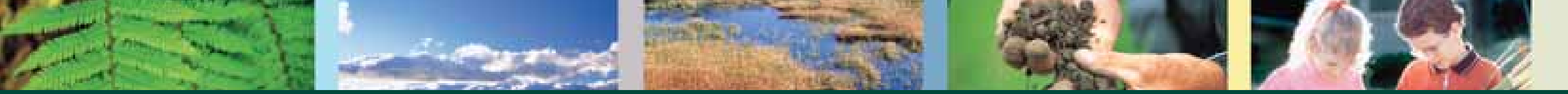

Annual coastal monitoring report for the Wellington region, 2009/10

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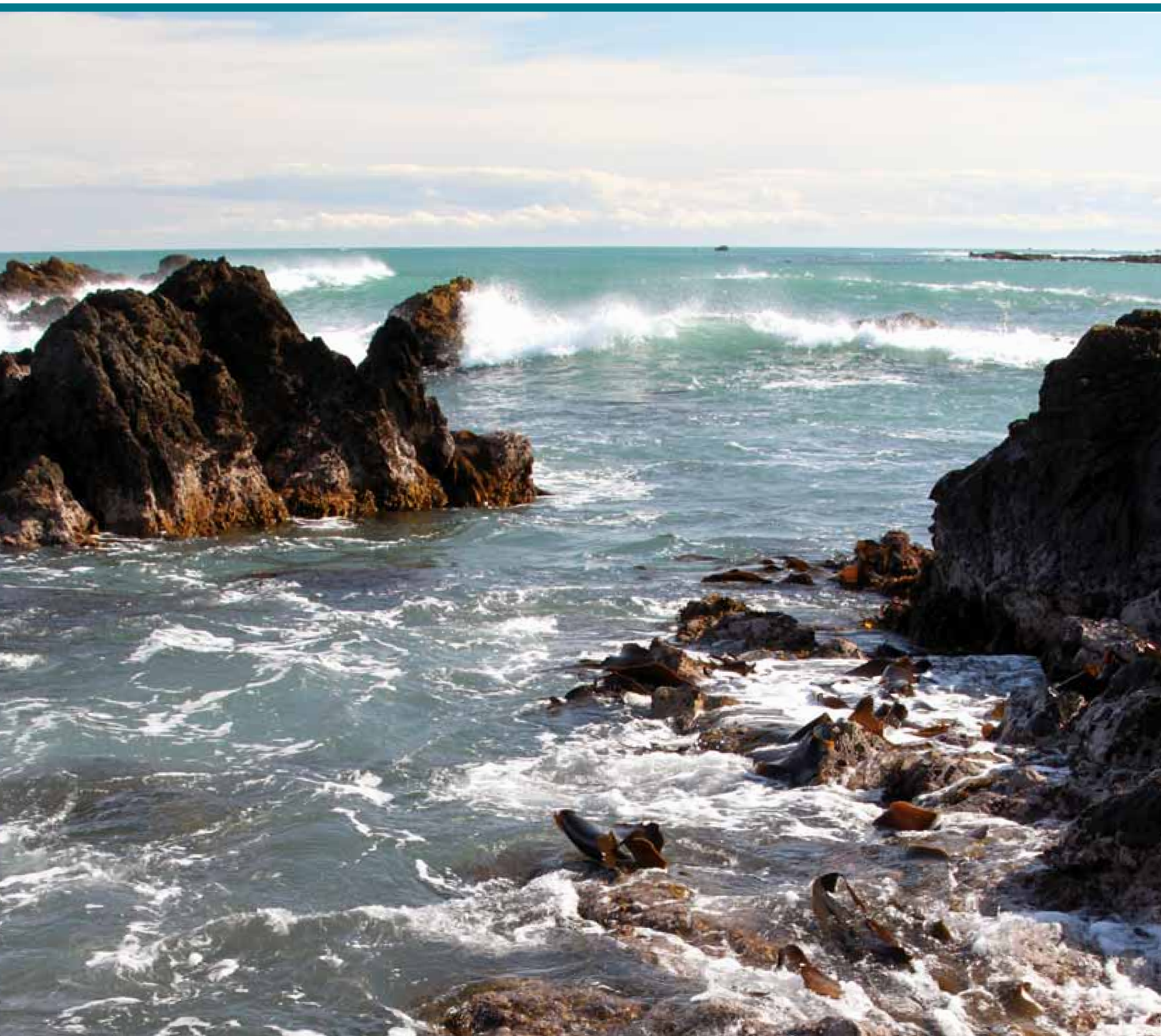

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Annual coastal monitoring report for the Wellington region, 2009/10

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1. Introduction

Greater Wellington Regional Council (Greater Wellington) has a responsibility to manage and monitor the Wellington region's near-shore coastal environment; the area extending from mean high water springs to 12 nautical miles offshore. This near-shore environment contains significant habitats for a wide variety of plants and animals, and also provides for a diverse range of human activities and values.

Greater Wellington's Environmental Monitoring and Investigations Department oversees monitoring and investigations of water quality, sediment quality and ecological health in the Wellington region's near-shore coastal environment. This report summarises the results of such monitoring and investigations undertaken over the period 1 June 2009 to 30 June 2010. Note that the suitability of coastal waters for contact recreation purposes is assessed separately under Greater Wellington's recreational water quality monitoring programme (see Ryan & Warr 2010).

2. Overview of coastal monitoring programme

2.1 Background

Coastal monitoring in the Wellington region began over 20 years ago, with a focus on microbiological water quality – a reflection of the high usage of much of the region's coastline for contact recreation such as swimming and surfing. Periodic assessments of contaminants in shellfish flesh commenced around 1997, with the most recent assessment undertaken at 20 sites in 2006 (see Milne 2006). In 2004 monitoring expanded into coastal ecology and sediment quality, with a key focus being the effects of urban stormwater on our coastal harbour environments. In addition, over 2004-2008 broad-scale surveys of the region's coastal habitats were carried out, with fine-scale sediment and ecological assessments undertaken at representative intertidal locations of selected estuaries and sandy beaches. The information gained from these surveys was combined with ecological vulnerability assessments to identify priorities for a long-term monitoring programme that will enable Greater Wellington to fulfil state of the environment monitoring obligations with respect to coastal ecosystems.

2.2 Monitoring objectives

The aims of Greater Wellington's coastal monitoring programme are to:

1. Assist in the detection of spatial and temporal changes in near-shore coastal waters;
2. Contribute to our understanding of coastal biodiversity in the region;
3. Determine the suitability of coastal waters for designated uses;
4. Provide information to assist in targeted investigations where remediation or mitigation of poor water quality is desired; and
5. Provide a mechanism to determine the effectiveness of policies and plans.

Note: the suitability of coastal waters for contact recreation purposes is assessed separately under Greater Wellington's recreational water quality monitoring programme.

2.3 Monitoring and investigations during 2009/10

Coastal monitoring and investigations undertaken over the period 1 June 2009 to 30 June 2010 included:

- Microbiological water quality monitoring at 74 sites across the region (Section 3);
- Fine-scale ecological monitoring in Waikanae Estuary (Section 4), Porirua Harbour (Section 5), Hutt Estuary (Section 6) and Whareama Estuary (Section 7);

- A sediment quality and ecological assessment at two sites in Lake Onoke (Section 8); and
- Further chemical analysis of surface sediment samples collected from Wellington Harbour in 2006/07 (Section 9).

3. Microbiological water quality monitoring

3.1 Introduction

Microbiological water quality was monitored at 74 coastal sites across the Wellington region over 2009/10 (Figure 3.1, Appendix 1), as follows:

- Kapiti Coast District – 20 sites
- Porirua City – 13 sites
- Hutt City – 15 sites
- Wellington City – 21 sites
- Wairarapa – 5 sites

Monitoring was a joint effort involving Greater Wellington, Kapiti Coast District Council, Porirua City Council, Hutt City Council, and Wellington City Council. The sites monitored reflect their use by the public for contact recreation; in particular, swimming, surfing, and boating.

There were three fewer sites monitored than last year. Plimmerton Beach at Queens Avenue and Paremata Beach at Pascoe Avenue (both in Porirua) were dropped from the recreational water quality monitoring programme because they are in close proximity to other sites. Kio Bay (Wellington City) was also dropped because it is not a commonly used recreation site. The site at Pukerua Bay was moved approximately 200 m from its previous location for safety reasons.

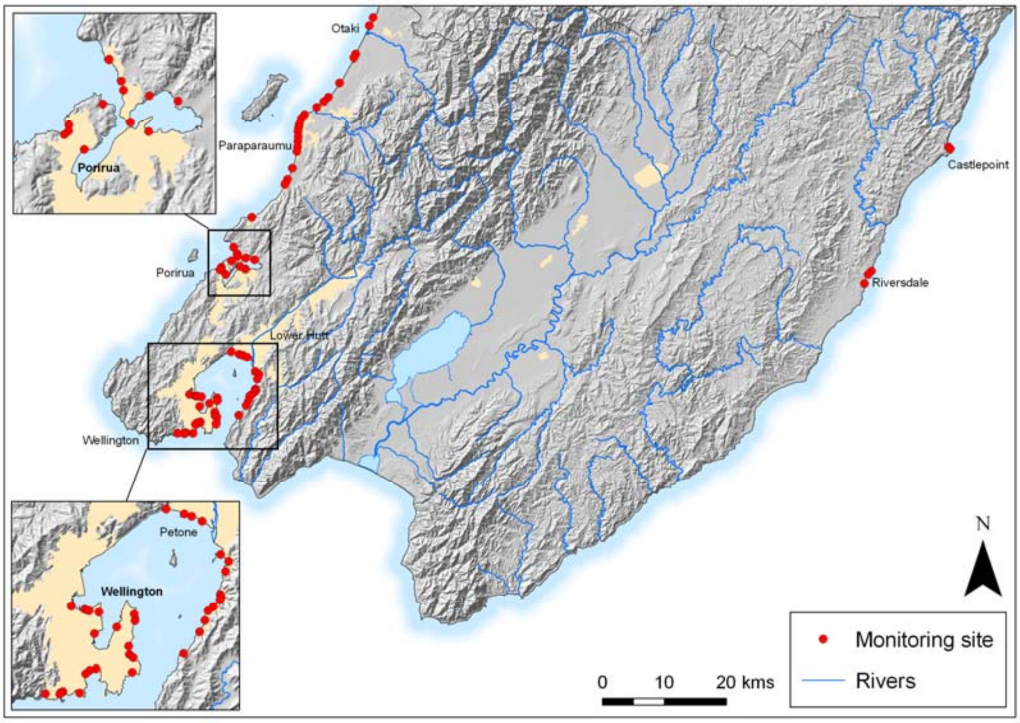


Figure 3.1: Coastal water quality sites monitored over 2009/10

3.2 Monitoring protocol

Sites were sampled weekly during the summer bathing season (1 November to 31 March inclusive) as part of Greater Wellington's recreational water quality monitoring programme (see Ryan & Warr 2010)[1], and at least monthly during the remainder of the year. On each sampling occasion a single water sample was collected 0.2 metres below the surface in 0.5 metres water depth and tested for enterococci indicator bacteria using a membrane filtration method. In addition, water samples from six sites popular for recreational shellfish gathering, and three sites in Porirua Harbour[2], were tested for faecal coliform indicator bacteria (Appendix 1). Turbidity was also measured at some of these sites.

Observations of weather and the state of the tide, and visual estimates of seaweed cover, were made at each site to assist with the interpretation of the monitoring results. For example:

- Rainfall may increase enterococci counts by flushing accumulated debris from urban and agricultural areas into coastal waters.
- Wind direction can influence the movement of currents along the coastline and can therefore affect water quality at a particular site.
- In some cases, an increase in enterococci counts may be due to the presence of seaweed. Under warm conditions when seaweed is excessively photosynthesising or decaying, enterococci may feed off the increased carbonaceous material produced during photosynthesis or off the decaying seaweed.

An estimate of the daily rainfall in the catchment adjoining each site over the bathing season was made by obtaining records from the nearest rain gauge.

A list of field and laboratory methods can be found in Ryan & Warr (2010).

3.3 Results

The results of microbiological water quality testing undertaken during the official summer bathing season are discussed in detail in *On the Beaches 2009/10: Annual recreational water quality monitoring report for the Wellington region* (Ryan & Warr 2010). Table 3.1 summarises the median, 95th percentile and maximum enterococci bacteria counts recorded from all sampling conducted during the period 1 July 2009 to 30 June 2010 for each of the 74 marine sites (i.e., these statistics include the results of additional follow-up sampling conducted in response to an exceedance of the Ministry for the Environment/Ministry of Health (2003) microbiological water quality guidelines). Table 3.2 presents summary statistics for the nine sites where faecal coliform indicator bacteria counts are also measured.

Twenty one sites recorded a maximum enterococci sample result of more than 1,000 cfu/100 mL, with the highest maximum counts recorded in water samples from the Pauatahanui Inlet at Browns Bay (5,332 cfu/100 mL on 29 December 2010), Island Bay at Reef Street Recreation Ground (4,320 cfu/100 mL on 8 December 2009) and Robinson Bay at HW Shortt Recreation Ground

[1] Breaker Bay (Wellington City), Princess Bay (Wellington City) and Riversdale Beach South (Wairarapa) were sampled fortnightly during the summer months while Camp Bay (Hutt City) was sampled monthly (see Ryan & Warr 2010).

[2] These sites, introduced in July 2007, are not recommended shellfish gathering sites but are monitored in response to community interest.

Table 3.1: Summary of enterococci counts recorded at 74 coastal sites monitored over 1 July 2009 to 30 June 2010 inclusive

Bathing Site	Total no. of samples	Enterococci (cfu/100 mL)		
		Median	95th percentile	Max
Kapiti Coast				
Otaki Beach @ Surf Club	29	10	98	270
Otaki Beach @ Rangiuru Rd	28	7	104	355
Te Horo Beach S of Mangaone Strm	30	15	490	1,350
Te Horo Beach @ Kitchener St	28	9	473	890
Peka Peka Beach @ Rd End	28	4	65	310
Waikanae Beach @ William St	28	5	83	440
Waikanae Beach @ Tutere St T.C.	29	10	141	585
Waikanae Beach @ Ara Kuaka C.P.	28	7	126	505
Paraparaumu Beach @ Ngapotiki St	29	20	185	1,830
Paraparaumu Beach @ Nathan Ave	29	10	213	1,165
Paraparaumu Beach @ Maclean Pk	29	25	154	205
Paraparaumu Beach @ Toru Rd	30	20	538	1,040
Paraparaumu Beach @ Wharemauku Rd	31	20	208	245
Raumati Beach @ Tainui St	27	11	84	115
Raumati Beach @ Marine Gardens	28	15	138	240
Raumati Beach @ Aotea Rd	28	15	120	1,025
Raumati Beach @ Hydes Rd	28	8	93	265
Paekakariki Beach @ Whareroa Rd	28	10	61	240
Paekakariki Beach @ Surf Club	28	7	94	1,270
Paekakariki Beach @ Memorial Hall	26	5	34	105
Porirua				
Pukerua Bay	30	4	334	808
Karehana Bay @ Cluny Rd	29	8	281	568
Plimmerton Beach @ Bath St	28	20	208	340
South Beach @ Plimmerton	36	24	663	704
Pauatahanui Inlet @ Water Ski Club	28	14	359	1,440
Pauatahanui Inlet @ Motukaraka Pt	29	2	251	330
Pauatahanui Inlet @ Browns Bay	30	10	531	5,332
Pauatahanui Inlet @ Paremata Bridge	28	4	206	720
Porirua Harbour @ Rowing Club	33	24	671	1,696
Titahi Bay @ Bay Drive	30	12	341	488
Titahi Bay at Toms Rd	28	12	203	512
Titahi Bay @ South Beach Access Rd	33	36	1,080	2,240
Onehunga Bay	27	4	204	270
Hutt				
Petone Beach @ Water Ski Club	27	4	96	130
Petone Beach @ Sydney St	29	8	350	1,424
Petone Beach @ Settlers Museum	29	4	188	232
Petone Beach @ Kiosk	30	6	189	512

Table 3.1 *cont*.: Summary of enterococci counts recorded at 74 coastal sites monitored over 1 July 2009 to 30 June 2010 inclusive

Bathing Site	Total no. of samples	Enterococci (cfu/100 mL)		
		Median	95th percentile	Max
Hutt				
Sorrento Bay	28	3	646	1,696
Lowry Bay @ Cheviot Rd	29	4	344	1,056
York Bay	28	2	19	504
Days Bay @ Wellesley College	28	10	109	880
Days Bay @ Wharf	28	14	133	1,792
Days Bay @ Moana Rd	29	8	132	196
Rona Bay @ N end of Cliff Bishop Pk	38	36	638	1,008
Rona Bay @ Wharf	30	26	260	364
Robinson Bay @ HW Shortt Rec Grd	33	12	630	4,240
Robinson Bay @ Nikau St	27	12	86	388
Camp Bay	12	4	18	20
Wellington City				
Aotea Lagoon	30	16	301	1,400
Oriental Bay @ Freyberg Beach	27	4	62	128
Oriental Bay @ Wishing Well	29	8	240	890
Oriental Bay @ Band Rotunda	27	4	65	120
Balaena Bay	27	4	8	12
Hataitai Beach	27	2	32	44
Shark Bay	27	4	56	92
Mahanga Bay	27	8	35	36
Scorching Bay	27	2	26	110
Worser Bay	28	2	57	160
Seatoun Beach @ Wharf	28	2	49	200
Seatoun Beach @ Inglis St	28	3	53	272
Breaker Bay	17	2	4	4
Lyall Bay @ Tirangi Rd	27	4	41	132
Lyall Bay @ Onepu Rd	27	2	35	44
Lyall Bay @ Queens Drive	29	4	232	1,700
Princess Bay	17	2	4	4
Island Bay @ Surf Club	31	8	242	424
Island Bay @ Reef St Recreation Grd	32	12	312	4,320
Island Bay @ Derwent St	28	2	48	380
Owhiro Bay	45	112	931	1,100
Wairarapa				
Castlepoint Beach @ Castlepoint Strm	29	4	135	1,700
Castlepoint Beach @ Smelly Creek	29	2	134	428
Riversdale Beach @ Lagoon Mouth	28	2	65	520
Riversdale Beach Between the Flags	29	2	65	312
Riversdale Beach South	19	2	8	12

Table 3.2: Summary of faecal coliform counts recorded at nine coastal sites monitored over 1 July 2009 to 30 June 2010 inclusive

Site	Total no. of samples	Faecal coliforms (cfu/100 mL)		
		Median	95th percentile	Max
Kapiti Coast				
Otaki Beach @ Surf Club	29	35	502	2,200
Peka Peka Beach @ Rd End	28	16	359	1,200
Raumati Beach @ Hydes Rd	28	20	214	540
Porirua				
Pauatahanui Inlet @ Motukaraka Point	30	4	171	180
Pauatahanui Inlet @ Browns Bay	30	42	595	900
Porirua Harbour @ Rowing Club	31	28	580	780
Hutt				
Sorrento Bay	28	2	344	590
Wellington City				
Shark Bay	27	2	37	730
Mahanga Bay	27	2	39	110

(4,240 cfu/100 mL on 15 September 2009). More than 30 mm of rainfall was recorded in the days leading up to the Pauatahanui Inlet sampling event, highlighting the well-established relationship between rainfall and elevated bacteria counts in surface waters (e.g., Milne & Wyatt 2006). In the case of the Island Bay result, an investigation by Capacity (for Wellington City Council) identified a blocked sewer on Dee Street as the likely source of contamination; this was subsequently fixed (Ryan & Warr 2010). The cause of the elevated Robinson Bay sample result is not known.

Titahi Bay at South Beach Access Road and Owhiro Bay on Wellington City's south coast both recorded 95th percentile enterococci counts well above other sites (1,080 and 931 cfu/100 mL respectively), indicating that significantly elevated bacteria levels were recorded on multiple occasions at these sites. Ryan and Warr (2010) noted that routine water sample results from these two sites exceeded the action level of the recreational water quality guidelines (280 cfu/100 mL) on four and nine occasions during the summer bathing season respectively, with many of these exceedences unrelated to rainfall. Porirua City Council is still investigating the source of faecal contamination at Titahi Bay (believed to be to sewerage infrastructure-related) while at Owhiro Bay, Capacity identified and repaired several significant faults in the public and private sewer network (Ryan & Warr 2010).

Two of the nine sites monitored for faecal coliform bacteria recorded maximum counts above 1,000 cfu/100 mL: Otaki Beach at Surf Club and Peka Peka Beach at Road End (Table 3.2). Both of these results (2,200 and 1,200 cfu/100 mL respectively) were recorded on 30 December 2009 and followed over 60 mm of rainfall in the two days leading up to sampling.

4. Waikanae Estuary intertidal ecological monitoring

4.1 Introduction and background

In January 2010 the first round of fine-scale ecological monitoring was undertaken in Waikanae Estuary, a 2 km long, "tidal river mouth" type estuary located on the Kapiti Coast. This monitoring, summarised here from reports by Robertson and Stevens (2010a) and Stevens and Robertson (2010a), followed an earlier assessment of coastal habitats in the western Wellington region (Robertson & Stevens 2007a) which recommended monitoring of the long-term condition of the Waikanae Estuary, focusing on core indicators of sedimentation, eutrophication and, to a lesser extent, contamination.

4.2 Monitoring sites, variables and methods

Monitoring included a broad-scale assessment of macroalgal cover over the estuary's intertidal habitat and a fine-scale assessment of ecological health at one 60 m by 15 m site located on unvegetated intertidal mudflats in the upper estuary (Figure 4.1 & Table A2.1, Appendix 2). Within this site up to 10 plots were assessed for selected fine-scale sediment condition indicators – including grain size (texture), the degree of oxygenation, nutrient and organic content, and heavy metal and pesticide (DDT) concentrations – as well as benthic (sediment-dwelling) fauna abundance and diversity. The broad and fine-scale monitoring methods were based on an extension of the tools included in the National Estuary Monitoring Protocol (Robertson et al. 2002). One of these extensions

(Source: Robertson & Stevens 2010a)

Figure 4.1: Location of the fine-scale monitoring site and sedimentation monitoring plates within the Waikanae Estuary

was the deployment (through burial to a measured depth) of four sedimentation monitoring plates adjacent to the fine-scale ecological monitoring site. The depth to these plates will be measured annually from 2011 onwards to assess sedimentation rates in the upper estuary reaches.

4.3 Key findings

The results for the selected physical, chemical and biological indicators of estuary condition showed that the dominant intertidal habitat was generally in a “fair” condition. Macroalgal cover was low, the sediments were moderately oxygenated with low to moderate concentrations of nitrogen, phosphorus and organic carbon, DDT was not detected in the sediment and concentrations of all heavy metals were well below ANZECC (2000) sediment quality guidelines. However, the sediments had a relatively high mud (i.e., particles sized <63 micron) content – approximately 15–38% – contributing to a benthic invertebrate fauna dominated by mud-tolerant taxa such as the amphipod *Paracorophium* sp. and the small snail *Potamaoprygus antipodarum* (i.e., reduced invertebrate diversity). This highlights a need to manage fine sediment inputs to the estuary.

Overall, it is recognised that the Waikanae Estuary has been physically altered from its original state for flood protection purposes, with floodgates in the lower reaches restricting tidal action and flushing to a large historical estuarine arm. These modifications – including artificial mouth opening – reduce the estuary’s ability to function efficiently and its ability to provide habitat for fish and birdlife.

4.4 Future monitoring

The 2010 fine-scale ecological assessment is the first in a proposed series of three or four annual assessments to establish a “baseline” of existing conditions in the Waikanae Estuary. After the baseline has been established, the frequency of monitoring will probably be reduced to five-yearly intervals.

5. Porirua Harbour intertidal ecological monitoring

5.1 Introduction and background

Routine intertidal sediment quality and ecological monitoring in Porirua Harbour began in January 2008, with the monitoring programme designed primarily to assess common estuary issues of sedimentation, eutrophication (nutrient enrichment), contamination and habitat loss (e.g., changes in substrate or vegetation cover). This section briefly summarises the results of the third round of intertidal monitoring undertaken in early 2010. This survey focused primarily on assessing indicators of sedimentation, eutrophication and, to a lesser extent, contamination. Full details of the monitoring are reported in Robertson and Stevens (2010b) and Stevens and Robertson (2010b).

5.2 Monitoring sites, variables and methods

The third intertidal survey was undertaken in January 2010 at two sites in each arm of Porirua Harbour (Figure 5.1 & Table A2.2, Appendix 2). This monitoring included assessments of up to 10 plots per site for selected fine-scale sediment condition indicators – including grain size (texture), the degree of oxygenation, nutrient and organic content, and heavy metal and pesticide (DDT) concentrations – as well as benthic (sediment-dwelling) fauna abundance and diversity. The methods used were based on an extension of the tools included in the National Estuary Monitoring Protocol (Robertson et al. 2002). The depths to 15 sedimentation monitoring plates buried in various locations in December 2007 were also measured (with four additional plates buried near the Paremata boatsheds) and the percentage cover of macroalgae (e.g., sea lettuce) mapped.

(Source: Robertson & Stevens 2010b)

Figure 5.1: Location of the four fine-scale intertidal monitoring sites and sedimentation monitoring plates within Porirua Harbour

5.3 Key findings

The results for the selected physical, chemical and biological indicators of estuary condition showed that the dominant intertidal habitat in Porirua Harbour was generally in a “moderate” condition. Macroalgal cover was elevated at most sites (Figure 5.2) and the oxygenated sediment layer extended just 1–2 cm below the surface (the lowest recorded in the three annual surveys to date). Despite this – and mud contents of up to 15% – sand still dominated the substrate and was found to support a relatively diverse benthic invertebrate fauna.

(Source: Wriggle Coastal Management)

Figure 5.2: Extensive macroalgae growth on intertidal mudflats within the Onepoto Arm of Porirua Harbour, January 2010

Although the sediment plates have only been in place for two years, sedimentation rates at most sites are low. The highest rate (3.75 mm/yr) was recorded in the upper Onepoto Arm opposite the Whitireia Polytechnic; however, as was the case in 2009, there was high variability across the two sedimentation plates at this site, indicating additional sedimentation plates are needed to more adequately assess sedimentation rates in this area of the harbour.

In terms of toxicants, all four sites recorded heavy metal concentrations well below ANZECC (2000) sediment quality guidelines. While this is not unexpected (heavy metal concentrations are known to be highest in the fine muds immediately adjacent to stormwater outfalls and in the subtidal basin of the Onepoto Arm), it was unusual that DDT was not measured in the sediments from any site. Previous sampling (e.g., Sorensen and Milne 2009, Stephenson & Mill 2004) has shown that DDT is widespread in the harbour’s sediments.

5.4 Future monitoring

The 2010 fine-scale ecological assessment was the third in a proposed series of three or four annual assessments and has helped to establish a “baseline” of existing conditions in the intertidal habitats of Porirua Harbour. Given that this baseline indicates the estuary has elevated sedimentation rates and poorly oxygenated and enriched sediments, a fourth survey – focussing on sediment indicators only – will be undertaken in 2011 to confirm the scope and frequency of future monitoring.

6. Hutt Estuary ecological monitoring

6.1 Introduction and background

In January 2010 the first round of fine-scale ecological monitoring was undertaken in Hutt Estuary, a 3 km long, "tidal river mouth" type estuary that discharges into Wellington Harbour at Petone. This monitoring, summarised here from reports by Robertson and Stevens (2010c) and Stevens and Robertson (2010c), followed an earlier assessment of coastal habitats in the western Wellington region (Robertson & Stevens 2007a) which recommended monitoring of the long-term condition of the Hutt Estuary, focusing on core indicators of sedimentation, eutrophication and contamination.

6.2 Monitoring sites, variables and methods

Monitoring included a broad-scale assessment of macroalgal cover over the estuary's intertidal habitat and a fine-scale assessment of ecological health at two shallow subtidal margin locations which represented the dominant estuarine habitat (Figure 6.1 & Table A2.3, Appendix 2). At each of these two sites a 20 metre long transect, aligned parallel to the edge of the channel, was marked out. At 2 metre intervals along each transect, 10 sampling points were assessed for selected fine-scale sediment condition indicators – including grain size (texture), the degree of oxygenation, nutrient and organic content, and heavy metal, polycyclic aromatic hydrocarbon (PAH) and pesticide (DDT) concentrations – as well as benthic (sediment-dwelling) fauna abundance and diversity.

(Source: Robertson & Stevens 2010c)

Figure 6.1: Location of the fine-scale monitoring sites and sedimentation monitoring plates within the Hutt Estuary

The broad and fine-scale monitoring methods were based on an extension of the tools included in the National Estuary Monitoring Protocol (Robertson et al. 2002). One of these extensions was the deployment (through burial to a measured depth) of four sedimentation monitoring plates on a small intertidal flat near the mouth of the estuary. The depth to these plates will be measured annually from 2011 onwards to assess sedimentation rates in this area of the estuary.

6.3 Key findings

The results for the selected physical, chemical and biological indicators of estuary condition showed that the Hutt Estuary was generally in a “fair” condition. Over 40% (4.2 ha) of the intertidal area had macroalgal cover (principally *Enteromorpha*[3]) above 50%, although localised nuisance conditions (e.g., rotting macroalgae and poorly oxgenated, sulphide-rich sediments) were only found in subtidal areas near the estuary mouth. In terms of the fine-scale indicators, the sediments were moderately oxygenated with low to moderate concentrations of nitrogen, phosphorus and organic carbon, while concentrations of heavy metals, PAHs and DDT were all well below ANZECC (2000) sediment quality guidelines. However, the sediments had a high mud (i.e., particles sized <63 micron) content – approximately 31–56% – and supported a benthic invertebrate fauna dominated by taxa tolerant of both mud and organic enrichment, in particular, the amphipod *Paracorophium* sp. (i.e., reduced invertebrate diversity). This highlights a need to manage both fine sediment and nutrient inputs to the estuary.

Overall, it is recognised that decades of reclamation and channelisation for urban development and flood protection purposes have resulted in the Hutt Estuary now having very low habitat diversity. As a consequence, this has reduced the ability of the estuary to function efficiently and support diverse populations of fish, shellfish, birds and other values.

6.4 Future monitoring

The 2010 fine-scale ecological assessment is the first in a proposed series of three or four annual assessments to establish a “baseline” of existing conditions in the Hutt Estuary. After the baseline has been established, the frequency of monitoring will probably be reduced to five-yearly intervals.

[3] Synonymous with *Ulva intestinalis.*

7. Whareama Estuary intertidal ecological monitoring

7.1 Introduction and background

In January 2010 a third round of fine-scale ecological monitoring was undertaken in Whareama Estuary, a 12 km long, tidal river lagoon estuary located on Wairarapa's eastern coast. This monitoring, summarised here from a report by Robertson and Stevens (2010d), followed an earlier assessment of Wairarapa coastal habitats (Robertson & Stevens 2007b) which recommended a long-term monitoring programme for Wairarapa coastal habitats. Included in the programme was monitoring of the long-term condition of the Whareama Estuary, focusing on core indicators of sedimentation, eutrophication and, to a lesser extent, contamination.

7.2 Monitoring sites, variables and methods

Monitoring was undertaken at two sites located on the unvegetated intertidal mudflats (Figure 7.1 & Table A2.4, Appendix 2). This monitoring included assessments of up to 10 plots per site for selected fine-scale sediment condition indicators – including grain size (texture), the degree of oxygenation, nutrient and organic content, and heavy metal concentrations – as well as benthic (sediment-dwelling) fauna abundance and diversity. The fine-scale monitoring methods were based on an extension of the tools included in the National Estuary Monitoring Protocol (Robertson et al. 2002). The depths to four sedimentation monitoring plates deployed at right angles to the Whareama River channel in January 2008 were also measured.

(Source: Robertson & Stevens (2010d)

Figure 7.1: Location of the fine-scale monitoring sites and sedimentation monitoring plates within the Whareama Estuary (left) and collection of benthic fauna sediment cores in January 2010 (right)

7.3 Key findings

The results for the selected physical, chemical and biological indicators of estuary condition were similar to 2009, indicating that the dominant intertidal habitat in the Whareama Estuary was generally in "fair" to "good" condition. Sediment concentrations of nitrogen, phosphorus and organic carbon were classed as low to moderate, and heavy metal concentrations were well below ANZECC (2000) sediment quality guidelines. However, the sediments comprise had an elevated mud (i.e., particles sized <63 micron) content – 23% at one site and 65% at the other – and have a shallow oxygenated surface layer (just 1 cm depth). These conditions support a benthic community largely dominated by small deposit-feeding organisms that prefer moderate mud and organic enrichment levels (e.g., the bivalve *Arthritica* sp. and polychaetes *Heteromastus filiformis* and *Scolecolepides benhami*). Overall, the 2010 results indicate an increasing shift towards mud-tolerant organisms; in the future, it is likely that the remnant sand-tolerant cockle population present may disappear unless mud concentrations decline.

Measurements from the sediment plates reveal a high sedimentation rate (6–7 mm/yr) over January 2008 to January 2010 (but down from an average of 14.5 mm over the first year). Excessive inputs of sediment are largely a natural phenomenon given the erosion-prone mudstone soils in the catchment.

Greater Wellington has a soil conservation programme in place within the Whareama catchment designed to reduce soil erosion; 10 farm plans covering 13 properties (approximately 20% of the total catchment area) were developed during 2009/10 (Stewart, pers. comm.[4]).

7.4 Future monitoring

The 2010 fine-scale ecological assessment was the third in a proposed series of three or four annual assessments and has enabled the establishment of a "baseline" of existing conditions in the Whareama Estuary. Given that this baseline indicates the estuary has elevated sedimentation rates and poorly oxygenated sediments, a fourth survey – focussing on sediment indicators – will be undertaken in 2011 to confirm future monitoring requirements.

[4] Andrew Stewart, Greater Wellington Land Management Project Coordinator.

8. Lake Onoke ecological monitoring

8.1 Introduction and background

Located on the Wairarapa's south coast, Lake Onoke is a highly modified shallow coastal lake/estuary fed by the lower Ruamahanga River. The lake drains to the sea at Palliser Bay through an opening at the southeastern end of the lake. The lake outlet regularly blocks and is opened artificially.

In August 2009, Greater Wellington commenced monthly water quality sampling in the lake and, in January 2010, undertook an ecological assessment at one intertidal and one subtidal location within the lake. This monitoring followed an earlier field and risk assessment (Robertson & Stevens 2007c) which recommended a range of monitoring and assessments to establish a "baseline" of existing conditions in Lake Onoke; the lake was identified as having a high risk of nutrient, sedimentation, pathogen and habitat loss problems, and there was a lack of ecological data.

The January 2010 ecological assessment is summarised here.

8.2 Sampling sites, variables and methods

Two sites were assessed; one on the unvegetated intertidal mudflat north of the lakes's centre and a subtidal location to the west of this mudflat (Figure 8.1 & Table A2.5, Appendix 2). The assessment at the intertidal location was essentially a fine-scale assessment in accordance with the National Estuary Monitoring Protocol (Robertson et al. 2002); a 30 metre by 40 metre site was divided into 12 plots and sampled for selected fine-scale sediment condition indicators – including grain size (texture), nutrient and organic content, and heavy metal and pesticide (DDT) concentrations – as well as benthic (sediment-dwelling) fauna abundance and diversity[5]. At the subtidal site, an Eckman grab sampler was used to obtain three composite sediment samples, with these samples then assessed for the same indicators as the intertidal site[6].

Figure 8.1: Location of the two sediment sampling sites in Lake Onoke (left) and collecting samples from the intertidal location in January 2010 (right)

[5] A sample from each of the 12 plots was sorted and identified for benthic fauna but physical-chemical analyses were only undertaken on three composite sediment samples (each composite comprising several random samples taken within each of four plots).

[6] Only three samples were identified for benthic fauna and physical-chemical analyses were only undertaken on two composite sediment samples.

8.3 Key findings

The results for the selected physical, chemical and biological indicators of estuary condition indicated that the dominant intertidal habitat was in "good" condition; the sediments at the intertidal site were well oxygenated and predominantly sandy (although the mud content was 34.7% in one replicate sample). In contrast, the sediments at the subtidal site were anoxic and sticky, a reflection of the very high mud content (94.6%, Figure 8.2).

Figure 8.2: Intertidal (left) and subtidal (right) sediment cores taken from Lake Onoke in January 2010

Organic carbon and nutrient concentrations were all in the low (organic carbon and nitrogen) to moderate (phosphorus) range, with concentrations highest in the subtidal sediments. Heavy metal concentrations were also highest in the subtidal sediments but still well below the ANZECC (2000) guidelines. The exception was nickel which ranged from 16–18 mg/kg across both sampling sites; the ANZECC (2000) low trigger is 21 mg/kg. DDT was largely undetected in the sediment at both sites.

In terms of the benthic fauna, the intertidal site supported a slightly more diverse fauna (up to eight species per site), with the amphipod *Paracorophium excavatum* the most abundant species present.

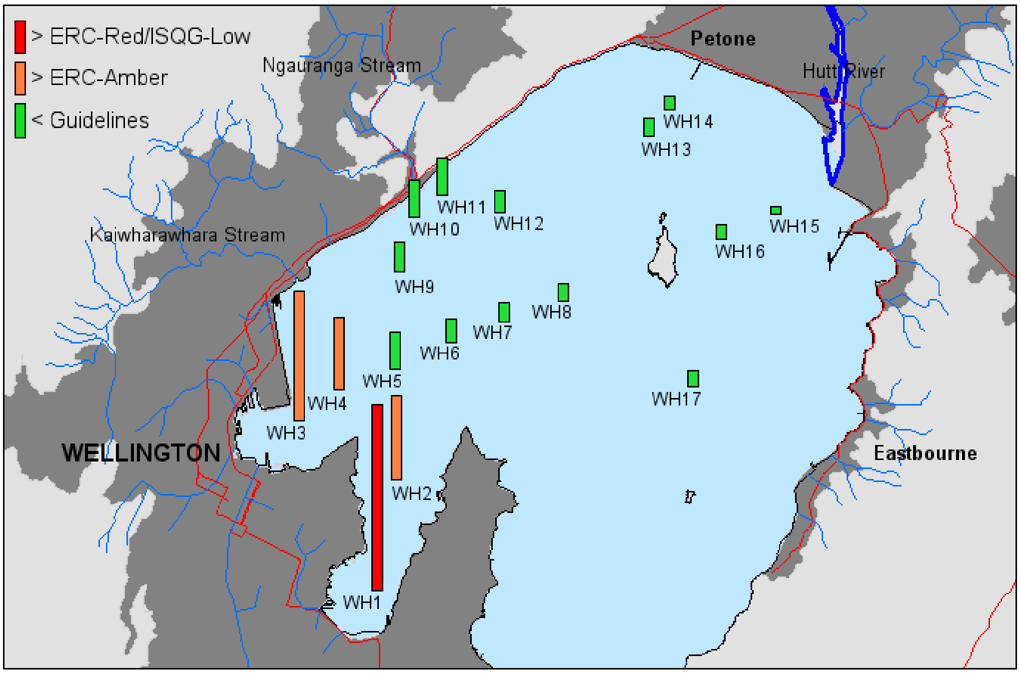
8.4 Future monitoring

Implementation of a long-term monitoring programme for Lake Onoke will be considered following an assessment of water quality monitoring results in 2011.

9. Wellington Harbour sediment quality

9.1 Introduction and background

In late 2006, Greater Wellington carried out an investigation of marine sediment quality at 17 subtidal sites in Wellington Harbour. The results of the investigation – documented in detail by Stephenson et al. (2008) and summarised in the 2007/08 annual coastal monitoring report (Milne 2008) – highlighted that several compounds, including a few heavy metals, polycyclic aromatic hydrocarbons (PAHs) and the pesticide DDT, were present at concentrations above sediment quality guidelines. The highest contaminant concentrations were found in sediment samples from Evans Bay and Lambton Basin (Figure 9.1) and attributed to urban stormwater discharges.



(Source: Stephenson et al. 2008)

Figure 9.1: Mean concentrations of Total High Molecular Weight PAHs in surface sediments of 17 sites sampled in Wellington Harbour in late 2006, based on the <500 µm fraction of five composite samples from each site. Bars coloured amber or red exceed one or more recognised sediment quality guidelines.

9.2 PAH source analysis work

During 2009 and 2010 some further work was carried out (documented in Milne 2010), including analysis of the 2006 sediment samples for a range of alkylated PAHs and marker compounds to assist with identifying the potential source of elevated levels of PAHs in some parts of the harbour. Further statistical analysis of the relationships between sediment contaminant concentrations and the benthic fauna was also carried out.

The results of the PAH source analyses (Depree 2010) were inconclusive but the pyrogenic nature of the PAHs in the harbour sediments indicates that the most likely sources are soot from mobile and/or stationary combustion of fossil fuels, and coal tar from either diffuse pollution (roading) or point sources (discharge of gasworks waste). Of these, coal tar appears to be the most likely source. Although largely unknown as a diffuse pollution source, coal tar was widely used throughout New Zealand between the early 1900s and the mid-1970s as a binder for sealing roads, and would have been used in catchments that discharge into Wellington Harbour (Depree 2010).

9.3 Future monitoring

Further investigative work is required to confirm if the principal source of PAHs is stormwater runoff from catchments containing roading coal tar. This work will be considered in 2011/12 when a second round of sediment contaminant and ecological monitoring – at a subset of the 17 original investigation sites – is undertaken in Wellington Harbour. This second monitoring round will help assess potential long-term trends in PAH (and other contaminant) concentrations in Wellington Harbour sediments with continued discharges of stormwater.

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Appendix 1: Microbiological water quality monitoring sites

Area	Site Name	NZTM co-ordinates		Type
		Easting	Northing	
Kapiti	Otaki Beach @ Surf Club	1778622	5488330	Marine[1]
Kapiti	Otaki Beach @ Rangiuru Road	1778010	5487069	Marine
Kapiti	Te Horo Beach S of Mangaone Stream	1775779	5482478	Marine
Kapiti	Te Horo Beach @ Kitchener Street	1775495	5481933	Marine
Kapiti	Peka Peka Beach @ Road End	1773215	5477905	Marine[1]
Kapiti	Waikanae Beach @ William Street	1771388	5475584	Marine
Kapiti	Waikanae Beach @ Tutere St Tennis Courts	1770655	5474862	Marine
Kapiti	Waikanae Beach @ Ara Kuaka Carpark	1769514	5473978	Marine
Kapiti	Paraparaumu Beach @ Ngapotiki Street	1767543	5472762	Marine
Kapiti	Paraparaumu Beach @ Nathan Avenue	1767033	5472174	Marine
Kapiti	Paraparaumu Beach @ Maclean Park	1766694	5471267	Marine
Kapiti	Paraparaumu Beach @ Toru Road	1766577	5470715	Marine
Kapiti	Paraparaumu Beach @ Wharemauku Road	1766503	5470070	Marine
Kapiti	Raumati Beach @ Tainui Street	1766531	5469229	Marine
Kapiti	Raumati Beach @ Marine Gardens	1766516	5468441	Marine
Kapiti	Raumati Beach @ Aotea Road	1766414	5467529	Marine
Kapiti	Raumati Beach @ Hydes Road	1766318	5466835	Marine[1]
Kapiti	Paekakariki Beach @ Whareroa Road	1765598	5464128	Marine
Kapiti	Paekakariki Beach @ Surf Club	1764791	5462273	Marine
Porirua	Pukerua Bay	1759058[2]	5456278	Marine
Porirua	Karehana Bay @ Cluny Road	1756093	5451360	Marine
Porirua	Plimmerton Beach @ Bath Street	1756706	5450316	Marine
Porirua	South Beach @ Plimmerton	1756810	5449874	Marine
Porirua	Pauatahanui Inlet @ Water Ski Club	1758074	5449593	Marine
Porirua	Pauatahanui Inlet @ Motukaraka Point	1759486	5449338	Marine[1]
Porirua	Pauatahanui Inlet @ Browns Bay	1758039	5447833	Marine[1]
Porirua	Porirua Harbour @ Rowing Club	1754891	5446947	Marine[1]
Porirua	Titahi Bay @ Bay Drive	1754132	5448169	Marine
Porirua	Titahi Bay at Toms Road	1754110	5447857	Marine
Porirua	Titahi Bay @ South Beach Access Road	1753906	5447682	Marine
Porirua	Onehunga Bay	1755796	5449181	Marine
Porirua	Pauatahanui Inlet @ Paremata Bridge	1757153	5448284	Marine
Hutt	Petone Beach @ Water Ski Club	1755744	5434591	Marine
Hutt	Petone Beach @ Sydney Street	1757045	5434248	Marine
Hutt	Petone Beach @ Settlers Museum	1757555	5434056	Marine
Hutt	Petone Beach @ Kiosk	1758326	5433711	Marine
Hutt	Sorrento Bay	1759632	5431384	Marine[1]
Hutt	Lowry Bay @ Cheviot Road	1760206	5430891	Marine
Hutt	York Bay	1759977	5430160	Marine
Hutt	Days Bay @ Wellesley College	1759616	5428529	Marine
Hutt	Days Bay @ Wharf	1759654	5428313	Marine
Hutt	Days Bay @ Moana Road	1759582	5428120	Marine
Hutt	Rona Bay @ N end of Cliff Bishop Park	1759109	5427654	Marine
Hutt	Rona Bay @ Wharf	1758730	5427371	Marine
Hutt	Robinson Bay @ HW Shortt Rec Ground	1758519	5426674	Marine
Hutt	Robinson Bay @ Nikau Street	1758131	5425856	Marine
Hutt	Camp Bay	1756990	5424288	Marine
Wellington	Aotea Lagoon	1748985	5427683	Marine
Wellington	Oriental Bay @ Freyberg Beach	1749920	5427464	Marine
Wellington	Oriental Bay @ Wishing Well	1750118	5427386	Marine
Wellington	Oriental Bay @ Band Rotunda	1750243	5427375	Marine

Area	Site Name	NZTM co-ordinates		Type
		Easting	Northing	
Wellington	Balaena Bay	1750958	5427267	Marine
Wellington	Hataitai Beach	1750632	5425730	Marine
Wellington	Shark Bay	1752211	5426197	Marine[1]
Wellington	Mahanga Bay	1753468	5427115	Marine[1]
Wellington	Scorching Bay	1753517	5426647	Marine
Wellington	Worser Bay	1753074	5424823	Marine
Wellington	Seatoun Beach @ Wharf	1753129	5424234	Marine
Wellington	Seatoun Beach @ Inglis Street	1753405	5423994	Marine
Wellington	Breaker Bay	1753312	5422970	Marine
Wellington	Lyall Bay @ Tirangi Road	1750747	5423230	Marine
Wellington	Lyall Bay @ Onepu Road	1750286	5423116	Marine
Wellington	Lyall Bay @ Queens Drive	1749990	5422868	Marine
Wellington	Princess Bay	1749586	5421504	Marine
Wellington	Island Bay @ Surf Club	1748377	5421590	Marine
Wellington	Island Bay @ Reef St Recreation Ground	1748229	5421542	Marine
Wellington	Island Bay @ Derwent Street	1748155	5421415	Marine
Wellington	Owhiro Bay	1747122	5421463	Marine
Wairarapa	Castlepoint Beach @ Castlepoint Stream	1871366	5467559	Marine
Wairarapa	Castlepoint Beach @ Smelly Creek	1871670	5467202	Marine
Wairarapa	Riversdale Beach @ Lagoon Mouth	1858965	5447543	Marine
Wairarapa	Riversdale Beach Between the Flags	1858435	5446948	Marine
Wairarapa	Riversdale Beach South	1857834	5445514	Marine

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

Appendix 2: Sediment and benthic fauna sampling sites

Table A2.1: Waikanae Estuary intertidal sampling location (Jan 2010)

Sampling Station	NZTM	
	Easting	Northing
Waikanae A	1769248 (Plot 01) 1769261 (Plot 10)	5473364 (Plot 01) 5473355 (Plot 10)

Table A2.2: Porirua Harbour intertidal sampling locations (Jan 2010)

Sampling Station	NZTM	
	Easting	Northing
Porirua A	1756457 (Plot 01) 1756494 (Plot 10)	5447774 (Plot 01) 5447811 (Plot 10)
Porirua B	1754615 (Plot 01) 1754587 (Plot 10)	5445422 (Plot 01) 5445503 (Plot 10)
Pauatahanui A	1757243 (Plot 01) 1757246 (Plot 10)	5448644 (Plot 01) 5448601 (Plot 10)
Pauatahanui B	1760358 (Plot 01) 1760378 (Plot 10)	5448343 (Plot 01) 5448341 (Plot 10)

Table A2.3: Hutt Estuary sampling locations (Jan 2010)

Sampling Station	NZTM	
	Easting	Northing
Hutt A	1759174.1 (Peg 1) 1759174.4 (Peg 2)	5433638.0 (Peg 1) 5433618.1 (Peg 2)
Hutt B	1759369.4 (Peg 1) 1759369.0 (Peg 2)	5434135.8 (Peg 1) 5434116.9 (Peg 2)

Table A2.4: Whareama Estuary intertidal sampling locations (Jan 2010)

Sampling Station	NZTM	
	Easting	Northing
Whareama A	1860703 (Plot 01) 5455343 (Plot 10)	1860684 (Plot 01) 5455338 (Plot 10)
Whareama B	1860084 (Plot 01) 5455318 (Plot 10)	1860067 (Plot 01) 5455294 (Plot 10)

Table A2.5: Lake Onoke sampling locations (Jan 2010)

Sampling Station	NZTM	
	Easting	Northing
Lake Onoke A	5417347 (Plot 01) 5417394	1778353 (Plot 01) 1778314
Lake Onoke B	5417066 5417065	1776978 1776983

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