On the beaches

Recreational water quality monitoring results for the 2013/14 summer

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Report prepared by:	S Morar	Environmental Monitoring Officer	
	S Greenfield	Senior Environmental Scientist	
Report reviewed by:	J Milne	Team Leader – Aquatic Ecosystems and Quality	
Report approved for release by:	G Sevicke-Jones	Manager, Environmental Science	

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Executive summary

This report summarises the results of weekly recreational water quality monitoring undertaken over the 2013/14 summer bathing season (1 November 2013 to 31 March 2014). The recreational water quality monitoring programme is undertaken by Greater Wellington Regional Council along with Kapiti Coast District Council, Porirua City Council, Hutt City Council and Wellington City Council to identify risks to public health from disease-causing organisms and toxic cyanobacteria.

Over the 2013/14 bathing season recreational water quality was monitored at 24 freshwater sites and 61 coastal sites. At each site, weekly water samples were taken for analysis of faecal indicator bacteria (*E. coli* at freshwater sites, enterococci at coastal sites and faecal coliforms at coastal shellfish gathering sites) and results were assessed against the Ministry for Environment (MoH)/Ministry of Health (MoH) (2003) national microbiological water quality guidelines. At freshwater sites, filamentous algae, mat algae and benthic cyanobacteria cover were assessed and results compared to the MfE (2000) nuisance periphyton guidelines and the MfE/MoH (2009) interim cyanobacteria guidelines. Water clarity was also assessed at freshwater sites (for the first time, replacing previous turbidity measurements) and results compared to the MfE (1994) guideline for recreational waters.

Of the 20 freshwater sites monitored weekly over the 2013/14 summer season, 12 sites (60%) went above the MfE/MoH (2003) action guideline on at least one occasion. All but two of these instances coincided with significant rainfall in the 24 hours prior to sampling and/or elevated river flows. Of the total 24 freshwater sites monitored, six sites (25%) have 'all weather' Suitability for Recreation Grades (SFRGs) of 'good' or better while 17 sites (71%) now have 'dry weather' SFRGs of 'good' or better. Faecal source tracking analyses undertaken on samples from Wainuiomata River at Richard Prouse Park and upstream tributaries suggested that discharges from on-site wastewater treatment systems, stock access to Wainuiomata Stream and illegal sewage discharges to Skerret's Creek are likely sources of contamination at this site.

There was only one occasion at one site, Ruamahanga River at Waihenga Bridge, when the MfE (2000) nuisance filamentous periphyton guideline was not met during the 2013/14 bathing season. The guidelines for nuisance mat periphyton and benthic cyanobacteria were met at all sites on all sampling occasions.

The MfE (1994) guideline for water clarity was met most of the time (80% of sampling occasions). Poor water clarity following freshes accounted for the majority of occasions when the guideline was not met, with upstream river works affecting clarity on a few occasions at some sites such as Hutt River at Poets Park.

Forty one of the 61 coastal sites (67%) failed to meet the MfE/MoH (2003) action guideline on at least one occasion during the 2013/14 summer. Sites that most frequently went over the action guideline were Island Bay at Reef Street Recreation Ground, Island Bay at Derwent Street and Owhiro Bay; several guideline breaches at these sites were not associated with significant rainfall prior to sampling.

As of the end of the 2013/14 bathing season, 28 (46%) coastal monitoring sites have SFRGs of 'good' or better. Twenty five sites are graded 'fair' and the remaining eight sites are graded 'poor': South Beach at Plimmerton, Porirua Harbour at Rowing Club, Titahi Bay at South Beach Access Road, Island Bay at Surf Club, Island Bay at Reef Street Recreation Ground, Island Bay at Derwent Street, Owhiro Bay and Rona Bay at Cliff Bishop Park.

Faecal source tracking investigations undertaken at coastal sites graded 'poor' in the 2013/14 bathing season suggested a range of faecal contamination sources including human sewage (Porirua Harbour at Rowing Club and Owhiro Bay as well as all tributary streams sampled), wildfowl (Titahi Bay at South Beach Access Road and Rona Bay at Cliff Bishop Park as well as all tributary streams sampled) and dogs (South Beach at Plimmerton and Owhiro Bay). Capacity Infrastructure Services and local councils are investigating sewer and stormwater infrastructure within the catchments of most sites currently graded 'poor'.

Of the seven coastal sites monitored to assess water quality for recreational shellfish gathering in 2013/14, only two (Peka Peka Beach on the Kapiti Coast and Shark Bay in Wellington City) fully complied with the MfE/MoH (2003) guidelines. The remaining five sites breached one or both guideline criteria.

Contents

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 during 2013/14 was once again a joint effort involving the Greater Wellington Regional Council (GWRC) 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 Population Health were consulted when the results of the monitoring indicated an increased likelihood of illness associated with recreational use. During the summer bathing season (mid-November 2013 to 31 March 2014), weekly water test results were collated by GWRC and displayed at www.gw.govt.nz/on-the-beaches. Information on the presence of potentially toxic cyanobacteria at freshwater sites is also displayed.

This report summarises the results of weekly monitoring undertaken over the 2013/14 summer bathing season and presents updated Suitability for Recreation Grades (SFRGs) for the region based on these results. A more comprehensive assessment of recreational water quality is prepared on a five-yearly basis as part of GWRC's State of the Environment reporting (eg, see Greenfield et al. 2012a).

Waikanae River upstream of the monitoring site at State Highway One. This site has a 'dry weather' grade of 'good' and an 'all weather' grade of 'fair'

2. Recreational water quality monitoring in the Wellington region

Recreational water quality monitoring in the Wellington region is a joint effort involving GWRC 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 GWRC's recreational water quality monitoring programme are to:

1. Determine the suitability of selected sites in coastal and fresh waters for contact recreation;
2. Determine the suitability of coastal waters for the gathering of shellfish for human consumption;
3. Assist in safeguarding public health and the environment;
4. Provide information required to determine the effectiveness of regional plans and policies;
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 (eg, 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 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 cannot be discounted (Philip 1991). 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 pathogens1. The indicators used are:

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

Compliance with the MfE/MoH (2003[2]) 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. With regard to contact recreation in marine and fresh waters the guidelines consist of two components; faecal indicator bacteria trigger values to assess individual monitoring results throughout the bathing season and beach grades which describe the general condition of a site at any given time.

2.2.1 Trigger values

The MfE/MoH (2003) guidelines provide 'trigger' values for fresh and coastal waters to help water managers assess individual monitoring results and 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	Public warnings, increased monitoring and investigation of source

[1] 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.

[2] The guidelines were published in June 2002 and updated in June 2003.

2.2.2 Suitability for recreation grades

The MfE/MoH (2003) guidelines outline a process to grade the suitability of fresh and coastal waters for recreational use from a public health perspective. The grades are intended to describe the general condition of the water at any given time. Identification of beach grades involves combining a qualitative assessment of the susceptibility of a recreational site to faecal contamination (the Sanitary Inspection Category (SIC) component) with measurements of the appropriate bacteriological indicator (the Microbiological Assessment Category (MAC) component) to generate a Suitability For Recreation Grade (SFRG) for the site. The MAC component of the SFRG is based on a 95th percentile of sample results from a five-year period (ie, typically 100 data points).

In 2012, SIC grades for all recreational water quality monitoring sites in the Wellington region were reviewed (Greenfield et al. 2012b). These updated SICs have been combined here with MAC grades based on data from the five most recent bathing seasons (2009/10–2013/14) to give updated SFRGs for each site.

It should be noted that because the MAC component of the SFRG is based on a 95th percentile calculated over five summer seasons, this value is heavily influenced by high indicator bacteria counts, often from wet weather sampling events. This means that from year to year a MAC (and therefore a SFRG) can fluctuate as high results are added (from the latest bathing season) or removed (from the first earliest season of results being replaced by the most recent results) from the data set. In many cases changes in MAC/SFRG may simply reflect the difference between the addition or loss of a wetter summer season from the data set, rather than a significant shift in water quality. All grade changes are checked to assess whether further investigation is required.

3. Recreational water quality in freshwaters

3.1 Introduction

Recreational water quality was monitored at 24 river sites across the Wellington region over the 2013/14 bathing season (Figure 3.1, Appendix 1), as follows:

- Kapiti Coast District – 4 sites
- Hutt and Wainuiomata river catchments – 8 sites
- Wairarapa – 12 sites

The sites monitored reflect their use by the public for contact recreation; in particular, swimming and boating[3].

3.2 Monitoring protocol

Sites were sampled weekly – for 20 weeks – during the bathing season, with the exception of the Otaki River at Pots (near Pukehinau on the Kapiti Coast), the Akatarawa River at Hutt Confluence (Upper Hutt), the Waiohine River at Gorge and the Tauherenikau River at Websters (Wairarapa), which were sampled monthly under GWRC's Rivers State of the Environment (RSoE) monitoring programme[4]. On each sampling occasion a single water sample was collected 0.2 m below the surface in 0.5 m water depth and analysed for *E. coli* indicator bacteria.

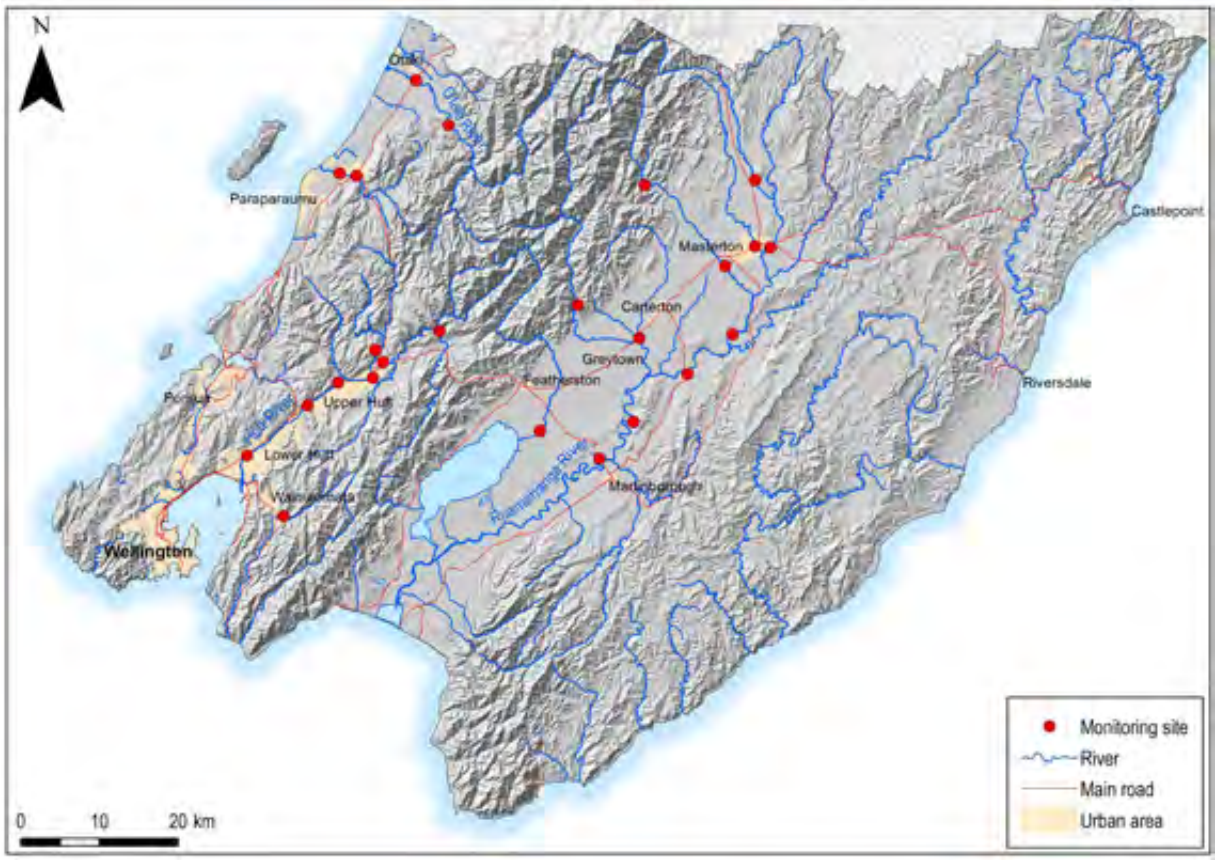

Figure 3.1: Freshwater recreation sites monitored over summer 2013/14

[3] The recreational water quality monitoring programme does not include monitoring of artificial water-bodies such as Henley Lake in Masterton or water-bodies on private land such as Lake Waitawa on the Kapiti Coast.

[4] Historically Otaki River at Pots and Waiohine River at Gorge were sampled separately under two GWRC 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. Assessment of recreational water quality at the Akatarawa River at Hutt Confluence and Tauherenikau River at Websters is also based on monthly data from the RSoE monitoring programme.

Measurements of water temperature, water clarity (for the first time, replacing turbidity) and visual estimates of periphyton (algae) and cyanobacteria cover, were also made at each site. 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 (Appendix 2). 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 3.

3.3 Guidelines

3.3.1 Microbiological water quality guidelines

(a) Compliance with trigger values

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

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 3.5.1). For this reason GWRC and Regional Public Health advise avoiding swimming and other contact recreation activities in freshwaters during and for up to several days after heavy rainfall.

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

Mode	Guideline *E. coli* (cfu/100mL)	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	Public warnings, increased monitoring and investigation of source

(b) Suitability for Recreation Grades

The SIC and MAC categories used to identify SFRGs for fresh waters are shown in Table 3.2.

Table 3.2: MfE/MoH (2003) Suitability for Recreation Grades (SFRGs) for fresh waters

Susceptibility to faecal influence		Microbiological Assessment Category (MAC)[1]			
		A ≤130 *E. coli*/100mL	**B** 131–260 *E. coli*/100mL	**C** 261–550 *E. coli*/100mL	**D** >550 *E. coli*/100mL
Sanitary Inspection Category (SIC)	**Very Low**	Very Good	Very Good	Follow Up[3]	Follow Up[3]
	Low	Very Good	Good	Fair	Follow Up[3]
	Moderate	Follow Up[2]	Good	Fair	Poor
	High	Follow Up[2]	Follow Up[2]	Poor	Very Poor
	Very High	Follow Up[2]	Follow Up[2]	Follow Up[2]	Very Poor

[1] 95th percentile value calculated using the Hazen percentile method from five years of data obtained from routine weekly monitoring during the bathing season.

[2] Indicates unexpected results requiring investigation (reassess SIC and MAC).

[3] Implies non-sewage sources of indicator bacteria that require verification.

Greenfield et al. (2012b) derived two SFRGs for each freshwater site: one based on all flow conditions and one based on 'dry weather' conditions only (defined as median flow or less). Two grades were derived as it has been identified that SFRGs for many freshwater sites are heavily influenced by a small number of elevated *E. coli* results recorded following heavy rainfall. The additional 'dry weather' SFRGs are intended to better represent microbiological water quality during conditions when people are most likely to be swimming or undertaking other types of primary contact recreation[5]. Microbiological risk factors and corresponding SIC values, together with MAC values, were derived under both conditions and combined to obtain the two grades.

3.3.2 Nuisance periphyton guidelines

In fresh waters, excessive amounts of periphyton[6] can reduce the amenity value of waterways by decreasing their aesthetic appearance, reducing visibility, and being a physical nuisance to swimmers.

The MfE (2000) periphyton 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.

3.3.3 Interim cyanobacteria guidelines

Growth of benthic cyanobacteria in rivers can pose a health risk as some species produce toxins which are harmful to humans and animals, particularly dogs (eg, Milne & Watts 2007; MfE/MoH 2009).

In 2009, interim New Zealand guidelines for cyanobacteria in recreational lakes and rivers were released (MfE/MoH 2009) for trial by monitoring and health agencies. The interim guidelines for rivers identify a three-tiered alert level framework for benthic cyanobacteria (Table 3.3). The warning sign used to advise the public of the risk from benthic cyanobacteria is shown in Figure 3.2.

Table 3.3: Alert-level framework for benthic cyanobacteria cover in rivers (Modified from MfE/MoH 2009)

Alert level	Guideline	Management action
Green/Surveillance	≤20% coverage of potentially toxic cyanobacteria attached to substrate.	Undertake routine monitoring.
Amber/Alert	20–50% coverage of potentially toxic cyanobacteria attached to substrate.	Notify public health, erect signs with information on appearance of mats and potential risks and consider testing for cyanotoxins.
Red/Action	>50% cyanobacteria coverage or cyanobacteria are visibly detaching from substrate and accumulating on the river's edge or becoming exposed on river's edge and the river level drops.	Notify public health unit, notify the public of potential risk to health, and consider testing for cyanotoxins.

In the Wellington region, the response to toxic algal blooms in rivers is managed by a working party of Regional Public Health, Wairarapa Population Health, Territorial Authority and GWRC staff. Close monitoring of 'flushing' river flows[7] and the potential for occurrence of cyanobacteria blooms is a critical part of this process.

[5] The MfE/MoH (2003) guidelines allow for modification of a SFRG grade in this way if the modified grade better reflects the water quality conditions the public are usually exposed to and is verified by the Regional Medical Officer of Health. The caveat is that modified grades should only be used where occasional and predictable contamination events are identified (eg, heavy rainfall) and interventions can be demonstrated to be effective in discouraging recreational use during these times. This requires adequate communication to river users of the increased risk of microbial contamination through such things as signage at affected sites, media releases and website postings.

[6] Periphyton refers to the slime coating on a riverbed, composed largely of algae and cyanobacteria.

[7] A 'flushing' flow is a high river flow (usually defined as 3x the median river flow) that generally follows a heavy rainfall event and can 'scour' periphyton from the riverbed.

Figure 3.2: Warning sign used to inform the public of the health risk from cyanobacteria in rivers in the Wellington region

3.3.4 Water clarity guidelines

Smith et al. (1991 & 1992) demonstrated that the perception of water clarity at a freshwater site markedly affected a site's overall suitability for bathing when clarity was poor. As well as being aesthetically pleasing, clear water is important for recreational users to be able to estimate depth and spot any submerged hazards. In 1994, MfE developed guidelines for the management of water colour and clarity in New Zealand waters (MfE 1994). The guidelines state that for water managed for contact recreation clarity measured horizontally through the water column should be greater than 1.6 m.

3.4 Faecal source tracking

Over the 2013/14 bathing season additional water samples were taken at Hutt River at Melling Bridge and Wainuiomata River at Richard Prouse Park sites for faecal source tracking assessment. These sites were chosen as they were graded 'poor' by Morar and Greenfield (2013). Samples were also taken from the Wainuiomata Stream at its confluence with the Wainuiomata River-approximately 50m upstream of the Richard Prouse Park site.

Additional water samples were collected weekly between 1 February and 31 March 2014. At each site one 500 mL water sample was taken for PCR marker analysis[8] and four 1 L samples were taken for faecal sterol analysis. In the laboratory, PCR marker samples were filtered using 0.2µM Supor 200 filters and buffered with GITC buffer while faecal sterol samples were filtered using GF/F glass microfiber filters. All samples were then frozen so that those that coincided with high faecal indicator bacteria counts (ie, typically greater than the MfE/MoH (2003) alert or action guidelines) could then be considered for analysis of PCR markers and, if necessary, faecal sterols. PCR markers analysed were a general marker (GenBac), two human markers (BiADO and BacH), as well as ruminant (BacR), bird (GFD) and dog (DogBac) markers.

At Wainuiomata River at Richard Prouse Park and Wainuiomata Stream at confluence sites faecal source tracking samples were also collected at the same time as some follow-up samples. On several occasions, additional samples were taken from the Wainuiomata River and tributaries upstream of the Richard Prouse Park site for analysis of *E. coli* counts and in some cases PCR markers.

3.5 Data analysis

All results have been assessed in accordance with the MfE/MoH (2003) recreational water quality guidelines for fresh waters (Tables 3.1 and 3.2), the nuisance periphyton guidelines outlined in Section 3.3.2,the interim national cyanobacteria guidelines (Table 3.3) and the water clarity guideline outlined in section 3.3.4.

During data processing, any *E. coli* 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 (ie, counts of <4 cfu/100mL and >400 cfu/100mL were treated as 2 cfu/100mL and 400 cfu/100mL, respectively). Rainfall was calculated for the 24, 48 and 72 hours prior to the day of sampling by summing up the rainfall for each 24 hour period ending at 9 am of each day. Any rainfall between 9 am and 3 pm on the day of sampling was defined as rainfall 'on the day' (samples were rarely collected after this time).

For most sites MAC grades were calculated using weekly *E. coli* data from samples collected over the past five summer bathing seasons (2009/10 to 2013/14). The exceptions were the four sites sampled monthly as part of GWRC's RSoE programme for which a longer data period was used. The MAC value for Otaki River at Pots and Waiohine River at Gorge was calculated from weekly data collected during

[8] Polymerase Chain Reaction (PCR) marker analysis involves identification of host specific (ie, found only in one host species or group) microbes associated with faecal material using PCR assays of DNA extracted from water samples.

bathing seasons from 2003/04 to 2005/06 and monthly data from 2006/07 onwards, while interim MAC values for Akatarawa River at Hutt Confluence and Tauherenikau River at Websters (n=55) were calculated from the results of monthly sampling during bathing seasons (November to March) between 2003/04 and 2013/14.

3.6 Results

3.6.1 Compliance with trigger values

Of the 20 freshwater sites monitored weekly over the 2013/14 summer bathing season, 12 sites (60%) went above the MfE/MoH (2003) action guideline on at least one occasion (Table 3.4, Appendix 4).

Table 3.4: Summary of action guideline breaches from routine weekly monitoring at 20 freshwater sites over the 2013/14 summer bathing season[1]

No. of times site breached the action guideline	No. of sites			Total no. of sites (20)	% of sites
	Kapiti (3 sites)	Hutt & Wainuiomata (7 sites)	Wairarapa (10 sites)		
0	3	2	3	8	40
1	0	4	6	10	50
2	0	0	1	1	5
3	0	1	0	1	5

[1] This analysis excludes Otaki River at The Pots (Kapiti), Akatarawa River at Hutt Confluence, Waiohine River at Gorge and Tauherenikau River at Websters (Wairarapa); these sites are only sampled monthly under GWRC's RSoE water quality monitoring programme.

Out of a total of 400 routine water samples, 15 (3.8%) returned *E. coli* counts above the MfE/MoH (2003) action guideline (Table 3.5). This was less than the 2012/13 season, where 7.5% of samples exceeded the action guideline (Morar & Greenfield 2013).

All but two of the action guideline breaches were associated with significant rainfall (≥ 10 mm) within the 24 hours prior to sampling or on the day of sampling itself. These findings are 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 (Greenfield et al. 2012a & 2012b).

At all but one of the sites, only one follow-up sample was required before *E. coli* counts dropped back below the surveillance guideline. The exception was Wainuiomata River at Richard Prouse Park where up to two follow-up samples also exceeded either the alert or action guideline. In addition to breaching the action guideline on three routine sampling occasions, this site breached the alert guideline twice. On one of these occasions (25 March 2014) four follow-up samples also breached the alert or action guideline. See Section 3.6.3 for more discussion on Wainuiomata River at Richard Prouse Park.

3.6.2 Suitability for recreation grades

Updated SFRGs for each site (as at the end of March 2014), based on the combined SIC and MAC values at all flows and during dry weather, are summarised in Figure 3.3. In total, six sites (25%) now have SFRGs of 'good' or better for 'all weather' flows and 17 sites (71%) have 'dry weather' SFRGs of 'good' or better.

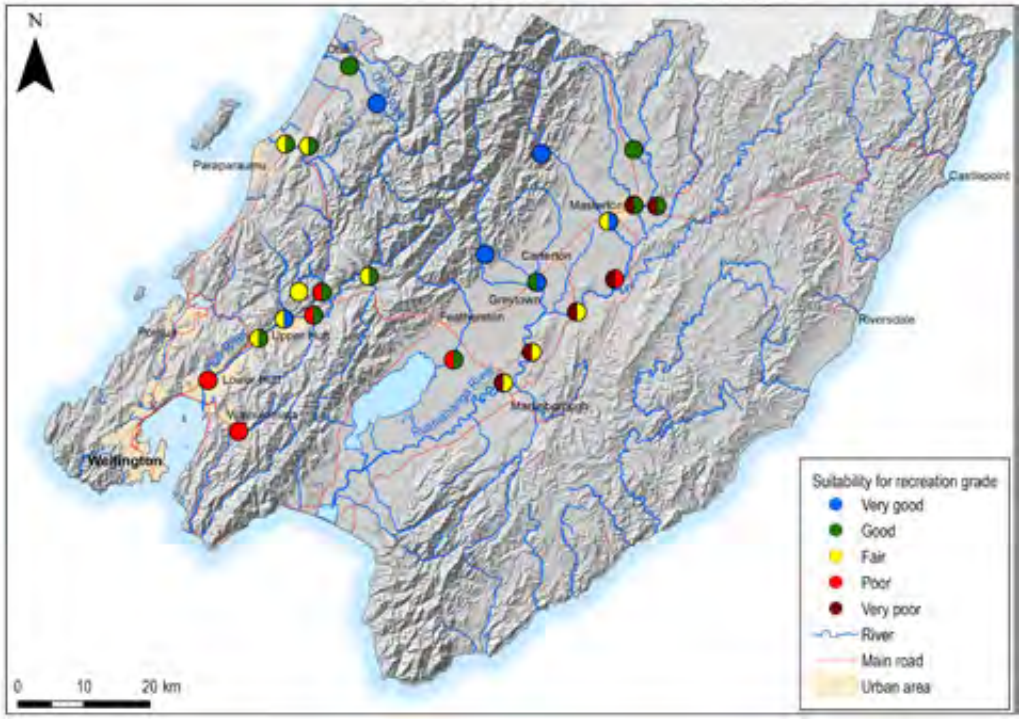

Figure 3.3: Suitability for Recreation Grades (SFRGs) for freshwater monitoring sites in the Wellington region as at the end of the 2013/14 bathing season. The left side of the symbol shows the 'all weather' SFRG while the right side of the symbol shows the 'dry weather' SFRG based on *E. coli* counts from samples collected during median flows or less

Table 3.5: Summary of action guideline breaches during routine monitoring at freshwater sites over the 2013/14 bathing season[1]. Rainfall prior to sampling and the number of follow-up samples required before compliance with the surveillance guideline was achieved are also summarised

Date	Site name	*E. coli* count (cfu/100mL)	Rainfall (mm)					Follow-up tests required
			Rainfall station[2]	72–49 hrs before sampling	48–25 hrs before sampling	Up to 24 hrs before sampling	On the day (9am-3pm)	
Hutt & Wainuiomata								
21/01/2014	Pakuratahi R at Hutt Forks	860	Centre Ridge	0	0	32.5	42.5	1
	Hutt R at Birchville	1,060	Te Marua	0	0	15	8	1
	Hutt R at Maoribank Corner	620						1
	Hutt R at Melling Br.	1,700	Birch Lane	0	0	10.5	15	1
	Wainuiomata R at RP Park	840	Wainui. Reservoir	0	0	9.5	13.5	1
04/02/2014	Wainuiomata R at RP Park	660	Wainui. Reservoir	0	0	0	0	2
04/03/2014	Wainuiomata R at RP Park	580	Wainui. Reservoir	0	0	5.5	0.5	3
Wairarapa								
06/01/2014	Ruamahanga R at Te Ore Ore	600	Mt Bruce	53	65	37.5	0	1
	Waipoua R at Colombo Rd	860						1
	Ruamahanga R at Kokotau	600	Angle Knob	163	201.5	92.5	0	1
	Ruamahanga R at Morrisons B.	740	Waiohine Gorge	58.3	28.5	25	0	1
	Ruamahanga R at Waihenga	620						1
13/01/2014	Ruamahanga R at Double Br.	580	Mt Bruce	0	0	10	0	1
	Ruamahanga R at Te Ore Ore	640						1
03/03/2014	Waingawa R at South Rd	680	Angle Knob	20.5	0	55	1	1[3]

[1] This analysis excludes the four sites sampled monthly under GWRC's RSoE water quality monitoring programme.

[2] See Appendix 2 for more details on rainfall stations.

[3] Sample arrived at lab outside recommended time and temperature range due to a delay in delivery so this follow-up test result can be considered indicative only.

Ruamahanga River sites from Te Ore Ore downstream and Waipoua River at Colombo Road carry the highest risk of microbiological contamination across all flow conditions – these sites are all graded 'very poor'. During dry weather conditions, when contact recreation is most likely, the highest risk of microbiological contamination is present at Hutt River at Melling Bridge, Wainuiomata River at Richard Prouse Park and Ruamahanga River at the Cliffs – these sites have dry weather SFRGs of 'poor'.

Runoff from agricultural land use during heavy or prolonged rainfall has been identified as the key contributor to 'very poor' all weather grades at Waipoua River at Colombo Road and Ruamahanga River sites (Greenfield et al. 2012b). Urban runoff is likely to be the key contributor to the 'poor' SFRG at Hutt River at Melling Bridge while at Wainuiomata River at Richard Prouse Park, stock access and discharges from on-site wastewater systems to upstream tributaries are likely to be the main sources

of contamination (see Section 3.6.3). The lack of information on pathogen removal efficiency of the municipal wastewater treatment plants that discharge to the Ruamahanga River mean that 'dry weather' SFRGs at sites downstream of these discharges (The Cliffs, Kokotau, Morrisons Bush and Waihenga Bridge) have conservatively been set at 'poor' or 'fair' and are regarded as interim grades (Greenfield et al. 2012b). SFRGs at Akatarawa River at Hutt Confluence, Hutt River at Melling and Tauherenikau River at Websters are also considered interim grades due to the limited data set available at these sites (n=55).

All weather SFRGs changed at three sites in the 2013/14 bathing season compared with those reported at the end of the 2012/13 season by Morar and Greenfield (2013). Waikanae River at Jim Cooke Park and Hutt River at Silverstream improved from 'poor' to 'fair', while Waingawa River at South Road deteriorated from 'good' to 'fair' at. 'Dry weather' SFRGs did not change at any sites in 2013/14 compared to 2012/13.

For a full list of all flow and 'dry weather' SFRGs for the 2013/14 season as well as their respective SIC and MAC grades, see Appendix 4.

3.6.3 Faecal source tracking

Over the 1 February to 31 March faecal source tracking investigation period, four samples from Wainuiomata River at Richard Prouse Park had *E. coli* counts high enough to warrant testing for PCR markers. These included both routine and follow-up samples. Six samples from Wainuiomata Stream at its confluence with the Wainuiomata River were also tested (Table 3.6), with one sample from each of these sites analysed for faecal sterols. Full results are reported in Scholes and Robson (2014a, b and c) and Scholes et al. (2014a and b). No samples taken at Hutt River at Melling over the investigation period returned *E. coli* counts high enough to warrant PCR marker or faecal sterol testing.

PCR marker results from Wainuiomata River at Richard Prouse Park did not suggest a single dominant source of contamination. The ruminant marker, although detected in all samples analysed, was only present in significant quantities in one sample (up to 50% of the general faecal contamination marker on 4 February). One of the two human markers was detected in the sample taken on 1 April while the wildfowl marker was also detected in just one sample.

E. coli counts from the Wainuiomata Stream at its confluence with the Wainuiomata River were above the MfE/MoH (2003) action guideline on 11 out of 14 sampling occasions suggesting that this is a likely source of contamination to the Richard Prouse Park site. However, water samples taken from the Wainuiomata River immediately above the Wainuiomata Stream confluence also exceeded the alert or action thresholds on four out of five sampling occasions suggesting a contamination source further upstream is also likely. Samples taken on 1 April 2014 indicated that Skerrett's Creek, which enters the Wainuiomata River approximately 600 m upstream of the Richard Prouse Park site, was also a potential source of contamination. Results from both streams are discussed below.

Table 3.6: Summary of faecal source tracking results from Wainuiomata River at Richard Prouse Park and Wainuiomata Stream at confluence based on weekly sampling between 1 February and 31 March 2014. Only samples with elevated *E. coli* counts were analysed

Site name	Date	Rainfall in previous 72 hrs (mm)	*E. coli* (cfu/100mL)	Source of contamination[1]
Wainuiomata R at Richard Prouse Park	04/02/2014	0	660	Ruminant 10–50%, wildfowl
	04/03/2014	5.5	580	Ruminant 10%
	25/03/2014	0	500	Ruminant 10%
	01/04/2014	0	700	Human (1), ruminant 10%
Wainuiomata S at confluence	04/02/2014	0	550	Ruminant 50%, human (1), wildfowl
	18/02/2014	0	960	Human (2), ruminant 50%, dog, wildfowl
	25/02/2014	0	720	Human (2), ruminant 10%, wildfowl
	09/03/2014	0	1,320	Human (2), ruminant 10%, wildfowl
	25/03/2014	0	1,720	Ruminant 50%
	01/04/2014	0	1,460	Human (1), ruminant 10%, wildfowl

[1] The number in brackets where human contamination was detected indicates whether 1 or 2 human markers were found.

Wainuiomata River at Richard Prouse Park

(a) Wainuiomata Stream

The Wainuiomata Stream drains the Moores Valley where land use is dominated by lifestyle blocks along with a small amount of sheep farming. Lifestyle blocks in the valley commonly support small numbers of livestock (predominantly sheep and horses). Wastewater from all households in the catchment (approximately 160) is treated via on-site septic tank systems.

PCR marker results from the Wainuiomata Stream at confluence identified a range of faecal contamination sources. The ruminant marker was detected at significant levels in two samples and human markers detected in five out of the six samples analysed (three of which contained both human markers). The wildfowl marker was also detected in all samples while the dog marker was detected in one sample.

On 1 April 2014 samples taken at four sites along the length of the Wainuiomata Stream indicated that *E. coli* counts decreased from high levels at the bottom of the catchment (1,460 cfu/100mL at Wainuiomata Stream at confluence) to moderate levels near the top of the catchment (580 cfu/100mL at Wainuiomata Stream at Brookfield Lane). In contrast, additional one-off sampling with HCC staff at 18 sites on 20 May 2014 found that *E. coli* counts were low in the lower catchment but high to moderate in the middle and upper catchment. Analysis of PCR markers at sites with high *E. coli* counts sites suggested human, ruminant and wildfowl contamination was present. Hutt City Council staff will inspect on-site wastewater treatment systems within the Wainuiomata Stream catchment in the second half of 2014 in order to identify those contributing to contamination of the stream (Gordon George[9], pers. comm.).

(b) Skerrett's Creek

Skerrett's Creek is a small stream which in its upper and mid reaches is dominated by regenerating indigenous forest and scrub. In its lower reaches the stream runs alongside Sunny Grove on the outskirts of Wainuiomata township. A sewer main runs along the length of Sunny Grove and properties on the eastern side of the street back onto the stream.

Skerret's Creek at its confluence with the Wainuiomata River

A single water sample taken from Skerret's Creek at its confluence with the Wainuiomata River on 1 April 2014 returned an *E. coli* count of 1,540 cfu/100mL. Both human and dog markers were detected in a PCR marker sample taken from the same site. Hutt City Council was notified of the results and undertook inspections of the sewer main and all sewer laterals along the street. No problems were identified with the main sewer but smoke testing identified a leaking sewer lateral at one property and a blocked sewer at another (Gordon George[9], pers. comm.). These issues are currently being followed up with land owners.

3.6.4 Compliance with nuisance periphyton and cyanobacteria guidelines

The number of periphyton cover assessments able to be made at freshwater monitoring sites ranged from just 11 for Ruamahanga River sites the Cliffs and Kokatau to 20 for both Waikanae River sites, Pakuratahi River at Hutt Forks site and Hutt River at Birchville. On most occasions, non-assessment of algal cover was due to poor water clarity and/or high flows following freshes.

The MfE (2000) nuisance filamentous periphyton cover guideline (>30%) was breached on one occasion at one site during the 2013/14 bathing season (Table 3.7). Filamentous periphyton cover at Ruamahanga River at Waihenga Bridge reached 60% on 18 November 2013 following an extended period of dry weather and low flows.

[9] Gordon George, Manager Trade Waste, Hutt City Council.

Table 3.7: Summary of compliance with MfE (2000) nuisance periphyton guidelines and MfE/MoH (2009) interim cyanobacteria guidelines at 20 river sites, based on routine weekly monitoring over the 2013/14 summer bathing season[1]. Values in bold indicate a guideline breach

Site	Total site visits	Assessments made (n)	Filamentous		Mat		Cyanobacteria		
			Max	>30%	Max	>60%	Max	20–50% (Alert)	>50% (Action)
Kapiti									
Otaki R at SH1	20	19	23.5	0	0.0	0	0.0	0	0
Waikanae R at SH1	20	20	9.5	0	0.0	0	6.5	0	0
Waikanae R at Jim Cooke Pk	20	20	3.8	0	10.8	0	11.8	0	0
Hutt & Wainuiomata									
Pakuratahi R at Hutt Forks	20	20	0.5	0	3.5	0	3.8	0	0
Hutt R at Birchville	20	20	12.5	0	4.5	0	7.5	0	0
Hutt R at Maoribank Cnr	20	19	9.5	0	3.0	0	7.0	0	0
Hutt R at Poets Pk	20	16	11.5	0	6.3	0	10.5	0	0
Hutt R at Silverstream Br.	20	18	20.8	0	6.5	0	10.5	0	0
Hutt R at Melling Br.	20	17	22.5	0	5.8	0	6.3	0	0
Wainuiomata R at RP Pk	20	19	26.0	0	34.8	0	9.3	0	0
Wairarapa									
Ruamahanga R at Double Br.	20	15	13.3	0	0.0	0	6.8	0	0
Ruamahanga R at Te Ore Ore	20	14	9.8	0	2.3	0	9.3	0	0
Waipoua R at Colombo Rd	20	19	15.3	0	47.3	0	12.5	0	0
Waingawa R at Kaituna	20	14	1.0	0	0.0	0	0.0	0	0
Waingawa R at South Rd	20	13	2.8	0	0.8	0	3.3	0	0
Ruamahanga R at The Cliffs	20	11	19.0	0	4.5	0	3.8	0	0
Ruamahanga R at Kokotau	20	11	22.3	0	13.8	0	13.0	0	0
Waiohine R at SH2	20	15	4.3	0	0.0	0	0.5	0	0
Ruamahanga R at Morrisons B.	20	12	28.8	0	0.0	0	7.8	0	0
Ruamahanga R at Waihenga Br.	20	13	60.0	1	0.0	0	8.5	0	0

[1] This analysis excludes the four sites sampled monthly under GWRC's RSoE water quality monitoring programme. The MfE (2000) nuisance mat periphyton cover guideline (60%) was not breached on any sampling occasion during the 2013/14 bathing season (Table 3.7).

The coverage of potentially toxic cyanobacteria did not breach the alert or action level of the MfE/MoH (2009) interim cyanobacteria guidelines at any time during the 2013/14 bathing season (Table 3.7). However, Hutt City Council erected health warning signs at key access points to the Hutt River at Silverstream site on 18 December 2013 due to the presence of detached mats on the river's edge. These were removed by elevated flows following rainfall just over a week later on 24 December 2014 but signs remained in place until the end of the bathing season as a precautionary measure.

3.6.5 Compliance with water clarity guideline

Of the 400 occasions water clarity was assessed, the MfE (1994) water clarity guideline of more than 1.6 m was met 80% of the time (329 occasions) (Table 3.8).

Table 3.8: Summary of compliance with the MfE (1994) water clarity guideline for contact recreation at 20 river sites, based on routine weekly monitoring over the 2013/14 summer bathing season[1]

Site	Assessments made *(n)*	Guideline >1.6 m not met *(n)*
Kapiti		
Otaki R at SH1	20	3
Waikanae R at SH1	20	0
Waikanae R at Jim Cooke Pk	20	1
Hutt & Wainuiomata		
Pakuratahi R at Hutt Forks	20	0
Hutt R at Birchville	20	0
Hutt R at Maoribank Cnr	20	1
Hutt R at Poets Pk	20	4
Hutt R at Silverstream Br.	20	3
Hutt R at Melling Br.	20	3
Wainuiomata R at RP Pk	20	2
Wairarapa		
Ruamahanga R at Double Br.	20	6
Ruamahanga R at Te Ore Ore	20	7
Waipoua R at Colombo Rd	20	1
Waingawa R at Kaituna	20	6
Waingawa R at South Rd	20	9
Ruamahanga R at The Cliffs	20	8
Ruamahanga R at Kokotau	20	7
Waiohine R at SH2	20	5
Ruamahanga R at Morrisons B.	20	7
Ruamahanga R at Waihenga Br.	20	6

[1] This analysis excludes the four sites sampled monthly under GWRC's RSoE water quality monitoring programme.

Of the 79 occasions the guideline was not met, 65 were due to poor water clarity following freshes, while 12 were a result of turbid water created by river works upstream. Poor clarity due to upstream river works was recorded four times at Hutt River at Poets Park, twice at Otaki River at SH1, Hutt River at Silverstream and Waingawa at South Road, and once at both Waikanae River at Jim Cooke Park and Waiohine River at SH2 . Poor water clarity recorded on 25 November 2013 at Waingawa River at South Road may have also been related to river works as records from GWRC's Flood Protection Department indicate that works were scheduled to occur in this area. The only occasion where poor water clarity could not be accounted for occurred at Ruamahanga River at Kokotau on 25 November 2013.

3.7 Summary

Of the 20 freshwater sites monitored weekly over the 2013/14 summer season, 12 sites (60%) exceeded the MfE/MoH (2003) action guideline on at least one occasion. All but two of these exceedances coincided with significant rainfall in the 24 hours prior to sampling and/or elevated river flows. Of the total 24 freshwater sites monitored, six sites (25%) now have 'all weather' SFRGs of 'good' or better while 17 sites (71%) have 'dry weather' SFRGs of 'good' or better. Faecal source tracking analyses undertaken on samples from Wainuiomata River at Richard Prouse Park and upstream tributaries suggested that discharges from on-site wastewater treatment systems, stock access to Wainuiomata Stream and illegal sewage discharges to Skerret's Creek are likely sources of contamination at this site. Hutt City Council is currently undertaking detailed inspections of both sewer/stormwater infrastructure and on-site wastewater treatment systems in this area.

There was only one occasion at one site, Ruamahanga River at Waihenga Bridge, when the MfE (2000) nuisance filamentous periphyton guideline was not met during the 2013/14 bathing season. The guidelines for nuisance mat periphyton and benthic cyanobacteria were met at all sites on all sampling occasions.

The MfE (1994) guideline for water clarity was met most of the time (80% of sampling occasions). Poor water clarity following freshes accounted for the majority of occasions when the guideline was not met, with upstream river works affecting clarity on a few occasions at some sites such as Hutt River at Poets Park.

An assessment of water clarity on the Hutt River at Silverstream. A black disc fixed at 1.6 m from the viewer is used to assess whether the water clarity guideline is being met

4. Recreational water quality in coastal waters

4.1 Introduction

Recreational water quality was monitored at 61 coastal sites across the Wellington region over the 2013/14 bathing season (Figure 4.1, Appendix 1), as follows:

- Kapiti Coast District – 14 sites
- Porirua City – 10 sites
- Hutt City – 13 sites
- Wellington City – 21 sites
- Wairarapa – 3 sites

4.2 Monitoring protocol

Sites were sampled weekly for 20 weeks between mid-November 2013 and 31 March 2014. On each sampling occasion a single water sample was collected 0.2 m below the surface in 0.5 m water depth and analysed for enterococci indicator bacteria.

Observations of weather, the state of the tide and visual estimates of seaweed cover were also made at each site to assist with 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 decaying seaweed. There is evidence that some strains of enterococci are able to replicate or persist in decaying seaweed (Anderson 2000).

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 (see Appendix 2).

A list of field and laboratory methods can be found in Appendix 3.

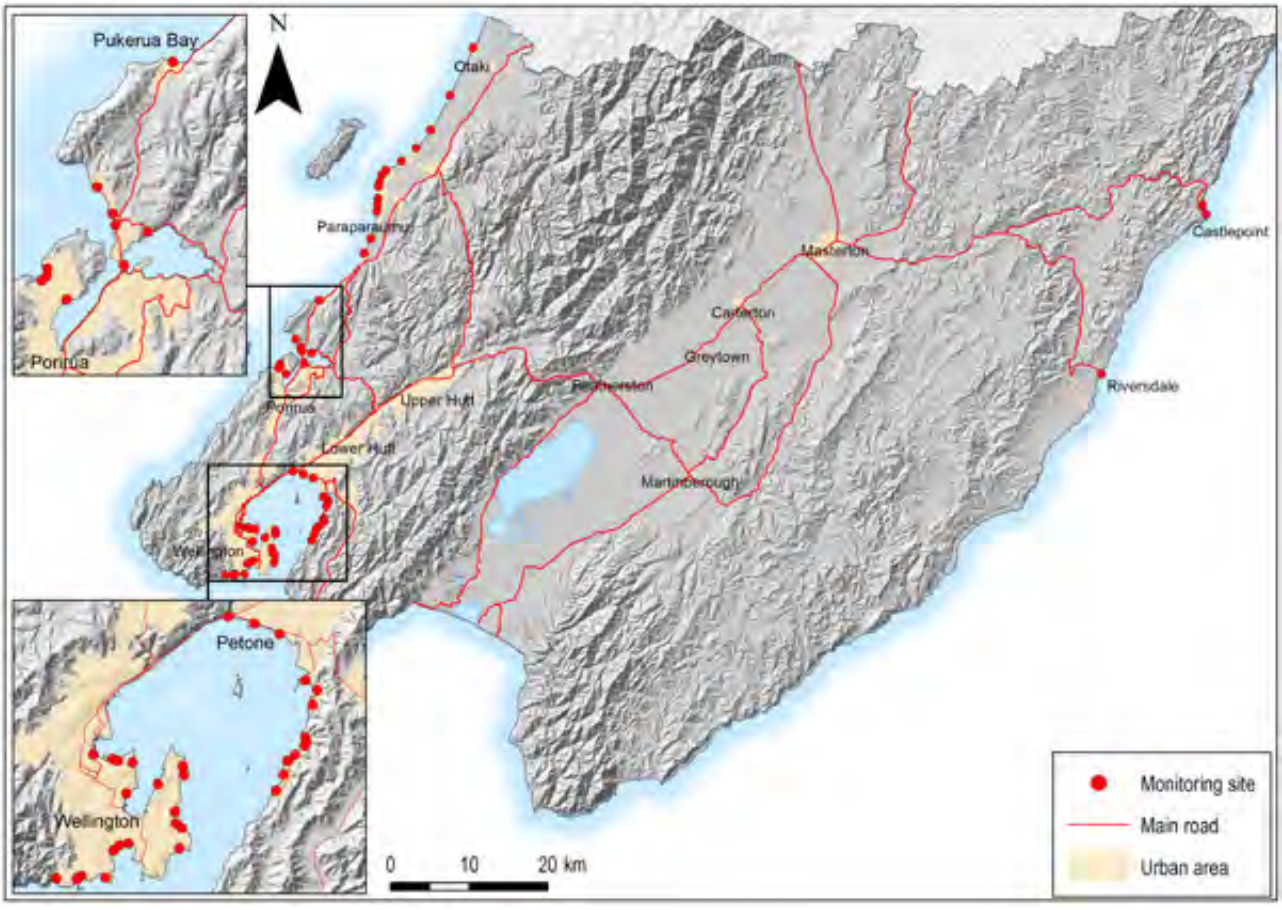

Figure 4.1: Coastal recreation sites monitored during 2013/14

4.3 Guidelines

4.3.1 Microbiological water quality trigger values

As outlined in Section 2.2, the MfE/MoH (2003) recreational water quality guidelines use bacteriological 'trigger' values to help water managers assess individual monitoring results and 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 (coastal) waters

Mode	Guideline Enterococci (cfu/100mL)	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	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 coastal waters the accepted level of risk is 19 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 the 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 heavy rainfall. This is because it is widely known that rainfall is associated with elevated bacteria counts in coastal waters (see Section 4.5.1). For this reason GWRC and Regional Public Health advise avoiding swimming and other contact recreation activities in coastal waters during and for up to two days after heavy rainfall.

In accordance with the MfE/MoH (2003) recreational water quality guidelines, sampling frequency is increased to daily at sites where a routine sample has exceeded the alert or action guideline. However, in some instances where an exceedance has coincided with significant and on-going rainfall, follow-up sampling may be delayed until rainfall has eased.

4.3.2 Suitability for recreation grades

The SIC and MAC categories used to identify SFRGs for coastal waters are shown in Table 4.2.

Table 4.2: MfE/MoH (2003) Suitability for Recreation Grades (SFRG) for marine (coastal) waters

Susceptibility to faecal influence		Microbiological Assessment Category (MAC)[1]			
		A ≤40 Enterococci/ 100mL	**B** 41–200 Enterococci/ 100mL	**C** 201–500 Enterococci/ 100mL	**D** >500 Enterococci/ 100mL
Sanitary Inspection Category (SIC)	**Very Low**	Very Good	Very Good	Follow Up[3]	Follow Up[3]
	Low	Very Good	Good	Fair	Follow Up[3]
	Moderate	Follow Up[2]	Good	Fair	Poor
	High	Follow Up[2]	Follow Up[2]	Poor	Very Poor
	Very High	Follow Up[2]	Follow Up[2]	Follow Up[2]	Very Poor

[1] 95th percentile value calculated using the Hazen percentile method from five years of data obtained from routine weekly monitoring during the bathing season.

[2] Indicates unexpected results requiring investigation (reassess SIC and MAC).

[3] Implies non-sewage sources of indicator bacteria that require verification.

4.4 Data analysis, limitations and cautionary notes

All results have been assessed 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 coastal bathing site only enters the action mode when two consecutive samples exceed 280 enterococci/100mL but, in practice, there can be delays in collecting a second sample (eg, bad weather). Therefore to ensure that recreational water quality is assessed on an equal basis across all 61 coastal sites, the approach taken by GWRC is to treat any single result greater than 280 enterococci/100mL obtained from routine weekly sampling as an exceedance of the red/action mode of the guidelines. This has also been the approach taken by the Ministry for the Environment in its annual national recreational water quality reporting and means that a second consecutive action result is simply used to confirm the appropriate management response (eg, 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 coastal waters in the Wellington region in the past.

During data processing, any enterococci 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 (ie, counts of <4 cfu/100mL and >400 cfu/100mL were treated as 2 cfu/100mL and 400 cfu/100mL, respectively). Rainfall was calculated for the 24, 48 and 72 hours prior to the day of sampling by summing up the rainfall for each 24 hour period ending at 9 am of each day. Any rainfall in the three hours after 9 am on the day of sampling was defined as rainfall 'on the day' (samples were rarely collected after midday).

4.5 Faecal source tracking

Between 1 February and 31 March 2014, additional weekly water sampling was undertaken at five coastal sites (South Beach at Plimmerton, Porirua Harbour at Rowing Club, Titahi Bay at South Beach Access Road, Owhiro Bay and Rona Bay at Clifford Bishop Park) for analysis of PCR markers and faecal sterols. These sites were chosen as they were graded 'poor' by Morar and Greenfield (2013). At each of these sites, samples were also taken from nearby streams considered to be a potential source of faecal contamination. PCR markers analysed included a general marker (GenBac), two human markers (BiADO and BacH), as well as ruminant (BacR), bird (GFD) and dog (DogBac) markers. In addition, water samples from Owhiro Bay were also tested for a marker specific to seagulls (Gull-2). See Section 3.4 for sample analysis details.

4.6 Results

4.6.1 Compliance with trigger values

Forty one of the 61 coastal sites (67%) exceeded the MfE/MoH (2003) action guideline during routine monitoring over the 2013/14 bathing season. Most of these sites (35) exceeded the guideline on two occasions or less (Table 4.3, Appendix 4).

A total of 71 out of 1,220 (5.8%) routine sample results exceeded the MfE/MoH (2003) action guideline of 280 cfu/100mL (Table 4.4). This was less than the 2012/13 season, where 7.6% exceeded the action guideline but more than the 2011/12, 2010/11 and 2009/10 bathing seasons when only 2.3%, 4.5% and 4.2% of results exceeded the action guideline, respectively (Morar & Greenfield 2013, Morar & Greenfield 2012, Morar & Warr 2011, Ryan & Warr 2010).

Table 4.3: Summary of action guideline breaches from routine weekly monitoring at 61 coastal sites over the 2013/14 summer bathing season

No. of times site breached the action guideline	No. of sites					Total no. of sites (61)	% of sites
	Kapiti (14 sites)	Porirua (10 sites)	Wellington (21 sites)	Hutt (13 sites)	Wairarapa (3 sites)		
0	9	0	3	5	3	20	32.8
1	2	6	8	7	0	23	37.7
2	3	3	5	1	0	12	19.7
3	0	1	2	0	0	3	4.9
4	0	0	0	0	0	0	0
5	0	0	3	0	0	3	4.9

Table 4.4: Summary of action guideline breaches during routine monitoring at coastal sites over the 2013/14 bathing season. Rainfall prior to sampling and the number of follow up samples required before compliance with the surveillance guideline was achieved are also summarised

Date	Site name	*E. coli* count (cfu/100mL)	Rainfall (mm)					Follow -up tests required
			Rainfall station[1]	72–49 hrs before sampling	48–25 hrs before sampling	Up to 24 hrs before sampling	On the day (9am-3pm)	
Kapiti								
30/12/2013	Raumati Beach at Tainui St	550	Paraparaumu Aerodrome	0	1.6	1.8	0	1
06/01/2014	Paraparaumu Beach at Maclean Pk	670	Paraparaumu Aerodrome	16.8	26	15.8	0	1
	Paraparaumu Beach at Toru Rd	500						1
	Raumati Beach at Tainui St	320						1
	Raumati Beach at Marine Gardens	305						1
	Raumati Beach at Aotea Rd	300						1
18/03/2014	Paraparaumu Beach at Maclean Pk	330	Paraparaumu Aerodrome	0.6	11.2	1	0	1
	Paraparaumu Beach at Toru Rd	310						1
Porirua								
26/11/2013	Pauatahanui Inlet at Paremata Br.	560	Whenua Tapu	0	0	9.5	1.5	1
	Porirua Harbour at Rowing Club	1,000	Seton Nossiter	0	0	16.4	1.2	1
17/12/2013	Titahi Bay at Toms Rd	2,100	Whenua Tapu	0	0	0	0	1
14/01/2014	South Beach at Plimmerton	1,500	Whenua Tapu	0	0	0	0	1
21/01/2014	Pukerua Bay	1,500	Whenua Tapu	0	0	19	14.5	1
	Karehana Bay at Cluny Rd	330						1
	Plimmerton Beach at Bath St	320						1
	Pauatahanui Inlet at Water Ski Club	4,000						1
	Titahi Bay at Bay Dr	530						1
	Titahi Bay at Toms Rd	1,100						1
	Titahi Bay at Sth Beach Access Rd	390						1
	Porirua Harbour at Rowing Club	900						1
04/02/2014	South Beach at Plimmerton	750	Whenua Tapu	0	0	0	0	1
	Titahi Bay at Sth Beach Access Rd	580						1
04/03/2014	Porirua Harbour at Rowing Club	840	Seton Nossiter	0	0	4.2	0	1

Table 4.4 cont: Summary of action guideline exceedances during routine monitoring at coastal sites over the 2013/14 bathing season. Rainfall prior to sampling and the number of follow up samples required before compliance with the surveillance guideline was achieved are also summarised

Date	Site name	*E. coli* count (cfu/100mL)	Rainfall (mm)					Follow -up tests required
			Rainfall station[1]	72–49 hrs before sampling	48–25 hrs before sampling	Up to 24 hrs before sampling	On the day (9am-3pm)	
Wellington City								
12/11/2013	Island Bay at Reef St Rec Grd	580	Wgtn Airport	0	0	0	0	2
	Island Bay at Derwent St	660						1
	Owhiro Bay	300						1
09/12/2013	Oriental Bay at Wishing Well	740	RCC	0.2	1	0	2	1
	Lyall Bay at Queens Dr	290	Wgtn Airport	0.1	0.9	0	2.7	1
	Island Bay at Surf Club	2,000						1
	Island Bay at Reef St Rec Grd	2,400						1
	Owhiro Bay	2,000						1
16/12/2013	Shark Bay	570	Wgtn Airport	0	0	0	0	1
24/12/2013	Hataitai Beach	480	Wgtn Airport	0	0	1.2	0.5	1
	Seatoun Beach at Wharf	300						1
	Lyall Bay at Tirangi Rd	460						1
	Island Bay at Reef St Rec Grd	330						1
	Island Bay at Derwent St	290						1
13/01/2014	Aotea Lagoon	460	RCC	0	0	0	0	1
	Oriental Bay at Freyberg Beach	300						1
21/01/2014	Balaena Bay	520	Wgtn Airport	0	0	6	5.1	1
	Hataitai Beach	650						1
	Shark Bay	620						1
	Scorching Bay	500						1
	Worser Bay	350						1
	Seatoun Beach at Wharf	400						1
	Seatoun Beach at Inglis St	420						1
	Breaker Bay	560						1
	Lyall Bay at Queens Dr	3,400						1
	Island Bay at Surf Club	3,800						1
	Island Bay at Reef St Rec Grd	5,400						1
	Island Bay at Derwent St	4,400						1
	Owhiro Bay	4,400						1

Table 4.4 cont: Summary of action guideline exceedances during routine monitoring at coastal sites over the 2013/14 bathing season. Rainfall prior to sampling and the number of follow up samples required before compliance with the surveillance guideline was achieved are also summarised

Date	Site name	*E. coli* count (cfu/100mL)	Rainfall (mm)					Follow-up tests required
			Rainfall stn[1]	72–49 hrs before sampling	48–25 hrs before sampling	Up to 24hrs before sampling	On the day (9am-3pm)	
Wellington City (continued)								
27/01/2014	Mahanga Bay	600	Wgtn Airport	0	0	15.6	0	1
	Scorching Bay	640						1
	Breaker Bay	560						1
	Island Bay at Reef St Rec Grd	560						1
	Island Bay at Surf Club	640						1
24/02/2014	Island Bay at Derwent St	1,000	Wgtn Airport	0	0	0	0	1
	Owhiro Bay	680						1
18/03/2014	Island Bay at Derwent St	960	Wgtn Airport	2.2	22	0.2	0	1
	Owhiro Bay	880						1
24/03/2014	Seatoun Beach at Wharf	360	Wgtn Airport	0	0	0	0	1
Hutt								
30/12/2013	Days Bay at Moana Rd	370	Shandon	22.5	1.5	4.5	0	1
	Rona Bay at Wharf	300						1
21/01/2014	Petone Beach at Sydney St	1,100	Shandon	0	0	11.5	13	1
	Petone Beach at Kiosk	1,400						1
	Sorrento Bay	430						1
	Lowry Bay at Cheviot Rd	930						1
	Rona Bay at Wharf	980						1
04/02/2014	Rona Bay at Cliff Bishop Pk	700	Shandon	0	0	0	0	1
24/03/2014	Petone Beach at Water Ski Club	380	Shandon	0	0	0	0	1

[1] See Appendix 2 for more details on rainfall stations.

Just under 62% (44) of the 71 action events were associated with at least 10 mm of rainfall either on the day of, or in the three days prior to, sampling (Table 4.4). Elevated enterococci counts in coastal waters during or shortly after rainfall events are common in many parts of the region due to urban stormwater (including sewer overflows), diffuse-source runoff into rivers and streams, and re-suspension of bottom sediments (Greenfield at al. 2012a).

Twenty seven action guideline breaches occurred following little or no rainfall prior to or on the day of sampling. The greatest number of dry weather action guideline breaches was recorded at Island Bay at Derwent Street, Island Bay at Reef Street Recreation Ground and Owhiro Bay in Wellington City (three each).

Follow-up samples were collected in response to all exceedances of the action guideline. All follow-up samples met the surveillance guideline with the exception of the sample collected at Island Bay at Reef Street Recreation Ground on 13 November 2013 - this sample also exceeded the action guideline. In consultation with Regional Public Health, warning signs were not put in place by Wellington City Council on this occasion as preliminary results from the second follow-up sample received on the morning of 15 November indicated that the enterococci count was well within the surveillance threshold.

Overall, Island Bay at Derwent Street recorded the lowest level of compliance with the surveillance guideline of all coastal sites monitored during the 2013/14 bathing season; just twelve of the twenty routine water samples taken from this site complied with the guideline (see Appendix 4). The poor result at this site as well as the two other sites in Island Bay is discussed further in Section 4.6.2. Poor compliance with the surveillance guideline was also recorded at nearby Owhiro Bay (only 13 samples complied with the surveillance guideline).

4.6.2 Suitability for recreation grades

Updated SFRGs (as at the end of the 2013/14 bathing season) for the 61 coastal recreational water quality monitoring sites in the Wellington region range from 'very good' to 'poor' (Figure 4.2, Appendix 4). In total, 28 (46%) monitoring sites now have SFRGs of 'good' or better while 33 coastal sites have SFRGs of 'fair' or 'poor'. The eight sites graded 'poor' are South Beach at Plimmerton, Porirua Harbour at Rowing Club, Titahi Bay at South Beach Access Road (all Porirua), Island Bay at Surf Club, Island Bay at Reef Street Recreation Ground, Island Bay at Derwent Street, Owhiro Bay (all Wellington City) and Rona Bay at Northern end of Cliff Bishop Park (Hutt). At all of these sites, urban stormwater discharges, some with potential sewage contamination, have been identified as a principal source of faecal contamination (Greenfield et al. 2012b).

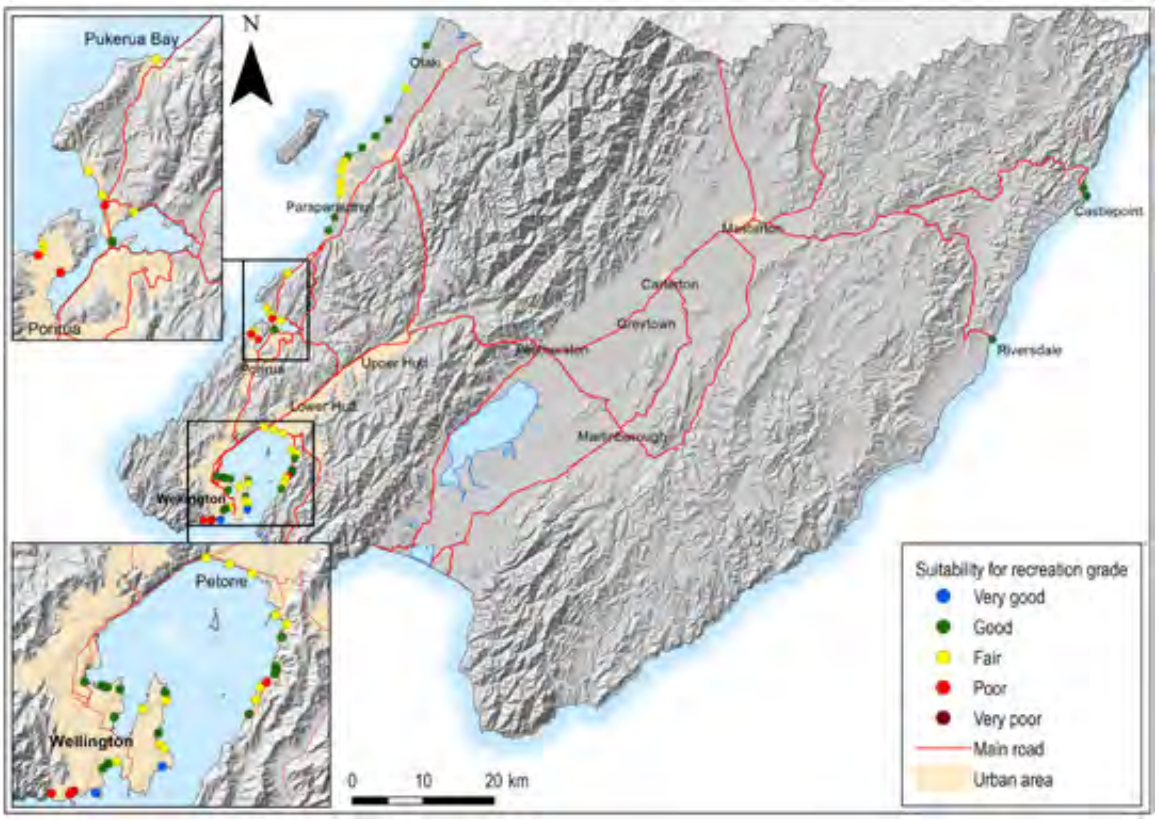

Figure 4.2: Suitability for Recreation Grades (SFRGs) for coastal recreational water quality monitoring sites in the Wellington region as at the end of the 2013/14 bathing season

Titahi Bay near the recreational water quality monitoring site at Bay Drive. This site is graded 'fair' for contact recreation

SFRGs improved at one site and deteriorated at fourteen sites in 2013/14 compared to the 2012/13 grades reported by Morar and Greenfield (2013). The only site where an improvement occurred was at Days Bay at Wellesley College where the SFRG went from 'fair' to 'good'. SFRGs deteriorated from 'good' to 'fair' at Paraparaumu Beach at Maclean Park, Raumati Beach at Tainui Street, Raumati Beach at Aotea Road, Shark Bay, Scorching Bay, Seatoun Beach at Wharf, Seatoun Beach at Inglis Street, Lyall Bay at Tirangi Road, Petone Beach at Water Ski Club, Lowry Bay at Cheviot Road and Robinson Bay at HW Shortt Recreation Ground. SFRGs at Island Bay at Surf Club and Island Bay at Reef Street Recreation Ground dropped from 'fair' to 'poor', while the SFRG at Island Bay at Derwent Street dropped two grades from 'good' to 'poor'. See Appendix 4 for more information on current SFRGs.

The reasons for the drop in grade are unclear at many of these sites but in some cases will likely relate to artefacts of the five-year MAC data set (the 2008/09 summer contained fewer wet weather-influenced enterococci counts than the replacement 2013/14 summer data set). The drop in grade at Raumati Beach sites may be related to the formation of multiple sand bars over the summer resulting in near shore waters not being as well flushed during the changing tide (Anne Robertson[11], pers. comm.). Water quality at Raumati Beach at Tainui Street may have been particularly affected by this.

The degradation in SFRG at Island Bay sites is likely to be linked to discharges from sewer and stormwater infrastructure in the area. A number of illegal cross-connections (ie, sewers connected to stormwater) have been found at private dwellings in the catchment. In addition, some faults have been identified in the sewer mains (Iqbal Idris[12], pers. comm.). Capacity has an on-going programme to fix sewer faults in the area and Wellington City Council is working with property owners to fix cross connections.

Results collected from all sites where SFRGs have deteriorated will be closely scrutinised over the coming season.

4.6.3 Faecal source tracking

Over the 1 February to 31 March 2014 faecal source tracking investigation period, either one or two samples from all five coastal sites sampled had enterococci counts high enough to warrant testing for PCR markers. Fourteen samples from nearby tributary streams were also analysed for PCR markers (Table 4.5). Of the total 21 samples analysed, only one was further analysed for faecal sterols (Taupo Stream on 25 February). Full results are reported in Scholes and Robson (2014a, b and c) and Scholes et al. (2014a and b).

[11] Anne Robertson, Laboratory Manager, Kapiti Coast District Council.

[12] Iqbal Idris, Senior Project Manager, Capacity.

Table 4.5: Summary of faecal source tracking results from five coastal recreation sites and nearby tributaries sampled weekly between 1 February and 31 March 2014. Enterococci was measured at coastal sites while *E. coli* was measured at stream sites. Only samples with elevated faecal indicator bacteria counts were analysed

Site name	Date	Rainfall in previous 72 hrs (mm)	Enterococci/ *E. coli* (cfu/100mL)	Source of contamination*
Porirua				
South Beach at Plimmerton	04/02/2014	0	750	Dog
Taupo Stream	11/02/2014	3.5	1,160	Human (2), wildfowl
	25/02/2014	0	3,680	Human (2), wildfowl
	04/03/2014	2	1,880	Wildfowl
	18/03/2014	16	1,360	Human (1), wildfowl
	25/03/2014	0	1,200	Wildfowl
Porirua Harbour at Rowing Club	04/03/2014	4.2	840	Human (2), wildfowl
Onepoto Stream	04/03/2014	4.2	440	Human (2)
	18/03/2014	21.2	1,380	Human (2, one marker at very high levels)
Titahi Bay at South Beach Access Rd	04/02/2014	0	580	Wildfowl
Wellington				
Owhiro Bay	24/02/2014	0	680	Dog
	18/03/2014	24.4	880	Human (2), wildfowl (no seagull)
Owhiro Stream	11/02/2014	8.5	1,600	No source identified
	17/02/2014	0	2,600	Human (2), wildfowl
	24/02/2014	0	600	Wildfowl
	10/03/2014	0	5,280	Human (1), wildfowl
	18/03/2014	24.4	2,880	Human (2), wildfowl
Hutt				
Rona Bay at N end of Cliff Bishop Park	04/02/2014	0	700	No source identified
	11/02/2014	16.5	180	Wildfowl
Rona Bay Stream	11/02/2014	16.5	400	Wildfowl
	24/02/2014	0	420	Human (2)

* The number in brackets where human contamination was detected indicates whether 1 or 2 human markers were identified.

The action guideline breach that occurred at South Beach at Plimmerton on 4 February 2014 following a period of dry weather was captured during the faecal source tracking investigation period. PCR marker results from this sample identified faecal inputs from dogs as the source of contamination. At nearby Taupo Stream, high *E. coli* counts were recorded on a number of occasions. Analysis of six of these samples for PCR markers (all but one of which were collected during dry weather) suggested both human and wildfowl contamination. Faecal sterol analysis of a sample taken from Taupo Stream on 25 February did not identify a source of contamination. Additional sampling of faecal indicator bacteria in the vicinity of South Beach at Plimmerton by Porirua City Council has identified two stormwater pipes that enter Taupo Stream downstream of the Plimmerton Domain as a potential source of contamination (Nick Macdonald[13] pers. comm). Porirua City Council is continuing investigations in this area.

Results from a water sample taken from Porirua Harbour at Rowing Club on 4 March 2014 following a small amount of rainfall indicated both human and wildfowl contamination. Human faecal contamination was also identified in a sample taken from nearby Onepoto Stream on the same day. Human faecal contamination was also detected in a water sample taken from Onepoto Stream on 18 March following heavy rain – this time at high levels.

The only sample from Titahi Bay at South Beach Access Road with a high enterococci count during the investigation period was taken on 4 February. PCR marker analysis of this sample identified wildfowl as the source of contamination. High *E. coli* counts (1,620–18,000 cfu/100mL) were recorded in all but one of the eight samples collected from the piped stream in the vicinity of the South Beach Access Road site. However, as a very high level of human faecal contamination was identified at this site during investigations undertaken in 2013, no further analysis of these samples was undertaken. Since 2013, Porirua City Council have found a number of illegal sewage discharges to the stream and are continuing to investigate sewer and stormwater infrastructure in the area (Joanna Saywell[14] pers. comm.). A public health warning sign remains in place at the site.

Titahi Bay at South Beach Access Road. Very high levels of human faecal contamination were identified in the small stream that discharges at this site. Investigations into sewer and stormwater infrastructure are ongoing

[13] Nick Macdonald, Senior Environmental Health Officer, Porirua City Council.

[14] Joanna Saywell, Wastewater Asset Manager, Capacity.

Faecal contamination from dogs was identified in a water sample taken from Owhiro Bay on 24 February while both human and wildfowl contamination was detected in a sample taken on 18 March following a significant amount of rainfall. These samples were also tested for a marker specific to seagulls but no seagull influence was found. Human contamination was detected in three out of the five water samples analysed from Owhiro Stream (including the sample taken on 18 March) while contamination from wildfowl was detected in four samples. No source of contamination could be identified from the Owhiro Stream sample taken on 11 February.

No faecal source of contamination was identified from a water sample taken from Rona Bay at North end of Cliff Bishop Park on 4 February while wildfowl contamination was detected in a sample taken following rainfall on 11 February. Wildfowl contamination was also detected in a sample taken on the same day from the unnamed stream which discharges from a pipe at the Cliff Bishop Park site. Human contamination was detected in another sample from the same stream during dry weather.

4.7 Summary

Forty one of the 61 coastal sites (67%) went over the MfE/MoH (2003) action guideline on at least one occasion during the 2013/14 bathing season. Sites that most frequently went above the action guideline were Island Bay at Reef Street Recreation Ground, Island Bay at Derwent St and Owhiro Bay; several exceedances at these sites were not associated with significant rainfall prior to sampling.

As of the end of the 2013/14 bathing season, 28 (46%) coastal monitoring sites have SFRGs of 'good' or better. Twenty five sites are graded 'fair' and the remaining eight sites are graded 'poor': South Beach at Plimmerton, Porirua Harbour at Rowing Club, Titahi Bay at South Beach Access Road, Island Bay at Surf Club, Island Bay at Reef Street Recreation Ground, Island Bay at Derwent Street, Owhiro Bay and Rona Bay at Cliff Bishop Park.

Faecal source tracking investigation undertaken at sites graded 'poor' in the 2013/14 bathing season suggested there a range of faecal contamination sources. While human contamination was clearly identified at two coastal sites following rainfall (Porirua Harbour at Rowing Club and Owhiro Bay), the causes of high enterococci counts that occurred during dry weather were more difficult to identify. Contamination from dog faeces was detected during dry weather on one occasion at South Beach at Plimmerton and Owhiro Bay while contamination from wildfowl was identified on one occasion at Titahi Bay at South Beach Access Road and Rona Bay at Cliff Bishop Park. More conclusive results were obtained from streams that discharge at or near to coastal sites graded 'poor'. Human faecal contamination was detected in both dry and wet weather conditions on several occasions at Taupo Stream (South Beach at Plimmerton), Onepoto Stream (Porirua Harbour at Rowing Club), Owhiro Stream (Owhiro Bay) as well as unnamed streams at Titahi Bay at South Beach Access Road (based on 2013 results) and Rona Bay at Cliff Bishop Park. Faecal contamination from wildfowl was also commonly detected in these streams.

Capacity and local councils are undertaking investigations within the catchments of most sites graded 'poor' to identify specific sources of contamination. Detailed investigations of sewer and stormwater infrastructure are currently being undertaken in the vicinity of South Beach at Plimmerton, Titahi Bay at South Beach Access Road, Island Bay and Rona Bay while significant repairs have already been undertaken in the vicinity of Porirua Harbour at Rowing Club and Owhiro Bay sites.

5. Recreational shellfish gathering water quality

5.1 Introduction

Recreational shellfish gathering water quality was monitored at seven coastal sites across the Wellington region in 2013/14 (Figure 5.1, Appendix 1), as follows:

- Kapiti Coast District – 3 sites
- Porirua City – 1 site
- Hutt City – 1 site
- Wellington City – 2 sites

5.2 Monitoring protocol

Sites were sampled weekly for 20 weeks between mid-November 2013 and 31 March 2014 at the same time as coastal recreational water quality sampling (all seven sites are also coastal bathing sites). On each sampling occasion a single water sample was collected 0.2 m below the surface in 0.5 m 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 an indicator 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/100mL; and
- Not more than 10% of samples collected over a shellfish gathering season should exceed 43 MPN/100mL.

The MfE/MoH (2003) guidelines also state that the guideline values above should be applied in conjunction with a sanitary survey. Sanitary surveys are presented for each site in Appendix 4 in the form of the Sanitary Inspection Categories (SICs) which

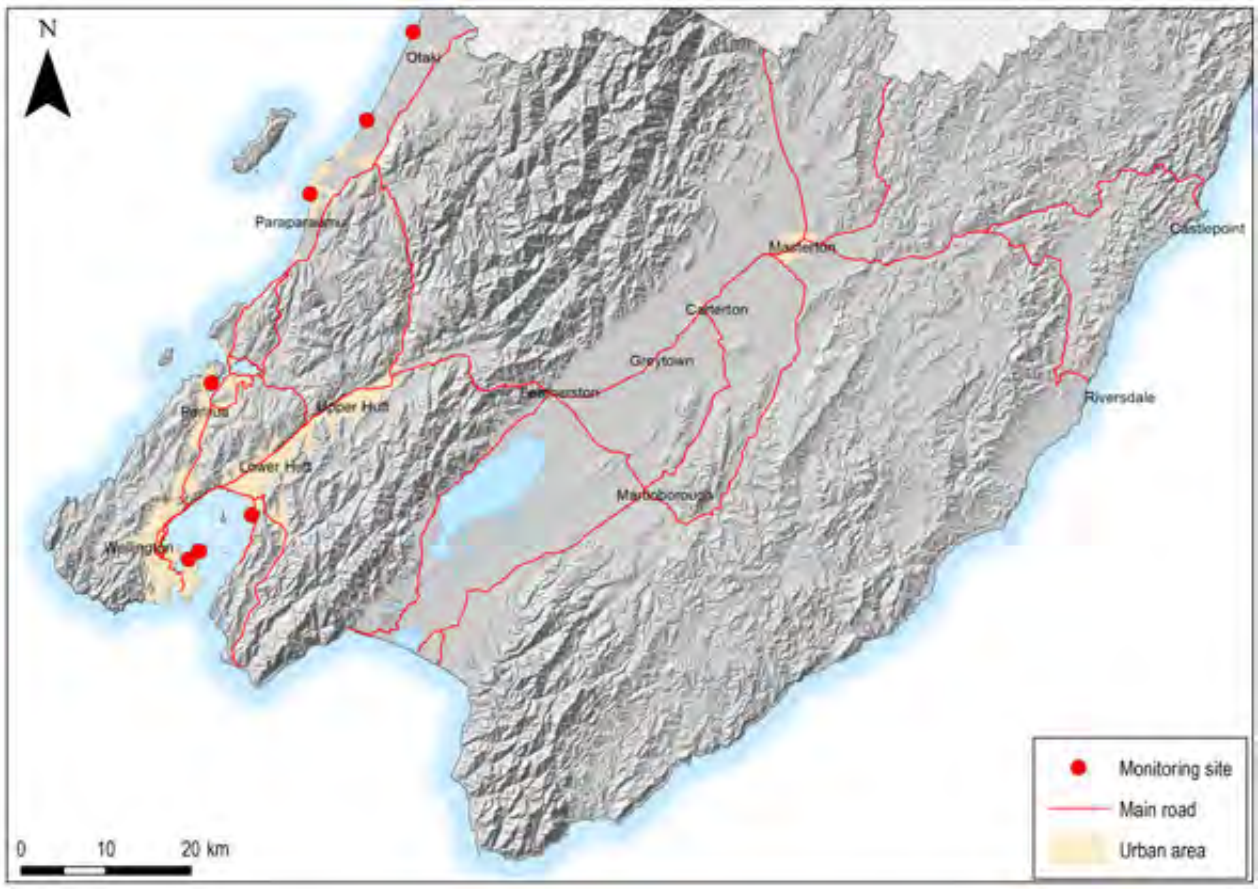

Figure 5.1: Recreational shellfish gathering water quality monitoring sites, 2013/14

People gathering shellfish from Porirua Harbour at Paremata

indicate the susceptibility of these sites to faecal contamination. More information on how these SICs were assigned can be found in Greenfield et al. (2012b).

5.3.1 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 cannot 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. GWRC periodically undertakes shellfish flesh monitoring; the last such monitoring was undertaken in early 2006 (Milne 2006). In general, GWRC and Regional Public Health recommend that shellfish collection be avoided close to urban areas and mouths of rivers and streams that receive significant agricultural runoff.

5.4 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 (ie, mid-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 recreational water quality guidelines for coastal waters. The results of these follow-up samples were excluded from the calculation of compliance with the recreational shellfish gathering water quality guidelines (ie, 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 (ie, counts of <4 cfu/100mL and >400 cfu/100mL were treated as 2 cfu/100mL and 400 cfu/100mL, respectively). Rainfall was calculated for the 24, 48 and 72 hours prior to the day of sampling by summing up the rainfall for each 24 hour period ending at 9 am of each day. Rainfall was also calculated for the period between 9 am and 12 pm on the day of sampling.

5.5 Results

Only two sites, Peka Peka Beach at Road End and Shark Bay, were fully compliant with shellfish gathering water quality guidelines over the 2013/14 summer period (Table 5.1). All other sites breached one or both of the guideline criteria. Shark Bay also complied with the shellfish gathering water quality guidelines in 2012/13 (Morar & Greenfield 2013). However, Peka Peka Beach at Road End has consistently failed to meet the guidelines since monitoring began at this site. The reason for the improvement in water quality at this site is unclear.

Table 5.1: Analysis of faecal coliform counts obtained from routine weekly monitoring during the 2013/14 summer months against the MfE/MoH (2003) guideline criteria for recreational shellfish-gathering waters. Values in bold font indicate non-compliance with guideline criteria

Site	Median (cfu/100mL)	Maximum (cfu/100mL)	No. (and percentage) of results >43 cfu/100mL	Total no. of samples
Kapiti				
Otaki Beach – Surf Club	14	250	5 (25%)	20
Peka Peka Beach – Road End	6	305	2 (10%)	20
Raumati Beach – Tainui St	43	1,435	10 (50%)	20
Porirua				
Porirua Harbour – Rowing Club	52	860	10 (50%)	20
Wellington City				
Shark Bay	3	190	1 (5%)	20
Mahanga Bay	3	880	3 (15%)	20
Hutt				
Sorrento Bay	16	140	4 (20%)	20

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- Samwell Warren, Joanna McVeagh, Charlie Hopkins and Brett Cockeram (Greater Wellington Regional Council)

Appendix 1: Monitoring sites

			NZTM coordinates	
Area	**Site type**	**Site name**	**Easting**	**Northing**
Kapiti	**Freshwater**	Otaki River at Pots[1]	1785444	5478749
		Otaki River at SH1	1781309	5484406
		Waikanae River at SH1	1773752	5472296
		Waikanae River at Jim Cooke Park	1772155	5472377
	Coastal	Otaki Beach at Surf Club[2]	1778622	5488330
		Te Horo Beach at Sea Road	1775692	5482324
		Peka Peka Beach at Road End[2]	1773215	5477905
		Waikanae Beach at William Street	1771388	5475584
		Waikanae Beach at Ara Kuaka Carpark	1769514	5473978
		Paraparaumu Beach at Ngapotiki Street	1767543	5472762
		Paraparaumu Beach at Nathan Avenue	1767033	5472174
		Paraparaumu Beach at Maclean Park	1766694	5471267
		Paraparaumu Beach at Toru Road	1766577	5470715
		Raumati Beach at Tainui Street[2]	1766531	5469229
		Raumati Beach at Marine Gardens	1766516	5468441
		Raumati Beach at Aotea Road	1766414	5467529
		Paekakariki Beach at Whareroa Road	1765598	5464128
		Paekakariki Beach at Surf Club	1764791	5462273
Porirua	**Coastal**	Pukerua Bay	1759058	5456278
		Karehana Bay at Cluny Road	1756093	5451360
		Plimmerton Beach at Bath Street	1756706	5450316
		South Beach at Plimmerton	1756810	5449874
		Pauatahanui Inlet at Water Ski Club	1758074	5449593
		Pauatahanui Inlet at Paremata Bridge	1757153	5448284
		Porirua Harbour at Rowing Club[2]	1754891	5446947
		Titahi Bay at Bay Drive	1754132	5448169
		Titahi Bay at Toms Road	1754110	5447857
		Titahi Bay at South Beach Access Road	1753906	5447682

			NZTM coordinates	
Area	**Site type**	**Site name**	**Easting**	**Northing**
Wellington City	**Coastal**	Aotea Lagoon	1748985	5427683
		Oriental Bay at Freyberg Beach	1749920	5427464
		Oriental Bay at Wishing Well	1750118	5427386
		Oriental Bay at Band Rotunda	1750243	5427375
		Balaena Bay	1750958	5427267
		Hataitai Beach	1750632	5425730
		Shark Bay[2]	1752211	5426197
		Mahanga Bay[2]	1753468	5427115
		Scorching Bay	1753517	5426647
		Worser Bay	1753074	5424823
		Seatoun Beach at Wharf	1753129	5424234
		Seatoun Beach at Inglis Street	1753405	5423994
		Breaker Bay	1753312	5422970
		Lyall Bay at Tirangi Road	1750747	5423230
		Lyall Bay at Onepu Road	1750286	5423116
		Lyall Bay at Queens Drive	1749990	5422868
		Princess Bay	1749586	5421504
		Island Bay at Reef Street Recreation Grd	1748229	5421542
		Island Bay at Surf Club	1748377	5421590
		Island Bay at Derwent Street	1748155	5421415
		Owhiro Bay	1747122	5421463

			NZTM coordinates	
Area	**Site type**	**Site name**	**Easting**	**Northing**
Hutt	**Freshwater**	Pakuratahi River at Forks	1784288	5452620
		Akatarawa River at Hutt Confluence[1]	1776183	5449184
		Hutt River at Birchville	1776196	5449091
		Hutt River at Maoribank Corner	1775882	5446696
		Hutt River at Poets Park	1771461	5446092
		Hutt River at Silverstream Bridge	1767598	5443172
		Hutt River at Melling Bridge	1759906	5436831
		Wainuiomata River at Richard Prouse Park	1764536	5429141
	Coastal	Petone Beach at Water Ski Club	1755744	5434591
		Petone Beach at Sydney Street	1757045	5434248
		Petone Beach at Kiosk	1758326	5433711
		Sorrento Bay[2]	1759632	5431384
		Lowry Bay at Cheviot Road	1760206	5430891
		York Bay	1759977	5430160
		Days Bay at Wellesley College	1759616	5428529
		Days Bay at Wharf	1759654	5428313
		Days Bay at Moana Road	1759582	5428120
		Rona Bay at Northern end of Cliff Bishop Park	1759109	5427654
		Rona Bay at Wharf	1758730	5427371
		Robinson Bay at HW Shortt Recreation Ground	1758519	5426674
		Robinson Bay at Nikau Street	1758131	5425856
Wairarapa	**Freshwater**	Ruamahanga River at Double Bridges	1824350	5471775
		Ruamahanga River at Te Ore Ore	1825529	5462917
		Waipoua River at Colombo Road	1824996	5462889
		Waingawa River at Kaituna	1810326	5471149
		Waingawa River at South Road	1820550	5460878
		Ruamahanga River at The Cliffs	1821476	5452180
		Ruamahanga River at Kokotau	1815756	5447191
		Waiohine River at Gorge[1]	1801853	5455936
		Waiohine River at SH2	1809665	5451711
		Ruamahanga River at Morrisons Bush	1808918	5441108
		Ruamahanga River at Waihenga	1804610	5436461
		Tauherenikau River at Websters[1]	1797082	5439942
	Coastal	Castlepoint Beach at Castlepoint Stream	1871366	5467559
		Castlepoint Beach at Smelly Creek	1871670	5467202
		Riversdale Beach Between the Flags	1858435	5446948

[1] Site sampled monthly under GWRC's Rivers State of the Environment water quality programme.

[2] Water quality is also monitored for recreational shellfish gathering purposes.

Appendix 2: Rainfall stations

Freshwater recreational sites

- Kapiti Coast District – Taungata Peak (Otaki River) and Waikanae Water Treatment Plant (Waikanae River)
- Hutt – Centre Ridge (Pakuratahi River), Te Marua (Hutt River), Birch Lane (lower Hutt River sites) and Wainuiomata Reservoir (Wainuiomata River)
- Wairarapa – Mount Bruce (Ruamahanga River), Angle Knob (located in the upper Waingawa catchment and used as indicator of rainfall high in Tararua Range – Waipoua River, Waingawa River, and mid Ruamahanga River sites) and Waiohine Gorge (Waiohine River and lower Ruamahanga River sites).

Coastal recreational sites

- Kapiti Coast District – Otaki Depot (Otaki Beach, Te Horo Beach), Waikanae Water Treatment Plant (Peka Peka Beach, Waikanae Beach) and Paraparaumu Aerodrome* (Paraparaumu Beach, Raumati Beach, Paekakariki Beach)
- Porirua City – Whenua Tapu and Seton Nossiter Park
- Hutt City – Shandon
- Wellington City – Regional Council Centre (Aotea Lagoon and Oriental Bay) and Wellington Airport* (remaining Wellington City sites)
- Wairarapa – Castlepoint*

*NIWA rainfall stations

Note: Some GWRC rainfall data used in the preparation of this report were raw/processed data that were yet to be formally quality checked and archived in GWRC's Hilltop Database.

Appendix 3: 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 Eurofins ELS.

Methods and detection limits

Determinant	Method	Detection limit
Escherichia coli at 44.5°C	APHA Standard Methods (20th Ed.) 9213D, Membrane filter on mTEC agar, Urea substrate	1–4/100mL
Enterococci at 41°C	US EPA Method 1600, Membrane filter on mEI agar	1–5 cfu/100mL
Faecal coliforms at 44.5°C	APHA Standard Methods (20th Ed.) 9222D, Membrane filter on mFC agar	1–5 cfu/100mL
Water temperature	Field meter or digital thermometer	0.1°C
Visual clarity	Modified version of the horizontal black disc method (Davies-Colley 1988). Instead of measuring the distance at which the 200 mm black disc disappears from view, a 'yes' or a 'no' was recorded depending on whether the disc was visible at 1.6 m.	–
Periphyton cover (including filamentous and mat-forming algae as well as cyanobacteria)	Cyanobacteria cover was assessed using the method outlined in Section 4.4.3 of the interim Cyanobacteria Guidelines (MfE & MoH 2009). Assessment of filamentous and mat-forming algae was undertaken using the same method	5%
Seaweed cover	Visual estimate within 5 m radius around sample point, including both floating and attached seaweed	5%

Appendix 4: Summary statistics and SFRGs

Microbiological water quality data for the 2013/14 summer are summarised in the tables below. The Microbiological Assessment Category (MAC) values and Suitability for Recreation Grades (SFRGs) determined by Greenfield et al. (2012b) have been updated using the 2009/10–2013/14 microbiological water quality results. Up and down arrows beside grades indicate positive and negative changes, respectively, in SFRGs from those assigned at the end of the 2012/13 bathing season (as presented in Morar & Greenfield (2013)).

(A) Fresh waters

Bathing site	*n*	No. sample results (*E. coli*/100mL)			Beach grading (2009/10–2013/14 data)					
					All flows			Dry weather flows		
		Surveillance (≤ 260)	Alert (261–550)	Action (>550)	SIC Grade	MAC Grade (95th%-ile value)	SFRG	SIC Grade	MAC Grade (95th%-ile value)	SFRG
Kapiti										
Otaki R – Pots[1]	5	5	0	0	Low	A (84)[2]	V. good	Very Low	A (44)[2]	V. good
Otaki R – SH1	20	20	0	0	Moderate	B (220)	Good	Low	B (152)	Good
Waikanae R – SH1	20	19	1	0	Moderate	C (435)	Fair	Low	B (208)	Good
Waikanae R – Jim Cooke Pk	20	20	0	0	Moderate	C (480)	Fair↑	Low	B (253)	Good
Hutt & Wainuiomata										
Pakuratahi R – Hutt Forks	20	19	0	1	Moderate	C (349)	Fair	Low	B (153)	Good
Akatarawa R – Hutt Confl.[1]	5	4	1	0	Moderate	C (475)[3]	Fair[3]	Low	C (382)	Fair[3]
Hutt R – Birchville	20	19	0	1	Moderate	D (820)	Poor	Moderate	B (148)	Good
Hutt R – Maoribank Cr	20	19	0	1	Moderate	D (590)	Poor	Low	B (181)	Good
Hutt R – Poets Park	20	19	1	0	Low	C (300)	Fair	Low	A (107)	V. good
Hutt R – Silverstream	20	18	2	0	Moderate	C (540)	Fair↑	Moderate	B (221)	Good
Hutt R – Melling Br.[4]	20	18	1	1	Moderate	D (920)	Poor	Moderate	D (1,144)	Poor
Wainuiomata R – RP Park	20	15	2	3	Moderate	D (600)	Poor	Moderate	D (552)	Poor
Wairarapa										
Ruamahanga R – Double Br.	20	19	0	1	Moderate	B (194)	Good	Moderate	B (138)	Good
Ruamahanga R – Te Ore Ore	20	18	0	2	High	D (750)	V. poor	Moderate	B (169)	Good
Waipoua R – Colombo Rd	20	19	0	1	High	D (880)	V. poor	Moderate	B (185)	Good
Waingawa R – Kaituna	20	19	1	0	Low/ moderate	A (96)	V. good	Low	A (36)	V. good
Waingawa R – South Rd	20	19	0	1	Low/ moderate	C (404)	Fair↓	Low	A (74)	V. good
Ruamahanga R – The Cliffs	20	20	0	0	High	D (600)	V. poor	High	A (76)[5]	Poor[5]
Ruamahanga R – Kokotau	20	19	0	1	High	D (1,350)	V. poor	Moderate	A (112)[5]	Fair[5]
Waiohine R – Gorge[1]	5	5	0	0	Low	A (108)[2]	V. good	Very Low	A (61)[2]	V. good
Waiohine R – SH2	20	20	0	0	Low/ moderate	A (72)	Good	Low	A (41)	V. good

(A) Fresh waters continued

Bathing site	n	No. sample results (*E. coli*/100mL)			Beach grading (2009/10–2013/14 data)					
					All flows			Dry weather flows		
		Surveillance (≤ 260)	Alert (261–550)	Action (>550)	SIC Grade	MAC Grade (95th%-ile value)	SFRG	SIC Grade	MAC Grade (95th%-ile value)	SFRG
Ruamahanga R – Morrisons B.	20	19	0	1	High	D (1,350)	V. poor	Moderate	A (119)[5]	Fair[5]
Ruamahanga R – Waihenga	20	19	0	1	High	D (1,140)	V. poor	Moderate	A (102)[5]	Fair[5]
Tauherenikau R – Websters[1]	5	5	0	0	High	C (408)[3]	Poor[3]	Moderate	B (150)[3]	Good[3]

[1] Sampled monthly under GWRC's Rivers State of the Environment (RSoE) water quality programme.

[2] Based on summer-time data collected weekly from 2003/04–2005/06 and monthly from 2006/07–2013/14.

[3] Interim MAC grade (n=55) based on summer-time data collected monthly under GWRC's RSoE water quality programme (2003/04–2013/14).

[4] Interim grading (SIC grading based on that for historic site at Boulcott and MAC based on three years of data (n=60 for 'all flows' and n=44 for 'dry flows')).

[5] Interim grades altered to reflect the uncertainty associated with the effects of upstream municipal wastewater treatment plant discharges on public health.

(B) Coastal waters

Bathing site	n	No. sample results (Enterococci/100mL)			Beach grading (2009/10–2013/14 data)		
		Surveillance (≤ 140)	Alert (141–280)	Action (>280)	SIC Grade	MAC Grade (95th%-ile value)	SFRG
Kapiti							
Otaki Beach – Surf Club	20	19	1	0	Moderate	B (102)	Good
Te Horo Beach – Sea Rd[1]	20	19	1	0	Moderate	C (250)	Fair
Peka Peka Beach – Road End	20	20	0	0	Low	B (75)	Good
Waikanae Beach – William St	20	20	0	0	Moderate	B (106)	Good
Waikanae Beach – Ara Kuaka	20	20	0	0	Moderate	B (118)	Good
Paraparaumu Beach – Ngapotiki St	20	19	1	0	Moderate	B (193)	Good
Paraparaumu Beach – Nathan Ave	20	17	3	0	Moderate	C (260)	Fair
Paraparaumu Beach – Maclean Pk	20	18	0	2	Moderate	C (215)	Fair↓
Paraparaumu Beach – Toru Rd	20	17	1	2	Moderate	C (408)	Fair
Raumati Beach – Tainui St	20	15	3	2	Moderate	C (253)	Fair↓
Raumati Beach – Marine Gdns	20	18	1	1	Moderate	C (328)	Fair
Raumati Beach – Aotea Rd	20	18	1	1	Moderate	C (238)	Fair↓
Paekakariki Beach – Whareroa Rd	20	19	1	0	Low	B (72)	Good
Paekakariki Beach – Surf Club	20	19	1	0	Low	B (76)	Good

Bathing site	*n*	No. sample results (Enterococci/100mL)			Beach grading (2009/10–2013/14 data)		
		Surveillance (≤ 140)	Alert (141–280)	Action (>280)	SIC Grade	MAC Grade (95th%-ile value)	SFRG
Porirua							
Pukerua Bay	20	19	0	1	Moderate	C (285)	Fair
Karehana Bay – Cluny Rd	20	19	0	1	Moderate	C (230)	Fair
Plimmerton Beach – Bath St	20	17	2	1	Moderate	C (360)	Fair
South Beach – Plimmerton	20	18	0	2	Moderate	D (895)	Poor
Pauatahanui Inlet – Water Ski Club	20	19	0	1	Moderate	C (270)	Fair
Pauatahanui Inlet – Paremata Br.	20	18	1	1	Moderate	A (27)	Good
Porirua Harbour – Rowing Club	20	15	2	3	Moderate	D (870)	Poor
Titahi Bay – Bay Dr	20	18	1	1	Moderate	C (400)	Fair
Titahi Bay – Toms Rd	20	17	1	2	Moderate	C (445)	Fair
Titahi Bay – Access Rd	20	17	1	2	Moderate	D (715)	Poor
Wellington City							
Aotea Lagoon	20	19	0	1	Moderate	B (145)	Good
Oriental Bay – Freyberg	20	19	0	1	Moderate	B (105)	Good
Oriental Bay – Well	20	19	0	1	Moderate	B (130)	Good
Oriental Bay – Rotunda	20	20	0	0	Moderate	B (125)	Good
Balaena Bay	20	19	0	1	Low	B (52)	Good
Hataitai Beach	20	18	0	2	Moderate	B (180)	Good
Shark Bay	20	17	1	2	Moderate	C (285)	Fair↓
Mahanga Bay	20	17	2	1	Low	B (130)	Good
Scorching Bay	20	18	0	2	Low	C (315)	Fair↓
Worser Bay	20	18	1	1	Moderate	B (155)	Good
Seatoun Beach – Wharf	20	17	0	3	Moderate	C (225)	Fair↓
Seatoun Beach – Inglis St	20	18	1	1	Moderate	C (276)	Fair↓
Breaker Bay[2]	20	18	0	2	Low	A (26)	Very good
Lyall Bay – Tirangi Rd	20	19	0	1	Moderate	C (216)	Fair↓
Lyall Bay – Onepu Rd	20	19	1	0	Moderate	B (100)	Good
Lyall Bay – Queens Dr	20	18	0	2	Moderate	B (44)	Good
Princess Bay[2]	20	20	0	0	Low	A (26)	Very good
Island Bay – Surf Club	20	16	1	3	Moderate	D (610)	Poor↓
Island Bay – Reef St Rec. Grd	20	15	0	5	Moderate	D (1440)	Poor↓
Island Bay – Derwent St	20	12	3	5	Moderate	D (700)	Poor↓↓
Owhiro Bay	20	13	2	5	Moderate	D (2100)	Poor

Bathing site	*n*	No. sample results (Enterococci/100mL)			Beach grading (2009/10–2013/14 data)		
		Surveillance (≤ 140)	Alert (141–280)	Action (>280)	SIC Grade	MAC Grade (95th%-ile value)	SFRG
Hutt							
Petone Beach – Water Ski Cub	20	15	4	1	Moderate	C (280)	Fair↓
Petone Beach – Sydney St	20	17	2	1	Moderate	C (468)	Fair
Petone Beach – Kiosk	20	18	1	1	Moderate	C (225)	Fair
Sorrento Bay	20	18	1	1	Low	C (375)	Fair
Lowry Bay – Cheviot Rd	20	18	1	1	Moderate	C (460)	Fair↓
York Bay	20	20	0	0	Low	B (140)	Good
Days Bay – Wellesley College	20	20	0	0	Moderate	B (160)	Good↑
Days Bay – Wharf	20	20	0	0	Moderate	B (140)	Good
Days Bay – Moana Rd	20	18	1	1	Moderate	B (188)	Good
Rona Bay – CB Pk	20	16	3	1	Moderate	D (545)	Poor
Rona Bay – Wharf	20	18	0	2	Moderate	C (342)	Fair
Robinson Bay – HWS Rec. Gd	20	18	2	0	Moderate	C (245)	Fair↓
Robinson Bay – Nikau St	20	18	2	0	Moderate	B (190)	Good
Wairarapa							
Castlepoint Beach – Castlepoint Stm	20	20	0	0	Moderate	B (82)	Good
Castlepoint Beach – Smelly Crk	20	20	0	0	Low	B (84)	Good
Riversdale Beach – Flags	20	20	0	0	Low	B (62)	Good

[1] Interim grade (SIC based on that from historic site at Mangaone Stream outflow, MAC grade based on three years of data (n=60)).

[2] Sampled fortnightly between 2007/08 & 2010/11 and weekly from 2011/12 onwards.

The Greater Wellington Regional Council promotes **Quality for Life** by ensuring our environment is protected while meeting the economic, social and cultural needs of the community

For more information contact the Greater Wellington Regional Council:

Wellington office
PO Box 11646
Manners Street
Wellington 6142

T 04 384 5708
F 04 385 6960

Masterton office
PO Box 41
Masterton 5840

T 06 378 2484
F 06 378 2146

Follow the Wellington Regional Council

info@gw.govt.nz
www.gw.govt.nz

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