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Recreational Water Quality in Hawke's Bay

Review of the 2005- 2006 Recreational Water Quality Monitoring Programme

May 2006
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Environmental Monitoring Section

Recreational Water Quality in Hawke's Bay: A review of the 2005-2006 Recreational Water Quality Monitoring Programme

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EXECUTIVE SUMMARY

Thirty sites were monitored as part of the 2005/06 Recreational Water Quality Monitoring Programme undertaken by Hawke's Bay Regional Council. This annual programme enables Council to assess the microbiological water quality of popular bathing areas, and elucidate trends in water quality throughout the region. In addition, for the 05/06 season five sites were also monitored to determine the suitability of areas for shellfish gathering.

Levels of faecal indicator bacteria were monitored at:

- fourteen marine sites (*Enterococci* bacteria),
- five marine sites for shellfish gathering (Faecal coliforms),
- nine freshwater rivers (*Escherichia coli* bacteria),
- six estuarine/lagoon sites (*Escherichia coli* bacteria), and
- one freshwater lake (*Escherichia coli* bacteria)

Sites were monitored on a weekly basis to assess their suitability for contact recreation and shellfish gathering. Results were compared with the Ministry for the Environment and Ministry of Health Microbiological Water Quality Guidelines (2003).

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

All marine sites in Hawke's Bay attained a 100% level of compliance with Ministry guidelines during the 2005/06 season and no significant water quality issues were identified for Hawke's Bays coastal marine waters.

Freshwater and estuarine sites achieved higher than normal levels of compliance, which can be attributed in part to dry weather throughout the season. All sites monitored achieved no less than 90% compliance, with two estuary sites (Pandora Pond and Porangahau Estuary) achieving 100% compliance with guidelines.

In addition to the recreational water quality sites, five sites were monitored to assess the quality of waters used for shellfish gathering. This was the first season in what is to be included in the annual Recreational Water Quality Monitoring programme. This will enable the Council to assess the microbiological water quality of popular shellfish gathering areas.

Shellfish gathering sites in Hawke's Bay had a high level of compliance with Ministry guidelines for biological water quality. Exceedance of the guidelines was restricted to the Waipatiki Beach site, and all other locations achieved compliance. No significant water quality issues were identified for Hawke's Bays shellfish gathering sites (Waipatiki Beach excepted).

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LIST OF ABBREVIATIONS

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

1 INTRODUCTION

Hawke's Bays coastal waters, freshwater lakes and rivers, are frequently used for a range of recreational activities. However, the suitability of these areas for contact recreation can be compromised through contamination of the waters by human and animal faecal matter, which may carry harmful pathogens that can cause illness¹.

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

The aims of the programme are to:

1. Determine the suitability of the coastal, estuarine and freshwater sites for recreational use;
2. Assist in safeguarding public health and the environment;
3. Compare the current water quality with that of previous studies;
4. Provide a baseline for future studies; and
5. Identify any problems and target investigations to those areas requiring mitigation, remediation or further study.

1.1 Legislative Responsibility

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

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

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

2 METHODOLOGY

2.1 Site Selection Criteria

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

- A popular recreational site;
- An area classified as 'Contact Recreation' under the Regional Coastal Plan (HBRC,1999);
- A site that will assist in determining the state of the environment;
- A site that will identify trends in coastal, estuarine and fresh water quality; and/or
- A site selected in co-operation with TLAs and the Hawke's Bay District Health Board.

2.2 Sampling and Notification

The programme for the 2005/2006 summer consisted of 30 sites between Mahanga and Porangahau Beaches. These sites are commonly used for recreational purposes (i.e. swimming, water skiing, rowing etc.) and include freshwater, estuarine/tidal and marine sites throughout the region.

Sampling was undertaken in accordance with MoH & MfE guidelines (2003), with samples taken on a weekly basis (Monday and Tuesday of each week) for a 20-week period over the summer season (Nov – March). Samples were collected at approximately knee depth in 400mL sterile bottles and chilled for later laboratory analysis. Environmental information was also collected for each site at the time of sampling. Samples were analysed for indicator bacteria (*Enterococci* in marine waters, *Escherichia coli* in brackish or freshwater, and faecal coliforms in shellfish gathering waters), and turbidity.

Rainfall measurements were collected from nearby rain gauges to determine whether significant rainfall had preceded sampling. If sample results exceeded guideline values, the data was reviewed to assist in identifying whether exceedances were related to high rainfall. Rainfall related exceedances in fresh and brackish water systems were not re-sampled as a previous study has shown bacteria levels to reach guideline values within three days under these conditions (Stansfield, 2002). Follow-up sampling was conducted for all exceedances (including rainfall related) in marine waters in order to determine the level of compliance against MfE & MoH guidelines.

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

2.3 Indicator Bacteria

The Recreational Water Quality Programme aims to assess the suitability of areas for contact recreation (see Section 1). To achieve these objectives it is necessary to determine whether sites have been subject to contamination from human or animal faecal matter that may compromise the health and safety of people using the area. As it is not feasible to analyse water samples for the range of pathogenic organisms that can cause illness, bacteria that are specific to the gut of warm-blooded animals are used to indicate whether faecal material is present in the water. The levels of this indicator can be used to provide an assessment of the relative risk of illness.

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

2.4 Guidelines

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

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

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

* Two consecutive samples exceed 280-enterococci/100 mL before Action Mode is initiated

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

The recreational shellfish-gathering bacteriological guideline values were also obtained from the 'Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas' (MoH and MfE, 2003; Box 3). These state that the median level of faecal coliform content should not exceed a Most Probable Number (MPN) of 14/100ml, and that no more than 10% of samples should exceed a MPN 43/100ml for the season.

2.5 Annapolis Protocol / Beach Grading

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

At the conclusion of the 2004/05 season, grades for all sites with at least a moderate sample history were reviewed and published. Sites were graded as Very Good, Good, Fair, Poor and Very Poor, dependant on the historical microbiological water quality, and catchment risk assessment (see Appendix 4 for more information relating to site grading). These grades were retained for the 2005-2006 season.

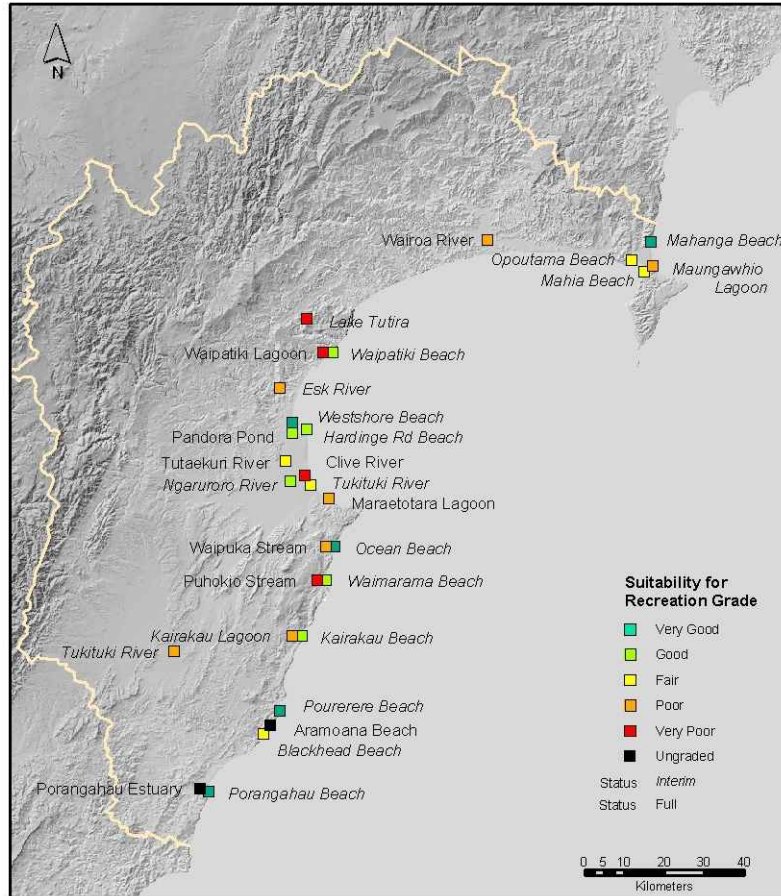


Figure 1: Suitability for Recreation Grades (SFRG's) for those sites included in the 2005/06 Recreational Water Quality Monitoring Programme.

2.6 Data Analysis

Monitoring information from the last six seasons was analysed to determine whether any significant trends were detectable in the microbiological water quality of sites associated with the Recreational Water Quality Monitoring programme. Whilst data could be corrected for flow, nor was it possible to remove the effect of variable weather which can impact on bacterial levels, it was considered that the long-term nature of the data set might be of sufficient length as to buffer the data from these effects.

Data from the previous six seasons was collated and any follow-up samples removed from the data set. Data were analysed using the Sen's slope/Mann-Kendall (WQ Stat) trend test and slope estimator. Results were identified as significant if they meet the following three criteria:

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

3 SAMPLING SITES

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

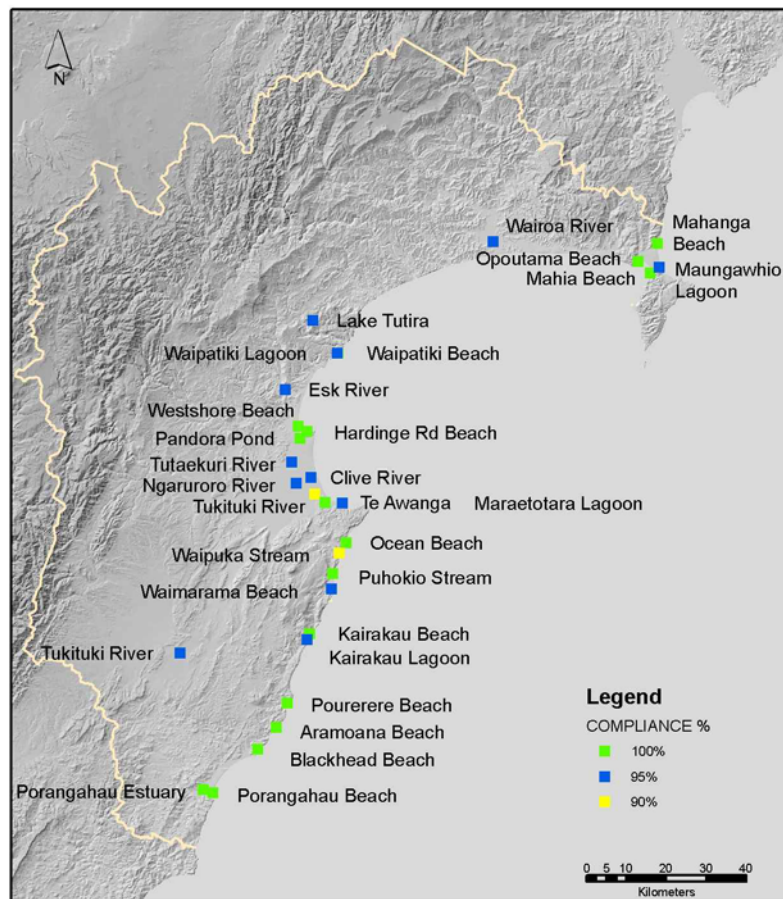


Figure 2: Map of sites included in the 2005/06 Recreational Water Quality Monitoring Programme including level of compliance with MfE & MoH action level guidelines (Marine action level compliance based on two consecutive sample exceedance).

4 RESULTS

4.1 Monitoring Results

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

4.1.1 Marine Recreational Sites

Marine waters within Hawke's Bay have water quality suitable for contact recreation. All fourteen sites sampled achieved 100% compliance with the two-consecutive exceedance guideline. Nine of the fourteen marine sites sampled; Mahia, Westshore, Kairakau, Waimarama, Aramoana, Blackhead, Pouterere, Te Awanga and Porangahau Beaches achieved 100% compliance with the more stringent single sample exceedance guideline (Table 2). None of the marine sites sampled appear to have any significant water quality issues, however individual high values obtained from some samples (i.e. Opoutama 2400cfu/100ml, Waipatiki Beach - 2700 cfu/100ml & Ocean Beach 3600 cfu/100ml) indicate the potential for marine waters to contain considerable levels of contamination after periods of intense rainfall in the surrounding catchment.

Table 1: Range of Enterococci results at the marine sites and compliance with guidelines 2005/06

Site	Minimum	Maximum	Alert Mode	Action Mode Single Sample Exceedance	Action Mode Two-Consecutive Exceedance Guideline
	(cfu enterococci /100ml)	(cfu enterococci /100ml)	(140 cfu enterococci /100ml)	(280 cfu enterococci /100ml)	(280 cfu enterococci /100ml)
Aramoana Beach	< 1	21	100%	100%	100%
Blackhead Beach	< 1	110	100%	100%	100%
Hardinge Rd Beach	< 1	410	95%	95%	100%
Kairakau Beach	< 1	140	100%	100%	100%
Mahanga Beach	< 1	330	90%	95%	100%
Mahia Beach	< 1	180	90%	100%	100%
Ocean Beach	< 1	3600	95%	95%	100%
Opoutama Beach	< 1	2400	95%	95%	100%
Porangahau Beach	< 1	68	100%	100%	100%
Pouterere Beach	< 1	5	100%	100%	100%
Te Awanga Coastal	< 1	140	100%	100%	100%
Waimarama Beach	< 1	120	100%	100%	100%
Waipatiki Beach	<1	2700	95%	95%	100%
Westshore Beach	<1	49	100%	100%	100%

Five single-sample action level exceedances occurred at marine sites during the current season. Of these, four were considered to be related to high rainfall. The exceedances were re-sampled within 24 hours of receiving the high results, in line with MfE & MoH guidelines, allowing them to be assessed under the two-consecutive sample exceedance mode. All five of these initial events were within guideline values by the second sample – therefore not triggering an action level response as defined by the guidelines.

In addition to the five single-sample action level results, four exceedances of the alert mode occurred. High rainfall accompanied only one of these results in contrast to the previous 2004/05 season where only one sample was non-rainfall related. All four re-samples had returned to below guideline values within 24 hours.

These results indicate that exceedance events in marine waters in Hawke's Bay tend to be short-lived, and that results of non-rainfall related events generally return to below guideline values before the two-consecutive sample action level as defined by MfE and MoH (2003) is reached.

4.1.2 Freshwater and Estuarine Recreational Sites

Freshwater and estuarine recreational areas in Hawke's Bay had variable water quality throughout the bathing season (Table 3). Two sites, Pandora Pond at Ahuriri Estuary, and the Porangahau Estuary achieved 100% compliance with Ministry guidelines.

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

Site	Minimum (cfu <i>E. coli</i> /100ml)	Maximum (cfu <i>E. coli</i> /100ml)	<i>E. coli</i> compliance with:	
			Alert Mode (260 cfu <i>E. coli</i> /100ml)	Action Mode (550 cfu <i>E. coli</i> /100ml)
Clive River at SH2	<1	580	90%	95%
Esk River	<1	2200	90%	95%
Kairakau Lagoon	<1	860	90%	95%
Lake Tutira	<1	700	95%	95%
Maraetotara Lagoon	<1	1900	95%	95%
Maungawhio Lagoon	<1	690	95%	95%
Ngaruroro River at Chesterhope	<1	1100	95%	95%
Pandora Pond	<1	70	100%	100%
Porangahau Estuary	<1	310	95%	100%
Puhokio Stream	<1	5500	90%	95%
Tukituki River at Black Bridge	<1	900	90%	90%
Tukituki River at Waipukurau	<1	3600	90%	95%
Tutaekuri River at Pakowhai Rd	2	3800	90%	95%
Waipatiki Lagoon	1	1600	85%	95%
Waipuka Stream at Ocean Beach	<1	3000	90%	90%
Wairoa River at Ski Club	<1	2800	95%	95%

A total of 16 action level exceedances of the water quality guidelines were reported from routine sampling of freshwater and estuarine sites. All 16 of these exceedances were related to high rainfall events, highlighting the adverse effect that heavy rainfall has on the microbiological water quality in Hawke's Bays Rivers and estuarine waters.

Follow-up sampling was conducted for all non-rainfall related exceedances at sites excluding Puhokio Stream. Given the frequent exceedances observed at this site during previous seasons, it was decided that contamination events were constant enough to warrant placing permanent signs in the area, warning the public of the potential health risk. A previous study provided an in-depth investigation into the water quality of the Puhokio Stream (Stansfield, 2003), and it was therefore decided that further follow-up sampling would provide little additional information on this stream.

In addition to the 16 action level exceedances, the alert level was reached on eight separate occasions. Only two out of eight (25%) of these events were related to periods of high rainfall and therefore were not resampled, and three were not resampled as they occurred at Puhokio Stream and Waipatiki Lagoon. Of the remaining three events, two had returned to guideline values within 24 hours and only one site (Clive River at SH2) still remained in alert mode until the next scheduled weekly sample. The reasons for these exceedances are unclear. They could be related to localised faecal contamination, bird or animal excreta or incorrect sampling techniques resulting in compromised samples. The otherwise rapid return to background levels suggests that as with marine sites, contamination events appear to be short-lived.

4.1.3 Shellfish Gathering Sites

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

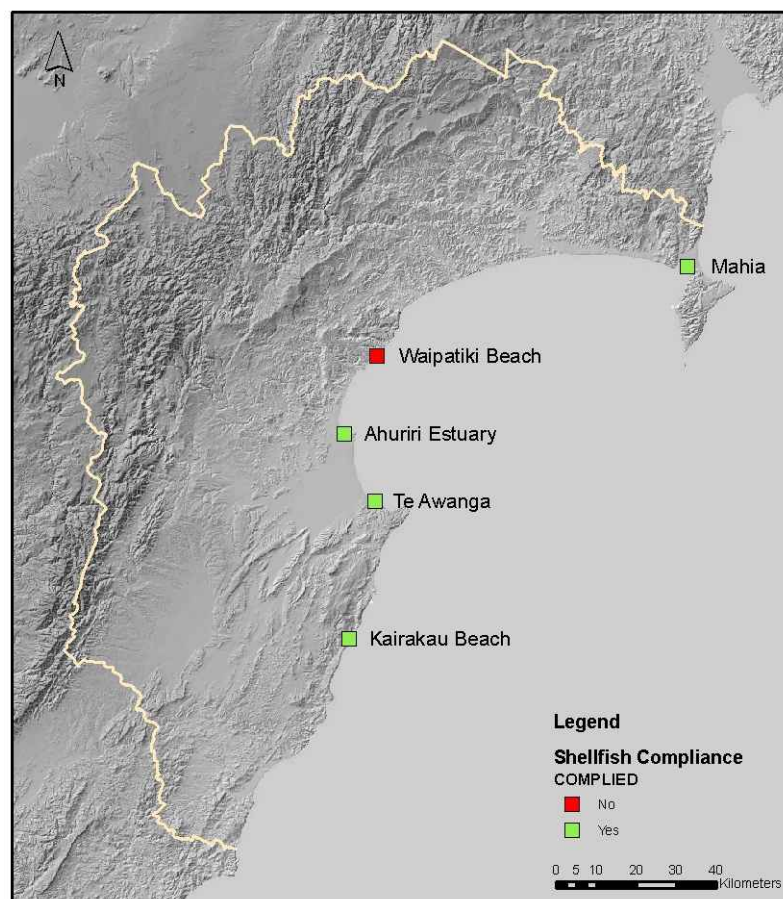


Figure 3: Compliance with MfE & MoH shellfish gathering water guidelines.

All sites sampled were generally within end of season guideline values with the exception of Waipatiki Beach. The Waipatiki Beach site failed to comply with the annual guideline levels in which no more than 10% of samples exceed a MPN value of 43/100ml.

4.2 Long-term trends

Comparison of the current seasons results to that of previous years in order to detect changes and trends in the microbial water quality of Hawke's Bays waters, is hindered by changing guideline values, sampling techniques (e.g. depth of sampling within the water column), and variable weather which can impact on bacterial levels. Statistical analysis of water quality trends, were performed on the data from the previous six seasons given the consistent sampling methodology over this time. Whilst data cannot be corrected for flow, and it is not possible to remove the effect of variable weather which can impact on bacterial levels, it was considered that the long-term nature of the data set may be sufficient to buffer these effects.

There has been no significant trend in the results over time for marine sites suggesting that microbiological water quality in marine waters is fairly stable.

Table 4: Trend analysis for sites between 2001 and 2006 (decreasing trends correspond to decreases in the level of bacteria and thus increases in water quality).

Site	Trend	Slope	Significant?	N
Blackhead Beach	Increase	0.179 Ent (cfu/100ml)	No ¹	110
Hardinge Rd Beach	No trend	-	-	109
Kairakau Beach	No trend	-	-	110
Mahanga Beach	No trend	-	-	50
Mahia Beach	No trend	-	-	110
Ocean Beach	No trend	-	-	109
Opoutama Beach	No trend	-	-	110
Porangahau Beach	Increase	0.119 Ent (cfu/100ml)	No ¹	99
Pourerere Beach	No trend	-	-	69
Waimarama Beach	No trend	-	-	110
Waipatiki Beach	No trend	-	-	110
Westshore Beach	No trend	-	-	110
Clive River	No trend	-	-	120
Esk River	Decrease	-6.734 E. coli (cfu/100ml)	Yes	119
Kairakau Lagoon	Decrease	-7.03 E. coli (cfu/100ml)	Yes	119
Lake Tutira	No trend	-	-	120
Maraetotara Lagoon	Decrease	-10.945 E. coli (cfu/100ml)	Yes	120
Maungawhio Lagoon	No trend	-	-	80
Ngaruroro river	Decrease	-5.723 E. coli (cfu/100ml)	Yes	119
Pandora Pond	Decrease	-0.904 E. coli (cfu/100ml)	No ¹	120
Puhokio Stream at Waimarama	Decrease	-35.604 E.coli (cfu/100ml)	Yes	120
Tukituki River at Blackbridge	Decrease	-8.286 E.coli (cfu/100ml)	Yes	99
Tukituki River at Waipukurau	Decrease	-3.253 E.coli (cfu/100ml)	Yes	100
Tutaekuri River	Decrease	-5.955 E.coli (cfu/100ml)	Yes	120
Waipatiki Lagoon	Decrease	-19.821 E.coli (cfu/100ml)	Yes	120
Waipuka Stream at Ocean Beach	No trend	-	-	120
Wairoa River	Decrease	-12.518 E.coli (cfu/100ml)	Yes	120

¹ Slope is less than laboratory detection limit.

² Magnitude of the slope did not represent >1% per year change as an expression of the mean.

Several of the freshwater and estuarine sites showed a significant decrease in the bacterial levels over time. In previous reports the Puhokio Stream at Waimarama has been identified as having ongoing water quality issues. These issues have been attributed to problems with septic tanks as well as agricultural runoff. The remedial works in this catchment in terms of upgrading the sewage treatment situation and continued riparian protection the Puhokio may have contributed to the significant decrease in *E. coli* contamination.

The 2004-2005 report highlighted the reduction in microbiological water quality at Lake Tutira. There had been a significant drop in the biological water quality during the 2004-2005 season resulting in investigations proposed to ascertain the causes this problem. The current seasons results however have indicated that there has been a return to the typical lake water quality, with compliance with guidelines increasing to the 95% level. This suggests that the result for the previous season was a minor anomaly in the seasonal trends and not an indication of serious decline in the water quality of the lake.

The trend analysis also indicates that there has been a significant increase in the microbiological water quality in the Waipatiki lagoon. This area has had continuing problems with contamination largely attributed to the inefficient functioning of septic tanks in the area. As part of current development within Waipatiki, a community sewage treatment plant is due for installation. This could further improve the microbiological loading of the lagoon area, and future results should be assessed with this in mind.

Given the relatively dry weather experienced during the 2005/06 season (see figure four), and the accompanying high level of compliance, data was re-analysed excluding the 2005/06 season to assess whether this impacted the results obtained. With the exception of the Tukituki River site at Blackbridge, none of the sites that recorded significant trends when analysed with the full data set returned significant results when the data from the 2005/06 season was excluded. Either insufficient data was available in the reduced dataset to detect a significant trend, or the high compliance levels experienced in the 2005/06 season contributed significantly to the results.

Table 5: Comparison of seasons for freshwater and estuarine sites

	% Compliance with Alert (260 <i>E. coli</i> /100ml)					% Compliance with Action (550 <i>E. coli</i> /100ml)				
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
Clive River at SH2	70	70	70	55	90	95	90	90	85	95
Esk River	90	90	90	90	90	90	95	95	95	95
Kairakau Lagoon	75	80	90	90	90	85	80	95	90	95
Lake Tutira	100	95	95	70	95	100	95	95	75	95
Maraetotara Lagoon	80	90	90	75	95	95	95	95	95	95
Maungawhio Lagoon	n/s	100	85	95	95	n/s	100	90	95	95
Ngaruroro River at Chesterhope	90	100	90	100	95	95	100	95	100	95
Pandora Pond	90	100	100	100	100	100	100	100	100	100
Porangahau Estuary	n/s	n/s	n/s	n/s	95	n/s	n/s	n/s	n/s	100
Puhokio Stream	65	80	55	40	90	80	85	80	80	95
Tukituki River at Black Bridge	n/s	90	95	95	90	n/s	100	95	100	90
Tukituki River at Waipukurau	85	100	80	75	90	90	100	90	95	95
Tutaekuri River at Pakowhai Rd	90	100	95	95	90	100	100	100	95	95
Waipatiki Lagoon	75	80	65	80	85	80	85	85	85	95
Waipuka Stream at Ocean Beach	75	85	85	70	90	85	90	90	85	90
Wairoa River at Ski Club	75	90	75	75	95	85	90	90	85	95

n/s = not sampled

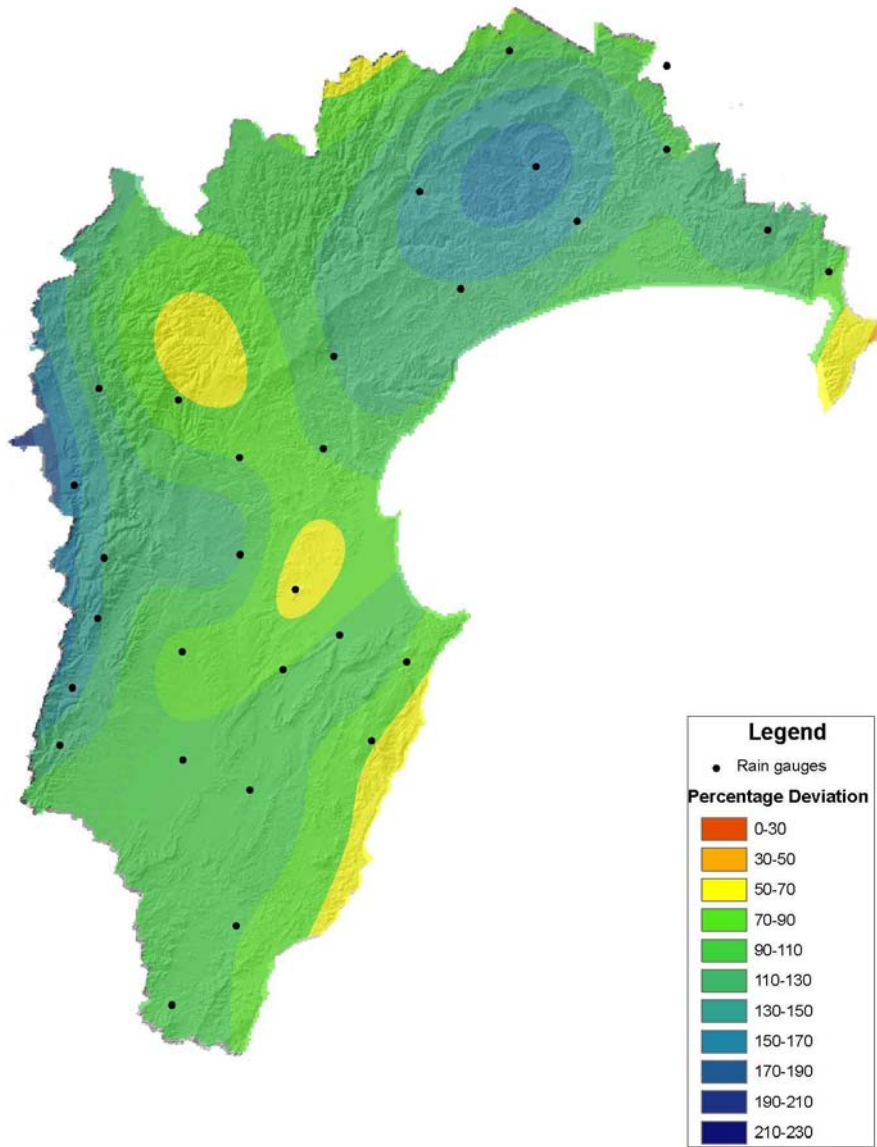


Figure 4: Percentage deviation from mean 30 year normal rainfall. (< 100 indicates less than average rainfall, >100 indicates higher than average rainfall).

5 DISCUSSION

Marine sites in Hawke's Bay have shown a high level of compliance with recreational water quality guidelines, supporting their use as a contact recreation resource. Whilst high bacterial numbers can occasionally occur in quantities that could pose a significant health risk, follow-up sampling has shown these events to be short-lived. Results tended to be within surveillance mode prior to reaching the two consecutive sample action level as set out in the Microbiological guidelines (MfE and MoH, 2003). Marine areas also appear to be less influenced by the effects of rainfall than the freshwater and estuarine sites sampled.

Historically the HBRC did not resample exceedance events that showed a strong correlation to rainfall. This decision was made following a report indicating that compliance was normally reached within three days of a rainfall event (Stansfield, 2002). Unfortunately, a significant gap existed in our understanding of how widely this could be applied to marine waters, as only one marine site was included in the original study. In order to assess marine waters in relation to the MfE and MoH Recreational Water Quality Guidelines (2003), follow-up sampling was undertaken for all exceedances, including those correlated with heavy rainfall. The results indicated that both rainfall and non-rainfall related exceedances in marine waters tend to return to below guidelines values within 24 hours, increasing the number of marine sites reaching 100% compliance compared to those reaching this level of compliance under the single sample exceedance approach.

The marine sites sampled under the current programme did not highlight any significant water quality issues, and generally, Hawke's Bays marine water quality supports contact recreation activities most, if not all of the time.

Microbiological water quality in the freshwater and estuarine sites shows higher variability, and water quality appears to be compromised at a number of sites in the days following heavy rainfall. A few sites have maintained a high level of water quality, however some persistent problem areas are repeatedly highlighted each season. A number of exceedances of the action guideline value suggest that at these sites water quality frequently poses an unacceptable health risk. Upgrading of sewage facilities as seen in Waipatiki, and other initiatives including riparian planting and stock exclusion may result in observable improvements in water quality at some of these sites.

Even with initiatives such as those described above, some of the exceedances observed in the freshwater and estuarine areas during the 2005/06 programme continue to be unrelated to high rainfall events, occurring in periods of dry weather and in the absence of any obvious external sources. In areas where fine sediments dominate, sediment resuspension occurring through disturbance by swimmers or wave action may increase bacteria numbers in the overlying waters. Given the potential for sediments to harbour, and subsequently resuspend bacteria, it may be possible that high bacterial levels at a given sampling time, may not originate from a discharge or by direct runoff, but from the resuspension of sediments by bathers. In order to assess whether sediment resuspension contributes as a significant source of the indicator bacteria, a resuspension study was undertaken to elucidate the relationship between sediment resuspension and elevated bacteria levels. The results of this study will be appearing in a separate report at a later date.

The results for the shellfish gathering waters reveal that four of the five sites sampled were suitable for shellfish gathering based on seasonal medians. The exception to this pattern was the Waipatiki Beach site, which exceeded the annual guideline limits.

6 RECOMMENDATIONS

1. That Hawke's Bay Regional Council continue to monitor freshwater, estuarine and marine bathing sites in accordance with the Ministry for the Environment and Ministry for Health guidelines.
2. That follow-up exceedance sampling for sites only be undertaken where the cause of the exceedance cannot be attributed to rainfall. Compliance of marine sites will need to be assessed under the more stringent single-sample exceedance if follow-up sampling of rainfall related exceedances is not proposed for these areas.
3. That follow-up sampling after an exceedance event at Puhokio Stream not be undertaken, unless there is reasonable cause to believe that the exceedance is extraordinary. Permanent signage is currently in place warning swimmers of the risk associated with this site.
4. Sampling sites be reviewed in the 2006/07 season with a view to decreasing sampling at those sites graded as Very Good, and those sites graded Very Poor if permanent signage is erected.
5. Monitoring of shellfish gathering waters in accordance with MfE and MoH guidelines be continued for the 2006/07 season.
6. As in 2005, it is recommended that annual reporting be amended so that a two-page report card may be made available to the public, summarising the season results. A technical report may still be produced, but would be restricted to in-house circulation or externally upon request.

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Appendix 1: Site Descriptions

Marine Sites

Aramoana

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

Blackhead Beach

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

Hardinge Rd. Beach

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

Kairakau Beach

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

Mahanga Beach

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

Mahia Beach

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

Ocean Beach

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

Opoutama Beach

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

Porangahau Beach

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

Pourerere Beach

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

Te Awanga

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

Waimarama Beach

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

Waipatiki Beach

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

Westshore Beach

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

Freshwater and Estuarine Sites

Clive River at State Highway 2 Bridge (Boat Ramp)

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

Esk River

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

Kairakau Lagoon

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

Lake Tutira

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

Maraetotara Lagoon

The Maraetotara River enters the coast via the Maraetotara Lagoon at Te Awanga, after passing through predominantly pastoral land. Due to the low flow in the river, and sea swells at the beach,

the mouth of the river is closed through much of the summer period. The Te Awanga camping ground is situated beside the northern embankment of the lower Maraetotara River, and the sample site is directly south of the main carpark. Te Awanga is popular due to its good surf break and its close proximity to Cape Kidnappers and the gannet colony.

Maungawhio Lagoon

The Maungawhio Lagoon is located on the northern side of the Mahia Peninsula, and is formed by the Kopuawhara Stream. The lagoon has been identified as a Significant Area in Hawke's Bays Regional Coastal Plan (HBRC, 1999), and is both an important fish spawning area, breeding and roosting area for variety of water birds. The lagoon is regularly used for swimming, fishing and shellfish gathering.

Ngaruroro River at Chesterhope Bridge

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

Pandora Pond

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

Puhokio Stream at Waimarama Beach

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

Tukituki River at Black Bridge

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

Tukituki River at SH2, Waipukurau

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

Tutaekuri River at Pakowhai Rd. Bridge

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

Waipatiki Lagoon

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

Waipuka Stream at Ocean Beach

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

Wairoa River (Boat ramp)

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

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

Shellfish Gathering Waters

Ahuriri Lagoon

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

Kairakau Beach

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

Mahia Beach at the Golf Club

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

Te Awanga Coastal

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

Waipatiki Beach

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

Appendix 2
Results Graphs

Appendix 3

Tables of Results

Marine Sites

Date Sampled	Aramoana Beach *	Blackhead Beach *	Hardinge Rd Beach	Kairakau Beach *	Mahanga Beach	Mahia Beach	Ocean Beach *	Opoutama Beach	Porangahau Beach *	Pourerere Beach *	Te Awanga Coastal *	Waimarama Beach *	Waipatiki Beach	Westshore Beach
7-Nov-05	1	2	74	2	9	1	33	2	11	<1	5	<1	1	37
14-Nov-05	<1	<1	1	1	6	6	<1	2	<1	<1	4	<1	1	2
21-Nov-05	1	6	1	3	330	<1	<1	2	35	2	3	2	3	7
28-Nov-05	21	2	33	140	45	<u>150 R</u>	3600 R	2400 R	3	1	23	120	95	40
5-Dec-05	20	1	<1	<1	26	18	<1	<1	14	4	6	<1	2	2
12-Dec-05	3	66	26	2	<u>160</u>	<u>180</u>	24	40	29	1	32	5	56	11
19-Dec-05	<1	14	410	4	21	110	<1	30	16	2	140	7	2700 R	49
28-Dec-05	1	110	6	<1	<1	38	<1	1	3	<1	2	<1	73	<1
4-Jan-06	2	1	2	<1	2	41	4	2	<1	5	68	1	5	3
9-Jan-06	<1	<1	3	2	<1	2	1	<1	<1	<1	7	46	1	4
16-Jan-06	<1	<1	4	<1	<1	5	<1	2	<1	<1	<1	<1	6	1
23-Jan-06	<1	<1	4	<1	1	27	<1	6	5	<1	2	6	6	1
30-Jan-06	<1	3	<1	1	2	9	9	5	1	4	38	20	<1	12
7-Feb-06	<1	2	3	<1	<1	19	8	32	3	2	3	14	<1	9
13-Feb-06	1	2	<1	<1	21	6	5	26	21	1	6	3	<1	7
20-Feb-06	<1	2	3	3	16	15	2	12	68	3	12	23	3	43
27-Feb-06	4	<1	3	<1	1	5	<1	8	2	2	17	<1	<1	<1
6-Mar-06	8	3	4	2	1	41	4	11	<1	4	31	<1	6	13
13-Mar-06	1	<1	<1	<1	25	8	<1	7	<1	<1	3	1	1	<1
20-Mar-06	5	11	31	<1	<1	11	82	3	2	<1	3	3	2	25

Exceeded Alert Level

(140 cfu enterococci/100ml)

Exceeded Action Level

(280 cfu enterococci/100ml)

R

Rainfall Related

Indicator species = Enterococci

* Sampled on day after the date in the left hand column

Freshwater and Estuarine Sites

Date Sampled	Clive River @ Boat Ramp *	Esk River	Kairakau Lagoon *	Lake Tutira	Maratotara Lagoon *	Maungawhio Lagoon	Ngaruroro River *	Pandora Pond	Porangahau Estuary *	Puhokio Stream *	Tukituki River @ Black Bridge *	Tukituki River @ Waipukurau *	Tutaekuri River @ Pakowhai *	Waipatiki Lagoon	Waipuka Stream @ Ocean Beach *	Wairoa River
7-Nov-05	23	46	2	7	2	4	1	1	<1	77	12	<1	23	44	<1	40
14-Nov-05	<u>300</u>	42	24	220	210	3	43	<1	6	78	7	2	120	31	51	43
21-Nov-05	72	300	2	35	74	<1	60	42	<1	300	30	4	31	310	25	72
28-Nov-05	580 R	2200 R	860 R	700 R	1900 R	690 R	1100 R	70	310 R	5500 R	900 R	510 R	3800 R	1600 R	3000 R	2800 R
5-Dec-05	130	8	1	130	130	2	65	6	<1	180	28	8	20	120	23	220
12-Dec-05	120	<1	92	<1	15	<1	22	<1	<1	260	640 R	3600 R	<u>540 R</u>	1	16	<1
19-Dec-05	31	13	<1	<1	26	3	84	<1	5	2	70	33	43	13	<1	9
28-Dec-05	100	<1	1	<1	48	1	39	<1	<1	72	14	1	23	100	3	2
4-Jan-06	50	<1	2	15	58	<1	32	<1	18	82	23	5	25	13	64	6
9-Jan-06	39	1	5	40	63	3	12	<1	1	41	<1	<1	14	63	<1	29
16-Jan-06	36	<1	12	<1	1	<1	16	10	<1	18	18	2	9	12	40	3
23-Jan-06	180	47	14	28	39	<1	13	2	2	170	22	21	2	<u>320 R</u>	51	3
30-Jan-06	58	1	<u>270</u>	78	47	4	42	1	25	120	46	7	20	11	18	140
7-Feb-06	31	10	<1	36	3	10	<1	<1	8	9	<1	2	15	52	2	130
13-Feb-06	27	31	5	4	<1	12	5	2	<1	130	<1	<1	13	45	3	69
20-Feb-06	110	<1	9	1	25	<1	16	<1	2	230	7	<1	10	45	120	<1
27-Feb-06	33	3	22	17	5	2	16	<1	3	82	26	<1	4	36	19	14
6-Mar-06	4	<1	<1	20	25	1	16	<1	<1	<1	3	<1	12	25	2	22
13-Mar-06	<1	15	<1	2	<1	6	16	2	<1	4	5	1	2	36	4	91
20-Mar-06	24	25	3	10	12	<1	13	<1	3	62	22	<1	16	4	1200 R	15

Exceeded Alert Level (260 cfu E.coli/100ml)

Exceeded Action Level (550 cfu E.coli/100ml)

R Rainfall Related

Indicator species = *Escherichia coli*

* Sampled on day after the date in the left hand column

Shellfish Gathering Sites

Date Sampled	Ahuriri Estuary	Kairakau Beach *	Mahia Beach at Golf Club	Te Awanga *	Waipatiki Beach
7-Nov-05	260	<1	2	17	46
14-Nov-05	6.3	22	1	21	4
21-Nov-05	<1	13	1	16	29
28-Nov-05	280	370	11	28	210
5-Dec-05	4	6	1	3	68
12-Dec-05	4	2	<1	1	38
19-Dec-05	<1	<1	19	240	<1
28-Dec-05	3	<1	1	3	13
4-Jan-06	1	<1	<1	42	5
9-Jan-06	5	<1	<1	<1	6
16-Jan-06	6	<1	11	1	<1
23-Jan-06	4	<1	1	3	10
30-Jan-06	5	1	<1	18	100
7-Feb-06	2	<1	<1	2	41
13-Feb-06	4	1	1	7	1
20-Feb-06	1	3	<1	9	9
27-Feb-06	11	<1	<1	5	2
6-Mar-06	2	<1	4	36	1
13-Mar-06	10	<1	1	1	1
20-Mar-06	2	<1	<1	<1	3

Indicator species = *Faecal coliforms*

* Sampled on day after the date in the left hand column

Appendix 4

Suitability For Recreation Grade (SFRG) Accompanying Information

Definitions for Suitability for Recreation Grades

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

Very Good

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

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

Good

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

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

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

Fair

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

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

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

Poor

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

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

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

Very Poor

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

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

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

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

Notes

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

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

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