

Recreational Water Quality in Hawke's Bay State of the Environment: 2013 - 2018

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Executive summary

Hawke's Bay's coastal waters, freshwater lakes and rivers provide for a range of recreational activities, increasing physical health, and enhancing well-being. How people use these waterways and the aspects that people take into consideration when choosing a recreational site are varied and may include aspects such as cleanliness, access, proximity as well as water quality. In terms of water quality, the suitability of these areas for contact recreation can be compromised through contamination by human and animal faecal matter, which may carry harmful, illness-causing pathogens. Microbiological water quality (the presence of bacteria indicating pathogen presence) is one aspect of water quality that is monitored to provide information to users of recreational waterbodies.

Hawke's Bay Regional Council (HBRC) undertakes an annual summer Recreational Water Quality Monitoring Programme in collaboration with Territorial Local Authorities (TLAs) and the Public Health Unit of the Hawke's Bay District Health Board (PHU). Thirty-two sites within Hawke's Bay were sampled for faecal indicator bacteria (*Escherichia coli* in freshwaters, enterococci in marine waters and both indicators in brackish waters) during the 2013-2018 swimming seasons. This included 14 beach sites, 8 estuary/lagoon sites, 9 freshwater sites and 1 lake. Sites were sampled for 20 weeks between November and March.

Hawke's Bay has a high number of sites with excellent water quality for contact recreation based on national microbiological guidelines. Between 2013 and 2018 Hawke's Bay's open coastal sites were suitable for swimming 98% of the summer monitoring time, and unsuitable for 1%. A further 1% of the time they were deemed suitable, however caution was advised for people with lower immunity.

Freshwater sites in Hawke's Bay were particularly influenced by the effects of rainfall which can wash contaminants from the land into waterways and may act to resuspend contaminants in river, lake and estuary bed sediments. Monitored freshwater recreation areas were suitable for swimming 89% of the summer monitoring time, unsuitable for 5% of the time, and caution was advised for 6% of the time. The influence of a number of guideline exceedances in the Wairoa River was notable in these analyses; without the Wairoa River results, swimmability in freshwater was 92%.

Estuary and lagoon sites in Hawke's Bay have the highest probability of exceeding the national microbiological guidelines. Between 2013-2018 estuary and lagoon sites in Hawke's Bay were suitable for swimming 81% of the time, unsuitable 10% of the time, and caution was advised 9% of the time.

Trend analysis was undertaken on the complete data record for each site to determine whether a directional trend indicating a long-term change in water quality was observed.

Overall improvements in water quality were observed in 15¹ sites, and deteriorating water quality was observed at 6 sites. Wairoa River and Pōrangahau Estuary have the most persistent deterioration in water quality, indicating that these trends are unlikely to be climatically driven.

Shellfish gathering water showed variable compliance with guidelines between years. Some sites such as Maungawhio Lagoon, Te Mahia, Te Awanga Beach and Pōrangahau Estuary failed to comply with guidelines during the entire sampling record (6-8 years) indicating that these sites may pose high risk to recreational users collecting shellfish for consumption.

¹ This excludes the improvement observed at Pandora Pond in enterococci levels, as concomitant deterioration was observed in *E. coli* levels.

1 Recreational Water Quality

Hawke's Bay's coastal waters, freshwater lakes and rivers provide for a range of recreational activities, increasing physical health, and enhancing well-being. How people use these waterways and the aspects that people take into consideration when choosing a recreational site are varied and may include aspects such as cleanliness, access, proximity as well as water quality. In terms of water quality, the suitability of these areas for contact recreation can be compromised through contamination by human and animal faecal matter, which may carry harmful, illness-causing pathogens. Microbiological water quality (the presence of bacteria indicating pathogen presence) is one aspect of water quality that is monitored to provide information to users of recreational waterbodies. Sources of faecal contaminants to waterways can include stormwater discharges, runoff from rural and industrial activities, wastewater inputs and wild animals including birds.

"Contact recreation" includes any activity that causes people to come into contact with water where a reasonable risk of inhaling or ingesting water exists. At times, human or animal faecal material may enter the water from land run-off, discharges, or from natural populations of animals or birds. During these events, water may contain pathogens from this faecal matter. The risk of contracting illnesses such as gastroenteritis, respiratory illnesses, Hepatitis A, giardiasis, cryptosporidiosis, campylobacteriosis, and salmonellosis increases as the risk of exposure to pathogenic organisms increases (MfE and MoH 2003).

The presence of faecal material cannot be observed in water, unless it is present with associated sediments which may make the water appear 'dirty'. This means that people undertaking contact recreation may risk negative health outcomes due to the inability of detecting the presence of faecal contamination. Therefore, a robust monitoring and communication programme is required to assist users of public waterways to better understand current information on water quality, and various factors that may alter the water quality of an area.

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 (TLAs) and the Public Health Unit of the Hawke's Bay District Health Board (PHU).

This report investigates the impact of microbiological contamination of recreational waterbodies.

The aims of the programme are to:

- Determine the suitability of the coastal, estuarine and freshwater sites for recreational use;
- Assist in safeguarding public health and the environment;
- Compare current water quality with that of previous seasons;
- Provide data to the public through the Land, Air, Water, Aotearoa website (lawa.org.nz);
- Provide a baseline for future research;
- Identify problems and target investigations to those areas requiring mitigation, remediation or further research and development.

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

The sites included for analysis in the current report include 14 beach sites, 8 estuary/lagoon sites, 9 freshwater sites and 1 lake (Appendix 1).

Table-1-1: Water quality guideline values and indicator organisms used to assess marine and freshwater recreational areas (MfE and MoH, 2003).

Response Level	Marine Water Enterococci CFU/100 mL Single Sample	Freshwater <i>E. coli</i> CFU/100 mL Single sample	Shellfish gathering waters Faecal coliforms CFU/100 mL (over season)
Green Mode	≤ 140	≤ 260	
Amber Mode	141 - 280	261 – 550*	
Red Mode	>280**	>550	
Seasons results			Median concentration < 14/100 mL and 90% of samples < 43/100 mL

CFU = Colony forming units on an agar plate.

* Note: The National Policy Statement for Freshwater Management (NPS-FM) uses the value of 540 *E.coli*/100mL to denote the change in swimmability status. Although the 2003 guidelines have 550 *E. coli*/100mL as the action mode exceedance level, 540 *E. coli*/100mL is used throughout the HBRC and LAWA 'Can I Swim Here' programmes to aid consistency.

**Note: Two consecutive samples taken within 24 hrs exceeding 280 enterococci/100 mL are required before action mode is initiated.

When water quality falls within the limits of the 'Green' mode, the risk of contracting an illness from bathing is considered acceptable (MfE and MoH 2003). If the water quality falls into the 'Amber' mode there is an increased risk of illness, but this risk is still considered acceptable, although those with compromised immunity are advised to avoid contact with the water. This result signals to agencies a requirement to conduct follow up sampling of the site to determine whether contamination levels have increased to the 'Red' mode. Once a sample result exceeds the 'Red' mode, the risk of contracting illness is considered unacceptable.

In addition to weekly monitoring results, an overall bacteria grade for a recreational site can be established using the Microbiological Assessment Category (MAC) described in the national microbiological guidelines (2003). The Microbiological Assessment Category takes monitoring data from routine weekly or fortnightly monitoring and determines the 95th percentile using the Hazen method (see MfE and MoH, 2003 for more details). This can be used in conjunction with weekly monitoring to provide context around the *general* water quality of a site. The MAC is a useful measure as it not only provides information on the number of exceedances a site may experience, but also the magnitude of those exceedances.

Table 1-2: Microbiological Assessment Category (MAC) definitions (from MfE & MoH, 2003).

MAC	Marine Waters	Freshwaters
A	Sample 95 percentile = <40 ent./100mL	Sample 95 percentile = <130 <i>E. coli</i> /100mL
B	Sample 95 percentile = 41-200 ent./100mL	Sample 95 percentile = 131-260 <i>E. coli</i> /100mL
C	Sample 95 percentile = 201-500 ent./100mL	Sample 95 percentile = 261-550 <i>E. coli</i> /100mL
D	Sample 95 percentile = >500 ent./100mL	Sample 95 percentile = >550 <i>E. coli</i> /100mL

2 Methodology

2.1 Long-term monitoring

Thirty seven sites within Hawke's Bay were sampled during the 2013-2018 seasons. These sites are commonly used for recreational purposes that include swimming, water skiing, rowing, diving, fishing, surfing and shellfish gathering.

These sites were sampled on a weekly basis, with the exception of the Clive River and Puhokio Stream sites, which are permanently sign posted for poor water quality and sampled fortnightly. Southern and northern beaches that have demonstrated excellent water quality (A MAC grade of A) were also sampled fortnightly.

Sampling was conducted between November and March, and samples were collected and stored in accordance with the sampling procedures outlined in sections D2 and E2 of the MfE and MoH guidelines (2003) until laboratory analysis. Associated environmental information was collected for each site at the time of sampling, including temperature, turbidity, electrical conductivity and the number of people present. Further information on this programme can be obtained from previous Hawke's Bay Regional Council Recreational Water Quality reports (see Gilmer, 2014).

When sample results exceeded guideline values for freshwater sites, the rainfall data for that particular catchment was reviewed. If cumulative rainfall of more than 8 mm was recorded at any of the catchment rainfall station(s) over the preceding 72 hour period, it was considered that the exceedance was related to rainfall, and follow-up sampling was not required. Previous research has shown that elevated bacterial levels caused by rain return to green mode levels within 3 days of heavy rain (Stansfield, 2002), so follow-up sampling was not deemed necessary to confirm the high levels of bacteria. At these sites water quality warnings remained in place until the following routine sampling period. Where exceedances were not related to rainfall (i.e., cumulative rainfall was less than 8 mm in 72hrs), follow-up sampling was conducted to confirm the high levels of bacteria. Follow-up sampling was conducted for all exceedances in marine waters, regardless of antecedent rainfall, in accordance with MfE and MoH guidelines (2003).

2.1.1 Faecal Indicator Bacteria

The most common illnesses associated with swimming include gastroenteritis, respiratory illnesses, and skin and ear infections. These illnesses can be caused by a wide range of pathogenic organisms including viruses, bacteria and protozoan species – these include *Salmonella*, *Campylobacter*, *Cryptosporidium*, and *Giardia*. It is not feasible to analyse water samples for these pathogenic organisms. However, these pathogens are associated with enterococci and *Escherichia coli* (*E. coli*) bacteria that are specific to the gut of warm-blooded animals. Measurement of the concentration of these indicator bacteria gives an indication of the health risk associated with contact recreation arising from pathogenic organisms (MfE and MoH 2003).

Samples were analysed for the indicator bacteria enterococci at marine sites. This is because its survival rate in saline waters is higher than for *E. coli*, and provides a better correlation between indicator presence and illness. Samples collected at freshwater sites were analysed for the indicator bacterium *E. coli*. At estuarine or freshwater sites subject to tidal influences, dual testing of indicator bacteria was undertaken. This ensured that the indicator organism appropriately indicated the risk of adverse health effects. Where electrical conductivity readings indicated a freshwater environment (<10,000 µS/cm), the laboratory analysis was conducted for *E. coli* only, otherwise both *E. coli* and enterococci levels were measured.

2.1.2 Data summaries and visualisation

Maps have been used to spatially represent the number of water quality samples that have exceeded MfE/MoH guideline values over the last 5 years for indicator bacteria (from November 2013 to March 2018). The region has been split into three areas to allow for easy interpretation.

Box plots have been used to summarise water quality data (faecal indicator bacteria and turbidity) for the same time period. Box plots graph data as a box representing statistical values. The lower boundary of each box indicates the 25th percentile, a line within the box marks the median, and the higher boundary of each box indicates the 75th percentile. The line at the end of the whiskers (error bars) above and below the box indicate the 90th and 10th percentiles respectively.

The enterococci concentrations for marine sites compared to enterococci trigger values on the left and the *E. coli* concentrations for freshwater sites compared to *E. coli* trigger values on the right. The box plots for beaches are coloured dark blue, for rivers medium blue and estuarine/ lagoon sites are coloured light blue.

2.1.3 Trend analysis

Trend analyses was conducted using Mann-Kendall trend tests rather than seasonal Kendall tests since no seasonality was expected due to sampling only occurring during the summer season. A 'significant' trend was deemed to exist where there was less than 5% probability that the observed data trend was obtained by chance ($p < 0.05$).

This approach is consistent with the approach used in previous SoE reporting, and consistent with the approach taken for nationwide water quality analyses up until 2 years ago (Land, Air, Water Aotearoa (LAWA)). LAWA is a national initiative that collects and analyses environmental datasets from all regional councils around New Zealand. LAWA presents trend results for many of the same sites in this technical report, but have recently adopted a different statistical analyses that relaxes the significance testing component of trend analyses. The current LAWA approach was not considered appropriate for regional trend analyses, and so the previous and more traditional style of trend analysis outlined below has been retained (Mann-Kendall test with Theil-Sen slope estimator).

To estimate the strength of trends over time, a Theil-Sen slope estimator was used. The non-parametric Theil-Sen slope estimator calculates the median slope amongst lines through all pairs of points in the dataset. This approach is effective at estimating the true slope in water quality data series because it is less sensitive to outliers.

The values derived from the Theil-Sen slope estimator are referred to as "Percent Annual Change" (PAC). A trend in PAC was considered meaningful if the PAC was greater than 1% per year, so a PAC of $< 1\%$ was considered statistically significant, but not meaningful. A PAC of less than 1% can occur when there are a number of tied values at a given site (e.g. less than detects). This indicates that the occurrence of these low values is becoming more common.

An increase in observed values represents a deterioration in water quality (i.e. there is more contaminant in the water).

In all tables that present trend results, the changes are represented in bold when they are significant (i.e. where p-value is less than 0.05). Given a significant trend for a particular variable, the PAC is highlighted in blue if there was a significant improvement in the water quality variable, and highlighted in red if there was a significant deterioration in the water quality variable. Microbiological Assessment Categories range between 'A' and 'D' with 'A' representing higher water quality (lower 95th percentile), while D represents sites with poor water quality (high 95th percentile).

A Sanitary Inspection Category (SIC) outlines the risk that activities in the catchment might pose to recreational water quality. For example, a catchment with intensive agriculture and high potential sources of faecal contaminants may have a SIC of 'High' whereas a catchment with low sources of potential contaminants would have a SIC of 'Low'.

2.2 Faecal Source Tracking

When large concentrations of indicator bacteria are recorded at priority sites such as estuaries, lagoons, or sites that have ongoing contamination issues, samples are sent to an ESR laboratory in Christchurch for faecal sterol and Polymerase Chain Reaction (PCR) analysis.

Faecal source tracking uses molecular and chemical techniques to identify the source of faecal contamination by PCR and sterol analysis. Polymerase chain reaction (PCR) analyses use extracted DNA from the water sample to indicate the presence of certain microorganisms which are specific to the organisms contributing faeces to the water. Faecal sterol analyses uses the lipids present in the animals faeces present in the water sample to identify the organism contributing faecal material.

This analysis allows for identification of the sources of the bacterial contamination that may be later targeted for management interventions. These are reported for each sub-region.

3 Results

3.1 Northern Hawke's Bay

3.1.1 State

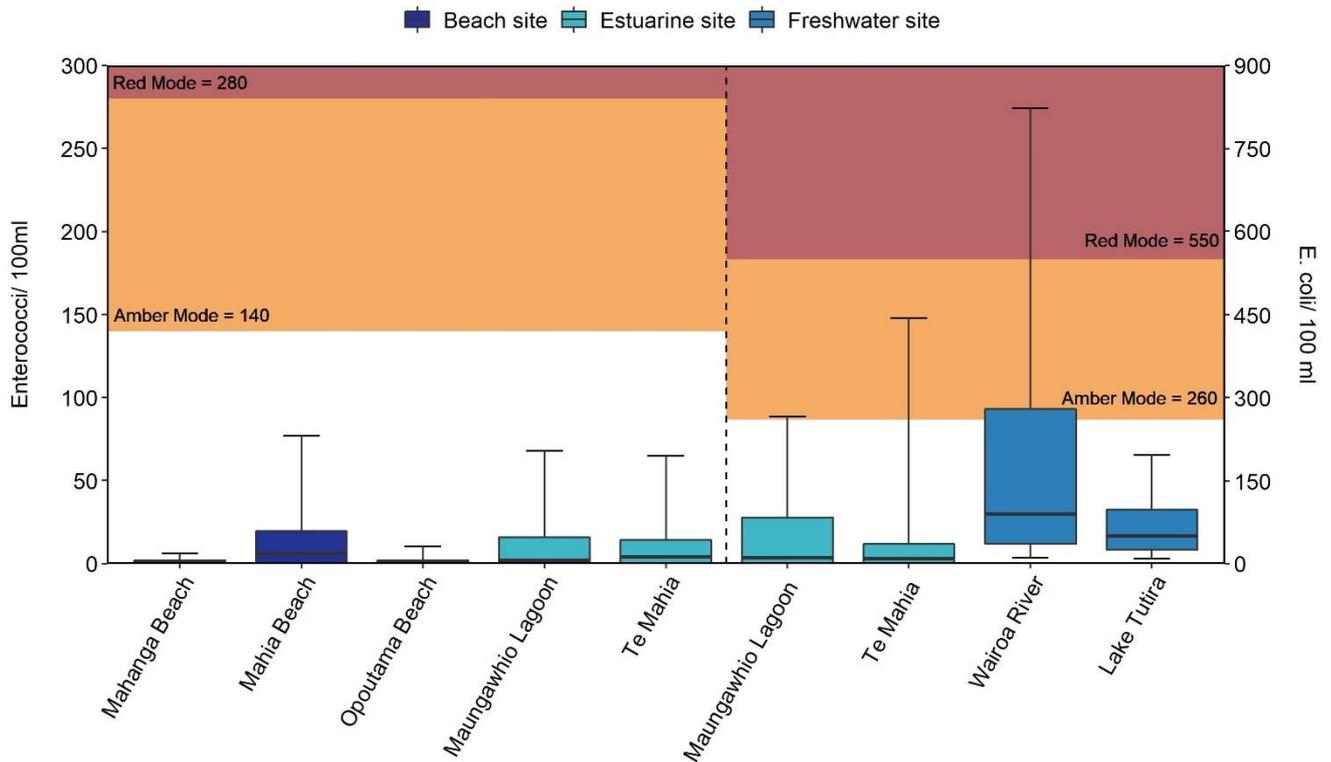


Figure 3-1: Faecal indicators for northern sites. Five year data with exceedance guideline thresholds (2013-2018). Red and amber areas indicate the MfE and MoH (2003) trigger values for the Red and Amber Modes respectively. The concentrations of indicator bacteria (cfu/100ml) associated with these modes are written above the line.

Recreational sites in the Northern Hawke's Bay generally had similar characteristics in water quality compared to other sub-regions. Beach water quality is generally very high (Figure 3-1) and is less influenced by rainfall washing contaminants from the land into waterways than freshwater rivers. Wairoa River has notable water quality, in that it is the only northern site where the 75th percentile (top of the box) sits within the amber mode. This indicates that at least 25% of the samples are in this mode, or higher. Most samples for lagoon areas in the northern sub-region are below guideline exceedance levels, however exceedances can occur more frequently due to the slow moving water and high levels of bird life.

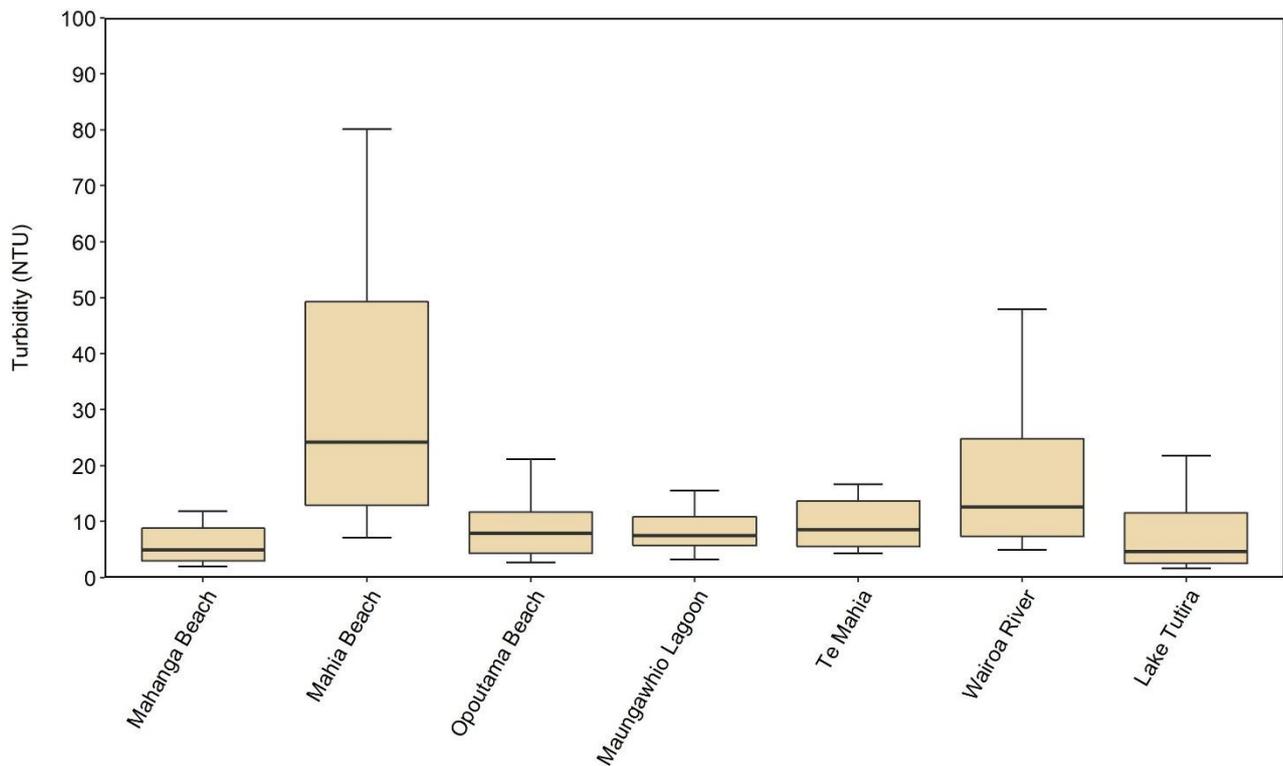


Figure 3-2: Turbidity levels (NTU) in northern recreational waters 2013-2018.

Turbidity levels were low across most northern recreational sites (Figure 3-2). Unexpectedly, Mahia Beach showed higher turbidity levels than Wairoa River, Te Mahia and Maungawhio Lagoons. Higher turbidity levels in this area may be due to wave and swell energy resuspending fine particles along this coastline, or other suspended particles such as plankton.



Figure 3-3: Northern sub-region sites 2013-2018. Percentage of samples exceeding contact recreation criteria.

The percentage of samples that exceeded contact recreation criteria and northern sites was assessed (Figure 3-3). Mahanga Beach was the beach site with highest recreational water quality in the northern area, with no samples exceeding national guidelines. Other beach sites – Oputama and Mahia, had low levels of non-compliance (2%). This indicates that recreational activities in the northern beaches of Hawke’s Bay are rarely restricted by water quality.

The Wairoa River is the only freshwater river site in the northern sub-region where the monitoring record is of sufficient length for inclusion in analyses. This site had the most exceedances of all freshwater sites within the region, with 15% of samples considered unsuitable for swimming. This indicates that, on average, the river was considered unsuitable for contact recreation for one day per week.

Northern lagoon sites tended to have less exceedances of the national guidelines compared with lagoon sites in other parts of the region. Te Mahia Harbour had the most exceedances of the northern sub-region lagoon sites and was considered unsuitable for swimming 10% of the time.

3.1.2 Trends

For the northern sites, four of the seven sites exhibited statistically significant decreases in bacterial numbers, indicating improvements in water quality over the 10-18 year period (Table 3-1).

All beach sites in the Northern Hawke's Bay area reported small, but statistically significant improvements in water quality over the period of the sampling record. The improvement was most pronounced at Opoutama Beach, with a percent annual change of 2.1%.

Maungawhio Lagoon showed no trend when analyses were undertaken on levels of enterococci, however an improving trend was identified in *E. coli* levels of 5.3% annual change.

Compared to the trend analyses undertaken in the previous report period, Opoutama Beach is continuing to improve at a slightly lower rate (PAC from 4.2 to 2.1%), and Wairoa River is continuing to deteriorate, again at a slightly lower rate (PAC from 7.2 to 2.8%).

Improving recreational water quality was identified at three sites in this reporting period that had not shown improving trends in the last reporting period: Mahanga Beach, Mahia Beach and Maungawhio Lagoon (*E. coli* only).

Wairoa River recorded a deteriorating trend in recreational water quality, with an average 2.8% annual change. When combined with this site's low compliance with national guidelines, and high hazen percentile (95th percentile of 2426 cfu/100ml), this indicates ongoing and persistent issues with water quality at this site.

Table 3-1: Northern sub-region site trend analyses 2000-2018.

Site	Trend p value	Percent annual change	Median	Sanitary Inspection Category (SIC) /Primary Impact	5 year MAC category (for data 2013-2018)	Number of samples used for MAC	Length of record used for trends (years)
Te Mahia (Ent)	Nil	N/A	4.5	Moderate, river – agriculture activities.	B: Hazen percentile 134	94	10
Te Mahia (E coli)	Nil	N/A	10.0	Moderate, river – agriculture activities.	D: Hazen percentile 1208	92	10
Maungawhio Lgn (E. coli)	Nil	N/A	7.5	High, Intensive agriculture.	C: Hazen percentile 211	97	16
Maungawhio Lgn (Ent)	Improving	-5.3	4.0	High, Intensive agriculture.	D: Hazen percentile 590	79	11
Mahanga Beach	Improving	0.0	0.5	Low, stream focal point of drainage.	A: Hazen percentile 10	88	18
Mahia Beach	Improving	-1.6	7.0	Moderate, urban storm water.	B: Hazen percentile 184	99	18
Opoutama Beach	Improving	-2.1	2.0	Moderate, river –agricultural, birds, feral animals.	B: Hazen percentile 72	98	18
Wairoa Rv	Deteriorating	2.8	70.0	High, intensive agriculture.	D: Hazen percentile 2426	99	18
Lake Tutira	Nil	N/A	27.5	High, manual change to accommodate all biological processes.	D: Hazen percentile 1061	89	16

*A 0.0 percent annual change, while statistically significant, typically refers to a change that is not environmentally meaningful.

3.1.3 Faecal Source Tracking

In areas where faecal bacterial levels are high, faecal source tracking can be used to identify the group or species of animal/s represented in the water sample to help guide management interventions for better water quality outcomes.

Between 2013 and 2018 faecal source tracking was undertaken at Maungawhio Lagoon, Opoutama Beach, Te Mahia, and the Wairoa River. Opoutama Beach has been previously reported on (Wade et al., 2016).

Maungawhio Lagoon

Maungawhio Lagoon is a brackish, tidal lagoon on the northern side of the Mahia Peninsula. It forms the mouth of the Kopuawhara River, and is identified as a Significant Conservation Area in the Regional Coastal Environment Plan (Figure 3-4). The area is widely used for contact recreation and shellfish gathering.

Previous sampling has indicated high levels of faecal contaminants at this site, particularly after periods of heavy rain. It has a Microbiological Assessment Category of 'D'.

Faecal source tracking was undertaken once for this site, and confirmed ruminant contamination consistent with the intensive agriculture in the surrounding catchment.



Figure 3-4: Maungawhio Lagoon, Northern Hawke's Bay

Te Mahia

Te Mahia Harbour lies on the north-eastern edge of the Mahia Peninsula (Figure 3-5). A popular boat launching area, the harbour is the mouth of the Whangawehi catchment which has undergone considerable rehabilitation over the last 10 years.

The catchment comprises forestry and agricultural activities and peaks of faecal contamination can occur following heavy rain.

There is a substantial difference between the levels of the two indicators at this site. Enterococci levels suggested mild contamination, however *E. coli* analysis indicated extensive faecal contamination with a Microbiological Assessment Category of 'D'. Faecal source tracking at this site has highlighted the influence of ruminant and avian sources.



Figure 3-5: Te Mahia, Northern Hawke's Bay.

Wairoa River

The Wairoa River lies at the northern end of Hawke’s Bay (Figure 3-6). The 65km river (Te Wairoa Hōpūpū Hōnengenenge Mātangi Rau), winds through intensive agricultural areas before reaching the township of Wairoa.

This site has significant inputs of faecal material from a number of sources, and faecal source tracking was undertaken to help guide management interventions.

Four faecal source tracking samples have been analysed between 2015 and 2018. These have highlighted the influence of ruminant sources of faecal material, with avian sources also detected at times.



Figure 3-6: Wairoa River, Northern Hawke's Bay.

3.2 Central (Mid) Hawke's Bay

3.2.1 State

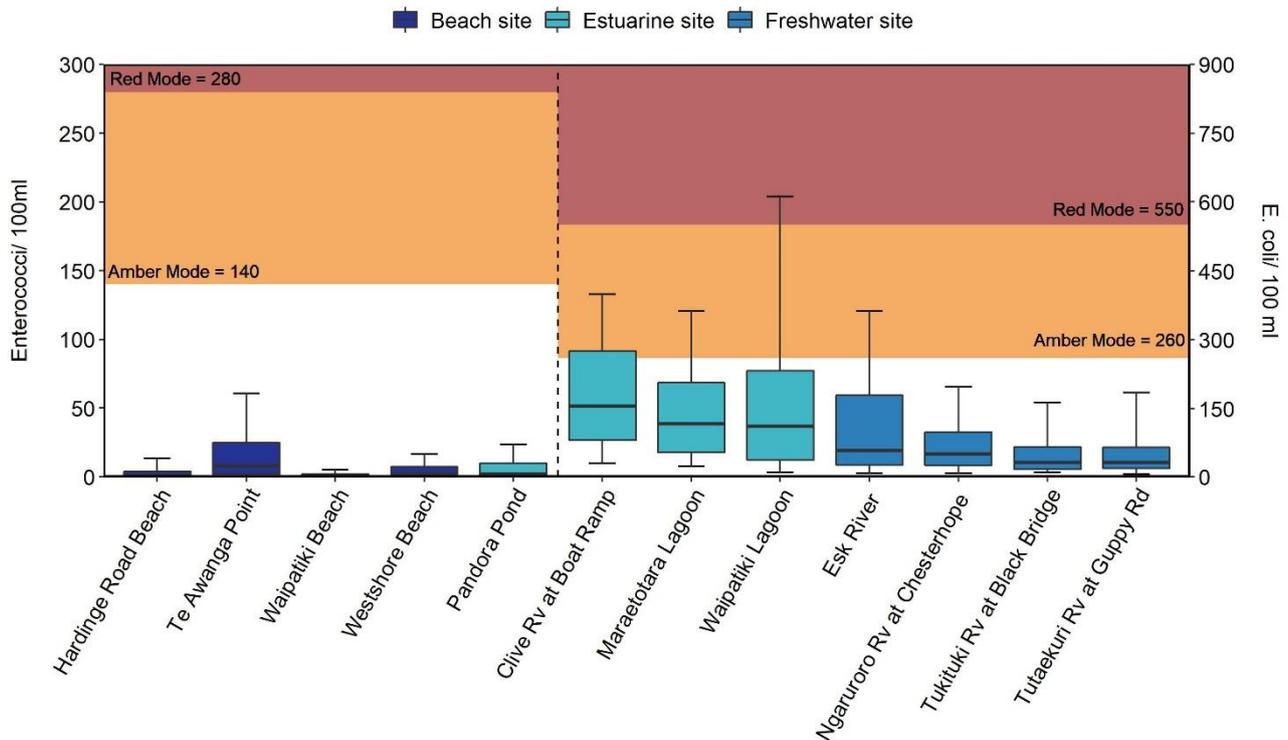


Figure 3-7: Faecal indicators for central (Mid) sites. Five year data with exceedance guideline thresholds (2013-2018). Red and amber areas indicate the MfE and MoH (2003) trigger values for the Red and Amber Modes respectively. The concentrations of indicator bacteria (cfu/100ml) associated with these modes are written above the line.

Similar to the patterns observed in the northern sub-region, central beach sites in Hawke's Bay appear to have very high microbiological water quality (Figure 3-7), despite being adjacent to urban areas. Lagoon sites in the central area generally have consistently higher levels of faecal bacteria, with at least 25% of the samples for Clive River exceeding the amber guideline (caution advised - Figure 3-7).

Esk River has a similar median *E. coli* level to the Ngaruroro River, but higher 75th and 90th percentiles (the top of the box and top of the whisker). This indicates that higher levels occur at this site at the top end of the data, likely to be driven by rainfall.

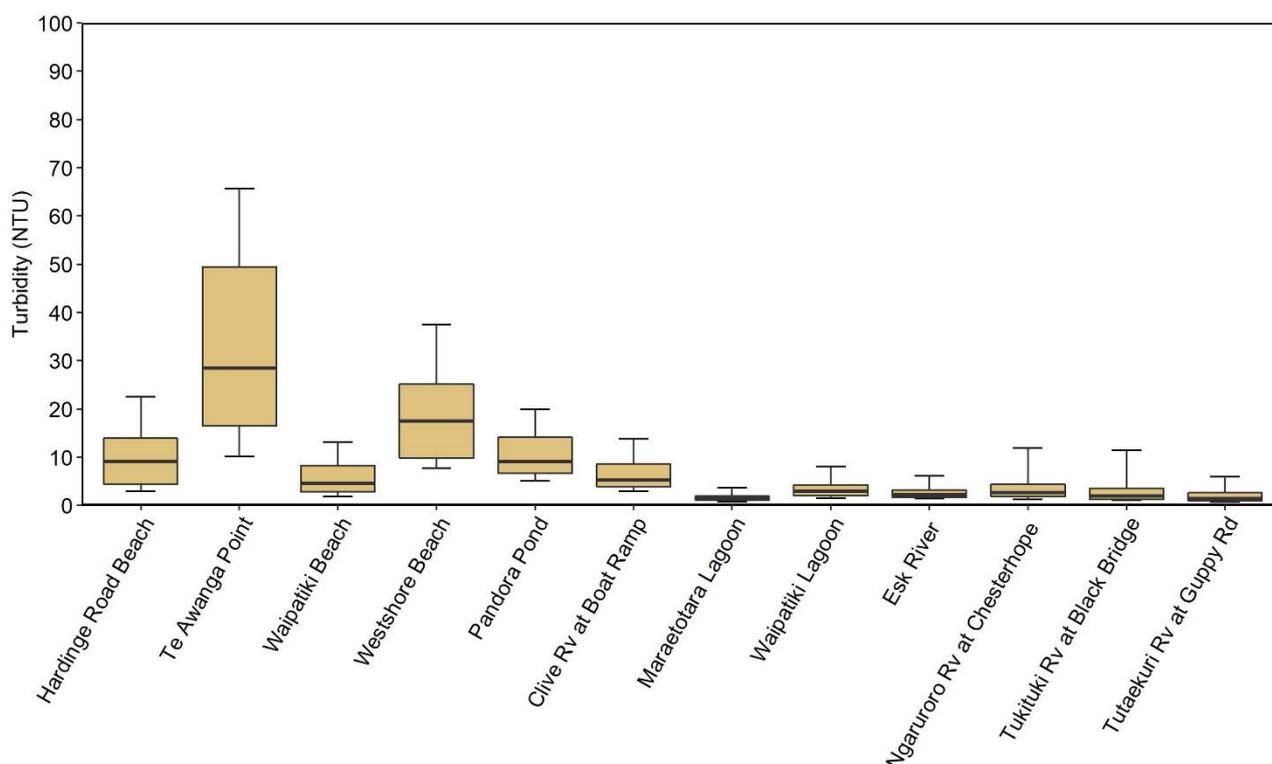


Figure 3-8: Turbidity levels (NTU) in central recreational waters 2013-2018. .

Levels of turbidity were highest at Te Awanga Point beach and were consistently low in the river sites (Figure 3-8). The high levels observed at Te Awanga are likely to be due to localised sediment resuspension from swell and waves.

Westshore Beach had the highest level of compliance with national guidelines of the beach site in the central area, with only 1% of samples exceeding national guidelines. Other beach sites – Hardinge Rd and Te Awanga, had low levels of non-compliance (2%) (Figure 3-9). This indicates that recreational activities in the central (mid) beaches of Hawke’s Bay are generally not restricted by water quality.

The Tūtaekurī River at Guppy Road and the Ngaruroro River at Chesterhope had the highest level of compliance with national guidelines of the central rivers with low levels (1%) of samples exceeding guidelines. Results for the Esk and Tukituki River at Blackbridge indicate higher levels of faecal contamination, with 6% and 5% of samples exceeding guideline values respectively.

Central lagoon sites were unsuitable for contact recreation between 3% (Pandora Pond) and 12% (Waipatiki Lagoon) of the time. Both of these sites have demonstrated the influence of avian and ruminant sources of faecal contamination.

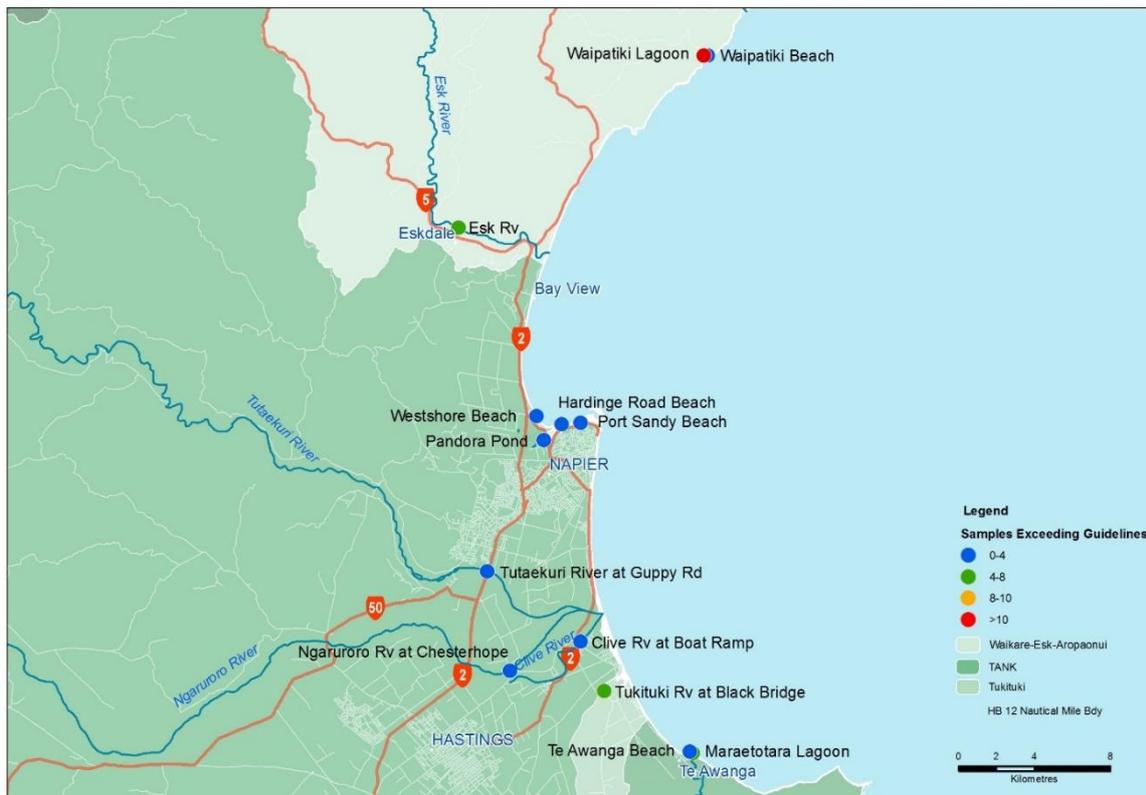


Figure 3-9: Central (Mid) sub-region sites 2013-2018. Percentage of samples exceeding recreation criteria.

3.2.2 Trends

For the central sites, five of the twelve sites exhibit statistically significant decreases in bacterial numbers, indicating improvements in water quality over the 13-18 year period (Table 3-2).

Similarly to the northern area, all but one beach sites reported small, but statistically significant improvements in water quality over the period of the sampling record. The improvement was most pronounced at Hardinge Rd Beach, with a percent annual change (PAC) of 4.1%.

Pandora Pond reported improving water quality in relation to enterococci levels at this site, yet deteriorating water quality in relation to *E. coli* levels. Further work needs to be undertaken to understand these conflicting results.

Esk River recorded a deteriorating trend in recreational water quality at a 2.8% annual change. Although this site generally complies with national guidelines, the high 95th percentile (at 730 cfu/100ml), indicates that at times large quantities of faecal material can make its way into the river.

In comparison to the last reporting period (2008-2013) more trends have been detected in the current reporting round. While the rate of improvements are similar at Hardinge Rd Beach, both Westshore Beach and Pandora Pond (enterococci) appear to be improving at slightly slower rates. Two sites that did not report trends in the last reporting period, have shown improving trends in the current reporting round: Tūtaekuri at Guppy Rd and Waipatiki Beach. The improvement observed at Waipatiki Beach has PAC of 0, indicating that while this is statistically significant, it is unlikely to be environmentally meaningful.

A further two sites that did not report trends in the last reporting period, have shown deteriorating water quality in the current reporting round. The Esk River and Pandora Pond (*E. coli*) have both shown deteriorating, and ecologically meaningful, declines in water quality.

Table 3-2: Central sub-region site trend analyses 2000-2018.

Site	Trend p value	Percent annual change	Median	Sanitary Inspection Category (SIC) /Primary Impact	5 year MAC category (for data 2013-2018)	Number of samples used for MAC	Length of record used for trends (years)
Clive Rv at Boat Ramp	Nil	N/A	130	High, bird life and agriculture	D: Hazen percentile 576	56	18
Hardinge Rd Beach	Improving	-4.1	2	Moderate, urban storm water.	A: Hazen percentile 27	99	18
Esk Rv	Deteriorating	2.8	49	Moderate, low intensity agriculture.	D: Hazen percentile 730	99	18
Maraetotara Lagoon	Nil	N/A	84	Moderate, low intensity agriculture.	D: Hazen percentile 599	99	18
Ngaruroro Rv at Chesterhope	Nil	N/A	52	Moderate, low intensity agriculture.	C: Hazen percentile 308.2	99	18
Pandora Pond (Ent)	Improving	-2.6	122	Moderate, urban storm water.	B: Hazen percentile 144	96	18
Pandora Pond (E. coli)	Deteriorating	4.2	140	Moderate, urban storm water.	C: Hazen percentile 540	18	18
Te Awanga point	Nil	N/A	8	Fair, river – agricultural.	C: Hazen percentile 246	99	13
Tukituki Rv at Black Bridge	Nil	N/A	33	High, unrestricted stock access.	C: Hazen percentile 333	98	18
Tutaekuri Rv at Guppy Rd	Improving	-2.1	36	Moderate, low intensity agriculture.	C: Hazen percentile 308	99	18
Waipatiki Beach	Improving	0	1	Very Low, focal point for drainage.	A: Hazen percentile 13	99	18
Waipatiki Lagoon	Nil	N/A	110	High, incidence of birdlife.	D: Hazen percentile 1428	99	18
Westshore Beach	Improving	-2.7	4	Moderate, storm water.	A: Hazen percentile 35	88	18

*A 0.0 percent annual change, while statistically significant, typically refers to a change that is not environmentally meaningful.

3.2.3 Faecal Source Tracking

In areas where faecal bacterial levels are high, faecal source tracking can be used to identify the group or species of animal/s represented in the water sample to help guide management interventions for better water quality outcomes.

Between 2013 and 2018 faecal source tracking was undertaken at Maraetotara Lagoon and around the Ahuriri Estuary including Pandora Pond.

Maraetotara Lagoon

The Maraetotara River enters the coast through the Maraetotara Lagoon at Te Awanga (Figure 3-10). Being a slow-flowing water body on an otherwise exposed coastline, and adjacent to a campground, the lagoon provides an area of contact recreation for families.

The catchment for the Maraetotara Lagoon consists of low intensity agriculture and small areas of forestry.

Maraetotara Lagoon has a history of water quality issues, and has a Microbiological Assessment Category of 'D'.

Faecal source tracking has been undertaken and has indicated ruminant and avian (bird) sources of faecal material.



Figure 3-10: Maraetotara Lagoon, Te Awanga.

Ahuriri Estuary

The Ahuriri Estuary is adjacent to the city of Napier (Figure 3-11). The estuary is a popular area for swimming, kayaking, and waka ama.

The Ahuriri Estuary catchment is relatively small, however has a high proportion of urban and industrial land uses combined with high intensity agriculture.

Concerns regarding water quality in the Ahuriri Estuary have increased in the last few years.

Faecal source tracking has been undertaken around the estuary. At the most upstream site, at the Railway Bridge, faecal source tracking has identified ruminant sources of faecal contamination as well as avian (bird) sources. Similarly at the Thames/Tyne site, faecal sources included ruminant (both cow and sheep) and avian sources. In the Pandora Pond, avian sources dominated the analyses with low level ruminant sources present.

As a gazetted wild-life refuge, avian sources are not unexpected.



Figure 3-11: Ahuriri Estuary, Napier.

3.3 Southern Hawke’s Bay

3.3.1 State

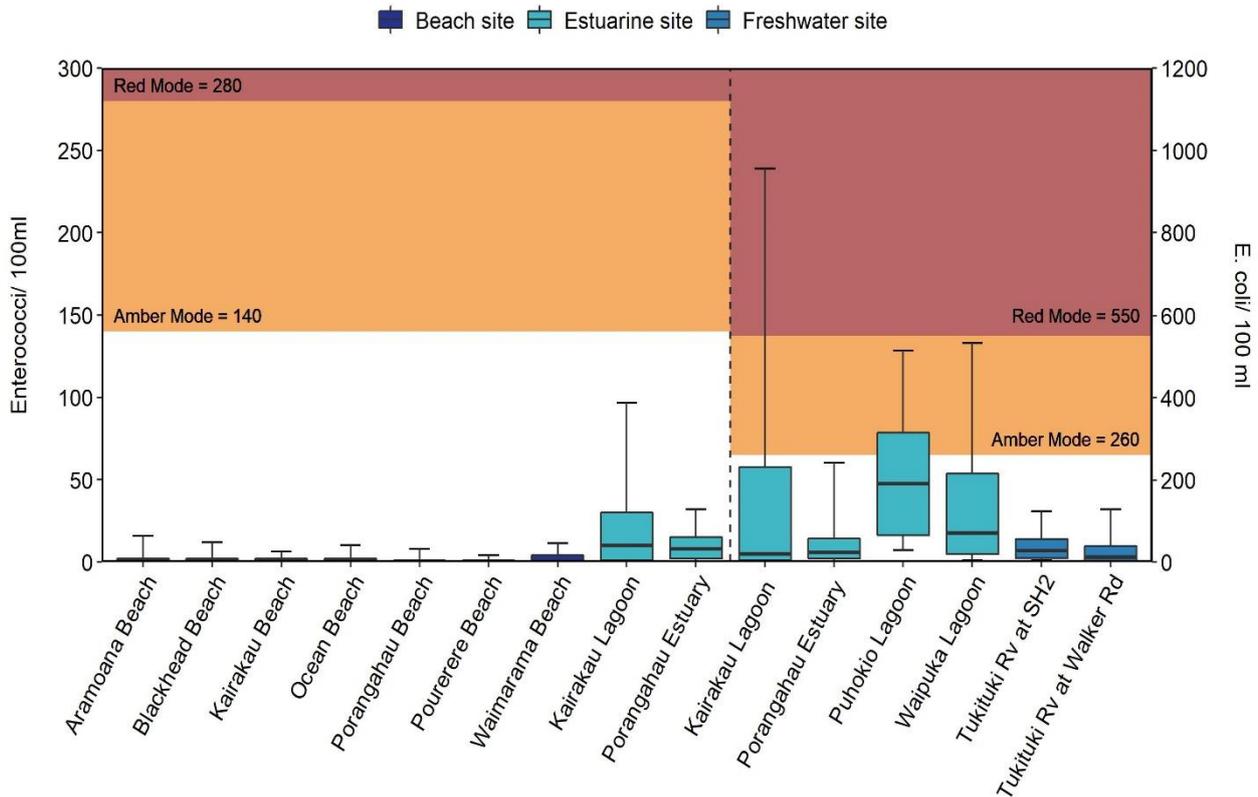


Figure 3-12: Faecal indicators for southern sites. Five year data with exceedance guideline thresholds (2013-2018). Red and amber areas indicate the MfE and MoH (2003) trigger values for the Red and Amber Modes respectively. The concentrations of indicator bacteria (cfu/100ml) associated with these modes are written above the line.

Patterns in recreational water quality for southern Hawke’s Bay appear slightly different compared to the Northern and Central (Mid) sub-regions. While beach water quality appears excellent with very few sites exceeding guideline values at any time, the lagoon sites appear to be more influenced by faecal material. Large systems such as the Kairākau Lagoon have high 95th percentile values, indicating peaks in faecal material entering the waterway, likely coinciding with rain. Smaller systems such as Puhokio and Waipuka Lagoons also show high levels of faecal contaminants, with Puhokio Lagoon showing a consistently high level of bacteria. It is possible that these soft-sediment systems may also be influenced by bacteria borne from sediment resuspension.

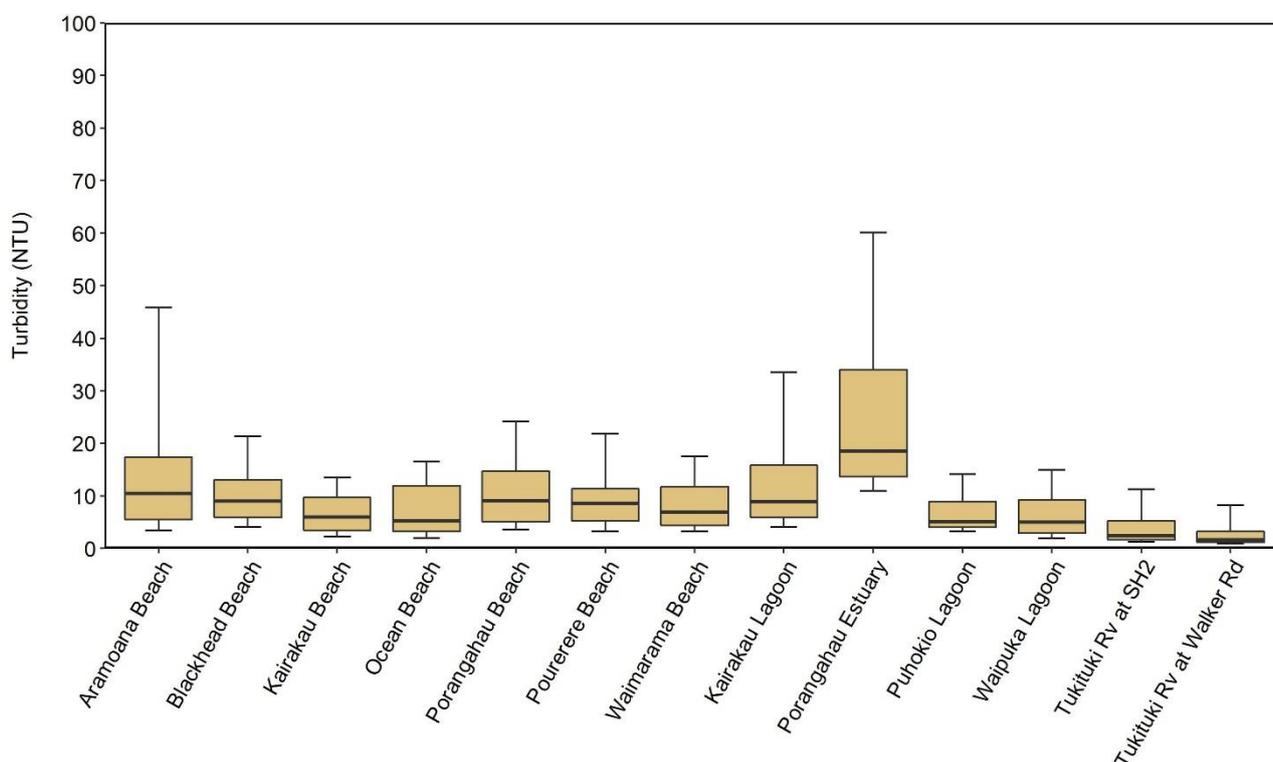


Figure 3-13: Turbidity levels (NTU) in southern recreational waters 2013-2018.

Turbidity levels were fairly consistent between the different recreational waterbodies in the southern region (Figure 3-13). Turbidity was highest and most variable in the Pōrangahau Estuary, and Aramoana Beach.

While lagoon water quality in the southern sub-region was relatively poor, the beaches in this areas have an excellent standard of recreational water quality, with no exceedances of national guidelines recorded for the 2013-2018 period (Figure 3-14). This indicates that while faecal material may be being delivered to the coast via the lagoons and estuaries, it is not causing an impact on recreational activities on the coast.

Kairākau Lagoon had the highest number of exceedances of national guidelines of the lagoon sites in both the southern sub-region, but also in the combined sub-regions. Water quality at this site was unsuitable for contact recreation in 19% of the samples over the last 5 years. Waipuka Stream at Ocean Beach also had a high number of exceedances, and was unsuitable for recreation in 10% of the samples. This was followed by Pōrangahau Estuary and Puhokio Stream at 7% and 5% of samples unsuitable for recreation respectively.

The two river sites in the southern sub-region, Tukituki at Waipukurau and Tukituki at Walker Road, had only 2% and 1% (respectively) of samples exceeding the national guideline in the last 5 years.

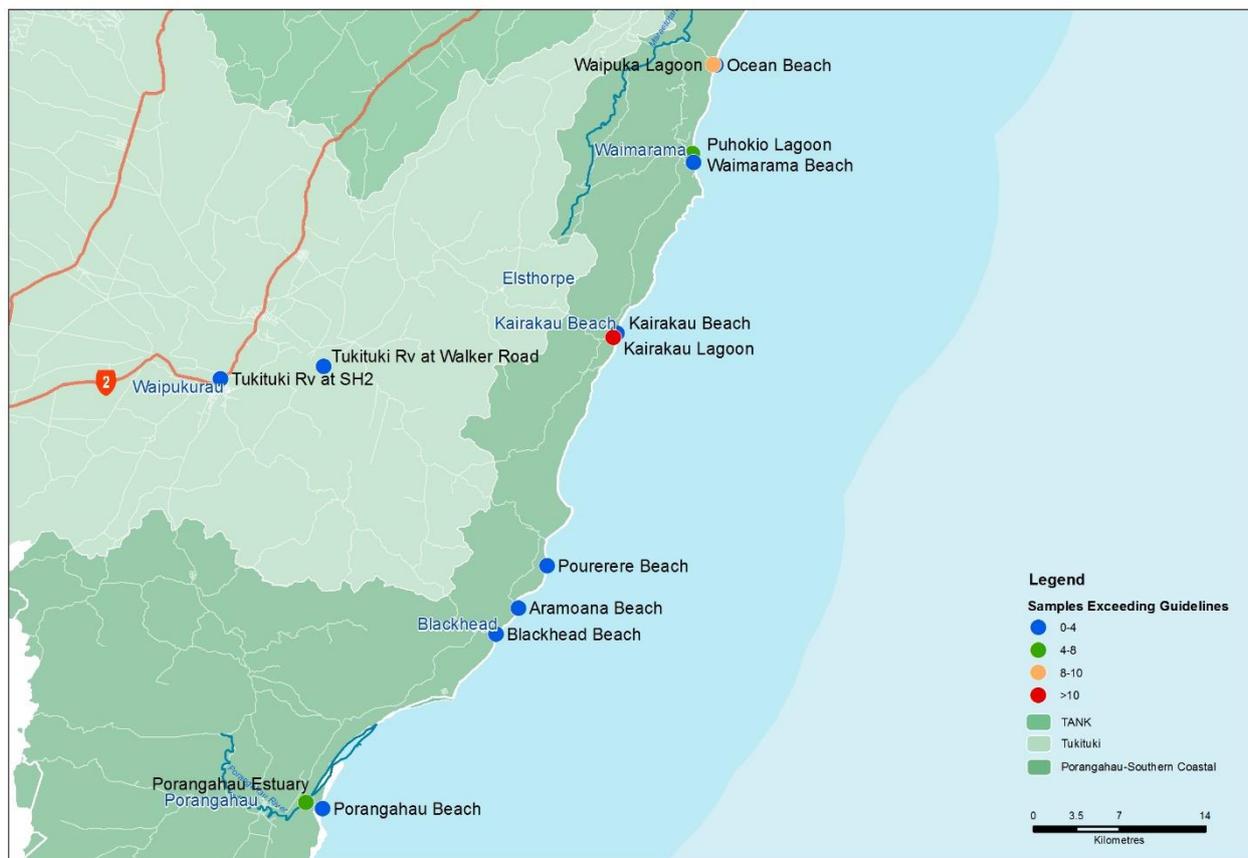


Figure 3-14: Southern sub-region sites 2013-2018. Percentage of samples exceeding recreation criteria.

3.3.2 Trends

Improvements in water quality were observed at seven of the thirteen sites over the 8-18 year period (Table 3-2). Of these seven sites, five of these were beach sites which typically report a high number of samples that are less than detection levels. Therefore four of the seven improving sites had a percent annual change (PAC) of 0, indicating a statistically significant improvement, however one not likely to be environmentally meaningful.

Two lagoon sites, Kairākau and Puhokio also reported improvements in water quality of between 2.3 % and 5.5%.

Three sites reported deteriorating water quality over the sampling period. The Pōrangahau Estuary has a history of deteriorating water quality over the last several years, and this is continuing to decline at a rate of 8.2% for the *E. coli* indicator. Waipuka Lagoon and the Tukituki River at Waipukurau also reported deteriorating water quality. Waipuka Lagoon has also had ongoing issues with contamination events.

Each of the sites that has reported deteriorating water quality in the current reporting period (Pōrangahau Estuary, Waipuka Lagoon and Tukituki at Waipukurau), also reported deteriorating water quality in the previous reporting period, indicating persistent water quality issues.

Table 3-3: Southern sub-region site trend analyses 2000-2018.

Site	Trend	Percent annual change	Median	SIC category/Primary Impact	5 year MAC category (for data 2013-2018)	Number of samples used for MAC	Length of record used for trends (years)
Aramoana Beach	Nil	N/A	0.5	Very low, no significant source.	A: Hazen percentile 30	88	14
Blackhead Beach	Improving	0	0.5	Very low, no significant source.	B: Hazen percentile 35	89	16
Kairakau Beach	Nil	N/A	0.5	Very low, no significant source.	A: Hazen percentile 12	99	18
Kairakau Lagoon (Ent)	Improving	-5.5	16	High, unrestricted stock access.	C: Hazen percentile 294	86	18
Kairakau Lagoon (E coli)	Improving	-2.3	16	High, unrestricted stock access.	D: Hazen percentile 1062	39	18
Ocean Beach	Nil	N/A	1	Very low, no significant source.	B: Hazen percentile 44	88	18
Porangahau Beach	Improving	0	0.5	Very low, no significant source.	A: Hazen percentile 10	89	18
Porangahau Estuary (Ent)	Nil	N/A	9	High, unrestricted stock access to waterways.	B: Hazen percentile 55	99	10
Porangahau Estuary (E coli)	Deteriorating	8.2	16	High, unrestricted stock access to waterways.	D: Hazen percentile 670	96	14
Puhokio Lagoon	Improving	-2.8	203	High, unrestricted stock access to waterways.	D: Hazen percentile 700	55	18
Pourerere Beach	Improving	0	0.5	Very low, no significant source.	A: Hazen percentile 29	88	18
Tukituki Rv at SH2	Deteriorating	4.4	24	High, run-off from low intensity agriculture.	C: Hazen percentile 250	99	18
Tukituki Rv at Walker Rd	Nil	N/A	14	Moderate, runoff from low intensity agriculture.	C: Hazen percentile 261	99	8
Waimarama Beach	Improving	0	1	Low, river focal point of drainage.	A: Hazen percentile 35	89	18
Waipuka Lagoon	Deteriorating	1.6	52	High, incidence of birdlife.	D: Hazen percentile 942	98	18

*A 0.0 percent annual change, while statistically significant, typically refers to a change that is not environmentally meaningful

3.3.3 Faecal Source Tracking

In areas where faecal bacterial levels are high, faecal source tracking can be used to identify the group or species of animal/s represented in the water sample to help guide management interventions for better water quality outcomes. Between 2013 and 2018 faecal source tracking was undertaken at Waipuka Lagoon.

Waipuka Lagoon

The Waipuka Stream flows through a small, steep, agricultural catchment before discharging into Hawke's Bay at Ocean Beach (Figure 3-15). The stream often forms a lagoon which is popular with families.

The catchment at this site is predominantly agricultural.

During the 2014/2015 and 2015/2016 seasons, high levels of bacteria were consistently recorded in the lagoon. A site survey, coupled with faecal source testing, identified avian sources of faecal contaminants to the lagoon. This was further tracked to geese upstream of the site.



Figure 3-15: Waipuka Stream, Ocean Beach.



Figure 3-16: Geese present upstream of the Waipuka Lagoon.

3.4 Overall state of Hawke's Bay Recreational Swimming areas 2013-2018

Hawke's Bay has a high number of sites with excellent microbiological water quality for contact recreation. In general, open coast sites have higher compliance with national guidelines for contact recreation due to the limited inputs from sources, and high exposure which facilitates flushing of contaminants. Between 2013 and 2018 Hawke's Bay's open coastal sites were suitable for swimming 98% of the time, and unsuitable for 1% (Figure 3-17). A further 1% of the time they were deemed suitable, however caution was advised for people with lower immunity.

Freshwater sites in Hawke's Bay were more influenced by the effects of rainfall which can wash contaminants from the land into waterways. These areas were suitable for swimming 89% of the time, unsuitable for 5%, and caution was advised for 6% of the time. The influence of the Wairoa River was notable in these analyses: without the Wairoa River, swimmability in freshwater was 92%, however the high exceedance rate for the Wairoa River brought this down to 89% when included.

Estuary and Lagoon sites in Hawke's Bay are waterways with the highest probability of exceeding national guidelines. These areas are the downstream receiving environments for the entire freshwater drainage network, and can have extensive bird life which can contribute high faecal loads. These factors, combined with the warm, slow-moving characteristics of lagoon sites, can mean these areas are more likely to become unsuitable for swimming than Hawke's Bay's ocean and river sites. Between 2013-2018, estuary and lagoon sites in Hawke's Bay were suitable for swimming 81% of the time, unsuitable 10% of the time and caution was advised 9% of the time.



Figure 3-17: Suitability for contact recreation 2013-2018.

3.5 Shellfish Gathering

In addition to monitoring water quality for contact recreation, HBRC also undertakes monitoring of the water quality overlying locations where shellfish gathering is popular. These sites are analysed for faecal coliform indicators, to determine the risk to the public from the consuming shellfish. Current monitoring guidance for shellfish gathering waters is detailed in Section F of the MfE/MoH (2003) guidelines. This guidance is based on the 1995 Ministry of Agriculture and Forestry 'Shellfish Quality Assurance Circular' and the 1992 Department of Health 'Provisional microbiological water quality guidelines for recreational and shellfish-gathering waters in New Zealand'. Results from monitoring are compared to national guidelines. However, unlike the guidelines for contact recreation, these are based on seasonal data and so compliance assessments are only able to be made post-hoc at the completion of the season. This is unlikely to provide timely guidance to the public on safe shellfish collection during a season, but it can inform the public as to the sites that persistently fail to comply.

3.5.1 Levels of compliance

Compliance with shellfish gathering guidelines of the microbiological water quality guidelines for marine and freshwater recreation areas are detailed in Table 3-4. Although some sites alternate between compliance states, some sites are notable in their complete non-compliance with shellfish gathering guidance (e.g. Maungawhio Lagoon, Te Mahia at the Boat ramp, Te Awanga Beach and Pōrangahau Estuary). These sites failed to comply with guidelines for their entire sampling record, indicating that these sites may pose high risk for shellfish consumption. Conversely, Mahia Beach (opposite the Golf Club), and Kairākau Beach had the highest level of compliance, with 8 of the 9 monitored seasons complying with national guidelines.

That said, there has been concern regarding the current guidelines and how relevant they may be to recreational fishers (see Bolton-Ritchie et al., 2013). Work is ongoing at a national level to improve these guidelines.

Table 3-4: Long term compliance with Shellfish Gathering Guidelines (2009-2018 – NT = Not tested).

Shellfish compliance	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	Compliance	% Compliance
Mahia Beach at Golf club	Yes	No	Yes	8/9 seasons	89%						
Maungawhio Lagoon	NT	NT	No	0/7 seasons	0%						
Te Mahia at Boat ramp	NT	No	0/8 seasons	0%							
Waipatiki at South end	Yes	No	No	Yes	Yes	Yes	No	No	NT	4/8 seasons	50%
Ahuriri Estuary	No	No	No	Yes	Yes	No	No	No	No	2/9 seasons	22%
Te Awanga Beach	No	NT	0/8 seasons	0%							
Kairākau Beach	No	Yes	8/9 seasons	89%							
Pōrangahau Estuary	NT	NT	NT	No	No	No	No	No	No	0/6 seasons	0%

3.5.2 Trends in shellfish gathering waters

Only one site reported a statistically significant trend in shellfish gathering water quality over the sampling period. Pōrangahau Estuary reported a significant deterioration in shellfish gathering water quality, with a percent annual change of 16.2%. This result is consistent with other results observed for this site as described in section 3.3. The deterioration observed in the recreational water quality (PAC 8.2%), in the shellfish gathering water (PAC 16.2%) and the high levels of non-compliance within a season (55% non-compliance in 2013/14 and 60% non-compliance in 2017/18), indicates an issue at this site that is likely to require further investigation.

4 Conclusions

Hawke's Bay has a number of popular swimming sites that support a range of recreational activities.

In general water quality at Hawke's Bay beaches is of extremely high quality with few exceedances of national guidelines. 98% of samples taken between 2013 and 2018 were suitable for swimming, indicating that recreational activities at open coast beach sites are not constrained due to water quality.

River sites also performed well in comparison to guidelines, with 89% of samples taken between 2013 and 2018 demonstrating water quality that was suitable for swimming. Prolonged or heavy rain can increase the incidence of faecal bacteria in the water, through overland flow carrying contaminants into waterways. Stock exclusion and riparian planting can reduce these flow paths, and improve water quality.

Lagoon areas had the lowest levels of compliance with national guidelines which can be due to the shallow, slow moving water and high incidence of bird life. Lagoon samples were suitable for swimming 81% of the time.

Faecal source tracking identified ruminant (predominantly sheep and cow) and avian sources as the most dominant cause of faecal bacteria in waterbodies where faecal source tracking was undertaken. In some areas, such as the Ahuriri wildlife refuge, this may be indicative of high ecological value, however in other areas (e.g. Waipuka Stream) introduced species such as geese may be contributing to water quality issues downstream.

Stock exclusion, riparian planting and planting designed to dissuade bird roosting can help to reduce these sources of faecal contaminants.

Shellfish gathering waters in Hawke's Bay can have variable compliance with national guidelines. However, some sites such as Maungawhio Lagoon, Te Mahia, Te Awanga Beach and Pōrangahau Estuary have failed to comply with guidelines during the entire sampling record (6-8 years) indicating that these sites may pose high risk for shellfish consumption.

Overall, improvements in water quality were observed in 15² sites, and deteriorating water quality was observed at 6 sites. Wairoa River and Pōrangahau Estuary have the most persistent deterioration in water quality, which has been observed over the last two reporting periods. The length of time period used in the current trend analyses spans 18 years for Wairoa River, and 14 years for Pōrangahau Estuary. Alongside long-term trends, fluctuations can occur in at scales such as seasonal, annual, interannual (2-6 years), decadal, or interdecadal scales which may be associated with climate cycles. The data used to assess trends for these two sites span almost two decades meaning that many climatic cycles will have been completed. This lessens the possibility of a trend observed simply due to a directional movement of a climate cycle, and supports the likelihood that these trends are unlikely to be climatically driven.

² This excludes the improvement observed at Pandora Pond in enterococci levels, as concomitant deterioration was observed in *E. coli* levels.

4.1 Recommendations for further investigation

The preceding report (Wade et al., 2016) provides an analysis of the data collected by HBRC regarding recreational water quality in Hawke's Bay. There is substantial data collected in association with water quality data that may go some way to describing patterns observed. It is therefore recommended that these data are analysed alongside microbiological water quality data. This includes investigating relationships between faecal indicator bacteria concentrations and variables such as turbidity, preceding rainfall, turbidity and/or flow/salinity, and relationships between faecal indicator bacteria and aspects of land use including land use type, levels of stock exclusion and/or riparian condition.

This report has highlighted areas where water quality deterioration has been observed. An analysis of how these results sit within the wider catchment (e.g. freshwater catchment state of the environment findings) may help to highlight areas for future management and plan change processes.

Further integration of analyses of trends between different domains such as land use, hydrology, freshwater quality and contact recreation should be undertaken where consistent trends are observed. These will be proposed through the 2022 Ten Year Plan process.

Where water quality has demonstrated persistent deterioration (e.g. Wairoa River and Pōrangahau Estuary), an assessment of consents, compliance and other possible sources of contaminants into the waterway should be undertaken to inform management options.

5 Acknowledgements

The authors acknowledge the Environmental Information team, the District and City councils, and the Public Health Unit for their assistance and collaboration on the Recreational Water Quality Monitoring project.

6 Glossary of abbreviations and terms

CFU	Colony forming units on an agar plate
FST	Faecal Source Tracking
HBRC	Hawke's Bay Regional Council
MAC	Microbiological Assessment Category
MfE	Ministry for the Environment
MoH	Ministry of Health
PAC	Percent Annual Change
PCR	Polymerase Chain Reaction
PHU	Public Health Unit
SIC	Sanitary Inspection Category
TLA	Territorial Local Authority (District and City Councils)

7 References

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Appendix One – Site list and descriptions

Name	Area	Eastings	Northing	Type
Mahanga Beach	North	2933100	6231500	Beach
Mahia Beach	North	2931300	6224000	Beach
Opoutama Beach	North	2928300	6226900	Beach
Lake Tutira	North	2846775	6212193	Lake
Maungawhio Lagoon	North	2933750	6225300	Brackish/Estuary
Te Mahia	North	2937959	6222442	Brackish/Estuary
Wairoa Rv at Ski Club	North	2891958	6232009	Freshwater
Waipatiki Beach	North	2853000	6203950	Beach
Hardinge Road Beach	Central	2845328	6184463	Beach
Te Awanga Beach	Central	2852061	6167177	Beach
Westshore Beach	Central	2844000	6184900	Beach
Clive Rv at Boat Ramp	Central	2846300	6173000	Freshwater
Maraetotara Lagoon	Central	2852200	6167100	Brackish/Estuary
Pandora Pond	Central	2844384	6183648	Brackish/Estuary
Waipatiki Lagoon	Central	2852800	6203950	Freshwater
Esk Rv	Central	2839922	6194857	Freshwater
Ngaruroro Rv at Chesterhope	Central	2842600	6171450	Freshwater
Tukituki Rv at Black Bridge	Central	2847566	6170374	Freshwater
Tutaekuri River at Guppy Rd	Central	2841400	6176700	Freshwater
Aramoana Beach	South	2837642	6110232	Beach
Blackhead Beach	South	2835850	6108100	Beach
Kairakau Beach	South	2845668	6132671	Beach
Ocean Beach	South	2853700	6154600	Beach
Porangahau Beach	South	2821736	6093836	Beach
Pourerere Beach	South	2840000	6113700	Beach
Waimarama Beach	South	2851900	6146640	Beach
Kairakau Lagoon	South	2845355	6132371	Brackish/Estuary
Porangahau Estuary	South	2820367	6094347	Brackish/Estuary
Puhokio Lagoon	South	2851795	6147360	Brackish/Estuary
Waipuka Lagoon	South	2853508	6154649	Brackish/Estuary
Tukituki Rv at SH2	South	2813451	6128979	Freshwater
Tukituki Rv at Walker Road	South	2821847	6129965	Freshwater

Marine Sites

Aramoana

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

Blackhead Beach

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

Hardinge Rd. Beach

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

Kairakau Beach

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

Mahanga Beach

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

Mahia Beach

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

Ocean Beach

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

Opoutama Beach

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

Porangahau Beach

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

Pourerere Beach

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

Te Awanga

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

Waimarama Beach

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

Waipatiki Beach

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

Westshore Beach

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

Freshwater and Estuarine Sites

Clive River at State Highway 2 Bridge (Boat Ramp)

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

Esk River

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

Kairakau Lagoon

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

Lake Tutira

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

Maraetotara Lagoon

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

Maungawhio Lagoon

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

Ngaruroro River at Chesterhope Bridge

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

Pandora Pond

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

Puhokio Stream at Waimarama Beach

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

Porangahau Estuary

Porangahau Estuary is a popular spot for swimming, boating, water skiing and jetskiing. The area may be influenced by wastewater discharges from the town's treatment plant, and unrestricted stick access.

Tukituki River at Black Bridge

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

Tukituki River at SH2, Waipukurau

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

Tutaekuri River at Pakowhai Rd. Bridge

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

Waipatiki Lagoon

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

Waipuka Stream at Ocean Beach

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

Wairoa River (Boat ramp)

The Wairoa River is one of the largest rivers in Hawke's Bay, and consequently has a large catchment in which the predominant land use is sheep and beef farming, with some dairying also occurring. The sampling site is at the Water Ski Club in the Wairoa township, and the river is tidal at this point. There are a number of discharges (in addition to the agricultural land use), which may affect the water quality at this site. Frasertown Meats is located upstream of the sampling site, and downstream discharges include Affco Wairoa and the municipal sewage discharge from Wairoa township. Additionally, there are a number of stormwater drains which flow into the river, and both active and closed landfills near the mouth of the river.

Shellfish Gathering Waters

Ahuriri Estuary

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.