Is it safe to swim?

Recreational water quality monitoring results for 2016/17

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

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Executive summary

This report summarises the results of weekly recreational water quality monitoring undertaken over the 2016/17 summer recreation period (1 December 2016 to 31 March 2017), as well as the periods either side of this that were monitored fortnightly and are referred to as the winter recreation period (1 July to 30 November 2016 and 1 April to 30 June 2017). The recreational water quality monitoring programme is undertaken by Greater Wellington Regional Council (GWRC) 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 2016/17 recreation periods, water quality was monitored at 25 river sites, one estuarine site and 64 coastal sites. At each site, water samples were taken for analysis of faecal indicator bacteria – E. coli at river/estuarine sites, enterococci at coastal sites and faecal coliforms at coastal shellfish gathering sites. These results are assessed against the Ministry for the Environment (MfE)/Ministry of Health (MoH) 2003 national microbiological water quality guidelines. At river sites, filamentous algae, mat algae and benthic cyanobacteria (toxic algae) cover were assessed and results compared to the MfE (2000) nuisance periphyton guidelines and the MfE/MoH (2009) interim cyanobacteris guidelines. Water clarity was also assessed at river sites and results compared to the MfE (1994) guideline for recreational waters.

Of the 22 river sites and one estuarine site monitored weekly over the summer recreation period (excludes three sites monitored monthly), 14 sites (61%) exceeded the MfE/MoH (2003) action guideline for microbiological water quality on at least one occasion. All of these events coincided with significant rainfall events and/or elevated river flows. Of the total 26 sites (including three monthly-monitored sites and one estuarine site), ten sites (38%) had 'all weather' Suitability For Recreation Grades (SFRGs) of 'good' or better, while 13 sites (50%) had 'dry weather' SFRGs of 'good' or better.

The MfE (2000) nuisance filamentous periphyton guideline was breached at just one site (Wainuiomata River at Richard Prouse Park) but on five different occasions. These guideline breaches mostly occurred in January and February 2017, following low and stable river flows.

The guideline for nuisance mat periphyton was also breached at just one site (Waipoua River at Colombo Road) but only on one occasion in late December. This covered up to 63% of the river bed – that majority of which was identified as a harmless, non-toxic diatom species. This bloom coincided with a bloom of potentially toxic cyanobacteria, which breached the alert level of the MfE/MoH (2009) interim cyanobacteria guidelines. Toxic algae information signs were put up at these sites by local councils and up-to-date warnings posted on GWRC and Land Air Water Aotearoa websites.

The MfE (1994) guideline for water clarity was met just over half of the time (66% of sampling occasions). Poor water clarity following freshes accounted for most (88%) of the occasions when the guideline was not met, while upstream river works accounted for 5% of water clarity guideline breaches.

On over half (64%) of the sampling occasions this season, no rubbish was visible across the 22 sites. The Waingawa River at South Road site is a problematic site known to accumulate rubbish, as are the Ruamahanga River at Te Ore Ore and Waipoua River at Colombo Road sites to a lesser degree.

Twenty one of the 64 coastal sites (42%) monitored weekly during the summer recreation period exceeded the MfE/MoH (2003) action guideline for microbiological water quality on at least one occasion. Sites that most frequently exceeded the action guideline were Porirua Harbour at Rowing Club, Porirua Harbour at Wi Neera Drive and Aotea Lagoon. Each of these sites had at least two exceedances that were not associated with significant rainfall prior to sampling and therefore considered 'dry' exceedances. For Aotea Lagoon, the cause(s) of these dry exceedances are unknown. Regarding the two Porirua Harbour sites, these are susceptible to poor water quality due to their proximity to stream inflows, the influence of wind-driven currents and possible sediment re-suspension. As of the end of the 2016/17 bathing season, 59% of coastal monitoring sites have SFRGs of 'good' or better and 39% of sites are graded 'fair'. The remaining 1% had insufficient data to be graded. No sites were graded 'poor' this bathing season.

All winter recreation period exceedances occurred at two of the eleven sites monitored (South Beach at Plimmerton and Porirua Harbour at Rowing Club). Four out of six exceedances were not associated with rainfall and are considered dry exceedances. Both sites are known to be susceptible to poor water quality, although the source(s) of contamination around South Beach at Plimmerton have not been identified. In general, SFRGs were lower during the winter than the summer recreation period.

All seven coastal sites monitored to assess water quality for recreational shellfish gathering breached one or both of the guideline criteria during the 2016/17 season. Porirua Harbour at Rowing Club and Otaki Beach at Surf Club had the highest faecal coliform counts and breached the guidelines on eleven and six occasions, respectively.

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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 coastal environment for recreation.

Recreational water quality monitoring in the Wellington region during 2016/17 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, Wellington City Council as well as Wellington Water. Regional Public Health was consulted when the results of the monitoring indicated an increased likelihood of illness associated with recreational use. During the summer recreation period (1 December 2016 to 31 March 2017), Suitability for Recreation Grades (SFRGs) as well as weekly water test results and cyanobacteria (toxic algae) warnings were displayed at *http://www.gw.govt.nz/is-it-safe-to-swim/*.

Weekly test results and other information are also displayed on a national website, Land and Water Aotearoa *(www.lawa.org.nz)*.

This report summarises the results of weekly monitoring undertaken over the 2016/17 summer recreation period and presents updated SFRGs for the region based on these results. Additional fortnightly microbial monitoring results at selected coastal sites outside of the summer recreation period are also reported here (previously reported in the Coastal Water Quality and Ecology Programme). 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).

Paekakariki Beach at Whareroa Road. This site is graded 'good' for contact recreation

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:

- Determine the suitability of selected sites in coastal and fresh waters for contact recreation;
- Determine the suitability of coastal waters for the gathering of shellfish for human consumption;
- Assist in safeguarding public health and the environment;
- Provide information required to determine the effectiveness of regional plans and policies;
- Provide information to assist in determining spatial and temporal changes in the environment (State of the Environment (SoE) monitoring); and

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 that are based on an assessment of the risk from exposure to contaminated water. These guidelines use bacteriological indicators associated with the gut of warm-blooded animals to assess the risk of faecal contamination and therefore the potential presence of harmful pathogens[1]. The indicators used are:

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

Compliance with the MfE/MoH (2003) microbiological 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 (coastal waters), and 5 (shellfish gathering waters) of this report. With regard to contact recreation in coastal and fresh waters the guidelines consist of two components:

1. Faecal indicator bacteria trigger values to assess individual monitoring results throughout the bathing season and
2. Beach grades that describe the general condition of a site at any given time.

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

2.2.1 Trigger values

The MfE/MoH (2003) guidelines provide 'trigger' values for fresh and coastal waters to help water managers assess individual microbiological 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

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 with the potential for the water to be unsuitable for swimming increasing as the grades decline. The two components providing a SFRG for the water at an individual site are:

- The Sanitary Inspection Category (SIC), which is a qualitative assessment of the susceptibility of the water body to faecal contamination; and
- The Microbiological Assessment Category (MAC), which is a measure of the actual water quality over time based on bacteriological test results.

The SIC allows the principal source of faecal contamination in a catchment (eg, sewage overflows, stormwater discharges, agricultural runoff, wildlife, etc.) to be identified and assigns a category (value) according to risk. This value is 'very high', 'high', 'moderate', 'low', or 'very low', and is found for a specific water body by use of a SIC flow chart. For more information see Greenfield et al. 2012b). SIC are reviewed every five years and were due to be reviewed in 2016. Unfortunately, this was not able to be completed due to staff changes and pending outcomes from policy and guideline reviews.

The MAC component of the SFRG is based on a 95th percentile of sample results from a three-year period (around 60 data points). These were previously calculated from the past five years of data, but were changed this season to align with the National Objectives Framework attribute guidance (part of the National Policy Statement for Freshwater Management; NPS-FM) and our Proposed Natural Resources Plan (MfE 2014; GWRC 2016). Microbiological Assessment Categories are updated each year at the end of the bathing season.

There are five SFRGs ranging from 'very good' to 'very poor' with risk to human health increasing as the grades decline (Table 2.2). For ease of interpretation, grades are expressed as letters from A to F in summary cards accompanying this report. Summary cards can be accessed from *www.gw.govt.nz/annual-monitoring-reports*.

Waiohine River at State Highway 2. This site is graded very good for contact recreation

Table 2.2: Suitability for Recreation Grades (SFRGs) and explanation of human health risk associated with each

SFRG		Summary card annotation	Explanation
	Very good	A	Generally excellent water quality and very few potential sources of faecal pollution. Water is considered suitable for swimming almost all of the time.
	Good	B	Suitable for swimming most of the time. Swimming should be avoided during or following heavy rain.
	Fair	C	Generally suitable for swimming but extra care should be taken to avoid contact with the water during or following rainfall or if there are signs of pollution such as discoloured water, odour or debris in the water.
	Poor	D	Susceptible to faecal pollution and water quality is not always suitable for swimming. During dry weather ensure that the site is free of signs of pollution such as discoloured water, odour or debris in the water and avoid swimming at all times during and for up to two days following rainfall.
	Very poor	F	Very susceptible to faecal pollution and water quality may often be unsuitable for swimming. It is generally recommended to avoid swimming at these sites.

In 2012, SIC grades for all recreational water quality monitoring sites in the Wellington region were reviewed (Greenfield et al. 2012b). These SICs have been combined here with MAC grades based on data from the three most recent bathing seasons (2014/15 –2016/17) 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 three 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 test results are added (from the latest bathing season) or removed (due to the first season of results being replaced by the most recent results) from the data set.

It should also be noted that, because the 2016/17 calculations were based on three years of data rather than five, changes in MAC, and subsequently SFRGs, should be interpreted with caution. 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 25 river sites and one estuarine site (Riversdale Lagoon) across the Wellington region over the 2016/17 bathing season (Figure 3.1, Appendix 1), as follows:

- Kapiti Coast District – 4 sites
- Hutt and Wainuiomata Districts – 8 sites
- Wairarapa Districts – 14 sites

The sites monitored reflect their use by the public for contact recreation; in particular, swimming and boating[2].

There were two changes made to the freshwater monitoring network for 2016/17. A new site, the Tauherenikau River at Bucks Road site was added to the network, while the Akatarawa River at Hutt Confluence site was permanently added to the network (previously only part of the monthly Rivers State of the Environment monitoring programme). These changes took place following an internal review of the programme documented by Greenfield (2016 unpublished).

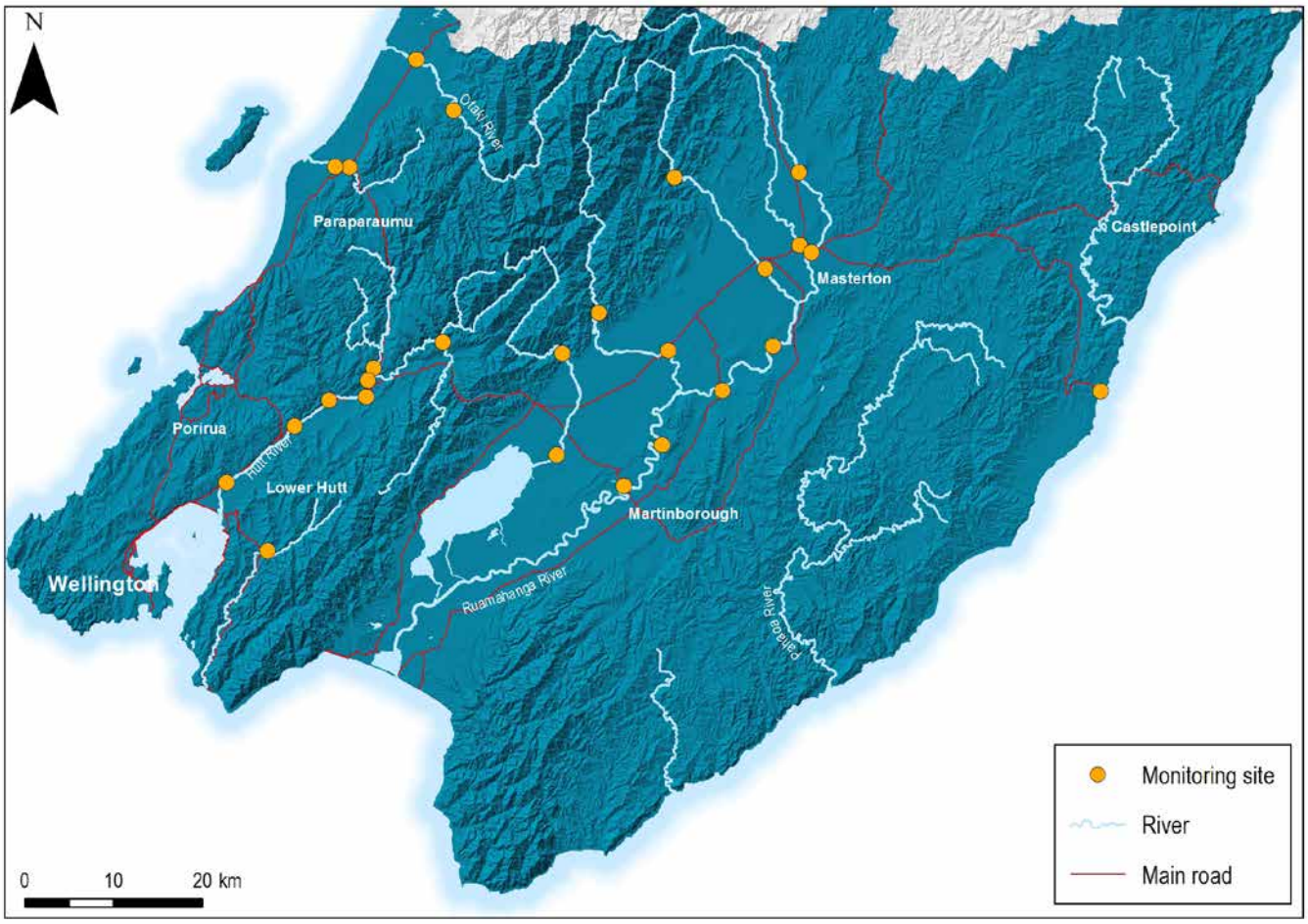


Figure 3.1: Freshwater recreation sites monitored over summer 2016/17

[2] 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. Riversdale Lagoon is not recommended for swimming (permanent health warning signs are in place) but is monitored in response to community interest.

3.2 Monitoring protocol

Summer water quality sites were sampled weekly for 17 weeks – between 1 December 2016 and 31 March 2017. The three exceptions were Otaki River at Pots (in Otaki Gorge on the Kapiti Coast), Waiohine River at Gorge and Tauherenikau River at Websters (Wairarapa), which were sampled monthly under GWRC's Rivers State of the Environment (RSoE) monitoring programme[3]. 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.

Measurements of water temperature were also collected at each site. Visual estimates of water clarity and periphyton (algae and cyanobacteria) cover were made at all river sites. Visual assessments of rubbish/litter were also included this year following the findings of Williamson et al (2016), which identified it as an attribute to support a more integrated approach to recreational water quality monitoring. Each site sampled was classified as having abundant, moderate, minimal or no litter in the water and/or on the banks on each sampling occasion. Rubbish/litter includes household/municipal, rural (e.g. dead stock) and industrial material (e.g. machinery).

Daily rainfall records were obtained for the nearest rain gauge for each site (Appendix 1), to give an indication of rainfall in the upstream catchment. Rainfall can have a significant impact on water quality through creation of runoff from rural or urban land and re-suspension of riverbed sediment.

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

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).

Table 3.1: MfE/MoH (2003) surveillance, alert and action levels for *E. coli* in freshwaters

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

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; 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 two days after heavy rainfall.

3 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 & 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 Tauherenikau River at Websters is also based on monthly data from the RSoE monitoring programme.

(b) Suitability for Recreation Grades

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

Greenfield et al. (2012b) derived two SFRGs for each river 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[4]. 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

Excessive amounts of periphyton[5] 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.

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

Susceptibility to faecal influence		Microbiological Assessment Category (MAC)[1]			
		A	**B**	**C**	**D**
		≤130	131–260	261–550	>550
		E. coli/100mL	*E. coli*/100mL	*E. coli/100mL*	*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.

[4] 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.

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

3.3.3 Interim cyanobacteria guidelines

Growth of benthic cyanobacteria (toxic algae) in rivers can pose a health risk as some species produce toxins (cyanotoxins) which are harmful to humans and animals, particularly dogs (eg, Milne & Watts 2007; MfE/MoH 2009; Heath & Greenfield 2016).

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).

Table 3.3: Alert-level framework for benthic cyanobacteria cover in rivers

(Modified from MfE/MoH 2009)

Alert level	Guideline	Management action
Surveillance (green mode)	≤20% coverage of potentially toxic cyanobacteria attached to substrate.	Undertake routine monitoring.
Alert (amber mode)	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.
Action (red mode)	>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, Territorial Authority and GWRC staff. Close monitoring of 'flushing' river flows [6] and the potential for occurrence of cyanobacterial blooms is a critical part of this process. Warnings based on latest weekly results are displayed on http://www.gw.govt.nz/is-it-safe-to-swim/. The information sign used to advise the public of the risk from benthic cyanobacteria is shown in Figure 3.2.

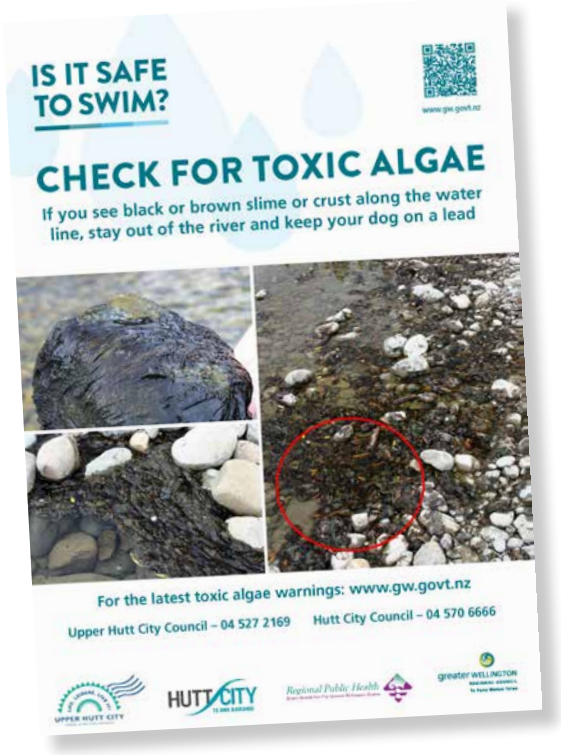


Figure 3.2: Sign used to inform the public of the health risk from cyanobacteria in rivers in the Wellington region

3.3.4 Water clarity guidelines

Smith et al. (1991) and Smith and Davies-Colley (1992) demonstrated that the perception of water clarity at a freshwater site markedly affected a site's overall suitability for swimming 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 water clarity should be greater than 1.6 m (measured horizontally through the water column) if the waters are being managed for contact recreation.

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

3.4 Data analysis

All results were assessed in accordance with the MfE/MoH (2003) recreational water quality guidelines for freshwaters (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 sampling by summing up the rainfall for each 24 hour period.

For most sites, MAC grades were calculated using weekly *E. coli* data from samples collected over the past three summer bathing seasons (2014/15 to 2016/17). The exceptions were four sites for which a longer data period was used: Otaki River at Pots and Waiohine River at Gorge were calculated from weekly data during the 2005/06 bathing season and monthly from 2006/07 onwards; Tauherenikau River at Websters was calculated from monthly sampling during bathing seasons between 2004/05 and 2016/17, while the grade for Akatarawa River at Hutt Confluence was calculated from monthly data between 2006/07 and 2015/16 and weekly for the 2016/17 bathing season. All 95th percentiles were calculated using the Hazen method as recommended in the MfE/MoH (2003) guidelines. As mentioned in section 2.2.2, the SICs were not reviewed this year so remain unchanged.

Rubbish/litter assessments were done as a qualitative measure and a tally for each river site is reported in section 3.5.5.

3.5 Results

3.5.1 Compliance with trigger values

Of the 22 river sites and one estuarine site monitored weekly over the 2016/17 summer recreation period, 14 sites (61%) went above the MfE/MoH (2003) action guideline for *E. coli* (>550 cfu/100mL) on at least one occasion (Table 3.4, Appendix 3).

From a total of 363 routine water samples collected during the bathing season, 17 (4.7%) returned *E. coli* counts above the MfE/MoH (2003) action guideline (Table 3.5). This was more than the 2014/15 and 2015/16 seasons, when 3.3% and 1.2% of samples, respectively, exceeded the action guideline (Keenan et al. 2015, Morar & Greenfield 2016). The wet weather conditions in the 2016/17 summer are likely to be the main driver of the high number of action guideline breaches. There were more rainfall events over the 2016/17 summer compared to the previous summer, particularly in the Wairarapa, Hutt Valley and Wainuiomata areas (GWRC 2016)[7].

Sixteen of the 17 action guideline breach events were associated with moderate to significant rainfall (≥ 5 mm in the 24 hours prior to sampling), while one in early January on the Ruamahanga River at Te Ore Ore was associated with some rainfall (0.5 mm) during the early stages of significant flood event (Table 3.5). In general, these guideline breach results 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).

None of the action guideline exceedances were prolonged contamination events and required only one follow-up sample before *E. coli* counts dropped back below the surveillance guideline. No health warnings were issued for microbiological contamination this season.

Table 3.4: Summary of action guideline breaches for E. coli (>550 cfu/100mL) from routine weekly monitoring at 22 river sites and one estuarine site over the 2016/17 summer recreation period[1]

No. of times site breached the action guideline	No. of sites			Total no. of sites (21)	% of sites
	Kapiti (3 sites)	Hutt & Wainuiomata (7 sites)	Wairarapa (11 sites)		
0	2	0	7	9	39.1
1	1	8	4	13	56.5
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	1	1	4.3

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

7 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.

Table 3.5: Summary of action guideline breaches during routine monitoring at freshwater sites over the 2015/16 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

			Rainfall (mm)				
Date	Site name	*E.coli* count (cfu/100mL)	Rainfall station[2]	Up to 24hrs before sampling	48–25hrs before sampling	72–49hrs before sampling	follow up samples required
Kapiti							
15/12/2016	Otaki R at SH 1	880	Taungata Pk	29.5	21.0	2	1
Hutt & Wainuiomata							
19/12/2016	Pakuratahi R at Hutt Forks	2,500	Centre Ridge	12	0	0	1
	Akatarawa R at Hutt Confl	1,740	Akatarawa C.	29.5	0	0	1
	Hutt R at Birchville	580	Te Marua	31.5	0	0	1
	Hutt R at Maoribank Cr	840					1
	Hutt R at Poets Pk	820					1
	Hutt R at Silverstream Br	920					1
	Hutt R at Melling Br	900	Birch Lane	6.6	0	0	1
	Wainuiomata R at RP Pk	680	Wainui Rsvr	11	0	0	1
Wairarapa							
19/12/2016	Waingawa R at South Rd	660	Angle Knob	90.5	0	0	1
	Ruamahanga R at Morrisons B	740	Waiohine G.	6.5	0	0	1
	Ruamahanga R at Waihenga	620	Angle Knob	90.5	0	0	1
10/1/2017	Ruamahanga R at Te Ore Ore	560	Mt Bruce	0.5	0	0	1
24/1/2017	Ruamahanga R at Te Ore Ore	1,500	Mt Bruce	0	69.5	24	1
13/2/2017	Ruamahanga R at Te Ore Ore	1,140	Mt Bruce	30.5	0	0	1
13/3/2017	Ruamahanga R at Te Ore Ore	960	Bruce	8.5	52.5	28	1
20/2/2017	Riversdale Lagoon	1,440	Ngaumu	1	18.6	46.4	N/A

[1] This analysis excludes the four sites sampled monthly under GWRC's RSoE water quality monitoring programme.
[2] See Appendix 1 for more details on rainfall stations.

3.5.2 Suitability for recreation grades

Updated SFRGs for all river and estuarine sites (as at the end of March 2017) are summarised in Figure 3.3 and listed in Appendix 3. These SFRGs are based on the combined SIC and MAC grades using 'all weather' flows and 'dry weather' flows (excluding Riversdale Lagoon, as 'dry weather' flows cannot be calculated here). Tauherinikau River at Bucks Road is a newly added site and as such could not be graded this year. In total, ten sites (38%) have SFRGs of 'good' or better for 'all weather' flows and 13 sites (50%) have 'dry weather' SFRGs of 'good' or better.

The Ruamahanga River site at Te Ore Ore carried the highest risk of microbiological contamination across 'all weather' conditions, as the only site to be graded 'very poor' (Figure 3.3 and Appendix 3). Three previously 'very poor' sites (Ruamahanga River at Morrisons Bush, Ruamahanga River at Kokotau and Waipoua River at Colombo Rd) had a reduced risk of contamination this bathing season. During dry weather conditions, when contact recreation is most likely, the highest risk of microbiological contamination was in the Hutt River at Melling Bridge, Wainuiomata River at Richard Prouse Park and Ruamahanga River at Te Ore Ore and the Cliffs; these four sites have dry weather SFRGs of 'poor'.

The large waterfowl population and urban stormwater inputs to Henley Lake have been identified as key contributors to the 'very poor' all weather grade at the Ruamahanga River Te Ore Ore site (Greenfield et al. 2012b). Contamination from rural runoff is also likely to be a factor in 'poor' all weather grades at other sites on the Tauherenikau and Ruamahanga rivers. Urban

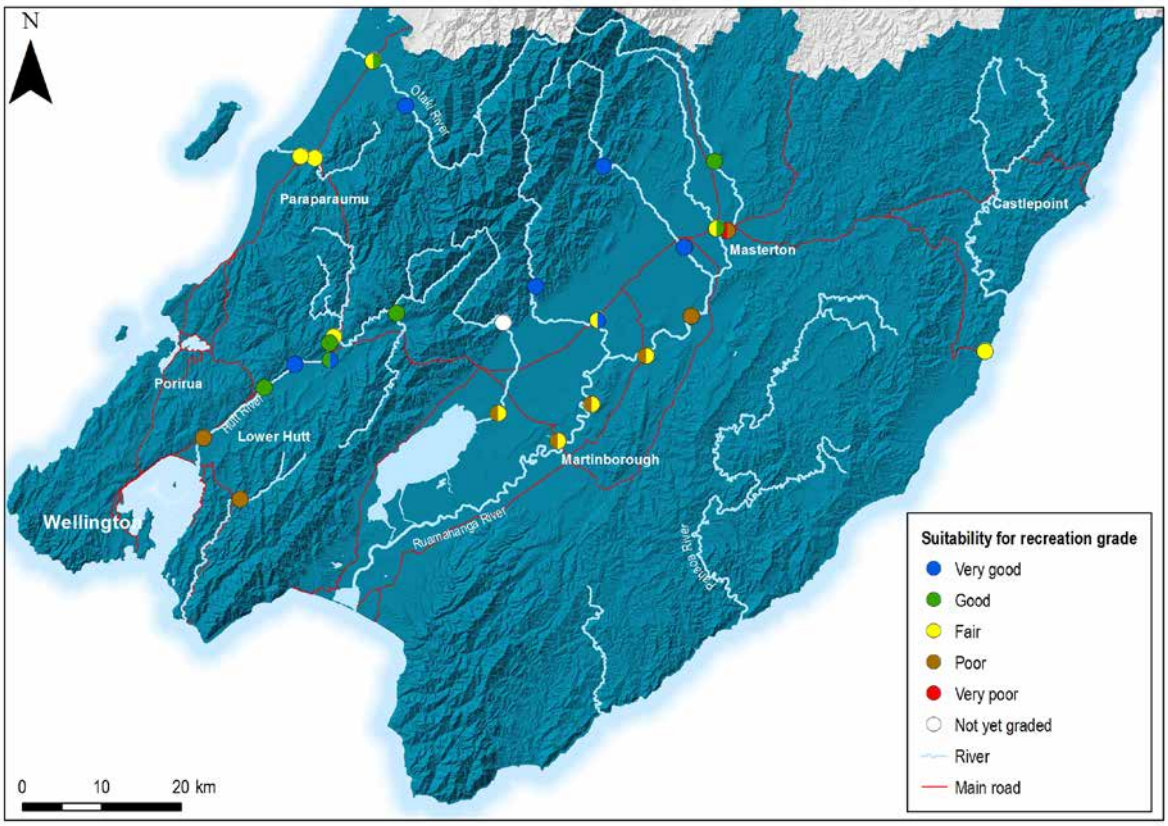


Figure 3.3: Suitability for Recreation Grades (SFRGs) for all 25 freshwater monitoring sites and one estuarine monitoring site in the Wellington region as at the end of the 2016/17 bathing season. The left side of the symbol shows the 'all weather' SFRG, while the right side of the symbol shows the 'dry weather' SFRG (uses only *E. coli* counts from samples collected during 3 x median flows or less). The SFRG for the single estuarine site (Riversdale Lagoon) is 'all weather' only

runoff is likely to be the key contributor to the 'poor' all weather and dry weather grade at Hutt River at Melling. 'Poor' grades during both all weather and dry weather conditions at Wainuiomata River at Richard Prouse Park are likely to be linked to contamination from rural land use and on-site wastewater systems in upstream tributaries (Morar & Greenfield 2014).

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). Masterton District Council's (MDC) operation to discharge treated wastewater from Masterton to land, rather than to the Ruamahanga River, during low flow conditions was fully operational for the first time in 2015/16. However, annual consent reporting from a full 12 month compliance year was not due for completion in time to re-assess the SIC for this report. In light of this, the SIC component of dry weather grades for Ruamahanga River sites downstream of Masterton will be reassessed in 2017/18 to reflect any reduction in risk to human health from contact recreation.

All weather SFRGs improved at seven sites in the 2016/17 bathing season compared with the 2015/16 season (Morar and Greenfield 2016). Hutt River at Poets Park increased from 'good' to 'very good'. The Hutt River at Silverstream continued to improve, changing from 'fair' to 'good'. Three other sites also improved one or two grades to 'fair'; Riversdale Lagoon, Akatarawa River at Hutt Confluence and Waipoua River at Colombo Road. Only two sites saw a drop in SFRG grade, the Otaki River at State Highway One and Waiohine River at State Highway Two. The Hutt River at Maoribank Corner was the only 'dry weather' improvement, up from 'good' to 'very good', while four sites dropped to either 'fair' or 'poor' (Appendix 3).

For a full list of 'all weather' and 'dry weather' SFRGs for the 2016/17 season, as well as their respective SIC and MAC grades see Appendix 3.

3.5.3 Compliance with nuisance periphyton and cyanobacteria guidelines

Only two sites, Wainuiomata River at Richard Prouse Park and Waipoua River at Colombo Road, were able to be assessed for periphyton on all 17 sampling occasions (Table 3.6). The remainder were either too turbid to make assessments or unsafe to enter due to flood conditions on at least one occasion. The majority of non-assessable occasions were due to flood flows, while a few isolated occasions were too turbid due to upstream consented river bed disturbances (on the Waiohine River; affecting the SH2, Morrison's Bush and Waihenga sites).

There were very few breaches of both the periphyton and cyanobacteria guidelines this season. Five breaches of the MfE (2000) nuisance filamentous periphyton cover guideline (>30% cover) occurred, all of which were in the Wainuiomata River at Richard Prouse Park. The maximum coverage occurred on the 16 January 2017 when filamentous periphyton cover reached 49% (Table 3.6).

The MfE (2000) nuisance mat periphyton cover guideline (>60% cover) was only breached on one occasion on the Waipoua River at Colombo Road, on the 19 December 2016, where mat periphyton covered 63% of the river bed (Table 3.6). The dominant species of this periphyton bloom is believed to be a species of the diatom *Cymbella* – a harmless, non-toxic type of periphyton. This exceedance followed a prolonged low flow period in the Waipoua River in early December and coincided with high growth of potentially toxic cyanobacteria, discussed below.

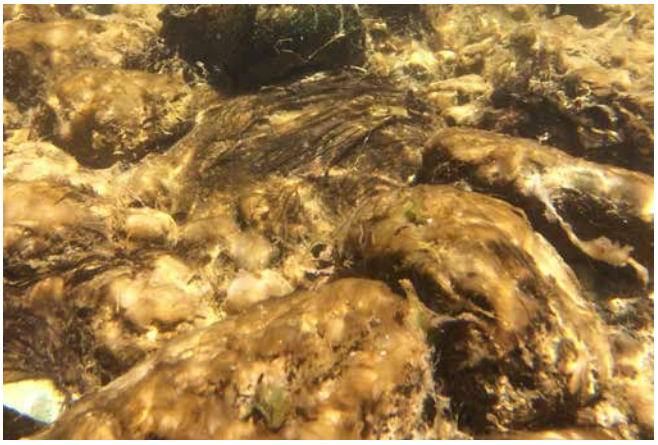
Table 3.6: Summary of compliance with MfE (2000) nuisance periphyton guidelines and MfE/MoH (2009) interim cyanobacteria guidelines at 22 river sites[1], based on routine weekly monitoring over the 2016/17 summer recreation period. Values in bold indicate a guideline breach

Site	Total site visits (*n*)	Assessments made (*n*)	Filamentous		Mat		Cyanobacteria		
			Max (%)	>30% (*n*)	Max (%)	>60% (*n*)	Max (%)	'Alert' level[2] (*n*)	'Action' level[3] (*n*)
Kapiti									
Otaki R at SH1	17	14	**8.5**	0	8	0	8	0	0
Waikanae R at SH1	17	14	5.5	0	0	0	0	0	0
Waikanae R at Jim Cooke Pk	17	14	15	0	1	0	1	0	0
Hutt & Wainuiomata									
Pakuratahi R at Hutt Forks	17	16	1.3	0	0	0	6.8	0	0
Akatarawa R at Hutt Confl	17	15	2	0	2.3	0	0	0	0
Hutt R at Birchville	17	15	8	0	0	0	1.5	0	0
Hutt R at Maoribank Cnr	17	15	2.3	0	0	0	4.8	0	0
Hutt R at Poets Pk	17	15	15.8	0	0	0	2.8	0	0
Hutt R at Silverstream Br	17	12	12	0	0	0	8.3	0	0
Hutt R at Melling Br	17	13	2.5	0	0	0	0	0	0
Wainuiomata R at RP Pk	17	17	**49.3**	**5**	1.8	0	3	0	0
Wairarapa									
Ruamahanga R at Double Br	17	13	9.5	0	36.3	0	7.5	0	0
Ruamahanga R at Te Ore Ore	17	11	6.8	0	14.5	0	7.3	0	0
Waipoua R at Colombo Rd	17	17	23.3	0	**63**	**1**	**50**	**2**	0
Waingawa R at Kaituna	17	16	0.5	0	0.8	0	1.8	0	0
Waingawa R at South Rd	17	15	13	0	35.3	0	5.8	0	0
Ruamahanga R at The Cliffs	17	12	8	0	9.8	0	2.8	0	0
Ruamahanga R at Kokotau	17	12	14.5	0	8	0	1.5	0	0
Waiohine R at SH2	17	12	8.8	0	14	0	2.3	0	0
Ruamahanga R at Morrisons Bush	17	7	1.8	0	0	0	0	0	0
Ruamahanga R at Waihenga Br	17	8	6.8	0	0.3	0	0	0	0
Tauherenikau R at Bucks Rd	17	13	1.5	0	0.8	0	1.3	0	0

[1] This analysis excludes the three sites sampled monthly under GWRC's RSoE water quality monitoring programme, and Riversdale Lagoon
[2] As in Table 3.3, 'alert' level is when there is 20-50% coverage of potentially toxic cyanobacteria attached to substrate.
[3] As in Table 3.3, 'action' level is when there is >50% coverage OR cyanobacteria are visibly detaching from substrate or becoming exposed on river's edge.

The Waipoua River at Colombo Road was also the only site to breach the alert level of the MfE/MoH (2009) interim cyanobacteria guidelines (>20% coverage). Microscope analysis of the mat material showed that the diatom Cymbella was the dominant species, but a precautionary amber alert was triggered because the potentially toxic cyanobacteria *Phormidium* was also present in sparse but dense patches and mats had started to detach from rocks. This occurred on just two occasions (13 and 19 December 2016), following a prolonged low flow period in the Waipoua River catchment where a large flushing flow occurred on 27 November, followed by at least 22 days without another significant flushing flow to remove the periphyton mats. Despite no flushing flows occurring until late January 2017, cyanobacteria growth subsided to less than 5% coverage within two weeks of the last exceedance. A very small amount of detached mats were associated with these exceedances but there were no known related incidences of human or animal illness. GWRC and territorial authorities issued a media release on 19 December and Masterton District Council posted toxic algae information signs at key access points along the Waipoua River. There were no action level (>50% cover) guideline breaches this season.

All guideline exceedances were reported at *www.gw.govt.nz/is-it-safe-to-swim/*. These webpages were advertised on radio and noted on toxic algae information signs as providing up-to-date toxic algae warning information. Warnings were also posted on the Land Air Water Aotearoa (LAWA) website *www.lawa.org.nz*.



Diatom (light brown) and cyanobacteria (dark brown) mats growing simultaneously on the river bed of the Waipoua River at Colombo Road on 22 December 2016

3.5.4 Compliance with water clarity guideline

Of the 374 occasions water clarity was assessed, the MfE (1994) water clarity guideline of more than 1.6 m visibility was met 66% of the time (247 occasions; Table 3.7).

Table 3.7: Summary of compliance with the MfE (1994) water clarity guideline for contact recreation at 22 river sites[1], based on routine weekly monitoring over the 2016/17 summer recreation period

Site	Assessments made (*n*)	Guideline >1.6 m met (*n*)
Kapiti		
Otaki R at SH1	17	8
Waikanae R at SH1	17	14
Waikanae R at Jim Cooke Pk	17	14
Hutt & Wainuiomata		
Pakuratahi R at Hutt Forks	17	16
Akatarawa R at Hutt Confl.	17	15
Hutt R at Birchville	17	11
Hutt R at Maoribank Cnr.	17	12
Hutt R at Poets Pk	17	11
Hutt R at Silverstream Br.	17	11
Hutt R at Melling Br.	17	10
Wainuiomata R at RP Pk	17	17
Wairarapa		
Ruamahanga R at Double Br.	17	11
Ruamahanga R at Te Ore Ore	17	7
Waipoua R at Colombo Rd	17	16
Waingawa R at Kaituna	17	15
Waingawa R at South Rd	17	11
Ruamahanga R at The Cliffs	17	8
Ruamahanga R at Kokotau	17	9
Waiohine R at SH2	17	9
Ruamahanga R at Morrisons Bush	17	5
Ruamahanga R at Waihenga Br.	17	5
Tauherenikau R at Bucks Rd	17	12

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

Of the 127 occasions the guideline was not met, 112 (88%) were due to poor water clarity following rainfall, while six (5%) were attributed to turbid water created by river works upstream[8]. These six instances of poor water clarity resulted from only three river works operations that impacted clarity at multiple downstream sites on the Waikanae, Hutt and Ruamahanga Rivers[9].

[8] In some cases upstream river works were observed by samplers, in others river works were not observed but were scheduled to occur in the area.
[9] These works were undertaken by GWRC's Flood Protection Department in accordance with their resource consent.

The Wainuiomata River at Richard Prouse Park was the only site that consistently met the clarity guidelines across the entire bathing season. The Waipoua River at Colombo Road also had comparatively good clarity, only failing the guidelines on one occasion. However, these clear conditions allow for greater light penetration through water and may also have contributed to the high filamentous periphyton and cyanobacteria growth seen at these sites (see section 3.5.3).

3.5.5 Rubbish/Litter Assessment

A total of 374 assessments of rubbish at 22 river sites were made over the 2016/17 bathing season. Sixty four percent of all assessments recorded no rubbish present on the banks or in the river channel. The Hutt and Wainuiomata region had the least rubbish with 5% of assessments showing at least some rubbish present at the 8 sites visited. The Kapiti region had at least some rubbish on 20% of visits to the three sites, while the Wairarapa had the most rubbish with 63% of assessments reporting at least some rubbish present across the 11 sites visited (Table 3.8).

Most notably, the Waingawa River at South Road site had abundant amounts of rubbish present on all 17 sampling occasions (Table 3.8). This site has large amounts of municipal and industrial waste deposited at the Hugh's Line access point all year round. Past efforts to deter the public from dumping rubbish here have not been successful and a resolution is yet to be found.

The Ruamahanga River at Te Ore Ore Site is also a common location with large amounts of rubbish present – often with moderate (13 occasions) and occasionally abundant (two occasions) amounts of rubbish recorded during the bathing season. The majority of rubbish is municipal with occasional industrial items observed. The Waipoua River at Colombo Road also accumulates municipal rubbish, probably dispersed by wind, with minimal or moderate amounts of rubbished recorded (on five and 12 occasions, respectively; Table 3.8).

Table 3.8 Summary of rubbish assessments made at 22 river sites[1], based on routine weekly monitoring over the 2016/17 summer recreation season

Site	Assessments made (*n*)	Rubbish Amount			
		None	Minimal	Moderate	Abundant
Kapiti					
Otaki R at SH1	17	17	0	0	0
Waikanae R at SH1	17	9	8	0	0
Waikanae R at Jim Cooke Pk	17	15	2	0	0
Hutt & Wainuiomata					
Pakuratahi R at Hutt Forks	17	17	0	0	0
Akatarawa R at Hutt Confl.	17	17	0	0	0
Hutt R at Birchville	17	17	0	0	0
Hutt R at Maoribank Cnr	17	15	2	0	0
Hutt R at Poets Pk	17	17	0	0	0
Hutt R at Silverstream Br	17	15	2	0	0
Hutt R at Melling Br	17	16	1	0	0
Wainuiomata R at Richard Prouse Pk	17	15	2	0	0
Wairarapa					
Ruamahanga R at Double Br	17	8	9	0	0
Ruamahanga R at Te Ore Ore	17	0	2	13	2
Waipoua R at Colombo Rd	17	0	5	12	0
Waingawa R at Kaituna	17	5	7	5	0
Waingawa R at South Rd	17	0	0	0	17
Ruamahanga R at The Cliffs	17	11	6	0	0
Ruamahanga R at Kokotau	17	9	8	0	0
Waiohine R at SH2	17	5	12	0	0
Ruamahanga R at Morrisons Bush	17	10	7	0	0
Ruamahanga R at Waihenga Br	17	13	4	0	0
Tauherenikau R at Bucks Rd	17	8	9	0	0

[1] This analysis excludes the three sites sampled monthly under GWRC's RSoE water quality monitoring programme and Riversdale Lagoon, which is estuarine.

3.6 Summary

Of the 22 river sites and one estuarine site monitored weekly over the 2016/17 summer season, 14 sites (61%) exceeded the MfE/MoH (2003) action guideline for microbiological water quality on at least one occasion. One hundred percent of these exceedances coincided with significant rainfall in the 24 hours prior to sampling and/or elevated river flows. Of the total 26 sites monitored weekly and monthly, ten sites (38%) had 'all weather' SFRGs of 'good' or better while 13 sites (50%) had 'dry weather' SFRGs of 'good' or better.

The MfE (2000) nuisance filamentous periphyton guideline was breached at just one site (Wainuiomata River at Richard Prouse Park) but on five different occasions. These guideline breaches mostly occurred in January and February 2017, following low and stable river flows.

The guideline for nuisance mat periphyton was also breached at just one site (Waipoua River at Colombo Road) but on only one occasion in late December, covering up to 63% of the river bed – the majority of this was identified as a harmless, non-toxic diatom species. This bloom coincided with a bloom of potentially toxic cyanobacteria, which breached the alert level of the MfE/MoH (2009) interim cyanobacteria guidelines. Toxic algae information signs were put up at these sites by local councils and up-to-date warnings posted on GWRC and LAWA websites.

The MfE (1994) guideline for water clarity was met just over half of the time (66% of sampling occasions). Poor water clarity following rainfall accounted for most (88%) of the occasions when the guideline was not met, while upstream river works accounted for 5% of water clarity guideline breaches.

On over half (64%) of the sampling occasions this season, no rubbish was visible across the 22 sites. The Waingawa River at South Road site is a problematic site known to accumulate rubbish, as are the Ruamahanga River at Te Ore Ore and Waipoua River at Colombo Road sites to a lesser degree.

4 Recreational water quality in coastal waters

4.1 Introduction

4.1.1 Summer recreation period

Recreational water quality was monitored at 63 coastal sites across the Wellington region over the 2016/17 bathing season (Figure 4.1, Appendix 1), as follows:

- Kapiti Coast District – 14 sites
- Porirua City – 12 sites
- Wellington City – 23 sites
- Hutt City – 13 sites
- Wairarapa Districts – 3 sites

Three changes were made to the coastal recreational water quality monitoring site network in 2016/17. Two sites were added to the network (Porirua Harbour at Wi Neera Drive Boat Ramp and Wellington City Waterfront at Shed 6) while weekly monitoring at Onehunga Bay ceased[10]. These changes were made following an internal review of the coastal recreational water quality programme by Greenfield (2016 unpublished).

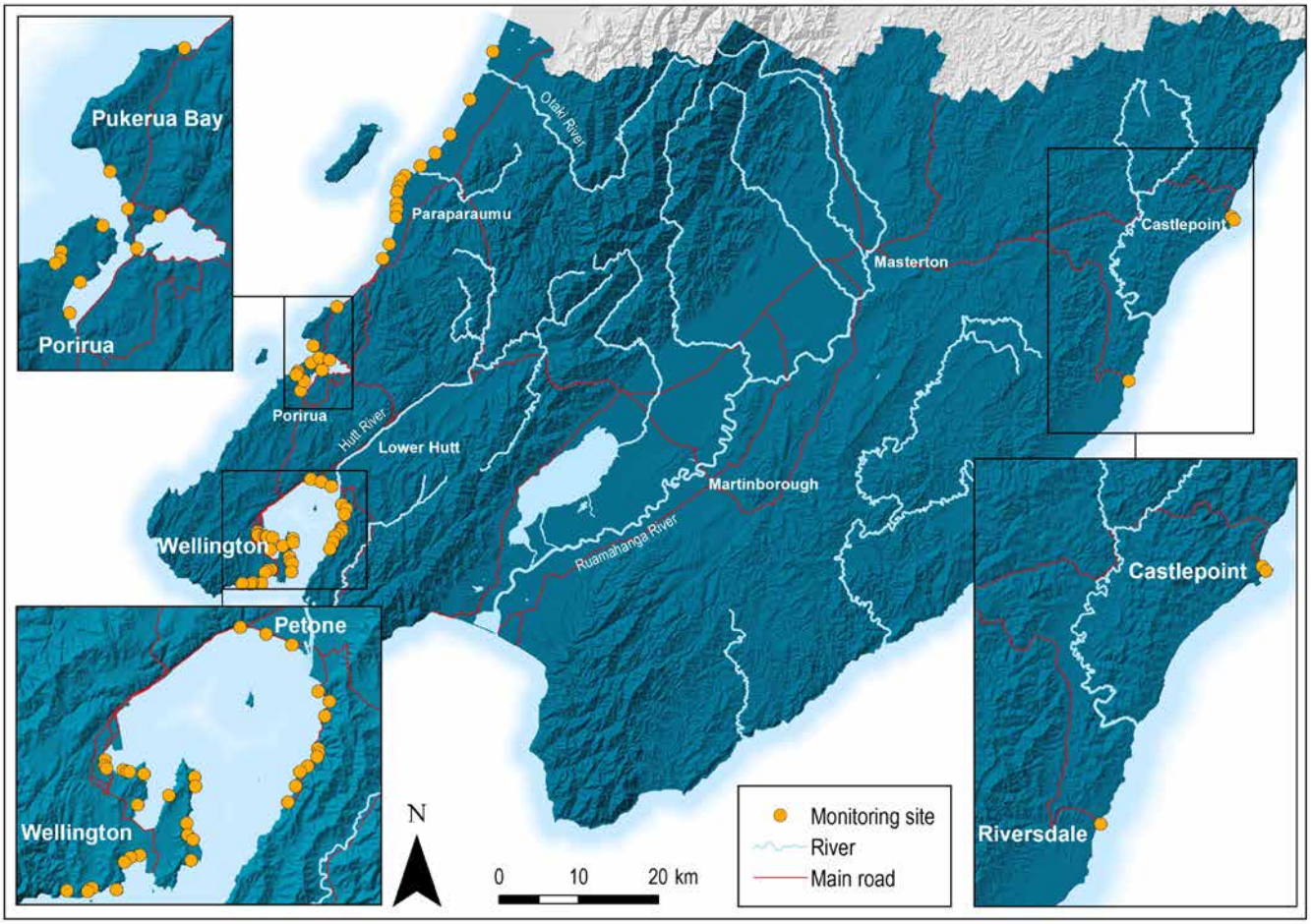


Figure 4.1: Coastal recreation sites monitored over the 2016/17 summer

10 Onehunga Bay was not monitored in 2016/17 but is included in the SFRG summary based on data collected in 2009/10, 2010/11 and 2015/16. Low land use intensity and consistently good water quality at this site means monitoring is only conducted once every five years to ensure no degradation in water quality has occurred (Greenfield et al. (2012b).

4.1.2 Winter recreation period

Recreational water quality was monitored fortnightly outside of the summer recreation period, from 1 July to 30 November 2016 and 1 April to 30 June 2017; for the purposes of this report this will be referred to as the 'winter' recreation period. A subset of eleven coastal sites from the 63 summer sites were monitored (Appendix 1), as follows:

- Kapiti Coast District – 2 sites
- Porirua City – 3 sites
- Hutt City – 2 sites
- Wellington City – 4 sites

This monitoring data was previously reported as part of the Coastal Water Quality and Ecology Programme. However, monitoring of coastal waters for recreational purposes was deemed necessary beyond the peak summer bathing times, as these coastal sites are used year-round for a variety of contact recreational purposes.

4.2 Monitoring protocol

For the summer recreation period, sites were sampled weekly for 17 weeks between 1 December 2016 and 31 March 2017.

For the winter recreation period, sites were sampled fortnightly from 1 July to 30 November 2016 and 1 April to 30 June 2017.

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).

Daily rainfall records were obtained from the rain gauge nearest to each bathing site to give an indication of rainfall in the catchment adjoining each site (see Appendix 1).

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

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 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. 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 when 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 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, due to bad weather). Therefore, to ensure that recreational water quality is assessed on an equal basis across all 63 coastal sites, the approach taken by GWRC is to treat any single result greater than 280 enterococci/100mL obtained from routine weekly/ fortnightly 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 sampling by summing up the rainfall for each 24 hour period.

All 95th percentiles associated with the MAC category of the SFGR were calculated using the Hazen method as recommended in the MfE/MoH (2003) guidelines. For the winter recreation data, slightly longer data collection periods were used rather than deferring to the three year MAC calculations; data from 2011/12 to 2016/17 were needed to reach at least 60 data points per site for statistical robustness

4.5 Results

4.5.1 Compliance with trigger values

Over the 2016/17 summer recreation period, 27 of the 64 coastal sites (42%) exceeded the MfE/MoH (2003) action guideline during routine monitoring. More than half of those sites (17) exceeded the guideline only once, while 10 sites had multiple exceedances (Table 4.3, Appendix 3).

Table 4.3: Summary of action guideline breaches from routine weekly monitoring at 64 coastal sites over the 2016/17 summer recreation period

No. of times site breached the action guideline	No. of sites					Total no. of sites (64)	% of sites
	Kapiti (14 sites)	Porirua (11 sites)[1]	Wellington (23 sites)	Hutt (13 sites)	Wairarapa (3 sites)		
0	13	7	14	0	3	37	57.8
1	1	2	5	9	0	17	26.6
2	0	0	3	3	0	6	9.4
3	0	0	0	1	0	1	1.6
4	0	1	1	0	0	2	3.1
5	0	1	0	0	0	1	1.6

[1] Excludes Onehunga Bay

A total of 45 out of 1,086 (4.1%) routine sample results exceeded the MfE/MoH (2003) action guideline of 280 cfu/100mL (Table 4.4). This was more than in the 2015/16 bathing season (1.9%) but similar to other past seasons; 3.5%, 5.8% and 7.6% of samples exceeded the action guideline in 2014/15, 2013/14 and 2012/13, respectively (Keenan et al. 2015, Morar & Greenfield 2014, Morar & Greenfield 2013). Rainfall in the Wellington region was near normal for the 2016/17 summer, compared to a dryer than normal summer in 2015/16 (NIWA 2016, 2017).The wetter weather conditions in the 2016/17 summer are likely to be the main driver of the increased number of action guideline breaches from last year.

Table 4.4: Summary of action guideline breaches (>280 enterococci/100mL) during routine monitoring at coastal sites over the 2016/17 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	Enterococci count (cfu/100mL)	Rainfall (mm)				follow-up samples required
			Rainfall Station[1]	Up to 24hrs before sampling	48–25hrs before sampling	72–49hrs before sampling	
Kapiti							
20/2/2017	Paraparaumu Beach at Maclean Pk	320	Waikanae WTP	16.5	0.5	9.5	1
Porirua							
28/12/2016	Porirua Harbour at Rowing Club	340	Seton Nossitor	0	0.0	0.0	1
4/1/2017	Porirua Harbour at Rowing Club	660	Seton Nossitor	7.8	0.2	6.8	1
24/1/2017	Wi Neera Drive Boat Ramp	940	Seton Nossitor	1	32.0	9.6	1
31/1/2017	Wi Neera Drive Boat Ramp	550	Seton Nossitor	0	0.0	0.0	2
14/2/2017	Wi Neera Drive Boat Ramp	400	Tawa Pool	2	2.2	0.0	2
28/2/2017	Porirua Harbour at Rowing Club	290	Seton Nossitor	0	0.0	0.0	1
14/3/2017	Wi Neera Drive Boat Ramp	400	Seton Nossitor	2.6	21.6	47.8	2
21/3/2017	Titahi Bay at South Beach Access Rd	360	Whenua Tapu	0	0.0	0.0	1
	Porirua Harbour at Rowing Club	290	Seton Nossitor	0	0.0	0.0	1
28/3/2017	Porirua Harbour at Rowing Club	360	Seton Nossitor	6.2	1.0	5.0	1
	Plimmerton Beach at Bath St	300	Whenua Tapu	0	0.5	3.0	1
Wellington City							
2/1/2017	Seatoun Beach at Wharf	530	Miramar N. Rd	15.5	0.5	0.0	2
	Seatoun Beach at Inglis St	310	Miramar B. Club	30.5	4.5	0.0	1
2/1/2017	Island Bay at Reef St Recreation G.	440	Berhampore N.	30.5	4.5	0.0	1
	Island Bay at Derwent St	440		30.5	4.5	0.0	1
23/1/2017	Balaena Bay	360	Old Hataitai PO	30	4.5	0.0	1
	Island Bay at Reef St Recreation G.	420	Berhampore N.	29.5	4.5	0.0	1
	Island Bay at Derwent St	310		29.5	4.5	0.0	1
	Owhiro Bay	400		29	4.5	0.0	1
6/2/2017	Aotea Lagoon	380	Te Papa	28.5	4.5	0.0	1
13/2/2017	Taranaki St Dive Platform	450	Te Papa	28.5	4.5	0.0	1
	Aotea Lagoon	430		0	0.0	0.0	1
20/2/2017	Oriental Bay at Freyberg Beach	300	Te Papa	2	0.0	0.0	1
	Aotea Lagoon	420		8	1.0	11.0	1
	Taranaki St Dive Platform	390		8	1.0	11.0	1
20/3/2017	Aotea Lagoon	320	Te Papa	8	1.0	11.0	1

Date	Site Name	Enterococci count (cfu/100mL)	Rainfall (mm)				follow-up samples required
			Rainfall Station[1]	Up to 24hrs before sampling	48–25hrs before sampling	72–49hrs before sampling	
Hutt							
2/1/2017	Rona Bay at N end of Cliff Bishop Pk	530	Shandon	15.5	0.5	0.0	2
23/1/2017	Robinson Bay at Nikau St	310	Shandon	30.5	4.5	0.0	1
	Robinson Bay at HW Shortt Rec G.	440		30.5	4.5	0.0	1
	Rona Bay at Wharf	440		30.5	4.5	0.0	1
	Rona Bay at N end of Cliff Bishop Pk	360		30	4.5	0.0	1
	Days Bay at Moana Rd	420		29.5	4.5	0.0	1
	Days Bay at Wharf	310		29.5	4.5	0.0	1
	Days Bay at Wellesley College	400		29	4.5	0.0	1
	York Bay	380		28.5	4.5	0.0	1
	Sorrento Bay	450		28.5	4.5	0.0	1
6/2/2017	York Bay	430	Shandon	0	0.0	0.0	1
13/2/2017	Days Bay at Wellesley College	300	Shandon	2	0.0	0.0	1
20/2/2017	Sorrento Bay	420	Shandon	8	1.0	11.0	1
	Lowry Bay at Cheviot Rd	390		8	1.0	11.0	1
	Rona Bay at N end of Cliff Bishop Pk	320		8	1.0	11.0	1
13/3/2017	Petone Beach at Water Ski Club	600	Shandon	6.5	68.0	16.0	3
	Petone Beach at Sydney St	510		6.5	68.5	16.0	3
	Petone Beach at Kiosk	450		6.5	68.0	16.5	3

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

Sixty two percent (28) of the 45 action exceedance events were associated with significant rainfall (defined as at least 5 mm of rainfall in the 24 hours prior to sampling or at least 10 mm in the three days prior) (Table 4.4). This is more than double the number of rainfall-associated exceedances that occurred in the 2015/16 bathing season (33%; Morar and Greenfield 2016) – highlighting the impact of the wet conditions this season. Elevated enterococci counts in coastal waters during or shortly after rainfall events are common in many parts of the region due to the influence of urban stormwater (including sewer overflows), diffuse-source runoff into rivers and streams, and re-suspension of bottom sediments (Greenfield et al. 2012a; DHI 2016, 2017).

Seventeen action guideline breaches occurred following little or no rainfall prior to sampling – these are regarded as dry weather exceedances. The greatest number of dry weather action guideline breaches occurred at Porirua Harbour at Rowing Club (three occasions), Porirua Harbour at Wi Neera Drive Boat Ramp and Aotea Lagoon (two occasions each). Results of follow up sampling at the Rowing Club and Aotea Lagoon were well within the surveillance guidelines. However, two follow up samples were needed at Wi Neera Drive Boat Ramp before surveillance guidelines were met again. In the Onepoto arm of the Porirua Harbour, significant sources of contaminants contributing to poor water quality have been identified (DHI 2016, 2017); these include the Onepoto Stream, Takapuwhahia Stream, Kenepuru Stream and Porirua Stream. Wind driven currents coupled with potential sediment resuspension mean that some sites, such as the Rowing Club and Wi Neera Drive Boat Ramp, in the harbour can be susceptible to poor water quality in the absence of rain.

In the Wellington CBD area, routine stormwater consent monitoring of the Te Aro St culvert in early March 2017 identified an issue with untreated sewage discharging into the stormwater culvert. This culvert discharges stormwater to coastal waters in the vicinity of the Taranaki St Dive Platform and resulted in contamination outside of the routine weekly monitoring times – thus was not captured in this reports dataset. In accordance with WCC's stormwater discharge consent, ongoing monitoring of coastal waters both within and outside the Taranaki St Dive Platform area was undertaken by Wellington Water, in consultation with GWRC, WCC and RPH. Initial monitoring indicated high concentrations of faecal indicator bacteria in excess of guideline levels.

Warning signs were erected at the Wellington Harbour at Taranaki St Dive Platform site, and ongoing culvert sanitary inspections were conducted whilst infrastructure repair works were undertaken. In addition, some damage to the skirting (a barrier that directs stormwater

outflow away from dive platform) was identified. Following the return to ambient concentrations in the coastal waters the warning signs were removed.

Across all weather conditions, Porirua Harbour at Rowing Club, Porirua Harbour at Wi Neera Drive Boat Ramp and Aotea Lagoon recorded the lowest level of compliance with the surveillance guideline of all coastal sites monitored during the 2016/17 bathing season, each with four exceedances in total (see Appendix 3B).

Over the winter recreation period, two of the 11 coastal sites (18%) exceeded the MfE/MoH (2003) action guideline during routine monitoring. Both sites exceeded the guideline on three occasions each (Table 4.5).

Table 4.5: Summary of action guideline breaches from routine fortnightly monitoring at 11 coastal sites outside of the 2016/17 summer recreation period

No. of times site breached the action guideline	No. of sites				Total no. of sites (64)	% of sites
	Kapiti (2 sites)	Porirua (3 sites)	Wellington (2 sites)	Hutt (4 sites)		
0	2	3	2	4	11	82%
3	0	2	0	0	2	18%

A total of six out of 198 routine sample results (3%) exceeded the MfE/MoH (2003) action guideline of 280 cfu/100mL (Table 4.6). Only two of the exceedances were associated with significant rainfall (defined as at least 5 mm of rainfall in the 24 hours prior to sampling or at least 10 mm in the three days prior), while the remaining four exceedances occurred following little or no rainfall prior to sampling.

Most guideline breaches required only one follow up sample before faecal indicators returned to surveillance levels. On one occasion, the South beach at Plimmerton site was re-sampled four times before the site returned to surveillance levels. The South Beach at Plimmerton site historically is susceptible to poor water quality, possibly due to the influence of the Taupo Stream (DHI 2016, 2017). The reasons for poor water quality in the Taupo Stream are yet to be resolved.

Table 4.6: Summary of action guideline breaches (>280 enterococci/100mL) during routine monitoring at coastal sites over the 2016/17 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	Enterococci count (cfu/100mL)	Rainfall (mm)				follow-up samples required
			Rainfall Station[1]	Up to 24hrs before sampling	48–25hrs before sampling	72–49hrs before sampling	
Porirua							
5/7/2016	Porirua Harbour at Rowing Club	1,400	Tawa Pool	0	0.0	0.0	1
	South Beach at Plimmerton	1,700	Whenua Tapu	0	0.0	0.0	1
19/7/2016	South Beach at Plimmerton	4,700	Whenua Tapu	0	1.5	0.0	1
16/8/2016	Porirua Harbour at Rowing Club	780	Tawa Pool	0.6	0.0	13.4	1
8/11/2016	Porirua Harbour at Rowing Club	470	Tawa Pool	30.2	1.2	2.2	1
18/4/2017	South Beach at Plimmerton	520	Whenua Tapu	0	2.5	0.0	4

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

All exceedances alerts were posted on the 'Is it Safe to Swim' website and interactive map: *http://mapping.gw.govt.nz/GW/RecWaterQualityMap/RecWaterQualityMap.htm*.

4.5.2 Suitability for recreation grades

Updated SFRGs (as at the end of the 2016/17 summer recreation period), for 64 summer coastal recreational water quality monitoring sites in the Wellington region, range from 'very good' to 'fair' (Figure 4.2, Appendix 3)[11]. In total, 38 monitoring sites (59%) now have SFRGs of 'good' or better, 25 monitoring sites (39%) have SFRGs of 'fair'. Two sites, Porirua Harbour at Wi Neera Drive Boat Ramp and Wellington City Waterfront at Shed 6, had insufficient data to be graded. There were no sites graded 'poor' or 'very poor' this bathing season.

[11] Onehunga Bay is assigned a SFRG even though it was not monitored in 2016/17, as explained in Section 4.1.

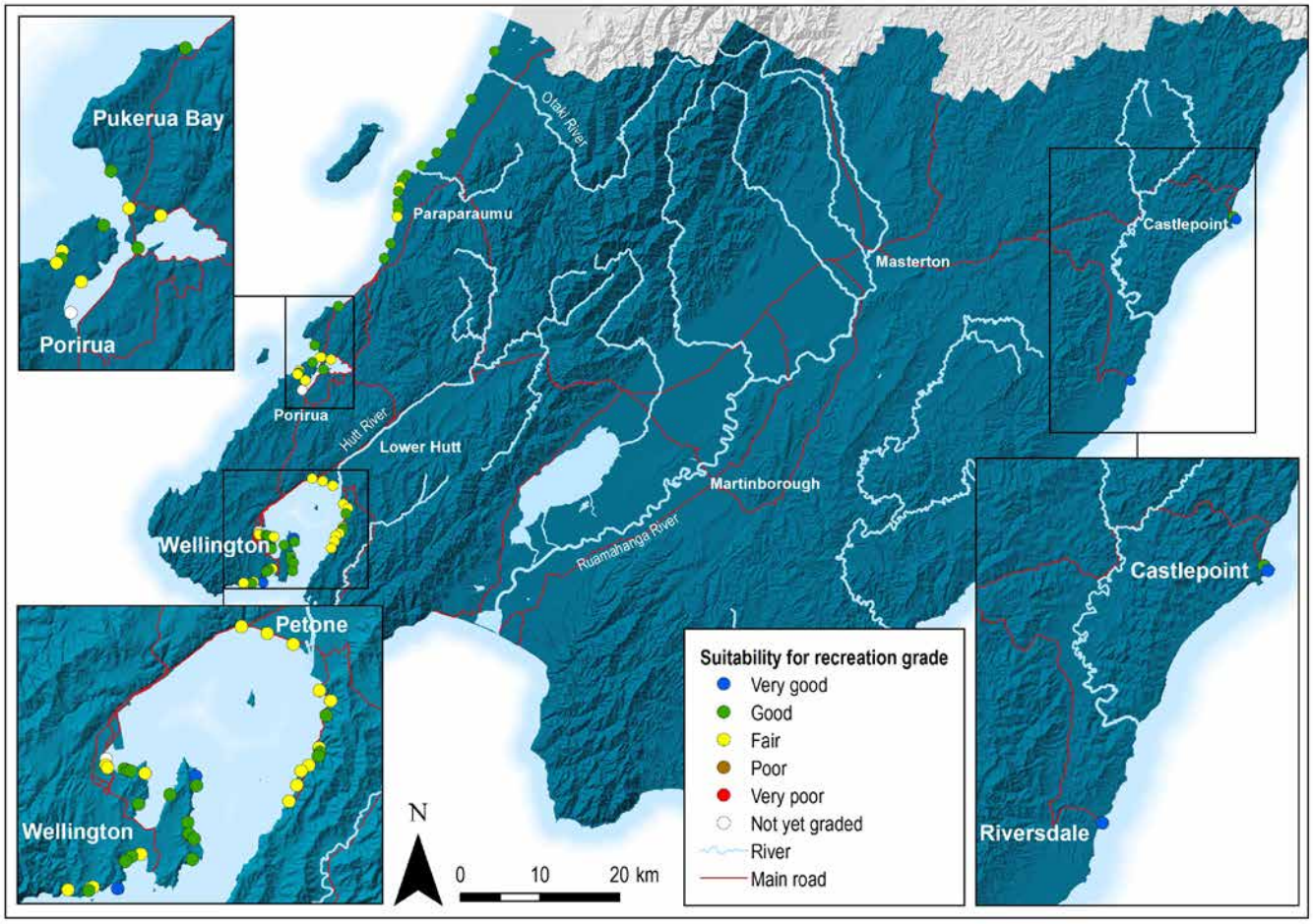


Figure 4.2: Suitability for Recreation Grades (SFRGs) for coastal recreational water quality monitoring sites in the Wellington region as at the end of the 2016/17 bathing season

SFRGs improved from the previous bathing season at 21 sites (33%), while grades dropped at only five sites (Appendix 3, see also Morar and Greenfield 2016). These five sites were Aotea Lagoon, Balena Bay, Days Bay at Wellesley College, Robinson Bay at HW Short Rec Ground and Robinson Bay at Nikau Street. The drop in grade for Aotea Lagoon from 'good' to 'fair' is due to the high number of exceedances experienced at this site, which increased the MAC 95th percentile value from 98 cfu/100mL in 2015/16 to 351 cfu/100mL in 2016/17 (see Morar and Greenfield 2016 and Appendix 3 B).

Two of the three sites that dropped in grade during the 2015/16 bathing season (Plimmerton Beach at Bath Street, Breaker Bay and Lyall Bay at Queens Drive) saw improvements this season. There were no alert or action exceedances for Lyall Bay at Queens Drive this year and, subsequently, the SFRG has improved to 'good' again. Breaker Bay also had no alert or action exceedances this season but remained on 'good'. Plimmerton Beach at Bath Street did have 3 exceedances, one at action level, but still improved its SFRG back to 'fair', most likely an artefact of the change from five to three year MAC calculations (95th percentiles were 530 and 433 cfu/100mL for 2015/16 and 2016/17, respectively).

SFRGs determined for the 11 winter coastal recreational water quality sites, monitored outside of the summer recreation season, ranged from 'good' to 'poor'. (Figure 4.3, Appendix 3C). The three sites graded 'poor' were Porirua Harbour at Rowing Club, South Beach at Plimmerton and Robinson Bay at Nikau Street. This is the first time that winter MAC and SFRGs have been calculated using data outside of the summer recreation period. Compared to the summer weekly monitoring data (see Appendix 3B), four sites had lower SFRGs outside of the summer recreation period (South Beach at Plimmerton, Porirua Harbour at Rowing Club, Titahi Bay at Toms Road, Robinson Bay at Nikau Street), while one site had a better SFRG (Lyall Bay at Tirangi Road). It should be noted that different time frames were used for the seasonal data sets; the winter data set included data from 2011/12 to 2016/17 in order to reach at least 60 data points per site for statistical robustness, whereas summer SFRGs used the last three years only.

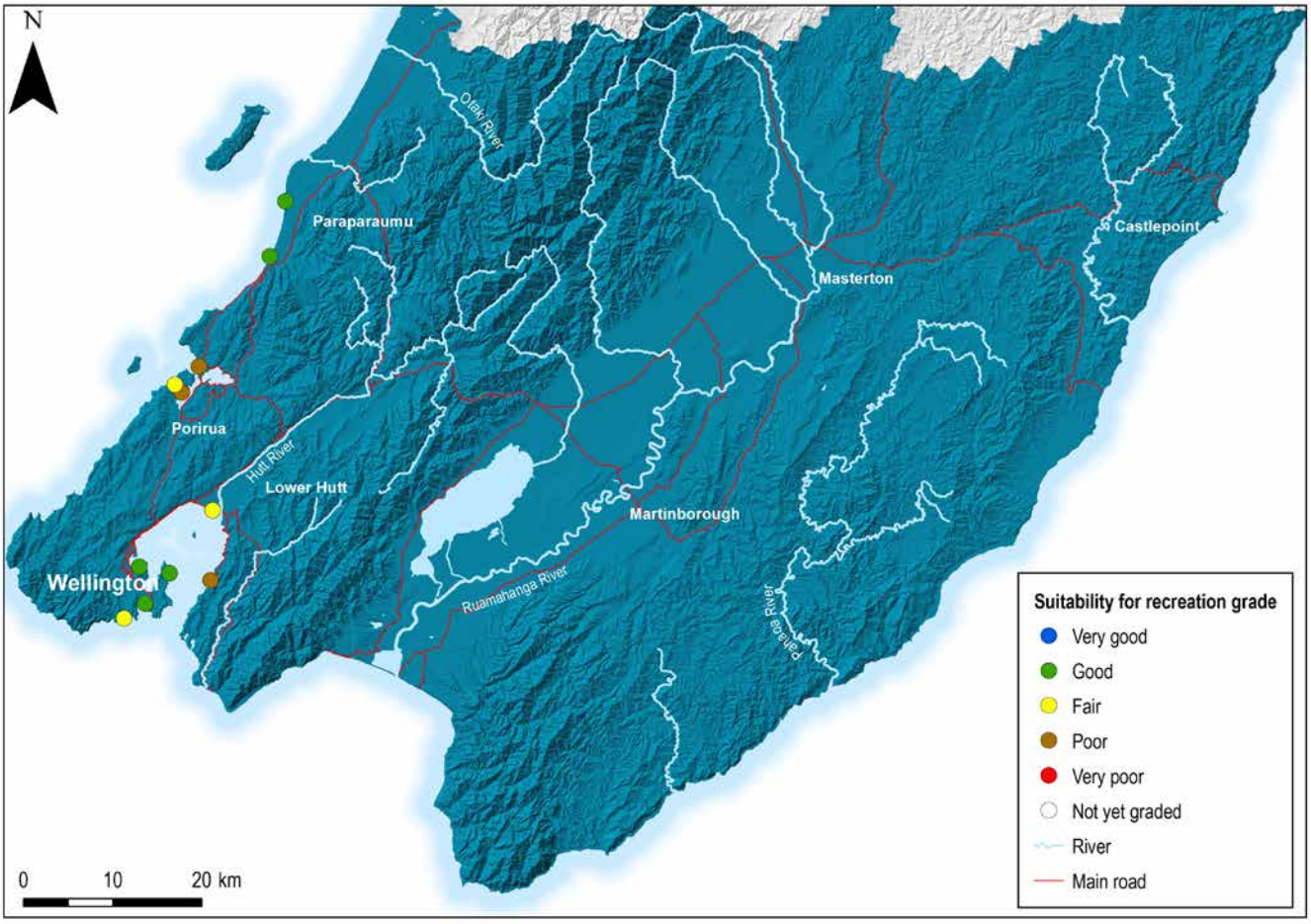


Figure 4.3: Suitability for Recreation Grades (SFRGs) for winter coastal recreational water quality sites in the Wellington region, monitored between 1 July to 30 November 2016 and 1 April to 30 June 2017

4.6 Summary

Twenty one of the 64 coastal sites (42%) monitored weekly during the 2016/17 summer recreation period exceeded the MfE/MoH (2003) action guideline for microbiological water quality on at least one occasion. Sites that most frequently exceeded the action guideline were Porirua Harbour at Rowing Club, Porirua Harbour at Wi Neera Drive and Aotea Lagoon. Each of these sites had at least two exceedances that were not associated with significant rainfall prior to sampling and therefore considered 'dry' exceedances. For Aotea Lagoon, the cause(s) of these dry exceedances are unknown. Regarding the two Porirua Harbour sites, these are susceptible to poor water quality due to their proximity to stream inflows, the influence of wind-driven currents and possible sediment re-suspension.

As of the end of the 2016/17 bathing season, 59% of coastal monitoring sites have SFRGs of 'good' or better and 39% of sites are graded 'fair'. The remaining 1% had insufficient data to be graded. No sites were graded 'poor' this bathing season.

All winter recreation period exceedances occurred at two of the eleven sites monitored (South Beach at Plimmerton and Porirua Harbour at Rowing Club). Four out of six exceedances were not associated with rainfall and are considered dry exceedances. Both sites are known to be susceptible to poor water quality, although the source(s) of contamination around South Beach at Plimmerton have not been identified. In general, SFRGs were lower during the winter than the summer recreation period.

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 2016/17 (Figure 5.1, Appendix 1), as follows:

- Kapiti Coast District – 3 sites
- Porirua City – 1 site[12]
- Hutt City – 1 site
- Wellington City – 2 sites

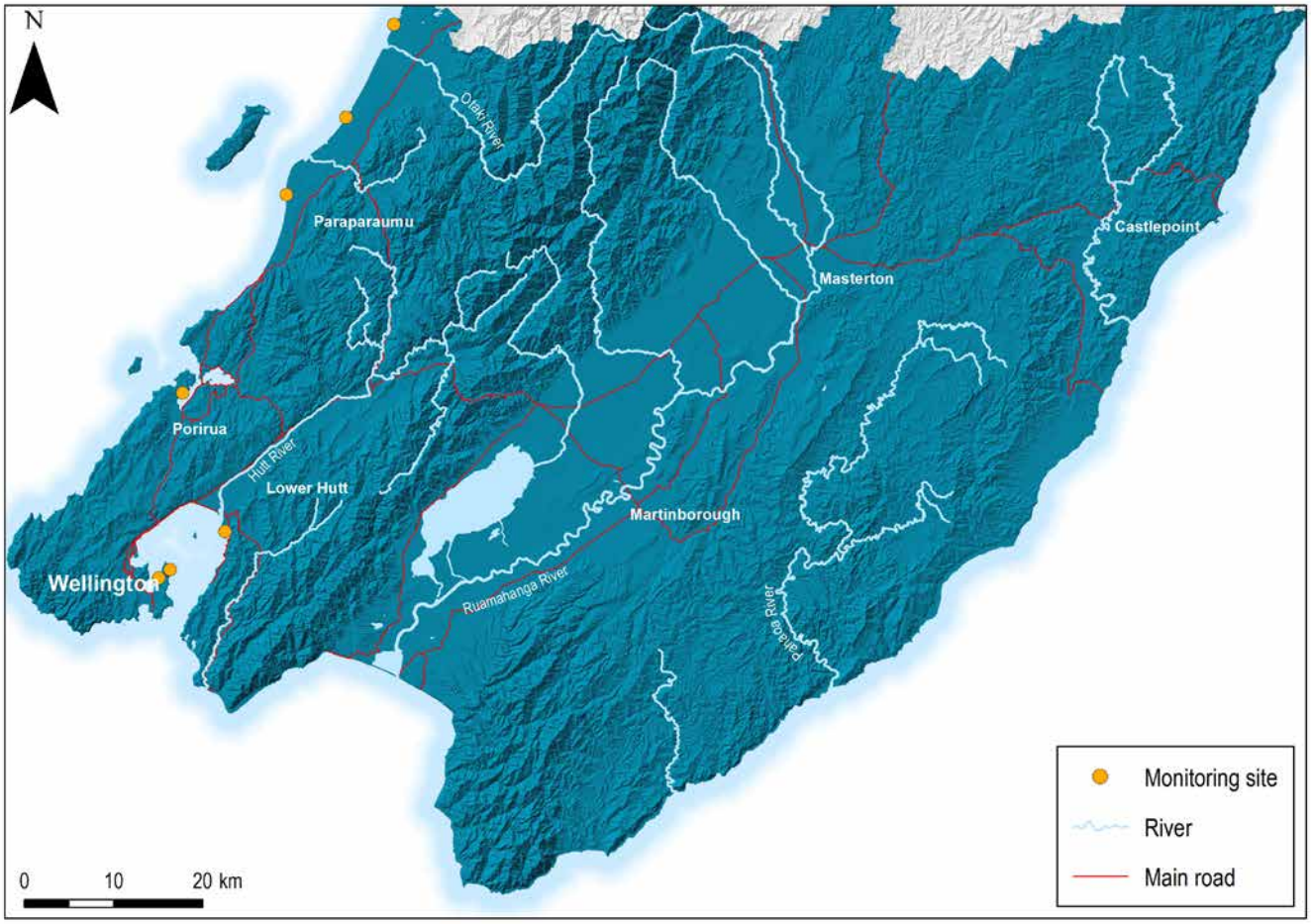


Figure 5.1: Recreational shellfish gathering water quality monitoring sites, 2016/17

5.2 Monitoring protocol

Sites were sampled weekly for 17 weeks between 1 December 2016 and 31 March 2017 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.

[12] This site, introduced in July 2007, is not recommended for shellfish gathering but is monitored in response to community interest.

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

5.3.1 Cautionary note

The MfE/MoH (2003) guidelines only address microbiological contamination. They do not address marine biotoxins, metals, or harmful organic contaminants which in certain places and locations can pose a significant risk to people gathering shellfish. In addition the guidelines often don't accurately represent the risk of contact with viruses. 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. Monitoring was last 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 recreation period (ie, 1 December 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).

5.5 Results

All seven sites breached one or both of the guideline criteria during the 2016/17 season (Table 5). This result differs from the 2015/16 season (Morar and Greenfield 2016) when two sites, Shark Bay and Mahanga Bay, were fully compliant with the guidelines. These two sites still had the lowest median and maximum faecal coliform counts compared to the other five sites for the 2016/17 season and only breached guideline levels on three occasions (18% of samples). Porirua Harbour at Rowing Club and Otaki Beach at Surf Club had the highest faecal coliform counts and breached the guidelines on eleven and six occasions, respectively.

Table 5.1: Analysis of faecal coliform counts obtained from routine weekly monitoring during the 2016/17 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 at Surf Club	**30**	545	6 **(35%)**	17
Peka Peka Beach at Road End	**25**	210	6 **(35%)**	17
Raumati Beach at Tainui St	**70**	225	10 **(59%)**	17
Porirua				
Porirua Harbour at Rowing Club	**56**	660	11 **(65%)**	17
Wellington City				
Shark Bay	4	190	3 **(18%)**	17
Mahanga Bay	8	200	3 **(18%)**	17
Hutt				
Sorrento Bay	**36**	300	8 **(47%)**	17

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Appendix 1: Monitoring sites

			NZTM coordinates		
Area	**Site type**	**Site name**	**Easting**	**Northing**	**Rainfall Gauge**
Kapiti	Freshwater	Otaki River at Pots[1]	1785444	5478749	Waitatapia Stream at Taungata
		Otaki River at SH1	1781309	5484406	Waitatapia Stream at Taungata
		Waikanae River at SH1	1773752	5472296	Waikanae River at WTP
		Waikanae River at Jim Cooke Park	1772155	5472377	Waikanae River at WTP
	Coastal	Otaki Beach at Surf Club[2]	1778622	5488330	Otaki River at Depot
		Te Horo Beach at Sea Road	1775692	5482324	Otaki River at Depot
		Peka Peka Beach at Road End[2]	1773215	5477905	Waikanae River at WTP
		Waikanae Beach at William Street	1771388	5475584	Waikanae River at WTP
		Waikanae Beach at Ara Kuaka Carpark	1769514	5473978	Waikanae River at WTP
		Paraparaumu Beach at Ngapotiki Street	1767543	5472762	Whareroa Stream at McKays Crossing
		Paraparaumu Beach at Nathan Avenue	1767033	5472174	Met Station at Paraparaumu EWS[3]
		Paraparaumu Beach at Maclean Park	1766694	5471267	Waikanae River at WTP
		Paraparaumu Beach at Toru Road	1766577	5470715	Waikanae River at WTP
		Raumati Beach at Tainui Street	1766531	5469229	Met Station at Paraparaumu EWS[3]
		Raumati Beach at Marine Gardens	1766516	5468441	Met Station at Paraparaumu EWS[3]
		Raumati Beach at Aotea Road	1766414	5467529	Met Station at Paraparaumu EWS[3]
		Paekakariki Beach at Whareroa Road	1765598	5464128	Met Station at Paraparaumu EWS[3]
		Paekakariki Beach at Surf Club	1764791	5462273	Met Station at Paraparaumu EWS[3]
Porirua	Coastal	Pukerua Bay	1759058	5456278	Taupo Stream at Whenua Tapu
		Karehana Bay at Cluny Road	1756093	5451360	Taupo Stream at Whenua Tapu
		Plimmerton Beach at Bath Street	1756706	5450316	Taupo Stream at Whenua Tapu
		South Beach at Plimmerton	1756810	5449874	Taupo Stream at Whenua Tapu
		Pauatahanui Inlet at Water Ski Club	1758074	5449593	Taupo Stream at Whenua Tapu
		Pauatahanui Inlet at Paremata Bridge	1757153	5448284	Porirua Stream at Tawa Pool
		Porirua Harbour at Rowing Club[2]	1754891	5446947	Porirua Stream at Tawa Pool
		Porirua Harbour at Wi Neera Drive Boat Ramp	1754485	5445706	Porirua Stream at Tawa Pool
		Titahi Bay at Bay Drive	1754132	5448169	Taupo Stream at Whenua Tapu
		Titahi Bay at Toms Road	1754110	5447857	Taupo Stream at Whenua Tapu
		Titahi Bay at South Beach Access Road	1753906	5447682	Taupo Stream at Whenua Tapu
		Onehunga Bay	1755796	5449181	Taupo Stream at Whenua Tapu

			NZTM coordinates		
Area	**Site type**	**Site name**	**Easting**	**Northing**	**Rainfall Gauge**
		Wellington City Waterfront at Shed 6	1749016	5427971	Wellington at Te Papa
		Aotea Lagoon	1748985	5427683	Wellington at Te Papa
		Wellington Harbour at Taranaki St Dive Platform	1749092	5427538	Wellington at Te Papa
		Oriental Bay at Freyberg Beach	1749920	5427464	Wellington at Te Papa
		Oriental Bay at Wishing Well	1750118	5427386	Wellington at Regional Council Centre
		Oriental Bay at Band Rotunda	1750243	5427375	Wellington at Regional Council Centre
		Balaena Bay	1750958	5427267	Hataitai at Old Post Office
		Hataitai Beach	1750632	5425730	Met Station at Wgtn Aero AWS[3]
		Shark Bay[2]	1752211	5426197	Wellington at Te Papa
		Mahanga Bay[2]	1753468	5427115	Miramar at Miramar North Road
		Scorching Bay	1753517	5426647	Met Station at Wgtn Aero AWS[3]
		Worser Bay	1753074	5424823	Met Station at Wgtn Aero AWS[3]
		Seatoun Beach at Wharf	1753129	5424234	Miramar at Miramar North Road
		Seatoun Beach at Inglis Street	1753405	5423994	Miramar at Miramar Bowling Club
		Breaker Bay	1753312	5422970	Met Station at Wgtn Aero AWS[3]
		Lyall Bay at Tirangi Road	1750747	5423230	Met Station at Wgtn Aero AWS[3]
		Lyall Bay at Onepu Road	1750286	5423116	Met Station at Wgtn Aero AWS[3]
		Lyall Bay at Queens Drive	1749990	5422868	Miramar at Miramar North Road
		Princess Bay	1749586	5421504	Met Station at Wgtn Aero AWS[3]
		Island Bay at Reef Street Recreation Grd	1748229	5421542	Berhampore at Nursery
		Island Bay at Surf Club	1748377	5421590	Berhampore at Nursery
		Island Bay at Derwent Street	1748155	5421415	Berhampore at Nursery
		Owhiro Bay	1747122	5421463	Berhampore at Nursery
Hutt	**Freshwater**	Pakuratahi River at Forks	1784288	5452620	Pakuratahi River at Centre Ridge
		Akatarawa River at Hutt Confluence	1776183	5449184	Akatarawa River at Cemetery
		Hutt River at Birchville	1776196	5449091	Hutt River at Te Marua
		Hutt River at Maoribank Corner	1775882	5446696	Hutt River at Te Marua
		Hutt River at Poets Park	1771461	5446092	Hutt River at Te Marua
		Hutt River at Silverstream Bridge	1767598	5443172	Hutt River at Te Marua
		Hutt River at Melling Bridge	1759906	5436831	Hutt River at Birch Lane
		Wainuiomata River at Richard Prouse Park	1764536	5429141	Wainuiomata River at Wainui Reservoir
	Coastal	Petone Beach at Water Ski Club	1755744	5434591	Hutt River at Shandon Golf Club
		Petone Beach at Sydney Street	1757045	5434248	Hutt River at Shandon Golf Club
		Petone Beach at Kiosk	1758326	5433711	Hutt River at Shandon Golf Club
		Sorrento Bay2	1759632	5431384	Hutt River at Shandon Golf Club
		Lowry Bay at Cheviot Road	1760206	5430891	Hutt River at Shandon Golf Club
		York Bay	1759977	5430160	Hutt River at Shandon Golf Club
		Days Bay at Wellesley College	1759616	5428529	Hutt River at Shandon Golf Club
		Days Bay at Wharf	1759654	5428313	Hutt River at Shandon Golf Club
		Days Bay at Moana Road	1759582	5428120	Hutt River at Shandon Golf Club
		Rona Bay at Northern end of Cliff Bishop Park	1759109	5427654	Hutt River at Shandon Golf Club
		Rona Bay at Wharf	1758730	5427371	Hutt River at Shandon Golf Club
		Robinson Bay at HW Shortt Recreation Ground	1758519	5426674	Hutt River at Shandon Golf Club
		Robinson Bay at Nikau Street	1758131	5425856	Hutt River at Shandon Golf Club

			NZTM coordinates		
Area	Site type	Site name	Easting	Northing	Rainfall Gauge
	Freshwater	Ruamahanga River at Double Bridges	1824350	5471775	Ruamahanga River at Mt Bruce
		Ruamahanga River at Te Ore Ore	1825529	5462917	Ruamahanga River at Mt Bruce
Wairarapa		Waipoua River at Colombo Road	1824996	5462889	Waipoua at Westons
		Waingawa River at Kaituna	1810326	5471149	Waingawa River at Angle Knob
		Waingawa River at South Road	1820550	5460878	Waingawa River at Angle Knob
		Ruamahanga River at The Cliffs	1821476	5452180	Waingawa River at Angle Knob
		Ruamahanga River at Kokotau	1815756	5447191	Waingawa River at Angle Knob
		Waiohine River at Gorge[1]	1801853	5455936	Waiohine River at Gorge
		Waiohine River at SH2	1809665	5451711	Waiohine River at Gorge
		Ruamahanga River at Morrisons Bush	1808918	5441108	Waiohine River at Gorge
		Ruamahanga River at Waihenga	1804610	5436461	Waingawa River at Angle Knob
		Tauherinikau River at Bucks Road			Tauherenikau at Bull Mound
		Tauherenikau River at Websters[1]	1797082	5439942	Tauherenikau at Bull Mound
		Riversdale Lagoon	1858304	5447128	Pahaoa at Ngaumu
	Coastal	Castlepoint Beach at Castlepoint Stream	1871366	5467559	Met Station at Castlepoint AWS[3]
		Castlepoint Beach at Smelly Creek	1871670	5467202	Met Station at Castlepoint AWS[3]
		Riversdale Beach Between the Flags	1858435	5446948	Met Station at Castlepoint AWS[3]

[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.
[3] NIWA rainfall stations

Appendix 2: Laboratory and field methods

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

Methods and detection limits

Determinant	Method	Detection limit
Escherichia coli at 44.5°C	APHA Standard Methods (22nd 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 (22nd 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%
Rubbish amount	Visual qualitative assessment of rubbish present either in the water or on the banks. This includes household/ municipal, rural (e.g., dead stock) & industrial rubbish/ waste.	–

Appendix 3: Suitability for recreation grades

Microbiological water quality data for the 2016/17 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 2014/15–2016/17 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 2015/16 bathing season (as presented in Morar and Greenfield 2016).

(A) Fresh waters

Bathing site	No. sample results (*E. coli*/100 mL)				River grading (2014/15 – 2016/17 data)					
					All flows			Dry flows		
	n	Surveillance (≤ 260)	Alert (261–550)	Action (>550)	SIC Grade	MAC Grade (95th %ile value)	2016/17 SFRG	SIC Grade	MAC Grade (95th %ile value)	2016/17 SFRG
Kapiti										
Otaki - Pots[1]	4	4	0	0	Low	A (79)[2]	Very good	Very low	A (42)[2]	Very good
Otaki - SH1	17	16	0	1	Moderate	C (315)	Fair ↓	Low	B (247)	Good
Waikanae - SH1	17	16	1	0	Moderate	C (365)	Fair	Low	C (408)	Fair ↓
Waikanae - JC Pk	17	16	1	0	Moderate	C (379)	Fair	Low	C (440)	Fair ↓
Hutt & Wainuiomata										
Pakuratahi - Hutt Forks	17	16	0	1	Moderate	B (199)	Good	Low	B (206)	Good
Akatarawa - Hutt Confl.	17	15	1	1	Moderate	C (508)[3]	Fair ↑	Low	C (340)3	Fair
Hutt - Birchville	17	16	0	1	Moderate	A (122)	Good[4]	Moderate	A (109)	Good4
Hutt - Maoribank Cr	17	16	0	1	Moderate	A (123)	Good[4]	Low	A (87)	Very good ↑
Hutt - Poets Pk	17	16	0	1	Low	A (117)	Very good ↑	Low	A (79)	Very good
Hutt - Silverstream Br.	17	16	0	1	Moderate	B (164)	Good ↑	Moderate	B (146)	Good
Hutt - Melling Br.	17	15	1	1	Moderate	D (704)	Poor	Moderate	D (572)	Poor
Wainuiomata - RP Pk	17	14	2	1	Moderate	D (966)	Poor	Moderate	D (988)	Poor
Wairarapa										
Ruamahanga - Double Br.	17	16	1	0	Moderate	B (158)	Good	Moderate	A (119)	Good[4]
Ruamahanga - Te Ore Ore	17	13	0	4	High	D (960)	Very poor	Moderate	D (840)	Poor ↓ ↓
Waipoua - Colombo Rd	17	17	0	0	High	B (240)	Fair ↑ ↑[4]	Moderate	B (240)	Good
Waingawa - Kaituna	17	17	0	0	Low/moderate	A (66)	Very good	Low	A (66)	Very good
Waingawa - South Rd	17	16	0	1	Low/moderate	A (89)	Very good	Low	A (81)	Very good
Ruamahanga - The Cliffs	17	17	0	0	High	A (110)	Poor[5]	High	A (110)	Poor[5]
Ruamahanga - Kokotau	17	17	0	0	High	B (153)	Poor ↑[5]	Moderate	B (154)	Fair
Waiohine - Gorge[1]	4	4	0	0	Low	A (85)[2]	Very good	Very low	A (49)[2]	Very good
Waiohine - SH2	17	15	2	0	Low/moderate	C (282)	Fair ↓↓	Low	A (49)	Very good
Ruamahanga - Morrisons Bush	17	16	0	1	High	B (157)	Poor ↑[4]	Moderate	B (142)	Fair
Ruamahanga - Waihenga Br.	17	16	0	1	High	B (157)	Poor[4]	Moderate	B (154)	Fair
Tauherenikau - Bucks Rd[6]	17	17	0	0	N/A	A (61)	Not graded	N/A	A (17)	Not graded
Tauherenikau - Websters[1]	3[7]	3	0	0	High	C (485)[8]	Poor	Moderate	C (470)[8]	Fair ↓
Riversdale Lagoon	17	14	2	1	Moderate	C (505)	Fair ↑	N/A	N/A	N/A

[1] Sampled monthly under GWRC's Rivers State of the Environment (RSoE) water quality programme.
[2] Based on summer-time data collected weekly from 2005/06 and monthly from 2006/07–2016/17 as part of the RSoE programme.
[3] Based on summer-time data collected monthly from 2007/08–2015/16 as part of the RSoE programme and weekly in 2016/17
[4] The combination of SIC and MAC for this site is unexpected. The SIC for this site will be reviewed in 2017/18
[5] Interim grades altered to reflect the uncertainty associated with the effects of upstream municipal wastewater treatment plant discharges on public health.
[6] Insufficient data available to assign a SIC grade, MAC grade, and SFRG at this stage.
[7] Only three samples were collected at this site in the 2016/17 season as the 4th sample was not processed by the lab correctly.
[8] Based on summer-time data collected monthly from 2004/05–2016/17 as part of the RSoE programme.

(B) Coastal waters – summer recreation period

Site	*n*	No. sample results (Enterococci cfu/100mL)			Beach grading (2014/15-2016/17 data)		
		Surveillance (≤ 140)	Alert (141–280)	Action (>280)	SIC Grade	MAC Grade (95th %ile value)	2016/17 SFRG
Kapiti							
Otaki Beach at Surf Club	17	17	0	0	Moderate	B (115)	Good
Te Horo Beach at Sea Road	17	16	1	0	Moderate	B (155)	Good
Peka Peka Beach at Road End	17	17	0	0	Low	B (80)	Good
Waikanae Beach at William Street	17	17	0	0	Moderate	B (86)	Good
Waikanae Beach at Ara Kuaka Carpark	17	17	0	0	Moderate	B (68)	Good
Paraparaumu Beach at Ngapotiki Street	17	16	1	0	Moderate	B (200)	Good
Paraparaumu Beach at Nathan Avenue	17	16	1	0	Moderate	B (71)	Good ↑
Paraparaumu Beach at Maclean Park	17	16	0	1	Moderate	C (225)	Fair
Paraparaumu Beach at Toru Road	17	17	0	0	Moderate	B (178)	Good ↑
Raumati Beach at Tainui Street	17	16	1	0	Moderate	B (130)	Good ↑
Raumati Beach at Marine Gardens	17	15	2	0	Moderate	B (151)	Good
Raumati Beach at Aotea Road	17	17	0	0	Moderate	C (210)	Fair
Paekakariki Beach at Whareroa Road	17	17	0	0	Low	B (82)	Good
Paekakariki Beach at Surf Club	17	17	0	0	Low	B (52)	Good
Porirua							
Pukerua Bay	17	17	0	0	Moderate	B (69)	Good
Karehana Bay at Cluny Road	17	17	0	0	Moderate	B (66)	Good
Onehunga Bay[1]	N/A	N/A	N/A	N/A	Low	B (110)1	Good1
Plimmerton Beach at Bath Street	17	14	2	1	Moderate	C (443)	Fair ↑
South Beach at Plimmerton	17	14	3	0	Moderate	C (279)	Fair ↑
Pauatahanui Inlet at Water Ski Club	17	15	2	0	Moderate	C (205)	Fair ↑
Pauatahanui Inlet at Paremata Bridge	17	17	0	0	Moderate	A (40)	Good[2]
Porirua Harbour at Wi Neera Drive Boat Ramp[3]	17	10	3	4	N/A3	D (803)3	Not yet graded[3]
Porirua Harbour at Rowing Club	17	11	1	5	Moderate	C (353)	Fair ↑
Titahi Bay at Bay Drive	17	17	0	0	Moderate	C (213)	Fair
Titahi Bay at Toms Road	17	17	0	0	Moderate	B (136)	Good ↑
Titahi Bay at South Beach Access Road	17	16	0	1	Moderate	C (325)	Fair ↑
Wellington City							
Wellington City Waterfront at Shed 6[3]	17	15	2	0	N/A3	C (215)2	Not yet graded[3]
Aotea Lagoon	17	13	0	4	Moderate	C (352)	Fair ↓
Wellington Harbour at Taranaki St Dive Platform	17	12	3	2	Moderate	C (332)	Fair
Oriental Bay at Freyberg Beach	17	15	1	1	Moderate	B (115)	Good
Oriental Bay at Wishing Well	17	16	1	0	Moderate	B (110)	Good
Oriental Bay at Band Rotunda	17	16	1	0	Moderate	B (126)	Good
Balaena Bay	17	16	0	1	Low	C (263)	Fair ↓
Hataitai Beach	17	17	0	0	Moderate	B (74)	Good ↑
Shark Bay	17	16	1	0	Moderate	B (146)	Good ↑
Mahanga Bay	17	17	0	0	Low	A (31)	Very good ↑
Scorching Bay	17	17	0	0	Low	B (143)	Good ↑

Site	*n*	No. sample results (Enterococci cfu/100mL)			Beach grading (2014/15-2016/17 data)		
		Surveillance (≤ 140)	Alert (141–280)	Action (>280)	SIC Grade	MAC Grade (95th %ile value)	2016/17 SFRG
Worser Bay	17	16	1	0	Moderate	B (146)	Good
Seatoun Beach at Wharf	17	16	0	1	Moderate	B (113)	Good ↑
Seatoun Beach at Inglis Street	17	16	0	1	Moderate	B (181)	Good ↑
Breaker Bay	17	16	1	0	Low	B (115)	Good
Lyall Bay at Tirangi Road	17	16	1	0	Moderate	C (437)	Fair
Lyall Bay at Onepu Road	17	16	1	0	Moderate	B (195)	Good
Lyall Bay at Queens Drive	17	17	0	0	Moderate	B (172)	Good ↑
Princess Bay	17	17	0	0	Low	A (39)	Very good
Island Bay at Reef St Recreation Ground	17	15	0	2	Moderate	C (283)	Fair ↑
Island Bay at Surf Club	17	17	0	0	Moderate	C (295)	Fair ↑
Island Bay at Derwent Street	17	15	0	2	Moderate	B (105)	Good ↑↑
Owhiro Bay	17	15	1	1	Moderate	C (445)	Fair ↑
Hutt							
Petone Beach at Water Ski Club	17	15	1	1	Moderate	C (368)	Fair
Petone Beach at Sydney Street	17	16	0	1	Moderate	C (391)	Fair
Petone Beach at Kiosk	17	16	0	1	Moderate	C (346)	Fair
Sorrento Bay	17	14	1	2	Low	C (336)	Fair
Lowry Bay at Cheviot Road	17	14	2	1	Moderate	C (342)	Fair
York Bay	17	15	0	2	Low	B (130)	Good
Days Bay at Wellesley College	17	15	0	2	Moderate	C (244)	Fair ↓
Days Bay at Wharf	17	14	2	1	Moderate	B (150)	Good
Days Bay at Moana Road	17	15	1	1	Moderate	B (136)	Good
Rona Bay at N end of Cliff Bishop Park	17	12	2	3	Moderate	C (399)	Fair
Rona Bay at Wharf	17	13	3	1	Moderate	C (242)	Fair
Robinson Bay at HW Shortt Rec Ground	17	12	4	1	Moderate	C (239)	Fair ↓
Robinson Bay at Nikau Street	17	14	2	1	Moderate	C (206)	Fair ↓
Wairarapa							
Castlepoint Beach at Castlepoint Stream	17	17	0	0	Moderate	B (51)	Good
Castlepoint Beach at Smelly Creek	16	16	0	0	Low	A (14)	Very good ↑
Riversdale Beach Between the Flags	16	16	0	0	Low	A (15)	Very good

[1] Not sampled in 2016/17, grade based on data collected in 2009/10, 2010/11 and 2015/16
[2] The combination of SIC and MAC for this site is unexpected and the grade assigned is interim. The SIC for this site will be reviewed in 2017/18
[3] Insufficient data available to assign SIC grade, MAC grade and SFRG at this stage.

(C) Coastal waters – winter recreation period

Site	*n*	No. sample results (Enterococci cfu/100mL)			Beach grading				
					SIC Grade	Winter data (2011/12-2016/17 data)3		Summer data (2014/15-2016/17 data)	
		Surveillance (≤ 140)	Alert (141–280)	Action (>280)		MAC Grade (95th %ile value)	2016/17 Winter SFRG	MAC Grade (95th %ile value)	2016/17 SFRG
Kapiti									
Raumati Beach at Marine Gardens	18	17	1	0	Moderate	B (174)	Good	B (151)	Good
Paekakariki Beach at Surf Club	18	17	1	0	Low	B (69)	Good	B (52)	Good
Porirua									
South Beach at Plimmerton	18	15	0	3	Moderate	D (1230)	Poor	C (279)	Fair
Porirua Harbour at Rowing Club	18	13	2	3	Moderate	D (1215)	Poor	C (353)	Fair
Titahi Bay at Toms Road	18	18	0	0	Moderate	C (246)	Fair	B (136)	Good
Wellington City									
Oriental Bay at Wishing Well	18	18	0	0	Moderate	B (179)	Good	B (110)	Good
Scorching Bay	18	18	0	0	Low	B (179)	Good	B (143)	Good
Lyall Bay at Tirangi Road	18	18	0	0	Moderate	B (63)	Good	C (437)	Fair
Island Bay at Surf Club	17[2]	17	0	0	Moderate	C (305)	Fair	C (295)	Fair
Hutt									
Petone Beach at Kiosk	18	18	0	0	Moderate	C (470)	Fair	C (346)	Fair
Robinson Bay at Nikau Street	18	18	0	0	Moderate	D (851)	Poor	C (206)	Fair

[1] Winter grades for Wellington sites based on data collected between 2012/13 and 2016/17 (60 data points)
[2] Site was not sampled during first week of winter sampling.
[3] Different time frames were used for the winter data set in order to reach at least 60 data points per site for statistical robustness.

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