



# On the beaches 2007/08

Annual recreational water quality monitoring report  
for the Wellington region

Alice Ryan and Summer Warr  
Environmental Monitoring and Investigations Department

In association with



For more information, contact:

Greater Wellington  
142 Wakefield Street  
PO Box 11646  
Manners Street  
Wellington 6142  
T 04 384 5708  
F 04 385 6960  
[www.gw.govt.nz](http://www.gw.govt.nz)

GW/EMI-T-08/79

June 2008



# Contents

<b>1.</b>	<b>Introduction</b>	<b>1</b>
<b>2.</b>	<b>Recreational water quality monitoring in the Wellington region</b>	<b>2</b>
2.1	Monitoring objectives	2
2.2	Microbiological water quality indicators and guidelines	2
2.2.1	Beach grading	3
<b>3.</b>	<b>Recreational water quality in fresh waters</b>	<b>4</b>
3.1	Introduction	4
3.2	Monitoring protocol	4
3.3	Guidelines	5
3.3.1	Periphyton guidelines	6
3.4	Data analysis, limitations and cautionary notes	6
3.5	Results	6
3.5.1	Kapiti	6
3.5.2	Hutt and Wainuiomata	7
3.5.3	Wairarapa	9
3.6	Synthesis	9
<b>4.</b>	<b>Recreational water quality in marine waters</b>	<b>11</b>
4.1	Introduction	11
4.2	Monitoring protocol	11
4.3	Guidelines	12
4.4	Data analysis, limitations and cautionary notes	13
4.5	Results	13
4.5.1	Kapiti	14
4.5.2	Porirua	14
4.5.3	Hutt	15
4.5.4	Wellington City	16
4.5.5	Wairarapa	17
4.6	Synthesis	18
<b>5.</b>	<b>Recreational shellfish gathering water quality</b>	<b>19</b>
5.1	Introduction	19
5.2	Monitoring protocol	19
5.3	Guidelines	20
5.4	Cautionary note	20
5.5	Data analysis and limitations	20
5.6	Results	21
5.6.1	Kapiti	21
5.6.2	Porirua	22
5.6.3	Wellington City	22
5.6.4	Hutt	23
5.7	Synthesis	23
<b>6.</b>	<b>References</b>	<b>24</b>
	<b>Acknowledgements</b>	<b>25</b>

<b>Appendix 1: Monitoring sites</b>	<b>26</b>
<b>Appendix 2: Laboratory and field methods</b>	<b>28</b>
<b>Appendix 3: Summary statistics and SFRGs</b>	<b>29</b>

## 1. Introduction

Regional and territorial authorities monitor recreational water quality to identify risks to public health from disease-causing organisms and advise the public of these risks. People can then make informed decisions about where, when, and how they use rivers and the marine environment for recreation.

Recreational water quality monitoring in the Wellington region over 2007/08 was once again a joint effort involving the Greater Wellington Regional Council (Greater Wellington) and its constituent local councils, in particular the Kapiti Coast District Council, Porirua City Council, Hutt City Council and Wellington City Council. Regional Public Health and Wairarapa Public Health were consulted on occasions when the results of the monitoring indicated a serious health risk might exist. During the summer bathing season, weekly water test results were collated by Greater Wellington and displayed at [www.gw.govt.nz/on-the-beaches](http://www.gw.govt.nz/on-the-beaches).

This report summarises the results of routine sampling undertaken over the 2007/08 summer bathing season (1 November 2007 to 31 March 2008 inclusive).



**Figure 1.1: Swimmers in the Hutt River near Poets Park, 20 January 2008.**

## **2. Recreational water quality monitoring in the Wellington region**

From the start of the 2000/01 summer, recreational water quality monitoring in the Wellington region has been a joint effort involving Greater Wellington and its constituent local councils. The sites monitored reflect their use by the public for contact recreation; in particular, swimming, canoeing, rafting, surfing, and boating.

### **2.1 Monitoring objectives**

The aims of Greater Wellington's recreational water quality monitoring programme are to:

1. Determine the suitability of selected sites in marine and fresh waters for contact recreation;
2. Determine the suitability of marine water in designated areas for the gathering of shellfish for human consumption;
3. Assist in safeguarding public health and the environment;
4. Provide a mechanism to determine the effectiveness of regional plans;
5. Provide information to assist in determining spatial and temporal changes in the environment (State of the Environment (SOE) monitoring); and
6. Provide information to assist in targeted investigations where remedial action or mitigation of poor water quality is desired.

### **2.2 Microbiological water quality indicators and guidelines**

Water contaminated by human or animal excreta may contain a diverse range of pathogenic (disease-causing) micro-organisms such as bacteria, viruses, and protozoa (e.g., salmonella, campylobacter, cryptosporidium, giardia, etc). These organisms may pose a health hazard when the water is used for recreational activities such as swimming. The most common illness from swimming in contaminated water is gastroenteritis, but recent evidence shows that respiratory illness and skin infections are also quite common. In most cases, the ill-health effects from exposure to contaminated water are minor and short-lived, although the potential for more serious diseases such as Hepatitis A, Giardiasis, Cryptosporidiosis, Campylobacteriosis, and Salmonellosis can not be discounted. It is likely that many cases of illness contracted through contact recreation activities in contaminated water go unreported.

In 2003 the Ministry for the Environment (MfE) and the Ministry of Health (MoH) finalised microbiological water quality guidelines for recreational waters which are based on an assessment of the risk from exposure to contaminated water. These guidelines use bacteriological indicators associated with the gut of warm-blooded animals to assess the risk of faecal

contamination and therefore the potential presence of harmful pathogens<sup>1</sup>. The indicators used are:

- Freshwater (including estuarine waters): *Escherichia coli* (*E. coli*)
- Marine waters: Enterococci
- Recreational shellfish-gathering waters: Faecal coliforms

Compliance with the MfE/MoH (2003<sup>2</sup>) microbiological water quality guidelines (from this point on referred to as *the recreational water quality guidelines*) should ensure that people using water for contact recreation are not exposed to significant health risks. The guideline values are outlined in Sections 3 (fresh waters), 4 (marine waters), and 5 (shellfish gathering waters) of this report. The guidelines for fresh and marine waters are essentially "trigger" values to help water managers determine when management intervention is required. The "trigger" values underpin a three-tier management framework analogous to traffic lights (Table 2.1).

**Table 2.1: Three-tier management framework for recreational waters advocated by MfE/MoH (2003).**

Mode	Management Response
Green/Surveillance	Routine monitoring
Amber/Alert	Increased monitoring, investigation of source and risk assessment
Red/Action	Closure, public warnings, increased monitoring and investigation of source

### 2.2.1 Beach grading

The MfE/MoH (2003) guidelines outline a process to grade the suitability of marine and fresh waters for recreational use from a public health perspective. This involves combining a qualitative assessment of the susceptibility of a recreational site to faecal contamination, and direct measurements of the appropriate bacteriological indicator at the site to generate a "Suitability for Recreation Grade" (SFRG) for the site. The SFRG describes the general condition of the water at a site at any given time.

SFRGs have already been determined for recreational sites in the Wellington region using microbiological data obtained from routine weekly sampling over the 2001/02 to 2005/06 summer bathing seasons (Milne and Wyatt 2006a). Updated SFRGs reflecting the 2007/08 microbiological water quality results are summarised in Appendix 3.

<sup>1</sup> Indicator bacteria are monitored because individual pathogenic organisms are often present in very low numbers, can be hard to detect, and the analytical tests are expensive.

<sup>2</sup> The guidelines were published in June 2002 and updated in June 2003.

### 3. Recreational water quality in fresh waters

#### 3.1 Introduction

Recreational water quality was monitored at 23 freshwater sites across the Wellington region over 2007/08 (Figure 3.1, Appendix 1), as follows:

- Kapiti Coast District – 4 sites
- Hutt and Wainuiomata river catchments – 7 sites
- Wairarapa – 12 sites

The sites monitored reflect their use by the public for contact recreation; in particular, swimming, surfing, and boating. This is the first year that recreational water quality has been monitored in the Wainuiomata River with the addition of a site at Richard Prouse Park.

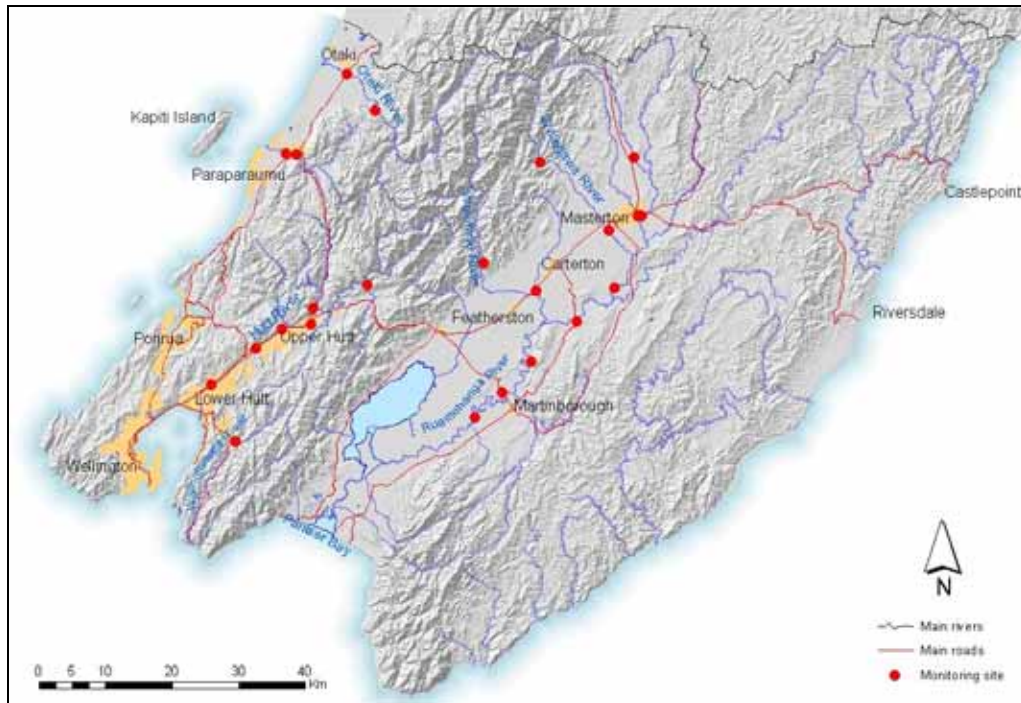


Figure 3.1: Freshwater recreation sites monitored over 2007/08.

#### 3.2 Monitoring protocol

Sites were sampled weekly during the bathing season, with the exception of the Otaki River at Pots (near Pukehinau on the Kapiti Coast) and the Waiohine River at Gorge (Wairarapa) which were sampled monthly under Greater Wellington’s Rivers State of the Environment (RSoE) monitoring programme<sup>3</sup>.

<sup>3</sup> Historically these sites were sampled separately under two Greater Wellington water quality monitoring programmes; recreational water quality and RSoE water quality. As both river sites have a “very low” to “low” risk of microbiological contamination and a high level of compliance with recreational water quality guidelines, Milne and Wyatt (2006) recommended that routine weekly sampling under the recreational water quality monitoring programme cease; the monthly microbiological water quality results obtained from these sites under the RSoE monitoring programme are now used to assess recreational water quality.



On each sampling occasion a single water sample was collected 0.2 metres below the surface in 0.5 metres water depth and analysed for *E. coli* indicator bacteria using a membrane filtration method. This analytical method provides a result in 24 hours, therefore enabling prompt re-sampling in the event that a result exceeds recommended guideline values.

Measurements of water temperature and turbidity, and visual estimates of periphyton (algae) cover, were also made at each site. Excessive amounts of periphyton, in particular filamentous algae, can reduce the amenity value of waterways by decreasing their aesthetic appearance, reducing visibility, and being a physical nuisance to swimmers. Some species of cyanobacteria (blue-green algae) can also produce natural toxins (cyanotoxins) which are harmful to humans and animals, particularly dogs (Milne and Watts 2007).

An estimate of the daily rainfall in the catchment adjoining each site over the bathing season was made by obtaining records from the nearest rain gauge. Rainfall can have a significant impact on water quality, as a result of runoff from rural or urban land and re-suspension of riverbed sediments.

A list of field and laboratory methods can be found in Appendix 2.

### 3.3 Guidelines

As outlined in Section 2.2, the MfE/MoH (2003) recreational water quality guidelines use bacteriological "trigger" values to help water managers determine when management intervention is required. The "trigger" values underpin a three-tier management framework analogous to traffic lights (Table 3.1).

**Table 3.1: MfE/MoH (2003) surveillance, alert and action levels for fresh waters.**

Mode	Guideline <i>E. coli</i> (cfu/100 mL)	Management Response
Green/Surveillance	Single sample ≤ 260	Routine monitoring
Amber/Alert	Single sample > 260 and ≤ 550	Increased monitoring, investigation of source and risk assessment
Red/Action	Single sample > 550	Closure, public warnings, increased monitoring and investigation of source

When water quality falls in the “surveillance mode”, this indicates that the risk of illness from bathing is acceptable (for freshwaters the accepted level of risk is 8 in every 1,000 bathers). If water quality falls into the “alert” category, this indicates an increased risk of illness from bathing, but still within an acceptable range. However, if water quality enters the “action” category, then the water poses an unacceptable health risk from bathing (MfE/MoH 2003). At this point, warning signs are erected at the bathing site, and the public is informed that it is unsafe to swim at that site. The only time a warning is unlikely to be issued is when an action level result is preceded by rainfall. This is because it is widely known that rainfall is highly correlated with elevated bacteria counts in rivers (see Section 3.6). For this reason Greater Wellington and the Ministry

of Health advise avoiding swimming and other contact recreation activities in freshwaters during and for up to several days after heavy rainfall.

### 3.3.1 Periphyton guidelines

The MfE (2000) periphyton<sup>4</sup> guidelines provide two maximum thresholds for periphyton cover in gravel/cobble bed streams managed for aesthetic and recreational values: 30% filamentous algae >2 cm long, and 60% cover for diatoms/cyanobacteria >0.3 cm thick. These thresholds relate to the visible areas of stream bed only.

## 3.4 Data analysis, limitations and cautionary notes

All sampling and evaluation of results have been undertaken in accordance with the MfE/MoH (2003) recreational water quality guidelines. However, the guidelines do not cover toxic algal blooms or proliferations, which in certain places and under certain conditions, may pose a significant risk to contact recreation. Toxic algae blooms were recorded at popular recreational spots in the Hutt and Waipoua rivers over much of the 2007/08 recreational season and were also present in several of Wellington's rivers over the 2005/06 summer (Milne and Watts 2007). The response to toxic algal blooms is managed by a working party of Regional Public Health, Territorial Authority and Greater Wellington staff.

## 3.5 Results

Action level *E. coli* results recorded during routine monitoring over 2007/08 are summarised below for bathing sites in Kapiti Coast, Hutt, Wainuiomata and Wairarapa rivers. The number of surveillance, alert and action level results recorded at each of the 23 bathing sites are summarised in Appendix 3. Follow-up sampling is generally conducted when a routine sample returns a result that exceeds the alert or action guideline. The key exception is when routine sampling coincides with, or is followed by, heavy rainfall and elevated river flows. Only action level-related follow-up sampling results are discussed here.

### 3.5.1 Kapiti

None of the four freshwater bathing sites on the Kapiti Coast exceeded the action guideline of 550 cfu/100mL during the 2007/08 bathing season.

Coverage of filamentous and mat algae was within guideline values on all sampling occasions at all sites. However, some growth of potentially toxic cyanobacteria was observed in the Waikanae River at Jim Cooke Park from mid-December 2007 onwards. This prompted the Kapiti Coast District Council to erect health warning signs in early January 2008 as a precautionary measure. These signs remained in place for the rest of the summer bathing season.

---

<sup>4</sup> Periphyton refers to the slime coating on a riverbed, composed largely of algae and cyanobacteria.

### 3.5.2 Hutt and Wainuiomata

All seven bathing sites in the Hutt and Wainuiomata river catchments exceeded the action guideline on at least one occasion during the summer bathing season. The Hutt River at Boulcott exceeded the action guideline on three occasions and the alert guideline six times. The action level events recorded in the Hutt and Wainuiomata River catchments during 2007/08 were:

- 18 December 2007 – Wainuiomata River at Richard Prouse Park (660 cfu/100 mL).
- 8 January 2008 – Hutt River at Birchville (1,800 cfu/100 mL), Maoribank (1,900 cfu/100 mL), Poets Park (1,600 cfu/100 mL), Silverstream (2,500 cfu/100 mL) and Boulcott (2,300 cfu/100 mL), Pakuratahi River at Forks (4,000 cfu/100 mL), and Wainuiomata River at Richard Prouse Park (2,000 cfu/100 mL).
- 12 February 2008 – Hutt River at Maoribank (980 cfu/100 mL).
- 4 March 2008 – Hutt River at Boulcott (1,900 cfu/100 mL).
- 18 March 2008 – Hutt River at Boulcott (3,300 cfu/100 mL).

All but one of the action guideline breaches coincided with at least 10 mm of rainfall either on the day of sampling or in the 72 hours prior. For example, the action level *E. coli* results recorded at all seven bathing sites on 8 January 2008 were preceded (in the 24 hours prior to sampling) by 24 mm and 38.5 mm of rain in the Hutt and Wainuiomata catchments respectively. Only the action guideline breach in the Hutt River at Boulcott on 18 March did not coincide with significant rainfall. The results of follow-up sampling carried out the next day complied with the surveillance guideline.

The cause of the unusually high number of action and alert level results in the Hutt River at Boulcott is unclear. Several of these coincided with in-stream works being undertaken by Greater Wellington's Flood Protection department between the Silverstream Bridge and the Boulcott site. In-stream works can contribute to elevated bacteria counts by re-suspending bacteria associated with bottom sediment. Faecal inputs from the large numbers of ducks observed upstream of the site on several occasions could also have contributed to some of the high results.

Filamentous algal growth in the Wainuiomata River at Richard Prouse Park exceeded the 30% threshold on two occasions in March. Coverage of mat-forming algae exceeded the 60% threshold at Hutt River at Silverstream on three occasions in February.

Although the guideline for mat-forming algae was only exceeded at the Silverstream site, cyanobacterial mat growth was widespread along the middle and lower reaches of the Hutt River from late December until the end of March (Figure 3.2). This cyanobacteria growth coincided with an extended period of lower than average flows in the Hutt River. Over much of this time large amounts of dislodged algal mats were exposed on the river banks (Figure 3.3). Three dogs died after coming into contact with these mats in the

Silverstream/Kennedy Good Bridge area early in the New Year. Health warning signs were promptly erected by Upper Hutt and Hutt City councils at public access points along the length of the Hutt River and remained in place until the end of March. Throughout this period, updates on algal presence were released to the media by Regional Public Health and/or Greater Wellington and posted on Greater Wellington's website. Moderate cyanobacterial growth was also recorded in the Wainuiomata River over the same period and health warning signs were erected at key public access points.



**Figure 3.2: Widespread cyanobacterial growth on the river bed in the Hutt River at Birchville on 29 January 2008.**



**Figure 3.3: Dislodged cyanobacterial mats on the river's edge at Silverstream on 7 January 2008.**

### 3.5.3 Wairarapa

Nine of the 12 bathing sites monitored in Wairarapa rivers exceeded the action guideline on one or more occasions during the summer bathing season. This is a similar result to 2006/07, when eight of the sites exceeded the action guideline (Milne 2007). The 2007/08 action events are summarised below:

- 11 December 2007 – Ruamahanga River at Te Ore Ore (940 cfu/100 mL).
- 8 January 2008 – Ruamahanga River at The Cliffs (640 cfu/100 mL), Kokotau (1,000 cfu/100 mL), Morrisons Bush (920 cfu/100mL), Waihenga (600 cfu/100 mL), and Bentleys Beach (1,100 cfu/100 mL), Waipoua River at Colombo Road (960 cfu/100 mL) and Waiohine River at State Highway 2 (1,300 cfu/100mL).
- 3 March 2008 – Ruamahanga River at Kokotau (580 cfu/100 mL) and Bentleys Beach (560 cfu/100 mL).
- 17 March 2008 – Ruamahanga River at Double Bridges (2,500 cfu/100mL).
- 25 March 2008 – Ruamahanga River at Double Bridges (580 cfu/100mL).

The majority of action level results coincided with significant rainfall prior to or during sampling. For example, 88mm of rain was recorded high in the Tararua Range in the 48 hours prior to sampling on 8 January 2008.

The action level breaches in the Ruamahanga River at Double Bridges on 17 and 25 March 2008 did not coincide with significant rainfall prior to sampling. Due to a lack of resources no follow-up sample was collected following the 17 March event. A follow-up sample collected following the 25 March action event showed that the *E. coli* count was below the surveillance mode guideline (260 cfu/100mL).

The filamentous periphyton cover threshold was exceeded in the Ruamahanga River at Te Ore Ore on two sampling occasions and at Waihenga on three occasions. All exceedances occurred in February 2008. Although there were no breaches of the 60% cover threshold for mat-forming algae, cyanobacterial mats covered up to 34% of the Waipoua River channel at Colombo Road. Health warning signs were erected at this site by Masterton District Council in early February and a press release issued.

## 3.6 Synthesis

Of the 21 freshwater sites monitored weekly over the 2007/08 summer bathing season, 16 (81%) exceeded the action guideline on at least one occasion (Table 3.2). Ten sites exceeded the guideline once, five sites exceeded the guideline twice and one site exceeded the guideline three times.

**Table 3.2: Summary of action guideline breaches from routine weekly monitoring at 21 freshwater sites over the 2007/08 summer bathing season†.**

No. of Times Site Exceeded the Action Guideline	No. of Sites in each Exceedance Category			Total No. of Sites (21)	% of Sites
	Kapiti (3 sites)	Hutt and Wainuiomata (7 sites)	Wairarapa (11 sites)		
0	3	0	2	5	23.8
1	0	4	6	10	47.6
2	0	2	3	5	23.8
3	0	1	0	1	4.8

† This analysis excludes the Otaki River at The Pots (Kapiti) and the Waiohine River at Gorge (Wairarapa); these sites are only sampled monthly under Greater Wellington's RSoE water quality monitoring programme.

A total of 23 routine sampling results exceeded the action guideline of 550 cfu/100mL. This is five less than the 2006/07 summer.

The majority (19) of the 23 action level results were associated with at least 10 mm of rainfall in the 72 hours prior to sampling. This finding is consistent with previous observations; elevated *E. coli* counts in fresh water are typically related to diffuse-source runoff, urban stormwater (including sewer overflows), and re-suspension of sediments during rainfall events (Milne and Wyatt 2006, Milne 2005).



## 4. Recreational water quality in marine waters

### 4.1 Introduction

Recreational water quality was monitored at 77 marine sites across the Wellington region over 2007/08 (Figure 4.1, Appendix 1), as follows:

- Kapiti Coast District – 20 sites
- Porirua City – 15 sites
- Hutt City – 15 sites
- Wellington City – 22 sites
- Wairarapa – 5 sites

The sites monitored reflect their use by the public for contact recreation; in particular, swimming, surfing, and boating. This year, for the first time, recreational water quality monitoring was carried out in the Pauatahanui Inlet at Paremata Bridge, bringing the number of sites in the Pauatahanui Inlet to four.

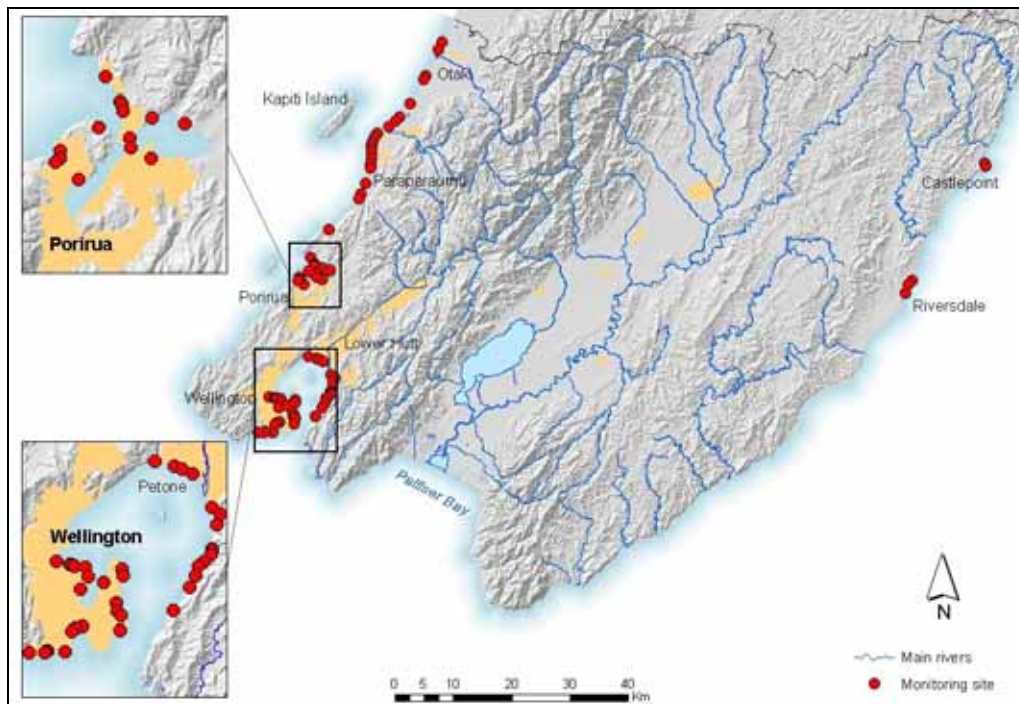


Figure 4.1: Marine recreation sites monitored over 2007/08.

### 4.2 Monitoring protocol

Sites were sampled weekly during the bathing season, with the exception of Camp Bay (Hutt City), Breaker Bay (Wellington City), Princess Bay (Wellington City) and Riversdale Beach South (Wairarapa) which were

sampled fortnightly<sup>5</sup>. On each sampling occasion a single water sample was collected 0.2 metres below the surface in 0.5 metres water depth and analysed for enterococci indicator bacteria using a membrane filtration method. This analytical method provides a result in 24 hours, therefore enabling prompt re-sampling in the event that a result exceeds recommended guideline values.

Observations of weather and the state of the tide, and visual estimates of seaweed cover, were also made at each site to assist with the interpretation of the monitoring results. For example:

- Rainfall may increase enterococci counts by flushing accumulated debris from urban and agricultural areas into coastal waters.
- Wind direction can influence the movement of currents along the coastline and can therefore affect water quality at a particular site.
- In some cases, an increase in enterococci counts may be due to the presence of seaweed. Under warm conditions when seaweed is excessively photosynthesising or decaying, enterococci may feed off the decayed seaweed or increased carbonaceous material produced by the seaweed during photosynthesis.

An estimate of the daily rainfall in the catchment adjoining each site over the bathing season was made by obtaining records from the nearest rain gauge.

A list of field and laboratory methods can be found in Appendix 2.

### 4.3 Guidelines

As outlined in Section 2.2, the MfE/MoH (2003) recreational water quality guidelines use bacteriological "trigger" values to help water managers determine when management intervention is required. The "trigger" values underpin a three-tier management framework analogous to traffic lights (Table 4.1).

**Table 4.1: MfE/MoH (2003) surveillance, alert and action levels for marine waters.**

Mode	Guideline Enterococci (cfu/100 mL)	Management Response
Green/Surveillance	Single sample ≤ 140	Routine monitoring
Amber/Alert	Single sample > 140	Increased monitoring, investigation of source and risk assessment
Red/Action	Two consecutive samples within 24 hours > 280	Closure, public warnings, increased monitoring and investigation of source

When water quality falls in the “surveillance mode”, this indicates that the risk of illness from bathing is acceptable (for marine waters the accepted level of

<sup>5</sup> Milne and Wyatt (2006) recommended the frequency of sampling reduce from weekly to fortnightly from 1 November 2006 because these sites have a “very low” to “low” risk of microbiological contamination and a high level of compliance with recreational water quality guidelines.



risk is 19 in every 1000 bathers). If water quality falls into the “alert” category, this indicates an increased risk of illness from bathing, but still within an acceptable range. However, if the water quality enters the “action” category, then the water poses an unacceptable health risk from bathing. At this point, warning signs are erected at the bathing site, and the public is informed that it is unsafe to swim at that site. The only time a warning is unlikely to be issued is when an action level result is preceded by heavy rainfall. This is because it is widely known that rainfall is often correlated with elevated bacteria counts in marine waters (see Section 4.6). For this reason Greater Wellington and the Ministry of Health advise avoiding swimming and other contact recreation activities in marine waters during and for up to several days after heavy rainfall.

#### **4.4 Data analysis, limitations and cautionary notes**

All sampling and evaluation of results have been undertaken in accordance with the MfE/MoH (2003) recreational water quality guidelines. However, it is not possible to accurately specify the number of true exceedances of the red/action mode of the guidelines. The guidelines state that a marine bathing site only enters the action mode when *two consecutive samples* exceed 280 enterococci/100 mL but, in practice, there can be delays in collecting a second sample (e.g., bad weather). Therefore to ensure that recreational water quality is assessed on an equal basis across all 77 sites, the approach taken by Greater Wellington is to treat any single result greater than 280 enterococci/100 mL obtained from routine weekly monitoring as an exceedance of the red/action mode of the guidelines. This is also the approach taken by the Ministry for the Environment in its national recreational water quality monitoring reporting and means that a second consecutive action result is simply used to confirm the appropriate management response (e.g., erection of public warnings), (MfE 2005).

The MfE/MoH (2003) recreational water quality guidelines do not cover toxic algal blooms, which in certain places and under certain conditions may pose a significant risk to contact recreation. Such blooms have occurred in marine recreational waters in the Wellington region in the past.

#### **4.5 Results**

Action level enterococci results recorded during routine monitoring over 2007/08 are summarised below for marine waters in Kapiti, Porirua City, Hutt City, Wellington City and the Wairarapa. The number of surveillance, alert and action level results recorded at each of the 77 bathing sites are summarised in Appendix 3. In accordance with the MfE/MoH (2003) recreational water quality guidelines, follow-up sampling is conducted when a routine sample returns a result that exceeds the alert or action guideline. Only action level-related follow-up sampling results are discussed here. On occasion, alert level follow-up sampling returns a result above the action guideline, triggering additional sampling or investigation.

#### 4.5.1 Kapiti

Nine of the 20 marine sites monitored along the Kapiti Coast exceeded the action guideline of 280 cfu/100 mL during the summer bathing season. Of these, three sites exceeded the guideline more than once. There were a similar number of exceedances in 2006/07 (Milne 2007). The 2007/08 action guideline breaches are summarised below:

- 5 November 2007 – Paraparaumu Beach at Ngapotiki Street (585 cfu/100mL) and Nathan Ave (450 cfu/100 mL), and Raumati Beach at Marine Gardens (450 cfu/100mL).
- 24 December 2007 – Paraparaumu Beach at Nathan Ave (520 cfu/100 mL).
- 10 January 2008 – Otaki Beach at Surf Club (330 cfu/100 mL), Te Horo Beach at Mangaone Stream (1,480 cfu/mL), Te Horo Beach at Kitchener St (570 cfu/100mL) and Waikanae Beach at Ara Kuaka (590 cfu/100mL).
- 23 January 2008 – Raumati Beach at Tainui St (355 cfu/100 mL), Raumati Beach at Marine Gardens (340 cfu/100ml), Raumati Beach at Aotea Road (435 cfu/100mL) and Te Horo Beach at Mangaone Stream (320 cfu/100mL).

The action guideline exceedances on 5 November 2007 and 10 January 2008 both coincided with significant rainfall prior to sampling. For example, 65 mm of rain fell in the 72 hours prior to sampling on 10 January 2008. No significant rainfall was recorded prior to the action level results on 24 December 2007 or 23 January 2008. Moderate nor-west winds and turbid water recorded at the three Raumati Beach sites on 23 January could have contributed to the action level results at these sites.

The Kapiti Coast District Council collected additional samples following all exceedances of the action guideline. The results of all of these follow-up samples complied with the surveillance guideline ( $\leq 140$  cfu/100 mL), indicating that no further management action was required.

#### 4.5.2 Porirua

Eight of the 15 sites monitored in Porirua City exceeded the action guideline during the bathing season, with one site (Porirua Harbour at Rowing Club) exceeding the guideline three times. This an improvement on the 2006/07 summer when 12 of the 14 sites exceeded the action guideline and four sites exceeded the guideline at least twice (Milne 2007). The 2007/08 action events are summarised below:

- 11 December 2007 –Titahi Bay at Toms Road (420 cfu/100 mL).
- 8 January 2008 – Pukerua Bay (600 cfu/100 mL), South Beach at Plimmerton (490 cfu/100 mL), Pauatahanui Inlet at Browns Bay (1,500 cfu/100 mL) and Paremata Bridge (410 cfu/100 mL), Paremata Beach at Pascoe Avenue (490 cfu/100 mL), Porirua Harbour at Rowing Club (1,600 cfu/100 mL, and Titahi Bay at Bay Drive (360 cfu/100 mL).

- 5 February 2008– Porirua Harbour at Rowing Club (3,600 cfu/100 mL).
- 12 February 2008 – Porirua Harbour at Rowing Club (9,600 cfu/100 mL).

The January 2008 sampling results that exceeded the action guideline coincided with 37.5mm of rainfall in the 24 hours prior to sampling. The influence of rainfall on water quality in Titahi Bay on 11 December 2007 and Porirua Harbour at Rowing Club on 5 and 12 February 2008 is less clear as the amount of rainfall recorded in the 72 hours prior to sampling was 10 mm or less on each occasion. A strong southerly wind was blowing at the Porirua Harbour at Rowing Club site on 5 February and may have resulted in re-suspension of sediment and associated bacteria (an elevated turbidity measurement was recorded on this occasion). Turbidity was very high (148 NTU) at the Rowing Club site on 12 February 2008 though the reason for this is unclear.

The Porirua City Council collected additional samples following all exceedances of the action guideline. The results of most of these follow-up samples complied with the surveillance guideline, indicating that no further management action was required. The exceptions were the results of follow-up sampling undertaken at Titahi Bay at Toms Road on 12 December 2007 and Porirua Harbour at Rowing Club on 10 January 2008. The follow-up samples taken from Titahi Bay at Toms Road exceeded the alert mode threshold on 12 December (230 cfu/100 mL) and the action threshold on 13 December (1,000 cfu/100 mL) at which point health warning signs were erected. A further follow-up sample taken on 14 December complied with the surveillance guideline. The follow-up sample taken at the Porirua Harbour at Rowing Club site on 10 January exceeded the action level threshold (300 cfu/100 mL) and health warning signs were erected. A further follow-up sample taken at this site the next day complied with the surveillance guideline. Health warning signs were removed once confirmation of a return to the surveillance mode was received.

Sanitary surveys were undertaken by the Porirua City Council in response to the consecutive action level results at the Titahi Bay at Toms Road and Porirua Harbour at Rowing Club sites. These sanitary surveys involved additional microbiological sampling in streams and stormwater drains close to each site but did not identify any obvious source of faecal contamination.

#### 4.5.3 Hutt

All but one of the 15 marine sites monitored in Hutt City exceeded the action guideline of 280 cfu/100 mL during the bathing season, with eight sites exceeding the guideline at least twice. In 2006/07, eight sites exceeded the guideline, with only one site (Robinson Bay) exceeding the guideline more than once (Milne 2007). The 2007/08 action events are summarised below:

- 18 December 2007 – Petone Beach at the Water Ski Club (380 cfu/100 mL), Petone Beach at Sydney Street (2,100 cfu/100 mL), Petone Beach at Settlers Museum (350 cfu/100 mL), Petone Beach at Kiosk (910 cfu/100 mL), Lowry Bay at Cheviot Road (2,000 cfu/100 mL), Days Bay at

Wellesley College (570 cfu/100mL), Days Bay at Wharf (520 cfu/100mL), and Robinson Bay at Nikau St (1,800 cfu/100 mL).

- 8 January 2008 – Sorrento Bay (840 cfu/100 mL), Lowry Bay at Cheviot St (1,000 cfu/100 mL), York Bay (1,000 cfu/100 mL), Days Bay at Wellesley College (1,400 cfu/100 mL), Days Bay at Wharf (1,200 cfu/100 mL), Days Bay at Moana Rd (960 cfu/100 mL), Rona Bay at Cliff Bishop Park (1,200 cfu/100 mL), Rona Bay at Wharf (1,300 cfu/100 mL), Robinson Bay at HW Shortt Rec Ground (1,000 cfu/100 mL) and Robinson Bay at Nikau St (1,100 cfu/100 mL).
- 12 February 2008 – Petone Beach at the Water Ski Club (430 cfu/100 mL), Petone Beach at Sydney Street (400 cfu/100 mL), Petone Beach at Settlers Museum (960 cfu/100 mL) and Petone Beach at Kiosk (1,000 cfu/100 mL), Lowry Bay at Cheviot Rd (360 cfu/100 mL), Days Bay at Wharf (370 cfu/100mL), and Robinson Bay at Nikau St (1,600 cfu/100 mL).

The January and February action events both coincided with significant rainfall (at least 19 mm in 48 hours) prior to sampling. There was no rainfall in the 72 hours prior to the action events on 18 December 2008, although it was raining at the time of sampling.

Hutt City Council collected additional samples following all exceedances of the action guideline, of which, the results of all but one sample were below the surveillance guideline; the exception was the follow-up sample collected at Lowry Bay at Cheviot Road on 10 January 2008. Enterococci counts at this site exceeded the action guideline on this occasion and again on 11 January 2008. The result of a further follow-up sample collected on 12 January complied with the surveillance guideline.

#### 4.5.4 Wellington City

Eleven of the 22 marine sites monitored in Wellington City exceeded the action guideline during the bathing season. Five of these sites exceeded the guideline on at least two occasions. This is a marked deterioration to the 2006/07 season during which only three sites exceeded the action guideline, on one occasion (Milne 2007). The 2007/08 action events are summarised below:

- 5 November 2007 – Lyall Bay at Tirangi Road (940 cfu/100 mL).
- 19 November 2007 – Lyall Bay at Tirangi Road (360 cfu/100 mL).
- 10 December 2007 – Aotea Lagoon (420 cfu/100 mL) and Seatoun Beach at Inglis St (330 cfu/100 mL).
- 22 January 2008 – Aotea Lagoon (710 cfu/100 mL) and Oriental Bay at Wishing Well (1,600 cfu/100 mL).
- 4 February 2008 – Aotea Lagoon (320 cfu/100 mL), Balaena Bay (390 cfu/100 mL), Island Bay at Surf Club (1,400 cfu/100mL), Island Bay at Reef St (2,200 cfu/100 mL), and Owhiro Bay (2,300 cfu/100 mL).

- 11 February 2008 – Oriental Bay at Freyberg Beach (1,700 cfu/100 mL), Oriental Bay at Wishing Well (1,000 cfu/100 mL), Oriental Bay at Band Rotunda (1,600 cfu/100 mL), and Owhiro Bay (480 cfu/100 mL).
- 18 February 2008 – Seatoun Beach at Wharf (1,800 cfu/100 mL).
- 3 March 2008 – Island Bay at Surf Club (380 cfu/100mL) and Owhiro Bay (430 cfu/100 mL).

The action level breaches on 11 February, 18 February and 3 March 2008 all coincided with more than 10 mm of rainfall in the 72 hours prior to sampling. The cause of exceedances on 5 and 19 November 2007, 10 December 2007 and 4 February 2008 is less clear. Only a small amount of rainfall (<10 mm on the day of or in the 72 hours prior to sampling) was recorded prior to action level breaches on 5 November 2007, 10 December 2007, 22 January 2008 and 4 February 2008 however this may have been enough to effect small catchments such as Aotea Lagoon. No rain was recorded prior to sampling on 19 November 2007.

The Wellington City Council collected additional samples following all exceedances of the action guideline. The results of most of these follow-up samples complied with the surveillance guideline, indicating that no further management action was required. The exceptions were the results of follow-up sampling undertaken at Owhiro Bay following the breach on 11 February and at Island Bay at Surf Club following the breach on 3 March. Follow-up samples taken at Owhiro Bay exceeded the action guideline on both 12 and 13 February (880 cfu/100ml and 600 cfu/100ml respectively). Health warning signs were subsequently erected and remained in place until 20 February, although the result from sampling undertaken on 14 February complied with the surveillance guideline.

Follow-up samples taken at Island Bay at Surf Club exceeded the alert level on 4 March (280 cfu/100 ml) and the action level on 5 March (730 cfu/100ml). Although the sample taken on 6 March exceeded the alert level (270 cfu/100ml), no further follow-up samples were taken. These action level breaches were attributed to a sewage pump station overflow following heavy rain on 2 March 2008 (Nick Urlich, Capacity, pers comm.).

#### 4.5.5 Wairarapa

Riversdale Beach at Lagoon Mouth was the only one of the five marine bathing sites in the Wairarapa that exceeded the action guideline of 280 cfu/100mL during the 2007/08 summer:

- 10 December 2007 – Riversdale Beach at Lagoon Mouth (1,100 cfu/100 mL).

The elevated enterococci result followed 14.2 mm of rainfall in the 48 hours prior to sample collection. This rainfall is likely to have affected water quality in the Motuwaireka Lagoon. No follow-up sample was collected.

## 4.6 Synthesis

Forty-three of the 77 marine sites (56%) monitored over the 2007/08 summer bathing season exceeded the action guideline, although many of these (26 sites) exceeded the guideline on only one occasion (Table 4.2).

**Table 4.2: Summary of action guideline breaches from routine weekly monitoring at 77 marine sites over the 2007/08 summer bathing season<sup>†</sup>.**

No. of Times Site Exceeded the Action Guideline	No. of Sites in each Exceedance Category					Total No. of Sites (77)	% of Sites
	Kapiti (20 sites)	Porirua (15 sites)	Hutt (15 sites)	Wellington (22 sites)	Wairarapa (5 sites)		
0	11	7	1	11	4	34	44.1
1	6	7	6	6	1	26	33.8
2	3	0	5	3	0	11	14.3
3	0	1	3	2	0	6	7.8

<sup>†</sup> includes four sites (one in Hutt City and the Wairarapa and two in Wellington City) sampled fortnightly.

The number of sites that remained below the action guideline of 280 cfu/100mL for the duration of the bathing period (34) was less than the 2006/07 (46 sites) bathing season (Milne 2007).

The majority (40) of the 66 action events were associated with at least 10 mm of rainfall in the three days prior to sampling; 24 were associated with more than 10 mm of rainfall in the 24 hours prior to the day of sampling. This finding is consistent with previous observations; elevated enterococci counts in marine waters are often related to urban stormwater (including sewer overflows), diffuse-source runoff into rivers and streams and re-suspension of sediments during rainfall events. Re-suspension of sediments (due to winds and/or tidal action) can also affect some beaches in dry weather as can poor water quality in rivers, streams and drains discharging directly to the coast (Milne and Wyatt 2006).

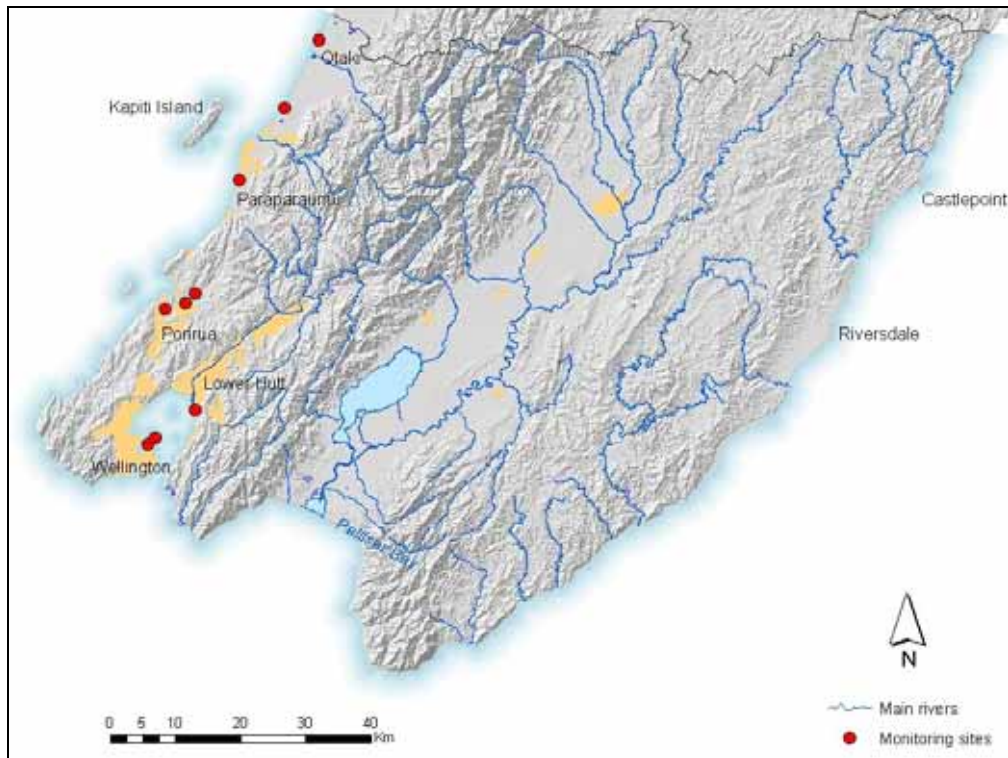
## 5. Recreational shellfish gathering water quality

### 5.1 Introduction

Recreational shellfish gathering water quality was monitored at nine marine sites across the Wellington region over 2007/08 (Figure 5.1, Appendix 1), as follows:

- Kapiti Coast District – 3 sites
- Porirua City – 3 sites<sup>6</sup>
- Hutt City – 1 site
- Wellington City – 2 sites

This is the first year that recreational shellfish gathering water quality has been monitored in the Porirua City area with two sites monitored in the Pauatahanui Inlet and one in Porirua Harbour.



**Figure 5.1: Recreational shellfish gathering water quality monitoring sites, 2007/08.**

### 5.2 Monitoring protocol

Sites were sampled weekly during 1 November 2007 to 31 March 2008 inclusive and at least monthly during the remainder of the year, at the same time as marine recreational water quality sampling (all nine sites are also marine bathing sites). On each sampling occasion a single water sample was

<sup>6</sup> These sites, introduced in July 2007, are not recommended shellfish gathering sites but are monitored in response to community interest.

collected 0.2 metres below the surface in 0.5 metres water depth and analysed for faecal coliform indicator bacteria using membrane filtration. Although the MfE/MoH (2003) guidelines recommend the five-tube decimal dilution test (known as the Most Probable Number (MPN) method), membrane filtration produces an equivalent result in colony forming units (cfu) and is a faster test, providing a result in 24 hours.

### 5.3 Guidelines

As outlined in Section 2.2, the MfE/MoH (2003) recreational water quality guidelines use faecal coliform bacteria as indicators of microbiological contamination in shellfish-gathering waters. The guidelines state:

- The median faecal coliform content of samples taken over a shellfish-gathering season shall not exceed 14 MPN/100 mL; and
- Not more than 10% of samples collected over a shellfish gathering season should exceed 43 MPN/100 mL.

The MfE/MoH (2003) guidelines also state the guideline values above should be applied in conjunction with a sanitary survey. Sanitary surveys are presented for each site in Appendix 3 in the form of the Sanitary Inspection Categories (SICs) which indicate the susceptibility of these sites to faecal contamination. More information on how these SICs were assigned can be found in Milne & Wyatt (2006).

### 5.4 Cautionary note

The MfE/MoH (2003) guidelines only address microbiological contamination. They do not address marine biotoxins, heavy metals, or harmful organic contaminants which in certain places and locations can pose a significant risk to people gathering shellfish. For this reason, the guidelines can not be used to determine whether shellfish are actually safe to eat. Monitoring of microbiological contaminants in *shellfish flesh* is needed to provide a direct measure of the risks associated with consuming shellfish. Greater Wellington periodically undertakes shellfish flesh monitoring; the most recent monitoring was undertaken in early 2006 (Milne 2006).

### 5.5 Data analysis and limitations

All sampling and evaluation of results have been undertaken in accordance with the MfE/MoH (2003) recreational water quality guidelines where possible. However, the guidelines do not define a shellfish gathering season, nor do they provide any guidance on the minimum number of samples that should be used to calculate compliance with the median guideline. In the absence of such guidance, the approach taken in this report is to align the shellfish gathering season with the summer bathing season (i.e., 1 November to 31 March inclusive), even though it is acknowledged that shellfish gathering is likely to occur year round at many sites to some degree.



In some cases, additional sampling was undertaken in conjunction with re-sampling of bathing sites following an exceedance of the alert or action levels of the marine recreational water quality guidelines. The results of these follow-up samples were excluded from the calculation of compliance with the recreational shellfish gathering water quality guidelines (i.e., only routine weekly sampling results are discussed here).

During data processing, any faecal coliform counts reported as less than or greater than detection limits were replaced by values one half of the detection limit or the detection limit respectively (i.e., counts of <4 cfu/100 mL and >400 cfu/100 mL were treated as 2 cfu/100 mL and 400 mL respectively).

## 5.6 Results

Compliance with the shellfish gathering water quality guidelines over the 2007/08 summer season is summarised below for marine waters in Kapiti, Porirua City, Wellington City and Hutt City.

### 5.6.1 Kapiti

None of the three monitoring sites on the Kapiti Coast complied with the recreational shellfish gathering water quality guidelines for the 2007/08 summer period (Table 5.1). The median faecal coliform count for the Otaki Beach and Peka Peka Beach monitoring sites did not exceed the guideline of 14 cfu/100 mL but more than 10% of water samples exceeded 43 cfu/100 mL. Raumati Beach at Hydes Road exceeded both guideline criteria.

**Table 5.1: Analysis of faecal coliform counts obtained from routine weekly monitoring during the 2007/08 summer months against the MfE/MoH (2003) guideline levels for recreational shellfish-gathering waters.**

Site	Median (cfu/100 mL)	Maximum (cfu/100 mL)	No. (and percentage) of results >43 cfu/100 mL	Total no. of samples
Otaki Beach – Surf Club	6	535	4 (19.0%)	21
Peka Peka Beach – Road End	6	237	4 (19.0%)	21
Raumati Beach – Hydes Rd	17	265	5 (23.8%)	21

The maximum faecal bacteria count recorded at Otaki Beach (535 cfu/100 mL on 10 January 2008) coincided with very turbid water. It also followed heavy rainfall; 65mm was recorded at the Paraparaumu Aerodrome rainfall station in the 72 hours prior to sampling.

The maximum faecal coliform counts recorded at Peka Peka Beach on 11 December 2007 and Raumati Beach on 23 January 2008 both coincided with small amounts of rainfall (<10 mm in previous 24 hours). The high count at Raumati Beach also coincided with moderate nor-west winds and moderately turbid water.

### 5.6.2 Porirua

Although shellfish gathering is not generally recommended at the three sites monitored in Porirua, one site (Pauatahanui Inlet at Motukaraka Point) complied with the recreational shellfish gathering water quality guidelines for the 2007/08 summer period (Table 5.2). The median faecal count for Pauatahanui Inlet at Browns Bay did not exceed the guideline of 14 cfu/100 mL but more than 10% of water samples exceeded 43 cfu/100 mL. The Porirua Harbour at Rowing Club exceeded both guideline criteria.

**Table 5.2: Analysis of faecal coliform counts obtained from routine weekly monitoring during the 2007/08 summer months against the MfE/MoH (2003) guideline levels for recreational shellfish-gathering waters.**

Site	Median (cfu/100 mL)	Maximum (cfu/100 mL)	No. (and percentage) of results >43 cfu/100 mL	Total no. of samples
Pauatahanui Inlet at Browns Bay	4	620	3 (14.1%)	21
Pauatahanui Inlet at Motukaraka Point	2	450	1 (4.8%)	21
Porirua Harbour at Rowing Club	28	6,400	8 (38.1%)	21

The maximum faecal bacteria counts recorded at Browns Bay and Motukaraka Point both occurred on 8 January 2008 and coincided with heavy rainfall prior to sampling (37.5 mm of rainfall in the 24 hours prior to sampling). The maximum faecal bacteria count in the Porirua Harbour at Rowing Club was recorded on 12 February 2008 and coincided with very turbid water but only a small amount of rainfall (10 mm in the 48 hours prior to sampling).

### 5.6.3 Wellington City

Both monitoring sites in Wellington City – Shark Bay and Mahanga Bay – complied fully with the recreational shellfish gathering water quality guidelines for the 2007/08 summer period. Both sites recorded one result above 43 cfu/100 mL (Table 5.3).

**Table 5.3: Analysis of faecal coliform counts obtained from routine weekly monitoring during the 2007/08 summer months against the MfE/MoH (2003) guideline levels for recreational shellfish-gathering waters.**

Site	Median (cfu/100 mL)	Maximum (cfu/100 mL)	No. (and percentage) of results >43 cfu/100 mL	Total no. of samples
Shark Bay	2	52	1 (4.8%)	21
Mahanga Bay	4	88	1 (4.8%)	21

#### 5.6.4 Hutt

In Hutt City, recreational shellfish gathering water quality was monitored at one site in Sorrento Bay. This site complied fully with the recreational shellfish gathering water quality guidelines for the 2007/08 summer period, despite two faecal coliform counts exceeding 43 cfu/100 mL (Table 5.4). The maximum faecal bacteria count recorded at Sorrento Bay (600 cfu/100 mL on 8 January 2008) coincided with 19 mm of rainfall in the 48 hours prior to sampling.

**Table 5.4: Analysis of faecal coliform counts obtained from routine weekly monitoring during the 2007/08 summer months against the MfE/MoH (2003) guideline levels for recreational shellfish-gathering waters.**

Site	Median (cfu/100 mL)	Maximum (cfu/100 mL)	No. (and percentage) of results >43 cfu/100 mL	Total no. of samples
Sorrento Bay	2	600	2 (9.5%)	21

### 5.7 Synthesis

Porirua City and Kapiti Coast sites had high faecal coliform counts compared with other areas. In contrast, water quality was consistently higher at Shark Bay, Mahanga Bay and Sorrento Bay, with all three sites complying fully with the MfE/MoH (2003) guidelines. Results from Kapiti Coast, Wellington City and Hutt City sites are consistent with results from the 2006/07 bathing season.

Analysis of rainfall records indicates that the majority of elevated faecal coliform results coincided with turbid waters and/or significant rainfall events prior to sampling. As discussed in Section 4.6, it is advisable to avoid contact with marine recreational waters for several days after heavy rain.

## 6. References

Milne, J.R. 2005. *Recreational water quality technical report*. Greater Wellington Regional Council, Publication No. GW/RINV-T-05/89.

Milne, J.R. 2006. *Contaminants in shellfish flesh: an investigation into microbiological and trace metal contaminants in shellfish flesh from selected locations in the Wellington region*. Greater Wellington Regional Council, Publication No. GW/EMI-G-06/285.

Milne, J.R. 2007. *On the beaches 2006/07: Annual recreational water quality monitoring report for the Wellington region*. Greater Wellington Regional Council, Publication No. GW/EMI-T-07/126.

Milne, J.R.; Watts, L. 2007. *Toxic benthic cyanobacteria proliferations in Wellington's rivers in 2005/06*. Greater Wellington Regional Council, Publication No. GW/EMI-T-07/72.

Milne, J.; Wyatt, K. 2006. *Will I get sick if I swim? Suitability for recreation grades for selected marine and freshwater bathing sites in the Wellington region*. Greater Wellington Regional Council, Publication No. GW/EMI-G-06/160.

Ministry for the Environment. 2000. *New Zealand periphyton guideline: Detecting, monitoring and managing enrichment of streams*. Ministry for the Environment, Wellington.

Ministry for the Environment, Ministry of Health. 2003<sup>7</sup>. *Microbiological water quality guidelines for marine and freshwater recreational areas*. Ministry for the Environment, Wellington.

Ministry for the Environment. 2005. *Follow-up (consecutive) sampling of marine waters – proposed amendments to guidelines. Draft discussion paper*. Ministry for the Environment, Wellington.

---

<sup>7</sup> Published June 2002, updated June 2003.

## Acknowledgements

Laura Watts assisted with the provision and analysis of hydrological data. Juliet Milne reviewed the draft version of this report and Marianne Miller kindly assisted with the formatting.

There are many people that play an important role in the Wellington region's recreational water quality monitoring programme, particularly in terms of water sample collection, analysis and/or reporting. Special thanks to:

- Anne Robertson and Eamon O'Sullivan (Kapiti Coast District Council)
- Tracey Fleming, Nicholas MacDonald and Peter Chapman (Porirua City Council)
- Terry Manning, Rob Deacon, Sunita Raju and the microbiological and water sampling teams at Environmental Laboratory Services
- Paul Schuchmann and Dean Bentley (Hutt City Council)
- Nick Urlich (Wellington Water Management Ltd)
- Scott Rostron and Annette Nesdale (Regional Public Health)
- Alton Perrie, Sheree Tidswell, Brett Cockeram, Juliet Milne and Wendy Purdon (Greater Wellington)

## Appendix 1: Monitoring sites

Area	Site Name	NZ Map Grid		Type
		Easting	Northing	
Hutt	Petone Beach @ Water Ski Club	2665765	5996304	Marine
Hutt	Petone Beach @ Sydney Street	2667067	5995961	Marine
Hutt	Petone Beach @ Settlers Museum	2667577	5995770	Marine
Hutt	Petone Beach @ Kiosk	2668348	5995425	Marine
Hutt	Sorrento Bay	2669654	5993098	Marine*
Hutt	Lowry Bay @ Cheviot Road	2670228	5992605	Marine
Hutt	York Bay	2669999	5991874	Marine
Hutt	Days Bay @ Wellesley College	2669639	5990243	Marine
Hutt	Days Bay @ Wharf	2669677	5990027	Marine
Hutt	Days Bay @ Moana Road	2669605	5989834	Marine
Hutt	Rona Bay @ N end of Cliff Bishop Park	2669132	5989367	Marine
Hutt	Rona Bay @ Wharf	2668753	5989084	Marine
Hutt	Robinson Bay @ HW Shortt Rec Ground	2668542	5988387	Marine
Hutt	Robinson Bay @ Nikau Street	2668154	5987569	Marine
Hutt	Camp Bay	2667013	5986001	Marine
Hutt	Hutt River @ Silverstream Bridge	2677619	6004887	Freshwater
Hutt	Hutt River @ Boulcott	2670941	5999283	Freshwater
Hutt	Wainuiomata River @ Richard Prouse Park	2674559	5990855	Freshwater
Kapiti	Otaki Beach @ Surf Club	2688639	6050044	Marine*
Kapiti	Otaki Beach @ Rangiu Road	2688028	6048783	Marine
Kapiti	Te Horo Beach S of Mangaone Stream	2685797	6044192	Marine
Kapiti	Te Horo Beach @ Kitchener Street	2685513	6043648	Marine
Kapiti	Peka Peka Beach @ Road End	2683233	6039620	Marine*
Kapiti	Waikanae Beach @ William Street	2681406	6037299	Marine
Kapiti	Waikanae Beach @ Tutere St Tennis Courts	2680673	6036577	Marine
Kapiti	Waikanae Beach @ Ara Kuaka Carpark	2679532	6035693	Marine
Kapiti	Paraparaumu Beach @ Ngapotiki Street	2677561	6034477	Marine
Kapiti	Paraparaumu Beach @ Nathan Avenue	2677051	6033889	Marine
Kapiti	Paraparaumu Beach @ Maclean Park	2676712	6032982	Marine
Kapiti	Paraparaumu Beach @ Toru Road	2676595	6032430	Marine
Kapiti	Paraparaumu Beach @ Wharemauku Road	2676521	6031785	Marine
Kapiti	Raumati Beach @ Tainui Street	2676549	6030944	Marine
Kapiti	Raumati Beach @ Marine Gardens	2676535	6030156	Marine
Kapiti	Raumati Beach @ Aotea Road	2676433	6029244	Marine
Kapiti	Raumati Beach @ Hydes Road	2676337	6028550	Marine*
Kapiti	Paekakariki Beach @ Whareroa Road	2675617	6025843	Marine
Kapiti	Paekakariki Beach @ Surf Club	2674810	6023988	Marine
Kapiti	Paekakariki Beach @ Memorial Hall	2674452	6023305	Marine
Kapiti	Otaki River @ The Pots	2695461	6040455	Freshwater
Kapiti	Otaki River @ State Highway 1	2691326	6046120	Freshwater
Kapiti	Waikanae River @ State Highway 1	2683770	6034011	Freshwater
Kapiti	Waikanae River @ Jim Cooke Park	2682173	6034092	Freshwater
Porirua	Pukerua Bay	2669309	6017968	Marine
Porirua	Karehana Bay @ Cluny Road	2666113	6013074	Marine
Porirua	Plimmerton Beach @ Bath Street	2666726	6012030	Marine
Porirua	Plimmerton Beach @ Queens Avenue	2666790	6011888	Marine
Porirua	South Beach @ Plimmerton	2666830	6011588	Marine
Porirua	Paremata Beach @ Pascoe Avenue	2667137	6010447	Marine
Porirua	Pauatahanui Inlet @ Water Ski Club	2668094	6011307	Marine
Porirua	Pauatahanui Inlet @ Motukaraka Point	2669506	6011052	Marine*
Porirua	Pauatahanui Inlet @ Paremata Bridge	2667173	6009998	Marine

Area	Site Name	NZ Map Grid		Type
		Easting	Northing	
Porirua	Pauatahanui Inlet @ Browns Bay	2668059	6009547	Marine*
Porirua	Porirua Harbour @ Rowing Club	2664911	6008661	Marine*
Porirua	Titahi Bay @ Bay Drive	2664152	6009883	Marine
Porirua	Titahi Bay @ Toms Road	2664130	6009571	Marine
Porirua	Titahi Bay @ South Beach Access Road	2663926	6009396	Marine
Porirua	Onehunga Bay	2665816	6010895	Marine
Upper Hutt	Pakuratahi River @ Forks	2694308	6014337	Freshwater
Upper Hutt	Hutt River @ Birchville	2686216	6010807	Freshwater
Upper Hutt	Hutt River @ Maoribank Corner	2685902	6008412	Freshwater
Upper Hutt	Hutt River @ Poets Park	2681482	6007807	Freshwater
Wairarapa	Ruamahanga River @ Double Bridges	2734363	6033494	Freshwater
Wairarapa	Ruamahanga River @ Te Ore Ore	2735543	6024638	Freshwater
Wairarapa	Waipoua River @ Colombo Road	2735010	6024610	Freshwater
Wairarapa	Waingawa River @ Kaituna	2720341	6032867	Freshwater
Wairarapa	Waingawa River @ South Road	2730565	6022599	Freshwater
Wairarapa	Ruamahanga River @ The Cliffs	2731492	6013902	Freshwater
Wairarapa	Ruamahanga River @ Kokotau	2725774	6008913	Freshwater
Wairarapa	Waiohine River @ Gauge	2711871	6017655	Freshwater
Wairarapa	Waiohine River @ State Highway 2	2719683	6013431	Freshwater
Wairarapa	Ruamahanga River @ Morrisons Bush	2718938	6002829	Freshwater
Wairarapa	Ruamahanga River @ Waihenga	2714631	5998182	Freshwater
Wairarapa	Ruamahanga River @ Bentleys Beach	2710556	5994533	Freshwater
Wairarapa	Castlepoint Beach @ Castlepoint Stream	2781366	6029287	Marine
Wairarapa	Castlepoint Beach @ Smelly Creek	2781670	6028931	Marine
Wairarapa	Riversdale Beach @ Lagoon Mouth	2768974	6009275	Marine
Wairarapa	Riversdale Beach Between the Flags	2768445	6008680	Marine
Wairarapa	Riversdale Beach South	2767844	6007246	Marine
Wellington	Aotea Lagoon	2659007	5989395	Marine
Wellington	Oriental Bay @ Freyberg Beach	2659942	5989176	Marine
Wellington	Oriental Bay @ Wishing Well	2660140	5989098	Marine
Wellington	Oriental Bay @ Band Rotunda	2660265	5989087	Marine
Wellington	Balaena Bay	2660980	5988979	Marine
Wellington	Kio Bay	2661163	5988311	Marine
Wellington	Hataitai Beach	2660654	5987442	Marine
Wellington	Shark Bay	2662233	5987909	Marine*
Wellington	Mahanga Bay	2663490	5988828	Marine*
Wellington	Scorching Bay	2663539	5988360	Marine
Wellington	Worser Bay	2663097	5986535	Marine
Wellington	Seatoun Beach @ Wharf	2663152	5985946	Marine
Wellington	Seatoun Beach @ Inglis Street	2663428	5985706	Marine
Wellington	Breaker Bay	2663335	5984682	Marine
Wellington	Lyllal Bay @ Tirangi Road	2660770	5984942	Marine
Wellington	Lyllal Bay @ Onepu Road	2660309	5984828	Marine
Wellington	Lyllal Bay @ Queens Drive	2660013	5984580	Marine
Wellington	Princess Bay	2659609	5983216	Marine
Wellington	Island Bay @ Surf Club	2658400	5983302	Marine
Wellington	Island Bay @ Reef St Recreation Ground	2658252	5983254	Marine
Wellington	Island Bay @ Derwent Street	2658178	5983127	Marine
Wellington	Owhiro Bay	2657145	5983174	Marine

\* Water quality is also monitored for recreational shellfish gathering purposes

## Appendix 2: Laboratory and field methods

Kapiti Coast District Council collected and analysed water samples collected in their district. Water samples collected in Porirua, Wellington City, Hutt City and the Wairarapa were analysed by Environmental Laboratory Services (ELS).

### Methods and detection limits

Determinant	Method	Detection Limit
<i>Escherichia coli</i> at 44.5°C	APHA Standard Methods (20 <sup>th</sup> Ed.) 9213D, Membrane filter on mTEC agar, Urea substrate	1-4/100 mL
Enterococci at 41°C	US EPA Method 1600, Membrane filter on mEI agar	1-5 cfu/100 mL
Faecal coliforms at 44.5°C	APHA Standard Methods (20 <sup>th</sup> Ed.) 9222D, Membrane filter on mFC agar	1-5 cfu/100 mL
Water temperature	Field meter or digital thermometer	0.1°C
Turbidity	APHA Standard Methods (20 <sup>th</sup> Ed.) 2130B	0.1 NTU
Periphyton cover (both filamentous and mat-forming algae)	Mean % of algae visually estimated (using a 20 cm diameter hoop) at 10 points on a single transect (or 5 points on two transects) across the river	5%
Seaweed cover	Visual estimate within 5 m radius around sample point, including both floating and attached seaweed	5%

### Rainfall stations

#### *Freshwater Recreational Sites*

- Kapiti Coast District - Taungata Peak (Otaki River) and Waikanae Water Treatment Plant (Waikanae River)
- Hutt – Kaitoke Headworks (Pakuratahi River), Te Marua (Hutt River), Wainuiomata Reservoir (Wainuiomata River)
- Wairarapa – Mount Bruce (Ruamahanga River), Kaituna (Waipoua River, Waingawa River), Phelps (Waiohine River), Angle Knob (located in the upper Waingawa catchment and used as indicator of rainfall high in Tararua Range).

#### *Marine Recreational Sites*

- Kapiti Coast District – Otaki Depot (Otaki Beach, Te Horo Beach), Waikanae Water Treatment Plant (Peka Peka Beach, Waikanae Beach), Paraparaumu Aerodrome\* (Paraparaumu Beach, Raumati Beach, Paekakariki Beach)
- Porirua City – Whenua Tapu
- Hutt City – Shandon
- Wellington City – Wellington Airport\*
- Wairarapa – Castlepoint\*

\* NIWA rainfall stations



## Appendix 3: Summary statistics and SFRGs

Microbiological water quality data for the 2007/08 summer are summarised in the tables below. The Microbiological Assessment Category (MAC) values, and therefore the Suitability for Recreation Grades (SFRGs) determined by Milne and Wyatt (2006)<sup>8</sup>, have been updated using the 2003/04 – 2007/08 microbiological results.

### (a) Freshwaters

Bathing Site	Total no. of samples	No. sample results ( <i>E. coli</i> /100 mL)			Beach grading (2003/04 – 2007/08 data)		
		Surveillance (≤260)	Alert (261-550)	Action (>550)	SIC Grade	MAC Grade (95 <sup>th</sup> -ile value)	SFRG†
<i>Kapiti</i>							
Otaki R @ Pots	5‡	5	0	0	Low	B (196)*	Good*
Otaki R @ SH 1	21	21	0	0	Moderate	C (276)	Fair
Waikanae R @ SH 1	21	21	1	0	Moderate	C (384)**	Fair**
Waikanae R @ Jim Cooke Park	21	21	0	0	Moderate <sup>§</sup>	B (189)	Good <sup>§</sup>
<i>Hutt &amp; Wainuiomata</i>							
Pakuratahi R @ Forks	21	19	1	1	Moderate	D (849)	Poor
Hutt R @ Birchville	21	19	1	1	Moderate	D (1,215)	Poor
Hutt R @ Maoribank Corner	21	19	0	2	Moderate	D (983)	Poor
Hutt R @ Poets Park	21	20	0	1	Moderate	D (726)	Poor
Hutt R @ Silverstream	21	18	2	1	Moderate	D (1,230)	Poor
Hutt R @ Boulcott	21	12	6	3	Moderate	D (1,545)	Poor
Wainuiomata R @ RP Park	21	18	1	2	Moderate <sup>§</sup>	D (1,263)	Poor <sup>§</sup>
<i>Wairarapa</i>							
Ruamahanga R @ Double Bridges	21	19	0	2	Mod/High	D (698)	Poor
Ruamahanga R @ Te Ore Ore	21	19	1	1	High	D (1,953)	Very Poor
Ruamahanga R @ The Cliffs	21	20	0	1	High	D (1,015)	Very Poor
Ruamahanga R @ Kokotau	21	19	0	2	High	D (1,520)	Very Poor
Ruamahanga R @ Morrisons Bush	21	18	2	1	High	D (906)	Very Poor
Ruamahanga R @ Waihenga	21	18	2	1	High	D (888)	Very Poor
Ruamahanga R @ Bentleys Beach	21	18	1	2	High	D (1,233)	Very Poor
Waipoua R @ Colombo Rd	21	18	2	1	High	D (1,242)	Very Poor
Waingawa R @ Kaituna	21	19	1	0	Low	C (393)	Fair**
Waingawa R @ South Rd	21	21	0	0	Moderate	C (349)	Fair
Waiohine R @ Gorge (Gauge)	5‡	5	0	0	Low	A (114)*	V. Good*
Waiohine R @ SH 2	21	20	0	1	Moderate	A (124)	Good

† Note that the freshwater SFRGs better reflect the condition of the water during wet weather than dry weather when contact recreation would be greatest (see Milne and Wyatt 2006).

‡ from November 2006, sampled monthly under Greater Wellington's Rivers State of the Environment water quality programme.

\* based on 2001/02 – 2006/07 data as presented in Milne and Wyatt (2006).

\*\* indicates a change in MAC/SFRG from that determined by Milne and Wyatt (2006).

§ interim grading (SIC grading based on previously graded sites in the same catchment or catchment knowledge, MAC grade based on 1 year of data, n = 21)

<sup>8</sup> The SFRGs are determined by the Sanitary Inspection Category (SIC) value and the MAC value. The SIC value (determined in 2006 and to be reviewed every five years) generally has the greatest influence on the SFRG. Milne and Wyatt (2006) provide a full explanation of the beach grades and the grading process.

**(b) Marine waters**

Bathing Site	Total no. of samples	No. sample results (Enterococci/100 mL)			Beach grading (2003/04 – 2007/08 data)		
		Surveillance (≤260)	Alert (141-280)	Action (>280)	SIC Grade	MAC Grade (95 <sup>th</sup> -ile value)	SFRG
<i>Kapiti</i>							
Otaki Beach @ Surf Club	21	20	0	1	Low	C (276)*	Fair*
Otaki Beach @ Rangiuuru Rd	21	20	1	0	Low	C (330)*	Fair*
Te Horo Beach S of Mangaone Strm	21	19	0	2	Moderate	D (553)*	Poor*
Te Horo Beach @ Kitchener St	21	20	0	1	Moderate	C (325)	Fair
Peka Peka Beach @ Rd End	21	20	1	0	Low	B (130)	Good
Waikanae Beach @ William St	21	20	1	0	Moderate	B (177)	Good
Waikanae Beach @ Tutere St T.C.	21	20	1	0	Moderate	B (163)	Good
Waikanae Beach @ Ara Kuaka C.P.	21	20	0	1	Moderate	C (305)	Fair
Paraparaumu Beach @ Ngapotiki St	21	19	1	1	Moderate	C (321)	Fair
Paraparaumu Beach @ Nathan Ave	21	18	1	2	Moderate	C (432)	Fair
Paraparaumu Beach @ Maclean Pk	21	19	2	0	Moderate	C (316)	Fair
Paraparaumu Beach @ Toru Rd	21	21	0	0	Moderate	C (333)	Fair
Paraparaumu Beach @ Wharemauku Rd	21	19	2	0	Moderate	C (213)	Fair
Raumati Beach @ Tainui St	21	19	1	1	Moderate	C (204)	Fair
Raumati Beach @ Marine Gardens	21	19	0	2	Moderate	C (323)	Fair
Raumati Beach @ Aotea Rd	21	19	1	1	Low/Mod	B (179)	Good
Raumati Beach @ Hydes Rd	21	19	2	0	Moderate	C (246)	Fair
Paekakariki Beach @ Whareroa Rd	21	21	0	0	Low	B (97)	Good
Paekakariki Beach @ Surf Club	21	21	0	0	Low	B (77)	Good
Paekakariki Beach @ Memorial Hall	21	21	0	0	Low	B (50)	Good
<i>Porirua</i>							
Pukerua Bay	21	20	0	1	Low	B (147)	Good
Karehana Bay @ Cluny Rd	21	20	1	0	Moderate	B (179)	Good
Plimmerton Beach @ Bath St	21	21	0	0	Moderate	C (365)*	Fair*
Plimmerton Beach @ Queens Ave	21	20	1	0	Moderate	C (206)	Fair
South Beach @ Plimmerton	21	20	0	1	Moderate	C (494)*	Fair*
Paremata Beach @ Pascoe Ave	21	20	0	1	Moderate	C (414)	Fair
Pauatahanui Inlet @ Water Ski Club	21	21	0	0	Moderate	B (198)*	Good*
Pauatahanui Inlet @ Motukaraka Pt	21	20	1	0	Moderate	B (176)	Good
Pauatahanui Inlet @ Browns Bay	21	20	0	1	Moderate	D (769)	Poor
Pauatahanui Inlet @ Paremata Bridge	21	20	0	1	Moderate <sup>s</sup>	C (211)	Fair <sup>s</sup>
Porirua Harbour @ Rowing Club	21	17	1	3	Moderate	D (1,015)	Poor
Titahi Bay @ Bay Drive	21	19	1	1	Moderate	C (366)*	Fair*
Titahi Bay @ Toms Rd	21	18	2	1	Moderate	C (318)	Fair
Titahi Bay @ South Beach Access Rd	21	19	2	0	Moderate	C (240)	Fair
Onehunga Bay	21	21	0	0	Moderate	B (132)*	Good*
<i>Hutt</i>							
Petone Beach @ Water Ski Club	21	19	0	2	Moderate	C (372)	Fair
Petone Beach @ Sydney St	21	19	0	2	Moderate	C (400)	Fair
Petone Beach @ Settlers Museum	21	19	0	2	Moderate	C (202)*	Fair*

Bathing Site	Total no. of samples	No. sample results (Enterococci/100 mL)			Beach grading (2003/04 – 2007/08 data)		
		Surveillance (≤260)	Alert (141-280)	Action (>280)	SIC Grade	MAC Grade (95 <sup>th</sup> -ile value)	SFRG
Petone Beach @ Kiosk	21	19	0	2	Moderate	C (283)*	Fair*
Sorrento Bay	21	20	0	1	Low	B (73)	Good
Lowry Bay @ Cheviot Rd	21	18	0	3	Low	C (335)	Fair
York Bay	21	19	1	1	Low	B (125)	Good
Days Bay @ Wellesley College	21	19	0	2	Low	B (89)	Good
Days Bay @ Wharf	21	18	0	3	Low	B (148)	Good
Days Bay @ Moana Rd	21	20	0	1	Low	B (139)	Good
Rona Bay @ N end of Cliff Bishop Pk	21	20	0	1	Low/Mod	C (342)	Fair
Rona Bay @ Wharf	21	19	1	1	Low/Mod	B (193)*	Good*
Robinson Bay @ HW Shortt Rec Grd	21	19	1	1	Low	C (412)	Fair
Robinson Bay @ Nikau St	21	17	1	3	Low	C (378)*	Fair*
Camp Bay	11†	11	0	0	Very Low	B (141)	V. Good
<i>Wellington City</i>							
Aotea Lagoon	21	18	0	3	Moderate	C (235)*	Fair*
Oriental Bay @ Freyberg Beach	21	20	0	1	Moderate	B (146)	Good
Oriental Bay @ Wishing Well	21	18	1	2	Moderate	D (524)*	Poor*
Oriental Bay @ Band Rotunda	21	19	1	1	Moderate	C (324)	Fair
Balaena Bay	21	20	0	1	Low	B (64)	Good
Kio Bay	21	20	1	0	Low	B (126)	Good
Hataitai Beach	21	21	0	0	Moderate	C (203)	Fair
Shark Bay	21	21	0	0	Low	B (61)	Good
Mahanga Bay	21	21	0	0	Low	B (163)	Good
Scorching Bay	21	20	1	0	Low	B (69)	Good
Worser Bay	21	21	0	0	Low	B (50)	Good
Seatoun Beach @ Wharf	21	20	0	1	Low/Mod	B (102)	Good
Seatoun Beach @ Inglis St	21	20	0	1	Low/Mod	B (74)	Good
Breaker Bay	11†	11	0	0	V. Low	A (36)	V. Good
Lyll Bay @ Tirangi Rd	21	19	0	2	Moderate	C (209)*	Fair*
Lyll Bay @ Onepu Rd	21	21	0	0	Moderate	B (73)	Good
Lyll Bay @ Queens Drive	21	21	0	0	Moderate	B (60)	Good
Princess Bay	11†	11	0	0	Low	A (25)	V. Good
Island Bay @ Surf Club	21	19	0	2	Moderate	C (270)*	Fair*
Island Bay @ Reef St Recreation Grd	21	20	0	1	Moderate	C (282)*	Fair*
Island Bay @ Derwent St	21	20	1	0	Moderate	B (105)‡	Good‡
Owhiro Bay	21	17	1	3	Moderate	C (383)	Fair
<i>Wairarapa</i>							
Castlepoint Beach @ Castlepoint Strm	21	21	0	0	Moderate	B (150)*	Good*
Castlepoint Beach @ Smelly Creek	21	21	0	0	Moderate	B (143)*	Good*
Riversdale Beach @ Lagoon Mouth	21	20	0	1	Moderate	B (90)	Good
Riversdale Beach Between the Flags	21	21	0	0	Low	B (51)	Good
Riversdale Beach South	11†	11	0	0	Very Low	A (33)	V. Good

† from November 2006, sampled fortnightly.

\* indicates a change in MAC/SFRG from that determined by Milne and Wyatt (2006).

‡ Interim grade (based on only 3.5 years of data, n=74).

§ Interim grade (SIC grading based on that for other Pauatahanui sites, MAC grade based on 1 year of data, n = 21)