Bathing Beach Water Quality State of the Environment Monitoring Report Summer 2012-2013

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Executive summary

This report provides an assessment of microbial water quality at 13 bathing beach sites in the Taranaki region, based on routine summer monitoring of faecal indicator bacteria (enterococci, *E. coli* and faecal coliforms) conducted by the Council between 1 November 2012 and 27 March 2013. The report focusses on enterococci results, as this indicator is considered to provide the closest correlation with risks of health effects 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).

Thirteen samples were collected at every monitored beach under dry weather conditions for state of the environment monitoring (SEM) purposes. An extra 7 samples were collected regardless of weather conditions at 5 sites, to satisfy MfE grading purposes.

During the 2012-2013 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 (≤37 enterococci cfu/100ml). Of the 169 SEM samples, 95% were below the guideline MfE 'Alert' level (140 enterococci cfu/100ml). Out of the 204 samples collected for both SEM and for additional monitoring purposes, 96% were below the Alert level. Of the few samples which individually entered the Alert guideline category (4%), half were associated with rainfall/freshwater influence.

The guideline MfE 'Action' mode is reached when enterococci counts in two consecutive samples exceed 280 enterococci cfu/100ml. One site (Waitara East) reached the Action mode on one occasion during the 2012-2013 season. This was the only event during the summer when any site was found to be unsuitable for swimming according to guidelines.

Mann-Kendall tests were performed in order to assess any long term trends in microbiological water quality. Two sites show a significant decrease in median enterococci counts over the 11-18 years monitored (Fitzroy and Ngamotu, $p < 0.05$), indicating an overall improvement in microbiological water quality. No site showed a significant increase in median enterococci count i.e. deterioration in microbiological water quality.

Opunake was the region's cleanest bathing beach site with a median enterococci count of <1 cfu/100ml and no samples reaching Alert mode throughout the 2012-2013 season. Waitara East and Ohawe recorded the highest median enterococci counts of the season (37 cfu/100ml). These two sites also exceeded MfE guideline levels more than other beaches in the region, with Ohawe reaching MfE Alert level four times and Waitara East entering MfE Action mode once.

During the 2012-2013 season, 7 of the 13 beach sites recorded the lowest or equal lowest SEM enterococci median counts to date (Fitzroy, Ngamotu, Opunake, Patea, Mana, Waverley and Wai-inu). This may reflect a prolonged dry summer.

Sites in Taranaki compared favorably to national results, with 89% of Taranaki sites considered satisfactory for swimming based on MfE 'Suitability for Recreation Grades' ('very good', 'good' and 'fair'), compared to 87% 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 2012-2013.

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, 12 of 13 beaches were compliant with the guidelines. The LTP target was therefore met.

Continuation of the bathing beach SEM programme is recommended in the 2013-2014 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	• Continue routine monitoring	• Increase sample to daily • Undertake sanitary survey • Identify sources of contamination • Consult CAC to assist in identifying possible source	• 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 ≤ 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.

Eighteen of the 19 sites monitored by the Council had sufficient data available to calculate SFRG grades for the period spanning November 2008 to April 2013 (Appendix II). Of these 18 sites, 12 were graded 'good', 4 were graded 'fair' and 2 were graded 'poor'. None of the beaches graded 'very poor'. As 16 of the 18 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 steams and rivers which heavily influenced the SIC assessment results.

For beaches with sufficient data, SFRG grades calculated for the November 2008 to April 2013 period remained the same as those calculated for the November 2007 to April 2012 period (Appendix III).

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.

It should be noted that the Ministry itself states that the SFRG '*reflects a precautionary approach to managing public health risks and does not represent an accurate picture of water quality in the catchment. …The grades reflect a precautionary approach to managing health risk and are not designed to represent health risks on a particular day. They tend to reflect the poorest water quality measured at a site rather than the average water quality. A site may be graded as poor but still be suitable for swimming much of the time….The indicator does not replace the site-specific information available on council websites*'[1]

Note: Table 3 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 for the period November 2008 to April 2013

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		
Wai-iti	Moderate 13	132	26	B	Good	100
Urenui	Moderate 13	23	26	A	Good	100
Onaero	Low	270	100	C	Fair	95
Onaero settlement	Low 14	59	26	B	Good	100
Waitara (East)	Moderate 13	520	65	D	Poor	90
Waitara (West)	Moderate 13	463	65	C	Fair	90
Bell Block	Moderate 3	680	30	D	Poor	90
Fitzroy	Moderate 3	87	102	B	Good	97
East End	Moderate 3	167	99	B	Good	97
Ngamotu	Moderate 3	134	101	B	Good	97
Oakura (SC)	Moderate 13	389	101	C	Fair	94
Oakura (CG)	Moderate 13	42	67	B	Good	100
Opunake	Moderate 3	47	100	B	Good	100
Ohawe	Moderate 13	243	65	C	Fair	96
Patea (Mana Bay)	Moderate 13	40	58	A	Good	100
Patea	Moderate 13	79	26	B	Good	100
Waverley	Moderate 13	11	26	A	Good	100
Wai-inu	Moderate 13	15	26	A	Good	100
Back	Low 14	Insufficent data to calculate				

* 13 = River - agricultural activities/birds/feral animals
14 = River - focal points of discharge
3 = Urban stormwater

[1] *Suitability for swimming: Indicator update July 2013: INFO 690*, Ministry for the Environment

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 m sampling pole was used for bacteriological sample collection immediately beneath the water surface and at a minimum of knee depth at the sites (Photo 1). Thirteen samples were collected from each site during the season.

Results for the 2012-2013 bathing season were posted on the Taranaki Regional Council website (www.trc.govt.nz) as soon as checking had been completed. Where single 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 thirteen sites sampled in the 2012-2013 programme are shown in Figure 1 and Table 4.

Table 4 Location of bathing water bacteriological sampling sites 2012-2013

Beach	Location	GPS	Site code
Onaero	Opposite surf lifesaving club	2628254-6244898	SEA900085
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	Oppostie 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
Patea	100m north of northern breakwater (and Patea River)	2637262-6158165	SEA907020
Patea Bay	Adjacent carpark "Mana" Bay	6237574-6158138	SEA907022
Waverley	Adjacent to baot ramp	2649820-6151265	SEA907085
Wai-inu	Adjacent to boat launching area	2659507-6147292	SEA907095

Primary beach sites are monitored each year (Figure 1). Remaining beach sites are sampled on a three year rotation, with Year 1 beaches sampled during the 2012-2013 monitoring programme (Table 5).

Table 5 Coastal bathing beach sampling programme

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

**since 1996-97*
*** since 2000-01 summer period*
**** since 2001-02 summer period*

Photo 1 Bacteriological sampling

3.3.1 Additional monitoring (MfE guidelines)

The revised guidelines (MfE, 2003) require weekly surveillance monitoring during the 5-month recreational period, with a minimum of 20 sampling dates, regardless of weather conditions 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 ($p < 0.05$ = 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 Mann-Kendall test. Further justification for this statistical approach can be found in Stark and Fowles (2006).

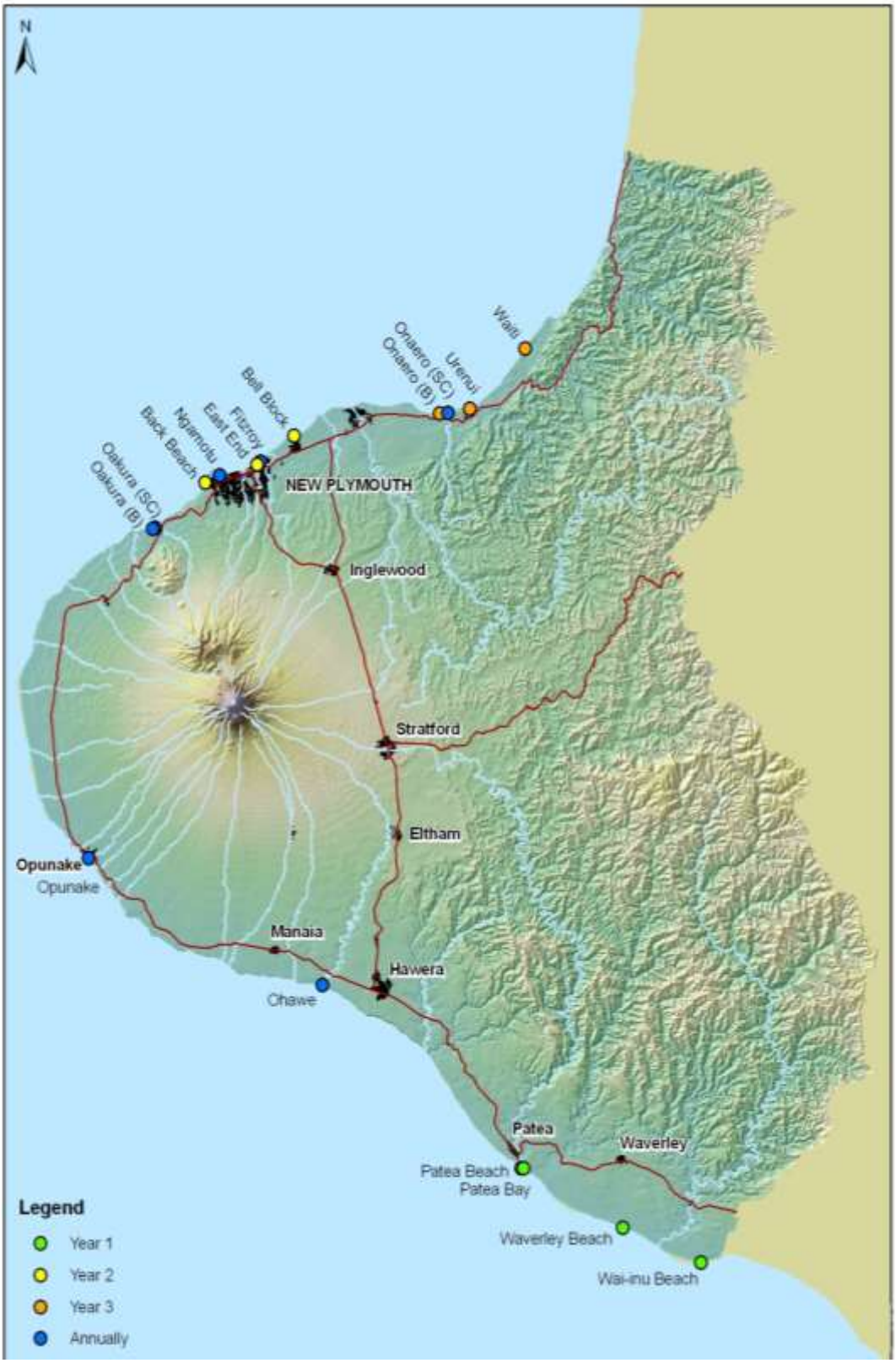

Figure 1 SEM beach bathing bacteriological survey sites

4. Results

From 1 November 2012 to 27 March 2013 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 Onaero Beach

4.1.1 SEM programme

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

Photo 2 Onaero Beach

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

Table 6 Bacteriological results for Onaero Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	09:50	4520	11	7	12	16.0
28 Nov 2012	10:20	4370	99	20	99	16.5
13 Dec 2012	10:20	4520	33	32	33	18.3
28 Jan 2013	10:30	4670	1	<1	1	21.1
31 Jan 2013	10:20	4560	12	5	15	21.4
11 Feb 2013	10:20	4690	1	16	1	20.2
14 Feb 2013	10:40	4710	5	8	5	19.7
18 Feb 2013	13:40	4570	5	28	5	20.9
25 Feb 2013	09:15	4690	8	3	11	18.1
28 Feb 2013	09:45	4730	20	20	20	19.7
04 Mar 2013	12:40	4630	26	18	26	20.7
12 Mar 2013	09:42	4790	5	4	5	19.6
27 Mar 2013	10:05	4760	13	15	13	20.1

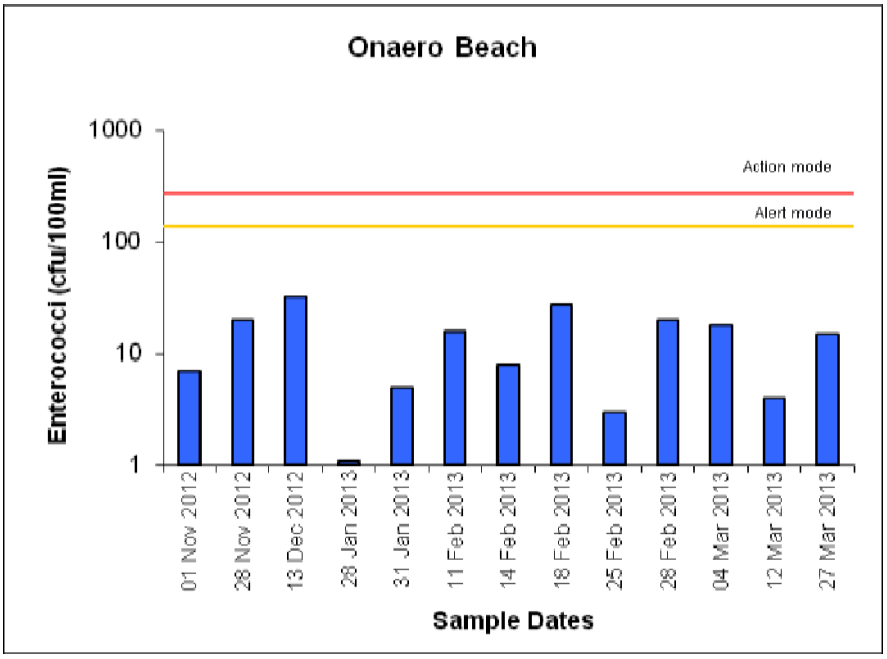

Figure 2 Enterococci numbers for the 13 SEM samples taken from Onaero Beach

Table 7 Statistical summary for Onaero Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4370	4790	4670
E. coli	cfu/100ml	13	1	99	11
Enterococci	cfu/100ml	13	<1	32	15
Faecal coliforms	cfu/100ml	13	1	99	12
Temperature	°C	13	16.0	21.4	19.7

Although no high individual enterococci counts were recorded throughout the season (all counts ≤38 cfu/100ml), the median enterococci count was at the higher end of the range for Taranaki coastal sites during 2012-2013 (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 SEM samples were below both Alert and Action guideline levels.

Table 8 Bacterial guidelines performance at Onaero Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/13	0%	0/13	0%

4.1.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Onaero Beach over 14 summers are presented in Table 9 and Figure 3.

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

Summer	96/97	99/00	01/02	02/03	03/04	04/05	05/06
Minimum	1	4	5	< 1	<1	<1	<1
Maximum	26	40	140	4200	52	1000	46
Median	13	12	17	9	5	15	4
	06/07	**07/08**	**08/09**	**09/10**	**10/11**	**11/12**	**12/13**
Minimum	2	<1	2	3	<1	1	<1
Maximum	560	59	64	27	96	42	32
Median	7	4	13	13	11	4	15

The median enterococci count obtained for the 2012-2013 summer (15 cfu/100ml) (Table 9, Figure 3) was within the range of previous results at this site. The maximum enterococci count (32 cfu/100ml) was one of the lowest recorded at Onaero Beach to date (Table 9).

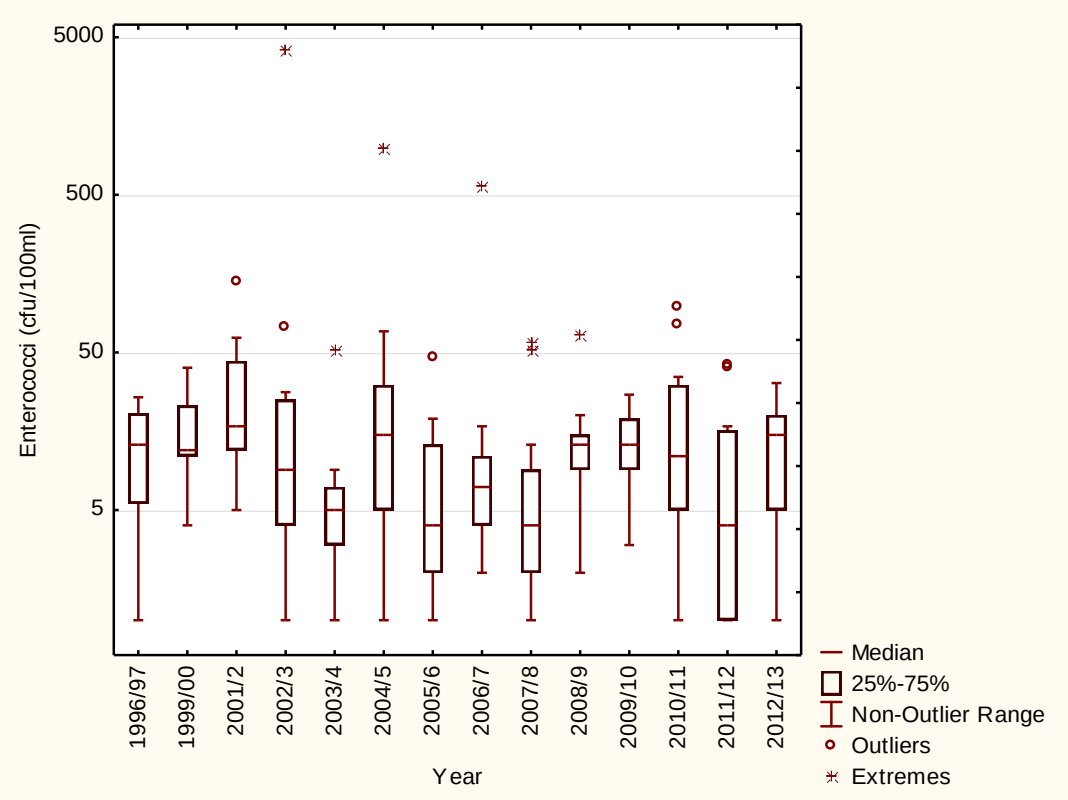

Figure 3 Box and whisker plots of enterococci for all summer SEM surveys at Onearo Beach

4.1.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 11 summer seasons (Figure 4) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

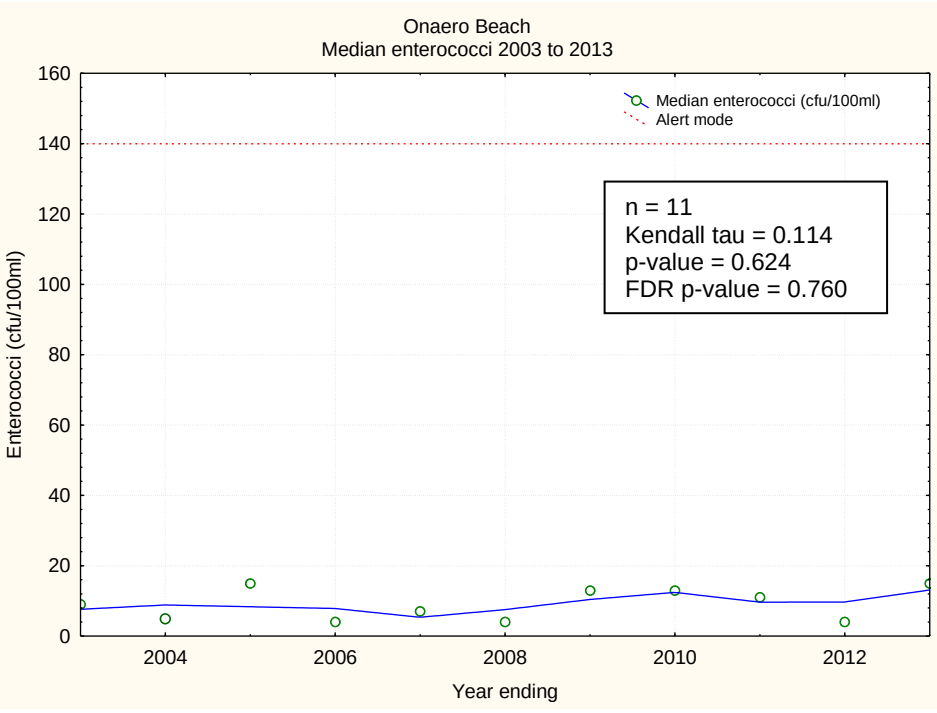

Figure 4 LOWESS trend analysis of median enterococci data at Onaero Beach

Over the 11 seasons monitored, there was a positive trend in median enterococci counts (Kendall tau = 0.114) that was not significant at the 5% level (p = 0.624).

4.1.5 MfE guidelines additional sampling

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

Table 10 Bacteriological results for MfE samples at Onaero Beach

Date	Time	Conductivity @ 20°C	Bacteria			Temperature
			E. coli	Enterococci	Faecal coliforms	
06 Nov 2012	08:55	4650	16	1	16	15.2
19 Dec 2012	08:50	2990	1300	830	1300	19.4
07 Jan 2013	09:30	4700	7	4	7	20.6
22 Jan 2013	08:50	4670	3	5	3	19.6
07 Feb 2013	09:15	4600	84	41	96	20.1
21 Feb 2013	09:30	4700	7	1	7	20.1
21 Mar 2013	09:05	4760	12	5	12	19.6

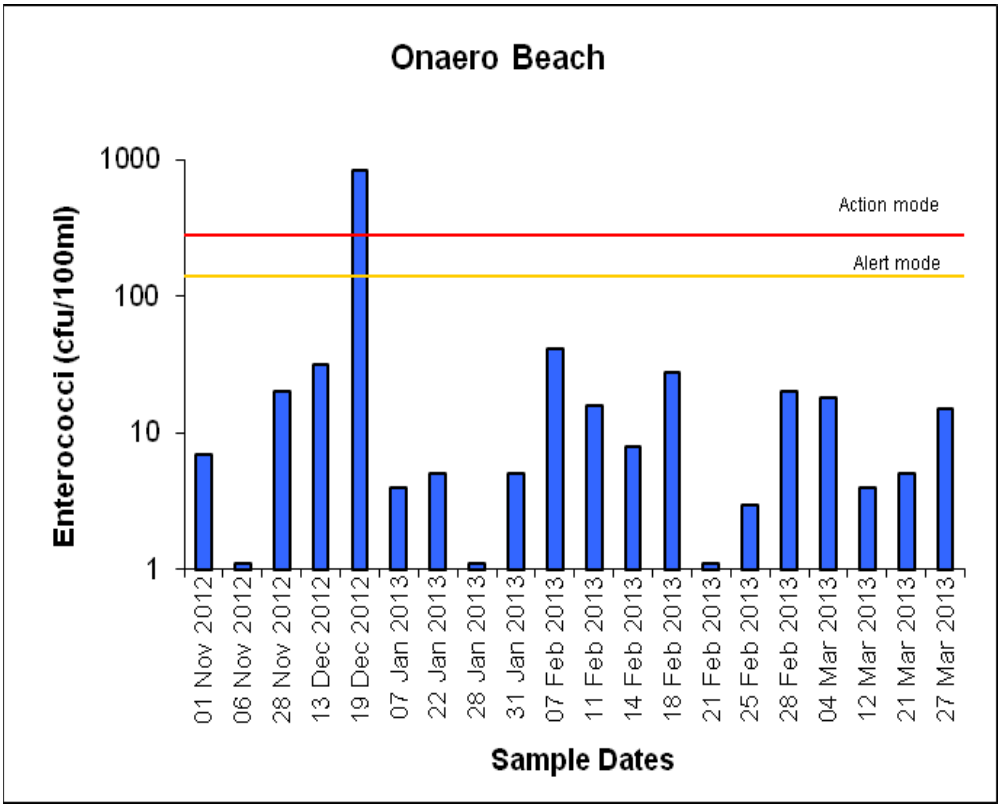

Figure 5 Enterococci numbers for the 20 sample extended survey at Onaero Beach

Table 11 Summary statistics for SEM and MfE samples at Onaero Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	2990	4790	4670
E. coli	cfu/100ml	20	1	1300	12
Enterococci	cfu/100ml	20	<1	830	8
Faecal coliforms	cfu/100ml	20	1	1300	12
Temperature	°C	20	15.2	21.4	19.7

The high enterococci count (830 cfu/100ml) obtained on 19 December was associated with a low conductivity of 2990 mS/m (Table 10, 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 count on this date, with heavy rainfall occurring a few days prior to sampling.

4.5.1.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage for the full suite of samples (20) is summarised in Table 12. At Onaero Beach, 1 out of 20 samples entered the Alert category.

Table 12 Bacterial guidelines performance at Onaero Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
Enterococci	1/20	5%	0/20	0%

4.2 Waitara East Beach

4.2.1 SEM programme

Waitara East Beach is located to the east of the Waitara River mouth (Photo 3). 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 and disinfected domestic wastes from the Waitara township are discharged through the Waitara Marine Outfall approximately 1800m out to sea.

Photo 3
Waitara East Beach

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

Table 13 Bacteriological results for Waitara East Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)	Turbidity (NTU)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)		
01 Nov 2012	10:30	4150	86	8	88	15.9	21
28 Nov 2012	09:50	4410	100	100	100	16.1	23
13 Dec 2012	09:45	4340	24	57	28	18.0	53
28 Jan 2013	11:06	3810	8	37	8	21.3	6.4
31 Jan 2013	11:25	4340	16	310	16	22.7	29
11 Feb 2013	09:45	4690	80	400	110	20.1	27
14 Feb 2013	11:15	4580	16	25	31	18.3	30
18 Feb 2013	14:05	4040	7	43	7	20.7	2.2
25 Feb 2013	09:50	4640	0.5	12	<1	17.5	17
28 Feb 2013	10:20	4760	16	38	16	19.6	22
04 Mar 2013	13:10	4750	<2	<1	<2	20.3	20
12 Mar 2013	10:30	4730	<2	8	<2	19.0	42
27 Mar 2013	09:30	4720	4	0.5	4	20.1	11

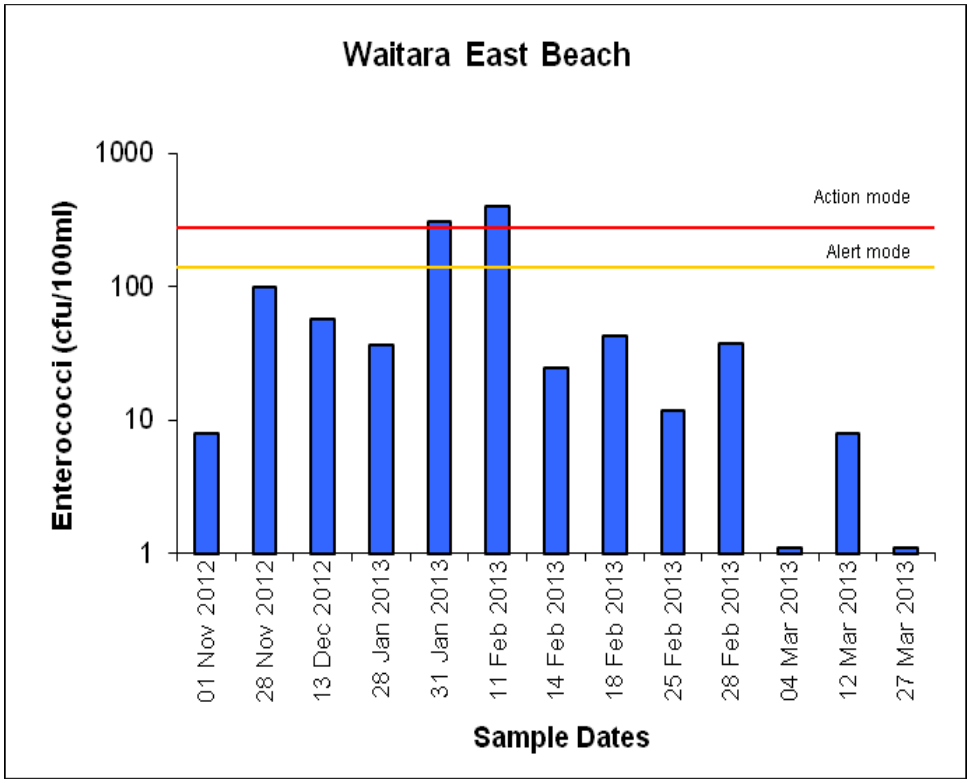

Figure 6 Enterococci numbers for the 13 SEM samples taken from Waitara East Beach

Table 14 Statistical summary for Waitara East Beach

Parameter	Unit	Number	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3810	4760	4580
E. coli	cfu/100ml	13	<1	100	16
Enterococci	cfu/100ml	13	<1	400	37
Faecal coliforms	cfu/100ml	13	<1	110	16
Temperature	°C	13	15.9	22.7	19.6
Turbidity	NTU	13	2.2	53	22

The median enterococci count (37 cfu/100ml) was relatively high at this site, with lower medians recorded for *E. coli* and faecal coliforms (16 cfu/100ml). The two highest enterococci counts (310 and 410 cfu/100ml), recorded on 31 January and 11 February 2013, remain unexplained as there was negligible rainfall >5 days prior to sampling and only minor freshwater influence (4340 and 4690 mS/m, Table 14).

4.2.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 15. As two consecutive samples had enterococci counts of above 280 cfu/100ml, the Action category was reached once during the bathing season.

Table 15 Bacterial guidelines performance at Waitara East Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT		ACTION	
Enterococci	0/13	0%	2/13	15%

4.2.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Waitara East Beach over 18 summers are presented in Table 16 and Figure 7. Maximum and median enterococci counts obtained during the 2012-2013 summer season were within the range previously recorded at this site (Table 16, Figure 7). Maxima at this site are historically high due to the influence of the Waitara River (Table 16).

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

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	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**	**2012-13**
Minimum	1	<1	1	1	<1	<1	<1	1	<1
Maximum	310	88	91	120	2400	210	1000	190	400
Median	9	9	27	12	41	15	3	6	37

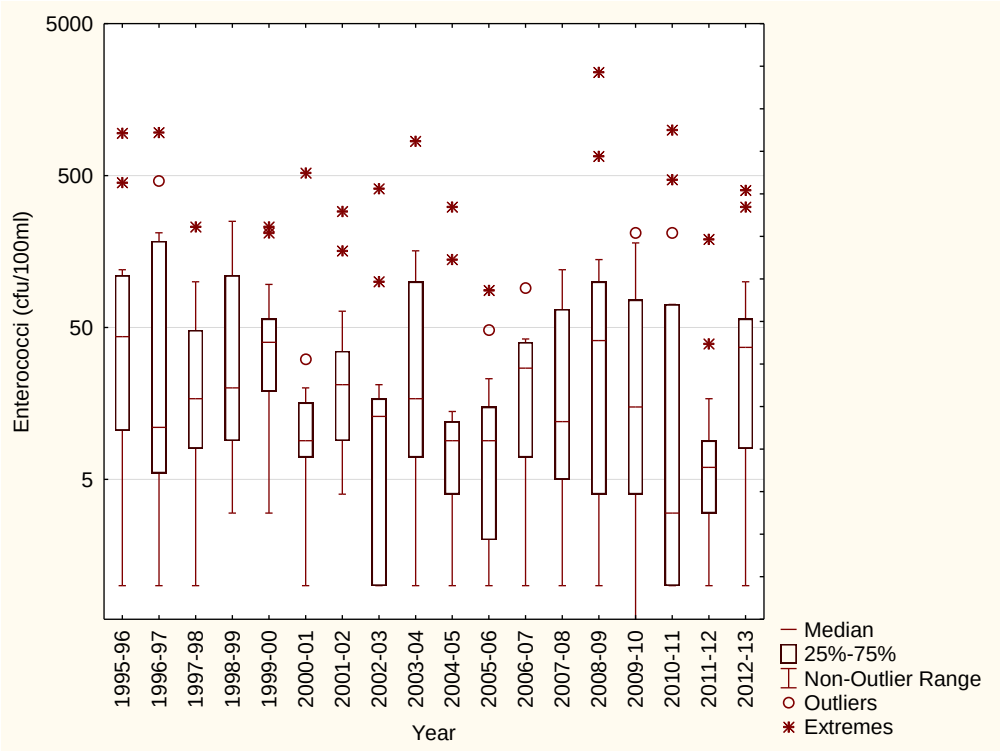

Figure 7 Box and whisker plots of enterococci for all summer surveys at Waitara East Beach

4.2.4 Long-term trend analysis

Trend analysis was performed by applying a LOWESS fit (tension 0.4) to a time scatterplot of the median enterococci data for 17 summer seasons (Figure 8) and testing the significance of any trend using the Mann-Kendall test at the 5% level, followed by Benjamini-Hochberg False Discovery Rate (FDR) analysis.

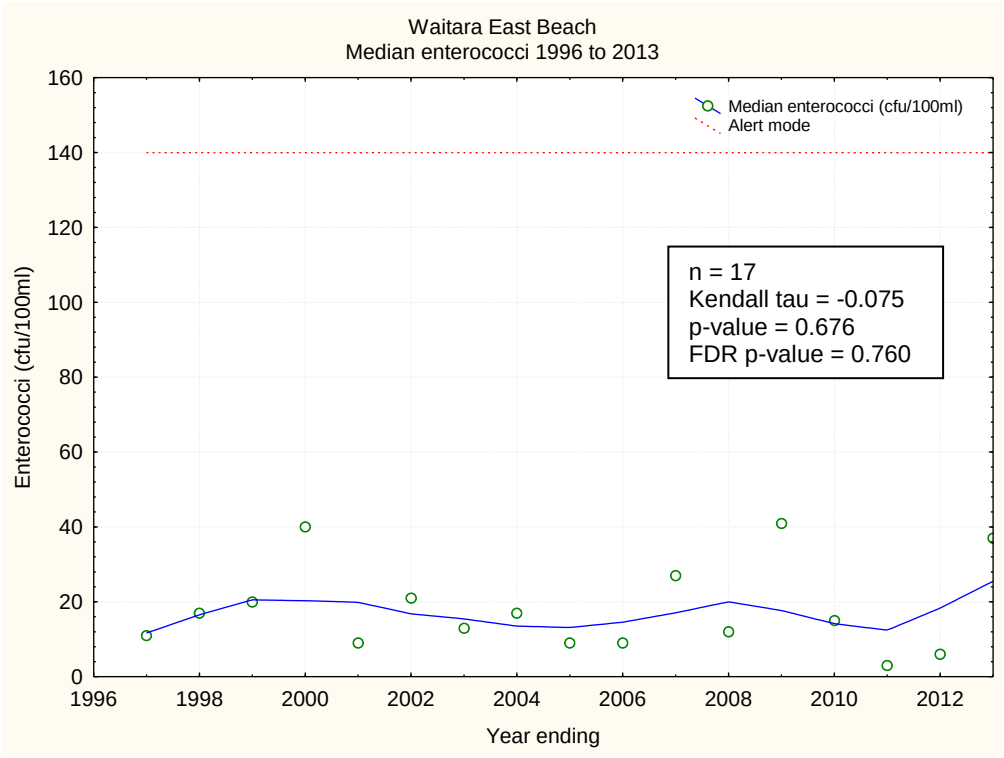

Figure 8 LOWESS trend analysis of median enterococci data at Waitara East Beach

Over the 16 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.075) that was not significant at the 5% level (p = 0.676).

4.3 Waitara West Beach

4.3.1 SEM programme

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

Photo 4 Waitara West Beach

The data for this site are presented in Table 17 and Figure 8, with a statistical summary provided in Table 18.

Table 17 Bacteriological results for Waitara West Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temperature (°C)	Turbidity (NTU)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)		
01 Nov 2012	11:00	4310	56	8	58	16.1	18
28 Nov 2012	09:24	4480	<3	3	<3	15.8	54
13 Dec 2012	09:20	4350	15	48	15	18.2	25
28 Jan 2013	11:48	3580	13	9	13	21.8	3
31 Jan 2013	11:55	4280	<1	7	<1	22.5	8.3
11 Feb 2013	09:25	4670	44	90	44	19.8	37
14 Feb 2013	11:50	4660	6	6	6	18.6	63
18 Feb 2013	14:30	4240	16	46	16	20.7	5.8
25 Feb 2013	10:20	4730	4	7	4	18.0	5.1
28 Feb 2013	10:40	4760	60	39	60	19.9	18
04 Mar 2013	13:35	4720	<3	6	<3	20.1	34
12 Mar 2013	11:08	4790	4	6	4	18.8	20
27 Mar 2013	09:00	4770	1	8	1	19.9	38

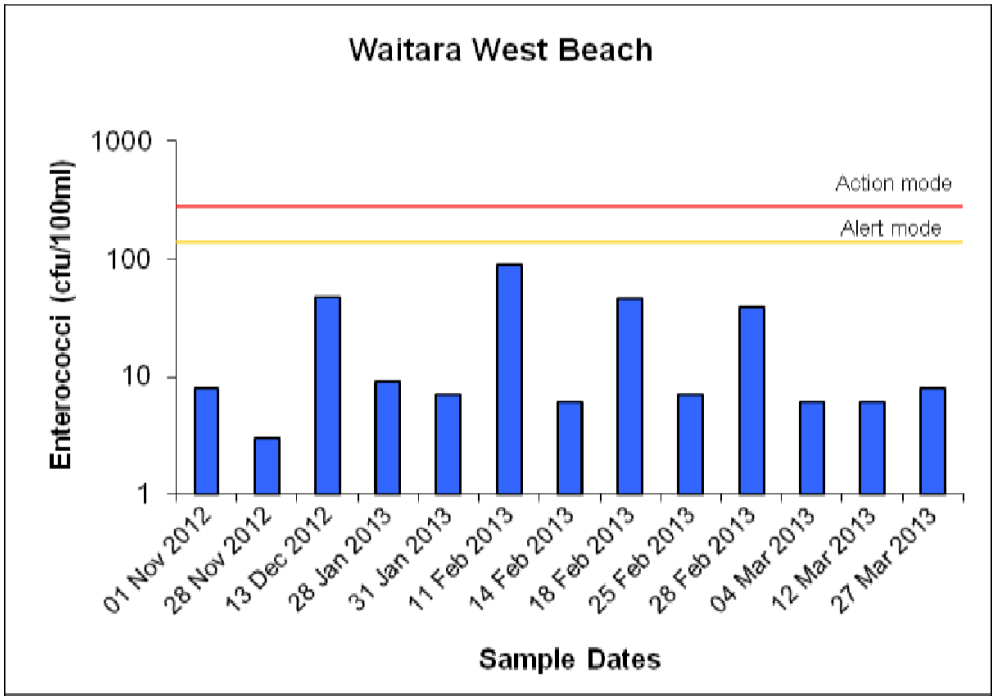

Figure 8 Enterococci numbers for the 13 SEM samples taken from Waitara West Beach

Table 18 Statistical summary for Waitara West Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3580	4790	4660
E. coli	cfu/100ml	13	<1	60	6
Enterococci	cfu/100ml	13	3	90	8
Faecal coliforms	cfu/100ml	13	<1	60	6
Temperature	°C	13	15.8	22.5	19.8
Turbidity	NTU	13	3	63	20

At Waitara West Beach the median enterococci count (8 cfu/100ml) was similar to medians recorded for *E. coli* and faecal coliforms (6 cfu/100ml).

4.3.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 19. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 19 Bacterial guidelines performance at Waitara West Beach

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

4.3.3 Comparison with previous summer surveys

Summary statistics for enterococci survey data collected at Waitara West Beach over 18 summers are presented in Table 20 and Figure 9.

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

Summer	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	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**	**2012-13**
Minimum	1	1	1	1	2	3	1	<1	3
Maximum	300	100	240	67	530	42	910	160	90
Median	7	8	8	5	120	12	20	13	8

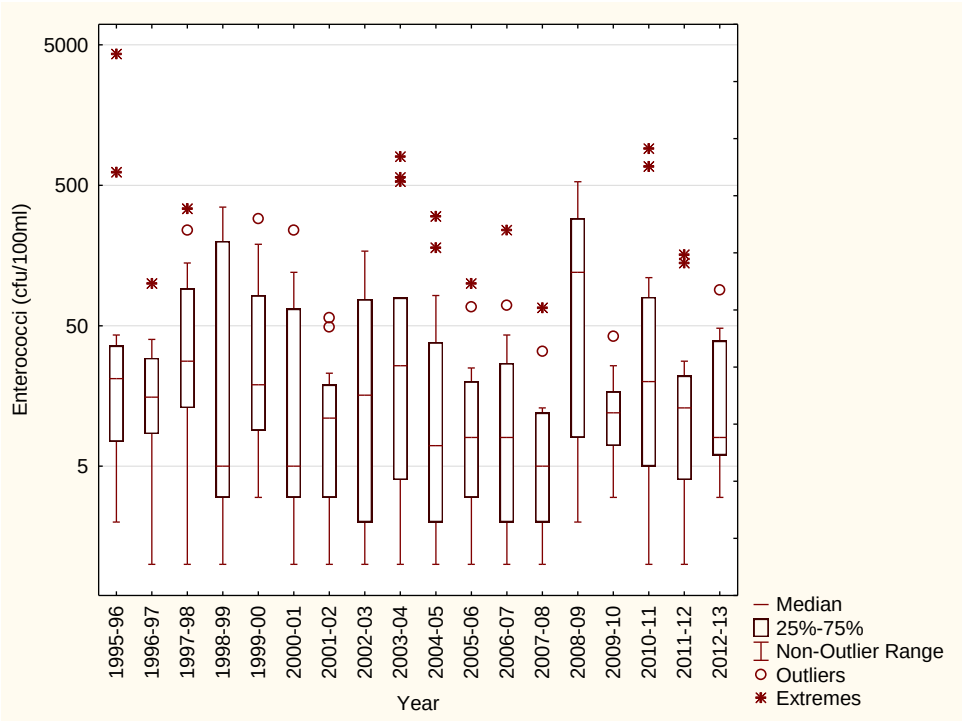

Figure 9 Box and whisker plots of enterococci for all summer SEM surveys at Waitara West Beach

Minima, maxima and median enterococci counts were within the range recorded in previous monitoring periods at this site (Table 20, Figure 9). Maxima at this site are historically high due to the influence of the Waitara River (Table 20).

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 17 summer seasons (Figure 10) 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.

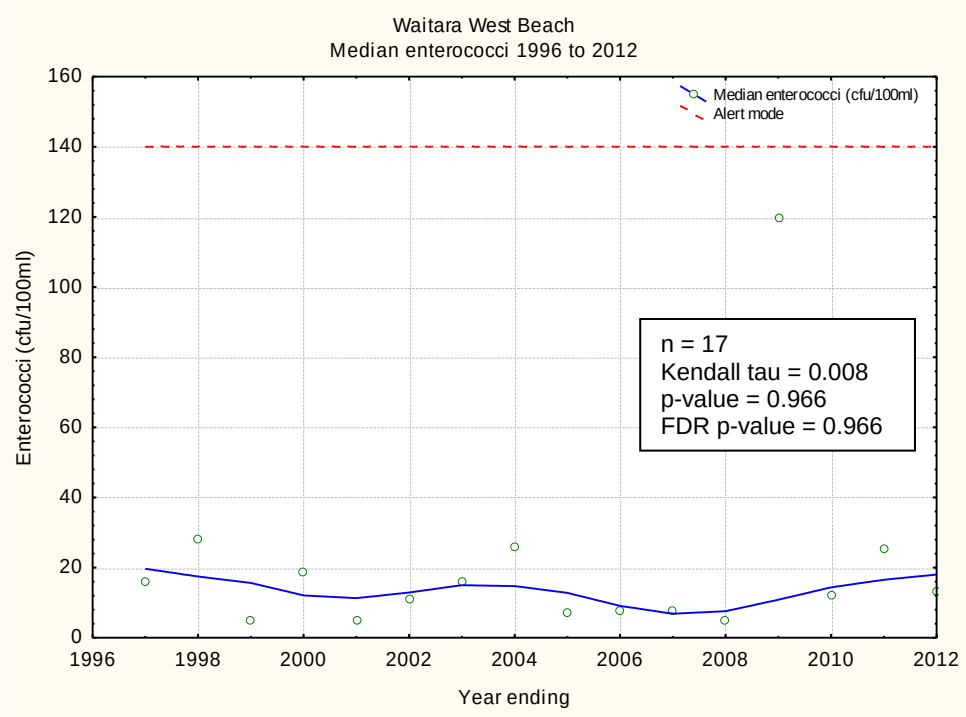

Figure 10 LOWESS trend analysis of median enterococci data at Waitara West Beach

Over the 17 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = 0.008) that was not significant at the 5% level (p = 0.966).

4.4 Fitzroy Beach

4.4.1 SEM programme

Fitzroy Beach is situated in New Plymouth and is one of the most popular bathing beaches in Taranaki. It is also a very popular surfing beach due to its central location and high quality waves (Photo 5). 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.

In addition to routine SEM and MfE sampling, during the 2012-2013 season Fitzroy Beach was also sampled weekly from December 2012 until the end of the monitoring year. This additional sampling was conducted in association with a major upgrade of the New Plymouth Wastewater Treatment Plant. The results of this additional monitoring are presented in TRC Annual Report 2013-25.

Photo 5 Surfer at Fitzroy Beach

The data for this site are presented in Table 21 and Figure 11, with a statistical summary provided in Table 22.

Table 21 Bacteriological results for Fitzroy Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	11:30	4640	<1	1	<1	15.6
28 Nov 2012	10:40	4540	15	9	16	16.3
13 Dec 2012	10:10	4690	7	3	7	19.0
28 Jan 2013	10:22	4760	3	3	3	21.2
31 Jan 2013	09:56	4700	1	36	1	21.8
11 Feb 2013	08:57	4730	<1	3	<1	19.9
14 Feb 2013	11:10	4630	8	8	8	19.3
18 Feb 2013	14:30	4650	<1	<1	<1	20.1
25 Feb 2013	10:10	4750	<1	4	<1	18.2
28 Feb 2013	11:40	4750	<1	4	<1	20.1
04 Mar 2013	14:25	4730	3	3	3	20.1
12 Mar 2013	10:30	4790	<1	<1	<1	19.4
27 Mar 2013	10:05	4790	<1	9	<1	20.4

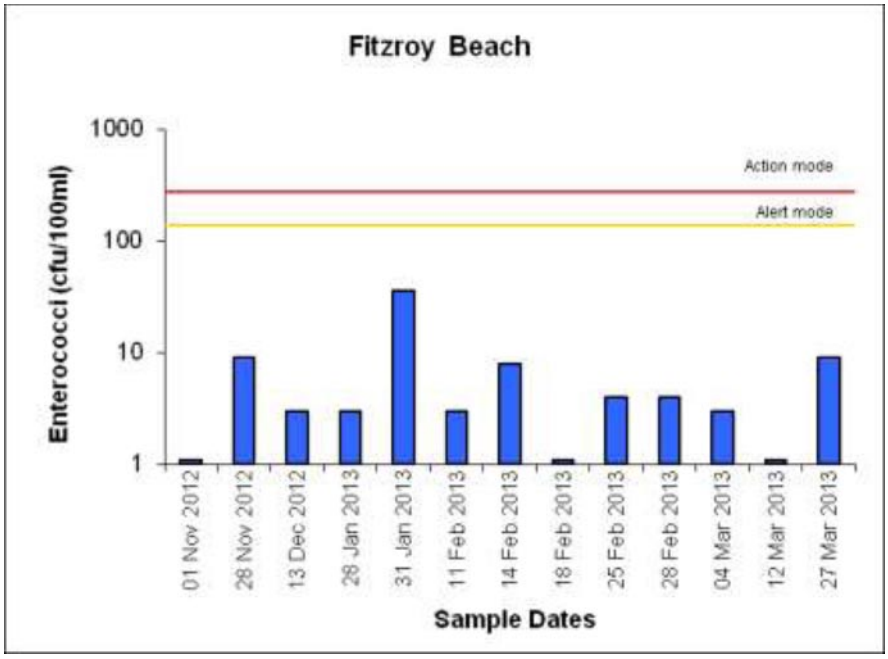

Figure 11 Enterococci numbers for the 13 SEM samples taken from Fitzroy Beach

Table 22 Statistical summary for Fitzroy Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4540	4790	4730
E. coli	cfu/100ml	13	<1	15	<1
Enterococci	cfu/100ml	13	<1	36	3
Faecal coliforms	cfu/100ml	13	<1	16	<1
Temperature	°C	13	15.6	21.8	19.9

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

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 Fitzroy Beach

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

4.4.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Fitzroy Beach over 18 summers are presented in Table 24 and Figure 12.

Table 24 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**	**2012-13**
Minimum	<1	<1	<1	<1	<1	1	<1	<1	<1
Maximum	52	85	33	44	110	60	43	930	36
Median	4	6	3	3	10	8	4	3	3

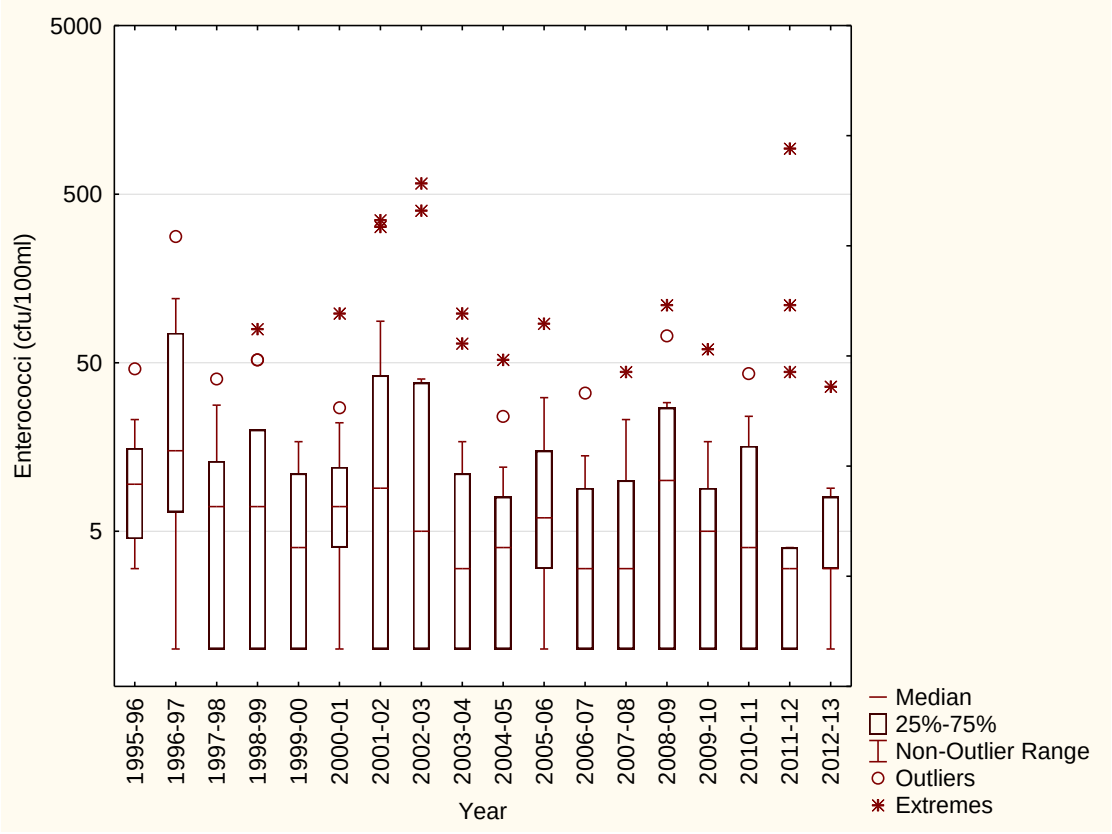

Figure 12 Box and whisker plots of enterococci for all summer SEM surveys at Fitzroy Beach

The median enterococci count (3 cfu/100ml) obtained for the 2012-2013 summer season at Fitzroy Beach was one of the lowest to date and low compared to other Taranaki beach bathing sites. The maximum enterococci count was also low relative to other years and sites.

4.4.4 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 eighteen summer seasons (Figure 13) 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.

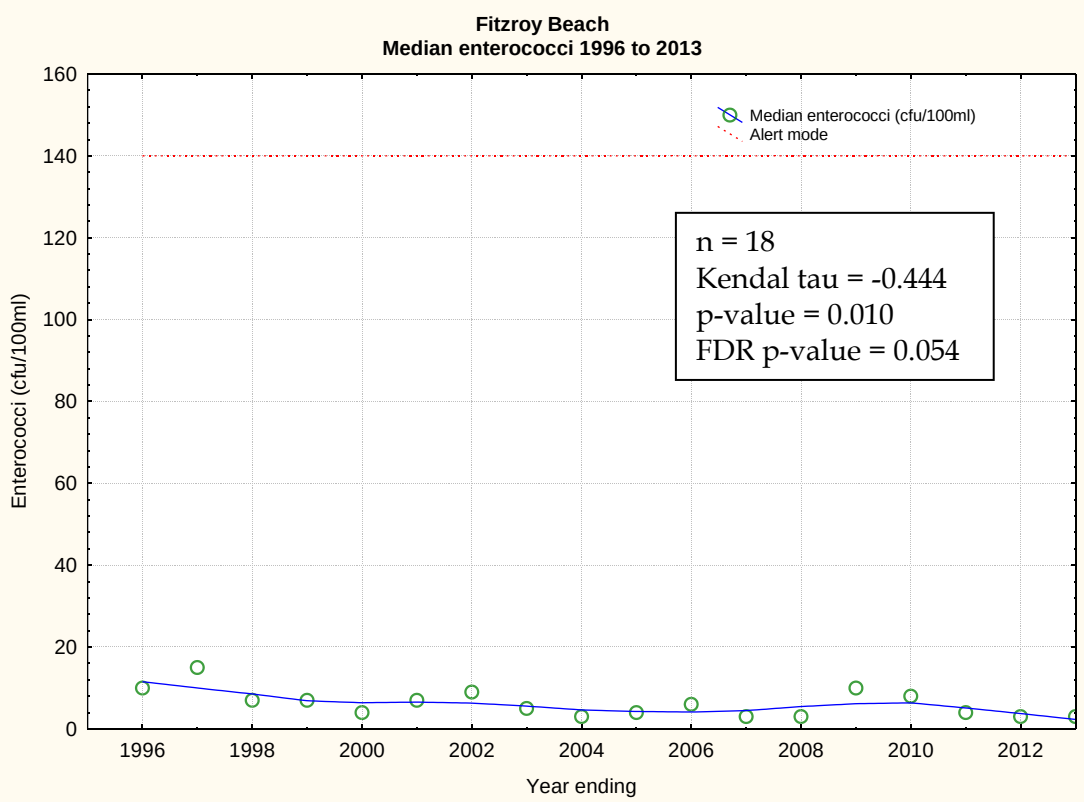

Figure 13 LOWESS trend analysis of median enterococci data at Fitzroy Beach

Over the 18 seasons monitored, there was a decrease in median enterococci counts (Kendall tau = -0.444). This negative trend was significant using the Mann-Kendall test (p = 0.010), but not significant after FDR application (p = 0.054).

4.4.5 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 25 and Figure 14, with a statistical summary provided in Table 26.

Table 25 Bacteriological results for MfE samples at Fitzroy Beach

Date	Time	Conductivity @ 20°C	Bacteria			Temperature
	(NZST)	(mS/m)	*E. coli* (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	(°C)
06 Nov 2012	10:05	4720	3	<1	3	14.9
19 Dec 2012	11:20	4560	31	4	32	19.5
07 Jan 2013	11:45	4340	1	<1	1	21.1
22 Jan 2013	11:25	4650	<1	<1	<1	21.8
07 Feb 2013	11:30	4750	5	1	5	19.7
21 Feb 2013	10:45	4730	3	1	3	20.3
21 Mar 2013	09:35	4760	<1	<1	<1	19.3

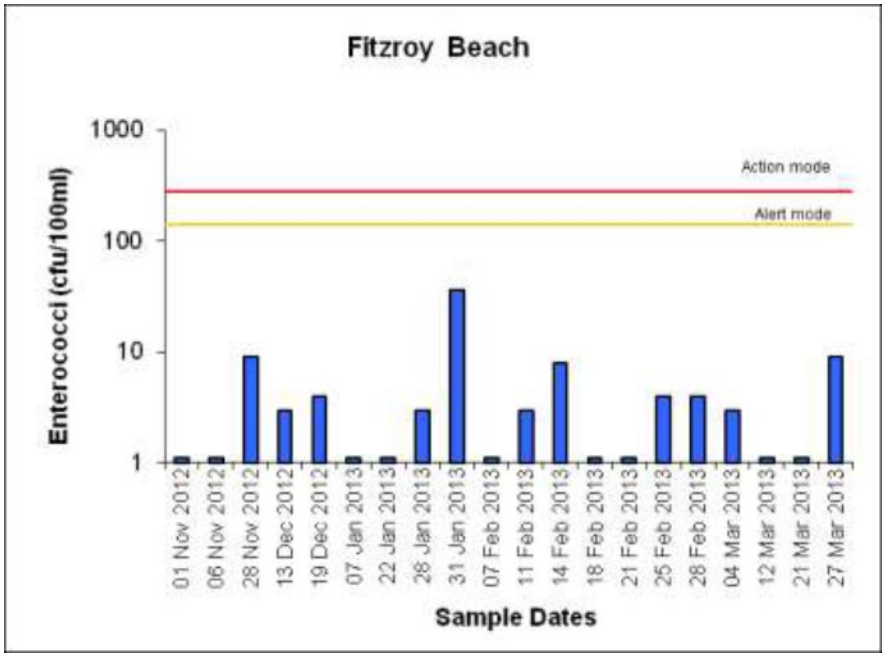

Figure 14 Enterococci numbers for the 20 sample extended survey at Fitzroy Beach

Table 26 Summary statistics for SEM and MfE samples at Fitzroy Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	4340	4790	4725
E. coli	cfu/100ml	20	<1	31	1
Enterococci	cfu/100ml	20	<1	36	3
Faecal coliforms	cfu/100ml	20	<1	32	1
Temperature	°C	20	14.9	21.8	19.8

Additional sampling resulted in no changes to the overall seasonal medians for all faecal indicator bacteria (Table 26), with water quality remaining high throughout the season.

4.5.4.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage for the full suite of samples (20) is summarised in Table 27. No samples reached the Alert mode during the 2012-2013 season.

Table 27 Bacterial guidelines performance at Fitzroy Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/20	0%	0/20	0%

4.5 Ngamotu Beach

4.5.1 SEM programme

Ngamotu Beach (Photo 6) is situated within Port Taranaki, in close proximity to boat traffic and Port activities. It receives urban stormwater and a piped stream. Due to its sheltered location, situated between two breakwaters, this beach is very popular with young children and school groups and is often used for sports events.

Photo 6 Ngamotu Beach

Data for this site are presented in Table 28 and Figure 15, with a statistical summary provided in Table 29.

Table 28 Bacteriological results for Ngamotu Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	10:25	4510	1	<1	1	16.2
28 Nov 2012	09:35	4740	<1	1	<1	15.7
13 Dec 2012	09:05	4730	12	29	12	18.4
28 Jan 2013	09:19	4680	4	1	4	21.5
31 Jan 2013	11:04	4710	23	7	23	22.9
11 Feb 2013	09:48	4710	16	7	20	20.5

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
14 Feb 2013	12:25	4760	<1	<1	<1	19.5
18 Feb 2013	15:25	4730	1	<1	1	20.3
25 Feb 2013	09:15	4760	3	<1	3	18.3
28 Feb 2013	10:30	4700	11	12	11	20.8
04 Mar 2013	13:40	4760	4	4	4	20
12 Mar 2013	09:25	4760	3	4	3	18.5
27 Mar 2013	09:15	4780	3	7	3	19.7

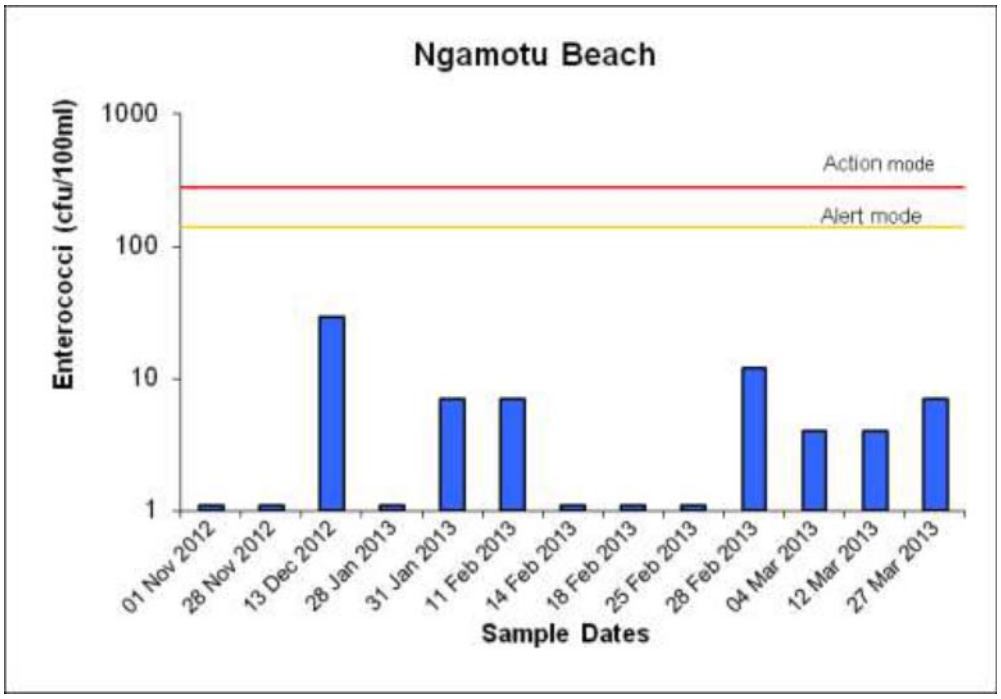

Figure 15 Enterococci numbers for the 13 SEM samples taken from Ngamotu Beach

Table 29 Statistical summary for Ngamotu Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4510	4780	4730
E. coli	cfu/100ml	13	<1	23	3
Enterococci	cfu/100ml	13	<1	29	4
Faecal coliforms	cfu/100ml	13	<1	23	3
Temperature	°C	13	15.7	22.9	19.7

Low counts were obtained for all SEM faecal indicator bacteria samples through the season (Tables 28 and 29, Figure 15).

4.5.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 30. Enterococci counts in all samples were below both Alert and Action guideline levels.

Table 30 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	0/13	0%	0/13	0%

4.5.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Ngamotu Beach over 18 summers are presented in Table 31 and Figure 16.

Table 31 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**	**2012-13**
Minimum	< 1	1	1	1	1	<1	<1	1	<1
Maximum	230	90	48	350	55	23	180	1000	29
Median	14	13	12	4	9	4	8	8	4

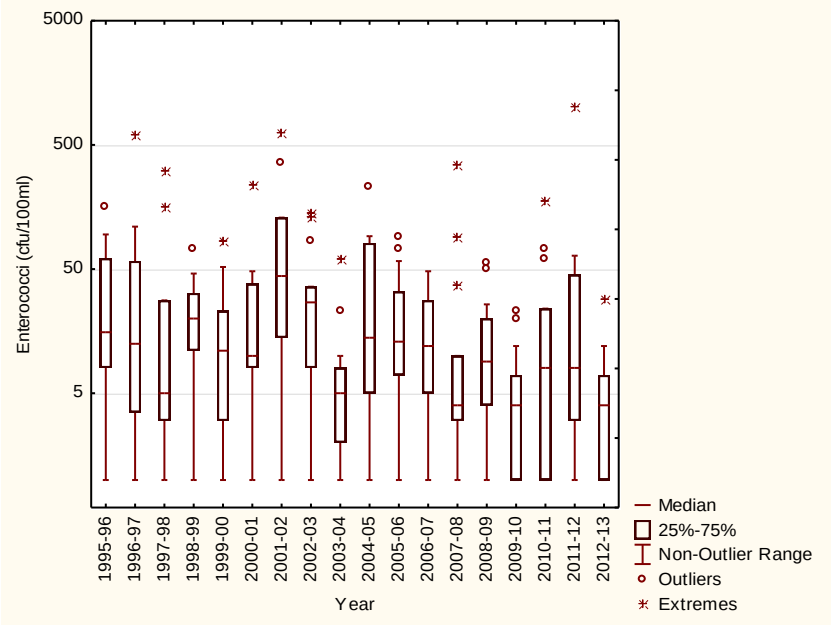

Figure 16 Box & whisker plots of enterococci for all summer SEM surveys at Ngamotu Beach

The median enterococci count (4 cfu/100ml) obtained for the 2012-2013 summer season was the equal lowest recorded at this site. The maximum count was within the lower range recorded at this site to date.

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 18 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.

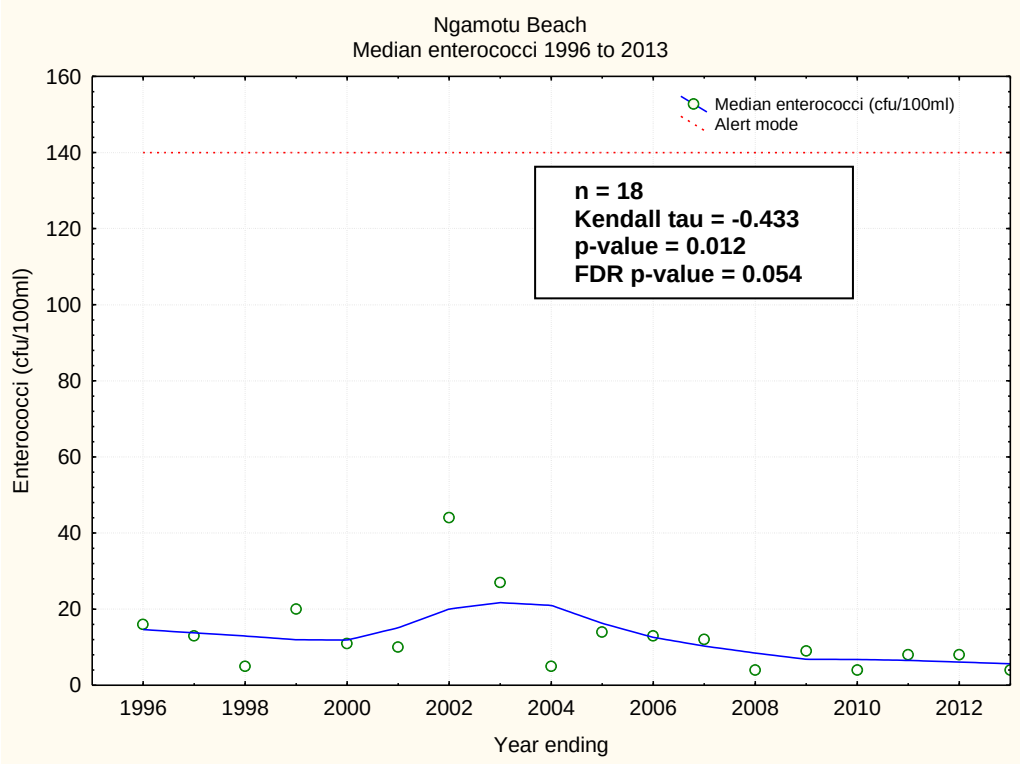

Figure 17 LOWESS trend analysis of median enterococci data at Ngamotu Beach

Over the 18 seasons monitored, there was a decrease in median enterococci counts (Kendall tau = -0.433). This negative trend was significant using the Mann-Kendall test (p = 0.012), but not significant after FDR application (p = 0.054).

4.5.5 MfE guidelines additional sampling

For the purpose of MfE monitoring, seven additional samples were collected at regular intervals and under varying weather conditions during the survey season. All data, including additional MfE samples, are presented in Table 32 and Figure 18, with a statistical summary provided in Table 33.

Table 32 Bacteriological results for MfE samples at Ngamotu Beach

Date	Time	Conductivity @ 20°C	Bacteria			Temperature
	(NZST)	(mS/m)	*E. coli* (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	(°C)
06 Nov 2012	10:35	4660	<1	3	<1	16.6
19 Dec 2012	11:50	4650	4	20	4	22.1
07 Jan 2013	12:20	4660	<1	5	<1	21.7
22 Jan 2013	12:00	4630	<1	1	<1	22
07 Feb 2013	12:00	4700	1	11	1	20.9
21 Feb 2013	11:25	4710	1	1	1	21.6
21 Mar 2013	10:10	4720	8	32	8	19.2

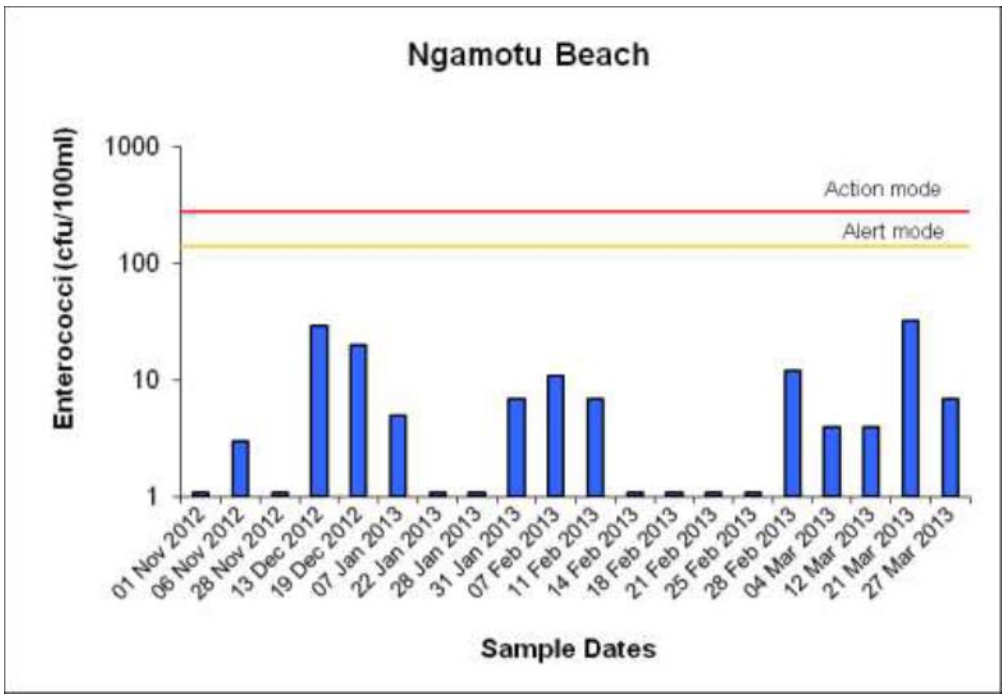

Figure 18 Enterococci counts for the 20 sample extended survey at Ngamotu Beach

Table 33 Summary statistics for SEM and additional samples at Ngamotu Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	4510	4780	4710
E. coli	cfu/100ml	20	<1	23	3
Enterococci	cfu/100ml	20	<1	32	4
Faecal coliforms	cfu/100ml	20	<1	23	3
Temperature	°C	20	15.7	22.9	20.2

Additional sampling resulted in no changes to the overall seasonal median for all faecal indicator bacteria (Table 33).

4.5.5.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage for the full suite of samples (20) is summarised in Table 34. No samples reached the Alert mode during the 2012-2013 season.

Table 34 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	0/20	0%	0/13	0%

4.6 Oakura Beach SC (opposite surf lifesaving club)

4.6.1 SEM programme

Oakura Beach (Photo 7) 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.

Photo 7 Oakura Beach

The data from this site are presented in Table 35 and Figure 19, with a statistical

summary provided in Table 36.

Table 35 Bacteriological results for Oakura Beach SC

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	09:45	4450	23	7	23	15.3
28 Nov 2012	09:00	4430	47	39	53	15.6
13 Dec 2012	08:25	4620	27	24	35	17.6
28 Jan 2013	08:40	4600	8	15	8	19.7
31 Jan 2013	11:45	4630	31	13	31	21.3
11 Feb 2013	10:28	4600	360	460	370	20.6
14 Feb 2013	13:05	4680	6	8	6	19.2
18 Feb 2013	16:05	4580	7	27	7	19.3
25 Feb 2013	08:30	4730	7	7	7	18.3
28 Feb 2013	10:00	4740	3	20	3	20.2
04 Mar 2013	13:05	4700	7	17	8	19.3
12 Mar 2013	08:40	4750	28	37	28	18.1
27 Mar 2013	08:30	4780	1	11	1	19.4

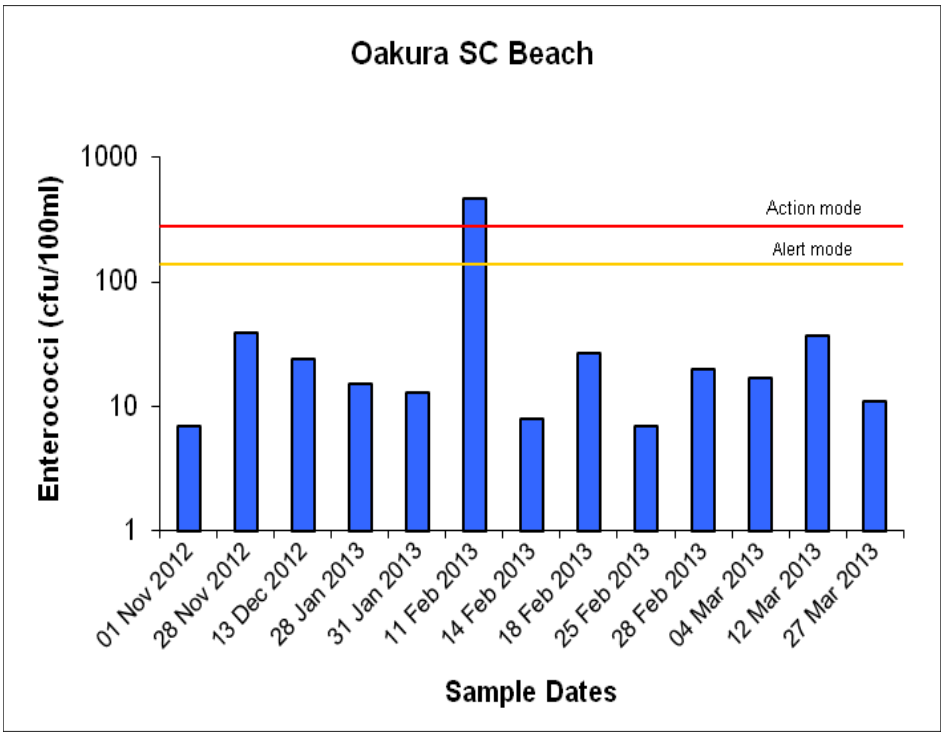

Figure 19 Enterococci numbers for the 13 SEM samples taken from Oakura Beach SC

Table 36 Statistical summary for Oakura Beach SC

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4430	4780	4630
E. coli	cfu/100ml	13	1	360	8
Enterococci	cfu/100ml	13	7	460	17
Faecal coliforms	cfu/100ml	13	1	370	8
Temperature	°C	12	15.3	21.3	19.3

Compared to other beach bathing sites around the region, the median enterococci count at this site was relatively high (17 cfu/100ml). The highest individual enterococci count (460 cfu/100ml), recorded on 11 February 2013, remains unexplained as there was negligible rainfall 6 days prior to sampling and only minor freshwater influence (4600 mS/m, Table 14).

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 principal contributors to elevated faecal indicator bacteria counts within these streams, particularly in the case of the Waimoku Stream (TRC 2011-01).

4.6.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 37. One SEM sample (11 Febuary 2013) reached Alert level (>140 enterococci cfu/100ml) at this site during summer 2012-2013.

Table 37 Bacterial guidelines performance at Oakura Beach SC

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	1/13	8%	0/13	0%

4.6.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Oakura Beach opposite the surf lifesaving club over 18 summers are presented in Table 38 and Figure 20.

Table 38 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	7
Maximum	250	300	230	160	250	800	100	130	460
Median	25	12	11	32	20	45	17	36	17

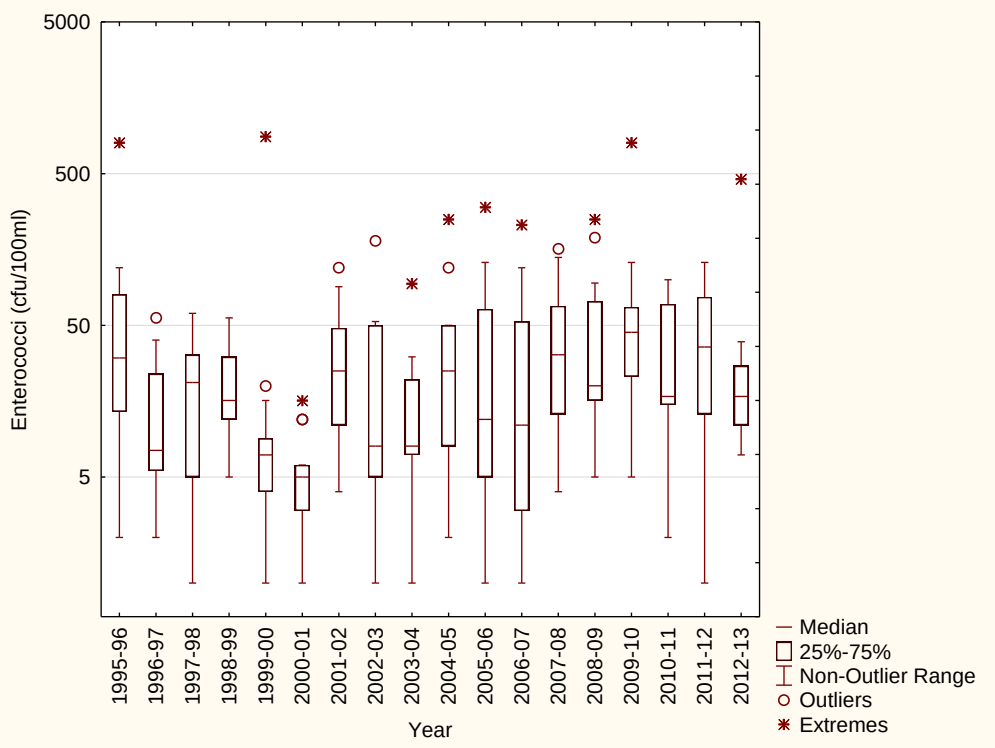

Figure 20 Box & whisker plots of enterococci for all summer SEM surveys at Oakura SC

The median enterococci count (17 cfu/100ml) obtained for the 2012-2013 summer season was within the range of values previously recorded at this site (Table 38, Figure 20). 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.

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 18 summer seasons (Figure 21) 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.

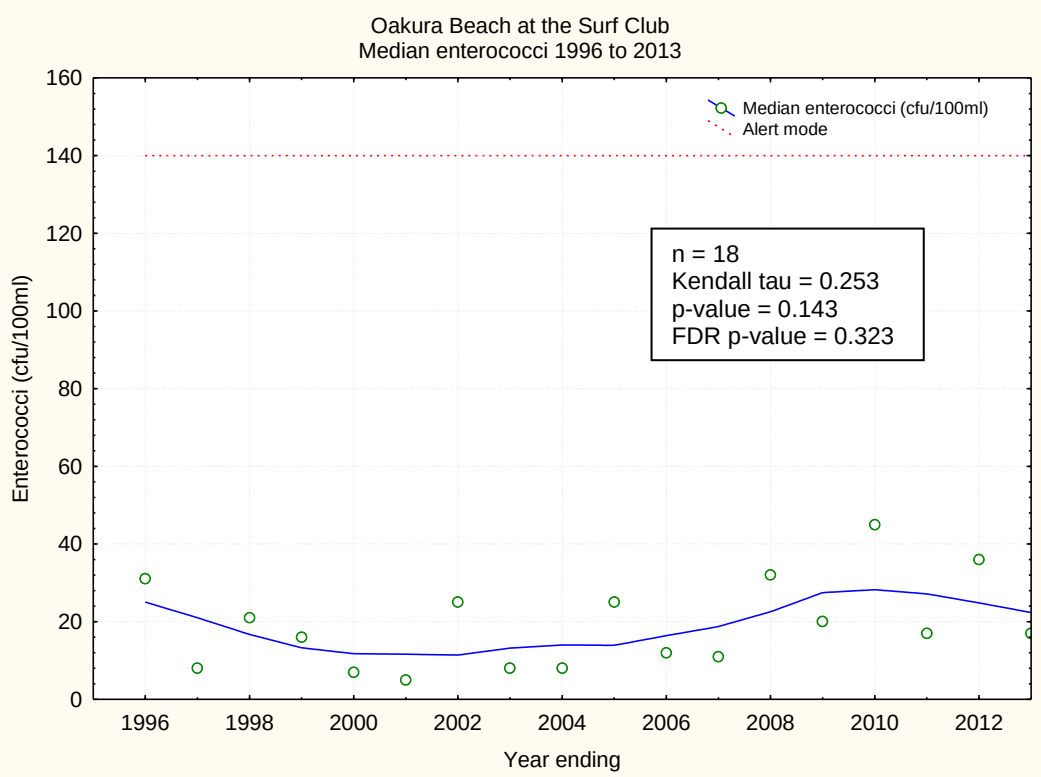

Figure 21 LOWESS trend analysis of median enterococci data at Oakura Beach SC

Over the 18 seasons monitored, there was a positive trend (i.e. an increase) in median enterococci counts (Kendall tau = 0.253) that was not significant at the 5% level (p = 0.143).

4.6.5 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 39 and Figure 22, with a statistical summary provided in Table 40.

Table 39 Bacteriological results for MfE samples at Oakura Beach SC

Date	Time	Conductivity @ 20°C	Bacteria			Temperature
	(NZST)	(mS/m)	*E. coli* (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	(°C)
06 Nov 2012	11:10	3560	56	12	64	15.8
19 Dec 2012	12:15	4630	92	110	92	20.5
07 Jan 2013	12:45	4640	23	28	23	19.6
22 Jan 2013	12:35	4670	1	3	1	18.5
07 Feb 2013	12:30	4680	<1	5	<1	20.6
21 Feb 2013	11:45	4500	57	47	57	19.4
21 Mar 2013	10:35	4710	11	25	11	20.1

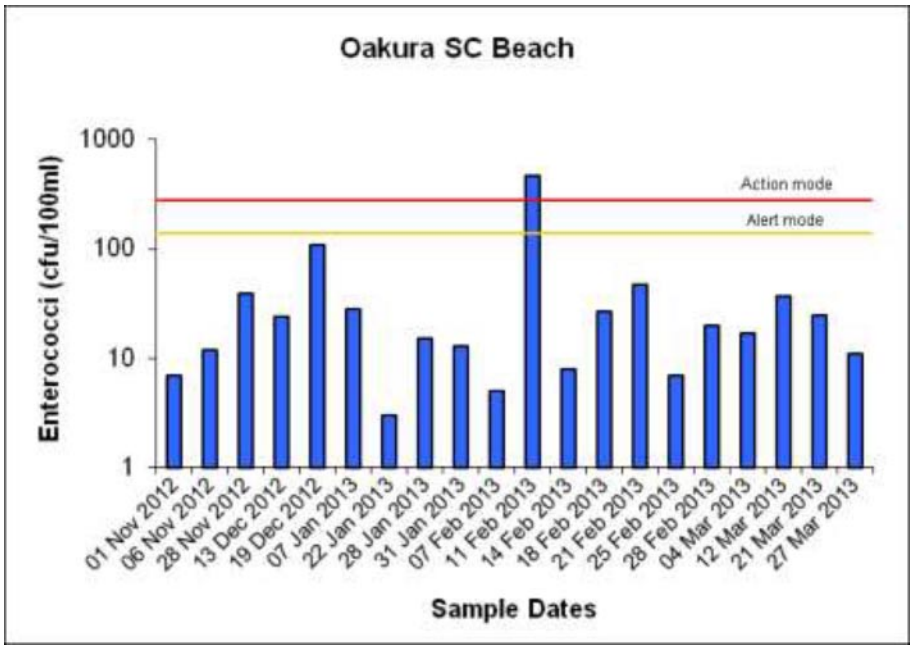

Figure 22 Enterococci numbers for the 20 sample extended survey at Oakura Beach SC

Table 40 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	3560	4780	4635
E. coli	cfu/100ml	20	<1	360	17
Enterococci	cfu/100ml	20	3	460	19
Faecal coliforms	cfu/100ml	20	<1	370	17
Temperature	°C	20	15.3	21.3	19.4

Additional sampling resulted in an increase in seasonal medians for all faecal indicator bacteria (Tables 36 and 40).

4.5.6.1 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage for the full suite of samples is summarised in Table 41. One sample (11 February 2013) reached Action level (>280 enterococci cfu/100ml) at this site during summer 2012-2013, but because the second sample was much lower, this does not constitute as exceedance of the Action guideline.

Table 41 Bacterial guidelines performance at Oakura Beach SC

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

4.7 Oakura Beach CG (opposite camp ground)

4.7.1 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 (Photo 8).

Photo 8 Oakura Beach in front of the campground

The data for this site are presented in Table 42 and Figure 23, with a statistical summary provided in Table 43.

Table 42 Bacteriological results for Oakura Beach CG

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	09:25	4700	<1	4	<1	15.0
28 Nov 2012	08:40	4700	5	3	5	15.2
13 Dec 2012	08:20	4740	<1	1	<1	17.2
28 Jan 2013	08:26	4640	16	35	16	19.2
31 Jan 2013	11:57	4630	9	12	9	21.2
11 Feb 2013	10:45	4720	560	260	560	20.5
14 Feb 2013	13:25	4700	4	3	4	19.3
18 Feb 2013	16:20	4730	<1	<1	<1	19.4
25 Feb 2013	08:20	4760	1	1	1	18.2
28 Feb 2013	09:40	4760	4	16	4	19.3

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
04 Mar 2013	12:45	4760	<1	1	<1	19.6
12 Mar 2013	08:20	4780	1	11	1	18.0
27 Mar 2013	08:15	4790	<1	<1	<1	19.8

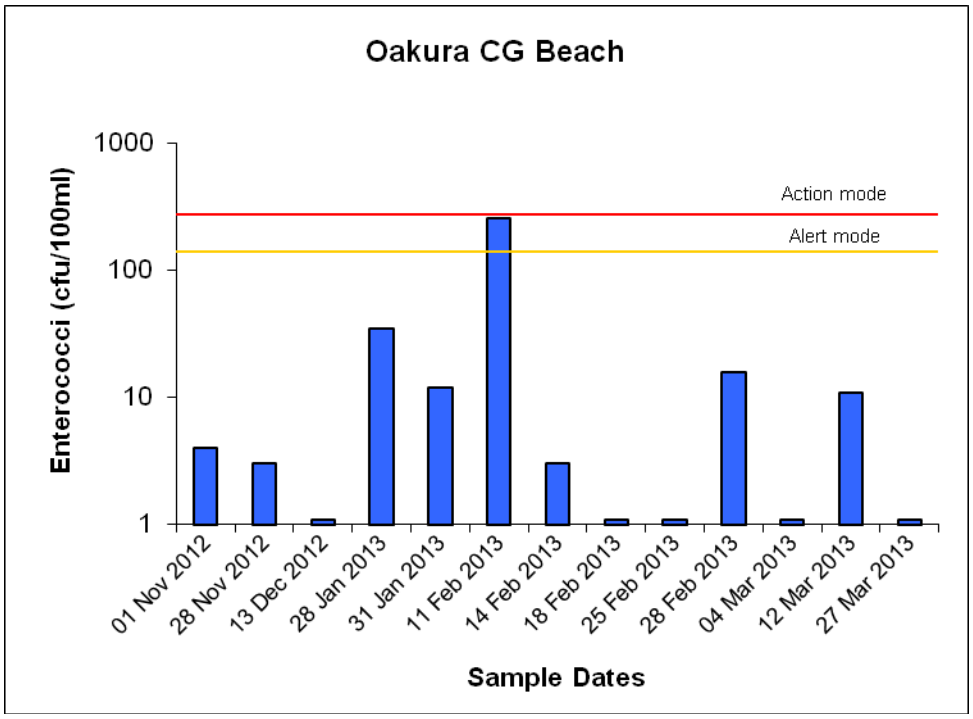

Figure 23 Enterococci counts for the 13 SEM samples taken from Oakura Beach CG

Table 43 Statistical results for Oakura Beach CG

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4630	4790	4730
E. coli	cfu/100ml	13	<1	560	1
Enterococci	cfu/100ml	13	<1	260	3
Faecal coliforms	cfu/100ml	13	<1	560	1
Temperature	°C	13	15.0	21.2	19.3

In general, water quality was good at this site with low medians for all faecal indicator bacteria (≤3 cfu/100ml). The highest enterococci count (260 cfu/100ml), recorded on 11 February 2013, remains unexplained as there was no significant rainfall 6 days prior to sampling and negligible freshwater influence (4720 mS/m, Table 14).

4.7.2 Compliance with guidelines

Compliance with the 2003 guidelines for freshwater contact usage is summarized in Table 44. One sample (11 February 2013) reached Alert level (>140 enterococci cfu/100ml) at this site during summer 2012-2013.

Table 44 Bacterial guidelines performance at Oakura Beach CG

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280/100ml	
Enterococci	1/13	8%	0/13	0%

4.7.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Oakura Beach opposite the campground over 18 summer surveys are presented in Table 45 and Figure 24.

Table 45 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**	**2012-13**
Minimum	< 1	<1	<1	<1	<1	<1	<1	<1	<1
Maximum	90	8	260	18	30	25	33	79	260
Median	6	1	3	7	6	1	<1	4	3

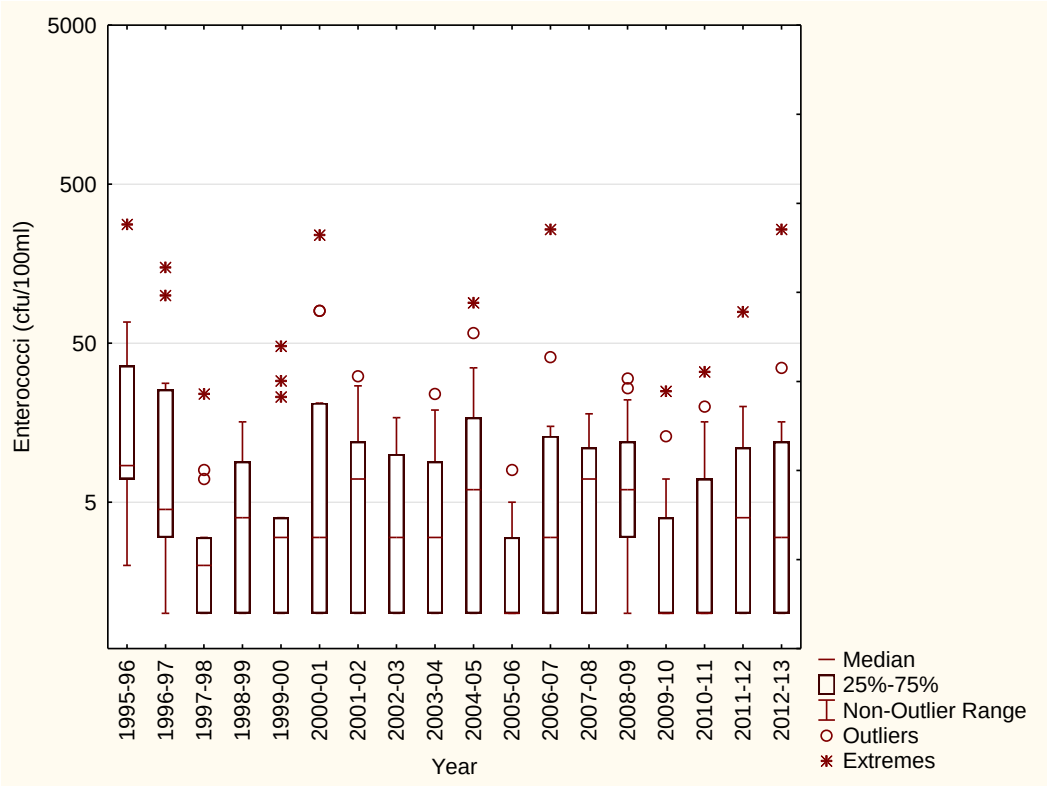

Figure 24 Box and whisker plots of enterococci for all summer SEM surveys at Oakura Beach opposite the campground

The median enterococci count for the 2012-2013 season was within the low range previously recorded at this site (3 cfu/100ml). Over the past 18 summers water quality has remained consistently high at this site (Table 45). The unusually high maximum enterococci count during the 2012-2013 season (260 cfu/100ml) was not typical for this site (Figure 24).

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 18 summer seasons (Figure 25) 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.

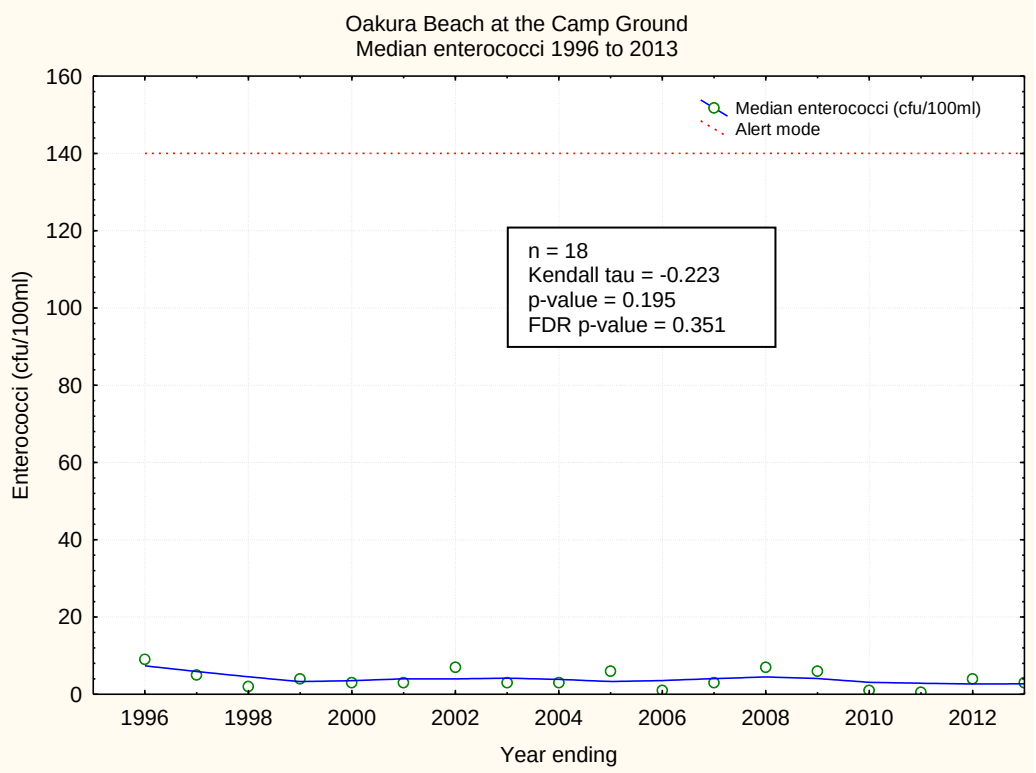

Figure 25 LOWESS trend analysis of median enterococci data at Oakura Beach Camp Ground

Over the 18 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.223) that was not significant at the 5% level (p = 0.195).

4.8 Opunake Beach

4.8.1 SEM programme

Opunake Beach (Photo 9) 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.

Photo 9 Opunake Beach and motor camp

The data for this site are presented in Table 46 and Figure 26, with a statistical summary provided in Table 47.

Table 46 Bacteriological results for Opunake Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	12:25	4680	<1	<1	<1	16.3
28 Nov 2012	08:25	4680	<1	<1	<1	16.5
13 Dec 2012	10:10	4740	<1	<1	<1	17.6
28 Jan 2013	12:05	4630	<1	<1	<1	22.5
31 Jan 2013	14:00	4760	<1	<1	<1	21.1
11 Feb 2013	11:55	4730	1	7	1	20.1
14 Feb 2013	11:35	4760	<1	4	<1	19.5
18 Feb 2013	16:55	3120	25	7	25	21.2
25 Feb 2013	11:25	4660	5	7	12	18.1
28 Feb 2013	13:00	4750	<1	<1	<1	20.0

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
04 Mar 2013	15:50	4760	<1	1	<1	19.5
12 Mar 2013	11:35	4750	<1	<1	<1	17.7
27 Mar 2013	09:10	4770	<1	7	<1	19.2

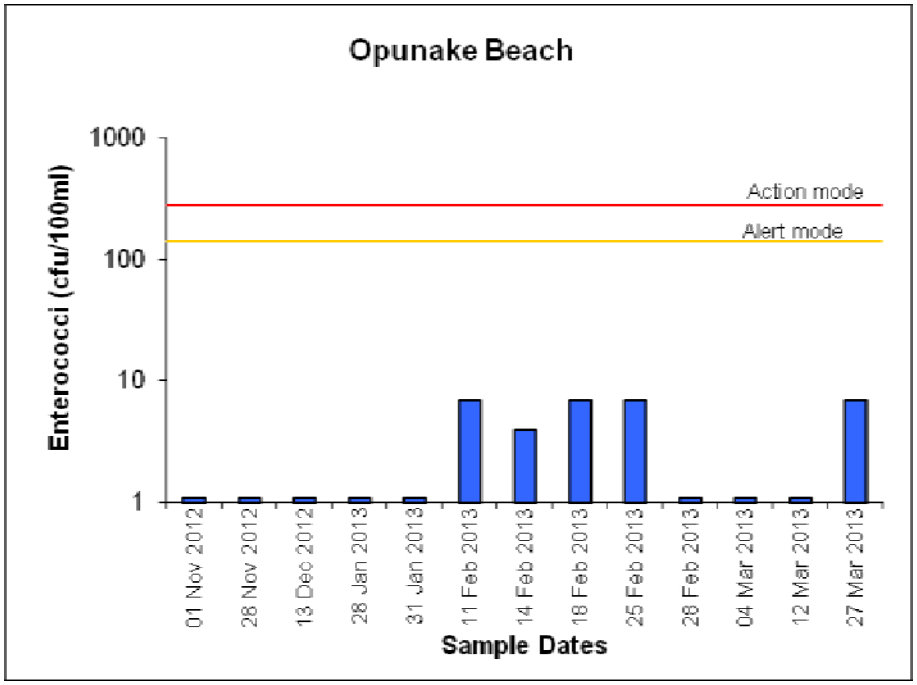

Figure 26 Enterococci numbers for the 13 SEM samples at Opunake Beach

Table 47 Statistical summary for Opunake Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3120	4770	4740
E. coli	cfu/100ml	13	<1	25	<1
Enterococci	cfu/100ml	13	<1	7	<1
Faecal coliforms	cfu/100ml	13	<1	25	<1
Temperature	°C	13	16.3	22.5	19.5

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

4.8.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 48. Water quality was considered suitable for contact recreation throughout the season, with all samples well below Alert guideline levels.

Table 48 Bacterial guidelines performance at Opunake Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/13	0%	0/13	0%

4.8.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Opunake Beach over 18 summers are presented in Table 49 and Figure 27.

Table 49 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**	**2012-13**
Minimum	<1	<1	<1	<1	<1	<1	<1	<1	<1
Maximum	10	19	8	11	25	4	100	17	7
Median	1	2	1	<1	2	<1	<1	3	<1

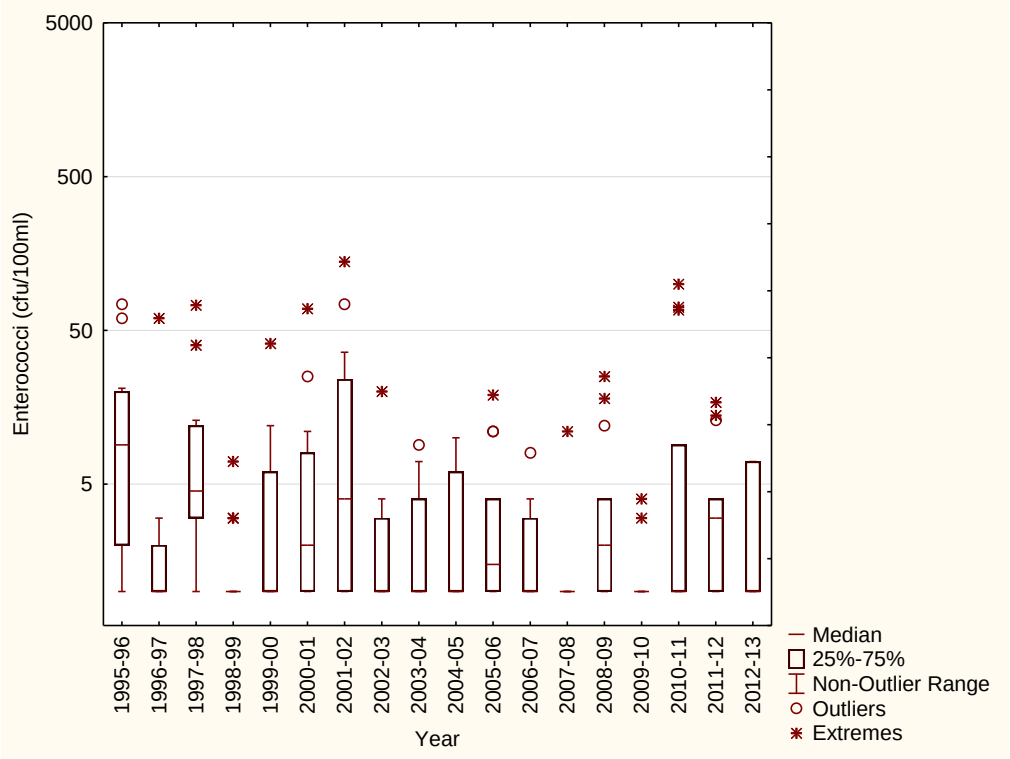

Figure 27 Box and whisker plots of enterococci for all summer SEM surveys at Opunake Beach

The low enterococci data obtained for Opunake Beach during the 2012-2013 summer continues the trend of excellent water quality at this site (Table 49, Figure 27).

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 18 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.

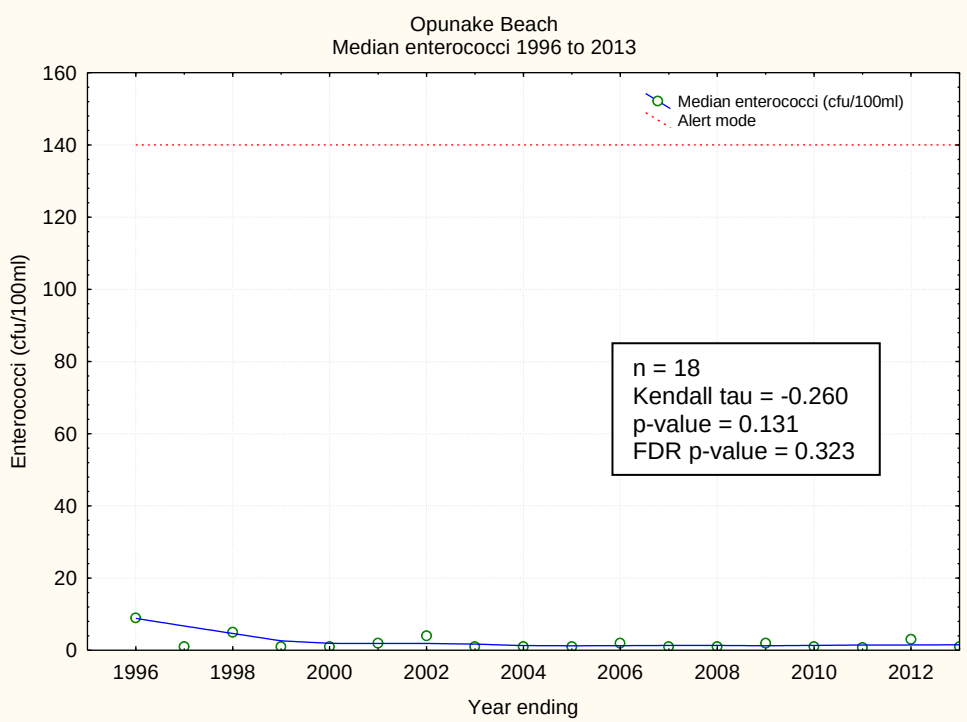

Figure 28 LOWESS trend analysis of median enterococci data at Opunake Beach

Over the 18 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.260) that was not significant at the 5% level (p = 0.131).

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 50 and Figure 29, with a statistical summary in Table 51.

Table 50 Bacteriological results for MfE samples at Opunake Beach

Date	Time	Conductivity @ 20°C	Bacteria			Temperature
	(NZST)	(mS/m)	*E. coli* (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	(°C)
06 Nov 2012	12:10	4550	<1	<1	<1	17.1
19 Dec 2012	13:15	4680	<1	<1	<1	19.9
07 Jan 2013	13:45	4720	<1	1	<1	20.0
22 Jan 2013	13:35	4700	<1	<1	<1	19.7

07 Feb 2013	13:30	4740	<1	1	<1	19
21 Feb 2013	12:55	4750	<1	<1	<1	19.9
21 Mar 2013	11:40	4770	<1	<1	<1	19.5

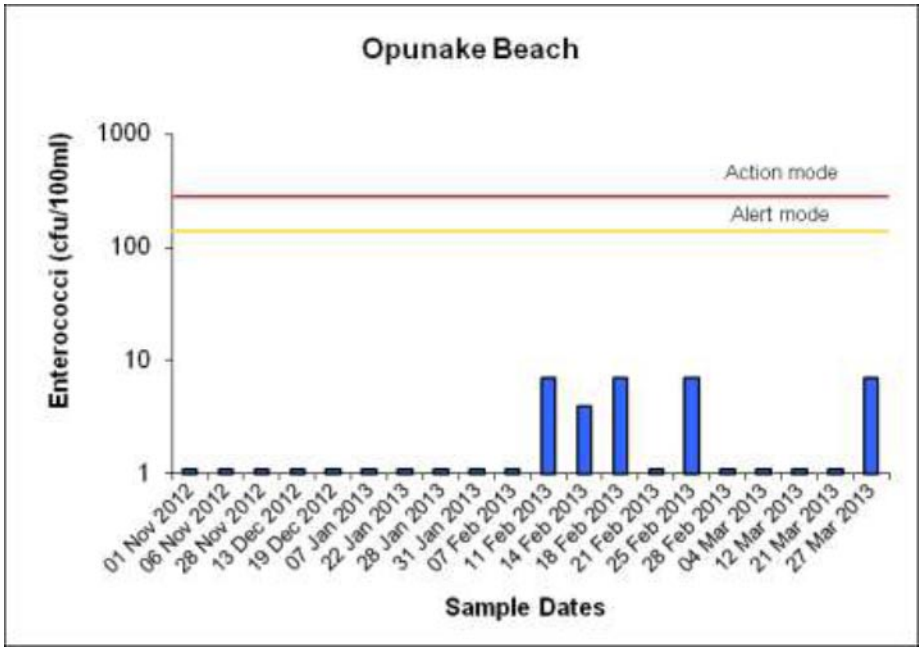

Figure 29 Enterococci numbers for the 20 sample extended survey at Opunake Beach

Table 51 Summary statistics for SEM and MfE samples at Opunake Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	20	3120	4770	4735
E. coli	cfu/100ml	20	<1	25	<1
Enterococci	cfu/100ml	20	<1	7	<1
Faecal coliforms	cfu/100ml	20	<1	25	<1
Temperature	°C	20	16.3	22.5	19.5

The additional MfE samples made no difference to the medians for all faecal indicator bacteria, reflecting consistently high water quality at this site.

4.8.6 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 52. No samples exceeded Alert level.

Table 52 Bacterial guidelines performance at Oakura Beach SC

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/20	0%	0/20	0%

4.9 Ohawe Beach

4.9.1 SEM programme

Ohawe Beach (Photo 10) is located close to the large Waingongoro River in South Taranaki.

This river passes through Eltham, previously accepting factory discharge (eg Riverlands) and sewage pond waste. In addition, the catchment drains highly modified agricultural land.

Photo 10 Ohawe Beach

Data from this site are presented in Table 53 and Figure 30, with a statistical summary provided in Table 54.

Table 53 Bacteriological results for Ohawe Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	11:00	3850	12	12	14	16.7
28 Nov 2012	09:30	3750	31	37	33	16.9
13 Dec 2012	08:15	4400	13	15	15	17.0
28 Jan 2013	10:45	4670	530	160	530	21.8
31 Jan 2013	12:25	4520	5	5	5	21.7
11 Feb 2013	10:40	4590	84	110	86	20.3
14 Feb 2013	12:30	4230	43	630	46	19.9
18 Feb 2013	15:40	4740	1	<1	3	21.6
25 Feb 2013	10:10	4740	28	100	28	19.3
28 Feb 2013	11:35	4460	13	180	16	19.2
04 Mar 2013	14:25	4460	8	4	8	20.1
12 Mar 2013	09:50	4760	1	8	1	19.0
27 Mar 2013	10:20	4380	220	230	220	19.2

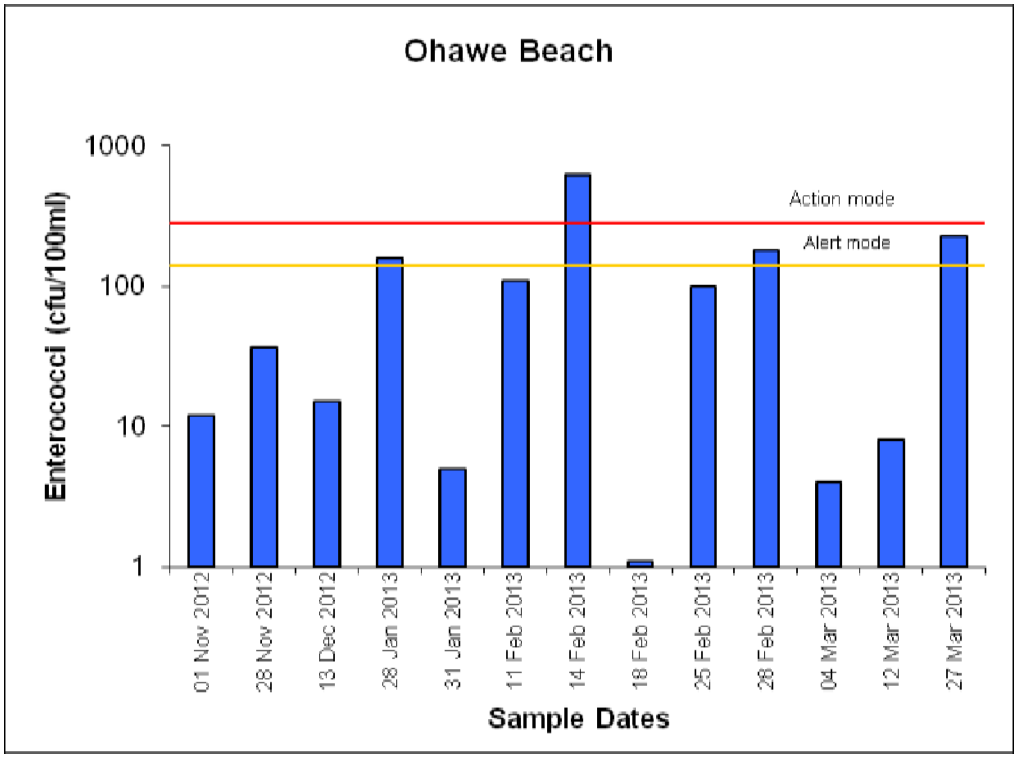

Figure 30 Enterococci numbers for the 13 SEM samples at Ohawe Beach

Table 54 Statistical summary for Ohawe Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	3750	4760	4460
E. coli	cfu/100ml	13	1	530	13
Enterococci	cfu/100ml	13	<1	630	37
Faecal coliforms	cfu/100ml	13	1	530	16
Temperature	°C	13	16.7	21.8	19.3

Relative to other beach bathing sites around the region, the median bacteria counts at this site were high (enterococci 37 cfu/100ml, *E. coli* 13 cfu/100ml and faecal coliforms 16 cfu/100ml). This site also had the greatest number of individual samples entering the 'Alert' mode (Figure 30). The site can be influenced by the Waingongoro River (see low conductivities recorded at the beginning of the season, Table 53). During the 2012-2013 season, microbial source tracking from samples taken at the river mouth and just upstream of the Ohawe settlement indicated that the main source of faecal contamination in the river was from ruminants and wildfowl (TRC 2013-01). However, of the four 'Alert' level samples taken from the Ohawe Beach site, only two showed evidence of freshwater influence (14 February and 27 March 2013, Table 53). High enterococci counts in samples taken on 28 January and 28 February 2013 (Table 53) remain unexplained.

4.9.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 55. Enterococci counts in four samples entered the Alert category. This was greater than any other coastal site in Taranaki during the 2012-2013 season.

Table 55 Bacterial guidelines performance at Ohawe Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100ml	
Enterococci	4/13	31%	0/13	0%

4.9.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Ohawe Beach over 17 summers are presented in Table 56 and Figure 31.

Table 56 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**	**2012-13**	
Minimum	1	<1	<1	2	3	<1	2	<1	
Maximum	1600	80	1800	280	350	83	160	630	
Median	13	7	5	20	16	7	34	37	

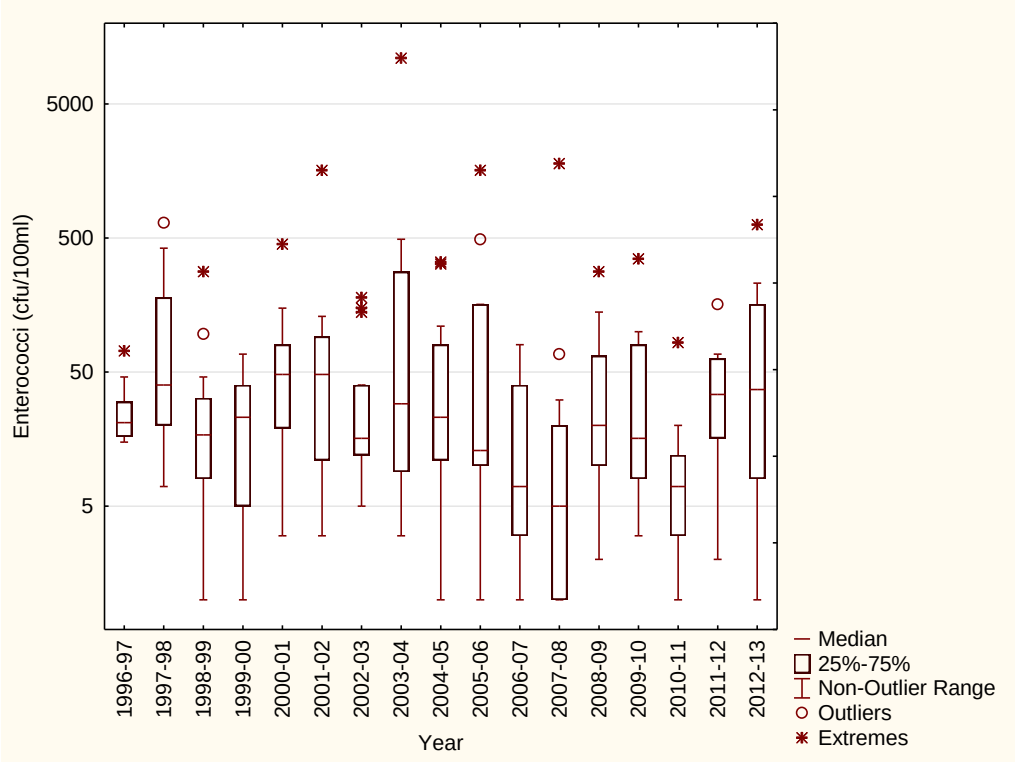

Figure 31 Box and whisker plots of enterococci for all summer surveys at Ohawe Beach

Minima, maxima and median enterococci counts were within the range recorded in previous monitoring periods at this site (Table 56, Figure 31). Maxima and medians at this site are historically variable due to the influence of the Waingongoro River (Table 56).

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 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.

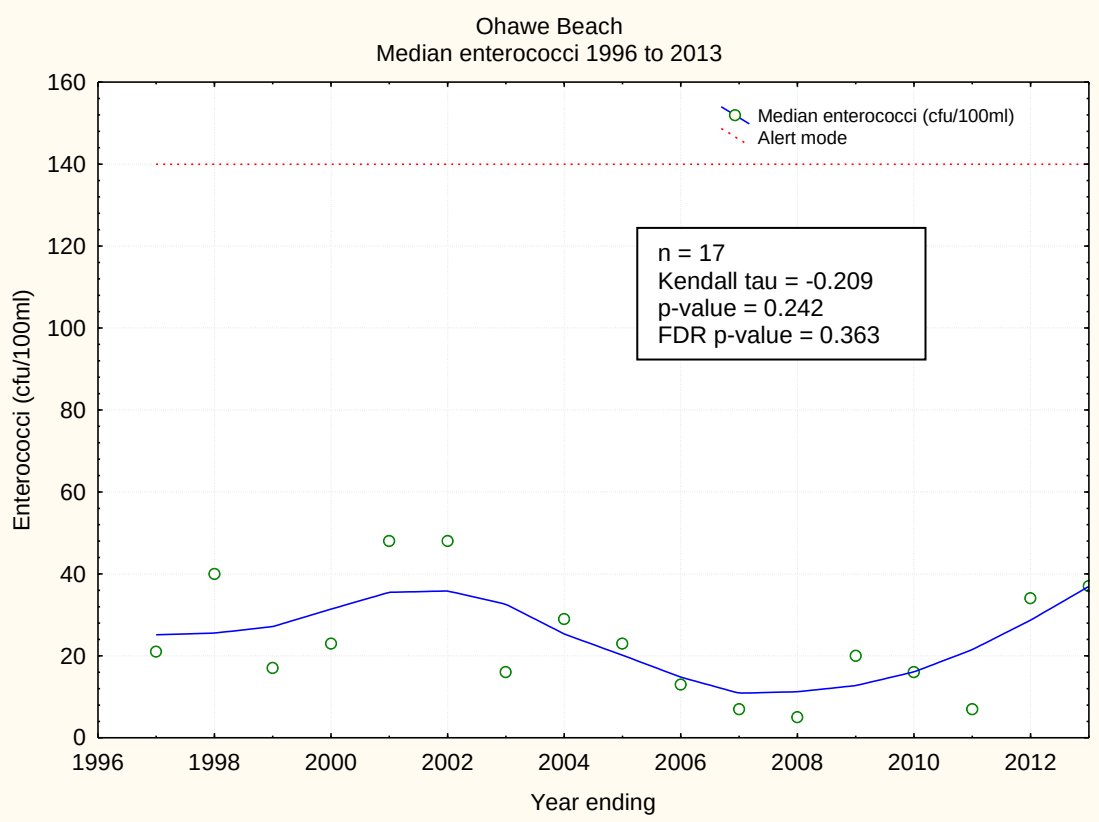

Figure 32 LOWESS trend analysis of median enterococci data at Ohawe Beach

Over the 17 seasons monitored, there was a decreasing trend in median enterococci counts (Kendall tau = -0.209) that was not significant at the 5% level (p = 0.242).

4.10 Patea Beach (SEA907020)

4.10.1 SEM programme

Patea Beach is situated at the mouth of the Patea River, which has the third largest catchment area in Taranaki. The sampling site is separated from the river by the northern of two moles, which direct the freshwater flow away from the shore. Recreational use is high over the summer holiday period, however younger swimmers tend to use the more sheltered adjacent area of Mana Bay.

Data from this site are presented in Table 57 and Figure 33, with a statistical summary provided in Table 58.

Table 57 Bacteriological results for Patea Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	10:15	4690	6	<2	6	16.8
28 Nov 2012	10:35	4690	1	1	1	16.8
13 Dec 2012	09:25	4680	3	<1	3	17.9

28 Jan 2013	10:05	4680	<1	<1	<1	22.2
31 Jan 2013	11:45	4740	5	3	5	22.6
11 Feb 2013	09:50	4680	13	31	15	20.3
14 Feb 2013	11:45	4710	11	6	11	20.1
18 Feb 2013	14:45	4700	<2	<1	<2	21.1
25 Feb 2013	09:25	4740	<1	<1	<1	19.1
28 Feb 2013	10:45	4720	8	4	8	20.3
04 Mar 2013	13:40	4740	1	5	1	19.7
12 Mar 2013	09:15	4750	<1	1	<1	18.3
27 Mar 2013	09:35	4740	3	5	3	19.5

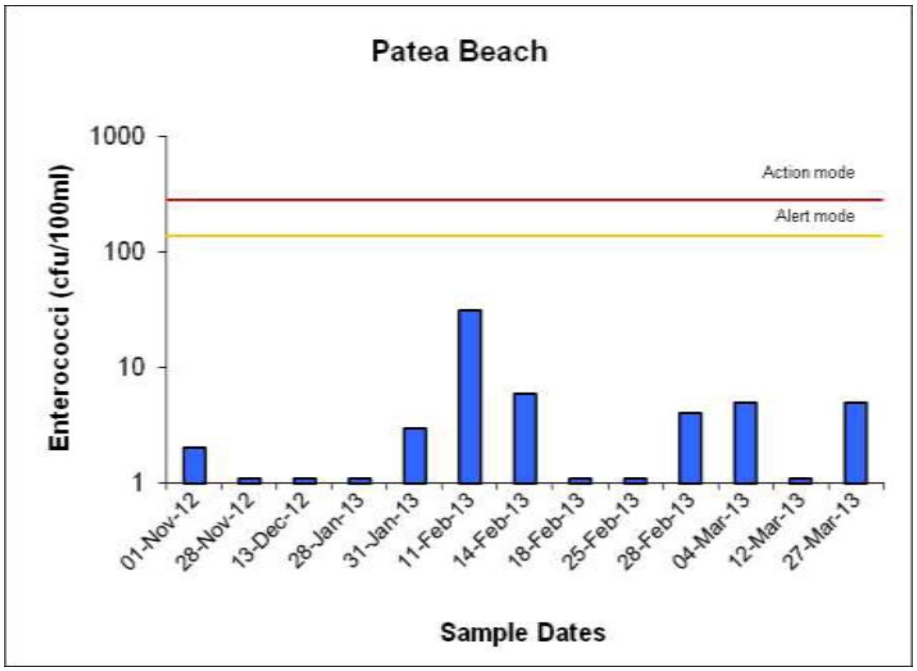

Figure 33 Enterococci numbers for the 13 SEM samples at Patea Beach

Table 58 Statistical summary for Patea Beach

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4680	4750	4710
E. coli	cfu/100ml	13	<1	13	3
Enterococci	cfu/100ml	13	<1	31	2
Faecal coliforms	cfu/100ml	13	<1	15	3
Temperature	°C	13	16.8	22.6	19.7

Water quality at Patea Beach remained high throughout the season, with low median and maximum values for all faecal indicator bacteria (Figure 33, Table 58).

4.10.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 59. Water quality was considered suitable for contact recreation throughout the season, with all samples well below Alert guideline levels.

Table 59 Bacterial guidelines performance at Patea 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%

4.10.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Patea Beach over 6 summers are presented in Table 60 and Figure 34.

Table 60 Summary enterococci data (cfu/100ml) for summer surveys at Patea Beach

Summer	1997/1998	2000/2001	2003/2004	2006/2007	2009/2010	2012/2013
Minimum	1	< 1	< 1	<1	<1	<1
Maximum	20	37	17	40	180	31
Median	4	7	3	8	3	2

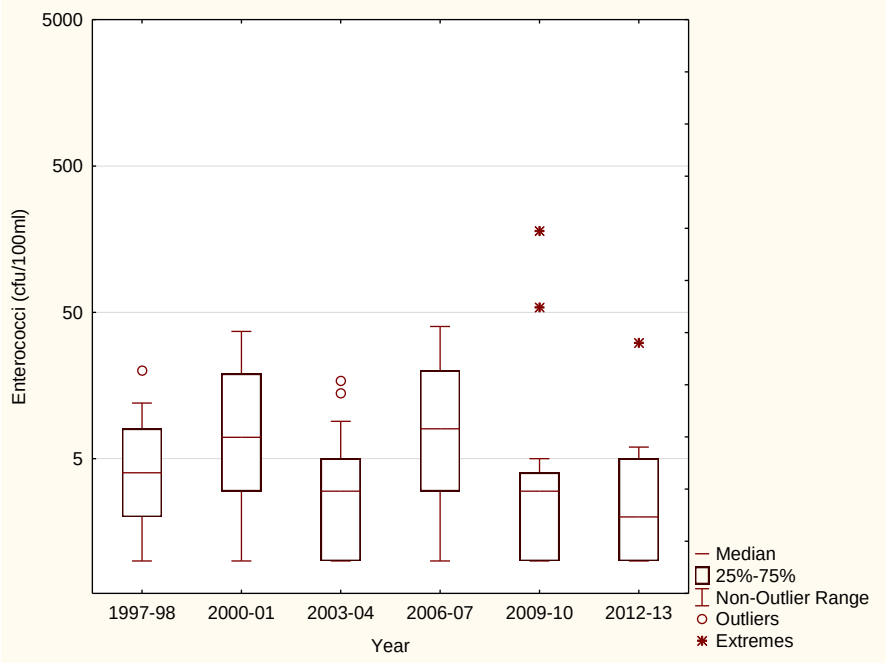

Figure 34 Box and whisker plots of enterococci for all summer SEM surveys at Patea Beach

Since the records began in 1997, median and maximum enterococci counts at Patea Beach have generally been low compared to other Taranaki beach bathing sites. The median enterococci count (2 cfu/100ml) obtained for the 2012-2013 summer season at Patea Beach was the lowest to date.

4.11 Patea (Mana) Bay (SEA902022)

4.11.1 SEM programme

Patea or Mana Bay (Photo 11) is a sheltered area inside the northern mole at the mouth of the Patea River. Recreational use is high over the summer holiday period, particularly by young children.

Photo 11 Patea ('Mana') Bay

Data from this site are presented in Table 61 and Figure 35, with a statistical summary provided in Table 62.

Table 61 Bacteriological results for Mana Bay

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	10:05	4680	2	<2	2	16.4
28 Nov 2012	10:25	4680	<1	1	<1	16.8
13 Dec 2012	09:15	4680	11	15	11	17.8
28 Jan 2013	09:55	4700	<1	<1	<1	21.9
31 Jan 2013	11:35	4720	3	1	3	22.9
11 Feb 2013	09:40	4670	13	64	13	20.8
14 Feb 2013	11:35	4720	3	8	3	19.9
18 Feb 2013	14:35	4710	<2	1	<2	21.2
25 Feb 2013	09:15	4740	1	4	1	19.0
28 Feb 2013	10:40	4700	13	3	13	20.0
04 Mar 2013	13:30	4740	1	4	3	19.8
12 Mar 2013	09:05	4740	2	2	2	18.3
27 Mar 2013	09:25	4730	<1	1	<1	19.2

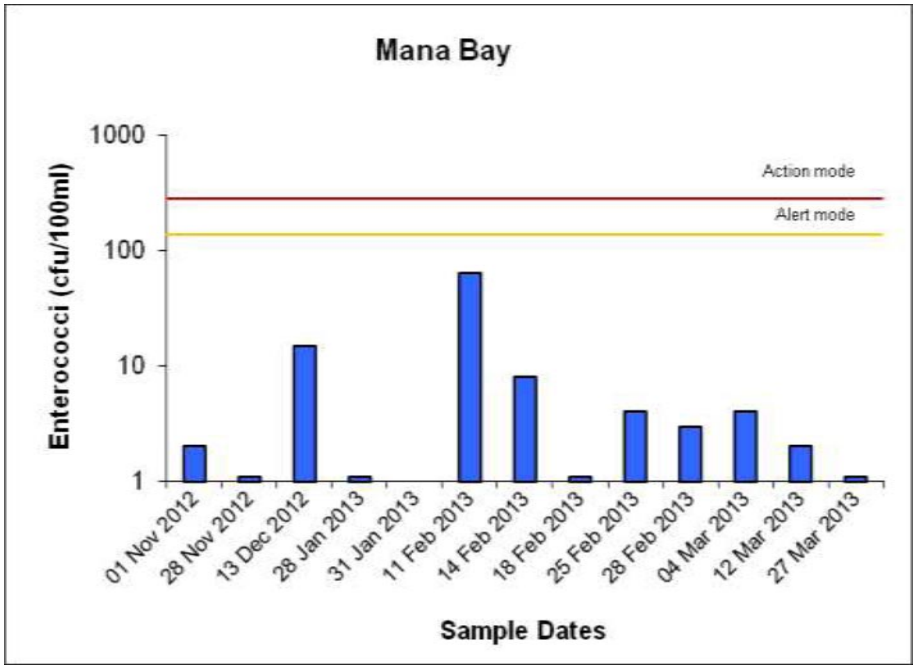

Figure 35 Enterococci numbers for the 13 SEM samples at Mana Bay

Table 62 Statistical summary for Mana Bay

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4670	4740	4710
E. coli	cfu/100ml	13	<1	13	2
Enterococci	cfu/100ml	13	<1	64	2
Faecal coliforms	cfu/100ml	13	<1	13	2
Temperature	°C	13	16.4	22.9	19.8

Water quality at Mana Bay remained high throughout the season, with low median and maximum values for all faecal indicator bacteria (Figure 35, Table 62).

4.11.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 63. Water quality was considered suitable for contact recreation throughout the season, with all samples well below Alert guideline levels.

Table 63 Bacterial guidelines performance at Mana Bay

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/13	0%	0/13	0%

4.11.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Mana Bay over 6 summers are presented in Table 64 and Figure 36.

Table 64 Summary enterococci data (cfu/100ml) for summer surveys at Mana Bay

Summer	2000/2001	2003/2004	2006/2007	2009/2010	2012/13
Minimum	1	< 1	<1	<1	<1
Maximum	40	54	20	48	64
Median	5	3	5	2	2

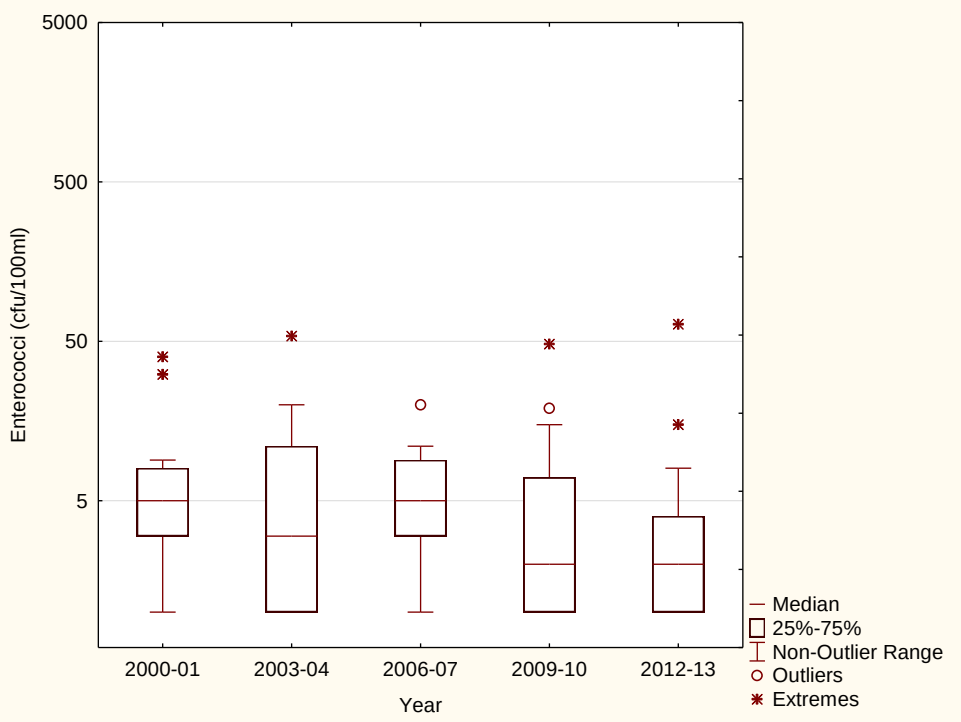

Figure 36 Box and whisker plots of enterococci for all summer surveys at Mana Bay

Since the records began in 2000, median and maximum enterococci counts at Mana Bay have been low compared to other Taranaki beach bathing sites. The median enterococci count (2 cfu/100ml) obtained for the 2012-2013 summer season at Mana Bay was one of the lowest to date.

4.12 Waverley Beach (SEA907085)

4.12.1 SEM programme

Waverley Beach (Photo 12) is well used during the summer months, in part due to the location of a popular campground nearby. As the beach is relatively sheltered, it provides a safe area for recreational water sports.

Photo 12 Waverley Beach

Data from this site are presented in Table 65 and Figure 42, with a statistical summary provided in Table 66.

Table 65 Bacteriological results for Waverley Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	09:30	4660	2	<2	2	16.6
28 Nov 2012	11:05	4510	<1	3	<1	17.2
13 Dec 2012	10:10	4710	17	1	17	18.3
28 Jan 2013	09:20	4730	<1	3	<1	20.6
31 Jan 2013	11:00	4730	3	1	3	22.4
11 Feb 2013	09:05	4660	12	11	12	19.6
14 Feb 2013	11:00	4640	8	11	8	19.5
18 Feb 2013	13:55	4640	3	4	7	21.2
25 Feb 2013	08:35	4690	4	1	4	17.4
28 Feb 2013	10:00	4730	<1	1	<1	19.3
04 Mar 2013	13:00	4690	4	3	4	19.8
12 Mar 2013	08:30	4660	33	11	33	17.7
27 Mar 2013	08:50	4740	9	3	9	18.3

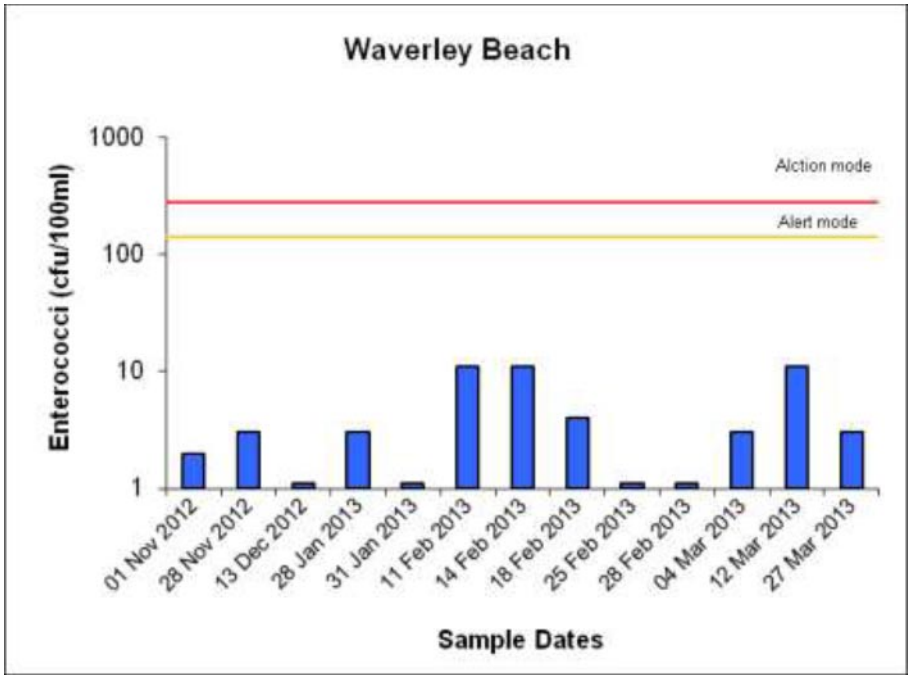

Figure 37 Enterococci numbers for the 13 SEM samples at Waverley Beach

Table 66 Statistical summary for Waverley

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4510	4740	4690
E. coli	cfu/100ml	13	<1	33	4
Enterococci	cfu/100ml	13	1	11	3
Faecal coliforms	cfu/100ml	13	<1	33	4
Temperature	°C	13	16.6	22.4	19.3

Water quality at Waverley Beach remained high throughout the season, with low median and maximum values for all faecal indicator bacteria (Figure 37, Table 66).

4.12.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 67. Water quality was considered suitable for contact recreation throughout the season, with all samples well below Alert guideline levels.

Table 67 Bacterial guidelines performance at Waverley Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/13	0%	0/13	0%

4.12.3 Comparison with previous summer surveys

Summary statistics for enterococci data collected at Waverley Bay over 6 summers are presented in Table 68 and Figure 38.

Table 68 Summary enterococci data (cfu/100ml) for summer surveys at Waverley Beach

Summer	1997/1998	2000/2001	2003/2004	2006/2007	2009/2010	2012/2013
Minimum	< 1	1	< 1	<1	<1	1
Maximum	31	140	9	42	8	11
Median	6	4	3	3	4	3

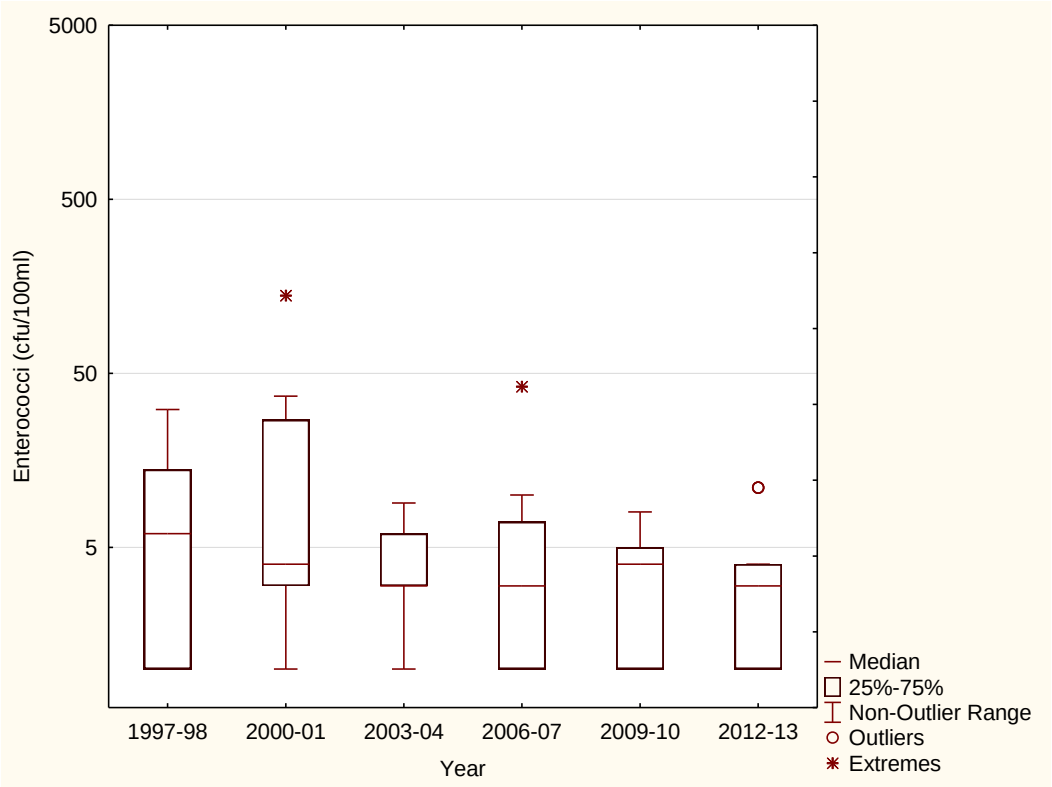

Figure 38 Box and whisker plots of enterococci for all summer SEM surveys at Waverley Beach

Since the records began in 1997, median and maximum enterococci counts at Waverley Beach have generally been low compared to other Taranaki beach bathing sites. The median enterococci count (3 cfu/100ml) obtained for the 2012-2013 summer season at Waverley Beach was one of the lowest to date.

4.13 Wai-inu Beach (SEA907095)

4.13.1 SEM programme

Wai-inu Beach (Photo 13) is the southern-most beach in the SEM programme. The site is adjacent to the Wai-inu Beach settlement and campground. Small fishing boats are launched over the iron-sand beach.

Photo 13 Surfer at Wai-inu Beach

Data from this site are presented in Table 69 and Figure 39, with a statistical summary provided in Table 70.

Table 69 Bacteriological results for Wai-inu Beach

Date	Time (NZST)	Conductivity @ 20°C (mS/m)	Bacteria			Temp (°C)
			E. coli (cfu/100ml)	Enterococci (cfu/100ml)	Faecal coliforms (cfu/100ml)	
01 Nov 2012	09:00	4570	<2	<2	<2	16.8
28 Nov 2012	12:05	4490	1	3	1	18.4
13 Dec 2012	10:55	4720	<1	<1	<1	18.4
28 Jan 2013	08:45	4680	<1	1	<1	21.5
31 Jan 2013	10:20	4640	1	7	1	22.8
11 Feb 2013	08:35	4590	3	1	3	19.7
14 Feb 2013	10:25	4450	20	11	20	19.7

18 Feb 2013	13:25	4690	<1	<1	<1	22.3
25 Feb 2013	08:00	4680	<1	3	<1	18.1
28 Feb 2013	09:15	4700	<1	<1	<1	19.4
04 Mar 2013	12:25	4620	3	7	3	20.4
12 Mar 2013	08:05	4660	3	16	3	17.4
27 Mar 2013	08:10	4740	1	1	1	17.6

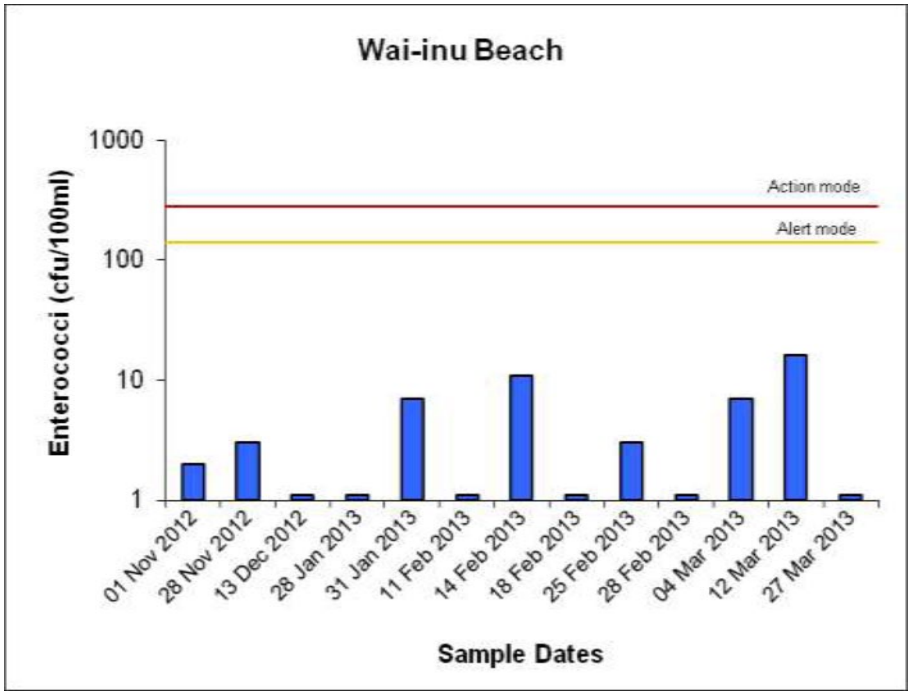

Figure 39 Enterococci counts for the 13 SEM samples at Wai-inu Beach

Table 70 Statistical summary for Wai-inu

Parameter	Unit	Number of samples	Minimum	Maximum	Median
Conductivity @ 20°C	mS/m	13	4450	4740	4660
E. coli	cfu/100ml	13	<1	20	1
Enterococci	cfu/100ml	13	<1	16	2
Faecal coliforms	cfu/100ml	13	<1	20	1
Temperature	°C	13	16.8	22.8	19.4

Water quality at Wai-inu Beach remained high throughout the season, with low median and maximum values for all faecal indicator bacteria (Figure 39, Table 70).

4.13.2 Compliance with guidelines

Compliance with the 2003 guidelines for marine contact usage is summarized in Table 71. Water quality was considered suitable for contact recreation throughout the season, with all samples well below Alert guideline levels.

Table 71 Bacterial guidelines performance at Waverley Beach

Parameter	Number of exceedances of enterococci guidelines			
	ALERT Single sample >140 cfu/100ml		ACTION Two consecutive samples >280 cfu/100 ml	
Enterococci	0/13	0%	0/13	0%

4.13.3 Comparison with previous summers' surveys

Summary statistics for enterococci data collected at Wai-inu Beach over 6 summers are presented in Table 72 and Figure 40.

Table 72 Summary enterococci data (cfu/100ml) for summer surveys at Wai-inu Beach

Summer	1997/1998	2000/2001	2003/2004	2006/2007	2009/2010	2012/2013
Minimum	1	< 1	< 1	<1	<1	<1
Maximum	88	15	31	210	15	16
Median	7	5	3	6	2	2

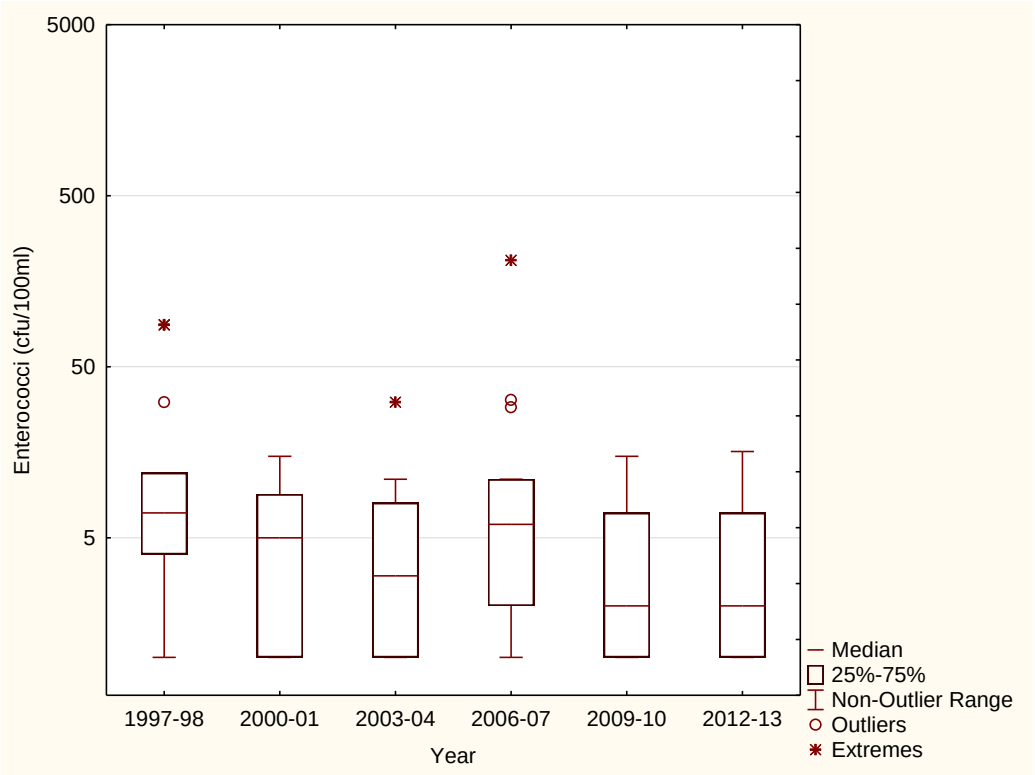

Figure 40 Box and whisker plots of enterococci for all summer SEM surveys at Wai-inu Beach

Since the records began in 1997, median enterococci counts at Wai-inu Beach have generally been low compared to other Taranaki beach bathing sites. The median enterococci count (2 cfu/100ml) obtained for the 2012-2013 summer season at Wai-inu Beach was one of the lowest to date.

5. General summary

5.1 Regional overview

During the 2012-2013 summer season, microbiological water quality was generally very good across bathing beaches in the Taranaki region (Table 73). Low median enterococci values were recorded for all beaches monitored (≤37 enterococci cfu/100ml). Out of the 204 samples collected at 13 beach sites, 96% were below guideline Alert levels (140 enterococci cfu/100ml). One site, Waitara East, reached Action mode (two consecutive samples >280 enterococci cfu/100ml) once during the 2012-2013 season. All sites assessed obtained a Suitability for Recreation Grade of either 'good' (8/13), 'fair' (4/13) or 'poor' (1/10). These grades reflect qualitative risk grading of the catchment in addition to quantitative enterococci results (see Section 2.2).

Table 73 Summary enterococci results for the TRC beach bathing monitoring programme 2012-2013

Beach sites[1]	Enterococci median (cfu/100 ml)		Number of samples above Alert mode (>140 cfu/100ml)		Trend analysis[4]			Suitability for recreation grade (SFRG)[6]
	SEM[2]	SEM+MfE[3]	SEM[2]	SEM+MfE[3]	Kendall tau[5]	Mann-Kendall p value	False Discovery Rate p value	
Opunake	<1	<1	0	0	-0.260	0.131	0.323	Good
Mana Bay	2	-	0	-	-	-	-	Good
Patea	2	-	0	-	-	-	-	Good
Wai-inu	2	-	0	-	-	-	-	Good
Fitzroy	3	3	0	0	-0.444	0.010	0.054	Good
Waverley	3	-	0	-	-	-	-	Good
Oakura CG	3	-	1	-	-0.223	0.195	0.351	Good
Ngamotu	4	4	0	0	-0.433	0.012	0.054	Good
Waitara West	8	-	0	-	-0.008	0.966	0.966	Fair
Onaero	15	8	0	1	0.114	0.624	0.760	Fair
Oakura SC	17	19	1	1	0.253	0.143	0.323	Fair
Waitara East	37	-	2	-	-0.075	0.676	0.760	Poor
Ohawe	37	-	4	-	-0.209	0.242	0.363	Fair

[1]Sites ordered in ascending order of SEM median enterococci
[2]SEM results based on 13 samples
[3]SEM+MfE results based on 20 samples (MfE data available for selected sites only)
[4]Trend analysis performed on SEM data only (Section 3.4)
[5]A negative/positive Kendall tau indicates a decreasing/increasing temporal trend in median enterococci respectively
[6]The 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
[6]Patea (Mana Bay) site not included in table as not an annual SEM site, but SFRG available ('good')
- = insufficient data

Opunake was the region's cleanest bathing beach with a median enterococci count of <1 cfu/100ml and no samples reaching Alert mode throughout the 2012-2013 season (Table 73, Figure 41). Water quality at this beach has remained consistently high since the Taranaki Regional Council bathing beach monitoring programme began in 1995-1996 (Figure 42).

Waitara East and Ohawe recorded the highest enterococci medians of the 2012-2013 season (37 cfu/100ml). Bacteriological water quality at these two sites has been historically variable due to the influence of nearby rivers. Of the individual samples with high counts (>140 cfu/100ml) recorded during the 2012-2013 season, approximately half could be attributed to freshwater influence, while the other half remained unexplained.

Long term trend analysis (11-18 years data) showed a significant (at the 5% level) decrease in enterococci medians at 2 of the 13 sites monitored (Fitzroy and Ngamotu) and no significant change at 10 of the 12 sites (Table 73, Kendall tau and Mann-Kendall p values). No 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 73, Kendall tau -0.444, Mann-Kendall p value 0.010). 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. 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.

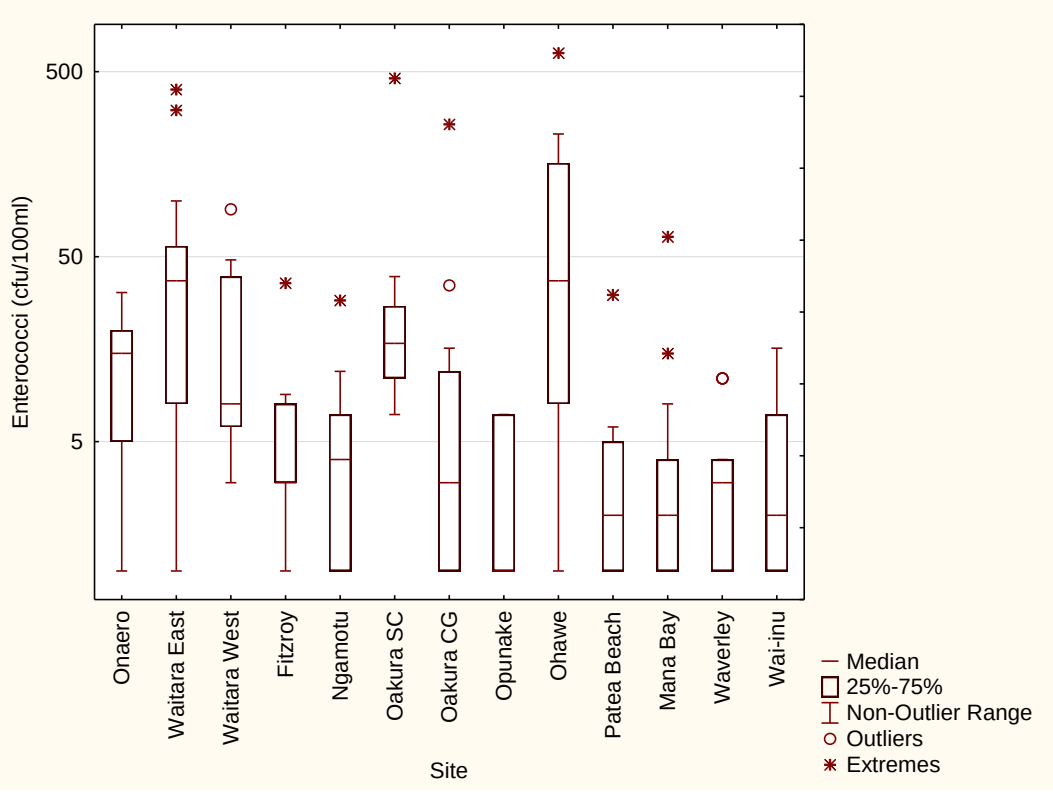

Figure 41 Box and whisker plots of enterococci at all sites during the 2012-2013 season (SEM data only)

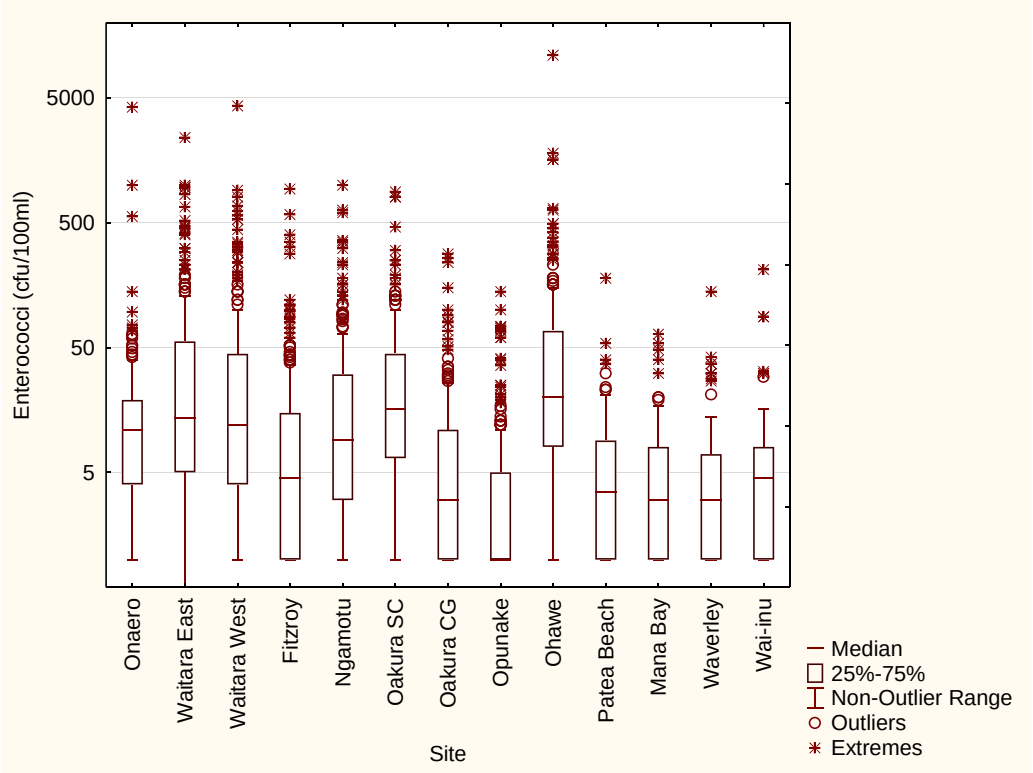

Figure 42 Box and whisker plots of long term enterococci data from 1995/implementation of monitoring to 2013 (SEM data only)

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 2013 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 43).

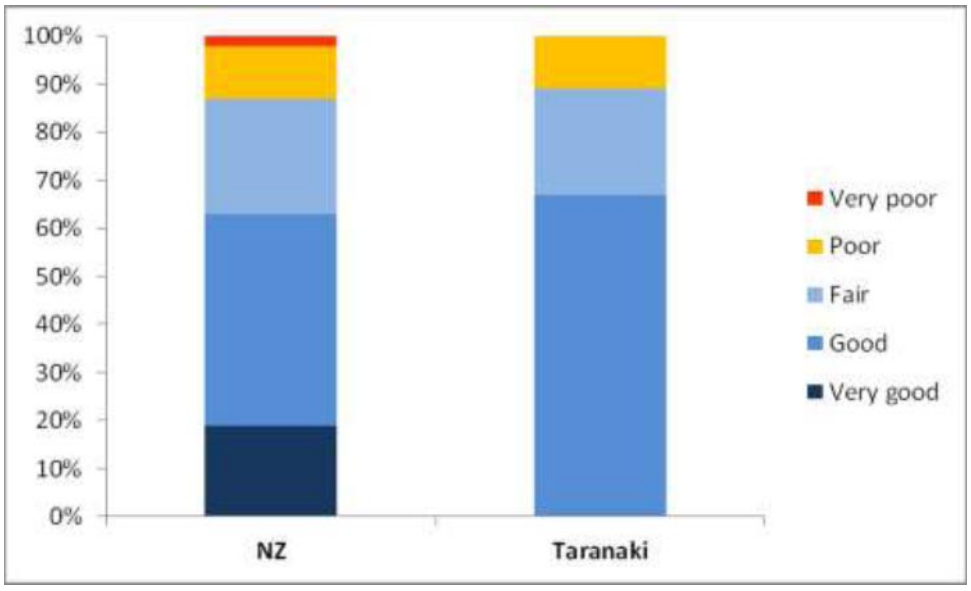

Figure 43 SFRG grades up to 2013 derived from five years enterococci data and catchment assessment

In general, microbiological water quality was good across New Zealand with 19%, 44% and 24% 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 67% and 22% 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, 11% of beaches (2 sites: Waitara East and Bell Block) received a 'poor' grade, compared to 11% 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 2012-2013 summer season, water quality across the Taranaki region was generally high with 96% of samples below guideline Alert levels (<141 enterococci cfu/100ml) and only one site reaching Action mode (two consecutive samples >280 enterococci cfu/100ml). Sites in Taranaki compared favorably to national results, with 89% of Taranaki sites considered generally satisfactory for swimming based on SFRG grades ('very good', 'good' and 'fair'), compared to 87% nationally (Section 5.2). In Taranaki, of the few samples which entered the Alert category (4%) during the 2012-2013 season approximately half were associated with 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 revealed that in addition to ruminants, birds (wildfowl and gulls) can also act as a key source of contamination in Taranaki freshwater environments (TRC 2010 and 2011, 2013). 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 2012-2013 summer marine contact recreation bacteriological survey it is recommended:

1. THAT the 2013-2014 summer survey be performed at 12 sites continuing with the existing sampling protocol (annual, plus Year 2 sites).

2. THAT the 2013-2014 summer survey also includes an additional 7 samples collected at the five principal usage sites (Onaero, Fitzroy, Ngamotu, 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	A measurement of water quality over time as provided by historical (five years) microbiological results – A, B, C or D Category (MAC)
RMA	Resource Management Act 1991 and subsequent amendments
Sanitary Inspection Category (SIC)	A measure of the susceptibility of a water body to faecal contamination – Very High, High, Moderate, Low or Very Low
Suitability for Recreation Grade (SFRG)	A combination of Sanitary Inspection Category (SIC) and Microbiological Assessment Category (MAC), describes the general condition of a site at any given time, based on both risk and indicator bacteria counts
Temp	Temperature, measured in °C (degrees Celsius)
Water quality	The bacteriological condition of a water body as it relates to human health, measured using indicator bacteria

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

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Appendix I

High tide times

High tide times (NZST) at New Plymouth for 2012-2013 sampling dates

Date		Time of HT
Thursday	1 November 2012	1055
Wednesday	28 November 2012	0928
Thursday	13 December 2012	0916
Monday	28 January 2013	1032
Thursday	31 January 2013	1217
Monday	11 February 2013	1025
Thursday	14 February 2013	1225
Monday	18 February 2013	1525
Monday	25 February 2013	0931
Thursday	28 February 2013	1116
Monday	4 March 2013	1422
Tuesday	12 March 2013	1003
Wednesday	27 March 2013	0934

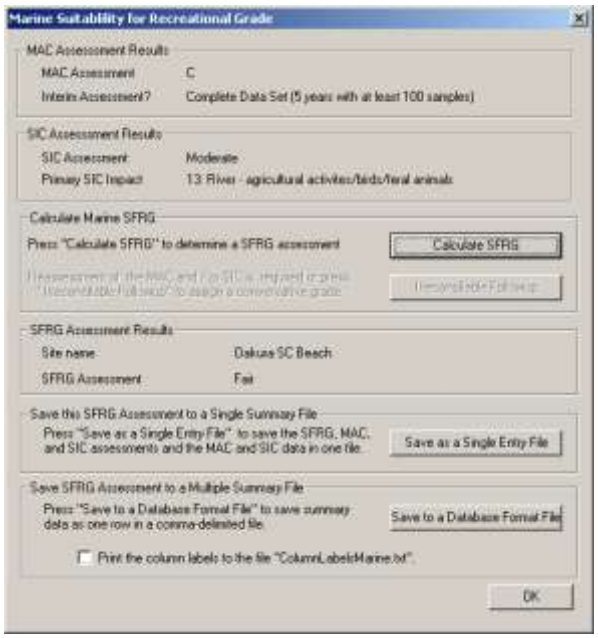
Appendix II

MAC assessments 2008-2013

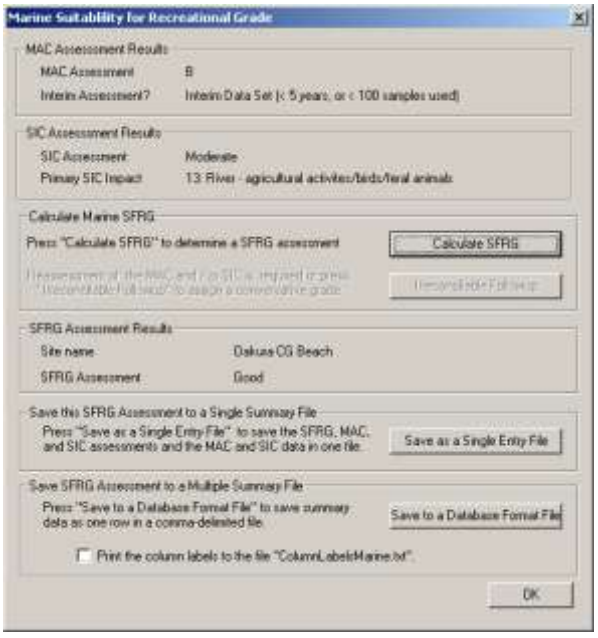
Onaero Beach

Nga Motu Beach

Oakura Beach (SC)



Oakura Beach (CG)

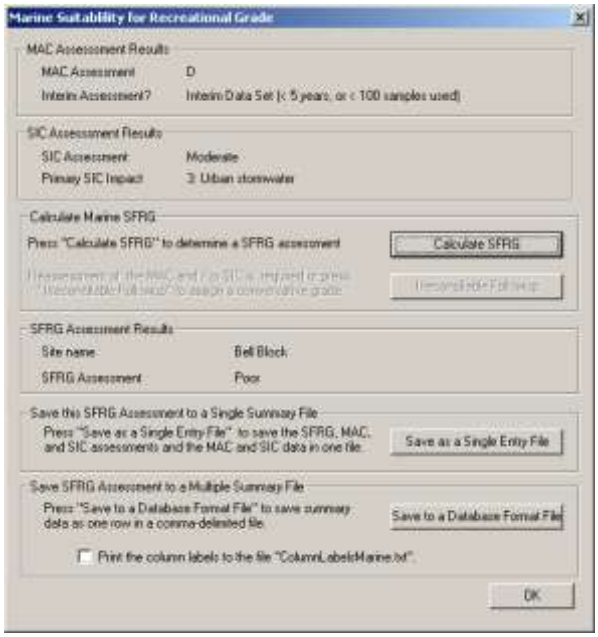


Ohawe Beach

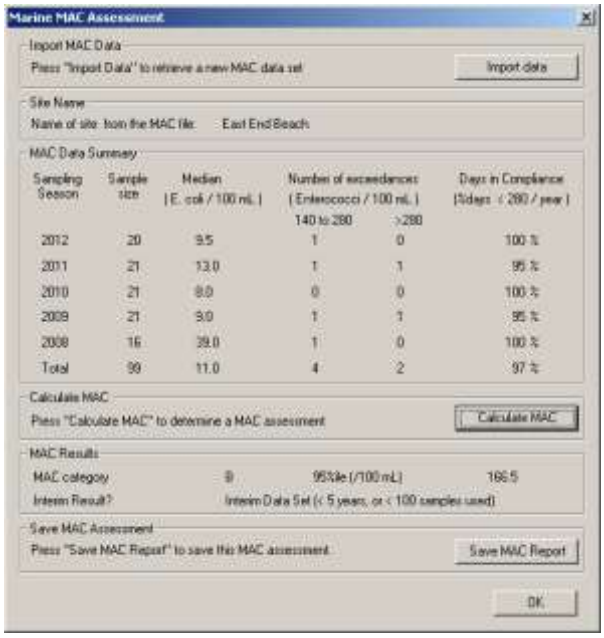
Opunake Beach

Fitzroy Beach

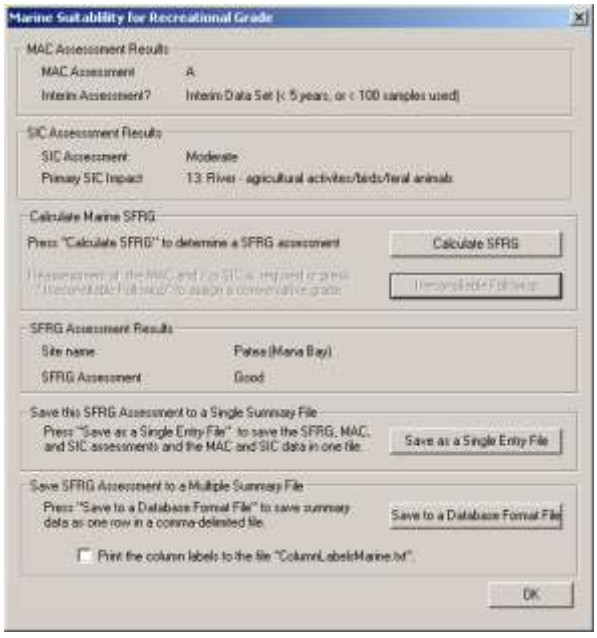
Bell Block



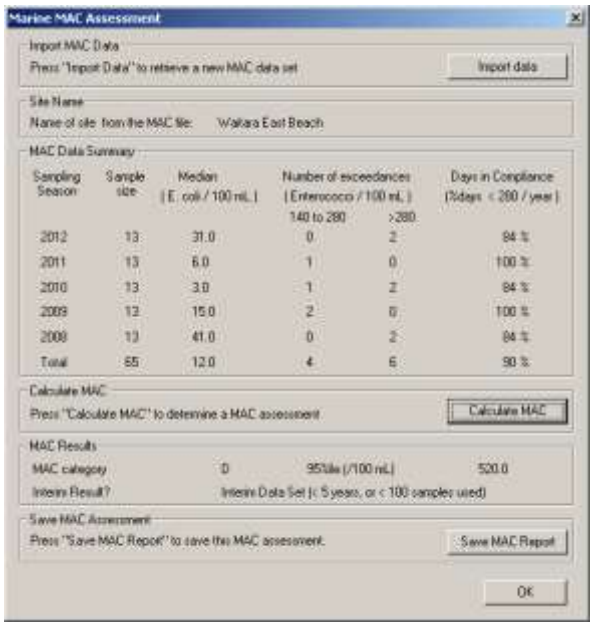
East End Beach



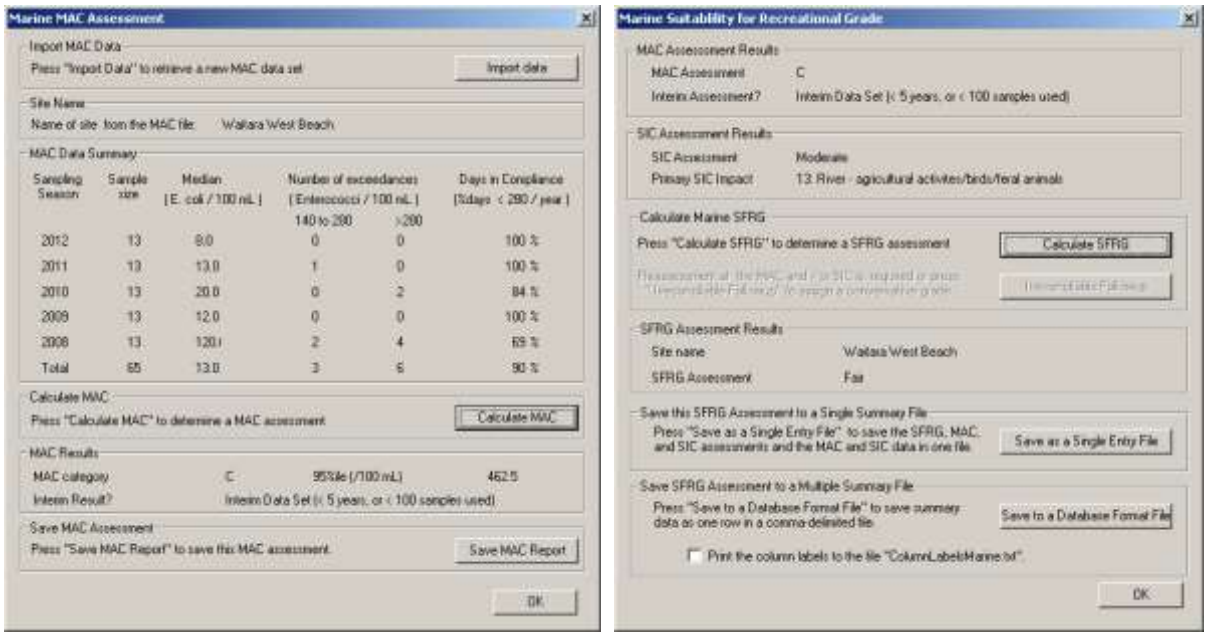
Patea (Mana Bay)



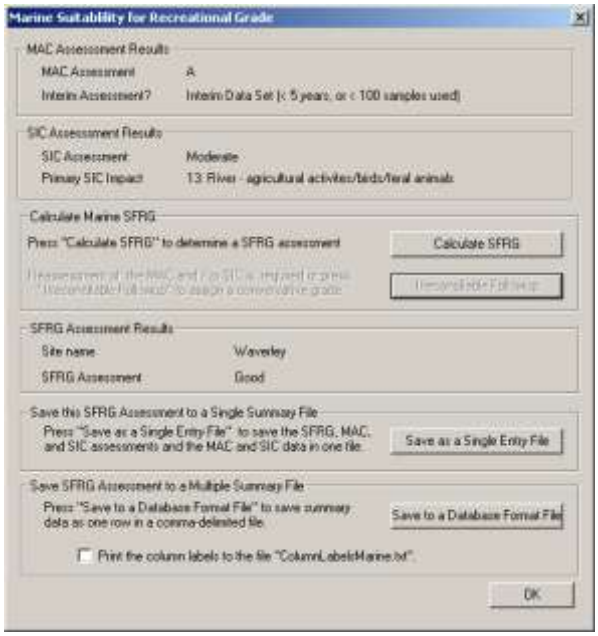
Waitara East Beach



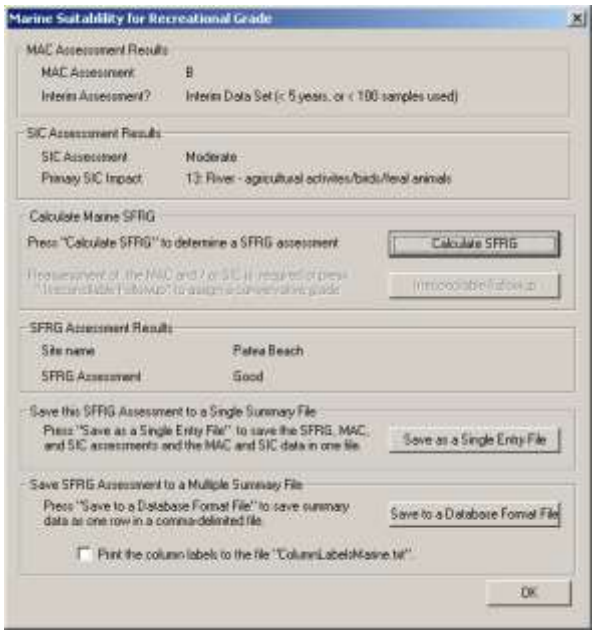
Waitara West Beach



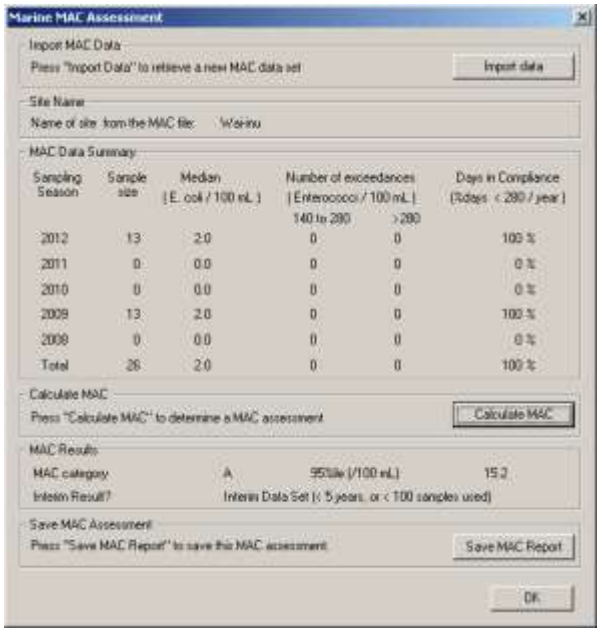
Waverley Beach



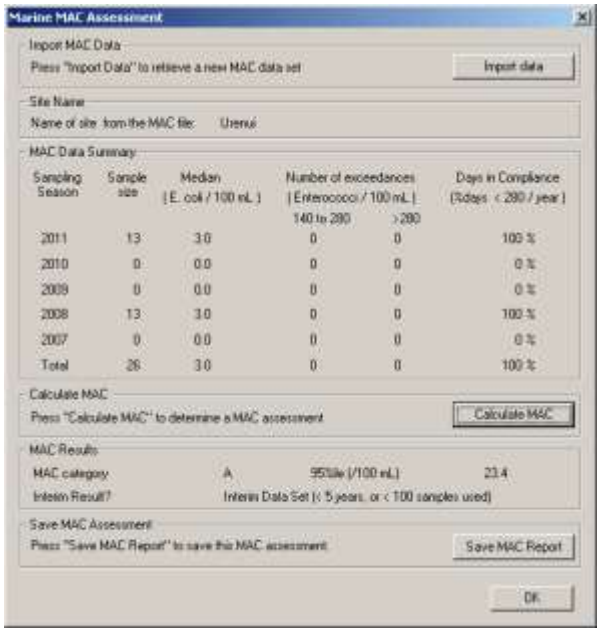
Patea Beach

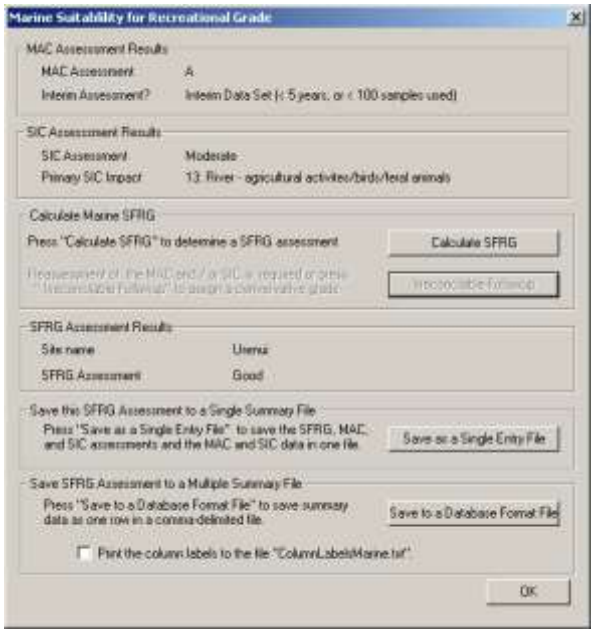


Wai-inu Beach



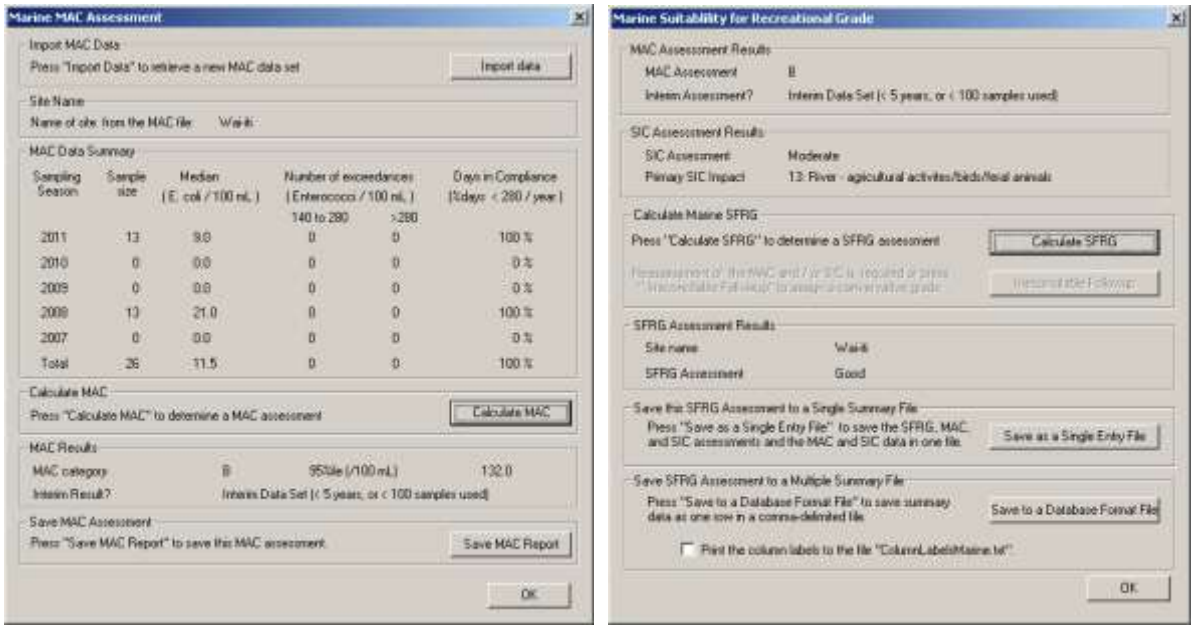
Urenui Beach





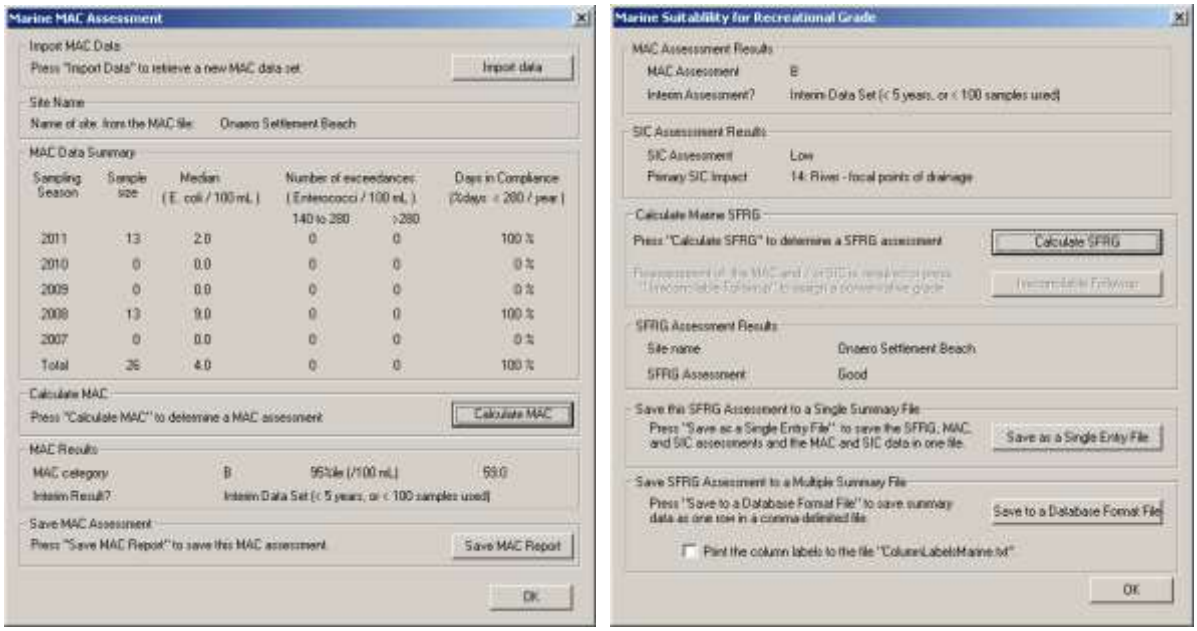
N.B. Correct dates used for analysis, but 2012-2013 data not available

Wai-iti Beach



N.B. Correct dates used for analysis, but 2012-2013 data not available

Onaero Settlement Beach



N.B. Correct dates used for analysis, but 2012-2013 data not available

Appendix III

SFRG 2007-2012

Suitability for recreation grade for the period November 2007 to April 2012

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		
Wai-iti	Moderate 13	132	26	B	Good	100
Urenui	Moderate 13	23	26	A	Good	100
Onaero	Low	240	100	C	Fair	96
Onaero settlement	Low 14	59	26	B	Good	100
Waitara (East)	Moderate 13	520	65	D	Poor	90
Waitara (West)	Moderate 13	463	65	C	Fair	90
Bell Block	Moderate 3	2156	26	D	Poor	96
Fitzroy	Moderate 3	87	102	B	Good	97
East End	Moderate 3	149	92	B	Good	97
Ngamotu	Moderate 3	196	102	B	Good	96
Back	Low 14	122	26	B	Good	100
Oakura (SC)	Moderate 13	286	101	C	Fair	95
Oakura (CG)	Moderate 13	33	67	A	Good	100
Opunake	Moderate 3	59	94	B	Good	100
Ohawe	Moderate 13	157	73	B	Fair	97
Patea (Mana Bay)	Moderate 13	32	46	A	Good	100
Patea	Moderate 13	Insufficent data to calculate				
Waverley	Moderate 13	Insufficent data to calculate				
Wai-inu	Moderate 13	Insufficent data to calculate				

* 13 = River - agricultural activities/birds/feral animals
14 = River - focal points of discharge
3 = Urban stormwater