually changed from Very Good due to WW treatment plant discharging upstream.
Pourerere Beach	Very Good	Very Good	Very Good	Very Good	Unchanged
Puhokio Stream	Very Poor	Very Poor	Very Poor	Very Poor	Unchanged
Te Awanga	Good	Ungraded	Ungraded	Ungraded	Interim Grade only
Tukituki River at Blackbridge	Fair	Fair	Fair	Fair	Unchanged
Tukituki River at Waipukurau	Fair	Fair	Fair	Poor	Unchanged
Tutaekuri River	Fair	Fair	Good	Fair	Unchanged
Waimarama Beach	Good	Fair	Good	Good	Improved - Change in MAC from C-B, 95%ile from 275 to 113
Waipatiki Beach	Good	Good	Good	Good	Unchanged
Waipatiki Lagoon	Very Poor	Very Poor	Very Poor	Very Poor	Unchanged
Waipuka Stream	Poor	Poor	Poor	Fair	Unchanged
Wairoa River	Fair	Poor	Poor	Poor	Improved- Change in MAC from D-C, 95%ile from 750 to 350
Westshore Beach	Very Good	Very Good	Very Good	Very Good	Unchanged

Five sites showed an improvement in grade related to a shift in the Microbiological Assessment Category (MAC). The MAC category is based on the 95%ile of indicator counts, so changes to this

category can reflect improvements in water quality within the past 5 years (i.e. including data from 2005).

At Waimarama beach the shift to Fair in 2008 was caused by a single exceedance in the 2007/08 season. This caused the MAC to change from B to C and therefore the grade from Good to Fair. It was predicted that the following season, providing there were no spikes, would see it return to Good and this turned out to be the case.

Mahia Beach site was manually placed into the Good category from the Very Good grade based on known potential concerns with individual septic tank systems, which can at times pose a risk. This change is reflected in the Sanitary Inspection Category of the assessment rather than the MAC, which improved from a 95%ile of 195 to 148.

Overall the changes in grades reflect the sensitivity of the software to small changes in the 95%ile which can affect the MAC grade category and subsequently the Suitability for Recreation Grade. Whether these represent general improvements or declines in the environmental quality relies on a subjective assessment of the rate and magnitude of any change. For a comparison of *all* years, for *all* sites regarding compliance percentages with alert and action modes see Table 10 and 11.

Table 10: Comparison of seasons 2002-2009 for freshwater and estuarine sites

Site	% Compliance with Alert Mode (260 *E. coli* /100ml)								% Compliance with Action Mode (550 *E. coli* /100ml)							
	2002	2003	2004	2005	2006	2007	2008	2009	2002	2003	2004	2005	2006	2007	2008	2009
Clive River @ SH2 Bridge*	70	70	70	55	90	100	90	95	95	90	90	85	95	100	90	100
Esk River @ Eskdale Park	90	90	90	90	90	90	90	90	90	95	95	95	95	100	100	90
Kairakau Lagoon	75	80	90	90	90	100	85	100	85	80	95	90	95	100	90	100
Lake Tutira @ Camping Ground	100	95	95	70	95	95	80	100	100	95	95	75	95	95	85	100
Maraetotara Lagoon	80	90	90	75	95	85	80	95	95	95	95	95	95	90	95	95
Maungawhio Lagoon	N/S	100	85	95	95	100	85	100	N/S	100	90	95	95	100	90	100
Ngaruroro River @ Chesterhope	90	100	90	100	95	80	90	95	95	100	95	100	95	100	100	100
Pandora Pond	90	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Porangahau Estuary	N/S	N/S	N/S	N/S	95	100	100	100	N/S	N/S	N/S	N/S	100	100	100	100
Puhokio Stream @ Waimarama*	65	80	55	40	90	50	60	75	80	85	80	80	95	67	80	85
Tukituki River @ Black Bridge	N/S	90	95	95	90	85	95	95	n/s	100	95	100	90	100	100	95
Tukituki River @ SH2 Waipukurau	85	100	80	75	90	100	85	95	90	100	90	95	95	100	100	100
Tutaekuri River @ Pakowhai Rd	90	100	95	95	90	100	95	95	100	100	100	95	95	100	100	100
Waipatiki Lagoon	75	80	65	80	85	75	60	100	80	85	85	85	95	95	75	100
Waipuka Stream @ Ocean Beach	75	85	85	70	90	85	80	95	85	90	90	85	90	100	90	95
Wairoa River @ Ski Club	75	90	75	75	95	85	90	100	85	90	90	85	95	100	95	100

* These sites were sampled fortnightly.

Table 11: Comparison of seasons 2002- 2009 for marine sites

Site	% Compliance with Alert Mode (140 *Enterococci* /100ml)								% Compliance with Action Mode (280 *Enterococci* /100ml)							
	2002	2003	2004	2005	2006	2007	2008	2009	2002	2003	2004	2005	2006	2007	2008	2009
Aramoana Beach	N/S	N/S	N/S	N/S	100	100	95	100	N/S	N/S	N/S	N/S	100	100	95	100
Blackhead Beach	N/S	100	95	90	100	100	90	100	N/S	100	95	90	100	100	95	100
Hardinge Road Beach	85	100	90	95	95	100	100	95	100	100	95	95	95	100	100	100
Kairakau Beach	95	100	95	95	100	100	95	100	95	100	95	100	100	100	100	100
Mahanga Beach	N/S	N/S	N/S	95	90	100	90	95	N/S	N/S	N/S	100	95	100	95	95
Mahia Beach	90	95	85	95	90	100	95	100	95	100	85	95	100	100	100	100
Ocean Beach	90	100	100	100	95	100	100	95	95	100	100	100	95	100	100	100
Opoutama Beach	95	90	90	90	95	100	100	95	100	90	90	90	95	100	100	95
Porangahau Beach	95	100	100	95	100	95	95	100	95	100	100	100	100	95	95	100
Pourerere Beach	N/S	N/S	100	95	100	100	100	100	N/S	N/S	100	95	100	100	100	100
Te Awanga Coastal	N/S	N/S	N/S	N/S	100	90	100	100	N/S	N/S	N/S	N/S	100	95	100	100
Waimarama Beach	100	100	90	85	100	100	95	100	100	100	90	90	100	100	95	100
Waipatiki Beach	100	100	95	90	95	100	100	95	100	100	95	90	95	100	100	100
Westshore Beach	95	100	100	90	100	100	95	100	100	100	100	95	100	100	95	100

5 DISCUSSION

As with the 2007/08 season, marine sites in Hawke's Bay have shown a reasonable level of compliance with recreational water quality guidelines - supporting their use as a contact recreation resource. Whilst high bacterial numbers can occasionally occur in quantities that could pose a significant health risk, follow-up sampling has shown these events to be short-lived. Results tend to return to surveillance mode prior to reaching the two consecutive sample action level as set out in the Microbiological guidelines (MfE and MoH, 2003). Of the just six elevated bacterial counts for the 08/09 season five occurred on the same day (Appendix 3). Two of those were attributed to rainfall events and three were re-sampled. All revealed a rapid return to background levels. The other elevated count occurred exactly one week prior to the others and yet all were around the time of high intensity usage associated with the festive season (5th -12th January). Thus it is possible that elevated counts in marine areas may be related to the volume of visitors and subsequent loading on wastewater and septic systems.

The marine sites sampled under the current programme did not highlight any significant water quality issues and in general it could be said marine areas appear to be less influenced by the effects of rainfall than the freshwater and estuarine sites sampled. Hawke's Bay marine water quality continues to support contact recreation activities most, if not all of the time.

Microbiological water quality in the freshwater and estuarine sites shows higher variability, and water quality appears to be compromised at a number of sites. A few sites have maintained a high level of water quality however some persistent problem areas are repeatedly highlighted each season (e.g. Puhokio stream). As with the marine sites, a 'run' of exceedances occurred on the same day – the 12th January (see earlier comment). However of the eight exceedances that occurred (out of a total sixteen for the season) on that day, the majority of them were attributed to rainfall events (seven of the eight).

The exceedances observed in the freshwater and estuarine areas during the 2008/09 programme are reasonably evenly divided between being rainfall related events and not being attributed to rainfall events. If the results for Puhokio stream are disregarded (due to the consistently high bacteria counts) then the remaining eleven alert/action mode exceedances are split thus, with six (recorded on the same day) related to a rainfall event and five unrelated to a high rainfall event, and occurring in periods of dry weather and in the absence of any obvious external sources.

Therefore it can be seen that rainfall events adversely impact on the water quality of Hawke's Bay. This can be explained by the influx of surface run-off, carrying bacteria sourced from the excreta of land based animals, and the resuspension of streambed sediments which can harbour bacteria. As for the non-rainfall related events, a possible explanation is that in areas where fine sediments dominate, sediment resuspension occurring through disturbance by swimmers or wind-induced wave action may increase bacteria numbers in the overlying waters. Given the potential for sediments to harbour, and subsequently resuspend bacteria, it may be possible that high bacterial levels at a given sampling time, may not originate from a discharge or by direct runoff, but from the resuspension of sediments by bathers.

The results for the shellfish gathering waters reveal that all of the five sites sampled were suitable for shellfish gathering based on seasonal medians. This is an improvement on last year when four of the five achieved full compliance.

In general, rainfall for Hawke's Bay was 30% below normal for the 2008/09 season (see Appendix 5). This undoubtedly, was a factor in the overall good water quality seen throughout the region for the season.

6 RECOMMENDATIONS

1. That Hawke's Bay Regional Council continue to monitor freshwater, estuarine and marine bathing and shellfish gathering sites in accordance with the Ministry for the Environment and Ministry for Health guidelines;

2. That follow-up exceedance sampling for sites only be undertaken where the cause of the exceedance cannot be attributed to rainfall. Compliance of marine sites will need to be assessed under the more stringent single-sample exceedance if follow-up sampling of rainfall related exceedances is not proposed for these areas;

3. That follow-up sampling after an exceedance event at Puhokio Stream not be undertaken, unless there is reasonable cause to believe that the exceedance is extraordinary. Permanent signage is currently in place warning swimmers of the risk associated with this site;

4. That monitoring of shellfish gathering waters in accordance with MfE and MoH guidelines be continued for the 2009/10 season;

5. That the monthly report visually showing the percentage compliance for freshwater, estuarine and marine sites continues to be produced, circulated internally and made available to the public via the regional councils website;

6. That sampling at Clive River and Puhokio Stream be undertaken fortnightly as these sites are fully graded, have a 'Very Poor' grade, and are permanently sign-posted. Ocean, Pourerere, Westshore and Porangahau Beaches could also be considered for reduced monitoring as these sites are fully graded as 'Very Good' and have retained this grade over the past four years.

7. That Pandora Pond, Maungawhio Lagoon and Porangahau Estuary are monitored for Enterococci and Faecal coliforms as these sites have been shown to be sufficiently saline/brackish to warrant the use of additional indicators.

8. That Clive River, Wairoa River, Waipuka Stream and Kairakau Lagoon, continue to be monitored for conductivity to assess the appropriateness of *E.coli* or *Enterococci* as the most appropriate indicator for each site at the time of sampling.

9. That Maraetotara lagoon, Puhokio Stream, Tukituki River and Waipatiki lagoon continue to be monitored for E.*coli* only as conductivity readings from these sites over the 2008/09 sampling season indicate a predominantly freshwater environment.

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Appendix 1

Site Descriptions

Marine Sites

Aramoana
Aramoana is a recent addition to the monitoring programme due to the development of a coastal subdivision and its associated expected increase in recreational water users. It stands at the northern boundary of the Te Angiangi marine reserve that receives increasing numbers of users each year.

Blackhead Beach
Blackhead Beach is the main access point to the Te Angiangi Marine Reserve, and is a popular swimming and recreation spot. There is a small settlement with holiday baches and two camping grounds.

Hardinge Rd. Beach
The beach at Hardinge Road is close to a number of recreational facilities, including a children's playground, beachfront walkway and ice cream parlour in close proximity to the sampling site. The beach is adjacent to the entrance to the inner harbour and the Port of Napier.

Kairakau Beach
Kairakau Beach is a popular spot for fishing, boating, surfing and diving. There is a small settlement with holiday baches, a camping ground and a few permanent residents. Over recent years, some erosion has occurred at this beach, making access to the beach difficult. The Kairakau Lagoon discharges at the southern end of the beach.

Mahanga Beach
On the northern side of the Mahia Peninsula, Mahanga Beach has a small resident population and a number of holiday baches. This area is currently expanding, with subdivision occurring inland toward the Mahia road. At present, the settlement is serviced solely by septic tanks.

Mahia Beach
Mahia Beach is a small settlement on the southern side of the Mahia Peninsula. The population of this settlement increases markedly in summer months due to the influx of holidaymakers using the baches and camping ground in the area. The settlement is serviced solely by septic tanks, and there is a stormwater drain out into the marine area near the boat ramp. Subdivision is occurring rapidly in this location with several new developments underway throughout the sampling season, and pressure on camping space has increased with the closure of the nearby Opoutama campsite.

Ocean Beach
Ocean Beach is a popular surf and swimming beach due to its close proximity to Napier and Hastings and the presence of a surf lifesaving patrol. The Waipuka Stream (mentioned below) discharges into the south-eastern end of the beach. Samples at this site are taken in main swimming area, immediately in front of the surf lifesaving tower.

Opoutama Beach
Opoutama Beach is located on the south side of the Mahia Peninsula. The only resident population includes a few lifestyle blocks. Subdivision of the former campsite is continuing. The Opoutama Stream runs into the western side of the beach, after draining a small agricultural catchment. The beach is commonly used for swimming and other recreational activities in the summer months.

Porangahau Beach
Porangahau Beach, located approximately 40km south east of Waipukurau is used for swimming, fishing and other recreational activities. There are no direct discharges in the vicinity of the beach, although the Porangahau River discharges approximately 10km north of the beach. The Porangahau Township is serviced by a community sewage treatment system.

Pourerere Beach
Pourerere Beach, in southern Hawke's Bay, is a popular holiday destination. The township is comprised of a number of holiday homes, as well as some permanent residents. The community is serviced solely by individual septic tank systems.

Te Awanga
The Te Awanga site is adjacent to the Maraetotara Lagoon sampling site and has been included in the sampling programme to reflect the high number of users at this site. It has a recognised surf break that at times attracts large numbers of surfers. The site has a reef environment as well as being the discharge point for the Maraetotara River.

Waimarama Beach
Due to its close proximity to Napier and Hastings, and the presence of a surf lifesaving patrol, Waimarama Beach remains a popular swimming beach. The beach has both a large resident population as well as numerous visitors over the summer season. The Puhokio Stream (see below) discharges into the northern end of the beach.

Waipatiki Beach
Waipatiki is a small settlement located approximately 20km north of Napier and consisting of a number of baches, a campground, and a small resident population. The area at the rear of the back dunes and on the headland is currently under development, and a community sewage treatment system has recently been installed. It's close proximity to Napier and Hastings makes it popular for day excursions. There is a small stream/lagoon, which drains into the beach (see Waipatiki Lagoon below).

Westshore Beach
Westshore Beach is located to the north of Napier city, and is popular with both locals and holidaymakers. A patrolled surf lifesaving club adds to the appeal of the beach. There are a number of stormwater discharges into the marine area near the beach, but these do not seem to affect the water quality at this beach.

Freshwater and Estuarine Sites

Clive River at State Highway 2 Bridge (Boat Ramp)
The Clive River catchment passes through pastoral, horticultural, viticultural, industrial and urban areas, as well as receiving all the stormwater from Hastings City. The river is used extensively for recreational use, particularly rowing, water skiing and jet skiing.

Esk River
The Esk River drains a moderately sized, rural catchment. It does not pass through or near any urban centres prior to discharging into the Bay between Whirinaki and Bayview. The sampling site is at Eskdale Park, which is a popular area for families.

Kairakau Lagoon
The Kairakau Lagoon is formed at the mouth of the Mangakuri River, which passes through a predominantly pastoral catchment before discharging into the ocean at Kairakau. The lagoon is situated close to the camping ground and is frequently used for fishing, boating and swimming, particularly by children.

Lake Tutira
Lake Tutira is one of the largest lakes in Hawke's Bay and is located approximately 50km north of Napier. It is a common camping/holiday site over the summer period, and is regularly used for canoeing, swimming, fishing and boating. In addition, this site is a country park, with significant birdlife. The sampling site is located at the boat ramp opposite the main campground.

Maraetotara Lagoon
The Maraetotara River enters the coast via the Maraetotara Lagoon at Te Awanga, after passing through predominantly pastoral land. Due to the low flow in the river, and sea swells at the beach, the mouth of the river is closed through much of the summer period. The Te Awanga camping ground is situated beside the northern embankment of the lower Maraetotara River, and the sample site is directly south of the main car park. Te Awanga is popular due to its good surf break and its close proximity to Cape Kidnappers and the gannet colony.

Maungawhio Lagoon
The Maungawhio Lagoon is located on the northern side of the Mahia Peninsula, and is formed by the Kopuawhara Stream. The lagoon has been identified as a Significant Area in Hawke's Bays Regional

Coastal Plan (HBRC, 1999), and is both an important fish spawning area, breeding and roosting area for variety of water birds. The lagoon is regularly used for swimming, fishing and shellfish gathering.

Ngaruroro River at Chesterhope Bridge
The site at Chesterhope Bridge is a popular bathing spot during the summer for locals from Napier and Hastings. The Ngaruroro River drains a catchment that is predominantly agricultural in the upper reaches, and used for intensive horticulture in the lower reaches. The Hawke's Bay Regional Council maintains this area for easy public access to the river.

Pandora Pond
Pandora Pond is a small, sheltered area of Ahuriri Estuary, separated from the main estuary by a spit, and located close to Napier. It is frequently used for water based recreational activities including swimming, kayaking, rowing and sailing. There has been a shift toward apartment style living in the vicinity of the sampling site so user numbers are expected to increase as the development is completed. The majority of Napier's stormwater discharges into the Ahuriri Estuary upstream of the site, and the Pandora Pond area itself is adjacent to a number of industries.

Puhokio Stream at Waimarama Beach
The Puhokio Stream drains a small, steep, agricultural catchment before passing through the settlement of Waimarama and discharging at the northern end of the beach. The warm temperatures and slow flowing lagoon type nature of the stream makes it particularly popular with children. In the past, the stream has repeatedly shown high levels of faecal contamination, predominantly sourced from agriculture, but also influenced by on-site wastewater treatment systems.

Porangahau Estuary
The sample location is directly down-stream of wastewater plant's discharge and is a boat launch ramp.

Tukituki River at Black Bridge
The Tukituki River drains the Ruataniwha Plains area, before passing through agricultural land on its way to Hawke Bay just south of Clive. The sampling site at Black Bridge is in the tidal part of the river, and is regularly used for swimming and other recreational activities.

Tukituki River at SH2, Waipukurau
The Tukituki River drains the Ruataniwha Plains area, before flowing through Waipukurau on its way to the coast at Haumoana. The river, in the vicinity of the SH2 bridge, is a popular swimming spot in the summer.

Tutaekuri River at Pakowhai Rd. Bridge
The Tutaekuri River drains a predominantly agricultural and forested catchment, with some intensive horticultural activities in the lower reaches. The recreational site at the Pakowhai Rd Bridge is a popular bathing spot, which can be accessed from the end of Guppy Rd in Taradale. The Hawke's Bay Regional Council has endeavoured to make this area more accessible to the public for recreational activities.

Waipatiki Lagoon
The Waipatiki Lagoon is formed by the Waipatiki Stream which drains a small, predominantly agricultural and forestry hill catchment, before flowing through the settlement of Waipatiki. This site frequently exceeds the Alert and Action guideline levels. In the past, evidence has suggested that the contamination of the stream is primarily faecal material from malfunctioning septic tanks in the settlement. The area has recently been upgraded to a community sewage treatment system with the majority of baches and houses connected.

Waipuka Stream at Ocean Beach
The Waipuka Stream flows through a small, steep, agricultural catchment before discharging into Hawke Bay at the eastern side of Ocean Beach. The stream also passes by baches at the small community, and often forms a lagoon, which is popular with small children.

Wairoa River (Boat ramp)
The Wairoa River is one of the largest rivers in Hawke's Bay, and consequently has a large catchment in which the predominant land use is sheep and beef farming, with some dairying also occurring. The sampling site is at the Water Ski Club in the Wairoa township, and the river is tidal at this point.There are

a number of discharges (in addition to the agricultural land use), which may affect the water quality at this site. Frasertown Meats is located upstream of the sampling site, and downstream discharges include Affco Wairoa and the municipal sewage discharge from Wairoa township. Additionally, there are a number of stormwater drains which flow into the river, and both active and closed landfills near the mouth of the river.

Shellfish Gathering Waters

Ahuriri Lagoon
This site is located on the true left bank of the Estuary approximately 40m upstream of the Pandora road bridge. It receives considerable fishing pressure throughout the year for cockles.

Kairakau Beach
The Kairakau Beach site is the same as for the recreational water quality monitoring site. The Kairakau Lagoon discharges at the southern end of the beach.

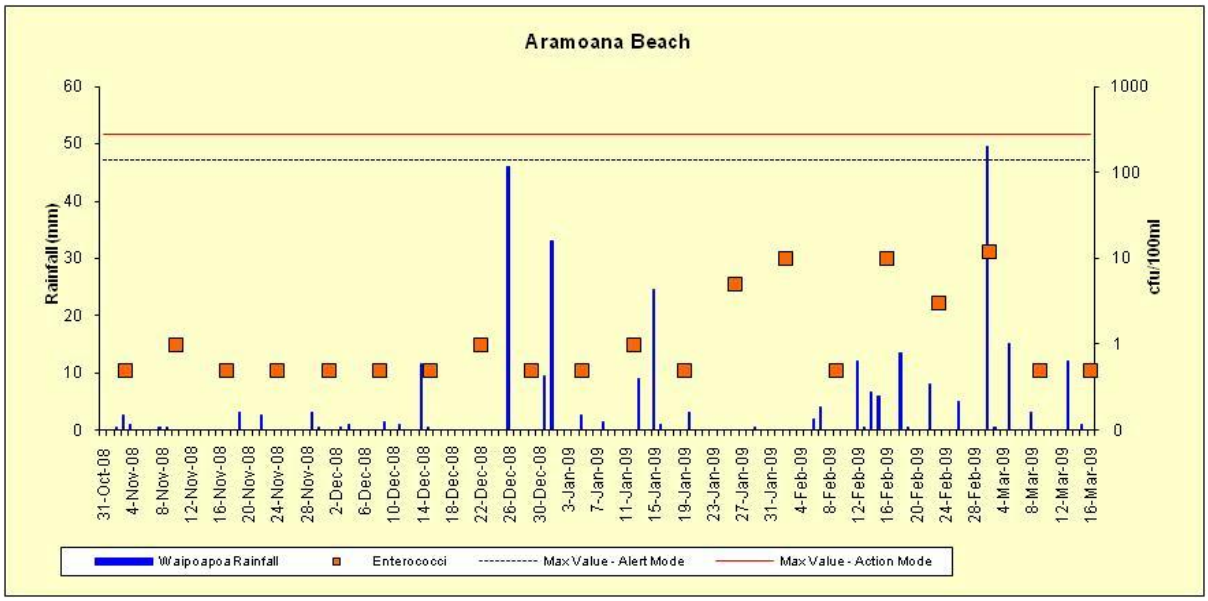
Mahia Beach at the Golf Club
This site falls between the Mahia Beach and Opoutama Beach recreational water quality sites. It is located adjacent to a well known pipi bed that receives considerable fishing pressure during the summer months. The site is accessed via the walkway that departs directly opposite the entrance to the Mahia Beach golf Club.

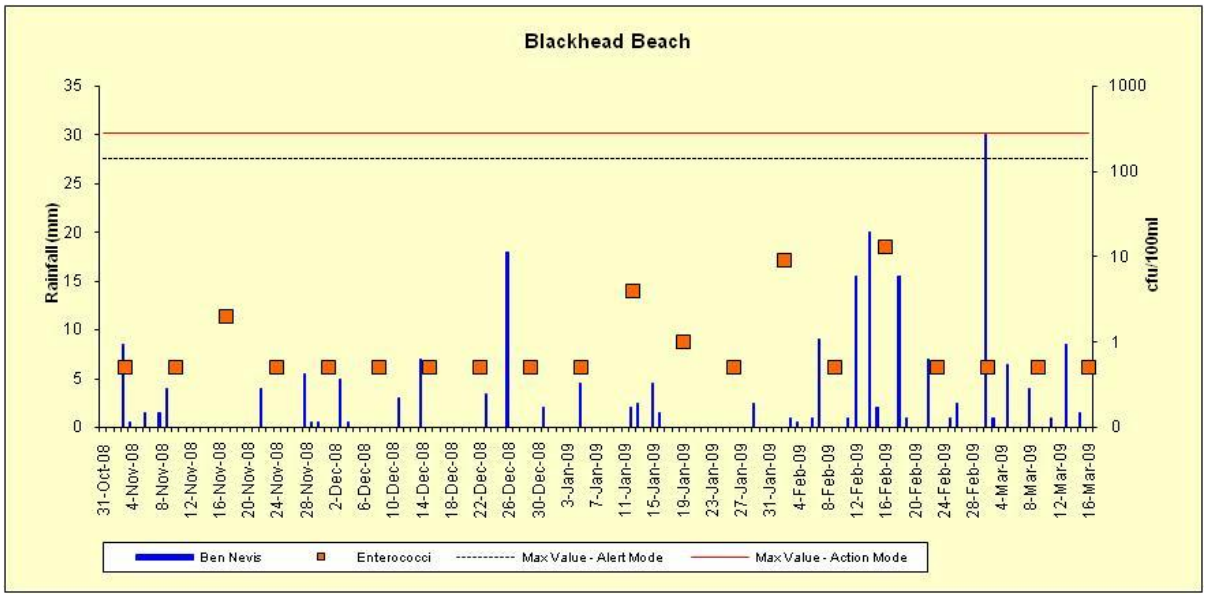
Te Awanga Coastal
The Te Awanga site is sampled at the same location as the Te Awanga recreational water quality site. The site has a reef environment historically known to harbour mussels.

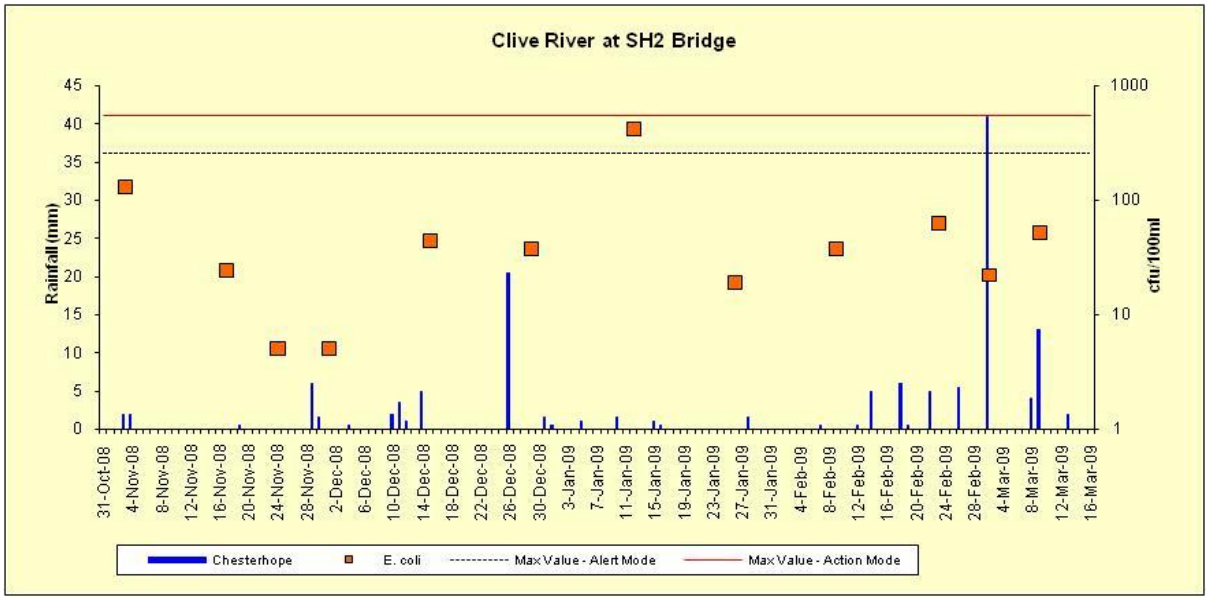
Waipatiki Beach
Waipatiki's close proximity to Napier and Hastings makes it popular for day excursions and for the collection of shellfish. Sampling is carried approximately 100m south of the Bathing beach site, near the start of the rocky reef system. There is a small stream/lagoon, which drains into the beach adjacent to the sampling site.

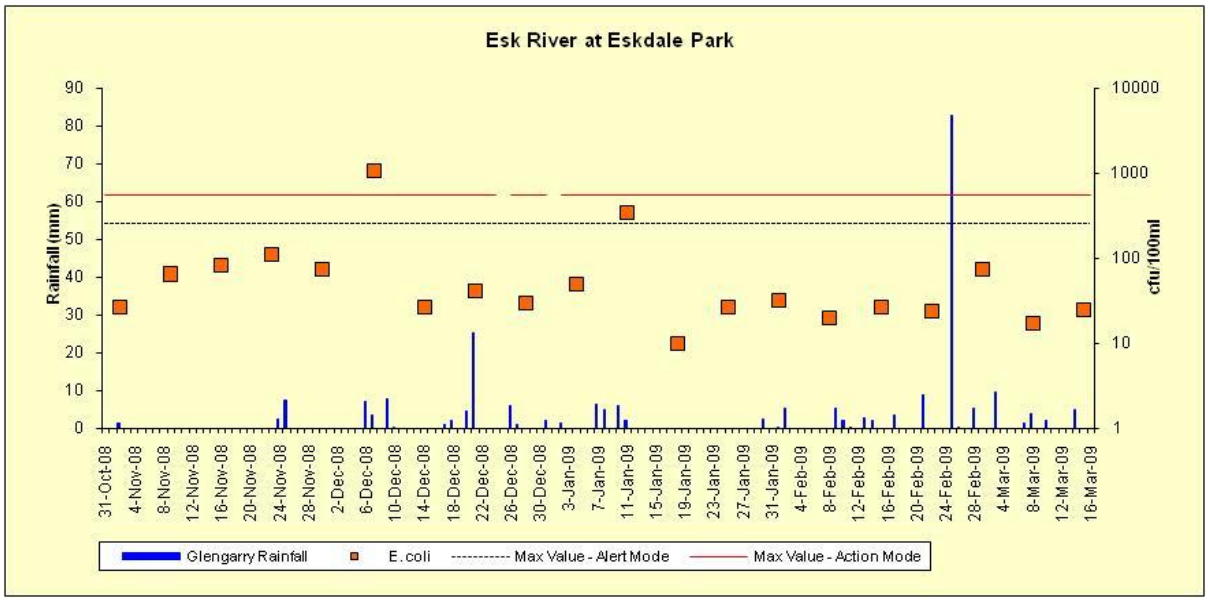
Appendix 2

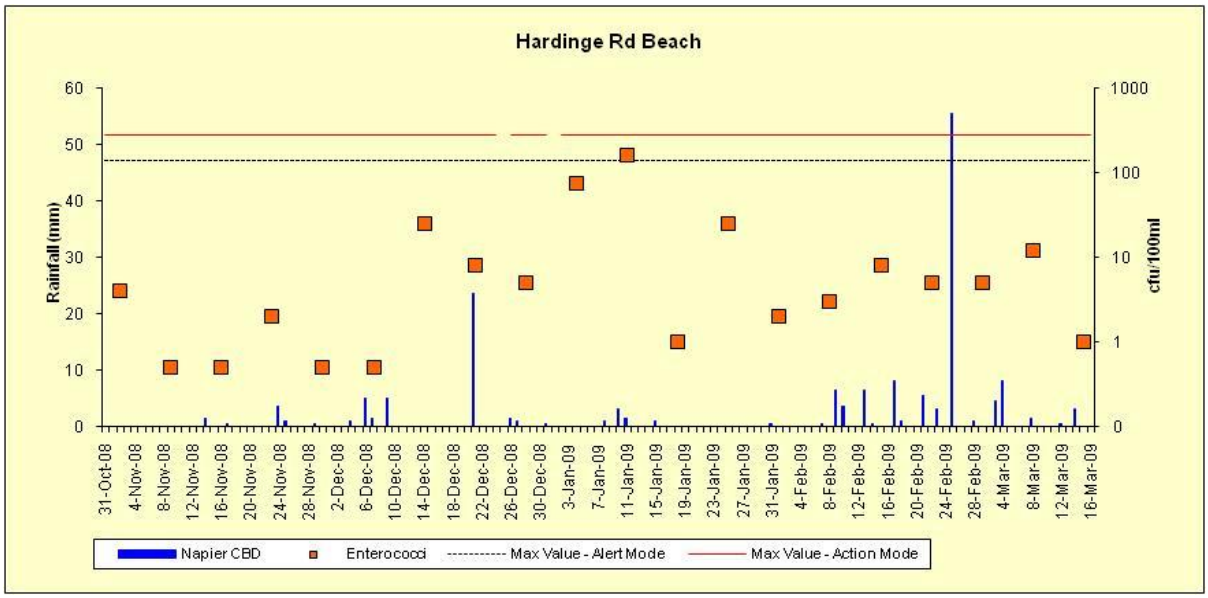
Results Graphs

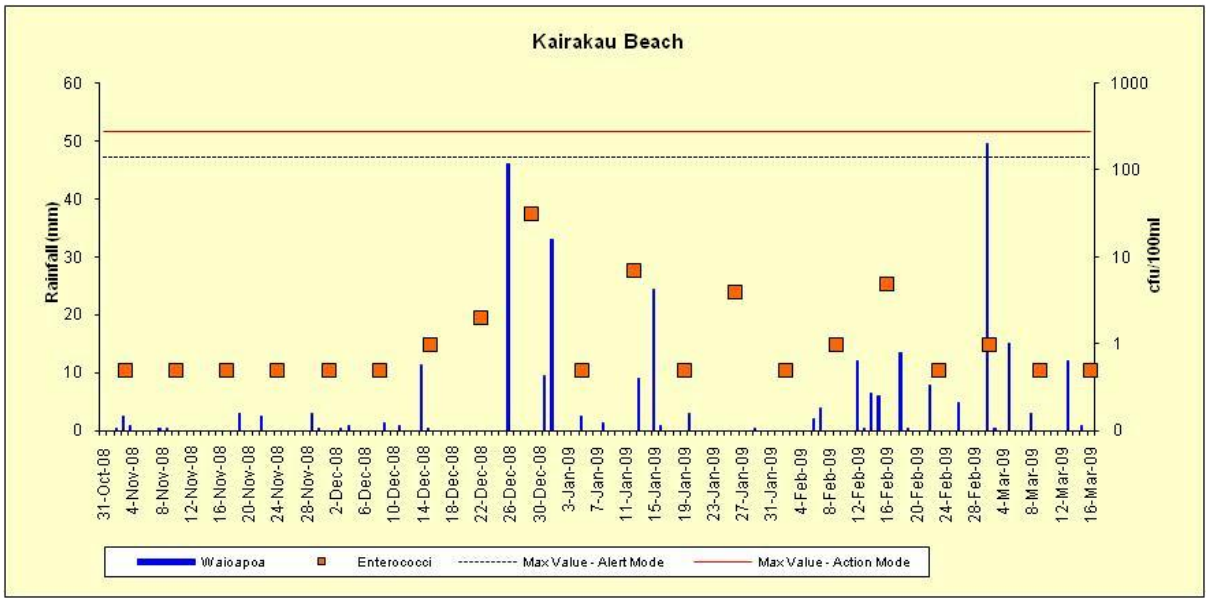

Aramoana Beach
Rainfall (mm)
cfu/100ml
Waipoapoa Rainfall
Enterococci
Max Value - Alert Mode
Max Value - Action Mode

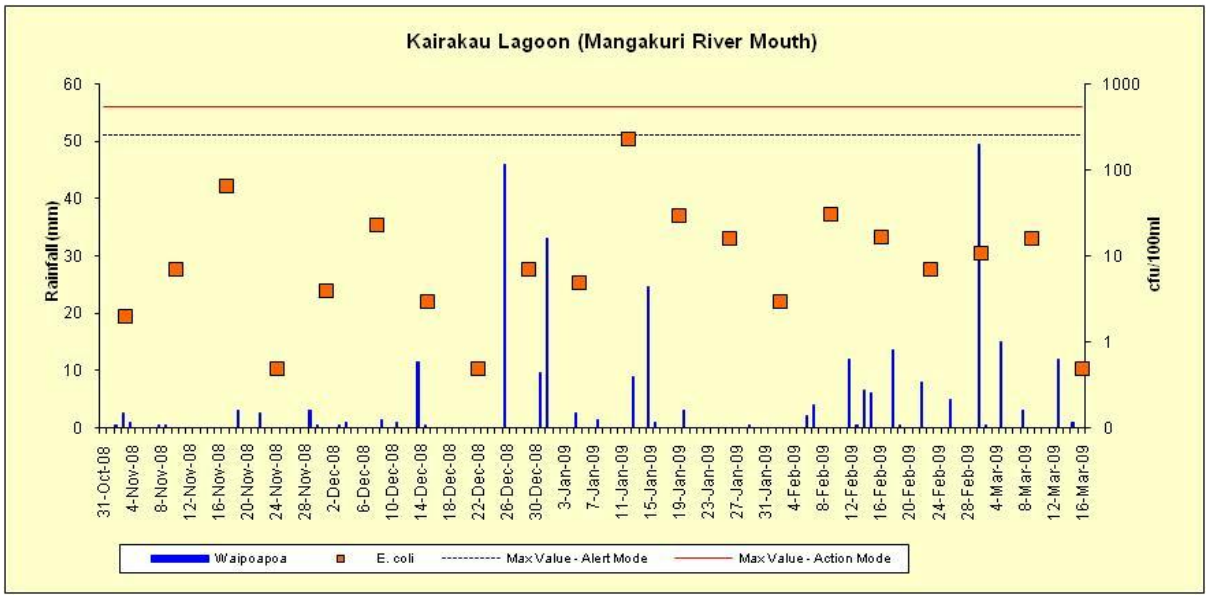

Blackhead Beach
Rainfall (mm)
cfu/100ml
Ben Nevis
Enterococci
Max Value - Alert Mode
Max Value - Action Mode

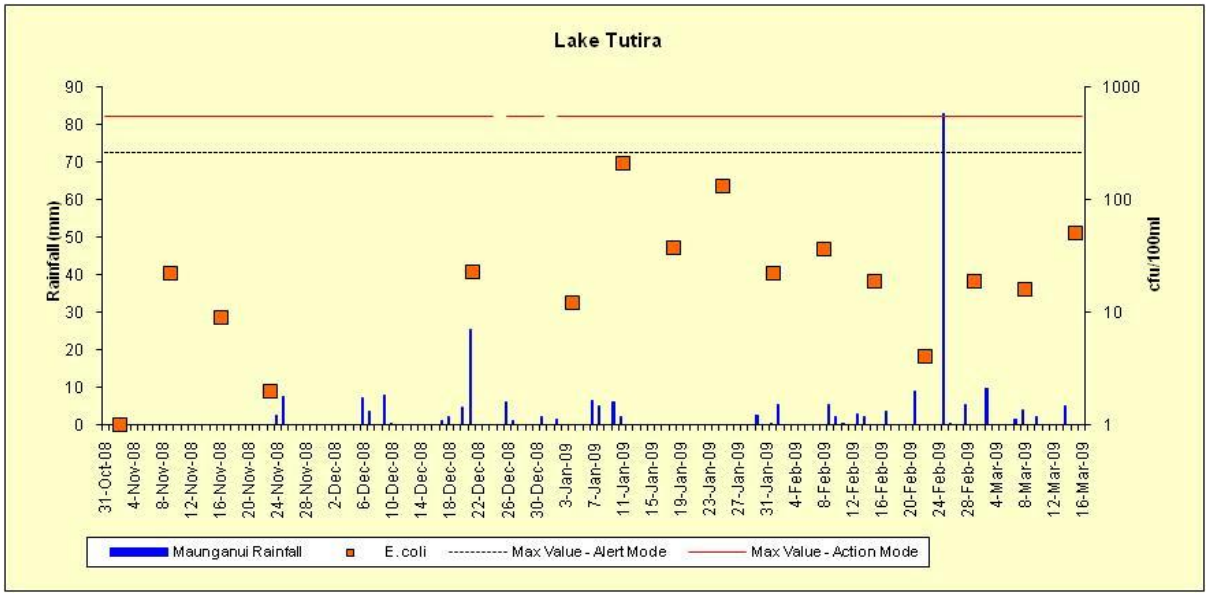

Clive River at SH2 Bridge
Rainfall (mm)
cfu/100ml
Chesterhope
E. coli
Max Value - Alert Mode
Max Value - Action Mode

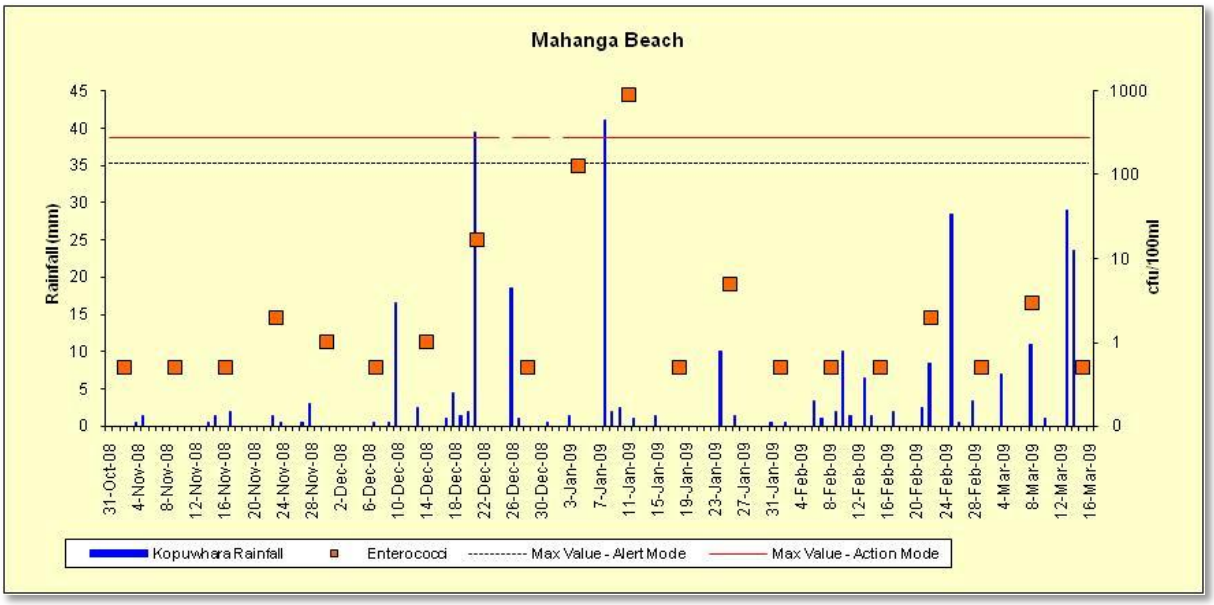

Esk River at Eskdale Park
Rainfall (mm)
cfu/100ml
Glengarry Rainfall
E.coli
Max Value - Alert Mode
Max Value - Action Mode

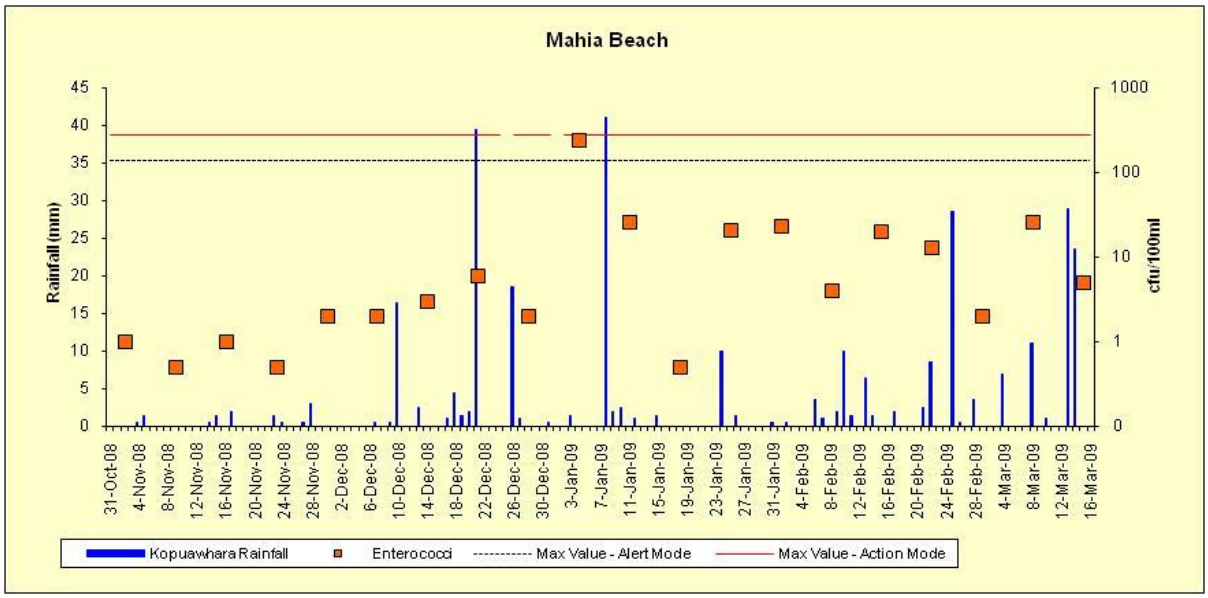

Hardinge Rd Beach
Rainfall (mm)
cfu/100ml
Napier CBD
Enterococci
Max Value - Alert Mode
Max Value - Action Mode

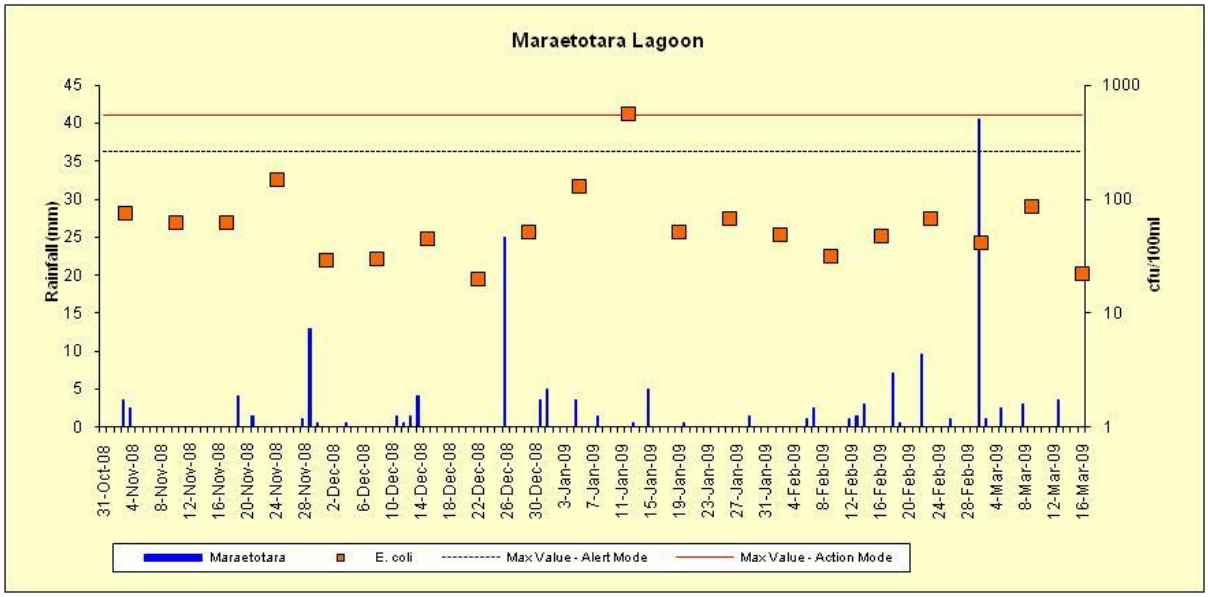

Kairakau Beach
Rainfall (mm)
cfu/100ml
Waioapoa
Enterococci
Max Value - Alert Mode
Max Value - Action Mode

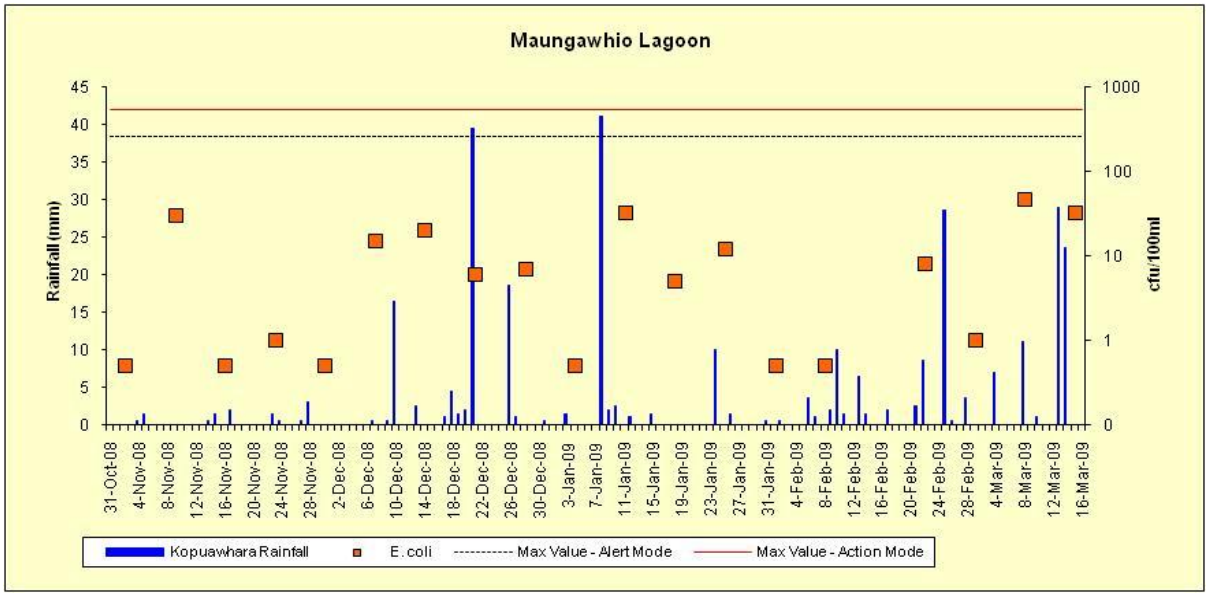

Kairakau Lagoon (Mangakuri River Mouth)
Rainfall (mm)
cfu/100ml
Waipoapoa
E. coli
Max Value - Alert Mode
Max Value - Action Mode

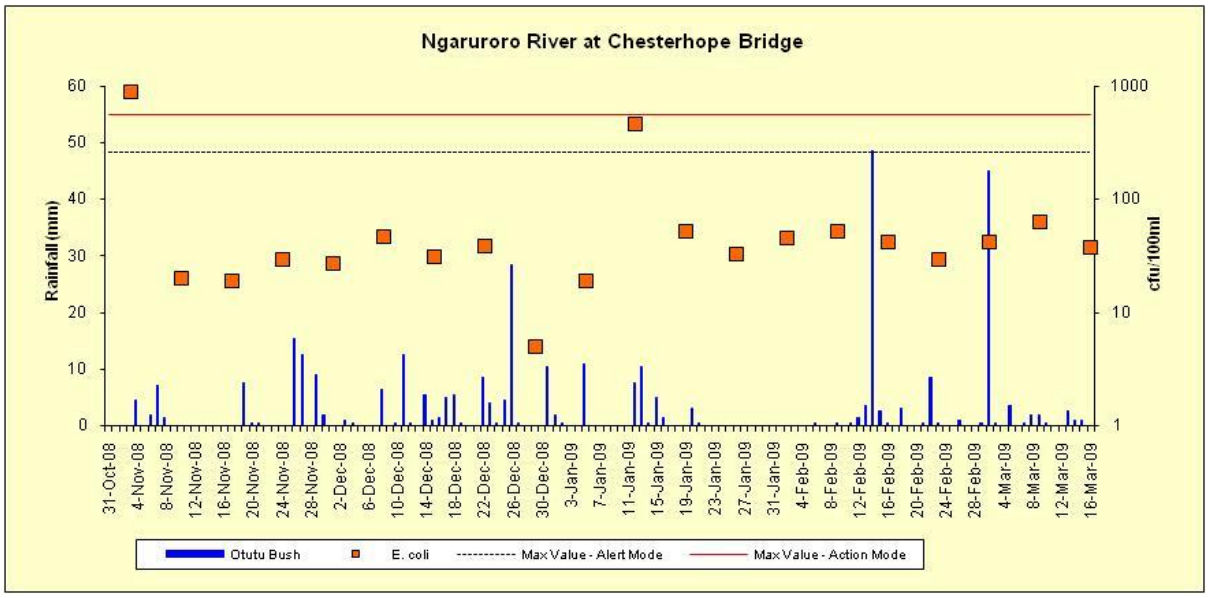

Lake Tutira
Rainfall (mm)
cfu/100ml
Maunganui Rainfall
E. coli
Max Value - Alert Mode
Max Value - Action Mode

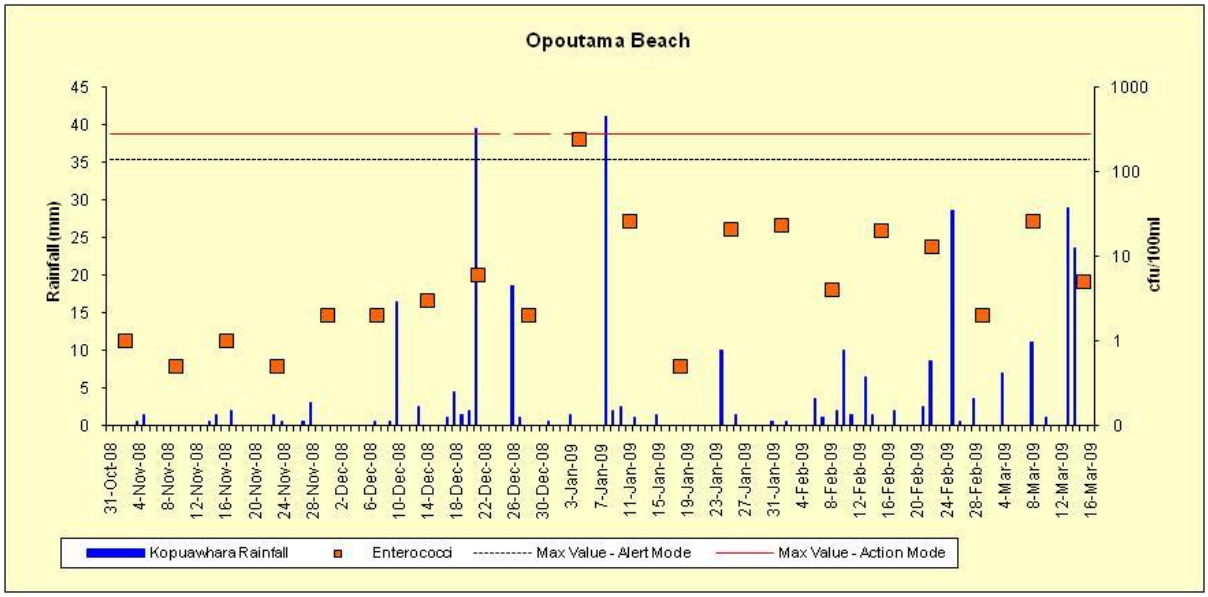

Mahanga Beach
Rainfall (mm)
cfu/100ml
Kopuwhara Rainfall
Enterococci
Max Value - Alert Mode
Max Value - Action Mode

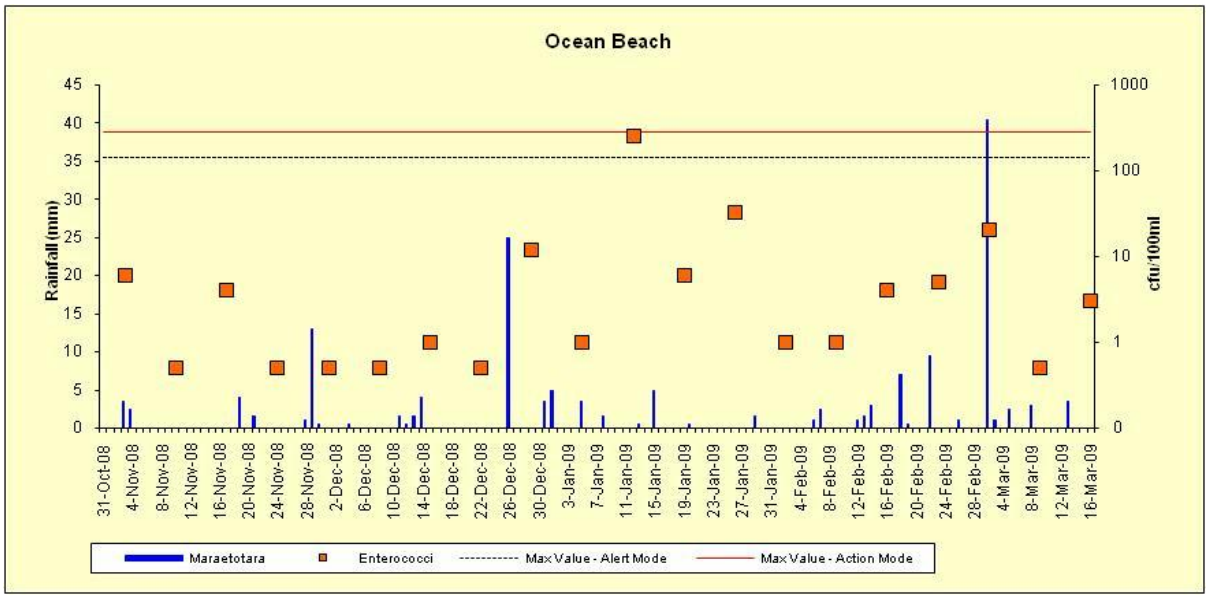

Mahia Beach
Rainfall (mm)
cfu/100ml
Kopuawhara Rainfall
Enterococci
Max Value - Alert Mode
Max Value - Action Mode

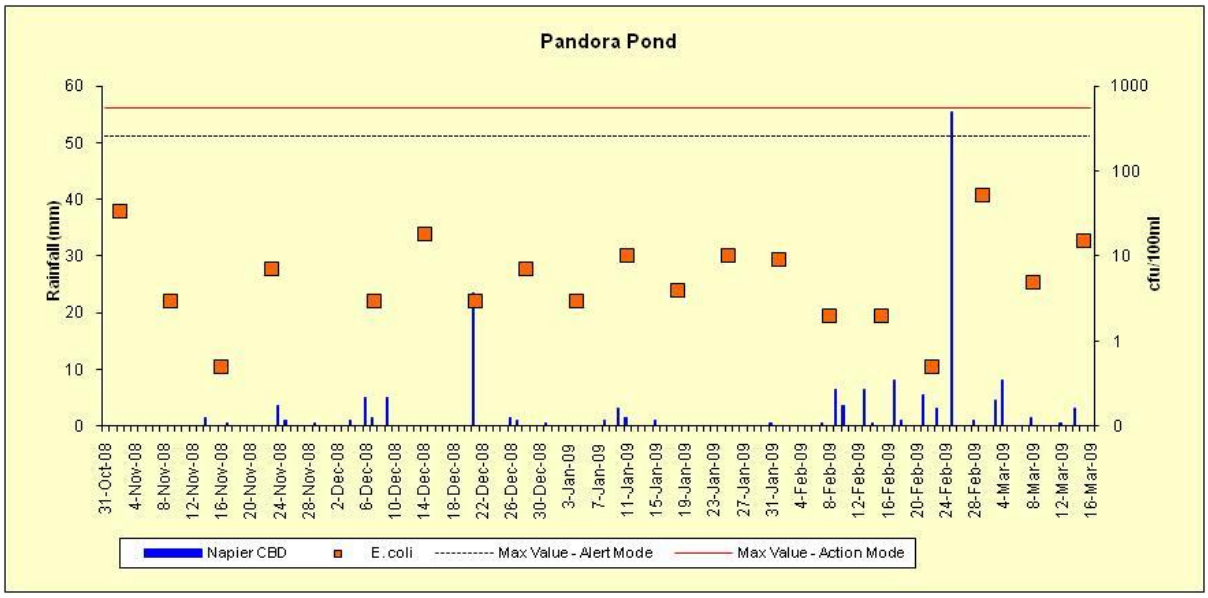

Maraetotara Lagoon
Rainfall (mm)
cfu/100ml
Maraetotara
E. coli
Max Value - Alert Mode
Max Value - Action Mode

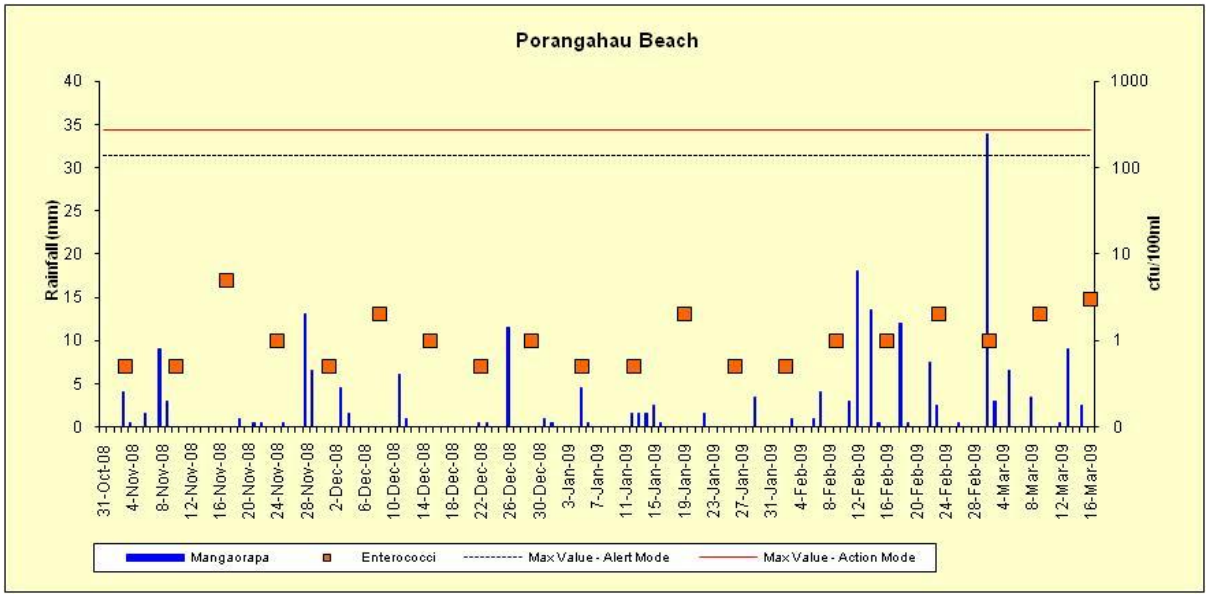

Maungawhio Lagoon
Rainfall (mm)
cfu/100ml
Kopuawhara Rainfall
E. coli
Max Value - Alert Mode
Max Value - Action Mode

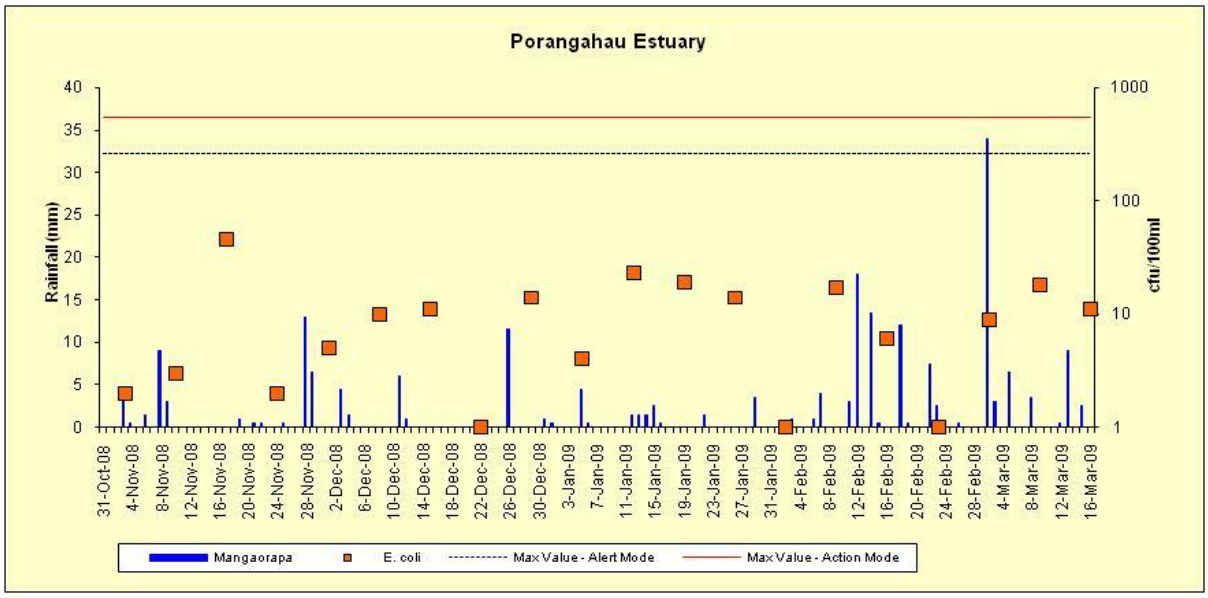

Ngaruroro River at Chesterhope Bridge
Rainfall (mm)
cfu/100ml
Otutu Bush
E. coli
Max Value - Alert Mode
Max Value - Action Mode


Opoutama Beach
Rainfall (mm)
cfu/100ml
Kopuawhara Rainfall
Enterococci
Max Value - Alert Mode
Max Value - Action Mode


Ocean Beach
Rainfall (mm)
cfu/100ml
Maraetotara
Enterococci
Max Value - Alert Mode
Max Value - Action Mode


Pandora Pond
Rainfall (mm)
cfu/100ml
Napier CBD
E. coli
Max Value - Alert Mode
Max Value - Action Mode


Porangahau Beach
Rainfall (mm)
cfu/100ml
Mangaorapa
Enterococci
Max Value - Alert Mode
Max Value - Action Mode


Porangahau Estuary
Rainfall (mm)
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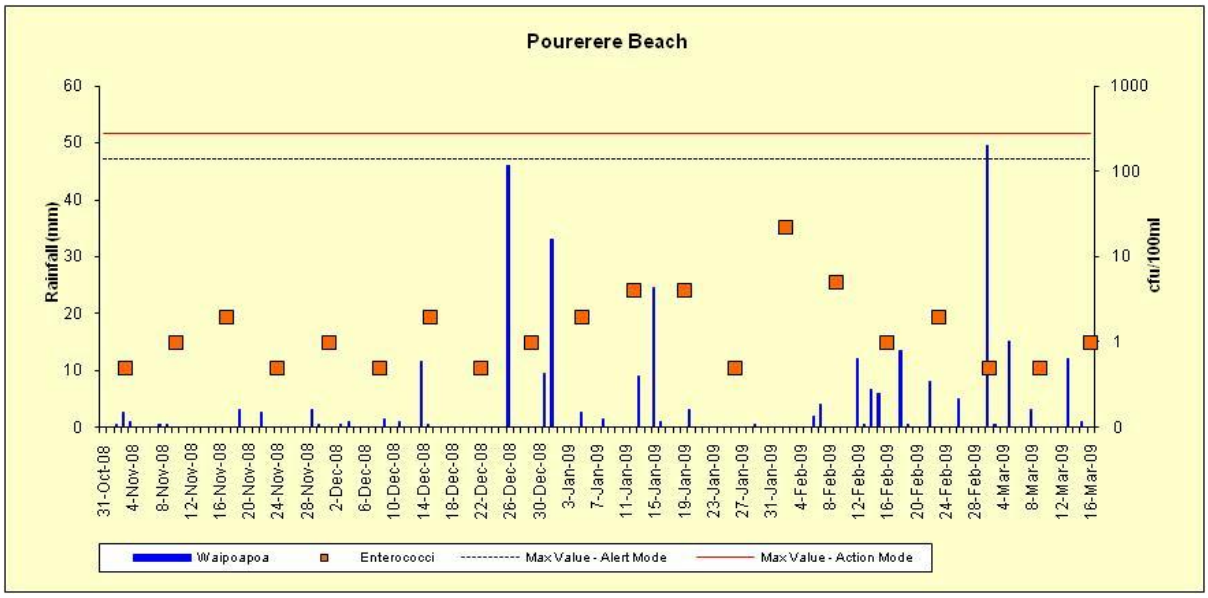
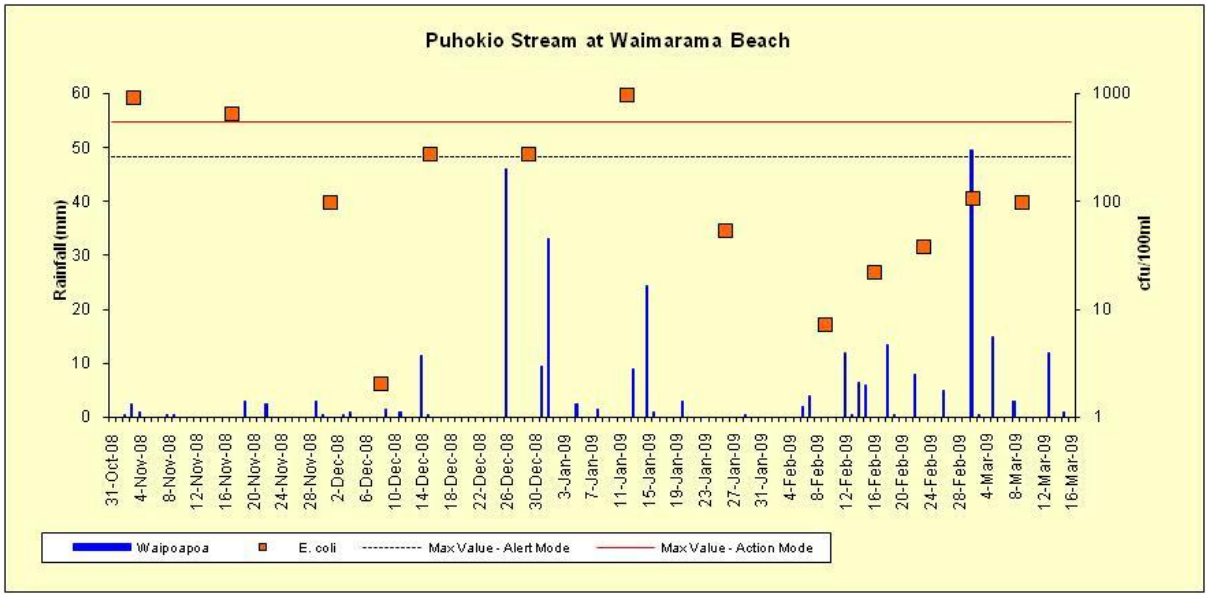
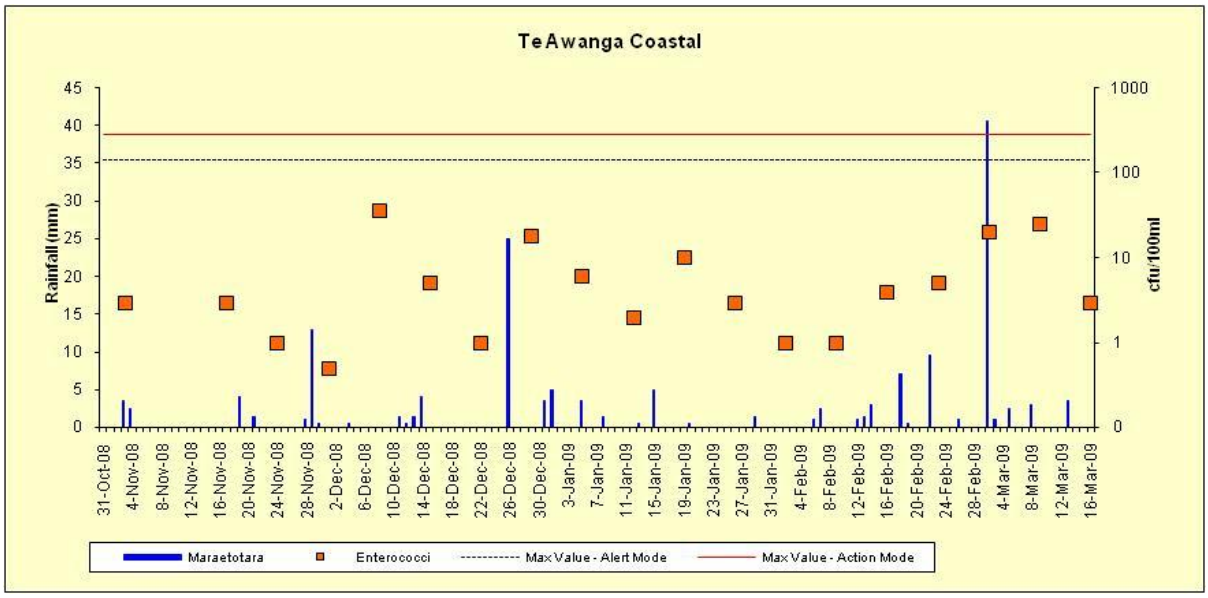
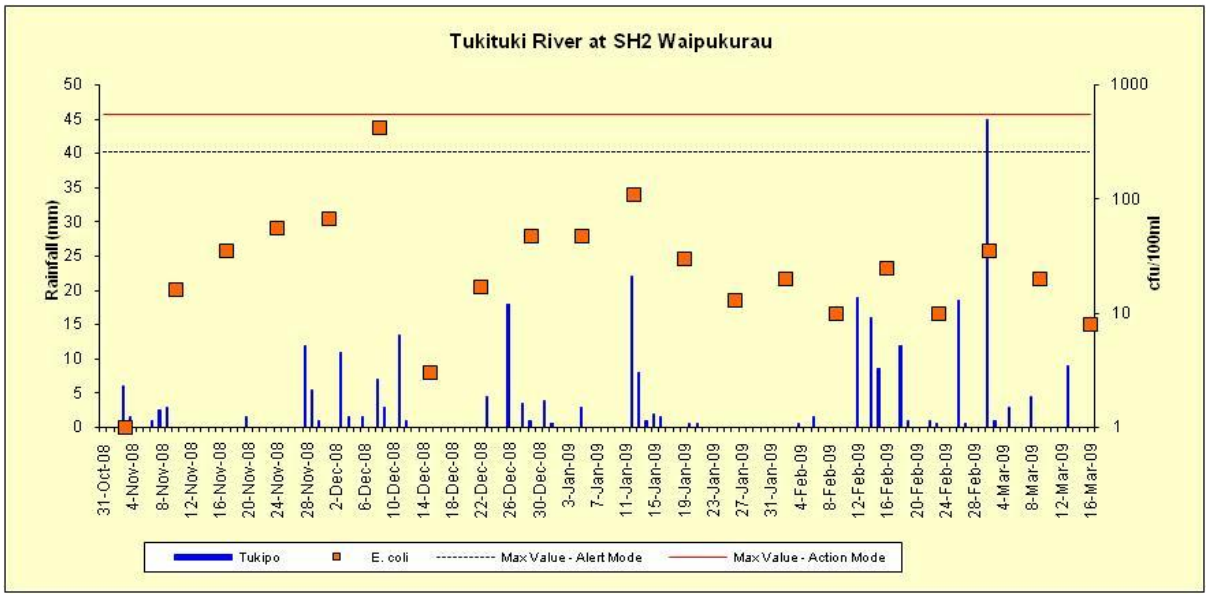
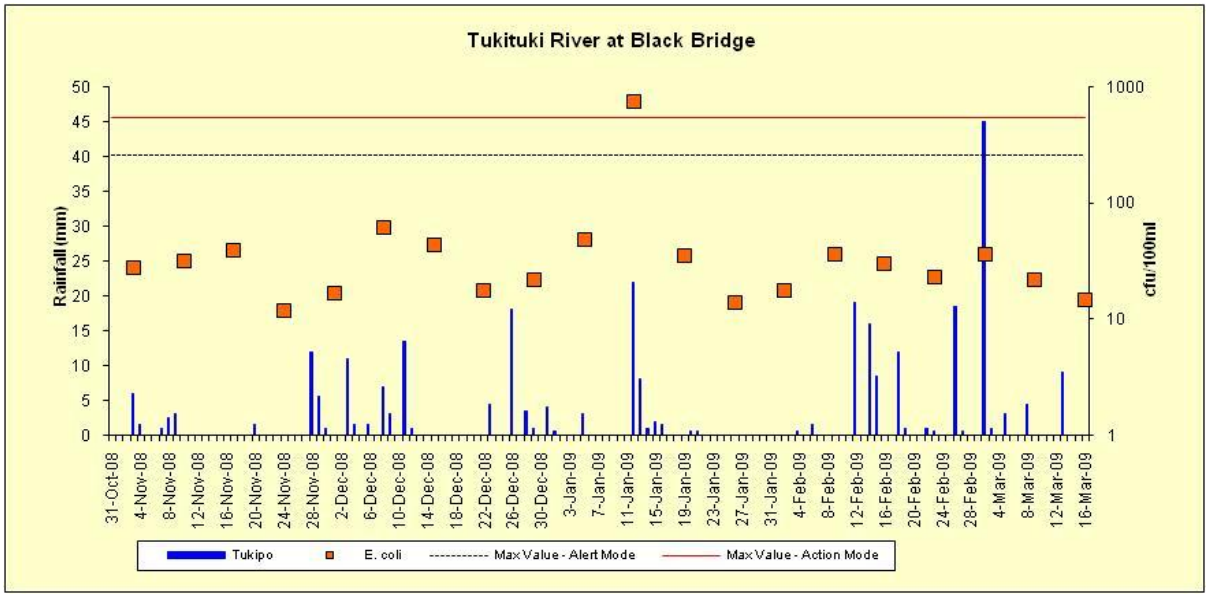
Mangaorapa
E. coli
Max Value - Alert Mode
Max Value - Action Mode

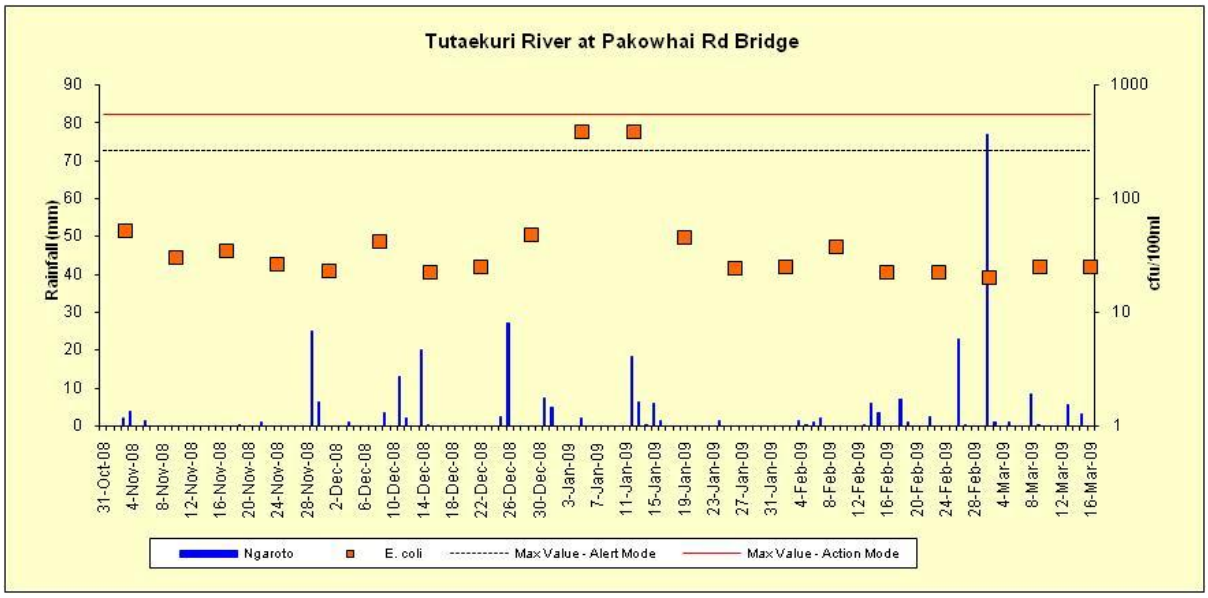

Pourerere Beach
Rainfall (mm)
cfu/100ml
Waipoapoa
Enterococci
Max Value - Alert Mode
Max Value - Action Mode

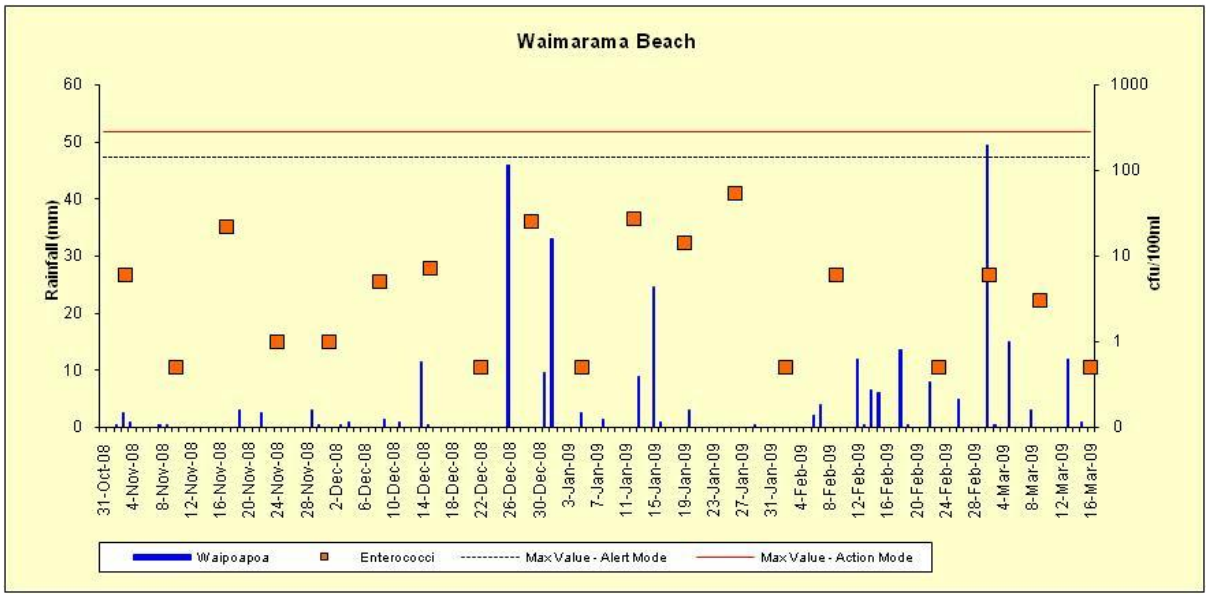

Puhokio Stream at Waimarama Beach
Rainfall (mm)
cfu/100ml
Waipoapoa
E. coli
Max Value - Alert Mode
Max Value - Action Mode

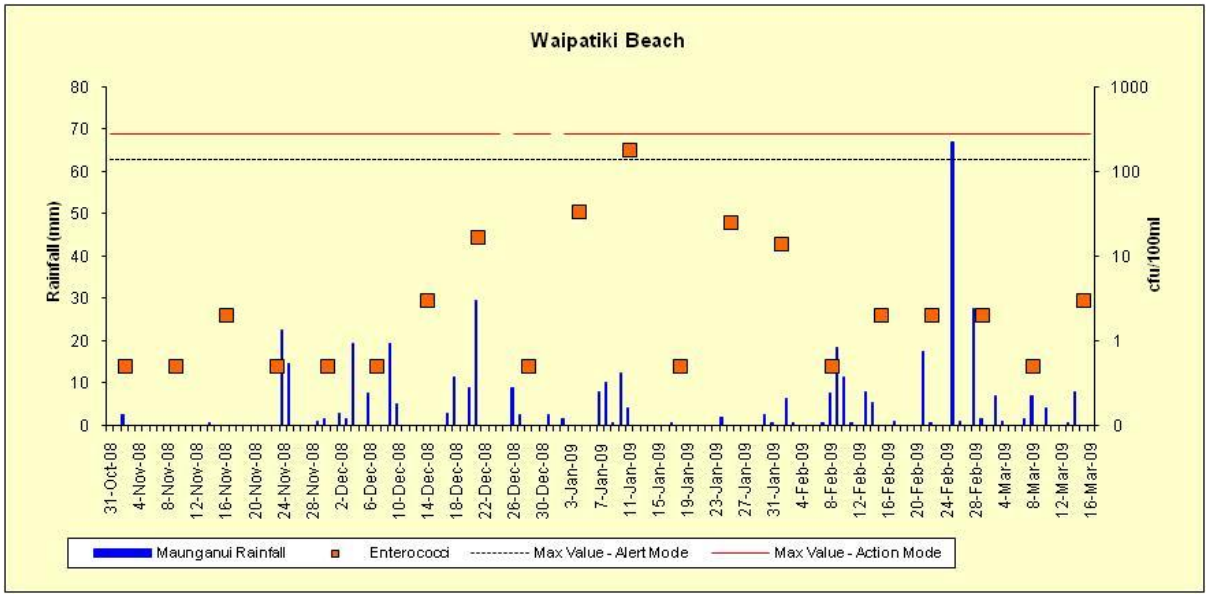

Te Awanga Coastal
Rainfall (mm)
cfu/100ml
Maraetotara
Enterococci
Max Value - Alert Mode
Max Value - Action Mode

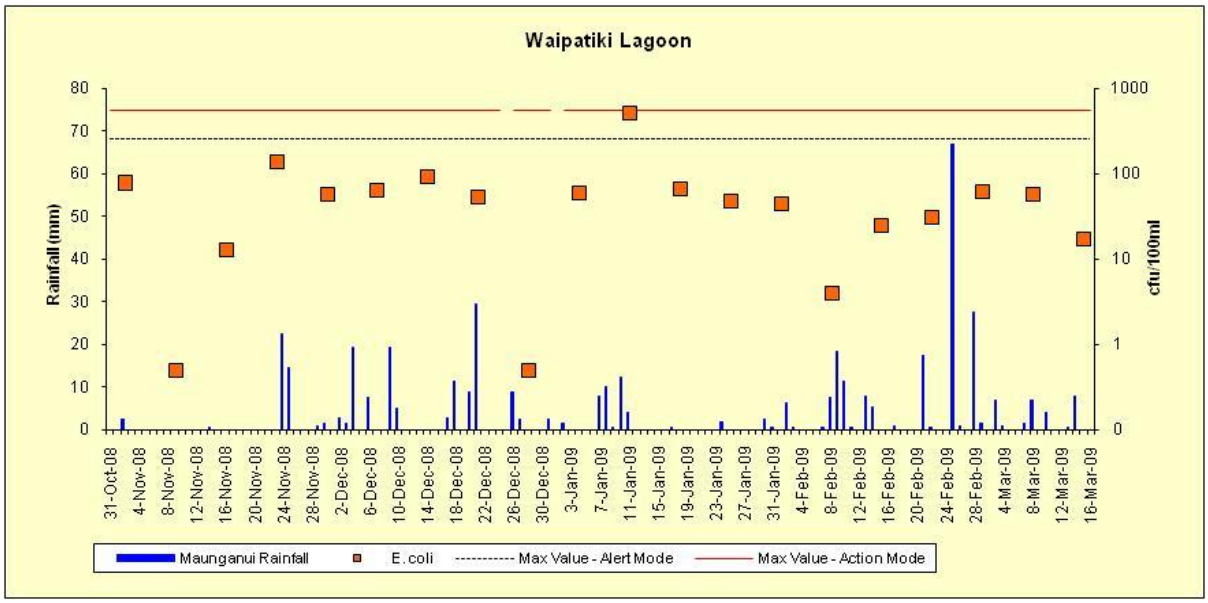

Tukituki River at SH2 Waipukurau
Rainfall (mm)
cfu/100ml
Tukipo
E. coli
Max Value - Alert Mode
Max Value - Action Mode

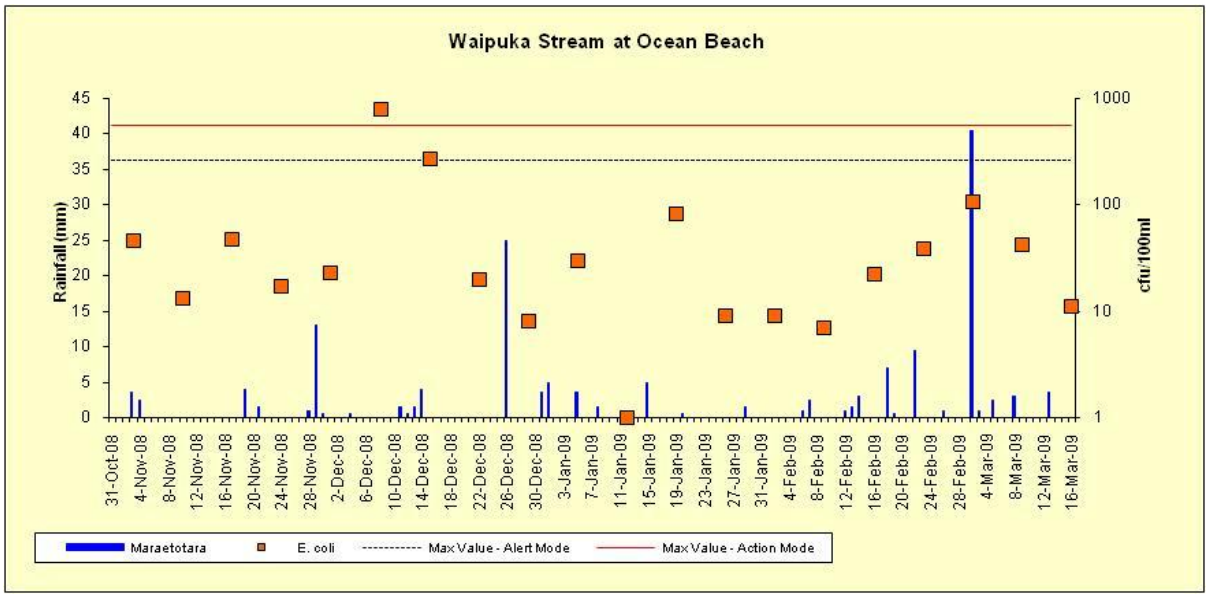

Tukituki River at Black Bridge
Rainfall (mm)
cfu/100ml
Tukipo
E. coli
Max Value - Alert Mode
Max Value - Action Mode

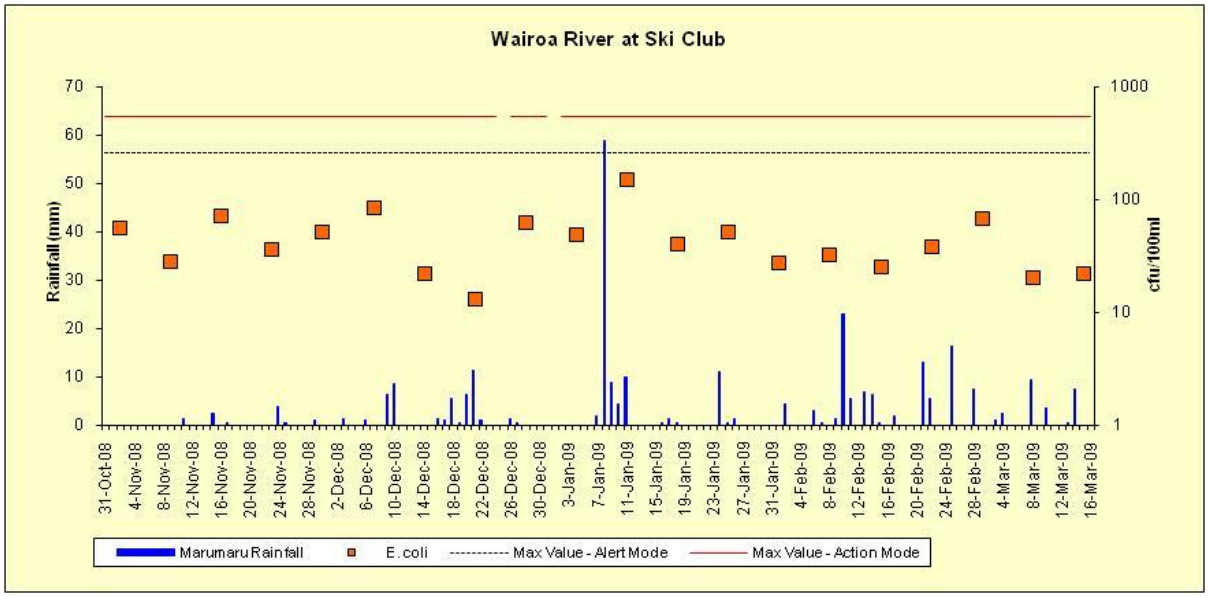

Tutaekuri River at Pakowhai Rd Bridge
Rainfall (mm)
cfu/100ml
Ngaroto
E. coli
Max Value - Alert Mode
Max Value - Action Mode

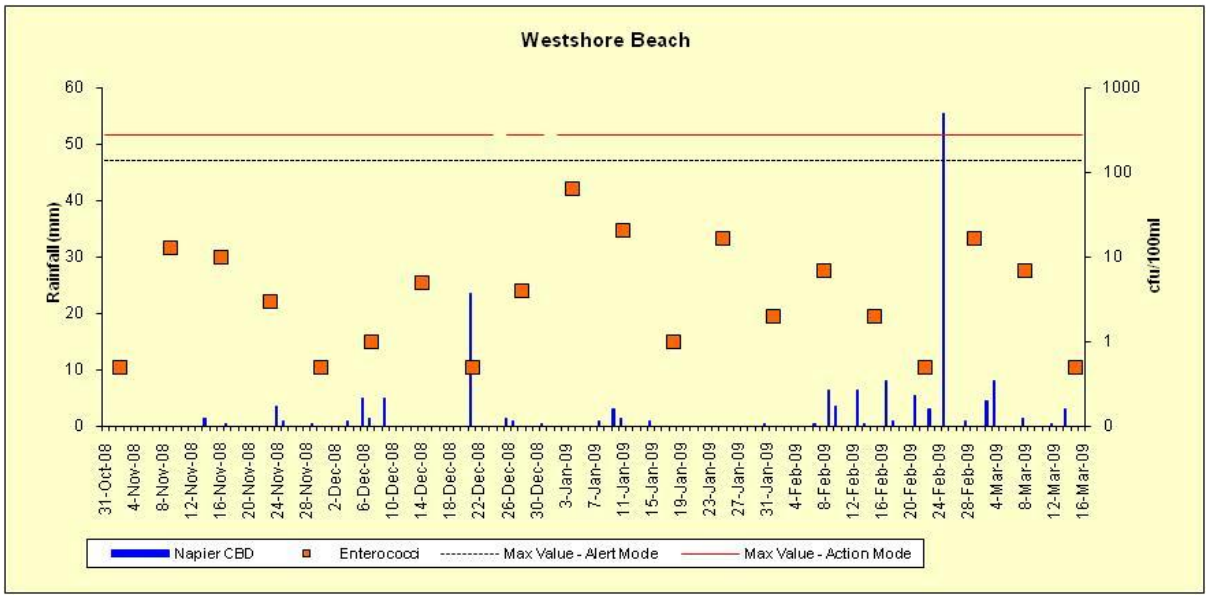

Waimarama Beach
Rainfall (mm)
cfu/100ml
Waipoapoa
Enterococci
Max Value - Alert Mode
Max Value - Action Mode


Waipatiki Beach
Rainfall (mm)
cfu/100ml
Maunganui Rainfall
Enterococci
Max Value - Alert Mode
Max Value - Action Mode


Waipatiki Lagoon
Rainfall (mm)
cfu/100ml
Maunganui Rainfall
E. coli
Max Value - Alert Mode
Max Value - Action Mode


Waipuka Stream at Ocean Beach
Rainfall (mm)
cfu/100ml
Maraetotara
E. coli
Max Value - Alert Mode
Max Value - Action Mode


Wairoa River at Ski Club
Rainfall (mm)
cfu/100ml
Marumaru Rainfall
E. coli
Max Value - Alert Mode
Max Value - Action Mode


Westshore Beach
Rainfall (mm)
cfu/100ml
Napier CBD
Enterococci
Max Value - Alert Mode
Max Value - Action Mode

Appendix 3

Tables of Results

Marine Sites – *Enterococci* Indicator

Date Sampled	Hardinge Road Beach	Mahanga Beach	Mahia Beach	Oputama Beach	Waipatiki beach	Westshore Beach	Date Sampled	Aramoana Beach	Blackhead Beach	Kairakau Beach	Ocean Beach	Porangahau Beach	Pourerere Beach	Te Awanga Coastal	Waimarama beach
03-Nov-08	4	0.5	1	0.5	0.5	0.5	**03-Nov-08**	0.5	0.5	0.5	6	0.5	0.5	3	6
10-Nov-08	0.5	0.5	0.5	2	0.5	13	**10-Nov-08**	1	0.5	0.5	0.5	0.5	1	3	0.5
17-Nov-08	0.5	0.5	1	7	2	10	**17-Nov-08**	0.5	2	0.5	4	5	2	3	22
24-Nov-08	2	2	0.5	0.5	0.5	3	**24-Nov-08**	0.5	0.5	0.5	0.5	1	0.5	1	1
01-Dec-08	0.5	1	2	5	0.5	0.5	**01-Dec-08**	0.5	0.5	0.5	0.5	0.5	1	0.5	1
08-Dec-08	0.5	0.5	2	0.5	0.5	1	**08-Dec-08**	0.5	0.5	0.5	0.5	2	0.5	36	5
15-Dec-08	25	1	3	3	3	5	**15-Dec-08**	0.5	0.5	1	1	1	2	5	7
22-Dec-08	8	17	6	0.5	17	0.5	**22-Dec-08**	1	0.5	2	0.5	0.5	0.5	1	0.5
29-Dec-08	5	0.5	2	0.5	0.5	4	**29-Dec-08**	0.5	0.5	32	12	1	1	18	25
05-Jan-09	73	130	240*	61	33	65	**05-Jan-09**	0.5	0.5	0.5	1	0.5	2	6	0.5
12-Jan-09	160*	910	26	400	180	21	**12-Jan-09**	1	4	7	250*	0.5	4	2	27
19-Jan-09	1	0.5	0.5	1	0.5	1	**19-Jan-09**	0.5	1	0.5	6	2	4	10	14
26-Jan-09	25	5	21	0.5	25	17	**26-Jan-09**	5	0.5	4	32	0.5	0.5	3	53
02-Feb-09	2	0.5	23	1	14	2	**02-Feb-09**	10	9	0.5	1	0.5	22	1	0.5
09-Feb-09	3	0.5	4	0.5	0.5	7	**09-Feb-09**	0.5	0.5	1	1	1	5	1	6
16-Feb-09	8	0.5	20	16	2	2	**16-Feb-09**	10	13	5	4	1	1	4	15
23-Feb-09	5	2	13	2	2	0.5	**23-Feb-09**	3	0.5	0.5	5	2	2	5	0.5
02-Mar-09	5	0.5	2	3	2	17	**02-Mar-09**	12	0.5	1	20	1	0.5	20	6
09-Mar-09	12	3	26	5	0.5	7	**09-Mar-09**	0.5	0.5	0.5	0.5	2	0.5	25	3
16-Mar-09	1	0.5	5	0.5	3	0.5	**16-Mar-09**	0.5	0.5	0.5	3	3	1	3	0.5

Exceeded Alert Level (140 cfu *Enterococc i* 100ml)
Exceeded Action Level (280 cfu *Enterococci* / 100ml
Rainfall related exceedance therefore not re-sampled / * = re-sampled

Freshwater Sites – *E.coli* Indicator

Date Sampled	Esk River @ Eskdale Park	Lake Tutira @ Camping ground	Ngaruroro River @ Chesterhope Bridge	Tukituki River @ SH2 Waipukarau	Tuaekuri River @ Pakawhai Rd Bridge
03-Nov-08	27	1	880*	1	52
10-Nov-08	65	22	20	16	30
17-Nov-08	82	9	19	35	34
24-Nov-08	110	2	29	55	26
01-Dec-08	73	n/s	27	67	23
08-Dec-08	1050	0	46	420*	42
15-Dec-08	27	0.5	31	3	22
22-Dec-08	42	23	38	17	25
29-Dec-08	30	n/s	5	47	47
05-Jan-09	49	12	21	47	19
12-Jan-09	340	210	460	110	380
19-Jan-09	10	37	52	30	45
26-Jan-09	27	133	33	13	24
02-Feb-09	32	22	45	20	25
09-Feb-09	20	36	52	10	37
16-Feb-09	27	19	42	25	22
23-Feb-09	24	4	29	10	22
02-Mar-09	73	19	42	35	20
09-Mar-09	17	16	62	20	25
16-Mar-09	25	50	37	8	25

Exceeded Alert Level (260 cfu *E. Coli* / 100ml)
Exceeded Action Level (550 cfu *E. Coli* / 100ml
Rainfall related exceedance therefore not re-sampled / * = resampled

Estuarine and Freshwater (with a tidal influence) Sites – *E.coli* / *Enterococci* Indicator

Site	Maungawhio lagoon	Pandora Pond	Waipatiki lagoon	Wairoa River @ Ski Club	Date Sampled	Clive River @ SH2 Bridge	Kairakau Lagoon	Maratotara lagoon	Porangahau Estuary	Puhokio Stream @ Waimarama Beach	Tukituki River @ Balck Bridge	Waipuka Stream @ Ocean Beach
03-Nov-08	0.5 / 1	34 / 17	78 / n/t	56 / n/t	**03-Nov-08**	130 /160^	2 / 0.5	76/ n/t	2 / 0.5	920 / n/t	28 / n/t	46 / n/t
10-Nov-08	30 / 11	3 / 6	0.5 / n/t	28 / n/t	**10-Nov-08**	n/s	7 / 28	62 / n/t	0.5 / 3	n/s	32 /n/t	13 / 31
17-Nov-08	0.5 / 0.5	0.5 / 3	13 / n/t	72 / n/t	**17-Nov-08**	24 / 36	65 / 72	63 / n/t	46 / 9	650 / n/t	40 n/t	47 / 10
24-Nov-08	1 / 1	7 / 8	136 / n/t	36 / n/t	**24-Nov-08**	n/s	0.5 / 0.5	150 / n/t	2 / 1	n/s	12 / n/t	17 / 4
01-Dec-08	0.5 / 1	0/ 0	57 / n/t	52 / n/t	**01-Dec-08**	5 / n/c	4 / 1	29 / n/t	5 / 2	97 / n/t	17 / n/t	23 / 25
08-Dec-08	15 / 2	3 / 0.5	64 / n/t	85 / 47	**08-Dec-08**	n/s	23 / 12	30 / n/t	10 / 1	n/s	62 / n/t	780* / 570*
15-Dec-08	20 / 7	18 / 57	92 / 47	22 / 30	**15-Dec-08**	44 / 47	3 / 7	45 / 30	11 / 17	270 / 230	44 / 270*	56 / 82
22-Dec-08	6 / 8	3 / 1	53 / n/t	13 / 22	**22-Dec-08**	n/s	0.5 / 0.5	20 / 22	1 / 1	n/s	18 / 350	20 / 22
29-Dec-08	7 / 4	7 / 3	0.5 / 42	62 / 140^	**29-Dec-08**	37 / n/c	7 / 0.5	52 / n/t	14 / 7	270 / n/t	22 / 22	8 / 9
05-Jan-09	0.5 / 320*	3 / 15	59 / n/t	48 / n/t	**05-Jan-09**	n/s	5 / 11	130 / n/t	4 / 6	n/s	49 / n/t	30 / 15
12-Jan-09	32 / 47	10 / 0.5	510 / 540	150 / 220	**12-Jan-09**	420 / 700	230 / 56	560* / 410*	23 / 3	970 / 920	n/c / 750	1 / 9
19-Jan-09	5 / 9	4 / 1	67 / 52	40 / 32	**19-Jan-09**	n/s	30 / 22	52 / n/t	19 / 16	n/s	36 /n/t	82 / 300*
26-Jan-09	12 / 2	10 / 7	47 / n/t	52 / 31	**26-Jan-09**	19 / 32	16 / 27	68 / n/t	14 / 3	53 / n/t	14 / n/t	9 / 47
02-Feb-09	0.5 / 5	9 / 2	45 / 42	27 / 18	**02-Feb-09**	n/s	3 / 22	49 / 42	1 / 1	n/s	18 / n/	9 / 22
09-Feb-09	0.5 / 4	2 / 24	4 / 22	32 / 32	**09-Feb-09**	37 / 72	31 / 7	32 / 30	17 / 2	17 / 7	37 / 66	7 / 26
16-Feb-09	n/s / 40	2 / 1	25 / 37	25 / n/t	**16-Feb-09**	n/s	17 / 60	47 / 60	6 / 15	n/s	30 / 38	22 / 72
23-Feb-09	8 / 2	0.5 / 5	31 / n/t	38 / n/t	**23-Feb-09**	63 / 45	7 / 8	67 / 63	1 / 0.5	74 / 28	23 / 20	38 / 53
02-Mar-09	1 / 7	52 / 39	62 / 75	32 / 67	**02-Mar-09**	n/s	11 / n/c	42 / n/t	9 / 5	n/s	37 / n/t	105 / n/t
09-Mar-09	47 / 23	5 / 9	57 / 123	20 / 23	**09-Mar-09**	52 / n/c	16 / 22	87 / 46	18 / 16	97 / 130	22 / 30	42 / 92
16-Mar-09	32 / 47	15 / 7	17 / n/t	22 / n/t	**16-Mar-09**	n/s	0.5 / 37	22 / n/t	8 / 2	n/s	15 / n/t	1 / 18

Exceeded surveillance Level (140 cfu *Enterococci* 100ml)
Exceeded Alert Level (280 cfu *Enterococci* / 100ml
Rainfall related exceedance therefore not re-sampled
^ not resampled due to a conductivity reading of >10mS or >10,000µS

* = resampled NB: Puhokio Stream not re-sampled
n/t = not tested
n/s = no sample

Shellfish Gathering Sites – Faecal Coliform Count Indicator

Date Sampled	Ahuriri Estuary faecal coliform count	Mahia @ Golf Club faecal coliform count	Waipatiki Beach faecal coliform count	Date Sampled	Te Awanga faecal coliform count	Kairakau beach faecal coliform count
03-Nov-08	24	0.5	20	**03-Nov-08**	1	10
10-Nov-08	3	0.5	0.5	**10-Nov-08**	n/s	2
17-Nov-08	8	1	0.5	**17-Nov-08**	8	2
24-Nov-08	0.5	0.5	3	**24-Nov-08**	0.5	0.5
01-Dec-08	0.5	0.5	3	**01-Dec-08**	3	0.5
08-Dec-08	5	54	0.5	**08-Dec-08**	n/s	n/s
15-Dec-08	6	0.5	19	**15-Dec-08**	10	0.5
22-Dec-08	11	0.5	18	**22-Dec-08**	2	5
29-Dec-08	1	0.5	13	**29-Dec-08**	12	4
05-Jan-09	120	1	0.5	**05-Jan-09**	6	0.5
12-Jan-09	11	110	9	**12-Jan-09**	6	8
19-Jan-09	23	2	0.5	**19-Jan-09**	7	1
26-Jan-09	1	1	6	**26-Jan-09**	2	0.5
02-Feb-09	22	9	12	**02-Feb-09**	4	2
09-Feb-09	3	1	7	**09-Feb-09**	0.5	1
16-Feb-09	20	1	1	**16-Feb-09**	7	0.5
23-Feb-09	18	3		**23-Feb-09**	1	0.5
02-Mar-09	30	1	12	**02-Mar-09**	27	0.5
09-Mar-09	20	27	3	**09-Mar-09**	19	2
16-Mar-09	1	0.5	2	**16-Mar-09**	0.5	1
No. of samples over 43	1	2	0		0	0
% of samples over 43	5%	10%	0%		0%	0%

Appendix 4

Suitability For Recreation Grade (SFRG)
Accompanying Information

Definitions for Suitability for Recreation Grades

NB: Different definitions exist for marine and freshwater gradings, however there is essentially little difference and therefore only the marine gradings have been described here to give an idea of the meaning of each grade. From MfE & MoH , 2003.

Very Good

Water quality tests and assessment of potential contamination sources indicate beaches within this category are considered to have very good water quality. There may be some runoff from low-intensity agriculture/urban/rural catchments, but there are likely to be no significant sources of faecal contamination.

Recommendation: Considered satisfactory for swimming at all times, and therefore may not require monitoring on a regular basis.

Good

Water quality tests and assessment of potential contamination sources indicate that beaches within this category are considered to have generally good water quality. On occasions (such as after high rainfall) there may be increased risk of contamination from run-off. Such sites receive run-off from one or more of the following sources and may contain animal or faecal material:

- River discharges impacted by tertiary treated wastewater, combined sewer overflows, intensive agriculture/rural catchments, feral bird/animal populations;
- River discharges impacted by run-off from low-intensity agricultural/urban/rural catchment;
- Stormwater not contaminated by sewage.

Recommendation: Satisfactory for swimming most of the time. Exceptions may include following rainfall. Such beaches are monitored regularly throughout the summer season and warning signs will be erected if water quality deteriorates.

Fair

Water quality tests and assessment of potential contamination sources indicate that beaches within this category are considered to have generally fair water quality. Events such as high rainfall increase the risk of contamination levels from run-off. Such sites receive run-off from one or more of the following sources of faecal material:

- River discharges impacted by tertiary treated wastewater, combined sewer overflows, intensive agriculture/rural catchments, feral bird/animal populations;
- River discharges impacted by run-off from low-intensity agricultural/urban/rural catchment;
- Stormwater not contaminated by sewage.

Recommendation: Generally satisfactory for swimming, through there are many potential sources of faecal material. Caution should be taken during periods of high rainfall, and swimming avoided if water is discoloured. Sites are monitored weekly and warning signs erected if water quality deteriorates.

Poor

Water quality tests and assessment of potential contamination sources indicate that beaches within this category are considered to have generally poor water quality. These sites receive run-off from one or more of the following sources and may contain animal or human faecal material:

- Tertiary treated wastewater;
- Urban stormwater, marinas or moorings, intensive agriculture;
- River discharges containing untreated /primary/secondary treated wastewater or on-site waste treatment systems.

Recommendation: Generally not okay for swimming, as indicated by historical results. Swimming should be avoided, particularly by the very young, very old and those with compromised immunity. Permanent warning signs may be erected at these sites, although councils may monitor these sites weekly and post temporary warnings.

Very Poor

Water quality tests and assessment of potential contamination sources indicate that beaches within this category are considered to have generally very poor water quality. These sites receive run-off from one or more of the following sources and may contain animal or human faecal material:

- Untreated/primary/secondary treated wastewater;
- Tertiary treated wastewater;
- Urban stormwater, marinas or moorings, intensive agriculture;
- River discharges containing untreated /primary/secondary treated wastewater or on-site waste treatment systems.

Recommendation: Avoid swimming as there are direct discharges of faecal material. Permanent signage will be erected at the beach stating that swimming is not recommended.

Suitability for Recreation Grade						
Susceptibility to faecal influence		**Microbiological Assessment Category (MAC)** Indicator counts (as percentiles)				**Exceptional Circumstances *** **
		(per 100ml) ≤ 40 Ent. ≤ 130 E. coli	(per 100ml) 41-200 Ent. 131-260 E. coli	(per 100ml) 201-500 Ent. 261-550	(per 100ml) >500 Ent. >550 E. coli	
Sanitary Inspection Category	Very Low	Very Good	Very Good	Follow-up**	Follow-up**	
	Low	Very Good	Good	Fair	Follow-up**	
	Moderate	Follow-up*	Good	Fair	Poor	
	High	Follow-up*	Follow-up*	Poor	Very Poor	
	Very High	Follow-up*	Follow-up*	Follow-up*	Very Poor	
Exceptional Circumstances						

Notes

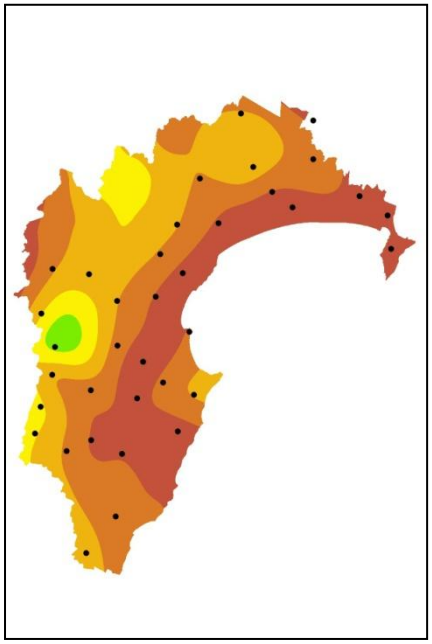
* Indicates unexpected results requiring investigation (reassess SIC and MAC). If after reassessment the SFRG is still follow-up, then assign a conservative grade (i.e. the first grade to the right of the follow-up in the same SIC row).

** Implies non-sewage sources of indicators, and this should be verified. If after verification the SFRG is still follow-up, then assign a conservative grade (i.e. the first grade after follow-up in the same MAC column.

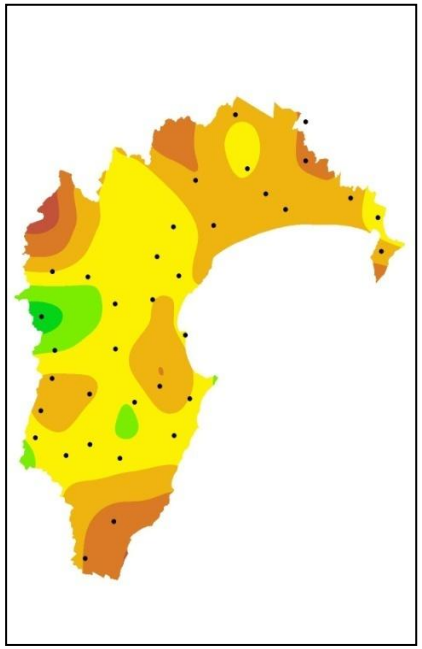
*** Exceptional circumstances: relate to known periods of higher risk for a graded beach, such as during a sewer rupture or an outbreak of a potentially waterborne pathogen in the community of the recreational area catchment. Under such circumstances a grading would not apply until the episode has abated.

Appendix 5

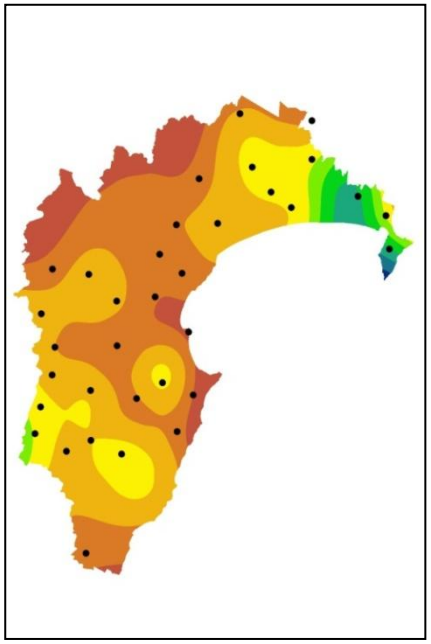
2008/09 Season –
Percentage of Normal Rainfall by Month



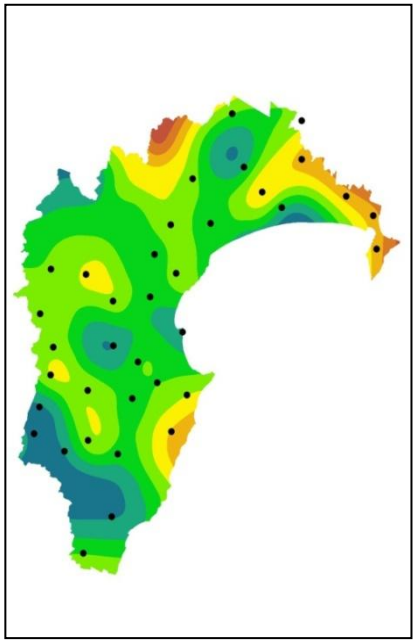
November 2008



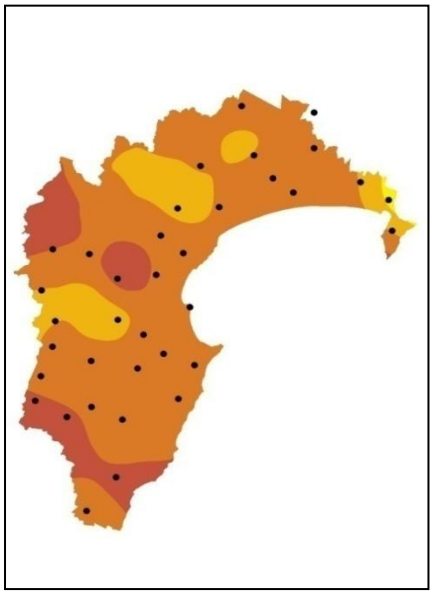
December 2008



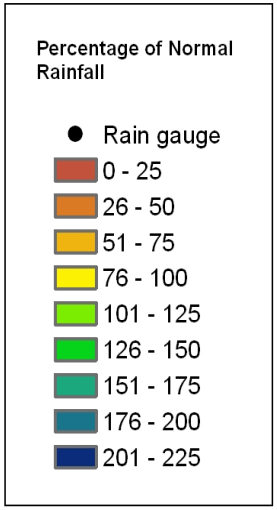
January 2009



February 2009



March 2009



Legend

2007/08 Season Rainfall - Percentage deviation from mean 30 year normal rainfall.
(<100 indicates less than average rainfall, >100 indicates higher than average rainfall).

Appendix 6

2008/09 Season –
Mann-Kendall Trend Test Results

Blackhead

Mann-Kendall test for Ecoli (c/100ml)

Starting month = November
Period analysed 6 years and 5 months from 2002 to 2009
170 observations from 12/11/02 to 16/03/09 with 134 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	1.00000	-1165.00000	514317.00000	-1.62307	0.10457	0.00000	0.00000	0.00000

Esk

Mann-Kendall test for Ecoli (cfu/100ml)

Starting month = November
Period analysed 8 years and 5 months from 2000 to 2009
179 observations from 23/11/00 to 16/03/09 with 80 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	40.00000	-412.00000	642329.33330	-0.51282	0.60808	-0.63345	-2.82608	1.29971

Hardinge

Mann-Kendall test for Ent (cfu/100ml)

Starting month = November
Period analysed 8 years and 4 months from 2000 to 2009
169 observations from 18/12/00 to 16/03/09 with 121 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	4.00000	-727.00000	535697.00000	-0.99192	0.32124	0.00000	-0.31406	0.00000

Clive

Mann-Kendall test for Ecoli (c/100ml)

Starting month = November
Period analysed 8 years and 5 months from 2000 to 2009
161 observations from 24/11/00 to 16/03/09 with 59 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	82.00000	-3008.00000	467808.00000	-4.39642	0.00001	-12.24773	-18.88848	-7.28692

Kairakau Beach

Mann-Kendall test for Ent (c/100ml)

Starting month = December
Period analysed 8 years and 4 months from 2000 to 2009
169 observations from 19/12/00 to 16/03/09 with 144 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	1.00000	-1175.00000	484651.00000	-1.68637	0.09172	0.00000	0.00000	0.00000

Kairakau Lagoon

Mann-Kendall test for Ecoli (cfu/100ml)

Starting month = December
Period analysed 8 years and 5 months from 2000 to 2009
179 observations from 24/11/00 to 16/03/09 with 92 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	20.00000	-3901.00000	641831.66670	-4.86804	0.00000	-3.74919	-6.13992	-2.10071

Lake Tutira

Mann-Kendall test for Ecoli (c/100ml)

Starting month = November
Period analysed 7 years and 5 months from 2001 to 2009
180 observations from 11/11/01 to 16/03/09 with 100 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	14.50000	-248.00000	652556.66670	-0.30577	0.75978	0.00000	-0.97711	0.73007

Mahia Beach

Mann-Kendall test for Ent (c/100ml)
Starting month = December
Period analysed 8 years and 4 months from 2000 to 2009
180 observations from 18/12/00 to 16/03/09 with 119 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	6.50000	-2195.00000	650668.33330	-2.71992	0.00653	-0.69357	-1.30446	-0.19601

Mahanga Beach

Mann-Kendall test for Ent (c/100ml)
Starting month = December
Period analysed 8 years and 4 months from 2000 to 2009
110 observations from 18/12/00 to 16/03/09 with 84 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	1.00000	-228.00000	132466.00000	-0.62370	0.53283	0.00000	0.00000	0.00000

Maraetotara Lagoon

Mann-Kendall test for Ecoli (c/100ml)
Starting month = December
Period analysed 8 years and 5 months from 2000 to 2009
180 observations from 24/11/00 to 16/03/09 with 69 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	73.50000	-1591.00000	653201.66670	-1.96731	0.04915	-4.18768	-7.85902	-0.49570

Mungawhio Lagoon

Mann-Kendall test for Ecoli (cfu/100ml)
Starting month = November
Period analysed 6 years and 5 months from 2002 to 2009
140 observations from 11/11/02 to 16/03/09 with 85 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	4.50000	225.00000	301795.66670	0.40775	0.68346	0.00000	0.00000	0.20930

Ngaururoro

Mann-Kendall test for Ecoli (c/100ml)
Starting month = November
Period analysed 8 years and 5 months from 2000 to 2009
179 observations from 24/11/00 to 16/03/09 with 74 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	52.00000	115.00000	642377.66670	0.14224	0.88689	0.00000	-1.97759	2.38901

Ocean Beach

Mann-Kendall test for ENT (c/100ml)
Starting month = December
Period analysed 8 years and 4 months from 2000 to 2009
169 observations from 19/12/00 to 16/03/09 with 131 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	1.00000	5.00000	507461.66670	0.00562	0.99552	0.00000	0.00000	0.00000

Oputama Beach

Mann-Kendall test for ENT (c/100ml)
Starting month = December
Period analysed 8 years and 4 months from 2000 to 2009
170 observations from 18/12/00 to 16/03/09 with 125 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	3.50000	-406.00000	543807.33330	-0.54920	0.58287	0.00000	-0.14554	0.00000

Pandora Pond

Mann-Kendall test for EColi (c/100ml)
Starting month = December
Period analysed 8 years and 5 months from 2000 to 2009
180 observations from 23/11/00 to 16/03/09 with 131 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	5.50000	-1113.00000	649830.33330	-1.37945	0.16776	-0.16678	-0.47870	0.00000

Porangahau Beach

Mann-Kendall test for ENT(c/100ml)
Starting month = November
Period analysed 7 years and 5 months from 2001 to 2009
159 observations from 12/11/01 to 16/03/09 with 124 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	1.00000	549.00000	423551.66670	0.84203	0.39977	0.00000	0.00000	0.00000

Pourerere Beach

Mann-Kendall test for ENT(c/100ml)
Starting month = November
Period analysed 8 years and 4 months from 2000 to 2009
129 observations from 19/12/00 to 16/03/09 with 104 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	1.00000	109.00000	221850.33330	0.22929	0.81864	0.00000	0.00000	0.00000

Puhokio Stream

Mann-Kendall test for Ecoli (c/100ml)
Starting month = November
Period analysed 8 years and 5 months from 2000 to 2009
161 observations from 24/11/00 to 16/03/09 with 47 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	180.00000	-2559.00000	467849.00000	-3.73979	0.00018	-21.75428	-35.77193	-10.67593

Tukituki at Black Bridge

Mann-Kendall test for Ecoli (c/100ml)
Starting month = November
Period analysed 8 years and 5 months from 2000 to 2009
159 observations from 29/11/00 to 16/03/09 with 77 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	32.00000	-2053.00000	450604.33330	-3.05689	0.00224	-3.11672	-4.83532	-1.46966

Tukituki at Waipukarau

Mann-Kendall test for Ecoli (c/100ml)
Starting month = November
Period analysed 7 years and 5 months from 2001 to 2009
160 observations from 11/11/01 to 16/03/09 with 90 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	16.50000	-172.00000	458770.66670	-0.25246	0.80068	0.00000	-1.28429	0.96188

Tutaekuri River at Pakawhai Bridge

Mann-Kendall test for Ecoli (c/100ml)
Starting month = November
Period analysed 8 years and 5 months from 2000 to 2009
180 observations from 24/11/00 to 16/03/09 with 90 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	36.50000	-2309.00000	652940.33330	-2.85627	0.00429	-2.46236	-4.02759	-0.99795

Waimarama Stream

Mann-Kendall test for ENT (c/100ml)

Starting month = December
Period analysed 8 years and 4 months from 2000 to 2009
170 observations from 19/12/00 to 16/03/09 with 125 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	2.00000	-165.00000	531398.33330	-0.22497	0.82200	0.00000	0.00000	0.00000

Waipatiki lagoon

Mann-Kendall test for Ecoli (c/100ml)

Starting month = November
Period analysed 8 years and 5 months from 2000 to 2009
180 observations from 23/11/00 to 16/03/09 with 57 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	111.00000	-2326.00000	653232.66670	-2.87666	0.00402	-8.87026	-14.04808	-3.77845

Waipatiki Beach

Mann-Kendall test for ENT (c/100ml)

Starting month = December
Period analysed 8 years and 4 months from 2000 to 2009
170 observations from 23/12/00 to 16/03/09 with 137 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	2.00000	-774.00000	525496.00000	-1.06634	0.28627	0.00000	0.00000	0.00000

Waipuka Stream

Mann-Kendall test for Ecoli (c/100ml)

Starting month = November
Period analysed 8 years and 5 months from 2000 to 2009
180 observations from 24/11/00 to 16/03/09 with 74 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	36.00000	-1200.00000	653120.66670	-1.48362	0.13791	-1.69443	-4.14085	0.00000

Westshore Beach

Mann-Kendall test for Ent (c/100ml)

Starting month = December
Period analysed 8 years and 4 months from 2000 to 2009
170 observations from 18/12/00 to 16/03/09 with 125 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	5.00000	-1117.00000	547234.33330	-1.50861	0.13140	-0.15437	-0.49225	0.00000

Wiaroa River at the Ski Club

Mann-Kendall test for Ecoli (c/100ml)

Starting month = November
Period analysed 8 years and 5 months from 2000 to 2009
180 observations from 23/11/00 to 16/03/09 with 73 ties
Sample size greater than 10 and normal approximation used to determine P value

	Median value	Kendall statistic	Variance	Z	P	Sen slope median annual	5% confidence limit	95% confidence limit
Unadjusted	57.00000	-2711.00000	653163.66670	-3.35319	0.00080	-6.52232	-11.09876	-3.27474

False Discovery Rate results for P-value
Samples with a probability level of 0.00653000 or less are significant at P = 0.05
There are 1 significant correlations

Row	Probability	Critical value	Adjusted P-value
Mahia	0.006530	0.050000	0.006530

False Discovery Rate results for P-value
Samples with a probability level of 0.00429000 or less are significant at P = 0.05
There are 7 significant correlations

Descriptor	Probability	Critical value	Adjusted P-value
Clive/P-value	0.000010	0.007143	0.000070
Puhokio/P-value	0.000180	0.014286	0.000630
Wairoa/P-value	0.000800	0.021429	0.001750
Kairakau Lagoon/P-value	0.001000	0.028571	0.001750
TT_BB/P-value	0.002240	0.035714	0.003136
WaipatikiLg/P-value	0.004020	0.042857	0.004290
Tutaekuri/P-value	0.004290	0.050000	0.004290