

Bathing Beach Water Quality
State of the Environment
Monitoring Report
Summer 2011-2012

Technical Report 2012-19

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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 15 November 2011 and 10 April 2012. 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 2011-2012 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 (≤ 36 enterococci cfu/100ml). Out of the 191 samples collected at 12 beach sites, >94% were below guideline MfE Alert levels (140 enterococci cfu/100ml). The few samples which individually entered the Alert guideline category (<6%) were generally associated with high rainfall/freshwater influence. Although 3% of samples exceeded 280 enterococci cfu/100ml, no site reached guideline MfE Action mode i.e. two consecutive samples >280 enterococci cfu/100ml.

Mann-Kendall tests were performed in order to assess any long term trends in microbiological water quality. Two sites showed a significant decrease in median enterococci counts over the 10-17 years monitored (Fitzroy and Ngamotu, $p > 0.05$) indicating an overall improvement in microbiological water quality. Not one site showed a significant increase in median enterococci count i.e. deterioration in microbiological water quality.

Onaero Beach Settlement, Opunake and Urenui were amongst the region's cleanest bathing beach sites with median enterococci counts of ≤ 3 cfu/100ml and no samples reaching Alert mode throughout the 2011-2012 season. Oakura Surf Club and Ohawe recorded the highest median enterococci counts of the season (36 and 34 cfu/100ml respectively). However, only one SEM sample entered the Alert category at Ohawe and all SEM samples were below Alert level at Oakura Surf Club, indicating a low and acceptable health risk to beach users during dry weather conditions.

During the 2011-2012 summer season, 5 of the 12 beach sites recorded the lowest or equal lowest SEM enterococci median counts to date (Wai-iti, Urenui, Onaero, Onaero Beach Settlement and Fitzroy). Although medians were typically low, high one-off sample counts (>900 enterococci cfu/100ml) were recorded at three sites (Oakura Surf Club, Fitzroy and Ngamotu), generally associated with freshwater input or high rainfall. The enterococci count of 4000 cfu/100ml, obtained for an MfE sample taken opposite the Oakura Surf Lifesaving Club 8 hours after heavy rainfall, was the highest recorded at this site to date. The Waimoku and Wairau Streams can influence the Oakura Surf Club site following heavy rainfall, with resident wildfowl being the principle contributors to elevated faecal indicator bacteria counts within these streams.

Sites in Taranaki compared favorably to national results, with 90% of Taranaki sites considered satisfactory for swimming based on MfE 'Suitability for Recreation Grades' ('very good', 'good' and 'fair'), compared to 86% nationally.

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 2011-2012.

Through the Council's LTP, 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 LTP target was therefore met.

Continuation of the bathing beach SEM programme is recommended in the 2012-2013 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 characterize 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 summarized 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.

Ten of the 19 sites monitored by the Council had sufficient data available to calculate SFRG grades for the period spanning November 2006 to April 2011 (Appendix II). Of these 10 sites, 6 were graded 'good', 3 were graded 'fair' and 1 was graded 'poor'. None of the beaches graded 'very poor'. As 9 of the 10 beaches obtained a SIC of 'moderate' it was not possible for any of these beaches to obtain 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 emphasized 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, November 2006 to April 2011

Site	Sanitary Inspection Category *	Microbiological assessment Enterococci (nos/100ml)			SFR Grade	% of all samples in compliance (ie: <280 enterococci)
		95 %ile	Number of samples	Category		
Onaero	Low	230.0	100	C	Fair	96
Fitzroy	Moderate 3	70.9	101	B	Good	98
Ngamotu	Moderate 3	136.0	101	B	Good	97
Oakura (SC)	Moderate 13	282.2	102	C	Fair	95
Oakura (CG)	Moderate 13	30.6	66	A	Good	100
Opunake	Moderate 3	68.6	86	B	Good	99
Ohawe	Moderate 13	134.0	73	B	Good	97
Patea (Mana Bay)	Moderate 13	33.0	45	A	Good	100
Waitara (East)	Moderate 13	520.0	65	D	Poor	93
Waitara (West)	Moderate 13	462.5	65	C	Fair	90
Patea	Moderate 13	Insufficient data to calculate				
Waverley	Moderate 13	Insufficient data to calculate				
Wai-inu	Moderate 13	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				
Bell Block	Moderate 3	Insufficient data to calculate				
East End	Moderate 3	Insufficient data to calculate				
Back	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 (Photograph 1). Thirteen samples were collected from each site during the season.

Results for the 2011-2012 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 analyzed 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 2011-2012 programme are shown in Figure 1 and summarized in Table 4.

Table 4 Location of bathing water bacteriological sampling sites 2011-2012

Beach	Location	GPS	Site code
Wai-iti	75m N of Wai-iti Stream	1727667-5690609	SEA900060
Urenui	East of Urenui River mouth	1720582-5683563	SEA900072
Onaero	Opposite surf lifesaving club	2628254-6244898	SEA900085
Onaero	Settlement beach	1717129-5683099	SEA900087
Waitara	East Beach	1706602-5683915	SEA901033
Waitara	West Beach	1705951-5683802	SEA901037
Fitzroy	Opposite surf lifesaving club	2605036-6239351	SEA902025
Ngamotu	Centre of beach	2600022-6237765	SEA902062
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

Primary beach sites are monitored each year (Table 5). Remaining beach sites are sampled on a three year rotation, with Year 3 beaches sampled during the 2011-2012 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



Photograph 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 or state of the tide. 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).

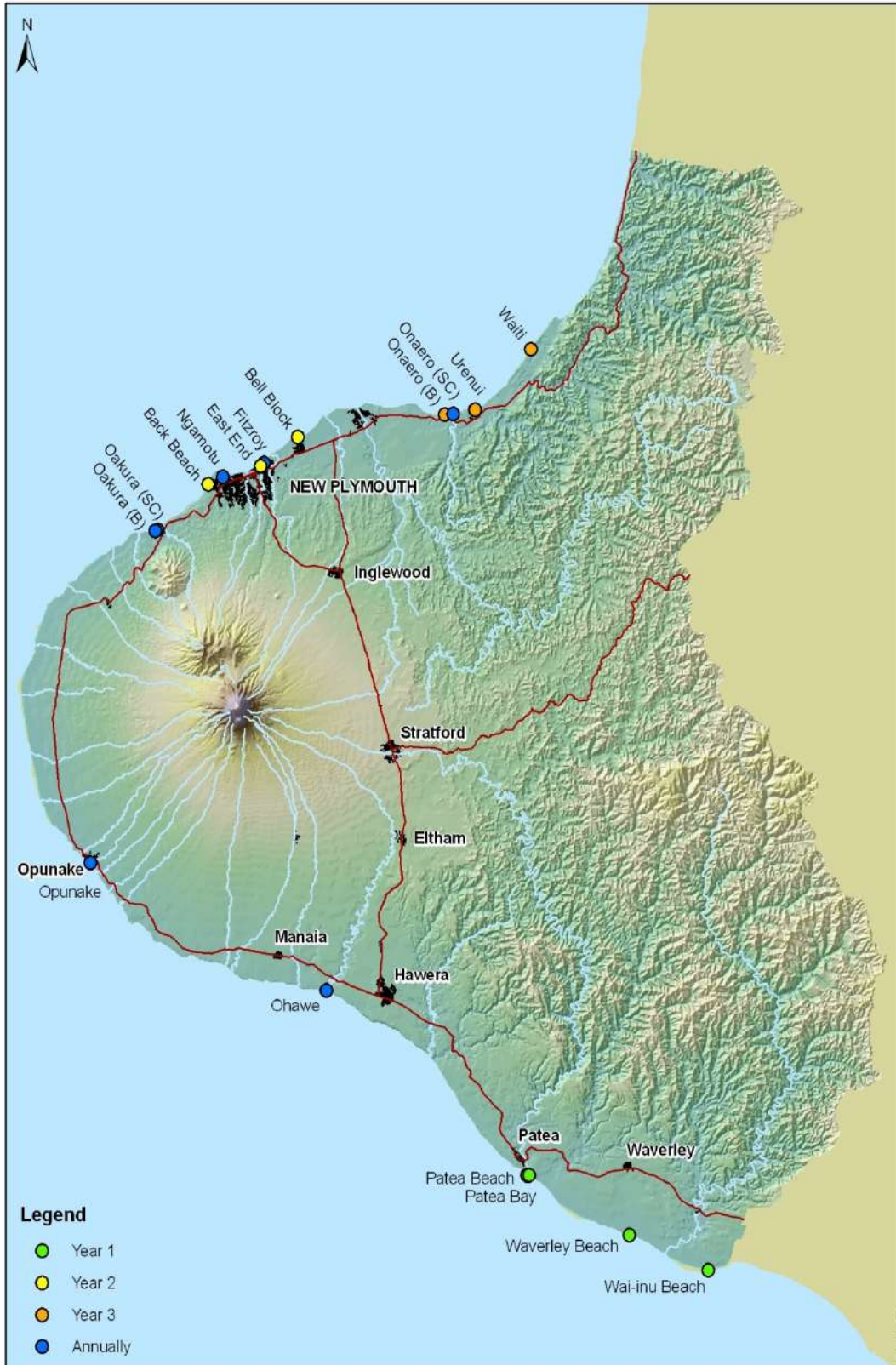


Figure 1 SEM beach bathing bacteriological survey sites

4. Results

From 15 November 2011 to 10 April 2012 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 localized 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 discussed 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 utilized for bathing and other contact recreational activities, particularly at weekends, dependent on suitable weather conditions.

4.1 Wai-iti Beach

4.1.1 SEM programme

Wai-iti Beach (Photograph 2) is located in north Taranaki. The relatively small Wai-iti Stream drains onto the southern end of the beach.



Photograph 2 Wai-iti 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 Wai-iti 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)	
15-Nov-11	10:10	4660	7	<1	7	16.8
28-Nov-11	10:15	4770	15	11	17	16.2
22-Jan-12	08:00	4410	100	80	110	19.2
26-Jan-12	09:50	4700	3	<1	3	19.1
07-Feb-12	08:05	4700	3	4	3	18.7
10-Feb-12	10:50	4750	1	3	1	20
13-Feb-12	12:05	4720	11	9	11	20.9
21-Feb-12	08:15	4520	32	32	32	20.5
27-Feb-12	10:55	4660	6	2	6	20.4
08-Mar-12	08:05	4680	4	32	4	17.4
28-Mar-12	13:35	4570	10	12	10	19.7
30-Mar-12	12:55	4470	19	51	20	20
10-Apr-12	10:55	4730	7	1	7	18.7

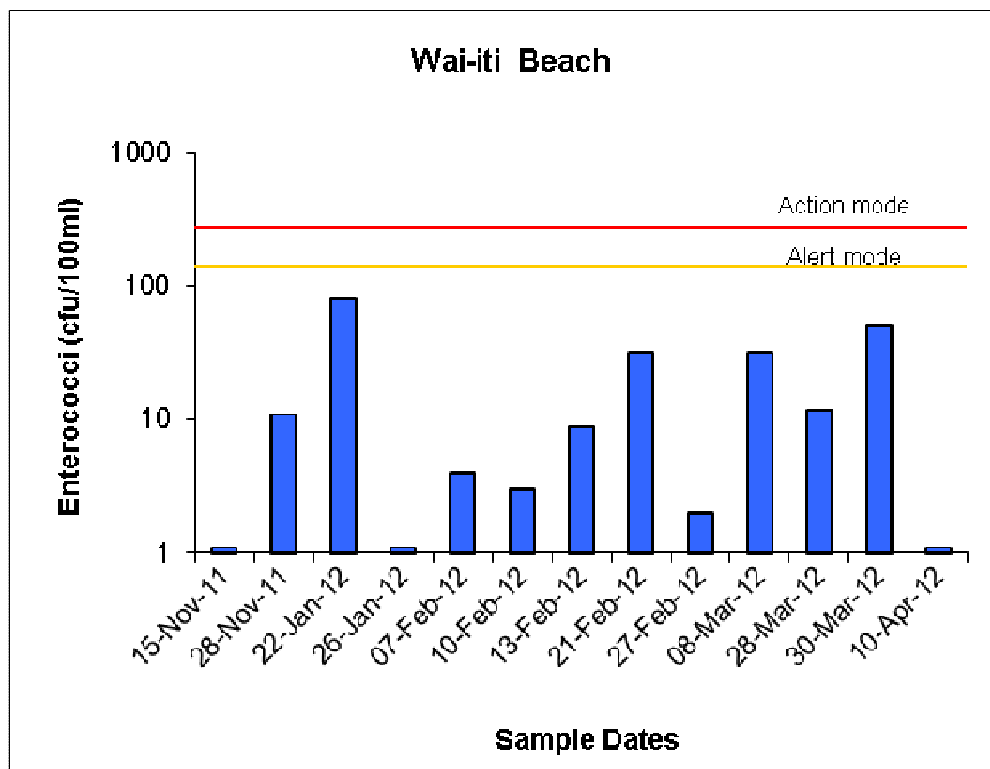
**Figure 2** Enterococci numbers for the 13 SEM samples taken at Wai-iti Beach

Table 7 Statistical summary for Wai-iti Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4410	4770	4680
<i>E. coli</i>	cfu/100ml	13	1	100	7
Enterococci	cfu/100ml	13	<1	80	9
Faecal coliforms	cfu/100ml	13	1	110	7
Temperature	°C	13	16.2	20.9	19.2

Microbiological water quality at Wai-iti Beach remained high throughout the season, with low median and maximum values for all faecal indicator bacteria (Table 7).

4.1.2 Compliance with guidelines

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

Table 8 Bacterial guidelines performance at Wai-iti Beach

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

4.1.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Wai-iti Beach over 6 summer seasons are presented in Table 9 and Figure 3.

Table 9 Summary of enterococci data (cfu/100 ml) for summer surveys at Wai-iti Beach

Summer	1996-97	1999-00	2002-03	2005-06	2008-09	2011-12
Minimum	3	3	1	4	<1	<1
Maximum	92	80	87	95	140	80
Median	16	15	7	15	21	9

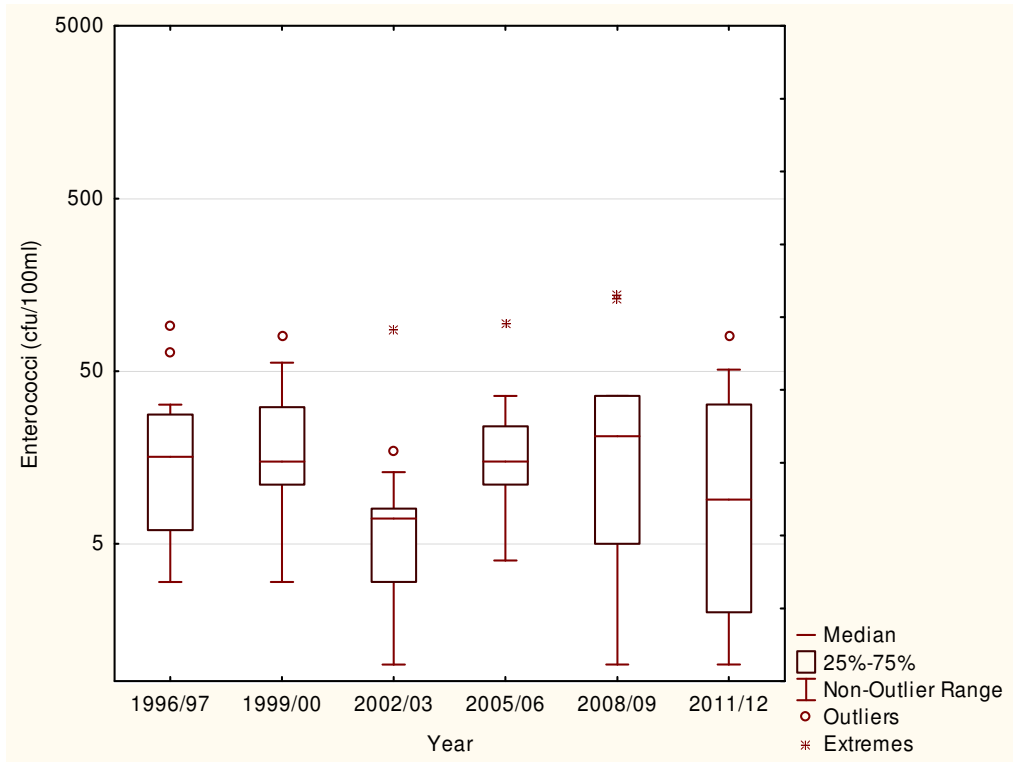


Figure 3 Box and whisker plots for all summer SEM surveys of enterococci numbers at Wai-iti Beach

The median and maximum enterococci data obtained for the 2011-2012 summer season at Wai-iti Beach were at the lower end of the range of values previously recorded at this site (Table 9, Figure 3).

4.1.4 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).

4.2 Urenui Beach

4.2.1 SEM programme

Urenui Beach (Photograph 3), in north Taranaki, is a relatively popular bathing beach, especially over the Christmas holiday period. Draining through predominantly agricultural land, the Urenui River enters at the western end of the beach and makes a significant contribution to bacteria counts subsequent to rainfall events.



Photograph 3 Urenui Beach

The data for this site are presented in Table 10 and Figure 4, with a statistical summary provided in Table 11.

Table 10 Bacteriological results for Urenui Beach

Date	Time	Conductivity @ 20° C	Bacteria			Temp
			<i>E. coli</i>	Enterococci	Faecal	
15-Nov-11	10:30	4680	<1	<1	<1	16.8
28-Nov-11	10:36	4590	52	21	52	16.3
22-Jan-12	08:20	4620	19	4	19	19.4
26-Jan-12	10:10	4650	7	3	7	19.2
07-Feb-12	08:25	4700	3	4	3	19.1
10-Feb-12	11:20	4710	7	8	7	19.9
13-Feb-12	12:30	4620	5	3	5	21.1
21-Feb-12	08:50	4710	<1	3	<1	21.3

Date	Time	Conductivity @ 20°C	Bacteria			Temp
			<i>E. coli</i>	Enterococci	Faecal	
27-Feb-12	11:25	4670	7	1	7	21
08-Mar-12	08:25	4690	12	16	12	17.6
28-Mar-12	13:05	4570	4	4	4	19.9
30-Mar-12	13:20	4650	1	<1	1	19.2
10-Apr-12	11:20	4700	1	1	1	19

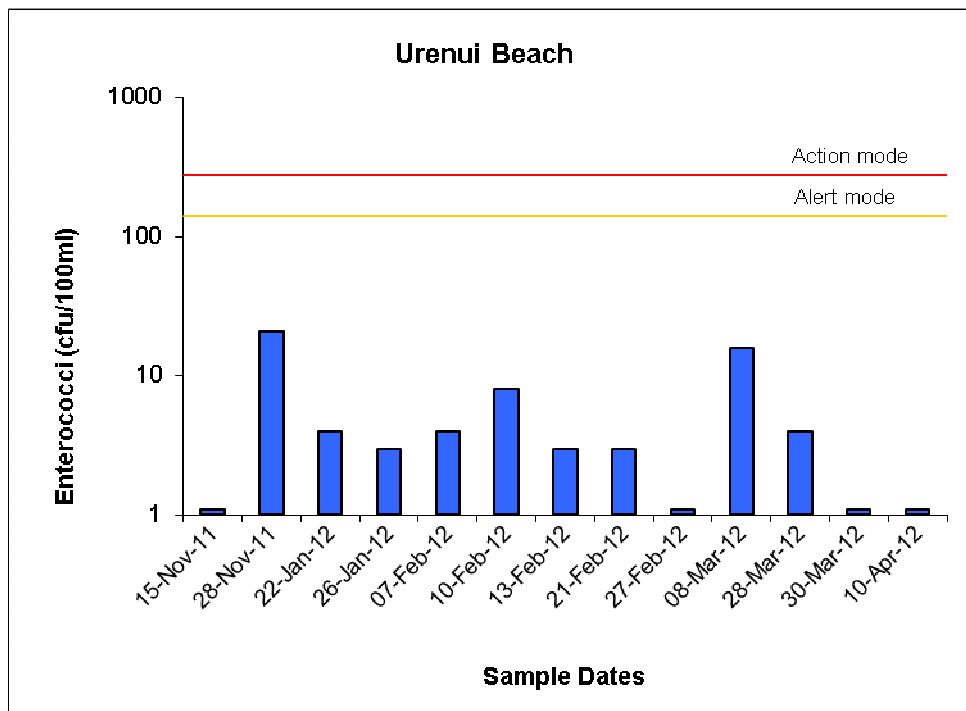


Figure 4 Enterococci numbers for the 13 SEM samples taken from Urenui Beach

Table 11 Statistical summary for Urenui Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4570	4710	4670
<i>E. coli</i>	cfu/100ml	13	<1	52	5
Enterococci	cfu/100ml	13	<1	21	3
Faecal coliforms	cfu/100ml	13	<1	52	5
Temperature	°C	13	16.3	21.3	19.2

Water quality at Urenui Beach remained high throughout the season, with low median and maximum values for all bacteriological faecal indicators.

4.2.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 12. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 12 Bacterial guidelines performance at Urenui Beach

Parameter	Number of exceedances of enterococci guidelines [% of 13 samples]	
	ALERT	ACTION
Enterococci	0 [0]	0 [0]

4.2.3 Comparison with previous summers' surveys

Summary statistics for enterococci data collected at Urenui Beach over 6 summers are presented in Table 13 and Figure 5.

Table 13 Summary of enterococci data (cfu/100 ml) for summer surveys at Urenui Beach

Summer	1996-97	1999-00	2002-03	2005-06	2008-09	2011-12
Minimum	<1	<1	<1	1	<1	<1
Maximum	20	25	53	160	33	21
Median	4	12	3	3	3	3

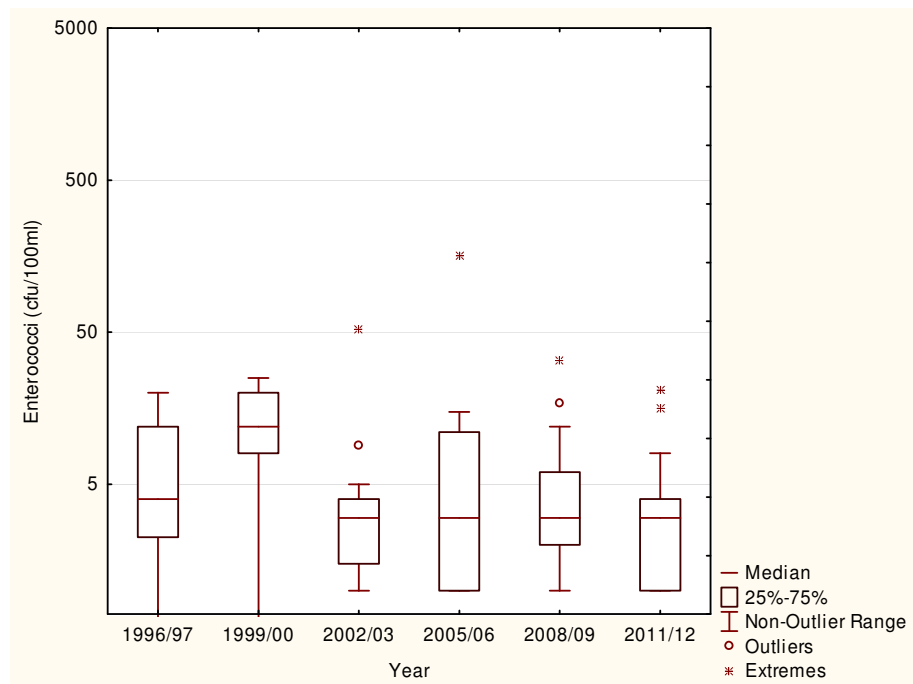


Figure 5 Box and whisker plots for all summer SEM surveys of enterococci numbers at Urenui Beach

Continued low median and maximum enterococci data obtained for Urenui Beach during the 2011-2012 summer continues the trend of excellent water quality at this site (Table 13, Figure 5).

4.2.4 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).

4.3 Onaero Beach

4.3.1 SEM programme

Onaero Beach (Photograph 4), 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.



Photograph 4 Onaero Beach

The data for this site are presented in Table 14 and Figure 6, with a statistical summary provided in Table 15.

Table 14 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)	
15-Nov-11	10:50	4590	35	17	35	17.3
28-Nov-11	11:00	4600	21	16	21	16.3
22-Jan-12	08:50	4670	12	13	15	19.2
26-Jan-12	10:40	4650	35	3	36	19.1
07-Feb-12	08:45	4710	8	1	8	19.2
10-Feb-12	11:55	4670	<1	4	<1	19.7
13-Feb-12	13:10	4630	1	1	1	21.1
21-Feb-12	09:10	4700	3	11	3	20.9
27-Feb-12	12:05	4700	3	1	3	20.8
08-Mar-12	08:48	4690	<4	<4	<4	18.1
28-Mar-12	12:50	3730	120	42	120	18.3
30-Mar-12	13:30	3890	48	40	48	18.5
10-Apr-12	11:55	4710	10	4	10	18.8

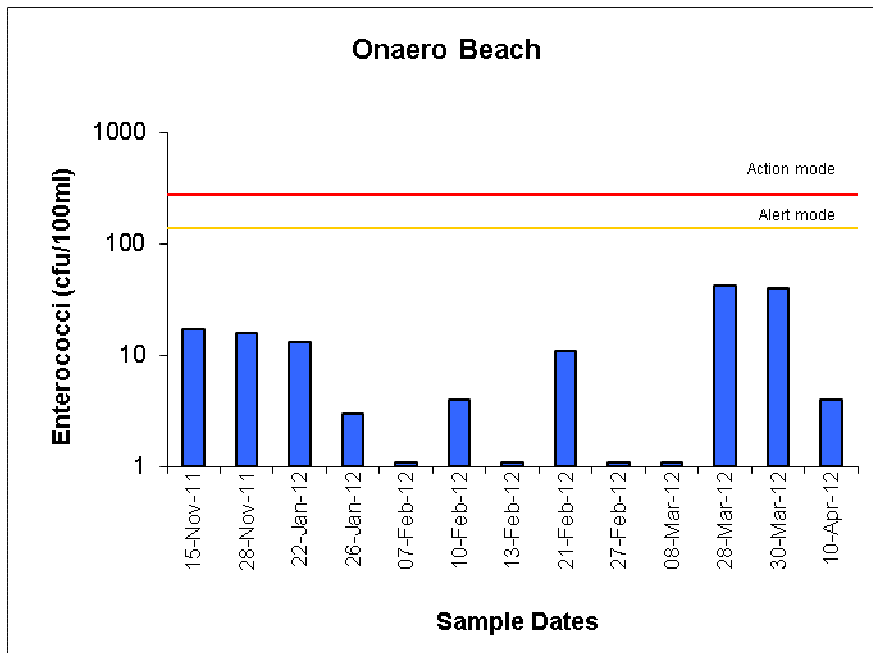


Figure 6 Enterococci numbers for the 13 SEM samples taken from Onaero Beach

Table 15 Statistical summary for Onaero Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3730	4710	4670
<i>E. coli</i>	cfu/100ml	13	<1	120	10
Enterococci	cfu/100ml	13	1	42	4
Faecal coliforms	cfu/100ml	13	<1	120	10
Temperature	°C	13	16.3	21.1	19.1

Microbiological water quality of the SEM samples taken during the 2011-2012 season was good, with relatively low counts of all bacteriological indicators throughout the bathing season (Table 15).

4.3.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 16. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 16 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	0/13	0%	0/13	0%

4.3.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Onaero Beach over 13 summers are presented in Table 17 and Figure 7.

Table 17 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	11/12	
Minimum	2	<1	2	3	<1	1	
Maximum	560	59	64	27	96	42	
Median	7	4	13	13	11	4	

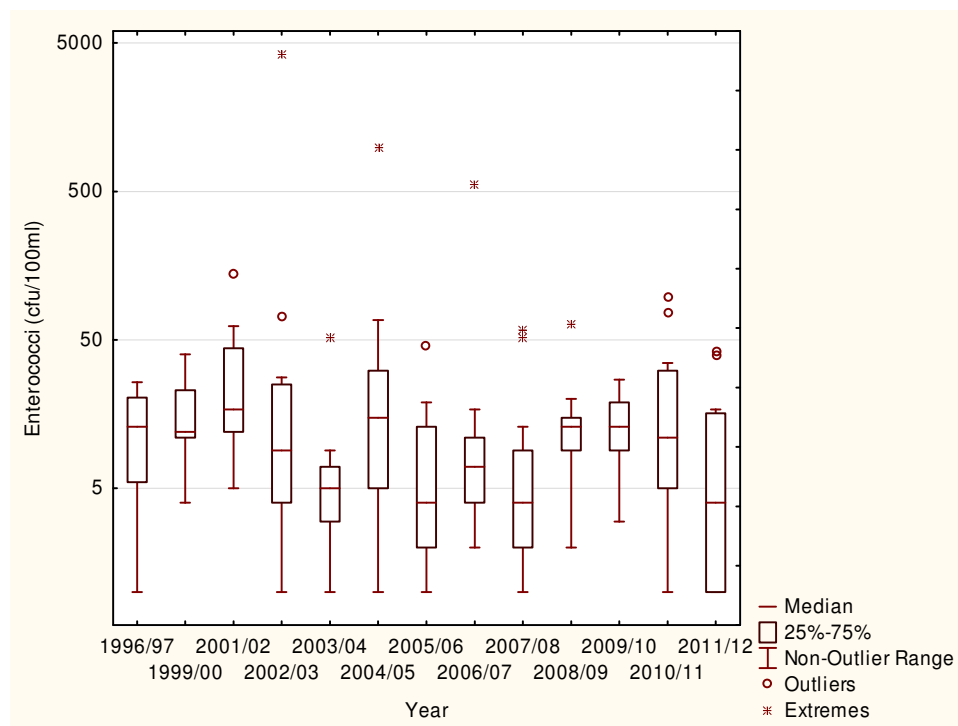


Figure 7 Box and whisker plots for all summer SEM surveys of enterococci numbers at Onaero Beach

The median enterococci count obtained for the 2011-2012 summer (4 enterococci/100ml) was one of the lowest recorded at Onaero Beach to date (Table 17, Figure 7). The maximum was within the range of previous long term results (Table 17).

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 10 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.

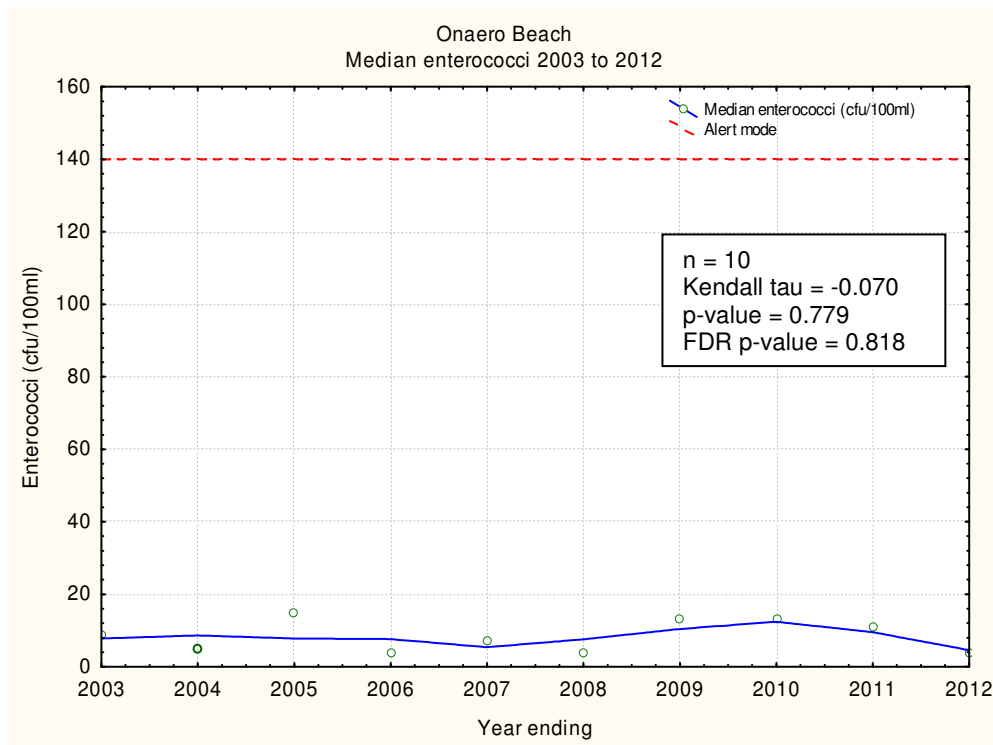


Figure 8 LOWESS trend analysis of median enterococci data at Onaero Beach

Over the 10 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.070) that was not significant at the 5% level ($p = 0.818$).

4.3.5 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 18 and Figure 9, with a statistical summary provided in Table 19.

Table 18 Bacteriological results for MfE samples at Onaero Beach

Date	Time	Conductivity @ 20°C	Bacteria			Temperature
			<i>E. coli</i>	Enterococci	Faecal coliforms	
22-Nov-11	10:10	2340	660	290	670	15.6
06-Dec-11	08:50	4240	390	230	400	18.1
20-Dec-11	09:00	4600	80	19	98	18.5
05-Jan-12	10:05	492	500	180	500	17.9
18-Jan-12	09:35	3770	40	32	44	19.6
31-Jan-12	08:55	4530	20	11	20	18.9
16-Feb-12	09:05	4360	1000	480	1000	21

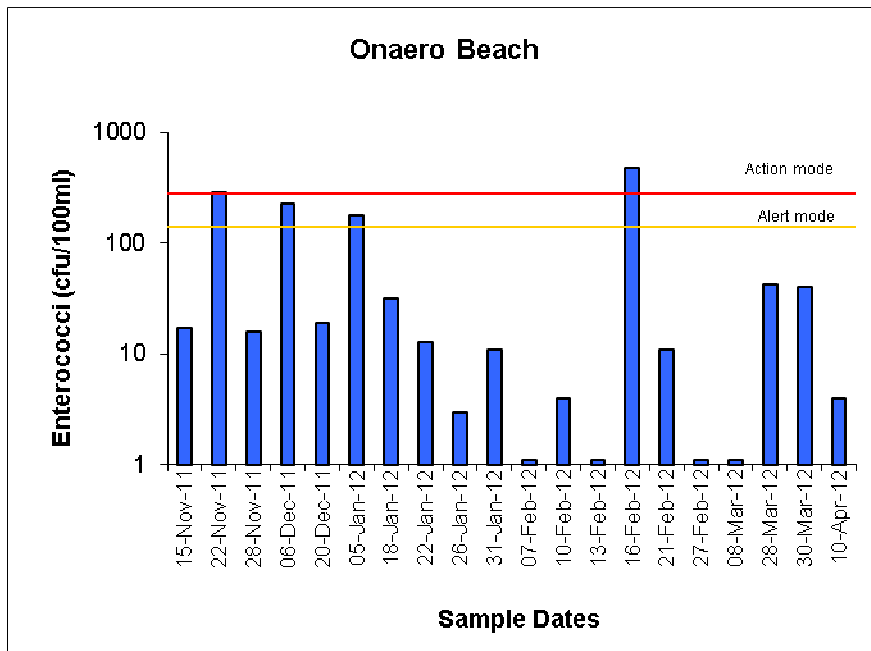


Figure 9 Enterococci numbers for the 20 sample extended survey at Onaero Beach

Table 19 Summary statistics for SEM and MfE samples at Onaero Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	492	4710	4600
<i>E. coli</i>	cfu/100ml	20	<1	1000	28
Enterococci	cfu/100ml	20	1	480	15
Faecal coliforms	cfu/100ml	20	<1	1000	28
Temperature	°C	20	15.6	21.1	18.9

The additional MfE sampling resulted in an increase in the overall seasonal medians for all three faecal indicator bacteria monitored during the 2012-2011 season (Table 15 and 19). High enterococci counts obtained on 22 November, 6 December, 5 January and 16 February were associated with low conductivity (Table 18, N.B. typical conductivity of seawater is 4750 mS/m). The Onaero River which drains to the southern end of the beach is likely to have made a significant contribution to the high bacteria counts on these dates. Samples collected on 6 December and 16 February had been affected by rainfall. A large river flood which preceded sampling on 5 January is likely to have resulted in high bacteria counts and the very low conductivity of this sample.

4.5.3.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 20. At Onaero Beach, 4 of 20 samples entered the Alert category. This was higher than any other bathing beach monitored during the 2011-2012 season. However, the beach did not enter the Action level at any time.

Table 20 Bacterial guidelines performance at Onaero Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
Enterococci	4/20	20%	0/20	0%

4.4 Onaero Beach Settlement

4.4.1 SEM programme

Onaero Beach Settlement is located approximately 1 km west of the Onaero River.

The data for this site are presented in Table 21 and Figure 10, with a statistical summary provided in Table 22.

Table 21 Bacteriological results for Onaero Beach Settlement

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
15-Nov-11	11:00	4610	1	1	1	16.6
28-Nov-11	11:10	4660	34	21	42	15.6
22-Jan-12	09:00	4650	13	<1	16	19.2
26-Jan-12	10:55	4680	<1	1	<1	18.9
07-Feb-12	08:55	4700	<1	3	<1	18.9
10-Feb-12	12:10	4690	3	1	3	20
13-Feb-12	13:30	4630	84	50	84	21.8
21-Feb-12	09:20	4660	31	31	32	21.4
27-Feb-12	12:20	4720	4	1	4	21
08-Mar-12	09:00	4700	<2	<2	<2	17.9
28-Mar-12	14:10	4580	2	<2	2	19.7
30-Mar-12	13:50	4590	1	4	1	19.7
10-Apr-12	12:20	4660	1	<1	1	18.7

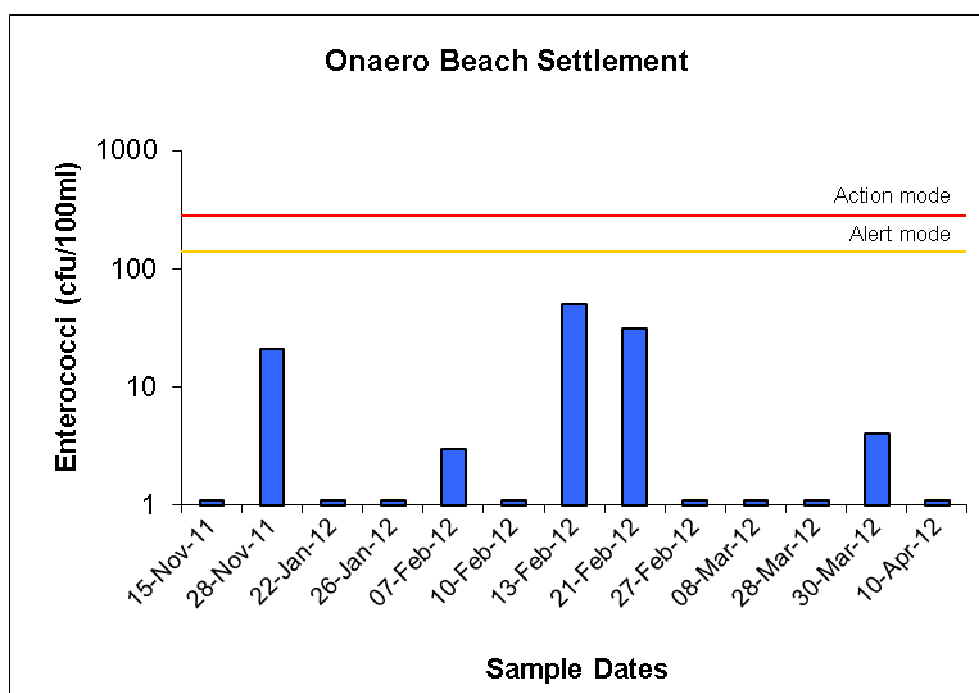


Figure 10 Enterococci numbers for the 13 SEM samples taken from Onaero Beach Settlement

Table 22 Statistical results summary for Onaero Beach Settlement

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4580	4720	4660
<i>E. coli</i>	cfu/100ml	13	<1	84	2
Enterococci	cfu/100ml	13	<1	50	1
Faecal coliforms	cfu/100ml	13	<1	84	2
Temperature	°C	13	15.6	21.8	19.2

Water quality was excellent at this site with low medians for all faecal indicator bacteria (≤ 2 cfu/100ml). Maxima were also low at 50 cfu/100ml for enterococci and 84 cfu/100ml for *E. coli* and faecal coliforms (Table 22).

4.4.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 23. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 23 Bacterial guidelines performance at Onaero Beach Settlement

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

4.4.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Onaero Beach Settlement over 6 summers are presented in Table 24 and Figure 7.

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

Summer	1996-97		1999-00	2002-03	2005-06	2008-09	2011-12
Minimum	1		1	<1	2	1	<1
Maximum	200		120	64	70	71	50
Median	12	16	5	10	9	1	

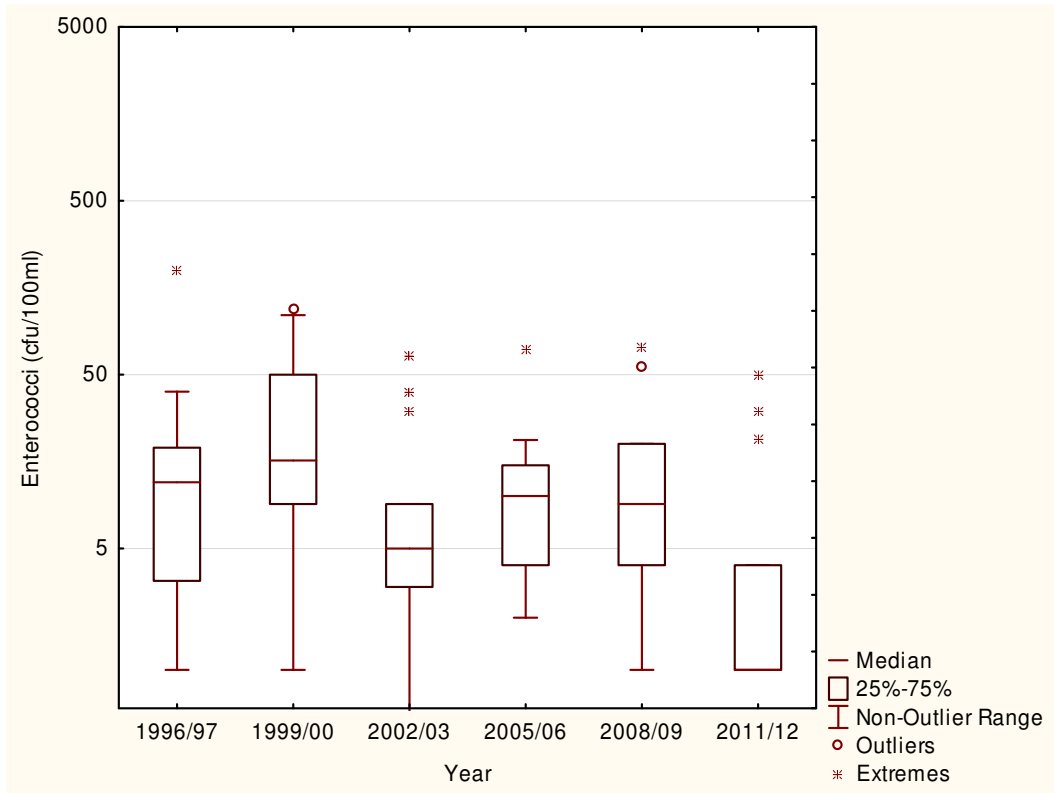


Figure 11 Box and whisker plots for all summer SEM surveys of enterococci numbers at Onaero Beach Settlement

The median and maximum enterococci data obtained for the 2011-2012 summer season at Onaero Beach Settlement are the lowest values recorded at this site to date (Table 24, Figure 11).

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 Waitara East Beach

4.5.1 SEM programme

Waitara East Beach is located to the east of the Waitara River mouth (Photograph 5). 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.



Photograph 5 Waitara East Beach

The data for this site are presented in Table 25 and Figure 12, with a statistical summary provided in Table 26.

Table 25 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)		
15-Nov-11	11:30	3600	54	3	54	17	16
28-Nov-11	11:40	3930	120	9	130	15.9	13
22-Jan-12	09:45	4490	31	17	31	18.7	23
26-Jan-12	11:25	4420	1	5	1	18.5	30
07-Feb-12	09:30	4520	17	8	20	19.9	20
10-Feb-12	12:50	4540	<1	3	<1	19.9	10
13-Feb-12	14:05	4100	1	1	1	21.5	5.2
21-Feb-12	10:00	4230	56	39	57	20.9	10
27-Feb-12	12:50	4370	18	6	18	20.7	10

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)		
08-Mar-12	09:30	4530	410	190	410	17.1	66
28-Mar-12	12:15	4210	34	2	34	19	15
30-Mar-12	14:25	3620	22	6	28	18.9	13
10-Apr-12	13:25	4480	5	4	5	18.2	16

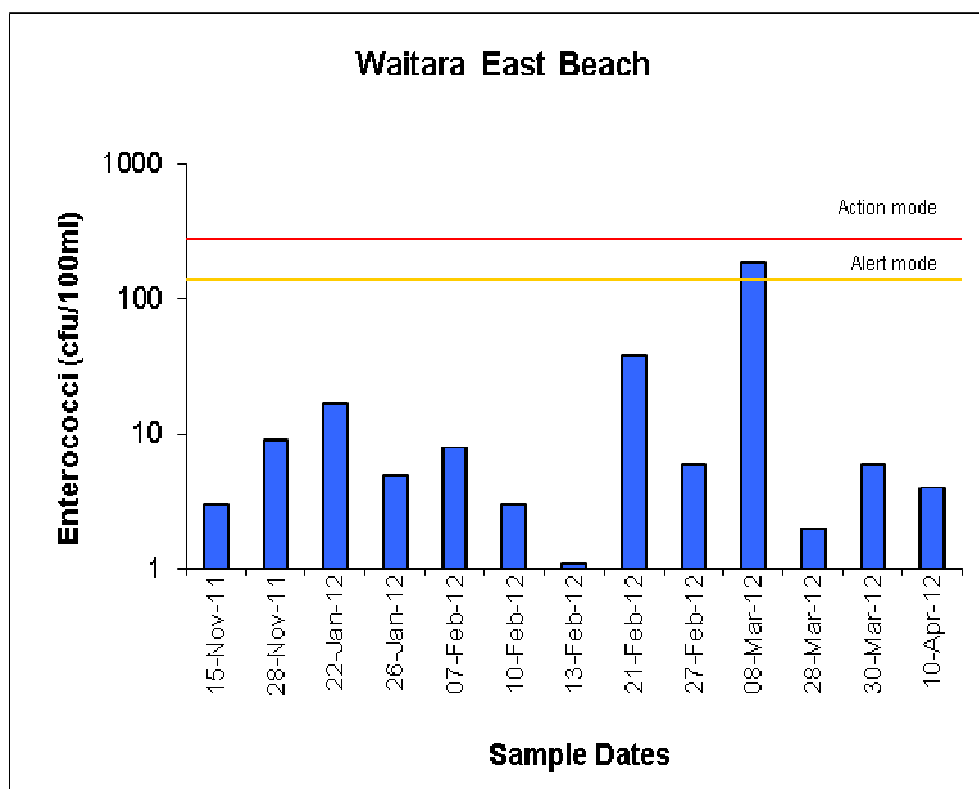


Figure 12 Enterococci numbers for the 13 SEM samples taken from Waitara East Beach

Table 26 Statistical summary for Waitara East Beach

Parameter	Unit	Number	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3600	4540	4370
<i>E. coli</i>	cfu/100ml	13	<1	410	22
Enterococci	cfu/100ml	13	1	190	6
Faecal coliforms	cfu/100ml	13	<1	410	28
Temperature	°C	13	15.9	21.5	18.9
Turbidity	NTU	13	5.2	66	15

The median enterococci count (6 cfu/100ml) was relatively low at this site, with higher medians recorded for *E. coli* (22 cfu/100ml) and faecal coliforms (28 cfu/100ml). The highest enterococci count (190 cfu/100ml), recorded on 8 March, remains unexplained as there was negligible rainfall 4 days prior to sampling and only minor freshwater influence (4530 mS/m, Table 25).

4.5.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 27. One of the thirteen samples (8 March 2012) entered the Alert category during the bathing season.

Table 27 Bacterial guidelines performance at Waitara East Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
Enterococci	1/13	8%	0/13	0%

4.5.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Waitara East Beach over 17 summers are presented in Table 28 and Figure 13.

Table 28 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	2003-04
Minimum	1	1	1	3	3	1	4	<1	<1
Maximum	950	960	230	250	230	520	290	410	840
Median	14	11	17	20	40	9	21	13	17
	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	
Minimum	1	<1	1	1	<1	<1	<1	1	
Maximum	310	88	91	120	2400	210	1000	190	
Median	9	9	27	12	41	15	3	6	

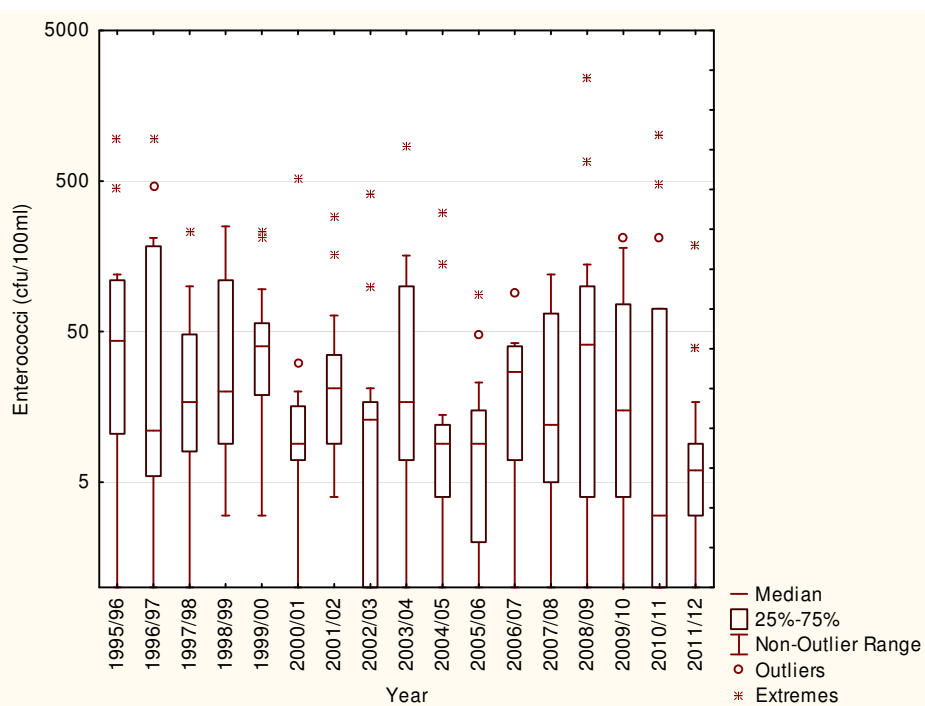


Figure 13 Box and whisker plots for all summer surveys of enterococci numbers at Waitara East Beach

Maximum and median enterococci counts obtained during the 2011-2012 summer season were at the lower end of the range previously recorded at this site (Table 28, Figure 13). Maxima at this site are historically high due to the influence of the Waitara River (Table 28).

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 16 summer seasons (Figure 14) 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.

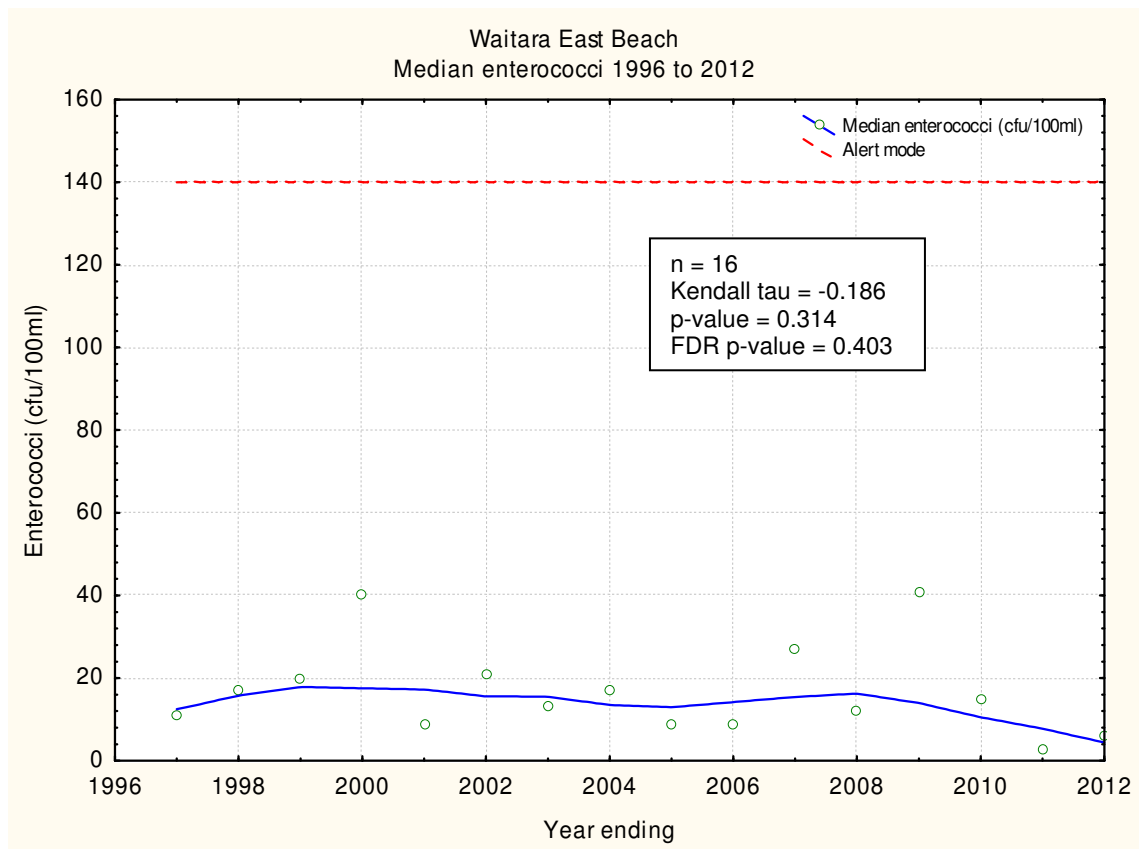


Figure 14 LOWESS trend analysis of median enterococci data at Waitara East Beach

Over the 16 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.186) that was not significant at the 5% level ($p = 0.314$).

4.6 Waitara West Beach

4.6.1 SEM programme

Waitara West Beach is located to the west of the Waitara River mouth (Photograph 6). 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.



Photograph 6 Waitara West Beach

The data for this site are presented in Table 29 and Figure 15, with a statistical summary provided in Table 30.

Table 29 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)		
15-Nov-11	12:00	4650	1	3	1	16.7	14
28-Nov-11	12:00	4000	120	17	130	15.7	24
22-Jan-12	10:05	4540	20	19	20	18.5	22
26-Jan-12	11:35	4610	<1	1	<1	18.7	50
07-Feb-12	09:50	4700	65	13	65	19.7	12
10-Feb-12	13:15	4680	20	28	20	19.9	21
13-Feb-12	14:30	3860	<1	<1	<1	21.9	3.1
21-Feb-12	10:25	4180	24	4	24	21.1	3
27-Feb-12	13:20	4660	24	22	24	20.8	34
08-Mar-12	09:49	4700	4	4	4	17.7	20
28-Mar-12	11:40	4200	88	140	88	19	31
30-Mar-12	14:40	3760	36	160	38	19	21
10-Apr-12	13:45	4610	1	13	1	19.4	32

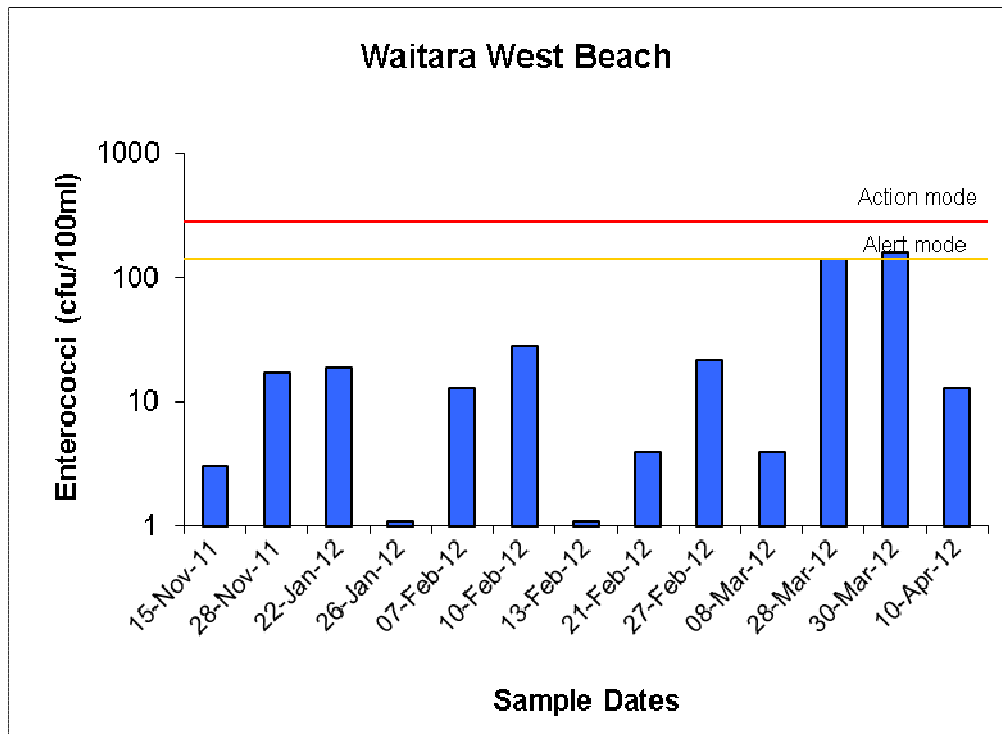


Figure 15 Enterococci numbers for the 13 SEM samples taken from Waitara West Beach

Table 30 Statistical summary for Waitara West Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3760	4700	4610
<i>E. coli</i>	cfu/100ml	13	<1	120	20
Enterococci	cfu/100ml	13	<1	160	13
Faecal coliforms	cfu/100ml	13	<1	130	20
Temperature	°C	13	15.7	21.9	19
Turbidity	NTU	13	3	50	21

In common with Waitara East Beach, at Waitara West Beach the median enterococci count (13 cfu/100ml) was lower than medians recorded for *E. coli* (20 cfu/100ml) and faecal coliforms (20 cfu/100ml). The highest enterococci count (160 cfu/100ml), recorded on 30 March, might have been influenced by freshwater input (3760 mS/m, Table 29), although there was negligible rainfall 5 days prior to sampling.

4.6.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 31. One sample (30 March 2001) entered the Alert category.

Table 31 Bacterial guidelines performance at Waitara West Beach

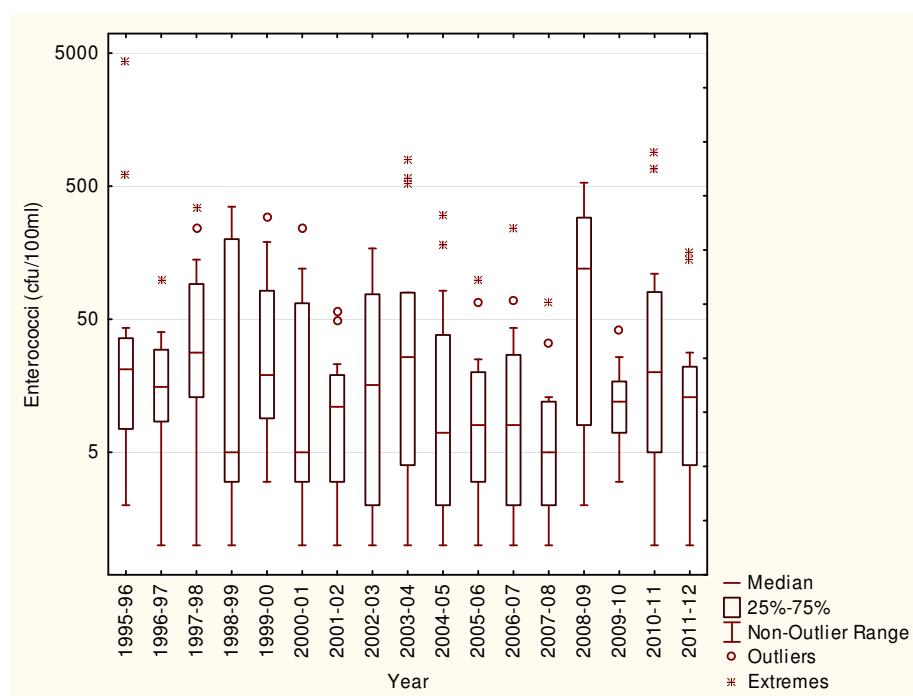
Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
Enterococci	1/13	8%	0/13	0%

4.6.3 Comparison with previous summer surveys

Summary statistics for enterococci survey data collected at Waitara West Beach over 17 summers are presented in Table 32 and Figure 16.

Table 32 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	2003-04
Minimum	2	1	1	1	3	1	1	1	1
Maximum	4300	100	340	350	290	240	57	170	800
Median	21	16	28	5	19	5	11	16	26
	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	
Minimum	1	1	1	1	2	3	1	<1	
Maximum	300	100	240	67	530	42	910	160	
Median	7	8	8	5	120	12	20	13	

**Figure 16** 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 at this site (Table 32, Figure 16). Maxima at this site are historically high due to the influence of the Waitara River (Table 32).

4.6.4 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 16 summer seasons (Figure 17) 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.

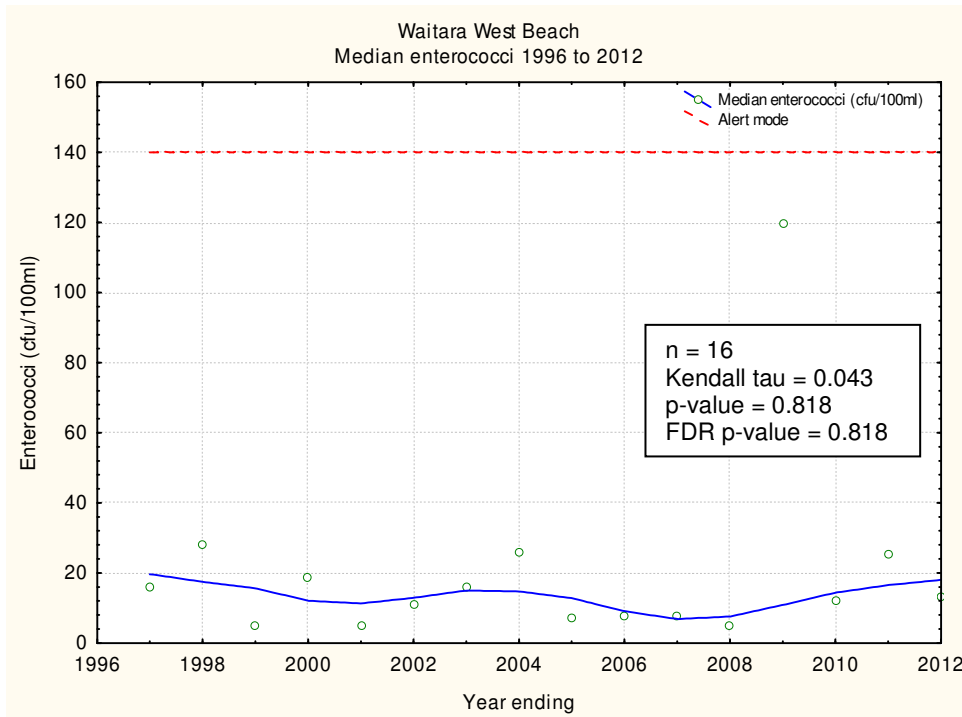


Figure 17 LOWESS trend analysis of median enterococci data at Waitara West Beach

Over the 16 seasons monitored, there was an increasing trend in median enterococci counts (Kendall tau = 0.043) that was not significant at the 5% level ($p = 0.818$).

4.7 Fitzroy Beach

4.7.1 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 (Photograph 7). In 2007, Fitzroy (along with Oakura and East End) became the first Blue Flag accredited beaches in New Zealand.

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 birdlife.



Photograph 7 Surfer at Fitzroy Beach

The data for this site are presented in Table 33 and Figure 18, with a statistical summary provided in Table 34.

Table 33 Bacteriological results for Fitzroy Beach

Date	Time (NZS T)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
15-Nov-11	12:15	4680	<1	<1	<1	16.1
28-Nov-11	11:40	4660	4	3	4	14.9
22-Jan-12	09:50	4430	160	930	170	18.7
26-Jan-12	11:34	4470	17	44	17	18.1

Date	Time (NZS T)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
07-Feb-12	10:05	4700	480	110	480	19.6
10-Feb-12	11:15	4690	1	4	1	19.7
13-Feb-12	12:00	4450	<1	1	<1	21.5
27-Feb-12	13:05	4660	1	3	1	19.5
08-Mar-12	10:25	4700	<1	1	<1	17.2
21-Mar-12	10:30	4750	28	3	28	17.8
28-Mar-12	13:55	4690	1	1	1	18.3
30-Mar-12	14:25	4620	<1	<1	<1	18.9
10-Apr-12	12:25	4700	<1	1	<1	18.8

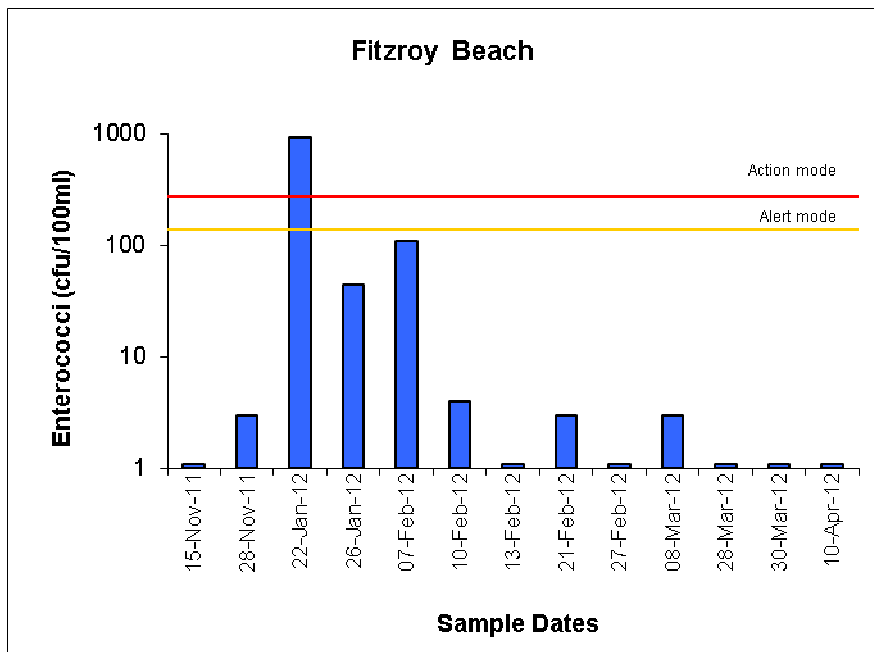


Figure 18 Enterococci numbers for the 13 SEM samples taken from Fitzroy Beach

Table 34 Statistical summary for Fitzroy Beach

Parameter	Unit	Number	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4430	4750	4680
<i>E. coli</i>	cfu/100ml	13	<1	480	1
Enterococci	cfu/100ml	13	<1	930	3
Faecal coliforms	cfu/100ml	13	<1	480	1
Temperature	°C	13	14.9	21.5	18.7

With the exception of three samples, bacteriological water quality at Fitzroy Beach was high throughout the season, with very low median values for all bacteriological parameters (≤ 3 cfu/100ml).

The one sample which exceeded guideline Alert levels, collected on 22 January 2012, appeared to have been influenced by freshwater, having the lowest conductivity recorded at this site during the 2011-2012 summer season (4430 mS/m). Freshwater influence at Fitzroy Beach comes largely from the Waiwhakaiho River and gulls have been identified as the main source of faecal contamination at the mouth of this river (TRC 2011).

4.7.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 35. One sample (22 January 2012) exceeded the Alert category during the 2011-2012 season.

Table 35 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	1/13	8%	0/13	0%

4.7.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Fitzroy Beach over 17 summers are presented in Table 36 and Figure 19.

Table 36 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	2003-04
Minimum	3	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Maximum	46	280	40	79	17	98	350	580	98
Median	10	15	7	7	4	7	9	5	3
	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	
Minimum	< 1	< 1	< 1	< 1	< 1	1	< 1	< 1	
Maximum	52	85	33	44	110	60	43	930	
Median	4	6	3	3	10	8	4	3	

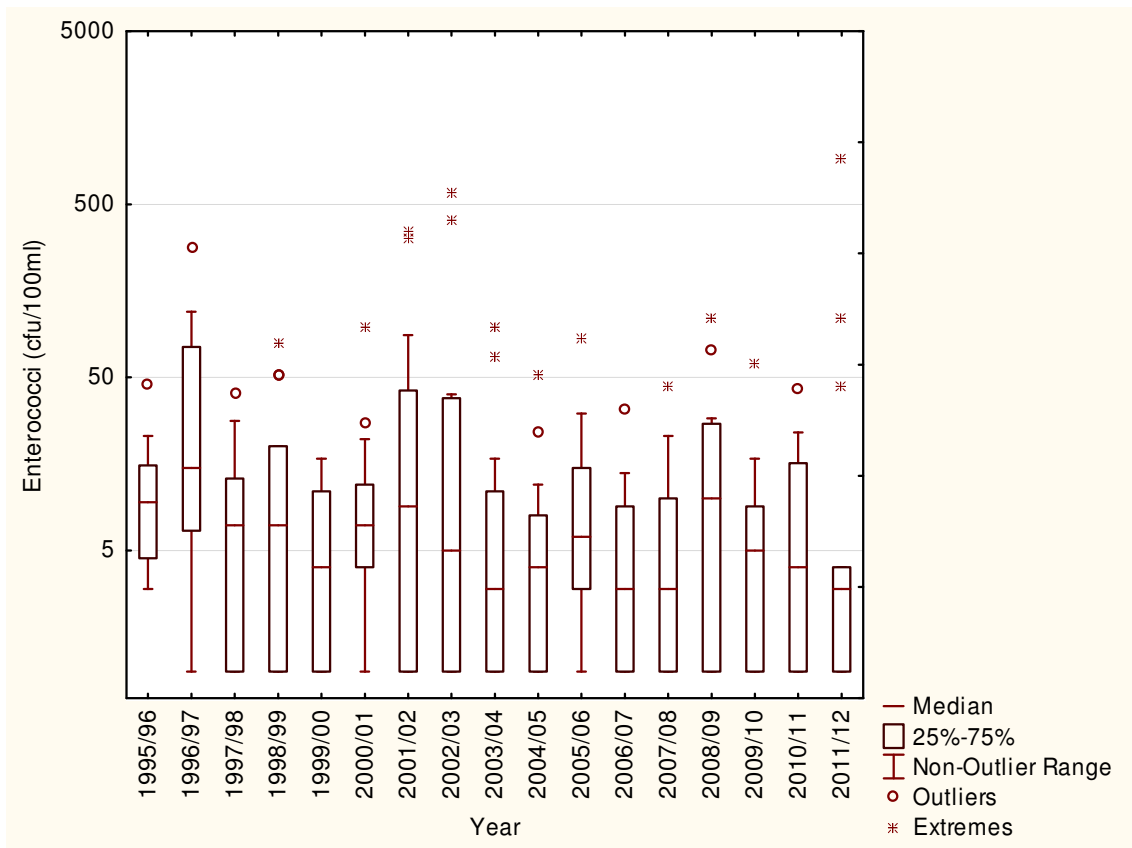


Figure 19 Box and whisker plots for all summer SEM surveys of enterococci numbers at Fitzroy Beach

The median enterococci count (3 cfu/100ml) obtained for the 2011-2012 summer season at Fitzroy Beach was one of the lowest to date and low compared to other Taranaki beach bathing sites. In contrast, the maximum enterococci count was the highest recorded for an SEM sample at this site to date and was likely related to freshwater influence (see Section 7.7.1).

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 20) 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.

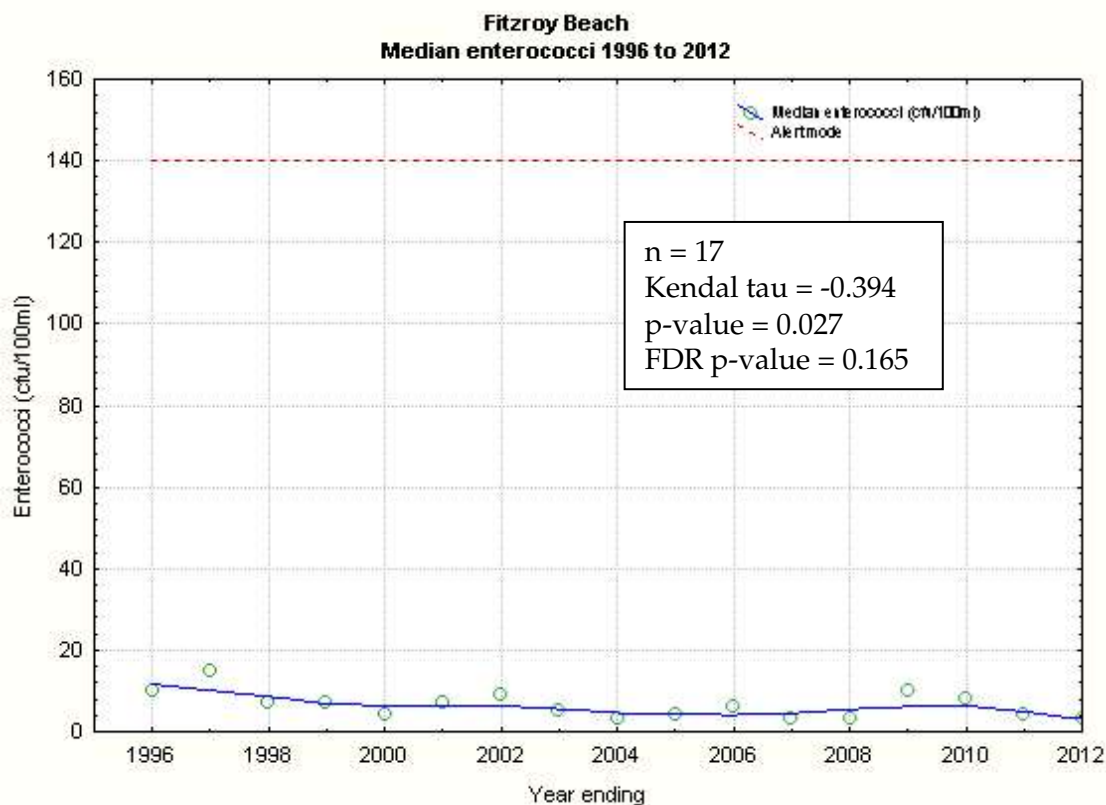


Figure 20 LOWESS trend analysis of median enterococci data at Fitzroy Beach

Over the 17 seasons monitored, there was a decrease in median enterococci counts (Kendall tau = -0.394). This negative trend was significant using the Mann-Kendall test ($p = 0.027$), but not significant after FDR application ($p = 0.165$).

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 37 and Figure 21, with a statistical summary provided in Table 38.

Table 37 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)	
22-Nov-11	10:30	4750	85	3	85	15.3
06-Dec-11	10:30	4700	25	7	25	18
20-Dec-11	10:15	4680	1	1	1	18.6
05-Jan-12	11:15	4530	5	<1	5	19.8
18-Jan-12	10:55	4410	<1	<1	<1	21.5
31-Jan-12	10:35	4520	11	7	11	17.2
16-Feb-12	10:35	4720	4	1	4	20.2

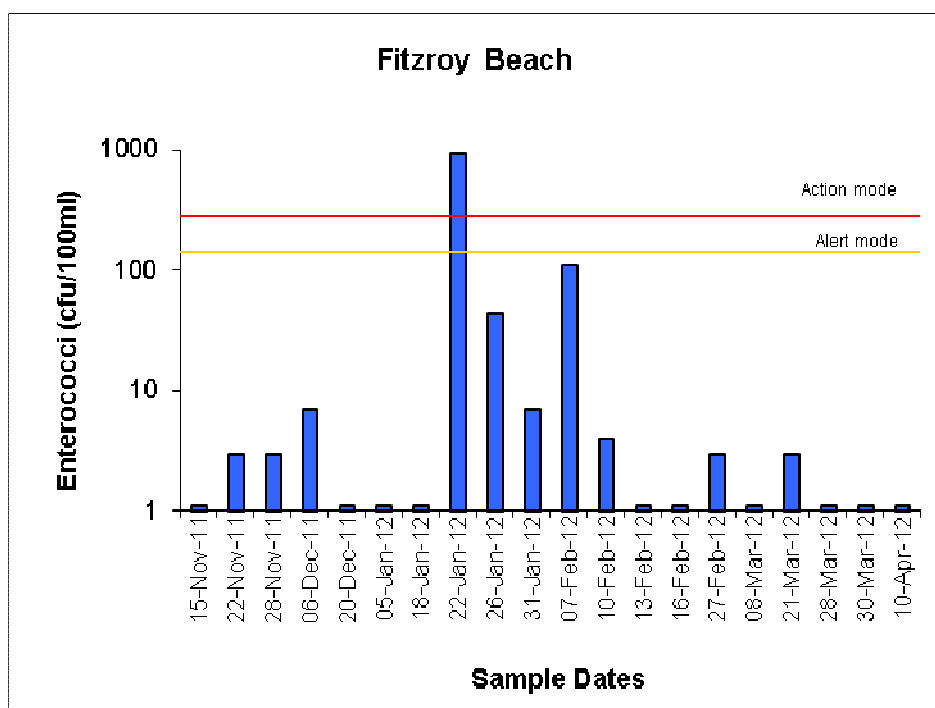


Figure 21 Enterococci numbers for the 20 sample extended survey at Fitzroy Beach

Table 38 Summary statistics for SEM and MfE samples at Fitzroy Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	4410	4750	4680
<i>E. coli</i>	cfu/100ml	20	<1	480	3
Enterococci	cfu/100ml	20	<1	930	2
Faecal coliforms	cfu/100ml	20	<1	480	3
Temperature	°C	20	14.9	21.5	18.7

Additional sampling resulted in only minor changes to the overall seasonal median for all faecal indicator bacteria (Table 38).

4.5.7.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 39. One sample (22 January 2012) exceeded the Alert level during the 2011-2012 season.

Table 39 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	1/20	5%	0/20	0%

4.8 Ngamotu Beach

4.8.1 SEM programme

Ngamotu Beach (Photograph 8) 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.



Photograph 8 Ngamotu Beach

Data for this site are presented in Table 40 and Figure 22, with a statistical summary provided in Table 41.

Table 40 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)	
15-Nov-11	11:30	4660	<1	5	<1	17.9
28-Nov-11	11:00	4630	23	8	23	15.4
22-Jan-12	09:00	4700	4	40	20	18.3
26-Jan-12	10:47	4720	<1	1	<1	17.4
07-Feb-12	09:15	4670	110	45	120	19
10-Feb-12	10:30	4710	<1	3	<1	19.9
13-Feb-12	13:15	4480	4	8	4	23.2

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			<i>E. coli</i> (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
27-Feb-12	12:15	4670	3	8	3	19.1
08-Mar-12	09:30	4640	190	64	190	16.9
21-Mar-12	09:30	4720	20	48	20	17.7
28-Mar-12	12:45	4480	3	3	3	19.3
30-Mar-12	13:50	4570	9	3	11	20
10-Apr-12	11:25	4690	71	1000	71	18.6

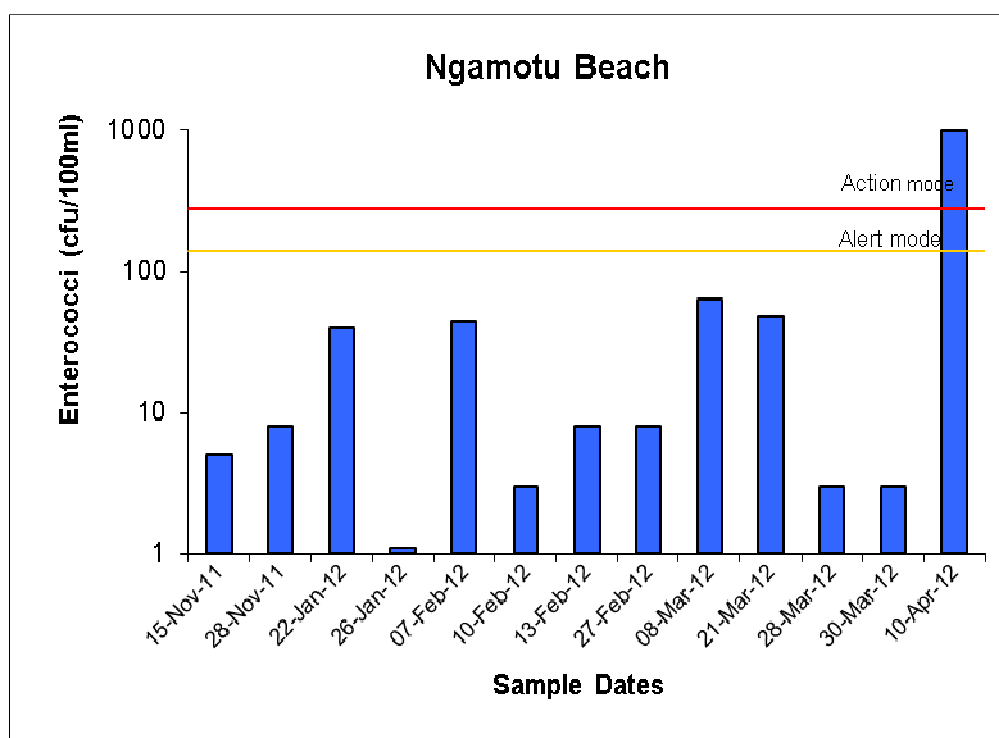


Figure 22 Enterococci numbers for the 13 SEM samples taken from Ngamotu Beach

Table 41 Statistical summary for Ngamotu Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4480	4720	4670
<i>E. coli</i>	cfu/100ml	13	<1	190	4
Enterococci	cfu/100ml	13	1	1000	8
Faecal coliforms	cfu/100ml	13	<1	190	11
Temperature	°C	13	15.4	23.2	18.6

Relatively low median counts were obtained for all faecal indicator bacteria (≤ 11 cfu/100ml). The maximum enterococci count, recorded on 10 April 2012 (1000 cfu/100ml), was unexplained with no significant rainfall 16 days prior to sampling. It was noted that the plate colonies from this sample were unusually uniform, indicating a single source of contamination.

4.8.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 42. One sample (10 April 2012) exceeded the Alert level during the 2011-2012 season.

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	1/13	8%	0/13	0%

4.8.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Ngamotu Beach over 17 summers are presented in Table 43 and Figure 23.

Table 43 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	2003-04
Minimum	< 1	1	< 1	< 1	< 1	< 1	1	< 1	< 1
Maximum	160	600	310	72	85	240	630	140	60
Median	16	13	5	20	11	10	44	27	5
	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	
Minimum	< 1	1	1	1	1	<1	<1	1	
Maximum	230	90	48	350	55	23	180	1000	
Median	14	13	12	4	9	4	8	8	

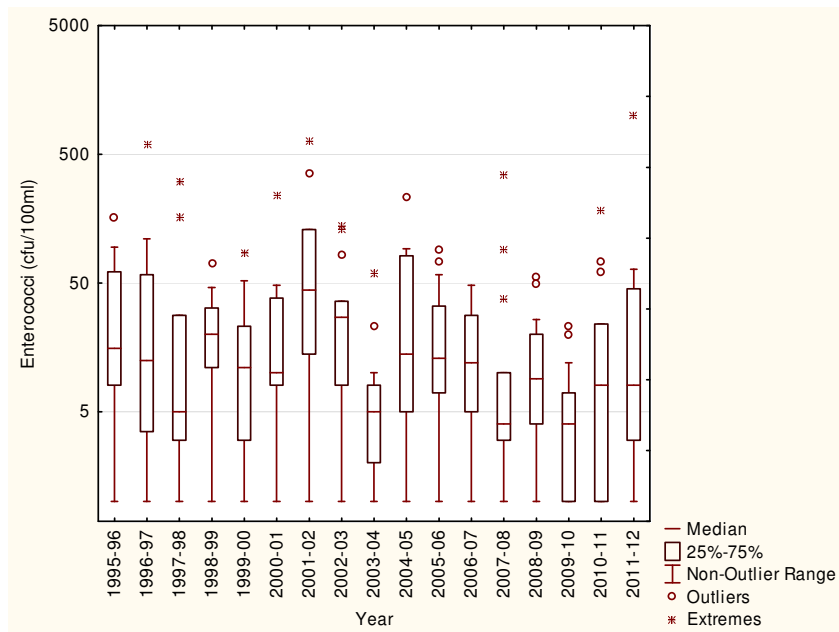


Figure 23 Box & whisker plots for all summer SEM surveys of enterococci numbers at Ngamotu Beach

The median enterococci count (8 cfu/100ml) obtained for the 2011-2012 summer season was within the range previously recorded at this site. The maximum count was the highest recorded for an SEM sample at this site to date.

4.8.4 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 17 summer seasons (Figure 24) 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.

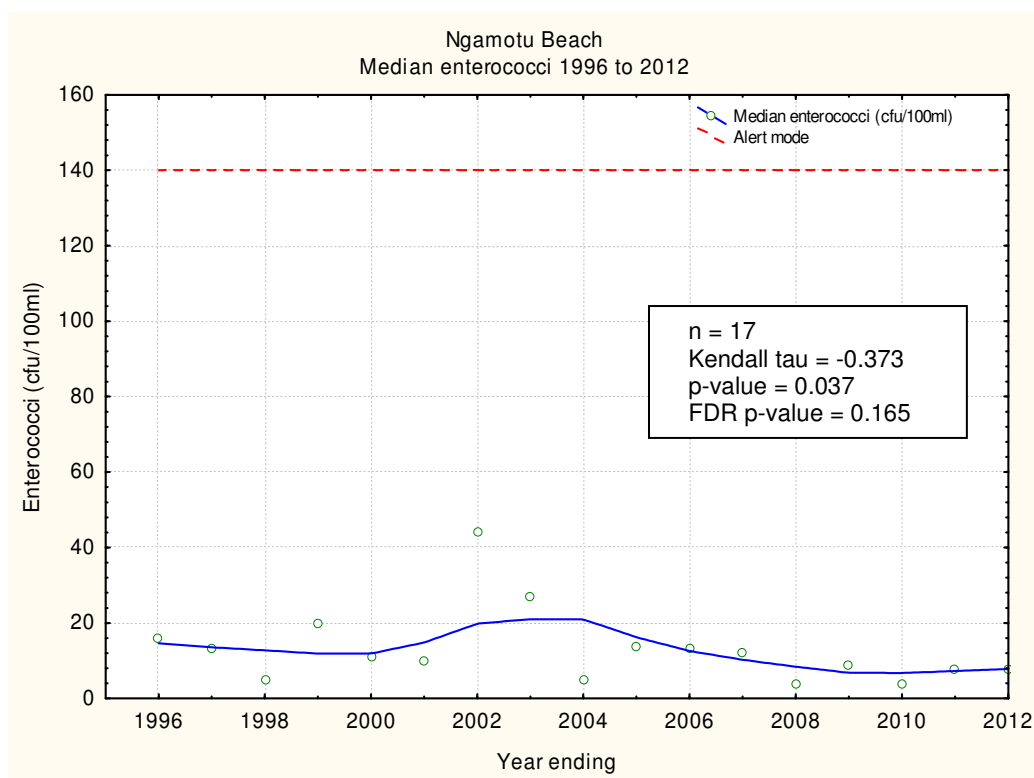


Figure 24 LOWESS trend analysis of median enterococci data at Ngamotu Beach

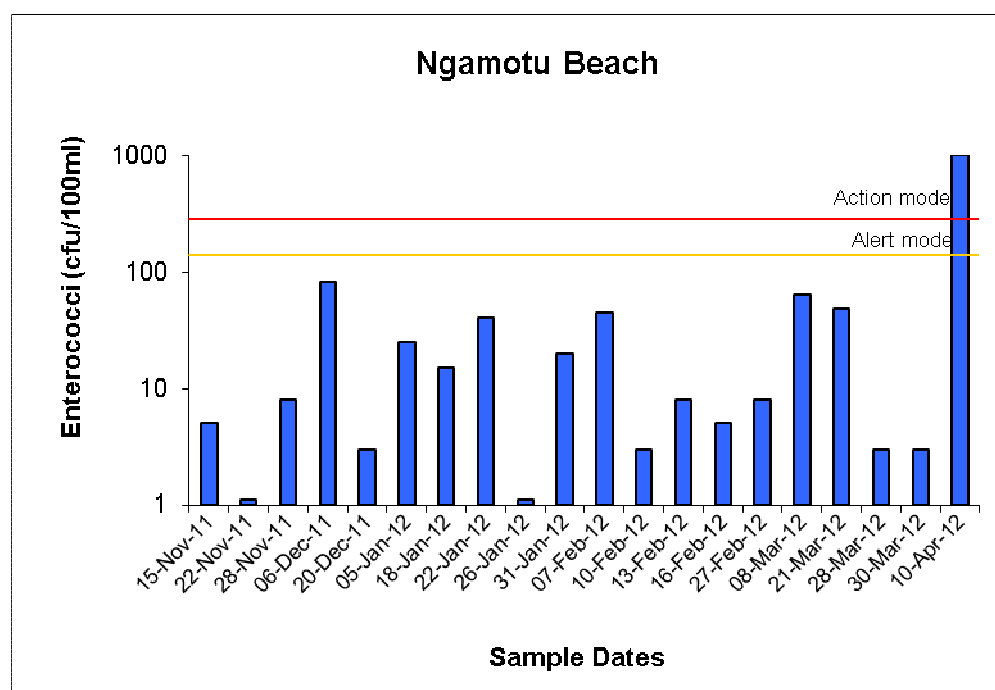
Over the 17 seasons monitored, there was a decrease in median enterococci counts (Kendall tau = -0.373). This negative trend was significant using the Mann-Kendall test ($p = 0.037$), but not significant after FDR application ($p = 0.165$).

4.8.5 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 44 and Figure 25, with a statistical summary provided in Table 45.

Table 44 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)	
22-Nov-11	11:00	4780	4	<1	4	16.3
06-Dec-11	10:35	4450	100	82	100	19
20-Dec-11	10:45	4610	<1	3	<1	19.2
05-Jan-12	11:45	4600	1	25	1	20.2
18-Jan-12	11:35	4630	3	15	3	22
31-Jan-12	11:10	4660	53	20	57	17.5
16-Feb-12	11:05	4520	11	5	11	22.1

**Figure 25** Enterococci numbers for the 20 sample extended survey at Ngamotu Beach**Table 45** Summary statistics for SEM and additional samples at Ngamotu Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	4450	4780	4650
<i>E. coli</i>	cfu/100ml	20	<1	190	4
Enterococci	cfu/100ml	20	<1	1000	8
Faecal coliforms	cfu/100ml	20	<1	190	8
Temperature	°C	20	15.4	23.2	19

Additional sampling resulted in only minor changes to the overall seasonal median for all faecal indicator bacteria (Table 45).

4.5.8.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 46. One of the 20 samples collected (10 April 2012) exceeded Alert level.

Table 46 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	1/20	5%	0/13	0%

4.9 Oakura Beach SC (opposite surf lifesaving club)

4.9.1 SEM programme

Oakura Beach (Photograph 9) is popular with beach bathers during summer, and frequented by surfers all year-round. In 2007, Oakura, along with Fitzroy and East End, became the first Blue Flag accredited beaches in New Zealand. Two small lowland streams (Waimoku and Wairau) enter the beach on either side of the site, and as a consequence concentrations of faecal indicator bacteria can increase significantly during periods of high rainfall.



Photograph 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)	
15-Nov-11	11:00	4660	1	1	1	16.6
28-Nov-11	10:25	4610	16	12	17	14.6
22-Jan-12	08:25	4570	130	130	130	18.3
26-Jan-12	10:05	4320	55	77	56	17.4
07-Feb-12	08:40	4360	28	37	29	18.5

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-Feb-12	09:50	4560	52	47	56	19.5
13-Feb-12	13:55	4380	15	27	15	21.6
27-Feb-12	11:30	4160	47	83	49	18.6
08-Mar-12	08:45	4260	71	83	71	17
21-Mar-12	08:45	4730	3	13	3	17.3
28-Mar-12	12:05	4420	20	25	21	18.5
30-Mar-12	13:15	4320	13	12	13	18.6
10-Apr-12	10:45	4600	21	36	23	18.3

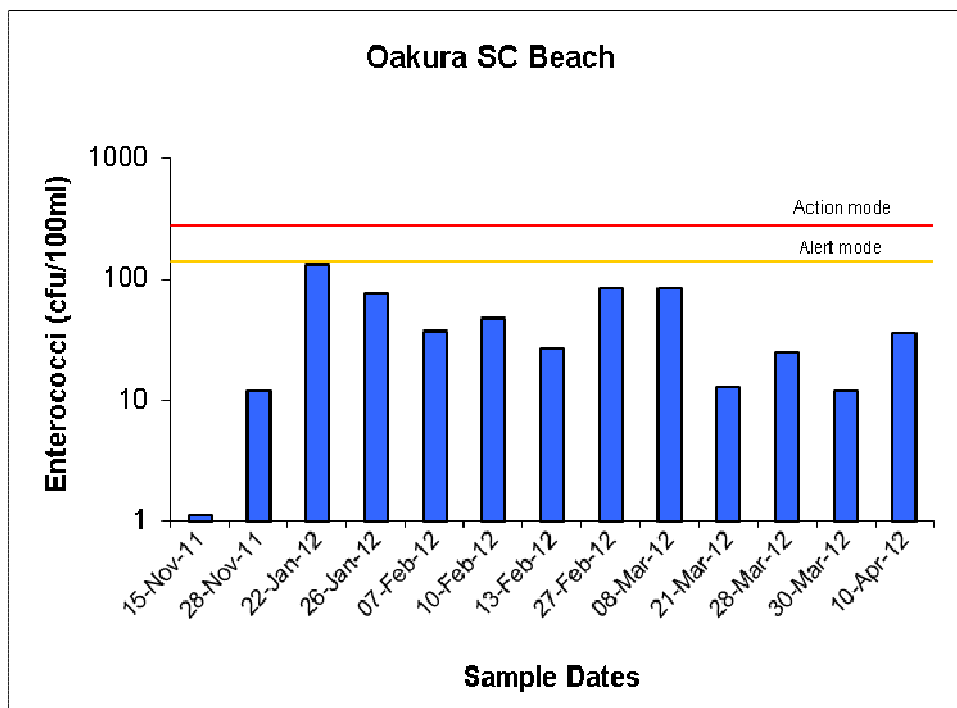


Figure 26 Enterococci numbers for the 13 SEM samples taken from Oakura Beach SC

Table 48 Statistical summary for Oakura Beach SC

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20° C	mS/m	13	4160	4730	4420
<i>E. coli</i>	cfu/100ml	13	1	130	21
Enterococci	cfu/100ml	13	1	130	36
Faecal coliforms	cfu/100ml	13	1	130	23
Temperature	°C	12	14.6	21.6	18.3

Relative to other beach bathing sites around the region, the median bacteria counts at this site were high (enterococci 36 cfu/100ml, *E. coli* 21 cfu/100ml and faecal coliforms 23 cfu/100ml).

However, the maxima were low with no SEM samples exceeding Alert level. The location of the stream mouths (Waimoku and Wairau) can influence water quality at this site. Microbial source tracking has shown that resident wildfowl are the principle contributors to elevated faecal indicator bacteria counts within these streams, particularly in the case of the Waimoku Stream (TRC 2011).

4.9.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 49. All SEM samples were below Alert level at this site during summer 2011-2012.

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 17 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	2003-04
Minimum	< 3	< 3	< 1	5	< 1	1	4	1	< 1
Maximum	800	56	60	56	880	16	120	180	94
Median	31	8	21	16	7	5	25	8	8
	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	
Minimum	2	1	<1	4	5	5	2	1	
Maximum	250	300	230	160	250	800	100	130	
Median	25	12	11	32	20	45	17	36	

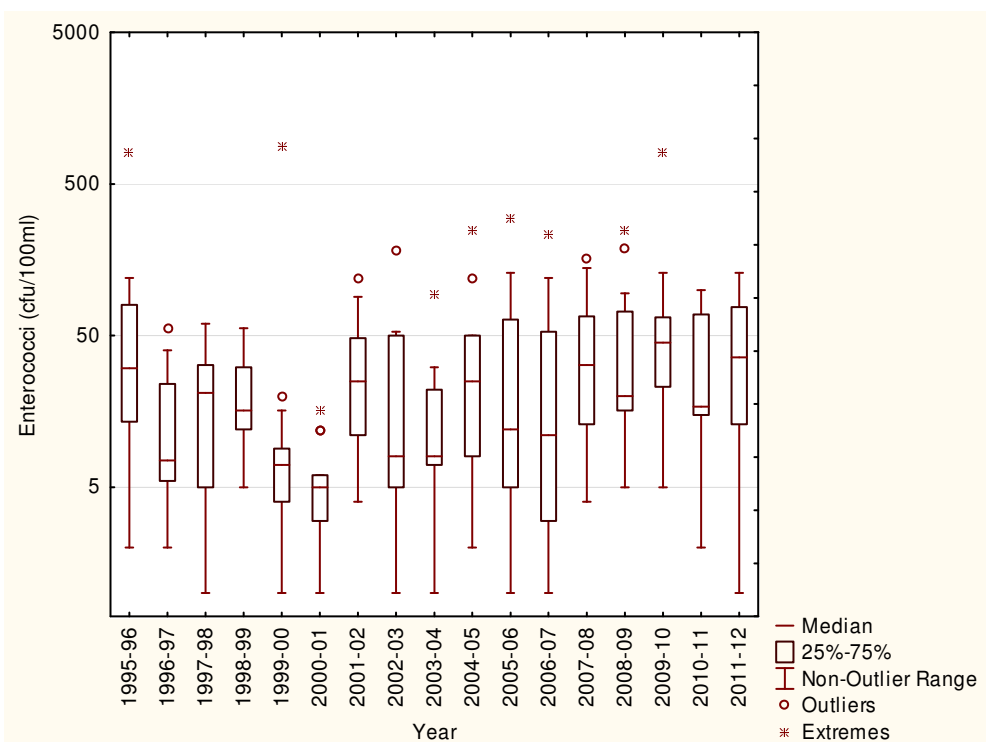


Figure 27 Box & whisker plots for all summer SEM surveys of enterococci numbers at Oakura SC

The median enterococci count (36 cfu/100ml) obtained for the 2011-2012 summer season was within the upper range of values previously recorded at this site (Table 50, Figure 27). Interannual variation in median enterococci counts at this site can be largely attributed to the changing location of the small stream mouths i.e. freshwater influence, relative to the sampling site. During the 2011-2012 season the sampling site appeared to be under greater influence of the streams, with a lower median conductivity (4420 mS/m) compared to the previous sample season (2010-2011 median conductivity, 4690 mS/m)

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 17 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.

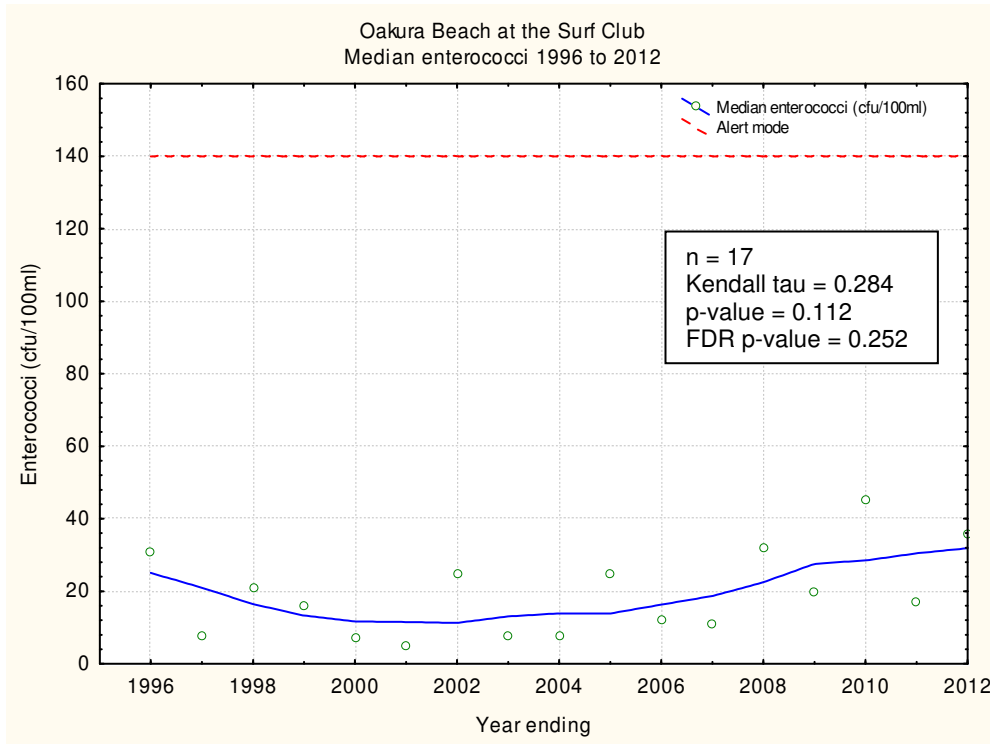


Figure 28 LOWESS trend analysis of median enterococci data at Oakura Beach SC

Over the 17 seasons monitored, there was a positive trend (i.e. an increase) in median enterococci counts (Kendall tau = 0.284) that was not significant at the 5% level ($p = 0.112$).

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 summary 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)	
22-Nov-11	11:25	4640	29	1	29	15.3
06-Dec-11	11:00	4050	4300	4000	4300	18.2
20-Dec-11	11:07	3880	32	11	35	18.6
05-Jan-12	12:10	3440	430	210	440	19
18-Jan-12	12:00	3640	19	39	19	20.9
31-Jan-12	11:35	4240	25	92	25	20.9
16-Feb-12	11:35	4610	5	8	5	21.7

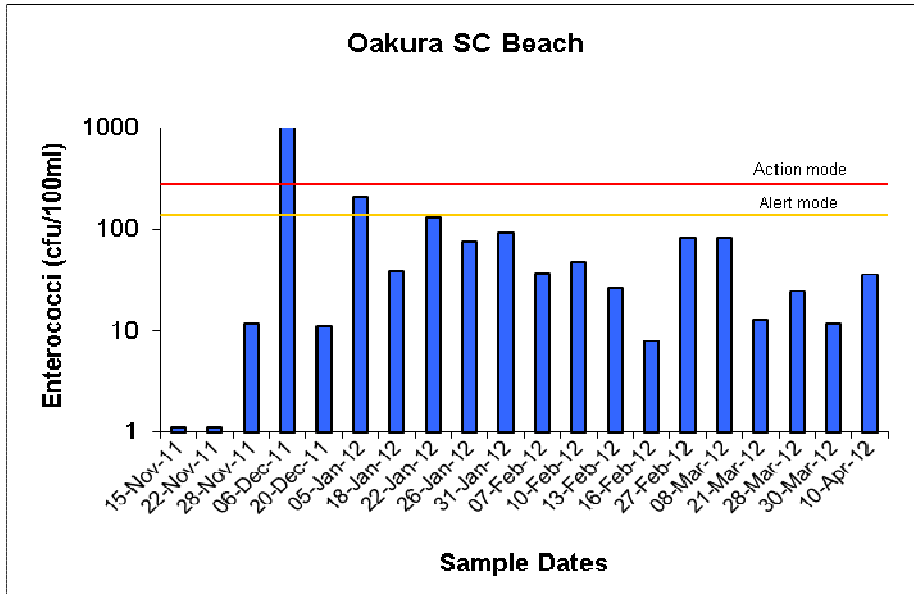


Figure 29 Enterococci numbers for the 20 sample extended survey at Oakura Beach SC

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	3440	4730	4370
<i>E. coli</i>	cfu/100ml	20	1	4300	27
Enterococci	cfu/100ml	20	1	4000	37
Faecal coliforms	cfu/100ml	20	1	4300	27
Temperature	°C	20	14.6	21.7	18.5

The enterococci count of 4000 cfu/100ml, obtained for the sample collected on 6 December 2011, was the highest recorded to date at Oakura Beach and the highest recorded for all Taranaki beach bathing sites monitored during the 2011-12 summer season. The most likely explanation for this high count is related to the high rainfall that occurred 8 hours prior to sampling (nearest rainfall meters; 30.5mm Carrington Rd, 34.5mm Stony River and 22.0mm Mangorei). Under high rainfall conditions, the location of the mouth of the Wairau Stream can temporarily shift, potentially resulting in incursion of stream water into the sample site. The relatively low conductivity (4050 mS/m) recorded on this day indicates the potential influence of freshwater on the sample site.

4.5.9.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 53. The extra sampling conducted as part of the MfE programme resulted in two samples entering Alert mode (6 December 2011, 5 January 2012).

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	2/20	10%	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	
15-Nov-11	10:35	4710	<1	1	<1	16.4
28-Nov-11	10:20	4710	5	3	5	14.6
22-Jan-12	08:15	4670	23	20	24	18.3
26-Jan-12	09:56	4690	9	4	9	17.4
07-Feb-12	08:30	4640	17	11	17	18.7
10-Feb-12	09:45	4690	1	4	1	19.5
13-Feb-12	14:10	4670	1	<1	1	21.5
27-Feb-12	11:25	4720	<1	1	<1	17.9
08-Mar-12	08:55	4610	20	16	20	17.4
21-Mar-12	08:35	4660	15	79	15	17.6
28-Mar-12	11:54	4680	9	4	9	17.8
30-Mar-12	13:05	4640	1	4	1	18.9
10-Apr-12	10:30	4710	3	1	3	18

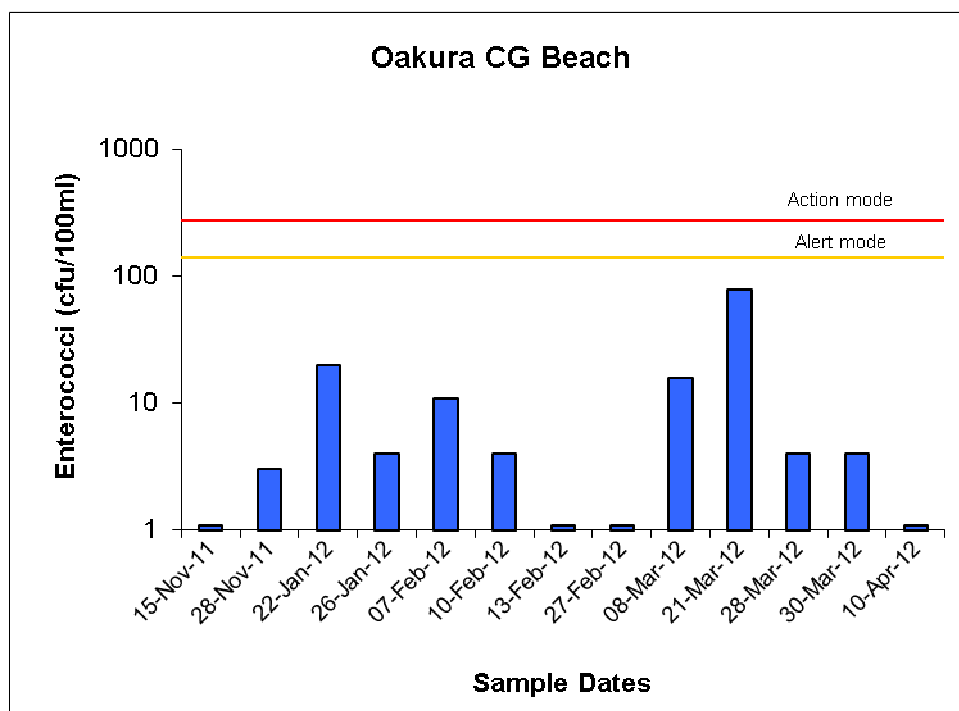


Figure 30 Enterococci numbers for the 13 SEM samples taken from Oakura Beach CG

Table 55 Statistical results for Oakura Beach CG

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4610	4720	4680
<i>E. coli</i>	cfu/100ml	13	<1	23	5
Enterococci	cfu/100ml	13	<1	79	4
Faecal coliforms	cfu/100ml	13	<1	24	5
Temperature	°C	13	14.6	21.5	17.9

Water quality was excellent at this site with low medians for all faecal indicator bacteria (≤ 5 cfu/100ml). Maxima were also low at 79 cfu/100ml for enterococci, 23 cfu/100ml for *E. coli* and 24 cfu/100ml for faecal coliforms.

4.10.2 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarized 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 Single sample 141-280/100ml		ACTION 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 17 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	2003-04
Minimum	2	1	<1	<1	<1	<1	<1	<1	<1
Maximum	280	150	24	16	48	240	31	17	24
Median	9	5	2	4	3	3	7	3	3
	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	
Minimum	<1	<1	<1	<1	<1	<1	<1	<1	
Maximum	90	8	260	18	30	25	33	79	
Median	6	1	3	7	6	1	<1	4	

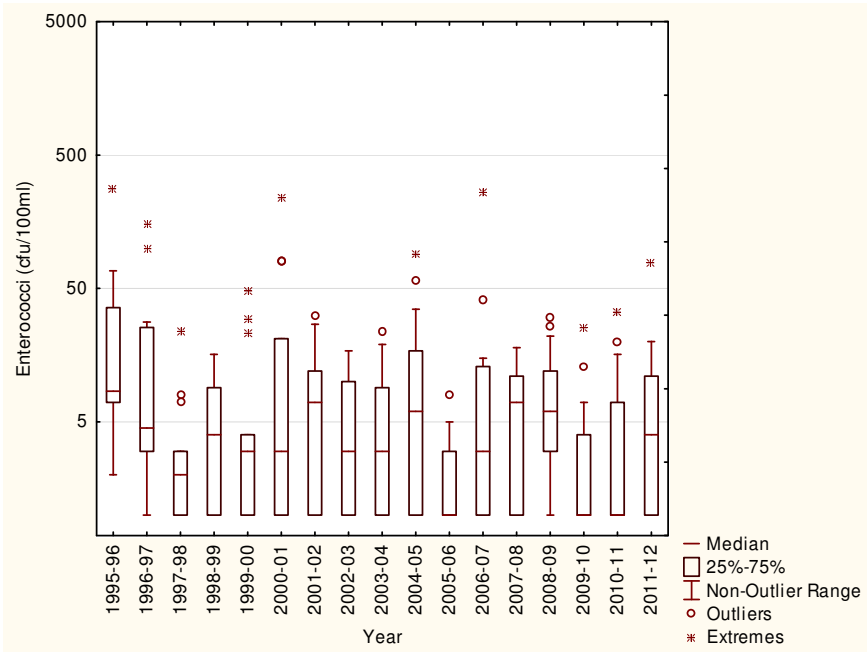


Figure 31 Box and whisker plots for all summer SEM surveys of enterococci numbers at Oakura Beach opposite the campground

The median enterococci count for the 2011-2012 season was well within the low range previously recorded at this site (4 cfu/100ml). Over the past 17 summers water quality has remained consistently 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 17 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.

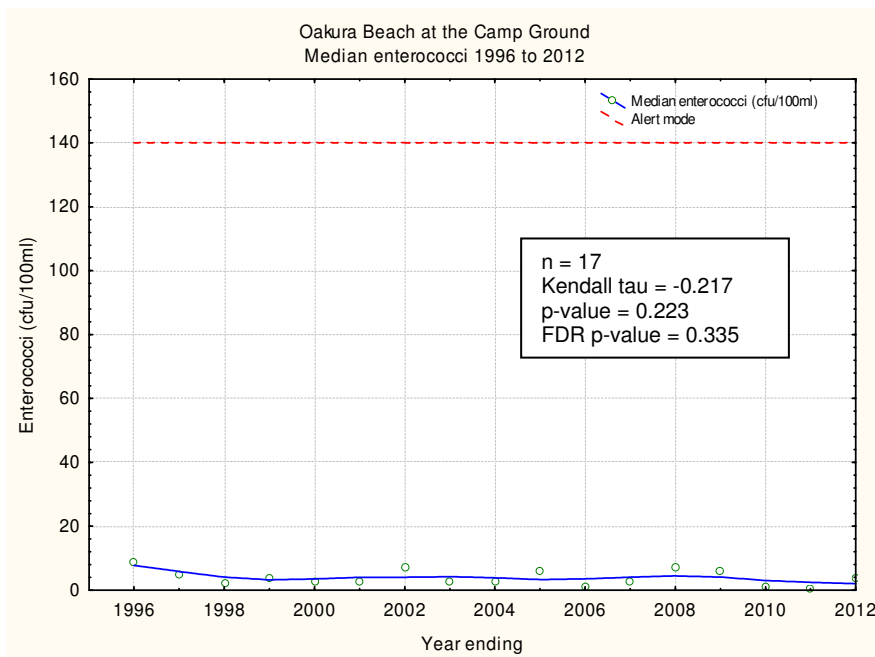


Figure 32 LOWESS trend analysis of median enterococci data at Oakura Beach Camp Ground

Over the 17 seasons monitored, there was a decreasing trend in median enterococci

counts (Kendall tau = -0.217) that was not significant at the 5% level ($p = 0.223$).

4.11 Opunake Beach

4.11.1 SEM programme

Opunake Beach (Photograph 10) 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.



Photograph 10 Opunake Beach and motor camp

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)	
15-Nov-11	12:10	4740	1	<1	1	16.1
28-Nov-11	11:20	4780	1	<1	1	16.2
22-Jan-12	10:30	4640	12	17	12	19.2
26-Jan-12	12:35	4660	5	3	5	19.2
07-Feb-12	11:10	4640	12	3	12	18.9
10-Feb-12	11:50	4710	7	3	7	18.9
13-Feb-12	14:05	4690	<1	1	<1	20.1
21-Feb-12	10:35	4710	<1	<1	<1	20.5
27-Feb-12	13:10	4680	<1	<1	<1	20
08-Mar-12	10:25	4580	40	13	40	16.7
28-Mar-12	13:00	4650	4	14	4	19
30-Mar-12	12:50	4760	<2	4	<2	18.2
10-Apr-12	12:35	4740	<1	1	<1	18.8

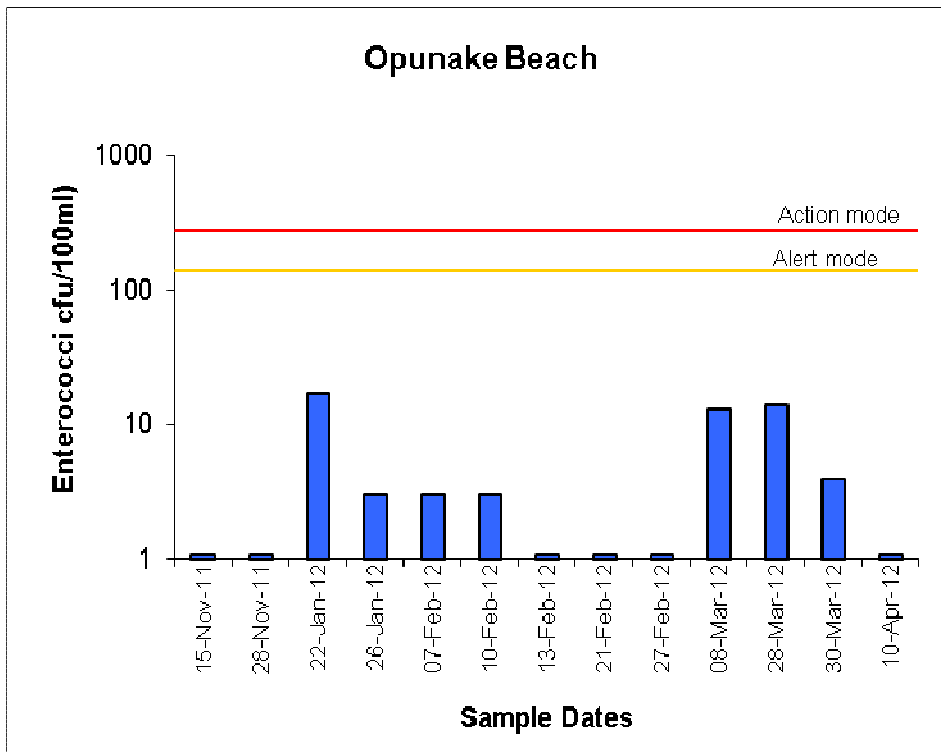


Figure 33 Enterococci numbers for the 13 SEM samples at Opunake Beach

Table 59 Statistical summary for Opunake Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4580	4780	4690
<i>E. coli</i>	cfu/100ml	13	<1	40	1
Enterococci	cfu/100ml	13	<1	17	3
Faecal coliforms	cfu/100ml	13	<1	40	1
Temperature	°C	13	16.1	20.5	18.9

Concentrations were very low for all faecal indicator bacteria, with medians of ≤ 3 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 summarized 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 Single sample 141-280/100ml		ACTION 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 17 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	2003-04
Minimum	<1	<1	1	<1	<1	<1	<1	<1	<1
Maximum	74	60	73	7	41	69	140	20	9
Median	9	<1	5	<1	1	2	4	1	1
	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	
Minimum	<1	<1	<1	<1	<1	<1	<1	<1	
Maximum	10	19	8	11	25	4	100	17	
Median	1	2	1	<1	2	<1	<1	3	

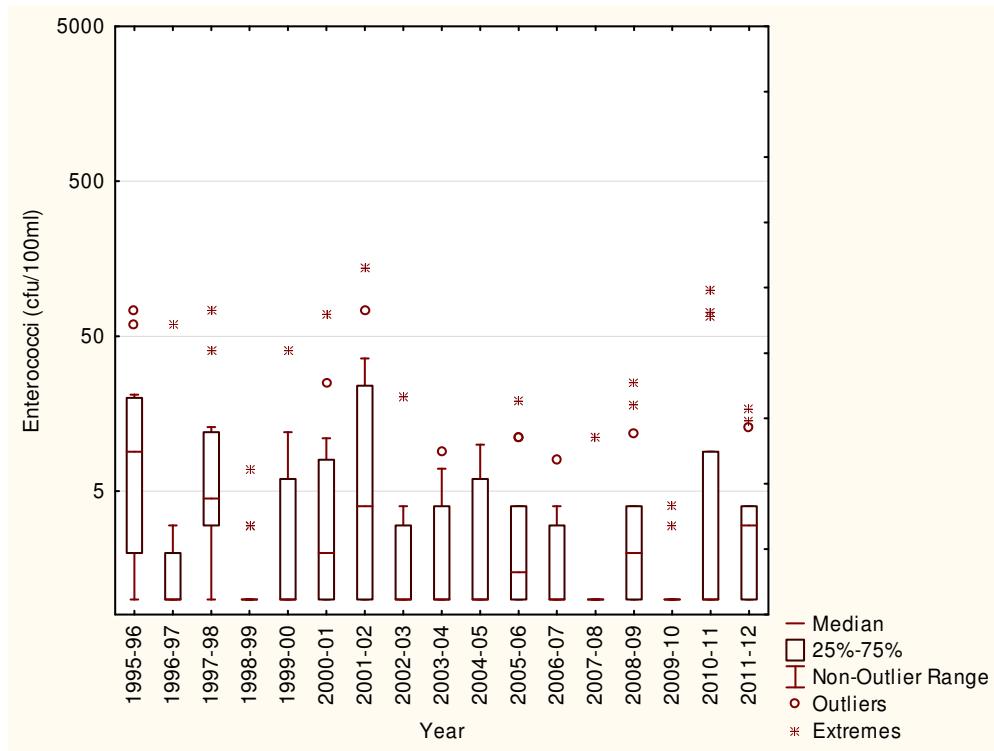


Figure 34 Box and whisker plots for all summer SEM surveys of enterococci numbers at Opunake Beach

The low enterococci data obtained for Opunake Beach during the 2011-2012 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 17 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.

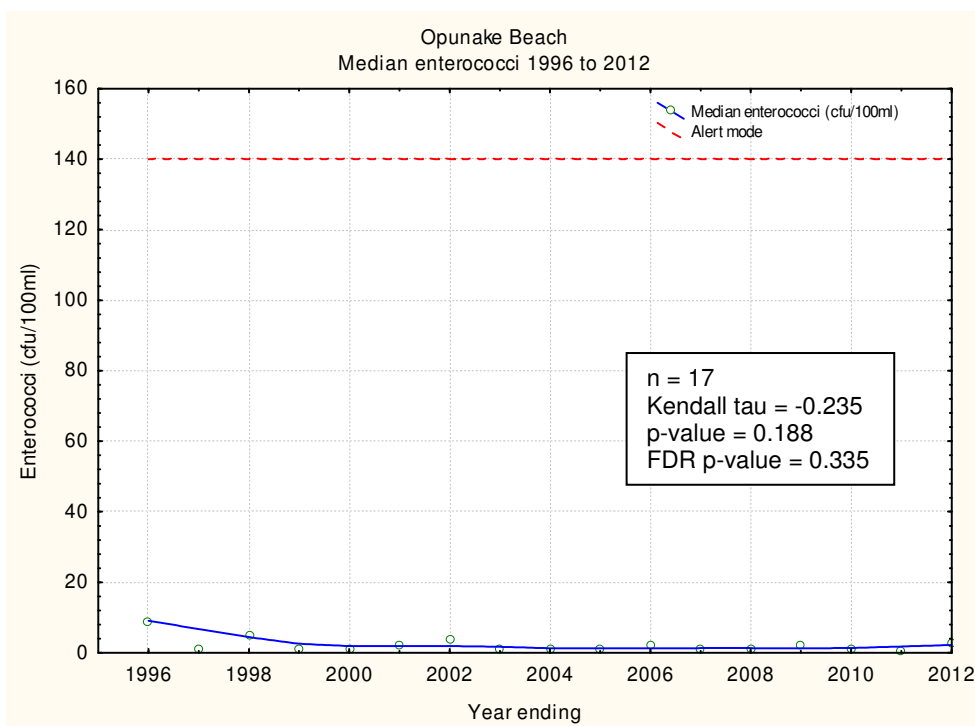


Figure 35 LOWESS trend analysis of median enterococci data at Opunake Beach

Over the 17 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.235) that was not significant at the 5% level ($p = 0.188$).

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)	
22-Nov-11	12:10	4760	<1	1	<1	16.2
06-Dec-11	11:45	4690	4	4	4	18.4
20-Dec-11	12:15	4680	1	<1	1	17.4
05-Jan-12	13:40	4690	<1	1	<1	18.5
18-Jan-12	13:15	4660	<1	<1	<1	21
31-Jan-12	12:20	4610	31	8	31	19.3
16-Feb-12	12:40	4680	9	1	9	21.8

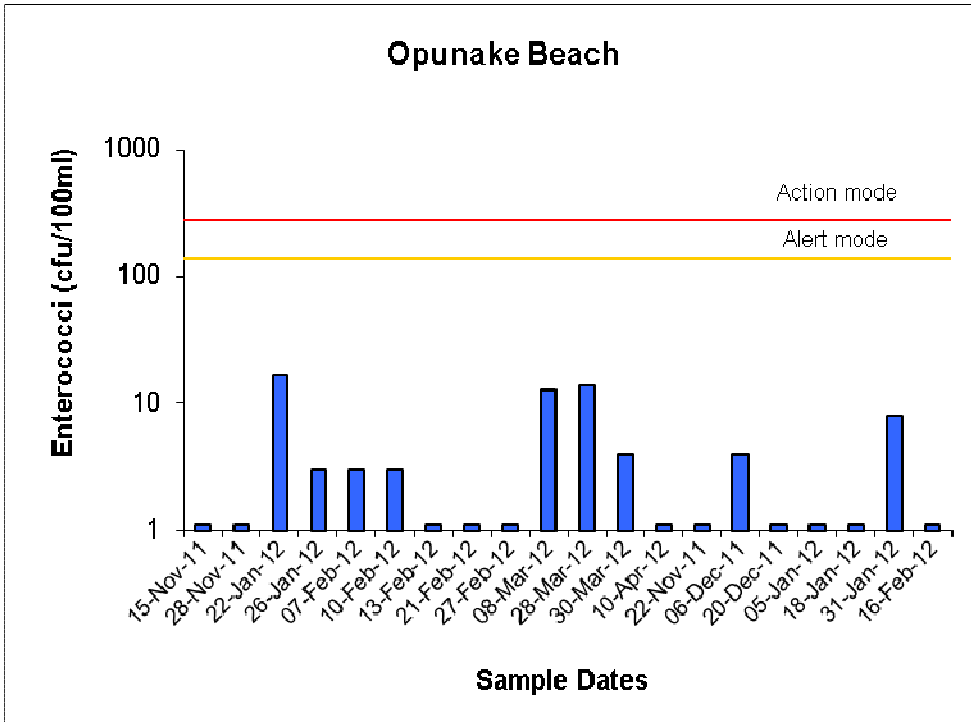


Figure 36 Enterococci numbers for the 20 sample extended survey at Opunake Beach

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	4580	4780	4685
<i>E. coli</i>	cfu/100ml	20	<1	40	1
Enterococci	cfu/100ml	20	<1	17	1
Faecal coliforms	cfu/100ml	20	<1	40	1
Temperature	°C	20	16.1	21.8	18.9

The additional MfE samples made little difference to the minimum, maximum and medians for all faecal indicator bacteria, reflecting consistently high water quality at this site.

4.5.11.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized 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 (Photograph 11) 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.

Photograph 11 Ohawe Beach

Data from this site are presented in Table 65 and Figure 37, with a statistical summary provided in Table 66.

Table 65 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)	
15-Nov-11	10:45	2710	31	13	31	16.9
28-Nov-11	10:20	4660	28	64	29	16.6
22-Jan-12	08:50	3060	120	160	120	18.5
26-Jan-12	11:00	3400	24	40	27	18.8
07-Feb-12	10:00	4680	290	51	320	18.8
10-Feb-12	10:10	4150	17	16	17	18.9
13-Feb-12	12:30	4090	6	2	6	20.2
21-Feb-12	09:05	4650	7	4	7	19.9
27-Feb-12	11:35	4250	6	34	6	19.6
08-Mar-12	08:55	4580	120	63	120	17.3
28-Mar-12	11:45	2650	63	68	63	17.7
30-Mar-12	13:35	3620	20	30	22	17.5
10-Apr-12	11:00	4000	8	22	8	17.3

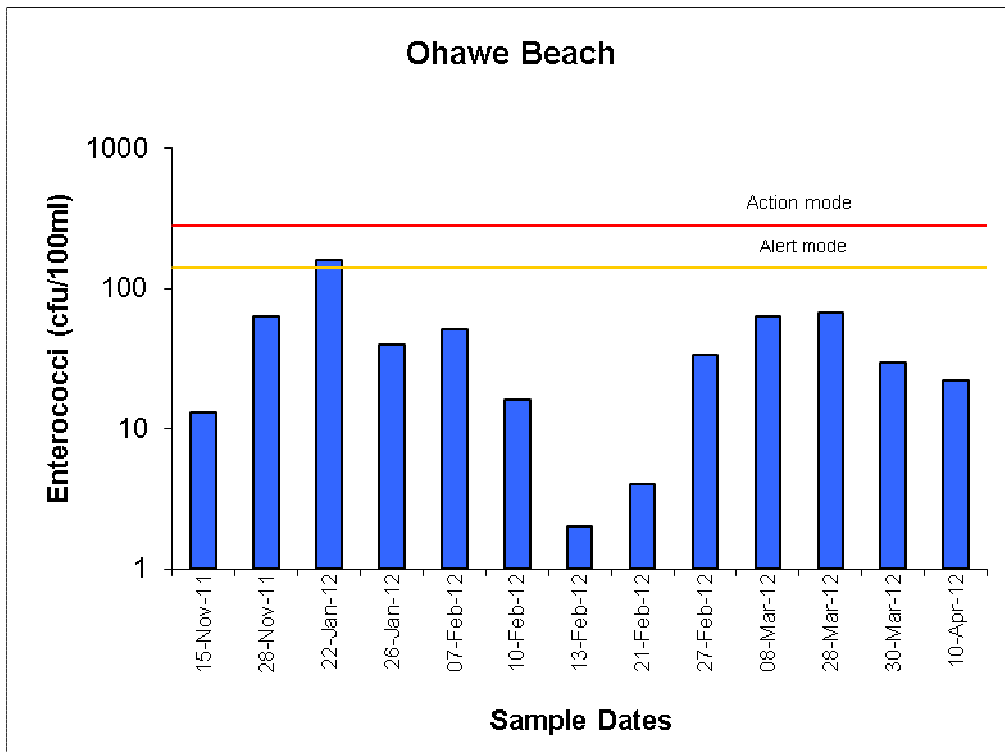


Figure 37 Enterococci numbers for the 13 SEM samples at Ohawe Beach

Table 66 Statistical summary for Ohawe Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	2650	4680	4090
<i>E. coli</i>	cfu/100ml	13	6	290	24
Enterococci	cfu/100ml	13	2	160	34
Faecal coliforms	cfu/100ml	13	6	320	27
Temperature	°C	13	16.6	20.2	18.5

Relative to other beach bathing sites around the region, the median bacteria counts at this site were high (enterococci 34 cfu/100ml, *E. coli* 24 cfu/100ml and faecal coliforms 27 cfu/100ml). However, only one SEM sample entered the Alert category. The high enterococci count obtained on 22 January 2012 was associated with low conductivity (3060 mS/m, Table 65).

4.12.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 67. Enterococci counts in one sample entered the Alert category.

Table 67 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	1/13	8%	0/13	0%

4.12.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Ohawe Beach over 16 summers are presented in Table 68 and Figure 38.

Table 68 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	2004-05
Minimum	15	7	<1	1	3	3	5	3	<1
Maximum	72	650	280	68	450	1600	180	11000	330
Median	21	40	17	23	48	48	16	29	23
	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12		
Minimum	1	<1	<1	2	3	<1	2		
Maximum	1600	80	1800	280	350	83	160		
Median	13	7	5	20	16	7	34		

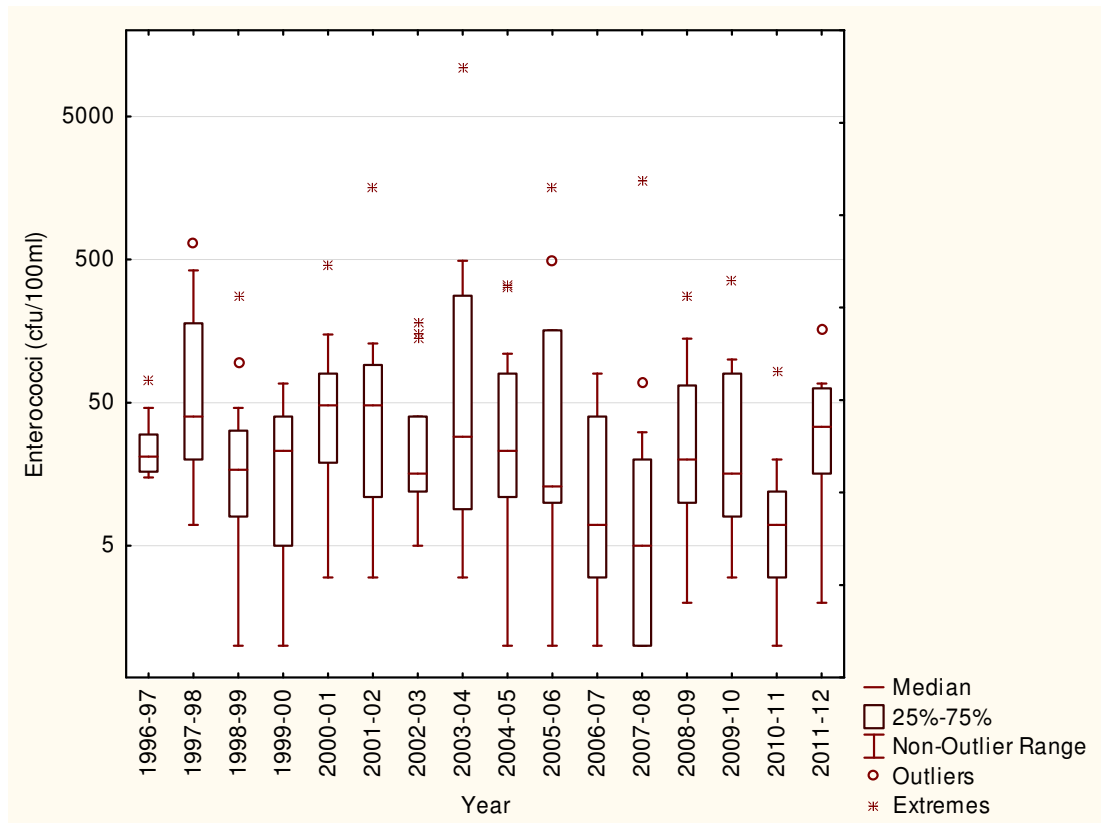


Figure 38 Box and whisker plots for all summer surveys of enterococci numbers at Ohawe Beach

Minima, maxima and median enterococci counts were within the range recorded in previous monitoring periods at this site (Table 68, Figure 38). Maxima and medians at this site are historically variable due to the influence of the Waingongoro River (Table 68). During the 2011-2012 season the sampling site appeared to be under greater influence of the Waingongoro River, with a lower median conductivity (4090 mS/m) compared to the previous sample season (2010-2011 median conductivity, 4450 mS/m).

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 16 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.

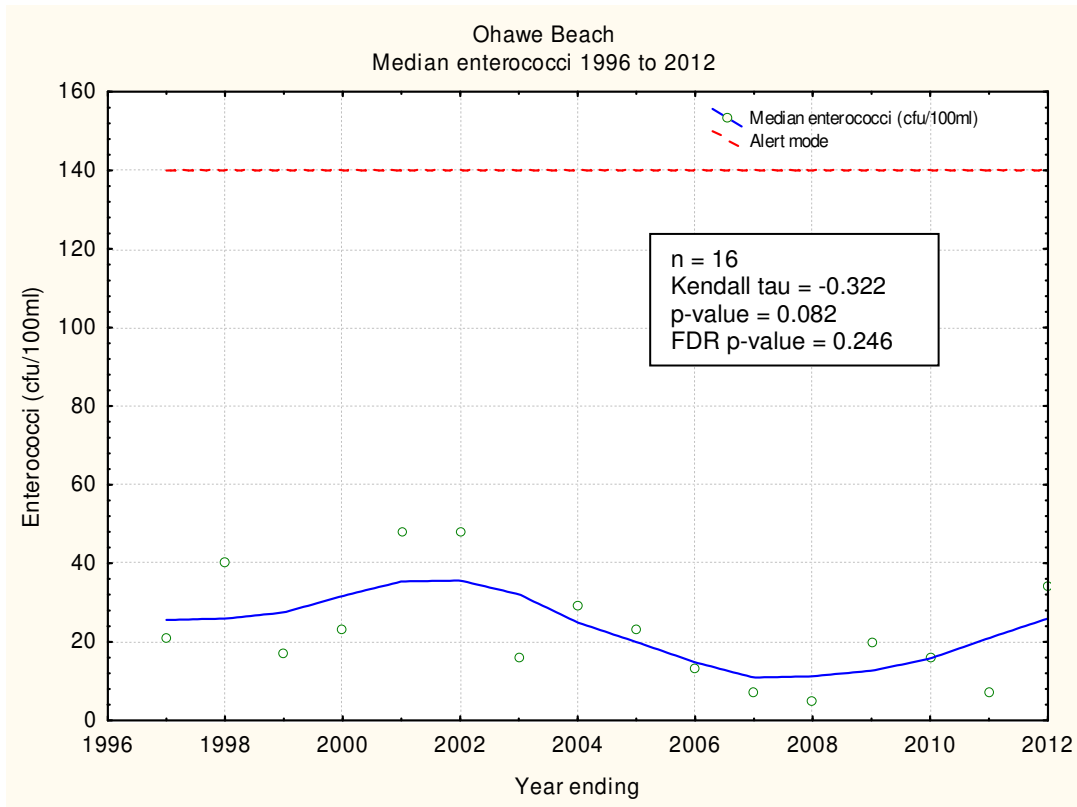


Figure 39 LOWESS trend analysis of median enterococci data at Ohawe Beach

Over the 16 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.322) that was not significant at the 5% level ($p = 0.0818$).

5. General summary

5.1 Regional overview

During the 2011-2012 summer season, microbiological water quality was generally very good across bathing beaches in the Taranaki region (Table 69). Low median enterococci values were recorded for all beaches monitored (≤ 36 enterococci cfu/100ml). Out of the 191 samples collected at 12 beach sites, $>94\%$ were below guideline Alert levels (140 enterococci cfu/100ml). No site reached Action mode (two consecutive samples >280 enterococci cfu/100ml) during the 2011-2012 season. All sites assessed obtained a Suitability for Recreation Grade of either 'good' (6/10), 'fair' (3/10) or 'poor' (1/10). These grades reflect qualitative risk grading of the catchment in addition to quantitative enterococci results (see Section 2.2).

Table 69 Summary enterococci results for the TRC beach bathing monitoring programme 2011-2012

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	
Onaero Settlement	1	-	0	-	-	-	-	-
Opunake	3	1	0	0	-0.235	0.188	0.335	Good
Fitzroy	3	2	1	1	-0.394	0.027	0.165	Good
Urenui	3	-	0	-	-	-	-	-
Oakura CG	4	-	0	-	-0.217	0.223	0.335	Good
Onaero	4	15	0	4	-0.070	0.779	0.818	Fair
Waitara East	6	-	1	-	-0.186	0.314	0.403	Poor
Ngamotu	8	8	1	1	-0.373	0.037	0.165	Good
Wai-iti	9	-	0	-	-	-	-	-
Waitara West	13	-	1	-	0.043	0.818	0.818	Fair
Ohawe	34	-	1	-	-0.322	0.082	0.246	Good
Oakura SC	36	37	0	2	0.284	0.112	0.252	Fair

¹Sites ordered in ascending order of SEM 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

⁶Patea (Mana Bay) site not included in table as not an annual SEM site, but SFRG available ('good')

- = insufficient data

Onaero Beach Settlement, Opunake and Urenui were amongst the region's cleanest bathing beaches with median enterococci counts of ≤ 3 cfu/100ml and no samples reaching Alert mode throughout the 2011-2012 season (Table 69, Figure 40). Water quality at Opunake, in particular, has remained consistently high since the Taranaki

Regional Council bathing beach monitoring programme began in 1995-1996 (Figure 41).

Oakura Surf Club and Ohawe recorded the highest enterococci medians of the 2011-2012 season (36 and 34 cfu/100ml respectively). However, only one SEM sample exceeded Alert mode at Ohawe and no SEM samples exceeded Alert mode at Oakura Surf Club, indicating a low and acceptable health risk to beach users during dry weather conditions. Bacteriological water quality at these two sites has been historically variable due to the influence of nearby streams and rivers. The effect of such freshwater inputs can be highly localized. For example, comparing water quality at the two Oakura sites, in contrast to the surf club site, the camp ground site is located away from the influence of the Waimoku and Wairau Streams and shows a consistent trend of excellent water quality since monitoring began in 1995-1996 (Figures 32, 40 and 41).

Long term trend analysis (10-17 years data) showed a significant (5% level) decrease in enterococci medians at 2 of the 12 sites monitored (Fitzroy and Ngamotu) and no significant change at 10 of the 12 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 i.e. deterioration in water quality.

The site at Fitzroy has shown the greatest improvement in microbiological water quality since 1995 (Table 67, Kendall tau -0.394, Mann-Kendall p value 0.027). Recent improvements in water quality might have arisen due to work undertaken by the New Plymouth District Council as part of the Stormwater Upgrade Project at Fitzroy. Completed last year, as a result of this project there is now less flow of stormwater to the stormwater infiltration galleries located in the Fitzroy beach car park.

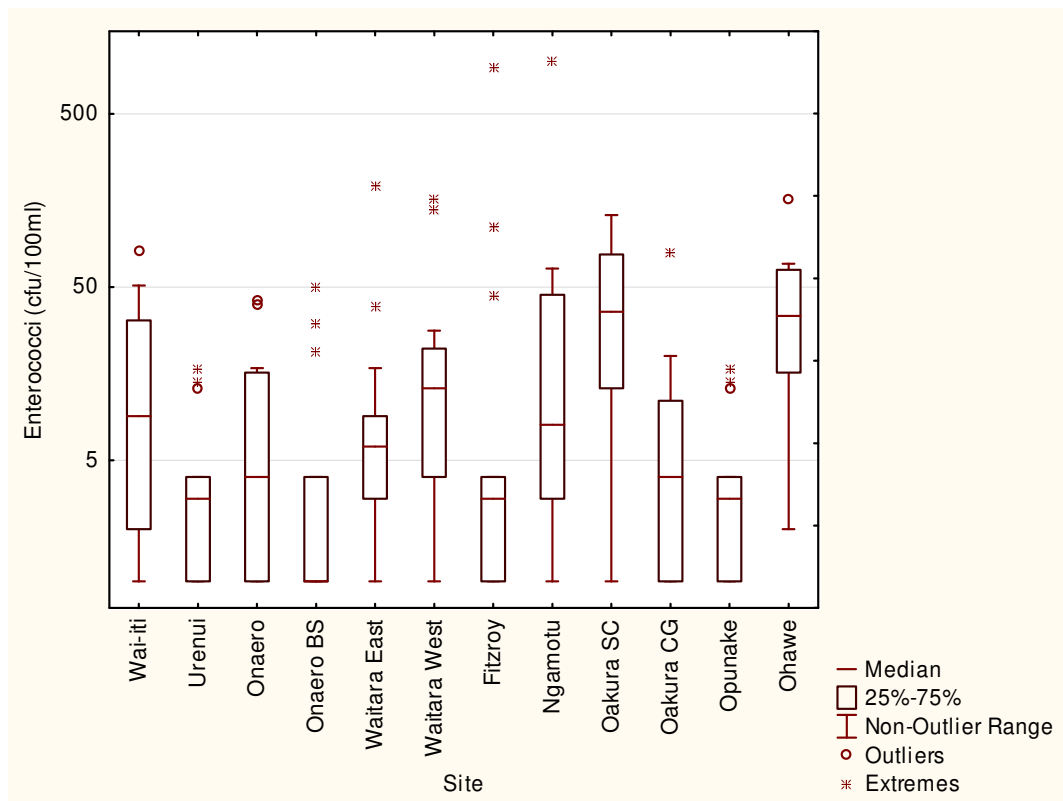


Figure 40 Box and whisker plots of enterococci at all sites during the 2011-2012 season (SEM data only)

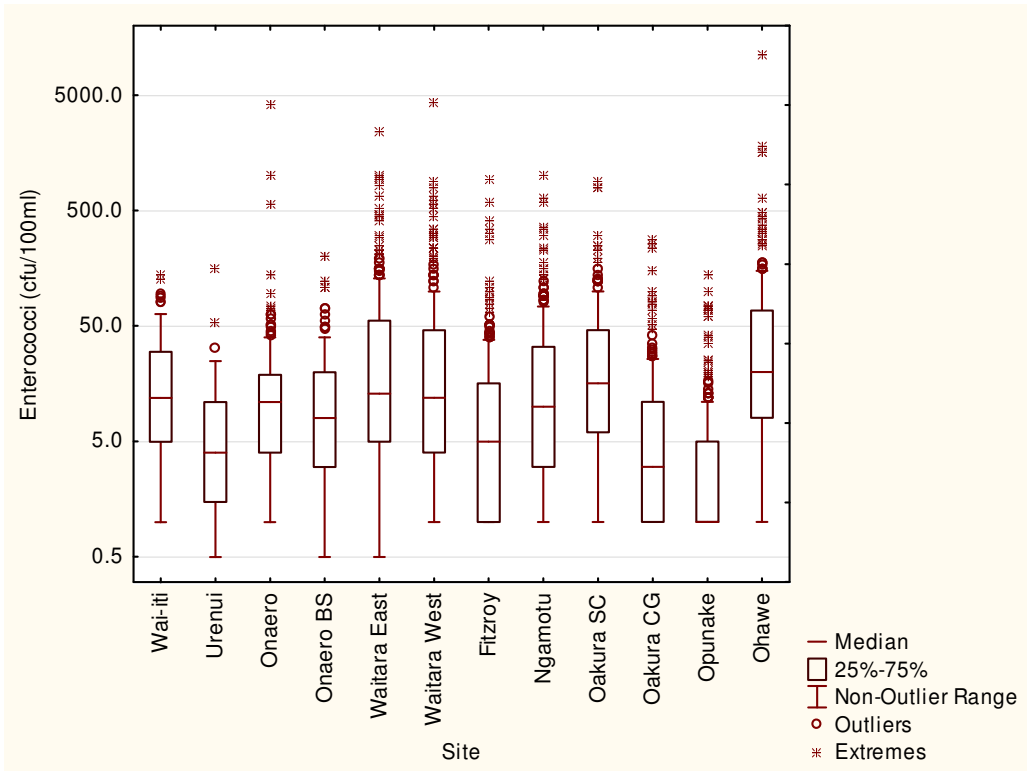


Figure 41 Box and whisker plots of long term enterococci data from 1995/implementation of monitoring to 2012 (SEM data only)

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 2012 reporting purposes, MfE used Suitability for Recreation Grades (SFRG, see Section 2.2) to provide a snapshot of recreational water quality of coastal beaches across New Zealand (Figure 42).

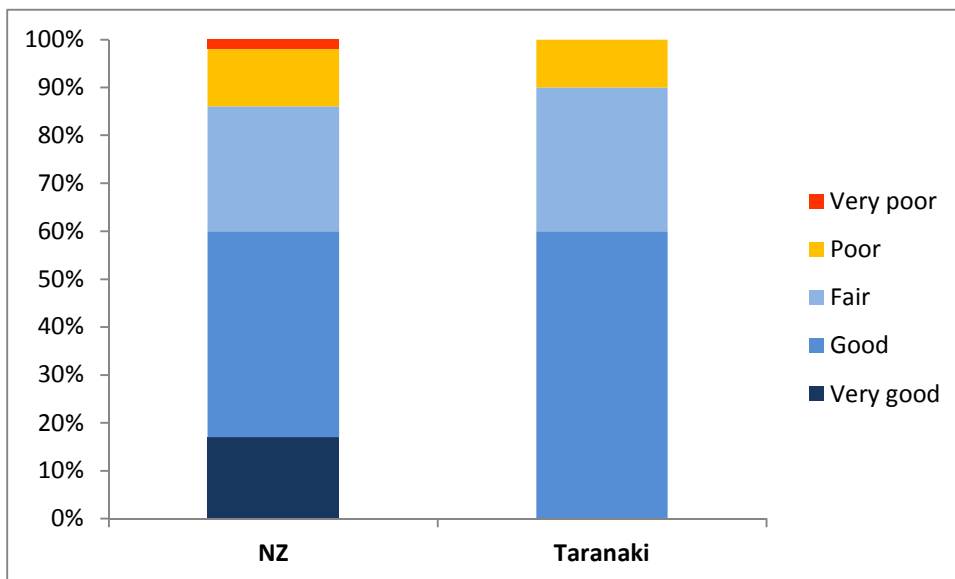


Figure 42 2011-2012 SFRG grades derived from the previous five years enterococci data and catchment assessment

In general, microbiological water quality was good across New Zealand with 17%, 43% and 26% of beach sites graded 'very good', 'good' and 'fair', respectively. MfE considered these sites to be generally satisfactory for swimming, though advised caution during periods of heavy rainfall. Taranaki sites compared favourably to national results with 60% and 30% of beach sites graded 'good' and 'fair', respectively. Largely as a result of risk grading of the catchment, no beaches in Taranaki received a 'very good' grade (see Section 2.2). In Taranaki, 10% of beaches (1 site: Waitara East) received a 'poor' grade, compared to 13% nationally. MfE considered these sites to be generally unsuitable for swimming. No sites in Taranaki were considered 'very poor', relative to 2% nationally.

5.3 Conclusion

During the 2011-2012 summer season, water quality across the Taranaki region was generally high with >94% 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 favorably to national results, with 90% of Taranaki sites considered generally satisfactory for swimming based on SFRG grades ('very good', 'good' and 'fair'), compared to 86% nationally (Section 5.2). In Taranaki, the few samples which entered the Alert category (<6%) during the 2011-2012 season were generally associated with high rainfall/fresh water influence. 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 and 2011). In order to minimize potential health risks, the Council recommends reducing coastal recreational activities for two-three days following heavy rainfall (when other water quality parameters such as discolouration and high turbidity are not conducive to bathing in any case).

6. Recommendations

As a result of the 2011-2012 summer marine contact recreation bacteriological survey it is recommended:

1. THAT the 2012-2013 summer survey be performed at 13 sites continuing with the existing sampling protocol (annual, plus Year 1 sites).
2. THAT the 2012-2013 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
E.coli	Escherichia coli, 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 RMA	A measurement of water quality over time as provided by historical (five years) microbiological results – A, B, C or D Category (MAC) 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 2011-2012 sampling dates

Date		Time of HT
Tuesday	15 November 2011	1210
Monday	28 November 2011	1139
Sunday	22 January 2012	0856
Thursday	26 January 2012	1141
Tuesday	7 February 2012	0922
Friday	10 February 2012	1120
Monday	13 February 2012	1335
Tuesday	21 February 2012 *	0925
Monday	27 February 2012	1252
Thursday	8 March 2012	0933
Wednesday	21 March 2012 **	0901
Wednesday	28 March 2012	1259
Friday	30 March 2012	1440
Tuesday	10 April 2012	1214

Notes: * northern and southern runs only
 ** central run only

Appendix II
MAC assessments

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

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	
2010	20	14.0	1	1	95 %
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 %
Total	100	12.0	4	4	96 %

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

MAC Results
MAC category: C 95thile (/100 mL): 230.0
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: Low
Primary SIC Impact: 14 River-focal points of drainage

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

SFRG Assessment Results
Site name: Onaero Beach
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".

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	
2010	21	1.0	0	0	100 %
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 %
Total	101	4.0	0	2	98 %

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

MAC Results
MAC category: B 95thile (/100 mL): 70.9
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 to 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".

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: Nga motu 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	
2010	20	8.0	1	1	95 %
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 %
Total	101	7.0	2	3	97 %

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

MAC Results
MAC category: B, 95%ile (/100 mL): 136.0
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: 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 to press "Reassessable Followup" to assign a conservative grade.

SFRG Assessment Results
Site name: Nga motu 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".

Oakura (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: SEA903030

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	
2010	20	18.5	0	1	95 %
2009	21	45.0	3	1	95 %
2008	20	50.5	3	2	90 %
2007	20	32.5	2	0	100 %
2006	21	21.0	2	1	95 %
Total	102	33.5	10	5	95 %

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

MAC Results
MAC category: C, 95%ile (/100 mL): 282.0
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/feal animals

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

SFRG Assessment Results
Site name: SEA903030
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 (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: SEA903032

MAC Data Summary

Sampling Season	Sample size	Median (E. coli / 100 mL)	Number of exceedances (Enterococci / 100 mL)	Days in Compliance (%days < 280 / year)
2010	13	1.0	0	100 %
2009	13	1.0	0	100 %
2008	13	6.0	0	100 %
2007	13	7.0	0	100 %
2006	14	2.5	1	100 %
Total	56	3.0	1	100 %

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

MAC Results
MAC category: A, 95thile (/100 mL): 30.6
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: 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/feral animals

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

SFRG Assessment Results
Site name: SEA903032
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 "ColumnLabelsMaine.txt".

Opunake

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)
2010	20	1.0	0	100 %
2009	19	1.0	0	100 %
2008	20	2.0	0	100 %
2007	14	1.0	0	100 %
2006	13	1.0	0	100 %
Total	86	1.0	0	100 %

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

MAC Results
MAC category: B, 95thile (/100 mL): 68.6
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 Maine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required to 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 "ColumnLabelsMaine.txt".

Ohawe

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: SEA905010

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	
2010	13	7.0	0	0	100 %
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 %
Total	73	9.0	1	2	97 %

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

MAC Results
MAC category: B, 95%ile (/100 mL): 134.0
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: 13: River - agricultural activities/birds/feral animals

Calculate Maine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required to press "Reassessable Followup" to assign a compliance grade.

SFRG Assessment Results
Site name: SEA905010
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 "ColumnLabelsMaine.txt".

Patea (Mana Bay)

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: SEA907022

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	
2010	19	3.0	0	0	100 %
2009	13	3.0	0	0	100 %
2008	0	0.0	0	0	0 %
2007	0	0.0	0	0	0 %
2006	13	5.0	0	0	100 %
Total	45	3.0	0	0	100 %

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

MAC Results
MAC category: A, 95%ile (/100 mL): 33.0
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: 13: River - agricultural activities/birds/feral animals

Calculate Maine SFRG
Press "Calculate SFRG" to determine a SFRG assessment.
Reassessment of the MAC and / or SIC is required to press "Reassessable Followup" to assign a compliance grade.

SFRG Assessment Results
Site name: SEA907022
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 "ColumnLabelsMaine.txt".

Waitara (East)

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: SEA901033

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	
2010	13	3.0	1	2	84 %
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 %
Total	65	16.0	3	4	93 %

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

MAC Results
MAC category: D 95%ile (/100 mL): 520.0
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: D
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/feral animals

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

SFRG Assessment Results
Site name: SEA901033
SFRG Assessment: Poor

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)

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: SEA901037

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	
2010	13	20.0	0	2	84 %
2009	13	12.0	0	0	100 %
2008	13	120.0	2	4	69 %
2007	13	5.0	0	0	100 %
2006	13	8.0	1	0	100 %
Total	65	12.0	3	6	90 %

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

MAC Results
MAC category: C 95%ile (/100 mL): 462.5
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/feral animals

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

SFRG Assessment Results
Site name: SEA901037
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".