greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Is it safe to swim?

Recreational water quality monitoring results for 2017/18

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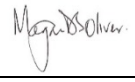
Report reviewed by:	M Oliver	Team Leader, Marine and Freshwater	
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Contents

1. Introduction

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

Recreational water quality monitoring in the Wellington region during 2017/18 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 2017 to 31 March 2018), Microbial Assessment Categories (MACs) 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, Air, Water Aotearoa (www.lawa.org.nz).

This report summarises the results of weekly monitoring undertaken over the 2017/18 summer recreation period and presents updated MAC grades for the region based on these results. Additional fortnightly microbiological 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).

2. Overview of monitoring programme

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.

[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.

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.

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 Microbiological Assessment Category

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. Previously, the Suitability for Recreation Grade (SFRG) was used for reporting regional beach/river grades. However for the purpose of national consistency and standardised reporting, for the 2017/18 period the Microbiological Assessment Category (MAC) grade, which is a numerical measure of the actual water quality over time, was used.

The MAC is based on a 95th percentile of routine surveillance 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 in 2016/17 to align with the National Objectives Framework attribute guidance (part of the 2014 National Policy Statement for Freshwater Management; NPS-FM) and our proposed Natural Resources Plan (MfE 2014; GWRC 2015). Microbiological Assessment Categories are updated each year at the end of the bathing season.

There are four MACs ranging from 'very good' to '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 D in table appendices as well as the summary cards accompanying this report. Summary cards can be accessed from http://www.gw.govt.nz/annual-monitoring-reports).

Table 2.2: Microbiological Assessment Categories (MACs) and explanation of associated human health risk

MAC	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.

It should be noted that because the MAC is based on a 95th percentile calculated over three summer seasons, this value is heavily influenced by high faecal indicator bacteria (FIB) counts, often following wet weather sampling. This means that from year to year a MAC 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. Thus any apparent shifts in grade 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 investigations are required.

3. Recreational water quality in freshwaters

3.1 Introduction

Recreational water quality was monitored at 25 river sites across the Wellington region over the 2017/18 bathing season (Figure 3.1, Appendix 1), as follows:

- Kapiti Coast District – 4 sites
- Hutt and Wainuiomata Districts – 8 sites
- Wairarapa Districts – 13 sites

The sites monitored reflect their use by the public for contact recreation; in particular, swimming and boating. Sites do not include monitoring of artificial water bodies such as Henley Lake (Masterton) or water bodies on private land (e.g. Lake Waitawa, Kapiti Coast).

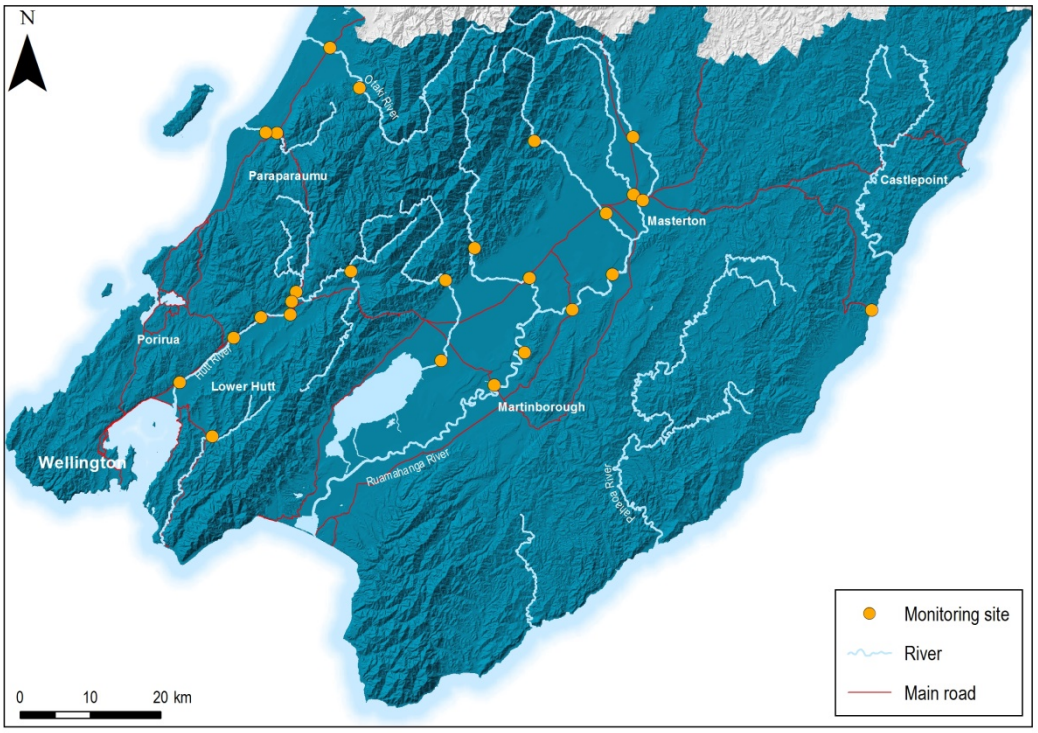

Figure 3.1: Freshwater recreation sites monitored over summer 2017/18. Note the Riversdale Lagoon site monitoring was discontinued in 2016/17 as there is a permanent health warning at the site, it is displayed here for location reference only.

3.2 Monitoring protocol

Summer water quality sites were sampled weekly for 17 weeks – between 1 December 2017 and 31 March 2018. The three exceptions were Otaki River at Pots (Kapiti), Waiohine River at Gorge and Tauherenikau River at Websters (Wairarapa), which were sampled monthly under GWRC's Rivers Water

Quality and Ecology (RWQE) monitoring programme[2]. 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 are also done, 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 as it generates runoff from rural and urban land and re-suspends 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

[2] Monthly microbiological water quality results for sites Otaki River at Pots and Waiohine River are obtained under the RWQE monitoring programme (see Milne & Wyatt 2006). Assessment of recreational water quality at Tauherenikau River at Websters is also based on monthly data from the RWQE monitoring programme.

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.

(b) Microbiological Assessment Categories

Microbiological Assessment Category thresholds, and associated risk of illness, are summarised in Table 3.2. Two types of MAC are reported for each river site: one based on all flow conditions and one based on 'dry weather' conditions only (defined as 3 x median flow or less). Two grades were derived as it has been identified that grades for many freshwater sites are heavily influenced by a small number of elevated *E. coli* results recorded following heavy rainfall. The additional 'dry weather' MACs 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.

Table 3.2: MfE/MoH (2003) Microbiological Assessment Category threshold values for freshwater recreational waters. Adapted from Table H2 MoH/MfE (2003) Microbiological Water Quality Guidelines.

Microbiological Assessment Category	95th percentile value of *E. coli*/100mL (rounded values)	Basis of derivation	Estimated risk of Campylobacter infection
A	≤ 130	NCRL for *Campylobacter* infection	<0.1% occurrence: Relates to less than 1 *Campylobacter* infection in every 1000 exposures
B	131-260	The 260/100mL values is above the NCRL threshold for *Campylobacter* infection	0.1-1% occurrence: The upper 95th percentile value of 260 relates to an average probability of one case of *Campylobacter* infection in every 100 exposures
C	260-550	Substantial elevation in probability of *Campylobacter* infection	1-5% occurrence: This range of 95th percentiles represents a probability of 1 in 100 to 5 in 100 of *Campylobacter* infection
D	>550	May be a significant risk of high levels of *Campylobacter* infection	>5% occurrence: The upper 95th percentile value of 550 represents a greater than 1 in 20 chance of *Campylobacter* infection

NCRL=no-calculated-risk-level

3.3.2 Nuisance periphyton guidelines

Excessive amounts of periphyton[3] can reduce the amenity value of waterways by decreasing their aesthetic appearance, reducing visibility, and being a physical nuisance to swimmers.

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

3.3.3 Interim cyanobacteria guidelines

Growth of benthic cyanobacteria (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[4] 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.

[3] Periphyton refers to the slime coating on a riverbed, composed largely of algae and cyanobacteria.
[4] 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.

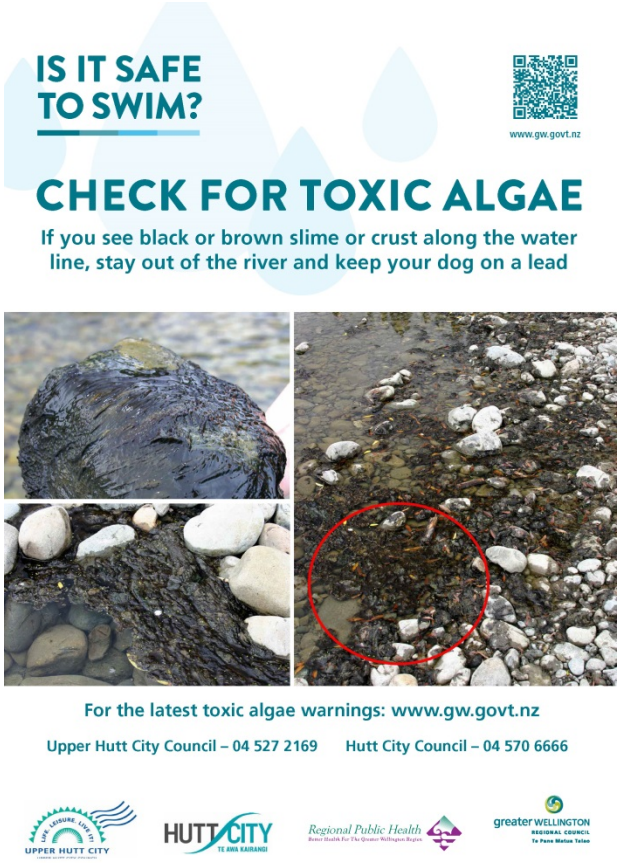

Figure 3.2: Sign used to inform the public of the health risk from cyanobacteria in rivers in the Wellington region

3.3.4 Water clarity guidelines

Smith et al. (1991) and Smith and Davies-Colley (1992) demonstrated that the perception of water quality 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.

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 (2015/16 to 2017/18). The exceptions were four sites for which a longer data period was used in order to achieve a statistically representative data set: Otaki River at Pots and Waiohine River at Gorge were calculated from monthly data from 2004/05 onwards; Tauherenikau River at Websters was calculated from monthly sampling during bathing seasons between 2005/06 and 2017/18, while the grade for Akatarawa River at Hutt Confluence was calculated from monthly data between 2011/12 and 2015/16 and weekly from the 2016/17 to 2017/18 bathing seasons. All 95th percentiles were calculated using the Hazen method as recommended in the MfE/MoH (2003) guidelines.

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 monitored weekly over the 2017/18 summer recreation period, 12 sites (55%) went above the MfE/MoH (2003) action guideline for *E. coli* (>550 cfu/100mL) on at least one occasion (Table 3.4, Appendix 3).

Table 3.4: Summary of action guideline breaches for *E. coli* (>550 cfu/100mL) from routine weekly monitoring at 22 river sites over the 2017/18 summer recreation period[1]

No. of times site breached the action guideline	No. of sites			Total no. of sites (22)	% of sites
	Kapiti (3 sites)	Hutt & Wainuiomata (8 sites)	Wairarapa (11 sites)		
0	0	2	8	10	45.5
1	2	0	3	5	22.7
2	1	3	0	4	18.2
3	0	2	0	2	9.1
4	0	1	0	1	4.5

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

From a total of 374 routine freshwater samples collected during the bathing season, 23 (6.1%) returned *E. coli* counts above the MfE/MoH (2003) action guideline (Table 3.5). This was more than the previous three summer bathing seasons, when 3.3%, 1.2% 4.7% of samples exceeded the action guideline (Keenan et al. 2015, Morar & Greenfield 2016, Brasell and Morar 2017). Periodic wet weather conditions in the 2017/18 summer are likely to be the main driver of the high number of action guideline breaches.

Seventeen of the 23 action guideline breach events were associated with significant rainfall (≥ 10 mm in the 24 hours prior to sampling); five were associated with moderate rainfall (≥ 5 mm in 24hr prior) and one with no

rainfall within 24hrs prior. 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 freshwater microbiological contamination this season.

Table 3.5: Summary of action guideline breaches for *E. coli* (>550 cfu/100mL) and preceding rainfall (mm) during routine monitoring at freshwater sites over the 2017/18 bathing season[1]. The number of follow-up samples required before compliance with the surveillance guideline was achieved is 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	No. follow-up samples required
Kapiti							
18/01/2018	Waikanae River at State Highway One	620	Waikanae River WTP	13	0	0	1
22/02/2018	Otaki River at State Highway One	800	Taungata Peak	57.5	32	20	1
	Waikanae River at State Highway One	1,700	Waikanae River WTP	51.5	18	27	1
	Waikanae River at Jim Cooke Park	2,100	Waikanae River WTP	51.5	17.5	27.5	1
Hutt & Wainuiomata							
4/01/2018	Pakuratahi River at Hutt Forks	700	Centre Ridge	28.6	0	0	0
28/12/2017	Wainuiomata River at Richard Prouse Park	660	Wainui Reservoir	6.5	10	20.5	1
4/01/2018	Hutt River at Maoribank Corner	2,720	Te Marua	48.0	0	0	0
	Hutt River at Poets Park	2,080	Te Marua	48.0	0	0	0
	Hutt River Upstream of Silverstream Bridge	1,280	Te Marua	48.0	0	0	0
8/01/2018	Wainuiomata River at Richard Prouse Park	1,380	Wainui Reservoir	0.5	0.5	54	1
23/01/2018	Hutt River at Melling Bridge	720	Birch Lane	0	0	0	1
26/02/2018	Pakuratahi River at Hutt Forks	560	Centre Ridge	17.8	0	0.2	1
	Hutt River at Maoribank Corner	680	Te Marua	21.0	0	0	1
	Hutt River at Poets Park	660	Te Marua	23.6	0	0	1
	Hutt River Upstream of Silverstream Bridge	720	Te Marua	24.6	0	0	1
	Hutt River at Melling Bridge	2,040	Birch Lane	23	0	0	1
	Wainuiomata River at Richard Prouse Park	940	Wainui Reservoir	15	0	0	1
27/03/2018	Hutt River at Maoribank Corner	800	Te Marua	0.4	0.4	6.4	1
	Hutt River at Melling Bridge	600	Birch Lane	2.4	0	3.6	1
	Wainuiomata River at Richard Prouse Park	720	Wainui Reservoir	1.5	0	3.5	1
Wairarapa							
3/01/2018	Ruamahanga River at Te Ore Ore	1,440	Mt Bruce	32	0	0	0
	Waipoua River at Colombo Road	3,360	Westons	20.5	0	0	0
	Ruamahanga River at The Cliffs	1,140	Angle Knob	13	0	1	0

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

3.5.2 Microbiological Assessment Categories

Updated MACs for all river and estuarine sites (as at the end of March 2018) are summarised in Figure 3.3 and listed in Appendix 3. These MACs are reported using 'all weather' flows and 'dry weather' flows. In total, twelve sites (55%) have MACs of 'A' or 'B' for 'all weather' flows and 17 sites (77%) have 'dry weather' MACs of 'A' or 'B'.

Across 'all weather' conditions, nine sites across the region carried a high risk of microbiological contamination, with 'D' MAC assessments (Figure 3.3 and Appendix 3). It is apparent that these were largely driven by several heavy rain events resulting in a number of high *E. coli* results thus higher MAC scores. For 'dry weather' conditions' five sites were initially assessed as a high risk of microbiological contamination. However for three headwater/low risk sites high *E. coli* results recorded on 4/1/18 were censored from the overall grade due to the time lag between heavy rainfall and river flow that was not automatically accounted for in the initial 'dry weather' assessment. This included Pakuratahi River at Hutt Forks, Hutt River at Maori Bank Corner, and Hutt River at Poets Park. Despite this, MAC grades at four of the eight Hutt Valley freshwater sites dropped at least one MAC grade, Hutt River at Poets Park dropped by two MAC grades. Microbiological risks remained the highest at the two Hutt Valley sites (Hutt River at Melling Bridge and Wainuiomata River at Richard Prouse Park). There were no improvements in grades for any of the Hutt Valley freshwater sites in the 2017/18 season, and no sites were graded 'A'.

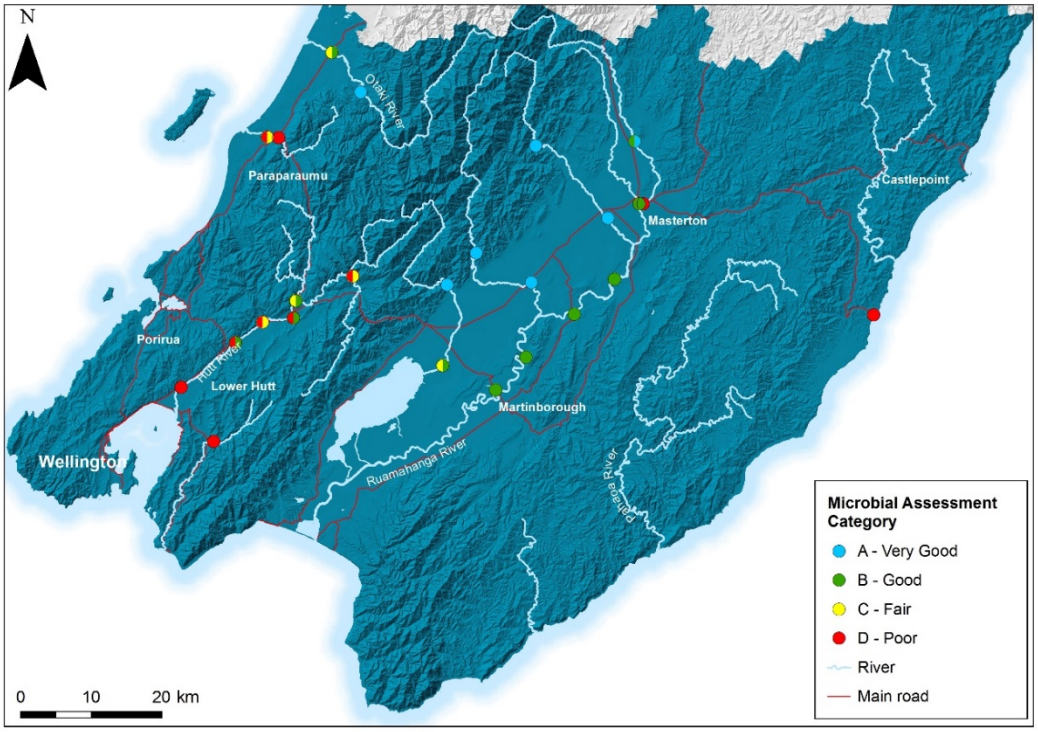

Figure 3.3: Microbiological Assessment Categories for all 25 freshwater monitoring sites, and one estuarine monitoring site in the Wellington region as at the end of the 2017/18 bathing season. The left side of the symbol shows the 'all weather' MAC, while the right side of the symbol shows the 'dry weather' MAC (uses *E. coli* counts from samples collected during 3 x median flows or less).

For the Wairarapa sites, the large waterfowl population and urban stormwater inputs to Henley Lake continue to be key contributors to the 'D' all weather and dry weather grade at the Ruamahanga River Te Ore Ore site. This site recorded the highest MAC percentile score for both assessment periods (Appendix 3). Overall the 'dry weather' grades improved at two sites in the Wairarapa; Ruamahanga River at Kokatau, Tauherenikau River at Websters, whereas there was a drop in the 'dry weather' grade at Ruamahanga River site at The Cliffs.

In the Kapiti region, water quality at the headwater site Otaki River at Pots remained good, and was assessed as 'A' grade in both wet and dry weather. A drop in MAG grade from 'C' to 'D' was recorded for the Waikanae River at State Highway 1 site, which is a lower catchment site on this river. Dry weather MAC grades remained unchanged at Otaki River at State Highway 1 ('B' grade), and at the Waikanae River at Jim Cooke Park site ('C' grade).

In general, runoff entering main stem water ways may be affected in part by compromised wastewater infrastructure (urban and rural), general urban runoff, as well as runoff from rural land use – these are key source contributors to reduced MAC grades, which are noticeable when comparing wet weather and dry weather grade assessments.

3.5.3 Compliance with nuisance periphyton and cyanobacteria guidelines

There were an increased number of breaches of both the periphyton and cyanobacteria guidelines this season. Twelve breaches of the MfE (2000) nuisance filamentous periphyton cover guideline (>30% cover) occurred, the majority of which were in the Wainuiomata River at Richard Prouse Park. The maximum coverage occurred on the 7 February 2018 when filamentous periphyton cover reached 66.8% (Table 3.6).

The MfE (2000) nuisance mat periphyton cover guideline (>60% cover) was only breached on one occasion on the Hutt River at Melling Bridge, on the 4 December 2017, where mat periphyton covered 62.8% of the river bed (Table 3.6).

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 2017/18 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	17	**31**	**1**	19.5	0	11.8	0	0
Waikanae R at SH1	17	17	2.3	0	0	0	8	0	0
Waikanae R at Jim Cooke Pk	17	17	3.5	0	0	0	9.3	0	0
Hutt & Wainuiomata									
Pakuratahi R at Hutt Forks	17	16	4	0	5.5	0	17.3	0	1
Akatarawa R at Hutt Confl	17	17	0	0	5.8	0	9.5	0	1
Hutt R at Birchville	17	15	4	0	31.8	0	**27.5**	**1**	**2**
Hutt R at Maoribank Cnr	17	15	3.8	0	0.5	0	**20.5**	**1**	**1**
Hutt R at Poets Pk	17	16	1.5	0	17.5	0	13.3	0	**4**[4]
Hutt R at Silverstream Br	17	17	6	0	15.5	0	**56**	**8**	**2**
Hutt R at Melling Br	17	16	5	0	**62.8**	**1**	13.5	0	0
Wainuiomata R at RP Pk	17	17	**66.8**	**9**	9.8	0	6.3	0	0
Wairarapa									
Ruamahanga R at Double Br	17	17	11	0	6.8	0	6.3	0	0
Ruamahanga R at Te Ore Ore	17	17	10	0	11.5	0	14.3	0	0
Waipoua R at Colombo Rd	17	17	19.8	0	10	0	11.8	0	0
Waingawa R at Kaituna	17	16	2.5	0	2.5	0	7.8	0	0
Waingawa R at South Rd	17	16	5.5	0	6	0	19.5	0	0
Ruamahanga R at The Cliffs	17	16	15.8	0	7.5	0	5	0	0
Ruamahanga R at Kokotau	17	16	**37.5**	**1**	5	0	1.3	0	0
Waiohine R at SH2	17	13	16.5	0	0	0	1.5	0	0
Ruamahanga R at Morrisons Bush	17	14	25.7	0	9.8	0	5.8	0	0
Ruamahanga R at Waihenga Br	17	15	**36.3**	**1**	19	0	4.8	0	0
Tauherenikau R at Bucks Rd	17	16	3.8	0	0.8	0	7.3	0	0

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

[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.

[4] Guideline breaches due to significant detached mats rather than percentage cover.

The Hutt River had multiple sites that breached the alert level (20-50% coverage) and action level (>50% coverage) of the MfE/MoH (2009) interim cyanobacteria guidelines this season. Multiple extreme cyanobacteria bloom events occurred in the Hutt River over the summer recreation period. These events posed a high health risk to both humans and dogs, leading to extensive 'no-swim' zones covering the majority of the river throughout the 2017/18 summer.

Initial cyanobacteria proliferations in the Hutt were noticed in early November 2017, during routine monthly RWQE monitoring, before the official start of our weekly Recreational Water Quality monitoring programme that commenced on 4th December 2017. As a precaution, weekly pre-season algae assessments were initiated in the three weeks leading up to December. The Hutt River at Silverstream site had an estimated coverage of 26.5% on 13

November 2017, with significant detached mats present as well (see Figure 3.4 for a photograph taken November 2017). The following week on 20 November 2017, 5 more sites were checked; three sites, Birchville, Silversream Bridge and Melling Bridge had coverages >20% but none above 50% (action level), and detached mats visible at the Pakuratahi at Hutt Forks site. During the third week, on 27 November, all 7 Hutt river catchment sites were sampled; coverages at all sites were below 20% (max 15.5% at Poets Park). However, three sites had significant detached mats – Pakuratahi at Hutt Forks, Hutt River at Birchville and Poets Park, which is expected as the bloom reached peak biomass and mats began to degrade and detach from the substrate.

During the bloom, drone footage of several locations along the Hutt River were taken, revealing extensive mat coverage, particularly thick in the middle third of the channel, in some places coverage was estimated close to 100%. Mat material was also sampled and sent to the Cawthron Institute for toxin analysis, returning some of the highest concentrations recorded in the Hutt River (or any NZ river) (Thomson-Laing et al. 2018). Note that no pre-season exceedances occurred in the Wainuiomata River or any of the Kapiti or Wairarapa rivers.

By the official start of recreational water quality monitoring on 4 December 2017, the Silverstream site mat coverage had trebled (from 11% to 33.5%) and detached mats remained at 4 other sites. The Hutt River at Silverstream site reached a maximum of 56% on 29 January 2018, breaching the Action level guideline, and retained high levels of coverage (>20%) until 12 February 2018, when coverage gradually receded. A number of sites also continued to have detached mats until the beginning of February 2018.

The proliferation of thick and detaching mats was widespread, which posed a significant health risk to both humans and animals. This led to the implementation of the highest level of risk warning for bathing and dog walking along the entire stretch of the lower Hutt River throughout December 2017. Toxic algae warning signs were erected at multiple sites along the length of the Hutt River and Pakuratahi River, commencing 18/12/2017, with final warnings lifted on 19/2/2018. Social media and radio messaging were also issued.

Due to the high risk of human and animal contact with detached mat material over the Christmas and New Year period, the high risk warning remained in place as a cautionary approach and to reduce confusion in public messaging. Coverage and detached mats did decrease over this period; the high risk warning was revoked and ‘no-swim’ signage taken down after 8 January 2018. Unfortunately, coverage returned to extreme levels (above action level) during January 2018, but warnings were limited to social media and permanent education signs rather than ‘no-swim’ signage. These breaches were less widespread; coverage at Silverstream remained over 50% for at least two weeks, while Birchville and Maoribank Corner exceeded alert level, likely contributing to the detached mats present downstream at Poets Park.

As per our standard procedures, all action 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 .

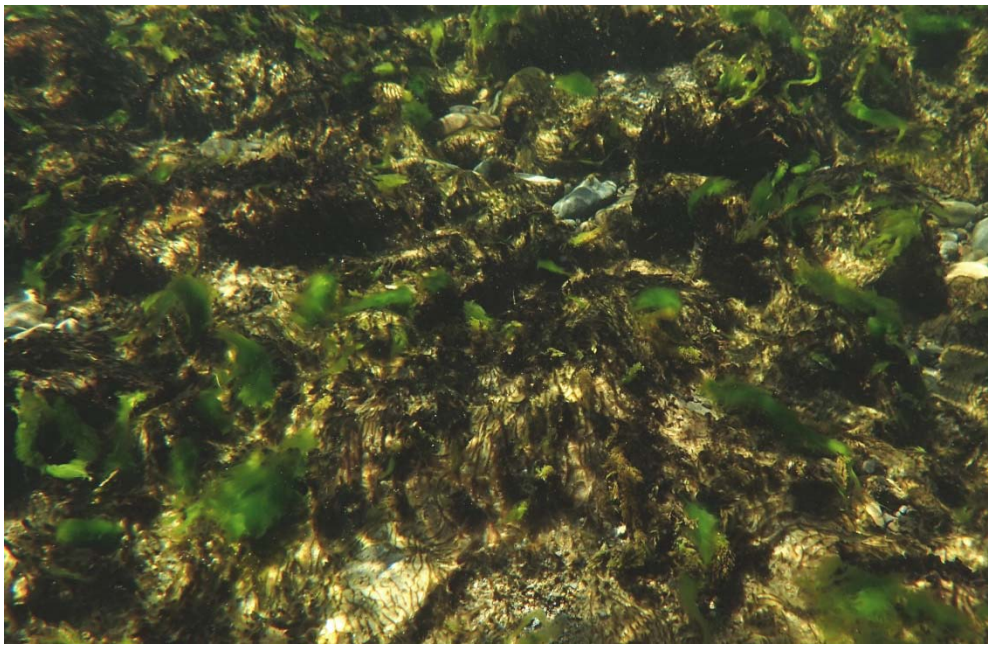

Figure 3.4: Green filamentous algae, diatom (light brown) and cyanobacteria (dark brown) mats growing simultaneously on the river bed of the Hutt River at Silverstream, taken 20 November 2017

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 87% of the time (326 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 2017/18 summer recreation period

Site	Assessments made (*n*)	Guideline >1.6 m met (*n*)
Kapiti		
Otaki R at SH1	17	14
Waikanae R at SH1	17	15
Waikanae R at Jim Cooke Pk	17	15
Hutt & Wainuiomata		
Pakuratahi R at Hutt Forks	17	15
Akatarawa R at Hutt Confl.	17	16
Hutt R at Birchville	17	15
Hutt R at Maoribank Cnr.	17	14
Hutt R at Poets Pk	17	15
Hutt R at Silverstream Br.	17	15
Hutt R at Melling Br.	17	15
Wainuiomata R at RP Pk	17	15
Wairarapa		
Ruamahanga R at Double Br.	17	16
Ruamahanga R at Te Ore Ore	17	15
Waipoua R at Colombo Rd	17	16
Waingawa R at Kaituna	17	16
Waingawa R at South Rd	17	15
Ruamahanga R at The Cliffs	17	14
Ruamahanga R at Kokotau	17	14
Waiohine R at SH2	17	14
Ruamahanga R at Morrisons Bush	17	13
Ruamahanga R at Waihenga Br.	17	14
Tauherenikau R at Bucks Rd	17	15

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

Of the 48 occasions the guideline was not met, 47 (98%) were due to poor water clarity following rainfall, whilst for one occasion (2%, observed at the headwater site Tauherenikau River at Bucks Road) the cause of poor clarity was unknown.

Whilst there was generally good clarity across all sites in dry weather, 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 affected sites, most notably on the Hutt River catchment (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 2017/18 bathing season. Forty nine percent of all assessments recorded no rubbish present on the banks or in the river channel. The Kapiti region had the least rubbish with 6% of assessments showing at least some rubbish present at the 4 sites visited. The Hutt/Wainuiomata region recorded at least some rubbish on 43% of visits to the eight sites, while the Wairarapa had the highest

frequency of observed rubbish, with 70% of assessments reporting at least some rubbish present across the 11 sites visited (Table 3.8).

As previously recorded, the Waingawa River at South Road site had abundant amounts of rubbish present on 16 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 to date and a resolution is yet to be found.

The Ruamahanga River at Te Ore Ore, as well as the Waipoua River at Colombo Road remain problematic, with high frequency of moderate litter observations recorded (11 and 14 occasions, respectively). The majority of rubbish is generally recorded as municipal with occasional industrial items observed. The cleanest sites in the Wairarapa were at the Ruamahanga River at Morrisons Bush (14 occasions where no rubbish was recorded) and at Tauherenikau River at Bucks Road (12 occasions where no rubbish was recorded).

The 'cleanest' river sites, where no rubbish was recorded on all sample occasions were in Kapiti; Otaki River at State Highway One, and Waikanae River at Jim Cooke Park both recorded zero rubbish on all 17 sampling occasions. The Waikanae River at State Highway One recorded zero rubbish on 14 occasions, and minimal rubbish on three occasions.

For the Hutt Valley, rubbish observations generally recorded as 'minimal' or zero. The cleanest' sites were the, Hutt River at Silverstream, Pakuratahi River at Hutt Forks and Hutt River at Maoribank corner (16, 15 and 12 occasions, respectively, where zero rubbish was recorded).

Table 3.8: Summary of rubbish assessments made at 22 river sites[1], based on routine weekly monitoring over the 2017/18 summer recreation season

Site Name	Assessments made (n)	Rubbish Amount			
		None	Minimal	Moderate	Abundant
Kapiti					
Otaki R at SH1	17	17	0	0	0
Waikanae R at SH1	17	14	3	0	0
Waikanae R at Jim Cooke Pk	17	17	0	0	0
Hutt & Wainuiomata					
Pakuratahi R at Hutt Forks	17	15	2	0	0
Akatarawa R at Hutt Confl.	17	9	5	3	0
Hutt R at Birchville	17	7	9	1	0
Hutt R at Maoribank Cnr	17	12	5	0	0
Hutt R at Poets Pk	17	8	7	2	0
Hutt R at Silverstream Br	17	16	1	0	0
Hutt R at Melling Br	17	4	13	0	0
Wainuiomata R at Richard Prouse Pk	17	7	8	2	0
Wairarapa					
Ruamahanga R at Double Br	17	0	11	6	0
Ruamahanga R at Te Ore Ore	17	0	3	11	3
Waipoua R at Colombo Rd	17	0	3	14	0
Waingawa R at Kaituna	17	2	15	0	0
Waingawa R at South Rd	17	0	0	1	16
Ruamahanga R at The Cliffs	17	8	9	0	0
Ruamahanga R at Kokotau	17	8	9	0	0
Waiohine R at SH2	17	7	10	0	0
Ruamahanga R at Morrisons Bush	17	14	3	0	0
Ruamahanga R at Waihenga Br	17	5	12	0	0
Tauherenikau R at Bucks Rd	17	12	5	0	0

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

3.6 Summary

Of the 22 river sites monitored weekly over the 2017/18 summer season, 12 sites (66%) exceeded the MfE/MoH (2003) action guideline for microbiological water quality on at least one occasion. Seventy-four percent of these exceedances coincided with significant rainfall in the 24 hours prior to sampling and/or elevated river flows. Of the total 25 sites monitored weekly and monthly, 12 sites (48%) had 'all weather' MACs of 'B' or better while 16 sites (64%) had 'dry weather' MACs of 'B' or better.

The MfE (2000) nuisance filamentous periphyton guideline was breached on 12 occasions at four sites across the region, but nine of these occurred at Wainuiomata River at Richard Prouse Park. The maximum coverage at this site was observed during early February 2018.

The guideline for nuisance mat periphyton was also breached at just one site (Hutt River at Melling Bridge) on only one occasion in early December, covering up to 63% of the river bed.

The Hutt River had multiple sites that breached the alert level (20-50% coverage) and action level (>50% coverage) of the MfE/MoH (2009) interim cyanobacteria guidelines. Multiple extreme cyanobacteria bloom events posed a high health risk to both humans and dogs, leading to extensive 'no-swim' zones covering the majority of the river throughout the 2017/18 summer. Toxic algae information signs were put up at affected sites as well as stretches of the river by local councils and up-to-date warnings posted on GWRC and LAWA websites. Toxin analysis of mats returned some of the highest concentrations recorded in the Hutt River, or any other New Zealand river.

The MfE (1994) guideline for water clarity was met for 87% of sampling occasions. Poor water clarity following rainfall accounted for nearly all (98%) of the occasions when the guideline was not met, whilst on one occasion (Tauherenikau River at Bucks Road) the cause of reduced clarity was unknown.

The 22 sites monitored were free of rubbish for almost half (49%) of the sampling occasions. The Waingawa River at South Road remains a problematic site known to be used for 'fly tipping' 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 61 coastal sites across the Wellington region over the 2017/18 bathing season (Figure 4.1, Appendix 1), as follows:

- Kapiti Coast District – 14 sites
- Porirua City – 11 sites
- Wellington City – 23 sites
- Hutt City – 13 sites

For the three Wairarapa coastal sites (Castlepoint Beach at Castlepoint Stream, Castlepoint Beach at Smelly Creek and Riversdale Beach between the flags) weekly surveillance monitoring was discontinued for the 2017/18 season, with approval from Masterton District Council and Regional Public Health. Previous monitoring has indicated that bathing water quality at these three beach sites is always good for nearly all of the time. Sites are retained in this current data report and the long term MAC grades are retained for reference purposes only. The Porirua site at Onehunga Bay was not sampled in 2017/18, and the MAC grade is based on previous data (listed in this report for location reference only).

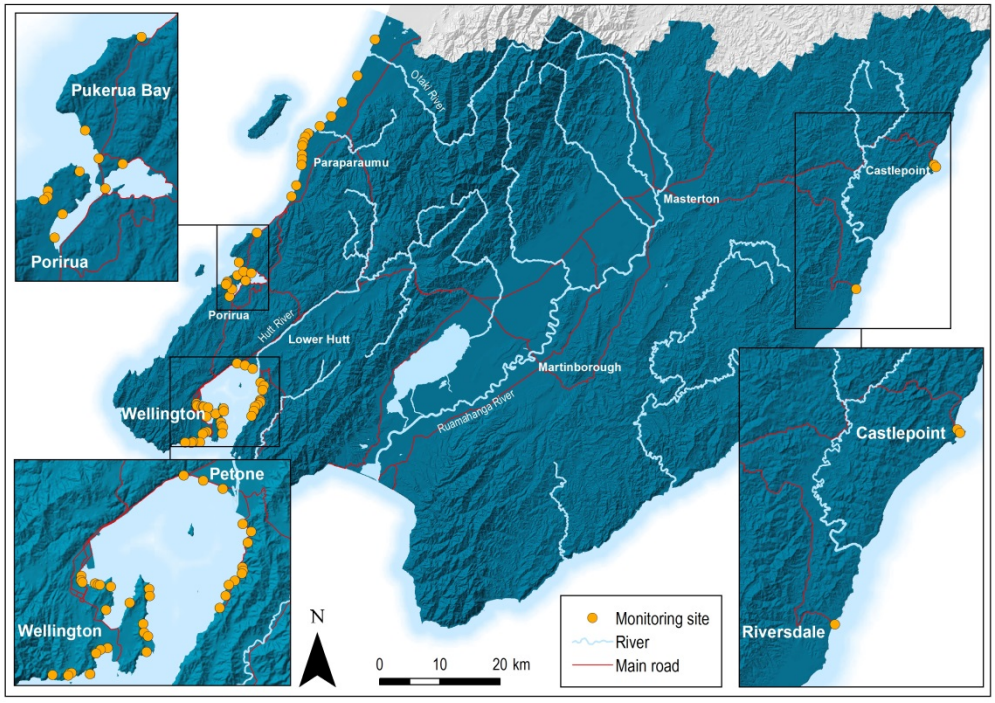

Figure 4.1: Coastal recreation sites monitored over the 2017/18 summer. Note that the three Wairarapa coastal sites, and the Porirua site at Onehunga Bay are indicated for reference only and were not sampled in 2017/18.

4.1.2 Winter recreation period

Recreational water quality was monitored fortnightly outside of the summer recreation period, from 1 July to 30 November 2017 and 1 April to 30 June 2018; for the purposes of this report this will be referred to as the 'winter' recreation period. A subset of eleven coastal sites, from the 61 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 2017 and 31 March 2018.

For the winter recreation period, sites were sampled fortnightly from 1 July to 30 November 2017 and 1 April to 30 June 2018.

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 marine (coastal) waters

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

When water quality falls in the 'surveillance mode', this indicates that the risk of illness from bathing is acceptable (for coastal waters the accepted level of risk is 19 in every 1,000 bathers). If water quality falls into the 'alert' category, this indicates an increased risk of illness from bathing, but still within an acceptable range. However, if the water quality enters the 'action' category, then the water poses an unacceptable health risk from bathing (MfE/MoH 2003). At this point, warning signs are erected at the bathing site, and the public is informed that it is unsafe to swim at that site. The only time a warning is unlikely to be issued is when an action level result is preceded by heavy rainfall. This is because it is widely known that rainfall is associated with elevated bacteria counts in coastal waters. 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 Microbiological Assessment Categories for coastal waters

Microbiological Assessment Category thresholds used to identify risk grading for coastal waters, and associate risk of illness, are shown in Table 4.2.

Table 4.2: MfE/MoH (2003) Microbiological Assessment Category threshold values for marine recreational waters. Adapted from Table H1 MoH/MfE (2003) Microbiological Water Quality Guidelines (see Guidelines for full descriptions).

Microbiological Assessment Category	95th percentile value of enterococci/100mL (rounded values)	Basis of derivation	Estimated risk
A	≤ 40	This value is below the NOAEL	<1% GI illness risk: People are exposed to a very low risk of GI infection (less than one incidence in every 100 exposures.
B	41-200	The 200/100mL values is above the threshold of illness transmission reported in most studies	1-5% GI illness risk: People are exposed to a low risk of infection (1-5%) from contact with the water
C	201-500	Substantial elevation in risk of illness	5-10% occurrence: People are exposed to a moderate risk of infection (5-10%) from contact with the water
D	>500	May be a significant risk of high levels of illness transmission	>10% GI occurrence: People are exposed to a high risk of infection (>10%) from contact with the water

NOAEL = no-observed-adverse-effect level, GI = gastrointestinal

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 64 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 were calculated using the Hazen method as recommended in the MfE/MoH (2003) guidelines. For the winter recreation data (at 11 coastal sits), slightly longer data collection periods were used rather than deferring to the three year MAC calculations; data from five years (2012/13 to 2017/18) 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 2017/18 summer recreation period, 44 of the 61 coastal sites (72%) exceeded the MfE/MoH (2003) action guideline during routine monitoring. Half of those sites (31) exceeded the guideline only once, while 13 sites had multiple exceedances (Table 4.3, Appendix 3).

Table 4.3: Summary of action guideline breaches from routine weekly monitoring at 61 coastal sites over the 2017/18 summer recreation period

No. of times site breached the action guideline	No. of sites				Total no. of sites (61)	% of sites
	Kapiti (14 sites)	Porirua (11 sites)[1]	Wellington (23 sites)	Hutt (13 sites)		
0	6	6	5	0	17	27.9
1	6	2	15	8	31	50.8
2	1	1	3	5	10	16.4
3	1	0	0	0	1	1.6
4	0	1	0	0	1	1.6
5	0	1	0	0	1	1.6

[1] Excludes Onehunga Bay

A total of 63 out of 1,034 (6%) routine sample results exceeded the MfE/MoH (2003) action guideline of 280 cfu/100mL (Table 4.4). This was more than in the 2016/17 bathing season (4%) but in the range (~3-7%) of those exceedances previously reported. Summer rainfall in the Wellington region was above or well-above the normal range for the 2017/18 period (NIWA 2018); these wetter weather conditions are likely to be the main driver of the increased number of action guideline breaches.

Table 4.4: Summary of action guideline breaches (>280 enterococci/100mL) and preceding rainfall (mm) during routine monitoring at coastal sites over the 2017/18 bathing season. The number of follow-up samples required before compliance with the surveillance guideline was achieved is also summarised.

Date	Site Name	Enterococci count (cfu/100mL)	Rainfall (mm)				No. of follow-up samples required
			Rainfall Station[1]	Up to 24hrs before sampling	48–25hrs before sampling	72–49hrs before sampling	
Kapiti							
19/12/2017	Paraparaumu Beach at Maclean Park	540	Waikanae WTP	0	0	0	**1**
16/01/2018	Paraparaumu Beach at Ngapotiki Street	1820	McKays Crossing	2.0	0	0	**1**
16/01/2018	Paraparaumu Beach at Nathan Avenue	289	Met Station EWS - Niwa	0	0	0	**3**
16/01/2018	Paraparaumu Beach at Maclean Park	560	Waikanae WTP	0	0	0	**3**
18/01/2018	Peka Peka Beach at Road End	360	Waikanae WTP	13	0	0	**1**
13/02/2018	Otaki Beach at Surf Club	860	Otaki Depot	3	68.5	10	**1**
13/02/2018	Te Horo Beach at Sea Road	940	Otaki Depot	4	71.5	10	**1**
13/02/2018	Peka Peka Beach at Road End	445	Waikanae WTP	14	35.5	12.5	**1**
13/02/2018	Paraparaumu Beach at Maclean Park	285	Waikanae WTP	15	36	12	**1**
13/02/2018	Raumati Beach at Marine Gardens	615	Waikanae WTP	15	36	12	**2**
13/02/2018	Raumati Beach at Aotea Road	410	Met Station EWS - Niwa	0	0	0	2
Porirua							
26/12/2017	Porirua Harbour at Wi Neera Drive Boat Ramp	330	Tawa Pool	23.4	0	0	0
3/01/2018	Porirua Harbour at Wi Neera Drive Boat Ramp	340	Tawa Pool	0	0	0	0
9/01/2018	Porirua Harbour at Wi Neera Drive Boat Ramp	1,100	Tawa Pool	0	0.4	0	3
23/01/2018	Porirua Harbour at Wi Neera Drive Boat Ramp	370	Tawa Pool	0.2	0	0	1
30/01/2018	South Beach at Plimmerton	540	Whenua Tapu	0	0	0	1
13/02/2018	Plimmerton Beach at Bath Street	920	Whenua Tapu	0.5	24.5	2.5	3
20/02/2018	Karehana Bay at Cluny Road	380	Whenua Tapu	42.5	0	1.0	1
20/02/2018	Plimmerton Beach at Bath Street	960	Whenua Tapu	42.5	0	1.0	1
20/02/2018	South Beach at Plimmerton	460	Whenua Tapu	42	0	1.0	1
20/02/2018	Porirua Harbour at Rowing Club	290	Tawa Pool	46.8	0	1.0	2
6/03/2018	South Beach at Plimmerton	410	Whenua Tapu	0	0	0	1
13/03/2018	South Beach at Plimmerton	320	Whenua Tapu	0	0	0	1
27/03/2018	South Beach at Plimmerton	340	Whenua Tapu	4.5	0	2.0	2
Wellington							
12/02/2018	Wellington City Waterfront at Shed 6	460	Wellington at Te Papa	10.8	2.4	0	1
12/02/2018	Aotea Lagoon	390	Wellington at Te Papa	10.8	2.4	0	1
12/02/2018	Wellington Harbour at Taranaki St Dive Platform	410	Wellington at Te Papa	10.8	2.4	0	1
12/02/2018	Oriental Bay at Freyberg Beach	380	Wellington at Te Papa	10.8	2.4	0	1
12/02/2018	Oriental Bay at Wishing Well	400	Wellington at Te Papa	10.8	2.4	0	1
12/02/2018	Oriental Bay at Band Rotunda	440	Regional Council Centre	0	0	0	1
12/02/2018	Balaena Bay	460	Hataitai at Old Post Office	11.0	2.4	0	1
12/02/2018	Hataitai Beach	380	Met Station at Wgtn Aero AWS - Niwa	0	0	0	1
12/02/2018	Mahanga Bay	380	Miramar at Miramar North Road	0	0	0	1
12/02/2018	Scorching Bay	390	Miramar at Miramar Bowling Club	11.6	2.6	0	1
12/02/2018	Worser Bay	370	Met Station at Wgtn Aero AWS - Niwa	0	0	0	1
12/02/2018	Seatoun Beach at Wharf	400	Miramar at Miramar North Road	0	0	0	1
12/02/2018	Lyall Bay at Onepu Road	410	Met Station at Wgtn Aero AWS - Niwa	0	0	0	1
12/02/2018	Princess Bay	430	Met Station at Wgtn Aero AWS - Niwa	0	0	0	1
12/02/2018	Island Bay at Reef St Recreation Ground	410	Berhampore at Nursery	9.2	6.8	0	1
12/02/2018	Island Bay at Derwent Street	460	Berhampore at Nursery	9.2	7.4	0	1
12/02/2018	Owhiro Bay	420	Berhampore at Nursery	9.2	7.4	0	1
26/02/2018	Wellington Harbour at Taranaki St Dive Platform	860	Wellington at Te Papa	12.4	0	0	1
26/02/2018	Breaker Bay	800	Met Station at Wgtn Aero AWS - Niwa	0	0	0	1
19/03/2018	Aotea Lagoon	340	Wellington at Te Papa	0	0	0	1
26/03/2018	Oriental Bay at Band Rotunda	300	Regional Council Centre	0	0	0	1
Hutt							
12/02/2018	Petone Beach at Sydney Street	320	Shandon	19.5	2.0	0	1
12/02/2018	Petone Beach at Kiosk	330		19.5	2.0	0	1
12/02/2018	Sorrento Bay	360		19.5	2.0	0	1
12/02/2018	Lowry Bay at Cheviot Road	420		19.5	2.0	0	1
12/02/2018	York Bay	380		19.5	2.0	0	1
12/02/2018	Days Bay at Wellesley College	450		19.5	2.0	0	1
12/02/2018	Days Bay at Wharf	340		19.5	2.0	0	1
12/02/2018	Days Bay at Moana Road	340		19.5	2.0	0	1
12/02/2018	Rona Bay at N end of Cliff Bishop Park	360		19.5	2.0	0	1
12/02/2018	Rona Bay at Wharf	300		19.5	2.0	0	1
12/02/2018	Robinson Bay at HW Shortt Rec Ground	300		19.5	2.0	0	1
12/02/2018	Robinson Bay at Nikau Street	370		19.5	2.0	0	1
26/02/2018	Petone Beach at Water Ski Club	490		10	0	0	1
26/02/2018	Petone Beach at Sydney Street	650		6.5	0	0	1
26/02/2018	Petone Beach at Kiosk	480		0	0	0	1
26/02/2018	Robinson Bay at HW Shortt Rec Ground	520		18.5	0	0	1
26/03/2018	Days Bay at Moana Road	390		0	3.0	1.0	1
26/03/2018	Rona Bay at Wharf	320		0	3.0	1.0	1

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

Sixty percent (38) of the 63 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 slightly less than the number of rainfall-associated exceedances that occurred in the 2016/17 bathing season (62%; Brasell and Morar 2017) – and again highlights the impact of the wet conditions across the region. Elevated enterococci counts in coastal waters during or shortly after rainfall events, even during moderate to low 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).

Twenty-four 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 Wi Neera Drive Boat Ramp and South Beach at Plimmerton sites (three occasions each). Two wet weather exceedances were also recorded at South Beach at Plimmerton.

Enterococci levels at the South Beach at Plimmerton site were generally within the surveillance guidelines after one or two follow-up samples. However, three follow-up samples were needed at the Wi Neera Drive Boat Ramp site before surveillance guidelines were met again (Table 4.4). 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, Takapuwahia 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.

Across all weather conditions, South Beach at Plimmerton (five exceedances), Porirua Harbour at Wi Neera Drive Boat Ramp (four exceedances) and Paraparaumu Beach at Maclean Park (three exceedances) recorded the lowest level of compliance with the surveillance guideline of all coastal sites monitored during the 2017/18 bathing season. Ten other coastal sites across the region recorded two guideline exceedances (see Appendix 3B).

Over the winter recreation period, five of the 11 coastal sites (45.5%) exceeded the MfE/MoH (2003) action guideline during routine monitoring on one occasion. One site in Porirua (Rowing Club) exceeded the action guideline on five occasions (Table 4.5).

Table 4.5: Summary of action guideline breaches from routine fortnightly monitoring at 11 coastal sites during the winter recreation period

No. of times site breached the action guideline	No. of sites				Total no. of sites (11)	% of sites
	Kapiti (2 sites)	Porirua (3 sites)	Wellington (4 sites)	Hutt (2 sites)		
0	2	0	2	1	5	45.5%
1	0	2	2	1	5	45.5%
5	0	1	0	0	1	9%

A total of ten out of 200 routine sample results (5%) exceeded the MfE/MoH (2003) action guideline of 280 cfu/100mL for the winter period (Table 4.6). Five 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 five exceedances occurred following moderate or no rainfall prior to sampling.

Most guideline breaches required only one follow-up sample before faecal indicators returned to surveillance levels. On one round, the Titahi Bay at Toms Road site was re-sampled three times before the site returned to surveillance levels, and the Porirua Harbour (Rowing Club) site required two follow-up samples. Compared with the 2016/17 season, the South Beach at Plimmerton site required only one re-sample on one occasion – a marked improvement from the previous winter season, despite the historical susceptibility of this site to poor water quality associated (DHI 2016, 2017). The Rowing Club site is also susceptible to poor water quality from both the Onepoto Stream following rain, and also can be influenced by poor water quality from the Porirua Stream plume that circulates in the Onepoto Arm of the harbour (DHI 2016, 2017). The Titahi Bay at Toms Road may also be susceptible to the influence of stormwater quality following moderate to heavy rainfall – the extent to which this is the case is to be further set out in the global stormwater consent process being set out by Wellington Water Ltd., as required under the proposed Natural Resources Plan (GWRC 2015).

Table 4.6: Summary of action guideline breaches (>280 enterococci/100mL) and preceding rainfall (mm) during routine winter monitoring at coastal sites over 2017/18. The number of follow-up samples required before compliance with the surveillance guideline was achieved is also summarised.

Date	Site Name	Enterococci count (cfu/100mL)	Rainfall (mm)				No. of follow-up samples required
			Rainfall Station[1]	Up to 24hrs before sampling	48–25hrs before sampling	72–49hrs before sampling	
Porirua							
17/10/2017	South Beach at Plimmerton	320	Whenua Tapu	0.0	3.0	0.5	1
11/07/2017	Porirua Harbour at Rowing Club	380	Tawa Pool	0.0	4.0	0.0	ns
25/07/2017	Porirua Harbour at Rowing Club	660	Tawa Pool	0.0	0.0	0.4	1
1/05/2018	Porirua Harbour at Rowing Club	1400	Tawa Pool	3.2	1.2	5.2	1
15/05/2018	Porirua Harbour at Rowing Club	720	Tawa Pool	0.8	4.2	9.2	1
30/05/2018	Porirua Harbour at Rowing Club	640	Tawa Pool	2.2	9.2	15.0	2
12/06/2018	Titahi Bay at Toms Road	500	Whenua Tapu	6.0	0.0	0.0	3
Wellington							
12/06/2018	Lyall Bay at Tirangi Road	500	Miramar Bowling Club	16.0	0.0	0.0	1
13/06/2018	Island Bay at Surf Club	430	Berhampore at Nursery	12.0	11.0	0.6	1
Hutt							
12/06/2018	Robinson Bay at Nikau Street	540	Shandon Golf Club	14.0	0.5	0.0	1

[1] See Appendix 1 for more details on rainfall stations; ns – follow-up sample not taken

All exceedances 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 Microbiological Assessment Categories

Updated MACs (as at the end of the 2017/18 summer recreation period), for 61 summer coastal recreational water quality monitoring sites in the Wellington region, range from 'very good' to 'poor' (Figure 4.2, Appendix 3)[5]. In total, 30 monitoring sites (48%) now have MACs of 'B' or better, 29 monitoring sites (47%) have MACs of 'C'. Two sites, Porirua Harbour at Wi Neera Drive Boat Ramp and Wellington City Waterfront at Shed 6, were assigned interim MACs based on two years of data only. Three sites (5%) were graded 'D' for this bathing season; Paraparaumu Beach at Maclean Park (Kapiti Coast), Plimmerton Beach at Bath Street and Porirua Harbour at Wi Neera Drive Boat Ramp (both Porirua Harbour).

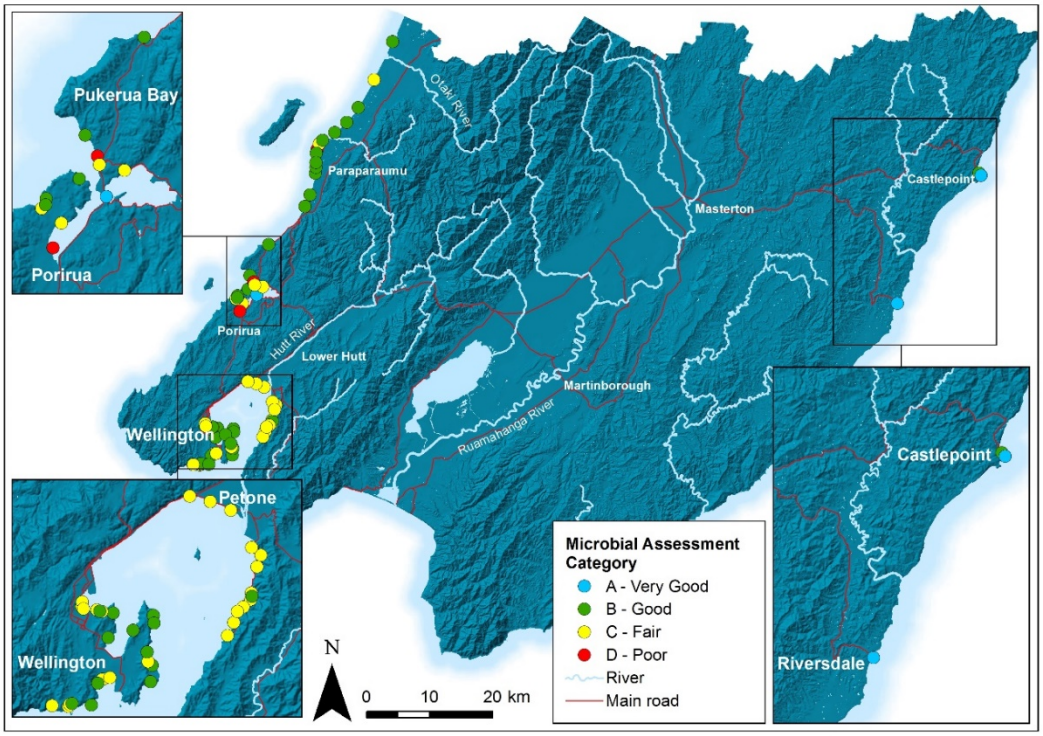

Figure 4.2: Microbial Assessment Categories for coastal recreational water quality monitoring sites in the Wellington region as at the end of the 2017/18 bathing season

MACs improved from the previous bathing season at three sites (5%), while grades dropped at 14 sites (23 %, Appendix 3, see also Brasell and Morar 2017). MACs at 44 sites (72%) remained unchanged from the previous bathing season.

Wellington City had eight of the 14 sites which dropped a MAC, and one site (Island Bay at Surf Club) that improved a grade. For Kapiti, MACs dropped at three sites and improved at one site. For Hutt City marine sites, two sites

[5] Onehunga Bay is assigned a MAC even though it was not monitored in 2017/18, as explained in Section 4.1.

dropped MACs, and there were no improvements. For Porirua, one site improved and one site dropped a MAC grade.

As indicated in Section 2.2.2, the shift to reporting MACs rather than suitability for recreation grades, demonstrates the sensitivity of site grades to higher indicator bacteria results. For coastal sites, it is important to remember that results also include those following wet weather events, thus inclusive of higher than ambient indicator bacteria during dry weather.

MACs determined for 11 winter recreational water quality sites, ranged from 'B' to 'D'. (Figure 4.3, Appendix 3C). The three sites graded 'D' were Porirua Harbour at Rowing Club, South Beach at Plimmerton and Robinson Bay at Nikau Street. This is the second time that winter MACs have been calculated using data outside of the summer recreation period. Overall, MACs were unchanged from the 2016/17 winter period except for Scorching Bay which dropped a grade from 'B' to 'C'. Compared to the summer weekly monitoring data (see Appendix 3B), six sites had lower MACs outside of the summer recreation period (South Beach at Plimmerton, Porirua Harbour at Rowing Club, Titahi Bay at Toms Road, Scorching Bay, Island Bay at Surf Club and Robinson Bay at Nikau Street). One site technically achieved a better MAC (Lyall Bay at Tirangi Road), but there was only a difference of 8 cfu/100mL between the calculated percentile scores that separated the two categories (Appendix 3C). It should be noted that different time frames were used for the seasonal data sets; the winter data set included data from 2013/14 to 2017/18 in order to reach at least 60 data points per site for statistical robustness, whereas summer MACs used the last three years only.

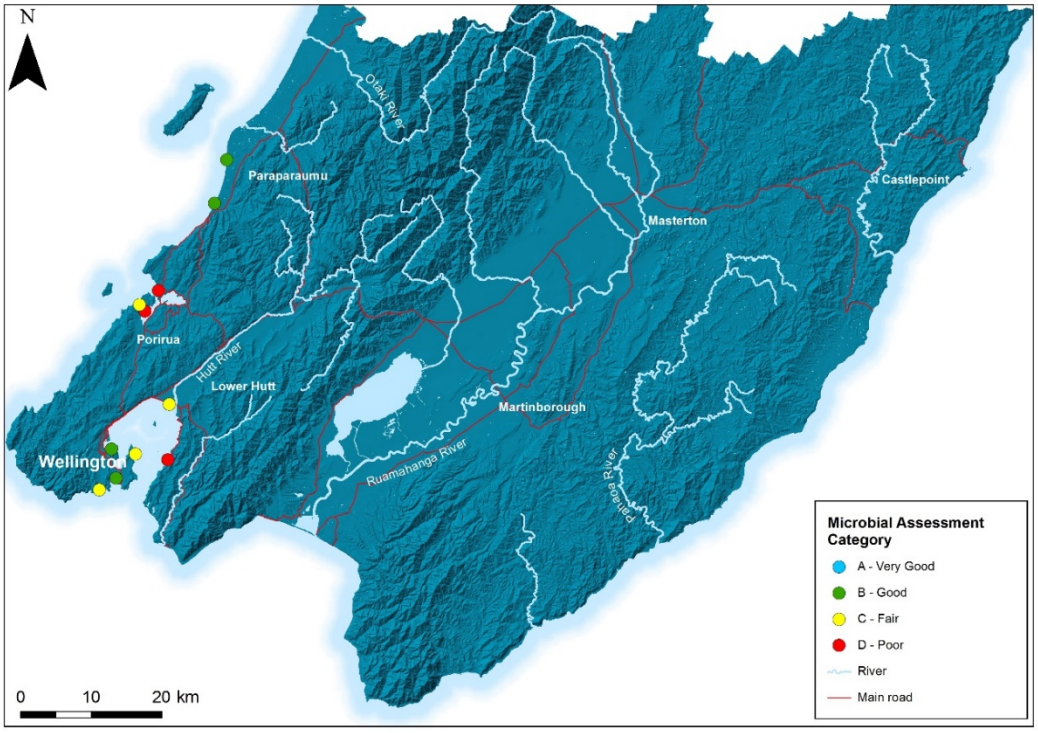

Figure 4.3: Microbiological Assessment Categories for winter coastal recreational water quality sites in the Wellington region, monitored between 1 July to 30 November 2017 and 1 April to 30 June 2018

4.6 Summary

Forty four of the 61 coastal sites (72%) monitored weekly during the 2017/18 summer recreation period exceeded the MfE/MoH (2003) action guideline for microbiological water quality on at least one or more occasions. Sites that most frequently exceeded the action guideline were Plimmerton Beach at South Road, Porirua Harbour at Wi Neera Drive, and Paraparaumu Beach at Maclean Park. 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 Plimmerton Beach at South Road the exact cause(s) of these dry exceedances are unknown, but investigations undertaken by Wellington Water have continued periodically in response to elevated surveillance results. Regarding the Wi Neera Drive at Boat Ramp site (Onepoto arm of Porirua Harbour), it is now demonstrated that this site, along with other sites in Porirua Harbour, particularly in the Onepoto Arm, 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 2017/18 bathing season, 48% of coastal monitoring sites have MACs of 'B' or better, and 47% of sites are graded 'C'. The remaining 5% were graded 'D' this bathing season.

Ten winter recreation period exceedances occurred at five of the eleven sites monitored – five of these occurred at one site (Porirua Harbour at Rowing Club). Three out of ten exceedances (including two at the Rowing Club site) were not associated with rainfall and are considered dry exceedances. This site is likely susceptible to poor water quality, both from the Onepoto Stream mouth discharge, as well as the Porirua Stream plume which eddies around the Onepoto Arm of the Harbour. In general, MACs 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 2017/18 (Figure 5.1, Appendix 1), as follows:

- Kapiti Coast District – 3 sites
- Porirua City – 1 site[6]
- Hutt City – 1 site
- Wellington City – 2 sites

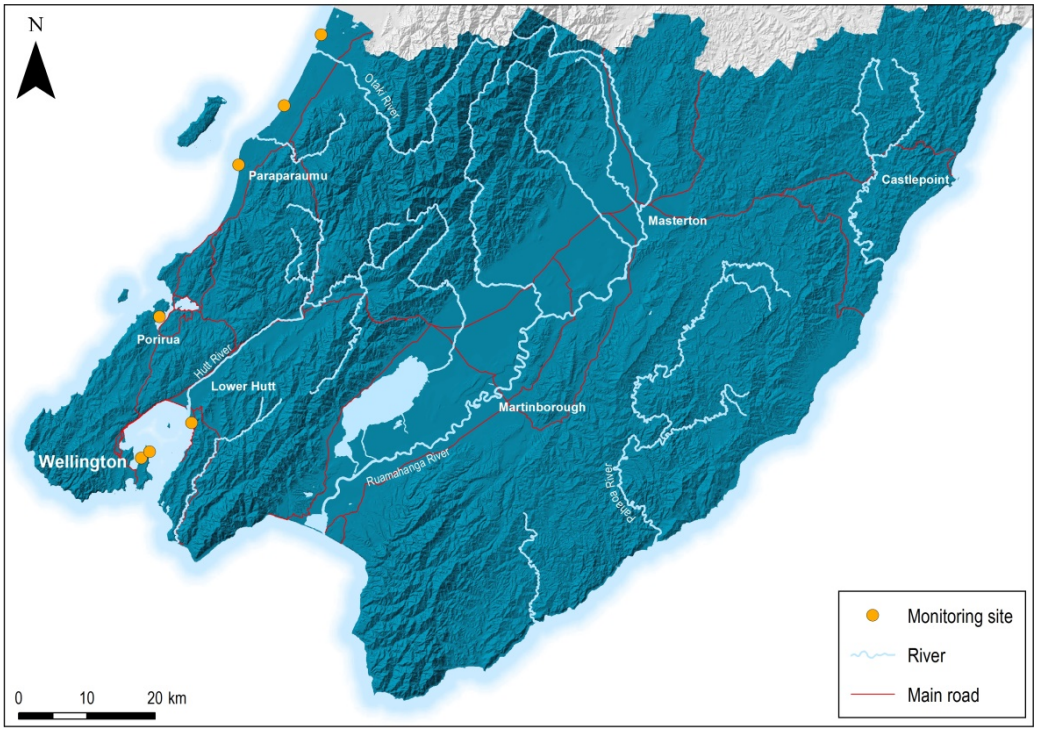

Figure 5.1: Recreational shellfish gathering water quality monitoring sites, 2017/18

5.2 Monitoring protocol

Sites were sampled weekly for 17 weeks between 1 December 2017 and 31 March 2018 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 method (with result reported in cfu/100mL).

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:

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

- 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 laboratory results for faecal coliforms were reported in colony forming units (CFU), rather than the most probably number (MPN) units as listed in the guidelines. Although the MfE/MoH (2003) guidelines recommend the five-tube decimal dilution test (known as the Most Probable Number (MPN) statistical method), membrane filtration produces a result in colony forming units (CFU) and is a faster test, providing a result in 24 hours. The MfE/MoH (2003) guidelines states that a validated alternative method (other than the MPN) is acceptable, where an equivalent result for the shellfish gathering waters being tested is achieved. The CFU method is considered an acceptable alternative for the high level risk assessment that this comparison against the guidelines produces.

The MfE/MoH (2003) guidelines also state that the guideline values above should be applied in conjunction with a sanitary survey. However this step is reliant on detailed objective information in the form of Sanitary Inspection Categories (SICs) which indicate the susceptibility of these sites to faecal contamination; this updated information is currently not available. Whilst this process is set out in the MfE/MoH (2003) guidelines, this procedure itself is in need of review.

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 and consuming 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. However this process is expensive to undertake on a regular basis required to quantitatively assess risks to human health. It also requires the support of appropriately benchmarked and updated guidelines to ensure appropriate levels of risk are applied (i.e. results are benchmarked against a full quantitative risk assessment). 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 2017/18 season (Table 5.1). This result is also consistent with the 2016/17 season (Brasell and Morar 2017) whereby no sites were fully compliant with the guidelines. Three sites recorded median faecal coliform counts below the 14 MPN criteria, but also recorded higher than 10% guideline exceedances. Porirua Harbour (Rowing Club) and the three Kapiti sites all recorded median faecal coliform counts at or higher than 14 MPN, and also breached the guidelines about one third of the sampling occasions.

Table 5.1: Analysis of faecal coliform counts obtained from routine weekly monitoring during the 2017/18 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	**14**	1030	5 (**31%**)	16
Peka Peka Beach at Road End	**24**	675	4 (**24%**)	17
Raumati Beach at Tainui St	**19**	410	5 (**29%**)	17
Porirua				
Porirua Harbour at Rowing Club	**16**	560	6 (**35%**)	17
Wellington City				
Shark Bay	8	270	2 (**12%**)	17
Mahanga Bay	4	160	2 (**12%**)	17
Hutt				
Sorrento Bay	8	200	3 (**18%**)	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[2]	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
Wellington City	**Coastal**	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

			NZTM coordinates		
Area	**Site type**	**Site name**	**Easting**	**Northing**	**Rainfall Gauge**
		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	1768396	5443805	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 Bay[2]	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

			NZTM coordinates		
Area	**Site type**	**Site name**	**Easting**	**Northing**	**Rainfall Gauge**
		Robinson Bay at Nikau Street	1758131	5425856	Hutt River at Shandon Golf Club
Wairarapa	**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
		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 Water Quality and Ecology (RWQE) 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 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: Microbiological Assessment Categories

Microbiological water quality data for the 2017/18 summer are summarised in the tables below. The Microbiological Assessment Category (MAC) values and have been updated using the 2015/16–2017/18 microbiological water quality results. Up and down arrows beside grades indicate positive and negative changes, respectively, in MACs from those assigned at the end of the 2016/17 bathing season (as listed in Brasell and Morar 2017).

(A) Fresh waters

Bathing site	No. sample results (*E. coli*/100 mL)				River grading (2015/16 – 2017/18 data)	
					MAC Grade (95th %ile value)	
	n	Surveillance (≤ 260)	Alert (261-550)	Action (>550)	All flows	Dry flows
Kapiti						
Otaki - Pots[1]	5	4	0	0	A (41)[2]	A (33)[2]
Otaki - SH1	17	16	0	1	C (443)	B (250)
Waikanae - SH1	17	14	1	2	D (616)↓	D (590) ↓
Waikanae - JC Pk	17	15	1	1	D (568) ↓	C (482)
Hutt & Wainuomata						
Pakuratahi - Hutt Forks	17	13	2	2	D (554) ↓↓	C (496)* ↓
Akatarawa - Hutt Confl.	17	14	3	0	C (510)[3]	C (416)[3]
Hutt - Birchville	17	15	2	0	C (383) ↓↓	B (245) ↓
Hutt - Maoribank Cr	17	14	0	3	D (788) ↓↓↓	B (235)* ↓
Hutt - Poets Pk	17	13	2	2	D (638) ↓↓↓	C (423)* ↓↓
Hutt - Silverstream Br.	17	15	0	2	D (664) ↓↓	B (176)
Hutt - Melling Br.	17	13	1	3	D (708)	D (606)
Wainuiomata - RP Pk	17	10	3	4	D (918)	D (929)
Wairarapa						
Ruamahanga - Double Br.	17	16	1	0	B (183)	A (109)
Ruamahanga - Te Ore Ore	17	16	0	1	D (1140)	D (969)
Waipoua - Colombo Rd	17	16	0	1	B (235)	B (236)
Waingawa - Kaituna	17	17	0	0	A (90)	A (58)
Waingawa - South Rd	17	17	0	0	A (96)	A (94)
Ruamahanga - The Cliffs	17	16	0	1	B (145) ↓	B (148)[5] ↓
Ruamahanga - Kokotau	17	17	0	0	B (175)	B (177)
Waiohine - Gorge[1]	3[7]	2	0	0	A (122) [2]	A (65)
Waiohine - SH2	17	17	0	0	A (63) ↑↑	A (37)
Ruamahanga - Morrisons Bush	17	17	0	0	B (164)	B (143)
Ruamahanga - Waihenga Br.	17	16	1	0	B (175)	B (156)
Tauherenikau - Bucks Rd	17	16	1	0	A (64)	A (82)
Tauherenikau - Websters[1]	3[7]	2	1	0	C (311)[4]	B (152)[4] ↑
Riversdale Lagoon[8]	N/A	N/A	N/A	N/A	C (505)	N/A

*High *E. coli* count recorded on 4/1/18 censored from overall dry weather grade due to time lag between heavy rainfall and river flow

[1] Sampled monthly under GWRC's Rivers Water Quality and Ecology (RWQE) water quality programme.

[2] Based on summer-time data collected monthly from 2004/05–2017/18 as part of the RWQE programme.

[3] Based on summer-time data collected monthly from 2011/12–2015/16 as part of the RWQE programme and weekly in 2017/18

[4] Based on summer-time data collected monthly from 2005/06–2017/18 as part of the RWQE programme.

[7] Not sampled on some occasions due to safety issues

[8] Sampling discontinued due to permanent health warning. MAC based on 2016/17 assessment

(B) Coastal waters – summer recreation period

Site	*n*	No. sample results (Enterococci cfu/100mL)			Beach grading (2015/16-2017/18 data)
		Surveillance (≤ 140)	Alert (141-280)	Action (>280)	MAC Grade (95th %ile value)
Kapiti					
Otaki Beach at Surf Club	17	16	0	1	B (120)
Te Horo Beach at Sea Road	17	14	2	1	C (223) ↓
Peka Peka Beach at Road End	17	15	0	2	B (102)
Waikanae Beach at William Street	17	16	1	0	B (117)
Waikanae Beach at Ara Kuaka Carpark	17	16	1	0	B (58)
Paraparaumu Beach at Ngapotiki Street	17	16	0	1	B (187)
Paraparaumu Beach at Nathan Avenue	17	15	1	1	C (217) ↓
Paraparaumu Beach at Maclean Park	17	13	1	3	D (529) ↓
Paraparaumu Beach at Toru Road	17	16	1	0	B (182)
Raumati Beach at Tainui Street	17	16	1	0	B (128)
Raumati Beach at Marine Gardens	17	16	0	1	B (167)
Raumati Beach at Aotea Road	17	16	0	1	B (174) ↑
Paekakariki Beach at Whareroa Road	17	17	0	0	B (78)
Paekakariki Beach at Surf Club	17	17	0	0	B (69)
Porirua					
Pukerua Bay	16	16	0	0	B (44)
Karehana Bay at Cluny Road	17	16	0	1	B (139)
Onehunga Bay[1]	N/A	N/A	N/A	N/A	B (110)[1]
Plimmerton Beach at Bath Street	17	14	1	2	D (858) ↓
South Beach at Plimmerton	17	10	2	5	C (455)
Pauatahanui Inlet at Water Ski Club	17	16	1	0	C (230)
Pauatahanui Inlet at Paremata Bridge	16	16	0	0	A (24)
Porirua Harbour at Wi Neera Drive Boat Ramp[2]	17	11	2	4	D (862)[2]
Porirua Harbour at Rowing Club	16	15	0	1	C (338)
Titahi Bay at Bay Drive	17	16	1	0	B (176) ↑
Titahi Bay at Toms Road	17	15	2	0	B (125)
Titahi Bay at South Beach Access Road	17	14	3	0	C (236)
Wellington					
Wellington City Waterfront at Shed 6[2]	17	15	1	1	C (236)[2]
Aotea Lagoon	17	14	1	2	C (390)
Wellington Harbour at Taranaki St Dive Platform	17	14	1	2	C (390)
Oriental Bay at Freyberg Beach	17	16	0	1	C (232) ↓
Oriental Bay at Wishing Well	17	16	0	1	B (118)
Oriental Bay at Band Rotunda	17	15	0	2	C (206) ↓
Balaena Bay	17	16	0	1	B (118) ↓
Hataitai Beach	17	16	0	1	B (80)
Shark Bay	17	16	1	0	B (175)
Mahanga Bay	17	16	0	1	B (52) ↓
Scorching Bay	17	16	0	1	B (67)
Worser Bay	17	16	0	1	B (84)
Seatoun Beach at Wharf	17	16	0	1	C (301) ↓
Seatoun Beach at Inglis Street	17	17	0	0	B (120)
Breaker Bay	17	16	0	1	B (130)
Lyall Bay at Tirangi Road	17	17	0	0	C (208)
Lyall Bay at Onepu Road	17	16	0	1	C (224) ↓
Lyall Bay at Queens Drive	17	17	0	0	B (97)
Princess Bay	17	16	0	1	B (55) ↓
Island Bay at Reef St Recreation Ground	17	16	0	1	C (280)
Island Bay at Surf Club	17	17	0	0	B (56) ↑
Island Bay at Derwent Street	17	16	0	1	C (279) ↓
Owhiro Bay	17	16	0	1	C (336)

Site	*n*	No. sample results (Enterococci cfu/100mL)			Beach grading (2015/16-2017/18 data)
		Surveillance (≤ 140)	Alert (141-280)	Action (>280)	MAC Grade (95th %ile value)
Hutt					
Petone Beach at Water Ski Club	17	15	1	1	C (230)
Petone Beach at Sydney Street	17	15	0	2	C (434)
Petone Beach at Kiosk	17	15	0	2	C (323)
Sorrento Bay	17	16	0	1	C (350)
Lowry Bay at Cheviot Road	17	16	0	1	C (356)
York Bay	17	16	0	1	C (368) ↓
Days Bay at Wellesley College	17	16	0	1	C (292)
Days Bay at Wharf	17	16	0	1	B (198)
Days Bay at Moana Road	17	15	0	2	C (336) ↓
Rona Bay at N end of Cliff Bishop Park	17	16	0	1	C (358)
Rona Bay at Wharf	17	15	0	2	C (298)
Robinson Bay at HW Shortt Rec Ground	17	15	0	2	C (319)
Robinson Bay at Nikau Street	17	15	1	1	C (306)
Wairarapa					
Castlepoint Beach at Castlepoint Stream[3]	N/A	N/A	N/A	N/A	B (51)[3]
Castlepoint Beach at Smelly Creek[3]	N/A	N/A	N/A	N/A	A (14)[3]
Riversdale Beach Between the Flags[3]	N/A	N/A	N/A	N/A	A (15)[3]

[1] = Not sampled in 2017/18, grade based on data collected in 2009/10, 2010/11 and 2015/16

[2] = Grade based on only 2 years of data, as site was recently added to the monitoring network

[3]= Sampling discontinued in 2017/18, MAC grades based on data for 2014/15, 2015/16, 2016/17

(C) Coastal waters – winter recreation period

Site	n	No. sample results (Enterococci cfu/100mL)			Beach Grading	
		Surveillance (≤ 140)	Alert (141-280)	Action (>280)	Winter data (2013/14-2017/18 data)[1]	Summer data (2015/16-2017/18 data)
					MAC Grade (95th %ile value)	MAC Grade (95th %ile value)
Kapiti						
Raumati Beach at Marine Gardens	18	18	0	0	B (131)	B (167)
Paekakariki Beach at Surf Club	18	18	0	0	B (73)	B (69)
Porirua						
South Beach at Plimmerton	18	16	1	1	D (1250)	C (455)
Porirua Harbour at Rowing Club	18	13	0	5	D (1225)	C (338)
Titahi Bay at Toms Road	18	17	0	1	C (275)	B (125)
Wellington[1]						
Oriental Bay at Wishing Well	18	15	3	0	B (193)	B (118)
Scorching Bay	18	16	2	0	C (202)↓	B (67)
Lyall Bay at Tirangi Road	19	15	2	1	B (200)	C (208)
Island Bay at Surf Club	19	14	3	1	C (255)	B (56)
Hutt						
Petone Beach at Kiosk	18	15	3	0	C (471)	C (323)
Robinson Bay at Nikau Street	18	15	2	1	D (602)	C (306)

[1] Winter grades for Wellington sites based on data collected between 2013/14 and 2017/18 (60 data points). Different time frames were used for the winter data set in order to reach a minimum of 60 data points per site for statistical robustness.