



Annual freshwater quality monitoring report for the Wellington region, 2011/12

Quality for Life



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REGIONAL COUNCIL
Te Pane Matua Taiao





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A Perrie
C Conwell

Environmental Science Department

For more information, contact the Greater Wellington Regional Council:

Wellington
PO Box 11646

Masterton
PO Box 41

T 04 384 5708
F 04 385 6960
www.gw.govt.nz

T 06 378 2484
F 06 378 2146
www.gw.govt.nz

GW/ESCI-G-13/32

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

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1. Introduction

Fresh water in the Wellington region is highly valued for a variety of uses, including water supply, irrigation, recreation and aquatic ecosystem health. To assist with the sustainable management of freshwater resources in the Wellington region, Greater Wellington Regional Council (GWRC) conducts regular monitoring of the quality of both surface waters (lakes, rivers and streams) and groundwater. GWRC also carries out a hydrological monitoring programme that includes a network of sites for measuring rainfall, river flows, and groundwater, wetland and lake levels (see Gordon et al. 2013).

Greater Wellington Regional Council's State of the Environment (SoE) fresh water quality monitoring programmes incorporate 55 river and stream sites, two lakes and 70 groundwater sites. This report summarises the results of SoE monitoring undertaken over the period 1 July 2011 to 30 June 2012 inclusive, as well as the key findings from targeted investigations carried out or completed during the year. Note that the suitability of fresh waters for contact recreation purposes is reported separately under GWRC's recreational water quality monitoring programme (for the 2011/12 results, see Morar & Greenfield 2012).

1.1 Monitoring objectives

The aims of GWRC's freshwater quality monitoring programmes are to:

1. Assist in the detection of spatial and temporal changes in fresh waters;
2. Contribute to our understanding of freshwater biodiversity in the Wellington region;
3. Determine the suitability of fresh waters for designated uses;
4. Provide information to assist in targeted investigations where remediation or mitigation of poor water quality or ecosystem health is desired; and
5. Provide information required to determine the effectiveness of regional plans and policies.

2. Rivers and streams

This section summarises the key results from the Rivers State of Environment (RSoE) monitoring programme for 2011/12. The RSoE programme incorporates monthly monitoring of water quality and periphyton cover at 55 river and stream sites, and annual assessments of aquatic health (invertebrate community composition and periphyton biomass).

2.1 Overview of RSoE monitoring programme

River and stream water quality has been routinely monitored in the western half of the Wellington region since 1987 and in the Wairarapa since 1991. The monitoring programme has continued to evolve since this time with changes made to the location and number of monitoring sites, the range of variables monitored, and the methods of analysis (see Milne and Perrie (2005) and Perrie et al. (2012) for details). However, since September 2003, the RSoE monitoring programme has remained largely unchanged, with only minor changes to the existing suite of monitoring sites and variables.

2.1.1 Monitoring network

Water quality and ecosystem health are currently monitored at 55 river and stream sites (Figure 2.1, Appendix 1). These sites were chosen to represent the major land uses and human activities, and also the natural diversity of rivers and streams, in the region.

(a) Changes to the monitoring network

In July 2011, monitoring commenced at a site located on the Waiwhetu Stream at Whites Line East (site RS57), approximately 0.9 km upstream of the existing long-term site located at Wainuiomata Hill Bridge (site RS27). This new site was established because it is above the point of tidal influence (water quality at site RS27 was occasionally influenced by tidal exchange (Perrie et al. 2012)). Water quality monitoring was undertaken concurrently at both sites for a six-month period (July 2011 to December 2011 inclusive) and all monitoring ceased at Waiwhetu Stream at Wainuiomata at Hill Bridge in December 2011. Only data for the new site are presented in this report.

2.1.2 Monitoring variables

(a) Water quality variables

River and stream water quality is assessed at monthly intervals by measuring a range of physico-chemical and microbiological variables: dissolved oxygen, temperature, pH, conductivity, visual clarity, turbidity, suspended solids, faecal indicator bacteria, total organic carbon, and dissolved and total nutrients. Water samples from ten RSoE sites located in urban catchments with likely exposure to heavy metal inputs, or which discharge into sensitive downstream receiving environments (eg, harbours and estuaries), are also analysed for dissolved concentrations of copper, lead and zinc. The full list of variables monitored, together with details of field and analytical methods, is provided in Appendix 2.

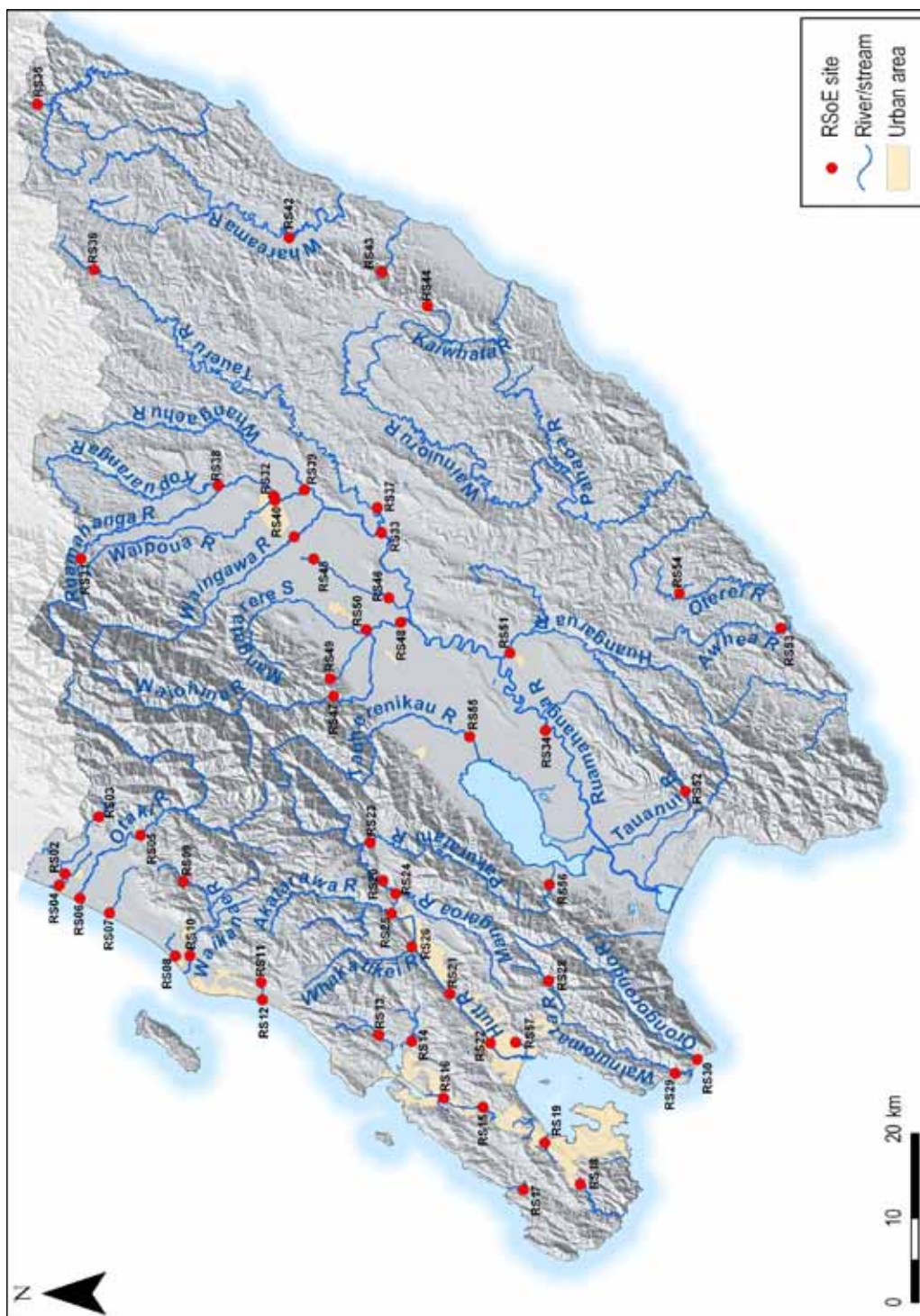


Figure 2.1: RSoE sites monitored over 2011/12

(b) Biological variables

Water quality in the region's rivers and streams is also assessed through annual biological monitoring, incorporating semi-quantitative assessments of macroinvertebrate communities and periphyton biomass during stable/low flows in summer/autumn. Assessments of periphyton are only undertaken at sites with hard substrates such as cobbles and large gravel (46 in total, see Appendix 1 for RSoE site substrate types). Periphyton cover is also assessed monthly at these sites at the time of water sample collection. Details of current biological monitoring methods are summarised in Appendix 2.

2.2 Physico-chemical and microbiological water quality

2.2.1 Approach to analysis

In this section a water quality index is used as a comparative measure to summarise water quality across the region, based on physico-chemical and microbiological data collected monthly from July 2011 to June 2012 inclusive (see Appendix 3 for full data summaries). Concentrations of heavy metals recorded at selected urban sites are also summarised. The summary information is typically based on 12 sampling events for all 55 sites. However, access to five sites (Beef Creek at Headwaters, Coles Creek tributary at Lagoon Hill Road, Parkvale tributary at Lowes Reserve, Totara Stream at Stronvar and Wainuiomata River at Manuka Track) was not always possible due to access issues (eg, during lambing or calving) or due to safety concerns (eg, access tracks dangerous during winter).

During data processing, any water quality variables reported as less than or greater than detection limits were replaced by values one half of the detection limit or the detection limit respectively (eg, a value of <2 became 1, a value of >400 became 400). The exception is the minimum values reported in the tabulated summaries in Appendix 3 (ie, a value of <2 is reported as <2).

(a) Water quality index

A water quality index (WQI), as described in Perrie (2007) and Perrie et al. (2012), is used to facilitate inter-site comparisons of the state of water quality in the region's rivers and streams. The WQI is derived from the *median* values of the following six variables: visual clarity (black disc), dissolved oxygen (% saturation), dissolved reactive phosphorus, ammoniacal nitrogen, nitrite-nitrate nitrogen and *Escherichia coli* (*E. coli*).

The application of the WQI enables water quality at each site to be classified into one of four categories as follows:

- Excellent: median values for all 6 variables comply with guideline values
- Good: median values for 5 of the 6 variables comply with guideline values, of which dissolved oxygen is one variable that must comply¹

¹ If the median dissolved oxygen concentration does not comply with the guideline value, then the WQI grade automatically drops to 'poor'.

- Fair: median values for 3 or 4 of the 6 variables comply with guideline values, of which dissolved oxygen is one variable that must comply¹
- Poor: median values for <3 of the 6 variables comply with guideline values.

The guidelines used in the WQI assessment are listed in Table 2.1. Refer to Perrie (2007) and Perrie et al. (2012) for further discussion on these guidelines.

Table 2.1: Physico-chemical and microbiological variables and guideline values used in GWRC's WQI

Variable	Guideline value	Reference
Dissolved oxygen (% saturation)	≥80	RMA 1991 Third Schedule
Visual clarity (m)	≥1.6	MfE (1994)
Nitrite-nitrate nitrogen (mg/L)	≤0.444	ANZECC & ARMCANZ (2000)
Ammoniacal nitrogen (mg/L)	≤0.021	ANZECC & ARMCANZ (2000)
Dissolved reactive phosphorus (mg/L)	≤0.010	ANZECC & ARMCANZ (2000)
<i>E. coli</i> (cfu/100mL)	≤100	ANZECC & ARMCANZ (2000)

(b) Heavy metals

Median heavy metal concentrations are compared against ANZECC (2000) chronic toxicity 'trigger values' (95% level of protection). Because water hardness affects the toxicity of some heavy metals, where a median concentration exceeds the trigger value, site-specific, hardness-modified trigger values are calculated based on recommendations and equations in ANZECC (2000). The median concentrations are then compared against their respective modified trigger value. Because water hardness is not part of the existing suite of variables analysed in the RSoE programme, the median water hardness from monthly monitoring over January 2008 to December 2008 (inclusive) is used as a surrogate of local water hardness conditions (see Perrie et al. (2012) for hardness information²).

2.2.2 Results and discussion

(a) Water quality index

Application of the WQI resulted in the following overall water quality grades for the 55 RSoE sites monitored in the Wellington region over the July 2011 to June 2012 reporting period (Figure 2.2, Table 2.2):

- Excellent: 19 sites (34.5%)
- Good: 11 sites (20.0%)
- Fair: 11 sites (20.0%)
- Poor 14 sites (25.5%)

Seventeen of the 19 RSoE sites graded 'excellent' are located on river and stream reaches in catchments with predominantly unmodified indigenous forest cover (refer Appendix 1 for dominant land cover). These tend to be sites on rivers flowing out of the Aorangi, Tararua and Rimutaka ranges and include the Otaki, Whakatikei and Waiorongomai rivers, and the upper reaches of the

² For the new RSoE site established in July 2011, Waiwhetu Stream at Whites Line East (RS57), water hardness data collected from the historical site at Wainuiomata Hill Bridge was used to generate site-specific, hardness-modified trigger values.

Hutt, Waitohu and Ruamahanga rivers. In contrast, RSoE sites graded ‘poor’ are typically located on small rivers or streams draining predominantly pastoral (nine sites) or urban (five sites) catchments. Sites with the poorest water quality during 2011/12 included the Waiwhetu Stream at Whites Line East, Mangapouri Stream at Bennetts Road and the Mangaone Stream at Sims Road Bridge (Table 2.2).

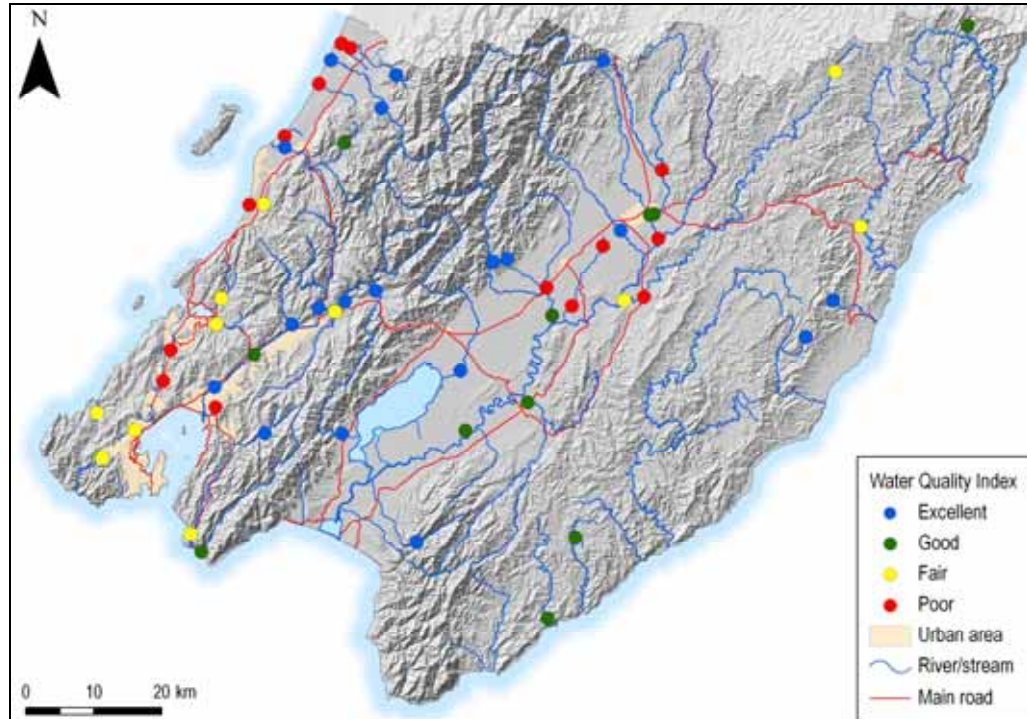


Figure 2.2: Water Quality Index grades for RSoE sites sampled at monthly intervals between July 2011 and June 2012, based on compliance of median dissolved oxygen, visual clarity, nitrite-nitrate nitrogen, ammoniacal nitrogen, dissolved reactive phosphorus and *E. coli* values with guideline values

As outlined in Perrie (2007), the WQI is for comparative purposes rather than an absolute measure of water quality; sites with a grade of ‘good’, ‘fair’, or ‘poor’ are all considered degraded to some degree because the median value of at least one of the six physico-chemical or microbiological variables in the WQI exceeded a guideline value. In addition, as the WQI is based on median values (ie, 50% compliance), sites awarded the same water quality grade may exhibit varying degrees of compliance (from 51 to 100%) with the guideline value. Therefore, to differentiate between ‘better’ and ‘poorer’ sites, in Table 2.2 the sites within each WQI class have been ranked based on the number of guideline exceedances for each of the six key variables (ie, a site that exceeded a guideline on 40% of sampling occasions will be ranked lower than a site with the same WQI grade that exceeded the guideline on 10% of sampling occasions).

The water quality variables that most commonly exceeded guideline values (based on median values) were visual clarity (26 sites), followed by *E. coli* (24 sites) dissolved reactive phosphorus (23 sites), and nitrite-nitrate nitrogen (14 sites). Guidelines for ammoniacal nitrogen and dissolved oxygen were not met at seven and five sites, respectively.

Table 2.2: Water Quality Index grades for RSoE sites sampled at monthly intervals over July 2011 to June 2012 inclusive, based on compliance of median dissolved oxygen (DO), visual clarity (clarity), *E. coli*, nitrite-nitrate nitrogen (NNN), ammoniacal nitrogen (Amm. N) and dissolved reactive phosphorus (DRP) values with guideline values

Rank	Site no.	Site name	Guideline compliance (median values)					
			DO	Clarity	<i>E. coli</i>	NNN	Amm. N	DRP
<i>Excellent water quality</i>								
1	RS52	Tauanui R at Whakatomotomo Rd	✓	✓	✓	✓	✓	✓
2	RS49	Beef Ck at Headwaters	✓	✓	✓	✓	✓	✓
3	RS47	Waiohine R at Gorge	✓	✓	✓	✓	✓	✓
4=	RS20	Hutt R at Te Marua Intake Site	✓	✓	✓	✓	✓	✓
4=	RS43	Motuwaireka S at Headwaters	✓	✓	✓	✓	✓	✓
4=	RS05	Otaki R at Pukehinau	✓	✓	✓	✓	✓	✓
4=	RS41	Waingawa R at South Rd	✓	✓	✓	✓	✓	✓
4=	RS56	Waiorongomai R at Forest Pk	✓	✓	✓	✓	✓	✓
4=	RS03	Waitohu S at Forest Pk	✓	✓	✓	✓	✓	✓
10=	RS25	Akatarawa R at Hutt confl.	✓	✓	✓	✓	✓	✓
10=	RS31	Ruamahanga R at McLays	✓	✓	✓	✓	✓	✓
10=	RS26	Whakatikei R at Riverstone	✓	✓	✓	✓	✓	✓
13=	RS23	Pakuratahi R 50m d/s Farm Ck	✓	✓	✓	✓	✓	✓
13=	RS55	Tauherenikau R at Websters	✓	✓	✓	✓	✓	✓
13=	RS44	Totara S at Stronvar	✓	✓	✓	✓	✓	✓
16	RS28	Wainuiomata R at Manuka Track	✓	✓	✓	✓	✓	✓
17=	RS06	Otaki R at Mouth	✓	✓	✓	✓	✓	✓
17=	RS10	Waikanae R at Greenaway Rd	✓	✓	✓	✓	✓	✓
19	RS22	Hutt R at Boulcott	✓	✓	✓	✓	✓	✓
<i>Good water quality</i>								
20	RS35	Mataikona Trib at Sugar Loaf Rd	✓	x	✓	✓	✓	✓
21	RS21	Hutt R opp. Manor Park G.C.	✓	✓	x	✓	✓	✓
22	RS54	Coles Ck Trib at Lagoon Hill Rd	✓	x	✓	✓	✓	✓
23	RS30	Orongorongo R at Orongorongo Stn	✓	x	✓	✓	✓	✓
24	RS53	Awhea R at Tora Rd	✓	x	✓	✓	✓	✓
25	RS09	Waikanae R at Mangaone Walkway	✓	✓	✓	✓	✓	x
26	RS32	Ruamahanga R at Te Ore Ore	✓	✓	x	✓	✓	✓
27	RS40	Waipoua R at Colombo Rd Br	✓	✓	✓	x	✓	✓
28=	RS51	Huangaia R at Ponatahi Br	✓	x	✓	✓	✓	✓
28=	RS34	Ruamahanga R at Pukio	✓	x	✓	✓	✓	✓
28=	RS48	Waiohine R at Bicknells	✓	✓	✓	✓	✓	x
<i>Fair water quality</i>								
31	RS29	Wainuiomata R d/s of White Br	✓	x	x	✓	✓	✓
32	RS42	Whareama R at Gauge	✓	x	x	✓	✓	✓
33	RS36	Taueru R at Castlehill	✓	x	✓	✓	✓	x
34	RS24	Mangaroa R at Te Marua	✓	x	x	✓	✓	✓
35	RS13	Horokiri S at Snodgrass	✓	✓	x	✓	✓	x
36	RS33	Ruamahanga R at Gladstone Br	✓	x	✓	✓	✓	x
37	RS11	Whareroa S at Waterfall Rd	✓	x	x	✓	✓	x
38	RS14	Pauatahanui S at Elmwood Br	✓	x	x	✓	✓	x
39	RS17	Makara S at Kennels	✓	x	x	✓	✓	x
40	RS18	Karori S at Makara Peak	✓	✓	x	x	✓	x
41	RS19	Kaiwharawhara S at Ngaio Gorge	✓	✓	x	x	✓	x
<i>Poor water quality</i>								
42	RS45	Parkvale Trib at Lowes Res.	x	✓	✓	x	✓	✓
43	RS37	Taueru R at Gladstone	✓	x	x	x	✓	x
44	RS38	Kopuaranga R at Stewarts	✓	x	x	x	✓	x
45	RS15	Porirua S at Glenside	✓	x	x	x	✓	x
46	RS16	Porirua S at Wall Park (Milk Depot)	✓	x	x	x	✓	x
47	RS46	Parkvale S at Weir	✓	x	x	x	✓	x
48	RS39	Whangaehu R 250m u/s confl.	✓	x	x	x	✓	x
49	RS50	Mangatarere S at SH 2	✓	✓	x	x	x	x
50	RS04	Waitohu S at Norfolk Cres	✓	x	x	✓	x	x
51	RS08	Ngarara S at Field Way	x	x	x	✓	x	x
52	RS12	Whareroa S at QE Park	x	x	x	✓	x	x
53	RS57	Waiwhetu S at Whites Line East	✓	x	x	x	x	x
54	RS02	Mangapouri S at Bennetts Rd	x	x	x	x	x	x
55	RS07	Mangaone S at Sims Rd Br	x	x	x	x	x	x

(b) Heavy metals

Median dissolved lead concentrations were below the ANZECC (2000) default trigger level at all 10 sites at which heavy metals are tested. Median concentrations of dissolved copper and zinc exceeded their respective default trigger values at two and three sites, respectively. Once local water hardness was taken into account and the site-specific, hardness-modified trigger values applied, no sites exceeded their modified guideline for dissolved copper. However, all three sites (Karori Stream at Makara Peak Mountain Bike Park, Porirua Stream at Wall Park and Waiwhetu Stream at Whites Line East) exceeded their modified guidelines for dissolved zinc.

2.3 Periphyton cover and biomass**2.3.1 Approach to analysis**

Assessment of periphyton data is limited to RSoE sites with hard substrates (46 of the 55 sites). Monthly observations of percent streambed periphyton cover, from July 2011 to June 2012 inclusive, and an assessment of periphyton biomass (chlorophyll *a* and Ash Free Dry Mass (AFDM)) undertaken in late summer/early autumn 2012 are compared against various MfE (2000) guidelines (Table 2.3).

Table 2.3: MfE (2000) guidelines used to assess periphyton streambed cover and biomass

Instream value/variable	Mat periphyton	Filamentous periphyton
<i>Aesthetics/recreation</i>		
Maximum cover of visible streambed	60% >0.3 cm thick	30% >2 cm long
<i>Benthic biodiversity</i>		
Maximum chlorophyll <i>a</i>	50 mg/m ²	50 mg/m ²
<i>Trout habitat and angling</i>		
Maximum AFDM	35 g/m ²	35 g/m ²
Maximum cover of visible streambed	N/A	30% >2 cm long

2.3.2 Results and discussion

The number of observations of streambed periphyton cover made during the reporting period varied among the 46 RSoE sites due to either site access being restricted or because turbid water or high flows prevented periphyton assessments being carried out.

Of the 46 RSoE sites, 17 exceeded the MfE (2000) guideline for filamentous periphyton streambed cover on at least one sampling occasion (Table 2.4). The sites that most often exceeded the guideline were Kaiwharawhara Stream at Ngaio Gorge (five times) and Porirua Stream at Wall Park (Milk Depot) (four times). These sites are both located in catchments dominated by urban land use.

Table 2.4: Summary of monthly observations at RSoE sites, over July 2011 to June 2012 inclusive, of visible streambed filamentous and mat-forming periphyton cover in relation to exceedances of the MfE (2000) guidelines

Site no.	Site name	n	Streambed cover (%)			
			Filamentous (>2 cm long)		Mats (>0.3 cm thick)	
			Max	n >30% cover	Max	n >60% cover
RS03	Waitohu S at Forest Pk	11	0	0	4	0
RS05	Otaki R at Pukehinau	10	2	0	1	0
RS06	Otaki R at Mouth	10	32	1	18	0
RS09	Waikanae R at Mangaone Walkway	12	0	0	0	0
RS10	Waikanae R at Greenaway Rd	10	5	0	23	0
RS11	Whareroa S at Waterfall Rd	10	0	0	0	0
RS13	Horokiri S at Snodgrass	11	46	2	37	0
RS14	Pauatahanui S at Elmwood Br	11	75	3	0	0
RS15	Porirua S at Glenside	10	91	3	13	0
RS16	Porirua S at Wall Park (Milk Depot)	9	83	4	17	0
RS17	Makara S at Kennels	9	4	0	0	0
RS18	Karori S at Makara Peak M.B. Park	11	71	2	14	0
RS19	Kaiwharawhara S at Ngaio Gorge	11	97	5	27	0
RS20	Hutt R at Te Marua Intake Site	11	0	0	12	0
RS21	Hutt R opp. Manor Park G.C.	11	20	0	38	0
RS22	Hutt R at Boulcott	11	17	0	82	1
RS23	Pakuratahi R 50m d/s Farm Ck	11	1	0	23	0
RS24	Mangaroa R at Te Marua	11	64	2	31	0
RS25	Akatarawa R at Hutt confl.	11	0	0	21	0
RS26	Whakatikei R at Riverstone	10	41	1	15	0
RS28	Wainuiomata R at Manuka Track	10	0	0	0	0
RS29	Wainuiomata R u/s of White Br	11	15	0	14	0
RS30	Orongorongo R at Orongorongo Stn	9	0	0	0	0
RS31	Ruamahanga R at McLays	8	0	0	0	0
RS32	Ruamahanga R at Te Ore Ore	9	0	0	8	0
RS33	Ruamahanga R at Gladstone Br	8	13	0	6	0
RS34	Ruamahanga R at Pukio	8	0	0	0	0
RS35	Mataikona Trib at Sugar Loaf Rd	11	0	0	0	0
RS37	Taueru R at Gladstone	4	97	3	0	0
RS38	Kopuaranga R at Stewarts	10	42	2	26	0
RS40	Waipoua R at Colombo Rd Br	10	44	2	69	1
RS41	Waingawa R at South Rd	10	23	0	35	0
RS43	Motuwaireka S at Headwaters	12	26	0	0	0
RS44	Totara S at Stronvar	10	0	0	74	1
RS45	Parkvale Trib at Lowes Res.	11	0	0	0	0
RS46	Parkvale S at Weir	9	11	0	2	0
RS47	Waiohine R at Gorge	10	0	0	9	0
RS48	Waiohine R at Bicknells	10	61	1	16	0
RS49	Beef Ck at Headwaters	11	0	0	1.5	0
RS50	Mangatarere S at SH 2	10	86	3	13	0
RS51	Huangerua R at Ponatahi Br	8	80	3	51	0
RS52	Tauanui R at Whakatomotomo Rd	11	19	0	7	0
RS53	Awhea R at Tora Rd	8	68	3	0	0
RS54	Coles Ck Trib at Lagoon Hill Rd	9	12	0	0	0
RS55	Tauherenikau R at Websters	9	80	1	0	0
RS56	Waiorongomai R at Forest Pk	11	2	0	19	0

Three sites exceeded the MfE (2000) guideline for mat-forming periphyton cover on one occasion during the reporting period: Hutt River at Boulcott, Totara Stream at Stronvar and Waipoua River at Colombo Road. It is important to note that observations of periphyton cover are typically undertaken in run habitat³, whereas some mat-forming periphyton (particularly cyanobacteria) tend to proliferate initially in riffle habitat⁴ and then in runs (MfE & MoH 2009). Thus the results presented here may not accurately represent the presence of mat-forming periphyton, or exceedance of mat-forming periphyton guidelines.

Fifteen RSoE sites exceeded the MfE (2000) chlorophyll *a* guideline for benthic biodiversity (Table 2.5). The highest chlorophyll *a* biomass recorded was in the Huangarua River at Ponatahi Bridge (360.1 mg/m²). This site was also the only site that exceeded the MfE (2000) AFDM guideline for trout habitat and angling.

There was a reasonable relationship between periphyton guideline compliance and WQI grades. In general, sites with 'excellent' water quality were more likely to comply with guidelines for both periphyton cover and biomass than sites assigned lower WQI grades. However, at some sites it was clear that variables other than water quality, such as accrual periods and streamside shade, more strongly influence periphyton growth and hence compliance with guidelines.

2.4 Macroinvertebrates

2.4.1 Approach to analysis

Macroinvertebrate sampling was undertaken at each of the 55 RSoE sites during late summer/early autumn 2012. The Macroinvertebrate Community Index (MCI) – an index of sensitivity to a complex of environmental variables (Stark & Maxted 2007) – is used to summarise macroinvertebrate health. Additional macroinvertebrate indices (QMCI, %EPT taxa, and taxa richness)⁵ are presented in Appendix 3. Refer to Perrie et al. (2012) for further explanation on these indices.

The quality classifications, as recommended by Stark and Maxted (2007), for interpretation of the MCI scores are outlined in Table 2.6. Soft bottomed MCI scores (MCI-sb) were calculated for the nine RSoE sites with soft substrates (see Appendix 1).

³ A run has a character in between that of a riffle and pool, it is moderate in depth and typically has a uniform current and an unbroken surface.

⁴ A riffle is an area of shallow depth, moderate to fast water velocity, with mixed currents and an unbroken but rippled surface.

⁵ QMCI = Quantitative MCI and %EPT = the percentage of pollution-sensitive Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) taxa. See Perrie et al. (2012) for index calculation details.

Table 2.5: Periphyton biomass (AFDM and chlorophyll *a*) from one-off sampling during late summer/ autumn of 2012. Non-compliance with MfE (2000) guidelines is highlighted in bold type

Site no.	Site name	AFDM (g/m ²)	Chlorophyll <i>a</i> (mg/m ²)
RS03	Waitohu S at Forest Pk	0.30	1.01
RS05	Otaki R at Pukehinau	0.30	0.47
RS06	Otaki R at Mouth	1.56	12.61
RS09	Waikanae R at Mangaone Walkway	1.13	2.58
RS10	Waikanae R at Greenaway Rd	7.81	72.73
RS11	Whareroa S at Waterfall Rd	7.29	10.40
RS13	Horokiri S at Snodgrass	9.59	72.74
RS14	Pauatahanui S at Elmwood Br	14.63	34.76
RS15	Porirua S at Glenside	3.46	50.51
RS16	Porirua S at Wall Park (Milk Depot)	2.24	20.82
RS17	Makara S at Kennels	2.23	13.67
RS18	Karori S at Makara Peak M.B. Park	5.60	67.80
RS19	Kaiwharawhara S at Ngaio Gorge	8.01	74.61
RS20	Hutt R at Te Marua Intake Site	5.11	35.97
RS21	Hutt R opp. Manor Park G.C.	22.15	189.58
RS22	Hutt R at Boulcott	22.95	208.88
RS23	Pakuratahi R 50m d/s Farm Ck	3.89	38.07
RS24	Mangaroa R at Te Marua	19.86	123.53
RS25	Akatarawa R at Hutt confl.	6.05	46.34
RS26	Whakatikei R at Riverstone	3.41	16.51
RS28	Wainuiomata R at Manuka Track	1.11	4.35
RS29	Wainuiomata R u/s of White Br	11.36	108.48
RS30	Orongorongo R at Orongorongo Stn	0.14	0.25
RS31	Ruamahanga R at McLays	0.23	0.49
RS32	Ruamahanga R at Te Ore Ore	2.73	34.19
RS33	Ruamahanga R at Gladstone Br	11.75	114.45
RS34	Ruamahanga R at Pukio	15.28	138.69
RS35	Mataikona Trib at Sugar Loaf Rd	0.99	1.62
RS37	Taueru R at Gladstone	7.95	36.45
RS38	Kopuaranga R at Stewarts	7.38	100.20
RS40	Waipoua R at Colombo Rd Br	1.57	6.67
RS41	Waingawa R at South Rd	6.90	47.51
RS43	Motuwaireka S at Headwaters	1.70	2.81
RS44	Totara S at Stronvar	1.49	6.96
RS45	Parkvale Trib at Lowes Res.	6.85	24.72
RS46	Parkvale S at Weir	26.91	218.20
RS47	Waiohine R at Gorge	0.57	3.65
RS48	Waiohine R at Bicknells	7.84	57.93
RS49	Beef Ck at Headwaters	2.28	12.89
RS50	Mangatarere S at SH 2	4.07	27.34
RS51	Huangarua R at Ponatahi Br	44.97	360.06
RS52	Tauanui R at Whakatomotomo Rd	2.56	5.67
RS53	Awhea R at Tora Rd	4.58	15.06
RS54	Coles Ck Trib at Lagoon Hill Rd	2.90	2.95
RS55	Tauherenikau R at Websters	0.59	2.38
RS56	Waiorongomai R at Forest Pk	0.28	0.57

Table 2.6: Interpretation of MCI-type scores (from Stark & Maxted 2007)

Quality class	MCI and MCI-sb
Excellent	≥ 120
Good	100–119
Fair	80–99
Poor	<80

2.4.2 Results and discussion

The MCI scores based on one sample collected from each monitoring site are presented in Table 2.7. The 55 RSoE sites fell into the following MCI quality classes (Figure 2.3):

- Excellent: 20 sites (36.4%)
- Good: 15 sites (27.3%)
- Fair: 13 sites (23.6%)
- Poor: 7 sites (12.7%)

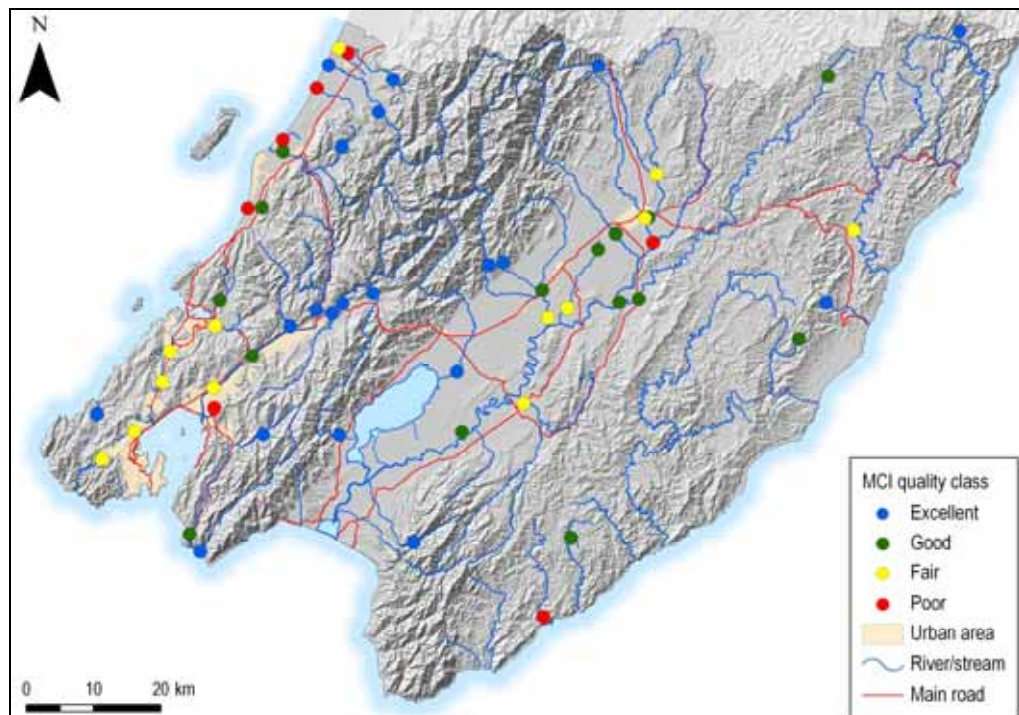


Figure 2.3: MCI quality classes for the 55 RSoE sites, determined from one sampling event over summer/autumn 2011/12

The majority (17 of 20) of the RSoE sites in the ‘excellent’ MCI quality class are located in catchments dominated by indigenous forest cover (eg, Waiohine River at Gorge). The seven RSoE sites in the ‘poor’ quality class are located in catchments dominated by either pastoral landcover (four sites) or urban landcover (three sites). Sites with soft-sediment substrate are also over-represented in this ‘poor’ class (six of nine sites).

Table 2.7: MCI scores for RSoE sites sampled in summer/autumn 2012. An * denotes MCI-sb scores that were used to apply quality classes at soft-bottomed sites while values in brackets are the MCI-hb scores for these sites

Site no.	Site name	MCI score	MCI quality class
RS02	Mangapouri S at Bennetts Rd	62.4* (75.0)	Poor
RS03	Waitohu S at Forest Pk	139.3	Excellent
RS04	Waitohu S at Norfolk Cres	90.7* (94.7)	Fair
RS05	Otaki R at Pukehinau	135.4	Excellent
RS06	Otaki R at Mouth	127.1	Excellent
RS07	Mangaone S at Sims Rd Br	62.8* (75.0)	Poor
RS08	Ngarara S at Field Way	74.3* (88.3)	Poor
RS09	Waikanae R at Mangaone Walkway	138.6	Excellent
RS10	Waikanae R at Greenaway Rd	118.5	Good
RS11	Whareroa S at Waterfall Rd	117.9	Good
RS12	Whareroa S at QE Park	68.9* (76.9)	Poor
RS13	Horokiri S at Snodgrass	107.8	Good
RS14	Pauatahanui S at Elmwood Br	93.9	Fair
RS15	Porirua S at Glenside	98.9	Fair
RS16	Porirua S at Wall Park (Milk Depot)	91.3	Fair
RS17	Makara S at Kennels	120.0	Excellent
RS18	Karori S at Makara Peak	95.5	Fair
RS19	Kaiwharawhara S at Ngaio Gorge	86.7	Fair
RS20	Hutt R at Te Marua Intake Site	135.4	Excellent
RS21	Hutt R opp. Manor Park G.C.	110.5	Good
RS22	Hutt R at Boulcott	97.3	Fair
RS23	Pakuratahi R 50m d/s Farm Ck	127.8	Excellent
RS24	Mangaroa R at Te Marua	127.1	Excellent
RS25	Akatarawa R at Hutt confl.	128.8	Excellent
RS26	Whakatikei R at Riverstone	132.3	Excellent
RS28	Wainuiomata R at Manuka Track	134.3	Excellent
RS29	Wainuiomata R d/s of White Br	105.3	Good
RS30	Orongorongo R at Orongorongo Stn	124.6	Excellent
RS31	Ruamahanga R at McLays	151.1	Excellent
RS32	Ruamahanga R at Te Ore Ore	116.9	Good
RS33	Ruamahanga R at Gladstone Br	101.5	Good
RS34	Ruamahanga R at Pukio	114.3	Good
RS35	Mataikona Trib at Sugar Loaf Rd	130.3	Excellent
RS36	Taueru R at Castlehill	119.7* (103.7)	Good
RS37	Taueru R at Gladstone	109.4* (84.3)	Good
RS38	Kopuaranga R at Stewarts	93.6	Fair
RS39	Whangaehu R 250m u/s confl.	57.7	Poor
RS40	Waipoua R at Colombo Rd Br	94.8	Fair
RS41	Waingawa R at South Rd	109.1	Good
RS42	Whareama R at Gauge	85.0* (82.0)	Fair
RS43	Motuwaireka S at Headwaters	136.6	Excellent
RS44	Totara S at Stronvar	117.9	Good
RS45	Parkvale Trib at Lowes Res.	100.0	Good
RS46	Parkvale S at Weir	84.4	Fair
RS47	Waiohine R at Gorge	150.5	Excellent
RS48	Waiohine R at Bicknells	99.1	Fair
RS49	Beef Ck at Headwaters	140.7	Excellent
RS50	Mangatarere S at SH 2	110.8	Good
RS51	Huangaaru R at Ponatahi Br	91.7	Fair
RS52	Tauanui R at Whakatomotomo Rd	127.4	Excellent
RS53	Awhea R at Tora Rd	77.6	Poor
RS54	Coles Ck Trib at Lagoon Hill Rd	112.4	Good
RS55	Tauherenikau R at Websters	131.1	Excellent
RS56	Waiorongomai R at Forest Pk	133.3	Excellent
RS57	Waiwhetu S at Whites Line East	50.8* (71.7)	Poor

There was a reasonable relationship between the MCI quality classes and WQI grades. For example, of the 20 RSoE sites with an 'excellent' MCI quality class, 15 had a WQI grade of 'excellent' and three a WQI grade of 'good' (refer Section 2.2.2). Similarly, six of the seven RSoE sites with an MCI quality class of 'poor' also had a WQI grade of 'poor'. The relationship between water quality and macroinvertebrate health based on WQI grades and MCI quality grades was less clear in the 'good' and 'fair' classes.

Sites that recorded higher MCI scores were also more likely to comply with both periphyton cover and biomass guidelines. For example, out of the 21 sites that complied with all periphyton guidelines, 16 had MCI grades of 'excellent' and the remaining five sites had MCI scores of 'good'.

2.5 Synthesis

Water quality and aquatic ecosystem health are strongly influenced by landcover; WQI and MCI scores are highest at RSoE sites located on hill-fed river and stream reaches with upstream catchments dominated by unmodified indigenous forest cover. Approximately one third of the rivers and streams within the Wellington region have upstream catchments dominated by indigenous forest. These rivers and streams can generally be expected to have excellent water quality and aquatic ecosystem health. In contrast, RSoE sites with poor WQI and MCI scores are typically located on smaller, low elevation streams draining predominantly pastoral or urban catchments. These sites were also more likely to exceed guidelines for periphyton cover and biomass. Approximately two thirds of rivers and streams in the region are located in pastoral (~60%) or urban catchments (~3%). Water quality and aquatic ecosystem health in these rivers and streams are likely to be impacted to some degree, and in a few cases, may be severely degraded.

3. Lakes

This section summarises results from water quality sampling in Lake Wairarapa and Lake Onoke during 2011/12. These are the only lakes routinely monitored for water quality in the Wellington region.

3.1 Overview of the lakes monitoring programme

Up until recently, GWRC has only routinely monitored water quality in one lake in the region, Lake Wairarapa. Monitoring in this lake commenced in 1994 and incorporates four principal sampling sites. In August 2009, water quality monitoring programmes were established for two additional lakes, Waitawa and Onoke (Figure 3.1). Monitoring of Lake Onoke is ongoing but monitoring in Lake Waitawa was restricted to a year-long investigation (see Perrie & Milne (2012) for a summary of data collected from Lake Waitawa).

In 2011, assessments of ecological condition, based on submerged plant community structure and composition, were also carried out in three lakes: Kohangapiripiri, Kohangatera and Pounui. The results from these assessments are summarised in Perrie and Milne (2012).

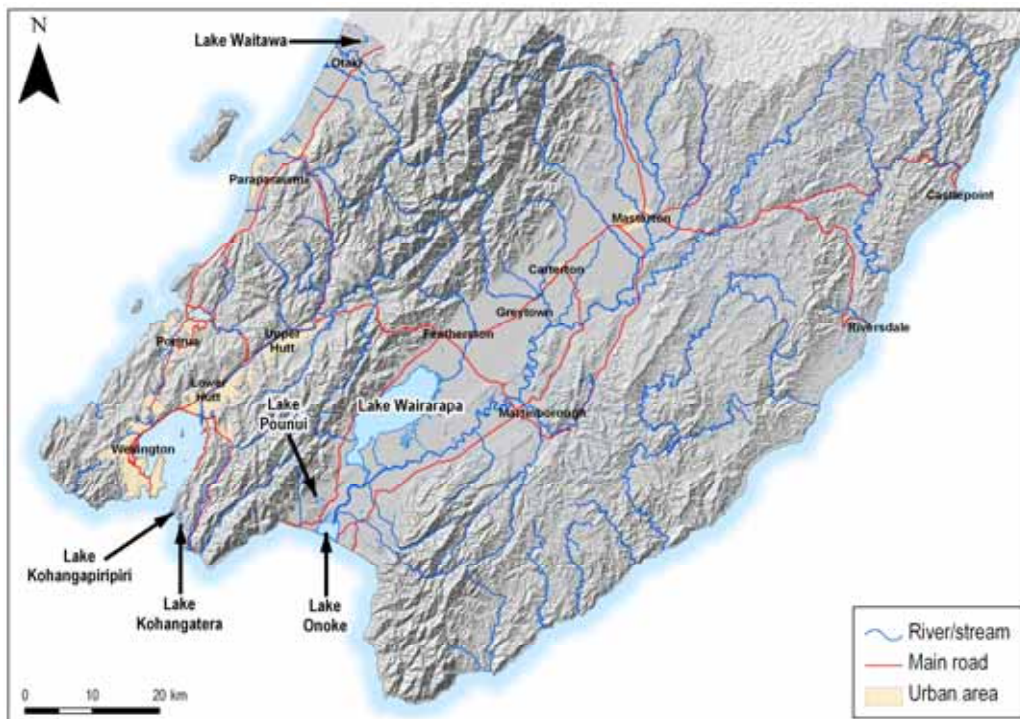


Figure 3.1: Locations of lakes monitored in the Wellington region to date

3.1.1 Monitoring sites

Lake Wairarapa and Lake Onoke water quality monitoring sites are shown in Figure 3.2. Coordinates for these sites can be found in Appendix 1. As the monitoring site in Lake Onoke is located where the Ruamahanga River enters the lake, it is unlikely to be representative of water quality across the whole lake (see Perrie & Milne 2012).

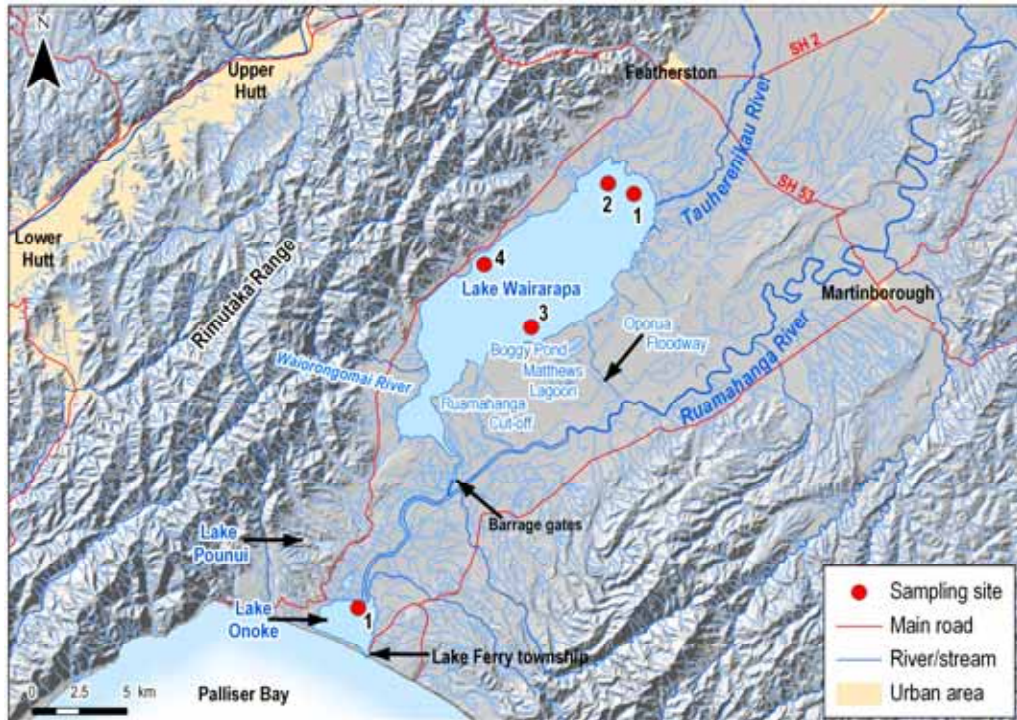


Figure 3.2: Water quality sampling sites on Lake Wairarapa and Lake Onoke

3.1.2 Monitoring variables

Water quality is assessed approximately every four weeks in Lake Onoke and approximately quarterly in Lake Wairarapa⁶ by measuring a range of physico-chemical variables: dissolved oxygen, temperature, pH, conductivity, visual clarity (Secchi depth), turbidity, suspended solids, chlorophyll *a* and dissolved and total nutrients. The full list of variables monitored, together with details of field and analytical methods is provided in Appendix 2.

3.2 Results and discussion

3.2.1 Approach to analysis

Water quality in Lakes Wairarapa and Onoke for the July 2011 to June 2012 period is assessed using the trophic level index (TLI). The TLI was developed by Burns et al. (2000) for assessing the water quality status of New Zealand lakes. The TLI is calculated using four key variables of lake water quality (chlorophyll *a*, Secchi depth, total phosphorus and total nitrogen) and is based on the following four regression equations:

1. $TLc = 2.22 + 2.54 \log(\text{Chlorophyll } a)$
2. $TLs = 5.10 + 2.27 \log\left(\frac{1}{\text{Secchi depth}} - \frac{1}{40}\right)$
3. $TLp = 0.218 + 2.92 \log(\text{Total phosphorus})$
4. $TLn = -3.61 + 3.01 \log(\text{Total nitrogen})$

⁶ In practice, quarterly sampling rarely occurs because strong winds common in South Wairarapa prevent safe access to sampling sites.

An overall TLI score is calculated by averaging the four individual TL equation results. Lake water quality is then assigned an overall trophic level status according to its average score (Table 3.1) (see Burns et al. 2000 for full details). Note that TLI results should be interpreted cautiously as Burns et al. (2000) recommend that at least two years of monthly monitoring is undertaken to provide an adequate baseline of current lake status. See Perrie and Milne (2012) for a more comprehensive assessment of water quality from Lakes Wairarapa and Onoke spanning a longer time period.

Table 3.1: Classification of lake trophic status using the TLI (after Burns et al. 2000) and nutrient enrichment descriptions described in Burns et al. (1999)

Trophic status (nutrient enrichment)	TLI	Chlorophyll <i>a</i> (mg/m ³)	Secchi depth (m)	Total phosphorus (mg/L)	Total nitrogen (mg/L)
Ultra-microtrophic (practically pure)	0.0–1.0	0.13–0.33	33–25	0.00084–0.0018	0.016–0.034
Microtrophic (very low)	1.0–2.0	0.33–0.82	25–15	0.0018–0.0041	0.034–0.073
Oligotrophic (low)	2.0–3.0	0.82–2.0	15–7.0	0.0041–0.009	0.073–0.157
Mesotrophic (medium)	3.0–4.0	2.0–5.0	7.0–2.8	0.0090–0.0200	0.157–0.337
Eutrophic (high)	4.0–5.0	5.0–12	2.8–1.1	0.0200–0.0430	0.337–0.725
Supertrophic (very high)	5.0–6.0	12–31	1.1–0.4	0.0430–0.0960	0.725–1.558
Hypertrophic (extremely high)	>6.0	>31	<0.4	>0.0960	>1.558

3.2.2 Lake Wairarapa

Water samples were collected from four sites on Lake Wairarapa on three occasions during 2011/12 and the results are summarised in Table 3.2. Trophic level classes based on the mean values of the four key lake water quality variables range from eutrophic (total nitrogen and chlorophyll *a*) to hypertrophic (Secchi depth). Overall, based on the year's sampling, the lake can be classed as supertrophic (Table 3.3).

Table 3.2: Summary of water quality in Lake Wairarapa, based on three sampling occasions between July 2011 and June 2012. All values presented are based on data pooled from the four sampling sites (D.L. = detection limit)

Variable	Mean	Median	Minimum	Maximum	%n <D.L.
Water temperature (°C)	13.2	15.6	7.6	16.8	—
Dissolved oxygen (% saturation)	92.7	92.6	84.4	103	—
Dissolved oxygen (mg/L)	9.9	9.3	8.5	12	—
pH ¹	7.4	7.6	6.6	7.8	—
Conductivity (µS/cm) ¹	521	429	207	947	—
Secchi depth (m)	0.30	0.25	0.12	0.56	—
Turbidity (NTU)	62.1	59.0	16.0	121	—
Total suspended solids (mg/L)	53.2	40.5	9.0	123	0
Volatile suspended solids (mg/L)	4.7	4.0	1.0	8.0	33
Total nitrogen (mg/L)	0.491	0.480	0.310	0.630	0
Nitrite nitrogen (mg/L)	0.001	0.001	0.001	0.003	83
Nitrite-nitrate nitrogen (mg/L)	0.133	0.056	0.001	0.440	33
Ammoniacal nitrogen (mg/L)	0.008	0.005	0.005	0.016	58
Total phosphorus (mg/L)	0.079	0.075	0.033	0.149	0
Dissolved reactive phosphorus (mg/L)	0.005	0.005	0.002	0.009	42
Chlorophyll <i>a</i> (mg/m ³)	5.9	4.5	1.5	19	58
<i>E. coli</i> (cfu/100 mL)	12	9	1	42	0
Faecal coliforms (cfu/100 mL)	14	9	1	48	0

¹ Data summary presented is based on laboratory measurements.

Table 3.3: Lake Wairarapa mean total nitrogen, total phosphorus, Secchi depth (water clarity) and chlorophyll *a* values. Trophic level (TL) values and classes for each variable as well as an overall TLI score and class are also presented. Values presented are based on data pooled for all four sites from three sampling occasions between July 2011 and June 2012

Key variable	Mean	TL value	TL class
Total nitrogen (mg/L)	0.491	4.5	Eutrophic
Total phosphorus (mg/L)	0.079	5.8	Supertrophic
Secchi depth (m)	0.30	6.3	Hypertrophic
Chlorophyll <i>a</i> (mg/m ³)	5.9	4.2	Eutrophic
Overall TLI score		5.2	Supertrophic

3.2.3 Lake Onoke

Water quality samples were collected from one site on Lake Onoke on 12 occasions during 2011/12 and the results are summarised in Table 3.4. Trophic level classes based on the mean values of the four key lake water quality variables range from eutrophic (total nitrogen and chlorophyll *a*) to supertrophic (total phosphorus and Secchi depth). Overall, based on the year's sampling, the lake can be classed as supertrophic (Table 3.5).

Table 3.4: Summary of water quality in Lake Onoke, based on 12 sampling occasions between July 2011 and June 2012 (D.L. = detection limit)

Variable	Mean	Median	Minimum	Maximum	<i>n</i> < D.L.
Water temperature (°C)	14.2	15.0	6.7	19.2	—
Dissolved oxygen (% saturation)	96.6	96.3	83.7	113	—
Dissolved oxygen (mg/L)	9.9	9.7	9.0	11.1	—
pH	7.4	7.4	7.0	8.1	—
Conductivity (µS/cm)	1,862	1,769	179	4,320	—
Secchi depth (m)	0.48	0.34	0.14	>0.95 ¹	—
Turbidity (NTU)	46.1	26.5	3.4	270	—
Total suspended solids (mg/L)	43.4	24.0	1	250	1
Volatile suspended solids (mg/L)	3.2	3.5	1	6	6
Total nitrogen (mg/L)	0.653	0.545	0.390	1.430	0
Nitrite nitrogen (mg/L)	0.003	0.003	0.001	0.006	2
Nitrite-nitrate nitrogen (mg/L)	0.352	0.270	0.082	0.920	0
Ammoniacal nitrogen (mg/L)	0.015	0.013	0.005	0.039	5
Total phosphorus (mg/L)	0.067	0.053	0.026	0.230	0
Dissolved reactive phosphorus (mg/L)	0.017	0.020	0.002	0.029	1
Chlorophyll <i>a</i> (mg/m ³)	4.8	2.8	1.5	19	7
<i>E. coli</i> (cfu/100mL)	591	60	7	4,700	0
Faecal coliforms (cfu/100mL)	667	60	7	5,500	0

¹ On three sampling occasions the Secchi disc was visible on the lake bottom (>0.80 to >0.95 m).

Table 3.5: Lake Onoke mean total nitrogen, total phosphorus, Secchi depth (water clarity) and chlorophyll *a* values, based on 12 sampling occasions between July 2011 and June 2012. Trophic level (TL) values and classes for each variable as well as an overall TLI score and class are also presented

Key variable	Mean	TL value	TL class
Total nitrogen (mg/L)	0.653	4.9	Eutrophic
Total phosphorus (mg/L)	0.067	5.6	Supertrophic
Secchi depth (m)	0.48	5.8	Supertrophic
Chlorophyll <i>a</i> (mg/m ³)	4.8	4.0	Eutrophic
Overall TLI score		5.0	Supertrophic

4. Groundwater

This section summarises the key results from the Groundwater Quality State of Environment (GQSoE) monitoring programme for 2011/12. This programme involves quarterly monitoring of water quality at 70 groundwater sites.

With only four sets of sampling results per year, a comprehensive evaluation of all of the data is not undertaken on an annual basis. The analysis in this section has therefore been restricted to two key indicators of groundwater contamination: nitrate-nitrogen and *Escherichia coli* (*E. coli*) bacteria.

4.1 Overview of GQSoE monitoring programme

Groundwater quality has been routinely monitored in the western half of the Wellington region (Kapiti Coast and Hutt Valley) since 1994 and in the Wairarapa since 1997. Although various changes have been made to the GQSoE monitoring programme since this time (see Tidswell et al. 2012), since late 2003, the programme has remained largely unchanged, with only minor changes to the existing suite of monitoring sites.

4.1.1 Monitoring network

The existing GQSoE monitoring network consists of 70 bores (Figure 4.1, Appendix 1). With the exception of a single bore at Riversdale on the eastern Wairarapa Coast, all of these bores are located in one of the three principal groundwater management areas in the Wellington region: the Kapiti Coast, Lower Hutt Valley, and the Wairarapa Valley (see Gordon et al. 2012 for a description of groundwater management zones in the Wellington region).

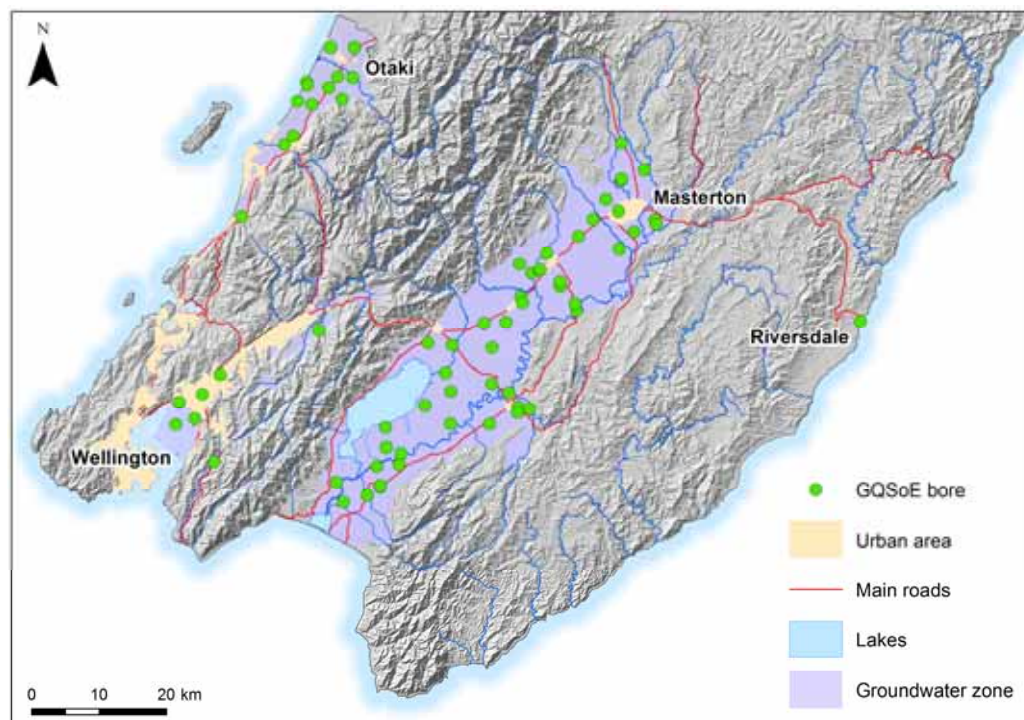


Figure 4.1: GQSoE sites monitored over 2011/12

Sampling of each bore is generally conducted at quarterly intervals (generally in March, June, September and December). However, during 2011/12 only 56 of the 70 bores were able to be accessed on all four sampling occasions.

(a) Changes to the monitoring network

The GQSoE monitoring network consisted of 71 bores up until September 2010 when privately owned bore R27/1137 was retired from use – GWRC no longer has access to this bore for sampling.

4.1.2 Monitoring variables

Groundwater quality is assessed by measuring a range of physical, chemical and microbiological variables, including dissolved oxygen, pH, conductivity, turbidity, faecal indicator bacteria⁷, total organic carbon, major ions, nutrients, and trace metals. The full list of groundwater quality variables, together with details of field and analytical methods, is provided in Appendix 2.

4.2 Results

4.2.1 Nitrate nitrogen (nitrate)

Based on median values recorded over 2011/12, 10 of 70 (14.3%) GQSoE bores had elevated (3–7 mg/L)⁸ concentrations of nitrate (Figure 4.2). A further four bores in Kapiti and the upper Wairarapa Valley recorded median nitrate concentrations in the relatively high range (7–11.3 mg/L). Two bores, both in the upper Wairarapa Valley, recorded median nitrate concentrations above the Ministry of Health Drinking Water Standards (MoH DWSNZ 2008) maximum acceptable value (MAV) of 11.3 mg/L. These were bore S26/0223 (median nitrate 11.35 mg/L, $n=4$) in the Taratahi groundwater zone and bore T26/0489 (median nitrate 12.2 mg/L, $n=3$) in the Te Ore Ore groundwater zone.

Overall, nitrate contamination was found in bores where previous sampling has detected elevated nitrate concentrations – in areas of intensive agriculture (Wairarapa) and horticulture (Kapiti Coast). The wide ranging depth of the bores with elevated nitrate concentrations (<5 m to 54 m) suggests that nitrate contamination is not limited to shallow unconfined aquifers but is able to migrate into deeper aquifer systems⁹.

Groundwater discharges to a number of surface water bodies throughout the Wellington region and there is the potential that groundwater discharge high in nitrogen could contribute to the decline of surface water quality. The ANZECC (2000) guidelines are commonly used to assess physico-chemical aspects of surface water quality in New Zealand rivers and streams. The 2011/12 GQSoE results show that the median nitrate concentrations in 35 (50%) of the 70 GQSoE bores were above the ANZECC (2000) trigger value

⁷ Faecal bacteria are only tested in groundwater samples from 43 of the 70 GQSoE bores.

⁸ While most groundwater in New Zealand rarely has background nitrate-nitrogen concentrations exceeding 1 mg/L (Close et al. 2001), in this report 3 mg/L NO₃-N is used as an indicator of anthropogenic influence in order to increase certainty caused by variability. See Tidswell et al. (2012) for further discussion.

⁹ This is particularly evident in recharge areas, with elevated nitrate concentrations not commonly found in deeper confined aquifers.

for lowland ecosystems (0.444 mg/L). Of these, 18 (25.7%) recorded median concentrations above the Hickey (2013) threshold for aquatic toxicity (2.4 mg/L)¹⁰.

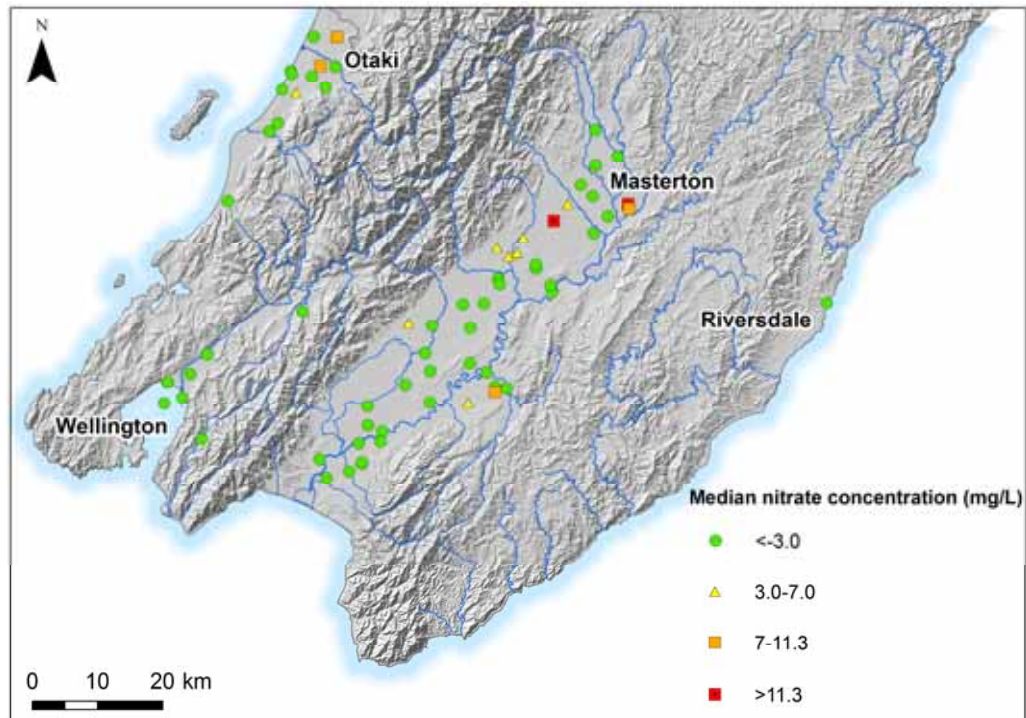


Figure 4.2: Median nitrate nitrogen (nitrate) concentrations recorded in GQSoE bores sampled over 2011/12

4.2.2 *E. coli*

The MoH DWSNZ (2008) use *E. coli* as an indicator of contamination of drinking water by faecal material¹¹. For drinking water supplies, *E. coli* counts should be <1 cfu/100 mL.

E. coli was detected in 12 bores on one or more occasions during the four rounds of GQSoE sampling over 2011/12 (Figure 4.3). Two bores both recorded the highest *E. coli* count of 270 cfu/100mL; bore (R25/5164) at Te Horo Beach, and a bore (S26/0117) in the Mangatarere catchment. *E. coli* levels in bore R25/5164 exceeded the MoH DWSNZ (2008) MAV on three of four sampling occasions, and two of four sampling occasions for bore S26/0117. Te Horo Beach is a small settlement reliant on onsite wastewater treatment systems for effluent disposal and it is possible that the microbial contamination in bore R25/5164 is due to the bore's proximity to a nearby wastewater treatment system (see Tidswell et al. 2012). This bore is not used as a potable drinking water supply. Bore S26/0117 is located in the Mangatarere groundwater zone at a depth of 5 m and is used for both potable and stock water supply. Bore S26/0117 has a history of *E. coli* contamination and the bore owner has been made aware of the contamination.

¹⁰ This (median) value replaces the former threshold of 1.7 mg/L (Hickey & Martin 2009) and is a recommended replacement value for the ANZECC (2000) toxicity TV of 7.2 mg/L.

¹¹ It is impracticable to monitor water supplies for all potential human pathogens, so surrogates are used to indicate possible contamination from such things as human and animal excrement, these being the most frequent causes of health-significant microbial contamination in drinking water supplies.

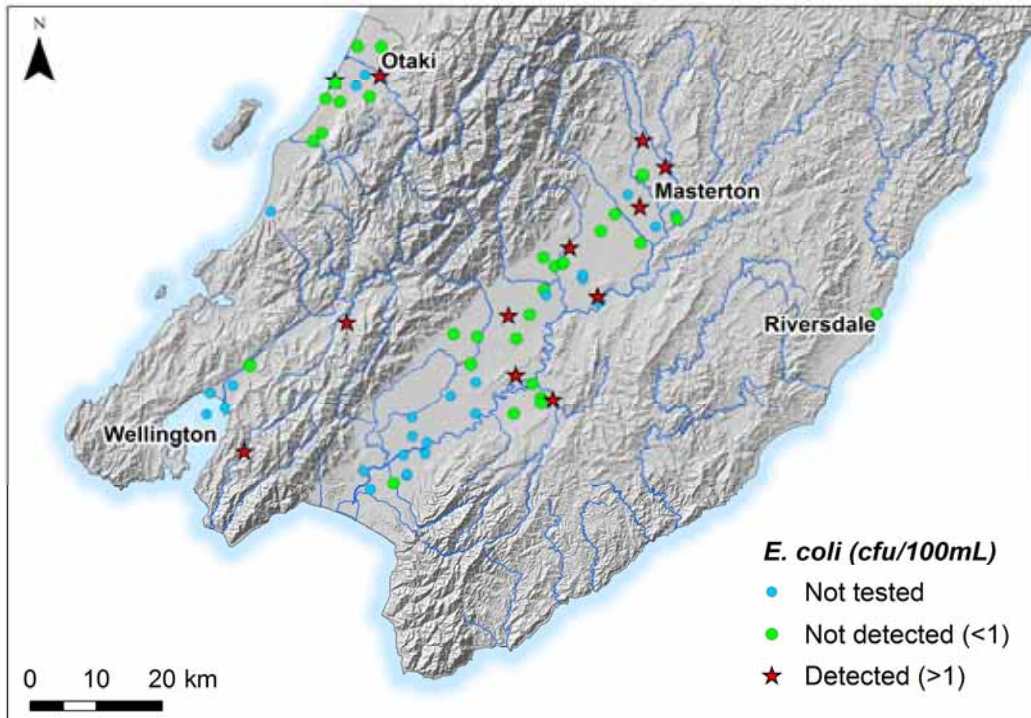


Figure 4.3: Detection (on one or more sampling occasions) of *E. coli* bacteria in GQSoE bores sampled quarterly over 2011/12

5. Targeted investigations

In addition to routine state of the environment monitoring of the region's fresh waters, during 2011/12 GWRC was involved in several targeted investigations. These included carrying out a third summer of stream biofilm sampling and a 12-month investigation of water quality and ecological health in the Pahaoa River catchment.

5.1 Stream biofilms

In early 2012, streambed biofilm¹² samples were collected from 10 of the 55 Rivers SoE monitoring sites and three additional stream sites as part of an Auckland Council-led national trial assessing the potential for biofilms to be used as ecological indicators of river and stream health (in much the same way as macroinvertebrates are currently used). This was the third year stream biofilm samples have been collected from the Wellington region; while the 2010 samples (19 sites sampled) targeted a variety of streams running through different land uses, the 2011 and 2012 samples mostly targeted urban sites. Lewis et al. (2010) have prepared a report on the first year of sampling results and an interim report on the 2011 results; a formal report incorporating the more recent results is expected later in 2013.

5.2 Pahaoa River water quality and aquatic ecology investigation

The Pahaoa River catchment¹³ is located within the eastern Wairarapa hill country. Despite being the third largest catchment in the Wellington region, current environmental monitoring undertaken by GWRC is limited to measuring flow (in association with NIWA) at Hinakura. To better understand the current condition of the Pahaoa River, a pilot investigation was undertaken incorporating both two-monthly water quality sampling and one-off biological assessments at six (to eight) sites throughout the catchment between August 2011 and June 2012 (Figure 5.1). The methodology and findings of the investigation are fully documented in Perrie and Lee (2013) and so only a brief summary of the investigation is provided here.

An overview of water quality in the catchment – using the Water Quality Index (WQI, see Section 2.2.1) – is presented in Table 5.1. Four of the six sites received WQI grades of 'fair' indicating that they failed to meet two or three of the six guidelines used in the WQI assessment. Water quality appeared to improve slightly with distance downstream in the catchment – the two most downstream sites were graded 'good'. All six sites failed the guideline for water clarity, and median *E. coli* and dissolved reactive phosphorus concentrations failed their respective guidelines at three sites each. All sites complied with guidelines for nitrite-nitrate nitrogen and ammoniacal nitrogen.

¹² A stream biofilm is the layer of greenish-brown slime that is found on rocks, plants and other surfaces in a stream. This layer is composed of bacteria, algae, fungi, protozoa and other microscopic organisms. Stream biofilms constitute a major component of the stream ecosystem and play important roles in primary production, nutrient cycling, water quality, suspended solid removal, and energy flow to higher trophic levels.

¹³ The catchment comprises two main sub-catchments, the Pahaoa River itself and the Wainuioru River. The Wainuioru River is the larger catchment, being more than 3.5 times greater in area than the Pahaoa River (based on catchment areas upstream of their confluence).

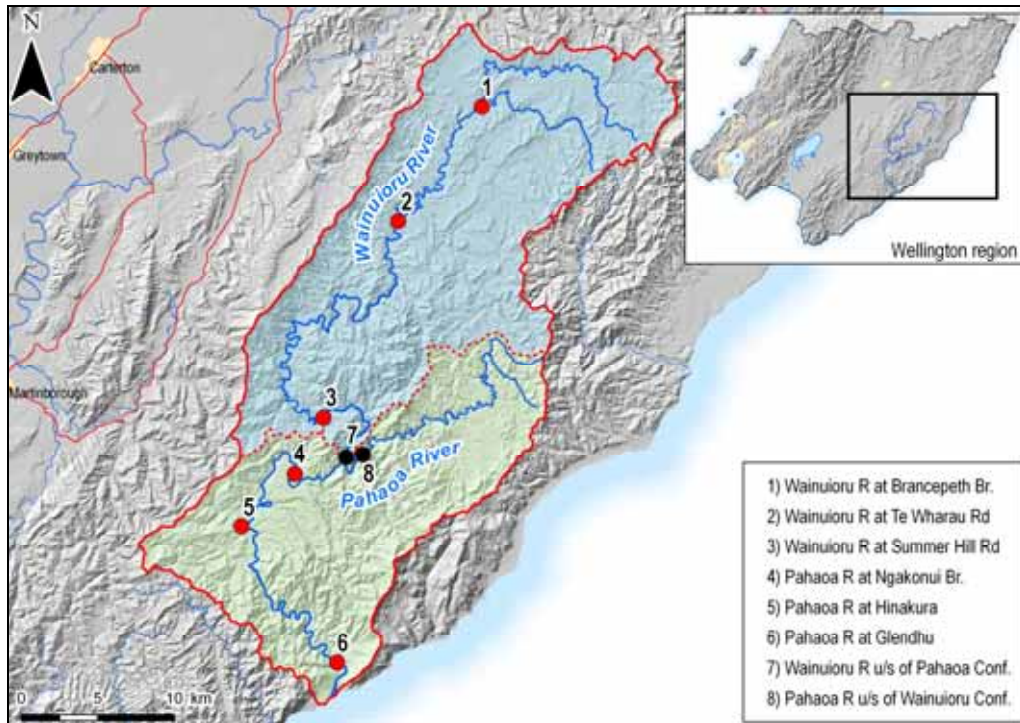


Figure 5.1: Locations of the six core sampling sites (red circles) and the two sites visited on only one occasion (black circles). The red line indicates the entire Pahaoa River catchment while the dashed red line separates the Wainuioru River catchment

Table 5.1: Water Quality Index grades for the six sites sampled two-monthly over August 2011 to June 2012 inclusive, based on compliance of median dissolved oxygen (DO), visual clarity (Clarity), *E. coli*, nitrite-nitrate nitrogen (NNN), ammoniacal nitrogen (Amm. N) and dissolved reactive phosphorus (DRP) values with guideline values

(Source: Perrie & Lee 2013)

Site name	Guideline compliance (median values)						WQI grade
	DO	Clarity	<i>E. coli</i>	NNN	Amm. N	DRP	
Wainuioru R at Brancepeth Br.	✓	x	x	✓	✓	x	Fair
Wainuioru R at Te Wharau Rd	✓	x	✓	✓	✓	x	Fair
Wainuioru R at Summer Hill Rd	✓	x	x	✓	✓	x	Fair
Pahaoa R Ngakonui Br.	✓	x	x	✓	✓	✓	Fair
Pahaoa R at Hinakura	✓	x	✓	✓	✓	✓	Good
Pahaoa R at Glendhu	✓	x	✓	✓	✓	✓	Good

Analysis of macroinvertebrate communities – using the Macroinvertebrate Community Index (MCI, see Section 2.4.1) – at the eight sites assessed generally indicated ‘fair’ to ‘good’ health and showed a similar trend to water quality (ie, there was generally a slight improvement in MCI score with distance downstream in the catchment). Perrie and Lee (2013) attributed the downstream improvements in MCI and water quality to changes in habitat quality and/or a slight reduction in the overall proportion of upstream pastoral landcover with distance downstream (relative to the locations of the sampling sites).

Compared with data collected from RSoE sites over a similar time period, Perrie and Lee (2013) concluded that the water quality and ecosystem health of the Wainuioru and Pahaoa rivers was not too dissimilar to other rivers and streams located in the eastern Wairarapa that drain predominantly pastoral catchments. Characteristics shared by the Pahaoa River and other rivers and streams in the eastern Wairarapa are elevated water temperatures, poor water clarity (and elevated turbidity and suspended solid concentrations), and generally low to moderate concentrations of nutrients and *E. coli*. Macroinvertebrate health tends to range from 'fair' to 'good' and periphyton cover and biomass are likely to, at times, reach high levels due to the long periods of stable low flows that are common in this part of the Wellington region.

6. Summary

Monitoring and investigations of fresh waters during 2011/12 found:

- Nineteen (34.5%) of 55 river and stream (RSoE) monitoring sites were assigned water quality grades of ‘excellent’ for the 2011/12 reporting period. Eleven sites scored grades of ‘good’, 11 sites ‘fair’ and 14 sites ‘poor’.
- Three of the ten RSoE sites routinely monitored for selected heavy metals recorded median dissolved zinc concentrations higher than their respective site-specific chronic toxicity guidelines.
- Seventeen of the 46 RSoE sites monitored for periphyton exceeded the MfE (2000) streambed cover guidelines for filamentous growths at least once and three sites exceeded the guideline for mat growths on one or more sampling occasions. The chlorophyll *a* guideline for benthic biodiversity was exceeded at 15 sites while the AFDM guideline for trout habitat and angling was exceeded at one site.
- Based on MCI scores, over half of the 55 RSoE sites received quality classifications of ‘excellent’ (20 sites) or ‘good’ (15 sites). Thirteen sites were classed as ‘fair’ and seven sites were classed as ‘poor’.
- Water quality results for Lake Wairarapa and Lake Onoke are indicative of these lakes having a supertrophic classification (ie, very high nutrients).
- Median nitrate concentrations were low (<3 mg/L) in most of the 70 groundwater SoE bores monitored. However, median concentrations in four bores located in Kapiti and Wairarapa were high (7–11.3 mg/L) and median concentrations in two bores (T26/0489 and S26/0223) exceeded the MoH DWSNZ (2008) MAV of 11.3 mg/L.
- *E. coli* bacteria counts met the MoH DWSNZ (2008) MAV on all sampling occasions in 31 of the 43 groundwater bores monitored (note that not all of these bores are used for potable supply).
- A pilot investigation of the Pahaoa River catchment indicated that water quality and ecological health generally ranged from ‘fair’ to ‘good’ throughout the catchment. Overall, the Pahaoa River – including the Wainuioru River – appears to be in a similar condition to other eastern Wairarapa rivers located in catchments with low intensity pastoral landcover that are monitored under the RSoE programme (ie, low to moderate signs of degradation).

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Appendix 1: Monitoring site locations

Table A1.1: River and stream (RSoE) monitoring sites

Site no.	Site name	NZTM site coordinates		Substrate (hard or soft bottomed)	REC	Dominant land cover
		Easting	Northing			
RS02	Mangapouri S at Bennetts Rd*	1780903	5487645	Soft	WD/L/AI/U**	Urban
RS03	Waitohu S at Forest Pk	1787593	5483689	Hard	CW/H/HS/IF	Indigenous forest
RS04	Waitohu S at Norfolk Cres	1779537	5488304	Soft	CW/L/HS/P	Pasture
RS05	Otaki R at Pukehinou	1785426	5478749	Hard	CW/H/HS/IF	Indigenous forest
RS06	Otaki R at Mouth	1777983	5485886	Hard	CW/H/HS/IF	Indigenous forest
RS07	Mangaone S at Sims Rd Br	1776242	5482408	Soft	WW/L/AL/P	Pasture
RS08	Ngarara S at Field Way*	1771180	5474620	Soft	WW/L/AL/U**	Urban
RS09	Waikanae R at Mangaone Walkway	1779974	5473638	Hard	CW/L/HS/IF	Indigenous forest
RS10	Waikanae R at Greenaway Rd*	1771223	5472915	Hard	CW/L/HS/IF**	Indigenous forest
RS11	Whareroa S at Waterfall Rd	1768074	5464532	Hard	WW/L/HS/IF**	Indigenous forest
RS12	Whareroa S at QE Park	1765976	5464400	Soft	WW/L/HS/P	Pasture
RS13	Horokiri S at Snodgrass	1761804	5450653	Hard	CW/L/HS/P	Pasture
RS14	Pauatahanui S at Elmwood Br	1761097	5446783	Hard	CW/L/HS/P	Pasture
RS15	Porirua S at Glenside*	1753289	5438364	Hard	CW/L/HS/U	Urban
RS16	Porirua S at Wall Park (Milk Depot)*	1754366	5443031	Hard	WW/L/HS/U	Urban
RS17	Makara S at Kennels	1743530	5433635	Hard	CW/L/HS/P	Pasture
RS18	Karori S at Makara Peak*	1744213	5426874	Hard	CW/L/HS/U	Urban
RS19	Kaiwharawhara S at Ngaio Gorge*	1749069	5431077	Hard	CW/L/HS/U	Urban
RS20	Hutt R at Te Marua Intake Site	1780071	5450158	Hard	CX/H/HS/IF	Indigenous forest
RS21	Hutt R opp. Manor Park G.C.*	1766679	5442285	Hard	CW/H/HS/IF	Indigenous forest
RS22	Hutt R at Boulcott*	1760858	5437486	Hard	CW/L/HS/IF	Indigenous forest
RS23	Pakuratahi R 50m d/s Farm Ck	1784607	5451677	Hard	CX/H/HS/IF	Indigenous forest
RS24	Mangaroa R at Te Marua	1778543	5448643	Hard	CW/L/HS/P	Pasture
RS25	Akatarawa R at Hutt confl.	1776183	5449184	Hard	CW/L/HS/IF	Indigenous forest
RS26	Whakatikei R at Riverstone	1772256	5446748	Hard	CW/L/HS/S	Indigenous forest
RS28	Wainuiomata R at Manuka Track	1768242	5430634	Hard	CW/L/HS/IF	Indigenous forest
RS29	Wainuiomata R u/s of White Br	1757316	5415724	Hard	CW/L/HS/IF	Indigenous forest
RS30	Orongorongo R at Orongorongo Stn	1758930	5413095	Hard	CW/H/HS/IF	Indigenous forest
RS31	Ruamahanga R at McLays	1818149	5485809	Hard	CX/H/HS/S	Indigenous forest
RS32	Ruamahanga R at Te Ore Ore	1825574	5463019	Hard	CW/L/SS/P	Pasture
RS33	Ruamahanga R at Gladstone Br	1821208	5450327	Hard	CW/L/SS/P	Pasture
RS34	Ruamahanga R at Pukio	1797832	5431010	Hard	CW/L/SS/P	Pasture
RS35	Mataikona Trib at Sugar Loaf Rd	1871844	5490906	Hard	CW/L/SS/IF**	Indigenous forest
RS36	Taueru R at Castlehill	1852300	5484198	Soft	CW/L/SS/P	Pasture
RS37	Taueru R at Gladstone	1824148	5450815	Hard	CD/L/SS/P	Pasture
RS38	Kopuaranga R at Stewarts	1826761	5469569	Hard	CW/L/SS/P	Pasture
RS39	Whangaehu R 250m u/s confl.	1826267	5459407	Soft	CD/L/SS/P	Pasture
RS40	Waipoua R at Colombo Rd Br	1825018	5462890	Hard	CW/L/HS/P	Pasture
RS41	Waingawa R at South Rd	1820716	5460649	Hard	CX/H/HS/IF	Indigenous forest
RS42	Whareama R at Gauge	1856090	5461229	Soft	WW/L/SS/P	Pasture
RS43	Motuwaireka S at Headwaters	1852018	5450302	Hard	CW/L/HS/S	Indigenous forest
RS44	Totara S at Stronvar	1848025	5444916	Hard	CW/L/HS/EF	Exotic forest
RS45	Parkvale Trib at Lowes Res.	1818094	5458352	Hard	WD/L/AI/P	Pasture
RS46	Parkvale S at Weir	1813515	5449469	Hard	WD/L/AI/P	Pasture
RS47	Waiohine R at Gorge	1801889	5455995	Hard	CX/H/HS/IF	Indigenous forest
RS48	Waiohine R at Bicknells	1810615	5448099	Hard	CW/H/HS/P	Pasture
RS49	Beef Ck at Headwaters	1803963	5456398	Hard	CW/L/HS/S	Indigenous forest
RS50	Mangatarere S at SH 2	1809768	5452160	Hard	CW/L/HS/P	Pasture
RS51	Huangarua R at Ponatahi Br	1807009	5435213	Hard	CD/L/SS/P	Pasture
RS52	Tauanui R at Whakatomotomo Rd	1790648	5414515	Hard	CW/H/HS/IF	Indigenous forest
RS53	Awhea R at Tora Rd	1809951	5403289	Hard	WW/L/SS/P	Pasture
RS54	Coles Ck Trib at Lagoon Hill Rd	1814020	5415217	Hard	WW/L/SS/S	Indigenous forest
RS55	Tauherenikau R at Websters	1797082	5439942	Hard	CW/H/HS/P**	Pasture
RS56	Waiorongomai R at Forest Pk	1779604	5430559	Hard	CW/H/HS/IF	Indigenous forest
RS57	Waiwhetu S at Whites Line East	1760977	5434510	Soft	WW/L/HS/U	Urban

*RSoE sites where water samples are also analysed for selected heavy metals.

**REC landcover class changed to reflect more up-to-date catchment scale landcover information from MfE (2010).

Table A1.2: Lake water quality monitoring sites

Lake	Site no.	NZTM site coordinates	
		Easting	Northing
Lake Wairarapa	1	1793054.6	5438917.3
	2	1791644.6	5439152.6
	3	1787266.3	5432687.1
	4	1785175.8	5435526.5
Lake Onoke	1	1778829.6	5417842.7

Table A1.3: Groundwater quality (GQSoE) monitoring sites

Bore no.	NZTM site coordinates		Depth (m)	Aquifer confinement	Bore use
	Easting	Northing			
<i>Kapiti Coast</i>					
R25/5100	1774552.15	5479451.35	48.20	Semi-confined	Irrigation
R25/5135	1779152.45	5481483.39	93.27	Confined	Irrigation
R25/5164	1775873.28	5482367.50	0.00	Unconfined	Domestic
R25/5165	1776019.28	5481886.47	8.00	Unconfined	Domestic
R25/5190	1776678.23	5478988.27	0.00	Unconfined	Potable domestic and stock
R25/5233	1779397.56	5487564.84	18.70	Semi-confined	Dairy Use
R26/6503	1766253.09	5462295.15	14.80	Unconfined	Irrigation
R26/6587	1772633.83	5473057.09	12.96	Unconfined	Irrigation
R26/6624	1773932.93	5474297.10	10.20	Confined	Irrigation
S25/5125	1782733.73	5483013.44	10.00	Unconfined	Irrigation
S25/5200	1781182.52	5479785.21	45.80	Semi-confined	Irrigation
S25/5256	1780490.58	5483153.49	30.78	Confined	Irrigation
S25/5322	1782982.85	5487485.83	27.00	Semi-confined	Irrigation
<i>Hutt Valley</i>					
R27/0320	1756996.50	5434507.51	114.6	Confined	Fire
R27/1171	1756493.07	5431226.71	23.20	Confined	Water level observation
R27/1180	1760435.48	5435698.05	39.00	Confined	Public
R27/1182	1759274.04	5432161.32	38.00	Confined	Groundwater quality
R27/1183	1763083.77	5438690.64	25.00	Confined	Air conditioning
R27/1265	1756997.50	5434515.51	48.30	Confined	Fire
R27/6833	1777716.35	5445323.81	24.50	Semi-confined	Potable and domestic
<i>Wainuiomata</i>					
R27/6418	1762217.86	5425695.18	8.00	Unconfined	Irrigation
<i>Wairarapa Valley</i>					
S26/0117	1811483.15	5456780.11	5.00	Unconfined	Potable and domestic
S26/0223	1816203.19	5459284.79	9.92	Unconfined	Potable and domestic
S26/0299	1818354.91	5461869.91	8.10	Unconfined	Potable and domestic
S26/0439	1807492.42	5455180.48	11.50	Unconfined	Stock
S26/0457	1807656.62	5450330.89	6.06	Unconfined	Potable, domestic and irrigation
S26/0467	1809272.40	5453850.06	6.20	Unconfined	Potable and domestic
S26/0568	1813486.57	5451921.15	45.00	Confined	Irrigation
S26/0576	1813461.67	5452534.23	31.00	Confined	Irrigation
S26/0705	1810471.61	5454278.93	27.40	Confined	Public
S26/0756	1815919.19	5448296.24	19.00	Confined	Irrigation
S26/0762	1815702.37	5449348.42	9.50	Confined	Domestic and stock
S26/0824	1810546.63	5454380.93	20.60	Confined	Public
S26/0846	1807902.50	5449491.76	39.30	Confined	Not used
S27/0009	1793895.42	5443481.45	10.50	Unconfined	Domestic

Bore no.	NZTM site coordinates		Depth (m)	Aquifer confinement	Bore use
	Easting	Northing			
S27/0070	1797507.54	5443110.86	14.60	Unconfined	Public
S27/0136	1802217.44	5446389.36	20.40	Unconfined	Potable, domestic and irrigation
S27/0156	1803402.88	5442775.85	20.70	Semi-confined	Irrigation
S27/0202	1805460.73	5446519.85	4.80	Unconfined	Irrigation
S27/0268	1793452.70	5434055.07	58.40	Confined	Irrigation and stock
S27/0283	1797276.24	5436168.48	19.00	Confined	Irrigation
S27/0299	1796503.73	5438935.77	17.40	Confined	Irrigation
S27/0344	1803347.81	5437340.43	16.00	Confined	Irrigation
S27/0389	1807205.35	5433792.40	17.85	Confined	Irrigation
S27/0396	1805858.70	5435961.84	17.00	Confined	Public
S27/0433	1787692.45	5427838.97	44.60	Confined	Irrigation
S27/0435	1787608.01	5430805.03	44.00	Confined	Stock
S27/0442	1789891.27	5426883.54	177.7	Confined	Potable domestic and stock
S27/0495	1797227.31	5431330.26	37.50	Confined	Irrigation
S27/0522	1803031.58	5431324.10	21.00	Confined	Potable and domestic
S27/0571	1807158.18	5433014.36	32.00	Confined	Irrigation
S27/0585	1780320.53	5422598.32	42.00	Confined	Irrigation
S27/0588	1784844.06	5420713.48	11.70	Confined	Public
S27/0594	1781350.93	5419721.16	44.00	Confined	Irrigation
S27/0602	1789625.95	5425301.57	60.95	Confined	Irrigation
S27/0607	1786288.91	5425037.20	38.00	Confined	Irrigation
S27/0614	1786778.28	5421924.10	35.80	Confined	Irrigation
S27/0615	1786805.33	5422158.09	18.20	Confined	Irrigation
S27/0681	1808952.42	5433542.02	5.00	Unconfined	Irrigation
T26/0003	1822559.22	5473236.52	5.50	Unconfined	Potable and domestic
T26/0087	1820295.66	5464750.15	36.00	Semi-confined	Potable domestic and stock
T26/0099	1822518.46	5467619.40	15.00	Unconfined	Potable and domestic
T26/0206	1822581.50	5467829.43	28.70	Unconfined	Irrigation
T26/0259	1825997.33	5469120.23	6.10	Unconfined	Public
T26/0332	1822230.80	5457401.54	13.40	Semi-confined	Domestic and stock
T26/0413	1824485.62	5459978.64	23.30	Confined	Potable, domestic and irrigation
T26/0430	1822130.71	5463027.57	0.00	Unconfined	Potable and stock
T26/0489	1827571.49	5461854.50	54.00	Semi-confined	Irrigation
T26/0538	1827738.41	5461169.34	9.00	Unconfined	Not used
<i>Eastern Wairarapa (Riversdale)</i>					
T27/0063	1858025.04	5446630.37	3.59	Unconfined	Groundwater quality

Appendix 2: Monitoring variables and methods

Rivers and streams

a) Physico-chemical and microbiological water quality

Water quality variables measured/analysed at each RSoE site are presented in Table A2.1. As far as practicable, individual RSoE monitoring sites are sampled at the same time of the month (and usually at the same time of the day) throughout the year, and where possible all sites on a river or stream are sampled on the same day. Field meters are calibrated on the morning of the day of sampling. Water samples are collected in mid stream (where possible), typically in run-type habitat from a representative reach of stream. Samples requiring laboratory analysis are placed in chillibins with ice and couriered overnight to RJ Hill Laboratories in Hamilton. Note that water samples for dissolved nutrient and metal testing are field filtered.

Table A2.1: RSoE field and analytical water quality methods and detection limits

Variable	Method	Detection limit
Water temperature	Field meter – generally YSI ProODO	0.01 °C
Dissolved oxygen	Field meter – generally YSI ProODO	0.01 mg/L
Visual clarity	Black disc (20 mm disc if clarity <0.5 m, 60 mm disc for clarity between 0.5 m and 1.5 m, 200 mm disc for clarity >1.5 m)	0.01 m
pH	Field meter – generally YSI Professional Plus	0.01 units
Conductivity	Field meter – generally YSI Professional Plus	0.1 uS/cm
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 21 st Ed. 2005	0.05 NTU
Total suspended solids	Filtration using Whatman 934 AH, Advantec GC-50 or 1-2 equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21 st Ed. 2005	2 mg/L
Total organic carbon	Catalytic oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC–TIC. APHA5310 B 21 st Ed. 2005	0.5 mg/L
Ammoniacal nitrogen	Filtered sample. Phenol/hyperchlorite colorimetry. Discrete Analyser. (NH ₄ -N = NH ₄ ⁺ -N + NH ₃ -N) APHA 4500-NH ₃ F (modified from manual analysis) 21 st Ed. 2005	0.001 mg/L
Nitrite	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₃ ⁻ I (Modified) 21 st Ed. 2005	0.002 mg/L
Nitrate	Calculation: (Nitrate-N + Nitrite-N) – Nitrite-N	0.002 mg/L
Nitrate + nitrite nitrogen	Total oxidised nitrogen. Automated cadmium reduction, Flow injection analyser. APHA 4500-NO ₃ ⁻ I (Modified) 21 st Ed. 2005	0.002 mg/L
Total Kjeldahl nitrogen	Kjeldahl digestion, phenol/hyperchlorite colorimetry (Discrete Analysis). APHA 4500-N Org C. (modified) 4500-NH ₃ F (modified) 21 st Ed. 2005	0.1 mg/L
Total nitrogen	Calculation: TKN + Nitrate-N +Nitrite-N	0.1 mg/L
Total phosphorus	Total Phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21 st Ed. 2005	0.004 mg/L
Dissolved reactive phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21 st Ed. 2005	0.004 mg/L
Faecal coliforms	APHA 21 st Ed. Method 9222D	1 cfu/100mL
<i>E. coli</i>	APHA 21 st Ed. Method 9222G	1 cfu/100mL
Dissolved copper	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st Ed. 2005	0.0005 mg/L
Dissolved lead	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st Ed. 2005	0.0001 mg/L
Dissolved zinc	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st Ed. 2005	0.0010 mg/L

b) Periphyton

Formal periphyton assessments are limited to the 46 RSoE sites with hard substrates.

Monthly assessment of visible streambed cover

Periphyton cover is determined by estimating the percentage of visible mats (>0.3 cm thick) and filaments (>2 cm long) present on the stream or river bed within a 20 cm diameter metal ring. Ten observations are made across the width of the stream or river, along a transect. If the stream or river is not wide enough for 10 observations, five observations are made across the width of the waterway in two locations at the site. Two transects of five observations (usually to 0.6 m depth) are also used where it is not possible to wade across more than half of the river's width.

Visible streambed periphyton cover assessments are typically carried out in a run, as opposed to riffle or pool-type habitats.

Annual assessment of biomass

Periphyton samples for quantitative biomass assessments (chlorophyll *a* and Ash Free Dry Matter) are collected during late summer/early autumn at the time of macroinvertebrate sample collection. Sampling protocols follow a modified version of quantitative method 1a (QM-1a), as outlined by Biggs and Kilroy (2000) that involves pooling periphyton samples from 10 rocks into a single composite sample for analysis.

Biomass assessments are carried out on periphyton samples collected in riffle-type habitats in close proximity to macroinvertebrate sampling sites.

c) Macroinvertebrates

A single macroinvertebrate sample is collected at or adjacent to each RSoE water sampling site during late summer/early autumn. The timing of sampling is determined at random, although macroinvertebrate sampling is, where practicable, avoided within two weeks of any flood event (flood events are defined as flows greater than three times the median river flow).

Samples are collected with the use of a kick-net (0.5 mm mesh size) following Protocol C1 of the national macroinvertebrate sampling protocols (Stark et al. 2001) for the 46 RSoE sites with hard substrate (in riffle habitat) and Protocol C2 for the nine RSoE sites with a soft substrate. All samples are processed in accordance with Protocol P2 (Stark et al. 2001).

Lakes

All monitoring sites are accessed by boat, except in the case of Lake Onoke, where sampling is carried out by wading from the lake's edge. Water samples are collected in accordance with the sub-surface grab method for sampling isothermal lakes described in Smith et al. (1989) and in the case of Lake Onoke, a 'grabber pole' is used to collect water samples in an effort to minimise the potential effects of re-suspension of lakebed sediments (caused by wading) on the samples. Note that the sub-surface grab method differs from protocols outlined in Burns et al. (2000) for the sampling of isothermal lakes.

Field measurements (conductivity, dissolved oxygen, pH and temperature) are generally taken using either a YSI 556 field meter, with the field meter calibrated on the day of sampling. Secchi disc measurement methodology is consistent with the procedure outlined in Burns et al. (2000) except that an underwater viewer is not used. Note that all field measurements collected from Lake Onoke are made from a 'wading position', although care is taken to minimise any disturbance of lakebed sediments.

Water samples requiring laboratory analysis are stored on ice upon collection and couriered overnight to RJ Hill Laboratories in Hamilton. The variables monitored and current analytical methods are summarised in Table A2.2. In contrast with river and groundwater samples, all lake water samples for dissolved nutrient analysis are filtered in the laboratory.

Table A2.2: Laboratory analytical methods for lake water samples

Variable	Method	Detection limit
pH (lab)	pH meter APHA 4500-H+ B 21 st Ed. 2005	0.1 pH units
Electrical conductivity (lab)	Conductivity meter, 25°C APHA 2510 B 21 st Ed. 2005	0.1 mS/m/ 1 µS/cm
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 21 st Ed. 2005	0.05 NTU
Total suspended solids	Filtration using Whatman 934 AH, Advantec GC-50 or 1-2 equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 21 st Ed. 2005	2 mg/L
Volatile suspended solids*	Filtration (GF/C, 1.2 µm). Ashing 550°C, 30 min. Gravimetric. APHA 2540 E 21 st Ed. 2005	2 mg/L
Ammoniacal nitrogen	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH ₄ -N = NH ₄ +N + NH ₃ -N) APHA 4500-NH ₃ F (modified from manual analysis) 21 st Ed. 2005	0.01 mg/L
Total Kjeldahl nitrogen	Kjeldahl digestion, phenol/hyperchlorite colorimetry (Discrete Analysis). APHA 4500-N Org C. (modified) 4500- F (modified) 21 st Ed. 2005	0.1 mg/L
Nitrate-N + Nitrite-N (NNN)	Total oxidised nitrogen. Automated cadmium reduction, Flow injection analyser. APHA 4500-NO ₃ - I (modified) 21 st Ed. 2005	0.002 mg/L
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N	0.002 mg/L
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₃ - I (modified) 21 st Ed. 2005	0.002 mg/L
Dissolved inorganic nitrogen (DIN)	Calculation: NH ₄ -N + NO ₃ -N + NO ₂ -N	—
Total nitrogen	Calculation: TKN + Nitrate-N +Nitrite-N	0.1 mg/L
Dissolved reactive phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21 st Ed. 2005	0.004 mg/L
Total phosphorus	Total Phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21 st Ed. 2005	0.004 mg/L
<i>E. coli</i> *	APHA 21 st Ed. Method 9222 G	1 cfu/100mL
Faecal coliforms*	Membrane Filtration, Count on mFC agar, Incubated at 44.5°C for 22 hours, APHA 9222 D, 21 st Ed. 2005	1 cfu/100mL
Chlorophyll <i>a</i> *	Acetone extraction. Spectroscopy. APHA 10200 H 21 st Ed. 2005	0.003 mg/L

*Note the detection limit for these variables is not always achieved (ie, is often higher than indicated here)

Groundwater

Groundwater samples are collected at quarterly intervals following nationally accepted protocols (Ministry for the Environment 2006). This involves purging the bore for a predetermined amount of time to remove any standing water and monitoring the pumped water continuously until field measurements (eg, conductivity) stabilise. These practices are employed to make sure that the water sampled is representative of the aquifer. Field measurements (temperature, conductivity, pH and dissolved oxygen) are taken using field meters calibrated on the day of sampling. Water samples requiring

laboratory analysis are stored on ice upon collection and couriered overnight to RJ Hill Laboratories in Hamilton. The variables monitored and current analytical methods are summarised in Table A2.3.

Table A2.3: Groundwater quality variables and analytical methods

Variable	Method	Detection limit
Temperature	Field meter –YSI 556 , WTW P4 Multi-line and WTW350i meters	0.01°C
Dissolved oxygen	Field meter –YSI 556 , WTW P4 Multi-line and WTW350i meters	0.01 mg/L
Electrical conductivity	Field meter –YSI 556 , WTW P4 Multi-line and WTW350i meters	0.1 µS/cm
pH	Field meter – YSI 556 , WTW P4 Multi-line and WTW350i meters	0.01 units
pH (lab)	pH meter APHA 4500-H+ B 21 st Ed. 2005	0.1 pH units
Total alkalinity	Titration to pH 4.5 (M-alkalinity), Radiometer autotitrator. APHA 2320 B (Modified for alk <20) 21 st Ed. 2005	1 mg/L as CaCO ₃
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO2 D 21 st Ed. 2005	1 mg/L at 25°C
Free carbon dioxide		1 mg/L at 25°C
Total hardness	Calculation from calcium and magnesium	1 mg/L CaCO ₃
Electrical conductivity (lab)	Conductivity meter, 25°C APHA 2510 B 21 st Ed. 2005	0.1 mS/m, 1 µS/cm
Total dissolved solids (TDS)	Filtration through GF/C (1.2 µm), gravimetric. APHA 2540 C (modified; drying temperature of 103–105°C used rather than 180 ± 2°C) 21 st Ed. 2005	10 mg/L
Dissolved boron	Filtered sample, ICP-MS, trace level. APHA 3125 B 21 st Ed. 2005	0.005 mg/L
Dissolved calcium	Filtered sample, ICP-MS APHA 3125 B 21 st Ed. 2005	0.05 mg/L
Dissolved iron	Filtered sample. ICP-MS APHA 3125 B 21 st Ed. 2005	0.02 mg/L
Dissolved lead	Filtered sample. ICP-MS APHA 3125 B 21 st Ed. 2005	0.0001 mg/L
Dissolved magnesium	Filtered sample, ICP-MS APHA 3125 B 21 st Ed. 2005	0.02 mg/L
Dissolved manganese	Filtered sample. ICP-MS APHA 3125 B 21 st Ed. 2005	0.0005 mg/L
Dissolved potassium	Filtered sample, ICP-MS APHA 3125 B 21 st Ed. 2005	0.05 mg/L
Dissolved sodium	Filtered sample, ICP-MS APHA 3125 B 21 st Ed. 2005	0.02 mg/L
Dissolved zinc	Filtered sample. ICP-MS APHA 3125 B 21 st Ed. 2005	0.001 mg/L
Bromide	Filtered sample. Ion Chromatography. APHA 4110 B 21 st Ed. 2005	0.05 mg/L
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500-Cl- E (modified from continuous-flow analysis) 21 st Ed. 2005	0.5 mg/L
Fluoride	Ion selective electrode APHA 4500-F- C 21 st Ed. 2005	0.05 mg/L
Total ammoniacal nitrogen	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH ₄ -N=NH ₄ +N + NH ₃ -N) APHA 4500-NH ₃ F (modified from manual analysis) 21 st Ed. 2005	0.01 mg/L
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO ₃ - I (modified) 21 st Ed. 2005	0.002 mg/L
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) – Nitrite-N	0.002 mg/L
Nitrate-N + Nitrite-N (NNN)	Total oxidised nitrogen. Automated cadmium reduction, Flow injection analyser. APHA 4500-NO ₃ - I (modified) 21 st Ed. 2005	0.002 mg/L
Dissolved reactive phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21 st Ed. 2005	0.004 mg/L
Reactive silica	Filtered sample. Heteropoly blue colorimetry. Discrete Analyser. APHA 4500-SiO ₂ F (modified from flow injection analysis) 21 st Ed. 2005	0.1 mg/L as SiO ₂
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 21 st Ed. 2005	0.5 mg/L
Total organic carbon (TOC)	Catalytic oxidation, IR detection, for Total C. Acidification, purging for Total Inorganic C. TOC = TC - TIC. APHA 5310 B (modified) 21 st Ed. 2005	0.05 mg/L
Total anions	Calculation: sum of anions as mEq/L [Includes Alk, Cl, NO _x N & SO ₄]	0.07 mEq/L
Total cations	Calculation: sum of cations as mEq/L [Includes Ca, Mg, Na, K, Fe, Mn, Zn & NH ₄ N]	0.06 mEq/L
Faecal coliforms	APHA 21 st Ed. Method 9222 D	1 cfu/100mL
<i>E. coli</i>	APHA 21 st Ed. Method 9222 G	1 cfu/100mL

Appendix 3: Tabulated river and stream monitoring results

Table A3.1: Water temperature (°C)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	13.7	8.8	9.0	17.4	17.5	12
RS03	Waitohu S at Forest Pk	10.6	7.0	7.1	14.7	15.2	12
RS04	Waitohu S at Norfolk Cres	12.6	7.9	8.0	17.0	17.1	12
RS05	Otaki R at Pukehinau	10.2	6.7	6.9	14.6	15.4	12
RS06	Otaki R at Mouth	11.8	7.6	7.7	16.4	16.8	12
RS07	Mangaone S at Sims Rd Br	12.4	8.1	8.5	17.0	17.6	12
RS08	Ngarara S at Field Way	14.9	9.5	10.0	18.3	18.8	12
RS09	Waikanae R at Mangaone Walkway	11.5	8.0	8.6	14.5	14.8	12
RS10	Waikanae R at Greenaway Rd	12.7	9.7	10.1	18.0	19.8	12
RS11	Whareroa S at Waterfall Rd	12.1	8.1	8.8	14.6	15.0	12
RS12	Whareroa S at QE Park	13.7	10.0	10.3	16.8	16.9	12
RS13	Horokiri S at Snodgrass	12.5	8.7	9.2	16.2	16.3	12
RS14	Pauatahanui S at Elmwood Br	12.6	7.6	8.2	16.1	16.3	12
RS15	Porirua S at Glenside	12.1	8.4	8.9	17.5	17.8	12
RS16	Porirua S at Wall Park (Milk Depot)	12.3	8.3	8.8	16.3	16.7	12
RS17	Makara S at Kennels	13.2	7.9	8.7	19.5	19.9	12
RS18	Karori S at Makara Peak	12.3	10.2	10.3	16.1	16.3	12
RS19	Kaiwharawhara S at Ngaio Gorge	12.2	8.7	9.3	18.8	19.1	12
RS20	Hutt R at Te Marua Intake Site	10.8	7.3	7.6	14.2	15.0	12
RS21	Hutt R opp. Manor Park G.C.	13.8	10.0	10.1	18.1	18.5	12
RS22	Hutt R at Boulcott	13.0	9.4	9.6	17.1	17.2	12
RS23	Pakuratahi R 50m d/s Farm Ck	11.2	7.4	8.2	14.1	14.3	12
RS24	Mangaroa R at Te Marua	11.9	8.5	9.3	15.7	15.8	12
RS25	Akatarawa R at Hutt confl.	11.3	6.8	7.8	15.4	15.5	12
RS26	Whakatikei R at Riverstone	11.7	6.4	7.7	15.8	15.8	12
RS28	Wainuiomata R at Manuka Track	10.6	6.7	6.8	13.9	14.0	11
RS29	Wainuiomata R d/s of White Br	13.8	8.2	8.9	17.0	17.1	12
RS30	Orongorongo R at Orongorongo Stn	13.9	9.3	9.4	19.2	19.7	12
RS31	Ruamahanga R at McLays	9.3	4.9	5.1	12.7	14.0	12
RS32	Ruamahanga R at Te Ore Ore	12.5	6.5	7.5	18.7	20.0	12
RS33	Ruamahanga R at Gladstone Br	12.8	5.9	7.6	19.6	21.4	12
RS34	Ruamahanga R at Pukio	12.0	5.9	7.6	20.5	22.9	12
RS35	Mataikona Trib at Sugar Loaf Rd	10.4	6.4	6.8	14.9	15.9	12
RS36	Taueru R at Castlehill	11.2	6.8	6.8	15.0	15.9	12
RS37	Taueru R at Gladstone	13.4	5.8	5.9	17.6	18.2	12
RS38	Kopuaranga R at Stewarts	12.6	6.2	7.8	15.5	17.1	12
RS39	Whangaehu R 250m u/s confl.	13.7	5.6	7.1	17.9	19.9	12
RS40	Waipoua R at Colombo Rd Br	14.3	5.4	7.3	20.0	20.7	12
RS41	Waingawa R at South Rd	13.6	5.5	6.5	19.2	19.3	12
RS42	Whareama R at Gauge	11.2	5.5	5.5	20.5	20.7	12
RS43	Motuwaireka S at Headwaters	10.8	6.3	6.5	17.1	17.2	12
RS44	Totara S at Stronvar	11.7	6.9	6.9	20.3	20.7	10
RS45	Parkvale Trib at Lowes Res.	12.7	10.5	10.7	14.6	15.1	11
RS46	Parkvale S at Weir	13.0	8.2	9.1	18.6	21.2	12
RS47	Waiohine R at Gorge	9.0	6.4	6.5	12.6	14.3	12
RS48	Waiohine R at Bicknells	13.0	7.3	7.8	16.0	16.7	12
RS49	Beef Ck at Headwaters	9.9	6.5	7.0	12.6	13.7	11
RS50	Mangatarere S at SH 2	11.8	9.3	9.5	16.8	17.2	12
RS51	Huangarua R at Ponatahi Br	14.2	6.0	6.5	19.4	19.4	12
RS52	Tauanui R at Whakatomotomo Rd	11.3	7.2	7.4	13.7	14.3	12
RS53	Awhea R at Tora Rd	16.0	6.6	7.9	21.5	22.0	12
RS54	Coles Ck Trib at Lagoon Hill Rd	12.4	7.2	7.6	16.1	16.5	9
RS55	Tauherenikau R at Websters	11.3	6.9	7.0	15.7	17.2	12
RS56	Waiorongomai R at Forest Pk	11.4	6.7	7.0	16.3	16.6	12
RS57	Waiwhetu S at Whites Line East	13.8	10.2	10.3	16.7	16.8	12

Table A3.2: Dissolved oxygen (% saturation)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	n
RS02	Mangapouri S at Bennetts Rd	71.9	56.7	57.6	85.0	86.0	12
RS03	Waitohu S at Forest Pk	101.0	98.4	99.2	102.9	104.0	12
RS04	Waitohu S at Norfolk Cres	83.3	75.6	76.1	94.3	96.0	12
RS05	Otaki R at Pukehinau	99.9	97.8	97.9	103.8	106.0	12
RS06	Otaki R at Mouth	100.5	98.2	98.8	104.0	104.0	12
RS07	Mangaone S at Sims Rd Br	71.3	46.5	54.8	83.3	85.2	12
RS08	Ngarara S at Field Way	46.9	15.5	15.8	56.6	59.8	12
RS09	Waikanae R at Mangaone Walkway	98.7	96.6	96.9	100.9	102.0	12
RS10	Waikanae R at Greenaway Rd	103.5	99.5	99.6	113.8	116.0	12
RS11	Whareroa S at Waterfall Rd	98.3	94.1	95.1	101.0	101.0	12
RS12	Whareroa S at QE Park	63.7	52.0	52.7	77.5	80.0	12
RS13	Horokiri S at Snodgrass	102.5	97.0	97.8	108.0	108.0	12
RS14	Pauatahanui S at Elmwood Br	97.9	94.5	94.7	103.9	105.0	12
RS15	Porirua S at Glenside	114.0	96.6	97.9	123.5	124.0	12
RS16	Porirua S at Wall Park (Milk Depot)	109.5	97.9	98.5	119.5	120.0	12
RS17	Makara S at Kennels	107.5	96.2	98.2	122.2	126.0	12
RS18	Karori S at Makara Peak	102.5	94.9	96.0	112.3	115.0	12
RS19	Kaiwharawhara S at Ngaio Gorge	105.5	98.5	98.7	116.8	119.0	12
RS20	Hutt R at Te Marua Intake Site	101.0	92.3	94.6	104.8	107.0	12
RS21	Hutt R opp. Manor Park G.C.	108.0	98.0	100.2	113.0	113.0	12
RS22	Hutt R at Boulcott	105.0	97.6	98.6	110.4	112.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	97.6	92.8	92.9	100.8	102.0	12
RS24	Mangaroa R at Te Marua	102.5	94.2	95.7	109.8	112.0	12
RS25	Akatarawa R at Hutt confl.	102.0	96.7	98.1	106.8	109.0	12
RS26	Whakatikei R at Riverstone	103.0	97.4	97.6	110.5	111.0	12
RS28	Wainuiomata R at Manuka Track	101.0	95.7	95.9	105.5	107.0	11
RS29	Wainuiomata R d/s of White Br	104.0	89.9	91.2	121.7	131.0	12
RS30	Orongorongo R at Orongorongo Stn	101.0	94.0	94.8	105.8	108.0	12
RS31	Ruamahanga R at McLays	99.2	95.6	96.1	101.9	103.0	12
RS32	Ruamahanga R at Te Ore Ore	102.0	97.8	98.4	108.5	109.0	12
RS33	Ruamahanga R at Gladstone Br	100.0	95.0	95.5	116.3	119.0	12
RS34	Ruamahanga R at Pukio	99.7	94.8	94.9	111.1	116.0	12
RS35	Matakona Trib at Sugar Loaf Rd	100.0	95.4	96.6	103.0	103.0	12
RS36	Taueru R at Castlehill	99.5	93.2	93.9	103.5	104.0	12
RS37	Taueru R at Gladstone	92.2	60.4	67.9	98.9	103.0	12
RS38	Kopuaranga R at Stewarts	97.0	93.7	94.3	98.9	99.0	12
RS39	Whangaehu R 250m u/s confl.	105.0	64.8	79.2	121.0	121.0	12
RS40	Waipoua R at Colombo Rd Br	103.5	98.8	99.2	117.7	121.0	12
RS41	Waingawa R at South Rd	101.5	98.1	98.9	112.5	118.0	12
RS42	Whareama R at Gauge	97.3	92.7	93.9	104.4	110.0	12
RS43	Motuwaireka S at Headwaters	100.0	92.5	95.8	102.9	104.0	12
RS44	Totara S at Stronvar	102.0	97.0	97.5	110.6	111.0	10
RS45	Parkvale Trib at Lowes Res.	73.5	62.7	64.7	78.9	79.4	11
RS46	Parkvale S at Weir	110.5	91.9	96.9	118.8	121.0	12
RS47	Waiohine R at Gorge	100.5	98.8	98.9	104.8	107.0	12
RS48	Waiohine R at Bicknells	100.5	93.1	93.9	116.0	122.0	12
RS49	Beef Ck at Headwaters	99.6	92.6	94.8	104.0	105.0	11
RS50	Mangatarere S at SH 2	99.7	92.7	93.8	121.2	130.0	12
RS51	Huangaaru R at Ponatahi Br	101.0	93.8	94.2	134.2	138.0	12
RS52	Tauanui R at Whakatomotomo Rd	99.6	96.8	97.1	102.5	103.0	12
RS53	Awhea R at Tora Rd	108.0	97.6	98.0	123.5	124.0	12
RS54	Coles Ck Trib at Lagoon Hill Rd	98.9	93.6	93.8	105.2	106.0	9
RS55	Tauherenikau R at Websters	100.4	95.7	96.2	105.9	107.0	12
RS56	Waiorongomai R at Forest Pk	101.5	98.1	98.8	104.9	106.0	12
RS57	Waiwhetu S at Whites Line East	82.4	45.5	50.6	108.7	112.0	12

Table A3.3: Dissolved oxygen (mg/L)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	7.3	5.7	5.7	9.5	9.9	12
RS03	Waitohu S at Forest Pk	11.3	10.2	10.2	12.2	12.2	12
RS04	Waitohu S at Norfolk Cres	9.1	7.3	7.7	10.5	11.0	12
RS05	Otaki R at Pukehinau	11.2	10.0	10.1	12.3	12.4	12
RS06	Otaki R at Mouth	10.8	9.8	9.8	12.1	12.2	12
RS07	Mangaone S at Sims Rd Br	7.4	4.4	5.3	9.6	10.1	12
RS08	Ngarara S at Field Way	4.7	1.4	1.5	6.2	6.6	12
RS09	Waikanae R at Mangaone Walkway	10.8	10.1	10.1	11.4	11.6	12
RS10	Waikanae R at Greenaway Rd	11.0	10.3	10.4	11.6	11.8	12
RS11	Whareroa S at Waterfall Rd	10.9	9.8	10.0	11.1	11.2	12
RS12	Whareroa S at QE Park	7.0	5.4	5.5	8.3	8.9	12
RS13	Horokiri S at Snodgrass	10.7	10.0	10.1	12.1	12.6	12
RS14	Pauatahanui S at Elmwood Br	10.4	9.4	9.6	12.2	12.3	12
RS15	Porirua S at Glenside	11.6	10.9	10.9	13.2	13.4	12
RS16	Porirua S at Wall Park (Milk Depot)	11.3	10.5	10.6	12.8	13.0	12
RS17	Makara S at Kennels	11.3	9.8	10.3	12.5	12.5	12
RS18	Karori S at Makara Peak	10.9	10.1	10.2	11.6	11.8	12
RS19	Kaiwharawhara S at Ngaio Gorge	11.1	9.8	10.4	12.3	12.4	12
RS20	Hutt R at Te Marua Intake Site	11.1	9.7	10.0	12.0	12.1	12
RS21	Hutt R opp. Manor Park G.C.	10.9	9.5	9.8	12.2	12.3	12
RS22	Hutt R at Boulcott	10.9	10.1	10.2	11.9	12.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	10.6	10.0	10.0	11.5	11.6	12
RS24	Mangaroa R at Te Marua	10.9	10.3	10.4	12.0	12.2	12
RS25	Akatarawa R at Hutt confl.	11.1	10.2	10.5	12.3	12.5	12
RS26	Whakatikei R at Riverstone	11.1	10.2	10.3	12.7	12.7	12
RS28	Wainuiomata R at Manuka Track	11.1	9.9	10.2	12.3	12.3	11
RS29	Wainuiomata R d/s of White Br	11.3	9.4	9.5	12.9	13.1	12
RS30	Orongorongo R at Orongorongo Stn	10.3	9.3	9.4	11.6	11.7	12
RS31	Ruamahanga R at McLays	11.5	10.2	10.5	12.6	12.7	12
RS32	Ruamahanga R at Te Ore Ore	10.9	9.6	9.7	11.9	12.0	12
RS33	Ruamahanga R at Gladstone Br	10.7	9.5	9.7	11.8	11.9	12
RS34	Ruamahanga R at Pukio	10.8	9.6	9.7	11.6	11.8	12
RS35	Mataikona Trib at Sugar Loaf Rd	11.0	10.5	10.7	12.4	12.6	12
RS36	Taueru R at Castlehill	11.0	9.7	9.8	12.0	12.1	12
RS37	Taueru R at Gladstone	10.1	5.7	6.9	11.6	11.7	12
RS38	Kopuaranga R at Stewarts	10.4	9.3	9.5	11.5	11.9	12
RS39	Whangaehu R 250m u/s confl.	11.4	6.5	8.4	11.8	11.9	12
RS40	Waipoua R at Colombo Rd Br	11.1	9.8	9.9	12.5	12.7	12
RS41	Waingawa R at South Rd	11.0	9.7	9.7	12.4	12.6	12
RS42	Whareama R at Gauge	10.7	8.7	9.0	12.2	12.3	12
RS43	Motuwaireka S at Headwaters	11.2	9.6	9.6	12.4	12.5	12
RS44	Totara S at Stronvar	11.2	8.9	9.3	12.4	12.4	10
RS45	Parkvale Trib at Lowes Res.	7.8	6.6	6.8	8.7	8.7	11
RS46	Parkvale S at Weir	11.1	10.4	10.5	12.4	12.4	12
RS47	Waiohine R at Gorge	11.8	10.1	10.5	12.5	12.6	12
RS48	Waiohine R at Bicknells	11.0	9.2	9.6	12.4	12.6	12
RS49	Beef Ck at Headwaters	11.4	10.1	10.4	12.0	12.1	11
RS50	Mangatarere S at SH 2	10.9	9.5	9.9	12.6	12.7	12
RS51	Huangaaru R at Ponatahi Br	11.1	9.4	9.8	12.9	13.1	12
RS52	Tauanui R at Whakatomotomo Rd	11.3	9.9	10.2	11.9	12.0	12
RS53	Awhea R at Tora Rd	10.9	8.6	9.1	12.5	13.2	12
RS54	Coles Ck Trib at Lagoon Hill Rd	11.3	9.1	9.2	12.1	12.3	9
RS55	Tauherenikau R at Websters	11.1	10.1	10.1	11.8	11.9	12
RS56	Waiorongomai R at Forest Pk	11.2	9.9	10.1	12.1	12.3	12
RS57	Waiwhetu S at Whites Line East	8.7	4.4	5.0	11.4	12.2	12

Table A3.4: pH

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	7.0	6.7	6.8	7.1	7.1	12
RS03	Waitohu S at Forest Pk	7.6	7.4	7.4	7.7	7.7	12
RS04	Waitohu S at Norfolk Cres	6.9	6.9	6.9	7.2	7.2	12
RS05	Otaki R at Pukehinau	7.5	7.3	7.4	7.7	7.8	12
RS06	Otaki R at Mouth	7.5	7.3	7.3	7.7	7.7	12
RS07	Mangaone S at Sims Rd Br	6.9	6.8	6.8	7.1	7.1	12
RS08	Ngarara S at Field Way	6.9	6.6	6.7	7.1	7.1	12
RS09	Waikanae R at Mangaone Walkway	7.5	7.4	7.4	7.7	7.8	12
RS10	Waikanae R at Greenaway Rd	7.5	7.2	7.2	8.3	8.8	12
RS11	Whareroa S at Waterfall Rd	7.8	7.5	7.6	7.8	7.9	12
RS12	Whareroa S at QE Park	6.8	6.6	6.6	6.9	6.9	12
RS13	Horokiri S at Snodgrass	7.5	7.3	7.3	7.8	7.8	12
RS14	Pauatahanui S at Elmwood Br	7.6	7.2	7.2	7.8	7.8	12
RS15	Porirua S at Glenside	8.3	7.2	7.4	8.9	9.0	12
RS16	Porirua S at Wall Park (Milk Depot)	7.8	7.2	7.4	8.6	8.7	12
RS17	Makara S at Kennels	7.7	7.2	7.3	8.0	8.1	12
RS18	Karori S at Makara Peak	7.5	7.0	7.1	7.7	7.8	12
RS19	Kaiwharawhara S at Ngaio Gorge	8.1	7.5	7.6	8.9	8.9	12
RS20	Hutt R at Te Marua Intake Site	7.4	7.3	7.3	7.8	7.8	12
RS21	Hutt R opp. Manor Park G.C.	7.3	7.0	7.1	7.7	7.7	12
RS22	Hutt R at Boulcott	7.4	7.2	7.2	7.7	7.9	12
RS23	Pakuratahi R 50m d/s Farm Ck	7.3	6.8	6.9	7.5	7.6	12
RS24	Mangaroa R at Te Marua	7.3	7.1	7.1	7.6	8.0	12
RS25	Akatarawa R at Hutt confl.	7.6	7.2	7.3	7.8	7.9	12
RS26	Whakatikei R at Riverstone	7.8	7.4	7.5	8.2	8.4	12
RS28	Wainuiomata R at Manuka Track	7.4	7.0	7.1	7.6	7.6	11
RS29	Wainuiomata R d/s of White Br	7.5	6.9	7.0	8.2	8.6	12
RS30	Orongorongo R at Orongorongo Stn	7.7	7.4	7.5	7.8	7.9	12
RS31	Ruamahanga R at McLays	7.7	6.8	6.8	7.8	7.8	12
RS32	Ruamahanga R at Te Ore Ore	8.0	7.7	7.8	8.2	8.3	12
RS33	Ruamahanga R at Gladstone Br	7.8	7.5	7.5	8.4	8.4	12
RS34	Ruamahanga R at Pukio	7.8	7.3	7.4	8.2	8.3	12
RS35	Mataikona Trib at Sugar Loaf Rd	8.1	7.9	7.9	8.3	8.4	12
RS36	Taueru R at Castlehill	7.8	7.4	7.4	7.9	7.9	12
RS37	Taueru R at Gladstone	7.8	7.3	7.5	8.1	8.2	12
RS38	Kopuaranga R at Stewarts	7.9	7.6	7.7	8.1	8.1	12
RS39	Whangaehu R 250m u/s confl.	7.8	7.5	7.5	8.2	8.3	12
RS40	Waipoua R at Colombo Rd Br	7.6	7.3	7.3	8.2	8.4	12
RS41	Waingawa R at South Rd	7.6	7.2	7.4	8.3	8.5	12
RS42	Whareama R at Gauge	7.9	7.6	7.7	8.1	8.1	12
RS43	Motuwaireka S at Headwaters	7.9	7.6	7.6	8.0	8.1	12
RS44	Totara S at Stronvar	7.9	7.4	7.5	8.0	8.1	10
RS45	Parkvale Trib at Lowes Res.	6.6	6.5	6.5	6.8	7.0	11
RS46	Parkvale S at Weir	8.0	7.3	7.3	8.8	9.2	12
RS47	Waiohine R at Gorge	7.8	7.3	7.4	8.1	8.3	12
RS48	Waiohine R at Bicknells	7.2	7.0	7.1	7.5	7.7	12
RS49	Beef Ck at Headwaters	7.8	7.6	7.6	7.9	7.9	11
RS50	Mangatarere S at SH 2	7.2	7.0	7.0	7.6	7.7	12
RS51	Huangaaru R at Ponatahi Br	8.1	8.0	8.0	8.5	8.6	12
RS52	Tauanui R at Whakatomotomo Rd	7.7	7.3	7.4	7.8	7.9	12
RS53	Awhea R at Tora Rd	8.2	8.0	8.0	8.6	8.7	12
RS54	Coles Ck Trib at Lagoon Hill Rd	8.0	7.8	7.9	8.2	8.2	9
RS55	Tauherenikau R at Websters	7.5	6.7	7.0	7.8	7.9	12
RS56	Waiorongomai R at Forest Pk	7.7	7.0	7.3	7.8	7.8	12
RS57	Waiwhetu S at Whites Line East	6.8	6.5	6.5	6.9	6.9	12

Table A3.5: Visual clarity (m)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.58	0.29	1.37	12
RS03	Waitohu S at Forest Pk	3.41	0.78	5.43	12
RS04	Waitohu S at Norfolk Cres	0.83	0.18	1.79	12
RS05	Otaki R at Pukehinau	4.61	0.16	8.44	12
RS06	Otaki R at Mouth	2.98	0.10	5.30	12
RS07	Mangaone S at Sims Rd Br	0.64	0.12	1.38	12
RS08	Ngarara S at Field Way	0.56	0.10	0.95	12
RS09	Waikanae R at Mangaone Walkway	3.65	0.86	4.50	12
RS10	Waikanae R at Greenaway Rd	3.65	0.23	7.03	12
RS11	Whareroa S at Waterfall Rd	0.43	0.08	0.76	12
RS12	Whareroa S at QE Park	0.60	0.16	1.36	12
RS13	Horokiri S at Snodgrass	2.28	0.21	3.53	12
RS14	Pauatahanui S at Elmwood Br	1.56	0.16	1.96	12
RS15	Porirua S at Glenside	1.57	0.31	2.88	12
RS16	Porirua S at Wall Park (Milk Depot)	1.52	0.21	3.10	12
RS17	Makara S at Kennels	1.34	0.23	2.24	12
RS18	Karori S at Makara Peak	2.28	0.08	4.09	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.92	0.42	3.51	12
RS20	Hutt R at Te Marua Intake Site	3.23	0.31	5.23	12
RS21	Hutt R opp. Manor Park G.C.	2.24	0.26	3.24	12
RS22	Hutt R at Boulcott	2.29	0.30	4.10	12
RS23	Pakuratahi R 50m d/s Farm Ck	2.91	0.36	4.78	12
RS24	Mangaroa R at Te Marua	1.32	0.16	2.05	12
RS25	Akatarawa R at Hutt confl.	4.70	0.43	6.24	12
RS26	Whakatikei R at Riverstone	3.43	0.31	4.36	12
RS28	Wainuiomata R at Manuka Track	1.99	0.40	3.96	11
RS29	Wainuiomata R d/s of White Br	1.51	0.61	2.55	12
RS30	Orongorongo R at Orongorongo Stn	1.45	0.09	4.43	12
RS31	Ruamahanga R at McLays	5.95	0.24	7.49	12
RS32	Ruamahanga R at Te Ore Ore	3.11	0.09	4.80	12
RS33	Ruamahanga R at Gladstone Br	1.07	0.10	2.91	12
RS34	Ruamahanga R at Pukio	1.25	0.09	3.46	12
RS35	Mataikona Trib at Sugar Loaf Rd	1.58	0.08	2.56	12
RS36	Taueru R at Castlehill	1.06	0.07	1.80	12
RS37	Taueru R at Gladstone	0.54	0.12	2.12	12
RS38	Kopuaranga R at Stewarts	1.26	0.32	2.44	12
RS39	Whangaehu R 250m u/s confl.	0.72	0.08	2.01	12
RS40	Waipoua R at Colombo Rd Br	3.12	0.67	5.50	12
RS41	Waingawa R at South Rd	2.90	0.11	7.96	12
RS42	Whareama R at Gauge	0.40	0.04	2.18	12
RS43	Motuwaireka S at Headwaters	3.00	0.80	4.00	12
RS44	Totara S at Stronvar	4.05	0.70	6.38	10
RS45	Parkvale Trib at Lowes Res.	3.88	2.11	4.00	11
RS46	Parkvale S at Weir	1.30	0.11	2.30	12
RS47	Waiohine R at Gorge	5.03	0.68	6.98	12
RS48	Waiohine R at Bicknells	1.98	0.25	3.30	12
RS49	Beef Ck at Headwaters	3.50	0.79	4.00	11
RS50	Mangatarere S at SH 2	1.69	0.20	3.82	12
RS51	Huangarua R at Ponatahi Br	0.90	0.10	3.21	12
RS52	Tauanui R at Whakatomotomo Rd	3.67	1.05	5.22	12
RS53	Awhea R at Tora Rd	1.06	0.05	4.55	12
RS54	Coles Ck Trib at Lagoon Hill Rd	1.01	0.24	1.96	8
RS55	Tauherenikau R at Websters	3.38	0.11	6.44	12
RS56	Waiorongomai R at Forest Pk	3.33	0.45	5.79	12
RS57	Waiwhetu S at Whites Line East	0.98	0.24	2.20	12

Table A3.6: Turbidity (NTU)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	6.6	3.3	15.9	12
RS03	Waitohu S at Forest Pk	1.1	0.5	5.4	12
RS04	Waitohu S at Norfolk Cres	5.0	2.0	37.0	12
RS05	Otaki R at Pukehinau	0.7	0.2	37.0	12
RS06	Otaki R at Mouth	0.9	0.3	69.0	12
RS07	Mangaone S at Sims Rd Br	6.7	3.1	66.0	12
RS08	Ngarara S at Field Way	8.4	2.8	50.0	12
RS09	Waikanae R at Mangaone Walkway	0.9	0.3	3.2	12
RS10	Waikanae R at Greenaway Rd	0.5	0.2	33.0	12
RS11	Whareroa S at Waterfall Rd	8.4	0.5	71.0	12
RS12	Whareroa S at QE Park	5.5	2.3	50.0	12
RS13	Horokiri S at Snodgrass	1.6	0.6	32.0	12
RS14	Pauatahanui S at Elmwood Br	2.3	0.9	43.0	12
RS15	Porirua S at Glenside	2.2	1.0	17.5	12
RS16	Porirua S at Wall Park (Milk Depot)	3.1	1.2	26.0	12
RS17	Makara S at Kennels	3.4	1.3	26.0	12
RS18	Karori S at Makara Peak	1.6	0.8	33.0	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.2	0.5	10.7	12
RS20	Hutt R at Te Marua Intake Site	0.7	0.3	3.6	12
RS21	Hutt R opp. Manor Park G.C.	1.7	0.5	11.0	12
RS22	Hutt R at Boulcott	1.2	0.4	8.2	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.9	0.4	4.1	12
RS24	Mangaroa R at Te Marua	1.9	0.7	18.4	12
RS25	Akatarawa R at Hutt confl.	0.7	0.3	3.6	12
RS26	Whakatikei R at Riverstone	0.9	0.4	10.7	12
RS28	Wainuiomata R at Manuka Track	1.2	0.9	7.4	11
RS29	Wainuiomata R d/s of White Br	1.6	0.9	3.9	12
RS30	Orongorongo R at Orongorongo Stn	2.8	0.6	157	12
RS31	Ruamahanga R at McLays	0.5	0.2	52.0	12
RS32	Ruamahanga R at Te Ore Ore	1.5	0.5	220	12
RS33	Ruamahanga R at Gladstone Br	4.5	0.6	199	12
RS34	Ruamahanga R at Pukio	3.3	0.6	340	12
RS35	Mataikona Trib at Sugar Loaf Rd	1.4	0.6	310	12
RS36	Taueru R at Castlehill	4.7	1.5	140	12
RS37	Taueru R at Gladstone	9.2	1.0	63.0	12
RS38	Kopuaranga R at Stewarts	2.4	1.0	19.4	12
RS39	Whangaehu R 250m u/s confl.	5.6	1.1	93.0	12
RS40	Waipoua R at Colombo Rd Br	0.9	0.4	8.5	12
RS41	Waingawa R at South Rd	1.2	0.3	62.0	12
RS42	Whareama R at Gauge	15.9	5.0	187	12
RS43	Motuwaireka S at Headwaters	1.0	0.5	4.3	12
RS44	Totara S at Stronvar	1.2	0.4	7.0	10
RS45	Parkvale Trib at Lowes Res.	0.5	0.2	1.9	11
RS46	Parkvale S at Weir	2.8	0.8	27.0	12
RS47	Waiohine R at Gorge	0.8	0.3	16.6	12
RS48	Waiohine R at Bicknells	1.8	0.8	28.0	12
RS49	Beef Ck at Headwaters	0.9	0.5	11.4	11
RS50	Mangatarere S at SH 2	1.9	0.4	133	12
RS51	Huangarua R at Ponatahi Br	3.9	0.4	102	12
RS52	Tauanui R at Whakatomotomo Rd	1.0	0.4	6.5	12
RS53	Awhea R at Tora Rd	8.3	0.6	460	12
RS54	Coles Ck Trib at Lagoon Hill Rd	4.1	2.7	70.0	9
RS55	Tauherenikau R at Websters	1.4	0.4	88.0	12
RS56	Waiorongomai R at Forest Pk	1.2	0.3	19.6	12
RS57	Waiwhetu S at Whites Line East	3.8	1.9	35.0	12

Table A3.7: Electrical conductivity ($\mu\text{S}/\text{cm}$)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	204	157	162	218	221	12
RS03	Waitohu S at Forest Pk	84	57	64	89	91	12
RS04	Waitohu S at Norfolk Cres	144	79	83	186	193	12
RS05	Otaki R at Pukehinau	67	42	44	73	73	12
RS06	Otaki R at Mouth	68	42	44	75	75	12
RS07	Mangaone S at Sims Rd Br	194	110	122	219	228	12
RS08	Ngarara S at Field Way	306	146	212	15,825	34,503	12
RS09	Waikanae R at Mangaone Walkway	85	75	76	90	90	12
RS10	Waikanae R at Greenaway Rd	104	89	91	110	111	12
RS11	Whareroa S at Waterfall Rd	228	198	199	250	252	12
RS12	Whareroa S at QE Park	255	221	231	271	278	12
RS13	Horokiri S at Snodgrass	177	144	151	184	184	12
RS14	Pauatahanui S at Elmwood Br	168	127	141	182	184	12
RS15	Porirua S at Glenside	252	196	210	256	257	12
RS16	Porirua S at Wall Park (Milk Depot)	253	196	209	258	261	12
RS17	Makara S at Kennels	258	204	212	271	273	12
RS18	Karori S at Makara Peak	224	168	179	229	231	12
RS19	Kaiwharawhara S at Ngaio Gorge	279	208	217	291	294	12
RS20	Hutt R at Te Marua Intake Site	72	54	56	80	81	12
RS21	Hutt R opp. Manor Park G.C.	96	78	81	109	110	12
RS22	Hutt R at Boulcott	92	73	73	102	102	12
RS23	Pakuratahi R 50m d/s Farm Ck	84	75	76	87	87	12
RS24	Mangaroa R at Te Marua	105	88	90	107	108	12
RS25	Akatarawa R at Hutt confl.	85	66	67	89	90	12
RS26	Whakatikei R at Riverstone	112	86	95	118	119	12
RS28	Wainuiomata R at Manuka Track	108	88	95	114	114	11
RS29	Wainuiomata R d/s of White Br	137	125	127	144	145	12
RS30	Orongorongo R at Orongorongo Stn	136	110	120	149	151	12
RS31	Ruamahanga R at McLays	52	25	29	57	57	12
RS32	Ruamahanga R at Te Ore Ore	137	45	51	155	156	12
RS33	Ruamahanga R at Gladstone Br	118	46	54	133	136	12
RS34	Ruamahanga R at Pukio	134	45	58	175	182	12
RS35	Mataikona Trib at Sugar Loaf Rd	329	151	225	391	398	12
RS36	Taueru R at Castlehill	188	118	142	226	245	12
RS37	Taueru R at Gladstone	362	290	305	438	441	12
RS38	Kopuaranga R at Stewarts	289	185	197	323	339	12
RS39	Whangaehu R 250m u/s confl.	315	258	271	353	360	12
RS40	Waipoua R at Colombo Rd Br	102	70	73	118	119	12
RS41	Waingawa R at South Rd	64	44	45	71	73	12
RS42	Whareama R at Gauge	487	371	376	602	614	12
RS43	Motuwaireka S at Headwaters	244	211	217	290	298	12
RS44	Totara S at Stronvar	262	213	220	306	306	10
RS45	Parkvale Trib at Lowes Res.	170	154	156	190	193	11
RS46	Parkvale S at Weir	135	128	129	168	183	12
RS47	Waiohine R at Gorge	55	39	40	64	69	12
RS48	Waiohine R at Bicknells	75	54	61	85	89	12
RS49	Beef Ck at Headwaters	98	77	79	108	110	11
RS50	Mangatarere S at SH 2	122	78	88	136	141	12
RS51	Huangaaru R at Ponatahi Br	357	210	240	416	453	12
RS52	Tauanui R at Whakatomotomo Rd	136	107	111	153	157	12
RS53	Awhea R at Tora Rd	422	269	303	471	479	12
RS54	Coles Ck Trib at Lagoon Hill Rd	470	240	249	752	828	9
RS55	Tauherenikau R at Websters	70	54	54	82	83	12
RS56	Waiorongomai R at Forest Pk	119	96	99	124	126	12
RS57	Waiwhetu S at Whites Line East	213	123	134	229	231	12

Table A3.8: Total organic carbon (mg/L)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	6.7	3.9	19.0	12
RS03	Waitohu S at Forest Pk	2.4	1.7	8.7	12
RS04	Waitohu S at Norfolk Cres	5.2	3.7	10.3	12
RS05	Otaki R at Pukehinau	1.6	<0.5	5.2	11
RS06	Otaki R at Mouth	1.3	1.0	6.7	12
RS07	Mangaone S at Sims Rd Br	5.3	3.5	10.5	12
RS08	Ngarara S at Field Way	15.0	9.6	23.0	12
RS09	Waikanae R at Mangaone Walkway	1.9	1.2	7.1	12
RS10	Waikanae R at Greenaway Rd	1.7	0.9	4.7	12
RS11	Whareroa S at Waterfall Rd	4.6	3.2	10.6	12
RS12	Whareroa S at QE Park	12.9	8.1	20.0	12
RS13	Horokiri S at Snodgrass	2.0	1.3	7.0	12
RS14	Pauatahanui S at Elmwood Br	3.7	1.6	12.8	12
RS15	Porirua S at Glenside	3.8	2.9	6.7	12
RS16	Porirua S at Wall Park (Milk Depot)	3.5	2.3	6.4	12
RS17	Makara S at Kennels	4.5	3.3	11.3	12
RS18	Karori S at Makara Peak	1.6	0.9	5.7	12
RS19	Kaiwharawhara S at Ngaio Gorge	3.6	2.5	6.7	12
RS20	Hutt R at Te Marua Intake Site	2.6	1.6	9.0	12
RS21	Hutt R opp. Manor Park G.C.	2.7	<0.5	9.1	11
RS22	Hutt R at Boulcott	2.7	0.8	8.1	12
RS23	Pakuratahi R 50m d/s Farm Ck	3.0	1.3	7.0	12
RS24	Mangaroa R at Te Marua	5.2	4.4	11.3	12
RS25	Akatarawa R at Hutt confl.	2.0	1.3	8.3	12
RS26	Whakatikei R at Riverstone	2.2	1.2	4.2	12
RS28	Wainuiomata R at Manuka Track	2.6	<0.5	11.9	10
RS29	Wainuiomata R d/s of White Br	1.8	1.0	3.6	12
RS30	Orongorongo R at Orongorongo Stn	1.4	<0.5	3.2	8
RS31	Ruamahanga R at McLays	1.4	1.1	4.8	12
RS32	Ruamahanga R at Te Ore Ore	4.0	1.9	5.5	12
RS33	Ruamahanga R at Gladstone Br	3.0	2.1	6.9	12
RS34	Ruamahanga R at Pukio	3.8	2.7	9.4	12
RS35	Mataikona Trib at Sugar Loaf Rd	3.2	2.1	9.2	12
RS36	Taueru R at Castlehill	5.6	4.3	21.0	12
RS37	Taueru R at Gladstone	7.8	5.2	9.9	12
RS38	Kopuaranga R at Stewarts	3.5	2.7	5.5	12
RS39	Whangaehu R 250m u/s confl.	7.9	6.9	12.4	12
RS40	Waipoua R at Colombo Rd Br	2.1	1.0	4.7	12
RS41	Waingawa R at South Rd	1.4	1.0	2.8	12
RS42	Whareama R at Gauge	6.0	3.3	8.8	12
RS43	Motuwaireka S at Headwaters	1.9	1.2	3.7	12
RS44	Totara S at Stronvar	3.5	2.5	4.1	10
RS45	Parkvale Trib at Lowes Res.	3.8	3.1	5.6	11
RS46	Parkvale S at Weir	5.1	4.1	14.6	12
RS47	Waiohine R at Gorge	1.3	0.8	3.6	12
RS48	Waiohine R at Bicknells	1.3	<0.5	4.1	10
RS49	Beef Ck at Headwaters	1.2	0.6	2.3	11
RS50	Mangatarere S at SH 2	2.1	0.9	5.7	12
RS51	Huangarua R at Ponatahi Br	3.4	1.8	9.6	12
RS52	Tauanui R at Whakatomotomo Rd	3.0	1.4	5.9	12
RS53	Awhea R at Tora Rd	4.4	2.7	10.2	12
RS54	Coles Ck Trib at Lagoon Hill Rd	4.7	3.4	5.7	9
RS55	Tauherenikau R at Websters	2.1	1.0	4.7	12
RS56	Waiorongomai R at Forest Pk	2.4	<0.5	5.0	11
RS57	Waiwhetu S at Whites Line East	4.0	2.5	11.8	12

Table A3.9: Ammoniacal nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.026	<0.01	0.181	12
RS03	Waitohu S at Forest Pk	0.005	<0.01	0.005	12
RS04	Waitohu S at Norfolk Cres	0.024	<0.01	0.073	12
RS05	Otaki R at Pukehinau	0.005	<0.01	0.005	12
RS06	Otaki R at Mouth	0.005	<0.01	0.011	12
RS07	Mangaone S at Sims Rd Br	0.074	<0.01	0.150	12
RS08	Ngarara S at Field Way	0.023	<0.01	0.057	12
RS09	Waikanae R at Mangaone Walkway	0.005	<0.01	0.036	12
RS10	Waikanae R at Greenaway Rd	0.005	<0.01	0.020	12
RS11	Whareroa S at Waterfall Rd	0.005	<0.01	0.019	12
RS12	Whareroa S at QE Park	0.051	<0.01	0.240	12
RS13	Horokiri S at Snodgrass	0.005	<0.01	0.013	12
RS14	Pauatahanui S at Elmwood Br	0.014	<0.01	0.036	12
RS15	Porirua S at Glenside	0.005	<0.01	0.044	12
RS16	Porirua S at Wall Park (Milk Depot)	0.005	<0.01	0.038	12
RS17	Makara S at Kennels	0.005	<0.01	0.035	12
RS18	Karori S at Makara Peak	0.019	<0.01	0.076	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.005	<0.01	0.036	12
RS20	Hutt R at Te Marua Intake Site	0.005	<0.01	0.005	12
RS21	Hutt R opp. Manor Park G.C.	0.005	<0.01	0.010	12
RS22	Hutt R at Boulcott	0.005	<0.01	0.005	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.005	<0.01	0.013	12
RS24	Mangaroa R at Te Marua	0.005	<0.01	0.033	12
RS25	Akatarawa R at Hutt confl.	0.005	<0.01	0.033	12
RS26	Whakatikei R at Riverstone	0.005	<0.01	0.005	12
RS28	Wainuiomata R at Manuka Track	0.005	<0.01	0.005	11
RS29	Wainuiomata R d/s of White Br	0.005	<0.01	0.015	12
RS30	Orongorongo R at Orongorongo Stn	0.005	<0.01	0.016	12
RS31	Ruamahanga R at McLays	0.005	<0.01	0.005	12
RS32	Ruamahanga R at Te Ore Ore	0.005	<0.01	0.005	12
RS33	Ruamahanga R at Gladstone Br	0.016	<0.01	0.042	12
RS34	Ruamahanga R at Pukio	0.005	<0.01	0.034	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.005	<0.01	0.014	12
RS36	Taueru R at Castlehill	0.005	<0.01	0.027	12
RS37	Taueru R at Gladstone	0.005	<0.01	0.024	12
RS38	Kopuaranga R at Stewarts	0.005	<0.01	0.015	12
RS39	Whangaehu R 250m u/s confl.	0.005	<0.01	0.066	12
RS40	Waipoua R at Colombo Rd Br	0.005	<0.01	0.013	12
RS41	Waingawa R at South Rd	0.005	<0.01	0.005	12
RS42	Whareama R at Gauge	0.005	<0.01	0.023	12
RS43	Motuwaireka S at Headwaters	0.005	<0.01	0.005	12
RS44	Totara S at Stronvar	0.005	<0.01	0.015	10
RS45	Parkvale Trib at Lowes Res.	0.005	<0.01	0.005	11
RS46	Parkvale S at Weir	0.005	<0.01	0.058	12
RS47	Waiohine R at Gorge	0.005	<0.01	0.005	12
RS48	Waiohine R at Bicknells	0.005	<0.01	0.030	12
RS49	Beef Ck at Headwaters	0.005	<0.01	0.005	11
RS50	Mangatarere S at SH 2	0.089	<0.01	0.630	12
RS51	Huangarua R at Ponatahi Br	0.005	<0.01	0.015	12
RS52	Tauanui R at Whakatomotomo Rd	0.005	<0.01	0.005	12
RS53	Awhea R at Tora Rd	0.005	<0.01	0.018	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.005	<0.01	0.005	9
RS55	Tauherenikau R at Websters	0.005	<0.01	0.005	12
RS56	Waiorongomai R at Forest Pk	0.005	<0.01	0.010	12
RS57	Waiwhetu S at Whites Line East	0.037	<0.01	0.133	12

Table A3.10: Nitrite-nitrate nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	1.695	0.910	3.800	12
RS03	Waitohu S at Forest Pk	0.030	<0.002	0.054	12
RS04	Waitohu S at Norfolk Cres	0.300	0.053	1.280	12
RS05	Otaki R at Pukehinau	0.034	0.014	0.060	12
RS06	Otaki R at Mouth	0.046	0.014	0.093	12
RS07	Mangaone S at Sims Rd Br	1.410	0.640	2.600	12
RS08	Ngarara S at Field Way	0.065	0.003	0.570	12
RS09	Waikanae R at Mangaone Walkway	0.151	0.079	0.260	12
RS10	Waikanae R at Greenaway Rd	0.230	0.027	0.480	12
RS11	Whareroa S at Waterfall Rd	0.365	0.188	1.210	12
RS12	Whareroa S at QE Park	0.211	0.011	1.420	12
RS13	Horokiri S at Snodgrass	0.380	0.049	1.120	12
RS14	Pauatahanui S at Elmwood Br	0.161	0.005	0.770	12
RS15	Porirua S at Glenside	1.035	0.710	1.600	12
RS16	Porirua S at Wall Park (Milk Depot)	0.920	0.550	1.310	12
RS17	Makara S at Kennels	0.415	0.041	1.280	12
RS18	Karori S at Makara Peak	1.315	0.900	1.550	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.130	0.920	1.490	12
RS20	Hutt R at Te Marua Intake Site	0.077	0.033	0.167	12
RS21	Hutt R opp. Manor Park G.C.	0.173	0.084	0.310	12
RS22	Hutt R at Boulcott	0.184	0.046	0.340	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.170	0.114	0.320	12
RS24	Mangaroa R at Te Marua	0.290	0.157	0.650	12
RS25	Akatarawa R at Hutt confl.	0.078	0.020	0.148	12
RS26	Whakatikei R at Riverstone	0.114	0.015	0.210	12
RS28	Wainuiomata R at Manuka Track	0.065	0.025	0.280	11
RS29	Wainuiomata R d/s of White Br	0.193	0.012	0.330	12
RS30	Orongorongo R at Orongorongo Stn	0.043	<0.002	0.056	12
RS31	Ruamahanga R at McLays	0.018	0.004	0.074	12
RS32	Ruamahanga R at Te Ore Ore	0.305	0.040	0.850	12
RS33	Ruamahanga R at Gladstone Br	0.350	0.062	0.940	12
RS34	Ruamahanga R at Pukio	0.325	0.057	0.970	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.016	<0.002	0.210	12
RS36	Taueru R at Castlehill	0.125	0.019	0.400	12
RS37	Taueru R at Gladstone	0.460	0.270	0.870	12
RS38	Kopuaranga R at Stewarts	0.950	0.480	1.440	12
RS39	Whangaehu R 250m u/s confl.	0.830	0.400	1.210	12
RS40	Waipoua R at Colombo Rd Br	0.525	0.230	1.450	12
RS41	Waingawa R at South Rd	0.052	0.005	0.230	12
RS42	Whareama R at Gauge	0.036	<0.002	0.390	12
RS43	Motuwaireka S at Headwaters	0.005	<0.002	0.042	12
RS44	Totara S at Stronvar	0.123	0.005	0.690	10
RS45	Parkvale Trib at Lowes Res.	4.700	3.300	7.800	11
RS46	Parkvale S at Weir	1.435	0.370	3.500	12
RS47	Waiohine R at Gorge	0.026	0.004	0.048	12
RS48	Waiohine R at Bicknells	0.370	0.179	0.650	12
RS49	Beef Ck at Headwaters	0.020	<0.002	0.050	11
RS50	Mangatarere S at SH 2	1.095	0.350	2.200	12
RS51	Huangarua R at Ponatahi Br	0.153	0.012	0.680	12
RS52	Tauanui R at Whakatomotomo Rd	0.010	<0.002	0.028	12
RS53	Awhea R at Tora Rd	0.084	<0.002	0.320	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.006	0.003	0.186	9
RS55	Tauherenikau R at Websters	0.027	<0.002	0.159	12
RS56	Waiorongomai R at Forest Pk	0.019	<0.002	0.055	12
RS57	Waiwhetu S at Whites Line East	0.555	0.250	1.110	12

Table A3.11: Total Kjeldahl nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.46	0.36	1.53	12
RS03	Waitohu S at Forest Pk	0.05	<0.10	0.14	12
RS04	Waitohu S at Norfolk Cres	0.25	0.17	0.58	12
RS05	Otaki R at Pukehinau	0.05	<0.10	0.16	12
RS06	Otaki R at Mouth	0.05	<0.10	0.22	12
RS07	Mangaone S at Sims Rd Br	0.47	0.27	0.83	12
RS08	Ngarara S at Field Way	0.58	0.42	1.09	12
RS09	Waikanae R at Mangaone Walkway	0.05	<0.10	0.17	12
RS10	Waikanae R at Greenaway Rd	0.05	<0.10	0.25	12
RS11	Whareroa S at Waterfall Rd	0.19	<0.10	0.62	12
RS12	Whareroa S at QE Park	0.53	0.33	1.16	12
RS13	Horokiri S at Snodgrass	0.18	<0.10	0.59	12
RS14	Pauatahanui S at Elmwood Br	0.20	0.12	0.89	12
RS15	Porirua S at Glenside	0.22	0.15	0.56	12
RS16	Porirua S at Wall Park (Milk Depot)	0.22	0.17	0.51	12
RS17	Makara S at Kennels	0.26	0.18	0.83	12
RS18	Karori S at Makara Peak	0.22	0.14	0.35	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.19	0.16	0.42	12
RS20	Hutt R at Te Marua Intake Site	0.05	<0.10	0.21	12
RS21	Hutt R opp. Manor Park G.C.	0.05	<0.10	0.54	12
RS22	Hutt R at Boulcott	0.05	<0.10	0.28	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.05	<0.10	0.17	12
RS24	Mangaroa R at Te Marua	0.17	0.13	0.53	12
RS25	Akatarawa R at Hutt confl.	0.05	<0.10	0.18	12
RS26	Whakatikei R at Riverstone	0.05	<0.10	0.33	12
RS28	Wainuiomata R at Manuka Track	0.05	<0.10	0.4	11
RS29	Wainuiomata R d/s of White Br	0.10	<0.10	0.19	12
RS30	Orongorongo R at Orongorongo Stn	0.05	<0.10	0.27	12
RS31	Ruamahanga R at McLays	0.05	<0.10	0.26	12
RS32	Ruamahanga R at Te Ore Ore	0.13	<0.10	0.37	12
RS33	Ruamahanga R at Gladstone Br	0.22	0.11	0.48	12
RS34	Ruamahanga R at Pukio	0.21	0.12	0.72	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.11	<0.10	0.63	12
RS36	Taueru R at Castlehill	0.29	0.2	1.3	12
RS37	Taueru R at Gladstone	0.51	0.34	0.67	12
RS38	Kopuaranga R at Stewarts	0.28	<0.10	0.43	12
RS39	Whangaehu R 250m u/s confl.	0.58	0.12	1.14	12
RS40	Waipoua R at Colombo Rd Br	0.16	<0.10	0.33	12
RS41	Waingawa R at South Rd	0.05	<0.10	0.11	12
RS42	Whareama R at Gauge	0.42	0.26	0.84	12
RS43	Motuwaireka S at Headwaters	0.05	<0.10	0.11	12
RS44	Totara S at Stronvar	0.11	<0.10	0.17	10
RS45	Parkvale Trib at Lowes Res.	0.33	0.24	0.47	11
RS46	Parkvale S at Weir	0.45	0.24	4.1	12
RS47	Waiohine R at Gorge	0.05	<0.10	0.13	12
RS48	Waiohine R at Bicknells	0.08	<0.10	0.23	12
RS49	Beef Ck at Headwaters	0.05	<0.10	0.16	11
RS50	Mangatarere S at SH 2	0.34	0.12	0.94	12
RS51	Huangaaru R at Ponatahi Br	0.21	0.15	0.76	12
RS52	Tauanui R at Whakatomotomo Rd	0.05	<0.10	0.19	12
RS53	Awhea R at Tora Rd	0.20	<0.10	0.91	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.17	0.1	0.28	9
RS55	Tauherenikau R at Websters	0.05	<0.10	0.27	12
RS56	Waiorongomai R at Forest Pk	0.05	<0.10	0.15	12
RS57	Waiwhetu S at Whites Line East	0.26	0.17	0.92	12

Table A3.12: Total nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	2.45	1.63	4.30	12
RS03	Waitohu S at Forest Pk	0.11	<0.11	0.16	12
RS04	Waitohu S at Norfolk Cres	0.74	0.29	1.72	12
RS05	Otaki R at Pukehinau	0.06	<0.11	0.18	12
RS06	Otaki R at Mouth	0.08	<0.11	0.27	12
RS07	Mangaone S at Sims Rd Br	1.98	1.37	3.10	12
RS08	Ngarara S at Field Way	0.74	0.45	1.52	12
RS09	Waikanae R at Mangaone Walkway	0.21	0.11	0.38	12
RS10	Waikanae R at Greenaway Rd	0.28	<0.11	0.69	12
RS11	Whareroa S at Waterfall Rd	0.58	0.23	1.83	12
RS12	Whareroa S at QE Park	0.67	0.45	2.60	12
RS13	Horokiri S at Snodgrass	0.63	0.18	1.70	12
RS14	Pauatahanui S at Elmwood Br	0.36	0.12	1.37	12
RS15	Porirua S at Glenside	1.22	0.93	2.20	12
RS16	Porirua S at Wall Park (Milk Depot)	1.16	0.75	1.83	12
RS17	Makara S at Kennels	0.68	0.29	2.10	12
RS18	Karori S at Makara Peak	1.52	1.10	1.88	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.41	1.19	1.65	12
RS20	Hutt R at Te Marua Intake Site	0.16	<0.11	0.27	12
RS21	Hutt R opp. Manor Park G.C.	0.37	0.18	0.71	12
RS22	Hutt R at Boulcott	0.32	0.16	0.41	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.28	0.21	0.39	12
RS24	Mangaroa R at Te Marua	0.55	0.34	0.84	12
RS25	Akatarawa R at Hutt confl.	0.13	<0.11	0.25	12
RS26	Whakatikei R at Riverstone	0.20	<0.11	0.45	12
RS28	Wainuiomata R at Manuka Track	0.16	<0.11	0.67	11
RS29	Wainuiomata R d/s of White Br	0.32	<0.11	0.47	12
RS30	Orongorongo R at Orongorongo Stn	0.06	<0.11	0.32	12
RS31	Ruamahanga R at McLays	0.06	<0.11	0.29	12
RS32	Ruamahanga R at Te Ore Ore	0.43	0.26	1.22	12
RS33	Ruamahanga R at Gladstone Br	0.52	0.40	1.38	12
RS34	Ruamahanga R at Pukio	0.52	0.34	1.59	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.15	<0.11	0.72	12
RS36	Taueru R at Castlehill	0.39	0.25	1.70	12
RS37	Taueru R at Gladstone	0.97	0.77	1.47	12
RS38	Kopuaranga R at Stewarts	1.18	0.90	1.75	12
RS39	Whangaehu R 250m u/s confl.	1.45	0.87	2.00	12
RS40	Waipoua R at Colombo Rd Br	0.66	0.41	1.63	12
RS41	Waingawa R at South Rd	0.10	<0.11	0.27	12
RS42	Whareama R at Gauge	0.49	0.30	0.95	12
RS43	Motuwaireka S at Headwaters	0.06	<0.11	0.12	12
RS44	Totara S at Stronvar	0.23	<0.11	0.79	10
RS45	Parkvale Trib at Lowes Res.	5.00	3.70	8.10	11
RS46	Parkvale S at Weir	1.72	0.90	6.60	12
RS47	Waiohine R at Gorge	0.06	<0.11	0.15	12
RS48	Waiohine R at Bicknells	0.54	0.32	0.77	12
RS49	Beef Ck at Headwaters	0.06	<0.11	0.16	11
RS50	Mangatarere S at SH 2	1.46	0.73	2.50	12
RS51	Huangarua R at Ponatahi Br	0.42	0.19	0.88	12
RS52	Tauanui R at Whakatomotomo Rd	0.08	<0.11	0.20	12
RS53	Awhea R at Tora Rd	0.28	0.12	1.06	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.17	0.12	0.29	9
RS55	Tauherenikau R at Websters	0.08	<0.11	0.29	12
RS56	Waiorongomai R at Forest Pk	0.06	<0.11	0.20	12
RS57	Waiwhetu S at Whites Line East	0.81	0.44	2.00	12

Table A3.13: Dissolved reactive phosphorus (mg/L)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.035	0.019	0.086	12
RS03	Waitohu S at Forest Pk	0.009	<0.004	0.011	12
RS04	Waitohu S at Norfolk Cres	0.016	0.004	0.040	12
RS05	Otaki R at Pukehinau	0.002	<0.004	0.005	12
RS06	Otaki R at Mouth	0.002	<0.004	0.006	12
RS07	Mangaone S at Sims Rd Br	0.031	0.013	0.044	12
RS08	Ngarara S at Field Way	0.056	0.032	0.104	12
RS09	Waikanae R at Mangaone Walkway	0.014	0.009	0.019	12
RS10	Waikanae R at Greenaway Rd	0.007	<0.004	0.011	12
RS11	Whareroa S at Waterfall Rd	0.034	0.015	0.046	12
RS12	Whareroa S at QE Park	0.037	0.014	0.053	12
RS13	Horokiri S at Snodgrass	0.011	<0.004	0.021	12
RS14	Pauatahanui S at Elmwood Br	0.015	0.008	0.020	12
RS15	Porirua S at Glenside	0.018	0.007	0.025	12
RS16	Porirua S at Wall Park (Milk Depot)	0.018	0.005	0.032	12
RS17	Makara S at Kennels	0.025	0.008	0.030	12
RS18	Karori S at Makara Peak	0.036	0.025	0.056	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.033	0.017	0.046	12
RS20	Hutt R at Te Marua Intake Site	0.002	<0.004	0.007	12
RS21	Hutt R opp. Manor Park G.C.	0.005	<0.004	0.010	12
RS22	Hutt R at Boulcott	0.003	<0.004	0.008	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.005	<0.004	0.009	12
RS24	Mangaroa R at Te Marua	0.009	<0.004	0.024	12
RS25	Akatarawa R at Hutt confl.	0.002	<0.004	0.006	12
RS26	Whakatikei R at Riverstone	0.007	<0.004	0.013	12
RS28	Wainuiomata R at Manuka Track	0.010	<0.004	0.019	11
RS29	Wainuiomata R d/s of White Br	0.008	0.005	0.017	12
RS30	Orongorongo R at Orongorongo Stn	0.005	<0.004	0.019	12
RS31	Ruamahanga R at McLays	0.002	<0.004	0.005	12
RS32	Ruamahanga R at Te Ore Ore	0.006	<0.004	0.016	12
RS33	Ruamahanga R at Gladstone Br	0.015	0.004	0.040	12
RS34	Ruamahanga R at Pukio	0.010	0.006	0.029	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.002	<0.004	0.011	12
RS36	Taueru R at Castlehill	0.012	<0.004	0.024	12
RS37	Taueru R at Gladstone	0.023	0.004	0.047	12
RS38	Kopuaranga R at Stewarts	0.013	<0.004	0.024	12
RS39	Whangaehu R 250m u/s confl.	0.043	0.013	0.073	12
RS40	Waipoua R at Colombo Rd Br	0.003	<0.004	0.009	12
RS41	Waingawa R at South Rd	0.002	<0.004	0.005	12
RS42	Whareama R at Gauge	0.006	<0.004	0.016	12
RS43	Motuwaireka S at Headwaters	0.002	<0.004	0.005	12
RS44	Totara S at Stronvar	0.002	<0.004	0.009	10
RS45	Parkvale Trib at Lowes Res.	0.007	<0.004	0.016	11
RS46	Parkvale S at Weir	0.023	0.009	0.155	12
RS47	Waiohine R at Gorge	0.002	<0.004	0.004	12
RS48	Waiohine R at Bicknells	0.012	0.006	0.031	12
RS49	Beef Ck at Headwaters	0.007	0.004	0.009	11
RS50	Mangatarere S at SH 2	0.087	0.022	0.430	12
RS51	Huangarua R at Ponatahi Br	0.009	<0.004	0.045	12
RS52	Tauanui R at Whakatomotomo Rd	0.005	<0.004	0.009	12
RS53	Awhea R at Tora Rd	0.008	<0.004	0.033	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.005	<0.004	0.008	9
RS55	Tauherenikau R at Websters	0.002	<0.004	0.004	12
RS56	Waiorongomai R at Forest Pk	0.002	<0.004	0.009	12
RS57	Waiwhetu S at Whites Line East	0.022	0.007	0.067	12

Table A3.14: Total phosphorus (mg/L)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.073	0.055	0.178	12
RS03	Waitohu S at Forest Pk	0.012	0.006	0.026	12
RS04	Waitohu S at Norfolk Cres	0.037	0.024	0.125	12
RS05	Otaki R at Pukehinau	0.005	<0.004	0.043	12
RS06	Otaki R at Mouth	0.005	<0.004	0.072	12
RS07	Mangaone S at Sims Rd Br	0.062	0.037	0.171	12
RS08	Ngarara S at Field Way	0.123	0.059	0.280	12
RS09	Waikanae R at Mangaone Walkway	0.016	0.012	0.028	12
RS10	Waikanae R at Greenaway Rd	0.010	0.005	0.050	12
RS11	Whareroa S at Waterfall Rd	0.053	0.029	0.121	12
RS12	Whareroa S at QE Park	0.069	0.045	0.240	12
RS13	Horokiri S at Snodgrass	0.017	0.011	0.107	12
RS14	Pauatahanui S at Elmwood Br	0.025	0.014	0.122	12
RS15	Porirua S at Glenside	0.024	0.017	0.058	12
RS16	Porirua S at Wall Park (Milk Depot)	0.026	0.016	0.092	12
RS17	Makara S at Kennels	0.037	0.026	0.130	12
RS18	Karori S at Makara Peak	0.049	0.033	0.105	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.040	0.035	0.064	12
RS20	Hutt R at Te Marua Intake Site	0.006	<0.004	0.011	12
RS21	Hutt R opp. Manor Park G.C.	0.008	0.005	0.030	12
RS22	Hutt R at Boulcott	0.008	<0.004	0.021	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.007	0.004	0.015	12
RS24	Mangaroa R at Te Marua	0.016	0.012	0.084	12
RS25	Akatarawa R at Hutt confl.	0.005	<0.004	0.016	12
RS26	Whakatikei R at Riverstone	0.009	0.006	0.048	12
RS28	Wainuiomata R at Manuka Track	0.016	0.010	0.044	11
RS29	Wainuiomata R d/s of White Br	0.015	0.010	0.024	12
RS30	Orongorongo R at Orongorongo Stn	0.012	<0.004	0.350	12
RS31	Ruamahanga R at McLays	0.003	<0.004	0.068	12
RS32	Ruamahanga R at Te Ore Ore	0.012	0.006	0.250	12
RS33	Ruamahanga R at Gladstone Br	0.027	0.021	0.220	12
RS34	Ruamahanga R at Pukio	0.025	0.018	0.440	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.007	<0.004	0.420	12
RS36	Taueru R at Castlehill	0.026	0.017	0.330	12
RS37	Taueru R at Gladstone	0.060	0.015	0.139	12
RS38	Kopuaranga R at Stewarts	0.027	0.018	0.073	12
RS39	Whangaehu R 250m u/s confl.	0.076	0.050	0.230	12
RS40	Waipoua R at Colombo Rd Br	0.011	<0.004	0.022	12
RS41	Waingawa R at South Rd	0.005	<0.004	0.031	12
RS42	Whareama R at Gauge	0.048	0.019	0.158	12
RS43	Motuwaireka S at Headwaters	0.005	<0.004	0.008	12
RS44	Totara S at Stronvar	0.007	<0.004	0.092	10
RS45	Parkvale Trib at Lowes Res.	0.014	0.010	0.020	11
RS46	Parkvale S at Weir	0.047	0.023	0.360	12
RS47	Waiohine R at Gorge	0.004	<0.004	0.021	12
RS48	Waiohine R at Bicknells	0.022	0.007	0.046	12
RS49	Beef Ck at Headwaters	0.009	0.006	0.027	11
RS50	Mangatarere S at SH 2	0.119	0.025	0.500	12
RS51	Huangarua R at Ponatahi Br	0.021	0.007	0.176	12
RS52	Tauanui R at Whakatomotomo Rd	0.009	0.005	0.019	12
RS53	Awhea R at Tora Rd	0.026	0.006	0.510	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.011	0.007	0.070	9
RS55	Tauherenikau R at Websters	0.008	<0.004	0.142	12
RS56	Waiorongomai R at Forest Pk	0.005	<0.004	0.108	12
RS57	Waiwhetu S at Whites Line East	0.044	0.022	0.152	12

Table A3.15: *E. coli* (cfu/100mL)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	1,100	320	32,000	12
RS03	Waitohu S at Forest Pk	8	<1	70	12
RS04	Waitohu S at Norfolk Cres	1,100	190	12,000	12
RS05	Otaki R at Pukehinau	6	2	70	12
RS06	Otaki R at Mouth	62	4	600	12
RS07	Mangaone S at Sims Rd Br	900	350	11,000	12
RS08	Ngarara S at Field Way	210	50	9,000	12
RS09	Waikanae R at Mangaone Walkway	10	2	1,200	12
RS10	Waikanae R at Greenaway Rd	28	7	1,200	12
RS11	Whareroa S at Waterfall Rd	125	5	8,000	12
RS12	Whareroa S at QE Park	115	12	4,500	12
RS13	Horokiri S at Snodgrass	360	140	8,100	12
RS14	Pauatahanui S at Elmwood Br	315	170	7,000	12
RS15	Porirua S at Glenside	225	90	2,100	12
RS16	Porirua S at Wall Park (Milk Depot)	600	200	3,000	12
RS17	Makara S at Kennels	300	40	2,400	12
RS18	Karori S at Makara Peak	1,550	390	7,000	12
RS19	Kaiwharawhara S at Ngaio Gorge	595	110	2,800	12
RS20	Hutt R at Te Marua Intake Site	19	3	270	12
RS21	Hutt R opp. Manor Park G.C.	165	16	3,800	12
RS22	Hutt R at Boulcott	90	12	1,100	12
RS23	Pakuratahi R 50m d/s Farm Ck	46	17	360	12
RS24	Mangaroa R at Te Marua	200	50	5,700	12
RS25	Akatarawa R at Hutt confl.	31	13	360	12
RS26	Whakatikei R at Riverstone	29	1	3,000	12
RS28	Wainuiomata R at Manuka Track	15	<1	100	11
RS29	Wainuiomata R d/s of White Br	110	6	1,000	12
RS30	Orongorongo R at Orongorongo Stn	88	<1	800	12
RS31	Ruamahanga R at McLays	6	<1	60	12
RS32	Ruamahanga R at Te Ore Ore	135	18	800	12
RS33	Ruamahanga R at Gladstone Br	50	8	900	12
RS34	Ruamahanga R at Pukio	71	8	1,600	12
RS35	Mataikona Trib at Sugar Loaf Rd	24	2	4,000	12
RS36	Taueru R at Castlehill	80	16	23,000	12
RS37	Taueru R at Gladstone	165	38	2,500	12
RS38	Kopuaranga R at Stewarts	185	120	1,000	12
RS39	Whangaehu R 250m u/s confl.	335	70	900	12
RS40	Waipoua R at Colombo Rd Br	42	15	1,200	12
RS41	Waingawa R at South Rd	27	8	120	12
RS42	Whareama R at Gauge	125	21	5,800	12
RS43	Motuwaireka S at Headwaters	10	1	140	12
RS44	Totara S at Stronvar	9	<1	120	10
RS45	Parkvale Trib at Lowes Res.	11	5	45	11
RS46	Parkvale S at Weir	390	70	22,000	12
RS47	Waiohine R at Gorge	4	1	13	12
RS48	Waiohine R at Bicknells	43	13	700	12
RS49	Beef Ck at Headwaters	4	<1	22	11
RS50	Mangatarere S at SH 2	145	34	2,900	12
RS51	Huangaaru R at Ponatahi Br	78	19	5,800	12
RS52	Tauanui R at Whakatomotomo Rd	2	<1	24	12
RS53	Awhea R at Tora Rd	74	12	5,400	12
RS54	Coles Ck Trib at Lagoon Hill Rd	20	2	120	9
RS55	Tauherenikau R at Websters	16	9	370	12
RS56	Waiorongomai R at Forest Pk	9	3	90	12
RS57	Waiwhetu S at Whites Line East	850	60	16,000	12

Table A3.16: Faecal coliforms (cfu/100mL)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	1,450	320	32,000	12
RS03	Waitohu S at Forest Pk	8	<1	73	12
RS04	Waitohu S at Norfolk Cres	1,250	220	12,000	12
RS05	Otaki R at Pukehinau	7	2	70	12
RS06	Otaki R at Mouth	71	5	600	12
RS07	Mangaone S at Sims Rd Br	1,000	440	11,000	12
RS08	Ngarara S at Field Way	245	70	9,000	12
RS09	Waikanae R at Mangaone Walkway	11	2	1,200	12
RS10	Waikanae R at Greenaway Rd	34	8	1,200	12
RS11	Whareroa S at Waterfall Rd	140	8	9,000	12
RS12	Whareroa S at QE Park	115	15	5,300	12
RS13	Horokiri S at Snodgrass	420	150	8,100	12
RS14	Pauatahanui S at Elmwood Br	325	210	9,000	12
RS15	Porirua S at Glenside	290	90	2,700	12
RS16	Porirua S at Wall Park (Milk Depot)	1,600	280	9,000	12
RS17	Makara S at Kennels	320	40	2,600	12
RS18	Karori S at Makara Peak	1,850	480	7,000	12
RS19	Kaiwharawhara S at Ngaio Gorge	790	120	3,100	12
RS20	Hutt R at Te Marua Intake Site	21	5	300	12
RS21	Hutt R opp. Manor Park G.C.	165	24	4,900	12
RS22	Hutt R at Boulcott	105	18	1,100	12
RS23	Pakuratahi R 50m d/s Farm Ck	56	24	420	12
RS24	Mangaroa R at Te Marua	230	60	8,000	12
RS25	Akatarawa R at Hutt confl.	41	15	530	12
RS26	Whakatikei R at Riverstone	38	1	3,500	12
RS28	Wainuiomata R at Manuka Track	17	<1	120	11
RS29	Wainuiomata R d/s of White Br	115	8	1,200	12
RS30	Orongorongo R at Orongorongo Stn	94	<1	800	12
RS31	Ruamahanga R at McLays	6	<1	60	12
RS32	Ruamahanga R at Te Ore Ore	145	18	1,000	12
RS33	Ruamahanga R at Gladstone Br	53	8	900	12
RS34	Ruamahanga R at Pukio	84	8	1,700	12
RS35	Mataikona Trib at Sugar Loaf Rd	24	2	4,000	12
RS36	Taueru R at Castlehill	80	16	23,000	12
RS37	Taueru R at Gladstone	170	38	2,500	12
RS38	Kopuaranga R at Stewarts	190	150	1,200	12
RS39	Whangaehu R 250m u/s confl.	385	80	900	12
RS40	Waipoua R at Colombo Rd Br	47	20	1,200	12
RS41	Waingawa R at South Rd	27	9	130	12
RS42	Whareama R at Gauge	135	21	6,800	12
RS43	Motuwaireka S at Headwaters	11	1	160	12
RS44	Totara S at Stronvar	10	<1	120	10
RS45	Parkvale Trib at Lowes Res.	11	5	45	11
RS46	Parkvale S at Weir	415	90	29,000	12
RS47	Waiohine R at Gorge	5	2	13	12
RS48	Waiohine R at Bicknells	47	13	700	12
RS49	Beef Ck at Headwaters	4	<1	22	11
RS50	Mangatarere S at SH 2	155	42	2,900	12
RS51	Huangarua R at Ponatahi Br	82	24	5,800	12
RS52	Tauanui R at Whakatomotomo Rd	3	<1	28	12
RS53	Awhea R at Tora Rd	82	12	5,400	12
RS54	Coles Ck Trib at Lagoon Hill Rd	25	2	120	9
RS55	Tauherenikau R at Websters	22	9	370	12
RS56	Waiorongomai R at Forest Pk	11	3	90	12
RS57	Waiwhetu S at Whites Line East	900	70	16,000	12

Table A3.17: Total suspended solids (mg/L)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	6.0	<2	13	12
RS03	Waitohu S at Forest Pk	1.0	<2	8	12
RS04	Waitohu S at Norfolk Cres	7.5	<2	80	12
RS05	Otaki R at Pukehinau	1.0	<2	42	12
RS06	Otaki R at Mouth	1.0	<2	66	12
RS07	Mangaone S at Sims Rd Br	4.5	<2	66	12
RS08	Ngarara S at Field Way	6.0	<2	43	12
RS09	Waikanae R at Mangaone Walkway	2.0	<2	5	12
RS10	Waikanae R at Greenaway Rd	1.0	<2	39	12
RS11	Whareroa S at Waterfall Rd	7.0	2	48	12
RS12	Whareroa S at QE Park	3.0	<2	59	12
RS13	Horokiri S at Snodgrass	1.5	<2	47	12
RS14	Pauatahanui S at Elmwood Br	1.0	<2	47	12
RS15	Porirua S at Glenside	1.0	<2	15	12
RS16	Porirua S at Wall Park (Milk Depot)	1.0	<2	25	12
RS17	Makara S at Kennels	3.0	<2	57	12
RS18	Karori S at Makara Peak	1.0	<2	37	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.0	<2	14	12
RS20	Hutt R at Te Marua Intake Site	1.0	<2	2	12
RS21	Hutt R opp. Manor Park G.C.	1.3	<2	8	12
RS22	Hutt R at Boulcott	1.0	<2	6	12
RS23	Pakuratahi R 50m d/s Farm Ck	1.0	<2	2	12
RS24	Mangaroa R at Te Marua	1.0	<2	12	12
RS25	Akatarawa R at Hutt confl.	1.0	<2	1.5	12
RS26	Whakatikei R at Riverstone	1.0	<2	10	12
RS28	Wainuiomata R at Manuka Track	1.0	<2	11	11
RS29	Wainuiomata R d/s of White Br	1.0	<2	3	12
RS30	Orongorongo R at Orongorongo Stn	2.0	<2	280	12
RS31	Ruamahanga R at McLays	1.0	<2	75	12
RS32	Ruamahanga R at Te Ore Ore	3.0	<2	290	12
RS33	Ruamahanga R at Gladstone Br	4.5	<2	250	12
RS34	Ruamahanga R at Pukio	4.5	<2	300	12
RS35	Mataikona Trib at Sugar Loaf Rd	1.0	<2	530	12
RS36	Taueru R at Castlehill	2.5	<2	230	12
RS37	Taueru R at Gladstone	7.5	<2	55	12
RS38	Kopuaranga R at Stewarts	1.5	<2	25	12
RS39	Whangaehu R 250m u/s confl.	3.0	<2	101	12
RS40	Waipoua R at Colombo Rd Br	1.0	<2	6	12
RS41	Waingawa R at South Rd	1.0	<2	12	12
RS42	Whareama R at Gauge	21.0	4	170	12
RS43	Motuwaireka S at Headwaters	1.0	<2	7	12
RS44	Totara S at Stronvar	1.0	<2	4	10
RS45	Parkvale Trib at Lowes Res.	1.0	<2	16	11
RS46	Parkvale S at Weir	4.0	<2	46	12
RS47	Waiohine R at Gorge	1.0	<2	8	12
RS48	Waiohine R at Bicknells	1.0	<2	17	12
RS49	Beef Ck at Headwaters	1.0	<2	5	11
RS50	Mangatarere S at SH 2	2.0	<2	38	12
RS51	Huangaaru R at Ponatahi Br	3.0	<2	114	12
RS52	Tauanui R at Whakatomotomo Rd	1.0	<2	4	12
RS53	Awhea R at Tora Rd	6.5	<2	540	12
RS54	Coles Ck Trib at Lagoon Hill Rd	2.0	<2	32	9
RS55	Tauherenikau R at Websters	1.5	<2	61	12
RS56	Waiorongomai R at Forest Pk	1.0	<2	9	12
RS57	Waiwhetu S at Whites Line East	2.0	<2	25	12

Table A3.18: Summary of dissolved copper, lead and zinc (mg/L) concentrations measured at 10 RSoE sites between July 2011 and June 2012 (D.L.=detection limit)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>	<i>n</i> < D.L.
<i>Dissolved copper</i>						
RS02	Mangapouri S at Bennetts Rd	0.00115	0.0005	0.0043	12	0
RS08	Ngarara S at Field Way	0.00025	<0.0005	0.0015	12	9
RS10	Waikanae R at Greenaway Rd	0.00025	<0.0005	0.0034	12	9
RS15	Porirua S at Glenside	0.00090	<0.0005	0.0018	12	1
RS16	Porirua S at Wall Park (Milk Depot)	0.00175	0.0012	0.0051	12	0
RS18	Karori S at Makara Peak	0.00115	0.0008	0.0037	12	0
RS19	Kaiwharawhara S at Ngaio Gorge	0.00130	0.0009	0.0020	12	0
RS21	Hutt R opp. Manor Park G.C.	0.00038	<0.0005	0.0009	12	6
RS22	Hutt R at Boulcott	0.00025	<0.0005	0.0009	12	8
RS57	Waiwhetu S at Whites Line East	0.00145	0.0007	0.0057	12	0
<i>Dissolved lead</i>						
RS02	Mangapouri S at Bennetts Rd	0.00022	0.0001	0.00040	12	0
RS08	Ngarara S at Field Way	0.00005	<0.0001	0.00029	12	10
RS10	Waikanae R at Greenaway Rd	0.00005	<0.0001	0.00005	12	12
RS15	Porirua S at Glenside	0.00009	<0.0001	0.00027	12	6
RS16	Porirua S at Wall Park (Milk Depot)	0.00038	0.00016	0.00280	12	0
RS18	Karori S at Makara Peak	0.00008	<0.0001	0.00049	12	6
RS19	Kaiwharawhara S at Ngaio Gorge	0.00008	<0.0001	0.00039	12	6
RS21	Hutt R opp. Manor Park G.C.	0.00010	<0.0001	0.00020	12	6
RS22	Hutt R at Boulcott	0.00005	<0.0001	0.00028	12	10
RS57	Waiwhetu S at Whites Line East	0.00037	0.00016	0.00052	12	0
<i>Dissolved zinc</i>						
RS02	Mangapouri S at Bennetts Rd	0.00385	0.0024	0.0088	12	0
RS08	Ngarara S at Field Way	0.00310	<0.0010	0.0068	12	3
RS10	Waikanae R at Greenaway Rd	0.00080	<0.0010	0.0024	12	6
RS15	Porirua S at Glenside	0.00505	0.0023	0.0157	12	0
RS16	Porirua S at Wall Park (Milk Depot)	0.02600	0.0115	0.0850	12	0
RS18	Karori S at Makara Peak	0.01660	0.0101	0.0670	12	0
RS19	Kaiwharawhara S at Ngaio Gorge	0.00700	0.0041	0.0188	12	0
RS21	Hutt R opp. Manor Park G.C.	0.00195	<0.0010	0.0057	12	4
RS22	Hutt R at Boulcott	0.00120	<0.0010	0.0068	12	4
RS57	Waiwhetu S at Whites Line East	0.03000	0.0137	0.0650	12	0

Table A3.19: Macroinvertebrate indices not featured in the text: QMCI, %EPT taxa and taxa richness

Site no.	Site name	QMCI	%EPT taxa	Taxa richness
RS02	Mangapouri S at Bennetts Rd	4.31	6.3	16
RS03	Waitohu S at Forest Pk	8.09	63.0	27
RS04	Waitohu S at Norfolk Cres	4.51	42.1	19
RS05	Otaki R at Pukehinau	7.75	76.9	13
RS06	Otaki R at Mouth	7.88	57.1	14
RS07	Mangaone S at Sims Rd Br	4.36	0	16
RS08	Ngarara S at Field Way	4.77	8.3	12
RS09	Waikanae R at Mangaone Walkway	7.76	62.1	29
RS10	Waikanae R at Greenaway Rd	5.98	51.9	27
RS11	Whareroa S at Waterfall Rd	6.45	41.4	29
RS12	Whareroa S at QE Park	4.29	3.8	26
RS13	Horokiri S at Snodgrass	5.60	52.2	23
RS14	Pauatahanui S at Elmwood Br	3.77	39.1	23
RS15	Porirua S at Glenside	6.03	38.9	18
RS16	Porirua S at Wall Park (Milk Depot)	4.35	31.3	16
RS17	Makara S at Kennels	5.57	55.6	18
RS18	Karori S at Makara Peak	4.30	27.3	22
RS19	Kaiwharawhara S at Ngaio Gorge	3.37	23.8	21
RS20	Hutt R at Te Marua Intake Site	7.70	61.5	26
RS21	Hutt R opp. Manor Park G.C.	6.28	42.9	21
RS22	Hutt R at Boulcott	4.56	31.8	22
RS23	Pakuratahi R 50m d/s Farm Ck	6.01	56.5	23
RS24	Mangaroa R at Te Marua	4.77	52.9	17
RS25	Akatarawa R at Hutt confl.	6.06	56.0	25
RS26	Whakatikei R at Riverstone	5.23	53.8	26
RS28	Wainuiomata R at Manuka Track	7.49	62.9	35
RS29	Wainuiomata R d/s of White Br	4.48	40.0	30
RS30	Orongorongo R at Orongorongo Stn	7.07	61.5	13
RS31	Ruamahanga R at McLays	8.21	66.7	18
RS32	Ruamahanga R at Te Ore Ore	7.72	61.5	13
RS33	Ruamahanga R at Gladstone Br	7.15	38.5	13
RS34	Ruamahanga R at Pukio	7.49	42.9	14
RS35	Mataikona Trib at Sugar Loaf Rd	7.23	58.1	31
RS36	Taueru R at Castlehill	4.34	29.6	27
RS37	Taueru R at Gladstone	4.31	47.1	17
RS38	Kopuaranga R at Stewarts	4.12	40.0	25
RS39	Whangaehu R 250m u/s confl.	4.39	17.4	23
RS40	Waipoua R at Colombo Rd Br	3.83	34.8	23
RS41	Waingawa R at South Rd	7.48	54.5	11
RS42	Whareama R at Gauge	4.03	20.0	10
RS43	Motuwaireka S at Headwaters	7.05	60.0	35
RS44	Totara S at Stronvar	7.68	52.6	19
RS45	Parkvale Trib at Lowes Res.	3.57	38.9	18
RS46	Parkvale S at Weir	4.35	33.3	18
RS47	Waiohine R at Gorge	7.99	68.4	19
RS48	Waiohine R at Bicknells	6.19	36.4	22
RS49	Beef Ck at Headwaters	7.49	60.0	30
RS50	Mangatarere S at SH 2	4.68	45.8	24
RS51	Huangarua R at Ponatahi Br	4.11	33.3	24
RS52	Tauanui R at Whakatomotomo Rd	7.18	59.3	27
RS53	Awhea R at Tora Rd	2.68	17.6	17
RS54	Coles Ck Trib at Lagoon Hill Rd	6.57	37.9	29
RS55	Tauherenikau R at Websters	7.86	61.1	18
RS56	Waiorongomai R at Forest Pk	8.25	62.5	24
RS57	Waiwhetu S at Whites Line East	4.10	0	12

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

For more information contact the Greater Wellington Regional Council:

Wellington office
PO Box 11646
Manners Street
Wellington 6142

T 04 384 5708
F 04 385 6960

Masterton office
PO Box 41
Masterton 5840

T 06 378 2484
F 06 378 2146



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

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