



Annual freshwater quality monitoring report for the Wellington region, 2010/11

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Te Pane Matua Taiao





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GW/EMI-G-12/149

June 2012

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The report may be cited as:

Perrie A, Conwell C, Milne JR and Cockeram B. 2012. *Annual freshwater quality monitoring report for the Wellington region, 2010/11*. Greater Wellington Regional Council, Publication No. GW/EMI-G-12/149, Wellington.

Cover photo: Parkvale Stream, Carterton

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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 (Greater Wellington) conducts regular monitoring of the quality of both surface waters (lakes, rivers and streams) and groundwater. Greater Wellington 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. 2012).

Greater Wellington's State of the Environment (SoE) fresh water quality monitoring programmes incorporate 55 river and stream sites, two lakes and 71 groundwater sites. This report summarises the results of SoE monitoring undertaken over the period 1 July 2010 to 30 June 2011 inclusive, as well as the key findings from targeted investigations carried out or completed during the year.¹ Note that the suitability of fresh waters for contact recreation purposes is reported separately under Greater Wellington's recreational water quality monitoring programme (for the 2010/11 results, see Morar & Warr 2011).

1.1 Monitoring objectives

The aims of Greater Wellington'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.

¹ Note that the inclusion of lake and groundwater quality data in this report is a new addition. Lake water quality data has not routinely been summarised on an annual basis in the past and groundwater quality was previously reported separately, together with groundwater levels (eg, see Tidswell et al. 2010).

2. Rivers and streams

This section summarises the key results from the Rivers State of Environment (RSoE) monitoring programme for 2010/11. 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.

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.² The full list of variables monitored, together with details of field and analytical methods, is provided in Appendix 2.

(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 Due to historic contaminant issues, water samples from one site, Waiwhetu Stream at Wainuiomata Hill Bridge, are also analysed for dissolved concentrations of arsenic, cadmium, chromium and nickel.

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 2010 to June 2011 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 four sites (Coles Creek tributary at Lagoon Hill Road, Parkvale tributary at Lowes Reserve, Totara Stream at Stronvar and Wainuiomata River at Manuaka 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 comply³
- Fair: median values for 3 or 4 of the 6 variables comply with guideline values, of which dissolved oxygen is one variable that must comply³
- 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.

³ If the median dissolved oxygen concentration does not comply with the guideline value, then the WQI grade automatically drops to 'poor'.

Table 2.1: Physico-chemical and microbiological variables and guideline values used in Greater Wellington'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 2009 or Perrie et al. 2012 for hardness information).

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 2010 to June 2011 reporting period (Table 2.2, Figure 2.2):

- Excellent: 18 sites (33%)
- Good: 11 sites (20%)
- Fair: 11 sites (20%)
- Poor 15 sites (27%)

Seventeen of the 18 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 Hutt, Waitohu and Ruamahanga rivers. In contrast, RSoE sites graded 'poor' are typically located on small rivers or streams draining predominantly pastoral (10 sites) or urban (5 sites) catchments. Sites with the poorest water quality during 2010/11 included Mangaone Stream at Sims Road Bridge, Mangapouri Stream at Bennetts Road, Mangatarere Stream at State Highway 2, Porirua Stream at Wall Park, Waiwhetu Stream at Wainuiomata Hill Road Bridge, and Kopuaranga River at Stewarts (Table 2.2).

Table 2.2: Water Quality Index grades for RSoE sites sampled at monthly intervals over June 2010 to July 2011 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=	RS03	Waitohu Stream at Forest Park	✓	✓	✓	✓	✓	✓
1=	RS43	Motuwaireka Stream at headwaters	✓	✓	✓	✓	✓	✓
1=	RS52	Tauanui River at Whakatomotomo Rd	✓	✓	✓	✓	✓	✓
4=	RS05	Otaki River at Pukehinau	✓	✓	✓	✓	✓	✓
4=	RS31	Ruamahanga River at McLays	✓	✓	✓	✓	✓	✓
4=	RS56	Waiorongomai River at Forest Park	✓	✓	✓	✓	✓	✓
7=	RS26	Whakatiwai River at Riverstone	✓	✓	✓	✓	✓	✓
7=	RS41	Waingawa River at South Rd	✓	✓	✓	✓	✓	✓
7=	RS47	Waiohine River at Gorge	✓	✓	✓	✓	✓	✓
10	RS44	Totara Stream at Stronvar	✓	✓	✓	✓	✓	✓
11=	RS06	Otaki River at Mouth	✓	✓	✓	✓	✓	✓
11=	RS25	Akatarawa River at Hutt R Confluence	✓	✓	✓	✓	✓	✓
11=	RS20	Hutt River at Te Marua Intake Site	✓	✓	✓	✓	✓	✓
14	RS28	Wainuiomata River at Manuka Track	✓	✓	✓	✓	✓	✓
15=	RS10	Waikanae River at Greenaway Rd	✓	✓	✓	✓	✓	✓
15=	RS23	Pakuratahi River 50m below Farm Creek	✓	✓	✓	✓	✓	✓
17	RS49	Beef Creek at headwaters	✓	✓	✓	✓	✓	✓
18	RS35	Mataikona tributary at Sugar Loaf Rd	✓	✓	✓	✓	✓	✓
<i>Good water quality</i>								
19=	RS09	Waikanae River at Mangaone Walkway	✓	✓	✓	✓	✓	x
19=	RS55	Tauherenikau River at Websters	✓	x	✓	✓	✓	✓
21	RS30	Orongorongo River at Orongorongo Stn	✓	x	✓	✓	✓	✓
22=	RS21	Hutt River Opposite Manor Park Golf Club	✓	✓	x	✓	✓	✓
22=	RS22	Hutt River at Boulcott	✓	x	✓	✓	✓	✓
24=	RS29	Wainuiomata River u/s of White Bridge	✓	✓	✓	✓	✓	x
24=	RS40	Waipoua River at Colombo Rd Bridge	✓	✓	✓	x	✓	✓
26	RS53	Awhea River at Tora Rd	✓	x	✓	✓	✓	✓
27	RS54	Coles Creek tributary at Lagoon Hill Rd	✓	x	✓	✓	✓	✓
28	RS32	Ruamahanga River at Te Ore Ore	✓	x	✓	✓	✓	✓
29	RS48	Waiohine River at Bicknells	✓	✓	✓	✓	✓	x
<i>Fair water quality</i>								
30	RS36	Taueru River at Castlehill	✓	x	x	✓	✓	✓
31	RS42	Whareama River at Gauge	✓	x	x	✓	✓	✓
32	RS51	Huanga River at Ponatahi Bridge	✓	x	x	✓	✓	✓
33	RS33	Ruamahanga River at Gladstone Bridge	✓	x	✓	✓	✓	x
34=	RS13	Horokiri Stream at Snodgrass	✓	✓	x	x	✓	x
34=	RS34	Ruamahanga River at Pukio	✓	x	x	✓	✓	x
36	RS14	Pauatahanui Stream at Elmwood Bridge	✓	x	x	✓	✓	x
37	RS11	Whareroa Stream at Waterfall Rd	✓	x	x	✓	✓	x
38	RS17	Makara Stream at Kennels	✓	x	x	✓	✓	x
39	RS18	Karori Stream at Makara Peak M.B. Park	✓	✓	x	x	✓	x
40	RS19	Kaiwharawhara Stream at Ngaio Gorge	✓	✓	x	x	✓	x
<i>Poor water quality</i>								
41	RS45	Parkvale tributary at Lowes Reserve	x	✓	✓	x	✓	x
42	RS24	Mangaroa River at Te Marua	✓	x	x	x	✓	x
43	RS37	Taueru River at Gladstone	✓	x	x	x	✓	x
44	RS15	Porirua Stream at Glenside O.C.	✓	x	x	x	✓	x
45	RS16	Porirua Stream at Wall Park (Milk Depot)	✓	x	x	x	✓	x
46=	RS38	Kopuaranga River at Stewarts	✓	x	x	x	✓	x
46=	RS46	Parkvale Stream at Weir	✓	x	x	x	✓	x
48	RS08	Ngarara Stream at Field Way	x	x	x	✓	✓	x
49	RS39	Whangaehu River at 250m from Conf.	✓	x	x	x	✓	x
50	RS27	Waiwhetu Stream at Wainuiomata Hill Br	x	x	x	✓	x	x
51	RS50	Mangatarere Stream at State Highway 2	✓	x	x	x	x	x
52	RS04	Waitohu Stream at Norfolk Crescent	✓	x	x	x	x	x
53	RS12	Whareroa Stream at QE Park	x	x	x	✓	x	x
54	RS02	Mangapouri Stream at Bennetts Rd	x	x	x	x	x	x
55	RS07	Mangaone Stream at Sims Road Bridge	x	x	x	x	x	x

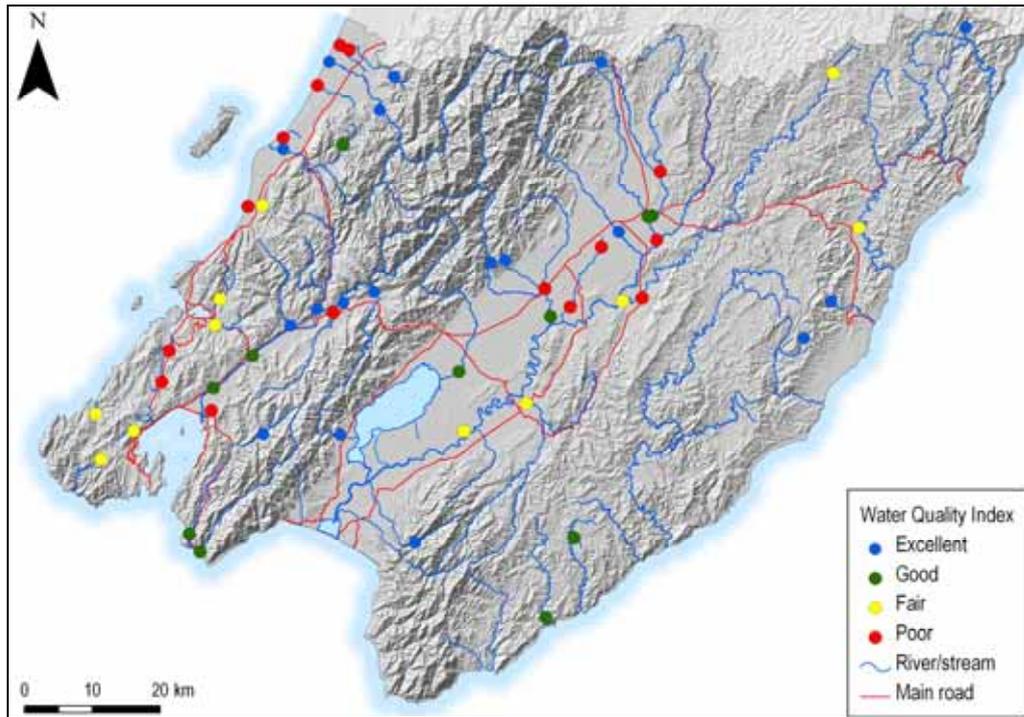


Figure 2.2: Water Quality Index grades for RSoE sites sampled at monthly intervals over June 2010 to July 2011, based on compliance of median dissolved oxygen, visual clarity, nitrite-nitrate nitrogen, ammoniacal nitrogen, dissolved reactive phosphorus and *E. coli* values with guideline values

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 (28 sites), followed by dissolved reactive phosphorus (26 sites), *E. coli* (25 sites) and nitrite-nitrate nitrogen (16 sites). Guidelines for ammoniacal nitrogen and dissolved oxygen were not met at six sites each.

(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 three and four sites, respectively. However, once local water hardness was taken into account and the site-specific, hardness-modified trigger

values applied, Porirua Stream at Wall Park was the only site to exceed the dissolved copper modified guideline. This site, along with Karori Stream at Makara Peak Mountain Bike Park and Waiwhetu Stream at Wainuiomata Hill Bridge, also exceeded the hardness-modified trigger value 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 2010 to June 2011 inclusive, and an assessment of periphyton biomass (chlorophyll *a* and Ash Free Dry Mass (AFDM)) undertaken in late summer/early autumn 2011 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, 18 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 Taueru River at Gladstone (five times), and Porirua Stream at Wall Park (Milk Depot), Huangarua River at Ponatahi Bridge, and Awhea River at Tora Road (four times each). These sites are all located in catchments dominated by pastoral or urban (Porirua Stream) land use and some – especially the Awhea, Taueru and Huangarua rivers – frequently experience prolonged periods without sufficient flows to remove algal growth.

Table 2.4: Summary of monthly observations at RSoE sites, over July 2010 to June 2011 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	12	0	0	4	0
RS05	Otaki R at Pukehinau	9	2.5	0	26.5	0
RS06	Otaki R at Mouth	9	31	1	16	0
RS09	Waikanae R at Mangaone Walkway	12	0	0	0	0
RS10	Waikanae R at Greenaway Rd	10	13	0	31.5	0
RS11	Whareroa S at Waterfall Rd	10	0	0	0	0
RS13	Horokiri S at Snodgrass	11	2	0	6.5	0
RS14	Pauatahanui S at Elmwood Br	10	52	1	0	0
RS15	Porirua S at Glenside	10	81	3	5	0
RS16	Porirua S at Wall Park (Milk Depot)	9	84	4	0	0
RS17	Makara S at Kennels	9	0	0	0	0
RS18	Karori S at Makara Peak M.B. Park	10	97	3	0	0
RS19	Kaiwharawhara S at Ngaio Gorge	10	100	3	3	0
RS20	Hutt R at Te Marua Intake Site	10	0	0	0	0
RS21	Hutt R opp. Manor Park G.C.	9	15.5	0	88	1
RS22	Hutt R at Boulcott	8	8	0	100	1
RS23	Pakuratahi R 50m d/s Farm Ck	10	0	0	11	0
RS24	Mangaroa R at Te Marua	10	22	0	40	0
RS25	Akatarawa R at Hutt confl.	10	0	0	9	0
RS26	Whakatikei R at Riverstone	10	0.5	0	1	0
RS28	Wainuiomata R at Manuka Track	10	0	0	0	0
RS29	Wainuiomata R u/s of White Br	10	4	0	8	0
RS30	Orongorongo R at Orongorongo Stn	9	49	3	11	0
RS31	Ruamahanga R at McLays	9	0	0	0	0
RS32	Ruamahanga R at Te Ore Ore	6	6.5	0	12	0
RS33	Ruamahanga R at Gladstone Br	7	42	1	11.5	0
RS34	Ruamahanga R at Pukio	5	96	1	0	0
RS35	Mataikona Trib at Sugar Loaf Rd	10	0	0	0	0
RS37	Taueru R at Gladstone	7	96	5	6	0
RS38	Kopuaranga R at Stewarts	5	98	1	10	0
RS40	Waipoua R at Colombo Rd Br	11	48	1	39	0
RS41	Waingawa R at South Rd	11	19	0	11	0
RS43	Motuwaireka S at Headwaters	12	0	0	0	0
RS44	Totara S at Stronvar	9	73	1	100	2
RS45	Parkvale Trib at Lowes Res.	9	0	0	0	0
RS46	Parkvale S at Weir	8	81	1	31	0
RS47	Waiohine R at Gorge	8	0	0	3	0
RS48	Waiohine R at Bicknells	10	11	0	10	0
RS49	Beef Ck at Headwaters	12	0	0	5	0
RS50	Mangatarere S at SH 2	10	65	2	56	0
RS51	Huangularua R at Ponatahi Br	9	100	4	80	2
RS52	Tauanui R at Whakatomotomo Rd	11	12	0	8.5	0
RS53	Awhea R at Tora Rd	7	100	4	36	0
RS54	Coles Ck Trib at Lagoon Hill Rd	8	12	0	0	0
RS55	Tauherenikau R at Websters	9	85	1	0	0
RS56	Waiorongomai R at Forest Pk	10	0	0	0	0

Four sites exceeded the MfE (2000) guideline for mat-forming periphyton cover during the reporting period: Hutt River opposite Manor Park (once), Hutt River at Boulcott (once), Totara Stream at Stronvar (twice) and Huangarua River at Ponatahi Bridge (twice). It is important to note that observations of periphyton cover are typically undertaken in run habitat⁴, whereas some mat-forming periphyton (particularly cyanobacteria) tend to proliferate initially in riffle habitat⁵ 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.

Eleven RSoE sites exceeded the MfE (2000) chlorophyll *a* guideline for benthic biodiversity (Table 2.5). The highest chlorophyll *a* biomass recorded was in the Taueru River at Gladstone (486.7 mg/m²). Two sites exceeded the MfE (2000) AFDM guideline for trout habitat and angling, with the highest biomass also recorded in the Taueru River at Gladstone (88.4 g/m²).

There was a reasonable relationship between periphyton guideline compliance and WQI grades. Sites with 'excellent' water quality were more likely to comply with guidelines for both periphyton cover and biomass than sites assigned 'poor' or 'fair' WQI grades. At some sites it was clear that variables other than water quality, such as accrual periods and streamside shade, are more strongly influencing periphyton growth and hence compliance with guidelines.

⁴ 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.

⁵ A riffle is an area of shallow depth, moderate to fast water velocity, with mixed currents and an unbroken but rippled surface.

Table 2.5: Periphyton biomass (AFDM and chlorophyll *a*) from one-off sampling during late summer/ autumn of 2011. 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	1.10	1.45
RS05	Otaki R at Pukehinau	0.48	1.04
RS06	Otaki R at Mouth	0.94	1.80
RS09	Waikanae R at Mangaone Walkway	0.20	0.35
RS10	Waikanae R at Greenaway Rd	4.28	19.06
RS11	Whareroa S at Waterfall Rd	1.72	1.07
RS13	Horokiri S at Snodgrass	8.63	77.21
RS14	Pauatahanui S at Elmwood Br	12.98	53.10
RS15	Porirua S at Glenside	2.37	30.28
RS16	Porirua S at Wall Park (Milk Depot)	2.10	20.01
RS17	Makara S at Kennels	0.34	0.09
RS18	Karori S at Makara Peak M.B. Park	1.52	10.79
RS19	Kaiwharawhara S at Ngaio Gorge	5.15	37.80
RS20	Hutt R at Te Marua Intake Site	0.45	0.39
RS21	Hutt R opp. Manor Park G.C.	0.43	1.64
RS22	Hutt R at Boulcott	2.81	20.57
RS23	Pakuratahi R 50m d/s Farm Ck	0.20	0.17
RS24	Mangaroa R at Te Marua	8.32	83.91
RS25	Akatarawa R at Hutt confl.	1.22	7.78
RS26	Whakatikei R at Riverstone	1.65	6.81
RS28	Wainuiomata R at Manuka Track	0.87	1.41
RS29	Wainuiomata R u/s of White Br	11.07	78.61
RS30	Orongorongo R at Orongorongo Stn	0.49	3.01
RS31	Ruamahanga R at McLays	0.23	1.80
RS32	Ruamahanga R at Te Ore Ore	12.79	90.45
RS33	Ruamahanga R at Gladstone Br	11.75	58.32
RS34	Ruamahanga R at Pukio	17.54	48.96
RS35	Mataikona Trib at Sugar Loaf Rd	2.03	3.99
RS37	Taueru R at Gladstone	88.36	486.66
RS38	Kopuaranga R at Stewarts	37.24	350.54
RS40	Waipoua R at Colombo Rd Br	7.69	46.12
RS41	Waingawa R at South Rd	0.71	1.54
RS43	Motuwaireka S at Headwaters	0.86	1.26
RS44	Totara S at Stronvar	7.42	25.83
RS45	Parkvale Trib at Lowes Res.	9.92	30.30
RS46	Parkvale S at Weir	24.56	49.60
RS47	Waiohine R at Gorge	0.26	0.46
RS48	Waiohine R at Bicknells	1.05	6.47
RS49	Beef Ck at Headwaters	2.11	7.61
RS50	Mangatarere S at SH 2	7.78	38.65
RS51	Huangarua R at Ponatahi Br	33.99	280.42
RS52	Tauanui R at Whakatomotomo Rd	0.90	1.74
RS53	Awhea R at Tora Rd	27.18	60.84
RS54	Coles Ck Trib at Lagoon Hill Rd	13.82	59.63
RS55	Tauherenikau R at Websters	1.40	1.97
RS56	Waiorongomai R at Forest Pk	0.81	0.56

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 2011. 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)⁶ 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).

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

Quality class	MCI and MCI-sb
Excellent	>119
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: 19 sites (34.5%)
- Good: 15 sites (27.3%)
- Fair: 13 sites (23.6%)
- Poor: 8 sites (14.5%)

The majority (16 of 19) of the RSoE sites in the ‘excellent’ MCI quality class are located in catchments dominated by indigenous forest cover (eg, Waitohu Stream at Forest Park). The eight RSoE sites in the ‘poor’ quality class are located in catchments dominated by either pastoral landcover (five sites) or urban landcover (three sites). Sites with soft-sediment substrate are also over-represented in this ‘poor’ class (six of eight sites).

There was a reasonable relationship between the MCI quality classes and WQI grades. For example, of the 19 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, seven of the eight RSoE sites with an MCI quality class of ‘poor’ also had a WQI grade of ‘poor’, the other site a WQI grade of ‘fair’. 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.

⁶ 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 2.7: MCI scores for RSoE sites sampled in summer/autumn 2011

Site no.	Site name	MCI score	MCI quality class
RS02	Mangapouri S at Bennetts Rd	81.9*	Fair
RS03	Waitohu S at Forest Pk	140.9	Excellent
RS04	Waitohu S at Norfolk Cres	72.7*	Poor
RS05	Otaki R at Pukehinau	139.1	Excellent
RS06	Otaki R at Mouth	121.3	Excellent
RS07	Mangaone S at Sims Rd Br	57.1*	Poor
RS08	Ngarara S at Field Way	67.8*	Poor
RS09	Waikanae R at Mangaone Walkway	144.8	Excellent
RS10	Waikanae R at Greenaway Rd	109.2	Good
RS11	Wharerua S at Waterfall Rd	112.6	Good
RS12	Wharerua S at QE Park	53.8*	Poor
RS13	Horokiri S at Snodgrass	106.7	Good
RS14	Pauatahanui S at Elmwood Br	109.0	Good
RS15	Porirua S at Glenside	83.8	Fair
RS16	Porirua S at Wall Park (Milk Depot)	82.0	Fair
RS17	Makara S at Kennels	110.0	Good
RS18	Karori S at Makara Peak	79.2	Poor
RS19	Kaiwharawhara S at Ngaio Gorge	86.7	Fair
RS20	Hutt R at Te Marua Intake Site	130.8	Excellent
RS21	Hutt R opp. Manor Park G.C.	106.1	Good
RS22	Hutt R at Boulcott	102.5	Good
RS23	Pakuratahi R 50m d/s Farm Ck	128.9	Excellent
RS24	Mangaroa R at Te Marua	120.6	Excellent
RS25	Akatarawa R at Hutt confl.	133.1	Excellent
RS26	Whakatikei R at Riverstone	140.0	Excellent
RS27	Waiwhetu S at Wainuiomata Hill Br	72.7*	Poor
RS28	Wainuiomata R at Manuka Track	137.2	Excellent
RS29	Wainuiomata R u/s of White Br	96.8	Fair
RS30	Orongorongo R at Orongorongo Stn	106.3	Good
RS31	Ruamahanga R at McLays	145.0	Excellent
RS32	Ruamahanga R at Te Ore Ore	100.0	Good
RS33	Ruamahanga R at Gladstone Br	96.0	Fair
RS34	Ruamahanga R at Pukio	103.3	Good
RS35	Mataikona Trib at Sugar Loaf Rd	129.0	Excellent
RS36	Taueru R at Castlehill	108.0*	Good
RS37	Taueru R at Gladstone	87.3	Fair
RS38	Kopuaranga R at Stewarts	94.7	Fair
RS39	Whangaehu R 250m u/s confl.	54.5*	Poor
RS40	Waipoua R at Colombo Rd Br	107.6	Good
RS41	Waingawa R at South Rd	110.7	Good
RS42	Whareama R at Gauge	82.6*	Fair
RS43	Motuwaireka S at Headwaters	128.2	Excellent
RS44	Totara S at Stronvar	88.7	Fair
RS45	Parkvale Trib at Lowes Res.	102.9	Good
RS46	Parkvale S at Weir	75.6	Poor
RS47	Waiohine R at Gorge	138.9	Excellent
RS48	Waiohine R at Bicknells	122.1	Excellent
RS49	Beef Ck at Headwaters	133.3	Excellent
RS50	Mangatarere S at SH 2	99.3	Fair
RS51	Huangarua R at Ponatahi Br	87.0	Fair
RS52	Tauanui R at Whakatomotomo Rd	139.2	Excellent
RS53	Awhea R at Tora Rd	84.6	Fair
RS54	Coles Ck Trib at Lagoon Hill Rd	107.0	Good
RS55	Tauherenikau R at Websters	121.0	Excellent
RS56	Waiorongomai R at Forest Pk	124.6	Excellent

* Denotes a site where a soft-bottomed MCI score is presented.

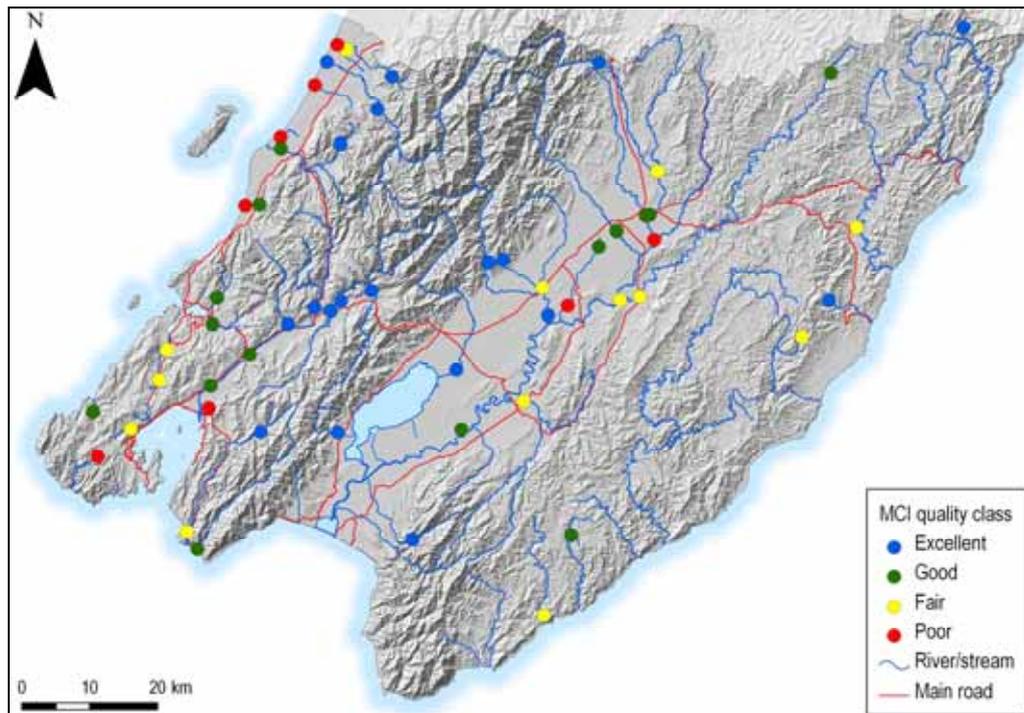


Figure 2.3: MCI quality classes for the 55 RSoE sites, determined from one sampling event over summer/autumn 2011

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 2010/11. 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, Greater Wellington 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).

In March 2011, assessments of ecological condition, based on submerged plant community structure and composition, were also carried out in three additional lakes: Kohangapiripiri, Kohangatera and Pounui. The results of these assessments are summarised in Section 5.3.

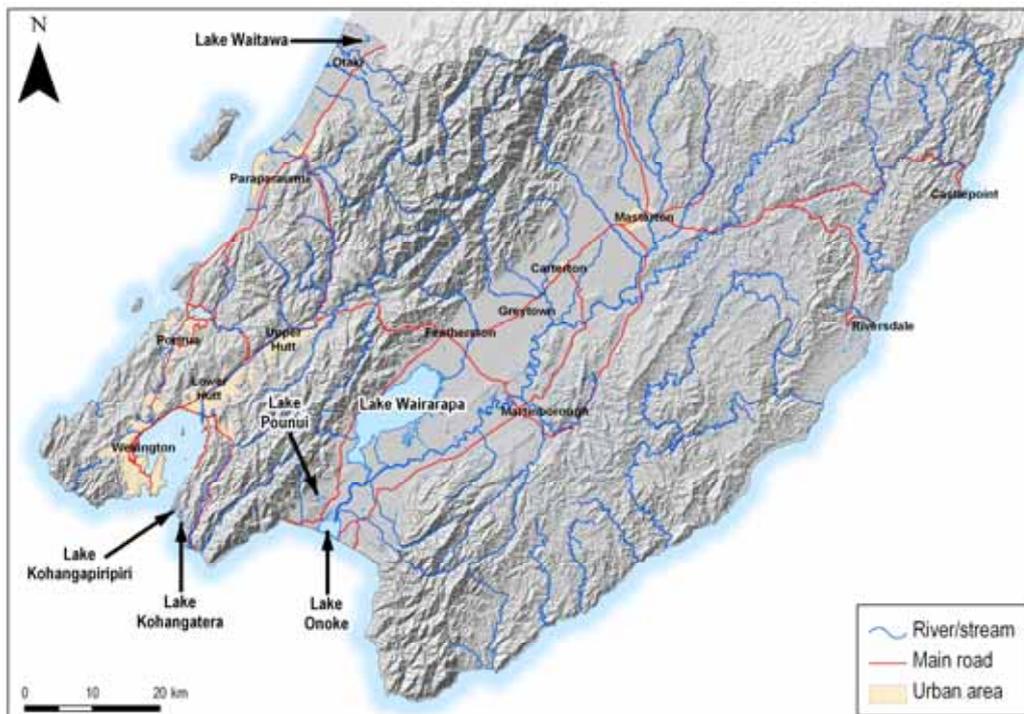


Figure 3.1: Locations of lakes monitored in the Wellington region to date, including the location of three lakes assessed for ecological condition in 2011

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).

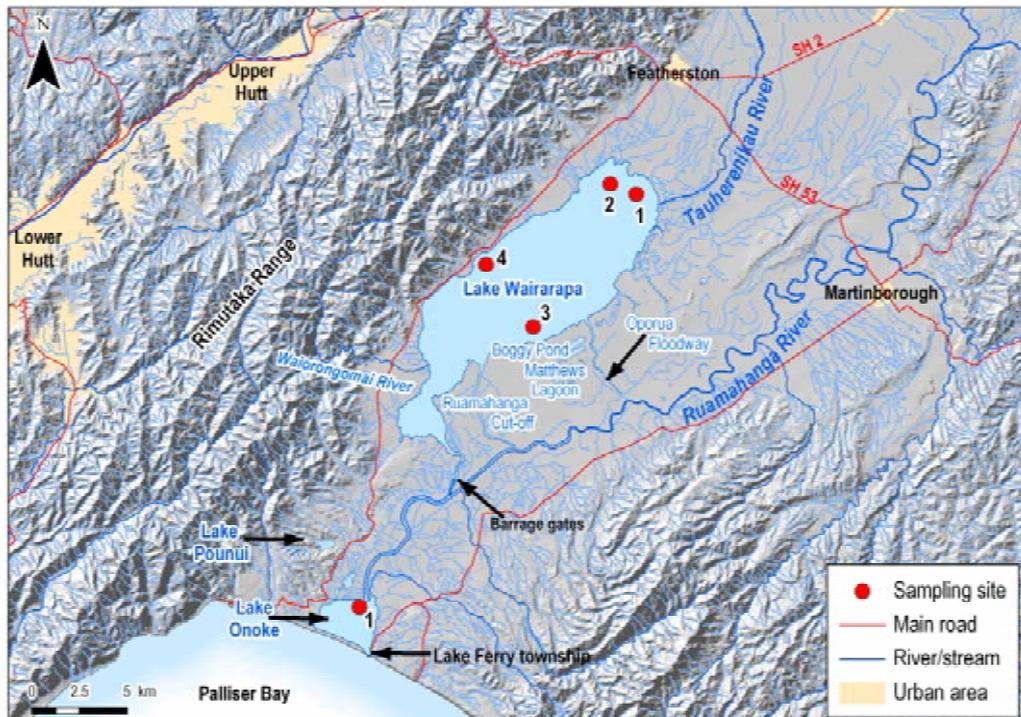


Figure 3.2: Water quality sampling sites on Lakes Wairarapa and Onoke

3.1.2 Monitoring variables

Water quality is assessed approximately every four to six weeks in Lake Onoke and approximately quarterly in Lake Wairarapa⁷ 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 2010 to June 2011 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. $TL_c = 2.22 + 2.54 \log(\text{Chlorophyll } a)$
2. $TL_s = 5.10 + 2.27 \log\left(\frac{1}{\text{Secchi depth}} - \frac{1}{40}\right)$
3. $TL_p = 0.218 + 2.92 \log(\text{Total phosphorus})$
4. $TL_n = -3.61 + 3.01 \log(\text{Total nitrogen})$

⁷ 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 2010/11 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 (total phosphorus and 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 2010 and June 2011. 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)	16.3	15.3	14.5	19.5	—
Dissolved oxygen (% saturation)	100.5	99.9	98.2	105	—
Dissolved oxygen (mg/L)	9.9	9.9	9.3	10.2	—
pH	7.5	7.5	7.2	8.1	—
Conductivity (µS/cm)	646	581	153	1,460	—
Secchi depth (m)	0.28	0.22	0.01	0.57	—
Turbidity (NTU)	111.3	59.5	12.8	320	—
Total suspended solids (mg/L)	99.4	50	11	300	0
Volatile suspended solids (mg/L)	8.7	7	2	18	0
Total nitrogen (mg/L)	0.515	0.46	0.27	0.93	0
Nitrite nitrogen (mg/L)	0.002	0.001	0.001	0.005	83.3
Nitrite-nitrate nitrogen (mg/L)	0.033	0.024	0.001	0.103	16.7
Ammoniacal nitrogen (mg/L)	0.011	0.013	0.005	0.018	41.7
Total phosphorus (mg/L)	0.131	0.091	0.024	0.340	0
Dissolved reactive phosphorus (mg/L)	0.006	0.002	0.002	0.012	58.3
Chlorophyll <i>a</i> (mg/m ³)	11.4	11.5	4	20	0
<i>E. coli</i> (cfu/100 mL)	16	10	4	45	8.3
Faecal coliforms (cfu/100 mL)	19	10	4	51	8.3

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 2010 and June 2011

Key variable	Mean	TL value	TL class
Total nitrogen (mg/L)	0.515	4.6	Eutrophic
Total phosphorus (mg/L)	0.131	6.4	Hypertrophic
Secchi depth (m)	0.28	6.3	Hypertrophic
Chlorophyll <i>a</i> (mg/m ³)	11.4	4.9	Eutrophic
Overall TLI score		5.6	Supertrophic

3.2.3 Lake Onoke

Water quality samples were collected from one site on Lake Onoke on nine occasions during 2010/11 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 mesotrophic (chlorophyll *a*) to hypertrophic (total phosphorus). 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 nine sampling occasions between July 2010 and 2011 (D.L. = detection limit)

Variable	Mean	Median	Minimum	Maximum	<i>n</i> < D.L.
Water temperature (°C)	15.2	13.0	9.3	23.6	—
Dissolved oxygen (% saturation)	96.5	91.2	79.5	132	—
Dissolved oxygen (mg/L)	9.6	10.3	7.91	11	—
pH	7.3	7.3	6.3	8.0	—
Conductivity (µS/cm)	2,212	1,331	70	7,856	—
Secchi depth (m)	0.43	0.41	0.11	>1.0*	—
Turbidity (NTU)	81.6	18.8	3	350	—
Total suspended solids (mg/L)	107.4	16.0	1.0	440	1
Volatile suspended solids (mg/L)	8.5	2.0	1.0	31	4
Total nitrogen (mg/L)	0.558	0.470	0.150	1.150	2
Nitrite nitrogen (mg/L)	0.002	0.002	0.001	0.004	3
Nitrite-nitrate nitrogen (mg/L)	0.202	0.162	0.001	0.630	2
Ammoniacal nitrogen (mg/L)	0.016	0.010	0.005	0.038	4
Total phosphorus (mg/L)	0.109	0.034	0.019	0.340	0
Dissolved reactive phosphorus (mg/L)	0.011	0.013	0.002	0.018	3
Chlorophyll <i>a</i> (mg/m ³)	4.8	2.0	1.5	19	6
<i>E. coli</i> (cfu/100mL)	395	150	5	1,600	1
Faecal coliforms (cfu/100mL)	407	150	5	1,600	1

*On one sampling occasion the Secchi disc was visible on the lake bottom.

Table 3.5: Lake Onoke mean total nitrogen, total phosphorus, secchi depth (water clarity) and chlorophyll *a* values, based on nine sampling occasions between July 2010 and June 2011. 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)	0.558	4.7	Eutrophic
Total phosphorus (mg/L)	0.109	6.2	Hypertrophic
Secchi depth (m)	0.43	5.9	Supertrophic
Chlorophyll <i>a</i> (mg/m ³)	4.8	3.9	Mesotrophic
Overall TLI score		5.2	Supertrophic

4. Groundwater

This section summarises the key results from the Groundwater Quality State of Environment (GQSoE) monitoring programme for 2010/11. This programme involves quarterly monitoring of water quality at 71 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 71 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).

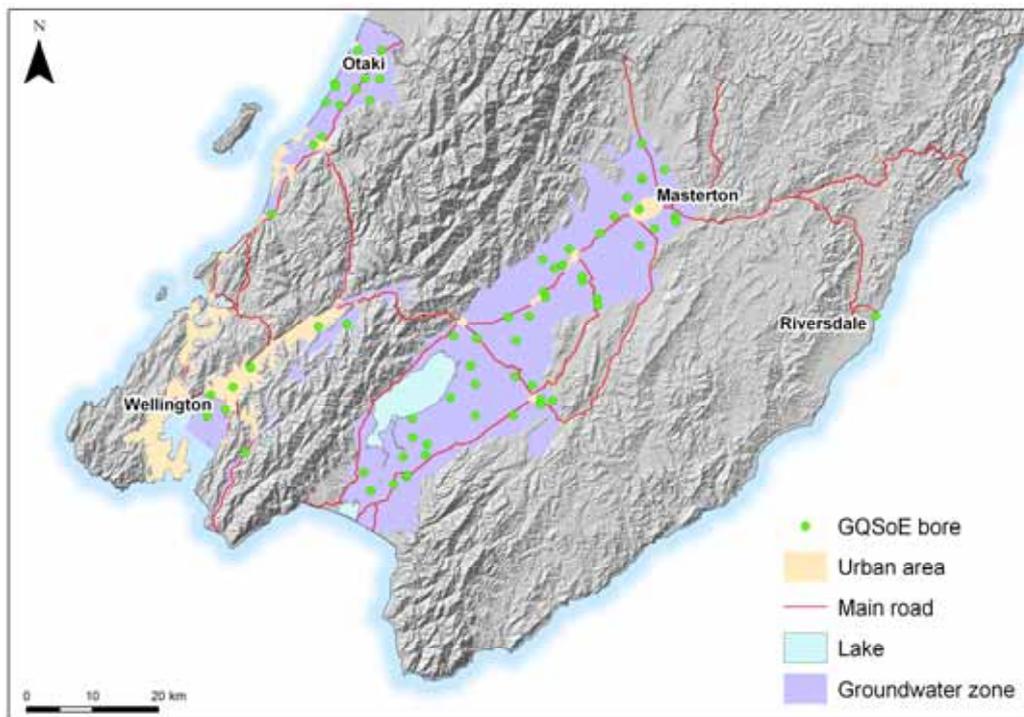


Figure 4.1: GQSoE sites monitored over 2010/11

Sampling of each bore is conducted at quarterly intervals (generally in March, June, September and December). A lack of power at the Salter bore (R25/5165) meant sampling could not be undertaken at this site during 2010/11. Therefore the analysis presented in the next section is based on only 70 bores. Note also that due to accessibility issues, bore R27/1137 was only sampled on one occasion during 2010/11.

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 bacteria⁸, 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 2010/11, eight of 70 (11.4%) GQSoE bores had elevated (3–7 mg/L)⁹ concentrations of nitrate (Figure 4.2). A further six bores in Kapiti and the upper Wairarapa Valley had median nitrate concentrations in the relatively high range (7–11.3 mg/L). No median nitrate concentrations were above the Ministry of Health Drinking Water Standards (DWSNZ 2005) maximum acceptable value (MAV) of 11.3 mg/L. However, on two sampling occasions nitrate concentrations in bore T26/0489 (upper Wairarapa Valley, 54 m deep) were equal to or above the DWSNZ (2005) MAV.

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 systems¹⁰.

Groundwater discharges to a number of surface water bodies throughout the 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 streams and rivers. The 2010/11 GQSoE results show that the median nitrate concentrations in 37 of the 70 GQSoE bores were above the ANZECC (2000) trigger value for lowland ecosystems (0.444 mg/L). Of these, 22 recorded median concentrations above the Hickey and Martin (2009) threshold for aquatic toxicity (1.7 mg/L)¹¹.

⁸ Faecal bacteria are only tested in groundwater samples from 44 of the 71 GQSoE bores.

⁹ 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.

¹⁰ This is particularly evident in recharge areas, with elevated nitrate concentrations not commonly found in deeper confined aquifers.

¹¹ This value is a recommended replacement value for the current ANZECC (2000) toxicity TV of 7.2 mg/L.

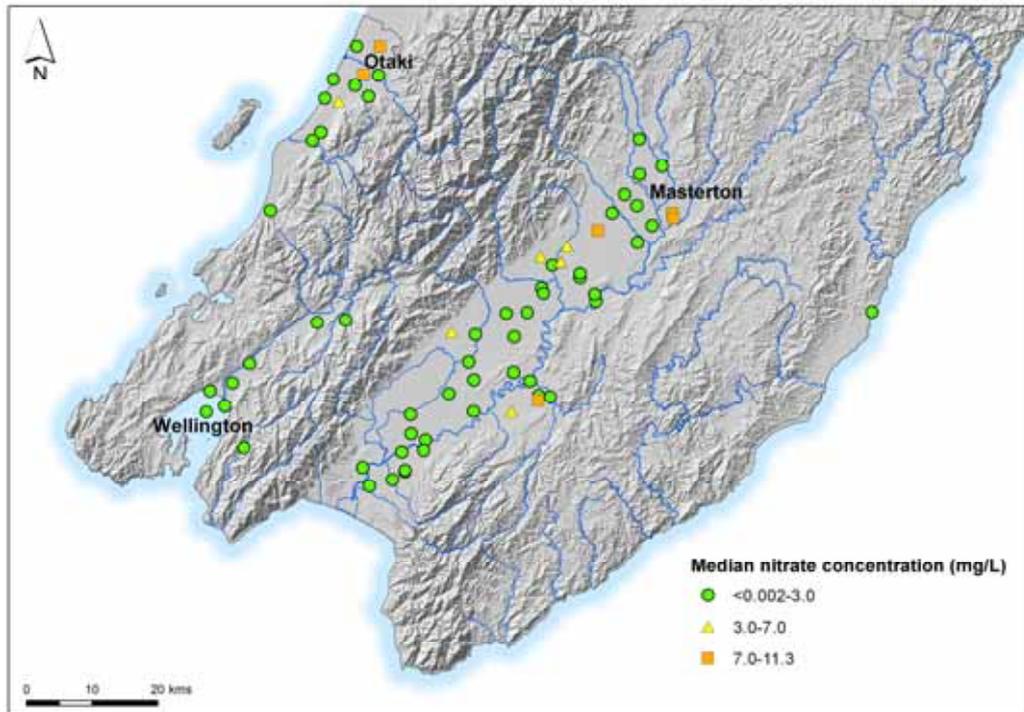


Figure 4.2: Median nitrate nitrogen concentrations recorded in GQSoE monitoring bores sampled over 2010/11

4.2.2 *E. coli*

The DWSNZ (2005) use *E. coli* as an indicator of contamination of drinking water by faecal material¹². For drinking water supplies, *E. coli* counts should be <math><1</math> cfu/100 mL.

E. coli was detected in 10 bores on one or more occasions during the four rounds of GQSoE sampling over 2010/11 (Figure 4.3). The highest *E. coli* count was 320 cfu/100mL in a bore (R25/5164) at Te Horo Beach. *E. coli* levels in this bore exceeded the DWSNZ (2005) MAV on all four sampling occasions. 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.

¹² 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.

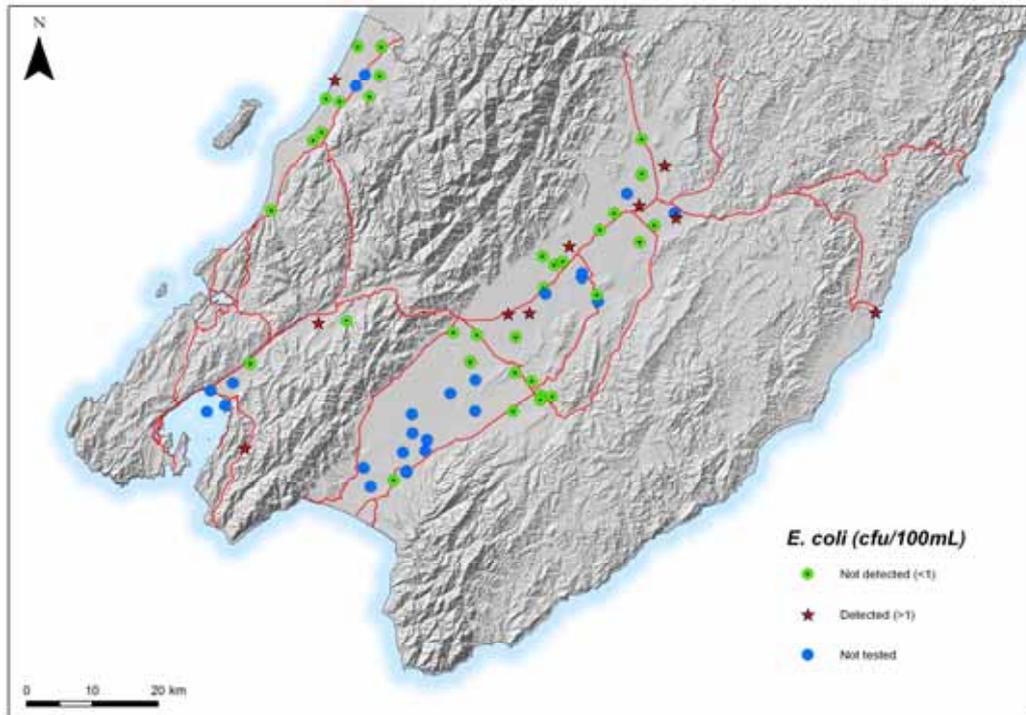


Figure 4.3: Detection (on one or more sampling occasions) of *E. coli* bacteria in GQSoE bores sampled quarterly over 2010/11

5. Targeted investigations

In addition to routine state of the environment monitoring of the region's fresh waters, during 2010/11 Greater Wellington was involved in several targeted investigations. These included completion of the reporting phase of the Mangatarere Stream catchment investigation, carrying out a second summer of stream biofilm sampling, commissioning surveys of the aquatic vegetation in three of the region's lakes, and participating in the sixth national survey of pesticides in groundwater.

5.1 Mangatarere Stream catchment investigation

In July 2010, Milne et al. (2010) completed a technical report documenting a comprehensive investigation of water quality in the Mangatarere Stream catchment near Carterton. The investigation examined soil, groundwater and surface water quality in the wider catchment in an attempt to better understand the causes of elevated nutrient concentrations in the lower reaches of the stream. The key findings of the investigation were summarised in the 2009/10 annual freshwater quality and groundwater monitoring reports (see Perrie & Cockeram 2010 and Tidswell et al. 2010, respectively).

5.2 Stream biofilms

In early 2011, steamed biofilm¹³ 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 second 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 samples mostly targeted urban sites. Lewis et al. (2010) have prepared a report on the first year of sampling results; a further report incorporating the 2011 results is expected in 2013.

5.3 Lake aquatic vegetation surveys

In recognition of a lack of information on the health of some of the region's lakes, in March 2011 surveys were conducted of the submerged aquatic plant communities in Lakes Kohangapiripiri and Kohangatera (collectively known as the Parangarahu Lakes) and Lake Pounui (refer Figure 3.1, Section 3). The surveys, which are documented in full in de Winton et al. (2011) and summarised in more detail in Perrie and Milne (2012), followed the nationally accepted LakeSPI (Submerged Plant Index) methodology developed by Clayton and Edwards (2006). This involved scuba divers assessing 11 metrics of macrophyte community structure and composition over a 2 m wide transect from the shore to the deepest vegetation limit at several sites which are representative of the lake. Metrics included measures of diversity from the presence of key plant communities, the depth of vegetation growth, and the extent that invasive weeds were represented.

¹³ 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.

These metrics were condensed into three indices expressed as a percentage of expected pristine state:

- A native condition index – the diversity and quality of the indigenous flora;
- An invasive condition index – the degree of impact by invasive weed species; and
- A LakeSPI index – an overall measure of lake ecological condition based on both the native condition and invasive condition indices.

Overall LakeSPI scores of 63%, 89% and 56% were calculated for Lakes Kohangapiripiri, Kohangatera and Pounui, respectively (Table 5.1). These scores classify Lake Kohangatera as having ‘excellent’ ecological condition and Lakes Kohangapiripiri and Pounui as having ‘high’ ecological condition. According to de Winton et al. (2011), out of 206 lakes surveyed using this method to date, Lakes Kohangapiripiri, Kohangatera and Pounui are ranked 47th, 10th and 66th, respectively. Further, de Winton et al. (2011) concluded that together, Lakes Kohangapiripiri and Kohangatera can be considered outstanding examples of lowland lake ecosystems.

Table 4.1: Summary of LakeSPI results for Lakes Kohangapiripiri, Kohangatera and Pounui from surveys undertaken by de Winton et al. (2011) in March 2011

Lake	LakeSPI index (%)	Native condition index (%)	Invasive impact index (%)
L Kohangapiripiri	63	73	38
L Kohangatera	89	83	5
L Pounui	56	65	44

All six key native flora types recognised by LakeSPI were recorded across the three lakes. Vegetation extended across the lake beds of Kohangapiripiri and Kohangatera and to depths of 4.5 to 4.9 m in Lake Pounui (de Winton et al. 2011). While Lake Kohangatera recorded the lowest invasive impact index score of the three lakes, the finding of a previously unrecorded exotic weed species (*Elodea canadensis*) is a potential threat to this lake’s high ecological values. A follow-up survey to identify the spatial extent of *E. canadensis* by Wells et al. (2011) discovered an additional exotic weed, *Egeria densa*, in the wetland upstream of the lake. Wells et al. (2011) made several recommendations in relation to managing the spread of weeds in the lake and also recommended that aquatic vegetation in the lake is re-surveyed in two years time.

5.4 Pesticides in groundwater

The sixth national pesticide survey conducted by Environmental Science and Research (ESR) was undertaken in late 2010. These surveys have been undertaken since 1990. A total of 10 bores in the Wellington region were sampled as part of the national survey. The survey results identified low concentrations of organonitrogen herbicides in two bores; one in Otaki (bore S25/5125; Norflurazon at 0.040 µg/L) and one in Wainuiomata (bore R27/6418; Terbutylazine at 0.059 µg/L). Both of these concentrations are well below the New Zealand Drinking Water Standard (2005) Maximum

Acceptable Value (MAV) guidelines for these pesticides. No pesticides were detected in any of the other bores sampled in the Wellington region. Results from the 2010 survey were consistent with the results of the last survey carried out in 2006 (summarised in McAlister 2007).

6. Summary

Monitoring and investigations of fresh waters during 2010/11 found:

- Eighteen (33%) of 55 river and stream (RSoE) monitoring sites were assigned water quality grades of 'excellent' for the 2010/11 reporting period. Eleven sites scored grades of 'good', 11 sites 'fair' and 15 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. One of these sites, Porirua Stream at Wall Park, also exceeded the chronic toxicity threshold for dissolved copper.
- 18 of the 46 RSoE sites monitored for periphyton exceeded the MfE (2000) streambed cover guidelines for filamentous growths at least once and four sites exceeded the guideline for mat growths on one or more sampling occasions. The chlorophyll *a* guideline for benthic biodiversity was exceeded at 11 sites while the AFDM guideline for trout habitat and angling was exceeded at two sites.
- Based on MCI scores, over half of the 55 RSoE sites received quality classifications of 'excellent' (19 sites) or 'good' (15 sites). Thirteen sites were classed as 'fair' and eight 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).
- Based on LakeSPI assessments undertaken in March 2011, Lake Kohangatera is classified as having 'excellent' ecological condition and Lakes Kohangapiripiri and Pounui as having 'high' ecological condition.
- Median nitrate concentrations were low (<3 mg/L) in most of the 70 groundwater SoE bores monitored. However, median concentrations in six bores located in Kapiti and Wairarapa were high (7–11.3 mg/L) and a groundwater sample from one bore (T26/0489) was equal to or exceeded the NZDWS (2005) MAV on two sampling occasions.
- *E. coli* bacteria counts met the NZDWS (2005) MAV on all sampling occasions in 35 of the 44 groundwater bores monitored (note that not all of these bores are used for potable supply).
- Two of ten groundwater bores surveyed as part of the sixth national pesticide survey recorded detectable levels of an organonitrogen herbicide, but concentrations were well below NZDWS (2005) MAV guidelines.

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Acknowledgements

Joanna McVeagh and Edward Lee carried out the majority of the river and groundwater sampling, respectively. Thanks also to Sheree Tidswell, Wendy Purdon and Sam Gundersen for assisting with the groundwater quality monitoring programme, and Greater Wellington harbours staff for providing safe boating on Lake Wairarapa. Shyam Morar prepared some of the maps included in this report.

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 Pukehinau	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/LAL/P	Pasture
RS08	Ngarara S at Field Way*	1771180	5474620	Soft	WW/L/LAL/P	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/P	Indigenous forest
RS11	Whareroa S at Waterfall Rd	1768074	5464532	Hard	WW/L/HSIF**	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
RS27	Waiwhetu S at Wainuiomata Hill Br*	1760565	5434141	Soft	WW/L/HS/U	Urban
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

*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
R27/1137	1773406.32	5444956.34	20.40	Unconfined	Industrial
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

Bore no.	NZTM site coordinates		Depth (m)	Aquifer confinement	Bore use
	Easting	Northing			
S27/0009	1793895.42	5443481.45	10.50	Unconfined	Domestic
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 analysis 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 550A and YSI 556 meters	0.01 °C
Dissolved oxygen	Field meter – generally YSI 550A and YSI 556 meters	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 550A and YSI 556 meters	0.01 units
Conductivity	Field meter – generally YSI 550A and YSI 556 meters	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	Gravimetric. 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 ₂ ⁻ I (proposed) 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 (Proposed) 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 taken using either a YSI 556, Hach HQ40d or a WTW 350i 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	—
Total suspended solids	Gravimetric. 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	7.0	7.8	16.2	17.1	12
RS03	Waitohu S at Forest Pk	11.0	4.6	5.7	14.5	14.6	12
RS04	Waitohu S at Norfolk Cres	12.8	6.0	6.8	15.8	16.2	12
RS05	Otaki R at Pukehinau	10.7	3.9	5.3	14.1	14.2	12
RS06	Otaki R at Mouth	11.8	5.3	6.7	17.2	17.6	12
RS07	Mangaone S at Sims Rd Br	12.3	7.5	7.7	15.4	15.5	12
RS08	Ngarara S at Field Way	14.3	7.1	7.9	18.4	19.5	12
RS09	Waikanae R at Mangaone Walkway	11.6	5.4	6.6	14.1	14.4	12
RS10	Waikanae R at Greenaway Rd	14.1	8.3	8.5	18.0	18.7	12
RS11	Whareroa S at Waterfall Rd	12.0	6.3	6.8	14.8	15.9	12
RS12	Whareroa S at QE Park	13.0	7.9	8.2	16.4	16.5	12
RS13	Horokiri S at Snodgrass	12.9	6.4	7.2	16.9	17.3	12
RS14	Pauatahanui S at Elmwood Br	12.4	5.3	6.7	16.8	17.2	12
RS15	Porirua S at Glenside	13.5	10.1	11.0	17.5	18.7	12
RS16	Porirua S at Wall Park (Milk Depot)	13.7	10.2	10.8	16.9	17.3	12
RS17	Makara S at Kennels	14.7	9.8	10.5	20.2	20.7	12
RS18	Karori S at Makara Peak	13.7	10.1	10.9	16.7	17.2	12
RS19	Kaiwharawhara S at Ngaio Gorge	13.5	10.0	10.7	19.0	19.0	12
RS20	Hutt R at Te Marua Intake Site	10.2	7.5	8.1	17.1	17.4	12
RS21	Hutt R opp. Manor Park G.C.	14.2	9.1	9.7	20.7	21.4	12
RS22	Hutt R at Boulcott	14.2	8.7	9.4	20.8	21.5	12
RS23	Pakuratahi R 50m d/s Farm Ck	10.9	8.3	8.7	17.1	17.4	12
RS24	Mangaroa R at Te Marua	11.8	9.0	9.5	17.8	18.2	12
RS25	Akatarawa R at Hutt confl.	11.1	7.4	8.4	17.4	17.5	12
RS26	Whakatikei R at Riverstone	11.2	7.8	8.8	17.3	17.4	12
RS27	Waiwhetu S at Wainuiomata Hill Br	14.5	10.3	11.0	18.1	18.2	12
RS28	Wainuiomata R at Manuka Track	9.7	8.2	8.4	14.3	14.5	11
RS29	Wainuiomata R u/s of White Br	13.1	9.5	9.6	19.2	19.6	12
RS30	Orongorongo R at Orongorongo Stn	15.4	9.4	10.6	21.1	21.5	12
RS31	Ruamahanga R at McLays	9.8	5.8	5.8	14.5	16.4	12
RS32	Ruamahanga R at Te Ore Ore	13.6	7.5	8.3	19.3	21.0	12
RS33	Ruamahanga R at Gladstone Br	13.8	8.6	9.0	19.2	20.9	12
RS34	Ruamahanga R at Pukio	13.2	8.0	8.6	18.7	19.8	12
RS35	Mataikona Trib at Sugar Loaf Rd	10.7	8.8	9.1	18.1	19.1	12
RS36	Taueru R at Castlehill	10.3	7.1	7.5	20.4	20.9	12
RS37	Taueru R at Gladstone	13.0	8.2	8.8	18.3	19.0	12
RS38	Kopuaranga R at Stewarts	13.4	7.4	7.9	17.2	17.6	12
RS39	Whangaehu R 250m u/s confl.	14.9	7.6	8.3	18.1	19.8	12
RS40	Waipoua R at Colombo Rd Br	12.8	8.9	10.2	22.0	25.0	12
RS41	Waingawa R at South Rd	11.5	8.1	9.2	20.9	21.2	12
RS42	Whareama R at Gauge	12.8	8.9	9.5	22.6	22.7	12
RS43	Motuwaireka S at Headwaters	11.0	7.9	8.1	18.4	18.6	12
RS44	Totara S at Stronvar	13.0	8.5	8.6	23.4	24.1	11
RS45	Parkvale Trib at Lowes Res.	13.0	10.9	11.1	15.3	15.4	9
RS46	Parkvale S at Weir	14.8	9.4	9.4	22.5	23.2	12
RS47	Waiohine R at Gorge	9.8	6.8	7.2	15.0	15.7	12
RS48	Waiohine R at Bicknells	11.7	9.4	9.7	17.5	18.0	12
RS49	Beef Ck at Headwaters	10.4	7.3	7.6	15.3	15.6	12
RS50	Mangatarere S at SH 2	12.4	9.2	9.4	17.9	18.0	12
RS51	Huangaaru R at Ponatahi Br	12.7	7.6	8.2	19.4	19.7	12
RS52	Tauanui R at Whakatomotomo Rd	11.3	6.5	7.5	16.4	16.5	12
RS53	Awhea R at Tora Rd	14.8	7.3	7.7	23.0	23.1	12
RS54	Coles Ck Trib at Lagoon Hill Rd	12.4	5.1	5.7	18.6	18.7	9
RS55	Tauherenikau R at Websters	11.6	7.7	8.6	19.4	19.8	12
RS56	Waiorongomai R at Forest Pk	11.7	7.1	8.2	17.9	18.1	12

Table A3.2: Dissolved oxygen (% saturation)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	71.7	30.9	35.1	93.7	100.0	12
RS03	Waitohu S at Forest Pk	101.0	91.5	92.5	119.1	129.0	12
RS04	Waitohu S at Norfolk Cres	84.7	73.5	75.2	107.3	121.0	12
RS05	Otaki R at Pukehinau	100.5	87.4	89.4	113.5	119.0	12
RS06	Otaki R at Mouth	100.3	85.2	89.9	115.2	119.0	12
RS07	Mangaone S at Sims Rd Br	68.2	53.5	56.5	90.8	92.7	12
RS08	Ngarara S at Field Way	51.0	9.0	14.9	65.6	68.3	12
RS09	Waikanae R at Mangaone Walkway	98.6	87.8	89.0	103.5	104.0	12
RS10	Waikanae R at Greenaway Rd	101.5	87.4	90.1	111.7	115.0	12
RS11	Whareroa S at Waterfall Rd	95.4	76.8	77.8	105.4	107.0	12
RS12	Whareroa S at QE Park	73.6	58.4	59.2	88.2	89.4	12
RS13	Horokiri S at Snodgrass	104.5	89.3	92.3	112.9	114.0	12
RS14	Pauatahanui S at Elmwood Br	100.4	77.6	83.0	109.1	114.0	12
RS15	Porirua S at Glenside	115.5	91.7	94.9	134.0	134.0	12
RS16	Porirua S at Wall Park (Milk Depot)	115.0	93.1	96.3	137.4	144.0	12
RS17	Makara S at Kennels	107.5	90.7	92.5	120.8	123.0	12
RS18	Karori S at Makara Peak	110.0	79.4	88.4	120.6	125.0	12
RS19	Kaiwharawhara S at Ngaio Gorge	109.5	91.6	94.1	127.2	131.0	12
RS20	Hutt R at Te Marua Intake Site	103.5	95.5	96.5	107.9	109.0	12
RS21	Hutt R opp. Manor Park G.C.	107.5	95.5	97.3	126.5	127.0	12
RS22	Hutt R at Boulcott	107.0	95.5	97.3	123.3	126.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	97.0	91.5	92.8	107.8	110.0	12
RS24	Mangaroa R at Te Marua	102.5	93.5	95.9	115.5	116.0	12
RS25	Akatarawa R at Hutt confl.	104.0	95.4	97.7	112.4	114.0	12
RS26	Whakatikei R at Riverstone	103.5	92.3	96.3	112.9	114.0	12
RS27	Waiwhetu S at Wainuiomata Hill Br	70.9	45.8	49.0	139.4	146.0	12
RS28	Wainuiomata R at Manuka Track	101.0	92.0	93.5	105.0	105.0	11
RS29	Wainuiomata R u/s of White Br	107.5	90.3	92.1	133.4	140.0	12
RS30	Orongorongo R at Orongorongo Stn	103.0	93.1	95.4	107.5	108.0	12
RS31	Ruamahanga R at McLays	98.8	85.2	89.8	106.8	109.0	12
RS32	Ruamahanga R at Te Ore Ore	101.0	93.4	93.5	108.5	109.0	12
RS33	Ruamahanga R at Gladstone Br	101.5	85.8	88.6	125.5	126.0	12
RS34	Ruamahanga R at Pukio	101.0	82.3	86.7	108.2	112.0	12
RS35	Mataikona Trib at Sugar Loaf Rd	100.4	89.7	91.2	105.4	107.0	12
RS36	Taueru R at Castlehill	97.0	92.5	92.8	104.5	105.0	12
RS37	Taueru R at Gladstone	93.4	72.8	78.5	105.5	111.0	12
RS38	Kopuaranga R at Stewarts	95.2	89.2	89.8	101.4	103.0	12
RS39	Whangaehu R 250m u/s confl.	87.6	42.9	62.2	118.7	133.0	12
RS40	Waipoua R at Colombo Rd Br	108.0	97.2	97.9	117.5	123.0	12
RS41	Waingawa R at South Rd	99.8	79.4	89.4	111.4	113.0	12
RS42	Whareama R at Gauge	98.5	90.7	92.0	115.0	115.0	12
RS43	Motuwaireka S at Headwaters	98.8	81.7	84.5	108.6	113.0	12
RS44	Totara S at Stronvar	104.0	80.5	84.7	122.5	133.0	11
RS45	Parkvale Trib at Lowes Res.	72.9	60.6	62.6	92.8	102.0	9
RS46	Parkvale S at Weir	103.0	87.8	89.1	124.4	131.0	12
RS47	Waiohine R at Gorge	100.4	86.0	90.8	113.5	119.0	12
RS48	Waiohine R at Bicknells	99.2	89.3	90.3	115.0	121.0	12
RS49	Beef Ck at Headwaters	101.0	82.4	88.2	111.3	119.0	12
RS50	Mangatarere S at SH 2	95.4	76.9	77.7	116.2	120.0	12
RS51	Huangarua R at Ponatahi Br	106.0	83.8	89.5	121.5	133.0	12
RS52	Tauanui R at Whakatomotomo Rd	102.0	90.2	91.2	108.9	110.0	12
RS53	Awhea R at Tora Rd	102.0	76.8	80.3	124.9	126.0	12
RS54	Coles Ck Trib at Lagoon Hill Rd	99.0	79.0	79.1	109.8	111.0	9
RS55	Tauherenikau R at Websters	99.3	88.2	88.3	109.7	113.0	12
RS56	Wairongomai R at Forest Pk	101.0	96.7	96.9	106.9	108.0	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	8.2	3.0	3.4	10.0	11.1	12
RS03	Waitohu S at Forest Pk	11.3	9.7	9.9	13.2	14.8	12
RS04	Waitohu S at Norfolk Cres	9.7	7.3	7.4	11.9	13.9	12
RS05	Otaki R at Pukehinau	11.6	9.2	9.7	13.2	14.5	12
RS06	Otaki R at Mouth	11.2	8.7	8.9	12.9	14.1	12
RS07	Mangaone S at Sims Rd Br	7.7	5.5	5.8	9.9	10.5	12
RS08	Ngarara S at Field Way	5.4	0.8	1.4	7.8	8.0	12
RS09	Waikanae R at Mangaone Walkway	11.0	9.1	9.3	12.4	12.5	12
RS10	Waikanae R at Greenaway Rd	10.0	8.8	9.0	12.6	12.7	12
RS11	Whareroa S at Waterfall Rd	10.3	7.8	8.1	12.7	12.9	12
RS12	Whareroa S at QE Park	7.8	5.7	5.8	10.2	10.5	12
RS13	Horokiri S at Snodgrass	11.0	9.2	9.4	13.2	13.3	12
RS14	Pauatahanui S at Elmwood Br	10.4	8.0	8.6	13.2	13.6	12
RS15	Porirua S at Glenside	11.9	9.9	10.1	13.7	14.1	12
RS16	Porirua S at Wall Park (Milk Depot)	12.3	10.2	10.3	13.5	14.0	12
RS17	Makara S at Kennels	10.8	9.9	9.9	12.3	12.4	12
RS18	Karori S at Makara Peak	11.4	8.6	9.4	12.5	12.6	12
RS19	Kaiwharawhara S at Ngaio Gorge	11.2	10.0	10.2	12.5	12.7	12
RS20	Hutt R at Te Marua Intake Site	11.1	9.5	9.6	12.1	12.4	12
RS21	Hutt R opp. Manor Park G.C.	10.7	10.0	10.1	12.6	13.1	12
RS22	Hutt R at Boulcott	10.7	9.6	9.9	11.9	12.9	12
RS23	Pakuratahi R 50m d/s Farm Ck	10.7	9.3	9.3	12.3	12.4	12
RS24	Mangaroa R at Te Marua	10.7	9.6	9.9	12.1	12.4	12
RS25	Akatarawa R at Hutt confl.	10.9	10.0	10.1	12.5	12.8	12
RS26	Whakatikei R at Riverstone	11.0	9.6	10.0	12.3	12.6	12
RS27	Waiwhetu S at Wainuiomata Hill Br	7.5	4.3	4.6	13.9	14.4	12
RS28	Wainuiomata R at Manuka Track	10.9	9.8	10.3	11.9	12.2	11
RS29	Wainuiomata R u/s of White Br	11.3	9.9	10.0	12.7	12.9	12
RS30	Orongorongo R at Orongorongo Stn	10.1	9.3	9.4	11.0	11.1	12
RS31	Ruamahanga R at McLays	11.4	8.4	9.5	12.5	13.0	12
RS32	Ruamahanga R at Te Ore Ore	10.3	9.1	9.4	11.9	12.1	12
RS33	Ruamahanga R at Gladstone Br	11.1	8.1	9.1	11.8	11.9	12
RS34	Ruamahanga R at Pukio	10.5	7.5	8.4	11.9	12.0	12
RS35	Mataikona Trib at Sugar Loaf Rd	11.2	8.6	8.9	11.7	11.8	12
RS36	Taueru R at Castlehill	10.9	8.4	8.7	11.8	12.0	12
RS37	Taueru R at Gladstone	10.2	6.7	7.5	11.8	12.6	12
RS38	Kopuaranga R at Stewarts	10.2	8.7	9.0	11.5	11.9	12
RS39	Whangaehu R 250m u/s confl.	9.0	4.2	5.8	12.7	13.1	12
RS40	Waipoua R at Colombo Rd Br	10.4	9.4	9.6	12.3	12.6	12
RS41	Waingawa R at South Rd	10.9	6.9	8.1	12.3	13.0	12
RS42	Whareama R at Gauge	10.6	8.0	8.2	12.0	12.1	12
RS43	Motuwaireka S at Headwaters	11.3	7.6	7.9	12.4	12.6	12
RS44	Totara S at Stronvar	10.9	7.5	7.6	13.6	15.1	11
RS45	Parkvale Trib at Lowes Res.	7.9	6.1	6.3	9.6	10.5	9
RS46	Parkvale S at Weir	10.6	8.6	8.7	13.0	14.1	12
RS47	Waiohine R at Gorge	11.4	9.8	9.8	13.2	14.6	12
RS48	Waiohine R at Bicknells	10.7	9.1	9.3	12.5	13.6	12
RS49	Beef Ck at Headwaters	11.3	9.2	9.2	12.9	14.3	12
RS50	Mangatarere S at SH 2	10.3	7.3	7.9	12.1	13.1	12
RS51	Huangarua R at Ponatahi Br	11.4	7.7	8.2	13.4	14.2	12
RS52	Tauanui R at Whakatomotomo Rd	11.4	8.8	8.9	12.6	12.9	12
RS53	Aweha R at Tora Rd	11.2	7.0	7.3	12.5	12.9	12
RS54	Coles Ck Trib at Lagoon Hill Rd	10.1	7.4	7.4	12.5	12.6	9
RS55	Tauherenikau R at Websters	10.7	8.1	8.5	12.3	12.4	12
RS56	Wairongomai R at Forest Pk	11.0	9.2	9.3	12.4	12.7	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	6.8	6.2	6.3	7.0	7.0	12
RS03	Waitohu S at Forest Pk	7.1	6.5	6.7	7.4	7.4	12
RS04	Waitohu S at Norfolk Cres	6.7	6.4	6.4	7.0	7.0	12
RS05	Otaki R at Pukehinau	7.1	6.2	6.5	7.5	7.5	12
RS06	Otaki R at Mouth	7.3	6.3	6.6	7.5	7.6	12
RS07	Mangaone S at Sims Rd Br	6.7	6.2	6.3	7.1	7.2	12
RS08	Ngarara S at Field Way	6.7	6.5	6.6	7.0	7.0	12
RS09	Waikanae R at Mangaone Walkway	7.1	6.6	6.8	7.5	7.8	12
RS10	Waikanae R at Greenaway Rd	7.0	6.9	6.9	7.4	7.4	12
RS11	Whareroa S at Waterfall Rd	7.3	6.7	6.8	7.8	7.9	12
RS12	Whareroa S at QE Park	6.6	6.3	6.3	7.1	7.1	12
RS13	Horokiri S at Snodgrass	7.1	6.8	6.9	7.5	7.6	12
RS14	Pauatahanui S at Elmwood Br	7.1	6.6	6.7	7.5	7.5	12
RS15	Porirua S at Glenside	7.7	6.8	7.0	8.7	8.7	12
RS16	Porirua S at Wall Park (Milk Depot)	7.6	6.7	6.9	8.6	8.9	12
RS17	Makara S at Kennels	7.4	6.7	6.8	7.9	8.0	12
RS18	Karori S at Makara Peak	7.2	6.0	6.4	7.9	8.1	12
RS19	Kaiwharawhara S at Ngaio Gorge	7.6	7.1	7.2	8.9	9.0	12
RS20	Hutt R at Te Marua Intake Site	7.1	6.5	6.5	7.3	7.4	12
RS21	Hutt R opp. Manor Park G.C.	7.1	6.6	6.6	7.9	8.5	12
RS22	Hutt R at Boulcott	7.0	6.6	6.6	7.3	7.3	12
RS23	Pakuratahi R 50m d/s Farm Ck	6.6	6.4	6.5	7.4	7.4	12
RS24	Mangaroa R at Te Marua	6.9	6.4	6.5	7.2	7.3	12
RS25	Akatarawa R at Hutt confl.	7.1	6.8	6.9	7.4	7.4	12
RS26	Whakatikei R at Riverstone	7.3	7.0	7.0	7.8	7.9	12
RS27	Waiwhetu S at Wainuiomata Hill Br	6.7	6.5	6.5	7.1	7.1	12
RS28	Wainuiomata R at Manuka Track	6.9	6.6	6.6	7.2	7.3	11
RS29	Wainuiomata R u/s of White Br	7.2	6.8	6.8	8.5	8.7	12
RS30	Orongorongo R at Orongorongo Stn	7.5	7.0	7.1	7.9	7.9	12
RS31	Ruamahanga R at McLays	7.0	6.5	6.5	7.7	7.9	12
RS32	Ruamahanga R at Te Ore Ore	7.7	7.2	7.3	8.6	9.2	12
RS33	Ruamahanga R at Gladstone Br	7.4	6.5	6.8	8.8	9.2	12
RS34	Ruamahanga R at Pukio	7.5	6.3	6.7	8.1	8.1	12
RS35	Mataikona Trib at Sugar Loaf Rd	7.8	7.2	7.5	8.1	8.2	12
RS36	Taueru R at Castlehill	7.6	6.8	6.9	8.1	8.3	12
RS37	Taueru R at Gladstone	7.7	7.3	7.4	7.9	7.9	12
RS38	Kopuaranga R at Stewarts	7.8	7.2	7.2	7.9	8.0	12
RS39	Whangaehu R 250m u/s confl.	7.4	6.9	7.1	8.0	8.1	12
RS40	Waipoua R at Colombo Rd Br	7.4	6.9	7.0	8.2	8.3	12
RS41	Waingawa R at South Rd	7.3	6.8	6.9	7.7	7.9	12
RS42	Whareama R at Gauge	7.9	7.5	7.5	8.3	8.3	12
RS43	Motuwaireka S at Headwaters	7.4	7.0	7.1	7.9	7.9	12
RS44	Totara S at Stronvar	7.5	7.1	7.1	8.1	8.2	11
RS45	Parkvale Trib at Lowes Res.	6.4	6.0	6.0	6.8	7.0	9
RS46	Parkvale S at Weir	7.5	6.6	6.7	8.5	8.7	12
RS47	Waiohine R at Gorge	7.1	6.6	6.7	7.7	7.7	12
RS48	Waiohine R at Bicknells	6.7	6.2	6.4	7.1	7.2	12
RS49	Beef Ck at Headwaters	7.2	6.4	6.5	7.8	7.9	12
RS50	Mangatarere S at SH 2	6.6	6.5	6.5	7.0	7.1	12
RS51	Huangarua R at Ponatahi Br	7.9	7.5	7.5	8.6	8.7	12
RS52	Tauanui R at Whakatomotomo Rd	7.4	7.1	7.1	7.7	7.8	12
RS53	Awhea R at Tora Rd	8.0	7.4	7.6	8.6	8.7	12
RS54	Coles Ck Trib at Lagoon Hill Rd	7.8	7.6	7.6	8.0	8.0	9
RS55	Tauherenikau R at Websters	7.1	6.5	6.5	7.3	7.4	12
RS56	Wairongomai R at Forest Pk	7.2	6.7	6.7	7.7	7.7	12

Table A3.5: Visual clarity (m)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.59	0.30	1.80	12
RS03	Waitohu S at Forest Pk	3.43	1.32	5.61	12
RS04	Waitohu S at Norfolk Cres	0.86	0.16	2.10	12
RS05	Otaki R at Pukehinau	4.96	0.12	9.50	12
RS06	Otaki R at Mouth	3.03	0.10	9.07	12
RS07	Mangaone S at Sims Rd Br	0.60	0.15	1.21	12
RS08	Ngarara S at Field Way	0.55	0.15	0.81	12
RS09	Waikanae R at Mangaone Walkway	3.89	1.68	5.66	12
RS10	Waikanae R at Greenaway Rd	3.81	0.34	8.89	12
RS11	Whareroa S at Waterfall Rd	0.63	0.10	1.40	12
RS12	Whareroa S at QE Park	0.73	0.09	0.88	12
RS13	Horokiri S at Snodgrass	1.66	0.23	4.48	12
RS14	Pauatahanui S at Elmwood Br	1.51	0.13	2.59	12
RS15	Porirua S at Glenside	1.54	0.05	3.17	12
RS16	Porirua S at Wall Park (Milk Depot)	1.23	0.05	3.06	12
RS17	Makara S at Kennels	1.19	0.04	1.97	12
RS18	Karori S at Makara Peak	2.34	0.21	4.50	12
RS19	Kaiwharawhara S at Ngaio Gorge	2.42	0.46	4.46	12
RS20	Hutt R at Te Marua Intake Site	2.65	0.33	6.64	12
RS21	Hutt R opp. Manor Park G.C.	1.66	0.19	5.47	12
RS22	Hutt R at Boulcott	1.50	0.12	6.31	12
RS23	Pakuratahi R 50m d/s Farm Ck	3.02	0.11	6.72	12
RS24	Mangaroa R at Te Marua	1.32	0.06	3.16	12
RS25	Akatarawa R at Hutt confl.	3.16	0.49	6.77	12
RS26	Whakatikei R at Riverstone	3.12	0.43	5.63	12
RS27	Waiwhetu S at Wainuiomata Hill Br	0.84	0.24	1.60	12
RS28	Wainuiomata R at Manuka Track	2.42	0.35	4.70	11
RS29	Wainuiomata R u/s of White Br	1.70	0.62	2.32	12
RS30	Orongorongo R at Orongorongo Stn	1.11	0.03	5.25	12
RS31	Ruamahanga R at McLays	3.27	0.63	7.65	12
RS32	Ruamahanga R at Te Ore Ore	0.83	0.05	5.70	12
RS33	Ruamahanga R at Gladstone Br	0.67	0.04	3.55	12
RS34	Ruamahanga R at Pukio	0.24	0.03	2.65	12
RS35	Mataikona Trib at Sugar Loaf Rd	2.22	0.12	4.00	12
RS36	Taueru R at Castlehill	1.11	0.10	2.88	12
RS37	Taueru R at Gladstone	0.66	0.13	3.61	12
RS38	Kopuaranga R at Stewarts	0.53	0.05	3.70	12
RS39	Whangaehu R 250m u/s confl.	0.56	0.04	2.20	12
RS40	Waipoua R at Colombo Rd Br	3.55	0.32	5.40	12
RS41	Waingawa R at South Rd	4.60	0.34	9.33	12
RS42	Whareama R at Gauge	0.54	0.05	1.41	12
RS43	Motuwaireka S at Headwaters	3.00	1.07	3.80	12
RS44	Totara S at Stronvar	3.86	0.90	5.10	11
RS45	Parkvale Trib at Lowes Res.	2.50	2.16	4.00	9
RS46	Parkvale S at Weir	0.91	0.12	1.98	12
RS47	Waiohine R at Gorge	3.65	0.09	7.62	12
RS48	Waiohine R at Bicknells	1.86	0.25	4.52	12
RS49	Beef Ck at Headwaters	1.87	1.03	3.50	12
RS50	Mangatarere S at SH 2	1.48	0.19	2.44	12
RS51	Huangarua R at Ponatahi Br	1.57	0.06	4.33	12
RS52	Tauanui R at Whakatomotomo Rd	4.21	0.41	5.83	12
RS53	Awhea R at Tora Rd	0.53	0.04	4.66	12
RS54	Coles Ck Trib at Lagoon Hill Rd	1.22	0.15	1.70	9
RS55	Tauherenikau R at Websters	1.47	0.09	7.19	12
RS56	Wairongomai R at Forest Pk	3.08	0.62	8.00	12

Table A3.6: Turbidity (NTU)

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	8.8	3.9	17.2	12
RS03	Waitohu S at Forest Pk	0.9	0.4	2.9	12
RS04	Waitohu S at Norfolk Cres	5.2	2.5	27	12
RS05	Otaki R at Pukehinau	0.6	0.3	48	12
RS06	Otaki R at Mouth	0.9	0.4	61	12
RS07	Mangaone S at Sims Rd Br	10.8	3.8	19.3	12
RS08	Ngarara S at Field Way	6.8	4.6	23	12
RS09	Waikanae R at Mangaone Walkway	0.8	0.4	5.4	12
RS10	Waikanae R at Greenaway Rd	0.7	0.3	16.9	12
RS11	Whareroa S at Waterfall Rd	11.4	3.4	176	12
RS12	Whareroa S at QE Park	9.0	5.3	132	12
RS13	Horokiri S at Snodgrass	1.9	0.4	20	12
RS14	Pauatahanui S at Elmwood Br	3.8	1.1	44	12
RS15	Porirua S at Glenside	2.0	0.8	250	12
RS16	Porirua S at Wall Park (Milk Depot)	4.2	1.3	100	12
RS17	Makara S at Kennels	3.9	1.6	155	12
RS18	Karori S at Makara Peak	1.4	0.7	27	12
RS19	Kaiwharawhara S at Ngaio Gorge	2.1	0.5	18.8	12
RS20	Hutt R at Te Marua Intake Site	0.7	0.4	11.3	12
RS21	Hutt R opp. Manor Park G.C.	2.0	0.4	35	12
RS22	Hutt R at Boulcott	2.9	0.3	44	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.7	0.4	47	12
RS24	Mangaroa R at Te Marua	1.7	0.6	56	12
RS25	Akatarawa R at Hutt confl.	0.6	0.2	7.6	12
RS26	Whakatikei R at Riverstone	0.9	0.3	10.6	12
RS27	Waiwhetu S at Wainuiomata Hill Br	6.3	1.9	30.0	12
RS28	Wainuiomata R at Manuka Track	1.0	0.6	14.1	11
RS29	Wainuiomata R u/s of White Br	1.8	0.7	7.1	12
RS30	Orongorongo R at Orongorongo Stn	3.5	0.7	1,600	12
RS31	Ruamahanga R at McLays	1.1	0.4	8.6	12
RS32	Ruamahanga R at Te Ore Ore	7.4	0.6	55	12
RS33	Ruamahanga R at Gladstone Br	4.3	0.7	56	12
RS34	Ruamahanga R at Pukio	18.5	1.8	108	12
RS35	Mataikona Trib at Sugar Loaf Rd	1.7	0.5	490	12
RS36	Taueru R at Castlehill	4.9	2.4	370	12
RS37	Taueru R at Gladstone	5.3	0.9	90	12
RS38	Kopuaranga R at Stewarts	8.5	0.9	63	12
RS39	Whangaehu R 250m u/s confl.	12.3	1.8	106	12
RS40	Waipoua R at Colombo Rd Br	0.8	0.3	17	12
RS41	Waingawa R at South Rd	0.7	0.3	17.2	12
RS42	Whareama R at Gauge	8.7	1.6	250	12
RS43	Motuwaireka S at Headwaters	0.8	0.3	5.9	12
RS44	Totara S at Stronvar	1.2	0.3	5.5	11
RS45	Parkvale Trib at Lowes Res.	1.2	0.2	2.4	9
RS46	Parkvale S at Weir	5.8	1.4	49	12
RS47	Waiohine R at Gorge	0.8	0.4	83	12
RS48	Waiohine R at Bicknells	2.2	1.1	26	12
RS49	Beef Ck at Headwaters	1.7	1.0	5.7	12
RS50	Mangatarere S at SH 2	2.3	0.6	30	12
RS51	Huangarua R at Ponatahi Br	1.6	0.4	290	12
RS52	Tauanui R at Whakatomotomo Rd	0.9	0.3	15.8	12
RS53	Awhea R at Tora Rd	12.1	0.4	610	12
RS54	Coles Ck Trib at Lagoon Hill Rd	6.1	0.7	27	9
RS55	Tauherenikau R at Websters	3.1	0.5	78	12
RS56	Wairongomai R at Forest Pk	1.1	0.3	9.1	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	210	191	192	221	222	12
RS03	Waitohu S at Forest Pk	82	65	69	89	89	12
RS04	Waitohu S at Norfolk Cres	149	94	96	178	180	12
RS05	Otaki R at Pukehinau	63	37	47	75	77	12
RS06	Otaki R at Mouth	65	37	47	78	80	12
RS07	Mangaone S at Sims Rd Br	192	129	137	219	221	12
RS08	Ngarara S at Field Way	300	248	254	981	1,738	12
RS09	Waikanae R at Mangaone Walkway	82	67	71	90	90	12
RS10	Waikanae R at Greenaway Rd	108	82	84	156	158	12
RS11	Whareroa S at Waterfall Rd	223	162	166	259	261	12
RS12	Whareroa S at QE Park	256	163	186	281	286	12
RS13	Horokiri S at Snodgrass	181	163	165	194	195	12
RS14	Pauatahanui S at Elmwood Br	170	142	142	186	186	12
RS15	Porirua S at Glenside	257	75	140	279	285	12
RS16	Porirua S at Wall Park (Milk Depot)	259	123	159	278	279	12
RS17	Makara S at Kennels	284	188	212	315	330	12
RS18	Karori S at Makara Peak	223	81	142	229	230	12
RS19	Kaiwharawhara S at Ngaio Gorge	289	190	224	324	333	12
RS20	Hutt R at Te Marua Intake Site	68	46	51	81	85	12
RS21	Hutt R opp. Manor Park G.C.	101	73	77	124	136	12
RS22	Hutt R at Boulcott	91	67	68	107	114	12
RS23	Pakuratahi R 50m d/s Farm Ck	84	65	70	88	89	12
RS24	Mangaroa R at Te Marua	103	78	83	109	109	12
RS25	Akatarawa R at Hutt confl.	79	62	64	90	93	12
RS26	Whakatikei R at Riverstone	109	76	84	120	123	12
RS27	Waiwhetu S at Wainuiomata Hill Br	259	176	190	1,326	2,377	12
RS28	Wainuiomata R at Manuka Track	104	89	91	115	116	11
RS29	Wainuiomata R u/s of White Br	142	129	132	155	155	12
RS30	Orongorongo R at Orongorongo Stn	137	102	104	160	162	12
RS31	Ruamahanga R at McLays	46	32	34	58	58	12
RS32	Ruamahanga R at Te Ore Ore	126	73	79	173	180	12
RS33	Ruamahanga R at Gladstone Br	110	70	75	137	145	12
RS34	Ruamahanga R at Pukio	132	51	62	170	172	12
RS35	Mataikona Trib at Sugar Loaf Rd	397	276	284	505	536	12
RS36	Taueru R at Castlehill	223	125	140	299	303	12
RS37	Taueru R at Gladstone	433	268	270	461	467	12
RS38	Kopuaranga R at Stewarts	247	165	167	377	380	12
RS39	Whangaehu R 250m u/s confl.	300	216	224	360	383	12
RS40	Waipoua R at Colombo Rd Br	100	70	81	127	130	12
RS41	Waingawa R at South Rd	58	39	43	70	73	12
RS42	Whareama R at Gauge	546	410	416	697	721	12
RS43	Motuwaireka S at Headwaters	291	205	210	399	429	12
RS44	Totara S at Stronvar	281	207	213	402	440	11
RS45	Parkvale Trib at Lowes Res.	171	155	159	203	217	9
RS46	Parkvale S at Weir	146	112	123	199	220	12
RS47	Waiohine R at Gorge	56	29	33	74	89	12
RS48	Waiohine R at Bicknells	76	37	46	94	106	12
RS49	Beef Ck at Headwaters	89	64	68	123	131	12
RS50	Mangatarere S at SH 2	114	84	88	149	162	12
RS51	Huangarua R at Ponatahi Br	390	204	251	459	468	12
RS52	Tauanui R at Whakatomotomo Rd	145	104	116	184	184	12
RS53	Aweha R at Tora Rd	425	248	308	500	502	12
RS54	Coles Ck Trib at Lagoon Hill Rd	391	286	293	1,334	1,491	9
RS55	Tauherenikau R at Websters	71	48	48	81	82	12
RS56	Wairongomai R at Forest Pk	123	80	82	138	139	12

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

Site no.	Site name	Median	Minimum	Maximum	n
RS02	Mangapouri S at Bennetts Rd	5.6	2.9	15.2	12
RS03	Waitohu S at Forest Pk	2.0	1.3	3.5	12
RS04	Waitohu S at Norfolk Cres	4.0	2.5	7.1	12
RS05	Otaki R at Pukehinau	1.4	0.6	3.9	12
RS06	Otaki R at Mouth	1.4	<0.5	4.6	12
RS07	Mangaone S at Sims Rd Br	4.5	3.4	7.3	12
RS08	Ngarara S at Field Way	15.9	10.4	19.2	12
RS09	Waikanae R at Mangaone Walkway	1.5	1.0	5.9	12
RS10	Waikanae R at Greenaway Rd	1.8	0.9	4.2	12
RS11	Whareroa S at Waterfall Rd	4.8	3.2	10.4	12
RS12	Whareroa S at QE Park	15.0	8.0	24.0	12
RS13	Horokiri S at Snodgrass	2.1	1.2	4.4	12
RS14	Pauatahanui S at Elmwood Br	4.8	3.1	7.4	12
RS15	Porirua S at Glenside	4.3	<0.5	9.1	12
RS16	Porirua S at Wall Park (Milk Depot)	3.8	0.5	9.0	12
RS17	Makara S at Kennels	5.8	1.3	13.6	12
RS18	Karori S at Makara Peak	2.8	1.0	7.6	12
RS19	Kaiwharawhara S at Ngaio Gorge	3.5	1.6	7.7	12
RS20	Hutt R at Te Marua Intake Site	2.1	0.9	8.7	12
RS21	Hutt R opp. Manor Park G.C.	2.5	1.6	10.6	12
RS22	Hutt R at Boulcott	2.3	1.1	9.8	12
RS23	Pakuratahi R 50m d/s Farm Ck	2.3	1.1	9.2	12
RS24	Mangaroa R at Te Marua	5.3	2.7	13.9	12
RS25	Akatarawa R at Hutt confl.	1.8	1.0	9.1	12
RS26	Whakatikei R at Riverstone	1.7	0.9	5.1	12
RS27	Waiwhetu S at Wainuiomata Hill Br	4.0	2.6	6.7	12
RS28	Wainuiomata R at Manuka Track	2.0	0.9	10.4	11
RS29	Wainuiomata R u/s of White Br	1.9	1.2	3.1	12
RS30	Orongorongo R at Orongorongo Stn	2.3	<0.5	6.7	12
RS31	Ruamahanga R at McLays	1.5	0.7	4.2	12
RS32	Ruamahanga R at Te Ore Ore	3.6	1.5	8.0	12
RS33	Ruamahanga R at Gladstone Br	3.6	1.3	7.0	12
RS34	Ruamahanga R at Pukio	4.8	2.2	6.6	12
RS35	Mataikona Trib at Sugar Loaf Rd	3.1	1.8	16.4	12
RS36	Taueru R at Castlehill	5.9	4.1	10.8	12
RS37	Taueru R at Gladstone	6.0	1.5	9.1	12
RS38	Kopuaranga R at Stewarts	5.2	<5.0	13.7	12
RS39	Whangaehu R 250m u/s confl.	8.5	3.6	17.1	12
RS40	Waipoua R at Colombo Rd Br	2.0	0.7	3.8	12
RS41	Waingawa R at South Rd	1.2	0.8	2.8	12
RS42	Whareama R at Gauge	6.5	4.7	9.5	12
RS43	Motuwaireka S at Headwaters	2.3	0.9	3.1	12
RS44	Totara S at Stronvar	3.2	2.1	4.2	11
RS45	Parkvale Trib at Lowes Res.	4.1	3.1	8.3	9
RS46	Parkvale S at Weir	5.8	3.3	12.6	12
RS47	Waiohine R at Gorge	1.5	0.9	4.6	12
RS48	Waiohine R at Bicknells	1.7	1.0	3.5	12
RS49	Beef Ck at Headwaters	2.0	1.3	5.1	12
RS50	Mangatarere S at SH 2	2.4	1.6	4.4	12
RS51	Huangarua R at Ponatahi Br	3.5	1.8	10.1	12
RS52	Tauanui R at Whakatomotomo Rd	3.1	1.6	5.5	12
RS53	Awhea R at Tora Rd	4.2	1.7	10.2	12
RS54	Coles Ck Trib at Lagoon Hill Rd	5.5	3.8	7.9	9
RS55	Tauherenikau R at Websters	1.6	0.8	5.5	12
RS56	Waiorongomai R at Forest Pk	2.5	1.5	8.4	12

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

Site no.	Site name	Median	Minimum	Maximum	n
RS02	Mangapouri S at Bennetts Rd	0.048	<0.01	0.096	12
RS03	Waitohu S at Forest Pk	0.005	<0.01	0.013	12
RS04	Waitohu S at Norfolk Cres	0.032	<0.01	0.056	12
RS05	Otaki R at Pukehinau	0.005	<0.01	0.005	12
RS06	Otaki R at Mouth	0.005	<0.01	0.014	12
RS07	Mangaone S at Sims Rd Br	0.066	0.016	0.121	12
RS08	Ngarara S at Field Way	0.021	<0.01	0.060	12
RS09	Waikanae R at Mangaone Walkway	0.005	<0.01	0.005	12
RS10	Waikanae R at Greenaway Rd	0.005	<0.01	0.005	12
RS11	Whareroa S at Waterfall Rd	0.005	<0.01	0.018	12
RS12	Whareroa S at QE Park	0.067	0.031	0.180	12
RS13	Horokiri S at Snodgrass	0.005	<0.01	0.030	12
RS14	Pauatahanui S at Elmwood Br	0.012	<0.01	0.027	12
RS15	Porirua S at Glenside	0.005	<0.01	0.027	12
RS16	Porirua S at Wall Park (Milk Depot)	0.005	<0.01	0.086	12
RS17	Makara S at Kennels	0.005	<0.01	0.032	12
RS18	Karori S at Makara Peak	0.005	<0.01	0.021	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.005	<0.01	0.052	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	0.025	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	0.005	12
RS24	Mangaroa R at Te Marua	0.005	<0.01	0.014	12
RS25	Akatarawa R at Hutt confl.	0.005	<0.01	0.005	12
RS26	Whakatikei R at Riverstone	0.005	<0.01	0.005	12
RS27	Waiwhetu S at Wainuiomata Hill Br	0.062	<0.01	0.154	12
RS28	Wainuiomata R at Manuka Track	0.005	<0.01	0.011	11
RS29	Wainuiomata R u/s of White Br	0.005	<0.01	0.042	12
RS30	Orongorongo R at Orongorongo Stn	0.005	<0.01	0.030	12
RS31	Ruamahanga R at McLays	0.005	<0.01	0.012	12
RS32	Ruamahanga R at Te Ore Ore	0.005	<0.01	0.013	12
RS33	Ruamahanga R at Gladstone Br	0.015	<0.01	0.066	12
RS34	Ruamahanga R at Pukio	0.009	<0.01	0.031	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.005	<0.01	0.014	12
RS36	Taueru R at Castlehill	0.005	<0.01	0.032	12
RS37	Taueru R at Gladstone	0.005	<0.01	0.030	12
RS38	Kopuaranga R at Stewarts	0.014	<0.01	0.029	12
RS39	Whangaehu R 250m u/s confl.	0.008	<0.01	0.040	12
RS40	Waipoua R at Colombo Rd Br	0.005	<0.01	0.012	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	0.005	11
RS45	Parkvale Trib at Lowes Res.	0.005	<0.01	0.015	9
RS46	Parkvale S at Weir	0.016	<0.01	0.122	12
RS47	Waiohine R at Gorge	0.005	<0.01	0.014	12
RS48	Waiohine R at Bicknells	0.015	<0.01	0.039	12
RS49	Beef Ck at Headwaters	0.005	<0.01	0.012	12
RS50	Mangatarere S at SH 2	0.101	<0.01	0.520	12
RS51	Huangarua R at Ponatahi Br	0.005	<0.01	0.028	12
RS52	Tauanui R at Whakatomotomo Rd	0.005	<0.01	0.005	12
RS53	Awhea R at Tora Rd	0.005	<0.01	0.022	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	Wairongomai R at Forest Pk	0.005	<0.01	0.005	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	2.230	0.610	3.500	12
RS03	Waitohu S at Forest Pk	0.019	<0.002	0.048	12
RS04	Waitohu S at Norfolk Cres	0.445	0.066	0.970	12
RS05	Otaki R at Pukehinau	0.027	<0.002	0.055	12
RS06	Otaki R at Mouth	0.045	<0.002	0.101	12
RS07	Mangaone S at Sims Rd Br	1.635	0.540	2.700	12
RS08	Ngarara S at Field Way	0.109	0.001	0.520	12
RS09	Waikanae R at Mangaone Walkway	0.120	0.033	0.173	12
RS10	Waikanae R at Greenaway Rd	0.220	0.031	0.390	12
RS11	Whareroa S at Waterfall Rd	0.325	0.159	0.750	12
RS12	Whareroa S at QE Park	0.430	0.059	0.920	12
RS13	Horokiri S at Snodgrass	0.455	0.058	0.960	12
RS14	Pauatahanui S at Elmwood Br	0.275	0.011	0.600	12
RS15	Porirua S at Glenside	0.905	0.480	1.810	12
RS16	Porirua S at Wall Park (Milk Depot)	0.875	0.360	1.870	12
RS17	Makara S at Kennels	0.410	0.004	1.050	12
RS18	Karori S at Makara Peak	1.235	0.400	4.300	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.055	0.720	1.600	12
RS20	Hutt R at Te Marua Intake Site	0.095	0.050	0.155	12
RS21	Hutt R opp. Manor Park G.C.	0.240	0.107	0.890	12
RS22	Hutt R at Boulcott	0.171	0.089	0.560	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.230	0.116	0.380	12
RS24	Mangaroa R at Te Marua	0.450	0.260	0.540	12
RS25	Akatarawa R at Hutt confl.	0.126	0.014	0.480	12
RS26	Whakatikei R at Riverstone	0.129	0.027	0.270	12
RS27	Waiwhetu S at Wainuiomata Hill Br	0.395	0.081	0.640	12
RS28	Wainuiomata R at Manuka Track	0.076	0.032	0.120	11
RS29	Wainuiomata R u/s of White Br	0.175	0.007	0.390	12
RS30	Orongorongo R at Orongorongo Stn	0.043	<0.002	0.082	12
RS31	Ruamahanga R at McLays	0.021	0.003	0.041	12
RS32	Ruamahanga R at Te Ore Ore	0.435	0.134	0.890	12
RS33	Ruamahanga R at Gladstone Br	0.420	0.023	0.840	12
RS34	Ruamahanga R at Pukio	0.380	<0.002	0.830	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.034	<0.002	0.180	12
RS36	Taueru R at Castlehill	0.112	<0.002	0.440	12
RS37	Taueru R at Gladstone	0.610	0.430	1.620	12
RS38	Kopuaranga R at Stewarts	1.010	0.860	1.370	12
RS39	Whangaehu R 250m u/s confl.	0.700	0.290	1.920	12
RS40	Waipoua R at Colombo Rd Br	0.885	0.240	1.610	12
RS41	Waingawa R at South Rd	0.046	0.017	0.189	12
RS42	Whareama R at Gauge	0.008	<0.002	0.400	12
RS43	Motuwaireka S at Headwaters	0.012	0.003	0.044	12
RS44	Totara S at Stronvar	0.015	0.005	0.167	11
RS45	Parkvale Trib at Lowes Res.	3.500	2.400	4.000	9
RS46	Parkvale S at Weir	1.465	<0.002	2.800	12
RS47	Waiohine R at Gorge	0.032	0.004	0.097	12
RS48	Waiohine R at Bicknells	0.415	0.010	0.610	12
RS49	Beef Ck at Headwaters	0.016	<0.002	0.056	12
RS50	Mangatarere S at SH 2	1.200	0.620	1.870	12
RS51	Huangarua R at Ponatahi Br	0.280	0.023	0.730	12
RS52	Tauanui R at Whakatomotomo Rd	0.010	<0.002	0.022	12
RS53	Awhea R at Tora Rd	0.067	<0.002	0.350	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.007	<0.002	0.052	9
RS55	Tauherenikau R at Websters	0.027	0.009	0.118	12
RS56	Waiorongomai R at Forest Pk	0.018	<0.002	0.034	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	0.58	0.36	1.04	12
RS03	Waitohu S at Forest Pk	0.05	<0.10	0.24	12
RS04	Waitohu S at Norfolk Cres	0.30	0.21	0.51	12
RS05	Otaki R at Pukehinau	0.05	<0.10	0.14	12
RS06	Otaki R at Mouth	0.05	<0.10	0.15	12
RS07	Mangaone S at Sims Rd Br	0.51	0.34	0.84	12
RS08	Ngarara S at Field Way	0.71	0.50	0.98	12
RS09	Waikanae R at Mangaone Walkway	0.05	<0.10	0.18	12
RS10	Waikanae R at Greenaway Rd	0.05	<0.10	0.18	12
RS11	Whareroa S at Waterfall Rd	0.22	0.13	0.89	12
RS12	Whareroa S at QE Park	0.67	0.45	1.36	12
RS13	Horokiri S at Snodgrass	0.17	<0.10	0.40	12
RS14	Pauatahanui S at Elmwood Br	0.26	0.20	0.67	12
RS15	Porirua S at Glenside	0.28	0.21	1.45	12
RS16	Porirua S at Wall Park (Milk Depot)	0.27	0.22	0.81	12
RS17	Makara S at Kennels	0.38	0.24	1.57	12
RS18	Karori S at Makara Peak	0.25	0.15	0.64	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.30	0.21	0.47	12
RS20	Hutt R at Te Marua Intake Site	0.05	<0.10	0.21	12
RS21	Hutt R opp. Manor Park G.C.	0.18	<0.10	0.48	12
RS22	Hutt R at Boulcott	0.08	<0.10	0.42	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.05	<0.10	0.35	12
RS24	Mangaroa R at Te Marua	0.20	0.13	0.84	12
RS25	Akatarawa R at Hutt confl.	0.05	<0.10	0.26	12
RS26	Whakatikei R at Riverstone	0.05	<0.10	0.19	12
RS27	Waiwhetu S at Wainuiomata Hill Br	0.29	0.16	0.58	12
RS28	Wainuiomata R at Manuka Track	0.05	<0.10	0.38	11
RS29	Wainuiomata R u/s of White Br	0.11	<0.10	0.21	12
RS30	Orongorongo R at Orongorongo Stn	0.05	<0.10	1.38	12
RS31	Ruamahanga R at McLays	0.05	<0.10	0.19	12
RS32	Ruamahanga R at Te Ore Ore	0.15	<0.10	0.55	12
RS33	Ruamahanga R at Gladstone Br	0.20	0.11	0.59	12
RS34	Ruamahanga R at Pukio	0.28	0.11	0.59	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.13	<0.10	1.85	12
RS36	Taueru R at Castlehill	0.35	0.21	2.60	12
RS37	Taueru R at Gladstone	0.41	0.27	0.86	12
RS38	Kopuaranga R at Stewarts	0.38	0.19	1.13	12
RS39	Whangaehu R 250m u/s confl.	0.60	0.37	1.46	12
RS40	Waipoua R at Colombo Rd Br	0.17	0.12	0.24	12
RS41	Waingawa R at South Rd	0.05	<0.10	0.21	12
RS42	Whareama R at Gauge	0.40	0.31	0.86	12
RS43	Motuwaireka S at Headwaters	0.05	<0.10	0.11	12
RS44	Totara S at Stronvar	0.05	<0.10	0.18	11
RS45	Parkvale Trib at Lowes Res.	0.38	0.29	0.83	9
RS46	Parkvale S at Weir	0.56	0.39	1.90	12
RS47	Waiohine R at Gorge	0.05	<0.10	0.27	12
RS48	Waiohine R at Bicknells	0.14	<0.10	0.26	12
RS49	Beef Ck at Headwaters	0.05	<0.10	0.30	12
RS50	Mangatarere S at SH 2	0.37	0.20	0.94	12
RS51	Huangarua R at Ponatahi Br	0.23	0.11	0.97	12
RS52	Tauanui R at Whakatomotomo Rd	0.05	<0.10	0.13	12
RS53	Awhea R at Tora Rd	0.22	<0.10	0.89	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.19	0.13	0.29	9
RS55	Tauherenikau R at Websters	0.05	<0.10	0.24	12
RS56	Waiorongomai R at Forest Pk	0.08	<0.10	0.19	12

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

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	3.00	1.22	4.10	12
RS03	Waitohu S at Forest Pk	0.06	<0.11	0.24	12
RS04	Waitohu S at Norfolk Cres	0.75	0.37	1.38	12
RS05	Otaki R at Pukehinau	0.06	<0.11	0.15	12
RS06	Otaki R at Mouth	0.08	<0.11	0.19	12
RS07	Mangaone S at Sims Rd Br	2.18	0.99	3.20	12
RS08	Ngarara S at Field Way	0.74	0.57	1.33	12
RS09	Waikanae R at Mangaone Walkway	0.18	<0.11	0.31	12
RS10	Waikanae R at Greenaway Rd	0.34	0.11	0.48	12
RS11	Whareroa S at Waterfall Rd	0.62	0.33	1.23	12
RS12	Whareroa S at QE Park	1.26	0.51	1.87	12
RS13	Horokiri S at Snodgrass	0.72	0.14	1.13	12
RS14	Pauatahanui S at Elmwood Br	0.68	0.24	1.01	12
RS15	Porirua S at Glenside	1.35	0.77	2.00	12
RS16	Porirua S at Wall Park (Milk Depot)	1.20	0.61	2.30	12
RS17	Makara S at Kennels	0.74	0.25	2.40	12
RS18	Karori S at Makara Peak	1.46	0.92	4.50	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.37	1.05	2.10	12
RS20	Hutt R at Te Marua Intake Site	0.19	<0.11	0.27	12
RS21	Hutt R opp. Manor Park G.C.	0.44	0.14	0.98	12
RS22	Hutt R at Boulcott	0.38	0.12	0.69	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.36	0.17	0.47	12
RS24	Mangaroa R at Te Marua	0.68	0.43	1.09	12
RS25	Akatarawa R at Hutt confl.	0.18	<0.11	0.51	12
RS26	Whakatikei R at Riverstone	0.21	<0.11	0.44	12
RS27	Waiwhetu S at Wainuiomata Hill Br	0.74	0.47	0.92	12
RS28	Wainuiomata R at Manuka Track	0.13	<0.11	0.49	11
RS29	Wainuiomata R u/s of White Br	0.28	<0.11	0.53	12
RS30	Orongorongo R at Orongorongo Stn	0.06	<0.11	1.46	12
RS31	Ruamahanga R at McLays	0.06	<0.11	0.20	12
RS32	Ruamahanga R at Te Ore Ore	0.56	0.25	1.05	12
RS33	Ruamahanga R at Gladstone Br	0.65	0.19	1.06	12
RS34	Ruamahanga R at Pukio	0.57	0.11	1.15	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.19	<0.11	2.00	12
RS36	Taueru R at Castlehill	0.43	0.21	2.80	12
RS37	Taueru R at Gladstone	1.28	0.86	1.94	12
RS38	Kopuaranga R at Stewarts	1.48	1.20	2.10	12
RS39	Whangaehu R 250m u/s confl.	1.65	0.66	2.60	12
RS40	Waipoua R at Colombo Rd Br	1.06	0.41	1.83	12
RS41	Waingawa R at South Rd	0.14	<0.11	0.32	12
RS42	Whareama R at Gauge	0.41	0.32	1.05	12
RS43	Motuwaireka S at Headwaters	0.06	<0.11	0.13	12
RS44	Totara S at Stronvar	0.13	<0.11	0.23	11
RS45	Parkvale Trib at Lowes Res.	4.00	2.80	4.30	9
RS46	Parkvale S at Weir	2.30	0.39	3.80	12
RS47	Waiohine R at Gorge	0.06	<0.11	0.30	12
RS48	Waiohine R at Bicknells	0.59	0.20	0.70	12
RS49	Beef Ck at Headwaters	0.09	<0.11	0.30	12
RS50	Mangatarere S at SH 2	1.51	0.81	2.80	12
RS51	Huangarua R at Ponatahi Br	0.54	0.19	1.21	12
RS52	Tauanui R at Whakatomotomo Rd	0.06	<0.11	0.14	12
RS53	Awhea R at Tora Rd	0.27	<0.11	1.00	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.22	0.15	0.30	9
RS55	Tauherenikau R at Websters	0.12	<0.11	0.27	12
RS56	Waiorongomai R at Forest Pk	0.12	<0.11	0.21	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	0.037	0.024	0.096	12
RS03	Waitohu S at Forest Pk	0.008	<0.004	0.012	12
RS04	Waitohu S at Norfolk Cres	0.018	0.008	0.037	12
RS05	Otaki R at Pukehinau	0.005	<0.004	0.009	12
RS06	Otaki R at Mouth	0.002	<0.004	0.009	12
RS07	Mangaone S at Sims Rd Br	0.025	0.014	0.047	12
RS08	Ngarara S at Field Way	0.046	0.033	0.113	12
RS09	Waikanae R at Mangaone Walkway	0.012	0.006	0.016	12
RS10	Waikanae R at Greenaway Rd	0.008	<0.004	0.012	12
RS11	Whareroa S at Waterfall Rd	0.024	0.014	0.040	12
RS12	Whareroa S at QE Park	0.041	0.031	0.060	12
RS13	Horokiri S at Snodgrass	0.012	<0.004	0.022	12
RS14	Pauatahanui S at Elmwood Br	0.015	0.004	0.022	12
RS15	Porirua S at Glenside	0.019	0.005	0.023	12
RS16	Porirua S at Wall Park (Milk Depot)	0.019	0.004	0.058	12
RS17	Makara S at Kennels	0.029	0.010	0.075	12
RS18	Karori S at Makara Peak	0.037	0.007	0.055	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.030	0.005	0.046	12
RS20	Hutt R at Te Marua Intake Site	0.004	<0.004	0.006	12
RS21	Hutt R opp. Manor Park G.C.	0.006	<0.004	0.011	12
RS22	Hutt R at Boulcott	0.005	<0.004	0.011	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.006	<0.004	0.010	12
RS24	Mangaroa R at Te Marua	0.012	0.004	0.026	12
RS25	Akatarawa R at Hutt confl.	0.005	<0.004	0.008	12
RS26	Whakatikei R at Riverstone	0.008	<0.004	0.011	12
RS27	Waiwhetu S at Wainuiomata Hill Br	0.022	<0.004	0.065	12
RS28	Wainuiomata R at Manuka Track	0.010	0.006	0.015	11
RS29	Wainuiomata R u/s of White Br	0.012	0.007	0.020	12
RS30	Orongorongo R at Orongorongo Stn	0.006	<0.004	0.010	12
RS31	Ruamahanga R at McLays	0.002	<0.004	0.004	12
RS32	Ruamahanga R at Te Ore Ore	0.010	<0.004	0.059	11
RS33	Ruamahanga R at Gladstone Br	0.017	0.010	0.029	12
RS34	Ruamahanga R at Pukio	0.014	<0.004	0.042	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.005	<0.004	0.009	12
RS36	Taueru R at Castlehill	0.008	<0.004	0.011	12
RS37	Taueru R at Gladstone	0.014	<0.004	0.033	12
RS38	Kopuaranga R at Stewarts	0.018	0.007	0.034	12
RS39	Whangaehu R 250m u/s confl.	0.042	0.018	0.085	12
RS40	Waipoua R at Colombo Rd Br	0.003	<0.004	0.006	12
RS41	Waingawa R at South Rd	0.002	<0.004	0.007	12
RS42	Whareama R at Gauge	0.004	<0.004	0.013	12
RS43	Motuwaireka S at Headwaters	0.002	<0.004	0.007	12
RS44	Totara S at Stronvar	0.002	<0.004	0.002	11
RS45	Parkvale Trib at Lowes Res.	0.017	0.005	0.027	9
RS46	Parkvale S at Weir	0.049	0.016	0.084	12
RS47	Waiohine R at Gorge	0.002	<0.004	0.005	12
RS48	Waiohine R at Bicknells	0.016	0.006	0.023	12
RS49	Beef Ck at Headwaters	0.008	0.004	0.011	12
RS50	Mangatarere S at SH 2	0.071	0.044	0.710	12
RS51	Huangarua R at Ponatahi Br	0.006	<0.004	0.027	12
RS52	Tauanui R at Whakatomotomo Rd	0.006	<0.004	0.010	12
RS53	Awhea R at Tora Rd	0.008	<0.004	0.022	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.007	<0.004	0.011	9
RS55	Tauherenikau R at Websters	0.002	<0.004	0.005	12
RS56	Waiorongomai R at Forest Pk	0.002	<0.004	0.005	12

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

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	0.072	0.042	0.172	12
RS03	Waitohu S at Forest Pk	0.010	0.004	0.016	12
RS04	Waitohu S at Norfolk Cres	0.040	0.030	0.102	12
RS05	Otaki R at Pukehinau	0.005	<0.004	0.054	12
RS06	Otaki R at Mouth	0.006	<0.004	0.061	12
RS07	Mangaone S at Sims Rd Br	0.064	0.024	0.104	12
RS08	Ngarara S at Field Way	0.092	0.064	0.210	12
RS09	Waikanae R at Mangaone Walkway	0.013	0.010	0.032	12
RS10	Waikanae R at Greenaway Rd	0.013	0.004	0.039	12
RS11	Whareroa S at Waterfall Rd	0.043	0.026	0.187	12
RS12	Whareroa S at QE Park	0.075	0.058	0.360	12
RS13	Horokiri S at Snodgrass	0.017	0.008	0.056	12
RS14	Pauatahanui S at Elmwood Br	0.028	0.018	0.098	12
RS15	Porirua S at Glenside	0.022	0.010	0.480	12
RS16	Porirua S at Wall Park (Milk Depot)	0.028	0.016	0.169	12
RS17	Makara S at Kennels	0.047	0.025	0.330	12
RS18	Karori S at Makara Peak	0.051	0.024	0.092	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.040	0.024	0.080	12
RS20	Hutt R at Te Marua Intake Site	0.006	<0.004	0.019	12
RS21	Hutt R opp. Manor Park G.C.	0.009	0.004	0.068	12
RS22	Hutt R at Boulcott	0.009	<0.004	0.064	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.009	<0.004	0.056	12
RS24	Mangaroa R at Te Marua	0.019	0.010	0.131	12
RS25	Akatarawa R at Hutt confl.	0.006	<0.004	0.017	12
RS26	Whakatikei R at Riverstone	0.011	0.005	0.025	12
RS27	Waiwhetu S at Wainuiomata Hill Br	0.064	0.017	0.118	12
RS28	Wainuiomata R at Manuka Track	0.012	0.009	0.049	11
RS29	Wainuiomata R u/s of White Br	0.019	0.012	0.030	12
RS30	Orongorongo R at Orongorongo Stn	0.006	<0.004	1.610	12
RS31	Ruamahanga R at McLays	0.004	<0.004	0.016	12
RS32	Ruamahanga R at Te Ore Ore	0.018	0.004	0.115	12
RS33	Ruamahanga R at Gladstone Br	0.030	0.016	0.118	12
RS34	Ruamahanga R at Pukio	0.050	0.008	0.164	12
RS35	Mataikona Trib at Sugar Loaf Rd	0.009	0.006	0.510	12
RS36	Taueru R at Castlehill	0.027	0.017	0.650	12
RS37	Taueru R at Gladstone	0.042	0.006	0.131	12
RS38	Kopuaranga R at Stewarts	0.038	0.016	0.181	12
RS39	Whangaehu R 250m u/s confl.	0.082	0.059	0.270	12
RS40	Waipoua R at Colombo Rd Br	0.009	0.006	0.037	12
RS41	Waingawa R at South Rd	0.005	<0.004	0.016	12
RS42	Whareama R at Gauge	0.037	0.012	0.220	12
RS43	Motuwaireka S at Headwaters	0.004	<0.004	0.013	12
RS44	Totara S at Stronvar	0.006	<0.004	0.063	11
RS45	Parkvale Trib at Lowes Res.	0.022	0.010	0.034	9
RS46	Parkvale S at Weir	0.078	0.037	0.390	12
RS47	Waiohine R at Gorge	0.002	<0.004	0.106	12
RS48	Waiohine R at Bicknells	0.023	0.014	0.075	12
RS49	Beef Ck at Headwaters	0.011	0.008	0.020	12
RS50	Mangatarere S at SH 2	0.082	0.051	0.810	12
RS51	Huangarua R at Ponatahi Br	0.010	<0.004	0.320	12
RS52	Tauanui R at Whakatomotomo Rd	0.007	0.004	0.032	12
RS53	Awhea R at Tora Rd	0.022	0.006	0.600	12
RS54	Coles Ck Trib at Lagoon Hill Rd	0.016	0.010	0.028	9
RS55	Tauherenikau R at Websters	0.008	<0.004	0.097	12
RS56	Wairongomai R at Forest Pk	0.006	<0.004	0.018	12

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

Site no.	Site name	Median	Minimum	Maximum	<i>n</i>
RS02	Mangapouri S at Bennetts Rd	800	180	2,500	12
RS03	Waitohu S at Forest Pk	5	<1	31	12
RS04	Waitohu S at Norfolk Cres	450	140	1,600	12
RS05	Otaki R at Pukehinau	8	1	21	12
RS06	Otaki R at Mouth	22	4	390	12
RS07	Mangaone S at Sims Rd Br	600	300	4,800	12
RS08	Ngarara S at Field Way	180	22	500	12
RS09	Waikanae R at Mangaone Walkway	12	1	110	12
RS10	Waikanae R at Greenaway Rd	25	4	500	12
RS11	Whareroa S at Waterfall Rd	130	29	12,000	12
RS12	Whareroa S at QE Park	285	60	18,000	12
RS13	Horokiri S at Snodgrass	385	37	2,800	12
RS14	Pauatahanui S at Elmwood Br	260	90	7,600	12
RS15	Porirua S at Glenside	275	80	2,100	12
RS16	Porirua S at Wall Park (Milk Depot)	800	160	6,300	12
RS17	Makara S at Kennels	485	120	1,800	12
RS18	Karori S at Makara Peak	1,600	800	6,800	12
RS19	Kaiwharawhara S at Ngaio Gorge	345	28	3,300	12
RS20	Hutt R at Te Marua Intake Site	26	10	300	12
RS21	Hutt R opp. Manor Park G.C.	195	30	3,700	12
RS22	Hutt R at Boulcott	83	10	1,800	12
RS23	Pakuratahi R 50m d/s Farm Ck	85	35	620	12
RS24	Mangaroa R at Te Marua	265	70	2,800	12
RS25	Akatarawa R at Hutt confl.	37	11	120	12
RS26	Whakatikei R at Riverstone	19	3	130	12
RS27	Waiwhetu S at Wainuiomata Hill Br	495	56	8,000	12
RS28	Wainuiomata R at Manuka Track	4	<1	140	11
RS29	Wainuiomata R u/s of White Br	58	27	4,200	12
RS30	Orongorongo R at Orongorongo Stn	15	1	1,300	12
RS31	Ruamahanga R at McLays	5	<1	24	12
RS32	Ruamahanga R at Te Ore Ore	60	15	2,900	12
RS33	Ruamahanga R at Gladstone Br	95	6	2,100	12
RS34	Ruamahanga R at Pukio	125	6	1,800	12
RS35	Mataikona Trib at Sugar Loaf Rd	55	11	3,000	12
RS36	Taueru R at Castlehill	180	32	13,000	12
RS37	Taueru R at Gladstone	140	53	1,800	12
RS38	Kopuaranga R at Stewarts	480	60	11,000	12
RS39	Whangaehu R 250m u/s confl.	500	160	5,300	12
RS40	Waipoua R at Colombo Rd Br	57	11	510	12
RS41	Waingawa R at South Rd	19	3	140	12
RS42	Whareama R at Gauge	125	10	1,000	12
RS43	Motuwaireka S at Headwaters	6	<1	160	12
RS44	Totara S at Stronvar	7	<1	170	11
RS45	Parkvale Trib at Lowes Res.	24	7	90	9
RS46	Parkvale S at Weir	675	<1	5,100	12
RS47	Waiohine R at Gorge	13	2	400	12
RS48	Waiohine R at Bicknells	100	11	1,100	12
RS49	Beef Ck at Headwaters	16	<1	650	12
RS50	Mangatarere S at SH 2	310	13	1,200	12
RS51	Huangarua R at Ponatahi Br	120	16	2,500	12
RS52	Tauanui R at Whakatomotomo Rd	4	1	53	12
RS53	Awhea R at Tora Rd	75	4	1,500	12
RS54	Coles Ck Trib at Lagoon Hill Rd	36	4	350	9
RS55	Tauherenikau R at Websters	23	1	120	12
RS56	Waiorongomai R at Forest Pk	11	1	31	12

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

Site no.	Site name	Median	Minimum	Maximum	n
RS02	Mangapouri S at Bennetts Rd	800	240	2,500	12
RS03	Waitohu S at Forest Pk	6	1	31	12
RS04	Waitohu S at Norfolk Cres	510	170	1,700	12
RS05	Otaki R at Pukehinau	8	1	21	12
RS06	Otaki R at Mouth	23	4	480	12
RS07	Mangaone S at Sims Rd Br	900	310	6,200	12
RS08	Ngarara S at Field Way	195	26	600	12
RS09	Waikanae R at Mangaone Walkway	16	1	150	12
RS10	Waikanae R at Greenaway Rd	32	7	500	12
RS11	Whareroa S at Waterfall Rd	165	32	13,000	12
RS12	Whareroa S at QE Park	325	60	18,000	12
RS13	Horokiri S at Snodgrass	475	46	3,100	12
RS14	Pauatahanui S at Elmwood Br	355	220	8,400	12
RS15	Porirua S at Glenside	385	80	2,600	12
RS16	Porirua S at Wall Park (Milk Depot)	1,650	260	56,000	12
RS17	Makara S at Kennels	530	170	2,700	12
RS18	Karori S at Makara Peak	1,850	900	6,800	12
RS19	Kaiwharawhara S at Ngaio Gorge	370	44	3,300	12
RS20	Hutt R at Te Marua Intake Site	28	14	440	12
RS21	Hutt R opp. Manor Park G.C.	250	30	3,900	12
RS22	Hutt R at Boulcott	95	16	1,800	12
RS23	Pakuratahi R 50m d/s Farm Ck	100	40	710	12
RS24	Mangaroa R at Te Marua	310	70	3,000	12
RS25	Akatarawa R at Hutt confl.	43	11	180	12
RS26	Whakatikei R at Riverstone	24	5	140	12
RS27	Waiwhetu S at Wainuiomata Hill Br	680	56	8,000	12
RS28	Wainuiomata R at Manuka Track	6	<1	160	11
RS29	Wainuiomata R u/s of White Br	75	32	4,800	12
RS30	Orongorongo R at Orongorongo Stn	19	1	1,400	12
RS31	Ruamahanga R at McLays	5	<1	35	12
RS32	Ruamahanga R at Te Ore Ore	61	25	3,100	12
RS33	Ruamahanga R at Gladstone Br	105	6	2,400	12
RS34	Ruamahanga R at Pukio	130	6	2,100	12
RS35	Mataikona Trib at Sugar Loaf Rd	56	11	3,600	12
RS36	Taueru R at Castlehill	205	41	14,000	12
RS37	Taueru R at Gladstone	210	71	2,500	12
RS38	Kopuaranga R at Stewarts	535	70	13,000	12
RS39	Whangaehu R 250m u/s confl.	500	170	10,000	12
RS40	Waipoua R at Colombo Rd Br	62	11	620	12
RS41	Waingawa R at South Rd	21	3	150	12
RS42	Whareama R at Gauge	125	10	1,000	12
RS43	Motuwaireka S at Headwaters	8	<1	160	12
RS44	Totara S at Stronvar	9	1	170	11
RS45	Parkvale Trib at Lowes Res.	35	9	90	9
RS46	Parkvale S at Weir	675	<1	5,100	12
RS47	Waiohine R at Gorge	14	2	400	12
RS48	Waiohine R at Bicknells	115	11	1,800	12
RS49	Beef Ck at Headwaters	22	<1	650	12
RS50	Mangatarere S at SH 2	320	13	2,400	12
RS51	Huangarua R at Ponatahi Br	140	22	2,600	12
RS52	Tauanui R at Whakatomotomo Rd	4	1	53	12
RS53	Awhea R at Tora Rd	80	4	1,600	12
RS54	Coles Ck Trib at Lagoon Hill Rd	50	6	380	9
RS55	Tauherenikau R at Websters	27	1	120	12
RS56	Waiorongomai R at Forest Pk	11	1	31	12

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

Site no.	Site name	Median	Minimum	Maximum	n
RS02	Mangapouri S at Bennetts Rd	6.5	<2	32	12
RS03	Waitohu S at Forest Pk	1.0	<2	3	12
RS04	Waitohu S at Norfolk Cres	8.0	<2	47	12
RS05	Otaki R at Pukehinau	1.0	<2	60	12
RS06	Otaki R at Mouth	1.0	<2	69	12
RS07	Mangaone S at Sims Rd Br	10.5	2	33	12
RS08	Ngarara S at Field Way	4.5	<2	13	12
RS09	Waikanae R at Mangaone Walkway	1.0	<2	6	12
RS10	Waikanae R at Greenaway Rd	1.0	<2	26	12
RS11	Whareroa S at Waterfall Rd	5.5	<2	106	12
RS12	Whareroa S at QE Park	5.5	3	173	12
RS13	Horokiri S at Snodgrass	1.0	<2	69	12
RS14	Pauatahanui S at Elmwood Br	4.0	<2	42	12
RS15	Porirua S at Glenside	2.5	<2	550	12
RS16	Porirua S at Wall Park (Milk Depot)	3.0	<2	145	12
RS17	Makara S at Kennels	3.5	<2	320	12
RS18	Karori S at Makara Peak	1.5	<2	32	12
RS19	Kaiwharawhara S at Ngaio Gorge	3.0	<2	19	12
RS20	Hutt R at Te Marua Intake Site	1.0	<2	14	12
RS21	Hutt R opp. Manor Park G.C.	1.5	<2	49	12
RS22	Hutt R at Boulcott	1.0	<2	57	12
RS23	Pakuratahi R 50m d/s Farm Ck	1.0	<2	58	12
RS24	Mangaroa R at Te Marua	1.0	<2	65	12
RS25	Akatarawa R at Hutt confl.	1.0	<2	6	12
RS26	Whakatikei R at Riverstone	1.0	<2	10	12
RS27	Waiwhetu S at Wainuiomata Hill Br	4.5	2	49	12
RS28	Wainuiomata R at Manuka Track	1.0	<2	19	11
RS29	Wainuiomata R u/s of White Br	1.5	<2	9	12
RS30	Orongorongo R at Orongorongo Stn	2.0	<2	1,390	12
RS31	Ruamahanga R at McLays	1.0	<2	7	12
RS32	Ruamahanga R at Te Ore Ore	8.0	<2	101	12
RS33	Ruamahanga R at Gladstone Br	6.0	<2	74	12
RS34	Ruamahanga R at Pukio	29.0	<2	135	12
RS35	Mataikona Trib at Sugar Loaf Rd	1.5	<2	1,320	12
RS36	Taueru R at Castlehill	3.0	<2	700	12
RS37	Taueru R at Gladstone	5.5	<2	94	12
RS38	Kopuaranga R at Stewarts	10.0	<2	118	12
RS39	Whangaehu R 250m u/s confl.	7.5	<2	133	12
RS40	Waipoua R at Colombo Rd Br	1.0	<2	15	12
RS41	Waingawa R at South Rd	1.0	<2	14	12
RS42	Whareama R at Gauge	7.5	<2	320	12
RS43	Motuwaireka S at Headwaters	1.0	<2	4	12
RS44	Totara S at Stronvar	1.0	<2	8	11
RS45	Parkvale Trib at Lowes Res.	2.5	<2	3	8
RS46	Parkvale S at Weir	9.0	<2	95	11*
RS47	Waiohine R at Gorge	1.0	<2	59	11*
RS48	Waiohine R at Bicknells	2.0	<2	24	11*
RS49	Beef Ck at Headwaters	1.0	<2	5	11*
RS50	Mangatarere S at SH 2	3.0	<2	59	11*
RS51	Huangarua R at Ponatahi Br	2.0	<2	430	11*
RS52	Tauanui R at Whakatomotomo Rd	1.0	<2	16	11*
RS53	Awhea R at Tora Rd	10.0	<2	720	11*
RS54	Coles Ck Trib at Lagoon Hill Rd	4.0	<2	18	8
RS55	Tauherenikau R at Websters	1.5	<2	114	12
RS56	Waiorongomai R at Forest Pk	1.0	<2	9	12

* The laboratory overlooked testing for TSS on one occasion.

Table A3.18: Summary of dissolved copper, lead and zinc (mg/L) concentrations measured at 10 RSoE sites between July 2010 and June 2011 (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	0.00080	<0.0005	0.0022	11	2
RS08	Ngarara S at Field Way	0.00025	<0.0005	0.0009	12	7
RS10	Waikanae R at Greenaway Rd	0.00025	<0.0005	0.0013	12	10
RS15	Porirua S at Glenside	0.00095	0.0007	0.0018	12	0
RS16	Porirua S at Wall Park (Milk Depot)	0.00210	0.0012	0.0112	12	0
RS18	Karori S at Makara Peak	0.00150	0.0008	0.0045	12	0
RS19	Kaiwharawhara S at Ngaio Gorge	0.00150	0.0010	0.0043	12	0
RS21	Hutt R opp. Manor Park G.C.	0.00038	<0.0005	0.0028	12	6
RS22	Hutt R at Boulcott	0.00025	<0.0005	0.0008	12	8
RS27	Waiwhetu S at Wainuiomata Hill Br	0.00090	<0.001*	0.0032	12	1
<i>Dissolved lead</i>						
RS02	Mangapouri S at Bennetts Rd	0.00019	<0.0001	0.00027	11	1
RS08	Ngarara S at Field Way	0.00005	<0.0001	0.00005	12	12
RS10	Waikanae R at Greenaway Rd	0.00005	<0.0001	0.00054	12	10
RS15	Porirua S at Glenside	0.00008	<0.0001	0.00022	12	6
RS16	Porirua S at Wall Park (Milk Depot)	0.00029	<0.0001	0.00142	12	1
RS18	Karori S at Makara Peak	0.00016	<0.0001	0.00070	12	4
RS19	Kaiwharawhara S at Ngaio Gorge	0.00012	<0.0001	0.00071	12	5
RS21	Hutt R opp. Manor Park G.C.	0.00013	<0.0001	0.00042	12	3
RS22	Hutt R at Boulcott	0.00005	<0.0001	0.00137	12	9
RS27	Waiwhetu S at Wainuiomata Hill Br	0.00036	0.00015	0.00058	12	0
<i>Dissolved zinc</i>						
RS02	Mangapouri S at Bennetts Rd	0.00350	<0.001	0.1960	11	1
RS08	Ngarara S at Field Way	0.00225	<0.001	0.0042	12	3
RS10	Waikanae R at Greenaway Rd	0.00155	<0.001	0.0043	12	4
RS15	Porirua S at Glenside	0.00585	<0.001	0.0197	12	3
RS16	Porirua S at Wall Park (Milk Depot)	0.02270	0.0028	0.0570	12	0
RS18	Karori S at Makara Peak	0.02180	0.0061	0.0680	12	0
RS19	Kaiwharawhara S at Ngaio Gorge	0.00995	<0.001	0.0390	12	1
RS21	Hutt R opp. Manor Park G.C.	0.00270	<0.001	0.0080	12	3
RS22	Hutt R at Boulcott	0.00135	<0.001	0.0055	12	4
RS27	Waiwhetu S at Wainuiomata Hill Br	0.02150	0.0084	0.1410	12	0

* Lower than usual laboratory detection limit.

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	4.29	11.8	17
RS03	Waitohu S at Forest Pk	8.06	77.3	22
RS04	Waitohu S at Norfolk Cres	4.88	18.2	11
RS05	Otaki R at Pukehinau	7.56	65.2	23
RS06	Otaki R at Mouth	6.93	50.0	16
RS07	Mangaone S at Sims Rd Br	4.08	0	11
RS08	Ngarara S at Field Way	4.62	0	21
RS09	Waikanae R at Mangaone Walkway	7.97	65.5	29
RS10	Waikanae R at Greenaway Rd	4.74	40.5	37
RS11	Whareroa S at Waterfall Rd	6.60	37.0	27
RS12	Whareroa S at QE Park	4.75	7.7	13
RS13	Horokiri S at Snodgrass	5.39	45.8	24
RS14	Pauatahanui S at Elmwood Br	4.13	44.8	29
RS15	Porirua S at Glenside	4.66	25.0	16
RS16	Porirua S at Wall Park (Milk Depot)	4.35	25.0	20
RS17	Makara S at Kennels	4.34	44.4	18
RS18	Karori S at Makara Peak	3.76	11.5	26
RS19	Kaiwharawhara S at Ngaio Gorge	3.74	23.8	21
RS20	Hutt R at Te Marua Intake Site	7.92	62.5	24
RS21	Hutt R opp. Manor Park G.C.	3.37	34.8	23
RS22	Hutt R at Boulcott	3.68	37.5	16
RS23	Pakuratahi R 50m d/s Farm Ck	7.40	59.3	27
RS24	Mangaroa R at Te Marua	5.61	48.5	33
RS25	Akatarawa R at Hutt confl.	7.52	57.7	26
RS26	Whakatikei R at Riverstone	6.83	65.5	29
RS27	Waiwhetu S at Wainuiomata Hill Br	3.97	6.7	15
RS28	Wainuiomata R at Manuka Track	6.78	55.2	29
RS29	Wainuiomata R u/s of White Br	4.13	32.0	25
RS30	Orongorongo R at Orongorongo Stn	6.88	31.3	16
RS31	Ruamahanga R at McLays	8.06	68.8	16
RS32	Ruamahanga R at Te Ore Ore	6.40	37.5	16
RS33	Ruamahanga R at Gladstone Br	6.97	40.0	10
RS34	Ruamahanga R at Pukio	7.82	33.3	12
RS35	Mataikona Trib at Sugar Loaf Rd	7.37	54.8	31
RS36	Taueru R at Castlehill	5.13	39.1	23
RS37	Taueru R at Gladstone	4.43	31.8	22
RS38	Kopuaranga R at Stewarts	3.69	36.8	19
RS39	Whangaehu R 250m u/s confl.	4.27	4.3	23
RS40	Waipoua R at Colombo Rd Br	3.64	37.9	29
RS41	Waingawa R at South Rd	7.34	46.7	15
RS42	Whareama R at Gauge	4.01	30.0	10
RS43	Motuwaireka S at Headwaters	6.45	59.0	39
RS44	Totara S at Stronvar	4.11	30.0	30
RS45	Parkvale Trib at Lowes Res.	4.58	38.1	21
RS46	Parkvale S at Weir	3.30	16.7	18
RS47	Waiohine R at Gorge	7.77	72.2	18
RS48	Waiohine R at Bicknells	7.21	52.6	19
RS49	Beef Ck at Headwaters	7.72	57.6	33
RS50	Mangatarere S at SH 2	4.53	35.7	28
RS51	Huangaaru R at Ponatahi Br	2.79	21.7	23
RS52	Tauanui R at Whakatomotomo Rd	6.91	65.4	26
RS53	Awhea R at Tora Rd	4.47	11.5	26
RS54	Coles Ck Trib at Lagoon Hill Rd	4.89	32.4	37
RS55	Tauherenikau R at Websters	7.56	52.4	21
RS56	Waiorongomai R at Forest Pk	7.34	57.7	26

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June 2012
GW/EMI-G-12/149



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