

Bathing Beach Water Quality
State of the Environment
Monitoring Report
Summer 2010-2011

Technical Report 2011-15

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Executive summary

This report provides an assessment of microbial water quality at 12 bathing beach sites in the Taranaki region, based on routine summer monitoring of faecal indicator bacteria (enterococci, *E. coli* and faecal coliforms) conducted between 9 November 2010 and 12 April 2011. The report focusses on enterococci results, as this indicator provides the closest correlation with health affects in New Zealand coastal waters. Results have been assessed for compliance with microbiological water quality guidelines prepared by the Ministry for the Environment (MfE) and the Ministry of Health (MfE, 2003).

During the 2010-2011 summer season, microbiological water quality was generally very good across bathing beaches in the Taranaki region. Low median enterococci counts were recorded for all beaches monitored (≤ 32 enterococci cfu/100ml). Out of the 191 samples collected at 12 beach sites, >93% were below guideline MfE Alert levels (140 enterococci cfu/100ml). No site reached guideline MfE Action levels (i.e. two consecutive samples >280 enterococci cfu/100ml). All sites assessed obtained an MfE 'Suitability for Recreation Grade' (SFRG) of either 'good' (64%) or 'fair' (36%).

Mann-Kendall tests were performed in order to assess any long term trends in microbiological water quality. Three sites showed a significant decrease in median enterococci counts over the 12-16 years monitored (Ohawe, Opunake and Ngamotu, $p > 0.05$) indicating an overall improvement in microbiological water quality. The site at Ohawe showed the greatest long term improvement in microbiological water quality. This is likely related to improved water quality within the Waingongoro River which flows into Ohawe Beach. Not one site showed a significant increase in median enterococci count i.e. a deterioration in microbiological water quality.

Opunake and Oakura Camp Ground were amongst the region's cleanest bathing beach sites with median enterococci counts of <1 cfu/100ml and no exceedances of Alert mode throughout the 2010-2011 season. Back Beach recorded the highest median enterococci count of the season (32 cfu/100ml). However, only one sample exceeded Alert mode at this site, indicating a low and acceptable health risk to beach users throughout the summer.

Sites in Taranaki compared favourably to national results, with all sites in the region posing a 'low' or 'generally low' health risk. The few samples which individually exceeded guideline levels (<7%) during the 2010-2011 season were generally associated with high rainfall.

Microbiological water quality results were regularly reported on the Taranaki Regional Council website (www.trc.govt.nz) and there was timely liaison with territorial local authorities and the Health Protection Unit of the Taranaki District Health Board throughout the summer bathing season of 2010-2011.

Through the Council's LTCCP, the Council's target in respect of the microbiological state of coastal bathing sites is that there is *maintenance or increase in the number of sites from 2003 compliant with 2003 Ministry of Health contact recreational guidelines*. In 2003, 10 of 11 coastal bathing sites were compliant with the guidelines ('Action' levels). In the season under review, all 12 beaches were compliant with the guidelines. The LTCCP target was therefore met.

Continuation of the bathing beach SEM programme is recommended in the 2011-2012 year.

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1. Introduction

The coastal waters of New Zealand are used for a broad range of recreational activities, including bathing, surfing, diving, sailing, kayaking, and shellfish gathering. Maintaining the quality of this recreational water is therefore an important resource management and environmental health issue.

1.1 State of the environment monitoring (SEM)

Regional councils have responsibilities under the Resource Management Act (1991) to monitor the state of the environment. The purpose of state of the environment monitoring (SEM) is to collect sufficient data to produce information on the general health of the environment. This information can then be used to measure how well management practices, policies and laws are working, and whether environmental outcomes are being achieved. As part of SEM, environmental performance indicators (EPI's) are used to measure human activities and their effects on the environment. Included amongst these EPI's, faecal indicator bacteria (enterococci, *E. coli* and faecal coliforms) can be monitored to assess the contamination of water by human or animal excreta. Levels of these faecal indicators are of particular interest in coastal waters used for recreational activities due to the potential health risks associated.

The Taranaki Regional Council has monitored faecal indicator bacteria at bathing beaches along the Taranaki coast since 1979, with systematic surveys undertaken from 1987. A more comprehensive annual bathing beach monitoring programme was implemented during the 1995-1996 summer as an on going component of the SEM programme for the Taranaki region.

The SEM bacteriological bathing water quality programme has three objectives:

- to characterise the bacteriological quality of principal recreation waters in the Taranaki area, and more specifically to determine their suitability for contact recreation;
- to identify changes in contact recreational water quality over time. Therefore the detection of trends is an important component in programme design;
- to assess compliance with recreational water quality guidelines.

[Note: Contact recreation concerns water-based activities involving a high probability of accidental water ingestion. This mainly applies to bathing, but may also include other high-contact water sports e.g. jet-skiing, surfing, kayaking]

2. Contact recreation water quality standards and guidelines

2.1 Microbiological water quality guidelines for marine recreational areas (2003)

Guidelines for microbiological water quality of marine recreational areas have been prepared by the Ministry for the Environment in conjunction with the Ministry of Health (MfE, 2003). The guidelines use a combination of a qualitative risk grading of the catchment, together with direct measurements of appropriate faecal indicators to assess the suitability of a site for recreation (see 2.2).

In addition, 'Alert' and 'Action' guideline levels are used for surveillance throughout the bathing season. These guideline levels are summarised in Table 1 and are based on keeping illness risk associated with recreational water use to less than approximately 2%. Levels are based on enterococci counts as these bacteria are the preferred indicators for marine waters. Research has shown that enterococci are the indicator most closely correlated with health effects in New Zealand marine waters, in common with general findings overseas (New Zealand Marine Bathing Study). In coastal waters, faecal coliforms and *E. coli* are not as well correlated with health risks, but can be used as indicators, in addition to enterococci, where enterococci levels alone may be misleading.

Table 1 Surveillance, Alert and Action levels for marine waters (2003)

	Mode		
	Surveillance	Alert	Action
Enterococci (cfu/100ml)	No single sample <140	Single sample >140	Two consecutive single samples >280
Procedure	<ul style="list-style-type: none"> Continue routine monitoring 	<ul style="list-style-type: none"> Increase sample to daily Undertake sanitary survey Identify sources of contamination Consult CAC to assist in identifying possible source 	<ul style="list-style-type: none"> Increase sample to daily Undertake sanitary survey Identify sources of contamination Consult CAC to assist in identifying possible source Erect warning signs Inform the public through the media that a public health problem exists

CAC = Catchment Assessment Checklist

2.2 Suitability for recreation grading (SFRG) of sites

The 2003 Microbiological Water Quality Guidelines (MfE, 2003) provide for the grading of recreational water bodies based on two components:

- *The Microbiological Assessment Category (MAC)*: this is established on the basis of five years' enterococci data for a particular site, providing a quantitative measurement of the actual water quality over time. Sites are assigned MAC categories ranging from A to D, with definitions provided in Table 2. For the Taranaki region, the Taranaki Regional Council provides the Ministry for the Environment with these data collected as part of the annual bathing beach monitoring programme.
- *The Sanitary Inspection Category (SIC)*: generates a measure of the susceptibility of a water body to faecal contamination. A site is allocated a category of either

Very High, High, Moderate, Low or Very Low, and is determined using the SIC flow chart. Information used in the flow chart comes from the Catchment Assessment Checklist (CAC) which provides qualitative risk information on the catchment. Detailed information about SIC, including the SIC flow chart and the CAC can be found in the 2003 Microbiological Water Quality Guidelines (MfE, 2003).

The SIC is combined with the MAC to determine a Suitability for Recreation Grade (SFRG) for each site. The SFRG therefore describes the general condition of a site based on both qualitative risk grading of the catchment and the quantitative measurement of faecal indicators. A grade is established on the basis of the most recent five years' data and recalculation of a grade is typically performed annually.

Table 2 Microbiological Assessment Categories

MAC	MAC definitions for marine waters
A	Sample 95 percentile \leq 40 enterococci/100ml
B	Sample 95 percentile 41 - 200 enterococci/100ml
C	Sample 95 percentile 201 - 500 enterococci/100ml
D	Sample 95 percentile $>$ 500 enterococci/100ml

SFRGs, as defined by the Ministry for the Environment, are:

- *Very Good*: considered satisfactory for swimming at all times.
- *Good*: satisfactory for swimming most of the time. Exceptions may include following rainfall.
- *Fair*: generally satisfactory for swimming, though there are many potential sources of faecal material. Caution should be taken during periods of high rainfall, and swimming avoided if water is discoloured.
- *Poor*: generally unsuitable for swimming, as indicated by historical results. Swimming should be avoided, particularly by the very young, the very old and those with compromised immunity.
- *Very Poor*: avoid swimming.

Eleven of the 19 sites monitored by the Council had sufficient data available to calculate SFRC grades for the period spanning November 2005 to May 2010 (Appendix II). Of these 11 sites, 7 (64%) were graded 'Good' and 4 (36%) were graded 'Fair'. None of the beaches graded 'Poor' or 'Very Poor'. As 10 of the 11 beaches obtained a SIC of 'Moderate' it was not possible for any of these beaches to be assigned a 'Very Good' SFRG grading regardless of the enterococci results used to calculate MAC. This was mainly related to either the agricultural nature of the catchment areas or the presence of nearby streams and rivers which heavily influenced the SIC assessment results.

It must be emphasised that the SFRG grade provides a conservative/precautionary guideline intended for assessing the suitability of beaches for contact recreation from a public health perspective. The grade is of limited use for assessing the state of the environment, as it includes the SIC: a static assessment based on qualitative information. Instead, the remainder of this report will focus on presenting and interpreting actual faecal indicator data collected during routine monitoring. This quantitative information base enables the assessment of general trends in coastal

water quality, and can be used to measure how well management practices and policies are working, and whether environmental outcomes are being achieved.

Note: Table 1 takes into account data from both standard SEM samples along with extra samples required by MfE (see Section 3).

Table 3 Suitability for recreation grade (SFRG) for coastal recreational areas in the Taranaki region, October 2005 to May 2010

Site	Sanitary Inspection Category *	Microbiological assessment Enterococci (cfu/100ml)			SFR Grade	% of all samples in compliance (ie: <280 enterococci)
		95 %ile	Number of samples	Category		
Onaero	Low 14	205.5	93	C	Fair	96
Waitara West Beach	Moderate 13	297.5	65	C	Fair	93
Waitara East Beach	Moderate 13	187.5	65	B	Good	96
Bell Block	Moderate 3	169.6	26	B	Good	96
Fitzroy	Moderate 3	75.6	101	B	Good	98
East End	Moderate 3	150.0	50	B	Good	98
Ngamotu	Moderate 3	95.0	101	B	Good	98
Oakura (SC)	Moderate 13	300.0	102	C	Fair	94
Oakura (CG)	Moderate 13	26.8	66	A	Good	100
Opunake	Moderate 3	15.0	80	A	Good	100
Ohawe	Moderate 13	329.0	76	C	Fair	94
Patea	Moderate 13	Insufficient data to calculate				
Patea (Mana Bay)	Moderate 13	Insufficient data to calculate				
Waverley	Moderate 13	Insufficient data to calculate				
Wai-inu	Moderate 13	Insufficient data to calculate				
Back	Low 14	Insufficient data to calculate				
Wai-iti	Moderate 13	Insufficient data to calculate				
Urenui	Moderate 13	Insufficient data to calculate				
Onaero settlement	Low 14	Insufficient data to calculate				

* 13 = River - agricultural activities/birds/feral animals

14 = River - focal points of discharge

3 = Urban stormwater

3. Monitoring methodology

3.1 SEM sample collection

The monitoring network is designed to assess coastal water quality in terms of its suitability for contact recreation. As such, the network targets the main bathing times and avoids, as far as possible, the influence of diffuse sources (i.e. streams and rivers) on coastal water quality. For these reasons the following criteria have been adopted during sampling:

Sample collection, field measurements, transport and analyses were undertaken according to documented Taranaki Regional Council procedures. It was intended that on average, four samples would be collected from each of the sites in each month when hydrological flow conditions permitted, within two hours of high tide. SEM sampling was performed only under dry weather flow conditions (i.e., not within three days of a fresh). Bathing water samples were taken between the hours of 0900 and 1800 hours (NZDT). Where necessary, a 2 metre sampling pole was used for bacteriological sample collection immediately beneath the water surface and at a minimum of knee depth at the sites (Photo 1). Thirteen samples were collected from each site during the season.

Results for the 2010-2011 bathing season were posted on the Taranaki Regional Council website (www.trc.govt.nz) as soon as checking had been completed. Where results fell in the Action mode, further sampling was performed when necessary i.e. where historical databases and staff expertise indicated this was warranted.

3.2 Sample analysis

Samples were analysed for enterococci, *E. coli*, faecal coliforms and conductivity. *E. coli* and faecal coliform numbers were obtained using the mTEC agar method #9213-d, Standard Methods for the Examination of Waters and Wastewaters (APHA, 2005). Enterococci were quantified using the EPA modified method #1600 on mEI agar (EPA, 1986).

At each of the sites the following additional information was recorded; time, water temperature, weather condition, wind condition, surf condition, colour/appearance of water, and number of bathers and other users.

3.3 Programme design

The locations of the twelve sites sampled in the 2010-2011 programme are shown in Figure 1 and summarised in Table 4.

Table 4 Location of bathing water bacteriological sampling sites 2010-2011

Beach	Location	GPS	Site code
Onaero	Opposite surf lifesaving club	2628254-6244898	SEA900085
Bell Block	West of Mangati Stream	2609210-6242224	SEA902001
Fitzroy	Opposite surf lifesaving club	2605036-6239351	SEA902025
East End	Opposite surf lifesaving club	2604605-6239000	SEA902035
Ngamotu	Centre of beach	2600022-6237765	SEA902062
Back	To the north of the Herekawe Stream	2598198-6236896	SEA902070
Oakura	Opposite surf lifesaving club, south of Wairau Stream	2591974-6231726	SEA903030
Oakura	Opposite motorcamp, south of Waimoku Stream	2591700-6231600	SEA903032
Opunake	Centre of beach	2583775-6193800	SEA904090
Ohawe	Adjacent to boat ramp, east of Waingongoro River	2612688-6179169	SEA906010
Waitara East	East Beach	1706602-5683915	SEA901033
Waitara West	West Beach	1705951-5683802	SEA901037

Primary beach sites are monitored each year (Table 5). Remaining beach sites are sampled on a three year rotation, with Year 2 beaches sampled during the 2010-2011 monitoring programme (Table 5).

Table 5 Coastal bathing beach sampling programme

Annually sampled	Year 1	Year 2	Year 3
Fitzroy	Patea	Bell Block	Wai-iti
Ngamotu	Patea Bay **	East End	Urenui
Oakura CG	Waverley	Back Beach	Onaero Settlement
Oakura SC	Wai-inu		
Opunake			
Ohawe *			
Onaero (opp. surf club)			
Waitara East			
Waitara West			

*since 1996-97

** since 2000-01 summer period

*** since 2001-02 summer period



Photo 1 Bacteriological sampling

3.3.1 Additional monitoring (MfE guidelines)

The revised guidelines (MfE, 2003) require weekly surveillance monitoring during the 5-month recreational period, with a minimum of 20 sampling dates, regardless of weather conditions, state of the tide or likelihood of bathers being present. Following consultation with the territorial local authorities and the Taranaki District Health Board, TRC added seven sampling dates to the SEM protocol at five of the most popular marine recreational sites (Onaero, Fitzroy, Ngamotu, Oakura and Opunake beaches) in the 2002-2003 period. These seven sampling dates were systematically selected (one per week) in weeks not sampled by the SEM programme. Sampling was undertaken regardless of prior weather conditions or tides but adhering to all other SEM programme protocols. [NB: These data will not be used for trend analysis purposes as they do not comply with the format of the originally established SEM programme].

3.4 Long-term trend analysis

For sites with sufficient data (≥ 10 years), non-parametric trend analysis was performed using annual median enterococci data. For each site, a LOWESS (Logically Weighted Scatterplot) line (tension 0.4) was fitted to a temporal scatter plot of the enterococci median data. Statistical significance of the trend was tested using a Mann-Kendall test. The sign (+/-) of the Kendall tau value was used to assess whether the trend was positive or negative and the significance of the trend was determined using the p value ($p < 0.05 = \text{significant}$).

When multiple correlations are undertaken, there is a chance that some will be found to be significant purely by chance. In order to deal with this potential problem, the Benjamini-Hochberg False Discovery Rate (FDR) method was applied to the results of the Man-Kendall test. Further justification for this statistical approach can be found in Stark and Fowles (2006).

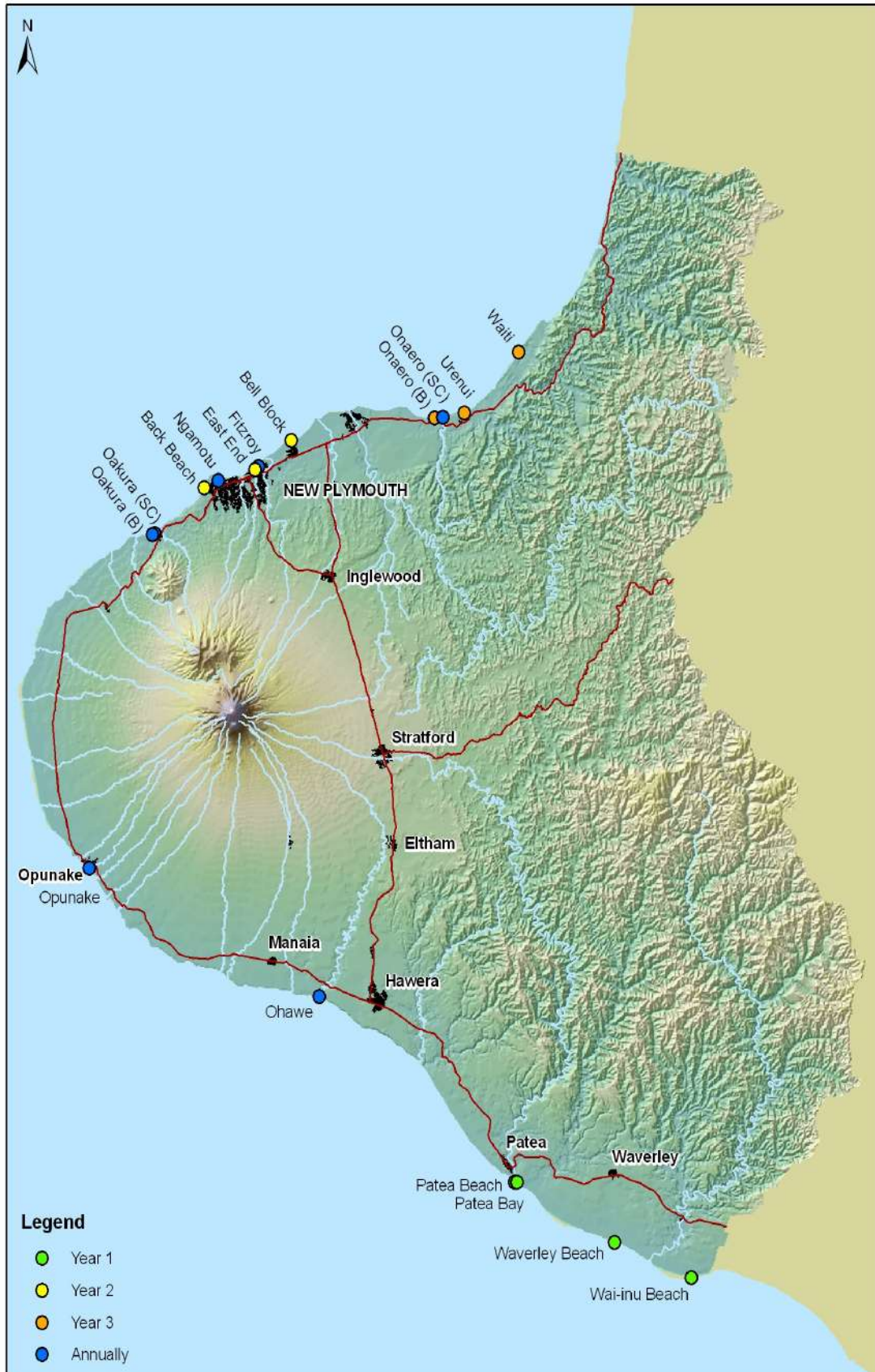


Figure 1 SEM beach bathing bacteriological survey sites

4. Results

From 9 November 2010 to 12 April 2011 a total of 13 samples were collected at each site for the purpose of state of the environment monitoring (SEM). Whenever possible, no SEM sampling was undertaken within three days following significant river freshes. However, occasionally sampling was affected by localised rainfall and elevated river flows. An additional seven samples were taken at five of the beaches (Onaero, Fitzroy Ngamotu, Oakura and Opunake) regardless of weather conditions for the purpose of MfE monitoring (as described in Section 3.3.1). All results within this report are presented and discussed on a site-by-site basis for the sampling period. The timing of high tide on the dates sampled is provided in Appendix I.

Sampling was confined to weekdays, with no public holidays included. For these reasons, recreational usage of the waters was generally less intensive, often with no apparent usage at the time of sampling. However, all sites are known to be regularly utilised for bathing and other contact recreational activities, particularly at weekends, dependent on suitable weather conditions.

4.1 Onaero Beach

4.1.1 SEM programme

Onaero Beach (Photo 2), located in north Taranaki, is a relatively popular bathing beach, particularly over the Christmas holiday period. The Onaero River drains to the southern end of the beach, making a significant contribution to bacteria counts following rainfall events.



Photo 2 Onaero Beach

The data for this site are presented in Table 6 and Figure 2, with a statistical summary provided in Table 7.

Table 6 Bacteriological results for Onaero Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
09-Nov-10	1030	4580	3	<1	3	16.8
24-Nov-10	930	4730	21	1	21	15.4
06-Dec-10	920	4680	9	5	11	17.8
06-Jan-11	930	4590	31	35	31	20.5
10-Jan-11	1200	4460	1	<1	1	21.4
03-Feb-11	1045	4240	130	76	130	18
11-Feb-11	1305	4640	9	7	9	21.4
18-Feb-11	950	4660	8	16	8	20.8
21-Feb-11	1020	4700	9	11	9	21.8
10-Mar-11	1100	4630	31	96	33	20.2
21-Mar-11	1110	4760	19	12	19	19.9
25-Mar-11	1140	4700	4	5	4	19
12-Apr-11	1430	4660	4	31	4	20.3

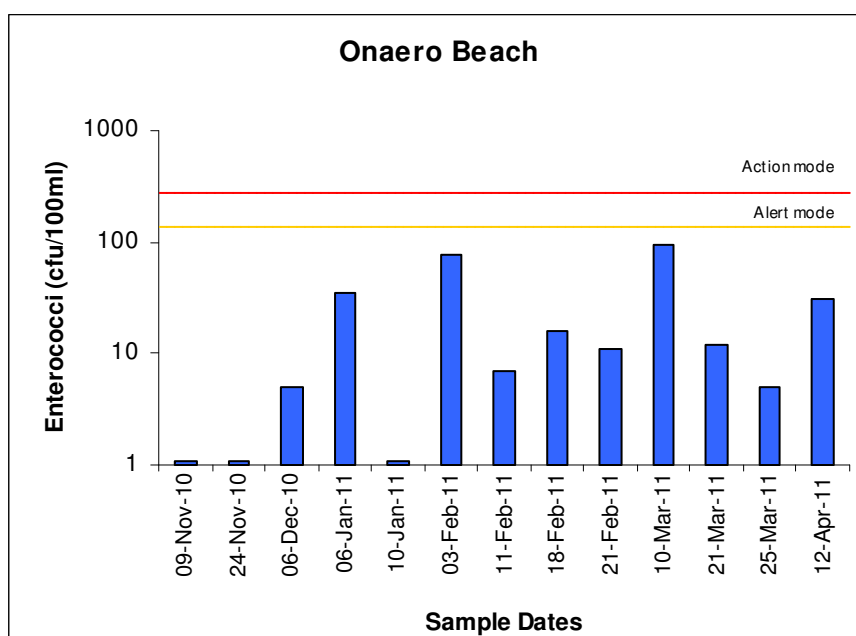


Figure 2 Enterococci numbers for the 13 SEM samples taken from Onaero Beach

Table 7 Statistical summary for Onaero Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4240	4760	4660
<i>E. coli</i>	cfu/100ml	13	1	130	9
Enterococci	cfu/100ml	13	<1	96	11
Faecal coliforms	cfu/100ml	13	1	130	9
Temperature	°C	13	15.4	21.8	20.2

Bacteriological water quality was good, with relatively low counts of all bacteriological indicators throughout the bathing season.

4.1.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 8. Enterococci counts in all samples were below Alert and Action guideline levels.

Table 8 Bacterial guidelines performance at Onaero Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
	Single sample 141-280/100ml		Two consecutive samples >280/100 ml	
Enterococci	0/13	0%	0/13	0%

4.1.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Onaero Beach over twelve summers are presented in Table 9 and Figure 3.

Table 9 Summary enterococci data (cfu/100ml) for summer surveys at Onaero Beach

Summer	96/97	99/00	01/02	02/03	03/04	04/05	05/06
Minimum	1	4	5	<1	<1	<1	<1
Maximum	26	40	140	4200	52	1000	46
Median	13	12	17	9	5	15	4
	06/07	07/08	08/09	09/10	10/11		
Minimum	2	<1	2	3	<1		
Maximum	560	59	64	27	96		
Median	7	4	13	13	11		

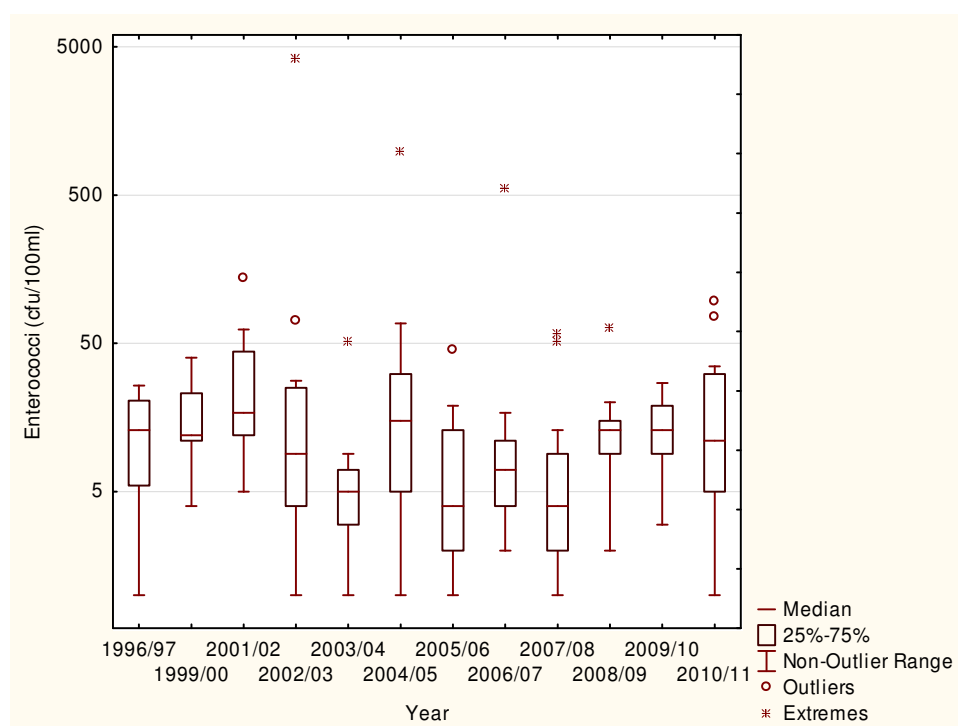


Figure 3 Box and whisker plots for all summer SEM surveys of enterococci numbers at Onaero Beach

The median obtained for the 2010-2011 summer (11 enterococci/100ml) was within the range of previous medians recorded at Onaero Beach (Table 9, Figure 3). The maximum was higher than the previous three years but within the range of previous long term results.

4.1.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for twelve summer seasons (Figure 4) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

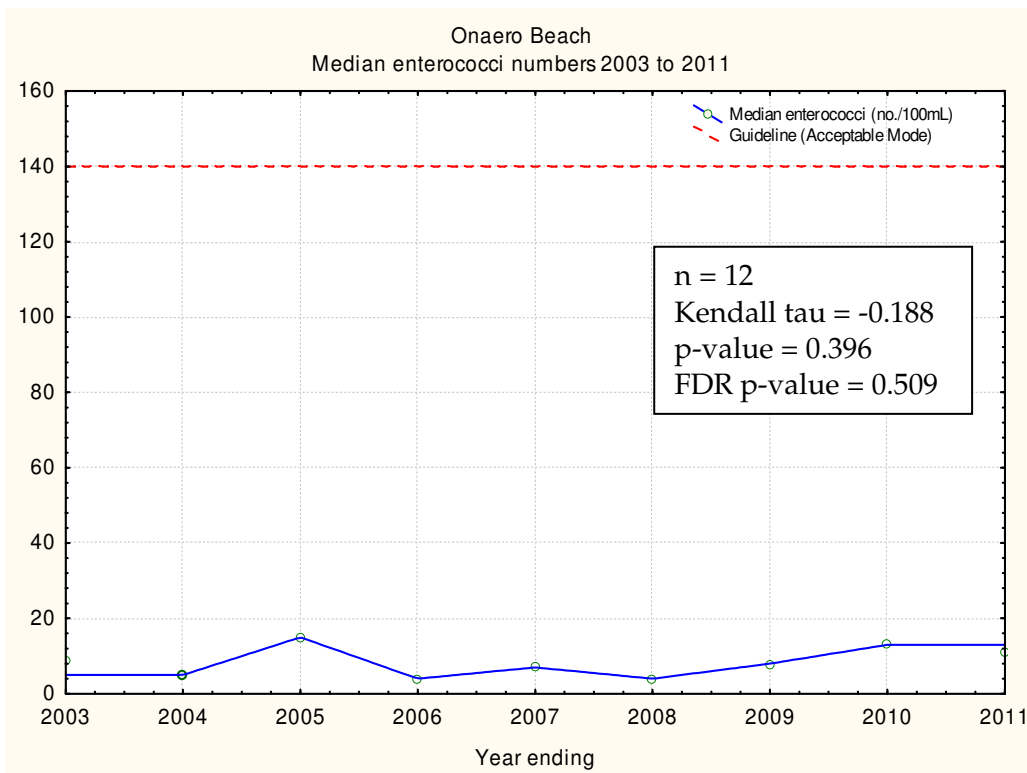


Figure 4 LOWESS trend analysis of median enterococci data at Onaero Beach

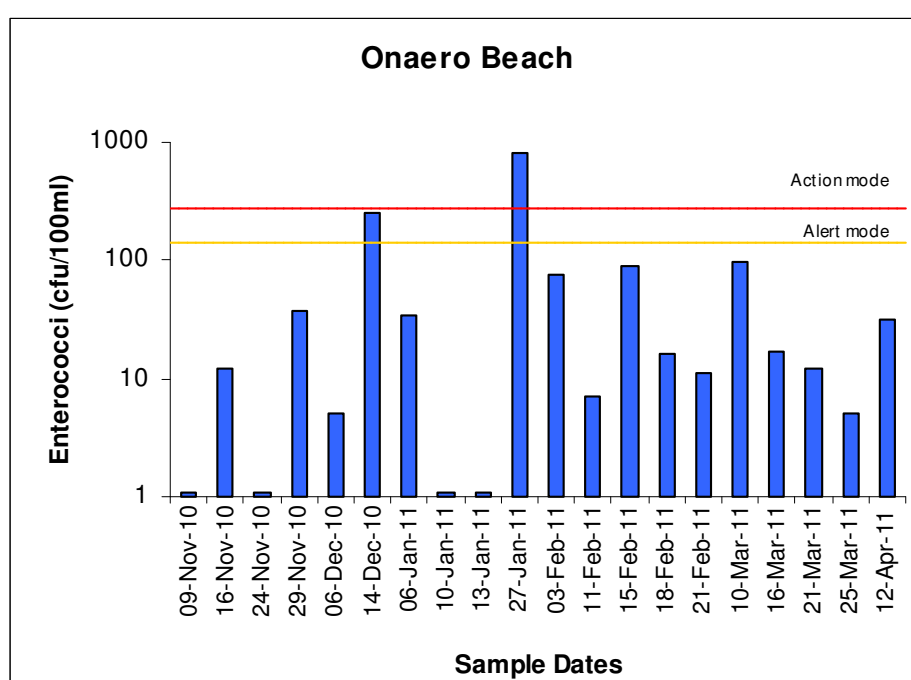
Over the twelve seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.188) that was not significant at the 5% level ($p = 0.396$).

4.1.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at regular intervals under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 10 and Figure 5, with a statistical summary provided in Table 11.

Table 10 Bacteriological results for MfE samples at Onaero Beach

Date	Time	Conductivity @ 20°C	Bacteria			Temperature
			<i>E. coli</i>	Enterococci	Faecal coliforms	
16-Nov-10	850	4740	100	12	100	15.4
29-Nov-10	900	3730	70	38	76	17.1
14-Dec-10	850	4380	200	250	200	17.6
13-Jan-11	905	4800	<1	<1	<1	20.1
27-Jan-11	855	2320	1000	820	1000	18.9
15-Feb-11	850	4180	120	91	130	20.7
16-Mar-11	850	4560	36	17	40	20.1

**Figure 5** Enterococci numbers for the 20 sample extended survey at Onaero Beach**Table 11** Summary statistics for SEM and MfE samples at Onaero Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	2320	4800	4585
<i>E. coli</i>	cfu/100ml	20	<1	1000	26
Enterococci	cfu/100ml	20	<1	820	10
Faecal coliforms	cfu/100ml	20	<1	1000	26
Temperature	°C	20	15.4	21.4	17.9

For both faecal coliforms and *E. coli* the additional sampling resulted in an increase in the overall seasonal median from 9cfu/100ml to 26 cfu/100ml. For enterococci the seasonal median decreased from 11cfu/100ml to 10 cfu/100ml.

4.1.5.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 12.

Table 12 Bacterial guidelines performance at Onaero Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	2/20	10%	0/20	0%

At Onaero Beach, 2 of 20 samples exceeded the Alert level. On 14 December 2010 there was localised rain in northern areas of Taranaki prior to sample collection, potentially resulting in elevated counts. The sample collected on 27 January 2011 as part of the MfE programme had also been influenced by rainfall.

4.2 Waitara East Beach

4.2.1 SEM programme

Waitara East Beach is located to the east of the Waitara River mouth (Photo3). Results at this site are influenced by the Waitara River which drains a large agricultural catchment and often contains high levels of bacteria. The primary treated domestic wastes from the Waitara township are discharged through the Waitara Marine Outfall approximately 1800m out to sea.



Photo 3 Waitara East Beach

The data for this site are presented in Table 13 and Figure 6, with a statistical summary provided in Table 14.

Table 13 Bacteriological results for Waitara East Beach

Date	Time (NZST)	Conductivity @ 20° C (mS/m)	Bacteria			Temperature (°C)	Turbidity (NTU)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)		
09-Nov-10	1115	4230	1	1	1	17.6	
24-Nov-10	1005	4730	4	<1	4	15.6	
06-Dec-10	845	4740	<1	1	<1	16.8	
06-Jan-11	1000	4670	120	1000	120	20.5	
10-Jan-11	1240	4000	13	71	13	22	
03-Feb-11	1010	4390	46	62	48	18	
11-Feb-11	1335	4060	7	1	7	21.4	
18-Feb-11	930	4580	83	210	83	20.7	
21-Feb-11	1100	4630	12	470	12	22.8	
10-Mar-11	1140	3970	48	1	50	20.7	22
21-Mar-11	1030	4530	7	40	7	19.7	36
25-Mar-11	1205	4720	1	3	1	19.1	18
12-Apr-11	1500	3760	19	3	19	19.5	13

NB: Turbidity added 10 March 2011

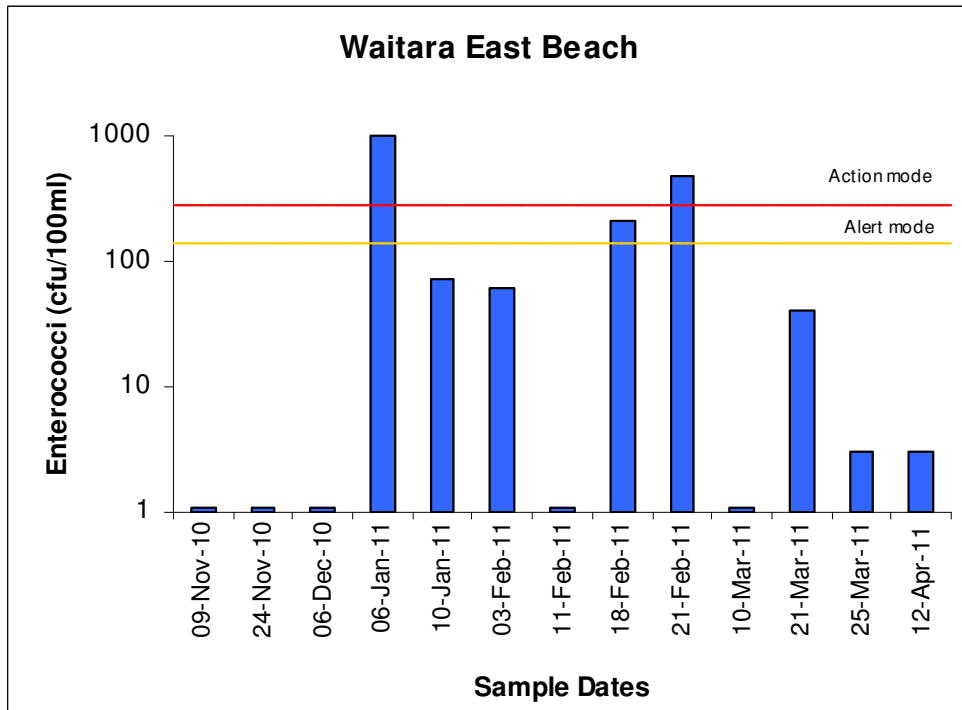


Figure 6 Enterococci numbers for the 13 SEM samples taken from Waitara East Beach

Table 14 Statistical summary for Waitara East Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3760	4740	4530
<i>E. coli</i>	cfu/100ml	13	<1	120	12
Enterococci	cfu/100ml	13	<1	1000	3
Faecal coliforms	cfu/100ml	13	<1	120	13
Temperature	°C	13	15.6	22.8	19.7
Turbidity	NTU	4	13	36	20

Although relatively low median counts were recorded for all bacteriological indicators (≤ 13 cfu/100ml), high maxima were obtained, especially for enterococci (1000 cfu/100ml Table 14). The high enterococci counts on 6 January, 18 and 21 February 2011 were all unexplained, with no significant rainfall for several days prior to sampling (Figure 6).

4.2.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 15.

Table 15 Bacterial guidelines performance at Waitara East Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	3/13	23%	0/13	0%

Three out of thirteen samples (23%) exceeded the Alert level guidelines during the bathing season.

4.2.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Waitara East Beach over sixteen summers are presented in Table 16 and Figure 7.

Table 16 Summary enterococci data (cfu/100 ml) for summer surveys at Waitara East Beach

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03
Minimum	1	1	1	3	3	1	4	<1
Maximum	950	960	230	250	230	520	290	410
Median	14	11	17	20	40	9	21	13
	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Minimum	<1	1	<1	1	1	<1	<1	<1
Maximum	840	310	88	91	120	2400	210	1000
Median	17	9	9	27	12	41	15	3

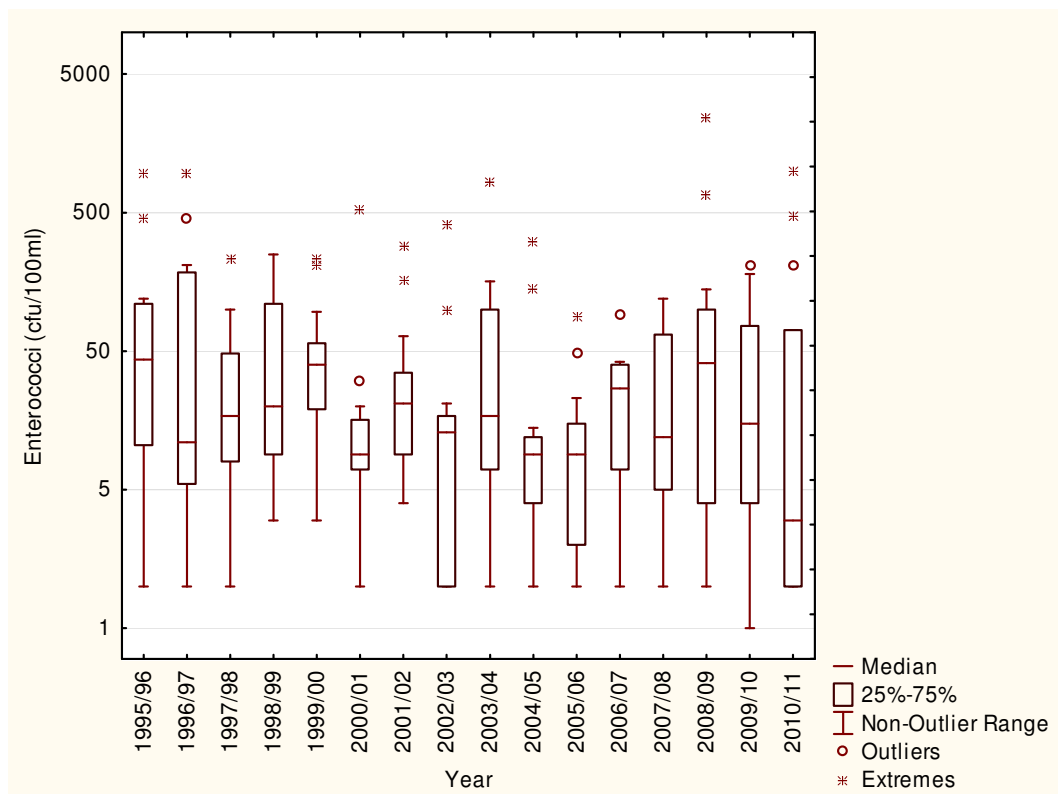


Figure 7 Box and whisker plots for all summer surveys of enterococci numbers at Waitara East Beach

Minima, maxima and median enterococci counts were within the range recorded in previous monitoring periods (Table 16, Figure 7). Maxima at this site are historically high due to the influence of the Waitara River (Table 16).

4.2.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for fifteen summer seasons (Figure 8) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

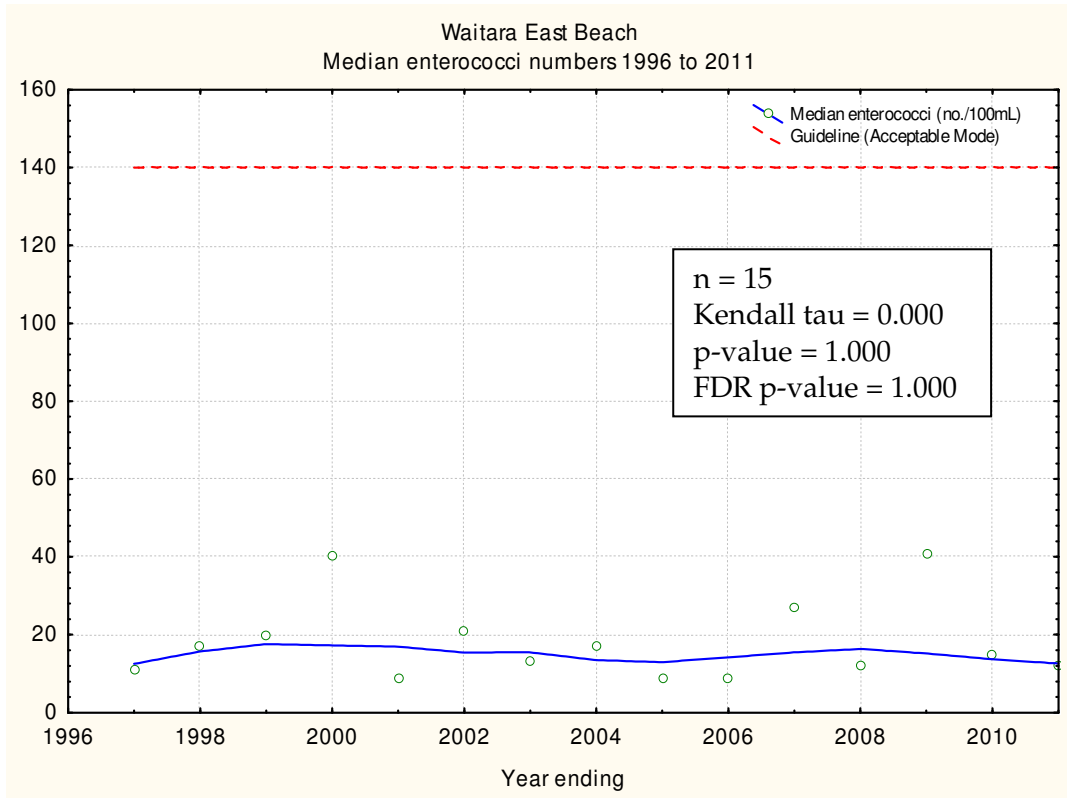


Figure 8 LOWESS trend analysis of median enterococci data at Waitara East Beach

There was no significant trend ($p = 1$) in median enterococci counts over the fifteen seasons monitored.

4.3 Waitara West Beach

4.3.1 SEM programme

Waitara West Beach is located to the west of the Waitara River mouth (Photo 4). As with Waitara East Beach, the results at this site can be influenced by the Waitara River and the discharge of primary treated domestic wastes from the Waitara township.



Photo 4 Waitara West Beach

The data for this site are presented in Table 17 and Figure 9, with a statistical summary provided in Table 18.

Table 17 Bacteriological results for Waitara West Beach

Date	Time (NZST)	Conductivity @ 20° C (mS/m)	Bacteria			Temperature (°C)	Turbidity (NTU)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)		
09-Nov-10	1140	3420	<1	1.1	<1	18.1	
24-Nov-10	1025	4730	<1	1	<1	16	
06-Dec-10	820	4680	9	7	9	17.4	
06-Jan-11	1020	4470	1000	680	1100	20.5	
10-Jan-11	1315	4560	<1	3	<1	22.6	
03-Feb-11	945	3950	81	80	83	18.6	
11-Feb-11	1405	4340	1200	910	1300	21.7	
14-Feb-11	1050	3810	72	31	74	23.3	
18-Feb-11	855	4600	120	49	120	20.9	
21-Feb-11	1130	4740	52	110	54	22.9	
10-Mar-11	1205	4010	68	31	74	20.5	16
21-Mar-11	1010	4760	12	20	12	19.6	39
25-Mar-11	1230	4440	9	5	9	19	6.5

NB: Turbidity added 10 March 2011

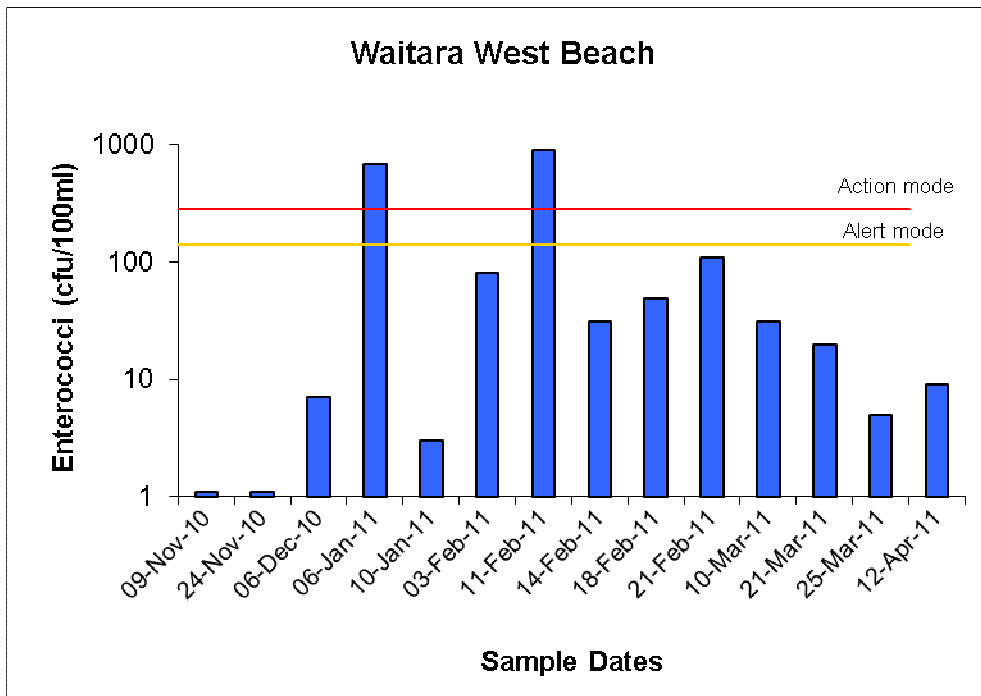


Figure 9 Enterococci numbers for the 13 SEM samples taken from Waitara West Beach

Table 18 Statistical summary for Waitara West Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3420	4760	4470
<i>E. coli</i>	cfu/100ml	13	<1	1200	12
Enterococci	cfu/100ml	13	<1	910	20
Faecal coliforms	cfu/100ml	13	<1	1300	12
Temperature	°C	13	16.0	23.3	20.1
Turbidity	NTU	4	6.5	39.0	27.5

Although relatively low median counts were recorded for all bacteriological indicators (≤ 20 cfu/100ml), high maxima were recorded (>1000 cfu/100ml for *E. coli* and faecal coliforms, Table 18).

4.3.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 19.

Table 19 Bacterial guidelines performance at Waitara West Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	2/13	15%	0/13	0%

Two samples exceeded the Alert level guidelines; 6 January and 11 February 2011. Both elevated counts were unexplained, with no significant rainfall prior to sampling.

4.3.3 Comparison with previous summer surveys

Summary statistics for enterococci survey data collected at Waitara West Beach over 16 summers are presented in Table 20 and Figure 10.

Table 20 Summary enterococci data (cfu/100 ml) for summer surveys at Waitara West Beach

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03
Minimum	2	1	1	1	3	1	1	1
Maximum	4300	100	340	350	290	240	57	170
Median	21	16	28	5	19	5	11	16
	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Minimum	1	1	1	1	1	2	3	1
Maximum	800	300	100	240	67	530	42	910
Median	26	7	8	8	5	120	12	20

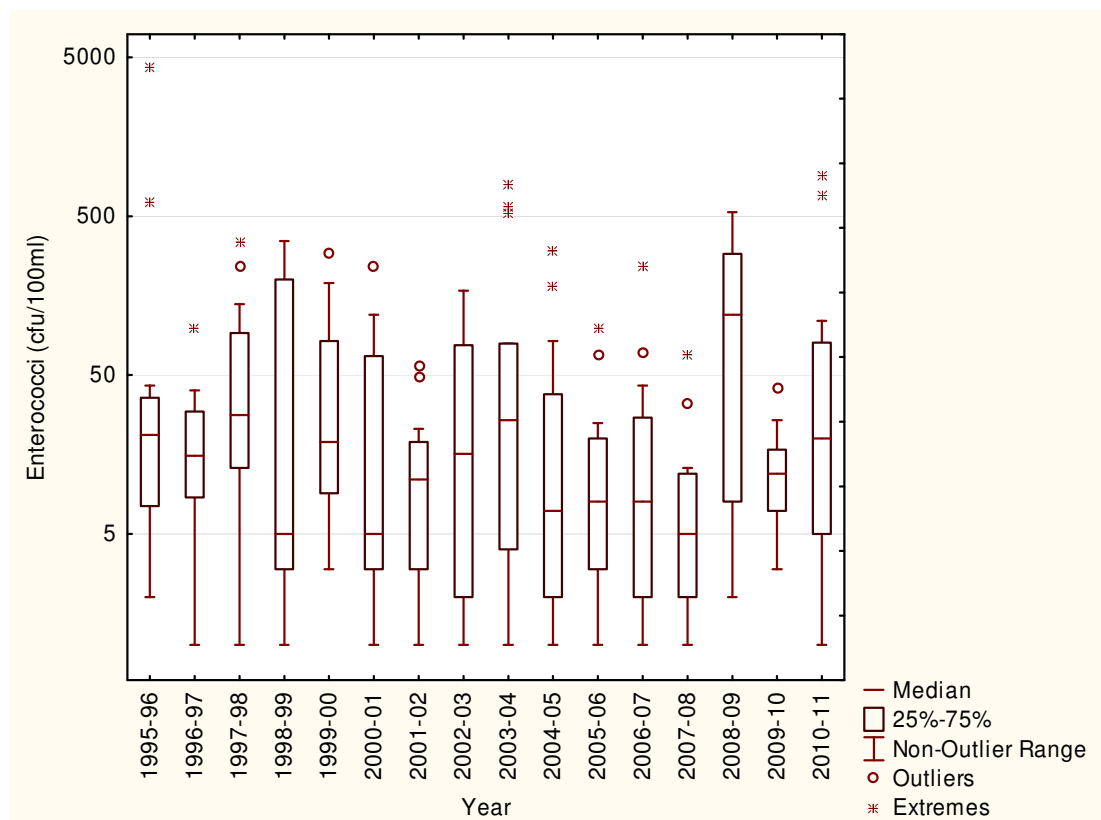


Figure 10 Box and whisker plots for all summer SEM surveys of enterococci numbers at Waitara West Beach

Minima, maxima and median enterococci counts were within the range recorded in previous monitoring periods (Table 16, Figure 7). Maxima at this site are historically high due to the influence of the Waitara River (Table 16).

4.3.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for fifteen summer seasons (Figure 11) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

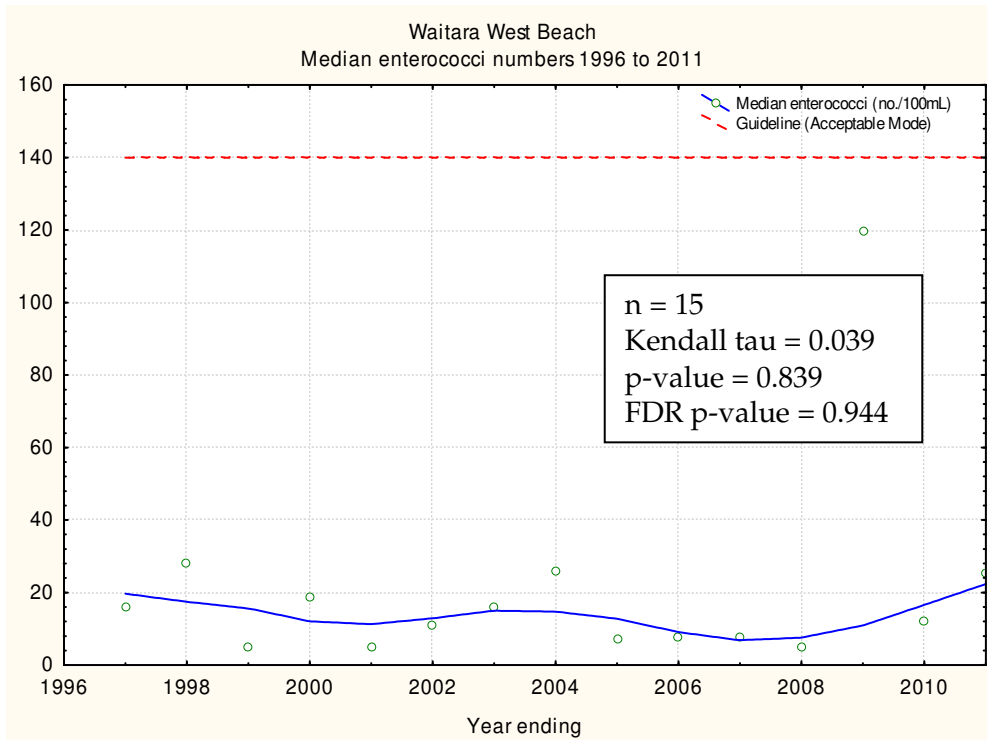


Figure 11 LOWESS trend analysis of median enterococci data at Waitara West Beach

Over the fifteen seasons monitored, there was an increasing trend in median enterococci counts (Kendall tau = 0.039) that was not significant at the 5% level ($p = 0.839$).

4.4 Bell Block Beach

4.4.1 SEM programme

Bell Block Beach (Photo 5) is a moderately popular summer bathing beach located north east of New Plymouth. The Mangati Stream enters the beach in the vicinity of the sample site. This stream drains through a highly modified/industrial catchment, which after rain, may impact significantly on bacteria numbers in the receiving waters.



Photo 5 Bell Block Beach

The data for this site are presented in Table 21 and Figure 12, with a statistical summary provided in Table 22.

Table 21 Bacteriological results for Bell Block Beach

Date	Time (NZST)	Conductivity @ 20° C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
09-Nov-10	1325	4700	<1	1	<1	17.2
24-Nov-10	1300	4740	17	3	17	17.1
06-Dec-10	1145	4760	9	<1	9	20
06-Jan-11	1105	4450	220	270	220	20.6
10-Jan-11	1410	4750	<1	4	<1	21.6
03-Feb-11	856	4680	3	5	3	18.8
11-Feb-11	1450	4600	4	5	4	21.6
18-Feb-11	825	4260	53	37	53	19.6
21-Feb-11	1200	4720	75	100	75	23.3
10-Mar-11	1240	4690	12	23	12	20.6
21-Mar-11	910	4650	6600	9700	7300	18.7
25-Mar-11	1305	4570	24	44	24	19
12-Apr-11	1550	4600	8	5	9	19.2

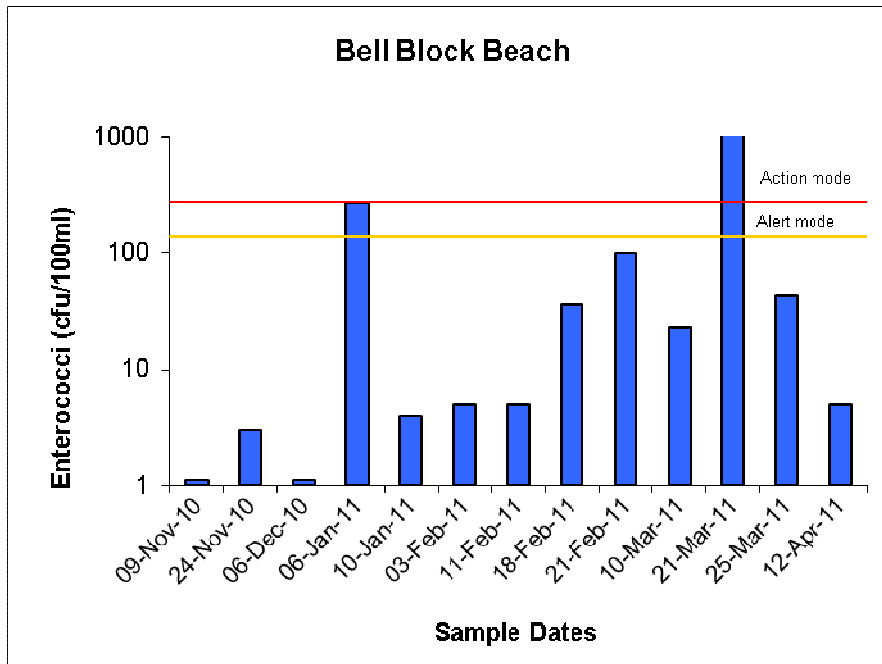


Figure 12 Enterococci numbers for the 13 SEM samples taken from Bell Block Beach

Table 22 Statistical summary for Bell Block Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4260	4760	4680
<i>E. coli</i>	cfu/100ml	13	<1	6600	12
Enterococci	cfu/100ml	13	<1	9700	5
Faecal coliforms	cfu/100ml	13	<1	7300	12
Temperature	°C	13	17.1	23.3	19.6

Although relatively low median counts were recorded for all bacteriological indicators (<13 cfu/100ml), very high maxima were recorded (>6500 cfu/100ml for all indicators, Table 18). These elevated maxima potentially resulted from a sewage overflow upstream of the sampling site on one occasion. Much lower counts were recorded for the remaining samples (Table 21).

4.4.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 23.

Table 23 Bacterial guidelines performance at Bell Block Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
	Single sample 141-280/100ml		Two consecutive samples >280/100 ml	
Enterococci	2/13	15%	0/13	0%

At Bell Block Beach two samples out of thirteen exceeded the Alert level. The high counts obtained on 6 January 2011 could have resulted from windy conditions, as high values were recorded throughout New Plymouth. The high count on 21 March 2011 was most likely caused by a sewage overflow from the Mangati pumping station.

4.4.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Bell Block Beach over 6 summer seasons are presented in Table 24 and Figure 13.

Table 24 Summary enterococci data (cfu/100ml) for summer surveys at Bell Block Beach

Summer	1995/1996	1998/1999	2001/2002	2004/2005	2007/2008
Minimum	3	<1	2	<1	<1
Maximum	480	110	800	600	81
Median	14	4	20	4	42
Summer	2010-11				
Minimum	1				
Maximum	9700				
Median	5				

NB Maximum value for 2010-11 caused by a sewage overflow upstream of the sampling site.

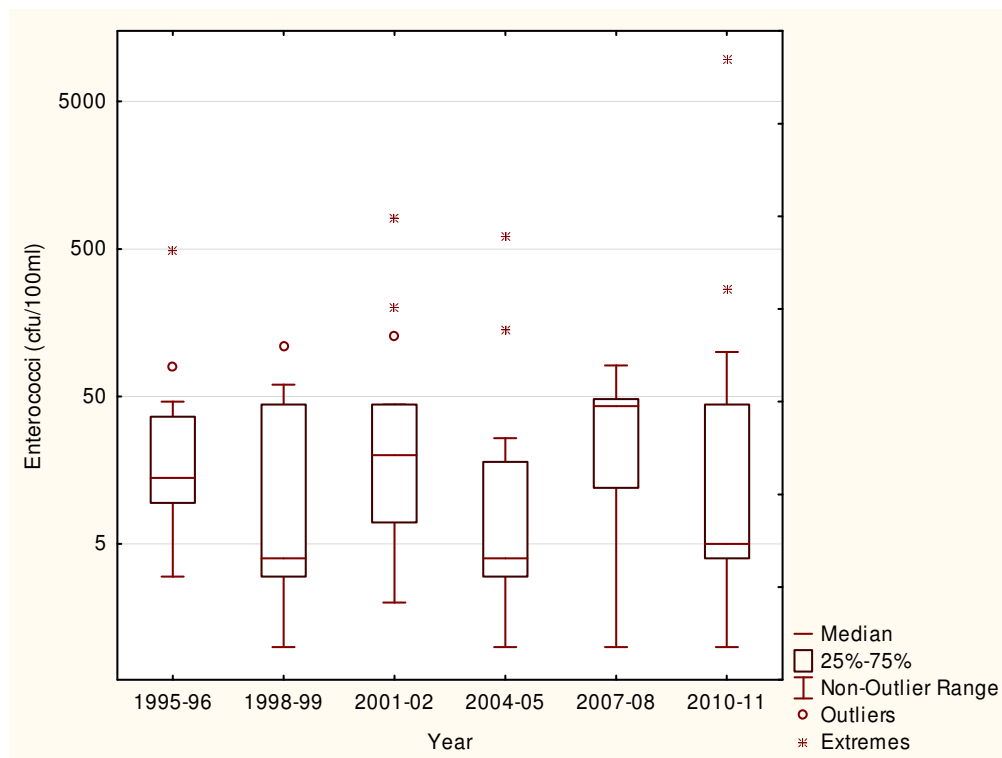


Figure 13 Box and whisker plots for all summer SEM surveys of enterococci numbers at Bell Block Beach

The median enterococci count from the 2010-2011 summer season was one of the lowest values recorded to date (Table 24). In contrast, the maximum count was the highest recorded to date, resulting from a sewage overflow upstream of site (Table 24). The box plot indicates that although the maximum enterococci count was high in 2010-2011, the water quality in the period under review was similar to the previous years.

4.4.4 Long-term trend analysis

Long-term trend analysis was not undertaken on data from this site as there were an insufficient number of samples (only triennial data available).

4.5 Fitzroy Beach

4.5.1 SEM programme

Fitzroy Beach is situated in New Plymouth and is one of the most popular bathing beaches in Taranaki. It is also a very popular surfing beach due to its central location and high quality waves (Photo 6). The mouth of the Waiwhakaiho River enters the sea at the eastern end of the beach, approximately 800m from the sample site, which can contribute significant amounts of freshwater during floods. Draining from a highly modified agricultural and industrial catchment, this can have a significant impact on bacteriological water quality subsequent to heavy rainfall. The river typically has a high level of contamination from bird life.



Photo 6 Surfer at Fitzroy Beach

The data for this site are presented in Table 25 and Figure 14, with a statistical summary provided in Table 26.

Table 25 Bacteriological results for Fitzroy Beach

Date	Time (NZST)	Conductivity @ 20° C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
09-Nov-10	1135	4740	<1	<1	<1	15.7
24-Nov-10	1055	4770	<1	1	<1	14.8
06-Dec-10	1035	4680	12	16	12	19
06-Jan-11	1100	4750	29	24	32	20.7
10-Jan-11	1320	4630	3	<1	3	21.8
03-Feb-11	1000	4700	8	11	8	17.3
11-Feb-11	1455	4660	<1	3	<1	20.9
18-Feb-11	955	4690	1	43	1	20.8
21-Feb-11	1110	4760	<1	4	<1	22.1

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
10-Mar-11	1240	4610	<1	4	<1	20.6
21-Mar-11	1035	4790	17	1	17	19.3
25-Mar-11	1330	4740	17	8	19	18.9
12-Apr-11	1550	4290	19	16	19	19.5

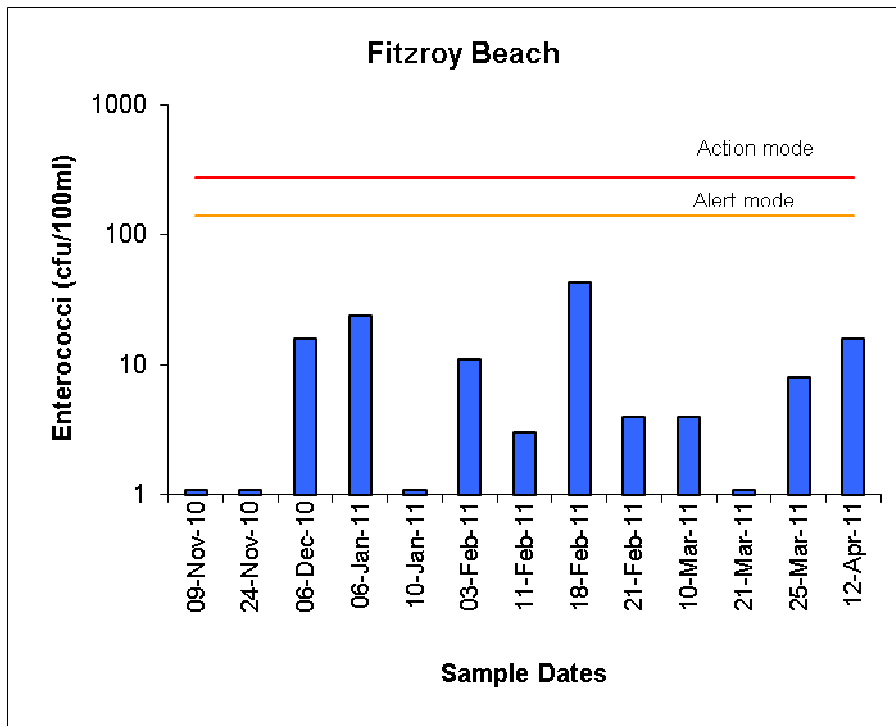


Figure 14 Enterococci numbers for the 13 SEM samples taken from Fitzroy Beach

Table 26 Statistical summary for Fitzroy Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4290	4790	4700
<i>E. coli</i>	cfu/100ml	13	<1	29	3
Enterococci	cfu/100ml	13	<1	43	4
Faecal coliforms	cfu/100ml	13	<1	32	3
Temperature	°C	13	14.8	22.1	19.5

Bacteriological water quality at Fitzroy Beach was high throughout the season, with low median values for all bacteriological parameters.

4.5.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 27. No single sample exceeded the Alert or Action modes during the 2010-2011 season.

Table 27 Bacterial guidelines performance at Fitzroy Beach

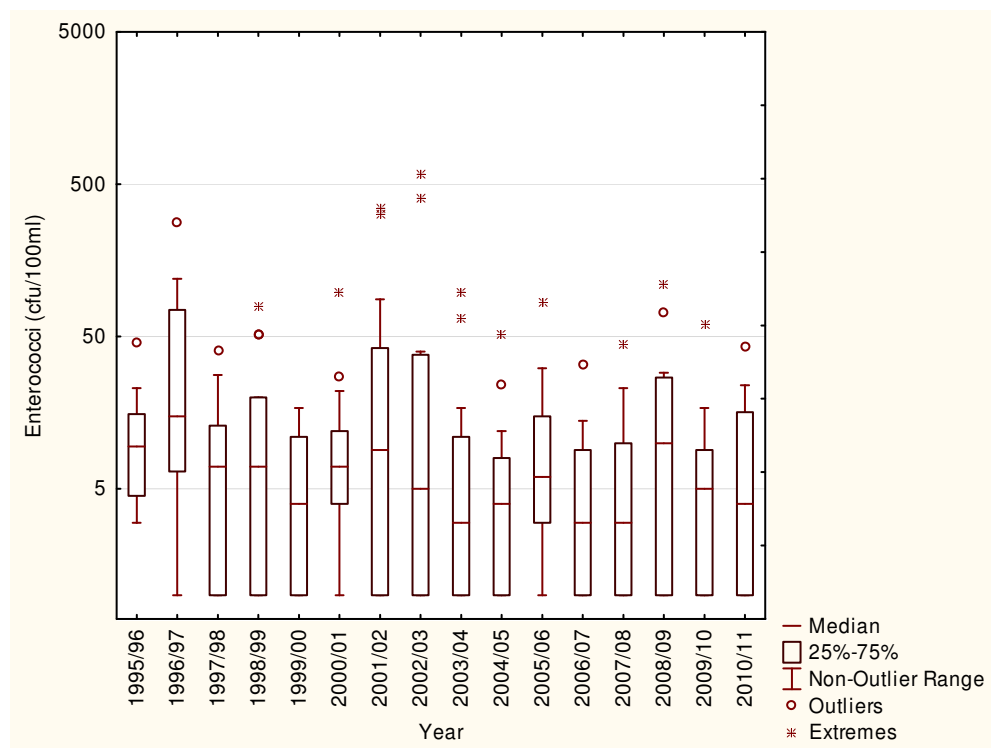
Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	0/13	0%	0/13	0%

4.5.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Fitzroy Beach over 16 summers are presented in Table 28 and Figure 15.

Table 28 Summary enterococci data (cfu/100 ml) for summer surveys at Fitzroy Beach

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03
Minimum	3	<1	<1	<1	<1	<1	<1	<1
Maximum	46	280	40	79	17	98	350	580
Median	10	15	7	7	4	7	9	5
	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Minimum	<1	<1	<1	<1	<1	<1	1	<1
Maximum	98	52	85	33	44	110	60	43
Median	3	4	6	3	3	10	8	4

**Figure 15** Box and whisker plots for all summer SEM surveys of enterococci numbers at Fitzroy Beach

The median and maximum enterococci data obtained for 2010-2011 at Fitzroy Beach were within the range of values previously recorded at this site and low compared to other Taranaki beach bathing sites.

4.5.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for sixteen summer seasons (Figure 16) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

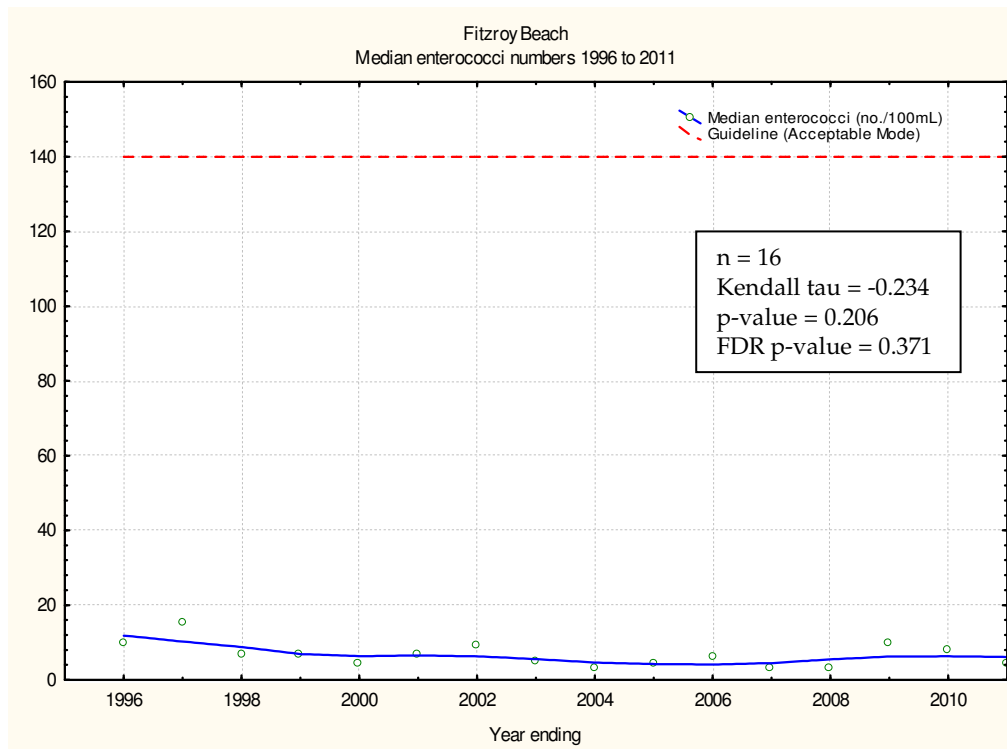


Figure 16 LOWESS trend analysis of median enterococci data at Fitzroy Beach

Over the sixteen seasons monitored, there was a negative (Kendall tau = -0.234) but not significant ($p = >0.05$) decrease in median enterococci numbers.

4.5.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at regular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 29 and Figure 17, with a statistical summary provided in Table 30.

Table 29 Bacteriological results for MfE samples at Fitzroy Beach

Date	Time	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)
	(NZST)		<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
16-Nov-10	955	4750	<1	<1	<1	15.9
29-Nov-10	1005	4700	1	1	1	17
14-Dec-10	950	4640	32	52	33	17.5
13-Jan-11	1010	4800	<1	<1	<1	19.1
27-Jan-11	1010	4780	1	1	1	19.2
15-Feb-11	950	4790	<1	1	<1	20
16-Mar-11	1005	4750	1	<1	1	20.3

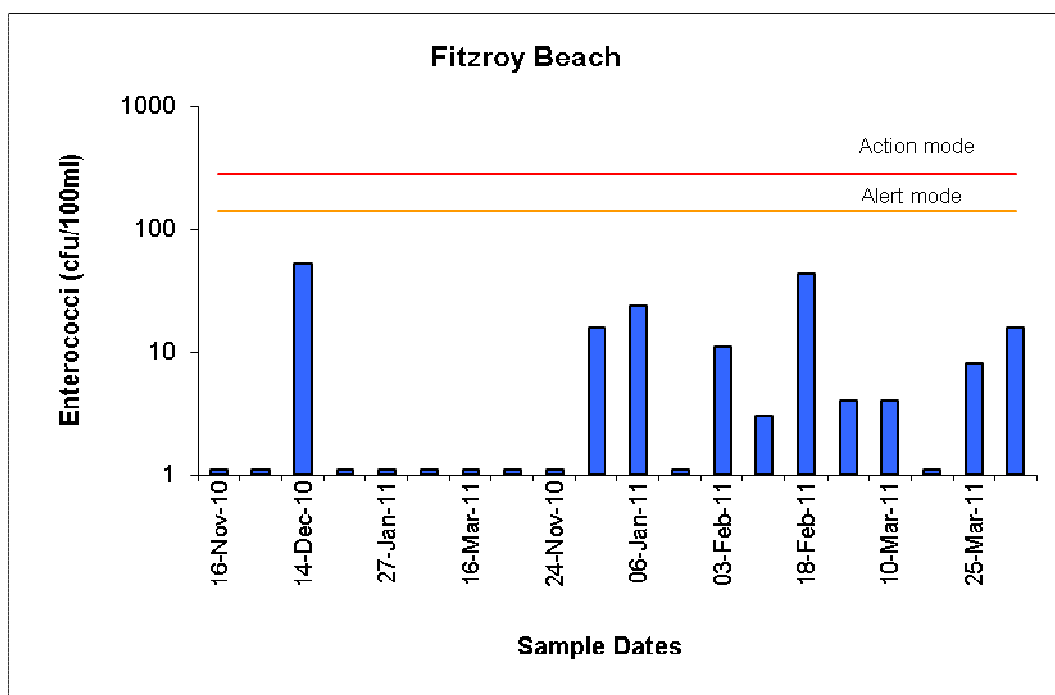


Figure 17 Enterococci numbers for the 20 sample extended survey at Fitzroy Beach

Table 30 Summary statistics for SEM and MfE samples at Fitzroy Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	4290	4800	4740
<i>E. coli</i>	cfu/100ml	20	0.5	32	1
Enterococci	cfu/100ml	20	0.5	52	2
Faecal coliforms	cfu/100ml	20	0.5	33	1
Temperature	°C	20	14.8	22.1	19.3

Additional sampling resulted in only minor changes to the overall seasonal median for all faecal bacteria indicators (Table 30).

4.5.5.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 31. No single sample exceeded the Alert or Action modes during the 2010-2011 season.

Table 31 Bacterial guidelines performance at Fitzroy Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	0/20	0%	0/20	0%

4.6 East End Beach

4.6.1 SEM programme

East End Beach is situated approximately 500m south-west of Fitzroy Beach in New Plymouth. This beach is popular with summer bathers and has its own Surf Life-saving Club. The Te Henui Stream enters the sea approximately 200m to the south-west of the sample site, which can result in high freshwater inputs during significant rainfall events.

Data from this site are presented in Table 32 and Figure 18, with a statistical summary provided in Table 33.

Table 32 Bacteriological results for East End Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
09-Nov-10	1125	4750	<1	<1	<1	16.3
24-Nov-10	1045	4770	1	9	1	15.3
06-Dec-10	1025	4580	48	37	48	19
06-Jan-11	1050	4700	39	57	39	20.7
10-Jan-11	1315	4490	<1	3	<1	21.6
03-Feb-11	950	4700	3	7	3	17.2
11-Feb-11	1440	4510	3	4	3	21.6
18-Feb-11	925	4690	11	44	11	20.8
21-Feb-11	1100	4750	4	12	4	22.2
10-Mar-11	1230	4490	3	11	3	20
21-Mar-11	1020	4700	32	36	33	19.4
25-Mar-11	1320	4740	11	29	11	19
12-Apr-11	1540	4380	3	3	3	19.6

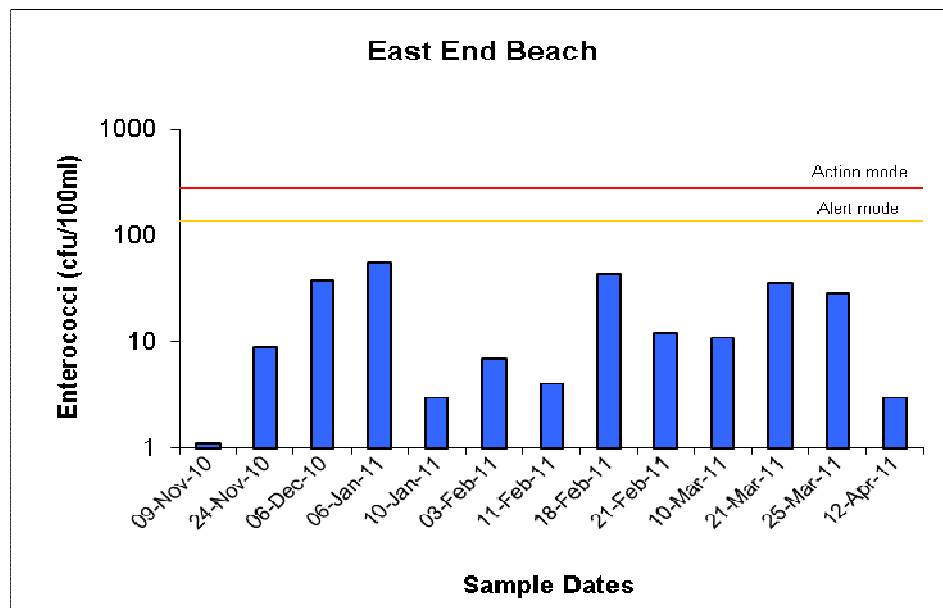


Figure 18 Enterococci numbers for the 13 SEM samples taken from East End Beach

Table 33 Statistical results summary for East End Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4380	4770	4700
<i>E. coli</i>	cfu/100ml	13	<1	48	3
Enterococci	cfu/100ml	13	<1	57	11
Faecal coliforms	cfu/100ml	13	<1	48	3
Temperature	°C	13	15.3	22.2	19.6

Bacteriological water quality at East End Beach was high throughout the season, with low median values for all bacteriological parameters.

4.6.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 34. Results for all parameters were well within acceptable guidelines.

Table 34 Bacterial guidelines performance at East End Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
	Single sample 141-280/100ml		Two consecutive samples >280/100 ml	
Enterococci	0/13	0%	0/13	0%

4.6.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at East End Beach over six summers (triennial surveys) are presented in Table 35 and Figure 19.

Table 35 Summary enterococci data (cfu/100ml) for summer surveys at East End Beach

Summer	1995/1996	1998/1999	2001/2002	2004/2005	2007/2008	2010/2011
Minimum	3	1	1	<1	1	<1
Maximum	340	88	200	100	140	57
Median	18	7	32	4	10	11

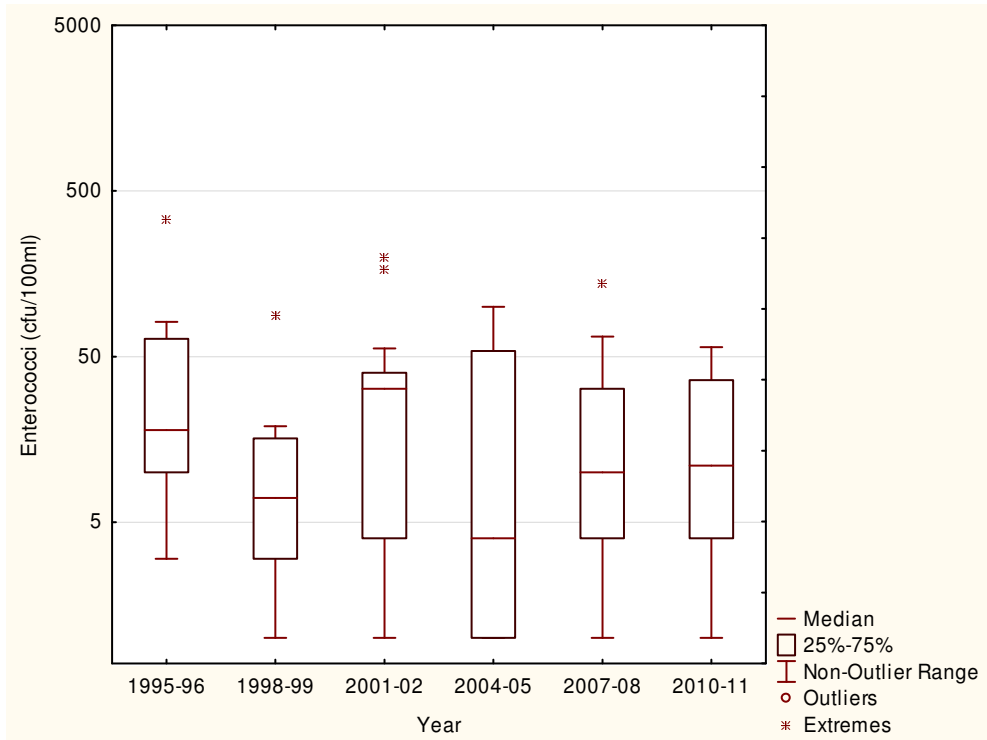


Figure 19 Box and whisker plots for all summer SEM surveys of enterococci numbers at East End Beach

All parameters were within the range of previously recorded results.

4.6.4 Long-term trend analysis

Long-term trend analysis was not undertaken on data from this site as there were an insufficient number of samples (only triennial data available).

4.7 Ngamotu Beach

4.7.1 SEM programme

Ngamotu Beach is situated within Port Taranaki, in close proximity to boat traffic and Port activities. It receives urban stormwater and a piped stream. Due to its sheltered location, situated between two breakwaters, this beach is very popular with young children and school groups and is often used for sports events.



Photo 7 Ngamotu Beach

Data for this site are presented in Table 36 and Figure 20, with a statistical summary provided in Table 37.

Table 36 Bacteriological results for Ngamotu Beach

Date	Time (NZST)	Conductivity @ 20° C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
09-Nov-10	1045	4560	<1	3	<1	18.9
24-Nov-10	1030	4750	<1	<1	<1	15.8
06-Dec-10	920	4780	1	8	1	19
06-Jan-11	1030	4740	63	61	65	20.6
10-Jan-11	1245	4760	<1	1	<1	22
03-Feb-11	935	4760	1	1	1	16.8
11-Feb-11	1425	4720	1	4	1	21.1
18-Feb-11	915	4650	250	180	270	20.2
21-Feb-11	1130	4690	29	73	37	22.8
10-Mar-11	1205	4660	<1	1	<1	20.4
21-Mar-11	1010	4780	19	9	20	19
25-Mar-11	1300	4770	19	24	31	18.8
12-Apr-11	1525	4320	4	15	4	20.3

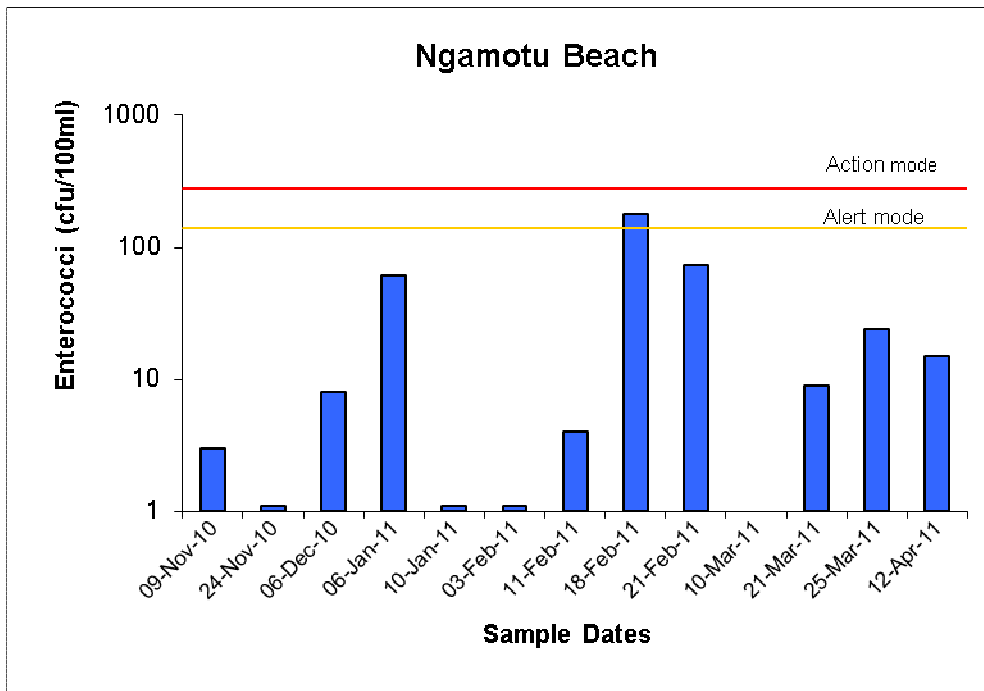


Figure 20 Enterococci numbers for the 13 SEM samples taken from Ngamotu Beach

Table 37 Statistical summary for Ngamotu Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4320	4780	4740
<i>E. coli</i>	cfu/100ml	13	<1	250	1
Enterococci	cfu/100ml	13	<1	180	8
Faecal coliforms	cfu/100ml	13	<1	270	1
Temperature	°C	13	15.8	22.8	20.2

Relatively low median counts were obtained for all faecal indicator bacteria (<9 cfu/100ml). The maximum enterococci count, recorded on 18 February 2011 (180 cfu/100ml), was unexplained with no significant rainfall 10 days prior to sampling. Alert levels were also recorded at Back Beach, a nearby recreational bathing beach, on 18 February 2011 (Figure 24).

4.7.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 38.

Table 38 Bacterial guidelines performance at Ngamotu Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	1/13	8%	0/13	0%

The enterococci sample collected on 18 February 2011 exceeded Alert level (180 cfu/100ml). The proceeding sample collected on 21 February had dropped back below Alert mode.

4.7.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Ngamotu Beach over sixteen summers are presented in Table 39 and Figure 21.

Table 39 Summary enterococci data (cfu/100 ml) for summer surveys at Ngamotu Beach

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03
Minimum	< 1	1	< 1	< 1	< 1	< 1	1	< 1
Maximum	160	600	310	72	85	240	630	140
Median	16	13	5	20	11	10	44	27
	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-2011
Minimum	< 1	< 1	1	1	1	1	< 1	< 1
Maximum	60	230	90	48	350	55	23	180
Median	5	14	13	12	4	9	4	8

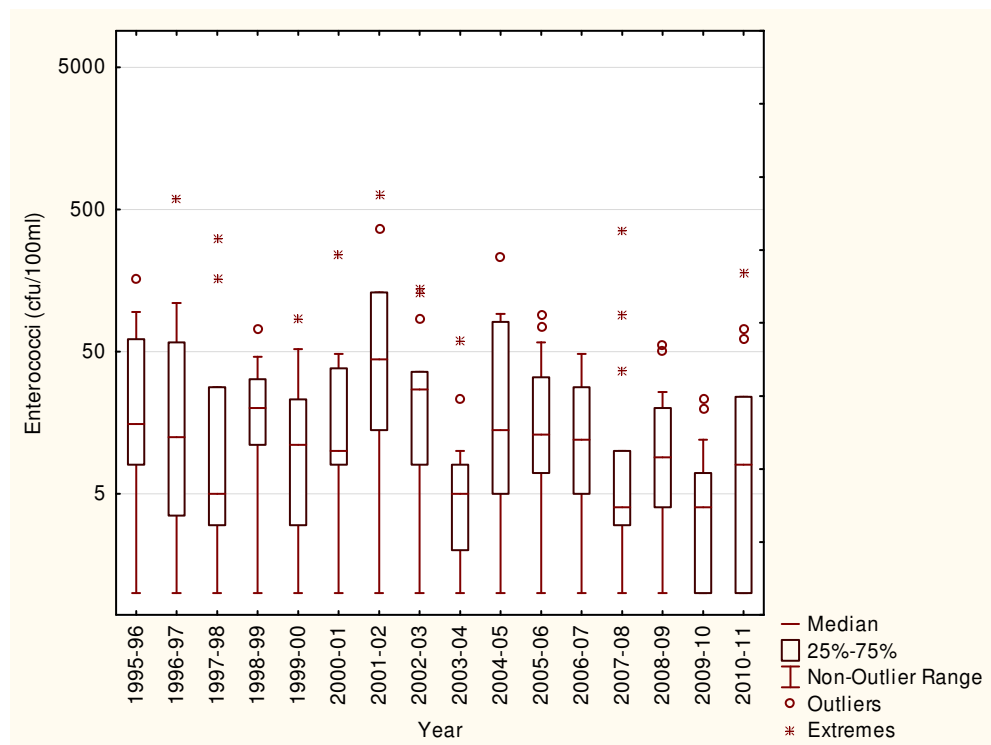


Figure 21 Box & whisker plots for all summer SEM surveys of enterococci numbers at Ngamotu Beach

The maximum and median enterococci numbers obtained for the 2010-2011 summer (180 and 8 cfu/100ml respectively) were within the range of previous values recorded at Ngamotu Beach (Table 39, Figure 21).

4.7.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for sixteen summer seasons (Figure 22) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

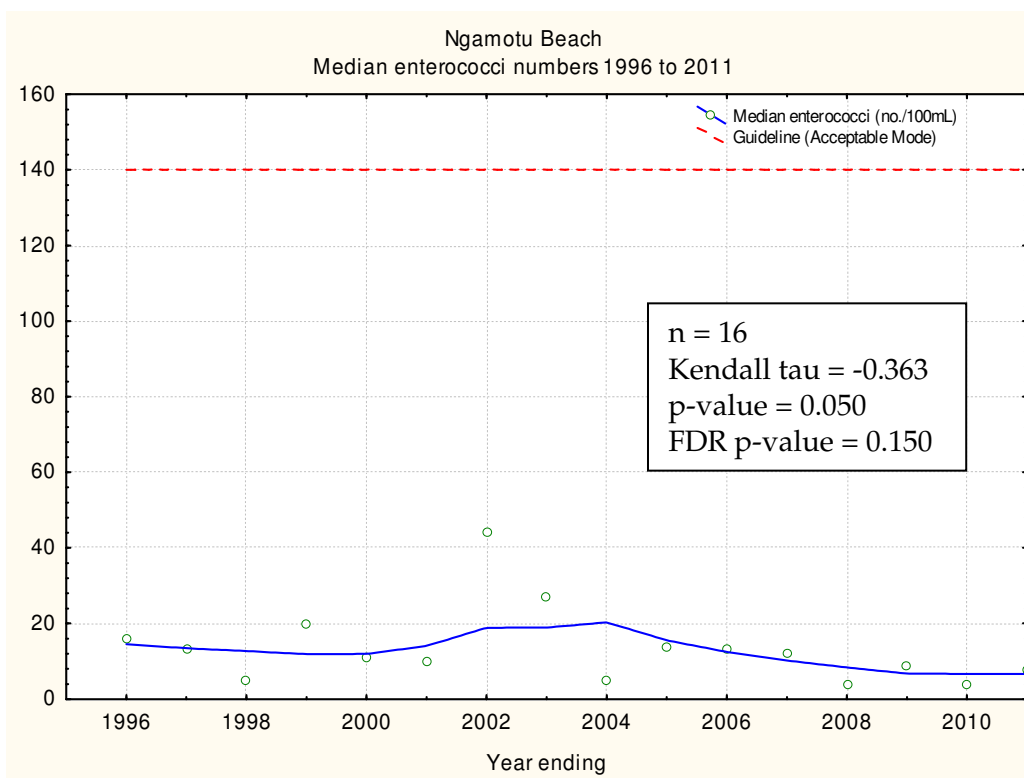


Figure 22 LOWESS trend analysis of median enterococci data at Ngamotu Beach

Over the sixteen seasons monitored, there was a decrease in median enterococci counts (Kendall tau = -0.363). This negative trend was significant using the Mann-Kendall test ($p = 0.050$), but not significant after FDR application ($p = >0.05$).

4.7.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at regular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 40 and Figure 23, with a statistical summary provided in Table 41.

Table 40 Bacteriological results for MfE samples at Ngamotu Beach

Date	Time	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)
	(NZST)		<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
16-Nov-10	1025	4700	<1	3	<1	17.3
29-Nov-10	1035	4700	<1	3	<1	17.3
14-Dec-10	1015	4320	77	310	93	18.3
13-Jan-11	1040	4790	12	9	12	20.7
27-Jan-11	1045	4750	3	5	3	20.3
15-Feb-11	1020	4730	5	8	5	21
16-Mar-11	1035	4710	7	19	7	20.8

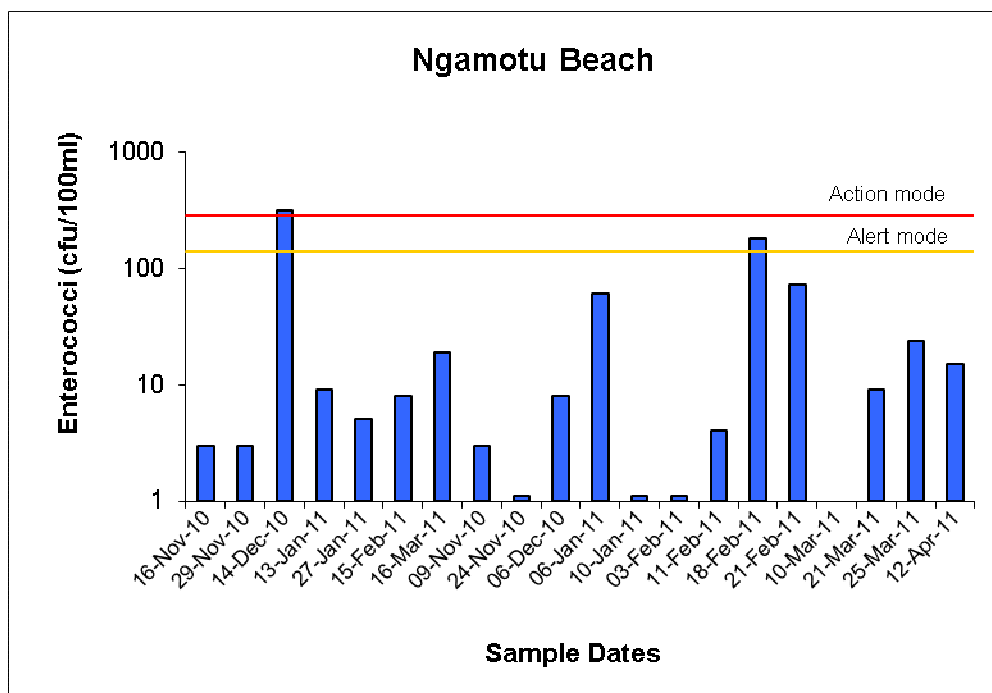


Figure 23 Enterococci numbers for the 20 sample extended survey at Ngamotu Beach

Table 41 Summary statistics for SEM and additional samples at Ngamotu Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	4320	4790	4725
<i>E. coli</i>	cfu/100ml	20	<1	250	3.5
Enterococci	cfu/100ml	20	<1	310	8
Faecal coliforms	cfu/100ml	20	<1	270	3.5
Temperature	°C	20	15.8	22.8	20.25

The sample collected on 14 December 2010 as part of the MfE programme had been influenced by rainfall. Conductivity was low and enterococci counts high relative to other samples. This sample had only a minor effect on the overall median (Table 37 and 23), which remained at 8 cfu/100ml for enterococci.

4.7.5.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 42. Two of the 20 samples collected exceeded Alert levels.

Table 42 Bacterial guidelines performance at Ngamotu Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	2/20	10%	0/13	0%

4.8 Back Beach

4.8.1 SEM programme

Back Beach (Photo 8) is situated to the west of New Plymouth. It is a very well used beach for swimming over the summer months and popular with surfers year-round. The Herekawe Stream enters the beach approximately 50m from the sampling site.



Photo 8 Back Beach

The data for this site are presented in Table 43 and Figure 24, with a statistical summary provided in Table 44.

Table 43 Bacteriological results for Back Beach

Date	Time (NZST)	Conductivity @ 20° C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
09-Nov-10	1030	4550	23	21	23	15.7
24-Nov-10	920	4590	12	9	13	14.6
06-Dec-10	910	4700	9	32	11	18
06-Jan-11	1015	4720	17	39	17	20.1
10-Jan-11	1230	4370	29	67	33	21.3
03-Feb-11	920	4740	47	84	47	16.8
11-Feb-11	1410	4740	3	27	4	19.9
18-Feb-11	905	4600	140	170	150	20.4
21-Feb-11	1030	4650	27	48	27	21.2
10-Mar-11	1155	4440	7	55	7	19.7
21-Mar-11	1000	4760	7	27	7	18.9
25-Mar-11	1255	4750	33	8	33	19.2
12-Apr-11	1510	4590	7	31	7	18.5

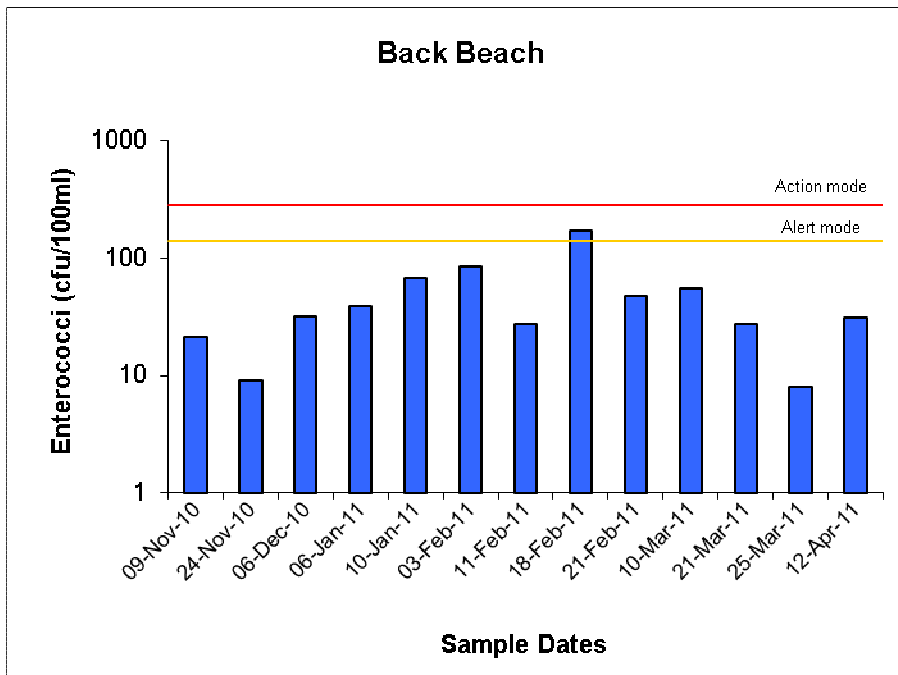


Figure 24 Enterococci numbers for the 13 SEM samples taken from Back Beach

Table 44 Statistical summary for Back Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4370	4760	4650
<i>E. coli</i>	cfu/100ml	13	3	140	17
Enterococci	cfu/100ml	13	8	170	32
Faecal coliforms	cfu/100ml	13	4	150	17
Temperature	°C	13	14.6	21.3	19.2

The median enterococci count (32 cfu/100ml) at Back Beach was the highest recorded at Taranaki beach bathing sites during the 2010-2011 summer season. The maximum enterococci count, sampled on 18 February 2011 (170 cfu/100ml), was unexplained with no significant rainfall 10 days prior to sampling. However, Alert mode counts were also recorded at nearby Ngamotu Beach on 18 February 2011 (Figure 20).

4.8.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 45. One sample was above Alert level.

Table 45 Bacterial guidelines performance at Back Beach

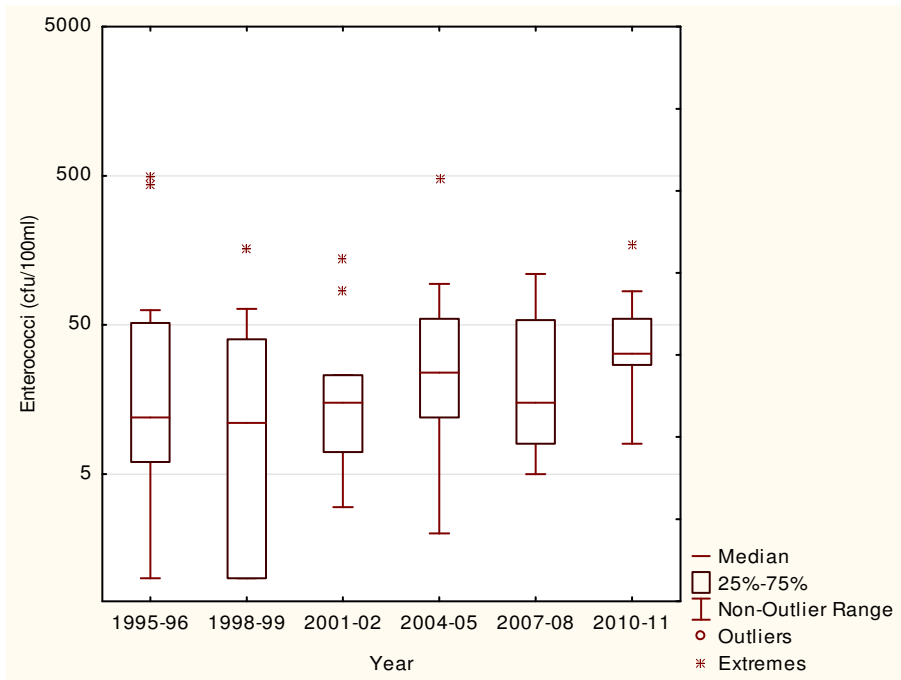
Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	1/13	8%	0/13	0%

4.8.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Back Beach are presented in Table 46 and Figure 25.

Table 46 Summary enterococci data (cfu/100ml) for summer surveys at Back Beach

Summer	1995/1996	1998/1999	2001/2002	2004/2005	2007/2008	2010/2011
Minimum	<1	<1	3	2	5	8
Maximum	500	160	140	480	110	170
Median	12	11	15	24	15	32

**Figure 25** Box and whisker plots for all summer SEM surveys of enterococci numbers at Back Beach

Although the maximum enterococci count (170 cfu/100ml) was well within the range typically recorded at this site, the median (32 cfu/100ml) was the highest recorded to date (Table 46, Figure 25). Microbial source tracking would be required to determine the exact source of contamination.

4.8.4 Long-term trend analysis

Long-term trend analysis was not undertaken on data from this site as there were an insufficient number of samples (only triennial data available).

4.9 Oakura Beach SC (opposite surf lifesaving club)

4.9.1 SEM programme

Oakura Beach (Photo 9) is popular with beach bathers during summer, and frequented by surfers all year-round. With two small lowland streams entering the beach on either side of the site, levels of bacteria found at this site can increase significantly during periods of high rainfall.



Photo 9 Oakura Beach

The data from this site are presented in Table 47 and Figure 26, with a statistical summary provided in Table 48.

Table 47 Bacteriological results for Oakura Beach SC

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
09-Nov-10	1005	2960	240	84	240	15.8
24-Nov-10	1010	4740	1	2	1	15.7
06-Dec-10	840	4710	9	17	9	18
06-Jan-11	945	4720	17	15	20	19.9
10-Jan-11	1205	4210	28	69	28	21.9
03-Feb-11	855	4710	17	15	17	16.4
11-Feb-11	1330	4690	7	9	7	20.5
18-Feb-11	835	4680	8	7	8	19.9
21-Feb-11	1010	4700	9	16	9	20.9
10-Mar-11	1130	4560	3	35	4	20.7
21-Mar-11	930	4700	15	20	15	19.2
25-Mar-11	1225	3990	170	100	170	18.3
12-Apr-11	1445	4520	67	100	67	19.1

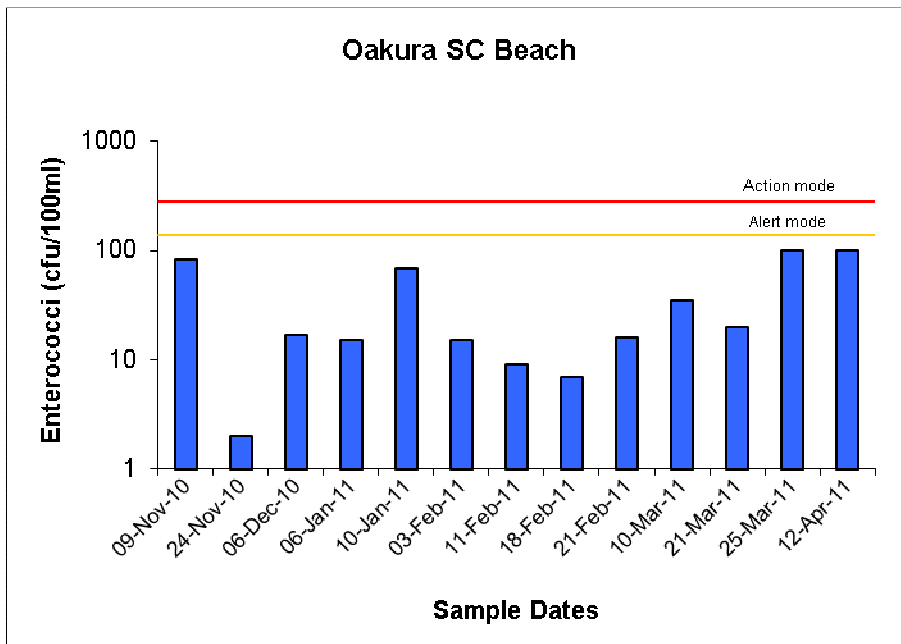


Figure 26 Enterococci numbers for the 13 SEM samples taken from Oakura Beach SC

Table 48 Statistical summary for Oakura Beach SC

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	2960	4740	4690
<i>E. coli</i>	cfu/100ml	13	1	240	15
Enterococci	cfu/100ml	13	2	100	17
Faecal coliforms	cfu/100ml	13	1	240	15
Temperature	°C	12	15.7	21.9	19.2

Median bacteria levels at this site were moderate at 15 cfu/100ml (*E. coli* and faecal coliforms) and 17 cfu/100ml (enterococci). The higher enterococci counts recorded on 9 November 2010 and 25 March 2011 were associated with low conductivity, indicating influence from the steams on these dates (Table 47).

4.9.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 49. All SEM samples were below Alert level at this site during summer 2010-2011.

Table 49 Bacterial guidelines performance at Oakura Beach SC

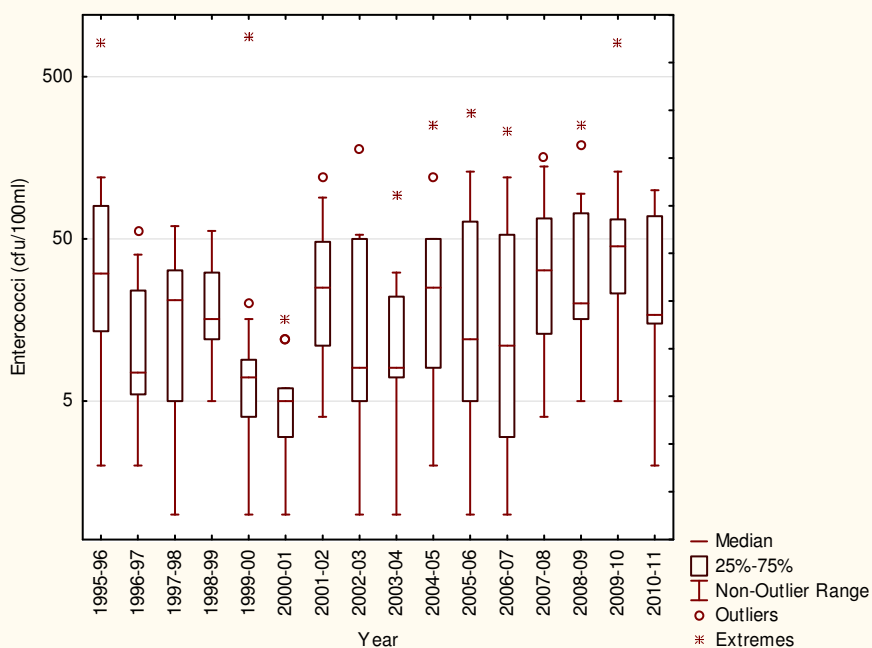
Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	0/13	0%	0/13	0%

4.9.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Oakura Beach opposite the surf lifesaving club over 16 summers are presented in Table 50 and Figure 27.

Table 50 Summary enterococci data (cfu/100ml) for summer surveys at Oakura SC

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03
Minimum	< 3	< 3	< 1	5	< 1	1	4	1
Maximum	800	56	60	56	880	16	120	180
Median	31	8	21	16	7	5	25	8
	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Minimum	< 1	2	1	<1	4	5	5	2
Maximum	94	250	300	230	160	250	800	100
Median	8	25	12	11	32	20	45	17

**Figure 27** Box & whisker plots for all summer SEM surveys of enterococci numbers at Oakura SC

Variation in the median/maximum values at this site can be largely explained by the changing location of the small stream mouths i.e. freshwater influence, relative to the sampling site.

4.9.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for sixteen summer seasons (Figure 28) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

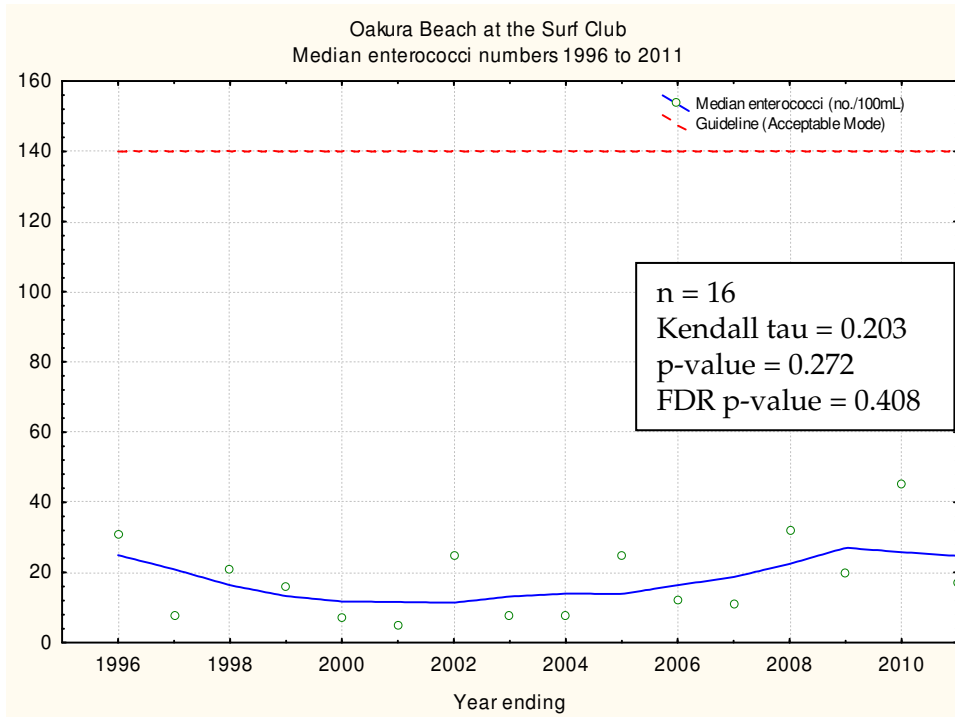


Figure 28 LOWESS trend analysis of median enterococci data at Oakura Beach Surf Club

Over the sixteen seasons monitored, there was a positive trend (i.e. an increase) in median enterococci counts (Kendall tau = 0.203) that was not significant at the 5% level ($p = 0.272$).

4.9.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at irregular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 51 and Figure 29, with a statistical survey provided in Table 52.

Table 51 Bacteriological results for MfE samples at Oakura Beach SC

Date	Time	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)
	(NZST)		<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
16-Nov-10	1050	4690	9	4	9	15.8
29-Nov-10	1100	4690	7	11	7	16.1
14-Dec-10	1040	4660	130	330	140	17.1
13-Jan-11	1105	4780	8	28	9	20
27-Jan-11	1115	4790	4	3	4	18.8
15-Feb-11	1040	4660	43	85	47	20.8
16-Mar-11	1105	4540	160	130	160	20.6

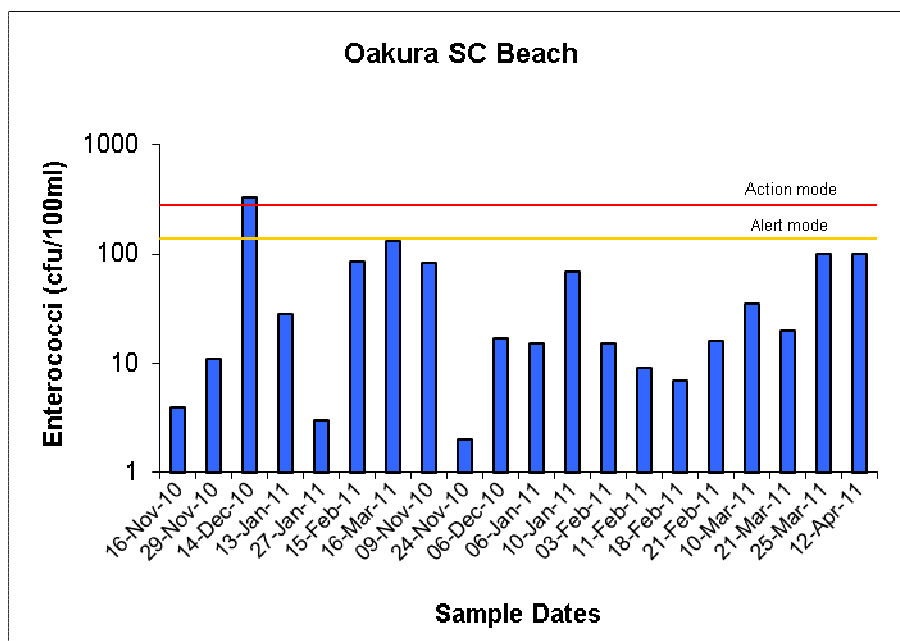


Figure 29 Enterococci numbers for the 20 sample extended survey at Oakura Beach SC

Table 52 Summary statistics for SEM and MfE samples at Oakura Beach SC

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	2960	4790	4690
<i>E. coli</i>	cfu/100ml	20	1	240	12
Enterococci	cfu/100ml	20	2	330	19
Faecal coliforms	cfu/100ml	20	1	240	12
Temperature	°C	20	15.7	21.9	19.2

The sample collected on 14 December 2010 as part of the MfE programme had been influenced by rainfall.

4.9.5.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 53. The extra sampling conducted as part of the MfE programme resulted in one sample exceeding Alert level.

Table 53 Bacterial guidelines performance at Oakura Beach SC

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	1/20	5%	0/20	0%

4.10 Oakura Beach CG (opposite camp ground)

4.10.1 SEM programme

This site, situated at the west end of Oakura Beach in front of the campground, is a popular site with bathers and surfers.

The data for this site are presented in Table 54 and Figure 30, with a statistical summary provided in Table 55.

Table 54 Bacteriological results for Oakura Beach CG

Date	Time (NZST)	Conductivity @ 20° C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
09-Nov-10	1000	4710	1	<1	1	15.8
24-Nov-10	1000	4740	<1	<1	<1	15
06-Dec-10	835	4740	1	<1	1	17
06-Jan-11	935	4410	23	33	23	19.9
10-Jan-11	1200	4740	1	<1	1	20.7
03-Feb-11	850	4730	<1	<1	<1	16.3
11-Feb-11	1330	4720	<1	<1	<1	20.1
18-Feb-11	825	4640	15	16	15	19.8
21-Feb-11	1005	4710	1	7	1	21
10-Mar-11	1115	4740	<1	<1	<1	19.9
21-Mar-11	920	4770	3	1	3	19.2
25-Mar-11	1220	4490	19	20	19	19
12-Apr-11	1435	4680	<1	<1	<1	19

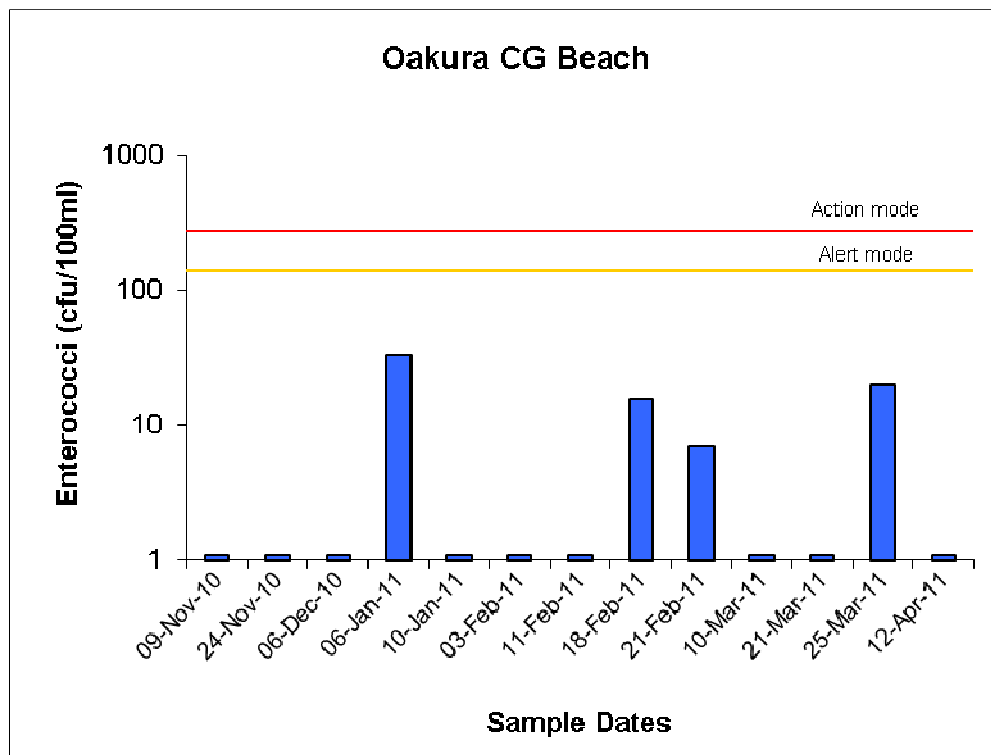


Figure 30 Enterococci numbers for the 13 SEM samples taken from Oakura Beach CG

Table 55 Statistical results for Oakura Beach CG

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4410	4770	4720
<i>E. coli</i>	cfu/100ml	13	<1	23	1
Enterococci	cfu/100ml	13	<1	33	<1
Faecal coliforms	cfu/100ml	13	<1	23	1
Temperature	°C	13	15	21	19.2

Water quality was excellent at this site with low medians for all faecal indicator bacteria (≤ 1 cfu/100ml). Maxima were also low at 33 cfu/100ml for enterococci and 23 cfu/100ml for *E. coli* and faecal coliforms.

4.10.2 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarised in Table 56. All samples were well below the Alert guideline.

Table 56 Bacterial guidelines performance at Oakura Beach CG

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
	Single sample 141-280/100ml		Two consecutive samples >280/100 ml	
Enterococci	0/13	0%	0/13	0%

4.10.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Oakura Beach opposite the campground over 16 summer surveys are presented in Table 57 and Figure 31.

Table 57 Summary enterococci data (cfu/100 ml) for summer surveys at Oakura Beach opposite the campground

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03
Minimum	2	1	<1	<1	<1	<1	<1	<1
Maximum	280	150	24	16	48	240	31	17
Median	9	5	2	4	3	3	7	3
	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Minimum	<1	<1	<1	<1	<1	<1	<1	<1
Maximum	24	90	8	260	18	30	25	33
Median	3	6	1	3	7	6	1	<1

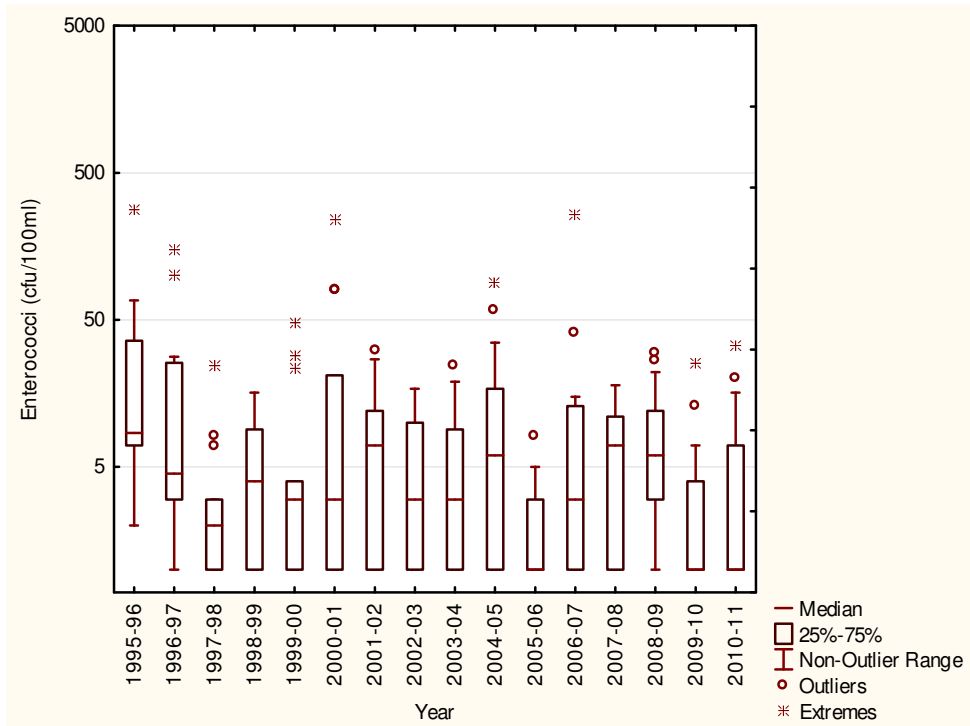


Figure 31 Box and whisker plots for all summer SEM surveys of enterococci numbers at Oakura Beach opposite the campground

The median enterococci count was the lowest recorded to date at this site (<1 cfu/100ml). Over the past 16 summers water quality has remained high at this site (Table 57).

4.10.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for sixteen summer seasons (Figure 32) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

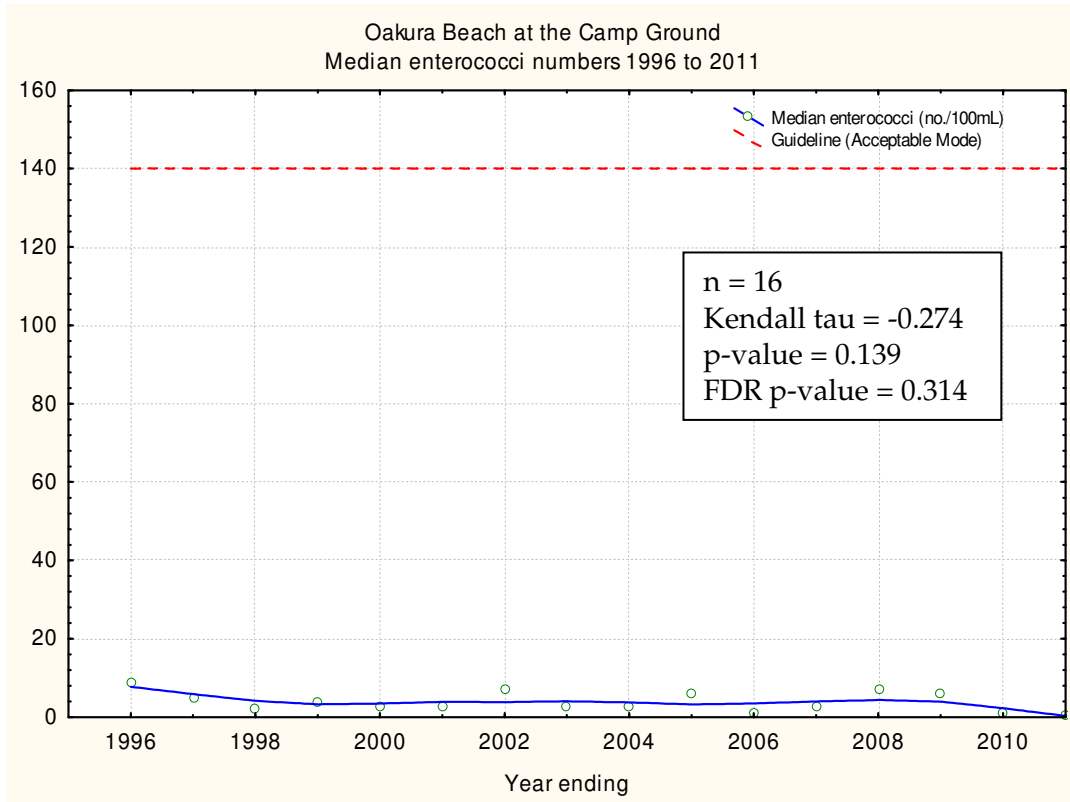


Figure 32 LOWESS trend analysis of median enterococci data at Oakura Beach CG

Over the sixteen seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.274) that was not significant at the 5% level ($p = 0.139$).

4.11 Opunake Beach

4.11.1 SEM programme

Opunake Beach is a very popular swimming beach in south Taranaki. There are no large rivers in the vicinity. However the outlet of a freshwater stream from the Opunake Power Station enters at the southern end of the beach.

The data for this site are presented in Table 58 and Figure 33, with a statistical summary provided in Table 59.

Table 58 Bacteriological results for Opunake Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
09-Nov-10	1130	4610	<1	<1	<1	16
24-Nov-10	1100	4640	<1	<1	<1	16.3
06-Dec-10	1020	4730	4	9	4	17.4
06-Jan-11	1110	4610	<1	<1	<1	18.8
10-Jan-11	1410	3950	5	<1	5	19.2
03-Feb-11	1045	4700	120	71	120	18.8
11-Feb-11	1320	4630	11	8	11	21.6
18-Feb-11	1010	4690	68	68	80	19.7
21-Feb-11	1215	4750	15	100	15	21.2
10-Mar-11	1305	4240	<1	<1	<1	20
21-Mar-11	1050	4720	<1	<1	<1	19.7
25-Mar-11	1400	4540	<1	3	<1	18.1
12-Apr-11	1615	4690	1	<1	1	18.7

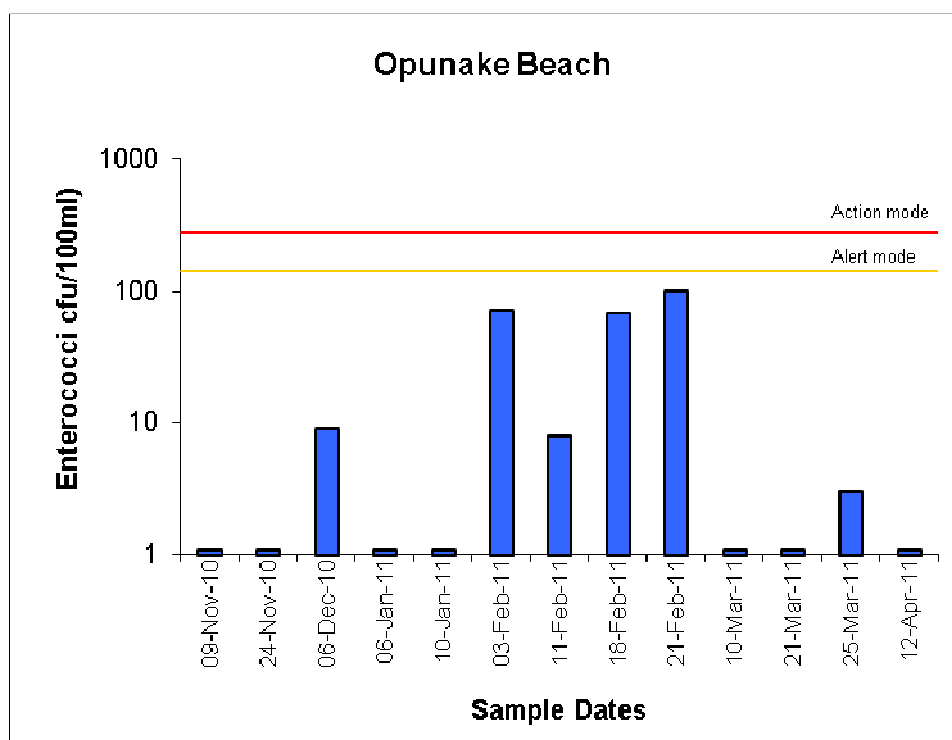


Figure 33 Enterococci numbers for the 13 SEM samples at Opunake Beach

Table 59 Statistical summary for Opunake Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3950	4750	4640
<i>E. coli</i>	cfu/100ml	13	<1	120	1
Enterococci	cfu/100ml	13	<1	100	<1
Faecal coliforms	cfu/100ml	13	<1	120	1
Temperature	°C	13	16	21.6	18.8

Concentrations were very low for all faecal indicator bacteria, with medians of ≤ 1 cfu/100ml, indicating excellent water quality at this site.

4.11.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 60. Water quality was considered suitable for contact recreation throughout the season, with all samples well below Alert guideline levels.

Table 60 Bacterial guidelines performance at Opunake Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
	Single sample 141-280/100ml		Two consecutive samples >280/100 ml	
Enterococci	0/13	0%	0/13	0%

4.11.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Opunake Beach over sixteen summers are presented in Table 61 and Figure 34.

Table 61 Summary enterococci data (cfu/100ml) for summer surveys at Opunake Beach

Summer	1995-96	1996-97	1999-98	1998-99	1999-00	2000-01	2001-02	2002-03
Minimum	<1	<1	1	<1	<1	<1	<1	<1
Maximum	74	60	73	7	41	69	140	20
Median	9	<1	5	<1	1	2	4	1
	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Minimum	<1	<1	<1	<1	<1	<1	<1	<1
Maximum	9	10	19	8	11	25	4	100
Median	1	1	2	1	<1	2	<1	<1

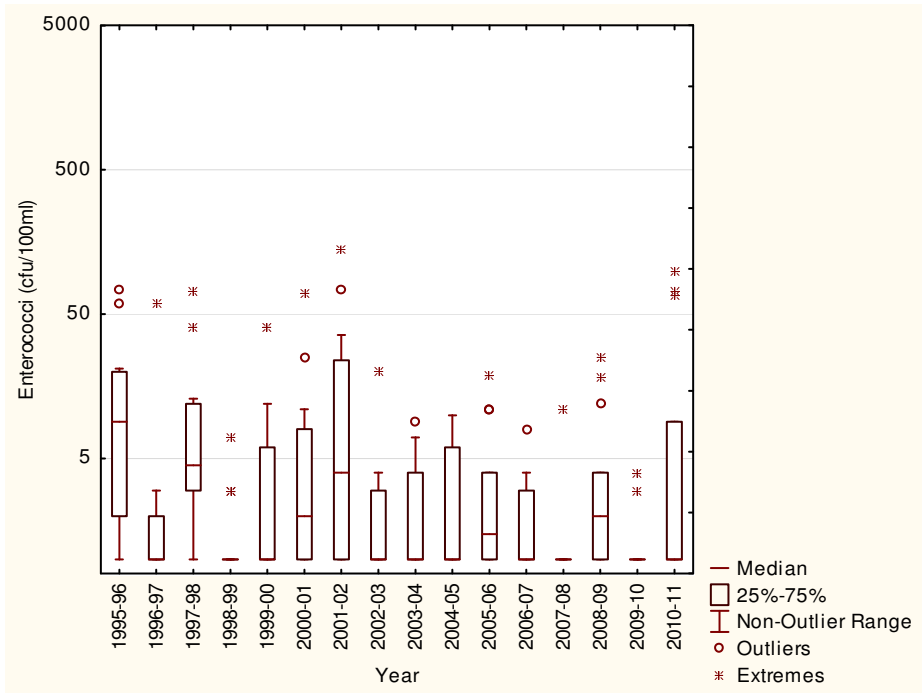


Figure 34 Box and whisker plots for all summer SEM surveys of enterococci numbers at Opunake Beach

The low enterococci data obtained for Opunake Beach during the 2010-2011 summer continues the trend of excellent water quality at this site (Table 61, Figure 34).

4.11.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for sixteen summer seasons (Figure 35) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

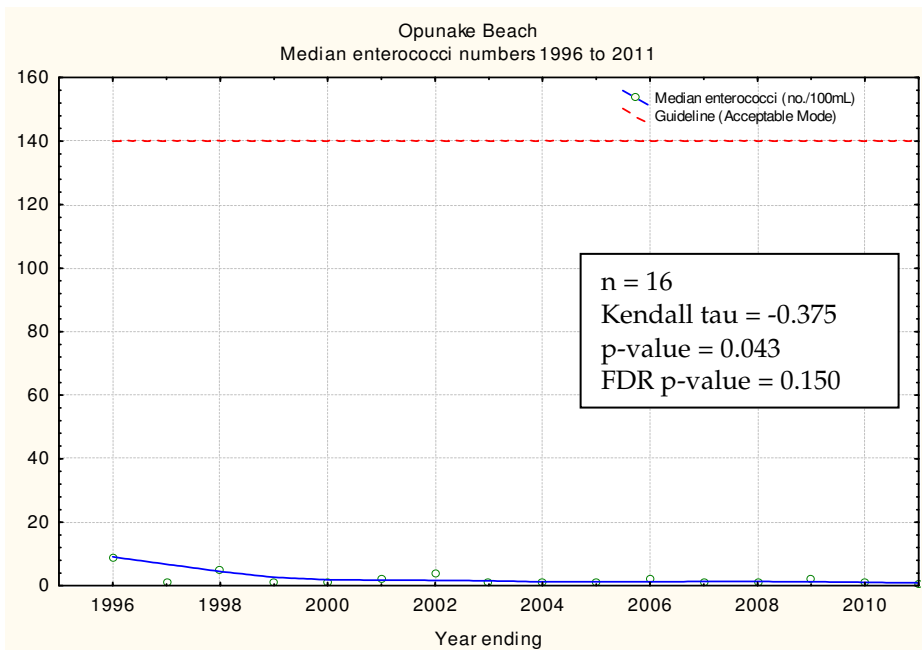


Figure 35 LOWESS trend analysis of median enterococci data at Opunake Beach

Over the sixteen seasons monitored, there was a decrease in median enterococci counts (Kendal tau = -0.375). This negative trend was significant using the Mann-Kendall test ($p = 0.043$), but not significant after FDR application ($p = >0.05$).

4.11.5 MfE guidelines additional sampling

For the purpose of MfE monitoring seven additional samples were collected at regular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples are presented in Table 62 and Figure 36, with a statistical summary in Table 63.

Table 62 Bacteriological results for MfE samples at Opunake Beach

Date	Time	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)
	(NZST)		<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
16-Nov-10	1140	4700	<1	1	<1	16.9
29-Nov-10	1155	4690	<1	<1	<1	16.7
14-Dec-10	1135	4710	<1	<1	<1	18.7
13-Jan-11	1200	4760	8	<1	8	19.2
27-Jan-11	1215	4740	44	88	44	18.7
15-Feb-11	1135	4750	5	1	11	19.4
16-Mar-11	1215	4800	1	1	1	19.2

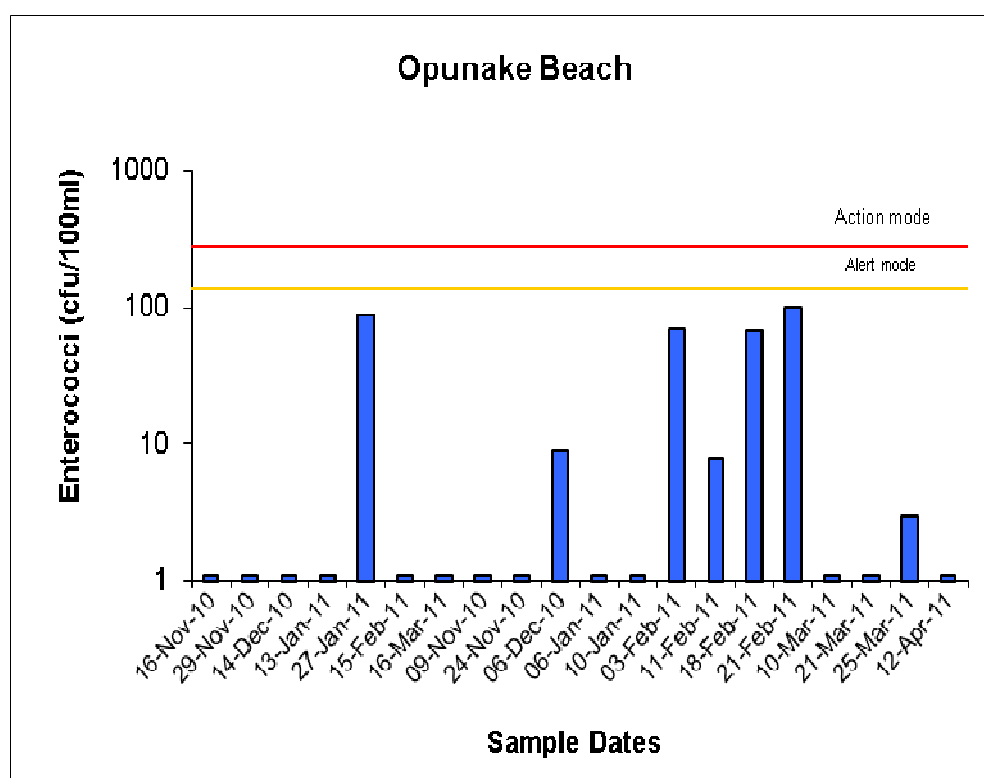


Figure 36 Enterococci numbers for the 20 sample extended survey at Opunake Beach

Table 63 Summary statistics for SEM and MfE samples at Opunake Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	3950	4800	4695
<i>E. coli</i>	cfu/100ml	20	<1	120	1
Enterococci	cfu/100ml	20	<1	100	<1
Faecal coliforms	cfu/100ml	20	<1	120	1
Temperature	°C	20	16	21.6	18.8

The additional MfE samples made no difference to the minimum, maximum and medians for all faecal indicator bacteria, reflecting consistently high water quality.

4.11.5.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 64. No samples exceeded Alert level.

Table 64 Bacterial guidelines performance at Oakura Beach SC

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	0/20	0%	0/20	0%

4.12 Ohawe Beach

4.12.1 SEM programme

Ohawe Beach is located close to the large Waingongoro River in South Taranaki. This river passes through Eltham, previously accepting factory discharge (eg Riverlands) and sewage pond waste. In addition, the catchment drains highly modified agricultural land.



Photo 10 Ohawe Beach

Data from this site are presented in Table 63 and Figure 37, with a statistical summary provided in Table 64.

Table 64 Bacteriological results for Ohawe Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
09-Nov-10	1020	4350	1	<1	1	16.3
24-Nov-10	1000	4450	8	1	8	17.7
06-Dec-10	850	4280	23	9	23	18.9
06-Jan-11	935	4560	16	12	16	19.9
10-Jan-11	1210	4760	<1	5	<1	20.7
03-Feb-11	925	3960	44	83	44	19.7
11-Feb-11	1430	4690	1	<1	1	21.1
18-Feb-11	845	4660	3	12	3	20.3
21-Feb-11	1040	4740	3	7	3	20.9
10-Mar-11	1145	4020	11	3	11	19.7
21-Mar-11	945	4350	16	20	20	18.8
25-Mar-11	1245	4670	1	3	1	18.4
12-Apr-11	1505	3550	24	17	27	17.7

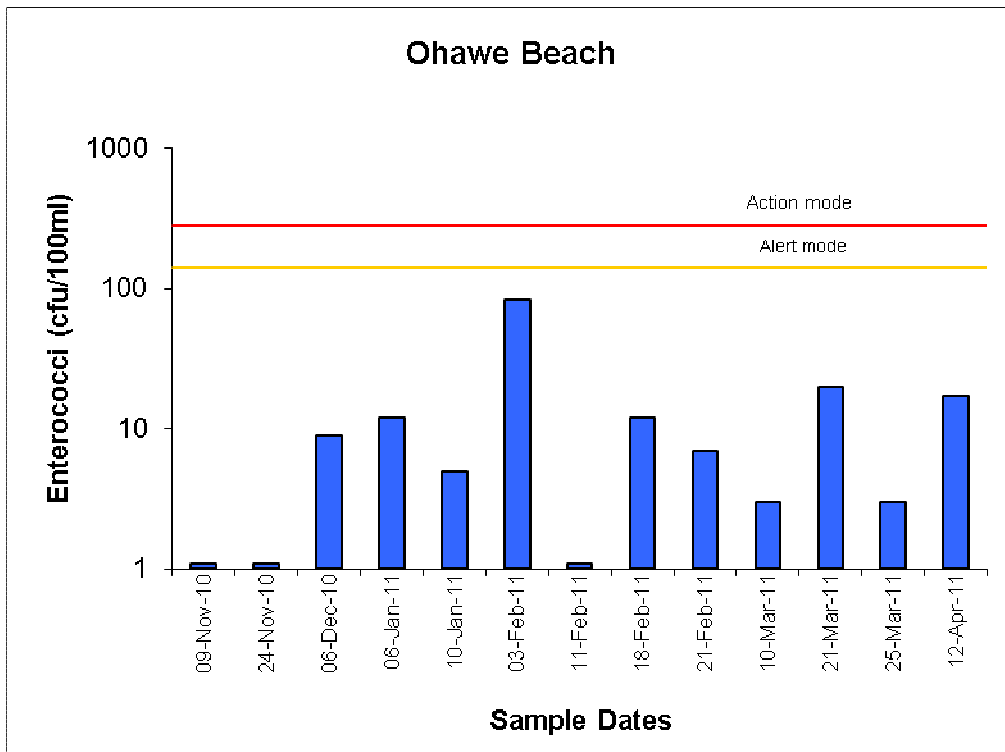


Figure 37 Enterococci numbers for the 13 SEM samples at Ohawe Beach

Table 65 Statistical summary for Ohawe Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3550	4760	4450
<i>E. coli</i>	cfu/100ml	13	<1	44	8
Enterococci	cfu/100ml	13	<1	83	7
Faecal coliforms	cfu/100ml	13	<1	44	8
Temperature	°C	13	16.3	21.1	19.7

Bacteriological water quality was good, with relatively low counts of all faecal bacteriological indicators throughout the bathing season.

4.12.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarised in Table 65. Enterococci counts in all samples were below Alert guideline levels.

Table 66 Bacterial guidelines performance at Ohawe Beach

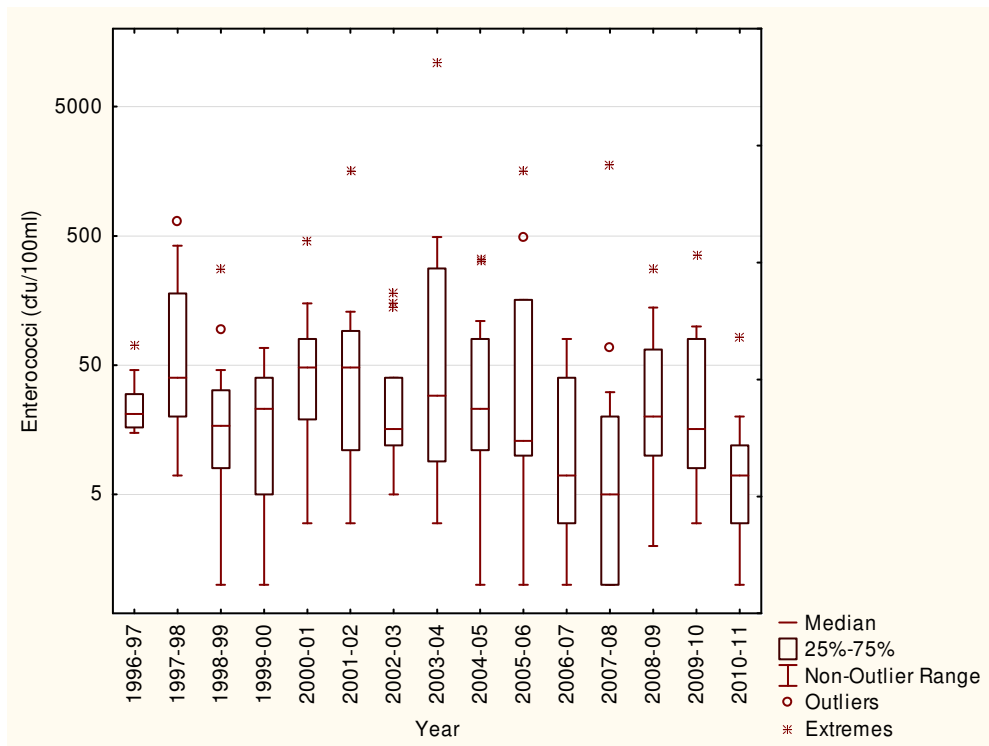
Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample 141-280/100ml		ACTION Two consecutive samples >280/100 ml	
Enterococci	0/13	0%	0/13	0%

4.12.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Ohawe Beach over fifteen summers are presented in Table 66 and Figure 38.

Table 67 Summary enterococci data (cfu/100ml) for summer surveys at Ohawe Beach

Summer	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Minimum	15	7	<1	1	3	3	5	3
Maximum	72	650	280	68	450	1600	180	11000
Median	21	40	17	23	48	48	16	29
	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	
Minimum	<1	1	<1	<1	2	3	<1	
Maximum	330	1600	80	1800	280	350	83	
Median	23	13	7	5	20	16	7	

**Figure 38** Box and whisker plots for all summer surveys of enterococci numbers at Ohawe Beach

The minimum, maximum and median obtained for the 2010-2011 summer (<1, 83 and 7 cfu/100ml respectively) were at the lower end of the ranges previously recorded at this site.

4.12.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for fifteen summer seasons (Figure 39) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

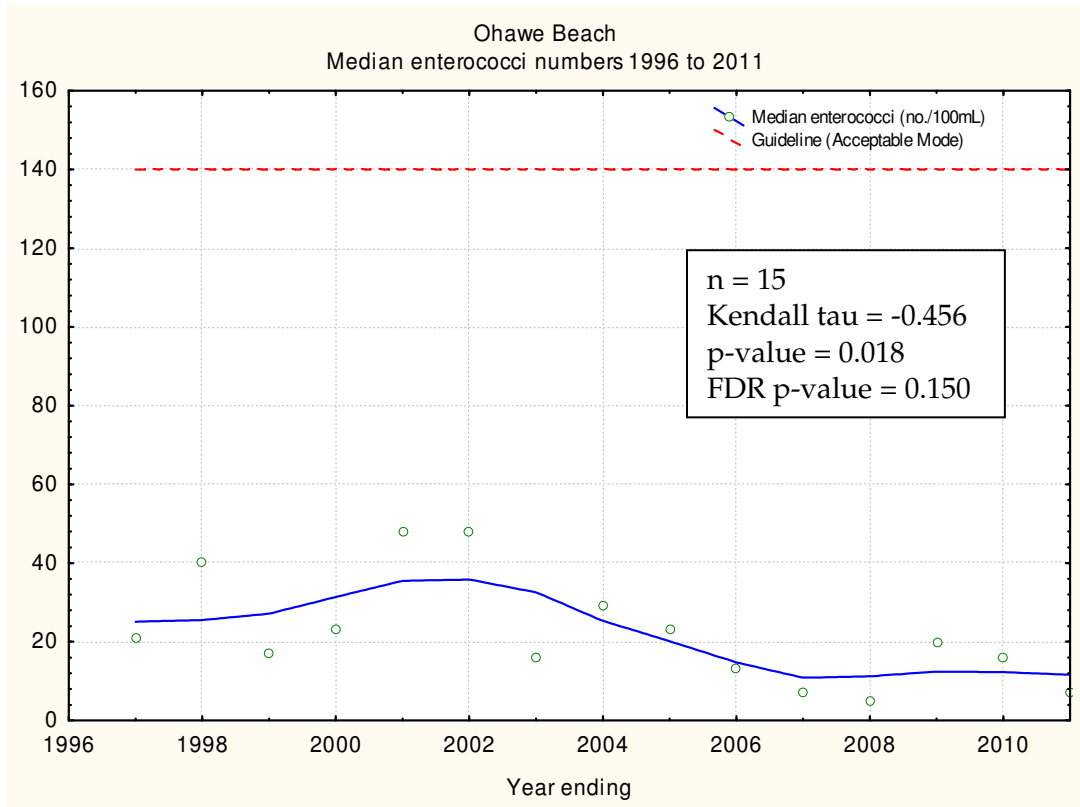


Figure 39 LOWESS trend analysis of median enterococci data at Ohawe Beach

Over the fifteen seasons monitored, there was a decrease in median enterococci counts (Kendall tau = -0.456). This negative trend was significant using the Mann-Kendall test ($p = 0.018$), but not significant after FDR application ($p = >0.05$).

5. General summary

5.1 Regional overview

During the 2010-2011 summer season, microbiological water quality was generally very good across bathing beaches in the Taranaki region (Table 67). Low median enterococci values were recorded for all beaches monitored (≤ 32 enterococci cfu/100ml). Out of the 191 samples collected at 12 beach sites, $>93\%$ were below guideline Alert levels (140 enterococci cfu/100ml). No site reached Action mode (two consecutive samples >280 enterococci cfu/100ml) during the 2010-2011 season. All sites assessed obtained a Suitability for Recreation Grade of either 'good' (64%) or 'fair' (36%).

Table 68 Summary enterococci results for the TRC beach bathing monitoring programme 2010-2011

Beach sites ¹	Enterococci median (cfu/100 ml)		Number of samples above Alert mode (>140 cfu/100ml)		Trend analysis ⁴			Suitability for recreation grade (SFRG) ⁶
	SEM ²	SEM+MfE ³	SEM ²	SEM+MfE ³	Kendall tau ⁵	Mann-Kendall p value	False Discovery Rate p value	
Opunake	<1	<1	0	0	-0.375	0.043	0.150	Good
Oakura CG	<1	-	0	-	-0.274	0.139	0.314	Good
Waitara East	3	-	3	-	0.000	1.000	1.000	Good
Fitzroy	4	2	0	0	-0.234	0.206	0.371	Good
Bell Block	5	-	2	-	-	-	-	Good
Ohawe	7	-	0	-	-0.456	0.018	0.150	Fair
Ngamotu	8	8	1	2	-0.363	0.050	0.150	Good
East End	11	-	0	-	-	-	-	Good
Onaero	11	10	0	2	-0.188	0.396	0.509	Fair
Oakura SC	17	19	0	1	0.203	0.272	0.408	Fair
Waitara West	20	-	2	-	0.039	0.839	0.944	Fair
Back	32	-	1	-	-	-	-	-

¹Sites ordered in ascending order of median enterococci

²SEM results based on 13 samples

³SEM+MfE results based on 20 samples (MfE data available for selected sites only)

⁴Trend analysis performed on SEM data only (Section 3.4)

⁵A negative/positive Kendall tau indicates a decreasing/increasing temporal trend in median enterococci respectively

⁶The Suitability for Recreational Grade is calculated using the Microbial Assessment Category (based on five years enterococci data) and the Sanitary Inspection Category (a qualitative risk assessment based on the catchment) as explained in Section 2.2

- = insufficient data

Long term trend analysis (12-16 years data) showed a significant (5% level) decrease in enterococci medians in 25% of the sites monitored (Ohawe, Opunake and Ngamotu) and no significant change in 75% of the sites (Table 67, Kendall tau and Mann-Kendall p values). Not one site showed a significant increase in enterococci medians over the time period monitored.

Opunake and Oakura Camp Ground were amongst the region's cleanest bathing beaches with median enterococci counts of <1 cfu/100ml and no exceedances of Alert mode throughout the 2010-2011 season (Table 67, Figure 40). Water quality at these two sites has remained consistently high since the Taranaki Regional Council bathing beach monitoring programme began in 1995-1996 (Figure 41). Back Beach recorded the highest enterococci median of the 2010-2011 season (32 cfu/100ml). However, only one sample exceeded Alert mode at this site, indicating a low health risk to beach users.

The site at Ohawe has shown the greatest improvement in microbiological water quality since 1996 (Table 67, Figures 40 and 41). This is likely related to long term improved water quality within the Waingongoro River which flows into Ohawe Beach (Freshwater Contact Recreational Water Quality State of the Environment Monitoring Report 2009-2010). Recently (mid-2010), there has been a reduction in meatworks' discharges to the Waingongoro River at Eltham and the elimination of all Eltham Waste Water Treatment Plant municipal discharges in the catchment.

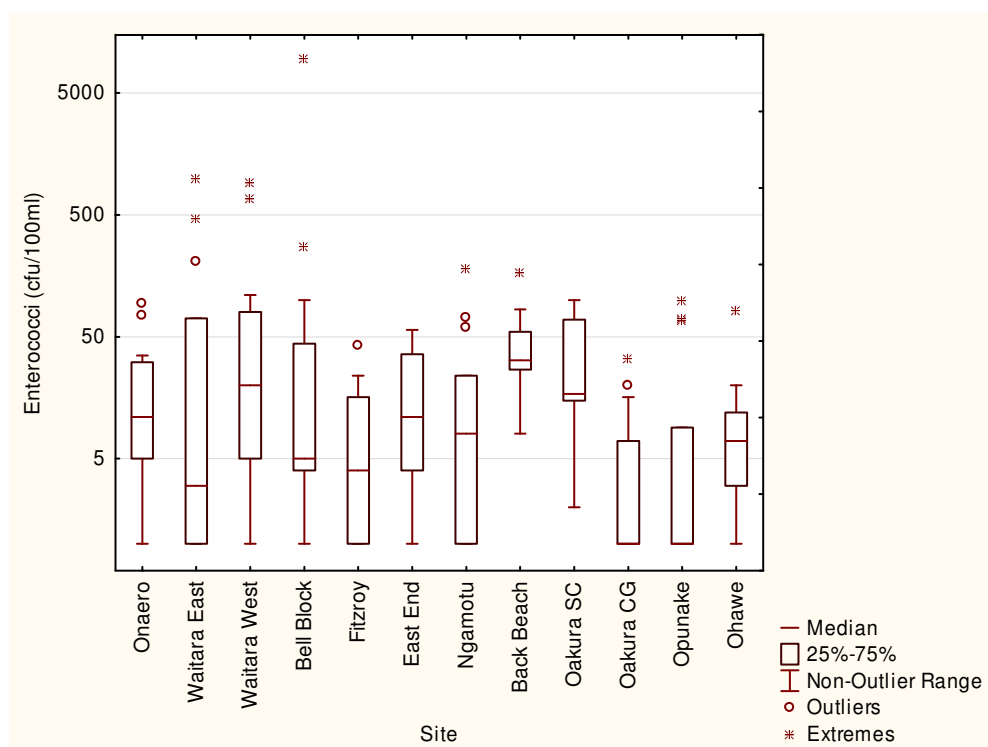


Figure 40 Box and whisker plots of enterococci at all sites during the 2010-2011 season (SEM data only)

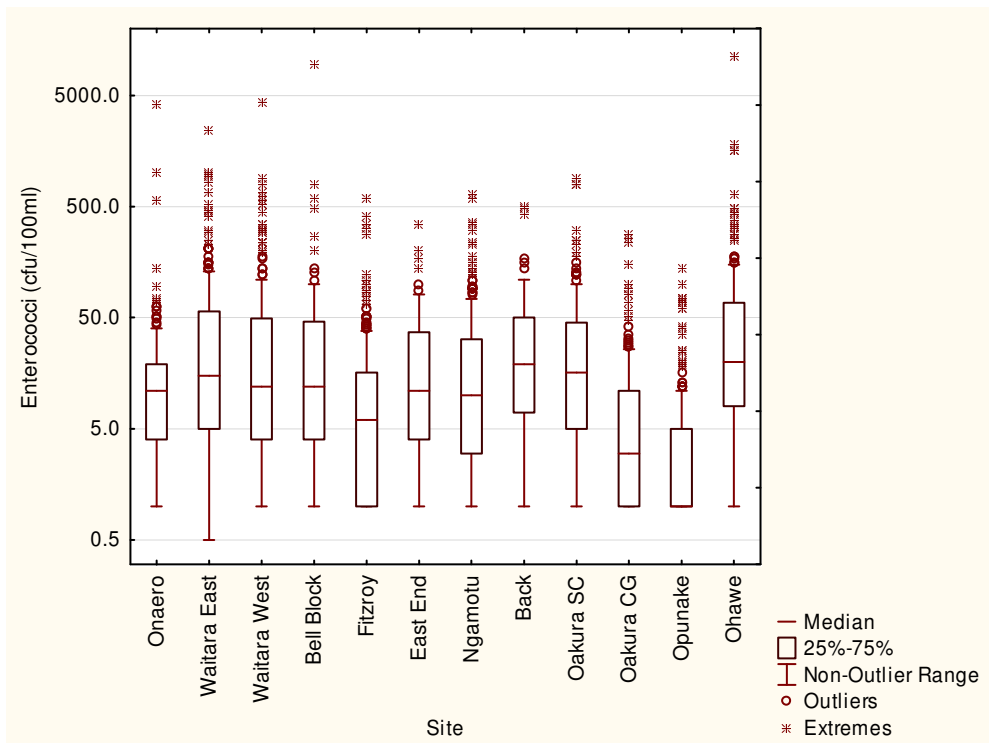


Figure 41 Box and whisker plots of long term enterococci data from 1995/implementation of monitoring to 2011 (SEM data only)

5.2 National context

Differences in monitoring protocols between regions make it difficult to compare microbiological water quality at a national level. However, regional data sets collated by the Ministry for the Environment (MfE) for national reporting purposes can be used to give an indication of how bathing beaches in the Taranaki region compare with those monitored across the rest of New Zealand. For the 2010-2011 summer season, MfE assigned each recreational site one of three risk categories ('low risk', 'generally low risk' and 'often high risk') based on the percentage of samples which exceeded the 280 enterococci cfu/100ml threshold. Sites with >95% of sample below threshold were categorized as 'low risk', sites with 75-95% of samples below threshold were categorized as 'generally low risk' and sites with <75% of samples below threshold were categorized as 'often high risk'.

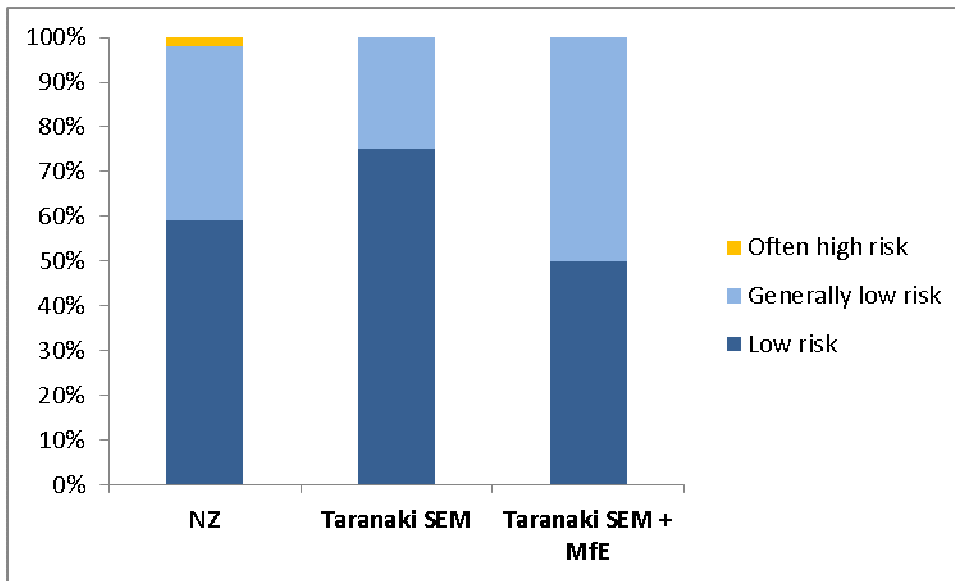


Figure 42 Ministry for the Environment assessment of the exposure to risk at monitored recreational coastal beaches during the 2010-2011 summer season i) across New Zealand, ii) for Taranaki beaches based on SEM sampling only and iii) for Taranaki beaches based on both SEM and MfE sampling

In general, microbiological water quality was good across New Zealand during the 2010-2011 summer season with 59% and 39% of beach sites posing a 'low' and 'generally low' health risk respectively. Based on SEM sampling only, Taranaki sites compared favourably to national results with 75% (9/12) and 25% (3/12) of beach sites posing a 'low' and 'generally low' health risk respectively. When MfE samples were taken into consideration, three sites shifted from 'low' to 'generally low' risk, with above threshold samples typically being taken following heavy rainfall. No sites in Taranaki were considered 'often high risk', compared to 2% nationally.

5.3 Conclusion

During the 2010-2011 summer season, water quality across the Taranaki region was generally high with >93% of samples below guideline Alert levels (140 enterococci cfu/100ml) and no site reaching Action mode (two consecutive samples >280 enterococci cfu/100ml). Sites in Taranaki compared favourably to national results, with all sites in the region posing a 'low' or 'generally low' health risk (Section 5.2). The few samples which exceeded Alert guideline levels (<7%) during the 2010-2011 season were generally associated with high rainfall. Many of the beach sites monitored in Taranaki are located close to stream or river mouths which can act as a source of contamination during heavy rainfall. The majority of these rivers and streams drain catchments with intensive agricultural land use, including dairying. Microbial source tracking has also revealed that birds (wildfowl and gulls) can act as a key source of contamination in Taranaki freshwater environments (TRC, 2010). In order to minimise potential health risks, the Council recommends reducing coastal recreational activities for two-three days following heavy rainfall (when other water quality parameters such as turbidity and discoloration are not conducive to bathing in any case).

6. Recommendations

As a result of the 2010-2011 summer marine contact recreation bacteriological survey it is recommended:

1. THAT the 2011-2012 summer survey be performed at twelve sites continuing with the existing sampling protocol (annual, plus Year Three sites).
2. THAT the 2011-2012 summer survey also includes an additional 7 samples collected at the five principal usage sites (Onaero, Fitzroy, Ngamotu and Oakura SC and Opunake) in accordance with MfE, 2003 guidelines.
3. THAT follow-up sampling be performed as deemed necessary by Council staff. This should include follow-up samples within 24 hours of any samples exceeding 280 cfu/100ml in order to assess if Action level has been reached.
4. THAT reporting of results be performed as appropriate during the season, and in an Annual Report upon completion of the season's programme.

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

'Action' mode	Two consecutive single samples greater than 280 enterococci cfu/100ml
Alert mode	Single sample greater than 140 enterococci cfu/100ml
Bacteriological faecal indicators	Micro-organisms selected as indicators of faecal contamination
Bathers	Those who enter the water, and either partially or fully immerse themselves
Bathing season	Generally the bathing season extends between 1 November and 31 March
Beach	The shore or any access point to the sea
cfu	Colony forming units. A measure of the concentration of bacteria usually expressed as per 100 ml sample
Condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m
Contact recreation	Recreation activities that bring people physically in contact with water, involving a risk of involuntary ingestion or inhalation of water
<i>E.coli</i>	<i>Escherichia coli</i> , member of the Enterobacteriaceae, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample
Enterococci	Members of the Streptococcus group of bacteria characterised as faecal in origin. Enterococci provide an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml of sample
Faecal coliform	An indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 ml sample
False Discovery Rate (FDR)	The expected proportion of true hypothesis rejected out of the total number of rejections
Follow-up sample	Second sample taken to confirm an initial high result; usually within 24-72 hours depending on accessibility/sample turnaround time, etc.
Median	Central value when values are arranged in order of magnitude
Microbiological Assessment	A measurement of water quality over time as provided by historical (five years) microbiological results – A, B, C or D Category (MAC)

RMA	Resource Management Act 1991 and subsequent amendments
Sanitary Inspection Category (SIC)	A measure of the susceptibility of a water body to faecal contamination – Very High, High, Moderate, Low or Very Low
Suitability for Recreation Grade (SFRG)	A combination of Sanitary Inspection Category (SIC) and Microbiological Assessment Category (MAC), describes the general condition of a site at any given time, based on both risk and indicator bacteria counts
Temp	Temperature, measured in °C (degrees Celsius)
Water quality	The bacteriological condition of a water body as it relates to human health, measured using indicator bacteria

For further information on analytical methods, contact the Council's laboratory

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Appendix I

High tide times

High tide times (NZST) at New Plymouth for 2010-2011 sampling dates

Date		Time of HT
Tuesday	9 November 2010	1129
Wednesday	24 November 2010	1107
Monday	6 December 2010	0950
Thursday	6 January 2011	1056
Monday	10 January 2011	1321
Thursday	3 February 2011	1001
Friday	11 February 2011	1451
Friday	18 February 2011	0936
Monday	21 February 2011	1149
Thursday	10 March 2011	1244
Monday	21 March 2011	1142
Friday	25 March 2011	1357
Tuesday	12 April 2011	1612

Appendix II

MAC assessments for all sites

Onaero Beach

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Onaero Beach

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2009	20	15.5	1	0	100 %
2008	20	13.0	1	1	95 %
2007	20	4.0	0	0	100 %
2006	20	13.5	1	2	90 %
2005	13	4.0	0	0	100 %
Total	93	11.0	3	3	96 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: C 95%ile (/100 mL): 205.5
Interim Result? Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

OK

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment? Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Low
Primary SIC Impact: 14: River - local points of drainage

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: Onaero Beach
SFRG Assessment: Far

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.

Print the column labels to the file 'ColumnLabelsMarine.txt'.

OK

Nga Motu Beach

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set

Site Name
Name of site from the MAC file: Ngerorou

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2009	20	4.0	0	0	100 %
2008	20	8.0	1	1	95 %
2007	21	5.0	0	1	95 %
2006	20	10.5	0	0	100 %
2005	20	14.5	0	0	100 %
Total	101	7.0	1	2	98 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment

MAC Results
MAC category: B 95%ile (/100 mL): 95.0
Interim Result? Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

OK

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment? Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3: Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment

Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade

SFRG Assessment Results
Site name: Ngamotu
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.

Print the column labels to the file 'ColumnLabelsMarine.txt'.

OK

Oakura Beach (SC)

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: Oakura beach (SC)

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2009	21	45.0	3	1	95 %
2008	20	50.5	3	2	90 %
2007	20	37.5	2	0	100 %
2006	21	21.0	2	1	95 %
2005	20	16.0	0	2	90 %
Total	102	31.5	10	6	94 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: C 95%ile (/100 mL): 300.0
Interim Result?: Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment?: Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/leal animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required or press "Inconclusive Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Oakura beach (SC)
SFRG Assessment: Fair

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Oakura Beach (CG)

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: Oakura Beach (CG)

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2009	13	1.0	0	0	100 %
2008	13	6.0	0	0	100 %
2007	13	7.0	0	0	100 %
2006	14	2.5	1	0	100 %
2005	13	1.0	0	0	100 %
Total	66	3.0	1	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: A 95%ile (/100 mL): 26.8
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: A
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/leal animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required or press "Inconclusive Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Oakura Beach (CG)
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Ohawe Beach

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: Ohawe Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2009	13	16.0	0	1	92 %
2008	13	20.0	1	0	100 %
2007	21	5.0	0	1	95 %
2006	13	7.0	0	0	100 %
2005	16	13.5	3	2	87 %
Total	76	12.0	4	4	94 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: C 95%ile (/100 mL): 329.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/leal animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required or press "Inconclusive Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Ohawe Beach
SFRG Assessment: Far

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Opunake Beach

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: Opunake Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2009	19	1.0	0	0	100 %
2008	20	2.0	0	0	100 %
2007	14	1.0	0	0	100 %
2006	13	1.0	0	0	100 %
2005	14	1.5	0	0	100 %
Total	80	1.0	0	0	100 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: A 95%ile (/100 mL): 15.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: A
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3: Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required or press "Inconclusive Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Opunake Beach
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Fitzroy Beach

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: Fitzroy Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2009	20	4.5	0	0	100 %
2008	20	5.5	0	2	90 %
2007	20	3.0	0	0	100 %
2006	20	3.5	0	0	100 %
2005	21	5.0	0	0	100 %
Total	101	4.0	0	2	98 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: B 95%ile (/100 mL): 75.5
Interim Result?: Complete Data Set (5 years with at least 100 samples)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment?: Complete Data Set (5 years with at least 100 samples)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3: Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required or press "Inconclusive Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Fitzroy Beach
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Bell Block

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: Bell Block

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2007	13	43.0	0	0	100 %
2006	13	20.0	0	1	92 %
2005	0	0.0	0	0	0 %
2004	0	0.0	0	0	0 %
2003	0	0.0	0	0	0 %
Total	25	23.5	0	1	96 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: B 95%ile (/100 mL): 169.6
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3: Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required or press "Inconclusive Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Bell Block
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

East End Beach

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: East End Beach

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2009	21	9.0	1	1	96 %
2008	16	39.0	1	0	100 %
2007	13	10.0	0	0	100 %
2006	0	0.0	0	0	0 %
2005	0	0.0	0	0	0 %
Total	50	12.0	2	1	96 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: B 95%ile (/100 mL): 150.0
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 3: Urban stormwater

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required or press "Inconclusive Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: East End Beach
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Waitara East Beach

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: WaitaraEast

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2009	13	15.0	2	0	100 %
2008	13	41.0	0	2	84 %
2007	13	12.0	0	0	100 %
2006	13	27.0	0	0	100 %
2005	13	9.0	0	0	100 %
Total	65	12.0	2	2	96 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: B 95%ile (/100 mL): 187.5
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: B
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/leal animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: WaitaraEast
SFRG Assessment: Good

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

Waitara West Beach

Marine MAC Assessment

Import MAC Data
Press "Import Data" to retrieve a new MAC data set.

Site Name
Name of site from the MAC file: WaitaraWest

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)		Days in Compliance (%days < 280 / year)
			140 to 280	>280	
2009	13	12.0	0	0	100 %
2008	13	120.1	2	4	69 %
2007	13	5.0	0	0	100 %
2006	13	8.0	1	0	100 %
2005	13	8.0	0	0	100 %
Total	65	9.0	3	4	93 %

Calculate MAC
Press "Calculate MAC" to determine a MAC assessment.

MAC Results
MAC category: C 95%ile (/100 mL): 297.5
Interim Result?: Interim Data Set (< 5 years, or < 100 samples used)

Save MAC Assessment
Press "Save MAC Report" to save this MAC assessment.

Marine Suitability for Recreational Grade

MAC Assessment Results
MAC Assessment: C
Interim Assessment?: Interim Data Set (< 5 years, or < 100 samples used)

SIC Assessment Results
SIC Assessment: Moderate
Primary SIC Impact: 13: River - agricultural activities/birds/leal animals

Calculate Marine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required or press "Irreconcilable Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: WaitaraWest
SFRG Assessment: Fair

Save this SFRG Assessment to a Single Summary File
Press "Save as a Single Entry File" to save the SFRG, MAC, and SIC assessments and the MAC and SIC data in one file.

Save SFRG Assessment to a Multiple Summary File
Press "Save to a Database Format File" to save summary data as one row in a comma-delimited file.
 Print the column labels to the file "ColumnLabelsMarine.txt".

